WP6- NA6: Integration, outreach, and sustainability
Deliverable D6.4 Report on definition of ACTRIS core station requirements including data stream functionalities

Introduction

A goal of ACTRIS is to prepare the next generation of ground observing stations. Together with GAW, ACTRIS has to provide a clear strategy for aerosol starting with the definition of core parameters that should define the basic equipment for all sites within the infrastructure. WP6 in ACTRIS is also the framework for defining how integration with other infrastructures should proceed. All the separate components of the atmosphere are highly interlinked, with many concurrent processes operating on a wide range of temporal and spatial scales, giving rise to a high degree of variety and complexity in the system. Understanding our atmospheric environment will require a multi-parameter approach. Clearly, the long term strategy for environmental research infrastructures is a much closer interoperability. Improving links amongst ground-based atmospheric research infrastructures, such as ICOS or INGOS seem clearly a required step for this integration.

More practically, the objectives of the D6.4 are dual. It is first to improve links with other infrastructures by showing the benefice for integration at the level of the single stations. Secondly, it is to set the way for more integration by merging at new operating stations core requirements from the different atmospheric infrastructures and integrate their essential components in order to guarantee coherent observations of atmospheric compounds (aerosols and gases).

Description of the work

Work towards the objectives of D6.4 is performed at 3 different levels: a first level is an assessment of current integration of networks and infrastructures operating at the EU scale, a second level is to favour integration of operating stations and a third level is a demonstration activity to develop prototype core stations accounting for functionalities required by other European core service stations (e.g. ICOS or other infrastructures). The long term goal is to allow different end-users to easily utilize data products in a comprehensive way, without the need for adapting to specific requirements from specific infrastructures. ACTRIS is therefore favouring the establishment of a network of environmental infrastructures in support of the atmospheric science community involved in climate change and air quality studies. Within this WP, we can note regular participation of ACTRIS representatives to the work performed within the ENVRI project.

Observations of atmospheric composition is, in Europe, undertaken by several networks all aiming at the systematic conduct of long-term observations at various locations in a defined region following established protocols related to site representativeness, QA/QC and data dissemination. An assessment of the current status of in-situ observations in Europe performed within the different operating structures/networks shows some interesting features. Historically, stations were often developed as local initiatives leading to significant regional gaps. Some of them joined one or more networks at different stages of their maturation leading to strong heterogeneity in the network densities, according to countries. In some cases these may overlap, and commonly a site location may contribute observations in support of several networks. In

some areas of EU, there are no observations, which in itself indicates quite strongly a less than optimal integration.

These networks all need to respond to the directions of their individual stakeholders, and their implementation will always rely on national capabilities (funding, competence etc). Thus, establishing a closer collaboration across networks through some additional efforts is seen as the way forward. Analysis of the different organized networks or infrastructures in Europe is interesting to that respect. Figure 1 below shows the status as of 2010 of ICOS, INGoS, EUSAAR, EARLINET, CLOUDNET and EMEP networks of stations.

