ÉCLAIRE WP1: FIELD STUDIES OF EXCHANGE PROCESSES

Eiko Nemitz

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

eclaire

Effects of climate change on air pollution impacts and response strategies for European ecosystems

SEVENTH FRAMEWORK PROGRAMME

ECLAIRE Kickoff meeting
24-26 October, Brescia, Italy

Objectives

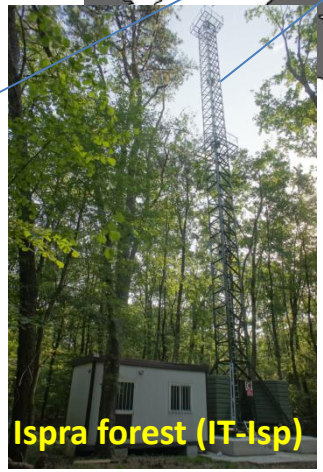
The aim of the WP is to make field flux measurements across the ÉCLAIRE flux network and during campaigns, to provide targeted high-quality data to derive mechanistic parameterisations of biosphere/atmosphere exchange in response to environmental drivers, utilising the natural climate variability at and between sites. The specific objectives are:

1. To obtain 15 months of high temporal resolution flux data of key trace compounds (O_3, NO, CO_2, H_2O) across a 9-site European flux network for the study of fluxes in relation to climatic drivers, using changing meteorological conditions at the sites as a proxy for climate.
2. To study the exchange of additional compounds (NH3, NOx, VOCs) through synchronised intensive measurement periods across the 9-site flux network, in relation to meteorological drivers, and to provide a test database for the evaluation of European chemical transport models.
3. To quantify the effect of aerosols on gross primary productivity through modulating in-canopy light levels for three forest ecosystems.
4. To quantify the importance of in-canopy chemical transformations on the deposition mechanism and effective emission of biogenic compounds into the atmosphere, through an integrated intensive measurement campaign above/within a polluted forest.
5. To make targeted measurements of NH3 exchange with Mediterranean semi-natural vegetation during distinct growth phases (active vs. dormant).O_3, N_r, VOCs

Task 1.1: Long-term flux measurements

- 9-site European flux network (NERC(EDI) (Nemitz) FDEA-ART, FRI, ECN, UHEL, FMI, ECN, INRA(G), JRC, UNICATT, ONU, CNR). Long-term, high quality flux
- 15 months (Aug 2012 - Oct 2013) over a European network spanning 9 sites.
- This will include eddy-covariance flux measurements of CO_2, H_2O, sensible heat and O3, as well as ground fluxes of NO by continuous chamber techniques or equivalent approaches.
- This will be augmented by extensive measurements of meteorological parameters including temperature, humidity, pressure, solar radiation, PAR (direct vs. diffuse), leaf wetness, soil temperature, moisture and soil heat flux, and water table height where relevant.
- Measurements will be made of canopy height, LAI, organic matter (above/below ground) and soil concentrations of NH_4^+ and NO_3^-. CO_2 fluxes will be measured according to the NitroEurope and CarboEurope protocols.

ÉCLAIRE Flux network



Task 1.1: Long-term flux measurements

- 9-site European flux network (NERC(EDI) (Nemitz) FDEA-ART, FRI, ECN, UHEL, FMI, ECN, INRA(G), JRC, UNICATT, ONU, CNR). Long-term, high quality flux
- 15 months (Aug 2012 - Oct 2013) over a European network spanning 9 sites.
- This will include eddy-covariance flux measurements of CO_2, H_2O, sensible heat and O3, as well as ground fluxes of NO by continuous chamber techniques or equivalent approaches.
- This will be augmented by extensive measurements of meteorological parameters including temperature, humidity, pressure, solar radiation, PAR (direct vs. diffuse), leaf wetness, soil temperature, moisture and soil heat flux, and water table height where relevant.
- Measurements will be made of canopy height, LAI, organic matter (above/below ground) and soil concentrations of NH_4^+ and NO_3^-. CO_2 fluxes will be measured according to the NitroEurope and CarboEurope protocols.

