The ACTRIS TNA activity provides two different types of access:

1. **Physical access:** access of researchers or research teams to any of the 11 advanced experimental atmospheric research stations within Europe (TNA1-11) in the frame of WP7-17 to carry out research projects using the state-of-the-art atmospheric research equipment available at these stations;

2. **Remote access:** access to the AERONET-EUROPE Calibration and Maintenance Centre (TNA12) in the frame of WP18 to allow the calibration and maintenance of AERONET sun photometers at a multi-site European infrastructure (1 installation in France and 2 in Spain).

An overview of TNA provided in the first reporting period (RP1) is given in table 1.5.1. The minimum quantity of access to be provided throughout ACTRIS is: (1) 1620 research-person working days (user days) within WP7-17, and (2) 305 calibrations within WP18, thus, a total of 1925 units of access.

### Table 1.5.1. Summary of transnational access provision per installation in RP1.

<table>
<thead>
<tr>
<th>Part no</th>
<th>WP</th>
<th>Org short name</th>
<th>Short name of infrastructure</th>
<th>Install no</th>
<th>Install short name</th>
<th>Unit of access</th>
<th>Min qty of access</th>
<th>Access prov in RP1</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WP1</td>
<td>CNR</td>
<td>CNR-IMAA Atmospheric Observatory</td>
<td>1</td>
<td>CIAO</td>
<td>1 rwd¹</td>
<td>90</td>
<td>22</td>
<td>-68,0</td>
</tr>
<tr>
<td>2</td>
<td>WP2</td>
<td>CNRS</td>
<td>SIRTA Atmospheric Observatory in Palaiseau</td>
<td>2</td>
<td>PAL</td>
<td>1 rwd</td>
<td>135</td>
<td>37</td>
<td>-98,0</td>
</tr>
<tr>
<td>2</td>
<td>WP3</td>
<td>CNRS</td>
<td>Observatory of Atmosph. Phys. of Réunion Island</td>
<td>3</td>
<td>MAIDO</td>
<td>1 rwd</td>
<td>225</td>
<td>0</td>
<td>-225,0</td>
</tr>
<tr>
<td>4</td>
<td>WP4</td>
<td>UHEL</td>
<td>SMEAR II</td>
<td>4</td>
<td>SMR</td>
<td>1 rwd</td>
<td>165</td>
<td>26</td>
<td>-139,0</td>
</tr>
<tr>
<td>5</td>
<td>WP5</td>
<td>TUD</td>
<td>Cabauw Experimental Site for Atmospheric Research</td>
<td>5</td>
<td>CESAR</td>
<td>1 rwd</td>
<td>170</td>
<td>42</td>
<td>-128,0</td>
</tr>
<tr>
<td>6</td>
<td>WP6</td>
<td>PSI</td>
<td>High Altitude Research Station Jungfraujoch</td>
<td>6</td>
<td>JFJ</td>
<td>1 rwd</td>
<td>185</td>
<td>24</td>
<td>-161,0</td>
</tr>
<tr>
<td>14</td>
<td>WP7</td>
<td>NUIG</td>
<td>Mace Head Atmospheric Research Station</td>
<td>7</td>
<td>MHD</td>
<td>1 rwd</td>
<td>210</td>
<td>286,5</td>
<td>76,5</td>
</tr>
<tr>
<td>15</td>
<td>WP8</td>
<td>NERC</td>
<td>Auchencorth Moss</td>
<td>8</td>
<td>AMO</td>
<td>1 rwd</td>
<td>125</td>
<td>7</td>
<td>-118,0</td>
</tr>
<tr>
<td>16</td>
<td>WP9</td>
<td>FORTH</td>
<td>Finokalia station</td>
<td>9</td>
<td>FKL</td>
<td>1 rwd</td>
<td>110</td>
<td>50</td>
<td>-60,0</td>
</tr>
<tr>
<td>18</td>
<td>WP10</td>
<td>DWD</td>
<td>Hohenpeissenberg Meteorological Observatory</td>
<td>10</td>
<td>HPB</td>
<td>1 rwd</td>
<td>110</td>
<td>0</td>
<td>-110,0</td>
</tr>
<tr>
<td>23</td>
<td>WP11</td>
<td>INOE</td>
<td>National Institute of R&amp;D for Optoelectronics</td>
<td>11</td>
<td>RADO</td>
<td>1 rwd</td>
<td>95</td>
<td>28</td>
<td>-67,0</td>
</tr>
</tbody>
</table>

**Total WP7-17**

| 1620 | 522,5 | -1097,5 |

| 2     | WP18 | CNRS | AERONET-EUROPE calibration center | 12 | LOA | 1 cal² | 150 | 33 | -117,0 |
| 13    | WP18 | CSIC | AERONET-EUROPE calibration center | 13 | IZANA | 1 cal | 70 | 24 | -46,0 |

**Total WP18**

| 305 | 74 | -231 |

**Total TNA**

| 1925 | 596,5 | -1328,5 |

¹ 1 rwd = 1 research-person working day
² 1 cal = 1 calibration per user per year
The actual quantity of access provided in RP1 represents (1) 522.5 users days and (2) 74 calibrations (total of 596.5 units of access). This corresponds to a variation on contract with respect to the overall ACTRIS duration of 32% and 24% (total of 31%), respectively; and to a variation on contract with respect to the first reporting period of 86% and 65% (total of 83%). The quantity of access provided is according to expectations, given the fact that some time was required after the start of the ACTRIS project to organize the activity and launch the call for TNA (done in month 4, cf. Deliverable D1.3). A couple of research stations have not yet provided any access: MAIDO has been newly constructed and is only fully operational since July 2012, currently 3 TNA proposals are ongoing; HBP has issued a special call for access in July 2012 and the TNA is carried out in November 2012 and will be reported as part of the RP2 report.

An overview on the actual number of access provided, the number of users and users projects as well as on user types is given in table 1.5.2. The numbers are presented with reference to those in the Annex I. It should be noted that the reference numbers from Annex I relate to the entire ACTRIS period.

Table 1.5.2. Summary of actual access provided, number of users projects, users, new users, and user types in RP1.

<table>
<thead>
<tr>
<th>WP</th>
<th>IS</th>
<th>Access</th>
<th>User projects</th>
<th>Users</th>
<th>New users</th>
<th>Research status</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min qty wtr</td>
<td>Actual access</td>
<td>User projects</td>
<td>Users</td>
<td>New users</td>
<td>Research status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annexe I</td>
<td>in RP1</td>
<td>variation on contract</td>
<td>est</td>
<td>elig</td>
<td>comp</td>
</tr>
<tr>
<td>WP1</td>
<td>CIAO</td>
<td>90</td>
<td>22</td>
<td>24%</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WP2</td>
<td>PAL</td>
<td>135</td>
<td>37</td>
<td>27%</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WP3</td>
<td>MAIDO</td>
<td>225</td>
<td>0</td>
<td>0%</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WP4</td>
<td>SMR</td>
<td>165</td>
<td>26</td>
<td>16%</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>WP5</td>
<td>CESAR</td>
<td>170</td>
<td>42</td>
<td>25%</td>
<td>9</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>WP6</td>
<td>JFJ</td>
<td>185</td>
<td>24</td>
<td>13%</td>
<td>8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WP7</td>
<td>MHD</td>
<td>210</td>
<td>286.5</td>
<td>136%</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>WP8</td>
<td>AMO</td>
<td>125</td>
<td>7</td>
<td>6%</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WP9</td>
<td>FKL</td>
<td>110</td>
<td>50</td>
<td>45%</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>WP1</td>
<td>HBP</td>
<td>110</td>
<td>0</td>
<td>0%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WP1</td>
<td>RADO</td>
<td>95</td>
<td>28</td>
<td>29%</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total WP1-17</td>
<td></td>
<td>1620</td>
<td>522.5</td>
<td>32%</td>
<td>76</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>WP1</td>
<td>LOA</td>
<td>150</td>
<td>33</td>
<td>22%</td>
<td>150</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>WP1</td>
<td>IZANA</td>
<td>70</td>
<td>24</td>
<td>34%</td>
<td>70</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>WP1</td>
<td>GOA</td>
<td>85</td>
<td>17</td>
<td>20%</td>
<td>85</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Total WP18</td>
<td></td>
<td>305</td>
<td>74</td>
<td>24%</td>
<td>305</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Total TNA</td>
<td></td>
<td>1925</td>
<td>596.5</td>
<td>31%</td>
<td>381</td>
<td>84</td>
<td>83</td>
</tr>
</tbody>
</table>

3 The variation on contract is based on the quantity of access to be provided, the number of projects and users as indicated in the Annex I.
(1) WP7-17:
In RP1, the estimated number of projects is 28 and the estimated number of users is 50, respectively. Overall, 24 proposals were received for TNA to 9 research stations, 23 projects were selected and 20 projects were completed (1 was refused by the selection panel, 1 was postponed to RP2, and 2 projects were cancelled). The 20 projects carried out comprised 57 users (of which 72% were new users, 60% young users, and 25% female users). The number of access provided was 522.5 rwd (research person working days, or user days) vs. 608 rwd expected for RP1 and 1620 rwd for RP1-3, representing 86% and 32%, respectively. The majority of projects involving access of users to the stations received funding or co-funding in form of T&S in order facilitate the TNA (following the review process and decided on a case-by-case basis).

(2) WP18:
In RP1, the estimated number of projects (calibrations) and users is 114 (in the case of this remote access, typically one project represents one user per instrument calibration). Overall, 61 proposals were received to the 3 installations concerned (1 was refused due to ineligibility), thus, 60 calibrations were carried out. This involved 68 users (including users located outside Europe via collaborative research programs), of which 21% were new and 12% female users. The majority of users are (expectantly) experienced researchers (85%) in charge of the instrument and the quality of the data provided. The number of access provided was 74 calibrations vs. 114 calibrations estimated in RP1 and 305 calibrations in RP1-3, representing 65% and 24%, respectively. Contrary to the T&S available to the TNA users, the shipment of the instrument for calibrations must be covered by the users and not support through ACTRIS is available to the transport costs.

Overall, in RP1 84 projects were eligible and 83 projects were selected. The details on the TNA activity per installation are furthermore summarized in the relevant work package descriptions of the periodic report.

Moreover appended to this deliverable are the following documents:

- the list of all TNA user projects carried out in the RP1 (as extracted from the MS Access DB),
- the list of all TNA users involved in the TNA projects in RP1 (MS Access DB),
- the list of panel members (MS Access DB),
- the individual scientific reports following the physical access to the experimental research stations, in alphabetical order (also available on the ACTRIS website: http://www.actris.net/TransNationalAccess/TNAreports/tabid/4689/language/en-GB/Default.aspx).
List of UserProjects
Title
Anthropogenic enhancement of biogenic secondary aerosols

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
Terpene oxidation products contribute to organic condensable material available for growth of aerosols after particle nucleation. Organosulfates of terpenes are of special interest due to their low volatility and as indicators of anthropogenic enhancement of biogenic secondary aerosols. We want to investigate variation in composition and concentration levels of terpene oxidation products and their organosulfates and, with the help of supplementary data, how this composition and concentration is affected by SO2, O3, NOx and the VOCs emitted by the vegetation. This will contribute to understanding the chemical processes involved in the formation of BSOA in the boreal environment and in the processes affecting particles growth as well.

Achievements
We successfully collected 51 samples with the high-volume sampler and 13 samples with the low-volume sampler. We will start the analysis of terpene oxidation products and organosulfates in aerosol samples within the next month. With this study we expect to improve our understanding of the chemical processes involved in the formation of the oxidation products of terpenes and the gas-particle partition of them as well, in a forest environment. This can lead to a better understanding of the cloud formation processes happening over forests and to improve climate change models as well.

Installation Use

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMEAR II</td>
<td>4</td>
<td>SMR</td>
<td>15</td>
</tr>
</tbody>
</table>
Title: Romanian Atmospheric Research 3D Observatory - RADO (Timisoara)

Scientific Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation

Objectives: Development of AERONET in Romania - development of Romanian Atmospheric Research 3D Observatory (RADO) - research and monitoring of atmospheric processes and compounds in the Planetary Boundary Layer

Achievements: Inclusion of Romanian Sunphotometers sites into AERONET - creation of Romanian Atmospheric Research 3D Observatory (RADO) in Bucharest - creation basic infrastructure for research in atmospheric physics

Installation Use

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>12</td>
<td>LOA</td>
<td>1</td>
</tr>
</tbody>
</table>
Title: Calibration of Cimel Radiometer

Objectives: Networks of ground based remote sensing instruments are indispensable for climate monitoring, in particular for the observations of trends. One of the most prominent examples is the AERONET network, providing spectral aerosol optical depths, and information on the microphysical properties of the aerosol particles. As this information is spatially integrated the combination with range resolving measurement techniques is one of the scientific objectives of ACTRIS. Especially the combination with lidar measurements as performed in the frame work of EARLINET is expected to improve aerosol climatologies, both with respect to the accuracy and the number of parameters. These goals can only be achieved if the high quality of the data is ensured. One of the most important steps in this context is the calibration of the radiometers. It can be shown that without a reliable calibration the errors of the retrieved aerosol optical depth and subsequently derived microphysical properties are significantly enlarged. These errors must be avoided in particular, as their influence is changing with the time of the day (dependent on solar zenith angle).

Achievements: Calibration was successfully performed in the calibration center at GOA-UVA, Valladolid, Spain. With the provision of accurate calibration coefficients it is possible to extend the existing activities at the meteorological institute of the Ludwig-Maximilians-universität, München, with respect to monitor the columnar aerosol properties over Munich. This includes primarily the derivation of aerosol optical depths, the Angström coefficient, and microphysical properties as the refractive index, the single scattering albedo, the fine mode fraction of the aerosols and the volume size distribution. These data – with a high accuracy – are indispensable to supplement the aerosol characterization provided by EARLINET measurements (multiwavelength Raman lidar measurements, range resolved data) provided regularly and whenever special events occur (Saharan dust outbreaks, volcanic eruptions), to validate coincident measurements with the spectral radiometer SSARA and to observe the regional heterogeneity of the aerosol distribution by comparing results at the sites in Munich, Maisach and UFS (Zugspitze). The AERONET data are also extremely valuable for the assessment of the potential of ceilometers to provided optical properties of aerosols in a quantitative way. This purpose could only be fulfilled because a precise calibration has been performed.
**Reporting Period**

PRE

**UserProject Acronym**

AEGOA_FI-HEL1-11

**Title**

Characterization of aerosol optical properties over Helsinki

**Scientific Field**

Main Field: Earth Sciences & Environment

Specific Discipline: Global change & Climate observation

**Objectives**

Provide long time series of quality data on atmospheric composition in a sparsely sampled environment in Northern Europe and the Arctic; satellite calibration and validation

**Achievements**

Time series since about 5 years have been used in scientific studies describing atmospheric composition and chemical properties over Finland, transport of pollutants to Finland and the Arctic from elsewhere, validation and evaluation of satellite retrieved aerosol properties and aerosol retrieval algorithm development, comparison with model results.

**Infrastructure Use**

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>1</td>
</tr>
</tbody>
</table>
Title: Ground-based aerosol monitoring at Hyytiala (Finland)

Scientific Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives: Provide long time series of quality data on atmospheric composition in a sparsely sampled environment in Northern Europe and the Arctic; satellite calibration and validation

Achievements: Time series since about 5 years have been used in scientific studies describing atmospheric composition and chemical properties over Finland, transport of pollutants to Finland and the Arctic from elsewhere, validation and evaluation of satellite retrieved aerosol properties and aerosol retrieval algorithm development, comparison with model results.

Installation Use

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>1</td>
</tr>
</tbody>
</table>
Ground-based AOD measurements in Finland

**Scientific Field**

- **Main Field**: Earth Sciences & Environment
- **Specific discipline**: Global change & Climate observation

**Objectives**

At Kuopio we aim at studying atmospheric fine particles and their effects on climate and health. In particular, remote sensing techniques are used to analyze satellite data on atmospheric aerosols. Furthermore, we study the impact of atmospheric particles on radiative transfer as a part of international AERONET and SolRad -Net –networks, and we develop a global UV radiation monitoring and forecasting system. Particles at different heights of the troposphere are examined with lidar measurements.

**Achievements**

- Continuation of good quality AOD data.

**Installation Use**

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
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<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>2</td>
</tr>
</tbody>
</table>
**Title**

Ground-based aerosol monitoring over Finland

**Scientific Field**

*Main Field* Earth Sciences & Environment

*Specific discipline* Global change & Climate observation

**Objectives**

Provide long time series of quality data on atmospheric composition in a sparsely sampled environment in Northern Europe and the Arctic; satellite calibration and validation

**Achievements**

Time series since about 5 years have been used in scientific studies describing atmospheric composition and chemical properties over Finland, transport of pollutants to Finland and the Arctic from elsewhere, validation and evaluation of satellite retrieved aerosol properties and aerosol retrieval algorithm development, comparison with model results.

**Installation Use**

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>1</td>
</tr>
</tbody>
</table>
Title
Atmospheric Aerosols over Ukraine Studied by Combining Ground-Based Measurements and Satellite Data

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
Study spatial and temporal aerosol distributions over Ukraine during 2011-12 using ground-based and satellite (PARASOL) remote sensing methods and establish a long-term open-access database facilitating continuous control of air quality and monitoring of climate changes. Conduct remote measurements of the aerosol optical parameters by passive methods using sunphotometers in Kyiv. The project is supported by French Ministry of Foreigner Affair (DNIPRO project) and NASU.

Achievements
It is expected to significantly improve the knowledge on atmospheric aerosol over this area, that still has poor coverage of ground-based data.

Installation Use

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>1</td>
</tr>
</tbody>
</table>
Atmospheric Aerosols over Ukraine Studied by Combining Ground-Based Measurements and Satellite Data

The project is supported in France by ministry of foreigner affairs and CNRS (Projet DNIPRO – Caractérisation et évolution des aérosols atmosphériques et de l’ozone en Ukraine), CNRS-NASU and CRDF program in the USA.

The main goal of our project is to study spatial and temporal aerosol distributions over Ukraine using ground-based and satellite (PARASOL) remote sensing methods and establish a long-term open-access database facilitating continuous control of air quality and monitoring of climate changes. Conduct remote measurements of the aerosol optical parameters by passive methods using sunphotometers in different regions of Ukraine of special interest as potential sources of aerosol emissions into the atmosphere. The site locations will be chosen to coincide with the sub-satellite ground track of the POLDER/PARASOL spacecraft. Archive the observational data and retrieve the optical and microphysical aerosol characteristics. Collect aerosol optical characteristics determined from PARASOL observations over Ukraine. Create a database of aerosol spatial and temporal distributions over Ukraine.

To maintain observation continuity during the calibration phase (1 to 2 month), we request calibration of a second instrument.

AERONET station at : http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Lugansk&nachal=0&year=20&aero_water=0&if_day=0&year_or_month=1&leve

It is expected to establish a long-term open-access database facilitating continuous control of air quality and monitoring of climate changes. The remote sensing measurements of the aerosol optical parameters by passive methods using sunphotometers in different regions of Ukraine has special interest as potential sources of aerosol emissions into the atmosphere.

<table>
<thead>
<tr>
<th>Installation Use</th>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
<td>14</td>
<td>GOA</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

lundi 26 novembre 2012
Aerosol characteristics over Minsk as seen through combination of Lidar and sunphotometer

**Main Field**  Earth Sciences & Environment

**Specific discipline**  Global change & Climate observation

LOA collaborates for almost 10 years with LOSM laboratory from Academy of science, Belarus. The main goal of the joint research program is to develop methodology to combine lidar and sunphotometer. LOA provide a sunphotometer to LOSM since. The archive available at Minsk site will be used to analyse trends and variability of aerosol. The joint project is supported by CNRS (support to international cooperation in the framework of agreement between CNRS and Belarusian academy of Science).

The main results are the development and validation of joint sunphotometer-lidar inversion. A specific software LIRIC has been developed and presented within JRA -1 ACTRIS and several meetings.

<table>
<thead>
<tr>
<th>Infrastructure Short Name</th>
<th>Installation ID</th>
<th>Installation Short Name</th>
<th>Amount of Access Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERONETEUROPE calibration center</td>
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<td>GOA</td>
<td>1</td>
</tr>
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Caracterisation of aerosols at the Oujda site - contribution to the ChArMEx campaign

**Main Field**
Earth Sciences & Environment

**Specific discipline**
Global change & Climate observation

**Objectives**
ChArMEx (the Chemistry-Aerosol Mediterranean Experiment) program is focused on the Mediterranean basin. The region is under the influence of different aerosol types: dust from Africa, industrial and urban aerosols mainly from Europe, biomass burning and sea-salt. From our side, objectives are (i) to obtain the spatial distribution, (ii) to evaluate the time variability and (iii) to quantify the contribution of the sources, natural versus anthropic. To do so, we set up several AERONET/PHOTONS photometer sites along the Mediterranean basin. Through a cooperation between Lille and Oujda Universities, LOA equipped a site at Oujda, at the border of Algeria and Morocco as a long-term monitoring station.

**Achievements**
The instrument has been deployed in Oujda (at the University) end of 2010 and requires a calibration every year, which has successfully been carried out.

**Installation Use**

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Title
Lidar-sunphotometer synergy for aerosol characterization in Antarctic

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
Field investigation of atmospheric aerosols and thin clouds in Antarctica and their long term trends will be implemented by means of lidar and sun-photometer synergy for estimation of their effect on radiated fluxes formation in the Earth atmosphere-surface system. The joint projet is supported by CNRS (support to international cooperation in the framework of agreement between CNRS and Belarussian academy of Science).

Achievements
The main results are measurements made in Antarctica at the Belarus site. The data are used in the framework of to development and validation of joint sunphotometer-lidar inversion. This campaign contributes to validation of a specific software (LIRIC) by LOA/France and LOSM/Belarus.

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Objectives

This sun photometer is located in an area of special interest since it is almost in the centre of the alpine region, namely South Tyrol, which is characterised by mountainous terrain. Major European transport routes cross the Alps in the area of interest (Brenner highways), representing a strong source of PM and its precursors. Strong gradients of PM (more than 50 µg m⁻³ in 25 km distance) are observed during atmospherically stable conditions (particularly during winter) due to the enhanced topography within valleys which represents a major challenge for both ground and satellite observations. The flat and the highly industrialised Italian Po River valley is situated South of the Alps, known for its high level of atmospheric pollutants (PM10 often higher than 100 µg m⁻³ in winter) is a source of aerosols which are frequently transported northward. This site, is the only Italian site in the Alps and is the only one sited at low altitude in an alpine valley. Its location is crucial because could help to better characterize the aerosol nature in the alpine region and it could help to distinguish between transported and local pollution. Moreover, the data of the sun photometer are used to calibrate the images acquired by the large satellite receiving station located nearby.

Achievements

With this project we characterized the aerosols in Alpine region.

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Title
Aerosol characterization at high latitude using lidar and Cimel sunphotometer

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Other - Earth Sciences

Objectives
As part of a long-term strategy, the Arctic Lidar Observatory for Middle Atmosphere Research (ALOMAR) has in the last seven years established instruments for making measurements in the troposphere. The focus is mainly to study aerosol dynamics and characterization, using instruments such as lidar and sun-photometer. The location of Alomar observatory makes it ideal both as a reference station for almost unpolluted, clean air coming from the north and north-west, and as a site to look at anthropogenic aerosol plumes that are transported from mid-latitudes and into the Arctic region. To obtain quality assured data it is of course crucial to have the Cimel sun-photometer calibrated routinely.

Achievements
The Cimel sun-photometer (part of AERONET and RIMA) and the Alomar Troposphere lidar (part of the European Aerosol Lidar Network, EARLINET) will provide continuous long-term measurements of aerosols in the Arctic that can have relevance to the understanding of climate change. By combining the two remote sensing techniques we aim to enhance the science output.

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Title
Monitoring of greenhouse gases and aerosols at the Zeppelin Observatory, Svalbard, and Birkenes Observatory, Aust-Agder, Norway

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
Since 1991, in commission for the Norwegian Climate and Pollution Agency, NILU is running a programme for monitoring greenhouse gases on Svalbard. In 2010 the monitoring programme was extended to also include the new observations from Birkenes of the greenhouse gases CO2 and CH4 and selected aerosol observations relevant for the understanding of climate change. The AERONET; aerosol depth, measurements from Birkenes are now a part of this programme. Specific objectives are to provide continuous long-term measurements resulting in high quality data that can be used in trend analysis, provide results of aerosol observations of relevance to the understanding of climate change, and indicate source regions with high influence on the measurements. In addition, contribution to the general AERONET Earth-Observation validation data set is anticipated.

Achievements
By this calibration of the Cimel sun-photometer the QA throughout the actual year is guaranteed.

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UserProject Acronym
AEGOA_PT-EVO1-11

Title
AERONET - EVORA

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
* Determine atmospheric aerosol optical depth on climatic scales
* Characterize aerosol optical and microphysical properties according to air mass
* Investigate differences in aerosol properties between coast and inland
* Fulfill AERONET objectives
* Recalibration within 12-month period as requested by AERONET.
* This instrument is used together with 2 other Cimel sun photometers (Aeronet numbers #143, #544) at 2 stations (Évora and Cabo da Roca). The instruments are rotating for calibration. Using 3 instruments for 2 stations has the effect of avoiding measurement gaps due to calibration. For details of the other 2 instruments, see the respective form.

Achievements
We have now data for 9 years at Evora (since June 2003). Thanks to the use of 3 sun photometers at 2 places (Évora and Cabo da Roca) we don't have any more gaps due to calibration of the instruments.

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Title: AERONET - Sunphotometer

Scientific Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation

Objectives:
* Determine atmospheric aerosol optical depth on climatic scales
* Characterize aerosol optical and microphysical properties according to air mass
* Investigate differences in aerosol properties between coast and inland
* Fulfill AERONET objectives
* Recalibration within 12-month period as requested by AERONET.
* This instrument is used together with 2 other Cimel sun photometers (Aeronet numbers #143, #248) at 2 stations (Évora and Cabo da Roca). The instruments are rotating for calibration. Using 3 instruments for 2 stations has the effect of avoiding measurement gaps due to calibration.

Achievements:
This sun photometer is needed for avoiding gaps due to calibration in the time series measured by the AERONET sun photometer at Évora and Cabo da Roca.

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**UserProject Acronym**

AEGOA-PT-CDR1-12

**Title**

AERONET - Cabo da Roca

**Scientific Field**

Main Field: Earth Sciences & Environment

Specific Discipline: Global change & Climate observation

**Objectives**

* Determine atmospheric aerosol optical depth on climatic scales
* Characterize aerosol optical and microphysical properties according to air mass
* Investigate differences in aerosol properties between coast and inland
* Fulfill AERONET objectives
* Recalibration within 12-month period as requested by AERONET.

This instrument is used together with 2 other Cimel sun photometers (Aeronet numbers #143, #248) at 2 stations (Évora and Cabo da Roca). The instruments are rotating for calibration. Using 3 instruments for 2 stations has the effect of avoiding measurement gaps due to calibration.

**Achievements**

We have now data for 9 years at Cabo da Roca (since December 2003). Thanks to the use of 3 sun photometers at 2 places (Évora and Cabo da Roca) we don't have any more gaps due to calibration of the instruments.

