The value of atmospheric near surface measurements with ice-tethered platforms over the Arctic ocean

Statements at Panel discussion

“Arctic Observing Based on Ice-Tethered Platforms”

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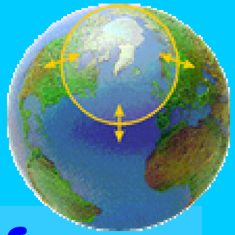
My talk:



1. **Arctic-Global climate interactions and the need for high quality atmospheric measurements in the Arctic**

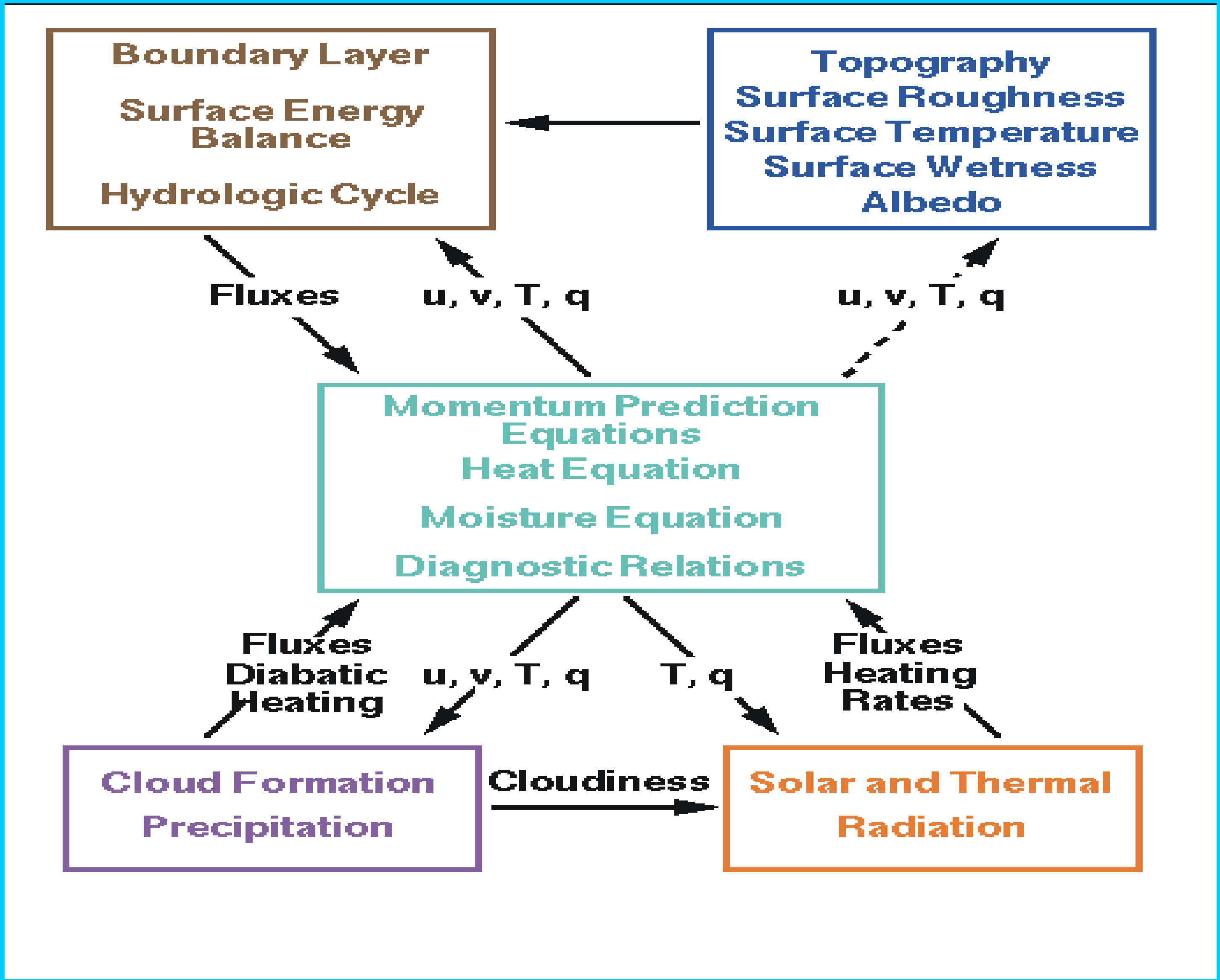
2. **Atmospheric key parameters and high-resolution modeling with the RCM HIRHAM4**

    Horizontal Structures
    Vertical Profiles
    Surface Properties
    Radiative Fluxes
    Turbulent Fluxes
    Cloud and Aerosol Properties

3. **Regional Atmosphere-Ocean-Sea-Ice-Land System of the Arctic**

    State of the coupled climate system A-O-I-L

Atmospheric measurements in accordance with model simulations, Model dynamics and physical parameterization packages



Complex exchanges of energy and water among ocean, sea ice and atmosphere cause the Arctic climate system to be particularly sensitive to climate change.

Clouds, snow and sea ice introduce a variety of feedbacks, some of which have powerfull global impacts.

