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Observing Networks for Arctic Climate and Weather

The design of an Arctic observing network depends on the intended application and is challenging to define for the diverse uses anticipated from the Arctic community. To illustrate this issue, a survey will be presented of a sampling of climate and weather phenomena (e.g., climate modes of variability; cloud coverage and characteristics; precipitation amount, frequency and phase; synoptic-scale weather events; polar lows; etc.) along with a qualitative assessment as to whether contemporary observing systems can monitor these features or whether plausible additions can be implemented to achieve these goals.

In addition, consideration will be extended to the sea ice cover in the Arctic Ocean, the ice-free ocean conditions, and the land surface features in the basins of the northward flowing rivers that empty in the Arctic Ocean. All these surfaces act as the lower boundary condition for the "Arctic" atmosphere.

In thinking about these issues, three aspects must be carefully coordinated. Remote sensing observations from polar orbiting satellites are the only feasible approach for observing many Arctic phenomena. However, many features cannot be measured from space so physically-based models are needed to provide a comprehensive picture of the components of the Arctic system. In situ observations are essential for testing and constraining both remote sensing and modeling results.

A synthesis of these approaches can be achieved through a regional reanalysis of the coupled atmosphere, ocean, sea ice, and land components of the Arctic, with the intent of monitoring and understanding the interactive Arctic physical system. Plans for and progress toward implementing the Arctic System Reanalysis will be described, with particular emphasis on assimilation of the voluminous satellite data. For monitoring applications near-real-time reanalysis output will be needed. The challenges will be outlined as to the timely needs for centralized data collection, quality control and reanalysis. Extensive consultations will be needed as to the output data forms and levels of specificity to maximize the usefulness to the broad Arctic community. Close coordination between the atmospheric and oceanic components is also required for the reanalysis to achieve the best results.

The reanalysis framework provides a basis for testing Arctic observing networks at least for particular atmospheric phenomena. Observing system experiments (OSEs) can be formulated that test the usefulness of existing observations and identify potentially critical new data. Advanced tools are now available (e.g., data assimilation diagnostics, adjoint sensitivities, ensembles, state-of-the-art data assimilation approaches (4D-Var, EnKF)) to perform more intelligent OSEs than simple data denial experiments. Substantial development of this concept will be needed to apply it in the coupled model environment.