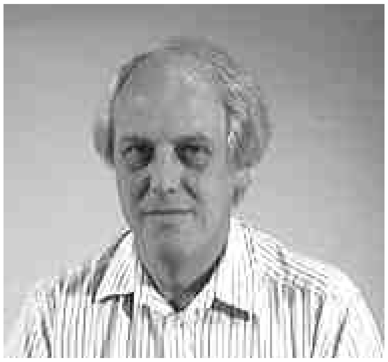
International Conference

Research, monitoring and modelling in the study of climate change and air pollution impacts on forest ecosystems

5-7 October 2010, Rome, Italy

BOOK OF ABSTRACTS

Dedication to Dr. John Derome



This conference is dedicated to Dr. John Derome, soil scientist, friend and colleague. We lost John on June 7, 2010. He was member of the Management Committee of Action FP0903 for Finland. At our last meeting in Turkey (March 2010), he gave – as usual – a great contribution of experience and advice to the progress of this Action. We miss not only his scientific expertise but also his sense of humour and spirit. His memory continues to live on.

October 5th, Tuesday

8:15-9:00 **Registration**

Opening session

Chair: Elena Paoletti

9:00-9:15 Elena Paoletti
Chair COST Action FP0903
The COST Action FP0903: Aims and prospects

9:15-9:30 Lucio di Cosmo
CRA-MPF & Italian Forest Service
Italian forests: an overview from the National Forest Inventory

Session 1 - Availability and evaluation of monitoring data at forest sites in Europe

Chair: Nicholas Clarke

9:30-9:50 Nicholas Clarke p. 15
Chair WG1 COST FP0903, Norwegian Forest and Landscape Institute (Norway)
Availability and evaluation of monitoring data: problems and opportunities

9:50-10:10 Wenche Aas p. 11
EMEP Chemical Coordinating Center, NILU (Norway)
Differences between European monitoring networks regarding quality control, availability and data access policies for measurements on atmospheric composition

10:10-10:30 Marco Ferretti p. 20
Chairman QA Committee of ICP Forests, TerraData environmetrics (Italy)
To what extent can we rely on ecological monitoring and research data?

10:30-11:00 **Coffee break**

Session 1 - continuation

Chair: Nicholas Clarke

11:00-11:20 Daniel Zlindra p. 36
Slovenian Forest Institute (Slovenia)
Harmonisation of forest monitoring: a case study with deposition samplers

11:20-11:40 David Leaver — p. 26
NitroEurope Data Centre Manager, CEH Edinburgh (UK)
A new database for time-series monitoring data: the NitroEurope approach

11:40-12:00 David Simpson — p. 33
EMEP MSC-W (Sweden)
Biosphere-atmosphere exchange in the EMEP chemical transport model. Experience and issues

12:00-12:15 Natalie Cools — p. 15
INBO (Belgium)
Availability and evaluation of European forest soil monitoring data

12:15-12:30 Allan Legge — p. 26
Biosphere Solutions (Canada)
Monitoring the Boreal Forest in Athabasca Oil Sands Region of Northeastern Alberta, Canada

12:30-14:00 **Lunch**

Session 1 - continuation

Chair: Giorgio Matteucci

14:00-14:15 Giada Bertini — p. 12
CRA-SEL (Italy)
Forest growth and climate change. Evidences from the ICP-Forests intensive monitoring in Italy

14:15-14:30 Cecilia Akselsson — p. 11
Lund University (Sweden)
Do soils and water recover from acidification in Swedish forests? Long-term trends in soil water chemistry and possible effects of climate change

14:30-14:45 Sasa Orlović — p. 31
National Park Fruska Gora (Serbia)
Monitoring of entomofauna in forest ecosystems of Serbia
CANCELLED

14:45-15:00 Lars Högbom — p. 22
Skogforsk-Uppsala (Sweden)
Nitrate losses following final felling in Sweden

15:00-15:15 Sofie Hellsten — p. 21
IVL Swedish Environmental Research Institute (Sweden)
Wind -throw caused increased concentrations of nitrate in forest soil water in southern Sweden

15:15-15:30	Per Erik Karlsson *IVL Swedish Environmental Research Institute (Sweden)* **Dry deposition of inorganic nitrogen to a surrogate surface – implications for estimating the total nitrogen deposition to coniferous forests in Sweden**		p. 24

15:30-16:00 **Coffee break**

Session 1 - continuation

Chair: Nenad Potocic

16:00-16:15	Sofia Leal *Instituto Superior de Agronomia, Lisboa (Portugal)* **Study of tree rings as climatic indicators in Portugal**		p. 25
16:15-16:30	Zane Libiete-Zalite *Latvia State Forest Research Institute „Silava" (Latvia)* **Potential use of Latvian forest monitoring data for the study of climate change and air pollution impact on forest ecosystems**		p. 27
16:30-16:50	Mohammed Ellatifi *President of Sylva World (Morocco)* **Monitoring climate change impacts on forests of the Mediterranean basin: Morocco as a case study**	CANCELLED	p. 19

Session 1 – Short presentations

16:50-16:55	Pierre Sicard *ACRI-S (France)* **Annual and seasonal trends for ambient ozone concentration and its Impact on Forest Vegetation in Mercantour National Park (South-eastern France) over the 2000-2008 period**	p. 33
16:55-17:00	Ana de la Cruz *CIFOR– INIA (Spain)* **Litterfall production and nutrients in intensive monitoring Level II plots (Spain)**	p. 15
17:00-17:05	Raitis Rieksts-Riekstins *Latvian State Forest Research Institute "Silava" (Latvia)* **Long term tree breeding trials as tool to monitor tree responses to climate changes**	p. 24
17:05-17:10	Ana Luísa Luz *Instituto Superior de Agronomia (Portugal)* **Stages of tree ring development along one cycle of cambial activity**	p. 28
17:10-17:30	**Discussion and conclusions**	

October 6th, Wednesday

Session 2 - Scientific gaps and modelling

Chair: Rainer Matyssek

9:00-9:20	Sebastian Gayler *University of Tuebingen (Germany)* **Modelling the effect of resource availability on carbohydrate allocation to defence-related metabolism in plants. An approach based on experimental results and theoretical considerations**	p. 21
9:20-9:40	Carlo Calfapietra *IBAF-CNR (Italy)* **Interactions between Volatile Organic Compounds emitted from vegetation and tropospheric ozone**	p. 14
9:40-10:00	Mikhail Sofiev *Chair COST ES0603 (Finland)* **On chemical and biological air quality: experience of COST-ES0603**	p. 34
10:00-10:20	Frits Mohren *Vice Chair COST FP0603 (The Netherlands)* **Modelling air pollutant effects on tree growth**	p. 31

10:20-11:00 **Coffee break**

Session 2 - continuation

Chair: Rainer Matyssek

11:00-11:20	Juha-Pekka Tuovinen *Vice Chair COST FP0903, Finnish Meteorological Institute (Finland)* **Modelling ozone fluxes: can we validate the models?**	p. 35
11:20-11:40	Pierre Dizengremel *EEF INRA/UHP Nancy Université (France)* **Improving the determination of the effective ozone flux in tree leaves for issuing a sub-model to be integrated in models predicting ozone risks to forest ecosystems**	p. 17
11:40-11:55	Rocío Alonso *CIEMAT (Spain)* **Modelling stomatal ozone fluxes to Holm oak forests**	p. 11
11:55-12:10	Stanislaw Cieslik *JRC, Ispra (Italy)* **A balloon borne probe to study gas exchange between air and vegetation**	p. 15

12:10-12:30 Gerhard Wieser p. 36
Vice Chair WG2 COST FP0903, BWF, Innsbruck (Austria)
High elevation forest soil CO_2 efflux in a changing environment

12:30-14:00 **Lunch**

Session 2 - continuation

Chair: Gerhard Wieser

14:00-14:20 Patrick Schleppi p. 32
WSL Birmensdorf (Switzerland)
Interactions between the N and C cycles in forests and how does the atmosphere chemistry impact forest ecosystems

14:20-14:40 Teis Mikkelsen p. 30
Chair WG3 COST FP0903, Risø DTU (Denmark)
Is methane released from the forest canopy?

14:40-15:00 Hojka Kraigher p. 25
COST FP0803, Slovenian Forestry Institute (Slovenia)
Belowground complexity

15:00-15:15 Wim de Vries p. 16
Alterra – Wageningen University and Research centre (the Netherlands)
Combining empirical research and model approaches to assess long-term impacts of changes in nitrogen deposition and climate on tree carbon sequestration in Europe

15:15-15:30 Michal V. Marek p. 28
CzechGlobe, Academy of Sciences (Czech Republic)
Environmental limits of the biological carbon pumping by the forests

15:30-16:00 **Coffee break**

Session 2 - continuation

Chair: Pavel Cudlin

16:00-16:15 Andrew Weatherall p. 35
University of Cumbria (UK)
Tracing carbon and nitrogen from stem injected trees into forest ecosystems

16:15-16:30 Marie Dury p. 18
Université de Liège (Belgium)
Response of the European forests to extreme climatic events predicted for the 21st century: sensitivity to climate models and their variability

16:30-16:45 Anu Sõber p. 34
University of Tartu (Estonia)
How combined changes in air humidity and temperature affect xylem flux and growth of fast-growing deciduous trees?

16:45-17:00 Daniela Famulari p. 19
CEH Edinburgh (UK)
NH_3 release through a forest canopy: an agro-forestry experiment

Session 2 – Short presentations

17:00-17:05 Alessandra de Marco p. 16
ENEA Casaccia (Italy)
The forest contribution to the Italian total nitrogen budget

17:05-17:10 Didier Le Thiec p. 27
UMR 1137 EEF INRA/UHP Nancy Université (France)
Vulnoz a french research project: Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030?

17:10-17:15 Yasutomo Hoshika p. 22
The University of Tokyo (Japan)
Stomatal conductance modeling of deciduous trees for ozone risk assessment in Japan

17:15-17:20 Akihiro Ishimura p. 23
The University of Tokyo (Japan)
Remote sensing of Japanese beech forest decline using water deficit index (WDI)

17:20-17:25 Chris Eastaugh p. 18
University of Natural Resources and Applied Life Sciences, Vienna (Austria)
Incorporating management history into forest growth modeling

17:25-17:30 Estelle Bortoluzzi p. 13
Université de Toulouse (France)
CANCELLED
Impacts of Nitrogen atmospheric deposition on French forest biodiversity in the context of climate changes: a coupled biogeochemistry-ecology dynamic modelling approach

17:30-17:35 Anu Sõber p. 34
University of Tartu (Estonia)
Launching experiment FAHM (Free air humidity manipulation)

17:35-18:30 **Discussion and conclusions**

October 7th, Thursday

Session 3 - Towards supersites

Chair: Teis Mikkelsen

9:00-9:20 Richard Fischer p. 20
PCC of ICP Forests, Vice Chair WG3 COST FP0903, vTI – Institute for World Forestry (Germany)
The ICP Forests monitoring programme – sites, protocols and links to other Transnational Networks

9:20-9:40 Andreas Ibrom p. 22
Risø DTU (Denmark)
NitroEurope forest supersites

9:40-10:00 Lars Lundin p. 27
Chair of ICP IM (Sweden)
Monitoring programme and sites of the ICP integrated monitoring programme and its links to other transnational networks

10:00-10:20 Michael Mirtl p. 31
Chair of LTER, Federal Environment Agency (Austria)
Distributed Long-term Ecosystem Research Network LTER-Europe – a major European research infrastructure comprising forested supersites

10:20-11:00 **Coffee break**

Session 3 - continuation

Chair: Teis Mikkelsen

11:00-11:20 Timo Vesala p. 35
Chair COST ES0804, University of Helsinki (Finland)
ABBA - Advancing the integrated monitoring of trace gas exchange between biosphere and atmosphere

11:20-11:40 Arnaud Carrara p. 14
Fundación CEAM (Spain)
A high level ecosystem monitoring station in Spain

11:40-12:00 Matthias Dobbertin p. 17
WSL Birmensdorf (Switzerland)
Linking different long-term research and monitoring sites and establishing common protocols that are open for new developments– experiences from Switzerland

12:00-12:20 Ovidiu Badea p. 12
ICAS (Romania)
Existing long-term monitoring networks in Romanian forests

12:20-14:00 **Lunch**

Session 3 - continuation

Chair: Richard Fischer

14:00-14:20 Dario Papale p. 32
DISAFRI, University of Tuscia (Italy)
The eddy covariance networks in Europe for forest carbon exchange monitoring

14:20-14:40 Giorgio Matteucci p. 29
Vice Chair WG1 COST FP0903, CNR–ISAFOM (Italy)
Integrating monitoring and research: examples and results from a "supersite" in a beech forest in Central Italy

14:40-14:55 Rastislav Jakuš p. 23
Slovak Academy of Sciences (Slovakia)
Link from monitoring plots to GIS and remote sensing based disturbance modelling: TANABBO approach

14:55-15:10 Panagiotis Michopoulos p. 30
Forest Research Institute of Athens (Greece)
Effects of CO_2 enrichment on trees and intensively monitored plots: research needs in view of future ecosystem studies

15:10-16:00 **Coffee break**

Session 3 - continuation

Chair: Richard Fischer

16:00-18:00 **Round table** : David Leaver, Wim De Vries (NitroEurope); Lars Lundin (ICP IM); Dario Papale (CarboEurope); David Simpson (EMEP); Timo Vesala (ICOS); Michael Mirtl (LTER); Juha-Pekka Tuovinen (COST FP0903); Richard Fischer (ICP Forests)

18:00-18:30 **Discussion and conclusions**

Differences between European monitoring networks regarding quality control, availability and data access policies for measurements on atmospheric composition

Wenche Aas, Cathrine Lund Myhre and Kjetil Tørseth*
NILU, Norwegian Institute for Air Research (EMEP/CCC), PB 100, 2027 Kjeller, Norway

There are several monitoring networks with measurements of atmospheric compositions in Europe. Some of the components across networks are overlapping and therefore several sites may serve many networks and programmes. There is a general tendency to integrate and combine different monitoring obligations and research interest at the same locations for scientific synergy across disciplines. Further, there is often a prerequisite for large research projects that these should be coordinated and harmonised with long term monitoring programmes. However, there are several challenges regarding harmonisation and co-location of measurements because of the different needs and requirements. Ecosystem specific monitoring station, i.e. for flux and deposition measurements are often dislocated from sites with more regional representative perspectives, though work is ongoing to disseminate information across various networks.

EMEP and ICP Forest are the two main long term monitoring programmes in Europe measuring atmospheric deposition. Further WMO/GAW is an important global network. EMEP and WMO/GAW are well harmonised regarding measurements method and data reporting, and the sites are to a large extent co-located on so called joint supersites. For EMEP and ICP Forest there are relatively large differences in location, methodology and data availability, and it is certainly room to better facilitate information across these two networks. Further on there are several EU research and infrastructure projects (like NitroEurope, CarboEurope, GEOMon, ICOS) that are very important supplements to the long tem monitoring programmes in Europe. Nevertheless, there are still large differences in the availability of data across networks and research programmes, and the quality and representatively may vary considerable, creating large challenges for the data users.

Do soils and water recover from acidification in Swedish forests? Long-term trends in soil water chemistry and possible effects of climate change

Cecilia Akselsson[1], Hans Hultberg[2], Gunilla Pihl Karlsson[2], Sofie Hellsten[2], Per Erik Karlsson[2]*
[1] Lund University, Department of Earth and Ecosystem Sciences, Sölvegatan 12, SE-223 62 Lund, Sweden
[2] IVL Swedish Environmental Research Institute, Box 5302, SE-400 14 Gothenburg, Sweden

Although there are clear signs of recovery from acidification in Swedish lakes, the problem with acidified soils and water persists. The soil recovery is generally a slow process, and the lakes cannot be fully recovered until the soils are recovered. Furthermore, the recovery process can be affected by several climate-related factors.