Modeling studies indicate that the polar regions play an important role in governing the global climate system.

Simulations of present-day climate differ widely from each other, especially in polar latitudes.

The most probably causes for the large disagreements in polar regions are related to unrealistic parameterizations of a variety of feedbacks.

Our understanding of the interactions and feedbacks among the components of the Arctic climate system can be significantly advanced by integrating new observations of Arctic climate variables with global and regional coupled A-O-I models.

The use of different measurements,e.g. field campaigns, like SHEBA or satellite sounders can be used to improve the accuracy of the models by evaluating the realism of their output, analysing feedback mechanisms and relationships among climate variables.

We compared in the Arctic RCM Intercomparison project study for the SHEBA year relationships among climate variables in the Arctic, like SLP, geopotential, temperature, radiative and turbulent fluxes, cloud cover etc.

There is a reasonable representation of the annual cycle and selected climate variables with major shortcomings in the PBL and the near surface.

This study makes a step forward to understand the feedbacks operating in the Arctic, which are believed to make this region sensitive to climate change.

The applicability of these results to other polar environments remains to be demonstrated.

The Arctic ocean is a data sparse area for which long-term, basin-wide, comprehensive and accurate data sets are not available at present.

The relationships and feedbacks between climate variables are not fixed over time and space; ratio of thermal and dynamical drivers could change (buoyancy/convection and vertical wind shear)

This establishes the request to compare the temporal evolution and spatial pattern of model relationships with the corresponding covariability in observed and measured climate variables on decadal time scales.

We can identify physically based causes for agreement and disagreement and focus on physical processes that should be more carefully investigated, e.g. surface fluxes in the stable PBL, albedo-radiation-low cloud feedbacks.

Need for increasing the vertical resolution of the PBL, so that the models should have their lowest layer at ca. 20 m in the surface layer.

Comparison of 3 hourly resolved surface variables, 2m temperature, 2m specific humidity, 10 m wind speed, sensible heat flux at 2 m level, radiative fluxes, cloud cover, daily precipitation, weekly snow depth measurements, monthly (P-E).

RCMs with high horizontal resolutions describe well the synoptic-scale atmospheric motion systems during SHEBA.

The SHEBA measurements provided a detailed look at Arctic cloud and boundary layer development throughout a full Arctic year and provided a opportunity to test aspects of the physical parameterization schemes in different models under same boundary conditions.

The ice-tethered platform study covering the whole Arctic ocean on decadal time scales would lead to a strongly improved understanding of the Arctic climate system.

The parameterization schemes tested in the RCMs environment will be implemented into global AOGCMs to verify their global impact, e. g. albedo, aerosols, vertical decoupling of the surface layer and the free troposphere following inversions.

Added value of a RCM compared with a GCM

Reduction of mean bias
Better spatial variability
More realistic variance
Better tail behaviour (i.e., extremes)
Ensemble integrations approach (nonlinearities and regime shifts)

Importance of synoptic-scale atmospheric dynamical processes in simulating strong regional variability of sea ice cover

Arctic specific parameterizations: surface albedo, turbulent and radiative fluxes, clouds, inversions, stratification, coupling of PBL with synoptic-scale atmospheric circulation.

Comparisons with radiosondes: give deficits of PBL, but not the reasons.

Complete comparisons are necessary: including turbulent and radiative fluxes, low clouds, upward and downward spikes of sensible heat fluxes, switch of PBL behaviour from stable to convectively unstable conditions as function of surface properties (leads in ice) → ITP measurements.

Measurements over the Arctic ocean; data sparse region.

RCM with high horizontal and vertical resolution as environment for testing and improving parameterization schemes.

→ near surface and PBL contains the highest bias.
→ parameterization schemes should be compatible between RCM and AOGCM.

Implementation of validated and improved PBL schemes into a global AOGCM.

Global impact of improved description of Arctic climate processes.

Understanding the physical processes that determine the Arctic surface heat, humidity and momentum fluxes.

Measurements of surface energy fluxes on time scales relevant for climate time scales and climate modeling; multi-year to decades.

Measurements not only at one ice camp, but troughout the whole Arctic basin.

Comparison of measurements against RCM output for the pan-Arctic domain.
→ Key region approach; Siberian coast?

Strategy: Integration of measurements and high resolution models

Measurements to improve key processes and their parameterizations.
→time scales 1 hour to seasons, several years, decades.
→ spatial scales 10 km (ice), atmosphere(500km), Arctic basin wide.
→ special emphasis on annual cycle.
→ local point measurements with ITP and area-aggregated measurements with the help of satellite data.

Area-aggregated measurements are designed to document the thermodynamic and dynamical state of the A-O-I system on a horizontal scale that may be compared to a RCM grid cell (50km).

What is the variability of radiative and turbulent properties of the atmosphere on climatically relevant time and space scales?

Radiative processes, turbulent PBL state, surface properties and hydrological cycle impact on cloud feedbacks that regulate climate.

Vertical wind shear and wind stress → vertical momentum flux .
Buoyancy/Convection → vertical sensible and latent heat fluxes.