September 2022 sea ice outlook (from September 1, 2022): Pan-arctic and all Arctic regions

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<u>Prediction type</u>: Dynamic model: **P**an-Arctic **I**ce-**O**cean **M**odeling and **A**ssimilation **S**ystem (**PIOMAS**, Zhang and Rothrock, 2003), with coupled sea ice and ocean model components. The ocean model is the POP (Parallel Ocean Program) model and sea ice model is the thickness, floe size, and enthalpy distribution (TFED) model (Zhang et al., 2016). Atmospheric forcing is from the NCEP Climate Forecast System (CFS) version 2 (Saha et al., 2014) hindcast and forecast.

<u>Pan-arctic outlook</u>: The September 2022 Arctic sea ice extent predicted from September 1, 2022 is **5.00 ± 0.40 million square kilometers**.

<u>Outlook of all Arctic regions</u>: The September 2022 Arctic sea ice thickness field and ice edge location are predicted and presented with standard deviation (uncertainty) (Figure 1).

<u>Method</u>: Results were obtained from a numerical seasonal forecasting system. The forecasting system is based on a synthesis of PIOMAS, the NCEP CFS hindcast and forecast atmospheric forcing, satellite observations of ice concentration and sea surface temperature (SST), and CryoSat2 observations of sea ice thickness. The CFS forecast ranges from hours to months: there are a total of 16 CFS ensemble forecast runs every day, of which four ensemble runs go out to 9 months, three runs go out to 1 season, and nine runs go out to 45 days (*Saha et al*., 2014). These ensemble runs all create 6-hourly forecast atmospheric data that are widely accessible in real time, thus ideal for forcing PIOMAS forecasts on daily to seasonal time scales. Here we used four CFS forecast ensemble members to drive the PIOMAS ice–ocean ensemble seasonal forecasts. Ensemble mean values from these four members are considered to be the prediction. To obtain the "best possible" initial ice-ocean conditions for the forecasts, we conducted a retrospective simulation that assimilates satellite ice concentration and SST data through the end of August 2022 using the CFS hindcast forcing data. We also assimilated CryoSat2 ice thickness available up to April 2020. After that, four ensemble PIOMAS forecast runs were conducted using atmospheric forecast forcing from four CFS ensemble runs. Additional information about PIOMAS prediction can be found in Zhang et al. (2008).

<u>Uncertainty for pan-Arctic extent</u>: The uncertainty of the predicted September 2022 Arctic sea ice extent is **± 0.40 million square kilometers** and the uncertainty of the predicted ice thickness field is reflected in the ensemble standard deviation (SD) of ice thickness field (Figure 1b). These uncertainties are derived from the 4 prediction ensemble members.

<u>Executive summary</u>: Driven by the NCEP CFS forecast atmospheric forcing, PIOMAS is used to predict the total September 2022 Arctic sea ice extent as well as ice thickness field and ice edge location, starting on August 1. The predicted September ice extent is **5.00 ± 0.40 million square kilometers**. The predicted ice thickness fields and ice edge locations for September 2022 are also presented.

<u>Data used</u>:
NCEP CFS hindcast and forecast atmospheric data for forcing.
Satellite sea ice concentration data (NASA team) and SST up to 8/2022 and CryoSat2 sea ice thickness up to 4/2020 for data assimilation.

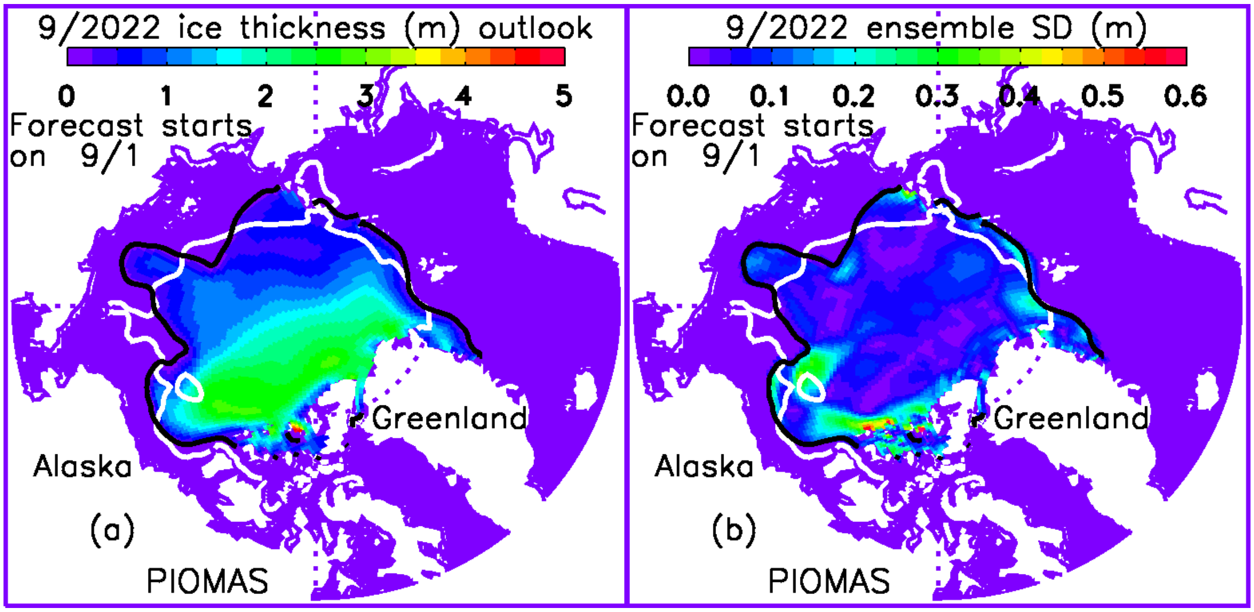

Figure 1. (a) Predicted Arctic September 2022 sea ice thickness and edge location (from ensemble mean), and (b) ensemble standard deviation (SD) of ice thickness which shows the uncertainty of the prediction. The white line represents the satellite-observed September 2021 ice edge defined as the line of 0.15 ice concentration, while the black line is the model predicted September 2022 ice edge.

References:

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