

SASSIE ECCO: A New High-Resolution Arctic Ocean and Sea Ice State Estimate

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Background

In support of the NASA SASSIE (Salinity and Stratification at the Sea Ice Edge) campaign, a high-resolution pan-Arctic coupled sea ice-ocean model was developed from the ECCO (Estimating the Circulation and Climate of the Ocean) project (Fig. 1). Model state estimates are dynamically and kinematically consistent reconstructions of the 3D time-evolving ocean, sea ice, and surface atmospheric states.

Model Summary

- SASSIE ECCO is a 7-year simulation (2014-2020) configured at a high resolution, with ~3.5 km horizontal grid spacing and 90 vertical levels (eddy-permitting)
- Produced by downscaling a multi-decadal global ECCO state estimate from 1/3° to 1/12° grid cells
- Uses the same native grid geometry as MITgcm: a staggered Arakawa C grid

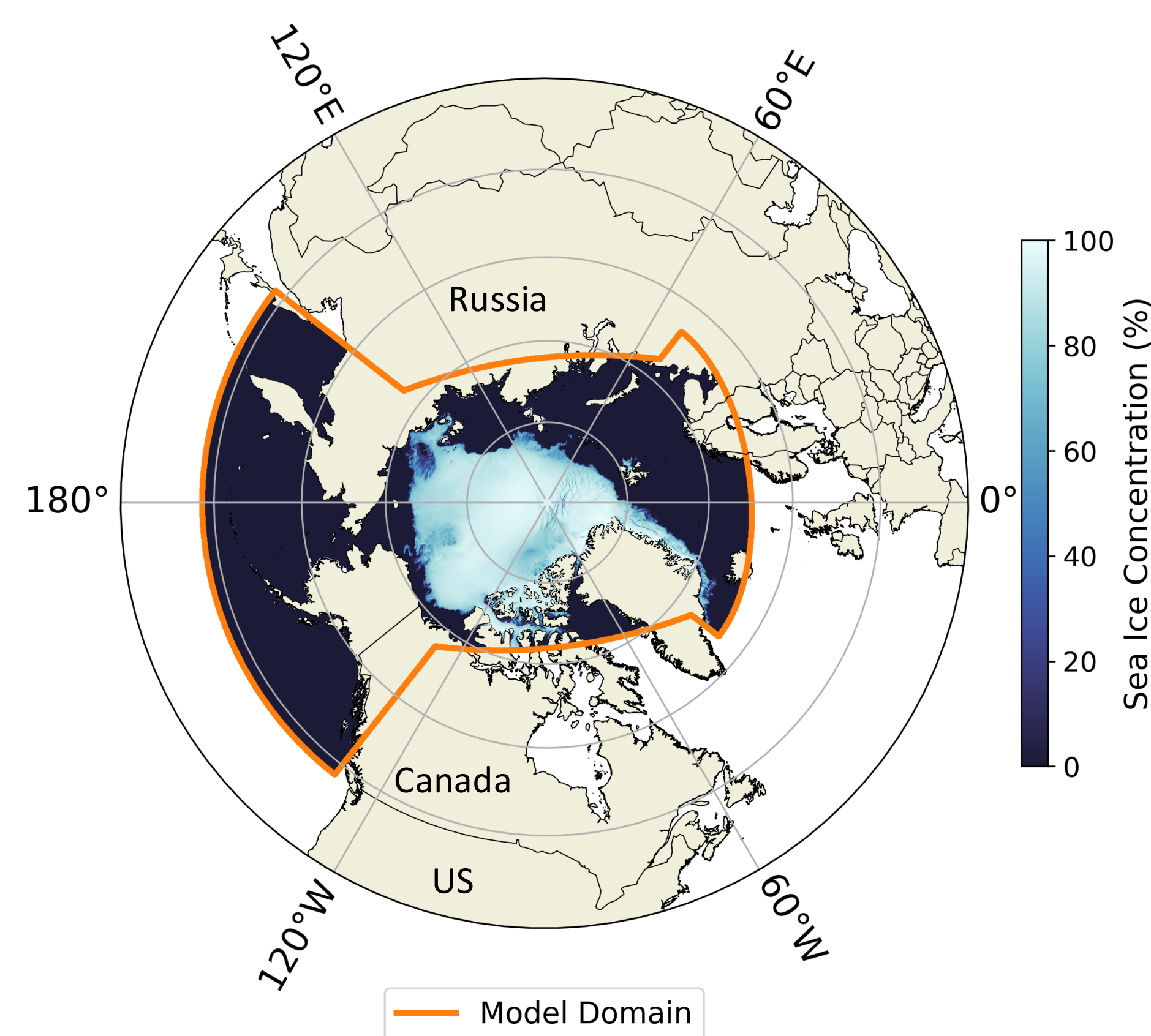


Figure 1. SASSIE ECCO model domain and example snapshot of daily mean sea ice concentration on September 15, 2020.

Now Published on NASA EARTHDATA

- 22 dataset collections in NetCDF format^[1]
- 15.2 TB total, >46,000 files
- Includes daily means of 85 variables and monthly mean snapshots of 10 variables for budget closures
- Spatial subsetting available

Significance

- Largest ocean model to be published on the NASA Physical Oceanography DAAC to date
- Model development advanced data-processing capabilities by developing scalable routines and tools for large datasets using AWS S3 cloud architecture
- Powerful tool for investigating the Arctic property budgets and conducting process-oriented studies with eddy-resolving model output

Publications:

[1] Zahn, M., et al. (2026). SASSIE ECCO llc1080 Coupled Sea Ice Ocean Model Version 1 Release 1. PO.DAAC, CA, USA. <https://doi.org/10.5067/SEL1D-DUG11>

[2] Zahn, M., et al. (2026). Mackenzie River Freshwater Anomalies Control Early Sea Ice Formation in the Eastern Beaufort Sea. *GRL*. <https://doi.org/10.1029/2025GL118871>

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Model Development

- The ECCO v5 Alpha (LLC270) global solution provided initial and boundary conditions and atmospheric forcing
- Fields consolidated onto single pan-Arctic curvilinear grid face from the 5 faces of ECCO model output (Fig. 2)
- Large data volume required all processing and analyses to be completed in the cloud