Soil water in the root zone is a key for increasing the understanding of the interactions between soil and surface water recovery. Within the Throughfall Monitoring Network in Sweden, deposition and soil water chemistry has been studied on a large number of forested sites since 1986. In this study, nine of the sites with the longest time series, 18-22 years, were studied in detail, and analysed in relation to decreased sulphur deposition, sea salt episodes and nitrogen status.

The sites were highly acidified, in most cases with pH substantially less than 5 and negative ANC. The reduced sulphur load was clearly reflected in decreased sulphur concentrations in soil water accompanied by decreased concentrations of e.g. calcium. There were some trends of less acidified soil water, with higher ANC and lower concentration of inorganic aluminium on many of the sites and increased pH on some of the sites. The improved situation can to some extent be explained by the reduced sulphur load, but heavy sea salt episodes in the beginning of the 1990s are an important explanatory factor as well. At the sites with the highest sulphur and nitrogen deposition, nitrification led to elevated nitrate concentration in soil water and lowering of the already low pH to levels below 4.5. If sea salt episodes become more frequent in a changing climate, the recovery can be substantially delayed. In areas where nitrification rates increase in the future due to warmer and wetter climate, this may further delay the recovery.

Modelling stomatal ozone fluxes to Holm oak forests

Rocío Alonso, Ignacio González-Fernández, Susana Elvira, Victoria Bermejo*
Ecotoxicology of Air Pollution, CIEMAT (Ed. 70), Avda. Complutense 22, Madrid 28040, Spain

Modelling stomatal ozone fluxes to vegetation is a powerful tool not only for evaluating the risk of negative effects of ozone on vegetation but also for analyzing the possible benefits of vegetation on ameliorating air quality in urban areas. An ozone deposition model (DO_3SE, Deposition of Ozone and Stomatal Exchange) has been developed in the framework of the Convention of Long-Range Transboundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UNECE). This model calculates stomatal conductance (g_s) based on the multiplicative approach defined by Jarvis (1976) and modified by Emberson et al. (2000). Holm oak (*Quercus ilex*) has been selected as a representative key species of Mediterranean vegetation to be used for integrated assessment modelling to optimise emission reductions for the protection of forests. A parameterization of the g_s model included in the DO_3SE has been proposed for *Q. ilex* based on literature review and experimental data recorded at three sites of the Iberian Peninsula experiencing continental or milder Mediterranean climatic conditions (Alonso et al., 2008). The model predicted reasonably well the actual g_s values recorded under a wide range of environmental conditions. However, the influence of soil moisture deficit on g_s needs further modelling development especially for the water-limited environments of the Mediterranean area. A method to estimate soil moisture deficit based on meteorological variables and canopy evapotranspiration has been tested for Holm oak forests. Implications for stomatal ozone flux estimations will be discussed.

References

Alonso, R., Elvira, S., Sanz, M.J, Gerosa, G., Emberson, L., Bermejo, V., Gimeno, B.S., 2008. Environmental Pollution 155, 473-480.
Emberson, L.D., Ashmore, M.R., Cambridge, H.M., Simpson, D., Tuovinen, J.-P., 2000. Environmental Pollution 109, 403-413.
Jarvis, P.G., 1976. Philosophical Transactions of the Royal Society, London B 273, 593-610

Existing long-term monitoring networks in Romanian forests

Ovidiu Badea[1], Ştefan Tamaş[2], Ionel Popa[1], Ştefan Neagu[1], Diana Silaghi[1]*
1.Forest Research and Management Institute,Voluntari,Ilfov, Romania
2. University Transilvania of Brasov, Romania

In order to meet the ever increasing needs for scientific knowledge progress about injury symptoms on forests that occurred since the years 1980s and the quality of different stressors (biotic, abiotic, pollution, fire etc.), as and in most of the European countries, several forest long-term monitoring networks have been designed and located in the forests of Romania. The first such networks (1990-1992) were created consistent with the objectives of both the ICP-Forests Level I (16 x 16 km - 254 plots and 4 x 4 km - 5600 plots) and the Level II monitoring (Intensive monitoring of forest ecosystems - 12 plots). In order to identify the effects of air pollution on distribution and status of forest health and biodiversity in the Carpathian Mountains, in 1997, the Carpathians countries in partnership with the USDA-Forest Service had placed a monitoring network consisting of 26 sites, 6 of which in the Romanian Carpathians. The researched carried out in the Carpathian network led to the admission in the International Long-Term Ecological Research (ILTER) of three Romanian sites (Retezat, Bucegi-Piatra Craiului and Rodna), and subsequently in the LTER-Europe. Retezat and Bucegi-Piatra Craiului ILTER sites were developed in 2000 and 2005 respectively, these research networks consisting of 10 and 22 long-term ecological plots, respectively. In addition, Romanian intensive forest monitoring sites (Level II - 12 plots) and LTER-Europe Network are components of the LTER Romania network. Furthermore, dendrochronological high potential of Romanian forest ecosystems, correlated with a lack of integration of Romanian research at the international level, were decisive factors in elaborating a network of dendrochronological series for the Romanian Carpathians which is integrated in European and international networks.
These networks provide an integrated scientific framework, aiming for advancement in complex research projects at national and international levels, specifically relying on supporting productive capacity of socio-ecological systems in the context of climate change and air pollution effects.

Forest growth and climate change. Evidences from the ICP-Forests intensive monitoring in Italy

G. Bertini[1], T. Amoriello[2], G. Fabbio[1], M. Piovosi[1]*
[1]Centro di ricerca per la selvicoltura CRA-SEL, Arezzo [2] CRA, Roma, Italy

A few concurrent or counteracting factors, i.e. CO_2 enrichment, ozone, nitrogen fertilization, drop off in sulphates deposition, increase of average air temperature, rainfall shortage, drought, drive today the soil-tree-atmosphere relationships in the Mediterranean area. Radial stem growth provides a sensitive response to these occurrences. Measured growth over time may be therefore balanced between opposite driving forces or a trend may be established, depending on prevailing drivers acting. Climate deviations and repeated anomalous seasons or extreme events are the major evidences of the change in progress. Summer 2003 is the main event occurred in this decade over a large part of Europe. In Italy, the heat wave 2003 produced a marked water deficit in the soil coupled to high air temperatures which resulted in a heavy water stress. The monitored growth 2000-2004, compared with the former 1997-99, showed reductions up to 50% on 2/3 of plots. Quite all the case-studies concerned were in/at: (i) northern-central Italy within the southern continental boundary of the climatic deviation; (ii) low elevations, more sensitive to high air temperatures and drought; (iii) deciduous broadleaved forests (beech and oaks), i.e. species with a predetermined, in the case reduced, early growth in the following year too. The current monitoring 2005-09, showed similar growth values on the same plot set. A steady growth rate following the former reduction is being then established. Over the last time-window, significant decreases were vice versa detected quite exclusively within the coniferous forests (spruce) located at medium-high elevations in the Alpine area. The analysis of the datasets is now in progress to highlight possible climatic anomalies or the presence of concurrent pressures within the geographical area. A clear evidence of climate change at a local scale is finally examined in a site where two oak species with a different auto-ecology live together.

Impacts of Nitrogen atmospheric deposition on French forest biodiversity in the context of climate changes: a coupled biogeochemistry-ecology dynamic modelling approach.

Bortoluzzi, E.[1,2], Belyazid, S.[2], Probst, A.[1,2]*

CANCELLED

[1] Université de Toulouse ; UPS, INP ; EcoLab (Laboratoire d'écologie foncti de l'Agrobiopôle, F-31326 Castanet-Tolosan, France
[2] CNRS ; EcoLab ; F-31326 Castanet-Tolosan, France
[3] Belyazid Consulting & Communication AB, Stationsvägen 13, 517 34 Bollebygd, Sweden

Nitrogen deposition constitutes a major threat in terms of acidification and eutrophication of the natural environment. With significant impacts on the ecosystem functioning, it is regarded as one of the factors of biodiversity erosion, more particularly of the vegetation. Within the framework of the Geneva Convention on long-range transboundary air pollution, the effects of this pollution on the ecosystems are evaluated through the concept of critical loads*.
Critical loads models (steady state, dynamic biogeochemical models or empirical models) have been applied with several atmospheric deposition scenarios, but limits were revealed in their application in terms of vegetation biodiversity protection.
In order to better integrate the direct impacts of atmospheric deposition on biodiversity, the use of a biogeochemical model coupled with an ecological one, was proposed. Atmospheric nitrogen deposition generates modifications of the soil biogeochemical characteristics (pH, nitrogen cycle,…)and this evolution of the trophic conditions implies a change in the plant community.
The ForSAFE model, designed for modelling biogeochemical cycles (water, acidity, base cation, nitrogen and carbon), was coupled to a vegetation response module (VEG). Veg introduces the effects of different parameters (temperature, soil moisture, acidification, nutrients, shading, palatability, competition between plants) on the ground vegetation.
Once Veg completed for the key species of the French forest ecosystems, this integrated model ForSAFE-VEG (Sverdrup et al., 2007) was first applied to several forest sites with an intensive survey in the RENECOFOR** Network.
The first runs of ForSAFE-VEG, associated to 3 different climatic changes scenarios, showed that with nitrogen atmospheric deposition reduced as recommended by the current legislation, the nitrogen critical load exceeds the maximum admitted change (5 points of variation in the plant community composition of the ground vegetation) whereas if the deposition is reduced to the maximal technical feasible possibilities, the changes of the ground vegetation remain under the tolerance limit.

* The critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.
**RENECOFOR national network with a long term survey of forest ecosystems (ICP forests level II)

References

Sverdrup, H., Belyazid, S., Nihlgård, B., Ericsson, L. (2007) Modelling Change in Ground Vegetation Response to

Acid and Nitrogen Pollution, Climate Change and Forest Management In Sweden 1500-2100 A.D. Water air soil pollution, 7,163-179.

Interactions between Volatile Organic Compounds emitted from vegetation and tropospheric ozone

Carlo Calfapietra, Silvano Fares, Francesco Loreto*
National Research Council (CNR, -Institute of Agro-Environmental & Forest Biology (IBAF), Monterotondo Scalo (Roma), Italy

Volatile Organic Compounds (VOC) emitted from vegetation (particularly isoprenoids) represent an important source of the atmospheric hydrocarbons (Guenther et al. 1991). Biogenic VOC emissions almost double the anthropogenic source. When biogenic VOC mix with NO_x in the presence of UV radiation, ozone is being formed. Biogenic contribution to ozone formation is particularly frequent around conurbations, or following wind transport over areas with anthropic pollution. This topic is particularly important in Mediterranean regions, since optimal conditions for ozone formation in terms of VOC/NO_x ratios, abundance of UV radiation, and presence of urban areas and recurrent wind regimes, are present for long periods of the year. Moreover, Mediterranean vegetation includes several species that are strong and evergreen isoprenoid emitters, and high temperatures for part of the year further stimulate these temperature-dependent emissions.
Emission of isoprenoids can be an evolutive mechanism to cope with ozone from the plant standpoint. Isoprenoids have been reported to remove and detoxify ozone in plants (Loreto et al. 2004). We present here current knowledge on the impact of rising ozone levels on isoprenoid emission (Calfapietra et al. 2007), and evidences showing that species that emit isoprenoids are more protected against oxidative stress because of isoprenoid antioxidant functions (Loreto & Fares, 2007). This trait not only influences plant tolerance to ozone but also may substantially alter the flux of ozone between atmosphere and biosphere.

A high level ecosystem monitoring station in Spain

Arnaud Carrara, Vicent Calatayud*
Fundación CEAM, Charles R. Darwin 14, Parque Tecnológico, Paterna, Spain

The experimental design and some results of a high level ecosystem monitoring station in Spain will be presented. This station (Majadas del Tiétar, Cáceres, Spain) is located at 5º 46’ 29’’ W longitude and 39º 56’ 26’’ N latitude, at approximately 258 m a.s.l., with a mean annual temperature (16.7 ºC) and an annual precipitation (572 mm) typically Mediterranean. The vegetation is a holm oak forest/savanna known in Spain as a Dehesa (tree density is approximately 20 per hectare), with an understory dominated by herbaceous species and a few shrubs.
The site was set up in 2003 in the frame of MIND EU-project, and has been running since then with the financial support of different EU and National projects (CarboEurope-IP, VULCA, CarborRed-ES, Balangeis, IMECC, NitroEurope-IP, CarboExtreme, CarboRed-ES II). The site is included in the IMECC European flux network, it is a level-2 site of NitroEurope-IP project. In the future, it would be included as a level 1 ecosystem station in the ICOS project. A level II plot of ICP-Forests will also be installed, and ozone flux measurements (with a fast-response ozone analyzer) will be measured in short.
Therefore, the station includes an exhaustive list of continuous measurements, most of them since 2004: CO_2, water vapor and energy fluxes measured with eddy covariance methodology, absolute CO_2 concentration (AIRCOA), meteorological parameters, different types of radiation; ecophysiological interesting parameters as, soil temperature and water content (profiles), soil CO_2 efflux, soil CO_2 concentration profile, sapflows, DBH. Other variables are measured discretely with different frequencies, seasonally: aboveground biomass, LAI; monthly: leaf water potential, NDVI (transects), soil respiration (transects), litterfall; daily: phenological assessment with a webcam images. In relation to the NitroEurope project: atmospheric bulk deposition, throughfall, air concentrations of O_3 and SO_2, (passive samplers), NO_2 and NH_3 (passive samplers and denuder) and NO_3H (denuder), and low cost nitrous oxide and methane flux measurements.
The station is an example of a highly instrumented plot integrating many different types of intensive monitoring measurements. Results of the different studies carried out in this station will be presented, and planned future activities will also be discussed.

A balloon borne probe to study gas exchange between air and vegetation

*G. Schayes[1], S. Mereu[2], S. Cieslik[3]**
[1]*Catholic University of Louvain, Belgium;* [2]*University of Sassari, Italy;* [3]*Joint Research Centre, Ispra, Italy*

A balloon-borne micrometeorological probe, capable of resolving fast fluctuations of atmospheric parameters such as wind vector components, temperature, humidity and pressure, was adapted and tested for chemical surface flux observations. A fast-response ozone sensor was coupled with the probe, such as to measure downward ozone fluxes, needed to study the effects of ozone on vegetation.
The probe was mounted on a tower equipped with micrometeorological instrumentation such as a sonic anemometer and a fast-response hygrometer. The recording of various parameters (wind, temperature, humidity, O3 concentration) has been made in parallel by the probe and the conventional micrometeorological station. Fluxes have been calculated using both sets of data. Turbulence spectra have been constructed.
The comparison gives good and reproducible results. The balloon-borne probe can thus be used as an alternative method for studying fluxes over vegetation, especially at higher elevations for which towers are unavailable.

Availability and evaluation of monitoring data: problems and opportunities

*Nicholas Clarke**
Norwegian Forest and Landscape Institute, P.O. Box 115, N-1431 Ås, Norway

Data from existing monitoring programmes such as ICP Forests, ICP integrated Monitoring and EMEP, as well as from large-scale international projects such as CarboEurope and NitroEurope, can be used to answer questions about the impacts of air pollution and climate change on forest ecosystems. However, for full use to be made of the available data, a number of questions need to be answered. For example, how can these databases be accessed (e.g. freely, over the internet, on request, by authorisation)? How should intellectual property rights be protected, while improving access to data? What relevant national databases exist, and to what extent are these harmonised with other national/international databases (e.g. by use of the same protocols)? Which quality assurance/quality control (QA/QC) procedures have been used (and for how long)? What publications related to both international and relevant national databases are available, and how are they accessible? These and other relevant questions will be discussed.

