



## **Coupling Earth System Models and Earth Observation for the Northern High Latitudes**

**An ESA/AIMES Workshop**

**Frascati, Italy**

**10-12 September 2007**

<http://www.congrex.nl/07m13/>

### **Introduction**

Studies on the impacts and feedbacks in regions where rapid rates of human development trigger changes in the atmosphere or biosphere, and where rapid local and regional changes have global consequences are a central objective of the IGBP Analysis Integration and Modelling of the Earth System (AIMES) project as it seeks to understand and quantify the *interactions and feedbacks between the biogeochemical and climate systems and the consequences of human activities and decisions*. This includes coordinating and promoting research dedicated to improving Earth System Models through model development, parameterisation, testing and evaluation, with observations seen as a key contributor to this process. One of the key ‘trigger’ regions are the northern high latitudes (NHL) where there is strong palaeo-evidence that the Arctic and high-latitudes have responded dramatically to both external forcing and through internal feedbacks (vegetation, sea ice) in the past and they are known to be changing rapidly under both human pressures and the impacts of Global Change; the Arctic is predicted to warm faster and to a greater degree than any other part of the Earth. It is hypothesised that because of significant biogeochemical, hydrological and energetic feedbacks between the Earth system and the NHL, the future state of the entire Earth system will be strongly influenced by the response of the NHL to this warming. To understand further this coupling requires studies of:

1. Changes in carbon storage and sequestration – in particular the vulnerability of the vast NHL soil carbon stocks to warming-induced nutrient mineralisation, which may accelerate CO<sub>2</sub> accumulation in the atmosphere and thus act as a positive feedback on warming;
2. Changes in albedo – reductions in albedo associated with reduced snow and ice, and increased forest cover, (enhanced absorption of radiation and elevated temperatures), increased albedo associated with removal of forest canopy through disturbance (e.g., wildfire, insect) and bare (snow covered) ground. Aerosols and their effect on haze and interactions with clouds are uncertain;
3. Changes in terrestrial hydrology - the implications of altered precipitation and evaporation for permafrost dynamics (see 1. above) and ocean salinity gradients. Freshwater loading to the Arctic Ocean from river discharge is

important in controlling the thermohaline circulation through deep-water formation.

4. Changes in ocean circulation – potential changes in thermohaline circulation through surface warming, changes to the salinity gradient, altered CO<sub>2</sub> uptake and changes to ocean solubility and uptake rates which may feed back on global climate;
5. Changes in human behaviour – impacts on indigenous communities, changes in resource use, alterations in transport networks, including opening of new shipping routes.

While a large number of studies are ongoing (e.g. Ecosystem Studies of Sub-Arctic Seas (ESSAS); Global Terrestrial Network on Permafrost (GTN-P); Northern Eurasian Earth Science Partnership Initiative (NEESPI); The International Tundra Experiment (ITEX); The Circum-Arctic Environmental Observatories Network (CEON); Global Implications of Arctic Climate Processes and Feedbacks – (GLIMPSE) and the Arctic Ocean Model Intercomparison Project (AOMIP)), the objective of AIMES is to provide a coherent strategy to integrate the various process, observation and modelling studies in a global context, and to fully explore the regional-to-global interactions through a global modelling framework. This workshop will build upon recommendations and insight from an Aspen Global Change Institute held in August, 2007 that will address process and regional modelling issues in the northern Eurasian domain of the high latitudes, specifically, the Northern Eurasian Earth Science Partnership Initiative (NEESPI). The AIMES/ESA workshop will continue the momentum from the Aspen Institute with a larger international remote sensing and global modelling participation. The specific goals of the AIMES/ESA integration workshop will be to:

1. Develop close collaboration with a broad range of northern high latitude programmes and activities, and other IGBP and ESSP projects with a northern high latitude focus;
2. Use this collaboration to identify and improve representation of key northern high latitude processes in global coupled carbon cycle climate models (C<sup>4</sup>MIP models) using local-to-regional northern high latitude experimental and modelling outputs;
3. Initiate a regional/global model intercomparison with global C<sup>4</sup>MIP models to determine current uncertainties and key thresholds in Northern High Latitudes-Earth System climate-biogeochemical coupling.

While models encapsulate our understanding of the Earth's processes, their dynamic behaviour and feedbacks. Numeric models, by their very nature, consist of equations whose solution requires data for input and evaluation. Therefore, a critical need also exists for measurements of Earth surface properties from both *in situ* networks and satellites with an emphasis on the creation of time series and spatial comprehensiveness.

### **Objectives of the workshop**

The AIMES-ESA NHL integration workshop objectives are:

1. To assess the key issues in northern high latitude-global connectivity in Earth System Modelling, define the problems in understanding these issues, and build the key partnerships aimed at realising a working strategy for NHL studies.
2. To examine the state of the art in data assimilation in Earth System Modelling, with an emphasis on Earth Observation data, identify current data gaps, specifically focusing on the NHL but also including the role of external teleconnections/feedback mechanisms in influencing the NHL.
3. To highlight the wealth of ongoing activities in the various projects, networks, space agencies and within the IPY aimed at the NHL and the current, planned and required networks and satellites to fill identified data gaps.

The workshop will be structured around review presentations from keynote contributors coupled with a series of break-out sessions covering the following themes:

- a. Hydrologic Cycle
- b. Carbon Cycle
- c. Ocean Circulation/Changes in Sea-Ice
- d. Global Teleconnections – drivers and feedbacks influencing NHL response to global change and how they are modelled.

Within each of these cross-cutting themes key issues of the current and likely change in distribution and variability of permafrost, peatland, fire, biophysical variables, sea ice and sea level will be addressed as well as the impact on and of anthropogenic processes and representation of these elements within regional and global models. Each theme will be tackled by a community of modellers (DGVM to Global), process, in situ observation and remote sensing scientists.

### **Target audience**

The target audience comprises the Earth System Modelling community and specifically those individuals active in AIMES, the EO community developing products for Earth System Models and those individuals already actively participating in the Northern High Latitude Study. Key individuals in the organization of the International Polar Year should also be sought as well as researchers active in the countries directly affected (USA (Alaska), Canada, Russia and the Scandinavian countries).

### **Convenors**

Kathy Hibbard, AIMES Executive Director  
Stephen Plummer, IGBP-ESA Joint Projects Office

### **Timing**

Taking into account other conferences/meetings the meeting will take place at ESA-ESRIN in the week of 10-12<sup>th</sup> September 2007.

### **Outputs from the Meeting**

Given the format of the meeting it is intended that the outputs will be:

- a. A meeting report as a rapid communication in EOS Transactions.

- b. A strategy paper generated by the convenors and technical committee with contributions from key individuals to be published in a major scientific journal (Global Change Biology, Climatic Change, Nature).
- c. A position/strategy document for discussion/action within the IGBP and associated programmes/projects and IPY.
- d. A forum for coordinating individual activities and allowing exchange between the AIMES modelling activities, the NHL science community and those in Earth Observation which will be activated following on from the meeting.
- e. Follow-on activities dovetailing with current modelling initiatives e.g. C<sup>4</sup>MIP focusing especially on modelling processes within the NHL and teleconnections affecting those processes. These activities will have as their objective ground-breaking scientific publications.