IASC WG Atmosphere Workshop

September 26-27, 2011 at AWI Potsdam

Atmospheric Investigations on a Drifting observatory in the Arctic sea and Regional and global Climate Model simulations (AIDA-RCM)

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Motivation for planning a new field experiment similar to SHEBA with a strong focus on the atmosphere

Polar regions are key players in the climate system; they are the heat sink of the global climate system. There is a strong modification of the surface energy budget in the Arctic through snow and ice cover, tightly coupled to the global circulation of the atmosphere and the ocean. Polar regions are highly sensitive regions to global change. The climate of the Arctic is already subject to obvious changes and several feedback mechanisms including the sea-ice albedo feedback acts as amplifiers of climate change. The observed decrease of Arctic summer sea ice cover over the last decades is best viewed as a combination of strong natural variability, due to large-scale dynamics and regional feedbacks in the coupled ice-ocean-atmosphere system, and a growing radiative forcing associated with rising concentrations of atmospheric greenhouse gases and an associated gradual thinning of the sea ice over the last several decades. The attribution of ongoing changes in the Arctic is difficult because natural variability is large, potentially masking the evidence of anthropogenic influences.

Atmospheric measurements of surface energy balance, heat and moisture fluxes, cloud and aerosol properties, water vapour and ozone are essential for the understanding of key processes in the Arctic climate system. Major gaps and uncertainties exist in the knowledge and understanding of processes governing e.g. the build-up of aerosols in the Arctic and its role for climate change. Processes in polar regions connected with a variety of feedbacks, including cloud-, aerosol-, ozone-, planetary boundary layer-, and sea ice processes introduce implications on the global scale and are not well represented in current climate models.

Changes in the polar energy sink region exert a strong influence on the mid- and high-latitude climate by modulating the strength of the Arctic circulation, the atmospheric teleconnection patterns and storm tracks. Changes and variability in the wintertime Arctic sea-ice and snow cover has the potential to induce perturbations in the zonal and meridional planetary wave train from the mid-latitudes into the Arctic.

Therefore a combination of in-situ process studies over an annual cycle, long-term climate process monitoring, regional and global climate modelling is necessary to improve the insufficient understanding of the Arctic climate system that is necessary to improve the performance of regional and global models. The merging of observations and modelling dealing with complex processes operating on wide range of spatial and temporal scales, interacting with each other sometimes in very nonlinear ways is necessary especially to improve parameterisations of sub-grid scale processes.

There are major gaps over the Arctic Ocean with respect to many tropospheric processes. Important atmospheric processes, related to clouds, aerosols, planetary boundary layer, inversions, baroclinic cyclones and atmospheric teleconnection patterns contribute to the recent changes in the perennial ice cover of the Arctic Ocean. Long-term, operational ground-based observations of key Arctic atmospheric parameters are limited to land areas with only few measurements over the ocean and sea-ice in the central Arctic Basin. Coordinated atmospheric measurements in the whole vertical column are essentially missing and are needed to understand the important processes related to clouds, aerosols, precipitation, atmospheric structure, large-scale circulation, vertical exchanges of heat, moisture and momentum through the tropopause, and surface energy budget, which govern the regional Arctic climate and dictate its response to changing globally. Such measurements today exist at only a few locations in the Arctic all on land and corresponding observations over the Arctic Ocean Long time series covering the whole annual cycle are required to understand the variability inherent in these processes, particularly as they respond to major climate shifts such as a drastic decrease in sea-ice concentration and shifts in teleconnection patterns

Therefore IASC WG Atmosphere suggest that establishing a semi-permanent, manned atmospheric observatory under international leadership in the ice pack of the Arctic Ocean should be explored, with instrumentation to observe:

An preliminary list of Arctic measurements (single points and satellites) to validate sub-grid scale parameterizations and to improve the performance of RESM and GESM

Measurements	
1. Surface energy budget components **2. Sea ice thickness and ice properties** **3. Snow depths on sea ice and land** **4. Convective plumes due to leads in the sea-ice**	A-O-I inter-actions
5. Atmospheric radiative and turbulent fluxes **6. Inversions, low level jets and decoupling** **7. Planetary boundary layer structure, PBL heights**	Coupled ABLS
8. PBL feedbacks with baroclinic cyclones (Polar lows) **9. Vertical profiles of ozone and carbon dioxide** **10. Aerosol concentrations and compositions (BC)** **11. Cloud properties and vertical distribution** **12. Precipitation occurrence and type**	Feedbacks with the troposphere
13. Coupling tropo-stratosphere-mesosphere **14. Gravity wave drag** **15. …**	Feedbacks with strato- and meso-sphere

The suggested process-study observations should be supported by regional and global climate modelling efforts with a strong focus on improvements in atmospheric sub-grid scale parameterizations.

The observatory should be build consistent with existing land-based atmospheric observatories. While a multi-year observatory will provide the most information on inter-annual variability of key processes, one year is the minimal requirement for the observatory.

A longer experimental effort will also benefit innovations and technology development that may form the backbone for future autonomous atmospheric monitoring.

IASC will organise a kick-off workshop by invitation to discuss and promote the AIDA-RCM idea from September 26-27, 2011 at AWI Potsdam. The following topics will be discussed:

1. **Contribution of measurements to improve Arctic specific sub-grid scale parameterizations in RCMs and GCMs**
2. **Arctic specific sub-grid-scale parameterizations in**
   - **@ Regional atmospheric climate models,**
   - **@ Coupled regional climate models of the Arctic Climate System**
   - **@ Coupled global climate models**

3 Design of an Arctic Observatory and the requested measurements

4. Funding and Sponsors of AIDA-RCM

The focus of the workshop will be to discuss the contribution of atmospheric measurements to improve Arctic specific sub-grid scale parameterizations, to assess the current state and shortcomings of Arctic sub-grid-scale parameterizations in RCMs and GCMs, and to design an Arctic Observatory and the requested measurements including satellite data with the main aim it improve the performance of RCMs and GCMs in the Arctic.