WP6: Integration, outreach, and sustainability
Deliverable D6.20: Comprehensive training course on techniques, outreach and integration to improve running a network-5

The training course was aimed at MSc students and young scientists in the field of experimental atmospheric/biospheric research. The emphasis was on introducing novel methods, including in situ measurements, aerosol, gas and ion instrumentation, and comparing and integrating the results from different approaches using advanced statistical analysis methods. The work done during the training course was organized in small projects, each done in a small group of course participants. There were a total of four groups, combining the topics of ACTRIS WPs 2-6 and 21-22 (Group 1: WP4 & 21; group 2: WP2, 5 & 22; group 3: WP4; group 4: WP2,3, 6 & 21). The groups collaborated with each other, shared the data and results and came to common conclusions.

The course included three group presentation sessions where each group presented their plans and results. At the end of the course, each group was given the task of writing a scientific report about their results.

The course was given at the Järvselja Experimental Forestry Station (SMEAR Estonia) in south east Estonia between October 6 and 15, 2014. The course was coordinated by the University of Helsinki and Estonian University of Life Sciences.

The lectures covered the following topics:
- Introduction to ACTRIS & the course
- Biosphere-atmosphere interactions
- Basics of aerosol science
- Processes behind the soil fluxes
- Human impact on aerosol-cloud mediated processes
- Processes in the atmosphere-biosphere system
- Career in science

The course saw the participation of 23 students of 7 different nationalities, representing 6 institutions in 4 different countries. The course saw the participation of 19 senior staff of 6 different nationalities, representing 3 institutions in 2 different countries.

Course leader :
- Prof. Markku Kulmala (University of Helsinki)

Other professors, senior scientists and assistants:
- Prof. Jaana Bäck, University of Helsinki
- Prof. Tuukka Petäjä, University of Helsinki
- Prof. Olaf Krüger, University of Tartu
- Dr.rer.nat. Steffen M. Noe, Estonian University of Life Sciences
- Dr. Kajar Köster, Estonian University of Life Sciences and University of Helsinki
- MSc Mikhail Paramonov, University of Helsinki
- MSc Ksenia Atlaskina, University of Helsinki
- MSc Stephany Buenrostro Mazon, University of Helsinki
- MSc Petri Keronen, University of Helsinki
- MSc Anna Nikandrova, University of Helsinki
- MSc Nina Sarnela, University of Helsinki
- Doc. Mari Pihlatie, University of Helsinki
- MSc Juan Hong, University of Helsinki

- Dr. Sander Mirme, University of Tartu
- Dr. Marko Vana, University of Tartu
- MSc Kaupo Komsaare, University of Tartu
- MSc Alisa Krasnova, Estonian University of Life Sciences
- MSc Dmitrii Krasnov, Estonian University of Life Sciences

Students:

- Ms. Liine Heikkinen	Finland
- Mr. Arto Heitto	Finland
- Ms. Laura Matkala	Finnish
- Ms. Dace Auzina	Latvian
- Mr. Andebo Waza	Ethiopian
- Mr. Lauri Ahonen	Finland
- Ms. Freya Majgaard Gøbel	Danish
- Ms. Elisa Halmeenmäki	Finland
- Ms. Maris Palo	Estonia
- Ms. Louise Skov Iversen	Danish
- Mr. Ott Kangur	Estonian
- Ms. Ida Alexandra Rosendahl	Danish
- Ms. Kristine Holm Kjær	Danish
- Ms. Rasmussen Berit Brøndum	Danish
- Mr. Filippo Xausa	Italian
- Ms. Krista Luoma	Finland
- Ms. Mari Mäki	Finnish
- Mr. Jaakko Heikkinen	Finnish
- Ms. Meeli Alber	Estonian
- Ms. Lubna Dada	Lebanese
- Mr. Jonas Emil Christensen	Danish
- Mr. Getachew Agmuas Adnew	Ethiopian
- Mr. Teemu Paljakka	Finnish

Main conclusions of the group work

Group 1 – Volatile Organic Compounds

Ground vegetation has lower influence on soil carbon dioxide flux, which is highly influenced by temperature, increase as temperature of the soil increases. Emission of monoterpenes is more dependent on the litterfall than the ground vegetation. Isoprene flux from the soil is relatively 20 lower as compared to monoterpenes since they do not have storage and the ground vegetation contribution is lower.