Availability and evaluation of European forest soil monitoring data

Nathalie Cools, Bruno De Vos*
Research Institute for Nature and Forest (INBO), B-9500 Geraardsbergen, Belgium

In the study of air pollution effect on forest ecosystems, models on critical load and target load calculation are frequently used. These models require a set of solid soil data such as cation exchange capacity, base saturation and other exchangeable cation fractions, soil texture, soil moisture data, mineral soil weathering rates, C/N ratio. This presentation will show the possibilities and the limitations of the data that the European countries reported on a selection of Level I and II plots within the existing Forest Soil Condition database of ICP Forests dating from the 1990s and within the EU Forests Focus BioSoil demonstration project more than 10 years later. Both surveys were conducted following the manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests of ICP Forests.

Litterfall production and nutrients in intensive monitoring Level II plots (Spain)

A.C. de la Cruz, I. Gonzalez, M. Serrano, M.T. Minaya, J.M. Grau*
CIFOR– INIA, Spain

Litterfall was collected from 2005 to 2009 in 11 intensive monitoring plots of the Pan-European Programme for Intensive Monitoring of Forest Ecosystem (Level II European grid). Main goals of litterfall are to know about the forest vitality and the annual return of nutrients.
There are 11 plots with 9 different species distributed along arid Mediterranean pure calcareous ecosystem (Alicante)

to wet temperate northwest forest on acid subtract (Galicia). Litterfall was collected monthly. Dry weights and N, P, K, S, Ca and Mg concentrations were examined in litterfall fractions (foliar-branch-others).
Foliar litterfall percentage ranged between 47% in *Pinus sylvestris* (Soria) and 72% in *Quercus petraea*; branch litterfall between 4.6% in *Pinus sylvestris* (Soria) and 17% in *Quercus ilex* and others litterfall (fruits cones, seeds, bark) between 16% in *Quercus petraea* (Palencia) and 40% in *Pinus sylvestris* (Segovia).
Total litterfall was in range of 1392-1868 $kg \cdot ha^{-1} \cdot yr^{-1}$ in Alicante plot and 5302-9695 $kg \cdot ha^{-1} \cdot yr^{-1}$ in Galicia plot; average nutrients were in range of 40 $kg \cdot ha^{-1} \cdot yr^{-1}$ (Alicante) and 142 $kg \cdot ha^{-1} \cdot yr^{-1}$ (Navarra).
Annual weighted average N in litterfall ranged between 5.2 $g \cdot kg^{-1}$ in *Pinus pinea* (Huelva) and 13 $g \cdot kg^{-1}$ in *Fagus sylvatica* (Navarra). Annual litterfall N content was significantly greater ($p<0.05$) for *Fagus sylvatica* in Navarra (68 $kg\ N \cdot ha^{-1} \cdot yr^{-1}$) than for *Quercus ilex* in Jaén (28 $kg\ N \cdot ha^{-1} \cdot yr^{-1}$) or *Pinus halepensis* in Alicante (10 $kg\ N \cdot ha^{-1} \cdot yr^{-1}$).

The forest contribution to the Italian total nitrogen budget

*Alessandra De Marco**
ENEA, CR Casaccia, Via Anguillarese 301, 00123, Rome, Italy

In the last two years on the behalf of UNECE Task Force on Reactive Nitrogen has been developed a new model to calculate the total nitrogen budget for selected nation. This model is quite simple and will be useful for policymakers to reduce nitrogen pollution. The yet existing OECD soil surface nitrogen balance indicator measures the difference between the nitrogen available to an agricultural system (inputs, mainly from livestock manure and chemical fertilizers) and the uptake of nitrogen by agriculture (outputs, largely crops and forage). The indicator provides information on the potential loss of nitrogen to the soil, the air, and to surface or groundwater (see Environmental Themes - Nutrient Use for further details). The new indicator proposed, instead, is applicable not only at a single ecosystem level, but it is the result of the calculation between anthropogenic nitrogen total input and output at more ecosystems. It can be used like a quantitative tools, it can be applied to evaluate pollutants scenarios, it can help to identify the right intervention points, and it can be used to extract indicators (i.e. total NH3 vs. NEC values or deposition vs. critical loads). The model has been applied to Italian system and the amounts of total nitrogen linked to different ecosystems (atmosphere, forest, agriculture, water) has been quantified. In the same time has been taken into account contribute due to different sources (emissions per sectors, transboundary pollution intake and losses, waste production). The balance between Nitrogen intake and loss has been estimated in Italian forest and compared to other ecosystem.

Combining empirical research and model approaches to assess long-term impacts of changes in nitrogen deposition and climate on tree carbon sequestration in Europe

Wim de Vries[1], Maximilian Posch[2], Gert Jan Reinds[1], Svein Solberg[2], Daniel Laubhann[3], Hubert Sterba[3], Matthias Dobbertin[1]*
[1] Alterra – Wageningen University and Research centre, P.O. Box 47, NL-6700 AA Wageningen, the Netherlands
[2] Coordination Centre for Effects (CCE), PO Box 303, 3720 AH Bilthoven, The Netherlands; max.posch@pbl.nl
[3] Norwegian Forest and Landscape Institute, P.O. Box 115, N-1431 Ås, Norway
[4] Department of Forest and Soil Sciences, BOKU, University of Natural Resources and Applied Life Sciences, Peter Jordan-Straße 82, A-1190 Vienna, Austria
[5] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland

Air quality, in terms of exposure to nitrogen and sulphur compounds (NH_3, NO_x ,SO_2) and ozone (O_3), in interaction with climate change affects the primary production (growth) of forests. In this presentation, impacts of changes in air quality, in terms of nitrogen and sulphur deposition, and climate on forest growth, and its related carbon sequestration will be shown at the European scale by combining empirical research and model approaches.
We used five-year growth data for the period 1994-1999 from roughly 650 intensive monitoring plots from the ICP Forests network in Europe to examine the influence of environmental factors on forest growth. Evaluations focused on the influence of nitrogen and sulphur deposition and weather variables and included both an individual tree-based and a stand-based regression model. The study included the main tree species common beech (*Fagus sylvatica*), sessile or pedunculate oak (*Quercus petraea* and *Q. robur*), Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*). The various models and statistical approaches indicated a slightly above 1 percent increase in volume increment per kg of nitrogen deposition per ha and year. Combining these results with other literature information

indicates an increase in growth in response to N deposition up to a certain optimum followed by a decline.
We modelled the combined effects of past and expected future changes in climatic variables (temperature and precipitation), nitrogen and sulphur deposition on focusing on European forests for the period 1900–2050, including a trapezoidal shape N response function based on the results of the empirical study. Two scenarios for deposition (current legislation and maximum feasible reductions) and two climate scenarios (no change and SRES A1 scenario) were used. With respect to forests growth and carbon sequestration, the possible limitation of other major nutrients, i.e. calcium, magnesium, potassium and phosphorus, was also investigated. Results are presented in terms of time trends over the period 1900-2050 and maps of the regional variations in forest carbon sequestration in 1900, 1980 and 2050 for 2 scenarios.

Improving the determination of the effective ozone flux in tree leaves for issuing a sub-model to be integrated in models predicting ozone risks to forest ecosystems.

Pierre Dizengremel, Yves Jolivet, Didier Le Thiec*
UMR 1137 EEF INRA/UHP Nancy Université, 54506 Vandoeuvre les Nancy, France

Ozone (O_3) is a phytotoxic air pollutant with strong oxidizing properties, impairing photosynthesis and reducing plant growth. The predicted increase in high surface-level ozone concentrations could thus lead to an increased vulnerability of agrosystems as well as forest ecosystems. As a consequence, this could mitigate the higher efficiency of carbon sink strength attributed to vegetation under increasing CO_2 levels. To improve the european risk indicators currently proposed which are based on atmospheric concentrations measurements or exposure indexes, it is necessary to estimate the "effective ozone flux" into plants, which is a balance between the stomatal ozone uptake and the detoxification capacity of foliar cells. The improvement of knowledge on these basic plant response mechanisms must allow to propose a sub-model to be ultimately integrated in global ozone impact prediction models (at regional scale) suitable for risk assessment. The crucial parameters thus are (i) the stomatal characteristics; (ii) constitutive detoxification capacity (mainly ascorbate), (iii) cellular capacity for regeneration of antioxidants, which is tightly dependent on (iv) redox power linked to changes in carbon metabolic pathways. In particular, the ratio between carboxylases (rubisco and PEPcase) is deeply modified, with a decrease of photosynthesis and an increase of respiration. First results on experiments carried out in phytotronic chambers on poplar and wheat will be presented.

Linking different long-term research and monitoring sites and establishing common protocols that are open for new developments– experiences from Switzerland

Matthias Dobbertin[1], Werner Eugster[2]*
[1]WSL Birmensdorf, Switzerland; [2]ETH Zurich, Switzerland

In Switzerland in 1985 three intensive forest research sites were established to study forest decline and the effects of air pollutants on forests. Sites included measurement towers for climate and air pollutants, as well as various soil and tree health related measurements. Following the end of the 4-year research project, different research continued at the sites. One site (Seehornwald Davos), for example, was upgraded to an eddy covariance flux site in 1995. Since 1997 continuous high-quality eddy covariance CO2 and water vapor flux were collected and analyzed, and since 1998 additional continuously recording point dendrometers and sapflow measuring instruments were installed. A second site (Lägeren) has relatively recently been upgraded to a Swiss fluxnet site.
In 1994 the Swiss long-term forest research sites were established as part of the ICP Forests level II network, they did originally not include the former decline study sites. While on level II sites periodic measurements of throughfall, litterfall amount and chemistry, soil solution chemistry and tree individual growth are made, all missing from the flux sites, the level II sites lack the detailed continuous information on green-house gas fluxes as well as tree physiological measurements. Only recently first attempts are made to add the flux tower sites into the level II monitoring network.
The European Integrated Carbon Observation System (ICOS) aims at bringing scientific efforts to carry out long-term measurements of greenhouse-gas fluxes to a higher level of operation that would allow scientists to focus more on the science questions at forest ecosystem monitoring sites, and spend less time on technical issues involved in demanding eddy covariance flux measurements.
The planned Swiss contribution to the ecosystem component of ICOS is the Davos eddy covariance flux site that was one of the three sites established as supersites for forest decline studies in 1986. In a recent publication by Zweifel et al. (2010) we were able to show the close relationship between continuous tree dendrometer measurements and the

net ecosystem productivity measurements obtained with the much more costly eddy covariance method. Based on this example it will be shown how difficult and long the way is to agree on common measurement protocols in an European network which is open enough for more recent scientific developments and still does not consume essential research funds for monitoring of components that may be of no use to any user, but must be continued if the long-term monitoring aspect is strictly followed.

References

Zweifel R, Eugster W, Etzold S, Dobbertin M, Buchmann N, Häsler R. (2010) Link between continuous stem radius changes and net ecosystem productivity of a subalpiine Norway spruce forest in the Swiss Alps. *New Phytol.*, **187**, 819–830.

Response of the European forests to extreme climatic events predicted for the 21st century: sensitivity to climate models and their variability

M. Dury[1], A. Hambuckers[2], P. Warnant[1], A. Henrot[3], E. Favre[1], M. Ouberdous[1], L. François[1]*
[1]Unité de Modélisation du Climat et des Cycles Biogéochimiques, Université de Liège, Bât. B5c, Allée du Six Août 17, B-4000 Liège, Belgium
[2]Département des Sciences et de Gestion de l'Environnement, Université de Liège, Bât. B22, Boulevard du Rectorat 27, B-4000 Liège, Belgium
[3]Laboratoire de Physique Atmosphérique et Planétaire, Université de Liège, Bât. B5c, Allée du Six Août 17, B-4000 Liège, Belgium

Significant climatic changes are currently observed and, according to projections, will be strengthened over the 21st century throughout the world with the enhanced greenhouse effect. Climate will be generally warmer with notably changes in the seasonality and in the precipitation regime. The CARAIB dynamic vegetation model is used to evaluate and analyse the potential impacts of climate change on forests ecosystems in Europe. Changes in the hydrological budget as well as in the intensity and the frequency of wildfires and their effects on forest productivity and distribution are especially assessed. CARAIB is driven by the ARPEGE-Climat model and some other regional climate models from the European Union (EU) project ENSEMBLES forced with IPCC A1B emission scenario. Climate projections indicate changes in variability and frequency of extreme events. Since climate variability governs the response of plant species (*e.g.* net primary productivity, NPP) to climate change, we analyse the climate variability (seasonal and interannual) given by climate models comparing it with the observed climate variability (CRU TS 3.0 historical climate dataset) over the period 1961-1990. The variability modelled by the ARPEGE-Climat model is notably slightly more pronounced than the observed one, at least for some areas. Since discrepancies between modelled and observed current climate variability may affect NPP variability calculated for the future as well as the intensity and the frequency of severe drought period and wildfires, comparing the forest ecosystem evolutions obtained with a range of climate models allows improving the assessment of climate change impacts on forest in the future.

Incorporating management history into forest growth modeling

Chris S. Eastaugh and Hubert Hasenauer*
Institute of Silviculture, University of Natural Resources and Applied Life Science (BOKU), Vienna, Austria

Mechanistic modeling is an important tool for understanding the impacts of climate change and pollutants on forest growth. One of the common practical limitations of these models is a lack of specific information regarding management activities such as thinning or harvesting, which can have a very strong influence on the accuracy of results. The use of inventory data for model parameterization and calibration is also problematic, as inventories are designed to have large volumes of data amalgamated to give accurate mean results across large areas. The precision of single point estimates is often quite low.
This study uses BIOME-BGC to model forest growth on 2014 sites of the Austrian National Forest Inventory, and develops a method to estimate timber removal patterns prior to the commencement of record keeping on the sites. Recognizing the poor precision of individual point estimates in the data, we do not seek to precisely calibrate the model to the data on each point. Rather, we assume that the point-wise inventory estimates will be normally distributed around the true values. We then model each site assuming no management interventions, and compare this with inventory results. Plotting the 'error' between model results and NFI data shows a strong right-skew,

reflecting the modeled lack of timber removals. A Box-Cox transformation of the error plot, centred on zero, would represent an unbiased model estimate of the data, thus we can determine the historic management timber removals as the difference between the original error curve and its Box-Cox transformation. Calibrating the model with this information allow us to represent forest growth with greater accuracy than would otherwise be possible.

Monitoring climate change impacts on forests of the Mediterranean basin: Morocco as a case study

CANCELLED

*Mohammed Ellatifi**
Senior Forestry Officer, President, Sylva-World for Development and the Protection of Forests and the Environment, Casablanca, Morocco

Although the outlook is still blurred, due to some remaining uncertainties, mainly related to its extent, timing and geographical variations, climate change is, today, a scientific unequivocal reality. According to the International Panel on Climate Change (IPCC, Fourth Assessment 2007), climate change is mostly due to anthropogenic emissions of greenhouse gases (GHG) in the atmosphere (mostly CO_2).
Many developing countries already suffer from climate change impacts (droughts, floods, deforestation, forest fires, large-scale population movements, etc.). They are the most vulnerable to future change.
Deforestation accounts for over 20 per cent of greenhouse emissions in the world, making it the second biggest source of GHG, after fossil fuels use. When forests burn or their wood decompose, and when the forest ecosystem is degraded or when the forest soil is ploughed and converted to agricultural use, all sequestered carbon in the forest soil and woody materials is released into the atmosphere. Most of the deforestation and forest degradation in the world is happening in developing countries, where millions of indigenous dwellers depend directly on forests for their livelihood (FAO, FRA 2005).
In the Mediterranean Basin, many countries are experiencing longer droughts, larger and more frequent forest fires, fewer natural forest regeneration, and forest stands mortality, along with more frequent insect and/or disease attacks.
Societies have, since centuries, always adapted themselves to cope with an uncertain future. Today, they need to make themselves better able to cope with climate change and adapt to its impacts.
This paper will analyze the impacts of climate change on the Mediterranean forests, and report impacts, vulnerability and adaptation strategies to it, within a sustainable development at national and regional level.

