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Tracking and responding to a changing Arctic sea-ice cover: How ice users can help the scientific community design better observing systems (Louis Agassiz Medal Lecture)

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The Arctic sea-ice cover is undergoing a major transformation, with substantial reductions in summer ice extent reflecting changes in ice thickness, age, and circulation. These changes are impacting Arctic ecosystems and a range of human activities. Anticipating and responding to such impacts, exacerbated by increasing economic activity in parts of the Arctic, requires a foundation of environmental observations and model predictions. Recent increases in industrial activities such as shipping and resource development in parts of the Arctic have further highlighted the need for an integrated observing system. In the case of a changing sea-ice cover, how would one best design and optimize such a system? One of the challenges is to meet the information needs of the scientific community in furthering fundamental understanding of the Arctic system, as well as those of key stakeholders and society, helping them to prepare for and respond to Arctic change.

This presentation focuses on how the concept of sea-ice system services, i.e. the uses and benefits (or harm) derived from sea ice, may help guide the implementation of an effective observing system. Principal service categories are (1) sea ice as climate regulator, marine hazard, and coastal buffer; (2) transportation and use of ice as a platform; (3) cultural services obtained from the "icescape"; and (4) support of food webs and biological diversity by sea ice. An analysis of the different ice services provided to different user groups can help prioritize different types of observations and determine optimal measurement strategies. Moreover, the focus on different uses of the ice cover may also help synthesize fundamental and applied research to help Arctic communities adapt in a changing environment.

Alaska has experienced some of the most substantial changes in sea-ice conditions throughout the Arctic over the past three decades and is used to illustrate the concepts discussed above. Specifically, we have examined use of sea ice as a platform for travel, hunting and resource development. Observations of variables (such as ice thickness and morphology) that constrain such use can help in developing models and forecasts of ice stability which in turn are of potential value to ice users. As discussed for a seasonal ice break-up forecast, the demands with respect to the spatial and temporal resolution of data and forecast products for such applied cases is not always met by existing data sets and can help guide design and optimization of future observing systems.