Multidisciplinary Drifting Observatory for the Study of Arctic Climate

Warming rates in the Arctic are exceeding twice the global average, but these observations are not well reproduced in earth system models. For example, models are largely underestimating the fast retreat of arctic sea ice. Many atmospheric processes in the Arctic are poorly represented in models because of a lack of year-round observations in the central Arctic.

The **Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC)** field campaign has been developed in response to these challenges. It consists of:

- an intensive, icebreaker-based observatory that will freeze in, and drift with, the arctic sea ice for a full annual cycle while making interdisciplinary measurements in the atmosphere, sea ice, upper ocean, and biosphere
- a distributed network of autonomous measurements to characterize spatial variability on model grid-box scales
- coordinated multiscale analysis and modeling activities.

The Atmospheric Radiation Measurement (ARM) user facility, a U.S. Department of Energy (DOE) scientific user facility, will play a critical role in this initiative by providing a comprehensive instrument suite to characterize the atmosphere and its interactions with the sea-ice surface. ARM will deploy its second mobile facility, along with advanced instrumentation to obtain physical and chemical properties of aerosols (tiny particles in the air). These instruments will be within the MOSAiC central observatory as it drifts through the central Arctic for a 13-month campaign starting in September 2019. The drift will begin from the northern Laptev Sea, a marginal sea of the Arctic Ocean off the northern coast of Siberia.

Science Objectives

Sea ice is an integrator of energy fluxes in the coupled arctic system; thus, atmosphere-ice-ocean processes influencing the flow of energy through this system in all seasons are the primary target of MOSAiC. The broader, collaborative MOSAiC initiative will allow for many interdisciplinary

studies along this theme. ARM's involvement will target specific areas related to the atmosphere and atmosphere-surface interactions that are critically under-observed in the Arctic, are leading contributors to model uncertainties in the region, and are important to DOE research and modeling programs.

The guiding science themes for ARM's participation in MOSAiC include:

- surface energy budget of young sea ice
- the spatial organization and properties of clouds and precipitation
- aerosol properties over an annual cycle
- atmospheric boundary layer, stratification, and vertical mixing processes.

Many fundamental issues concerning these themes are lacking in observational constraints, particularly in the arctic winter and through consecutive seasons. The proposed ARM observations will ultimately have a dramatic effect on the arctic research community and its ability to represent coupled arctic processes in numerical models. The results of MOSAiC will help enhance understanding of the regional and global consequences of arctic warming and sea-ice loss, and improve weather and earth system predictions.

Research Instrumentation

This campaign uses the observatory known as the second ARM Mobile Facility, operating 24 hours a day, seven days a week. Onsite technicians monitor and maintain approximately 50 instruments to ensure that the best and most complete data set is acquired.

Key instruments include vertically pointing Ka- and W-band radars, along with a scanning dual-frequency X- and Ka-band radar to measure properties of cloud and precipitation particles. Depolarization lidars will monitor elevated aerosol layers and thin clouds. A radar wind profiler will measure vertical wind profiles, while an infrared spectral radiometer, a microwave radiometer, and radiosondes (weather balloons) will combine to provide continuous information on atmospheric thermodynamic structure, water vapor, and cloud liquid water path. Various gauges and disdrometers will collectively measure precipitation, while radiometers and an eddy correlation system will measure surface radiative and turbulent heat fluxes. A suite of aerosol instrumentation will be used to collect measurements of aerosol radiative properties, composition, size distribution, and cloud activity, as well as information on key trace gases.

Using an ARM Mobile Facility (AMF). Mobile facility deployments are determined through a user proposal process. An AMF can be deployed for stand-alone campaigns or for collaboration with interagency experiments. Scientists interested in using an AMF are encouraged to submit proposals at the following web page: ***www.arm.gov/research/campaign-proposal***.

Collaborations

MOSAiC has been designed by an international consortium of leading polar research institutions, under the umbrella of the International Arctic Science Committee, and is led by the Alfred Wegener Institute's Helmholtz Centre for Polar and Marine Research (Germany), the Arctic and Antarctic Research Institute (Russia), and the University of Colorado's Cooperative Institute for Research in Environmental Sciences. Participants from at least 20 nations will support broad, high-impact research.

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Additional information is available on the ARM website at www.arm.gov.