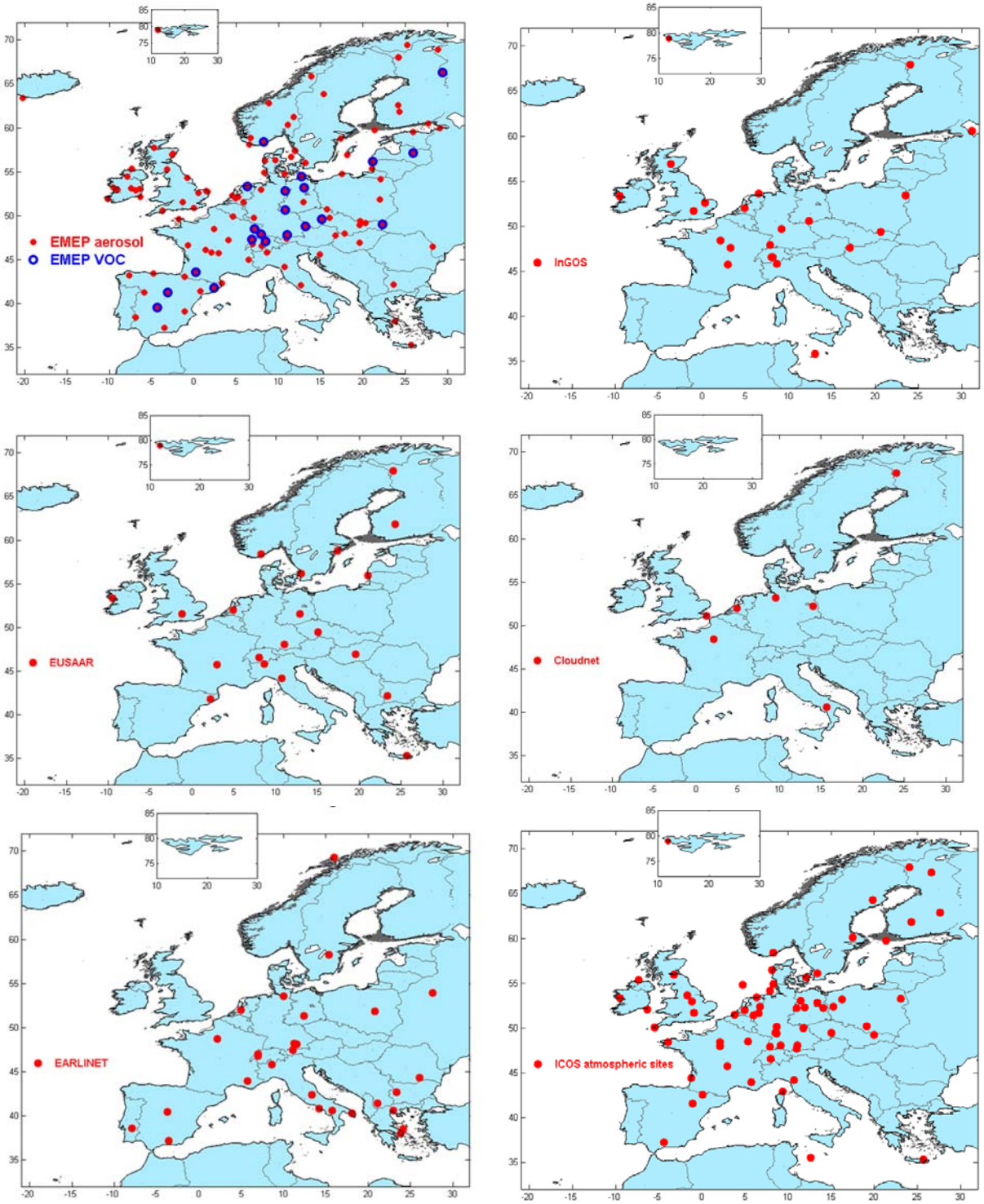

Figure 1: station location for 6 networks/infrastructures active in Europe as of 2010: from up to down, left to righ: a) EMEP with specific highlight for EMEP VOC stations, b) INGOS, c) EUSAAR, d)

CLOUDNET, e) EARLINET, f) ICOS atmospheric sites.

An interesting feature that can be derived from this figure is that presently, only one station in Europe belongs to all operating networks presented above: Cabauw in the Netherlands. There is clearly a great potential for improving the integration of observations across the various networks, and there is further a need to develop cost-efficient monitoring capacity in regions currently inadequately covered. Conclusions are at the EU scale there that there is a clear need for improving the concept of network of networks that can bring together a much larger set of independent networks into an informal federation of those existing networks. This is essential to facilitate communication, coordination, harmonisation, capacity building, etc amongst the different networks. In particular, the degree of integration between ICOS ESFRI and ACTRIS stations could be improved. A number of stations in Europe are part of both ACTRIS and ICOS infrastructures as compiled in the table below:

Station Short Name	**Station long Name**	**Station Type eco or atm (ICOS)**	**Country**
JFJ	Jungfraujoch	atm	CH
K	Kosetice	atm	CZ
HPB	Hohenpeißenberg	atm	DE
LIN	Lindenberg	atm	DE
ZPZ	Zugspitze	atm	DE
SCH	Schauinsland	atm	DE
IZA	Izaña	atm	ES
SMEAR II	SMEAR II Hyytiälä	atm	FI
Pallas	Pallas node of Pallas-Sodankylä GAW station	atm	FI
Sodankylä	Sodankylä node of Pallas-Sodankylä GAW station	atm	FI
FIK	Finokalia	atm	Greece
MHD	Mace Head Atmosphere Research Station	atm	IR
MTC	mont cimone	atm	IT
CBW	Cabauw	atm	NL
BIR	Birkenes Observatory	atm	NO
AND	Andøya Observatory	atm	NO
ZEP	Zeppelin Observatory	atm	NO
SE-Nor	Norunda	eco	SE
AUC	Auchencorth	eco	UK
GIF	Gif-sur-Yvette	atm	FR
PUY/PDD	Puy de Dôme	atm	FR
OPE	Observatoire Pérenne de l'Environnement	atm	FR
OHP	Observatoire de Haute Provence	atm	FR
REU	OPAR La Réunion	atm	FR

Global GAW stations are indicated in grey. Some stations listed in its table also belong to other networks such as EMEP or LTER (Long-term Ecological Research).

