MOSAiC

The Multidisciplinary drifting Observatory for the Study of Arctic Climate

http://www.mosaic-expedition.org

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Areas of contribution

Polar atmospheric processes

Oceanic processes

Modelling and forecasting

Education

Observations

Sea ice processes

Data assimilation

Summary

MOSAiC will be focused on obtaining a full year of coupled atmosphere, ice, ocean, and ecosystem measurements from a drifting station in the central Arctic sea ice.

Description

Multi-year, detailed, and comprehensive measurements, extending from the atmosphere through the sea-ice and into the ocean of the central Arctic Basin are needed to improve our understanding and modeling of the changing Arctic climate and weather, and enhance Arctic sea-ice predictive capabilities. The Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) initiative aims to address this fundamental need through cross-cutting, observational and modeling activities. The program is organized around the central science question: “What are the causes and consequences of an evolving and diminished Arctic sea ice cover?” Using sea-ice as a central theme, scientific emphasis will focus on coupled-system processes that transfer heat, moisture, density, momentum, and nutrients through the central Arctic climate system.

To address the science objectives, the program will include three coordinated components.
1) A manned, ship-based central observatory that drifts for a full annual cycle with the central Arctic sea ice. This observatory will be a base for an intensive observational component designed to provide an interdisciplinary, process-level understanding of coupled atmosphere, sea-ice, ocean, and biological processes that are leading to, and responding to, drastic changes in the sea-ice. This central observatory will be installed in the newly forming sea ice in the northern East Siberian Sea in autumn of 2019 and will drift along the "transpolar drift" for a full annual cycle. The Polarstern icebreaker has been provided to serve as this drifting observatory.
2) Information on spatial variability and heterogeneity of key inter-disciplinary processes on model grid-box scales will be obtained using a coordinated network of distributed measurements around the central observatory from buoys, unmanned aerial systems, and autonomous underwater vehicles. Additionally long-range context will be provided by coordinated measurements from additional ships, aircraft, and satellites as available. These spatial measurements are being specifically designed via interaction with the YOPP community and other modeling communities in order to provide information at spatial scales that is appropriate for numerous modeling applications.
3) A hierarchy of analysis, modeling, and synthesis activities will capitalize on these observations to study detailed climate processes, evaluate and improve model parameterizations, facilitate regional model intercomparisons, and elucidate the impacts of Arctic processes on hemispheric circulation patterns. Important links will be maintained with the YOPP community to facilitate broader engagement on this element and to ensure the efficient and effective integration of MOSAiC information into YOPP activities.

MOSAiC has a few distinctive features that are worth mentioning. First, MOSAiC has been established from the beginning based on a dialog between observing and modeling communities. The scientific foci and the measurement design is targeted to provide the information needed to improve model representation of the central Arctic system. One important aspect is this is the coupled system design wherein coupled processes will be characterized. One major objective of the modeling community, and of the YOPP, is to support the development of operational coupled system models. MOSAiC will provide crucial observational information for evaluating, constraining, and developing coupled models. Additionally, the full annual cycle aspect of MOSAiC is particularly captivating as it will offer insight into how processes unfold over continuous seasons. Many processes, such as the sea ice mass budget, are dependent on inter-seasonal processes that require continuity. A full year of observations will also offer unique insights into many aspects of the system that have been largely lacking in the central Arctic, particularly in winter, including clouds, aerosols, biological activity, atmospheric and ocean boundary layer processes, and others.

MOSAiC is an international effort that has largely been coordinated via the International Arctic Science Committee. It will be supported by many different nations and agencies and will entail a great deal of international coordination. There are still many uncertainties about MOSAiC and many details that are still to be

determined. One important motivator for MOSAiC is the YOPP and the numerous international activities that will be occurring on that time frame. It is a primary objective of MOSAiC to coordinate with other YOPP activities to the fullest extend possible.

Timeline

2019-09-01 - 2020-10-25

Regional emphasis

Northern hemisphere: Yes

Southern hemisphere: No

Key project deliverables

The project will provide a vast array of observational data that targets coupled system processes in the sea-ice environment of the central Arctic Ocean. While most observations will be designed to characterize coupled system processes, a brief overview is provided here that outlines the basic types of data products that will be provided along disciplinary lines.

Atmosphere: Continuous vertical tropospheric thermodynamic and dynamic structure; Periodic spatial atmospheric thermodynamic and dynamic structure; Continuous vertical profiles of cloud properties; Periodic spatial distribution of cloud properties; Continuous near-surface aerosol properties; Periodic spatial and vertical aerosol properties; Continuous surface energy budget terms (radiation, turbulence, conductivity) at multiple stations; Continuous trace gas measurements;

Sea-ice: Continuous thermodynamic ice structure at multiple sites; Continuous ice thickness and mass measurements at multiple sites; Periodic spatial mapping of sea ice and surface type distribution; Continuous transmitted radiation at multiple sites; Periodic ice crystal morphology measurements; Periodic surface albedo surveys; Periodic ice top and bottom surface roughness characterization;

Ocean: Continuous upper-ocean and deeper-ocean state profiling at multiple locations; Continuous and periodic spacial ocean state measurements; Continuous upper-ocean current and turbulence measurements and multiple locations; Continuous vertical heat flux measurements to bottom of ice at multiple locations;

Biogeochemistry and Ecosystem: Continuous mass budget of organic and inorganic carbon, methane, macro- and micronutrients; Continuous assessment of primary productivity; Periodic spatial samples of upper ocean and sea ice BGC properties; Periodic sampling of bacteria, phhytoplankton, proto- and mesozooplankton;

Data management

Many of these details regarding data management for MOSAiC are still to be determined. PANGAEA has been discussed as one possibility. Many of the atmospheric measurements are funded by the US Department of Energy's Atmospheric Radiation Measurement Program and will be archive at their open public archive (www.archive.arm.gov). Due to the international nature of MOSAiC, the numerous participants, and the desire to link strongly with YOPP, MOSAiC will have a data policy that encourages open sharing and access to data as soon as possible after they are collected and quality controlled.

Is data provided to WMO Global Telecommunication System

No

Real-time provision

Real-time access to data will be limited by the connectivity available on the Polarstern. Priority for real-time distribution of data from the site will be for those data sets (such as atmospheric radiosonde profiles) that are useful for assimilation into operational models and for real-time evaluation of models. Appropriate data will be distributed via the GTS and potentially other means. These activities will be coordinated with YOPP leaders and projects to ensure an effective collaborative environment.

Other information

Regarding time lines:
In coordination with the MOSAiC year-long drift there will likely be numerous intensive observing periods focused on specific processes such as the spring melt and autumn freeze.

There is still a great deal of funding that must be secured to make MOSAiC happen. Specifically, support is needed for re-supply of the Polarstern and for a number of specific scientific modules. Numerous applicable proposals have either been submitted or will be submitted within the coming year.

Timelines

Location	Latitude	Longitude	Start date	End date	Activity
Central Arctic Ocean	-	-	2019-09-01	2020-10-25	Drifting field station along the Transpolar drift in the central Arctic Ocean. This will involve routine and continuous observations of coupled system processes.