Broad Objectives, Science Questions, and Justification for MOSAiC

The proposed Multi-disciplinary Drifting Observatory for the Study of the Arctic Climate (MOSAiC) initiative would deploy a multi-disciplinary, international, manned drifting station in the Arctic sea-ice for at least 1-2 years to obtain detailed needed climate-related observations that are not currently available. The drifting observatory will provide observations addressing key processes and structures in several disciplines involved in the Arctic sea-ice environment, and issues regarding the interactions between these disciplines. Some of the overarching science questions include: What are the physical causes of the observed decrease in Arctic sea ice? What is the relative importance of the advective export of sea ice from the Arctic Basin compared to thermodynamic melting? What are the relative roles of atmospheric and oceanic energy fluxes to thermodynamic melting? What are the key atmospheric, cryospheric, and oceanic processes contributing to the advective export and thermodynamic melting, and what changes have been occurring in these processes? What are the key elements in the air-ice-ocean interactions for the "New Arctic", which has much greater first-year ice and less multi-year ice compared to previously? What processes within the three primary disciplines are poorly known and thereby limit our understanding and modeling of the Arctic sea-ice environment? How do these interactions affect the regional and global weather and climate? How do they affect the Arctic ecosystems over sea ice and on the surrounding land? How do they affect human activity in the Arctic? Are there features that are currently poorly documented but which may be of importance, such as atmospheric storm tracks or oceanic currents? Each of these overarching questions encompass many specific science questions, such as ones related to Arctic clouds, sea-ice albedo evolution, and oceanic heat fluxes through the stable halocline.

The need for detailed observations of atmospheric, cryospheric, oceanographic and biological processes and interactions in the central Arctic sea-ice environment is particularly significant. This environment is unique and cannot be sufficiently characterized by land-based or remote observations. Moreover, climate change is particularly evident in the Arctic and there are very few process-quality observations obtained within the central Arctic sea-ice. Our general lack of process-level understanding

of the central Arctic has important implications on regional and global modeling communities, since Arctic physical processes have both regional and global impacts. The need for process validations and improved parameterizations, specifically in the central Arctic, is great. Beyond helping improve modeling capabilities, the proposed drifting observatory will provide an opportunity to collect high-quality data that can be used to improve satellite remote sensing techniques, which face serious difficulties in the Arctic environment. Further, the observatory will serve as a testbed for developing automated technologies for long-term Arctic observations and for assessing the impact of high-quality Arctic Ocean synoptic data for operational weather forecasting. Finally, as climate change continues to lead to increased human activity in the Arctic, measurements and enhanced understanding of shorter-term cryospheric, atmospheric, and oceanographic processes are crucial for providing reliable operational weather and sea-ice forecasts and effective emergency responses. Hence, the drifting observatory will benefit climate and weather research, as well as having direct impacts on human societies.