A well-defined strategy leading to a more efficient integration of aerosol measurement capabilities on continental or larger scales will results in clear benefits such as improved data access and availability, improved comparability of data, more uniform data quality standards from different networks, increased synergy of measurements and prevention of unnecessary duplication. Even moderate resources invested towards developing synergies could significantly enhance such integration.

One goal is to start improving the situation with three specific actions:

1- Whenever a new station in installed within or outside of Europe, it should be designed at a larger scale then the ACTRIS partnership and opened towards other observing networks of infrastructure.
2- Whenever possible, when ACTRIS and ICOS stations are located at short distance from each other, efforts should be made towards integration of the 2 stations;
3- The community should start working towards common standards and procedures that will contribute to reducing costs (maintenance of instrumentations in particular) and improve interoperability of data acquisition and transfer.

During the first 18 months of activity, ACTRIS partners have worked towards implementation of these 3 specific actions.

<u>Actions towards implementation of point 1).</u>

A first realisation towards point 1) above, concerns links with ICOS. WP6 ACTRIS prepared and installed an entire set of instrument for measurement the core ACTRIS parameters at one of the ICOS Atmospheric Demonstration Experiment. We chose the level 1 demo station which is the new OPE/ANDRA station located in the east of France (indicated in dark grey in the table). This new station designed by LSCE/IRFU with the assessment of the ICOS community will constitute the ICOS Atmospheric Station (AS) pattern for the coming construction of new ICOS AS. The ICOS demonstration experiment will afford to validate the ICOS AS pattern before deployment. The Level 1 station uses the ICOS standard instrument for the CO2/CH4 measurements (Picarro G1301 or G2301), calibrated with working gases provided by the ICOS calibration center. ICOS demo sites measures the meteorological parameters: wind direction, wind speed, atmospheric pressure, temperature and relative humidity and sends the raw data to the Atmospheric Thematic Center (ATC) in near real time (at least once a day), in a format specified by the ICOS Atmospheric thematic Center (ATC). The ICOS demo site is also equipped with a commercial aerosol Lidar that is not yet part of ACTRIS (no WP2 quality control). In winter-spring 2012, core WP3 ACTRIS measurements were added to the instrumental set-up using similar data transfer procedures.

Figure 2 shows a view of the OPE/ANDRA station, now a joint ICOS/ACTRIS site that delivers NRT data to ACTRIS and ICOS data centers.

The OPE station is now equipped with EUSAAR quality standard aerosol instruments: absorption photometer (aethalometer), nephelometer, Scanning particle sizer (SMPS), PM10 filter unit for OC/EC measurements. CNRS/ANDRA personnels are trained for the maintenance of both instrument types in ICOS and ACTRIS.

A second realization related to point 1) is the new GAW station at Chacaltaya (CHC) Bolivia where both WP3 partners along with an ICOS partner have installed a core ACTRIS/ICOS station in operation since December 2011. Instrumentation at CHC includes Backscattered aerosol lidar, AERONET multi--λ sun-photometer, CO2 Lycor analyzer, O3 monitor, 7-λ aethalometer, 3-λ nephelometer, Aerosol ion spectrometer, differential mobility particle sizer, particle counters, high-volume aerosol sampler (PI LGGE), UV and VIS pyranometers, pluviometers for isotopic analyses in precipitation and hydrometeorological stations. Data quality will meet the international standards of the European infrastructure ACTRIS (for aerosol and reactive gases) and IMECC/ICOS for CO2. All data will be made available through GAW world data centers and use similar data stream functionalities from CHC to the local data center.

Figure 3 shows the CHC main operation room with the ICOS CO2 instrument and the ACTRIS instrumentation

A third action towards point 1) has been jointly performed by CNRS and CNR partners, in collaboration with ICOS partners as a proof of concept activity. The goal is to integrate into a single mobile station, measurement for aerosol, reactive and greenhouse made up with basic instruments managed and controlled by a microcontroller/pc with dedicated software and customizable. A small station was built containing measurements for CO2 levels, aerosol size and number distribution, aerosol absorption coefficient, and Ozone all controlled by a single unit and transmitted with unified data stream functionalities (Figure 4). This proof of concept that

required efforts to integrate all measurements into a special thermostated box in which the inlet will be specifically studied and realized according to the needs of the monitoring activities. The ACTRIS core station can be installed on a dedicated mechanical support and associated with a safety connection to a docking power system supplying energy from a photovoltaic power structure with small solar panels. Communication system is optimized for remote operations and the data will be stored on-board and transmitted in NRT using appropriate systems (Satellite, WiFi, WiMax, IR, …).

