Input to IARPC Arctic Research Plan 2022-2026

IARPC Guidelines for Contribution

From: The Sea Ice Prediction Network—Phase 2 (SIPN2) Leadership Team

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SIPN2 Key Collaborators: Cecilia Bitz, Elizabeth Hunke, Thomas Jung, François Massonnet, Walt Meier ,and James Overland.

Recommended Research Goal: Improve Arctic prediction to support daily-to-annual weather- and climate-sensitive decisions.

Description: The SIPN2 leadership team lays out a framework that will improve prediction across the Arctic system, and builds upon successful outcomes from SIPN activities over the last 15 years. We propose an IARPC research goal on prediction, organized via a coordinated network of prediction networks. These linked networks consist of groups, projects, and individuals working on predicting Arctic variables across the cryosphere, atmosphere, ocean, ecosystem, and socio-economic systems.

The research goal would focus on subseasonal (1-6 weeks) to seasonal-to-interannual timescales to align with current knowledge gaps and research activity. These predictions must be placed in the context of long-term (decadal to century) climate change.

A network of networks (i.e., bringing together networks on focal topics such as sea ice, atmosphere, ocean, vegetation, socio-economic systems, and permafrost) including a research infrastructure component (e.g., data storage and management, field equipment and logistics) would provide a framework to: share information on how to improve predictions, develop community prediction exercises, prioritize key variables that are important to decision-makers across Arctic domains, and communicate with current and potential future user groups to better define information needs. The resilience of the socio-ecological system (including resources and environmental services upon which humans depend) under consideration would be increased given that the research goal provides usable information for decision support at daily-to-annual time scales.

Rationale: Improved prediction contributes to knowledge of the Arctic system and processes, which can then guide priorities for observations. Predictions also bring relevant research to decision-makers and stakeholders for adaptation and mitigation strategies as well as information needs associated with operations and emergency response. IARPC is well positioned through its ability to coordinate across agencies to advance the science of prediction, as prediction efforts are now siloed by discipline and scattered across funding

agencies and programs. This would be achieved by connecting across the Arctic system components while preserving the strengths of the focal networks that have existing links to their respective scientific community and decision makers. A cross-cutting prediction goal would gather experts from multiple disciplines, sectors, and perspectives (e.g., storm/precipitation prediction is Arctic-relevant for sea ice and also stakeholders; ocean/sea-ice processes are relevant for seasonal-to-interannual variability and permafrost active layer and permafrost hydrology; etc.) to create an interconnected network (**Figure 1**). This network meets the goals of research and key mission-driven agencies.

Example/Possible Activities: Agency-specific programs that would fit with this network include: SAON; Global Cryosphere Watch; WMOs seasonal prediction activity *S2S Prediction Ocean Subproject*[1], permafrost carbon network, and others. One unique aspect of SIPN is the bringing together of a broadly-defined community to a joint prediction activity (in this case, the Sea Ice Outlook), which has helped understanding prediction and also strengthened connections across the network. To advance seasonal sea-ice prediction, improved predictions for the atmosphere, ocean and land are needed because of the strong inter-relationships. Sharing understanding between the focus networks would help to advance prediction in all networks. Potential topics or prediction activities for which increased networking holds promise include:

- Explore increases in predictive skill through synthesis of S2S predictions, long-lead forecasts issued by the NOAA Climate Prediction Center, and predictions of northern hemisphere sea-ice cover by top-performing contributors to SIPN2.
- Develop measures of success for quantifying predictive skill improvements.
- Explore new additional variables/products that are user-inspired (e.g., sea ice thickness, sea ice velocity, storminess, precipitation, etc.)
- Improvement of fisheries and marine resource predictions relevant to e.g., NOAA, USFWS, BOEM through integration of model output from terrestrial, hydrological, and land surface, and coupled ice-ocean models.
- Development of harmful algal bloom forecasts drawing on predictions of key physical and biogeochemical predictors.
- Develop glossary of decision-maker needs (e.g, lead time, time of year, and accuracy/quality required of forecasts).
- Understand the process of decision making and how it uses probabilistic guidance.
- Consider how predicted changes in physical and biological systems may impact human activities in the Arctic and beyond.

[1] This is part of the S2S Prediction project which is coordinated by the World Meteorological Organization http://s2sprediction.net/.

