

Moving Sea Ice Prediction Forward via Community Intercomparison

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First Sea Ice Outlook Contributors' Workshop

What: Participants met to discuss how to support and improve seasonal sea ice prediction via the annual Sea Ice Outlook (SIO), an international activity organized each year by the multiagency-sponsored Sea Ice Prediction Network—Phase 2 (SIPN2).

When: 21–22 January 2021

Where: Virtual

KEYWORDS: Arctic; Sea ice; Seasonal forecasting

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The Sea Ice Prediction Network—Phase 2 (SIPN2) is a multiagency international effort to compare seasonal sea ice prediction methods and results at pan-Arctic, pan-Antarctic, and regional spatial scales using a multidisciplinary approach that includes modeling, data analysis, and scientific networks. SIPN2 builds on lessons learned during the first phase of the Sea Ice Prediction Network (2014–17), and since then has expanded in scope with activities that have included community seminars, workshops, and extensive research on the topic of seasonal sea ice prediction.

A central SIPN2 activity and product is a Sea Ice Outlook (SIO) developed and released for each summer month (June–August). The SIO is a vehicle for interested individuals and research groups to submit a seasonal prediction of sea ice conditions; these are then collected and categorized based on the prediction method employed: (i) dynamical modeling, (ii) statistical modeling (including machine learning), and (iii) heuristic methods. Predictions of pan-Arctic September mean sea ice extent (SIE) are requested on three dates: 1 May, 1 June, and 1 July. (SIE is defined as the summed area of all model grid cells with a sea ice concentration of at least 15%. September represents the end of the ice melt season when SIE is at its seasonal minimum.) SIO predictions are typically validated using SIE derived from the satellite passive microwave brightness temperature record that extends from late 1978 to the present. While Arctic SIE has trended downward over the period of satellite observations in all months (and most strongly in September), extent at both the pan-Arctic and regional scales is highly variable from year to year.

Work under SIPN is relevant to understanding both the trends and variability of sea ice parameters. Regional-scale variability is of particular interest to a variety of stakeholders, including indigenous communities, fisheries, shipping, and national security interests. More recently, the scope of SIPN has expanded to include Southern Ocean seasonal sea ice prediction, where SIE is characterized by pronounced regional anomalies, strong interannual variability, and a slight positive trend at the pan-Antarctic scale. The SIO has also expanded to include the prediction of other variables such as the timing of ice retreat and advance. Several studies have analyzed SIO predictions, comparing them with observations and with predictions based on simple schemes such as persistence or linear trends (Stroeve et al. 2014; Hamilton and Stroeve 2016).

On 21–22 January 2021, the first-ever SIO Contributors Forum was held as an online workshop, hosted by the Arctic Research Consortium of the United States (ARCUS). There were 70 participants from 10 countries, including SIO contributors and the SIPN2 leadership team. Sessions were held in the morning (Pacific time) on both days, and in the evening on the first day (Pacific time) to facilitate participation with colleagues in both European and East Asian time zones. The meeting included a mix of prerecorded presentations, plenary and lightning talks, and breakout group discussions. The agenda and list of participants may be found at www.arcus.org/sipn/meetings/2021/contributors-workshop. Online presentations were not publicly posted, since this forum focused on the free exchange of ideas and information, including

work in progress and “messy results” that require further study.

Participants shared and discussed successes and challenges in Arctic and Antarctic sea ice prediction, identified future activities to improve seasonal prediction, and recommended future collaboration and networking activities.

Plenary presentations covered a broad range of topics relevant to the SIO, including an intercomparison between SIE observational products (which use different methods to convert satellite data into ice concentration), a review of the role of sea ice initial conditions (the starting point of forecasts that may include SIE but also sea

ice thickness, sea surface temperature, and other variables), potential lessons to be learned on predictability from the hurricane prediction community, a perspective from the private stakeholder sector, and a meta-analysis of the more than 1,000 predictions contributed to the SIO to date. Lightning talks provided brief updates from each SIO contributor, structured around the following questions: What method are you using? What is working well? What is not working? Are your forecasts improving? What is needed in the future to improve forecasting?

Breakout group discussion topics were guided by a summary of an SIO contributor survey that was circulated prior to the meeting. These topics included skill metrics, model validation, model intercomparison, user needs, predictability, initialization, and data assimilation.

The SIO for the 2021 Arctic sea ice melt season implemented some of the recommendations from the meeting (see sidebar). In particular, contributors were asked to submit SIE anomaly predictions, relative to their computed long-term linear trends. Additionally, a 1 September prediction was solicited. Moving forward, annual SIPN contributors’ workshops are envisioned, subject to funding.

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Key recommendations

Several key recommendations emerged from the workshop:

- Extend the number of annual pan-Arctic September mean SIE prediction dates from the current three (1 June, 1 July, 1 August) to five (adding 1 May and 1 September).
- Explore adding new metrics, including SIE anomalies and measures of ice advance timing. Specifics may benefit from a survey of contributors and users.
- Update a previous 2016 initialization experiment with a consistent ice thickness initialization, while perturbing initial states and analyzing the impact of “initialization shocks” in more detail.
- Publish a synthesis study of dynamical and statistical model forecasts approaches and skill.
- Create an SIO database to facilitate meta-analysis of predictions.

References

Hamilton, L. C., and J. Stroeve, 2016: 400 predictions: The SEARCH Sea Ice Outlook 2008–2015. *Polar Geogr.*, **39**, 274–287, <https://doi.org/10.1080/1088937X.2016.1234518>.

Stroeve, J., L. C. Hamilton, C. M. Bitz, and E. Blanchard-Wrigglesworth, 2014: Predicting September sea ice: Ensemble skill of the SEARCH Sea Ice Outlook 2008–2013. *Geophys. Res. Lett.*, **41**, 2411–2418, <https://doi.org/10.1002/2014GL059388>.