NH_3 release through a forest canopy: an agro-forestry experiment

D. Famulari, C. Braban, A. White, C. Helfter, M. Coyle, M.A. Sutton, E. Nemitz*
CEH Bush Estate Penicuik, Edinburgh, UK

The objective of this study is to assess the efficacy of farm woodlands for the recapture of agricultural ammonia emissions. The NH_3 capture efficiency of a dense, closed canopy has been found to be very effective (see e.g. Nemitz et al., 2000). However, the efficiency of vegetation, as would typically be used in a silvo-pastoral system (where livestock range beneath a tree canopy), has not been quantified. In this work, a release system was setup in a larch forest area in Southern Scotland, to simulate a chicken woodland farm. Concentrated CH_4 and NH_3 were released through the same grid of point sources located at the ground level of the under storey. The vertical concentration profiles were measured at the centre of the selected area, both within and just above the canopy. CH_4 was used as a tracer to assess the recapture ratios when compared to NH_3. For these measurements a photo-acoustic NH_3 detector with a response time of 30 s and a detection limit of 100 ppt was used, alongside a tunable diode laser for fast CH_4 concentrations, together with an automatic profiler system, and a switching system that sequentially cycled through the series of vertical inlet positions. In addition, vertical turbulence profiles (primarily of σ_w/u_*) were measured using a miniature ultrasonic anemometer with a reduced path length of 5 cm, to better resolve the turbulence structure within plant canopies. The results are compared to a wind-tunnel test-study, and will be used to infer the ground level emission of ammonia and the amount recaptured by a tree canopy.

References

Nemitz E., Sutton M.A., Gut A., San Josè R., Husted S. and Schjørring J.K. , 2000: Sources and sinks of ammonia within an oilseed rape canopy. *Agric. Forest Meteorol.* **105**(4): 385-404.

To what extent can we rely on ecological monitoring and research data?[1]

*Marco Ferretti**
TerraData environmetrics, Siena, Italy

Much of our knowledge about status and changes of ecological systems originated from the collection of data about different environmental entities. Usually, when a monitoring and/or a research need is identified, a series of steps are undertaken to collect data, to store and process them in order to understand (in quantitative, descriptive, deterministic/mechanistic terms) the problem in hands. Obviously, even the most sophisticated statistical and modelling technique cannot provide reliable results if the input data are flawed. In this case, any policy decision originated on the basis of the monitoring and research results risks to be severely wrong.

If there is an agreement that environmental monitoring and research is the basis for a sound environmental policy, then the quality of the environmental data is essential and must be explicit. Unfortunately, this essential need is constrained by two facts. Firstly, all the steps of a monitoring programme are subject to errors: no matter the target (tree health, soil, precipitation and atmospheric chemistry, species diversity), the platform (terrestrial, aerial, satellite), the "device" (human eye, electrodes, multispectral scanners), the same error types always occur simply because they are inherent to the very nature of environmental monitoring. Secondly (and regrettably) scientists and monitoring organizations are sometimes unwilling and not prompt to report about, and to invest on, the quality of their data.

In this presentation, different error sources (sampling errors, measurement errors, errors in modelling, non-statistical errors) and their occurrence in various monitoring fields (tree health, biodiversity, air pollution monitoring,...) and monitoring programmes (national, international) will be outlined, and possible consequences discussed.

The ICP Forests monitoring programme – sites, protocols and links to other Transnational Networks

*Richard Fischer**
vTI – Institute for World Forestry, PCC of ICP Forests, Hamburg, Germany

The International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was founded in 1985 under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP). ICP Forests provides field-based, continuous and harmonized monitoring data on forests for most countries in Europe. Monitoring occurs at two levels of intensity: 'Level I' monitoring involves ~ 6000 systematically selected plots in 38 participating countries across Europe, while the more intensive 'Level II' monitoring takes place on ~ 800 plots in a number of the most important forest ecosystems in 29 participating countries. ICP Forests is one of the largest and longest running transnational forest monitoring programmes in the world, covering more than 200 million hectares. Close cooperation between the European Commission and ICP Forests since 1986 was followed by the project *Further Development and Implementation of an EU-level Forest Monitoring System* (FutMon) in 2007.

FutMon widens the scope of forest monitoring across Europe by creating a pan-European forest monitoring system that will provide information for a range of different purposes. Harmonisation between the activities of ICP Forests and FutMon means that the number of Level II plots monitored under ICP Forests will fall to 300 within EU countries, plus 90 in non-EU countries. In turn, monitoring is intensified on the remaining plots in order to provide data to complex models in the fields of nutrient cycling, critical loads for deposition, water balance in the soil, forest growth, carbon flux, ozone flux, and biodiversity.

In this context the monitoring manual of the programme, laying down the scientific methods for the surveys, has been completely revised and updated in 2010. The methods and the data are open to the wider research community.

ICP Forests is collaborating with several other transnational networks like EMEP, ICP Integrated Monitoring and LTER Europe and the monitoring sites are in many countries used for research purposes of additional programmes and institutions. An overview on the current state of such collaboration on national and transnational national levels will be provided. This provides the basis for identifying possible "supersites", i.e. sites that can provide the infrastructure and data for different research and monitoring networks.

---

[1] Parts of this abstract originates from an invited review being submitted to CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources

Modelling the effect of resource availability on carbohydrate allocation to defence-related metabolism in plants. An approach based on experimental results and theoretical considerations

Sebastian Gayler[1], Eckart Priesack[2]*
[1]Water & Earth System Science Research Institute (WESS) c/o University of Tuebingen, Center For Applied Geoscience, D-72074 Tuebingen, Germany
[2]Helmholtz-Zentrum München - German Research Center for Environmental Health, Institute of Soil Ecology, D-85764 Neuherberg, Germany

Environmental factors such as nutrient supply, light or carbon dioxide can influence the partitioning of carbohydrates and nitrogen between competing plant internal demands. In particular, the balance between growth-related primary metabolism and defence-related secondary metabolism is the object of several plant-defence theories which provide conceptual ideas how the level of defence-related carbon-based secondary compounds (CBSCs) varies with changing environmental conditions. Under these hypotheses, the Growth-Differentiation-Balance hypothesis (GDBH) was identified to be the most mature and many experiments were carried out to test the adequacy of this hypothesis for different plant species and experimental scenarios. However, in many cases these tests did not reveal consistent reaction patterns of CBSCs concentrations on experimental treatments.
GDBH predicts a non-linear relationship between resource availability and allocation to secondary metabolism with highest allocation rates in case of intermediate resource availability. Consequently, evaluating GDBH needs to quantify the availability of the required resource in a given experiment on a scale from low to high resource availability. Further difficulties in testing GDBH arise from the fluctuating source and sink strength dynamics of plant internal resource pools during different growth stages and between different experiments, which cannot be fully addressed by a conceptual hypothesis. As an approach to overcome such difficulties, we developed the numeric plant growth simulation model PLATHO, which simulates allocation to CBSCs depending on variable plant internal source and sink strength of carbon and nitrogen, which result from the impact of volatile environmental factors on resource uptake and plant internal demands for maintenance and growth. This model is used to analyse the response of CBSCs concentrations in juvenile beech to contrasting levels of light and nitrogen supply or to elevated atmospheric concentrations of carbon dioxide and ozone in different experiments, which were carried out within the scope of the integrated research program SFB 607.

Wind-throw caused increased concentrations of nitrate in forest soil water in southern Sweden

Sofie Hellsten[1], Johanna Stadmark[1], Gunilla Pihl Karlsson[1], Per Erik Karlsson[1], Cecilia Akselsson[2]*
[1] IVL Swedish Environmental Research Institute, Box 5302, SE-400 14 Gothenburg, Sweden
[2] Lund University, Department of Physical Geography and Ecosystems Analysis, Sölvegatan 12, SE-223 62 Lund, Sweden

Storm frequencies may increase in the future due to climate change. In January 2005, south west Sweden was hit by a severe storm (wind speeds up to ~42 m s^{-1}) that caused significant damage to the forests through the massive wind-throw, resulting in a tenfold increase in clearcuts in some areas. Studies have shown that leaching of nitrogen from the forest soil increase following logging and the effect is expected to be similar for areas where wind throw has occurred, which may lead to an increase in the total N-load to streams and lakes.
The aim of this study was to assess the effect of wind throw on nitrate (NO_3-N) concentrations in soil water on forest plots within the Swedish Throughfall Monitoring Network, an environmental monitoring network that measures soil water chemistry at 64 forest sites in Sweden. Many of these sites were damaged to different extents due to the storm, and allocated a “damage class”, and the effect on soil water chemistry (primarily nitrate) was evaluated.
The level of damage due to the storm correlated with the level of nitrate concentration in soil water. Sites that were most severely damaged by the storm had higher nitrate concentrations in the soil water, compared with sites less affected by the storm. However, the effect varied within each damage class and also depended on other factors, e.g. ground vegetation, nitrogen deposition, stand age and soil water pH.

Nitrate losses following final felling in Sweden

Lars Högbom[1], Martyn N Futter[2], Stefan Löfgren[2] and Eva Ring[1]*
[1]Skogforsk-The Forestry Research Institute of Sweden, Uppsala Science Park, SE-751 83 Uppsala, Sweden
[2]Swedish University of Agricultural Science, Dept. of Environmental Assessment, SE-750 70 Uppsala, Sweden

Boreal forests are characterized by closed nitrogen (N) circulation and generally it is difficult to detect inorganic N in growing forests. After final felling, most sites starts to leach N as nitrate (NO_3^-). However, the time between final felling and when NO_3^--N could be detected varies quite substantially between sites. At most studied sites elevated NO_3^--N soil solution concentration could be detected in the first year following harvest, although at some sites this phase is substantially longer, up to 4-5 years. In most cases the period with elevated NO_3^--N concentration lasts for 5-6 years, but there are sites when this period is extended. There are good reasons to believe that these patterns are somehow related to the site quality – productive sites react more rapidly and generate higher NO_3^--N concentrations than less productive sites. Typically, maximum NO_3^- -N concentration reach 1-2 and 5-7 mg N/l at low and high productive sites, respectively. Currently, tops and branches are commonly extracted as a bio energy source following final felling. This extraction usually leads to a lowering of the NO_3^--N concentrations in the soil solution, there are a number of possible reasons for this, for example: mulching effects, extraction of easy degradable organic matter or changes in water flow. The effect of final felling on NO_3^--N concentrations in runoff following in northern boreal forest systems is largely unexplored. The very few studies that have been conducted indicate a similar lag-phase as mentioned above, however it is still too early to draw any conclusions about the duration of the elevated concentrations. Final felling also leads to approx. 50% more runoff indicating that the increased concentration most be put in relation to the increase in runoff. In this talk data from soil solution- and catchment studies will be presented.

Stomatal conductance modeling of deciduous trees for ozone risk assessment in Japan

Yasutomo Hoshika, Kenji Omasa*
Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, Japan

The stomatal flux-based approach based on stomatal ozone uptake was hardly developed to assess an ozone damage of plants in Japan. Therefore, estimations of stomatal ozone uptake for dominant temperate deciduous tree species were conducted to assess ozone risks using estimated ozone concentration and climate data, and vegetation data in Japan. Key parameters such as stomatal conductance parameters of each species were collected from scientific literatures in Japan. The comparisons of the maps between $AF_{st}0$ (accumulative stomatal ozone uptake) and AOT40 (accumulative exposure above a threshold concentration of 40 ppb during daylight hours) showed that the areas with high $AF_{st}0$ were not always the same as the areas with high AOT40. These differences were mainly due to stomatal closure induced by vapour pressure deficit. As a result, ozone risk assessment using AOT40 would overestimate ozone risks for temperate deciduous forest tree species. Therefore, to assess the risk of temperate deciduous forest tree species, the approach based on stomatal ozone uptake would be useful in Japan.

NITROEUROPE forest supersites

Andreas Ibrom[1], Ute Skiba[2], Susan Owen[2], Stefan Reis[2], Mark Sutton[2]*
[1]Risø DTU, Frederiksborgvej 399, DK-4000 Roskilde, Denmark
[2]Centre for Ecology and Hydrology, Bush Estate, Penicuik, Midlothian EH26 0QB , UK

NitroEurope-IP (EU-FP6) investigates the nitrogen cycle and its influence on the European greenhouse gas balance. One of the key objectives is to establish robust data sets of the key nitrogen fluxes and net greenhouse-gas exchange in relation to C-N cycling of representative European ecosystems. To achieve this goal a hierarchical approach was implemented reaching from intensive plot studies at a few sites, over a denser network with less intensive study sites and, finally, to regional and European continental scale modeling of reactive nitrogen fluxes and impacts on GHG balances. The core of the intensive network consists of 13 so-called Level 3 Supersites, covering for major ecosystem types. Out of these sites are 4 forest sites.
The NitroEurope Level 3 network was build from existing sites using infrastructure and results from parallel partner projects (CarboEurope–IP, IMECC). This made it possible to directly extend these sites to measure various parameters of the nitrogen cycle including the major background data that are required to model the effects of N

dynamics on GHG fluxes. One of the important merits of NitroEurope is the establishment of standard sampling and analysis methods and protocols, standard units, and a data base that is able to handle these highly diverse data ranging from conservative entities like, e.g., soil texture to N mineralization rates, bio essays, GHG chamber flux studies and continuous 30 minute flux and meteorological measurements that are being performed from a multitude of independent teams and labs across Europe.
This presentation will give an overview about the data that are being collected at the NitroEurope Level 3 Supersites, including single and regular measurements from those groups that are running the sites as well as cross-cutting special activities from external specialist groups, network activities and modeling.

Remote sensing of Japanese beech forest decline using water deficit index (WDI)

Akihiro Ishimura, Yo Shimizu, Parinaz Rahimzadeh Bajgiran, Kenji Omasa*
Department of Biological and Environmental Engineering, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, Japan

Tanzawa mountains spreading over Kanagawa, Yamanashi and Shizuoka prefectures in Japan, are known as a natural beech forest mountain range. Since 1980s, the decline of the beech forests, probably caused by air pollution, water stress and insect infestation, has become a serious problem. We have therefore estimated the natural beech forest decline at the mountains, using multi-temporal 8day-composite data obtained from MODIS instrument aboard the Terra satellite, daily air temperature data at meteorological stations (AMeDAS) in 2007 and Global Digital Elevation Model (GDEM) obtained from ASTER aboard Terra. For the estimation, Normalized Difference Vegetation Index (NDVI) indicating the vegetation density and Water Deficit Index (WDI) indicating the difference of transpiration rates between similar vegetation density areas were used. The NDVI and WDI maps were compared with an existing mortality map of beech forests at the study area in order to verify their accuracy. To produce WDI maps, we calculated maps of air temperature using the ambient air temperature and elevation data. The interpolation method using the environmental lapse rate calibrated air temperature maps with the good accuracy of RMSE = 0.49°C. The WDI map could detect the mortality more accurately than NDVI map in summer although both maps were effective in spring. WDI enabled us to detect forest decline inducing the reduction of transpiration rates caused by air pollution and water deficit, and could be expected as an index for monitoring vegetation decline.