Task 1.2: Campaigns across flux network

- Intensive measurement periods across the flux network (NERC(EDI) (Nemitz), FDEA-ART, ERTI-FRI, ECN, UHEL, FMI, ECN, INRA(G), JRC, UNICATT, ONU, CNR). During two contrasting measurement periods, which will be *harmonised* across the network (envisaged are Feb/Mar and Jun/Jul 2013, but this may be refined according to the management at the arable sites), targeted flux measurements will be made of additional
- compounds, including
  - above-canopy NO and NO_2 by gradient and/or eddy-covariance,
  - NH_3
  - volatile organic compounds (VOCs).

Task 1.3: Effect of direct/diffuse PAR on GPP

- Assessment of the effect of aerosol on gross primary productivity (JRC (Cescatti), UHEL, ECN, NERC(EDI)). Aerosols play an important and not fully understood indirect effect on plant productivity by affecting the radio between direct and diffuse radiation. It has been shown that diffuse radiation stimulates photosynthesis by enhancing the canopy light use efficiency. The apparent increase in light use efficiency can be ascribed to a change in the distribution of light on the leaf area and/or to variation in the fraction of absorbed PAR (FaPAR).
- In order to address this important issue in WP 1 we will perform consistent measurement of FaPAR at forest sites and analyze the variation in light use efficiency induced by changes in aerosol load and fraction of diffuse light. This analysis will also draw on existing sun photometer measurements and ground-based aerosol characterisation at Hyytiala and the Ispra Forest.

Task 1.3: Aerosol effect on GPP

nature Vol 458|23 April 2009|doi:10.1038/nature07949

LETTERS

Impact of changes in diffuse radiation on the global land carbon sink

Lina M. Mercado[1], Nicolas Bellouin[2], Stephen Sitch[2], Olivier Boucher[2], Chris Huntingford[1], Martin Wild[3] & Peter M. Cox[4]