The concentration of monoterpenes peaks during nighttime and drops during daytime. This is most likely because of monoterpenes being part of photochemical reactions during daytime. Isoprene also participate in such reactions, but monoterpenes generally reacts faster, so the drop in concentration is more prominent.

VOC emissions from shoots had an optimal type of behavior with temperature and linear relationship with VPD in SMEAR II in September. The correlation between VOC emissions and VPD was significant for isoprene. These links were weaker with monoterpenes in August and unable to see from SMEAR Estonia data, probably because of remote temperature and RH data. There was no similar behavior in daily monoterpene emissions between SMEAR II and SMEAR Estonia. Scots pine in SMEAR II and Norway spruce in SMEAR Estonia might have different type of behavior in monoterpene emissions. Also lag in growing season in SMEAR II or higher temperatures in SMEAR Estonia can be one of the reasons for this. The standard temperature was found to be 16.5 °C after fitting the Guenther algorithm to data in SMEAR II. The size of the dataset used in this study for defining the standard temperature is still too small for general conclusions.

VOC concentrations in ambient air are also higher in Järvselja than in Hyytiälä. Main reason of this is due to differences of forest composition.

The connections between photosynthetic capacity and VOC concentrations were also examined. To make any relevant conclusions, more measurements and better understanding of photosynthetic capacities response delay to temperature changes is needed.

To make data from the two sites comparable, similar conditions have to be present as well as the same meteorological data needs to be available. The measurements have to be conducted at the same date and preferably with the same type of equipment to minimize inaccuracy. Continuous online measurements for the Estonian station are also needed, since it would make it easier to predict the average conditions and hence optimize the comparison of both sites.

Group 2 – Remote Sensing

The thermodynamic method of using combined relative differences is able to roughly determine the days when profiles of thermodynamic parameters are similar and indicate the same air mass over different SMEAR stations. Considering annual variation and determining optimal threshold values for each season for each parameter would improve the method and, thus, only cases with best matches could automatically be found.

Aerosol optical properties, especially single scattering albedo, are useful parameters for detecting same air masses over different areas. The optical data received from the satellite can be combined with the ground-based in situ measurements, such as DMPS, can give good results if there is no local pollution episode at the same time. The aerosol optical parameters can, however, only be used for detection of the same air mass during days without snow or cloud cover. The understanding of seasonal variation of these optical parameters is very challenging task since in the high latitudes aerosol optical properties retrieval from satellite-based instruments is often impossible during winter time. But it could be clearly seen that during early spring and late summer there were drops in the SSA-values in every station and this data was used to identify the same air mass.

Satellite trace gas data can be used to identify similar air masses over stations. Using CO data it was found that when one station has higher anthropogenic influence, the higher level is more influenced than the lower level and this could be due to long-range transport. Cases with high CO concentrations in spring and summer were identified and with few cases of overlap between stations. Furthermore, the single levels were found not to be representative for the whole atmosphere column, which can be important for investigating vertical mixing of the atmosphere in the future. Further work could be to investigate whether cases of delay can be identified with CO data and the days 13.08.2012 and 14.08.2012 could be studied further in detail to confirm whether they are actual cases of delay. Days with high CO concentrations for all stations at the same time, could also be interesting to compare with other types of data.

The annual variations of NO_2 and O_3 were also studied and both gases were found to have clear seasonal trends. It could be clearly seen that NO_2 levels were high during the winter and in contrary O_3 levels were high during the summer. Also the variations of the annual mean values of these chemical compounds were investigated in this study. This investigation together with the study of the annual trends clearly states that the O_3 production is not NO_x dependent.

Cases with increased O_3 concentrations over different stations were also studied. An episode with the same air mass traveling from SMEAR 1 to SMEAR 2 was captured and confirmed with backward trajectory analysis. Also the source of the pollution was found with a CO concentration plot. A further investigation would include a study of radiation, VOC and horizontal and vertical air mixing profiles.