Link from monitoring plots to GIS and remote sensing based disturbance modelling: TANABBO approach

R. Jakuš[1] , M. Turčáni[2], P. Cudlín[3], L., M. Blaženec[1], W. Grodzki[4], M. Ježík[1]*
[1] Institute of forest ecology, Slovak academy of sciences, Štúrova 2, 960 53 Zvolen, Slovakia
[2] The Czech Agriculture University, Kamýcká 1176, 165 00 Praha-Suchdol, Czech Republic
[3] Institute of Systems Biology and Ecology, Academy of Sciences of the Czech Republic, Na Sádkách 7, 370 05 České Budějovice, Czech Republic
[4] Forest Research Institute, ul. Fredry 39, 30-605 Krakow, Poland

The change of generation in spruce stands is usually initiated by wind or bark beetle caused disturbances. Depending on the type of disturbance, the process of old stand decline could be relatively fast. We have developed approach combining semi-temporal monitoring plots, remote sensing and GIS technologies in order to understand and model these processes. The active sub plots are localized in areas with high probability of bark beetle or wind caused disturbances. The optimal localization of this kind of plots is usually active forest edges (the zone of the maximal temporal change in bark beetles abundance dynamics) - border between wind blown or bark beetle attacked part of forest stand and undisturbed part of stand. The possible control plots are in undisturbed forest stands as standard monitoring plots.
The key studied variable is tree mortality caused by bark beetles. Other variables are similar like in standard monitoring plots. Study has been focused to weather condition; soil moisture; tree health variables: crown, defoliation, transformation, discoloration; sap flow rate; changes in stem diameter. Tree defence indicators (resin flow, phenolic compounds) have been analyzed and reaction of tree to bark beetle inoculation has been measured. Bark beetle population is monitored with the use of various types of passive and pheromone traps.
The next step is combining of terrestrial data with data obtained by remote sensing. Time series of satellite images (LANDSAT, ASTER, AISA-EAGEL) have been analyzed in order to obtain information about pattern and localization of wind blown and bark beetle attacked trees. The weather monitoring data have been used for prediction

of bark beetle population and water stress development. Obtained information is integrated in GIS based system (ERDAS) and future bark beetle infestations are predicted.

Long term tree breeding trials as tool to monitor tree responses to climate changes

A. Jansons, R. Rieksts-Riekstiņš, B. Dzerina, I. Baumanis*
Latvian State Forest Research Institute "Silava"

Survival and growth of forest trees are affected by numerous, often un-predictable factors, including fluctuations in meteorological conditions. To observe true influence of climatic conditions on trees, long term experiments are essential. Tree breeding trials, intended to test performance of provenances or progenies of individual trees, can be used to analyses these influence.

Study is based on 2 sets of experiments: 1) Scots pine geographical provenance trials, located in 3 sites in Latvia, consisting of 6 Polish and 27 Eastern-German provenances at the age of 28 years. Trial sites have similar soil conditions, photoperiodic conditions, altitude, but differ by 1^0C gradient in mean temperature during autumn and winter; 2) Latvian Scots pine open pollinated progeny trials at the age of 14 and 17 years, located in 5 sites in Southern-Sweden, heaving similar photoperiodic conditions, but by 1-4^0C different winter and summer temperatures.

Trial location (site) has significant influence to survival of Scots pine from Eastern-Germany in Latvia – at the age of 6 years survival ranged from 52% in hottest site to only 35% in coldest. Site effect to Polish Scots pine provenances was not significant, survival ranging from 50% to 44% respectively. Pronounced reaction to climatic conditions for Eastern-German provenances in comparison to Polish was observed also in growth traits (height, diameter) and yield. In warmest site provenances form Eastern-Germany have similar yield (calculated for 20% dominant trees) than those from Poland, but in coldest site difference reached 23%.

Open-pollinated families of Latvian Scots pine plus trees in Southern-Sweden in specific sites have significantly different survival (54-75%), but no trend, related to climatic variables, could be observed. Both survival and growth rates were similar to those, observed for local Scots pines at particular sites.

Results indicated high phenotypic plasticity of Scots pine and capacity to adapt to minor climatic changes.

Dry deposition of inorganic nitrogen to a surrogate surface – implications for estimating the total nitrogen deposition to coniferous forests in Sweden

Per Erik Karlsson[1], Cecilia Akselsson[2], Martin Ferm[1], Sofie Hellsten[1], Hans Hultberg[1], Gunilla Pihl Karlsson[1]*
[1] IVL Swedish Environmental Research Institute, Box 5302, SE-400 14 Gothenburg, Sweden
[2] Lund University, Department of Physical Geography and Ecosystems Analysis, Sölvegatan 12, SE-223 62 Lund, Sweden

Throughfall (TF) deposition measurements should provide an estimate of the total wet and dry deposition of different compounds to forests, providing that the compound is not affected by internal circulation within the canopies. In the case of nitrogen compounds, a large fraction of the deposited nitrogen is absorbed directly by the leaves and needles as well as by the epiphytes on the leaf surfaces. This fraction will not reach the TF collectors. In the northern part of Sweden the nitrate and ammonium concentrations in TF are close to zero.

A method to estimate the dry deposition of nitrogen to coniferous forests was developed by Ferm and Hultberg (1999). Teflon strings placed below a roof construction were used as surrogate surfaces resembling needles. The dry deposition for a certain ion was calculated from the ratio between the deposition of the ion and sodium on the surrogate surface multiplied by the net throughfall (TF subtracted by bulk deposition) of sodium to the forest. The assumption made was that the deposition of sodium to forests is not affected by any biological activity. Furthermore, the method will only consider particlebound dry deposition.

Bulk-, throughfall and teflonstring deposition were measured on a monthly basis during 2003-2007 at ten different Norway spruce sites within The Swedish Throughfall Monitoring Network. The results showed that dry deposition of nitrate constituted in the order of 30% of the total (wet+dry) nitrate deposition in southern Sweden, while the dry deposition was almost zero in the northern part. Regarding ammonium, the share of dry deposition was around 30% in southernmost Sweden, while it was only 10% or below in the remaining parts of Sweden.

From these results, it is possible to estimate the total deposition of inorganic nitrogen to Swedish coniferous forests based on bulk deposition measurements.

References

Ferm, M., Hultberg, H. 1999. Atmospheric Environment 33, 4421-4430.

Belowground complexity

Hojka Kraigher and Primož Simončič*
Slovenian Forestry Institute, Vecna pot 2, 1000 Ljubljana, Slovenia

Belowground carbon allocation depends on the aboveground biotic and abiotic factors which have been part of research and monitoring activities through long decades, while a number of uncertainties in belowground interactions yet need to be resolved. These uncertainties are likely to severely limit our ability to make reliable predictions of how climate change will impact on ecosystem functioning. Over 75% of the C in terrestrial ecosystems is stored in forests, with more than half of this C being in soil organic matter (SOM), which has the potential to sequester the largest amount of C for the longest period of time. Although the fine roots (<2 mm in diameter) of forest trees contribute less than 2% of tree biomass in mature forests (appr. 6-8 t/ha in temperate and boreal forests), they contribute largely to the belowground C stocks as they are short-lived organs with life expectancy from weeks to several years and a rapid turnover. Estimates of fine root lifespans are needed to determine if forest soils will be a C source or sink in the future as the global environmental changes. Unfortunately, estimates of fine root lifespans range from <1 year to >10 yrs depending on the method used, and turnover of individual fine roots is often conflated with turnover of the fine root C pool. The yearly contribution of the fine roots to the belowground C pools is assumed with 1 t/ha.yr to be about equal to the yearly leaf or needle input. Approximately 20-30% of current assimilates are further allocated to mycorrhizal fungi. Fungal mantles and extrametrical mycelia of these mycorrhizal fungi are estimated to have a biomass of about 0.5-0.7 t/ha. It is further assumed that at least 30% of the microbial biomass and 80% of the fungal biomass belong to the extraradical hyphae of the mycorrhizal fungi. Very little is known about the turnover of the hyphae, and the few results available reported contradictory results. Using ^{13}C techniques, mycorrhizal mycelia turnover was shown to be a dominant process for C input into soil C stocks, contributing more than 60% of new soil C. The largest C pool in forest soils is the SOM. The main changes in the soil C stock are due to the input of remains of fine roots, mycorrhizal hyphae, leaf and needle litter and the loss of C through respiration or leaching of dissolved organic carbon (DOC). An overview of constraints in methodological approaches in fine root and mycorrhizal studies possibly applied in biogeochemical models will be presented and discussed with a view for a sustainable belowground C management strategies, which might ensure a maximum of resilience of forest ecosystems under adverse or gradually changing environmental conditions.

Study of tree rings as climatic indicators in Portugal

Sofia Leal, Alexandra Lauw, Helena Pereira*
dendroPORT – Centro de Estudos Florestais, Instituto Superior de Agronomia, Tapada da Ajuda 1349-017 Lisboa, Portugal

The research was carried out with the objective of studying the effects of drought events on the growth of the Portuguese forest. The study is part of a recently started project PTDC/AAC-CLI/103046/2008: "Past climate reconstructions and future climate change scenarios in Portugal using a dendroclimatological approach" funded by the Portuguese National Science Foundation (FCT). Portugal has a particular climate combining two very distinct climatic influences, Atlantic and Mediterranean. The impact of drought events on forest species growth is becoming increasingly preoccupying given the actual tendencies in climate, which anticipate an increase of the occurrence of these events in the future.

Two endemic oak species, *Quercus faginea* and *Quercus pyrenaica*, were analyzed along with two conifer species, *Abies alba* and *Pinus sylvestris*, for control purposes. The study falls upon the effect of the 1976's drought, identified by several authors as a significantly dry year affecting tree growth in central European countries. Methods of dendrochronology, microscopy and image analysis techniques were used.

Results show, within the period from 1950 to the present, a marked decrease in tree ring growth for *Quercus pyrenaica* during the 1970s decade, while *Quercus faginea* rings appear to be less affected by this drought episode. The conifers present a steady growth along the period of time under observation. Around the 1980s the trees affected by the drought had already recovered returning to their usual growth rates.

The research is ongoing. Further analyses will fall upon the wood anatomical characteristics before, during, and after the drought period under study.

A new database for time-series monitoring data: the NitroEurope approach

Susan M Owen[1]*, David S Leaver*[1]**, William J Bealey*[2]
[1]*Centre for Ecology & Hydrology, Edinburgh, EH26 0QB, UK*
[2]*Rory Wilson, Modality Solutions Ltd., Edinburgh, UK*

The NitroEurope Integrated Project (2006 – 2011) aims to gain a better understanding of the nitrogen cycle and its impacts on greenhouse gas emissions. Over sixty project partners are collecting large volumes of data from sites all over Europe. There are ten forest sites in seven countries submitting flux data, including beech, oak, spruce and mixed forests. The data are at different temporal resolutions, from one-off measurements to 30-minute time-series data. Around 500 parameters are measured including flux measurements of different greenhouse gases and their precursors. The NitroEurope research community therefore needed a database to provide easy upload and extraction of data for analysis, interpretation and modelling.
The database development team worked with an external software contractor to produce a bespoke web-based database product to fulfil the project's requirements in a user-friendly and attractive online environment. Site managers submit data by uploading completed Excel templates directly to the relational database through the web front-end. Data are run through a series of automatic checks on upload and are checked by a data manager. An online graphing tool is available to facilitate the checking. The data are then validated and made available to the NitroEurope community for downloading. The reporting tools enable data from different sites and activities to be brought together and datasets can be previewed and graphed before they are downloaded. The database has almost 300 users and currently contains over eight million rows of data. The data will be made available to the wider scientific community two years after the project ends. The database structure is extremely flexible and has been used for the storage and reporting of different time-series data at our institute.

Monitoring the Boreal Forest in the Athabasca Oil Sands Region of North-eastern Alberta, Canada

Allan H. Legge[1]**, Kevin E. Percy*[2]
[1]*Biosphere Solutions, 1601 11th Avenue N.W., Calgary, Alberta, Canada T2N 1H1*
[2]*Wood Buffalo Environmental Association, 100-330 Thickwood Blvd., Fort McMurray, Alberta, Canada T9H 1Y1*

The Wood Buffalo Environmental Association (WBEA) is a not-for-profit, independent, community-based multi-stakeholder association based in Fort McMurray, a city of 80,000 located at 57 degrees latitude in north-eastern Alberta, Canada. WBEA monitors air quality and terrestrial environmental effects from industrial air emissions in the 70,000 km^2 airshed that includes the Athabasca Oil Sands Region (AOSR). The AOSR has proven oil reserves that rank second only to those of Saudi Arabia. In 2009, output from the region was some 1.5 million barrels per day, and is expected to reach 4 million barrels per day by 2020. WBEA uses 15 continuous air monitoring stations, time-integrated, passive and specialized techniques to monitor air quality in communities and the remote Boreal Forest. WBEA's terrestrial effects program has been significantly enhanced through a substantial increase in funding since 2008 to conduct science-based effects monitoring, deposition monitoring, dispersion model evaluation and reporting in support of informed decisions on air quality management in the AOSR. The forest health approach has been adopted and a network of ecologically-analogous monitoring locations containing forest plots operating at Level I and Level II is being established for both early-warning stand edge and within stand measurements. Deposition to the forest is estimated from data obtained from bulk and throughfall resin measurements and passive sampler (SO_2, NO_2, O_3, HNO_3 and NH_3) at location distributed across the AOSR. In addition, 8 plots are being instrumented for process (Level III) tower-based, solar-powered continuous co-measurement of meteorological parameters and selected pollutant input. Source apportionment and receptor modelling are underway to attribute geospatially arrayed elemental and trace metal concentrations in lichens to source type and define exposure/deposition patterns across the landscape.

Vulnoz a French research project: Vulnerability to ozone in anthropized ecosystems. Which risks for 2020-2030?

Didier Le Thiec, Yves Jolivet, Pierre Dizengremel*
UMR 1137 EEF INRA/UHP Nancy Université, 54280 Champenoux, France

In industrialized countries, ozone (O_3) is an important gaseous air pollutant with phytotoxic effects due to strong oxidizing properties. The elevated surface-level ozone concentrations have become a factor of climate change tending to mitigate the carbon sink strength of vegetation under the increasing atmospheric CO_2 level. An increased vulnerability of agroecosystems could occur. The partners in VULNOZ, ANR project, aim at improving knowledge on basic plant response mechanisms to ozone in order to integrate them in global ozone impact prediction models (at regional scales) suitable for economic risk assessment. Here, we will present :
- the general diagram of the workpackages
- the metabolic sub-model (detoxifying function) to be linked to the physiological impact model
- the O_3 deposition model (partitioning stomatal and non-stomatal fluxes).