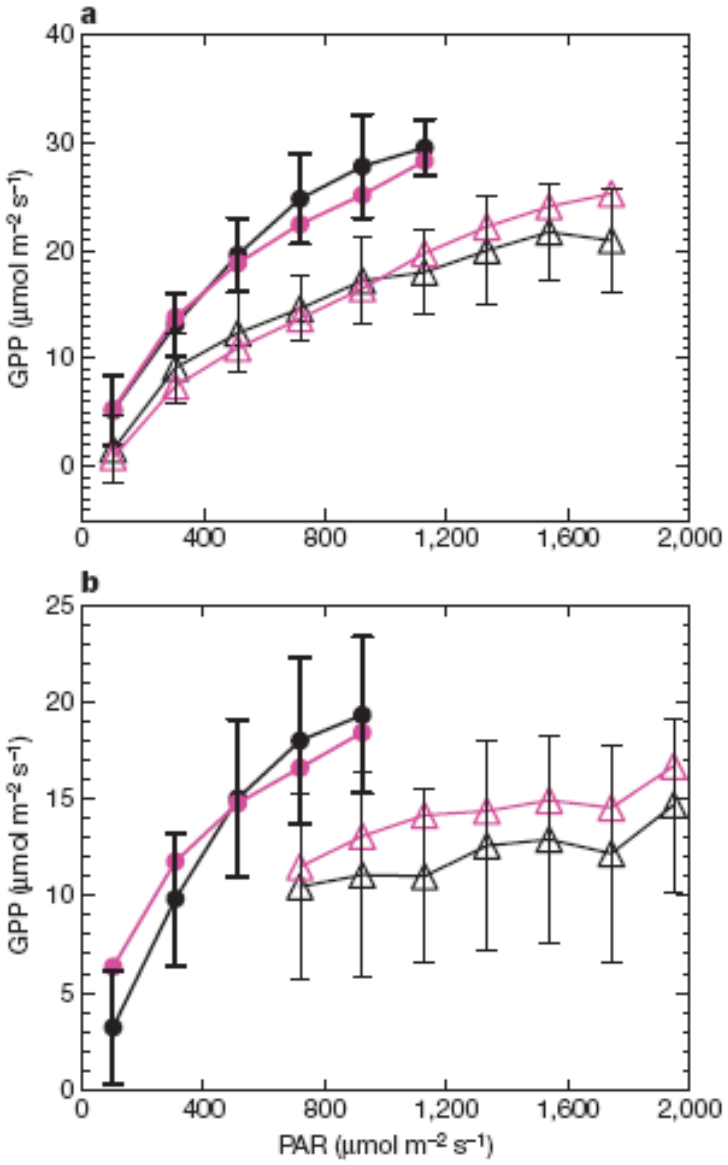


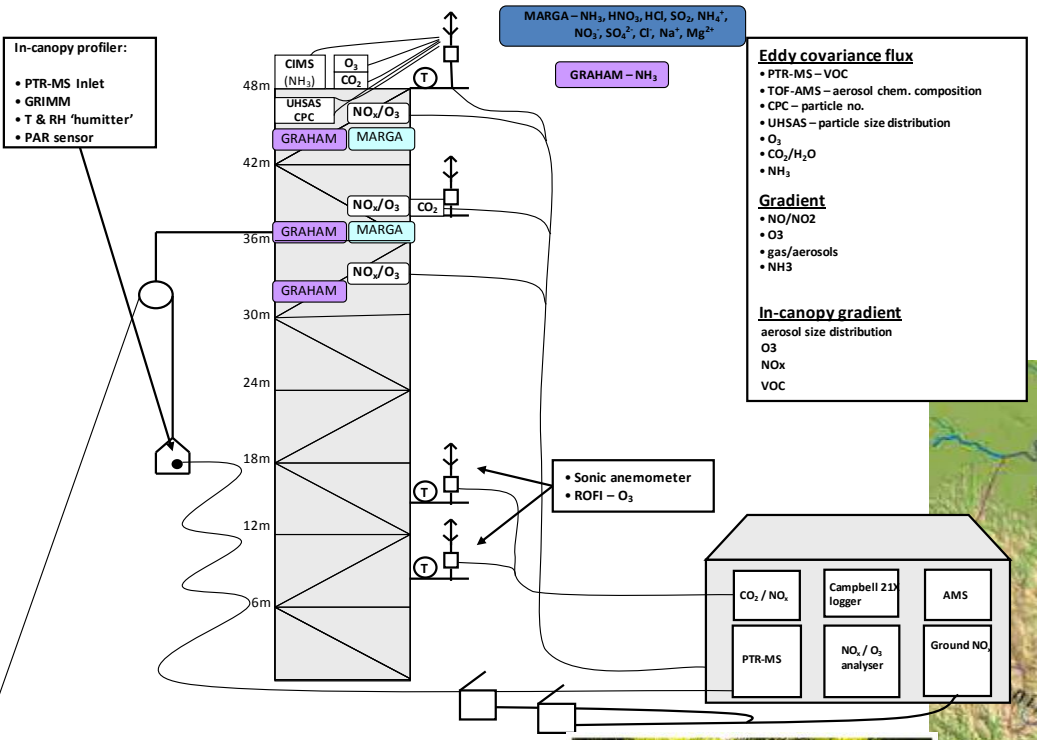
Figure 1 | JULES model evaluation against observations. Observed and modelled light response of the GPP to both direct and diffuse PAR (open triangles and filled circles, respectively) averaged over bins of 200 μmol quanta per square metre per second: **a**, broadleaf forest site; **b**, needleleaf forest site. For the purposes of this validation, data points are split into 'diffuse' and 'direct' conditions, using diffuse fractions of greater than 80% and less than 25% to discriminate between these two cases. Measurements inferred from eddy correlation are given in black (error bars, 1 s.d.), and simulations are given in pink (Methods).