Group 3 – Soil Dynamics

According to chamber measurements, we found temperature response of CO_2 flux to differ between seasons in 2009–2012, although results can be biased because heterotrophic and autotrophic respiration with different temperature responses was not separated. We discovered EC measurements from above canopy to possess adequate estimation of soil CO_2 flux compared to measurements under canopy in 2012. Relatively large difference in CO_2 flux between sub-canopy and soil during night-time refers to the insufficient turbulent mixing under the canopy leading to underestimation of soil CO2 flux by EC method in sub-canopy. The methods for collecting and analyzing data should be comparable to make comparisons between SMEAR-stations so the interaction between Finland and Estonia should be increased.

We found evidence of occasional CH4 emissions from the forest floor in summertime 2013–2014. Overall, the forest floor acted as a sink of CH4 in 2012–2014. The whole ecosystem acted as a small source of CH4 in 2012, especially in autumn. The flux was approximately neutral (only slightly positive or negative) from spring to autumn. Hence the occasional emissions from forest floor do not, however, completely explain the ecosystem scale CH4 flux.

Group 4 – Aerosols

The results obtained clearly show that the highest number of events was recorded in spring with a peak in March and April, with the highest frequency for Hyytiälä followed by lower patterns in Värriö and Järvselja. The starting time of NPF in Järvselja occurs before noon while the maximum particle concentration was recorded after noon in the period 9:00-15:00.

The comparison of the medians of CS for the event days revealed that the computed CS was relatively higher in SMEAR Estonia in juxtaposition of Värriö in which the CS was lower by a factor of ten. Such difference was observed in the comparison scatter plot of event days over the whole measurement days in common within the stations.

The computation of growth (GR) and formation rates (J2) along with condensable vapour source rates (Q) agreed with the results regarding event days fraction and CS. The data obtained from SMEAR Estonia show a higher condensable vapour source rates compared to Hyytiälä, almost by a factor of 2, with a peak in the spring season. The source rate shows a significant increment during spring and autumn periods as well, while the diurnal time series for formation rate (J2) confirms the NPF starting time and its relative peak occurring before and after noon, respectively.

The concentration of particles and ions is generally lower on non-eventdays than on event days. Both places show a higher concentration of ions at ground level (except during burst for Hyytiälä) and increased cluster ion concentration during evening due to increased ionization rate near the ground and reduced vertical mixing respectively (Tammet et al., 2006). A slightly higher association between radon and ion concentration on ground compared to tower level was also observed.

For SMEAR Estonia the concentration of particles is higher than ions of both polarities for all days at both tower and ground level. There is more charge in the tower during nighttime while the charge is more mixed during daytime. For ions in the size range 1.9–2.9 nm the general trend is a higher concentration at ground level during daytime while the concentration at nighttime is approximately equal for both vertical measurements. Negative ions in the size range 2.9–10.9 nm is equally divided between the tower and ground level during nighttime, but during noon the concentration of intermediate ions in the tower is higher than the ground level measurements and in the afternoon and evening the concentration of ions is higher at the ground level for event days.

For Hyytiälä the concentration of cluster ions is several factors higher than the concentration of intermediate ions, which show a burst at noon for event days for both tower and ground level, which is not seen for cluster ions.

The charging ratio shows more charge in the tower during night and more charge at the ground level during the day. The charge is nearly equally divided between tower and ground level during noon. One explanation for whether the fraction of charged particle was higher in the tower or ground is that the change in neutral particle is greater during the day than the change in ion concentration. This would explain the difference in the fraction of ion against total concentration which is mainly neutral. Particle concentration had fairly similar diurnal variation between tower and ground level than ion concentration and concentrations were higher in the tower at day time and at ground at nighttime.

The cluster ion concentration at Hyytiälä is higher than the concentration for SMEAR Estonia which may be due to the thin soil layer in Hyytiälä and the radioactivity of the ground and air may be significant (Tammet et al., 2006). The concentration of ions in the size range 1.9–2.9/3.3 nm is higher at ground level during burst at SMEAR Estonia whereas the concentration during burst is higher in the tower for Hyytiälä, which might be due to differences in the environment

From the particle concentration data there was no clear indication whether NPF events tend to start from the ground level or at the tower level. Further investigation with greater time resolution should be made. At least PSM could be used with greater time resolution if compromise is made with size resolution.