Potential use of Latvian forest monitoring data for the study of climate change and air pollution impact on forest ecosystems

Andis Lazdins, Zane Libiete-Zalite, Dagnija Lazdina*
Latvia State Forest Research Institute „Silava"

During the last decades global forest monitoring has become increasingly important as the main tool to provide information on forest ecosystems. The future information demand will, among other issues, focus on climate change policies and challenges on forests due to changing climatic conditions.
In Latvia, *ICP Forests* Level I forest monitoring was started in 1990. Presently integration of Level I forest monitoring into the National Forest Inventory (NFI) is carried out within the scope of *FutMon* project (*Further Development and Implementation of an EU-level Forest Monitoring System*). Information on forest health supposedly will be one of the most important issues in the context of more frequent natural calamities caused by the climate change.
Level I forest monitoring and NFI have the key role in elaboration of National greenhouse gas (GHG) inventory in Land use, land use change and forestry (LULUCF) sector under the United Nations Framework Convention on Climate Change and it's Kyoto protocol. Level I forest monitoring provides data about organic carbon stock change in dry and drained mineral forest soils. NFI is the main source of activity data for calculations of GHG emissions and CO_2 removals in LULUCF sector. NFI provides information about forest area and gross increment of living biomass in forest lands for calculation of CO_2 and N_2O emissions from drained soils. From 2010 the NFI will also provide data for elaboration of land use matrix. Evaluation of historical land use changes since 1990 is now performed, based on satellite image analysis. Methodologies that have to be elaborated for the GHG accounting in the LULUCF sector and implemented as a part of the NFI include estimation of carbon stock changes in dead biomass, drained organic forest soils and agricultural soils as well as harvesting – related living biomass losses and biomass burning related emissions.

Monitoring Programme and Sites of the ICP Integrated Monitoring Programme and its links to other Transnational Networks

*Lars Lundin**
Swedish University of Agricultural Sciences, Dept Aquatic Sciences and Assessment, PO BOX 7050 Uppsala, Sweden

In forest ecosystems, climate change will have consequences for conditions and balances within the system. This will further affect processes already impacted by air pollution that may have altered natural ecosystem behavior. Turnover of elements relate e.g. to acidity, nitrogen, organic matter and metals. These depend on hydrology, which is strongly influenced by changes in precipitation and temperature, being main climatic variables. It is foreseen that more frequently occurring extreme events will need to be monitored and understood in a wide geographical context.
Effects of atmospheric deposition and climate conditions are studied in the UN ECE International Cooperative

Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP IM) within the Working Group on Effects (WGE) of the Convention on Long-Range Transboundary Air Pollution (CLRTAP, 2007). The programme focus is on total ecosystem monitoring to reveal cause-effect connections and to give causal explanations for identified changes and effects. Only natural ecosystems are considered. Ecosystems with direct anthropogenic impacts such as agriculture or forest management in the past 100 years are excluded. This facilitates an understanding of large scale pressures without disturbing local activities.
Managed forests are included in other programmes such as the ICP on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) including over 30 countries in the ECE region. ICP Forests is carried out on two scales. Level I is large scale monitoring of a large number of small plots and Level II is intensive monitoring of a smaller number of c. 0.25 ha areas located in production, but not totally mature, forests. Linked to this programme is also the LIFE project FutMon. National Forest Inventories (NFIs) also have large scale monitoring, often with a statistical lay-out to cover a spatial distribution. Forest conditions are monitored periodically to identify changes over time. Thus, NFI resemble the ICP Forests Level I but national lay-outs vary between countries. However, these are being harmonized in the European Forest Inventory network (ENFIN).
Another relevant monitoring programme where impacts of output from forest ecosystems could be revealed is the ICP on Assessment and Monitoring of Air Pollution Effects on Waters (ICP Waters). This programme studies conditions in rivers and lakes and provides information on forest land pressures on aquatic ecosystems.
Climate effects can already be seen in changed hydrology where snowmelt in winter increased water flow and element transport during the dormant period in earlier cold winter regions. Also absence of spring flood events from snowmelt are seen and new patterns created that could mean drastic changes in element turnover with consequences for ecosystem function.

References

CLRTAP. 2007. C Convention on Long-Range Transboundary Air Pollution. UN ECE web site; url: http://www.unece.org/env/lrtap

Stages of tree ring development along one cycle of cambial activity

Ana Luísa Luz, Helena Pereira, Sofia Leal*
dendroPORT – Centro de Estudos Florestais, Instituto Superior de Agronomia, Tapada da Ajuda 1349-017 Lisboa, Portugal

The study is part of a recently started project PTDC/AAC-CLI/103046/2008: "Past climate reconstructions and future climate change scenarios in Portugal using a dendroclimatological approach" funded by the Portuguese National Science Foundation (FCT). It aims at identifying and dating the several stages of tree ring development along one year of tree growth. Tree species of temperate climate initiate their radial growth in the beginning of spring time, entering a dormancy period by the end of autumn. The exact extension in time of the growth season and different phases involved, as well as the differences between species, are not well known.
The development of the tree ring corresponding to the year of 2010 is being followed in 12 species common in Portuguese forests (*Acacia melanoxylon, Cupressus sempervirens, Ceratonia siliqua, Acer pseudoplatanus, Eucalyptus globulus, Olea europaea, Populus alba, Quercus suber, Pinus pinea, Fraxinus angustifolia, Abies alba, Schinus terebinthifolius*). Samples of branches are being collected, with a monthly frequency, since the beginning of the growth season and will continue until no cambial activity is observed. Transverse microcuts are being taken from the branches and double-stained in order to distinguish lignified from non-lignified tissues. Image analysis, wood anatomy, and microscopic techniques are being used to study the characteristics and development of the wood cells. The research is ongoing and sampling will be carried out until the end of the growing season.

Environmental limits of the biological carbon pumping by the forests

*Michal V. Marek**
CzechGlobe – Centre for Global Change Impact Studies, Academy of Sciences, Czech Republic, Poříčí 3b, CZ-603 00 Brno Czech Republic

Carbon fluxes between forest stands and atmosphere play the particular role in the global mass and energy exchange. Carbon exchange of a forest stand can be regarded as a permanent balance between assimilatory activity and respiratory losses of the carbon. The respiration carbon efflux is a result of both autotrophic (mainly plants roots) and heterotrophic (soil bacteria) activity strongly dependent on the temperature and soil moisture, respectively. Thus, because the fundamental engagement of the photosynthetic process is evident, the carbon exchange is extremely sensitive to the impact of environmental factors, primarily the effects of microclimatic factors and external synoptic events, and by the seasonal ontogeny of assimilatory apparatus and soil biota. Carbon fluxes show significant seasonality, which is strongly determined by the assimilatory activity ontogeny resulting in the strong differentiation during the seasonal course and in individual season's comparison. The obtained results show the significance of individual species in the forest stands ability to be the carbon depositor. Local forest stand environment, especially temperature, is important environmental parameter affecting the source/sink engagement of the individual forest stand. Because of the importance of the assimilatory activity in the process of the carbon exchange, solar radiation quantity and type is of great importance. Especially, the beam versus diffusive radiation ratio plays significant role in the within crown body assimilatory apparatus illumination. The real carbon exchange between a forest stand and adjacent atmosphere shows distinctive spatial differentiation related to the stand surface illumination.

Integrating monitoring and research: examples and results from a "supersite" in a beech forest in Central Italy

Giorgio Matteucci[1], Bruno De Cinti[2], Alberto Masci[3], Giuseppe Scarascia Mugnozza[4]*
[1]. CNR–ISAFOM, National Research Council, Inst. for Agriculture and Forest Systems in the Mediterranean, Via Cavour 4-6 87036, Rende (CS), Italy
[2]. CNR–IBAF, National Research Council, Inst. of Agroenvironmental and Forest Biology, Via Salaria km 29,300, 00060, Monterotondo Scalo (RM), Italy
[3]. EFS, Sardinia Forest Institute, Cagliari, Italy
[4]. CRA–DAF, Agricultural Research Council, Dep. of Agronomy, Forestry and Land Use, Via del Caravita 7, 00184, Rome, Italy

Forest ecosystems play a major role in the global carbon cycle and are important in the cycle of other greenhouse gases (O_3, N_2O, CH_4) and for filtering anthropogenic pollutants. At the same time, forests are exposed to natural (climate, meteorology, site features, etc.) and anthropogenic factors (pollution, nitrogen deposition, management, climate change) that affect their functioning, carbon sequestration potential and that can modify their geographic distribution and biodiversity.

Since the 90s' of the last century, research and monitoring of forest ecosystems gained new momentum due to the establishment of experimental sites to investigate their functionality, the drivers of primary productivity and responses to climate and to local and transported pollution.

In 1991, an experimental site was established by University of Tuscia, Dep. of Forest Environment and Resources in the beech forest of Collelongo (Central Italy, 41°50'58 N, 13°35'17" E, 1560 m a.s.l.), to study ecology and silviculture of Apenninian beech forest. In 1993, the site was the first european forest to be instrumented to measure ecosystem level fluxes with eddy covariance. In 1996, the area became the first ICP-Forests level II plot in Italy (ABR-1, CON.ECO.FOR. programme). Since 2004, research and monitoring at the site is coordinated and supervised by the Inst. of Agroenvironmental and Forest Biology of National Research Council (IBAF-CNR). In 2006-07, the site is one of the main stations of the Long-Term Ecological Research site "Forests of the Apennine", which is part of the italian LTER network.

Along the years, the site was included in several EU research (EUROFLUX, CANIF, ECOCRAFT, LTEEF-II, CARBOEUROFLUX, FORCAST, MEFIQUE, CARBOEUROPE-IP), monitoring (ICP-Forests, ICP-Integrated Monitoring, ForestFocus, BioSoil, LIFE+ FutMon) and environmental (LIFE+ EnvEurope) projects.

The presentation will address research and monitoring results obtained along 20 years with particular emphasis on the carbon cycle studied with different techniques (canopy fluxes, measurement of growth, biomass harvesting and net primary production, soil carbon mineralisation) and to the response of beech forest to climate variability. The benefit of the integration of research and monitoring and of the long-term perspective will be discussed.

In the future, sites were both research and monitoring are carried out should become Multilevel Research and Monitoring Platforms to study in detail processes and responses to natural and anthropogenic disturbances. Those sites may be selected with a sound stratification concept to provide the necessary process understanding for upscaling and modelling data from large-scale monitoring networks.

Effects of CO_2 enrichment on trees and intensively monitored plots: Research needs in view of future ecosystem studies

*Panagiotis Michopoulos**
Forest Research Institute of Athens, Terma Alkmanos, Athens 115 28, Greece

The intensively monitored plots in Europe have offered a lot of information with regard to the dynamics of forest ecosystems. A large stock of data is already available as an input to ecological models. The carbon sequestration challenge is a little different from others. It requires a long term study and some additional information from what we already have.

So far research in the intensively monitored plots have mainly focused on above ground processes, i.e., crown assessment, phenology, deposition, litterfall, tree growth, foliar chemistry. All these parameters are valuable and will continue to be so. However, according to the latest literature reviews on the subject, the key to understanding the reaction of trees to climate change lies in the belowground processes. In this respect, we have data on soil available base cations, total carbon stocks in soils and soil solution. Information is needed on nitrogen mineralization rates, available phosphorus in soils, soil respiration rates, labile carbon forms in soils. The list does not end here but the above mentioned parameters can be measured relatively easy. A long term study is expensive but science is not easy. If we take into account that countries pay for their carbon emissions and paid for carbon sequestration, a research like this can be worth doing. Most importantly, the ecological models can be enriched and therefore be more precise in predicting tree response to climate change.

Is methane released from the forest canopy?

Mikkelsen, TN[1], Bruhn D[1], Ambus P[1], Larsen, KS[1], Ibrom, I[1], Dellwik, E[2], Pilegaard K[1].*
Risø National Laboratory for Sustainable Energy, [1] Biosystems Division & [2] Wind Energy Division,
BIO-330, P.O. Box 49, Frederiksborgvej 399, DK-4000 Roskilde, Denmark

Methane (CH_4) is the second most important anthropogenic greenhouse gas, contributing about 30% to the total net anthropogenic radiative forcing of 1.6 W m^{-2}. Most of the methane from natural sources in Earth's atmosphere is thought to originate from biological processes in anoxic environments, but a large terrestrial source of CH_4 was proposed by Keppler et al. (2006), who observed emissions from vegetation foliage under aerobic experimental conditions. These finding have been confirmed by other group in the laboratory, but with significant lower emissions. In general, rates of CH_4 emission were found to depend exponentially on increasing temperature and linearly on UV irradiance. The UV irradiance shall be spectrally weighted and shorter wavelengths results in higher CH_4 emissions. (Vigano et al. 2008; McLeod et al. 2008; Bruhn et al. 2009). Global upscaling models for estimating aerobic CH4, based on lab results, have be conducted with varying results, but until now, field measurements based on eddy covariance have failed to show CH_4 emissions from forest canopies (Bowling et al. 2009; Smeets et al. 2009). To detect any CH_4 production in the canopy of a beech stand we installed a CH_4 analyzer in a profile system that samples air below and above the canopy from seven heights all in all. A profile system can detect gas concentration gradients with a high sensitivity under conditions with no or little air movements. Under these conditions we found indications for $_{CH4}$ emissions in the canopy, but more data needs to analyzed before the canopy can be considered as a CH_4 source or not.

References

Bowling D.R., Miller J.B., Rhodes M.E., Burns S.P., Monson R.K, and Baer D. (2009). Soil, plant, and transport influences on methane in a subalpine forest under high ultraviolet irradiance. Biogeosciences, 6, 1311–1324,
Bruhn D., Mikkelsen T.N, Øbro J., Willats W.G.T. & Ambus P. (2009). Effects of temperature, ultraviolet radiation and pectin methyl esterase on aerobic methane release from plant material. Plant Biology 11 (Suppl. 1) 43–48.
Keppler F., Hamilton J.T.G., Braß M., Röckmann T. (2006) Methane emissions from terrestrial plants under aerobic conditions. Nature, 439, 187–191.
McLeod A.R., Fry S.C., Loake G.J., Messenger D.J., Reay D.S., Smith K.A., Yun B.-W. (2008) Ultraviolet radiation drives methane emissions from terrestrial plant pectins. New Phytologist, 180, 124–132.
Smeets C. J. P. P., Holzinger,R., Vigano I., Goldstein A. H., and Röckmann T. (2009) Eddy covariance methane measurements at a Ponderosa pine plantation in California. Atmos. Chem. Phys., 9, 8365–8375.
Vigano I., van Weelden H., Holzinger R., Keppler F., Röckmann T. (2008) Effect of UV radiation and temperature on the emission of methane from plant biomass and structural components. Biogeosciences Discussions, 5, 243–270.

Distributed Long-term Ecosystem Research Network LTER-Europe – a Major European Research Infrastructure Comprising Forested Supersites

*M Mirtl**
Federal Environment Agency Austria (Umweltbundesamt), Spittelauer Lände 5, 1090 Wien, Austria.

LTER-Europe is the umbrella network for Long-Term Ecosystem Research (LTER) and Long-Term Socio-Ecological Research (LTSER) in Europe. It forms part of the global LTER network (ILTER). Comprising 21 formal national member networks and 7 emerging ones LTER-Europe represents more than 400 LTER sites and 23 LTSER platforms. More than 50% of LTER-Europe´s Sites are forested. 70 of these forested LTER Sites feature an ecosystem research component on top of high quality regular monitoring according to UNECE ICP Forest and LIFE+/FutMon. A strategic process has been launched in 2007 to foster network integration in order to maximize synergies with European forest monitoring. Besides the *in-situ* component LTER-Europe stands for a network of scientists, disciplines, institutions, data and metadata, and research projects. The Network of Excellence ALTER-Net (FP6) provided the frame for meeting the objective to integrate the highly fragmented European infrastructure with LTER potential across national and disciplinary boarders. LTER-Europe has become the terrestrial and aquatic component in the network of networks, currently organized by the ESFRI preparatory project LifeWatch. LTSER platforms (regions) have been developed as multi-scale and multi-level infrastructure for investigating interactions of human and natural systems on the regional or sub-regional level. The character and functional niche of LTER-Europe is best described by four core characteristics, namely "*in-situ*, long-term, system and process": LTER-Europe´s research is generating or using data gathered together with a maximum of other sources of knowledge at concrete locations in the long term. This allows for the detection and quantification of processes of ecosystems and socio-ecological systems, which determine the sustainable provision of ecosystem services. Summarizing, LTER-Europe is a multifunctional network, but also a process structuring and optimizing a distributed research infrastructure, catalyzing the development of research projects meeting societal needs and helping to streamline and harmonize the entire sector on the institutional, national, European and global level.