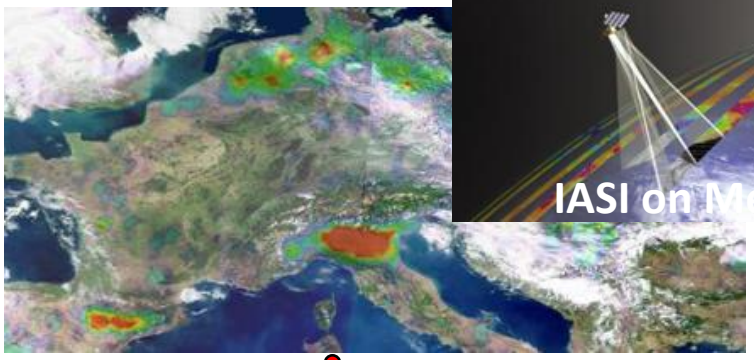
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

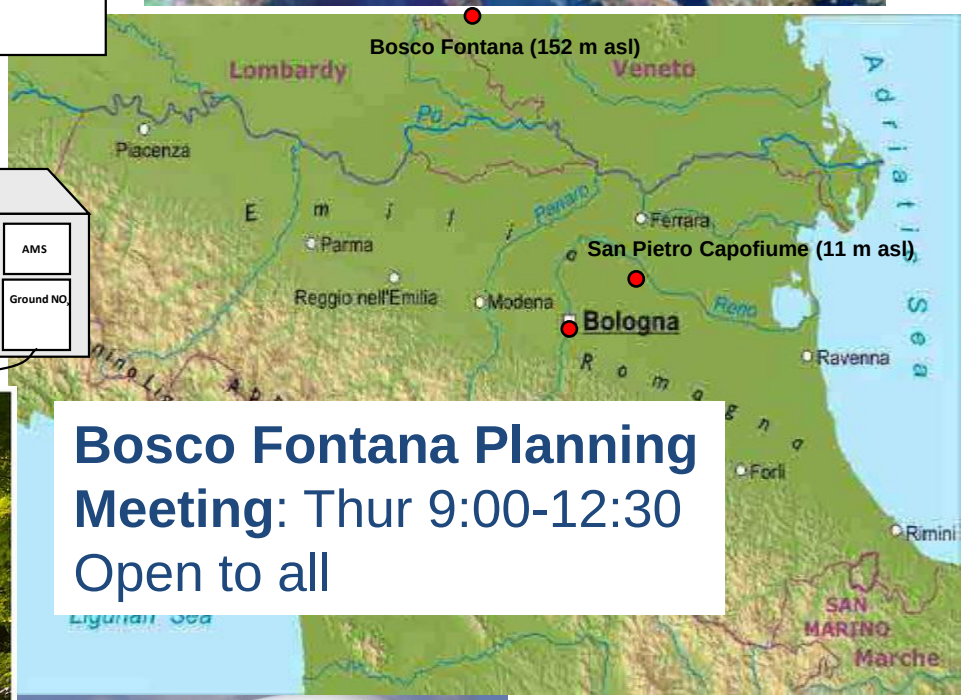
Task 1.4: Intensive Measurement Campaign

- Intensive measurement campaign (NERC(EDI) (Nemitz), UNICATT, ECN, INRA(G), KIT, ULB, CNR, UHEL, Juelich, ERTI-FRI). A 6-week (including set-up) intensive measurement campaign above a mixed oak forest at Bosco Fontana in the Po Valley, Italy in June/July 2012, will study the importance of in-canopy chemical processes on net biosphere / atmosphere exchange fluxes, with emphasis of chemistry of the NH3-HNO3-NH4NO3 and NO-NO2-O3-VOC systems. This site was chosen as it provides the possibility to study the interaction of a semi-natural ecosystem with its emissions of BVOCs in the context of a landscape with considerable emissions from agricultural and industrial emissions. The Po Valley is one of the most polluted regions in W Europe and also offers the possibility to study the effect of increased temperatures and drought and the interactions, relevant for future climate of large parts of Europe. Measurements will include:

Task 1.4: Bosco Fontana intensive measurement campaign June 2012

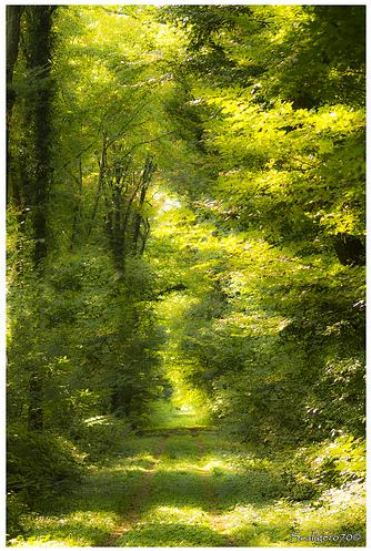






Bosco Fontana Planning Meeting: Thur 9:00-12:30
Open to all

- Flux parameterisations
  - Draught effect
  - Input to PEGASOS
- In-canopy chemical interactions
  - O_3-NO-NO_2-VOC
  - NH_3-HNO_3-$NH4NO_3$



PEGASOS
Pan-European Gas-AeroSOls-climate interaction Study

Measurements during Bosco Fontana Campaign

- above-canopy gradients of NH_3, HNO_3, HCl, SO_2, NH_4^+, NO_3^-, SO_4^{2-}, Cl^- with a wet-chemistry gradient system (ECN/NERC(EDI)),
- above-canopy fluxes of aerosol numbers and aerosol chemical components by Aerosol Mass Spectrometer (NERC(EDI)),
- above-canopy eddy-covariance fluxes of NO (INRA(G)),
- soil fluxes of NO, N_2O and CH_4 by automated chamber (KIT),
- measurements multi-height ozone fluxes by eddy-covariance (INRA(G) / NERC(EDI)),
- gradients of turbulence, temperature, relative humidity and radiation (NERC(EDI)),
- above-canopy fluxes of VOCs by PTR-ToF-MS (UHEL / Juelich / NERC(EDI))
- aerosol physics (UHEL),
- in-situ measurements of leaf-level VOC emissions responses with speciation (CNR),
- in-canopy concentration gradients of NO, NO_2, VOCs and aerosol (NERC(EDI)),
- fluxes of CO_2, H_2O and standard meteorological parameters (UNICATT).

- Earth Observation (EO) based concentration fields of NH_3, O_3, HNO_3, CO, CH_3OH and HCOOH derived from IASI/MetOp satellite data (ULB)
- weekly passive sampler measurements of NH_3, HNO_3, O_3 and NO_2 in the wider landscape, validated at the main site (NERC(EDI))

Task 1.5: Targeted NH_3 flux measurements Spain

- Targeted measurements of NH_3 exchange with Mediterranean vegetation. (UPM (Theobald), NERC(EDI)).
- There is a complete lack of understanding of NH3 exchange for Southern European vegetation and climate and therefore for those climatic conditions that will become more prevalent across Europe, with periods of high temperatures and associated drought.
- Targeted measurements of NH3 exchange will therefore be made above semi-natural vegetation (e.g., semi-natural grassland or 'matorral') in Spain, during two 4-week campaigns, contrasting the active and dormant vegetation period (spring and late summer).
- Measurements will be accompanied by measurements of CO_2/H_2O/O_3? fluxes and meteorological parameters to study the fluxes in relation to plant functioning, stomatal controls and meteorological variables.
- The work will collaborate with Spanish partners external to ÉCLAIRE (e.g., CSIC - Spanish National Research Council).

WP1 Deliverables

D1.1 First 6 months of continuous flux data of CO_2, H_2O, O_3 and meteorological variables at 9 sites: [month 18]

D1.2 Final 9 months of continuous flux data of CO_2, H_2O, O_3 and meteorological variables at 9 sites: [month 24]

D1.3 2 x 6 weeks of campaign-based fluxes of VOCs, NH_3 and NO_x at selected sites: [month 24]

D1.4 NH_3 fluxes over Mediterranean agricultural and semi-natural surfaces: [month 15]

D1.5 Integrated dataset of canopy scale flux and in-canopy gradient measurements at a forest site: [month 16]

D1.6 Four publications on integrated campaign: [month 30]