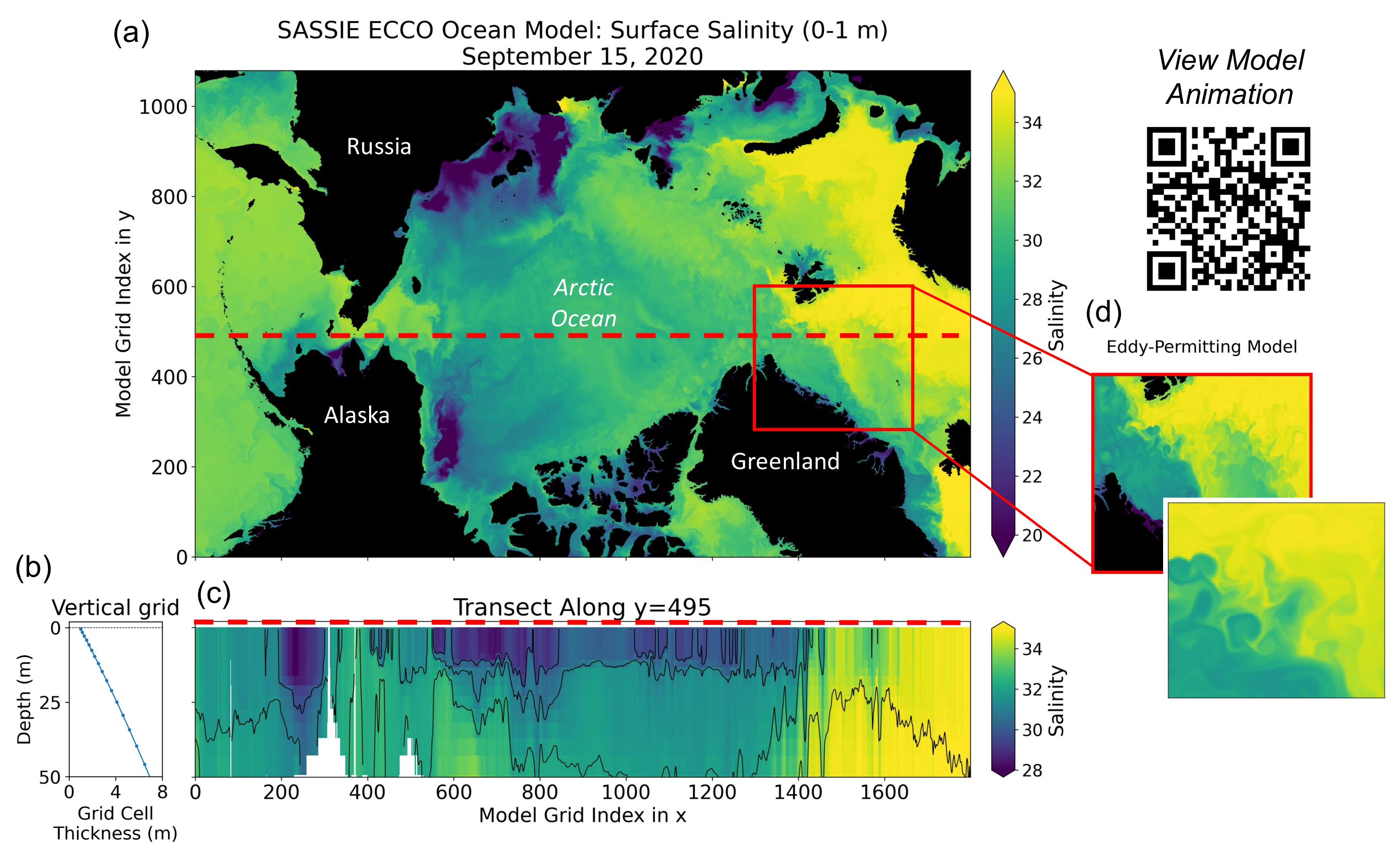


Figure 2. (a) Daily mean surface salinity on September 15, 2020. (b) Vertical grid spacing and corresponding grid-cell thickness in the upper 50 m. (c) Vertical transect along model grid y-index 495 across the Arctic Ocean with overlaid isopycnals. Insets in (d) highlight eddies resolved in the model.

Table 1. Overview of SASSIE ECCO state estimate.

Simulation time coverage	January 15, 2014 – February 7, 2021
Domain	Pan-Arctic
Grid and Horizontal Resolution	LLC1080 (1/12 degree), 0.4 – 5.7 km
Vertical Resolution	90 levels (non-uniform spacing), 0 – 7000 m
Temporal Resolution	Daily averages with monthly snapshots
Data Format	NetCDF-4 + Cloud-Based Virtual Data Store

Variable Summary

- Ocean State (temperature, salinity, velocity, sea level, density, hydrostatic pressure)
- Sea Ice State (concentration, ice and snow thickness, velocity, pressure loading)
- Atmosphere Surface State (temperature, humidity, precipitation, winds, wind stress)
- Ocean and Sea Ice Fluxes (freshwater, heat, volume)
- Ocean 3D Fluxes (temperature, salinity, volume)
- Sea-Ice 2D Fluxes (ice and snow volume)



Example Model Dataset

Future Work

- Analyze sea ice and ocean heat budgets
- Leverage for upcoming Arctic field campaigns (e.g., FRESH, FORTE) and satellite comparisons