Modelling air pollutant effects on tree growth

*Frits Mohren**
Vice Chair COST FP0603 (The Netherlands)

abstract missing

Monitoring of entomofauna in forest ecosystems of Serbia

CANCELLED

D. V. Stojanović[1], S. Orlović[2], Z. Galić[2]*
[1]National Park Fruška Gora, Zmajev trg 1, 21208 Sremska Kamenica, Serbia;
[2]University of Novi Sad, Institute of Lowland Forestry and Environment, Novi Sad, Serbia

The inventory of entomofauna diversity in forest biocenoses is a first stage in consistent approach to its conservation. Diversity of life forms in forest habitats is in direct correlation to their sustenance and presence. In forest biocenoses that are undisturbed and in balance, qualitative and quantitative number of habitants oscillates only slightly. Extremely high number of some insects in forest ecosystems undoubtedly points to unwanted influence causing imbalance and increase of such parameter. Abiotic factors influence living world with wide consequences. Presence or absence of stenovalent species is a possible indicator of parameter variation in environment, especially climate. Vertical and horizontal distribution of eurivalent and stenovalent insect species and their monitoring in forest biocenoses gives a large number of information, useful in defining presence and intensity of climate changes in this geographical area. Insects, as most numerous habitants of forest biocenoses (about 75% of total number in qualitative and quantitative composition), are also poikilothermic organisms and are directly influenced by climate variations. At a number of points throughout Serbia, entomofauna monitoring is conducted: by light traps, Malaise traps, Linex apparatus, acetum traps, sticky belts, catchers, nets, aspirators and manual collection. In investigated area, permanent monitoring is being conducted for more than thirty migratory Lepidoptera species. A significant change of dispersion area was found for following species: *Colias erate* (Esper, 1805), *Agrochola wolfschlaegeri* Boursin, 1953 and *Noctua haywardi* (Tams, 1926).

The eddy covariance networks in Europe for forest carbon exchange monitoring

*Dario Papale**
DISAFRI – University of Tuscia – Viterbo (Italy)

The eddy covariance network in Europe is providing direct measurements on the 'breathing of the terrestrial biosphere'. The CO_2, water and energy exchange between the terrestrial biosphere and the atmosphere measured at the eddy covariance sites is giving us insights on how ecosystem metabolism to climatic perturbations and disturbances across a spectrum of time scales and different ecosystem and climate regimes. These ecosystem fluxes data are critical to improve our knowledge of the climate-ecosystems relations and feedbacks and for validating and improving the next generation of mechanistic models, that are being used to compute coupled climate-ecosystem interactions and biogeochemical cycling of carbon and water.
The current European eddy covariance measurements database, strictly interconnected with other similar initiatives in others continents and at global level with FLUXNET (www.fluxdata.org), assembles data from more than 100 sites, encompassing all major biomes of the world and being processed in a standardized way.
This unique dataset provides copious amounts of information about the fluxes characteristics and their responses to climate and disturbances. The methods available to estimate from Net Ecosystem Production (NEP) the two main components Gross Primary Production (GPP) and Total Ecosystem Respiration (TER) give possibilities to analyze the relations between these three quantities and their link to climate variables like temperature and precipitation and to disturbances, while the water fluxes permit to look at the water/carbon cycles interactions. At the same time the long time-series available for many sites (up to 14 years) offer the opportunity to analyze the interannual variability of fluxes and the effect of extreme climate conditions.
In this talk the European eddy covariance network and database will be presented, including the potentiality and uncertainties, highlighting how these measurements can help our scientific activities and focussing on the data availability, data policies, data exchange tools and databases coordination.

Interactions between the N and C cycles in forests and how does the atmosphere chemistry impact forest ecosystems

Patrick Schleppi, Kim Krause*
Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Zürcherstr. 111, CH-8142 Birmensdorf

Carbon (C) and nitrogen (N) are intimately interacting in each form of life on Earth. Large-scale changes induced by human activities include increased concentrations of CO_2 and of reactive N (oxidised and reduced) in the atmosphere. How increased CO_2 concentration and N deposition interact in forests is of prime interest both for the forests themselves and for the climate of our planet. This question can be split into two main aspects: (1) how does N deposition affects the C balance of forests and (2) is N becoming a more limiting nutrient as atmospheric CO_2 concentration increases.
In a subalpine *Picea abies* forest in central Switzerland (Alptal, 1200 m a.s.l.), an N addition is conducted as a paired-catchment experiment since 1994. N deposition is increased by 25 kg/ha/a in a small catchment (1500 m^2) by sprinkling small but frequent amounts of NH_4NO_3 in rain water. This treatment is compared to a control catchment under ambient deposition (12 kg/ha/a). Labelling with ^{15}N enabled us to follow the fate of the added N. Most of it was retained in the soil, while some was lost by leaching as nitrate. Uptake by the trees did not exceed 12% of the added ^{15}N. Simple stoichiometric calculations based on the C/N ratio of the different ecosystem pools and fluxes showed that for each kg N deposited, the additional sequestration of C is at most 50 kg, as shown also in similar ^{15}N experiments in other temperate coniferous forests in Europe and North America. Part of this sequestration corresponds to an increased uptake by photosynthesis, part is due to a reduced respiration of the soil under increased N deposition. The numbers obtained are much smaller than those based on eddy-covariance studies but comparable to studies on tree growth under increased N deposition or fertilisation.
Experiments in chambers or with young plantations indicate that trees grow better under increased CO_2 concentrations, and that this can lead to a depletion of available N in the soil. These observations led to the theory of progressive N limitation (PNL). We tested if PNL also occurs in a mature deciduous forest in northern Switzerland (Hofstetten), where CO_2 was experimentally enriched around a group of trees (*Fagus sylvatica*, *Quercus petraea*, *Q. robur* and *Carpinus betulus*). Nitrate was sampled in the soil solution by suction cups and by ion-exchange resin bags along transects through the treated zone. Unlike the PNL hypothesis, more nitrate was available under increased CO_2 concentration. This relates to the fact that older trees don't appear to react in their growth, but in their foliar C/N ratio, thus lowering their N demand. Our experiments (and others) demonstrate that the C and N cycles are more

stable relative to each other as would be expected from their strong interactions, perhaps because of the number of these different interactions.

Annual and seasonal trends for ambient ozone concentration and its Impact on Forest Vegetation in Mercantour National Park (South-eastern France) over the 2000-2008 period

Pierre Sicard[1], Laurence Dalstein-Richier[2], Nicolas Vas [2]*
[1] ACRI-ST, 260 route du Pin Montard, BP 234, 06904 Sophia Antipolis cedex, France
[2] G.I.E.F.S (Groupe International d'Etudes sur les Forêts Sud-européennes), 69 avenue des Hespérides, 06300 Nice, France

In the South-Eastern French Mediterranean region, high ozone concentrations were measured since many years and specific symptoms like chlorotic mottles were detected on Arolla pines. This study presents results for the 2000-2008 period concerning the trend analysis for ambient ozone concentrations and related forest damages, with the Mann Kendall and seasonal Kendall tests in the Mercantour National Park. Emissions of ozone precursors from Europe and France have been substantially reduced over the last 20 years. Decreases in annual averages, median, 25^{th} and 98^{th} percentiles and maxima values were found. The seasonal trend analysis for the high-lying stations showed a decreasing trend for the warm season, when main ozone production is the photochemistry, and an increase for the cold period, caused by a reduced ozone titration by reduced NO_x emissions. The intercontinental transport resulting from North America, maximum in summer, and the decrease for the ozone precursors emissions are in agreement with the ozone decrease during the warm period. The transport resulting from Asia, maximum in autumn, and the emissions increase for NO_x and NMVOC, are in line with the ozone increase found during the cold period. At high-lying stations, significant decreasing trends for AOT40 values were observed. Such quantities that systematically exceed threshold levels may provide an explanation for the physiological injury. Statistics on Arolla Pine reveal strong correlations between mottling intensity and the high ozone concentrations. The specific ozone related symptoms on conifers needles (chlorotic mottles) slightly decreased. Gaseous pollutants such as ozone are implicated in the visible leaf injury found but the likely explanation for the die-back on Arolla pine in the Mercantour may be also linked to multiple inter-related factors including climate and soil conditions. Finally, decreases for the ozone concentrations, and associated statistics, AOT40 values and for the mottling intensity on conifers needles were observed.

Biosphere-atmosphere exchange in the EMEP Chemical transport model. Experience and Issues

*David Simpson**
EMEP MSC-W, Norwegian Meteorological Institute, Oslo, Norway & Dept. Earth & Space Sciences, Gothenburg, Sweden

The European Monitoring and Evaluation Programme (EMEP, see www.emep.int) started in 1977, a successful effort between European countries to pool resources in tackling major environmental problems. EMEP is an integral part of the LRTAP Convention, and plays an important part in the development of emission reductions scenarios, for both the Convention and the European Commission.
The chemical transport model used at EMEP MSC-W in Oslo is a 3D Eulerian model, covering all of Europe with a resolution of about 50x50 km2. Local-scale (e.g. 5 km) and global-scale versions are in development. This model is typically used to tackle problems within the fields of acid deposition, tropospheric ozone, and particles. Biosphere-atmosphere interactions included in the EMEP model include emissions of biogenic volatile organic compounds (primarily from forests), emissions of NO from soils [1], and deposition of gases and particles to ecosystems [1--4].
As well as nitrogen and sulphur deposition, recent work has focused on calculating the uptake of ozone through the plant's stomata [2-3]. Such modelling is challenging, requiring estimates of plant responses to temperature, light, humidity, and soil water - the latter is particularly difficult to calculate and verify in a large scale model.
An important part of this work is to identify and evaluate appropriate datasets. Even information on apparently simple data such as tree height, biomass and leaf-area has proven surprisingly difficult to get hold of (the "pretty-picture" syndrome -- availability of a nice map, but dubious reliability of content -- is widespread!). It is clear that future versions of the EMEP model will include ever more complex and realistic treatments of biosphere-atmosphere interactions, from local to global scales, with even greater data requirements. In this talk we will highlight the major problem areas, and possible sources for future improvement.

References
[1] Simpson, D. et al., Deposition and Emissions of Reactive Nitrogen over European Forests: A Modelling Study. *Atmospheric Environment*, 40:5712–5726, 10.1016/j.atmosenv.2006.04.063.
[2] Emberson, LD et al., 2001, Modelling and mapping ozone deposition in Europe. *Water, Air and Soil Pollution*, 130:577–582.
[3] Simpson, D, et al. 2007, A comparison of two different approaches for mapping potential ozone damage to vegetation. A model study, Environmental Pollution, 146, 715-725.
[4] Tuovinen, JP et al. 2009, Modelling ozone fluxes to forests for risk assessment: status and prospects Annals of Forest Science, 2009, 66, 401

How combined changes in air humidity and temperature affect xylem flux and growth of fast-growing deciduous trees?

Anu Sõber, Jaak Sõber, Priit Kupper, Arvo Tullus*
University of Tartu, Institute of Ecology and Earth Sciences, Estonia

Saplings of silver birch and hybrid aspen were grown at ambient and increased air humidity for two growing-seasons (2008 and 2009). Misting technique, used in free air humidity manipulation experiment „FAHM" enabled to rise relative humidity about 10 % during about 50% of daytime in both years (misting was provided when humidity was lower 75 %, air temperature higher than 15 ^{0}C and wind speed lower than 8 m/s). Misting caused about 30 % lower values of xylem flux (measured by heat balance sensors on stems and calculated per leaf area). Average values of xylem flux did not differ in misted and control plots during periods without misting. Average stem growth rate was significantly lower under misting treatment. There occurred 24% and 37 % decrease in stem growth rate in 2008 and 2009 respectively for silver birch and 25 % decrease for hybrid aspen in 2009 due to misting (in 2008 effect was not signifficant for hybrid aspen). There was also less leaf area under misting treatment but the ratio of leaf area and stem volume did not differ. Volume of buds, formed under misting treatment was also lower (by 30 and 20 percent for aspen and birch respectively). Stomata were slightly more open, but net photosynthesis, leaf chlorophyll and mass per area were 5-7 % lower under misting treatment. As leaves were often wet during misting, temperature of these leaves was 2-6 degrees lower than leaf temperature in control plots.
Influence of (a) nutrient deficiency (caused by lower xylem flux density), (b) lower leaf temperature and (c) leaf wetness, (causing damage of young developing leaves) on tree growth is discussed..

Launching experiment FAHM (Free air humidity manipulation)

Anu Sõber, Jaak Sõber, Priit Kupper, Arne Sellin, Krista Lõhmus, Martin Zobel, Olevi Kull*
University of Tartu, Institute of Ecology and Earth Sciences, Estonia

As air humidity can change during the process of global warming and humidity rise can affect (probably enchance) tree growth, it is important to held free air experiments with humidity manipulation. As this task is technically very complicated, there is only few attemts made. We started to deal with experiment FAHM in 2006, with the aim to investigate effects of humidity on forest ecosystem (especiajjy on deciduous tree growth and species-richness of understory).The tubing-system like in „Face" (Free air carbon enrichment) experiments was built up for air humidificationin 2006 and 2007. The conclusion was made, that it is impossible to rise air humidity, using tubing-system, known from "Face" experiments. (As the added humidity can not be higher than saturated-one, there was not enough water added to compete with the wind and increase in humidity was neglible). In 2008 we started to rise air humidity by misting. We used hydraulic pressure of 8 bars for misting, and this exeriment was running in summers 2008 and 2009. Misting caused significant rise in relative humidity, but caused also wetness of leaves. Growth rates of trees were not higher but much less under misting treatment and damage of developing light-exposed leaves often occurred. In 2010 we started misting by 70 bar pressure. New system generates smaller (size about 10 microns) water-particles, which will evaporate before condensing on trees and ground. Air humidity was about 15 % higher and leaves were practically dry in summer 2010. (Data about changes in plants not available yet).

On chemical and biological air quality: experience of COST-ES0603

*Mikhail Sofiev**

Chair COST ES0603 (Finland)

Abstract missing

Modelling ozone fluxes: can we validate the models?

*Juha-Pekka Tuovinen**
Finnish Meteorological Institute, Climate Change Research, P.O. Box 503, FI-00101 Helsinki, Finland

Risk assessment of ozone effects on forests and other vegetation is gradually moving from concentration-based metrics, such as AOT40, to alternatives that are based on the ozone dose absorbed via plant stomata. Whilst the latter approach provides a more mechanistic basis for describing biological effects of ozone, it poses a significantly greater scientific challenge, since the calculation of the absorbed dose entails the determination of the stomatal flux. In practice, this means that the stomatal conductance of plants must be modelled, whenever a flux-based risk index is applied. Thus, in order to benefit from the improving mechanistic understanding of plant physiology in the context of environmental risk assessment, reliable, fit-for-purpose models for ozone fluxes are needed.
A key element of the above-mentioned scientific challenge, namely the validation of ozone flux models, is discussed in this presentation. Previous studies of model calibration and validation are critically reviewed, highlighting possibilities, inherent limitations and research needs. Differences in the validation techniques between the models employed at different (leaf, canopy, regional) scales are discussed. Examples are presented based on actual field data and numerical simulations. Statistical issues related to model validation are addressed, with suggestions for more rigorous methods and reporting practices.