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**UserProject Acronym**

AEIZO_FR-LIL-11_001

**Title**
Calibration of master instrument FR-LIL-11_001 for AERONET-EUROPE

**Scientific Field**
- Main Field: Earth Sciences & Environment
- Specific discipline: Global change & Climate observation

**Objectives**
calibration of master instrument FR-LIL-11_001 for LOA and GOA components of AERONET-EUROPE

**Achievements**
calibration of master instrument FR-LIL-11_001 for LOA and GOA components of AERONET-EUROPE

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**Grant Agr. I** 262254  
**Reporting Period** PR1  

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Title: Calibration of master instrument FR-LIL-11_002 for AERONET-EUROPE

Scientific Field: Main Field - Earth Sciences & Environment
Specific discipline - Global change & Climate observation

Objectives: Calibration of master instrument FR-LIL-11_002 for AERONET-EUROPE

Achievements: calibration of master instrument FR-LIL-11_002 for LOA and GOA components of AERONET-EUROPE

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Title: Calibration of master instrument FR-LIL-11_003 for AERONET-EUROPE

Scientific Field:
- Main Field: Earth Sciences & Environment
- Specific discipline: Global change & Climate observation

Objectives: Calibration of master instrument FR-LIL-11_003 for AERONET-EUROPE

Achievements: Calibration of master instrument FR-LIL-11_003 for LOA and GOA components of AERONET-EUROPE

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**UserProject Acronym**

AEIZO_FR-LIL-11_004

**Title**
Calibration of master instrument FR-LIL-11_004 for AERONET-EUROPE

**Scientific Field**
- **Main Field**: Earth Sciences & Environment
- **Specific discipline**: Global change & Climate observation

**Objectives**
Calibration of master instrument FR-LIL-11_004 for AERONET-EUROPE

**Achievements**
calibration of master instrument FR-LIL-11_004 for LOA and GOA components of AERONET-EUROPE

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UserProject Acronym
AEIZO_FR-LIL-11_005

Title
Calibration of master instrument FR-LIL-11_005 for AERONET-EUROPE

Scientific Field
Main Field
Earth Sciences & Environment
Specific discipline
Global change & Climate observation

Objectives
Calibration of master instrument FR-LIL-11_005 for AERONET-EUROPE

Achievements
calibration of master instrument FR-LIL-11_005 for LOA and GOA components of AERONET-EUROPE

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Title
Calibration of master instrument FR-LIL-12_001 for AERONET-EUROPE

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
Calibration of master instrument FR-LIL-12_001 for AERONET-EUROPE

Achievements
calibration of master instrument FR-LIL-12_001 for LOA and GOA components of AERONET-EUROPE

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Calibration of master instrument FR-LIL-12_002 for AERONET-EUROPE

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
Calibration of master instrument FR-LIL-12_002 for AERONET-EUROPE

Achievements
Calibration of master instrument FR-LIL-12_002 for AERONET-EUROPE

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**UserProject Acronym**

**AEIZO_FR-LIL-12_003**

**Title**
Calibration of master instrument FR-LIL-12_003 for AERONET-EUROPE

**Achievements**
calibration of master instrument FR-LIL-12_003 for LOA and GOA components of AERONET-EUROPE

**Scientific Field**

- **Main Field**: Earth Sciences & Environment
- **Specific discipline**: Global change & Climate observation

**Objectives**
Calibration of master instrument FR-LIL-12_003 for AERONET-EUROPE

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Title: Calibration of master instrument FR-LIL-12_004 for AERONET-EUROPE

Scientific Field:
- Main Field: Earth Sciences & Environment
- Specific discipline: Global change & Climate observation

Objectives: Calibration of master instrument FR-LIL-12_004 for AERONET-EUROPE

Achievements: Calibration of master instrument FR-LIL-12_004 for AERONET-EUROPE

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AEIZO_FR-LIL-12_005

Title
Calibration of master instrument FR-LIL-12_005 for AERONET-EUROPE

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
Calibration of master instrument FR-LIL-12_005 for AERONET-EUROPE

Achievements
Calibration of master instrument FR-LIL-12_005 for AERONET-EUROPE

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Title: Calibration of master instrument FR-LIL-12_006 for AERONET-EUROPE

Scientific Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation

Objectives: Calibration of master instrument FR-LIL-12_006 for AERONET-EUROPE

Achievements: Calibration of master instrument FR-LIL-12_006 for AERONET-EUROPE

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Grant Agr. I: 262254

UserProject Acronym: AEIZO_FR-LIL-12_006

Reporting Period: PR1

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**Title**  
Calibration of master instrument FR-LIL-12_007 for AERONET-EUROPE

**Scientific Field**  
*Main Field*  
Earth Sciences & Environment

*Specific discipline*  
Global change & Climate observation

**Objectives**  
Calibration of master instrument FR-LIL-12_007 for AERONET-EUROPE

**Achievements**  
Calibration of master instrument FR-LIL-12_007 for AERONET-EUROPE

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**lundi 26 novembre 2012**
**Title**  
Calibration of master instrument FR-LIL-12_008 for AERONET-EUROPE

**Scientific Field**  
*Main Field* Earth Sciences & Environment  
*Specific discipline* Global change & Climate observation

**Objectives**  
Calibration of master instrument FR-LIL-12_008 for AERONET-EUROPE

**Achievements**  
Calibration of master instrument FR-LIL-12_008 for AERONET-EUROPE

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Title

Advanced exploitation of Ground-based measurements for Atmospheric Chemistry and Climate applications – II (AGACC II)

Scientific Main Field

Earth Sciences & Environment

Specific discipline

Global change & Climate observation

Objectives

One of the objectives of the project (AGACC II) is: To advance our understanding of aerosol characteristics above Brussels and to estimate the aerosol direct radiative forcing above Brussels. Therefore the underlying objectives are - to retrieve more information regarding aerosol properties from remote sensing measurements with Brewer and MAXDOAS spectrometers; - to deploy a lidar ceilometer at Ukkel; - to combine the information from all instruments including those from the CIMEL sun photometer, for a more comprehensive evaluation of the aerosol properties at Brussels; - to derive information about the aerosol sources by modeling with CHIMERE and backtrajectory studies. The second objective is to continue the measurements of the integrated water vapor.

Achievements

- A comparison between the data obtained with the Brewer and Cimel instruments has been done
- A comparison between the measurements of aerosols obtained by the Cimel and the Maxdoas instruments has been done (see paper: Clémer, K., M. Van Roozendael, C. Fayt, F. Hendrick, C. Hermans, G. Pinardi, R. Spurr, P. Wang, and M. De Mazière, Multiple wavelength retrieval of tropospheric aerosol optical properties from MAXDOAS measurements in Beijing, Atmos. Meas. Tech., 3, 863-878, 2010.)
- An analysis of the water vapor with a different instrument is under course (see paper in preparation: Integrated Water Vapour Observations for Climate Change Analysis. Part 1: An inter-technique Comparison, Van Malderen and all.).

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Title
Monitoring of Ozone and Related Trace Gases, UV Radiation and Aerosol Particles in Support of Atmospheric Chemistry and Climate Research (BELATMOS)

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
BELATMOS project contributes to the long-term monitoring of the particle and chemical composition of the Antarctic atmosphere and to the quantification of the UV radiation reaching the surface. The Belatmos aerosol measurements are important to evaluate changes in background concentrations, to understand long-range transport of these particles, and to investigate aerosol-cloud interactions and the aerosol radiative impact in this sensitive region.

Achievements
During the Belgian Antarctic Expedition 2011/2012, in February 2012, the aerosol observatory with all six aerosol instruments was the first time measuring simultaneously (aethalometer, sunphotometer, nephelometer, TEOM-FDMS, laser optical particle counter, U-CPC) at Utsteinen. All instruments were operated successfully. The observations confirm the clean atmosphere in Antarctica, with low AOD values, low total number concentrations, very low BC and total aerosol mass concentrations. The size of the ambient aerosol seemed to be mostly restricted to particles below 1 micrometer, indicating no distinct influence by coastal or marine aerosol. The combination of U-CPC and LAS measurements allowed to derive the number of aerosol particles below 100 nm. The number in this size range appeared to be important, indicating new particle formation events, either of local origin, or transported to Utsteinen. For some days there was a diurnal cycle detectable for the size range below 100 nm. The total number of aerosol particles showed a diurnal cycle behaviour on many days and the overall number concentration declined towards end of February. The spectral dependency of the sunphotometer measurements point, however, to a distinct contribution of particles between 100 and 1000 nm size diameter or larger. However, the sunphotometer observations are done for the whole atmospheric column. In addition, a Brewer ozone spectrophotometer was installed successfully and did very good observations of the total ozone column and the UV irradiation during summers 2010/11 and 2011/12. Total ozone observations are important to follow the evolution and location of the ozone hole during its refilling phase. During austral winter 2012, the aethalometer, the TEOM-FDMS, and partly the laser optical counter, did continuous measurements.

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Title
Sand and Dust Storm Early Warning System in the Magreb Region (SDS-Africa) El Cairo 2011

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Other - Earth Sciences

Objectives
Cairo sunphotometer is part of the Project “Sand and Dust Storm Early Warning System in the Magreb Region” (SDS-Africa), financed by the AECID (“Agencia Española de Cooperación Internacional para el Desarrollo”- Spanish Agency for International Cooperation for the Development) through a World Meteorological Organization (WMO) Trust Fund.

The main goal of this complementary project to the SDS WS for Europe, Africa and Middle East is to establish a ground-based network of sun photometers in selected sites of Northern Africa (Morocco, Algeria, Tunisia and Egypt) to detect and watch dust storms in real time. These stations will be also used for near real time satellite-based sensor validation and calibration, and for dust modelling validation.

Specifically the Cimel at Cairo is used to monitor and characterize anthropogenic aerosols in one of the most important megalopolis in Africa as well as the impact of Saharan dust intrusions into this city.

Cairo is an AERONET station. See [http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cairo_EMA&nachal=2&level=1&place_code=10](http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cairo_EMA&nachal=2&level=1&place_code=10)

Achievements
Aerosol optical properties characterization of a station which is placed in one of the most important megalopolis in Africa which is affected by anthropogenic and Saharan dust aerosols. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.

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Title
Aerosols and radiation monitoring (AELOA_CANCILLO-ES-BAA1-11)

Scientific Field
Main Field  Earth Sciences & Environment
Specific discipline  Global change & Climate observation

Objectives
One of the research lines of our Group- AIRE (Atmósfera, clIMA y Radiación en Extremadura // University of Extremadura) is the study of solar radiation field in the region of Extremadura (Spain). This area presents particular interest for these studies because it receives very high insolation throughout the year.
In this framework, our goal is to describe and predict the solar radiation in terms of all its components: global, diffuse and direct.
The AIRE Research Group operates a radiometric station in Badajoz, the largest city in this region. This station is well equipped with instruments to measure direct, global and diffuse solar radiation. The global and diffuse components of erythemal radiation are also measured, as well as long wave radiation. Besides these broadband instruments, a NILU-UV-6 multichannel radiometer provides information of spectral radiation in the UV interval in five bands.
The characterization of aerosols is achieved by the CIMEL 318 sunphotometer and sky state is determined by a SONA all sky camera.
Our team combines surface and satellite observations with empirical and physically-based models in order to advance in the understanding of the interactions between radiation and atmospheric constituents such as gases, aerosols and clouds, responsible for its attenuation.
For optimum results in this research, it is essential the availability of high-quality data and, therefore all our instruments are periodically calibrated following standardized protocols. In this sense, it is essential to have access to the AERONET-EUROPE calibration services, ensuring that our CIMEL measurements follow the highest calibration standards.

Achievements
The CIMEL sun-photometer has been placed on our station of Badajoz in summer-2012. This instrument complements this well equipped radiometric station, allowing the study of columnar aerosol optical properties in this region of Spain.
Our research group (AIRE) is currently involved in two research projects. Both of them imply the consolidation and implementation of surface stations to measuring total and ultraviolet solar radiation in the southwest of the Iberian Peninsula in order to have long continuous series of high quality measurements of total and ultraviolet solar radiation and their modulating meteorological factors (ozone, cloudiness and aerosols) for a better knowledge of its regional variability in the study area.
Besides the analysis of the measurements obtained, the AIRE Research Group investigates the use of empirical and physically-based models for the estimation of solar radiation at ground level.
The important role played by the atmospheric aerosols in the radiation balance and the complex mechanisms of interaction, still not completely understood, makes this type of studies very interesting in order to advance in a better understanding of the radiative forcing.
In this research line, the AIRE team closely collaborates with several research groups: INTA (National Institute for Aerospace Technology), GOA (Atmospheric Optics Group, University of Valladolid) and GFAT (Grupo de Física de la Atmósfera, University of Granada) in Spain; CGE (Geophysics Centre of Evora) in Portugal and the University of Tasmania in Australia.

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Title Link between AERONET and GAWPFR networks

Scientific Main Field Earth Sciences & Environment
Field

Specific discipline Global change & Climate observation

Objectives The World Optical depth Research and Calibration Center (WORCC) is a section of the World Radiation Center (WRC) at Davos, serving as the primary reference for AOD measurements for the World Meteorological Organization (WMO). WORCC operates a global AOD baseline network for the Global Atmosphere Watch (GAW) programme of WMO.

WORCC regularly conducts intercomparisons of instruments representing national or international AOD networks like AERONET/PHOTONS in order to establish a global traceability of AOD measurements.

With AERONET/PHOTONS being the largest network by far, it is important for WORCC to establish cooperation with this network by maintaining a representative instrument at Davos. A CIMEL radiometer is operated at PMOD/WRC since October 2005, and was repeatedly calibrated by the PHOTONS facilities at the Laboratoire d’Optique Atmosphérique of the Université de Lille 1.

Achievements The PHOTONS #354 instrument has participated in 2 international and several smaller intercomparisons of filter radiometers held at Davos since 2005. The additional data products derived from this instrument are frequently used to support WORCC and WRC calibration activities.

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Title: Monitoring of columnar aerosol properties over the Caribbean sea

Scientific Field:
  Main Field: Earth Sciences & Environment
  Specific discipline: Global change & Climate observation

Objectives:
The aerosol measurements in Camagüey (Cuba) are carried out in cooperation with the Cuban Meteorological Institute, with which the University of Valladolid has an official agreement. Several projects regarding columnar aerosol properties, radiation and clouds and in situ aerosol measurements are carried out. The Cimel sun photometer at Camagüey, included in AERONET since 2008, is a key instrument in these investigations. Furthermore, the calibration of this site would not be possible to be done at NASA due to political restrictions. The objective is to characterize the aerosol properties in the region, with emphasis on the properties of long-range transported Saharan dust.

Achievements:
First results about aerosol observations in Camagüey have been presented at several conferences (Barja et al., 2011; Estevan et al., 2011), including columnar and in situ aerosol properties (mass, absorption).

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Objective

We operate this system in Büsum and a second on Helgoland as contribution to the world-wide aerosol monitoring in the framework of AERONET and PHOTON. Our specific emphasis is here on coastal gradients in the aerosols optical characteristics. For the coastal station we are also interested to study polarisation effects. The measurement results are used by ourselves primarily for improvement of atmospheric corrections for optical satellite measurements in complex coastal areas.

Achievements

improvement of atmospheric corrections

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Title

Calibration of a dual polar sun photometer of IfT for worldwide aerosol characterization

Scientific Field

Main Field

Earth Sciences & Environment

Specific discipline

Global change & Climate observation

Objectives

Currently the characterization of the urban pollution and transported particles that contribute to the local particle load over the megacity Guangzhou in southern China is the short-term objective. With polarized measurements by a lidar and a sun photometer we gain more optical information about the particles and can improve the derivation of optical and microphysical properties. Medium and long term objectives are the characterization of particles in Europe and in the plume of the Saharan dust over the northern Atlantic towards the Caribbean and South America.

Achievements

We present a dataset of simultaneous lidar depolarization profiles and sun photometer polarization measurements by a dual-polar instrument. The data were taken in southern China during the Megacities campaign from October 2011 to June 2012. The mean values for the background urban aerosol measured by the sun photometer are an aerosol optical depth (AOD) of 0.45 and an Ångström exponent of 1.33. The lidar depolarization ratio has typical values of urban pollution below 5% and the degree of linear polarization (DOLP) measured by the dual-polar sun photometer shows no specific wavelength dependence for urban background particles.
Title: FZI-JOYCE CE318 calibration

Scientific Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation

Objectives: JOYCE (Jülich Observatory for Cloud Evolution) is a new state-of-the-art platform for cloud research currently set-up at Forschungszentrum Jülich (FZJ) in cooperation between Institute for Energy- and Climate Research of FZJ and University of Cologne, Institute of Geophysics and Meteorology. The main target is the investigation of cloud formation, cloud evolution and cloud/radiation interaction by remote sensing instruments combined with solar and terrestrial radiation measurements to improve the prediction of clouds and precipitation in weather and climate models. JOYCE is designed for long-term observations and also contributes to Transregio 32, a research programme implemented at DFG on exchange processes between soil, vegetation and the atmospheric boundary layer. Key instruments of JOYCE are a Doppler radar operating at 36 GHz for the observation of 3D cloud structures and a scanning microwave detector for the measurement of profiles of temperature, liquid and gaseous water. These instruments are combined with a number of further active (Ceilometer, Doppler-Wind LIDAR, Micro rain radar) and passive instruments (infrared radiance interferometer, sun-photometer, total sky imager, solar- and terrestrial radiation sensors) for continuous observation of the state of the atmosphere. JOYCE is also closely linked to ongoing research of atmospheric photolysis processes through measurements of spectral actinic flux densities that are strongly influenced by clouds and aerosols. The provision of aerosol and cloud information from the remote sensing instruments will open the possibility to validate existing radiation transport models with onsite measurements. Quality assured sunphotometer measurements within the AERONET will strongly support these activities.

Achievements: The new CIMEL instrument was calibrated successfully and installed at FZJ. It is operative since end of June 2012. Raw data are submitted continuously to AERONET and evaluated on a daily basis. Measurements and data analysis together with other instruments at the JOYCE installation are ongoing throughout the year.
Title: Saharan Air Layer Analysis and Monitoring (SALAM)

Objectives:

In 2006 the Tamanrasset-Izaña “GAW-Twining” SALAM (Saharan Air Layer Air Mass characterization) project was initiated. This is part of a cooperation program between the “Office National de la Météorologie” (ONM, Algeria) and the former INM (now AEMET). In September 2006 was installed the AERONET and PHOTONS / RIMA Tamanrasset-INM Cimel station (see http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Tamanrasset_INM&nachal=2&level=1&place_code=10)

Tamanrasset station is located in a strategic site, in the core of the Sahara. This project has the following objectives:
1. Monitoring and characterization of the Saharan Air Layer near dust sources.
2. Validation of regional and global dust models.
3. Validation of satellite-based dust measurements over high reflectivity ground conditions.
4. Enhance the dust early warning system in Northern Africa.

Concerning the last objective this station is now also part of the Project “Sand and Dust Storm Early Warning System in the Magreb Region” (SDS-Africa).

Achievements:

Aerosol optical properties characterization of a station representative of pure desert dust. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.

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Title  Western Mediterranean Aerosol

Scientific Field  Main Field  Earth Sciences & Environment
Specific discipline  Global change & Climate observation

Objectives  One of the main objectives of this project is the characterization of aerosol optical and physical properties over Mediterranean Sea; one of the more climatically sensitive regions of the world with regard to aerosol effects. To accomplish this objective, we propose to install sun photometer CIMEL in Alborán Islet in the western Mediterranean Sea (35º 56´ 42´´ N, 3º 2´ 12´´ W). The location of Alborán Islet between African and European continents and the no presence of local anthropogenic aerosol sources in the site can offer us an excellent opportunity to identify and characterize distinct aerosol types originated from the different sources surrounding the Mediterranean sea. This will help as to understand the extent to which continental aerosols, both natural and anthropogenic, can be transported over the Mediterranean and to characterize the meteorological processes that are responsible for such transport. In addition, the measured aerosol data can allow us to fill up a gap in the knowledge of aerosol properties over the Mediterranean Sea and permit as the validations of satellite aerosol product and aerosol transport models as well as the evaluation of the aerosol models currently used for atmospheric corrections.

Achievements  The instrument will be installed in the next weeks, once the arrangements with the Spanish Army, in charge of the logistic in Alboran Island, will be completed. Data from the 2011 summer will be processed by AERONET in the next months.

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Title
Monitoring of columnar aerosol properties over southwestern Spain

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
The aerosol measurements at Huelva site started in 2010 although the aerosol monitoring within AERONET in this area (old site El Arenosillo) started in 2000 and constitute the longest dataset of columnar aerosol properties in the Iberian Peninsula. The site “Huelva” is located just by the Donana national park and is run in collaboration with the University of Huelva. The instrument is installed in CIECEM, which is an Institute with an aerosol monitoring station equipped with in situ instrumentation (PM10, PM2.5, TSP, filter sampling for chemical analysis, etc.). The objective is to continue the characterization of the aerosol properties in the region, after the 10-year dataset at El Arenosillo (only 16km away), with emphasis on the properties of Saharan dust events and synergy with the in-situ aerosol properties.

Achievements
It has been observed a reduction in the industrial aerosol frequency with respect to the former site El Arenosillo. We expect to provide assessment of the in situ properties in comparison with the columnar (sun photometer) retrievals.

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**Title**
Global Atmospheric Watch (GAW) Izana

**Scientific Field**

- **Main Field**: Earth Sciences & Environment
- **Specific Discipline**: Other - Earth Sciences

**Objectives**
The Izaña Atmospheric Observatory is a Global Atmospheric Watch (GAW) station of global importance (see [http://gaw.empa.ch/gawsis/reports.asp?StationID=7](http://gaw.empa.ch/gawsis/reports.asp?StationID=7)).

Optical properties with the AERONET Cimel sunphotometer is part of the long-term aerosol GAW program. AOD and Alfa are routinely compared with GAW Precision Filter Radiometer (GAW-PFR) managed by the World Radiation Center (WRC).

Izana is an AERONET station. See [http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Izana&nachal=2&level=3&place_code=10](http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Izana&nachal=2&level=3&place_code=10)

**Achievements**
Lunar photometer prototype validation Near real time comparison to Precision Filter Radiometer (GAW-PFR) Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) Comparison with MACC-ECMWF reanalysis

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Title: Vertical Profiling of microphysical properties of the atmospheric aerosol

Scientific Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation

Objectives: The aim of this project is to contribute to the advancement of the atmospheric aerosol research, particularly to increase our knowledge on its radiative forcing contribution. For this purpose a complete observational program is proposed to extend existing monitoring capabilities to spectral dependence of the aerosol absorption, the vertical profiling of aerosol microphysical properties. These profiles are used for the computation of radiative forcing and changes in the atmospheric heating rates. One of the various objectives of this project is to make continuous measurements of aerosol physical and optical parameters by Sun Photometer CIMEL at Sierra Nevada mountain in South-Eastern Spain (37° 6’ N, 3° 28’ W, 1830 m asl). This high altitude background station is about 15 km from Granada experimental station (located in the valley, 680 m a.s.l) where different instruments are operated. The simultaneous measurements over both stations allow us to follow changes in the aerosol properties in the atmospheric column with low cost compared to aircraft measurements and studying the aerosol properties of anthropogenic particles injected by mountain-valley breeze winds into the lower free troposphere. In addition, high mountain site measurements can permit identifying the natural and anthropogenic sources of aerosols transported over long distances (i.e. desert dust, biomass burning smoke from large fires, regional-scale hazes of combustion aerosols, anthropogenic particles). Furthermore, aerosol data obtained at Sierra Nevada station can be used as constraints for Lidar measurements made at Granada station and for evaluating the microphysical aerosol properties at high altitude retrieved from Lidar measurements.

Achievements: At the moment the instrument is running at the site and data acquired in 2011 summer are waiting to be processed by AERONET.
Title
Global Atmospheric Watch (GAW) - SCO1

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Other - Earth Sciences

Objectives
The Izana Atmospheric Observatory is a Global Atmospheric Watch (GAW) station of global importance (see http://gaw.empa.ch/gawsis/reports.asp?StationID=7). Santa Cruz de Tenerife is an AERONET station. See http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Santa_Cruz_Tenerife&nachal=2&level=3&place_code=10 Optical properties with the AERONET Cimel sunphotometer are part of the long-term aerosol GAW program.

Achievements
AOD from Cimel sun photometer used as a continuously constrainst for derivating the aerosol extinction coefficient profiles obtained from Micro-pulsed Lidar measurements. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis. One month campaign of comparison with a PREDE sun photometer.

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Title: Global Atmospheric Watch (GAW) Santa Cruz

Scientific Main Field: Earth Sciences & Environment
Specific discipline: Other - Earth Sciences

Objectives: The Santa Cruz de Tenerife Station is a complementary facility of the Izaña GAW station to provide information of background urban pollution for atmospheric research within Urban Research Meteorology and Environment (GURME) and to perform complementary measurement programs to those performed at the Global GAW Izaña station (see http://gaw.empa.ch/gawsis/reports.asp?StationID=-739518870).

Achievements: AOD from Cimel sun photometer used as a continuously contrainst for derivating the aerosol extinction coefficient profiles obtained from Micro-pulsed Lidar measurements. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis. One month campaign of comparison with a PREDE sun photometer.

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AELOA_LOR-ES-MON1-11

**Title**
Analysis of the optical, chemical and physical properties of the aerosols at a continental background site (El Montsec)

**Scientific Field**
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

**Objectives**
The instrument is located on the roof of a measurement unit of the Network for monitoring and forecast pollution of the Generalitat de Catalunya equipped with different gas analysers (SO2, NOx, CO and O3). At the same unit, the Institute of Environmental Assessment and Water Studies (IDAEA-CSIC) has installed some aerosol monitoring equipment to measure real-time levels of PM10, PM2.5 and PM1 and black carbon. As a complementary data, the Meteorological Service of Catalonia has a wide variety of meteorological instruments to measure wind components, temperature, humidity, precipitation and global solar radiation. The station is located far from polluted areas, so the aerosol sources are natural and it is affected by long-range transport of Saharan dust particles. It is considered a continental background site. The altitude of the station avoids any horizon obstruction. The station of El Montsec is a complete station with optical and granulometric measurements, so it is possible to relate aerosol optical properties with aerosol particulate concentrations under different meteorological conditions and air masses. Additionally, the wide variety of measurements and the characteristics of the location make the station a good site for the validation of satellite-based estimations of particulate matter concentrations.

**Achievements**
We are working on the characterization of the aerosol relating the optical properties with the meteorological conditions and the air masses. The results will be compared to the levels of particulate matter (PM10 and PM1). Additionally, the study is considering the effect of the longwave radiative processes of the aerosols on the energy budget.

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**Continuation**

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Reporting Period

UserProject Acronym

AELOA_MA-OUA1-11_yyy

**Title**

Sand and Dust Storm Early Warning System in the Magreb Region (SDS-Africa)

Ouarzazate

**Objectives**

Ouarzazate sunphotometer is part of the Project “Sand and Dust Storm Early Warning System in the Magreb Region” (SDS-Africa), financed by the AECID (“Agencia Española de Cooperación Internacional para el Desarrollo”; International Cooperation Agency for the Development of Spain), through a World Meteorological Organization (WMO) Trust Fund.

The main goal of this complementary project to the SDS WS for Europe, Africa and Middle East is to establish a ground-based network of sun photometers in selected sites of Northern Africa (Morocco, Algeria, Tunisia and Egypt) to detect and watch dust storms in real time. These stations will be also used for near real time satellite-based sensor validation and calibration, and for dust modelling validation.

Specifically the Cimel at Ouarzazate is used to monitor and characterize Saharan dust intrusions into this city.

The Cimel at Ouarzazate station was for first time installed after AERONET-Europe calibration.

**Achievements**

Aerosol optical properties characterization of a station which is placed in the north-west border of the Sahara desert. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.

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Title
CIMEL

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
CESAR Observatory is a unique site. Although other atmospheric observatories exist worldwide, only a few are as well-instrumented as CESAR. An important advantage of the site is its location: both close to the sea and to some of the major European industrial and populated areas. This location leads to a large variety of air mass types at the site. Other advantages are its long term dataset of advanced parameters, the coinciding location of the different instruments, and the area around the site, which is flat and therefore easier to model. These advantages have made the observatory very appealing to the international scientific community. International research groups aiming at targeted measurement campaigns are attracted by the complete set of observations continuously available at CESAR. The CIMEL is one of the continuously operated instruments that is often used in studies, e.g. studies on radiation closure, aerosol partitioning, validation of satellite products or ground-based remote sensing instruments. By calibration of the CIMEL sun-photometer the QA throughout the actual year will be guaranteed.

Achievements
Calibration succesfull.

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Title  
Messina station, Italy

Scientific Field
Main Field  
Earth Sciences & Environment

Objectives
The Messina sunphotometer is of interest both for remote sensing studies devoted to investigate and quantitatively map the active optical parameter of Messina Straits Case1 waters, and to be used as an additional station, located at sea level, to compare the Thala and Lampedusa AOT reading. With Messina installation, including Thala (Lybia), Lampedusa (Italy) and the new station of Messina (Italy), a clearer dynamic of the sand dust could be so reconstructed. Moreover, Sicily there is also Etna station, but it is mainly useful for measurements of volcano plumes and is not lying at the sea level. Therefore, calibration activities are mandatory to sustain the site operational

Achievements
The Messina site allowed to e better atmospheric characterization suitable to improve the remotely sensed data calibration. Experiences has been performed with airborne campaign and by using satellite data

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**Title**

Sand and Dust Storm Early Warning System in the Magreb Region (SDS-Africa) El Cairo 2011 Rep

**Scientific Field**

Main Field: Earth Sciences & Environment  
Specific discipline: Other - Earth Sciences

**Objectives**

Cairo sunphotometer is part of the Project "Sand and Dust Storm Early Warning System in the Magreb Region" (SDS-Africa), financed by the AECID (Agencia Española de Cooperación Internacional para el Desarrollo; International Cooperation Agency for the Development of Spain), through a World Meteorological Organization (WMO) Trust Fund.

The main goal of this complementary project to the SDS WS for Europe, Africa and Middle East is to establish a ground-based network of sun photometers in selected sites of Northern Africa (Morocco, Algeria, Tunisia and Egypt) to detect and watch dust storms in real time. These stations will be also used for near real time satellite-based sensor validation and calibration, and for dust modelling validation.

Specifically the Cimel at Cairo is used to monitor and characterize anthropogenic aerosols in one of the most important megalopolis in Africa as well as the impact of Saharan dust intrusions into this city.

Cairo is an AERONET station. See [http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cairo_EMA&nachal=2&level=1&place_code=10](http://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_opera_v2_new?site=Cairo_EMA&nachal=2&level=1&place_code=10)

**Achievements**

Aerosol optical properties characterization of a station which is placed in one of the most important megalopolis in Africa which is affected by anthropogenic and Saharan dust aerosols. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.

