The NOPEX project, experiences and scientific results

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NOPEX is devoted to study land-surface-atmosphere interaction in northern European forest-dominated landscapes. Equal weight is put on long-term measurements and time-limited, areally extended field efforts. Data are collected both on energy (micrometeorological) and water (hydrological) balances. The two NOPEX study regions represent the southern (Uppsala, Sweden) and northern (Sodankylä, Finland) parts of the boreal zone, situated in the Baltic Sea drainage basin. NOPEX specifically aims at investigating fluxes of energy, momentum, water, and CO_2 between the soil, the vegetation and the atmosphere, between lakes and the atmosphere as well as within the soil and the atmosphere on local to regional scales ranging from centimetres to tens of kilometres.

Gottschalk *et al.* (1999) compare fluxes of sensible and latent heat over the southern NOPEX region calculated with five methods (airborne and balloon-sounding measurements, weighted mast measurements, and two models) and found rather large differences between some of them. The aircraft measurements of sensible heat fluxes were generally lower than those obtained from ground measurements whereas latent heat fluxes showed a fair agreement. Good agreement was found between all the different methods when it came to evaporation fluxes. This indicates that evaporation fluxes can be aggregated from land-use-weighted mast fluxes in this boreal-forest region. Frech & Jochum (1999) evaluated flux-aggregation methods from aircraft measurements and found different behaviour for momentum and scalar transfer. It seems as if the momentum transfer is governed by the roughest elements (the forest) whereas the sensible heat flux is determined by the predominant land-cover type in a given grid cell or aircraft run segment. The ECOMAG hydrological model was further developed as a combined prediction and assimilation tool for the southern NOPEX region (Motovilov et al., 1999) and was used as a first step towards a fully coupled hydrological-atmospheric model. Beldring et al. (1999) found that measured soil-moisture content and groundwater levels show a characteristic pattern which are closely related to the landscape elements in the region. The variability of average values between areas decreases to a minimum for catchments with size larger than 1 km^2. The main part of the spatial variability in the forest-covered till soils of the NOPEX region was found in such small catchments.

The high latitudes are snow-covered for as much as nine months of the year. The difference between open snow fields and forests is probably the largest land-surface contrast found in the terrestrial biosphere. The presence of a snow cover radically alters the surface radiation budget, changes the surface aerodynamic characteristics and insulates the ground, preventing very cold air temperatures propagating into the soil. Transpiration rates are small during winter, because of cold, often frozen soils. In spring, a substantial solar radiation input to the canopy is balanced by a substantial upward sensible heat flux (Gryning *et al.*, 2001). A comparison between surface and aircraft observations, and numerical simulations (Savijärvi & Amnell 2001, Melas *et al.* 2001, Batchvarova *et al.* 2001) showed good agreement. These studies also illustrate the high sensible heat flux from the forested areas, leading to the development of a convective atmospheric boundary layer. The importance of the snow model within a NWP model is illustrated in Savijärvi & Kauhanen (2001). Night-time air temperatures were under-predicted by between 12 and 15°C in their study and the thermal snow-surface properties appeared crucial for this. All these studies show the importance of the snow-vegetation-atmosphere interface to the atmosphere. The improvements in the parameterisations of the fluxes across this interface substantially improved the simulations of the atmospheric boundary layer and will likely lead to improved performance of NWP and climate models in high-latitude regions.

References in the abstract refer to the following three publications:

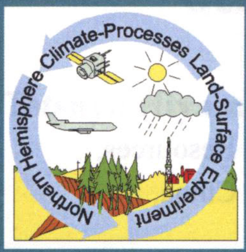
Halldin, S., Gryning, S.-E., Gottschalk, L., Jochum A. A. van de Griend., Boreal Forest and Climate, NOPEX Special Issue. *Agricultural and Forest Meteorology*. Vol. **98-99**., 1999

Halldin, S., Gryning, S.-E., Lloyd, C.R., Land-surface/atmosphere exchange in high-latitude landscapes. NOPEX/LAPP Special Issue. *Theoretical and Applied Climatology*, vol **70**, No. 1-4, 2001.

Boundary-Layer Meteorology, Vol. **99**, No. 3, 2001

The NOPEX project

Experiences and scientific results



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Geographical setting

- Mesoscale land-surface experiment in the Baltic Sea drainage basin
- Representative for the boreal-forest zone in northern Europe

Objectives

- To investigate fluxes of energy, momentum, water, and CO_2
- at scales ranging from centimetres to tens of kilometres
- in order to establish daily and annual budgets of water and energy budgets
- and to analyse and model the land-surface-atmosphere interface

Flux-aggregation conclusions

- Forests dominate regional fluxes of momentum and sensible heat, but in different ways
- Regional evaporation can be modelled as simple land-use-weighted local fluxes
- CO_2 fluxes can be accounted for by boundary-layer budgeting if free-air concentration is known

Experiences

- Longterm, unbroken measurements from representative landscapes are very valuable
- Closure of energy and water budgets require both traditional hydrological and micrometeorological/boundary-layer data
- Measurements and modelling are siamese twins, neither lives well without the other
- Be critical to models developed for other soils, vegetations, landscapes and climates

Experiences, continued

- Publication strategy and plans should be clear already at the beginning of the project
- Database strategy, incl time schedule for delivery of data and metadata, and final publication/release of data should be clear at the beginning of the project. As part of traditional publication it gives merits to the "author"