ABBA - Advancing the integrated monitoring of trace gas exchange between biosphere and atmosphere

Timo Vesala[1], Tanja Suni[1], Almut Arneth[2]*
[1]Department of Physics, University of Helsinki, Finland
[2]Physical Geography and Ecosystem Analysis, Lund University, Sweden

ABBA, a 4-year European Cooperation in Science and Technology (COST) Action, was created in 2008 with a view on the next generation of European comprehensive multi-species flux monitoring sites. ABBA provides a strong and dedicated coordination platform where the planning, analysis and synthesis efforts of current flux monitoring sites can take place. ABBA will create standardised methods and protocols for

- site location selection
- flux measurement techniques
- processing and storage of data.

The aim is to facilitate wider use of flux data by a more diverse community of researchers, operational forecasters, and environmental assessment organisations. ABBA is a pan-European network of land-atmosphere interaction scientists jointly working towards these goals.
Four working groups have been established:
WG 1: Analysis and synthesis of the current state of the flux monitoring sites, measurement techniques, data handling methods and storage of data in Europe
WG 2: Work towards comprehensive multi-species flux monitoring sites
WG3: Assessing regional representativeness of flux sites in different ecosystems
More information at http://www.ileaps.org/multisites/cost0804/.

Tracing carbon and nitrogen from stem injected trees into forest ecosystems

Andrew Weatherall[1], Carolyn Churchland[2], Sue Grayston[3]*
[1]National School of Forestry, University of Cumbria, Penrith, CA11 0AH, U.K.
[2]Belowground Ecosystem Group, Department of Forest Sciences, University of British Columbia, Canada

This paper will describe a novel method of quantifying the flux of carbon from individual trees into forest soils and the wider forest ecosystem. This technique addresses an important scientific gap in our knowledge of how forests

mitigate climate change. Previous stem injection of stable isotopes will be reviewed, this has predominantly been undertaken to study nitrogen fluxes using ^{15}N. Recent experimental work tracing carbon fluxes using ^{13}C are described. Carbon has been traced from stem injected trees through forest soil into soil CO_2 efflux. The potential unique benefits of using the stem injection method will be discussed.

High elevation forest soil CO_2 efflux in a changing environment

*Gerhard Wieser[1] *, Maria-Soledad Jimenez[2], Domingo Morales[2], Patricia Brito[2], Michael Bahn[3]*
[1]Unit Alpine Timberline Ecophysiology, Federal Research and Training ´Centre for Forests, Natural Hazards and Landscape (BFW),Rennweg 1, A-6020 Innsbruck, Austria.
[2]Dpt. Plant Biology, University La Laguna, C/Astrofisico Francesco Sanchez s/n E-38207 La LagunaTenerife, Spain
[3]Institute of Ecology, University Innsbruck,Sternwartestraße 15, A-6020 Innsbruck, Austria

Soil respiration is the major source of CO_2 released by terrestrial ecosystems and constitutes the second largest carbon flux between ecosystems and the atmosphere. In view of growing interest concerning the role of forests in the global carbon cycle and its feedbacks to climate change information on the control of soil CO_2-efflux by soil temperature and soil water availability is needed to understand the present and future carbon sink strength of forest ecosystems in different climatic zones.

Under present climatic conditions the influence of soil water availability on soil CO_2-efflux in high elevation forest ecosystems of the Central Austrian Alps is negligible because soil water availability is supra-optimal. In the Mediterranean by contrast, soil drought significantly limits soil CO_2

As climate warming will causes an increase in evapotranspiration and thus also a decline soil water availability a future warmer climate will cause an increase in soil respiration in cold and humid and a decline in soil respiration in warm and dry environments, respectively.

Finally, an increased probability of forest fires due to climate change may also affect microbial biomass and basal respiration

Harmonisation of forest monitoring: a case study with deposition samplers

*Daniel Zlindra**
Lab Forest Ecology, Slovenian Forestry Institute, Vecna pot 2, Ljubliana, Slovenia

In recent years the tendency for harmonizing the methods of forest monitoring is present. Among the so called C-actions of the FutMon project (LIFE07 ENV/D/00021) the C1-Dep-22(SI) action was established with the goal to harmonize and develop the deposition monitoring methods. The sampling equipment, spatial design and time schedule of sampling throughout Europe varies considerably. Therefore we made step-by-step approach and developed and tested the harmonized sampling equipment first. The harmonized samplers were installed in one observation plot of each participating country where measurements of throughfall and bulk deposition are running. To evaluate the agreement between methods different statistical analyses were used, namely Altman-Bland plot, model II regression, repeated measures ANOVA, etc. Preliminary results from Slovenia show a good agreement between national (gutter-type) and harmonized bulk samplers while comparison of throughfall measurements indicates the systematic bias between harmonized and national samplers.

Attendance list

	Name	Surname	Institute	Country	email
1	Dan	Aamlid	Norwegian Forest and Landscape Institute, Ås	Norway	dan.aamlid@skogoglandskap.no
2	Wenche	Aas	NILU, Norwegian Institute for Air Research (EMEP/CCC), Kjeller	Norway	waa@nilu.no
3	Cecilia	Akselsson	Lund University, Department of Earth and Ecosystem Sciences	Sweden	cecilia.akselsson@nateko.lu.se
4	Rocio	Alonso	Ecotoxicology of Air Pollution, CIEMAT, Madrid	Spain	rocio.alonso@ciemat.es
5	Ovidiu	Badea	Forest Research and Management Institute, Voluntari, Ilfov	Romania	obadea@icas.ro
6	Giada	Bertini	CRA-SEL, Arezzo	Italy	giada.bertini@entecra.it
7	Svetla	Bratanova-Doncheva	IBER-BAS/ Ecosystem Research, Sofia	Bulgaria	sbrat@abv.bg
8	Nazzareno	Buttafuoco	CNR, central office	Italy	Nazzareno.buttafuoco@cnr.it
9	Vincent	Calatayud	Fundación CEAM, Paterna	Spain	vicent@ceam.es
10	Carlo	Calfapietra	IBAF-CNR, Porano	Italy	carlo.calfapietra@ibaf.cnr.it
11	Arnaud	Carrara	Fundación CEAM, Paterna	Spain	arnaud@ceam.es
12	Stanislaw	Cieslik	JRC Ispra	Italy	stanislaw.cieslik@jrc.it
13	Nicholas	Clarke	Norwegian Forest and Landscape Institute, Ås	Norway	nicholas.clarke@skogoglandskap.no
14	Nathalie	Cools	Research Institute for Nature and Forest (INBO), Geraardsbergen	Belgium	n.cools@telenet.be
15	Pavel	Cudlin	Institut of Systems Biology and Ecology, Ceske Budejovice	Czeck Republic	pavelcu@usbe.cas.cz
16	Ana	De La Cruz	CIFOR– INIA	Spain	calleja@inia.es
17	Alessandra	De Marco	ENEA Casaccia, Rome	Italy	alessandra.demarco@enea.it
18	Wim	De Vries	Alterra – Wageningen University and Research centre	Netherlands	wim.devries@wur.nl
19	Lucio	Di Cosmo	CRA-MPF & Italian Forest Service	Italy	lucio.dicosmo@entecra.it
20	Pierre	Dizengremel	UMR 1137 EEF INRA/UHP Nancy Université	France	dizengre@scbiol.uhp-nancy.fr
21	Matthias	Dobbertin	WSL Birmensdorf	Switzerland	matthias.dobbertin@wsl.ch
22	Marie	Dury	Unité de Modélisation du Climat et des Cycles Biogéochimiques, Université de Liège	Belgium	Marie.Dury@ulg.ac.be
23	Chris	Eastaugh	Institute of Silviculture, University of Natural Resources and Applied Life Science (BOKU), Vienna	Austria	cseastaugh@yahoo.com.au
24	Dieter	Ernst	Institut of Biochemical Plant Patology, Helmholtz	Germany	ernst@helmholtz-muenchen.de

			Zentrum Munchen		
25	Gianfranco	Fabbio	CRA-SEL, Arezzo	Italy	fabbiogianfranco@libero.it
26	Clementina	Falco	IPP-CNR, Sesto Fiorentino	Italy	c.falco@ipp.cnr.it
27	Daniela	Famulari	CEH Bush Estate Penicuik, Edinburgh	UK	danf@ceh.ac.uk
28	Marco	Ferretti	TerraData environmetrics, Siena	Italy	ferretti@terradata.it
29	Richard	Fischer	vTI – Institute for World Forestry, PCC of ICP Forests, Hamburg	Germany	richard.fischer@vti.bund.de
30	Louis	François	UMCCB Univ. Liege	Belgium	Louis.francois@ulg.ac.be
31	Paloma	Garcia	Forest Healt Unit (DG Nature and Forest Policy - Ministry of Environment and Rural and Marine Affairs, Madrid)	Spain	at_pgarciaf@mma.es
32	Sebastian	Gayler	WESS c/o University of Tuebingen, Center For Applied Geoscience	Germany	sebastian.gayler@uni-tuebingen.de
33	Sofie	Hellsten	IVL Swedish Environmental Research Institute, Gothenburg	Sweden	sofie.hellsten@ivl.se
34	Lars	Hogbom	Skogforsk - The Forestry Research Institute of Sweden, Uppsala	Sweden	lars.hogbom@skogforsk.se
35	Yasutomo	Hoshika	Graduate School of Agricultural and Life Sciences, The University of Tokyo	Japan	ahoshika@mail.ecc.u-tokyo.ac.jp
36	Andreas	Ibrom	Risø DTU, Roskilde	Denmark	anib@risoe.dtu.dk
37	Akihiro	Ishimura	Graduate School of Agricultural and Life Sciences, The University of Tokyo	Japan	aa106199@mail.ecc.u-tokyo.ac.jp
38	Rastislav	Jakus	Institute of forest ecology, Slovak academy of sciences, Zvolen	Slovakia	jakus@savzv.sk
39	Hubert	Jochheim	ZALF, Inst. Lanscape System Analysis, Muencheberg	Germany	hubert.jochheim@zalf.de
40	Per Erik	Karlsson	IVL Swedish Environmental Research Institute, Gothenburg	Sweden	pererik.karlsson@ivl.se
41	Gunilla Pihl	Karlsson	IVL Swedish Environmental Research Institute, Gothenburg	Sweden	gunilla@ivl.se
42	Hojka	Kraigher	Slovenian Forestry Institute, Ljubljana	Slovenia	hojka.kraigher@gozdis.si
43	Didier	Le Thiec	UMR 1137 EEF INRA/UHP Nancy Université, Champenoux	France	lethiec@nancy.inra.fr
44	Sofia	Leal	dendroPORT – Centro de Estudos Florestais, Instituto Superior de Agronomia, Lisboa	Portugal	spleal@yahoo.co.uk

45	David	Leaver	CEH, Edinburgh	UK	leav@ceh.ac.uk
46	Allan	Legge	Biosphere Solutions, Calgary, Alberta	Canada	allan.legge@shaw.ca
47	Rosa	Lella	ANSA	Italy	rusenella@gmail.com
48	Zane	Libiete	Latvia State Forest Research Institute „Silava”	Latvia	zane.libiete@silava.lv
49	Lars	Lundin	Swedish University of Agricultural Sciences, Dept Aquatic Sciences and Assessment, Uppsala	Sweden	Lars.Lundin@vatten.slu.se
50	Ana Luisa	Luz	dendroPORT – Centro de Estudos Florestais, Instituto Superior de Agronomia, Lisboa	Portugal	luzanalu@gmail.com
51	Ion	Machedon	National Forest Administration ROMSILVA, Bucharest	Romania	obadea@icas.ro
52	Sirkku	Manninen	Dept Environmental Sciences, University of Helsinki	Finland	sirkku.manninen@helsinki.fi
53	Michael V.	Marek	CzechGlobe – Centre for Global Change Impact Studies, Academy of Sciences, Brno	Czeck Republic	marek.mv@czechglobe.cz
54	Giorgio	Matteucci	CNR–ISAFOM, Rende	Italy	giorgio.matteucci@isafom.cs.cnr.it
55	Rainer	Matyssek	Technische Universitat Munchen	Germany	matyssek@wzw.tum.de
56	Medori	Mauro	IBAF-CNR, Montelibretti	Italy	Mauro.medori@ibaf.cnr.it
57	Simone	Mereu	University of Sassari	Italy	Si.mereu@gmail.com
58	Paivi	Merila	Finnish Forest Research Institute (METLA) - Parcano	Finland	paivi.merila@metla.fi
59	Panagiotis	Michopoulos	Forest Research Institute of Athens	Greece	mipa@fria.gr
60	Teis	Mikkelsen	Risø National Laboratory for Sustainable Energy, Roskilde	Denmark	temi@risoe.dtu.dk
61	Michael	Mirtl	Federal Environment Agency Austria (Umweltbundesamt), Wien	Austria	michael.mirtl@umweltbundesamt.at
62	Frits	Mohren	Wageningen University	Netherlands	frits.mohren@wur.nl
63	Arianna	Morani	IBAF-CNR, Montelibretti	Italy	Arianna.morani@ibaf.cnr.it
64	Markus	Neumann	BFW, Federal Research and Traninig Centre for Forest, Natural Hazards and Landscape	Austria	markus.neumann@bfw.gv.at
65	Katri	Ots	Deprt Ecophysiology, Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Tallin	Estonia	Katri.Ots@rmk.ee

66	Elena	Paoletti	IPP-CNR, Sesto Fiorentino	Italy	e.paoletti@ipp.cnr.it
67	Dario	Papale	DISAFRI, University of Tuscia, Viterbo	Italy	darpap@unitus.it
68	Nenad	Potocic	Croatian Forest Research Institute - Jastrebarsko	Croatia	nenadp@sumins.hr
69	Raitis	Rieksts-Riekstins	Latvian State Forest Research Institute "Silava"	Latvia	aris.jansons@silava.lv
70	Patrick	Schleppi	WSL Birmensdorf	Switzerland	schleppi@wsl.ch
71	Pierre	Sicard	ACRI-ST, Sophia Antipolis Cedex	France	pierresicard25@hotmail.com
72	Primoz	Simoncic	Slovenian Forestry Institute, Ljubljana	Slovenia	primoz.simoncic@gozdis.si
73	David	Simpson	EMEP MSC-W, Norwegian Meteorological Institute, Oslo, Norway & Dept. Earth & Space Sciences, Gothenburg	Sweden	david.simpson@chalmers.se
74	Anu	Sober	University of Tartu, Institute of Ecology and Earth Sciences	Estonia	asober@ut.ee
75	Jaak	Sober	University of Tartu, Institute of Ecology and Earth Sciences	Estonia	jaaks@ut.ee
76	Mikhail	Sofiev	Finnish Meteorological Institute, Air Quality Research, Helsinki	Finland	Mikhail.sofiev@fmi.fi
77	Stefan	Tamas	Transilvania University of Brasov	Romania	stamas@unitbv.ro
78	Juha-Pekka	Tuovinen	Finnish Meteorological Institute, Climate Change Research, Helsinki	Finland	juha-pekka.tuovinen@fmi.fi
79	Timo	Vesala	Department of Physics, University of Helsinki	Finland	timo.vesala@helsinki.fi
80	Andrew	Weatherall	National School of Forestry, University of Cumbria, Penrith	UK	andrew.weatherall@cumbria.ac.uk
81	Gerhard	Wieser	Unit Alpine Timberline Ecophysiology, Federal Research and Traninig Centre for Forest, Natural Hazards and Landscape (BFW), Innsbruck	Austria	gerhard.wieser@uibk.ac.at
82	Daniel	Zlindra	Lab Forest Ecology, Slovenian Forestry Institute, Ljubliana	Slovenia	daniel.zlindra@gmail.com