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**Title**  
Characterization of aerosol optical and microphysical properties above Magurele-Bucharest, Romania

**Scientific Field**  
*Main Field*  
Earth Sciences & Environment  
*Specific discipline*  
Global change & Climate observation

**Objectives**  
Regular calibration within 12-month period as requested by AERONET. In the context of regional climate change and air quality, the project goal is to study aerosol loading, its variability and trends over a sub-urban region of Bucharest, Romania. Aerosol products by AERONET sun-sky radiometer measurements combined with air-mass backtrajectories are going to be analyzed in order to identify source regions and pathways of air masses carrying aerosols to south-east Romania, and to determine the dependence of aerosol mean optical properties on advection patterns. Aerosol Raman lidar observations of particle extinction and backscatter coefficients at 532nm are going to be used in combination with Sun photometer observations of the particle optical depth at eight wavelengths from 340-1020nm to fully characterize column-integrated microphysical properties of boundary-layer aerosol such as volume and surface concentrations, effective radius, refractive index, and single scattering albedo.

**Achievements**  
Better lidar inversion products, better studies related to aerosol characterisation, more publications in Journals

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Reporting Period
PR1

UserProject Acronym
AELOA_RO-CLJ1-12

Title
Romanian Atmospheric research 3D Observatory - RADO (Cluj)

Continuation
N

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Other - Environment

Objectives
The instrument is a member of the Romanian Atmospheric research 3D Observatory (RADO) is a state-of-the-art facility at national level (and so far unique in SE Europe), dedicated to research and monitoring of atmospheric processes and compounds in the Planetary Boundary Layer and Free Troposphere.

Achievements
The CLUJ UBB AERONET site is functioning since July 2010 as #643. The current infrastructure is opened to developing new projects and ideas which explore all atmospheric-related phenomena, including the interactions of the Atmosphere with Land, Hydrosphere and Biosphere.

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Title

Variability of the aerosols' microphysics and optical properties at North Eforie, Romania

Scientific Field

Main Field  Earth Sciences & Environment

Specific discipline  Other - Earth Sciences

Objectives

The knowledge of aerosol microphysics and optical properties provides the understanding of aerosols’ role in the air quality and climate.

Therefore, the objectives of the project are:
- to have correct measurements of columnar aerosol using sun-photometer (so, care of calibration and maintenance of the sun-photometer);
- to determine the spectral aerosol optical depth (AOD) daily variation and parameters such as the coarse aerosol fraction (fc), fine (ff), Ångström exponent and single scattering albedo ( ) in conjunction with meteorological parameters like the wind speed (v) and humidity;
- to determine turbidity which characterizes the air masses and consequently air quality;
- to study the aerosols’ effects;
- to determine surface radiative forcing of the aerosols, using optical properties;

Achievements

- data base with spectral aerosol optical depth (AOD), Ångström exponent and single scattering albedo;
- publications (Intercomparison between the continental and marine AOD, using sunphotometer measurements, 2012)

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Continuation

N
Title: Romanian Atmospheric research 3D Observatory - RADO

Scientific Field: Earth Sciences & Environment

Specific discipline: Other - Environment

Objectives: The current infrastructure is opened to developing new projects and ideas which explore all atmospheric-related phenomena, including the interactions of the Atmosphere with Land, Hydrosphere and Biosphere: tropospheric measurement of a large variety of chemical compounds (including toxic elements like mercury or lead), chemical transformations, evidenced their physico-chemical properties influences upon the self-organization space charges induced light phenomena, temperature, humidity, pressure and mixture gas influences upon the change regional weather, ice nucleation-organic compound freezing influences, storms, health and climate changes. This station is part of the Optical Atmosphere, Spectroscopy and Lasers (LOA-SL), Faculty of Physics, Alexandru Ioan Cuza University of Iasi [see: (http://spectroscopy.phys.uaic.ro]

Achievements: The project proposes both to monitoring, diagnosis and quantification of air pollutants, theirs influences upon both health and climate change, to establish the strategies to reduce their concentration and prevent their harm in terrestrial ecosystems but also to improve some field remote spectral technology in order to study various atmospheric phenomena: storms, lighting and plasma gas mixture discharge, laser-condensed matter interaction, etc. To control the quality of air pollutants, several key air pollutants both composition and physico-chemical transformation are measured and monitored offline (laser-condensed matter mass spectroscopy desorption) and also online (spectral tele-monitoring of the atmosphere like as complex dynamic and self-organizing system) which is built for the management of air quality and relationship with the human health, etc).

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UserProject Acronym
AELOA_TN-THA1-11

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<td>Objectives</td>
<td>Thala sunphotometer is part of the Project “Sand and Dust Storm Early Warning System in the Magreb Region” (SDS-Africa), financed by the AECID (“Agencia Española de Cooperación Internacional para el Desarrollo”; International Cooperation Agency for the Development of Spain), through a World Meteorological Organization (WMO) Trust Fund. The main goal of this complementary project to the SDS WS for Europe, Africa and Middle East is to establish a ground-based network of sun photometers in selected sites of Northern Africa (Morocco, Algeria, Tunisia and Egypt) to detect and watch dust storms in real time. These stations will be also used for near real time satellite-based sensor validation and calibration, and for dust modelling validation. Specifically the Cimel at Thala will be used to monitor and characterize the impact of Saharan dust intrusions into this city.</td>
</tr>
<tr>
<td>Achievements</td>
<td>Aerosol optical properties characterization of a station which is placed in the north border of the Sahara desert. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.</td>
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Title
Sand and Dust Storm Early Warning System in the Magreb Region (SDS-Africa) Thala 2012

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Other - Earth Sciences

Objectives
Thala sunphotometer is part of the Project “Sand and Dust Storm Early Warning System in the Magreb Region” (SDS-Africa), financed by the AECID (“Agencia Española de Cooperación Internacional para el Desarrollo”; International Cooperation Agency for the Development of Spain), through a World Meteorological Organization (WMO) Trust Fund.

The main goal of this complementary project to the SDS WS for Europe, Africa and Middle East is to establish a ground-based network of sun photometers in selected sites of Northern Africa (Morocco, Algeria, Tunisia and Egypt) to detect and watch dust storms in real time. These stations will be also used for near real time satellite-based sensor validation and calibration, and for dust modelling validation.

Specifically the Cimel at Thala will be used to monitor and characterize the impact of Saharan dust intrusions into this city.

Thala station is still pending for installation.

Achievements
Aerosol optical properties characterization of a station which is placed in the north border of the Sahara desert. Near real time validation of dust models within WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Comparison with MACC-ECMWF reanalysis.

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**Title**
Effect of aerosols on solar energy utilization

**Scientific Main Field**
Earth Sciences & Environment

**Specific discipline**
Global change & Climate observation

**Objectives**
Short and medium term objectives: Aerosol properties are very relevant for the calculation of direct irradiance, which is the resource for concentrating solar power (CSP) plants. The uncertainties of aerosol data cause uncertainties in the calculation of DNI which has to be reduced. Providing measurements to the community increases these Aerosols are the most relevant atmospheric scatterers beside clouds. Thus they are relevant for circumsolar radiation. The exact understanding of circumsolar radiation is required for performance analysis of CSP. Long term objectives: For the analysis of the atmospheric boundary layer LIDAR systems can be used. For the calibration of LIDAR instruments sun photometric measurements will be used. Analysis of the influence of aerosols on irradiimeter calibration using the sun as light source.

**Achievements**
Aeronet data can be used to model circumsolar radiation and DNI for cloudless skies.


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UserProject Acronym
AELOA-BALDASANO-ES-B

Title
Investigate on aerosol types and its influence on regional meteorological processes

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
In the Barcelona greater urban area, we found industrial activities and big highways. Its location, together with its surrounding orography contributes to the complexity of the dispersion of pollutants in the region. Due to its location in the Mediterranean basin, Barcelona is influenced by two major aerosol source regions: Europe and the Western Mediterranean Basin, as a major source of anthropogenic pollutants, and North Africa, as a principal source of natural dust. The African dust outbreaks occur mainly in spring and last summer-autumn. The local aerosol sources are mainly heavy traffic together with the re-suspension of the material available on the ground, especially during the warm season when the reduced rainfall and soil dryness can increase the contribution of local mineral dust. Taking into account all the above considerations, the composition of atmospheric aerosols in Barcelona station is a mixing of aerosols and the proportion of aerosols in this area could vary as a function of local anthropogenic emissions, trade winds intensity, regional and local re-circulations, African dust contributions and sea spray.

Thus, the Barcelona AERONET site is key localization for the detection of desert dust in the Eastern Iberian Peninsula and it is routinely used in the daily verification of the forecast products of the BSC-DREAM8b mineral dust model (http://www.bsc.es/projects/earthscience/DREAM/). Additionally, Barcelona site is part of SolRad-Net (http://solrad-net.gsfc.nasa.gov/), MPLNet (mplnet.gsfc.nasa.gov/) and EARLINET (www.earlinet.org/) networks. This set of instruments provides an opportunity to investigate the presence for different aerosol types and its influence on regional meteorological processes.

Achievements
This set of instruments provides an opportunity to investigate the presence for different aerosol types and its influence on regional meteorological processes.
LIDAR, sunphotometer and satellite data were used to analyze Eyjafjallajökull ash.

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lundi 26 novembre 2012
Title

Fennec: the Saharan Climate system

Scientific Field

Main Field
Earth Sciences & Environment

Specific discipline
Global change & Climate observation

Objectives

The Cimel instrument from the Aeronet site in London was temporarily deployed as Aeronet station Bordj Badj Moukthar (BBM) in southern Algeria under the project Fennec. It is now being re-deployed in London but first requires calibration. Fennec: the Saharan climate system This is an international project (UK, France, Germany, USA, Algeria, Morocco, Mauritania) to measure aerosol-climate processes in the central Sahara. The central Sahara has one of the most extreme climates on Earth characterised by the highest aerosol loading on the planet and the Saharan heat low (SHL).

Achievements

Prior to Fennec there were no observations from this region. During the Fennec IOP in June 2011 we obtained a new and unique dataset for the central Sahara and surrounding regions including ground, air and satellite observations, targeted to improve the representation of this area, and its influences on a wider scale, in NWP and climate models. The BBM aeronet station was a central component of this.

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Title
Aerosol direct Radiative Effect based on LIdar and Sunphotometer measurements in an Eastern European AERONET/EARLINET Site

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Other - Environment

Objectives
The objective of this project is characterization of aerosol optical properties and assessment of aerosol shortwave direct radiative forcing and heating rates, in case of different airmasses at AERONET/EARLINET site in Bucharest. Particular emphasis is given to investigating the sensitivity of aerosol radiative forcing to vertical profile of aerosol extinction. For that purpose, co-located CIMEL sunphotometer, lidar and aerodynamic particle sizer (APS) have been used as complementary instruments. The possibility of synergetic use of the lidar and sunphotometer measurements will be tested, as it requires testing the sensitivity of the output parameters to various known problems, such as operating time (Raman lidar: nighttime, sunphotometer: daytime), lidar overlap, pointing direction, etc. We focus on the analysis of aerosol optical properties necessary for estimating aerosol radiative effects. Vertically integrated aerosol optical properties (aerosol optical depth, single scattering albedo and asymmetry parameter) have been obtained from the sunphotometer measurements, while lidar measurements are used to derive vertical profile of aerosol extinction coefficient. The possibility of synergetic use of the lidar and sunphotometer measurements will be tested, as it requires testing the sensitivity of the output parameters to various known problems, such as operating time (Raman lidar: nighttime, sunphotometer: daytime), lidar overlap, pointing direction, etc.

Achievements
The training on lidar operation and data processing has been provided to us at the beginning of our stay at RADO. We were introduced to challenges in processing of lidar data, as well as to ways of dealing with problems related to their use in synergy with sunphotometer measurements. This will be very useful to us, not only for our research as a part of this project, but also in future studies, since our laboratory is in the process of purchasing a lidar and a sunphotometer. The collected data, as well as selected interesting data sets from previous measurements at the site will be useful for our planned research on aerosol radiative effects. The ARELISEES project helped us to create link with the group at RADO, and we expect that it will lead to more opportunities for collaborative projects in future.

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Title
Comparison of OH and OH reactivity

Objectives
The science objectives for this campaign were
1) to compare OH reactivity measurements made with different techniques, and
2) to provide OH reactivity measurements during an intercomparison of OH measurement techniques
namely CIMS and LIF.

Achievements
1) Side by side comparisons of two differently configured CRM systems were made for the first time. 2) The MPI OH reactivity systems (both GC-PID and PTR-MS) and measured ambient air the remote continental site throughout the campaign with minimal instrumental problems. As well as in relatively clean ambient conditions when the air came from the south or southwest (reactivity ca. 5 s⁻¹), measurements were also made in the Paris plume which was advected over the site in the period 3rd-5th July. 3) The Paris plume impacted the site at the time that CIMS and FAGE techniques for the measurement of OH were being compared. Thus we have obtained in-situ OH, the OH sink (OH reactivity) and measurements of several key sources (ozone, CH₂O, HONO). 4) The impact of high NO concentrations on the OH reactivity measurement was examined both in ambient data situations (when NO increased to ca. 15 ppbv) and in careful sequential additions of NO from a standard). 5) On the 7th of July the grass surrounding the measurement station was cut with a motorized lawnmower. This released significant quantities of biogenic "wounding" compounds such as hexenol and hexenal from the grass and NO from the lawnmower motor. This enabled the NO sensitivities to be examined in ambient mixtures of VOC. 6) In the final stages of the experiment the CRM OH reactivity set-up and the FAGE OH reactivity measured in parallel, providing for the first time a dataset with which the two techniques may be compared.

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Reporting Period
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UserProject Acronym
FAME-11

Title
Finokalia Aerosol Measurement Experiment

Scientific Field
Main Field Earth Sciences & Environment

Specific discipline Global change & Climate observation

Objectives
The objective was to better characterize organic aerosol (OA) sources and properties in the Eastern Mediterranean during a period of the year (fall) when photochemistry offers the best conditions to investigate OA having different oxidation states. This field experiment was a follow-up of the FAME-2008 field experiment which has shown that OA aerosol at Finokalia was highly oxygenated during summer (Lee et al., ACP, 2010) while its primary fraction (hydrogen-like OA) was not detected (Hildebrandt et al., ACP, 2010). High OH exposure may have partly explained this unusual pattern providing the need to perform a new field experiment (FAME-2011) under lower oxidative conditions (September-October 2011). Based on a multi-tracer approach of organic material in gases/aerosols, LSCE contributed to this study providing a time-resolved source apportionment of OA and VOCs (PMF & AETHALOMETER models). Such information is particularly valuable regarding the time-limited (but intense) OA-containing plumes which are passing over Crete Isl. Real-time information of water-(in)soluble OA (LSCE) will complete the OA oxidation/volatility measurements performed by FORTH.

Achievements
Complementary to the instruments deployed by FORTH (thermo-denuded HR-ToF AMS, dry/wet SMPS, DAASS, APS …) and those available at Finokalia station, LSCE provided real-time information of water-(in)soluble OA (PILS-TOC & EC-OC Sunset field instruments), real-time measurement of specific organic tracers (Oxalate, MSA by PILS-IC; levoglucosan, pinic/pinonic acids by PILS + LC-MS/MS), and real-time measurements of gas precursors (light NMHC by GC-FID, OVOCs by PTR-MS, NH3 by AirMonia).

Filter samples were collected every 6h as back-up of the on-line instruments and provided complementary information (sample library available for exploratory organic speciation).

During FAME-11, a lot of power supply breaks occurred causing a lot of data loss. After a first data processing and post-calibrations of the instruments, we will have a better view of our dataset.

Complementary analyses of organic tracers could then be scheduled on 120 6-hour filters (PM2.5 Partisol), and on 710 30-minute vials (PM2.5 PILS/BMI).

After this data processing period, data exchange and discussions will occur between the 2 other partners of FAME11 (ECPL and Univ. of Patras).

Results of the FAME experiments (2008 and 2011) will be compared with similar field studies which will be performed in 2012 & 2013 in the Western Mediterranean (Corsica Isl. in particular) as part of the CHARMEX program (http://charmex.lsce.ipsl.fr/; PI = François Dulac).

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Objectives

This project’s general objective is to perform column measurements of CO, CH4, and N2O with a Fourier Transform Infrared (FTIR) spectrometer at Cabauw. Wherever feasible, information about the vertical distribution will also be retrieved from the spectra. The target species are relevant for air quality and climate studies.

The more specific objectives of the project are:
- To perform the FTIR measurements in a period that includes the period when the PEGASOS (Pan-European Gas-AeroSOls-climate interaction Study, http://pegasos.iceht.forth.gr) zeppelin flies over the Cabauw site (May-June 2012), and to perform measurements in support of the PEGASOS and ACTRIS scientific objectives: partial and total columns of CH4, CO, N2O, and if possible also of CO2 and NO2.
- To make the observations with the FTIR instrument alongside with in-situ measurements on the ground and on the tall tower of Cabauw of the same target species plus NOx.

Therefore, the combination of the various observations should enable the study of the diurnal variation of local and regional sources and sinks. In the end, it is hoped to propose an optimization of the use of emission inventories in local and regional models.

Achievements

The PEGASOS Zeppelin flew over the CESAR site in Cabauw on five days between 19 and 27 May. There were in-situ measurements of a.o. CO, NO2, CO2, CH4, and N2O. During the INGOS campaign between 4 and 27 June, there were several instruments measuring CH4, CO2 and N2O. Two air-quality models have been run for this time period: the Dutch Lotos-Euros model and the EURAD model from the University of Cologne. The data is currently being collected from the participating institutes.

The weather during June and July was unfortunately less sunny than normal, but in May we had a reasonable amount of clear sky hours, which is a prerequisite for obtaining good FTIR measurements. Despite the bad weather, we got nearly 1000 FTIR spectra during the measurement campaign. The analyses of the FTIR data obtained during this campaign are currently ongoing in collaboration between the participating teams of KNMI (Ankie Piters) and BIRA (M. De Mazière et al.)
Title
HIgh mass RESolution Measurements of Aerosol Composition at Cabauw

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
Atmospheric aerosols have direct and indirect effects on the global climate. Particles alter the properties of clouds by acting as cloud condensation nuclei (CCN) and as surface for heterogeneous reactions. Also particles are known to have adverse health effects. Amongst others these effects depend on the chemical composition of the particles. Aerosol chemical composition can be measured with high time resolution by the Aerodyne High Resolution Time-of-Flight-Aerosol-Mass-Spectrometer (HR-ToF-AMS). In this campaign the applicants propose to operate a HR-ToF-AMS at the CESAR-tower in Cabauw, the Netherlands in November 2011. We will characterise the non refractory aerosol-composition and compare the results to data from the newly developed high resolution Thermo-Desorption-Proton-Transfer-Mass-Spectrometer (TD-PTR-ToF-MS) that will be operated at Cabauw during this period. Previous comparisons of HR-ToF-AMS measurements with the quadrupole mass spectrometer TD-PTR-MS were performed by the group in summer 2008 and spring 2009. To investigate the seasonal cycle of aerosol chemical composition at Cabauw and to deepen the comparison of the two instruments, further measurements in autumn season are needed. This will widen the range of meteorological and atmospheric chemical conditions covered in our observations. Note that the use of high mass resolution for both instruments will allow for a much more detailed analysis of the composition of the organic fraction of the aerosols than previously performed, thus contributing to an improved understanding of organic aerosol formation and aging processes. Additionally this campaign acts as training for the PI who has no prior experience in performing field measurements.

Achievements
During the campaign, both the HR-ToF-AMS and the TD-PTR-ToF-MS measured the aerosol chemical composition and acquired data over almost the whole time period. In the first analysis of the AMS raw data, several periods with different total aerosol masses can be seen. Also the mass fractions of the major aerosol species, organics, nitrate, and sulfate, vary over time, too. The average particulate mass loading measured by the HR-AMS during November 2011 was 4.96 Âµg m-3 and lower than observed in previous campaigns in May 2008 (9.72Âµg/m3) and March 2009 (5.62 Âµg/m3). The organic fraction was the dominant species (40 %) in November 2011, followed by nitrate (27 %) and sulphate (19%). The observed aerosol composition was thus overall similar to the results from summer 2008, whereas in spring 2009 a dominant nitrate fraction (42%) was observed. A first evaluation of the particle concentrations, which were measured by CPCs at the AMS- and the PTR-MS inlet, respectively, shows good agreement. Hence, the PTR-MS- and the AMS data are comparable and will be used in detailed analysis of the composition of the organic fraction of the aerosols. Amongst others, further AMS data analysis will evaluate aerosol composition as function of size. For more detailed analysis of the organic fraction elemental analysis and Positive Matrix Factorization (PMF) will be performed. In addition, this campaign proved to be a successful test campaign for the PI and for the upcoming field measurements at the CESAR tower in May 2012, which will partly take place in parallel with observations on aerosols onboard a Zeppelin flying over Cabauw.
Title: Marine Aerosol-Cloud Interactions 2.1 (MaCloud Inc. 2.1)

Scientific Field:

- Main Field: Earth Sciences & Environment
- Specific discipline: Global change & Climate observation

Objectives:

1. To source apportion marine aerosol
2. Quantify formation and evolution characteristics
3. Quantify hygroscopic and Cloud Condensation Nuclei (CCN) properties
4. Quantify marine aerosol impacts on cloud microphysics.

The purpose of the winter campaign in 2010 is to quantify sea-salt production and it will characterise the low biological activity period on aerosol-cloud interactions. This will be followed up by a 2011 summer campaign to quantify primary/secondary and organic/biological impact on cloud microphysics within a high biological activity period.

Achievements:

The aim of this study was to gain insight into participating compounds in both coastal and marine particle formation events by looking in detail the chemical composition of atmospheric ions at Mace Head, Ireland. We quantified the atmospheric ion population in terms of the chemical composition and their physical character using an atmospheric pressure interface - time of flight mass spectrometer (APi-TOF). The data indicate that the ion composition during new particle formation event is dominated by iodine, iodic acid and their clusters. Multiple positively charged organic ions were identified during the nucleation events. We also provided a detailed physical characterization of the ion population using an Air Ion Spectrometer (AIS) and furthermore deployed a Particle Size Magnifier (PSM) to reveal concentration of both charged and neutral particles in the sub-3nm size, in which the gas-to-particle conversation occurs. A more detailed data analysis is currently underway ans the results in this short report should be considered preliminary.

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Objectives

MaCloud Inc. (Marine Aerosol – Cloud Interactions) aims to build on recent advances in marine aerosol secondary and primary formation processes. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics. This project aims to better characterize these coastal and open ocean events. Further, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low growth factors. The project will aim to characterize the growth factor and CCN activity of varying organic matter enrichments in sea-spray aerosol. In particular, the project will:

1. use a range of on-line aerosol mass spectrometric techniques and off-line HNMR techniques for aerosol chemical characterisation
2. use a range of aerosol physics instrumentation for physical characterisation with a focus on cluster formation as a function of I2 and H2SO4;
3. use a range of mass spectrometer techniques for gaseous characterisation
4. use a range of hygroscopic uptake and CCN instruments both for air and laboratory studies into secondary and primary organic aerosol.

Aims and objectives:

1. to source apportion marine aerosol
2. quantify formation and evolution characteristics
3. quantify hygroscopic and CCN properties
4. quantify of marine aerosol impacts on cloud microphysics.

The 2011 campaign will characterise the high biological activity period impacts on aerosol formation and aerosol-cloud interactions and follows the winter 2010 low biological activity period of measurements, which was part supported by EUSAAR.

Achievements

The University of Manchester (UoM) deployed the UoM's bespoke hygroscopicity tandem differential mobility analyser (HTDMA) and monodisperse cloud condensation nuclei counter (CCN) systems to measure the water uptake behaviour of submicron particles and their cloud-forming potential. These were the same instruments and inlet system that was deployed at Mace Head during the winter phase of the MaCloud Inc. project in December 2010. As before, the instruments were be deployed in the UoM trailer laboratory, using a cyclone inlet to remove larger particles. The UoM deployment brought in the unique capabilities of both the technical configuration of the instruments (such as the capability for automated humidograms) and UoM's inversion and modelling techniques that can link composition (measured using the NUIG instrumentation) with both the sub- and super-saturated hygroscopic behaviour. This will contribute to the complete characterisation of the marine boundary layer air with respect to the water affinity of the CCN-active particles. These measurements were also performed coincident with measurements performed on the UK FAAM BAe-146 research aircraft. These measurements will help to make an explicit linkage between the in situ aerosol composition, the cloud microphysics and the remote sensing data. Also, the coincident hygroscopicity and CCN measurements performed by other groups such as NUI Galway and Claremont Ferrend will allow for the validations of the techniques and where differences exist, the exploration of roles effects such as equilibration time in studying these aerosols.
| Mace Head Atmospheric Research Station | 7 | MHD | 33.5 |
Objectives

In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics. This project aims to better characterize these coastal and open ocean events. Further, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low growth factors. The project will aim to characterize the growth factor and CCN activity of varying enrichments of sea-spray aerosol. Extensive measurements of aerosol physical and chemical properties, both in gas and solid phase, will be used simultaneously for aerosol characterization. In particular, LaMP measurements contribute to a better quantification of volatile and CCN properties of marine aerosols by using VTDMA and CCN measurements in parallel and coupled. The 2011 May campaign characterizes the high biological activity period on aerosol-cloud interactions and can be compared to the previous winter 2010 low biological activity period. In case of open ocean nucleation, the volatility and hygroscopic properties of the newly formed aerosol will complete the information obtained from the TD-CIMS operated by the Helsinki group.

Achievements

Both marine and continental air masses were prevailing during this time and the obtained data will allow comparing the CCN activation properties at different air mass types. Results will be compared with those of the other groups to obtain a wider range of supersaturations and to ensure the congruence and quality of the data. For the whole campaign particle volatile properties at 100 (and 150) degrees were measured as a function of size, and, dry and volatile scans at different diameters performed. This data will be complementary for aerosol chemical composition, hygroscopic and CCN activation measurements to better understand the effect of changes in chemical composition for the particle climate effects during aerosol processing and to examine the particle mixing state. For the last two weeks of the campaign, the V-TDMA instrumentation was modified and coupled with the CCN chamber to measure the change in CCN activation properties after volatilisation of the particles (offering supplementary, novel data for other measurements). Bubbling experiments with artificial sea salt and sea water were also done for obtaining a reference for atmospheric results to facilitate the interpretation. Results will help to understand if the results of these the volatile, presumably organic, fraction of the marine aerosol suppresses cloud activation. Such type of measurements have never been obtained previously. Coupled with aerosol chemical composition, size distributions, hygroscopic properties and air mass origin, the results can be used to quantify the volatile properties and activation potential of primary and secondary marine organic aerosol.

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Title
Marine Aerosol-Cloud Interactions 2.4
(MaCloud Inc. 2.4)

Scientific Field
Main Field  Earth Sciences & Environment
Specific discipline  Global change & Climate observation

Objectives
New particle formation is the spontaneous creation of new nanometer-sized particles in the atmosphere. Observations spanning from megacities to isolated forests show that these events can occur frequently and extend for hundreds of square kilometers. While the impacts of these events are not well understood, they are often the dominant source of particles in the remote regions and could play a crucial role in the Earth's climate by regulating the number and activity of cloud condensation nuclei (CCN). The current study is motivated by the need to understand the species and mechanisms by which new particles form and grow in a coastal environment. This will be accomplished by directly measuring the chemical composition of nanometer-sized particles at Mace Head Research Station in County Galway, Ireland using the Thermal Desorption Chemical Ionization Mass Spectrometer (TDCIMS). If successful, these will be one of the most complete data sets on the composition of nanometer-sized marine aerosol.

Achievements
The TDCIMS measurements were performed during 13 - 31 May 2011 (2.5 weeks). The instrument was located in the upper cottage at Mace Head, with a sampling inlet consisting of 10 mm copper tubing protruding above the cottage. Sampling was performed at three different particle diameters: 15 nm, 20 nm, and 30 nm. The size was chosen to correspond to the peak in the nucleation mode of the size distribution. Samples were collected for 15-30 min, and both positive and negative ion mass spectra were acquired to obtain the most complete representation of size-resolved aerosol composition. This resulted in a measurement frequency of approx. 1 hr. Standards for calibrating inlet sensitivity as well as mass spectrometer accuracy were applied throughout the study. The measurement period was characterized by steady offshore winds and offshore "open ocean nucleation events". The TDCIMS-derived mass spectra of the chemical composition of aerosol sampled during such open ocean events shows the presence of chlorine-and sulfur-containing species. Additionally, many smaller peaks that correspond to organic compounds were observed. During the observation period, onshore iodine-influenced events were observed only during a few periods.

A thorough analysis of the dataset is currently underway. Already it is clear that the dataset will provide many insights into the composition of aerosol produced during open ocean nucleation events. A publication is planned summarizing TDCIMS measurements of nanometer-sized marine aerosols from the campaign. This will be submitted on or before summer 2012.