Potential Outcomes:

- Improved understanding of Arctic change processes across scientific domains.
- A structure that facilitates an iterative process between a diverse group of researchers and stakeholders, to co-develop and share usable prediction products.
- Current users of existing prediction products benefit from increased prediction skill brought about by integrating processes and prediction system components that cut across different domains (e.g., improving snowfall prediction improves permafrost hydrology and sea ice prediction products at up to seasonal scales)
- Newly conceived prediction products link to information needs by newly identified user groups (e.g., prediction of the state of vegetation relevant from a food security perspective)
- Agencies develop cross-cutting capacity and collaborate on compound predictions (e.g., relevant to fire weather, food security, terrestrial or marine hazards)

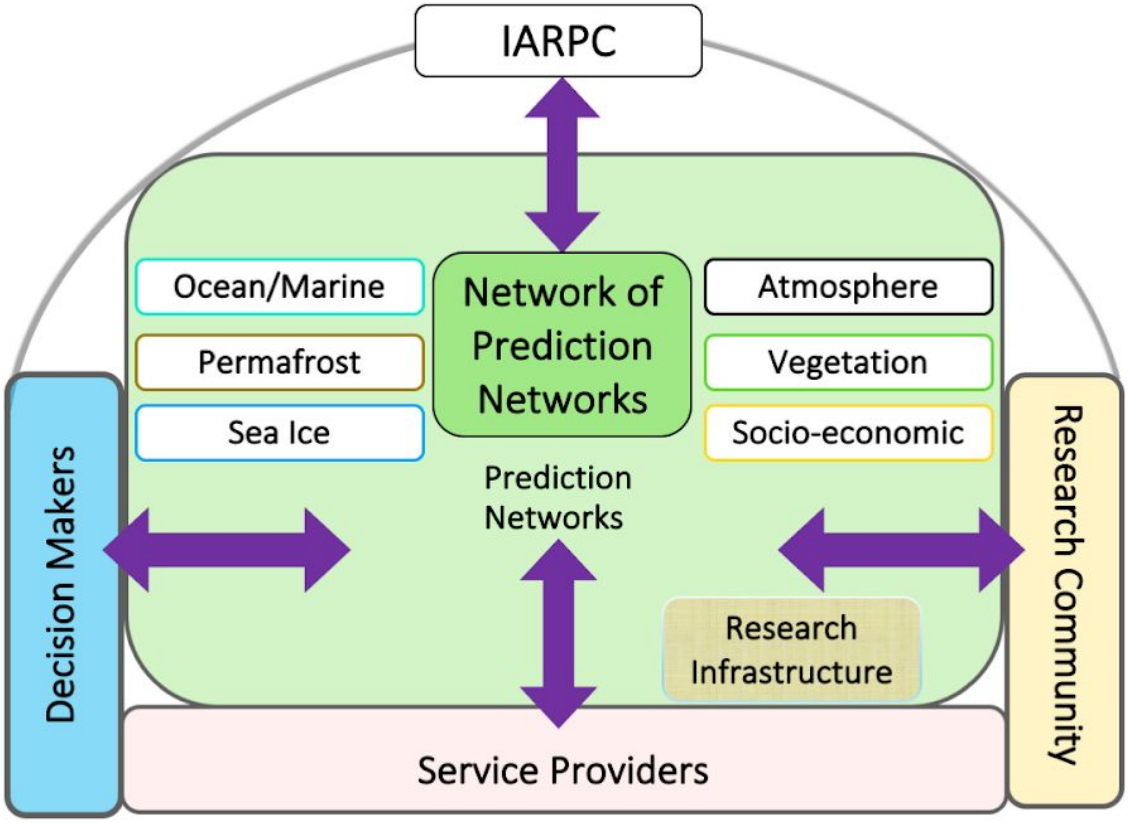

Figure 1. Visual of how coordination through a network of networks could operate. "Decision Makers" refers to both current information product users, such as the Bering Sea fishing industry or federal agencies such as the Bureau of Ocean Energy Management, as well as broader communities, including potential future users whose needs (and specific requirements of prediction products) have not been clearly defined yet. "Research Community" refers broadly to groups and individuals whose research can inform prediction. "Service Providers" refers to groups that are tasked with providing information for decision support (e.g., National Weather Service). Importantly, in order to improve prediction system forecast skill, social scientists and economists are needed to help identify the information needs of key potential user groups. A robust research infrastructure (e.g., data storage and management, field equipment and logistics) is also needed to support related investigations and analysis, and the broader relevance of information produced.

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