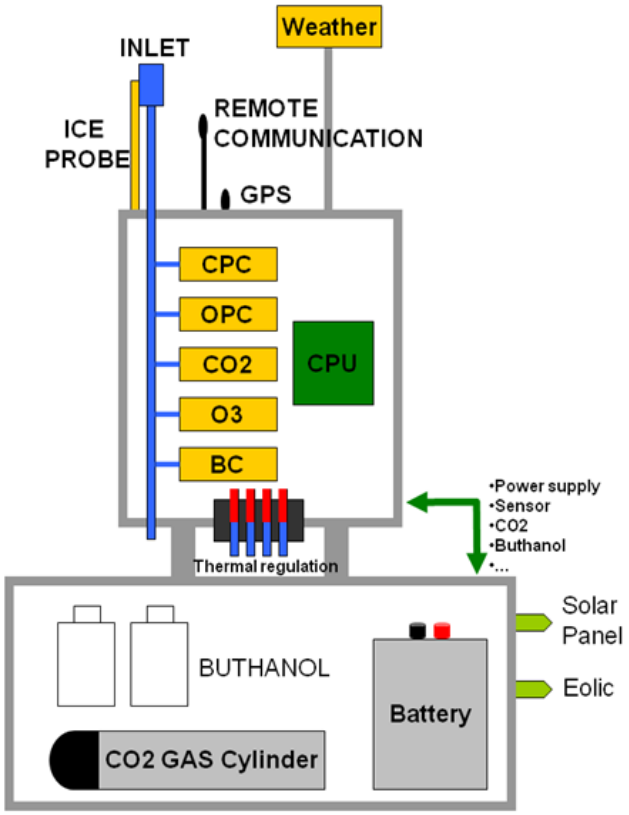

Figure 4: schematic description of the ACTRIS integrated station with the instrumented box containing all 5 instruments for gas and aerosol phases as well as the acquisition and communication systems. The second box contains batteries and standards / chemical for the instrumentation. A thermal regulation connects the 2 boxes.

Actions towards implementation of point 2).

An example of action towards point 2) is the recent move of the EUSAAR Vavihill station in Sweden to be reinstalled at the Norunda ecosystem ICOS station. The Norunda research station (ca. 30 km north of Uppsala in central Sweden, lat. 60°05'N, lon. 17°29'E) was established in 1994 and is operated by Lund University. The site is located in a mature boreal forest, dominated by Norway spruce (Picea abies) and Scots pine (Pinus sylvestris) with a small fraction of deciduous trees, mainly birch (Betula sp.). The area contains of stands of various age and height, but within a 1 km radius, old (120 years) and middle-aged (70-90 years) forest of about 25 m height dominates.

Figure 5: Main research tower (102m) at the Norunda research station

At present, the research station has a 102-m high tower, with eddy flux instrumentation at 35 m (H2O, CO2) and 100 m (H2O, CO2), and a profile gradient system consisting of concentration measurements (H2O, CO2, CH4) at up to 10 levels between 8 and 35 m height. In addition, a wide range of radiation and meteorological parameters are measured. Currently, the station is being upgraded with new measurement equipment within the ICOS project. Starting in 2013 (Swedish national funding), WP3 and WP4 ACTRIS instruments will be installed as part of the joint ICOS/ACTRIS strategy. O3 and BVOC (PTR-MS technique) in-canopy concentration profiles will be added to the site, and continuous aerosol particle measurements (SMPS, AIS) will start at Norunda in spring 2013. Beyond the scientific interest for operating measurements of long and short lived climate substance, there is a clear strategy for integration of different network into a single operating station.

Actions towards point 3) for working towards common standards and procedures have been mainly taking place within the ENVRI concept of which ACTRIS is now an associated observer.

In conclusion, work towards integration of the various components of ACTRIS with different networks / infrastructure operating in Europe was performed within the first 18 month of activity. We are proposing an initial vision for the operation and scope of a network of atmospheric infrastructures and performed initial steps towards its implementation. This is fundamental for developing a shared vision and implementation plan that will include joint activities e.g. workshops and campaigns, shared planning of new site locations, co-location and shared operations for large scale facilities, coordination of the expansion of the networks by collocating instruments to existing monitoring sites of other networks, coordination of the expansion of the networks by establishing new sites in regions with few or complete lack of observations. It also includes to further contribute to a shared/common metadata access portal. The long-term perspective should aim at further developing common harmonised methodologies, DQOs, QA/QC procedures etc. across measurement frameworks to the extent possible and to facilitate expertise exchange programs.