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**Title**
Marine Aerosol-Cloud Interactions 2.5
(MaCloud Inc. 2.5)

**Scientific Field**
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

**Objectives**
MaCloud Inc. (Marine Aerosol –Cloud Interactions) aims to build on recent advances in marine aerosol formation processes, both in terms of secondary and primary formation processes. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics. These aerosols show effective cloud nucleating properties. This project aims to better characterize these coastal and open ocean events to derive their source, formation and evolution characteristics. The results will be used to quantify marine aerosol impacts on cloud microphysics. In particular, the project will use a range of on-line aerosol mass spectrometric techniques and off-line HNMR techniques for aerosol chemical characterisation and aerosol physics instrumentation for physical characterisation with a focus on cluster formation as a function of I2 and H2SO4. Different techniques are applied for gaseous characterisation. The measurements are completed with a range of hygroscopic uptake and CCN instruments both for air and laboratory studies of secondary and primary organic aerosol.

The 2011 campaign characterise the high biological activity period with strong iodine emission and its impacts on aerosol formation and aerosol-cloud interactions and follows the winter 2010 low biological activity period of measurements in 2010.

This sub-project is about the observation of Reactive Halogen Species (RHS, especially IO) during MaCloud to quantify coastal iodine emissions and iodine-driven particle nucleation and growth.

**Achievements**
Measurements with two iodine oxide instruments (LP-DOAS and CE-DOAS) could successfully be realised at Mace Head. However weather conditions were unexpected very bad during MaCloud and thus unfavourable for emissions of RHS. Temperature and solar radiation were too low for RHS emissions and concentrations are below the detection limits of the instruments (LP-DOAS 1.0ppt; CE-DOAS 2ppt), as expected. Only during two days the LP-DOAS observed concentrations up to 2ppt. The concentration peaks correlate well with high solar radiation and low tide as typical for biological iodine emissions. However the level is much lower than typically observed for this time of year at Mace Head. Thus iodine driven particle nucleation is less important during MaCloud than it is the typical case. The CE-DOAS instrument could not observe IO on the same days, but for a short sunny period on the 30th of May with levels of up to 22ppt when it was not measured simultaneously with the LP-DOAS. The differences in both instruments, which actually observe the IO concentration from different air masses, indicate that emissions and concentrations are very inhomogeneous.

Additional measurements at other coastal sites close to Mace Head and higher macro algae concentration show very inhomogeneous and high IO concentration up to 100ppt, and thus much higher than so far observed. They prove for the first time modelled concentrations for iodine driven particle nucleation. The influence of iodine emissions may thus be much more important than so far derived from measurements at Mace Head.

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**Grant Agr. I**
262254

**UserProject Acronym**
MaCloud Inc. 2.5

**Reporting Period**
PR1

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**Infrastructure**

**Short Name**
Mace Head

**Installation ID**
7

**Installation Short Name**
MHD

**Amount of Access Delivered**
63
Objectives

Marine aerosol-cloud interactions are very important for global climate. It is of importance to increase the understanding of cloud formation processes in marine environments. Dimethylsulphide (DMS) is emitted by phytoplankton and is oxidized in the atmosphere. Most of the products of DMS end up in the aerosol particle phase and DMS is considered an important source of cloud condensation nuclei (CCN). The aim of this part of the project is to assess the concentration of methanesulphonate in different aerosol particle sizes. Since the only known source for methanesulphonate is DMS this will give information about the role of DMS as a precursor for CCN.

Achievements

Aerosol particles were collected in ten different size bins with a multistage impactor. The impactor foils have been extracted in pure water and the concentration of anions has been measured. The concentration of methanesulphonate varies with particle size and is most often found in two modes - one centered around a particle diameter 300 nm and another mode centered around one micrometer. Further investigations will give us information about the role of methanesulphonate versus sea salt concentrations as well as the role of meteorological parameters. Furthermore, the samples will be investigated for an influence of the volcanic eruption of Grimsvötn.

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Main Field: Earth Sciences & Environment

Specific discipline: Global change & Climate observation
Reporting Period
PR1

UserProject Acronym
MHDCloud

Title
Investigation of marine boundary layer and clouds with remote sensing instruments at Mace Head

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
The objectives of the project were to study marine boundary layer and its associated clouds, and facilitate on-going aerosol and atmosphere-ocean exchange research at the Mace Head research infrastructure by: 1) comparing remote sensing instruments (ceilometer and Doppler lidar) and methods (based on aerosol layers or dissipation of turbulent kinetic energy) for retrieving the marine boundary layer structure, 2) investigating coupling and decoupling of marine stratocumulus clouds within the boundary layer, 3) investigating the potential for interaction between marine aerosol particles and clouds coupled within the mixed layer.

Achievements
We have just finished our campaign with a Doppler lidar at Mace Head and data analysis is currently on-going. A number of steps must be undertaken in the processing of the raw instrument data. The first step is to create profiles of backscatter, Doppler radial velocity and horizontal winds in standard netCDF format with artifacts and other non-meteorological noise removed. Data for the entire campaign has been processed to this level. Currently, we are deriving the dissipation rate of turbulent kinetic energy, from which we will determine mixing layer height. After this liquid cloud layers can be classified as coupled or decoupled with the surface, and further characterised by means of cloud fraction, cloud thickness, liquid water content, drizzle and precipitation, cloud droplet number concentration. Comparison with surface in-situ aerosol measurements will then allow the investigation of the relationship between cloud condensation nuclei and cloud droplets through parameters such as aerosol number concentration and hygroscopicity. In addition, we expect that the comparison of methods to retrieve the boundary layer structure would guide future discussion on instruments and methods to achieve the best estimate for boundary layer structure through the EU COST programme EG/CLIMET.

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**Title**  
Measurement of NO2 and O3 in the free troposphere by a LOPAP instrument

**Scientific Field**  
Main Field: Earth Sciences & Environment  
Specific discipline: Other - Environment

**Objectives**  
In the present project an NO2-LOPAP should be intercompared with a standard chemiluminescence instrument (CLD) and a Quantum Cascade Laser Absorption Spectrometer (QCLAS) under clean atmospheric conditions at the high alpine research station Jungfraujoch (JFJ). In addition, the new O3 channel of the LOPAP instrument should be intercompared with a standard UV absorption instrument.

**Achievements**  
In the present study, a new O3-NO2-LOPAP was intercompared at the High Alpine Research Station Jungfraujoch to standard instruments and a Quantum Cascade Laser Absorption Spectrometer (QCLAS) from EMPA. For O3 excellent absolute agreement was observed between the LOPAP and preliminary data from the UV absorption instrument, which routinely measures at JFJ. The good agreement demonstrates that interferences in the O3 channel of the instrument can be neglected also for low pollution levels, in agreement with urban and smog chamber results. For the NO2 channel of the instrument significantly lower concentrations compared to the preliminary data from the standard chemiluminescence instrument were observed. Caused by the excellent correlation of the data, these results indicate some calibration problems of one instrument. In contrast, interferences of the NO2-LOPAP instrument seem to be of minor importance, which is confirmed by the negligible signal in the interference channel of the LOPAP instrument. Since comparison to the QCLAS data is still an open task, reasons for the systematic discrepancy will be hopefully answered in the near future, when all data are available.

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Title
Training on NH3 measurement by wet chemistry techniques

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
The planned project aims at providing training to Christine Gritsch, PhD student at BOKU University, Vienna. The idea is to design a measurement approach in Austria for NH3 flux exchange between biosphere and atmosphere within a laboratory incubation experiment carried out for the EU project ECLAIR. Besides CO2, CH4, N2O and NOx we want to include an NH3 measurement system to our laboratory incubation system. We are planning to make soil and litter incubations and to measure online gas emissions in the laboratory. At Auchencorth Moss training will be provided on NH3 measurement by wet chemistry techniques, based on the infrastructure and expertise at Auchencorth. For implementation purposes we will use the AiRRmonia system for continuous measurements of gas phase ammonia.

Achievements
The one week of NH3 measurement training provided useful information about how to measure NH3 with the AiRRmonia instrument as well as improved knowledge of handling NH3 measurements in general. The training involved handling of the instrument from switched off mode to final measurements including all preparation and cleaning steps in between. Future studies with two other instruments will provide our final decision of choosing the most appropriate instrument to be included to our laboratorial incubation system at BOKU University.

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UserProject Acronym
OVOC-TOOC

Title
OVOC analysis for Total Observed Organic Carbon determination

Objectives
The performance of mass closure experiments of atmospheric organic carbon at different European environments is an excellent tool for validating the importance of gaseous and particulate organic compounds in the atmosphere. The TNA proposed within this project will test the concept of Total Observed Organic Carbon (TOOC). The concept of TOOC is based on the analysis of ideally all gaseous and particulate organic species at a certain site. This has already been performed in the USA but will be tested for the first time in Europe in spring 2012 at SMEAR II.

Achievements
Concentrations of oxygenated VOCs and normal VOCs were measured by 3 different instruments. Measurements of GC-MS, GC-FID and PTR-MS showed a very consistent picture for the gaseous compounds together with the particulate carbon measurements using the aerosol mass spectrometer. This will possibly be the first campaign where the concept of the Total Observed Organic Carbon (TOOC) is tested in Europe.

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Title
Pan-European Gas-AeroSOls-climate interaction Study

Scientific Field
Main Field: Earth Sciences & Environment
Specific discipline: Global change & Climate observation

Objectives
Atmospheric aerosols have direct and indirect effects on the global climate. Particles alter the properties of clouds by acting as cloud condensation nuclei (CCN) and as surface for heterogeneous reactions. Particles are also known to have adverse health effects. These effects depend partly on the chemical composition of the particles. Aerosol chemical composition can be measured online with high time resolution by the Aerodyne High Resolution Time-of Flight-Aerosol-Mass-Spectrometer (HR-ToF-AMS). Within the EU FP7 funded project PEGASOS intensive measurements of atmospheric chemical composition including gas and particle phase measurements were performed onboard of a Zeppelin airship. A campaign was scheduled for May 2012 targeting to explore the vertical distribution of aerosol composition in the planetary boundary layer over the Netherlands with specific focus on the area around Cabauw. The applicants operated a HR-ToF-AMS at the CESAR-tower in Cabauw, the Netherlands in May 2012, to provide ground based reference data on the aerosol chemical composition. These measurements were made in parallel with measurements performed by the HR-ToF-AMS onboard a Zeppelin at several heights within and above the planetary boundary layer. The combined results will give an improved understanding of the vertical distribution of ambient aerosol composition. In particular this data set will provide insight into organic aerosol formation and aging processes. Thus, they will contribute to investigations on the effect of climate change on the number and mass concentration of atmospheric aerosols, and on the interaction of the atmospheric self-cleaning processes with the aerosol formation.

Achievements
During the campaign, the HR-ToF-AMS measured the aerosol chemical composition and acquired data over almost the whole time period. In the first analysis of the AMS raw data, several periods with different total aerosol masses can be seen. Also the mass fractions of the major aerosol species, organics, nitrate, and sulphate, vary over time, too. The average particulate mass loading measured by HR-AMS during May and beginning of June 2012 was 7.8 µg m-3 and lower than observed in previous campaigns in Cabauw in May 2008 (9.7 µg m-3), but higher than amounts of November 2011 (5.0 µg m-3) and March 2009 (5.6 µg m-3). The organic fraction was the dominant species (37 %) in May 2012, followed by nitrate (25 %) and sulphate (20 %). The observed aerosol composition was thus overall similar to the results from autumn 2011 and summer 2008, whereas in spring 2009 a dominant nitrate fraction (42 %) was observed.

A first evaluation of the aerosol measurements onboard the Zeppelin over Cabauw, which were performed in parallel to the data acquisition at ground level, shows vertical profiles of the chemical species, where especially the nitrate and organic amounts are lower above than within the planetary boundary layer. In contrast, sulphate concentrations had only little changes with altitude. Both AMS data sets measured onboard the Zeppelin and on the ground, will be used in detailed analysis of the vertical distribution of ambient aerosol composition.

For more detailed analysis of the organic fraction elemental analysis and Positive Matrix Factorization (PMF) will be performed.
Reporting Period PR1

UserProject Acronym POPLRTMED

Title Long-range atmospheric transport and transformation of persistent organic pollutants in the Eastern Mediterranean

Scientific Field

Main Field Earth Sciences & Environment

Specific discipline Other - Earth Sciences

Objectives

Environmental exposure towards persistent organic pollutants (POPs) is determined by long-range transport (LRT). Most POPs are semivolatile organic compounds, i.e. partition between the phases of aerosols and undergo re-volatilisation from the sea and soils (multi-hopping). Their cycling (LRT, local processes such as air/sea exchange, air/soil exchange, gas/particle partitioning, and chemical reactivity) is insufficiently understood. We aim to advance this knowledge by addressing key processes of POP cycling in the marine boundary layer in air masses characterized at a receptor site and influenced by regional (Aegean) and remote (central and eastern Europe) sources (concurrently with measurements at other sites in the region, see below Techn. Descr.). Choice of site and time are furthermore motivated by the results of earlier studies carried out by the host institution (University of Crete, Dept. of Chemistry) and in the context of international field campaigns. In particular we determine:

- Concentrations in air, aerosol mass size distributions and determination of environmental parameters influencing the gas/particle partitioning of POPs,
- Concentrations in seawater and determination of environmental parameters influencing the air/sea exchange of POPs,
- Concentration changes along transport and determination of environmental parameters influencing the reactivity of POPs (in cooperation with sampling at other stations (see below) and meteorological analysis).

The selected POPs are: polycyclic aromatic hydrocarbons (PAH), nitro- and oxo-PAH, polybrominated diphenyl ethers (BDE), organochlorine pesticides (e.g. HCH, DDT), polychlorinated biphenyls (PCB). For some of these substances very few data from remote environments exist so far.

Achievements

Particle and trace gas samples have been collected (for off-line analysis in the laboratory) and various supporting in situ-measurements were done during 2-13 July 2012. Directly at the shore, air-sea exchange (vertical flux) of POPs was addressed sampling at 2 heights above ground along with micrometeorological measurements. In addition, few water samples were collected (for off-line analysis in the laboratory). The chemical analysis of some 250 samples from this campaign will expectedly be completed within 6-9 months. Not much can be said before the samples collected have been analysed. We expect complementary data for a number of substances which had been rarely observed in the marine boundary layer (e.g. nitro- and oxy-PAHs, PBDEs), and insights into the processes determining gas-particle partitioning and sinks of few PAHs and, eventually, PCB congeners in a clean marine boundary layer, i.e. photochemical transformation and air-sea exchange. The POP levels in air data will be analysed and interpreted together with data from simultaneous sampling at other locations run by partner institutions in the region (not linked to FP7 infrastructure projects). The large scale atmospheric flow was favourable with this regard.

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**Title**

Reactive Iodine and Particle Observations

**Scientific Field**

*Main Field* Earth Sciences & Environment

*Specific discipline* Marine science/Oceanography

**Objectives**

Marine aerosol formation processes at coastal sites are to a large amount iodine-driven nucleation and growth events. Iodine are emitted by macro algae growing at the coast when they are set under "stress" e.g. if they are exposed to the atmosphere during low tide. Strong solar radiation enhances the emissions and lead to photolysis of iodine and subsequent oxidation to iodine oxide (IO) and destruction of tropospheric ozone. At high IO levels nucleation to particles can arise which can have a significant contribution to cloud formation and the solar energy budget. Most of these investigations on iodine emissions and particle formation were performed at the research station in Mace Head. However the variability between different locations are poorly quantified. They arise due to different types and distribution of macro algae. This may have significant influence on the estimation of local and global iodine driven particle formation. This project aims is to better characterize these coastal iodine emission events. Especially the spatial distribution of the emissions on a small scale (~10m) close to Mace Head and on a larger scale (~5 km) by combining different measurements. The measurements at Mace Head will be accompanied by aerosol physics instrumentation. Aims and objectives: (1) quantify iodine emissions and its spatial variability at Mace Head (2) quantify formation and evolution characteristics of particle formation during these events (3) quantify the difference of iodine emissions from Mace Head to other location at the Irish Westcoast (4) test new instruments for atmospheric IO measurements.

**Achievements**

Measurements with different spectroscopic measurement instruments for the detection of halogens (IO, I₂, BrO) and ozone could be realised at Mace Head and along the Irish west coast. Two Long Path (LP)-DOAS instruments were applied. One was operated stationary at Mace Head for the whole campaign. The measurement light path of the instrument was set up almost parallel to the coast pointing to a reflector 3km north of Mace Head. The second LP-DOAS was operated mobile at different measurement locations (up to 100km from Mace Head) along the coast. Inter-comparison measurements were performed at Mace Head for several days. As both instruments average the concentration over several 100m up to 3km the derived concentration is representative for the location. We observed differences in halogen concentration of at least an order of magnitude with much lower concentrations at Mace Head. Additionally a new mobile Cavity Enhanced (CE)-DOAS instrument for the point measurement of IO was applied. It allows in combination with the LP-DOAS to quantify locally enhanced iodine emissions e.g. directly at the macro algae. Measurements at Mace Head indicate only two local emission sources (hot spots). But also with this instrument only low iodine emissions and concentrations could be observed at Mace Head. Measurements with this instrument at other coastal sites investigate also much higher iodine emissions. With this instrument local emission sources could be identified and assigned to different algae species at different weather conditions. Due to rainy and windy weather particle nucleation events couldn't be observed.
Reporting Period PR1

UserProject Acronym
SYNERGY

Title
High altitude aerosol in situ characterization in synergy with LIDAR vertical profiles

Scientific Field
Main Field Earth Sciences & Environment
Specific discipline Global change & Climate observation

Objectives
Aerosols monitoring is of high relevance for studying pollution spread and climate evolution. The Puy de Dôme (PdD) station includes instruments to characterize in situ aerosol physico-chemical properties (size distribution, optical properties, hygroscopicity, ...) at 1465 m a.s.l. Eleven kilometers far from the station, a 355 nm aerosol lidar with Raman capability (Clermont-Ferrand (CL) lidar) has been performing optical measurements since 2009. The synergy between in-situ and lidar measurements allow the retrieval of aerosol mass vertical profiles over the whole atmosphere in order to study events like dust, volcanic eruptions or pollution transport. In addition, integrating the CL lidar data will contribute to long-term climate monitoring programs such as the EARLINET and ACTRIS networks. In order to perform these research activities with the quality assurance required by the EARLINET community, training at a state-of-art atmospheric research infrastructure including expert support and know-how transfer was necessary and strongly beneficial to retrieve aerosols optical properties from the lidar data. The first objective of this training activity was to learn how to calculate, from raw lidar data, aerosol extinction and backscatter using only elastic channels during day-time measurements and using both elastic and Raman channels during night-time measurements. The second objective was to get familiar with using the Single Calculus Chain (SCC) developed by some groups of the EARLINET community. The aim of the SCC is to provide a tool for processing all the different lidar data of the EARLINET community in the same manner to get consistent aerosol optical properties.

Achievements
The training activities were divided into three parts. The first part was dedicated to quality assurance: the tests on the optical, electronic and hardware parts of the lidar and the regular quality check of the system and the data acquisition that need to be performed. Most of the tests have been implemented on the CL lidar and the configuration of the system and the parameters for the data acquisition have been optimized. The second part of the training was dedicated to aerosol extinction and backscatter calculations. Routines have been developed to calculate aerosol extinction and backscatter for day-time and night-time measurements. To check the quality of the routines developed, CIAO provided synthetic lidar data used by the EARLINET community to check the agreement of all the algorithms developed by each station. The developed algorithm shows good agreement with the one developed by CIAO. CL processing routines are now used to process the data acquired during the last EMEP campaign (8 June – 17 July 2012). The last part of the training was dedicated to the SCC description as well as web interface use. In the framework of an EARLINET operational exercise and a ChArMEx pre-campaign, 72-hour continuous lidar measurements were performed by 11 stations including Clermont-Ferrand from 9 July 6:00 UTC until 12 July 6:00 UTC. The CL lidar raw data files were converted into SCC netcdf input files and 59 of the 72 hourly files submitted to the Potenza centralized server were processed successfully.

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**lundi 26 novembre 2012**

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Anthropogenic enhancement of biogenic secondary aerosols, ABSOA

Project leader: Marianne Glasius

• Introduction and motivation
Atmospheric aerosols play an important role in the global climate balance as they affect the formation and lifetime of clouds, the atmospheric chemistry and the global radiation budget. Aerosols are known to have a net cooling effect on the climate, but according to the Intergovernmental Panel on Climate Change (IPCC), they are "the dominant uncertainty in radiative forcing". Therefore we need to improve our knowledge about the chemical composition of aerosols and the chemical processes involved.
In this study we will focus our attention on SOA (Secondary Organic Aerosols) and more in detail on BSOA (Biogenic Secondary Organic Aerosols) which are the product of the oxidative processes occurring to BVOC (Biogenic Volatile Organic Compounds) emitted by vegetation, this natural contribution to SOA is estimated to exceed the contribution from anthropogenic emissions by approximately a factor of three.

• Scientific objectives
Terpene oxidation products contribute to organic condensable material available for growth of aerosols after particle nucleation. Organosulfates of terpenes are of special interest due to their low volatility and as indicators of anthropogenic enhancement of biogenic secondary aerosols.
We want to investigate variation in composition and concentration levels of terpene oxidation products and their organosulfates and, with the help of supplementary data, how this composition and concentration is affected by SO$_2$, O$_3$, NO$_x$ and the VOCs emitted by the vegetation.
This will contribute to understanding the chemical processes involved in the formation of BSOA in the boreal environment and in the processes affecting particle growth as well.

• Reason for choosing station
As we decided to focus our study on BSOA the SMR Station for Measuring Forest Ecosystem-Atmosphere Relations - SMEAR II was the ideal location as the station is located in a rather homogenous Scots pine (Pinus sylvestris L.) stand on a flat terrain. The station represents boreal coniferous forests, which cover 8% of the earth’s surface and store about 10% of the total carbon in the terrestrial ecosystem.
The station has top class instrumentation for measurements of aerosol microphysics, atmospheric chemistry, and micrometeorology and in this way we can obtain easy access to supplementary data which can help to understand and interpretate the results of our study.

• Method and experimental set-up
We installed a high-volume (23.1 m$^3$/h) sampler with a PM$_{1}$ sampling inlet and a home-made denuded low-volume (2.3 m$^3$/h) sampler with PM$_{2.5}$ sampling inlet for collection of aerosols. High-volume samples were collected automatically on a diurnal basis for most of the study period, while low-volume samples were collected manually on a diurnal basis during intensive sampling periods (otherwise on a daily basis).
In this way we collected aerosol samples for qualitative and quantitative analysis of terpene oxidation products and organosulfates. In particular the samples collected with the denuder system will help to understand the gas-particle partition of the aforementioned compounds.
Aerosol samples will be analyzed at Aarhus University by HPLC quadrupole time-of-flight mass spectrometry after extraction. Data analysis and interpretation will benefit from the huge amount of data obtained from on-going measurements at the site.
• Preliminary results and conclusions
We successfully collected 51 samples with the high-volume sampler and 13 samples with the low-volume sampler. The samples were shipped to Aarhus at cold conditions and they are stored in controlled conditions at -20°C. The analysis of these samples for the terpene oxidation products and organosulfates is not straightforward, and they require a careful extraction procedure. We will start this within the coming month.

• Outcome and future studies
With this study we expect to improve our understanding of the chemical processes involved in the formation of the oxidation products of terpenes and the gas-particle partition of them as well, in a forest environment. This can lead to a better understanding of the aerosol and cloud formation processes happening over forests and to improve climate models as well.

• References

• **Introduction and motivation**

The role of atmospheric aerosols in Earth's radiative budget is important, but there are still uncertainties in quantifying their radiative effects (IPCC 2007). Aerosols affect the Earth-atmosphere energy budget in different ways: directly, by scattering and absorbing solar and thermal infrared radiation; indirectly, by modifying cloud properties; semi-directly, by heating the atmosphere and evaporating low level clouds. Direct shortwave radiative effect of aerosols is addressed in this project. It depends on aerosol optical properties, in particular aerosol optical depth, single scattering albedo and asymmetry parameter. The uncertainties in modeled aerosol radiative effects are largely due to poor knowledge of their optical properties. Aerosol loading and optical properties are temporally and spatially variable, mainly due to their short lifetimes and spatial variability of their sources and sinks. Their vertical profiles are also variable, and depend on how high they were injected in the atmosphere and on various atmospheric processes. Some studies indicated the importance of knowledge of aerosol vertical profile for estimating their direct radiative effect in cloudy conditions and in the longwave (thermal infrared) spectral range (Yu et al., 2006, and references therein). The importance of this information on modeled shortwave (solar) aerosol radiative forcing in clear sky conditions has also been investigated. Meloni et al. (2005) showed that in the case of strongly absorbing aerosols, aerosol shortwave radiative forcing at the top of the atmosphere (TOA) depends on vertical structure of aerosol layer. Guan et al. (2010) considered weakly and moderately absorbing aerosols and reported that sensitivity of aerosol direct radiative forcing at both the TOA and the surface to a change in vertical profile of aerosol extinction coefficient is not significant. However, they reported that the vertical variability of aerosol extinction coefficient affects vertical profile of the aerosol radiative forcing.

In the frame of the ARELISEES project we conducted lidar, sunphotometer and in-situ measurements at the AERONET/EARLINET site (RADO) in Bucharest, to study variability of aerosol optical properties and to estimate aerosol direct shortwave radiative effects. One of the focuses of the project was also to investigate the sensitivity of modeled aerosol radiative effects on aerosol profile.

• **Scientific objectives**

The objective of this project is characterization of aerosol optical properties and assessment of aerosol shortwave direct radiative forcing and heating rates, in the cases of different airmasses transported to AERONET/EARLINET site in Bucharest. Particular emphasis has been given to investigating the sensitivity of aerosol radiative forcing to vertical profile of aerosol extinction. For that purpose, co-located CIMEL sunphotometer, lidar and aerodynamic particle sizer (APS) have been used as complementary instruments. We focused on the analysis of aerosol optical properties necessary for estimating aerosol radiative effects. Vertically integrated aerosol optical properties (aerosol optical depth, single scattering albedo and asymmetry parameter) have been obtained from the sunphotometer measurements, while lidar measurements were used to derive vertical profile of aerosol extinction coefficient.
• **Reason for choosing station**

The RADO station has been chosen because it is equipped with a sunphotometer and a multi-wavelength Raman lidar, necessary for our project, as well as in-situ instruments for measuring aerosol properties at the ground level. This site is also interesting because it is affected by aerosols originating from different source regions, including biomass burning from Eastern and Southern Europe and Saharan dust (Nemuc et al., 2011). The period of observation has been chosen due to frequent influence of Saharan dust.

• **Method and experimental set-up**

We organized an intensive 1-month measurement campaign, from 13 May to 9 June 2012, at RADO (44.348 N, 26.029 E) using a multi-wavelength Raman lidar and sunphotometer. Ground-based size distribution and composition measurements, using APS and AMS, were also conducted to account for Planetary Boundary Layer (PBL) contribution.

The multiwavelength lidar system (RALI) is based on compact, pulsed Nd:YAG laser, emitting simultaneously pulses of 110, 55 and 65 mJ output energy at 1064, 532 and 355 nm, respectively, with a 10 Hz repetition rate (Nicoiae et al., 2010). The receiving Cassegrainian telescope has a primary diameter of 40 cm. A complete overlap between the laser beam and the telescope field of view is expected at the range of 700 m. Photomultiplier tubes (PMTs) are used to detect the received lidar signals in the analog and the photon counting mode, with a corresponding spatial resolution of 3.75 m. The detection channels include elastic wavelengths (1064, 532p, 532s, and 355 nm) and Raman wavelengths (607, 387 and 408 nm). Averaging time of the lidar profiles was of the order of 1 min for daytime measurements and 5 min during the night. Optical parameters of aerosols were extracted from lidar data using pre-processing and processing algorithms (Talianu et al., 2007) based on Fernald-Klett method (Klett, 1981; Fernald, 1984) previously tested and validated in the intercomparison campaign of EARLINET-ASOS project (Böckmann et al., 2004).

CIMEL Sunphotometer is an automatic sun and sky radiometer. The measurement data are centrally processed at GSFC NASA. From direct sun radiance measurements at seven wavelengths (340, 380, 440, 500, 675, 870, and 1020 nm) aerosol optical depth (AOD) is derived, while measurements at 940 nm are used to derive water vapor content. Diffuse sky radiance is measured at four wavelengths (440, 675, 870, and 1020 nm). Aerosol size distributions, refractive indices, single scattering albedo and asymmetry parameter are inferred by inversion of sun and sky radiances.

Aerodynamic Particle Sizer (APS) was used for ambient air monitoring and measurements of particles from 0.5 to 20 μm in diameter, and Aerosol Mass Spectrometer (AMS) was used for real-time detection of aerosol chemical composition.

Fu-Liou radiative transfer code (Fu and Liou, 1992) has been used for the calculus of the direct shortwave aerosol radiative effects. It is a four stream broadband model with delta approximation for strong forward scattering of large particles. In this model the solar spectrum is divided into six bands: 200-700 nm, 700-1300 nm, 1300-1900 nm, 1900-2500 nm, 2500-3500 nm, and 3500-4000 nm. Besides aerosols and clouds, the model takes into account the Rayleigh scattering and absorption of O₃, H₂O, O₂, and CO₂. The correlated k-distribution method is used for band-averaging of gaseous absorption coefficients.

• **Preliminary results and conclusions**

The possibility of synergetic use of the lidar and sunphotometer measurements is subject of ongoing analysis, as it requires testing the sensitivity of the output parameters to various known problems, such as operating time (Raman lidar: night-time, sunphotometer: daytime), lidar overlap, pointing direction, etc. During the measurement period, few profiles with elevated aerosol layers were observed, which are particularly interesting for our project. Although the weather conditions
were not favorable most of the time during the measurement period, on several occasions nighttime measurements with Raman channels were conducted. In total, 37 one-hour backscatter profiles (both elastic and Raman datasets) were measured during the campaign, and 8 extinction profiles from Raman datasets.

Two interesting cases were identified during the campaign. Lidar range corrected signals for the two selected cases (measurements taken on 22 May and 9 June) are shown in Fig. 1. One-hour profiles of backscatter and extinction coefficients have been calculated.

![Figure 1. Time series of range corrected signal for the cases of 22 May and 9 June](image)

In both cases AERONET Level 1.5 inversion products show the presence of coarse aerosol mode (Fig. 2), and high single scattering albedo (weakly absorbing aerosols). The lidar-derived vertical profiles of extinction coefficients and corresponding 355-532 nm Ångström exponents shown in Fig. 3, suggest significant decrease of the relative concentration of fine aerosol particles with altitude, up to about 2 km.

![Figure 2. Integrated column size distribution from sunphotometer on 22 May and 9 June](image)

![Figure 3. Extinction coefficient and 355-532 nm Ångström exponent profiles for the cases 22 May and 9 June](image)
Lidar (profiles) and sunphotometer (integrated column) retrievals show a possible signature of the mineral dust mixed with continental polluted aerosols, with a pronounced contribution of smoke on 9 June 2012. The presence of dust is confirmed by DREAM model (Fig. 4) for both cases.

Increased contribution of smoke on 9 June is probably due to the collection of biomass burning aerosols from North Italy, where dense forest fires were present in this period. Increased concentrations of organics and sulfates were sensed on 9 June also at the ground by the C-ToF AMS (Fig. 5), as well as an increased number of fine particles for these species, which are typical for biomass burning.

Preliminary radiative transfer calculations have been performed for these two cases, using Level 1.5 sunphotometer-derived aerosol optical properties (aerosol optical depth, single scattering albedo and asymmetry parameter). For that purpose they were interpolated/extrapolated at 35 wavelengths between 200 and 4000 nm, after which the spectral averaging within the six solar bands of the code was performed. The vertical profile of aerosol extinction coefficient obtained from the lidar measurements at 532 nm was used, assuming a constant value below the range of the full overlap (below the altitude of 700m). The aerosol direct radiative forcing results are -15.1 and -31.3 W/m² at the TOA and -18.28 and -39.5 W/m² at the surface, for the cases of May 22 and June 9, respectively. The sensitivity of the aerosol radiative effects to vertical profile of aerosol extinction is subject of current research.

More interesting cases, with two well divided aerosol layers, and influences from Saharan dust, volcanic dust and smoke have also been selected from previous measurements at the site, for study of aerosol radiative effects.
• **Outcome and future studies**

After obtaining quality assured data, in-depth analysis of aerosol optical properties based on sunphotometer and lidar measurements in combination with APS will be carried out. A comprehensive study of aerosol radiative effects based on these measurements, as well as cases selected from previous measurements collected at the site, will be conducted. Particular emphasis will be given to the effect of the assumed vertical profile of aerosol extinction on the modeled heating rates and vertical profile of aerosol radiative forcing.

It should be noted that using the lidar and sunphotometer measurements in synergy requires test of consistency between them for the cases of interest. This will be done by comparison of lidar-derived aerosol optical depth and Ångström exponent with the corresponding properties obtained from the sunphotometer measurements; cases in which close agreement is reached will be used. Available night-time lidar measurements will be used along with sunphotometer measurements in cases in which temporal and spatial stability of the aerosol layer is observed.

• **References**


Comparison of OH and OH reactivity, COMPOH

Jonathan Williams

• Introduction and motivation
  A large number of chemical species with diverse structures are emitted into the atmosphere from biogenic and anthropogenic sources. Each can be oxidized by OH, O3 and NO3 to a multitude of further products resulting in a complex cocktail of volatile organic compounds. In 2001 a new measurement technique called “OH reactivity” was devised by Kovacs and Brune in 2001. This pioneering study showed that by adapting a Laser Induced Fluorescence (LIF) technique for measuring OH with a flow tube it was possible to determine the total sink for OH in the atmosphere directly rather than measuring all relevant species individually. Three alternative measurement systems for OH reactivity have been subsequently developed: a flow tube-LIF combination (e.g. Kovacs and Brune 2001), a pump and probe-LIF method (e.g. Sadanaga et al. 2004, Parker et al. 2011), and a comparative reactivity measurement (CRM) initially based on proton transfer reaction mass spectrometry (Sinha et al. 2008). A comparison of these different techniques has not yet been made. In this OH and OH reactivity campaign “COMPOH” campaign, the opportunity was taken to compare: two different CRM techniques with PTR-MS; a new CRM technique with GC-PID; and the LIF system.

  The COMPOH campaign took place at the SIRTA measurement site from June 20th until July 13th. Within the framework of this intercomparison the Max Planck Institute undertook OH reactivity measurements using the CRM method both with the standard PTR-MS type measurement and with a new GC-PID system. These were compared with another CRM technique with using ambient measurements and a series of interferences tests, most notably NO.

• Scientific objectives
  The science objectives for this campaign were 1) to compare OH reactivity measurements made with different techniques, and 2) to provide OH reactivity measurements during an intercomparison of OH measurement techniques namely CIMS and LIF.

• Reason for choosing station
  The SIRTA station was chosen for several reasons. The site is impacted by rural continental air (for background reactivity values) and occasionally by the pollution plume of Paris which lies ca. 20km to the northeast of the site. In this way a span of OH reactivities and pollution levels, conducive to comparison, can be expected during the campaign. Furthermore meteorological and OH CIMS instrumentation were already at the site.

• Method and experimental set-up
  In the CRM method for measuring OH reactivity, a reactive molecule (X), not normally present in air, is passed through a glass reactor and its concentration is monitored at ppbv levels with a suitable detector. OH radicals are then introduced in the glass reactor at a constant rate to react with X, first in the presence of zero air and then in the presence of ambient air containing VOCs and other OH reactive species. Comparing the amount of X exiting the reactor with and without the ambient air allows the OH reactivity in ambient to be determined. In the first version of this set up, molecule X was pyrrole (C5H4N) and the detector used was a proton transfer reaction.
spectrometer (PTR-MS), although in principle any detector may be used if a suitable molecule is
available. The PTR-MS has been used extensively over the last decade to measure ambient VOCs
(Lindinger et al. 1998). If a molecule of interest has a proton affinity greater than water and is at
sufficient concentration it may be measured by PTR-MS. An advantage of the CRM method is that it
requires only the precise quantification of a stable VOC at ppbv levels rather than the more
technically challenging LIF based measurement of highly reactive OH radicals at concentrations
more than 103 times lower.

- **Preliminary results and conclusions**
  1) Side by side comparisons of two CRM systems were made for the first time. These systems were
     configured slightly differently, and this campaign should permit an assessment of the two different
     regimes.
  2) The MPI OH reactivity systems (both GC-PID and PTR-MS) and measured ambient air the remote
     continental site throughout the campaign with minimal instrumental problems. As well as in
     relatively clean ambient conditions when the air came from the south or southwest (reactivity ca.5
     s-1), measurements were also made in the Paris plume which was advected over the site in the
     period 3rd-5th July.
  3) The Paris plume impacted the site at the time that CIMS and FAGE techniques for the measurement
     of OH were being compared. Thus we have obtained in-situ OH, the OH sink (OH reactivity) and
     measurements of several key sources (ozone, CH2O, HONO).
  4) The impact of high NO concentrations on the OH reactivity measurement was examined both in
     ambient data situations (when NO increased to ca. 15 ppbv) and in careful sequential additions of
     NO from a standard). This is the most thorough examination of this interference done to date.
  5) On the 7th of July we arranged that grass surrounding the measurement station would be cut with a
     motorized lawn mower. This released significant quantities of biogenic “wounding” compounds
     such as hexenol and hexenal from the grass and significant quantities of NO from the lawnmower
     motor. This enabled the NO sensitivities to be examined in ambient mixtures of VOC. Figure 1a
     shows the lawnmower in operation at the site, and Figure 1b the peak in reactivity observed in the
     raw data.

Figure 1a
6) In the final stages of the experiment the CRM OH reactivity set-up and the FAGE OH reactivity were measured in parallel, providing for the first time a dataset with which the two techniques may be compared.

- **Outcome and future studies**
  The data from all instruments must first be worked up and corrected for known interferences before final conclusions can be drawn. However, data for this comparison has been successfully obtained and a workshop has been planned in November for the detailed discussion of the results. The experience from this study can be taken forward into future intercomparisons.

- **References**


The purpose of the project is to better characterize organic aerosols (OA) and gas precursors (sources and properties) in the Eastern Mediterranean during a period of the year (falls) when photochemistry offers the best conditions to investigate OA having different oxidation states.

This project is part of ACTRIS TNA activity on “In-situ chemical properties of aerosols & Trace gases networking: Volatile organic carbon”. It is headed by LSCE (France, François Dulac) and hosted by FORTH for the Finokalia infrastructure.

This field experiment was a follow-up of the FAME-2008 field experiment which has shown that OA aerosol at Finokalia was highly oxygenated during summer (Lee et al., ACP, 2010) while its primary fraction (hydrogen-like OA) was not detected (Hildebrandt et al., ACP, 2010). High OH exposure may have partly explained this unusual pattern providing the need to perform a new field experiment (FAME-2011) under lower oxidative conditions (September-October 2011).

Based on a multi-tracer approach of organic material in gases/aerosols, LSCE contribute to this study by providing a time-resolved source apportionment of OA and VOCs (PMF & AETHALOMETER models). Such information is particularly valuable regarding the time-limited (but intense) OA-containing plumes which are passing over Crete Isl. Real-time information of water-(in)soluble OA (LSCE) will complete the OA oxidation/volatility measurements performed by FORTH.

The 2 LSCE Ph-D students – new users José Nicolas and Cerise Kalogridis work on the characterization of aerosols and reactive gases in the Mediterranean, respectively. These 2 students had here a unique opportunity to participate to an international field experiment (12 participants from Greek, French and US research tams) and get trained on many state-of-the-art field instruments.

Reason for choosing station

The Finokalia measurement station is ideally placed to examine the air masses advected from continental Europe. Local pollution is restricted to a few cars maximum per day passing on a minor coastal road ca. 50 m west of and some 20 m below the station. Coastal orography shifts the local wind direction from north/north-west to almost due west in summer, and only a slight sea-breeze oscillation in wind direction between day and night is generally observed. Air passing a substantial distance over Crete before arrival at the site is therefore rare at Finokalia under these conditions (Mihalopoulos et al., 1997), so that local effects on the atmospheric chemistry are minimal for long periods (Salisbury et al, 2003).
• Method and experimental set-up

Complementary to the instruments deployed by FORTH (thermo-denuded HR-ToF AMS, dry/wet SMPS, DAASS, APS …) and those available at Finokalia station, LSCE provided real-time information on water-(in)soluble OA (PILS-TOC & EC-OC Sunset field instruments), real-time measurement of specific organic tracers (oxalate, MSA by PILS-IC; levoglucosan, pinic/pinonic acids by PILS + LC-MS/MS), and real-time measurements of gas precursors (light NMHC by GC-FID, OVOCs by PTR-MS, NH₃ by AirRmonia). Filter samples were collected every 6 h as back-up of the on-line instruments and provided complementary information (sample library available for future exploratory organic speciation).

These measurements have been developed and qualified by LSCE (Sciare et al., AGU, 2011) and used successfully in the field to explore the water-(in)soluble fraction(s) of SOA (Sciare et al., JGR in revision, 2011). Most of these instruments have been deployed during the EU-FP7 MEGAPOLI experiments providing unique information on carbonaceous aerosols (Healy et al., 2011, submitted to ACP).

• Preliminary results and conclusions

Preliminary results are presented on the graphs below.
Aerosols’ measurements with an PM2.5 aethalometer, PILS-IC & PILS-TOC

During FAME-11, many breaks in power supply occurred causing a lot of data loss. After a first data processing and post-calibrations of the instruments, we will have a better view of our dataset. Complementary post-campaign analyses of organic tracers could then be scheduled on 120 6-hour filters (PM2.5 Partisol), and on 710 30-minute vials (PM2.5 PILS/BMI).

- Outcome and future studies

After this data processing period, data exchange and discussions will occur with the FAME-11 partners.

Results of the FAME experiments (2008 and 2011) will be compared with similar field studies which are planned in 2012 & 2013 in the western Mediterranean (Corsica Isl. in particular) as part of the CHARMEX project (http://charmex.lsce.ipsl.fr/; PI = François Dulac).

- References


FTIR participation during PEGASOS at Cabauw.

Acronym: FTIRPEG.

Martine DE MAZIERE.

Introduction and motivation.

This project’s general objective is to perform column measurements of CO, CH₄, and N₂O with a Fourier Transform Infrared (FTIR) spectrometer at Cabauw. Wherever feasible, information about the vertical distribution will also be retrieved from the spectra. The target species are relevant for air quality and climate studies.

Scientific objectives.

The more specific objectives of the project are:

- To perform the FTIR measurements in a period that includes the period when the PEGASOS (Pan-European Gas-AeroSOls-climate interaction Study, http://pegasos.iceht.forth.gr) zeppelin flies over the Cabauw site (May-June 2012), and to perform measurements in support of the PEGASOS and ACTRIS scientific objectives: partial and total columns of CH₄, CO, N₂O, and if possible also of CO₂ and NO₂.
- To make the observations with the FTIR instrument alongside with in-situ measurements on the ground and on the tall tower of Cabauw of the same target species plus NOx.

Therefore, the combination of the various observations should enable the study of the diurnal variation of local and regional sources and sinks. In the end, it is hoped to propose an optimization of the use of emission inventories in local and regional models.

Reason for choosing the Cabauw station.

The station hosted two relevant campaigns during the visiting period.
The first was the PEGASOS campaign (Pan-European Gas-AeroSOls-climate interaction Study) in May, and the second was the INGOS (Integrated Non-CO₂ Greenhouse gas Observing System) CH₄ Flux campaign.
Because of these campaigns, many other instruments were present in Cabauw, measuring a variety of relevant atmospheric parameters. Cabauw is situated in one of the most polluted regions of Europe, and is at the same time relatively far from local emission sources, so that the measurements at this site are representative for background pollution.

**Method and experimental set-up.**

The experimental set-up is the same as the one that we used during the 2004 and 2007 observations campaigns and for the continuous measurements since 2009 at La Réunion Island in the frame of the Network for the Detection of Atmospheric Composition Change (NDACC). It consists of an automatic and remote control system for solar absorption observations of the atmospheric composition with a Fourier transform Infrared Interferometer (FTIR) (Bruker IFS120M), the so-called BARCOS system. A complete description of BARCOS is given in Neefs et al. (2007).

Besides the FTIR instrument (Bruker 120M), the system also includes a solar tracker (ST), a meteorological station, an automatic liquid nitrogen filling system for cooling the detectors, and a data logger unit.

This setup enables completely automatic operation of the experiment; it enables also remote control from Brussels via Internet (a VNC connection).

A more complete description of the experimental setup at La Réunion can be found in Senten et al. (2008) and, Vigouroux et al. (2009; 2012).

**Preliminary results and conclusions.**

The PEGASOS Zeppelin flew over the CESAR site in Cabauw on five days between 19 and 27 May. There were in-situ measurements of a.o. CO, NO₂, CO₂, CH₄, and N₂O. During the INGOS campaign between 4 and 27 June, there were several instruments measuring CH₄, CO₂ and N₂O. Two air-quality models have been run for this time period: the Dutch Lotos-Euros model and the EURAD model from the University of Cologne. The data is currently being collected from the participating institutes.

The weather during June and July was unfortunately less sunny than normal, but in May we had a reasonable amount of clear sky hours, which is a prerequisite for obtaining good FTIR measurements.

Despite the bad weather, we got nearly 1000 FTIR spectra during the measurement campaign. The following table shows the number of raw spectra per day which we have obtained during this campaign (the letters ch, cl, ... correspond to different optical filters that we use to limit the spectral range of the light incident on the detectors. The different spectral ranges are listed and described in Senten et al. (2008).)

The analyses of the FTIR data obtained during this campaign are currently ongoing in collaboration between the participating teams of KNMI (Ankie Piters) and BIRA (M. De Mazière and Bavo Langerock, et al.) At start, BIRA will do the retrievals of the target species from the
FTIR spectra, and provide the retrieval results (i.e., the vertical profiles and total columns of the target species, and the associated averaging kernels and error budgets) to KNMI. The retrieval is performed with the latest version of SFIT2 (v3.94), which is the standard retrieval code in the NDACC Infrared Working Group. It is a line-by-line radiative transfer code, coupled with an inversion module based on the Optimal Estimation Method. The error evaluation algorithm was developed at BIRA for our NDACC retrievals at Réunion Island. Then the retrieved data will be exploited in synergy with the other data gathered at the site, by KNMI together with the other participating institutes.

As an example of retrieval results, Figure 1, left-hand side, shows parts of the solar absorption spectrum observed on May 24 in the 3micro windows, that are used to retrieve the CO vertical profile and total column. The retrieved profile, together with the a priori profile, is shown in the right-hand side of Figure 1. We have approximately 2 Degrees of Freedom for Signal in the CO vertical profile.

Outcome and future studies.

With the collected measurements, combined with the in-situ measurements of CO, CO₂, CH₄, N₂O, and NOₓ, we plan to study the diurnal variation in local and regional sources and sinks and possibly propose an optimization in the use of emission inventories in local and regional models.

References.


Table 1. Number of FTIR spectra acquired during the campaign. The various columns indicate the type of spectra, according to the optical filters limiting the spectral bandwidth incident on the detectors.

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Figure 1.
LHS: Solar absorption spectrum measured on May 24 at Cabauw. The three microwindows that are depicted are the ones selected for the retrieval of CO, shown in brown in the RHS of the figure; the a priori CO profile is shown in green. In the LHS, the observed spectrum is in blue, the simulated spectrum corresponding to the retrieved CO profile is in brown. The top figure shows the spectral residuals.
Introduction and motivation / Scientific objectives

Atmospheric aerosols have direct and indirect effects on the global climate. Particles alter the properties of clouds by acting as cloud nucleation nuclei (CCN) and as surface for heterogeneous reactions. Also particles are known to have adverse health effects (Pope and Dockery, 2006). Amongst others these effects depend on the chemical composition of the particles.

Aerosol chemical composition can be measured with high time resolution by the Aerodyne High Resolution Time-of Flight-Aerosol-Mass-Spectrometer (HR-ToF-AMS). In this campaign the applicants operated a HR-ToF-AMS at the CESAR-tower in Cabauw, the Netherlands in November 2011. The purpose was to characterize the non refractory aerosol-composition and to compare the results to data from the newly developed high resolution Thermo-Desorption-Proton-Transfer-Mass-Spectrometer (TD-PTR-ToF-MS) that was operated at Cabauw during this period. Previous comparisons of HR-TOF-AMS measurements with the quadrupole mass spectrometer TD-PTR-MS were performed by the group in summer 2008 and spring 2009 (Mensah et al., 2012). To investigate the seasonal cycle of aerosol chemical composition at Cabauw and to deepen the comparison of the two instruments, further measurements in autumn season were needed to widen the range of meteorological and atmospheric chemical conditions covered in our observations. Note that the use of high mass resolution for both instruments allowed for a much more detailed analysis of the composition of the organic fraction of the aerosol than previously performed, thus contributing to an improved understanding of organic aerosol formation and aging processes.

Data analysis involves instrument comparison with the co-located TD-PTR-TOF-MS. Using high resolution mass spectrometric data from both instruments the relative contributions of N- and O-containing organics to the aerosol composition are determined. This deepens the understanding of processes involved in organic aerosol mass formation and aging.

Additionally, this campaign acted as a trial for the upcoming PEGASOS-campaign in May 2012, partly in parallel with aerosol measurements onboard a Zeppelin over Cabauw.

Reason for choosing station

Besides the fact that the previous campaigns mentioned above were also performed at Cabauw Experimental Site for Aerosol Research (CESAR), it is located at a rural site and is a representative for North-West Europe. Depending on the wind directions, the conditions can be either of maritime or continental character. Furthermore, the plain geography of the Netherlands and especially in the area of Cabauw reduces ambiguities in terms of air parcel convection and turbulences.
Method and experimental set-up

The Aerodyne HR-ToF-AMS was deployed in the tower basement and connected to the aerosol sampling manifold installed at the 60 m platform. From there, it measured the size distribution and chemical composition of particles and was operated 24 hours/7 days a week for 5 weeks with a time resolution of 4 minutes. Its transmission efficiency for particles in a range of 70 nm to 500 nm is almost 100% (Jayne et al., 2000).

The sampling line was shared by other aerosol instrumentation like an SMPS. Close to the AMS inlet, a Condensation Particle Counter (CPC, TSI 3025a) was deployed, resulting in an overall flow of 380 mL min⁻¹ between the manifold and the AMS inlet through 3 m stainless steel tubing with an inner diameter of 4 mm.

Once a week the instrument was maintained and calibrated for the ionization efficiency and particle size using a calibration rack containing an aerosol-generator and a Differential-Mobility-Analyzer (DMA), and a CPC (TSI 3025a). To determine the gas phase background signal, measurements with an in line particle filter was performed every 2-3 days.

The TD-PTR-ToF-MS sampled from a height of 5m above the ground through a 10 m long copper tube with an inner diameter of 4mm. It is equipped with both a gas and an aerosol inlet and collects ambient particles in the size of 70 µm to 2 µm at an air sample flow rate of 1L/min (Holzinger et al., 2010a; Holzinger et al., 2010b)

Preliminary results and conclusions

The following graphs show preliminary data from AMS measurements:

Fig. 1: Mass concentrations and fractional abundances of aerosol species; relative humidity (RH) and temperature (Temp)
Figure 1 shows the temporal evolution of the total aerosol mass as well as of the most important aerosol species. Clearly seen are a number of periods with different mass loadings and different fractional abundances of these species, partly dominated by organics, sulfate or nitrate. These observations have to be referred to meteorological data like wind directions.

A first evaluation of the diurnal cycles shows night time maxima of the total mass and of the concentrations of Organics and nitrate. The last can be explained by the heterogeneous conversion of nitrate in the night and the volatilization of nitrate, especially ammonium nitrate, during the day.

The average particulate mass loading measured by the HR-ToF-AMS during November 2011 (Fig. 2) was 4.96 µg m$^{-3}$ (collection efficiency = 0.5) and lower than observed in previous campaigns in May 2008 (9.72 µg m$^{-3}$) and March 2009 (5.62 µg m$^{-3}$), both with a dynamic, nitrate-mass-dependent collection efficiency. The organic fraction was the dominant species (40 %) in November 2011, followed by nitrate (27 %) and sulphate (19 %). The observed aerosol composition was thus overall similar to the results from summer 2008, whereas in spring 2009 a dominant nitrate fraction (42 %) was observed (Mensah et al., 2012).

**Outcome and future studies**

A first evaluation of the particle concentrations, which were measured by CPC’s at the AMS- and the PTR-MS inlet, respectively, shows good agreement. Hence, the TD-PTR-ToF-MS- and the AMS data are comparable and will be used in detailed analysis of the composition of the organic fraction of the aerosols. Amongst others, further AMS data analysis will evaluate aerosol composition as function of size. For more detailed analysis of the organic fraction elemental analysis and Positive Matrix Factorization (PMF) will be performed.

In addition, this campaign proved to be a successful test campaign for the follow-up field measurements at the CESAR tower in May 2012, which partly took place in parallel with observations on aerosols onboard a Zeppelin flying over Cabauw and was coordinated with a European intensive measurement period defined by EMEP.
References


Introduction and motivation

The general aim of the MaCloud Inc. (Marine Aerosol – Cloud Interactions) was to build on recent advances in marine aerosol formation processes. In addition to coastal iodine-driven nucleation and growth events, it has been established that open ocean particle production and growth is frequent over the NE Atlantic and appears to be driven by organics. We aimed to better characterize these coastal and open ocean events. Recently, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low hygroscopic growth factors. We also looked into the role of halogens as well as organic ions in the burst-like new particle events at Mace Head.

Scientific objectives

(1) To source apportion marine aerosol
(2) Quantify formation and evolution characteristics
(3) Quantify hygroscopic and Cloud Condensation Nuclei (CCN) properties
(4) Quantify marine aerosol impacts on cloud microphysics.

The purpose of the winter campaign in 2010 is to quantify sea-salt production and it will characterise the low biological activity period on aerosol-cloud interactions. This will be followed up by a 2011 summer campaign to quantify primary/secondary and organic/biological impact on cloud microphysics within a high biological activity period.

Reason for choosing station

Coastal new particle formation is a frequent phenomenon (O’Dowd and Hoffmann, 2005) that has a strong connection to coastal tides, air mass origin and solar radiation. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is common over the NE Atlantic. We also observe sulphuric acid production with a distinctive diurnal cycle, but the involvement to the new particle formation bursts is much less than in continental air masses. The unique location of Mace Head station with strong costal tides makes it possible to study the two different nucleation pathways.

Method and experimental set-up

Our contribution to project “MaCLOUD Inc.” was to quantify atmospheric ion population in both in terms of the chemical composition and their physical character. A special focus was put to bursts of freshly nucleated particles in the coastal environment of Mace Head. We measured with an Atmospheric Pressure interface-time-of-flight mass spectrometer (API-TOF, Junninen et al. 2010, Ehn et al. 2010), which can probe the chemical composition of naturally charged ions in the atmosphere.
We also provided a detailed physical characterization of the ion population with a long-term (6 months) commitment using an Air Ion Spectrometer (AIS, Mirme et al. 2007) for size segregated ion concentration. Furthermore, we deployed a Particle Size Magnifier (PSM, Vanhanen et al. 2010), which reveals the concentration of both charged and neutral particles in sub-3 nm particle size. These instruments provided data in the sub-3 nm particle size, which is the size where the gas-to-particle conversion occurs (Kulmala et al. 2007).

**Preliminary results and conclusions**

Preliminary data indicates that during the campaign the ion composition during the new particle formation bursts (Fig. 1) was dominated by iodine, iodic acid, and their clusters. We also observed sulphuric acid production with a clear correlation with solar radiation. The involvement of sulphuric acid to the new particle formation bursts was much less than in continental air masses. Negative ions such as bromine, bromate, perchlorate, and their clusters were often present as well as multiple positively charged organic ions. Example of the identified negative ions is presented in figure 2 and time series of the most abundant negative ions in figure 3. The process of assimilating the ion composition of the marine aerosol with the coastal tides, temperature and radiation is still ongoing.

A more detailed data analysis is currently underway and the results presented in this short report need to be considered as a preliminary effort only. However, already the vast amount of data that we gathered during the MaCLOUD experiment will definitely improve our understanding about the marine and coastal aerosol particles and ions and their role in the atmosphere.

Figure 1. Number size distribution of ambient ions measured with AIS at Mace Head on 30th April 2011 showing Class I type new particle formation event.
Figure 2. Negative ion spectrum measured with the API-TOF at noon 30th May 2011 showing iodine containing ion clusters and sulphuric acid and its clusters.

Figure 3. An exemplary time series of most abundant naturally charged negative ions in Mace Head, 30th May 2011.
Outcome and future studies

Future studies will concentrate on better understanding the frequently observed coastal new particle formation. Preliminary results indicate iodine, bromine and sulphuric acid to dominate the chemical composition of the marine aerosol but more detailed analysis is yet required to further characterize positively charged organic ions and the effect of algae emission on nanocluster formation.

Due to a long period of ongoing measurements we are able to study seasonal variation and the influence of biological activity to ions and nanoclusters in Mace Head atmosphere. A vast amount of data gathered during MaCloud Inc campaigns will definitely improve our understanding about the marine and coastal aerosol particles and ions.

As a product of this TNA, the following conference abstract to was produced:


Furthermore, the following manuscripts are currently under way;


References


Introduction and motivation

MaCloud Inc. (Marine Aerosol –Cloud Interactions) aims to build on recent advances in marine aerosol formation processes, both in terms of secondary and primary formation processes. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics. In spite of the potentially major influence these particulates have on marine clouds, these constituents and processes are currently not adequately represented in meteorological and climate models (Forster et al., 2007), so in order to improve predictive capability, a greater bottom-up understanding of these behaviors must be obtained through comprehensive observations in real-world scenarios.

Scientific objectives

This project aims to better characterize these coastal and open ocean events. Further, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low growth factors. The project will aim to characterize the growth factor and CCN activity of varying organic matter enrichments in sea-spray aerosol. In particular, the project will:

1. use a range of on-line aerosol mass spectrometric techniques and off-line HNMR techniques for aerosol chemical characterisation (e.g. AMS, ATOFMS, MOVI-CIMMS, TD-CIMMS);
2. use a range of aerosol physics instrumentation for physical characterisation (NAIS/AIS, PH-CPC, nano SMPS, SMPS) with a focus on cluster formation as a function of I2 and H2SO4;
3. use a range of mass spectrometer techniques for gaseous characterisation (O3, VOC, OH, H2SO4, MSA, I2, AMSs API-TOF, PSM, and PTR-MS)
4. use a range of hygroscopic uptake and CCN instruments both for air and laboratory studies into secondary and primary organic aerosol. (HTDMA, VHTDMA, CCN, Bubble tanks).

Aims and objectives:

1. to source apportion marine aerosol
2. quantify formation and evolution characteristics
3. quantify hygroscopic and CCN properties
4. quantify marine aerosol impacts on cloud microphysics.

The 2011 campaign will characterise the high biological activity period impacts on aerosol formation and aerosol-cloud interactions and follows the winter 2010 low biological activity period of measurements in 2010 which was part supported by EUSAAR.

Reason for choosing station

Mace Head is the best location for this work for a number of reasons. It has been shown to be one of the best stations for the measurement of Northern Atlantic marine air, as it is frequently influenced by
airmasses from the west that have not been influenced by European emissions. The site is very well
classified, with a wealth of previous measurements (from both long-term and intensive campaigns).
The measurements were also very well supported by the permanently deployed instrumentation at the
site, which provided meteorological, remote sensing and other in situ aerosol composition measurements
that would strongly complement the measurements proposed. It is also useful that the PI has worked at the
site on a number of occasions in the past, so is already familiar with the facilities.

- Method and experimental set-up

The University of Manchester (UoM) deployed a hygroscopic tandem differential mobility analyser
(HTDMA) (Cubison et al., 2005) and monodisperse cloud condensation nuclei counter (CCN) (Irwin et al.,
2010; Good et al., 2010). The purpose of these was to measure the water vapor interactions of particles in
the sub- and supersaturated regimes respectively. The HTDMA is similar to other instruments deployed by
NUI Galway and Claremont Ferrand, but it brought the ability to be able to perform programmable
humidograms (studying water uptake as a function of relative humidity rather than a fixed humidity) and
adjust the equilibration times in the instrument. The CCN allowed the study of the activated fraction of
particles (compared to a condensation particle counter) as a function of both supersaturation and particle
dry size. Inversion methods developed at UoM are employed in the analysis of data from both instruments
(Gysel et al., 2009). The instruments were located in a trailer owned by UoM and sampled air through a
cyclone to remove larger particles. The aerosol was dried using a membrane drier prior to analysis by both
instruments. The instruments were also made coincident with measurements aboard the FAAM BAe-146
research aircraft, which conducted in situ measurements of cloud microphysics above the site.

- Preliminary results and conclusions

Analysis work is currently ongoing, but initial results have been promising. The growth factors of particles at
90% RH have been retrieved and can be seen to vary, so a variety of different aerosol types were
characterized:
The HTDMA was also able to collect humidograms of the ambient aerosol:

The analysis of the CCN data is currently ongoing but initial results show that good data coverage was obtained. Overall, a high-quality dataset was obtained where a number of different aerosol types were encountered.

- **Outcome and future studies**

These results will be the subject of ongoing analysis. Once the inversion and quality assurance of the HTDMA and CCN data are complete, they will be compared with the other data available from the site from other institutes. This will include other equivalent hygroscopicity measurements and measurements of composition from the Aerosol Mass Spectrometer and impactor analyses. On a technical level, consistency
between hygroscopicity measurements will be assessed and where differences exist, we will investigate this in lights of variables such as organic content of the particles and the residence time in the instrument. The measurements of composition will be used to inform a closure study between the measured and modeled values of growth factor and critical supersaturation. The performance of detailed models such as ADDEM (Topping et al., 2005a, b) will be tested, as well as less explicit parametrisations such as kappa-Kohler (Petters and Kreidenweis, 2007) that are better suited for implementation in large-scale models. These assessments will also be compared with similar exercises performed in other environments and geographic areas (Good et al., 2010; Irwin et al., 2010; Allan et al., 2009). These results will be analysed in the context of the data on meteorology, airmass origin and phytoplankton activity provided by NUI Galway, to assess the potential influence of biogenic organic matter, as has been performed in previous studies (O’Dowd et al., 2004). Finally, we will try to form linkages between the aerosol composition and properties measured on the ground with stratocumulus cloud microphysics, measured in situ using FAAM or the remote sensing products available at Mace Head. This will in turn help to validate and inform model treatments of cloud microphysics in these environments. Throughout this, we will work closely with our collaborators at Galway and Claremont Ferrand and will work together to produce publications on these subjects, speculatively aiming to submit to a high-impact journal during the latter half of 2012.

• References

Introduction and motivation

Oceans, covering about 70% of the earth surface, are an important source of both primary and secondary aerosols, which further affect formation and properties of marine clouds. Recent advances in understanding the production processes of marine aerosols are encouraging (e.g. O’Dowd, C. D. and de Leeuw, G., 2007). Yet, a more quantitative knowledge is required in order to adequately present the climatic effects of marine aerosols in global scale models. This project aims to build on recent advances in marine aerosol formation processes and marine aerosol-cloud interactions.

Scientific objectives

In addition to coastal iodine-driven nucleation and growth events (e.g. O’Dowd et al., 2002), it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics (O’Dowd et al., 2010). This project aims to better characterize these coastal and open ocean events. Further, aerosol mass spectrometry has revealed unique marine aerosol organic characteristics with effective cloud nucleating properties despite low growth factors (Ovadnevaite et al., 2011). The project will aim to characterize the growth factor and CCN activity of varying enrichments of sea-spray aerosol. Extensive measurements of aerosol physical and chemical properties, both in gas and solid phase, will be used simultaneously for aerosol characterization. In particular, LaMP measurements contribute to a better quantification of volatile and CCN properties of marine aerosols by using VTDMA and CCN measurements in parallel and coupled. The 2011 May campaign characterises the high biological activity period on aerosol-cloud interactions and can be compared to the previous winter 2010 low biological activity period. In case of open ocean nucleation, the volatility and hygroscopic properties of the newly formed aerosol will complete the information obtained from the TD-CIMS operated by the Helsinki group.

Reason for choosing station

The station is one of the rare sites where fresh marine aerosols, without major anthropogenic influences, can be studied. It is frequently gathering air masses directly from the East Atlantic and has served as a research site for several marine aerosol studies in the past. The station infrastructure is excellent, and the measurements profit of the diverse permanent on-site instrumentation as well as the supportive campaign measurements.

Method and experimental set-up

LaMP provided measurements of aerosol size resolved CCN properties at 2 different supersaturations, as well as aerosol volatilization at temperatures between 100 and 150 degrees.
Size-resolved CCN-activation properties of particles were measured for the first 2 weeks of the campaign using a mini-CCN chamber at two supersaturations. Both marine and continental air masses were prevailing during this time and the obtained data will allow making comparisons of the CCN activation properties at different air mass types. Results will be compared with those of the other groups to obtain a wider range of supersaturations as well as to ensure the congruence and quality of the data.

Particle volatile properties at 100 degrees (occasionally also 150 degrees) as a function of size were measured for the whole campaign using self-built LaMP VHTDMA system (Villani et al., 2008). Dry and volatile scans were performed, one by one, for sizes 50, 75, 110 and 165 nm in diameter. This data will be complementary for aerosol chemical composition, hygroscopic and CCN activation measurements to better understand the effect of changes in chemical composition for the particle climate effects during aerosol processing as well as to examine the particle mixing state.

For the last two weeks of the campaign, the V-TDMA instrumentation was modified and coupled with the CCN chamber with an ambitious goal to measure the change in CCN activation properties after volatilisation of the particles. This was done in order to offer supplementary, novel data for other measurements. Bubbling experiments with artificial sea salt and sea water were also done for obtaining a reference for atmospheric results to facilitate the interpretation. The data will be used to answer the question whether the volatile, presumably organic, fraction of the marine aerosol suppresses cloud activation. In my knowledge, these types of measurements have not been obtained previously. Coupled with aerosol chemical composition, size distributions, hygroscopic properties and air mass origin, the results can be used to quantify the volatile properties and activation potential of primary and secondary marine organic aerosol.

**Preliminary results and conclusions**

Particle volatile properties showed interesting variations with both time and size. In particular, in marine air masses, bimodal volatilized distribution, indicative of external mixture, was often observed. In this case, a non-volatile sea-salt mode coexisted with a moderately volatile mode likely composed of sulphate particles enriched with varying fraction of organics. Particle volatility generally increased with size and average “growth” factors varied around 0.85 and 0.95 (Fig. 1).

![Figure 1. Time series of volatilized fractions for different sizes.](image-url)
It also appeared that there is a correlation between particle volatility and CCN activation (Fig. 2). However, a detailed time-series analysis with supplementary data is needed to confirm the effect of different types of organics, of which a part may not be volatile at measured 100 degrees.

Figure 2. Preliminary (uncorrected for losses etc.) averaged particle activated fraction as a function of size for volatilized (100 °C) aerosol (open black circles), for dry aerosol (filled circles) and for ammonium sulfate (blue diamonds) using CCNc temperature difference of 6 °C. Colour scale indicates the change of the volatilized fraction between dry and volatilized measurement.

Outcome and future studies

The results offer important auxiliary information, when the effects of different types of organics for particle cloud activation and cloud microphysical properties are studied. They also provide direct evidence of the effects of aerosol volatile fraction on particle cloud activation. As a first step, quality assurance will be completed by comparisons with measurements of groups from UK, Ireland and Finland. Analysis of air mass origin together with particle chemistry will be used to separate between aerosols of different origin and organic enrichment. Periods with indications of influences from primary marine organics as well as the periods of open ocean particle formation will be studied separately to conclude on the volatile properties of marine primary organics, after which the cloud activation properties of different aerosol types will be studied. Finally, the impact of these activated aerosols on cloud optical and microphysical properties will be studied.
References


Introduction and motivation

New particle formation is the spontaneous creation of new nanometer-sized particles in the atmosphere. Observations spanning from megacities to isolated forests show that these events can occur frequently and extend for hundreds of square kilometers. While the impacts of these events are not well understood, they are often the dominant source of particles in the remote regions and could play a crucial role in the Earth’s climate by regulating the number and activity of cloud condensation nuclei (CCN). This effect of aerosols on cloud properties is recognized in the Fourth IPCC Assessment Report as the largest single contributor to uncertainty in predicting climate change. Since cloud droplet activation normally occurs on particles of about 100 nm in diameter, the key to understanding the impact of new particle formation on climate lies in the ability to predict both the formation and growth rates of newly formed particles.

Scientific objectives

The current study is motivated by the need to understand the species and mechanisms by which new particles form and grow in a coastal environment. This will be accomplished by directly measuring the chemical composition of nanometer-sized particles at Mace Head Research Station in County Galway, Ireland using the Thermal Desorption Chemical Ionization Mass Spectrometer (TDCIMS) (Smith, Moore et al. 2004). If successful, these will be one of the most complete data sets on the composition of nanometer-sized marine aerosol.

Reason for choosing station

The site of the measurement campaign, Mace Head Research Station, is the most extensively studied marine site focusing on aerosol physico-chemical properties. Two primary types of marine-influenced events have been reported. The first is characterized by intense bursts of sub-20nm diameter particles, and is thought to be caused by iodine species emitted from seaweed at low tide (O’Dowd, Jimenez et al. 2002). These events are thought to occur onshore. The second is characterized by the appearance of 15 nm diameter particles at Mace Head, which subsequently grow slowly to diameters of ~50nm (O’Dowd, Monahan et al. 2010). These events are expected to occur offshore, and have been termed “open ocean nucleation events.” Other studies at Mace Head have highlighted the importance of organic compounds in marine aerosol during periods of high biological activity (Facchini, Decesari et al. 2008).

Method and experimental set-up

The TDCIMS measurements were performed during 13 – 31 May 2011 (2.5 weeks). The instrument was located in the upper cottage at Mace Head, with a sampling inlet consisting of 10mm copper tubing protruding above the cottage. Sampling was performed at three different particle diameters: 15 nm, 20 nm, and 30 nm. The size was chosen to correspond to the peak in the nucleation mode of the size distribution. Samples were collected for 15-30 min, and both positive and negative ion mass
spectra were acquired to obtain the most complete representation of size-resolved aerosol composition. This resulted in a measurement frequency of approx. 1 hr. Standards for calibrating inlet sensitivity as well as mass spectrometer accuracy were applied throughout the study.

**Preliminary results and conclusions**
The measurement period was characterized by steady offshore winds and offshore “open ocean nucleation events” such as the one shown in Figure 1. Two events are actually shown in the plot: one from the previous day ends at ordinal date 140.2 (≈5:00AM) with a peak at ≈40 nm (black circle) and another that begins at ordinal date 140.3 (≈7:00 AM) with a peak at ≈20 nm. Figure 2 shows a TDCIMS-derived mass spectrum of the chemical composition of aerosol sampled during the period circled in Figure 1. This spectrum is typical of many obtained during the measurement period. As shown in Figure 2, chlorine-and sulfur-containing species dominate the ion abundance. Additionally, many smaller peaks that correspond to organic compounds were observed. During the observation period, onshore events were observed only during a few periods.

**Outcome and future studies**
A thorough analysis of the dataset is currently underway. Already it is clear that the dataset will provide many insights into the composition of aerosol produced during open ocean nucleation events. A publication is planned summarizing TDCIMS measurements of nanometer-sized marine aerosols from the campaign. This will be submitted on or before summer 2012. A future study that focuses on iodine-influence onshore formation events would nicely complement the current data set. Although no future plans have been made, the PI is interested in participating in such a study in the near future as schedules and funding permit.

Figure 1. Particle size distribution evolution on 20 May 2011, showing the tail end of an open ocean nucleation event (circled) as well as the start of a new open ocean event starting at 7:00 (corresponding to 140.3 on the abscissa).
Figure 2. TDCIMS-derived background-subtracted negative ion mass spectrum of the composition of 30 nm diameter particles collected during the period circled in Figure 1. Positive-going peaks correspond to ions detected in the sampled aerosol. The identities of the major ions are shown.

References

Introduction and motivation

The Earth’s atmosphere represents a complex chemical and dynamical system. Its behavior is governed by various feedback mechanisms and interactions with other subsystems of the Earth – such as ocean, biosphere and cryosphere – that frequently cause non-linear responses of the atmosphere to external perturbations, often with harmful consequences for the environment. It is therefore of great importance to quantify the key processes controlling the chemical, dynamical and radiative properties of our atmosphere as a whole.

During recent years it became increasingly clear that halogen chemistry - beyond its well known influence on stratospheric ozone - plays an important role in the chemical and physical processes of the troposphere [e.g., Barrie and Platt 1997, Platt 2000, Platt and Hönninger 2003, von Glasow and Crutzen 2007, Pöhler et al. 2010]. This is particularly evident within the marine boundary layer [e.g. Sander and Crutzen 1996, von Glasow et al. 2002a, b, Read et al. 2008], but chemical processes related to reactive halogen species (RHS) i.e. halogen atoms, molecular halogens and oxidised halogen species may affect the entire troposphere [e.g. Platt and Hönninger 2003, von Glasow et al. 2004]. Also it turned out that liberation and the recycling of RHS is largely promoted by multi-phase processes [e.g. Vogt et al. 1996, Tuckermann et al. 1997, Platt and Lehrer 1997]. To date significant involvement of reactive halogen species has been identified in a large number of processes, many of them connected to the atmospheric oxidation capacity and the nitrogen and sulfur cycling between the atmosphere and the ocean. These include:

- Modification of the tropospheric oxidation capacity
- Formation of new particles through nucleation of iodine oxides
- Change in the DMS degradation mechanism leading to reduced formation of sulfur particles
- Ozone destruction and reduction of ozone formation
- Enhancement of the OH/HO\textsubscript{2} ratio
- Enhancement of the NO/NO\textsubscript{2} ratio (Leighton ratio)

In summary it is now very likely that halogen chemistry has a significant influence on – at least - the marine atmospheric chemistry and physics on a global scale. However, many underlying mechanisms are presently not understood. Also the spatial emission and extent of the areas where halogen chemistry is of importance needs to be much better quantified. The most likely source of reactive iodine is the photolysis of molecular iodine and organohalogenes emitted by macro algae at coastal sites if they set under “stress”. O’Dowd et al. [2002] and Mäkelä et al. [2002] indicate that reactive iodine plays a key role in the formation of new particles in coastal areas which could also be shown by our group [e.g. Seitz et al. 2010]. If those particles grow to become cloud condensation nuclei (CCN), they could influence cloud properties and therefore have an impact on climate.

However the emission strength variability and influence on aerosol formation are not well quantified. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics.

To quantify both formation processes the measurements of particles in combination with RHS are required. However RHS observations are rare as their low concentration and high reactivity makes the observation impossible with most measurement techniques. Many field studies on RHS were carried by applying the LP-DOAS technique at the Mace Head atmospheric research station [e.g., Alicke et al., 1999; Hebestreit, 2001; Saiz-Lopez and Plane, 2004; Saiz-Lopez et al., 2004a, 2006a,b; Peters et al., 2005; Seitz et al. 2010]. The most relevant RHS at such coastal sites is iodine oxide (IO) which is studied in this project. IO emissions seem to be highest at high solar radiation, and thus in summer, with coincidental low tide, when the coastal macro algae are set under “stress”.

Model calculations from Burkholder et al. [2004] state that the concentrations of iodine species (the most relevant RHS in these coastal areas) derived so far (at different locations including Mace Head) with the LP-DOAS measurements are to low to account for the large aerosol production observed. They suggested a
possible reason for the disagreement between model calculations and field observations which is an inhomogeneous location of iodine sources, with much above average IO mixing ratios, so called “hot-spots”. This would have significant influence on the RHS chemistry and particle formation processes and thus the total impact of RHS on a global scale. Such strong local variations are possible as emitted RHS can have a very low lifetime and/or chemical processes directly occur after emission. Recently our group from Heidelberg could support this theory by observations at the MRI, where concentrations of IO were very different on the scale of few 100m observed with two averaging LP-DOAS light paths [Seitz et al. 2010]. To prove the theory of inhomogeneous iodine sources and chemistry several authors [e.g. Seitz et al., 2010; Furneaux, 2010] recommend further in-situ measurements with new mobile I$_2$ or IO instruments that measure these trace gases directly inside the macroalgae beds and thus allow to determine reliable emission factors for different macro algae and seaweed species in their natural environment. Furthermore this would also allow to quantify the local distribution of reactive iodine with a high spatial resolution, a key information for the validation of chemical models which is important to improve our understanding of tropospheric halogen chemistry.

**Scientific objectives**

MaCloud Inc. (Marine Aerosol –Cloud Interactions) was aimed to build on recent advances in marine aerosol formation processes, both in terms of secondary and primary formation processes. Different measurement techniques were applied to better characterize these coastal and open ocean events. Therefore different aerosol mass spectrometry observations are used to quantify marine aerosol organic characteristics with effective cloud nucleating properties. The project was aimed to characterize the growth factor and CCN activity of varying organic matter enrichments in sea-spray aerosol in combination with a series of gaseous characterization. In particular, the project was applying for the aerosol observation:

1. use a range of on-line aerosol mass spectrometric techniques and off-line HNMR techniques for aerosol chemical characterisation (e.g. AMS, ATOFMS, MOVI-CIMMS, TD-CIMMS);
2. use a range of aerosol physics instrumentation for physical characterisation (NAIS/AIS, PH-CPC, nano SMPS, SMPS) with a focus on cluster formation as a function of I$_2$ and H$_2$SO$_4$;
3. use a range of mass spectrometer and spectroscopic techniques for gaseous characterisation (IO, O$_3$, VOC, OH, H$_2$SO$_4$, MSA, I$_2$, BrO, AMSs API-TOF, PSM, and PTR-MS)
4. use a range of hygroscopic uptake and CCN instruments both for air and laboratory studies into secondary and primary organic aerosol. (HTDMA, VHTDMA, CCN, Bubble tanks).

With the aim:

1. to source apportion marine aerosol
2. quantify formation and evolution characteristics
3. quantify hygroscopic and CCN properties
4. quantify of marine aerosol impacts on cloud microphysics.

The 2011 campaign was characterising the high biological activity period impacts on aerosol formation and aerosol-cloud interactions and follows the winter 2010 low biological activity period of measurements in 2010 which was part supported by EUSAAR.

Our part was to quantify the contribution of coastal halogen emissions on aerosol formation by measurements of RHS. To derive the spatial variability of the RHS and thus the possible very local influence on aerosol formation, we applied a new in-situ technique (CE-DOAS for IO) in combination with the well established LP-DOAS (IO, BrO, O$_3$) technique.

**Reason for choosing station**

The West coast of Ireland is famous for large amounts of different macro algae and the remote site Mace Head is perfect for the investigation of naturally emitted RHS from coastal macro algae and the formation of particles. In this area interferences with human pollution are low. Most of former investigations of RHS are made at Mace Head, thus new techniques and measurements can be compared to these observations. Only 6km south-east from Mace Head the Martin Ryan Institute (MRI) is located where the Marine Science is investigated including macro algae. Our cooperation with the MRI helps us to quantify the different algae types and thus their influence on RHS. The permanent measurement of aerosols at MaceHead, and the additional aerosol characterisation during MaCloud, gives the possibility to put the RHS observation in context to aerosol formation.
Method and experimental set-up

The DOAS technique, investigated by Prof. U. Platt (University of Heidelberg, Platt et al. 1979), allows the direct observation of many RHS in the atmosphere. The basic principle is based on the absorption spectroscopy of the molecules. To separate between different molecules and the aerosols, DOAS use the spectrally narrow and characteristic structures of the molecules in the UV and visible spectral range. Therefore active Long Path (LP-) DOAS instruments emit a broad spectrum in the desired spectral range (typically UV and visible) which passes the atmosphere few 100m to 10km. The received spectrum can then be analysed and gives the concentration of the trace gas averaged along the light path. Most RHS are measured using LP-DOAS at ppt level with several kilometer light paths. One has to keep in mind that possible inhomogeneous distributions of RHS cannot be resolved along the path. We developed in Heidelberg two new measurement instruments also based on the DOAS technique to quantify the spatial variability of IO which is part of current research.

First, a new LP-DOAS instrument was developed and applied for the first time during the MaCloud campaign. The new instrument allows now to setup LP-DOAS measurements of RHS within few hours at different locations and thus to quantify the concentrations at different coastal sites. The lower power consumption allows a battery power supply. The LP-DOAS was setup at Mace Head with a light path of 3km crossing three bays with potential RHS emissions (Fig. 1).

Fig 1: Set-up of LP-DOAS and CE-DOAS at Mace Head. LP-DOAS was set-up this time to cross 3 bays with high macro algae amount and thus be more correlated to coastal affects that for the measurements in 2007. The CE-DOAS was located first directly at Mace Head, and later about 200m from the station directly at the water line (bay).

Second, we applied the very new Cavity Enhanced (CE) – DOAS technique [Platt et al. 2009, Meinen et al. 2010], to the observation of IO in the ppt range. CE-DOAS uses passive optical resonators to provide long light paths (> 1km), in a relatively compact setup with resonator lengths in the order of 1m (see Fig 2). Thus a CE-DOAS instrument achieves the same sensitivity like a LP-DOAS but measures the air mass just at the
instrument location. We focused on the development of a mobile CE-DOAS instrument for the observation of IO down to 1ppt, which is the first instrument of this kind. Our final setup has a weight of about 25 kg and can be placed on two tripods at any location. Thus it can observe so called “hot spots” with locally very high concentration. In combination with the compact LP-DOAS instrument it can answer the question of spatial iodine variations at coastal sites and their influence on aerosol formation and tropospheric ozone destruction. The instruments are complemented by an Ozone monitor.

Continuous measurements were done at Mace Head (incl. installation) between 14th to 30th May 2011. Thereby the CE-DOAS instrument was varied between two locations, one directly at the measurement station, and a second about 200 m away directly at the waterline in the bay were significant algae are present. Afterwards measurements were performed at other coastal sites outside Mace Head. The research station was still used as base for repair of instruments and calibration. Measurements were performed for several days at the Martin Ryan Institute (MRI), Carna, one day at Meenish Island, one day at an Belly Conelly and one day at a seaweed factory. The Days at Mace Head research station were as follows:

<table>
<thead>
<tr>
<th>Date</th>
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<th>Persons</th>
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</tr>
</thead>
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<td>3</td>
<td>Installation and continuous measurements at Mace Head, Calibrations</td>
</tr>
<tr>
<td>31/05</td>
<td>1</td>
<td>3</td>
<td>Calibration</td>
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<tr>
<td>04/05</td>
<td>1</td>
<td>3</td>
<td>Calibrations</td>
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<tr>
<td>06/06</td>
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</table>

**Preliminary results and conclusions**

Measurements with the two applied instruments could be realised at Mace Head during several days. However weather conditions were very bad for this time of year and thus unfavourable for emissions of RHS. Most of the days were rainy or cloudy with wind speeds above 10 m/s. Thus solar radiation was to low for RHS emissions. If emissions arise the strong wind resulted in a very fast dilution so that RHS concentrations are typically below detection limit. During days with stormy weather (23rd and 26th of May), with wind speeds above 20 m/s, the instruments had to be dismantled to avoid larger damages. At these metrological conditions the observed concentrations are most of the time below the detection limits of the instruments (LP-DOAS 1.5ppt; CE-DOAS 2ppt), as expected. Only during two days the LP-DOAS observed concentrations of up to 2ppt (Fig 3), with max. concentration of up to 2ppt. Concentration peak correlate well with high solar radiation and low tide as expected. However the level is much lower than typically observed for this time of year. Thus particle formation due to RHS is less important during the MaCloud measurement campaign than it is the typical case for Mace Head. The CE-DOAS instrument could not observe IO on the same days, but for a short sunny period on the 30th of May with levels of up to 22ppt when it was not measured with the LP-DOAS. The differences in both instruments, which actually observe the IO concentration from different air masses, indicate that emissions are very inhomogeneous. The CE-DOAS could see very shortly a very high concentration as it was located only few m from the algae. However the LP-DOAS average over a large area, but may also see emissions further away due to different algae types.

Fig 3 Observed IO up to 2ppt at Mace Head with the LP-DOAS. Concentration peak correlates well with high solar radiation and low tide. However the concentration is very low for this time of year and location.
In June measurements were performed at other coastal sites outside from Mace Head. These were typically locations where large areas with macro algae were exposed to the air during low tide. Even if metrological conditions were better as for the measurements at Mace Head, the observed concentrations were one order of magnitude higher that at Mace Head (Fig 4). Also very strong local variability could be observed. For example on the 2\textsuperscript{nd} of June when the LP-DOAS measured up to 30ppt averaged over 1012m, the CE-DOAS could observe even 100ppt in the algae field itself (Fig. 4). On other days when the CE-DOAS could still observe significant IO levels of much more than 10ppt in the algae field the LP-DOAS just saw a few ppt (<10ppt) (Fig 4). These observations prove the spatial inhomogeneous emission of iodine and distribution of IO.

Similar observations could also be made at the Coast of Meanish Island. We also saw very strong variability between the locations. Thus much more observations are required to do any assumptions about total emissions and impact of iodine for the whole coastline.

![Fig 4 Observed IO up to 30ppt at the MRI with the LP-DOAS (left). Concentration peak correlates well with high solar radiation and low tide. The CE-DOAS observed at the same time up to 100ppt. Also CE-DOAS observed IO up to 50ppt at days when the LP-DOAS just observed levels around few ppt (right).](image)

**Outcome and future studies**

We conclude that the RHS concentrations are very low at Mace Head during cloudy and windy weather situations. RHS are not significantly involved in aerosol formation and ozone depletion during MaCloud. Different concentrations observed with the two instruments indicate very different sources with strong spatial variability. A general conclusion with any RHS measurement cannot be made for aerosol formation as their concentration may be spatially very variable. Further improvements to the instruments are necessary to be more resistant to the strong winds permanently arising at Mace Head.

Future observations at Mace Head and surrounding should be performed over a longer period to perform measurements at various metrological situations and thus have the possibility to conclude on the variability of RHS levels for different conditions.

At other locations close to Mace Head, with much higher macro algae abundance, much higher IO concentrations are observed. Thus indicating that halogen emissions are maybe much more important at the West coast of Ireland than so far expected from measurements at Mace Head. Further measurements of RHS are necessary especially at various coastal sites to investigate the local importance and difference from coast to coast. However many of these measurements are necessary as the metrological conditions have a very strong influence on the actual emissions.

We could prove that local IO concentrations are several times higher in these algae field than so far observed with the LP-DOAS averaging over a few 100m. Thus concentrations are actually above the algae field sufficient high to initiate particle nucleation as described above.

Additional measurements of IO with the improved instruments are planned for summer 2012 at Mace Head and along the Irish West coast. The results from the measurements 2010 are planned to be published.

**References**


Introduction and motivation
Phytoplankton is ubiquitous in the oceans and most species of phytoplankton excrete dimethylsulphide (DMS). DMS is oxidized in the atmosphere and a significant amount of the products will end up in aerosol particles. The role of the aerosol particles as cloud condensation nuclei lead to the suggestion of biologically emitted DMS being important for global climate [Charlson et al., 1987]. The publication Charlson et al. (1987) gave name to what has become known as the CLAW hypothesis. The hypothesis states that global warming will lead to increased emissions of DMS which will increase the concentration of cloud condensation nuclei (CCN). An increase of the concentration of CCN will lead to a larger concentration of cloud droplets that on average will turn smaller. When the average size of the droplets turn smaller the clouds will turn brighter and thus the clouds will more efficiently reflect the incoming sunlight and thus lead to a cooling of the climate. Thus the role of phytoplankton would be to stabilize climate.
The actual role of DMS on climate has been debated and later studies have pointed out that sea spray should not be neglected as a source of marine CCN [O’Dowd et al., 1997]. However the global emission of DMS is estimated to 13-37 Tg(S)/a and DMS is thus a main source of atmospheric sulphur [Kettle and Andreae, 2000]. A lot of questions about the actual role of DMS emissions on climate remain to be fully answered.

Scientific objectives
After the release of DMS to the marine atmosphere, it is rapidly oxidized to different sulphur containing compounds, where methanesulphonic acid (MSA) and SO$_2$ are among the most important. The only known source of MSA is from the oxidation of DMS. This makes it an important measure of the marine biogenic contribution to sulphur aerosols. The ratio between MSA and SO$_2$ is often calculated and used as a measure of how much sulphur that is released from natural versus anthropogenic sources. The purpose of the project is to measure the concentration of marine MSA in different aerosol particle size bins. In addition several other anions will be measured to facilitate the interpretation of the measurements.

Reason for choosing station
The Mace Head atmospheric research station is located close to the ocean on the Irish west coast. The site is ideally located to measure the prevailing (about 51% of the time) westerly-southwesterly air from the Atlantic [Jennings et al., 2003] and thus the airmasses often reflect the background remote marine conditions.
There are several continuous measurements of aerosol particle characteristics and meteorological parameters at the station, which is provided to optimize the planning of measurements and the interpretation of data. There is also an option to connect to a clean sector system so that the instrument only runs during clean background marine conditions. Furthermore the visit took place during the MACLOUD II campaign so that several intense measurements of special aerosol particle characteristics were carried out – which will provide additional data relevant for the interpretation of our results.

Method and experimental set up
An M110 MOUDI cascade impactor with ten rotating stages was used to collect particulate matter (PM) on impactor foils. The PM is size segregated into 10 size bins during collection and the instrument was operated with a flow rate of 30 L/min. The instrument was placed in a tower roughly 10 m above ground level at the Mace Head atmospheric research station. The distance to the shore line varied from roughly 80
m to 180 m depending on the tide. The samples were collected over two to three days to get enough mass for the analysis. The collected foils were extracted in Millipore water in ultrasonic bath for one hour. The solutions were filtrated and analyzed with ion chromatography using a Metrohm suppressed chromatography system with a Metrosep A supp 5-250 anion column.

Preliminary results
From the ion chromatograms the concentrations of several anions have been calculated. The preliminary results from the first five samples of the concentration of MSA versus particle size are depicted in figure 1. There seem to be two modes present – one centered around a particle diameter of 300 nm and another mode closer to a particle diameter of 1 μm. For the 5 shown samples two of them are partly influenced by continental airmasses during the days May 7th to 10th and again during May 13th to 15th. However from studies of wind direction, back trajectories and aerosol particle properties the three other depicted samples are expected to reflect background marine North Atlantic airmasses. There are still three samples remaining to be analyzed and all three of them are expected to be entirely representative of the marine North Atlantic background – except for one of them being influenced by the volcanic eruption of Grimsvötn.

Figure 1. The concentration of methanesulphonate in the different particle size bins versus aerosol particle size. The concentration (C) is inferred from ion chromatograms.

Outcome and future studies
The size distributions of methanesulphonate in marine airmasses have been inferred and from the preliminary results there seem to be two modes present. The picture seems to be similar when the samples are partly influenced by continental airmasses. The size distributions of other anions will also be inferred. Intercomparisons of the different anion concentrations may give information on whether the methanesulphonate is present in particles primarily consisting of sea salt or whether there will be separate modes dominated by sulphur containing compounds. During the campaign we encountered some days with very high winds speeds – so it will be investigated how wind speed has an effect on emission of DMS.

On May 24th the airmasses were influenced by the eruption of the Icelandic volcano Grimsvötn. Studies of backtrajectories and modeling performed by Volcanic Ash Advisory Centre in London confirmed that the
Airmasses were influenced by the eruption. The Aerodyne aerosol mass spectrometer at Mace Head detected an elevated level of the SO$_4^{2-}$ concentration for roughly 8 hours on May 24$^{th}$ along with an increase in particulate matter with particle diameters below 10 μm. The samples from this special event will be analyzed with a scanning electron microscope (SEM) to check whether ash particles are deposited on the foils. Furthermore the SEM studies may provide useful information about the morphology of the deposited particles in general.

References
Investigation of marine boundary layer and clouds with remote sensing instruments at Mace Head, MHDCloud

Anne Hirssikko

Introduction and motivation
There has been extensive research on the properties of clouds, their formation and evolution, as clouds are responsible for redistributing water and are a major component in the global energy budget. Aerosols can modify cloud properties and further research is required to understand this aerosol-cloud interaction. Cloud layers within the well-mixed boundary layer are directly influenced by ground and ocean based anthropological and natural cloud condensation nuclei (CCN) sources. Turbulent mixing within the atmospheric boundary layer provides a mechanism for transporting gaseous and particulate matter, and is a significant factor in a variety of processes (e.g. gas exchange between the atmosphere and soil/ocean, aerosol nucleation, cloud formation). For many of these processes, an important parameter to determine is the mixing-level height, MLH, which is the top of the atmospheric region in constant contact with the surface through turbulent mixing (White et al., 2009).

Liquid cloud layers, such as stratocumulus or cumulus, at the top of the boundary layer can then be separated into two distinct groups:

- Coupled, where the cloud layer is present within or at the top of the mixed layer
- Decoupled, where the cloud layer is above the MLH

For cloud layers that are coupled with the surface, we assume that the aerosol properties measured at the surface are representative of the atmospheric column within the mixed layer, whereas this assumption may no longer be valid for decoupled cloud layers. By combining ground-based remote-sensing and in-situ aerosol observations we can investigate the propensity for coupling - decoupling of liquid cloud layers with the surface, and evaluate the conversion of boundary-layer CCN into cloud droplets. Any differences in coupled or decoupled cloud properties can also be evaluated.

Continuous measurements of the boundary layer structure at high temporal resolution are still sparse. Various methods have been derived to retrieve atmospheric layers from lidar and ceilometer data (e.g. O'Connor et al., 2010; Milroy et al., 2011; Barlow et al., 2011). Single-channel elastic-backscatter lidars and ceilometers are only capable of measuring the backscatter signal from aerosol particles and hydrometeors, which allows detection of aerosol layers (Milroy et al., 2011). However, it is uncertain how reliably MLH can be diagnosed from aerosol layers alone. A method is available for determining MLH based on the dissipation rate of turbulent kinetic energy (Barlow et al., 2011) derived from the vertical motion of air (O’Connor et al., 2010). As there is no commonly agreed way to retrieve boundary layer structure, a comparison of measurement techniques and methods is required.

Scientific objectives
The objectives of the measurement campaign with a Doppler lidar at the Mace Head research infrastructure were to study marine boundary layer and its associated clouds, and facilitate on-going aerosol and atmosphere-ocean exchange research at Mace Head by:

1) comparing methods for retrieving the marine boundary layer structure (O’Connor et al., 2010; Milroy et al., 2011),

2) investigating coupling and decoupling of marine stratocumulus clouds within the boundary layer,
investigating the potential for interaction between marine aerosol particles and clouds coupled within the mixed layer.

**Reason for selecting site**

As a large fraction of the Earth’s surface is covered by oceans, understanding marine boundary layer dynamics and clouds is essential. The research infrastructure at Mace Head in Ireland is ideal for investigating the marine boundary-layer as it is located on the western shore of the North Atlantic Ocean and has a wide marine sector (ca. 120°). The site at Mace Head operates a suite of remote sensing (Mira-36 Doppler cloud radar, Vaisala and Jenoptik ceilometers, HATPRO microwave radiometer) and ground-based in-situ instruments for continuous monitoring of cloud and aerosol properties. However, information on atmospheric dynamics in the boundary layer is not currently available, and therefore, deployment of a Doppler lidar would provide added value to the already comprehensive dataset collected at the site.

**Method and experimental set-up**

The Finnish Meteorological Institute (FMI) deployed a 1.5-µm wavelength Doppler lidar equipped with a depolarisation channel (Halo-Photonics, Pearson et al., 2009). This instrument measures the backscatter signal and Doppler velocity from aerosol particles, drizzle, rain, cloud droplets and ice crystals. The FMI lidar was co-located with the permanent remote sensing instruments at Mace Head and operated continuously for approximately 25 days during February and March 2012. During the campaign, the Doppler lidar was set to measure in vertical stare mode, with vertical profiles of horizontal wind obtained from the Doppler Beam Swinging technique at ten-minute intervals. In vertical stare mode, the Doppler velocity from aerosol targets, which have no appreciable terminal fall velocity, provides a direct measurement of the vertical air motion within the boundary layer. From this, the dissipation rate of turbulent kinetic energy is derived (O’Connor et al., 2010), from which the mixing layer height can be determined (e.g. Barlow et al., 2011); we can then investigate the relative frequency of whether stratocumulus and cumulus clouds are coupled or decoupled within the boundary layer.

**Preliminary results and conclusions**

![Time-height quicklook of vertical profiles of attenuated backscatter coefficient (top panel) and Doppler velocity (lower panel) at Mace Head, Ireland, on 20th February 2012.](image)

Figure 1. Time-height quicklook of vertical profiles of attenuated backscatter coefficient (top panel) and Doppler velocity (lower panel) at Mace Head, Ireland, on 20th February 2012.
The measurement campaign at Mace Head has just finished and data analysis is currently on-going, thus, we only provide a preliminary view of the data here. A number of steps must be undertaken in the processing of the raw instrument data. The first step is to create profiles of backscatter and Doppler radial velocity in standard netCDF format with artifacts and other non-meteorological noise removed. An example daily quicklook plotted from the vertical profiles is shown in Fig 1. Horizontal winds are then obtained from the cleaned DBS profiles (an example is given in Fig. 2). Data for the entire campaign has been processed to this level. The next step is to derive the dissipation rate of turbulent kinetic energy, and determine MLH; currently in progress.

Once MLH has been determined, liquid cloud layers can then be classified as coupled or decoupled, and further characterised by means of cloud fraction, cloud thickness, liquid water content, drizzle and precipitation, cloud droplet number concentration; parameters provided routinely from Mace Head remote sensing observations. Comparison with surface in-situ aerosol measurements will then allow the investigation of the relationship between CCN and cloud droplets through parameters such as aerosol number concentration and hygroscopicity.

**Outcome and future studies**

In co-operation with researchers from NUI-Galway we will study the boundary layer structure for air masses which may have either marine or continental influence, and determine MLH from two different methods. This comparison is expected to guide future discussion on instruments and methods to achieve the best estimate for boundary layer structure through the EU COST programme EG/CLIMET.

We plan to publish at least two manuscripts in international peer-reviewed journals. Preliminary titles are:

1. Comparing methods to retrieve marine boundary layer structure.
2. Investigating the boundary layer structure for coupled/decoupled stratocumulus in the marine environment.

In addition, we will present and publish the results in the proceedings of upcoming conferences and workshops. This will also help publicise this dataset, with the intent that it is used within the wider ACTRIS community; we plan to collaborate with various groups to attempt to answer some of the major scientific questions concerning aerosol-cloud interaction.
References


**ACTRIS TNA Activity Report**

*Measurements of NO₂ and O₃ in the free troposphere by a New LOPAP Instrument (MINI)*

**PD Dr. Jörg Kleffmann**

Physikalische Chemie / FB C, Bergische Universität Wuppertal, Wuppertal, Germany

- **Introduction and motivation**
  NO₂ is an important harmful trace species, which controls oxidant and acid formation in the atmosphere. Caused by its health effects, an annual average threshold value of ca. 20 ppb was introduced by the EU in 2010, which is typically exceeded under polluted urban conditions (EEA, 2007; Vestreng et al., 2009). Standard chemiluminescence NO₂ instruments are known to be affected by interferences (Villena et al., 2012). Thus, a new sensitive (DL 2 ppt) NO₂-LOPAP instrument was developed (Villena et al., 2011), which was recently extended for the simultaneous detection of O₃ (Peters et al., 2012). The instrument was successfully intercalibrated under urban conditions and in a smog chamber (Villena et al., 2011; 2012; Peters et al., 2012), however, validation under remote conditions was still an open task.

- **Scientific objectives**
  In the present project an NO₂-LOPAP should be intercompared with a standard chemiluminescence instrument (CLD) and a Quantum Cascade Laser Absorption Spectrometer (QCLAS) under clean atmospheric conditions at the high alpine research station “Jungfraujoch” (JFJ). In addition, the new O₃ channel of the LOPAP instrument should be intercompared with a standard UV absorption instrument.

- **Reason for choosing the station**
  The EMPA had a parallel CLD and QCLAS NO₂ intercomparison campaign planned at JFJ in March and April 2012, which was thus considered as an ideal option to also intercompare our new LOPAP instrument for low pollution levels. Since JFJ is typically in the free troposphere, remote conditions are often prevailing in this easily accessible measurement station in the middle of Europe. Thus, the place and date was ideal for the scientific objectives.

- **Method and experimental set-up**
  In the LOPAP instrument, O₃ is collected in a temperature controlled stripping coil by an effluent containing the intensively colored Indigo dye. The de-coloring of the dye is used to quantify O₃ in the gas phase. NO₂, which almost completely passes the O₃ channel, is collected in a downstream stripping coil by a selective chemical reaction, converted into an azo-dye, which is sensitively measured in a liquid core wave guide. In addition, a further similar stripping coil is used to quantify losses of NO₂ from the NO₂ channel and potential interferences, which were however found to be negligible under polluted conditions. Details of the NO₂ and O₃ instruments are explained elsewhere (Villena et al., 2011; 2012; Peters et al., 2012). In contrast to these publications, modified stripping coils were used for the detection of NO₂. In addition, caused by the lower pressure at JFJ, some instrument parameters were different to those specified for standard conditions. For example, caused by the lower residence time of the gas phase in the stripping coil, a higher Indigo concentration of 40 µg/l was used in the O₃ channel for most days. Although the sampling efficiency for O₃ was still 99 % for these conditions, leading to a negligible O₃ interference in the NO₂ channel, the O₃ sensitivity was significantly lower (DL = 2 ppb, compared to the 0.4 ppb specified in Peters et al., 2012). Caused by the low gas flow rate (0.35 l/min) necessary for the O₃-detection and the lower used NEDA concentration of the NO₂ effluent (0.3 g/l), which was optimized for the new stripping coil at
standard pressure, the sensitivity and sampling efficiency for \( \text{NO}_2 \) were also reduced. For compensation of the reduced \( \text{NO}_2 \) sensitivity a longer optical path length of 5 m was used. However, an additional problem with the signal stability of the instrument was observed, which was caused by the proximity to the air conditioning of the laboratory (± 6 °C), leading to higher periodic noise of the instrument. Thus, a detection limit and sampling efficiency for \( \text{NO}_2 \) of only 10 ppt and 91 % were obtained, whereas the short term detection limit without this periodic noise was 1-2 ppt, similar to our former results (Villena et al., 2011). For the last 2 days of the campaign, when it became evident that the \( \text{NO}_2 \) interferences channel was not necessary also at low pollution levels, the third coil of the instrument was used to detect also NO. For conversion of NO into \( \text{NO}_2 \) a commercial converter from a Luminol \( \text{NO}_2 \) instrument was used. However caused by an unidentified gas leak, the measurement data of the instrument could not be used for that time period.

The instrument was installed at the Sphinx station at JFJ (3590 m) near to the other \( \text{NO}_2 \) instruments (CLD, QCLAS) and intercompared for 9 days of which only 7 could be used (see above). In contrast to the normal operation of the instrument for which the external sampling unit is directly placed in the atmosphere of interest, gas samples were collected by a x m long PFA sampling line (4 mm i.d.) similar to the other instruments.

- Preliminary results and conclusions
  a) General observations
  During the campaign \( \text{O}_3 \) and \( \text{NO}_2 \) mixing ratios in the range 40-70 ppbv and 0.02-1.8 ppbv were measured by the LOPAP instrument, respectively (see Fig. 1), while average \( \text{O}_3 \) and \( \text{NO}_2 \) values of 59 and 0.27 ppbv were determined. Ozone mixing ratios were relatively constant, except one pollution episode on the 5.4.2012 when \( \text{O}_3 \) concentrations dropped shapely, while those of \( \text{NO}_2 \) increased (see Fig. 1). In contrast, \( \text{NO}_2 \) showed stronger variability with higher concentrations during night-time.

![Fig. 1: \( \text{O}_3 \)- and \( \text{NO}_2 \)-LOPAP data during the intercomparison campaign at Jungfraujoch.](image)

b) \( \text{O}_3 \) intercomparison
  For \( \text{O}_3 \) excellent agreement between the LOPAP and the data measured by a standard UV absorption instrument was obtained (see Fig. 2 and Fig. 3, using preliminary \( \text{O}_3 \) data from the NABEL data base). From the correlation of both instruments only an average difference of 2 % was determined (see Fig. 3). In addition, also a very similar variability was obtained. Both results are in agreement with intercomparison
campaigns of an O₃-LOPAP instrument under urban and smog chamber conditions (Peters et al., 2012). Thus, it is concluded that potential interferences are of minor importance for the LOPAP O₃ data.

![Fig. 2: Intercomparison of the 1 h averaged O₃ data from the LOPAP and a standard UV-absorption instrument (NABEL) at Jungfraujoch.](image)

![Fig. 3: Correlation of all 1 h averaged O₃ data from the LOPAP and a standard UV-absorption instrument (NABEL) at Jungfraujoch.](image)

**b) NO₂ intercomparison**
A high correlation ($R^2 = 0.98$) of the NO₂ data by the LOPAP and the standard chemiluminescence instruments were obtained (Fig. 4 and Fig. 5). In addition, in a correlation plot of both data only a negligible intercept, lower than the precision error, was observed, indicating a high performance of the LOPAP instrument also at very low NO₂ levels. However, systematically lower mixing ratios (ca. 35 %) were measured by the LOPAP instrument (see Fig 4 and Fig. 5). These observations indicate some calibration problems of one instrument. In addition, whereas concentrations ($\mu$g/m³) were specified in the NABEL database, mixing ratios are determined by the LOPAP instrument. Thus, there may be also still some unit...
conversion errors. Since more information to the NABEL data will be available only soon and since the QCLAS data was also still not available, reasons for the discrepancy are still unclear.

The excellent correlation of the NO₂ data indicates that interference problems of the LOPAP instrument are of minor importance for the conditions on the Jungfraujoch, in good agreement to intercomparison campaigns under urban and smog chamber conditions (Villena et al., 2012). In contrast, for potential interference problems of the LOPAP instrument, variable differences between both instruments would be expected.

![Fig. 4: Intercomparison of the 1 h averaged NO₂ data from the LOPAP and a standard chemiluminescence instrument (NABEL) at Jungfraujoch.](image)

![Fig. 5: Correlation of the 1 h averaged NO₂ data from the LOPAP and a standard chemiluminescence instrument (NABEL) at Jungfraujoch.](image)
• **Outcome and future studies**
In the present study, a new O$_3$-NO$_2$-LOPAP was intercompared at the High Alpine Research Station Jungfraujoch to standard instruments and a Quantum Cascade Laser Absorption Spectrometer (QCLAS) from EMPA. For O$_3$ excellent absolute agreement was observed between the LOPAP and the UV absorption instrument, which routinely measures at JFJ. The good agreement demonstrates that interferences in the O$_3$ channel of the instrument can be neglected also for low pollution levels, in agreement with urban and smog chamber results. For the NO$_2$ channel of the instrument significantly lower concentrations compared to the standard chemiluminescence instrument were observed. Caused by the excellent correlation of the data, these results indicate some calibration problems of one instrument. In contrast, interferences of the NO$_2$-LOPAP instrument seem to be of minor importance, which is confirmed by the negligible signal in the interference channel of the LOPAP instrument. Since comparison to the QCLAS data is still an open task, reasons for the systematic discrepancy will be hopefully answered in the near future, when all data are available. In addition, up to now only the 1 h average data accessible from the NABEL data base were used. Thus, it is planned to intercompare also high time resolution data from all instruments in the near future.

• **Acknowledgement**
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• **References**


Soils are a major source of primary and secondary greenhouse gases. Within the EU project ÉCLAIRE we are investigating soil gas exchange processes amongst other topics. We are currently designing a methodological approach to measure gas flux exchanges between biosphere and atmosphere within a laboratorial incubation experiment at BOKU, Austria. Additional to CO₂, CH₄, N₂O and NOₓ gas measurements, we want to include an NH₃ measurement instrument (AiRRmonia) to our laboratorial incubation system. This methodological approach will be used to differentiate between soil and litter primary and secondary greenhouse gas emissions of samples originating from nine different sites across Europe.

Scientific objectives

A one week training at CEH Auchencorth was provided on handling the AiRRmonia instrument correctly. Very helpful recommendations were given to optimize our laboratory incubation system for the experimental set-up at BOKU University.

Reason for choosing station

Based on the infrastructure and long lasting expertise at Auchencorth regarding NH₃ measurements as well as AiRRmonia experiences, we decided to collaborate with CEH Auchencorth.

Method and experimental set-up

The AiRRmonia measuring principle is based on wet chemistry techniques. Its analyzer contains a membrane sampler for quantitative sampling of the gas-phase of ammonia. After diffusion through the membrane, the ammonia is absorbed in a sampling solution, and the sample solution pumped continuously through a conductivity detector. The AiRRmonia system has the potential to detect 0,1 µg/m³ to 100 µg/m³ (preliminary results). The measurement period can be adjusted with a highest sampling resolution of 1 minute. [1] Figure 1 shows the scheme of the AiRRmonia instrument and the different flow directions of the solutions. NaHSO₄ at concentrations of 50 ppb and 500 ppb, respectively, are used to calibrate the system.
The channel system is positioned on a Teflon membrane, which is permeable for gasses. On the opposite side of the membrane flows an absorption solution in counter-flow direction. The sampling channel is dimensioned in such a way that all the ammonia will pass the membrane and forms ammonium in the absorption solution. A three-channel syringe pump is used to displace the solutions with a fixed flow rate. All flows entering the detector block are led through a de-bubbling chamber first. In the detector block a hydroxide solution is mixed with the sample revealing gaseous ammonia again. Then the sampling solution is led along a Teflon membrane again. The gaseous ammonia is able to penetrate the membrane. This is the ammonia selective step in the process, since apart from small volatile amines, no known airborne compounds will be gaseous at this stage. A purified water flow at the opposite side of the membrane dissolves the ammonia that penetrated the membrane. A conductivity cell monitors the initial conductivity. The resulting content of ammonium and hydroxide after the membrane exchange is measured with a second conductivity cell. The conductivity difference is a measure for the original ammonia content in the sampled air. Figure 2 shows the measure principle of the AiRRmonia graphically. The conductivity is corrected for temperature drifts. The calibration curve has a second order shape due to the ammonium/ammonia dissociation equilibrium.
Fig. 2: Measure principle of the AiRRmonia Instrument. The Air sample gets mixed with a water flow in counter-flow direction within the sample block where ammonia turns after passing the membrane into ammonium. After reacting with a sodium hydroxide solution, ammonium turns into ammonia, passes again a membrane and a demineralized water flow within the detector block, where the conductivity differences between demineralized water and the ammonium solution are measured.

- Preliminary results and conclusions

The one week of NH$_3$ measurement training provided useful information about how to measure NH$_3$ with the AiRRmonia instrument as well as improved knowledge of handling NH$_3$ measurements in general. The training involved handling of the instrument from switched off mode to final measurements including all preparation and cleaning steps in between. Once the instrument was switched off, reinitializing included replacement of syringes and parts of syringes, respectively, if necessary as well as removal of air bubbles. To replace the membranes of
the detector, the sample block had to be disassembled and cleaned with demineralized water. A column containing resin for water purifying purposes needs to be maintained occasionally by adding quartz wool on both sides to avoid blockages. The instrument must be calibrated manually all four days and reaction solutions need to be refilled all 6 days. Values are calibrated against 0, 50 and 500 ppb NaHSO4 solution which must be prepared in advance. Data analysis are operated with a labview Airrmonia software programme written by Chris Flechard (INRA, France) and modified by CEH Edinburgh. The response time of the instrument takes about 40 minutes without heating of the tubes. Heating of tubes decreases the response time.

• Outcome and future studies

The AiRRmonia training provided familiarity with the instrument as well as a good knowledge of handling NH3 measurements in general. Heating of tubes proofed to be necessary regardless of the instrument type used. Future studies with two other instruments will provide our final decision of choosing the most appropriate instrument to be included to our laboratorial incubation system at BOKU University.

• References

[1] MECHATRONICS AiRRmonia manual
OVOC analysis for Total Observed Organic Carbon determination, OVOC-TOOC

Stefan Reimann

- **Introduction and motivation**
  In the Total Observed Organic Carbon (TOOC) concept as many as possible gaseous and particulate organic substances are measured at a site (Heald et al., 2008). This gives an indication about the importance of different species for aerosol formation and other air quality issues. The novelty of the concept is that not only gaseous or particulate compounds are looked at, as done normally, but that both types of air pollutants are evaluated in a common experiment. At the SMEAR II stations a first measurement campaign was performed in Europe to test the concept. Within OVOC-TOOC Empa provided an in-situ GCMS system, which is customized for oxygenated volatile organic compound (OVOC) (Legreid et al., 2008) measurements to the spring campaign in SMEAR II (Finland).

- **Scientific objectives**
  The performance of mass closure experiments of atmospheric organic carbon at different European environments is an excellent tool for validating the importance of gaseous and particulate organic compounds in the atmosphere. The TNA proposed within this project the will test the concept of Total Observed Organic Carbon (TOOC). The concept of TOOC is based on the analysis of ideally all gaseous and particulate organic species at a certain site. This has already been performed in the USA but will be tested for the first time in Europe in spring 2012 at SMEAR II,

- **Reason for choosing station**
  The SMEAR II site is an excellent station for the research performed under the OVOC-TOOC project. First, it is located in a relatively pristine environment in Northern Europe. This is a very favorable position for first testing the concept of TOOC measurements in absence of local anthropogenic sources of VOCs and OVOCs. Furthermore, several instruments for measurement of OVOCs and VOCs were already present at the site. One GC-FID for the measurements of VOCs and two PTR-MS for the measurements of VOCs and OVOCs. Furthermore, the good reachability and the very experienced staff made it a nearly optimal site for our purposes.
Method and experimental set-up

As the concept of TOOC measurement includes the analysis of the whole range of suite of gaseous and particulate organic carbon VOCs, OVOCs and organic particles were measured using the following instruments during the campaign in spring 2012:

- GC-MS (Empa) for measurements of OVOCs and VOCs (Legreid et al., 2008)
- GC-FID (Finnish Meteorological Institute) for measurements of VOCs (Hakkola, 2012)
- PTR-TOF-MS (University of Helsinki)
- PTR-MS (University of Helsinki) (Rinne et al., 2007)
- AMS (University of Helsinki)

Furthermore, measurements of other air pollutants (e.g. CO) and meteorological observations were available for origin of air masses and potential filtering of local sources.

Preliminary results and conclusions

Measurements of GC-MS, GC-FID and PTR-MS showed a very consistent picture for the gaseous compounds. As an example for the VOC measurement the dataset for benzene measured by 3 independent instruments is given below. Remarkably concentrations exhibit the same pattern of pollution events and clean periods. Differences in concentrations are due to preliminary calibration, but will disappear after full quality assurance of the data has been performed. Also the more complicated OVOCs (as shown for acetone measurements) shows a very good comparability between GC-MS and PTR-MS measurements.

![Graph of acetone/propanal measurements](image_url)

Concentrations of acetone/propanal measured with 3 different instruments
• **Outcome and future studies**

The measurement campaign at the SMEAR II station was a successful in proving that the concept of TOOC measurements can be performed by using different instruments for the measurement of gaseous and particulate organic compounds. The location in Northern Europe will be an important station in providing a general picture of TOOC in Europe with its diverse landscapes and climate zones. The TOOC concept will be further tested during the EMEP intensive campaign in 2012/13 and within the ACTRIS JRA 5.

• **References**


**Introduction and motivation / Scientific objectives**

Atmospheric aerosols have direct and indirect effects on the global climate. Particles alter the properties of clouds by acting as cloud condensation nuclei (CCN) and as surface for heterogeneous reactions. Particles are also known to have adverse health effects (Pope and Dockery, 2006). These effects depend partly on the chemical composition of the particles. Aerosol chemical composition can be measured online with high time resolution by the Aerodyne High Resolution Time-of Flight-Aerosol-Mass-Spectrometer (HR-ToF-AMS). Within the EU FP7 funded project PEGASOS intensive measurements of atmospheric chemical composition including gas and particle phase measurements were performed onboard of a Zeppelin airship. A campaign was scheduled for May 2012 targeting to explore the vertical distribution of aerosol composition in the planetary boundary layer over the Netherlands with specific focus on the area around Cabauw. The applicants operated a HR-ToF-AMS at the CESAR-tower in Cabauw, the Netherlands in May 2012, to provide ground based reference data on the aerosol chemical composition. These measurements were made in parallel with measurements performed by the HR-ToF-AMS onboard a Zeppelin at several heights within and above the planetary boundary layer. The combined results will give an improved understanding of the vertical distribution of ambient aerosol composition. In particular this data set will provide insight into organic aerosol formation and aging processes. Thus, they will contribute to investigations on the effect of climate change on the number and mass concentration of atmospheric aerosols, and on the interaction of the atmospheric self-cleaning processes with the aerosol formation.

Additionally, the results are compared to data from the newly developed high resolution Thermo-Desorption-Proton-Transfer-Mass-Spectrometer (TD-PTR-MS) that was operated at Cabauw during this period. Previous comparisons of HR-ToF-AMS measurements with the quadrupole mass spectrometer TD-PTR-MS were performed by the group in summer 2008 and spring 2009 (Mensah et al., 2012) and with the TD-PTR-TOF-MS in November 2011. To investigate the seasonal cycle of aerosol chemical composition at Cabauw and to deepen the comparison of the two instruments, further measurements were needed to widen the range of meteorological and atmospheric chemical conditions covered in our observations. Data analysis involves instrument comparison with the co-located TD-PTR-TOF-MS. Using high resolution mass spectrometric data from both instruments the relative contributions of N- and O-containing organic fragments to the aerosol composition are determined. This deepens the understanding of processes involved in organic aerosol mass formation and aging.
**Reason for choosing station**

Besides the fact that the previous campaigns mentioned above were also performed at Cabauw Experimental Site for Aerosol Research (CESAR), the Zeppelin made its flights mainly nearby the tower. This site is located at a rural site and is a representative for North-West Europe. Depending on the wind direction, the condition can be either of maritime or continental character. Furthermore, the plain geography of the Netherlands and especially in the area of Cabauw reduces ambiguities in terms of air parcel convection and turbulences.

**Method and experimental set-up**

The Aerodyne HR-ToF-AMS sampled from a height of 5 m above the ground through a 7 m long, ½” Polyflo tubing. It measured the size distribution and chemical composition of particles and was operated 24 hours/7 days a week for 5 weeks with a time resolution of 4 minutes. Its transmission efficiency for particles in a range of 70 nm to 500 nm is almost 100% (Jayne et al., 2000).

The sampling line was shared by a Monitor for AeRosol and GAses (MARGA). Close to the AMS inlet, a Condensation Particle Counter (CPC, Model TSI 3785) was deployed, resulting in an overall flow of 1080 mL min\(^{-1}\) between the MARGA inlet and the AMS inlet through 1.5 m stainless steel tubing with an inner diameter of 4 mm.

Once a week the instrument was maintained and calibrated for the ionization efficiency and particle size using a calibration rack containing an aerosol-generator and a Differential-Mobility-Analyzer (DMA), and a CPC (Model TSI 3025a). To determine the gas phase background signal, measurements with an in line particle filter was performed every 2-3 days.

The TD-PTR-ToF-MS also sampled from a height of 5 m above the ground through a separate, 10 m long copper tube with an inner diameter of 4 mm. It is equipped with both a gas and an aerosol inlet and collects ambient particles in the size range of 70 nm to 2 µm at an air sample flow rate of 1L/min (Holzinger et al., 2010a; Holzinger et al., 2010b)

**Preliminary results and conclusions**

Figure 1 shows the temporal evolution of the total aerosol mass as well as of the most important aerosol species. Clearly seen are a number of periods with different mass loadings and different fractional abundances of these species, partly dominated by organics, sulfate or nitrate. These observations have to be referred to meteorological data like wind directions.

A first evaluation of the diurnal cycles shows night time maxima of the total mass and of the concentrations of organics and nitrate. The last can be explained by the heterogeneous conversion of nitrate in the night and the volatilization of nitrate, especially ammonium nitrate, during the day.

The average particulate mass loading measured by the HR-AMS during May and the beginning of June 2012 was 7.8 µg m\(^{-3}\) and lower than observed in previous campaigns in Cabauw in May 2008 (9.7 µg m\(^{-3}\)), but higher than the amounts of November 2011 (5.0 µg m\(^{-3}\)) and March 2009 (5.6 µg m\(^{-3}\); Fig. 2). The organic fraction was the dominant species (37 %) in May 2012, followed by nitrate (25 %) and sulphate (20 %). The observed aerosol composition was thus overall similar to the results from autumn 2011 and summer 2008, whereas in spring 2009 a dominant nitrate fraction (42%) was observed.
Fig. 1: Mass concentrations and fractional abundances of aerosol species; relative humidity (RH) and temperature (Temp)

Fig. 2: Aerosol components average
A first evaluation of the aerosol measurements onboard the Zeppelin over Cabauw, which were performed in parallel to the data acquisition at ground level, shows vertical profiles of the chemical species, where especially the nitrate and organic amounts are lower above than within the planetary boundary layer. In contrast, sulphate concentrations had only little changes with altitude.

**Outcome and future studies**

Both AMS data sets measured onboard the Zeppelin and on the ground, will be used in detailed analysis of the vertical distribution of ambient aerosol composition. Amongst others, further AMS data analysis will evaluate aerosol composition as function of size. For more detailed analysis of the organic fraction elemental analysis and Positive Matrix Factorization (PMF) will be performed.

Directly after the PEGASOS campaign, follow-up measurements at the CESAR tower were performed in June and July 2012 and were coordinated with a European intensive measurement period defined by EMEP.

**References**


Long-range atmospheric transport and transformation of persistent organic pollutants in the Eastern Mediterranean (POPLRTMED)

Gerhard Lammel

- Introduction and motivation
Environmental exposure towards persistent organic pollutants (POPs) is determined by long-range atmospheric transport (LRT). Most POPs are semivolatile organic compounds, i.e. partition between the phases of aerosols and undergo re-volatilisation from the sea and soils (multi-hopping). Their cycling (LRT, local processes such as air/sea exchange, air/soil exchange, gas/particle partitioning, and chemical reactivity) is insufficiently understood. We have addressed processes of POPs cycling by measurements in aerosols at polluted and remote sites (e.g., Lammel et al., 2009a, 2010a, 2010b), of fluxes at the ground (terrestrial: Lammel et al., 2011; Škrdlíková et al., 2011; marine: Lammel et al., 2013; Mai et al., 2013) and large-scale modelling and source attribution studies (e.g., Lammel et al., 2009b; Dvorská et al., 2012; Stemmler and Lammel, 2012).

- Scientific objectives
We aim to advance the understanding of POP cycling far from sources by addressing key processes in the marine boundary layer in air masses characterized at a receptor site and influenced by regional and remote sources (concurrently with measurements at other sites in the receptor region, see below, Method and Exp’l setup). Choice of site and time are furthermore motivated by the results of earlier studies carried out by the host institution (University of Crete, Dept. of Chemistry) and in the context of international field campaigns. In particular, it had been shown that semivolatile organics undergo photochemistry (at least to some extent) in the Mediterranean atmospheric environment (Mandalakis et al., 2003; Tsapakis and Stephanou, 2007). Dry deposition and eventually accumulation in (Mandalakis et al., 2005; Guitart et al., 2010) and volatilisation from (e.g. Berrojalbiz et al., 2011; Tsapakis et al., 2006) the sea surface layer are other relevantation processes.

This project addresses:
- Concentrations in air, aerosol mass size distributions and determination of environmental parameters influencing the gas/particle partitioning of POPs,
- concentrations in seawater and determination of environmental parameters influencing the air/sea exchange of POPs,
- concentration changes along transport and determination of environmental parameters influencing the reactivity of POPs (in cooperation with sampling at other stations (see below) and meteorological analysis).

The selected POPs are: polycyclic aromatic hydrocarbons (PAH), nitro- and oxo-PAH, polybrominated diphenyl ethers (PBDE), organochlorine pesticides (e.g. HCH, DDT), polychlorinated biphenyls (PCB). For some of these substances very few data from remote environments exist so far.

- Reason for choosing station
Finokalia is situated in a receptor region, receiving air influenced by regional (Aegean) and remote (central and eastern Europe) sources (in particular in summer). The Large scale flow in the Aegean is
often carrying pollution from central and eastern Europe, most likely in summer (Mihalopoulos et al., 1997; Lelieveld et al., 2002).
The measurements could be complemented by other simultaneous measurements (with similar methods, partly to be analysed in the same laboratory) in the region (run by university institutes in Thessaloniki, Bursa, Izmir and the NCSR Demokritos institute; Fig. 1). In the direct vicinity of Finokalia the shore could be accessed in order to address air-sea exchange of organics.

![Fig. 1: Sites contributing air (1-5) and water (1, 2) measurements to POPLRTMED, intensive measurement period 2.-13.7.2012](image)

- **Method and experimental set-up**
Particle-size resolved and (total) filter sampling of the particulate phase and collection of trace gases to sorbents was performed using a 6-stage cascade impactor, 2 high-volume samplers (F = 32-68 m³/h) and 1 low-volume sampler (F ≈ 2 m³/h; for off-line analysis in the laboratory) at Finokalia observatory. Day and night sampling (sampling durations between 9 and 72 h). Sampling protocols and methods were harmonized among the locations of simultaneous sampling in the region. Aerosol number concentration, N (cm⁻³), was determined at Finokalia using an optical particle counter (Grimm; 31 channels between 0.25 and 32 μm of aerodynamic particle diameter).
At a coastal site in ca. 3 km direct distance from Finokalia, Selles (site 1b in Fig. 1), directly at the shore, air-sea exchange (vertical flux) of POPs was addressed by micrometeorological measurements, low-volume sampling for organics and in situ-measurement of ozone, CO₂ and water vapour at 2 heights above ground (vertical gradient; e.g. Lammel et al., 2011). In addition, meteorological parameters were measured using mobile stations and seawater was sampled (for off-line analysis in the laboratory).
Passive air samples (method: Klánová et al., 2006) have been exposed at Finokalia and Selles and passive water samples (method: Booij and Smedes, 2010) 2 sites close to the shore of Selles. In addition, few surface (film) and grab water samples were collected.

- **Preliminary results and conclusions**
The chemical analysis of 235 air samples (gaseous and particulate fractions) and 6 water samples from Finokalia (including Selles) and ca. 250 samples from sites 2-5 (Fig. 1) will expectedly be completed in 6-9 months.
The routine measurements at Finokalia indicated little anthropogenic influence on atmospheric composition as expected. The POP levels in air data will be analysed and interpreted together with data from simultaneous sampling at other locations run by partner institutions in the region, as well as from own monitoring programmes (in the Czech Rep. and Europe-wide). The large scale flow was favourable with this regard, with advection of air parcels to Finokalia across the Aegean Sea. Many of these had passed Izmir or Bursa 10-24 h before. According to relatively high wind speeds (>5 m/s almost throughout the measurement period) at Selles we expect particular difficulties for detection and quantification of vertical gradients and, hence, fluxes.

- Outcome and future studies

Not much can be said before the samples collected have been analysed. We expect complementary data for a number of substances which had been rarely observed in the marine boundary layer (e.g. nitro- and oxy-PAHs, PBDEs), and insights into the processes determining gas-particle partitioning and sinks of few PAHs and, eventually, PCB congeners in a clean marine boundary layer, i.e. photochemical transformation and air-sea exchange.

Future studies are tentatively planned to focus on air-soil exchange, but planning is subject to outcome of this campaign among other unknowns.

- References


Mai C., Theobald N., Lammel G., Hühnerfuss H. (2013): Spatial, seasonal and vertical distributions of currently used pesticides in the marine atmospheric boundary layer of the North Sea – Estimation of atmospheric deposition into the surface seawater, manuscript in preparation
INTRODUCTION AND MOTIVATION

The Earth’s atmosphere represents a complex chemical and dynamical system. Its behavior is governed by various feedback mechanisms and interactions with other subsystems of the Earth – such as ocean, biosphere and cryosphere – that frequently cause non-linear responses of the atmosphere. During recent years it became increasingly clear that halogen chemistry - beyond its well known influence on stratospheric ozone - plays an important role in the chemical and physical processes of the troposphere [e.g. Barrie and Platt 1997, Platt 2000, Platt and Hönninger 2003, von Glasow and Crutzen 2007, Pöhler et al. 2010]. This is particularly evident within the marine boundary layer [e.g. Sander and Crutzen 1996, von Glasow et al. 2002a, b, Read et al. 2008], but chemical processes related to reactive halogen species (RHS) i.e. halogen atoms, molecular halogens and oxidised halogen species may affect the entire troposphere [e.g. Platt and Hönninger 2003, von Glasow et al. 2004]. Also it turned out that liberation and the recycling of RHS is largely promoted by multiphase processes [e.g. Vogt et al. 1996, Tuckermann et al. 1997]. To date significant involvement of reactive halogen species has been identified in a large number of processes, many of them connected to the atmospheric oxidation capacity and the nitrogen and sulfur cycling between the atmosphere and the ocean. These include:

- Modification of the tropospheric oxidation capacity
- Formation of new particles through nucleation of iodine oxides
- Change in the DMS degradation mechanism leading to reduced formation of sulfur particles
- Ozone destruction and reduction of ozone formation
- Enhancement of the OH/HO\(_2\) ratio
- Enhancement of the NO/NO\(_2\) ratio (Leighton ratio)

In summary it is now very likely that halogen chemistry has a significant influence on – at least - the marine atmospheric chemistry and physics on a global scale. However, many underlying mechanisms are presently not understood. Also the spatial emission and extent of the areas where halogen chemistry is of importance needs to be much better quantified. The most likely source of reactive iodine is the photolysis of molecular iodine and organohalogens emitted by macro algae at coastal sites if they set under “stress”. O’Dowd et al. [2002] and Mäkelä et al. [2002] indicate that reactive iodine plays a key role in the formation of new particles in coastal areas which could also be shown by our group [e.g. Seitz et al. 2010]. If those particles grow to become cloud condensation nuclei (CCN), they could influence cloud properties and therefore have an impact on climate. However the emission strength variability and influence on aerosol formation are not well quantified. In addition to coastal iodine-driven nucleation and growth events, it has been recently established that open ocean particle production and growth is quite frequent over the NE Atlantic and appears to be driven by organics.

To quantify both formation processes the measurements of particles in combination with RHS are required. However RHS observations are rare as their low concentration and high reactivity makes the observation impossible with most measurement techniques. Many field studies on RHS were carried out by applying the LP-DOAS technique at the Mace Head atmospheric research station [e.g., Alicke et al., 1999; Hebestreit, 2001; Saiz-Lopez and Plane, 2004; Saiz-Lopez et al., 2004a, 2006a,b; Peters et al., 2005; Seitz et al. 2010]. The most relevant RHS at such coastal sites is Iodine oxide (IO) which is studied in this project. IO is formed from iodine emissions and concentrations are highest at high solar radiation, and thus in summer, with coincidental low tide, when the coastal macro algae are set under “stress”.

Model calculations from Burkholder et al. [2004] state that the concentrations of iodine species (the most relevant RHS in these coastal areas) derived so far (at different locations including Mace Head) with the LP-DOAS measurements are too low to account for the large aerosol production observed. They suggested a possible reason for the disagreement between model calculations and field observations which is an inhomogeneous location of iodine sources, with much above average IO mixing ratios, so called “hot-spots”.

ACTRIS TNA Activity Report

Reactive Iodine and Particle Observations (RIPO)

Denis Pöhler
This would have significant influence on the RHS chemistry and particle formation processes and thus the total impact of RHS on a global scale. Such strong local variations are possible as emitted RHS can have a very low lifetime and/or chemical processes directly occur after emission.

Recently observations at the Martin Ryan Institute (Carna co. Galway, Ireland), show indications of such inhomogeneous distributions [Seitz et al. 2010]. To prove the theory of inhomogeneous iodine sources and chemistry several authors [e.g. Seitz et al., 2010; Furneaux, 2010] recommend further in-situ measurements with new mobile I\(_2\) or IO instruments that measure these trace gases directly inside the macro-algae beds and thus allow to determine reliable emission factors for different macro algae and seaweed species in their natural environment. Furthermore this would also allow to quantify the local distribution of reactive iodine with a high spatial resolution, a key information for the validation of chemical models which is important to improve our understanding of tropospheric halogen chemistry.

Additionally our current knowledge on macro algae driven iodine emissions mainly rely on several measurements at Mace Head. Strong variations between different locations may arise due to different types and distribution of macro algae. This may have significant influence on the estimation of local and global iodine driven particle formation. Measurements from 2011 indicate that iodine concentrations are likely very different for different locations even on a scale of few km. Thus a comparison of iodine emissions of Mace Head to other coastal sites is essential to quantify the total emission of iodine and review our current understanding of the total impact on ozone depletion and particle formation.

### Scientific objectives

The variability of iodine emissions between different coastal locations are poorly quantified. This project aims is to better characterize these coastal iodine emission events at the irish west coast around Mace Head. The spatial distribution of the emissions on a small scale (~10m) close to Mace Head and on a larger scale (~5 km) are performed by combining different measurements. The first are performed to investigate locally so called « hot spots » and strongest iodine emitters and thus help to better understand the emission processes. The second are important to investigate different algae populations and better quantify the total iodine emission and impact on ozone depletion and particle formation. The measurements at Mace Head will be accompanied by aerosol physics instrumentation.

Aims and objectives:

1. quantify iodine emissions and its spatial variability at Mace Head
2. quantify formation and evolution characteristics of particle formation during these events
3. quantify the difference of iodine emissions from Mace Head to other location at the Irish Westcoast
4. test new instruments for atmospheric IO measurements

### Reason for choosing station

The West coast of Ireland is famous for significant amounts of different macro algae and the remote site Mace Head is perfect for the investigation of naturally emitted RHS from coastal macro algae and the formation of particles. Most of former investigations of RHS are made at Mace Head, and almost our whole understanding of iodine emissions from macro algae rely on these observations. Due to instrumentation limitations it was so far not possible to quantify the local emission sources and their distribution directly at the coastline in front of Mace Head. This is one main objective to quantify former observations. Additionally the variability along the coast is not quantified so far. Thus conclusion form observations of Mace Head for the whole Irish coast and globally can not be made. We perform measurements simultaneously at Mace Head and at different sites along the Irish Westcoast to quantify these variabilities. They allow to scale measurements at Mace Head to other locations and estimate a regional iodine emission.

### Method and experimental set-up

The DOAS technique, investigated by Prof. U. Platt (University of Heidelberg, Platt et al. 1979), allows the direct observation of many RHS in the atmosphere. The basic principle is based on the absorption spectroscopy of the molecules. To separate between different molecules and the aerosols, DOAS use the spectrally narrow and characteristic structures of the molecules in the UV and visible spectral range. Therefore active Long Path (LP-) DOAS instruments emit a broad spectrum in the desired spectral range (typically UV and visible) which passes the atmosphere few 100m to 10km. The received spectrum can then...
be analysed and derives the average concentration of the trace gas along the light path. Most RHS are measured using LP-DOAS at ppt level with several kilometre light paths. One has to keep in mind that possible inhomogeneous distributions of RHS cannot be resolved along the path.

Figure 1: Map of area around Mace Head with characterised algae species and LP-DOAS light path. With the mobile LP-DOAS also measurements at a close bay were performed.

We developed in Heidelberg two new measurement instruments also based on the DOAS technique to quantify the spatial variability of IO which is part of current research and applied in this project. First, two LP-DOAS instrument were applied. One was stationary at Mace Head, the second mobile and could fast (within few hours) set up at different measurement locations. The lower power consumption allows a battery power supply. The LP-DOAS at Mace Head featured a light path of 3km crossing three bays with potential RHS emissions (Figure 1).

Second, we applied the new Cavity Enhanced (CE) – DOAS technique [Platt et al. 2009, Meinen et al. 2010], to the observation of IO in the ppt range. CE-DOAS uses passive optical resonators to provide long light paths (> 1km), in a relatively compact setup with resonator lengths in the order of 1m. Thus a CE-DOAS instrument achieves the same sensitivity like a LP-DOAS but measures the air mass just at the instrument location. We focused on the development of a mobile CE-DOAS instrument for the observation of IO down to 1ppt, which is the first instrument of this kind. Our final setup has a weight of about 25 kg and can be placed on two tripods at any location. Thus it can observe so called “hot spots” with locally very high concentration. In combination with the compact LP-DOAS instrument it can answer the question of spatial iodine variations at coastal sites and their influence on aerosol formation and tropospheric ozone destruction. The instrument was further improved since measurements at 2011. The instruments are complemented by an Ozone monitor, a mobile weather station and aerosol measurements at Mace Head.

Inter-comparison measurements between the different instruments and characterisation of RHS emissions at Mace Head were performed for the first part of this campaign and on the last day. During other days the one LP-DOAS was operated at Mace Head, while the other instruments were set up at other locations at the irish west coast. We totally covered 7 measurement locations.

Preliminary results and conclusions

Figure 2: Preliminary results LP-DOAS Mace Head averaged over a light path of 3km along the coast to the north.
Continuous measurements of RHS compounds could be realised with a LP-DOAS at Mace Head. Weather conditions were characterised by “typical Irish” weather with temperatures of typically 15°C and regular rain and wind. We had few days with sunshine, however these days mostly did not match with days with low tide at noon, what would be preferably for RHS emissions. IO concentrations are typically below 5ppt (Figure 2). Measurement accuracy was often limited by low visibility due to fog and rain. Correlations between increased IO and tidal height for a clean air sector are identified for 3 days (19th - 21st July). Highest concentrations are observed for non clean air sectors with winds from north-east with simultaneously increased NO2 (2nd - 4th August). These RHS emissions arise from algae fields about 4km north-east of Mace Head (see Figure 1).

Measurements with the mobile LP-DOAS instruments show good agreement for the comparison at Mace Head with very low IO concentrations. Very surprisingly, measurements at all other measurement locations at the coast show much higher IO levels and thus much stronger RHS emissions compared to Mace Head (Figure 3) and even much higher concentrations at unfavourable weather conditions ever observed at Mace Head.

Observations of the mobile CE-DOAS confirm these observations. Measurements at Mace Head (15th - 20th of July and 6th of August) feature a much lower concentration than observed on any other location (Figure 4). At Mace Head two emission areas could be identified (Figure 1), where strong emissions of the laminaria digitata only arise shortly on very low tides.

**Figure 3: Preliminary results of the mobile LP-DOAS and weather data of a mobile weather station.**

**Figure 4: Preliminary results of the mobile CE-DOAS instrument.**

**Outcome and future studies**

Strong variations of IO levels at different measurement locations with concentrations varying one order of magnitude indicate very strong variability in RHS emissions. Concentrations at Mace Head are much lower and significantly underestimate the total RHS emissions. Even at unfavourable weather conditions with rain and wind, several 10 ppt IO could be observed at other locations. Mace Head just show enhanced locally
emitted IO concentrations if very low tides match with sunny weather conditions, a very rare phenomenon at this site. Thus a review of RHS emissions at coastal sites is necessary. Any conclusions on regional and global scale of RHS emissions, its influence on ozone depletion and particle formation has to be reviewed. We could clearly correlate higher IO concentrations to specific macro algae. Similar mobile measurements are planed for other coastal sites to proof strong spatial variability and RHS emission strength.

References
High altitude aerosol in situ characterization in synergy with LIDAR vertical profiles, SYNERGY

Nadège Montoux

- Introduction and motivation
  Aerosols monitoring is of high relevance for studying pollution spread and climate evolution. The Puy de Dôme (PdD) station includes instruments to characterize in situ aerosol physico-chemical properties (size distribution, optical properties, hygroscopicity, ...) at 1465 m a.s.l. Eleven kilometers far from the station, a 355 nm aerosol lidar with Raman capability (Clermont-Ferrand (CL) lidar) has been performing optical measurements in clear sky conditions since 2009. Aerosol optical properties obtained from the lidar alone (with the Raman channels) and from the lidar coupled with a CIMEL sunphotometer can be compared. The synergy between in-situ and lidar measurements allow the retrieval of aerosol mass vertical profiles over the whole atmosphere in order to study events like dust, volcanic eruptions or pollution transport (Freney et al., 2011; Hervo et al., 2012). In addition, integrating the CL lidar data will contribute to long-term climate monitoring programs such as the EARLINET and ACTRIS networks. In order to perform these research activities with the quality assurance required by the EARLINET community, training at a state-of-art atmospheric research infrastructure including expert support and know-how transfer was necessary and strongly beneficial to retrieve aerosols optical properties from the lidar data.

- Scientific objectives
  The first objective of this training activity was to learn how to calculate from raw lidar data:
  - aerosol extinction and backscatter using only elastic channels during day-time measurements with assumption of a well-known ratio between extinction and backscatter coefficients,
  - aerosol extinction and backscatter using both elastic and Raman channels during night-time measurements with no assumption of the ratio between extinction and backscatter coefficients.
  The second objective was to get familiar with using the Single Calculus Chain (SCC) developed by some groups of the EARLINET community. The aim of the SCC is to provide a tool for processing all the different lidar data of the EARLINET community in the same manner to get consistent aerosol optical properties.

- Reason for choosing station
  The CNR-IMAA Atmospheric Observatory (CIAO) has a long experience in lidar remote sensing: instrumentation design and development, quality check, retrieval algorithms and data analysis. In addition, this group is one of the three main groups involved in the SCC development and is in charge of the SCC web interface.

- Method and experimental set-up
  The training activities were divided into three parts.
  The first part was dedicated to quality assurance. The following points were discussed in order to constantly check instrumental problems and ensure, thus, high-quality measurements in the future:
  - tests on the optical, electronic and hardware parts of the lidar (for example, tests on the quality of the polarization splitter, on the electronic delay between emission and acquisition),
- optimization of the telescope and laser beam positions to allow coverage at low altitude ranges (~1000 m asl). The method for optimizing the alignment was shown on the Potenza EARlinet Raman Lidar (PEARL) at CIAO,
- regular quality check of the system and the data acquisition (for example, telecover test, dark measurement, Rayleigh fit),
- adjustment of the lidar acquisition to avoid distortion on the signals (for example, high-voltage of the photomultipliers, neutral density filters add).

The second part of the training was dedicated to aerosol extinction retrieval using the $N_2$ Raman channel. Basic Raman scattering as well as applications on the CIAO measurements were shown. The last part of the training was dedicated to the SCC description (input file requirements, modules included in the chain, and output files provided by the SCC) as well as web interface use.

**Preliminary results and conclusions**

The training was very successful and now allows us to optimize the altitude range of our measurements and to avoid spurious effects in our measurements. Most of the tests have been implemented on the CL lidar and the configuration of the system and the parameters for the data acquisition have been optimized.

Routines have been developed to calculate aerosol extinction and backscatter for day-time and night-time measurements. To check the quality of the routines developed, CIAO provided synthetic lidar data used by the EARLINET community to check the agreement of all the algorithms developed by each station (Pappalardo et al., 2008). The results of this intercomparison are shown in Figure 1. The developed algorithm shows good agreement with the one developed by CIAO. The small differences can probably be explained by different choices of vertical averaging between both algorithms and will be investigated further.

![Figure 1: (Left) Aerosol extinction and (Right) aerosol backscatter obtained from synthetic lidar data simulated at 355 nm. Red curve: result from the CIAO algorithm taken as reference. Blue curve: result from the algorithm developed during and after the training using the Raman and elastic channels. Black curve: same as blue curve but using only elastic channels.](image)

CL processing routines are now used to process the data acquired during the last EMEP campaign (8 June – 17 July 2012).

In the framework of an EARLINET operational exercise and a ChArMEx pre-campaign, 72-hour continuous lidar measurements were performed by 11 stations including Clermont-Ferrand from 9
July 6:00 UTC until 12 July 6:00 UTC. This provided a good opportunity to check the improvements of the lidar configuration made since the training activity at CIAO. Unfortunately, during this exercise no dust were observed above Clermont-Ferrand and the sky was most of the time cloudy by low-level clouds (~2 km high). The raw data files were converted into SCC netcdf input files and 59 of the 72 hourly files submitted to the Potenza centralized server were processed successfully.

- **Outcome and future studies**
  Further optimization of the lidar setup, like use of plates in the optical box of the lidar to check improvements of the depolarization measurements and to have a better estimate of the depolarization factor of the system, are planned before the end of 2012. In addition, an intercomparison campaign with the mobile lidar of the Munich group is considered in 2013. This campaign could also help to improve our knowledge of spurious effects affecting the lidar signals that have never been addressed before.
  
  The processing of all data acquired since 2009 is ongoing and aerosol extinction and backscatter data will be submitted to ACTRIS/EARLINET before the next report in 2013. Moreover, continuous aerosol in-situ measurements at PdD station as well as CIMEL and lidar measurements will allow to compare aerosols properties retrieved in the same altitude range (~1465 m asl) and to study future events like dust, volcanic eruptions or pollution transport.
  Long term analysis of the optical properties at the PdD station will be performed. The aerosol hygroscopic growth and its impact on optical properties and especially lidar ratio will be investigated.

- **References**
