

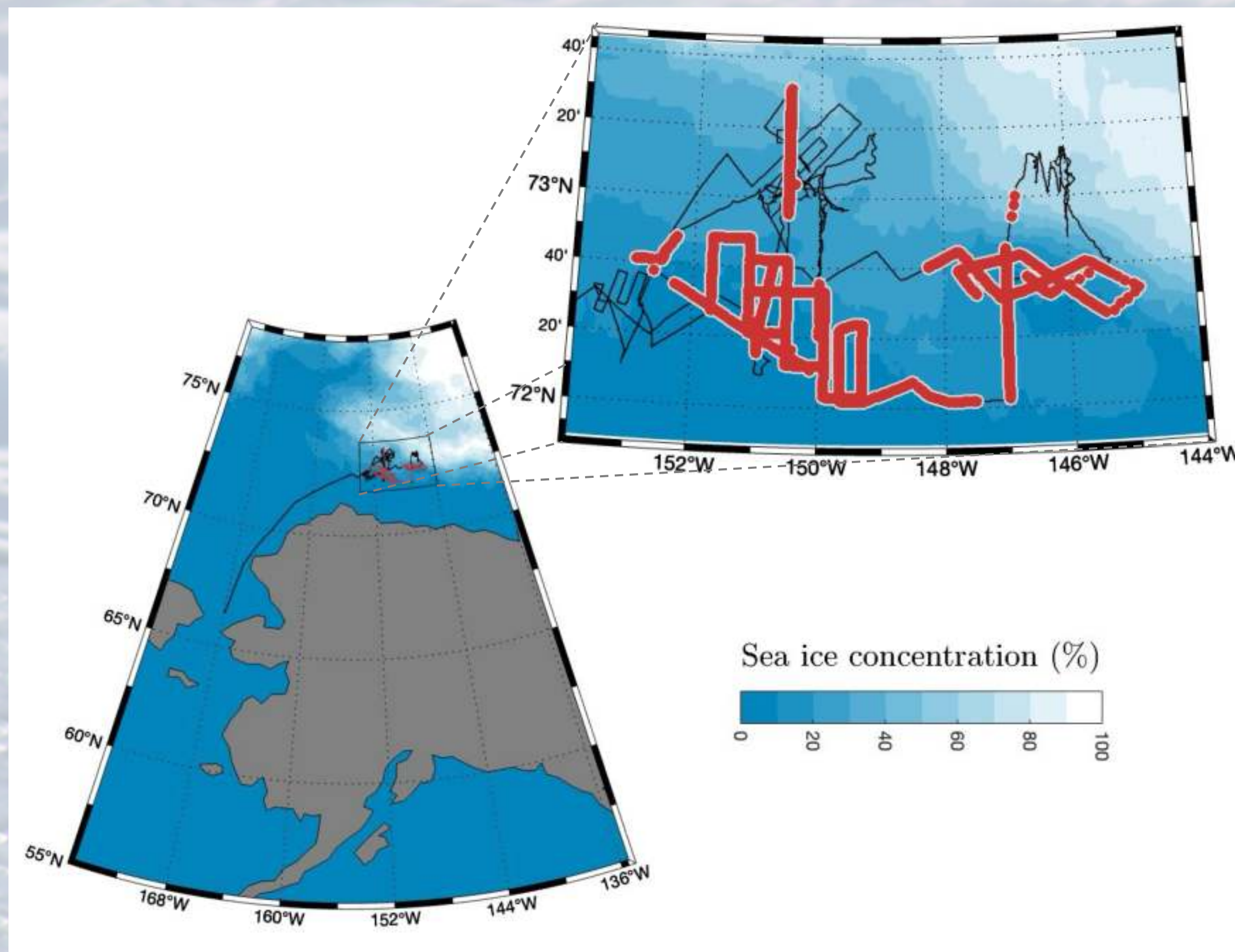
Observations of (sub)mesoscale salinity and temperature variability from underway CTD

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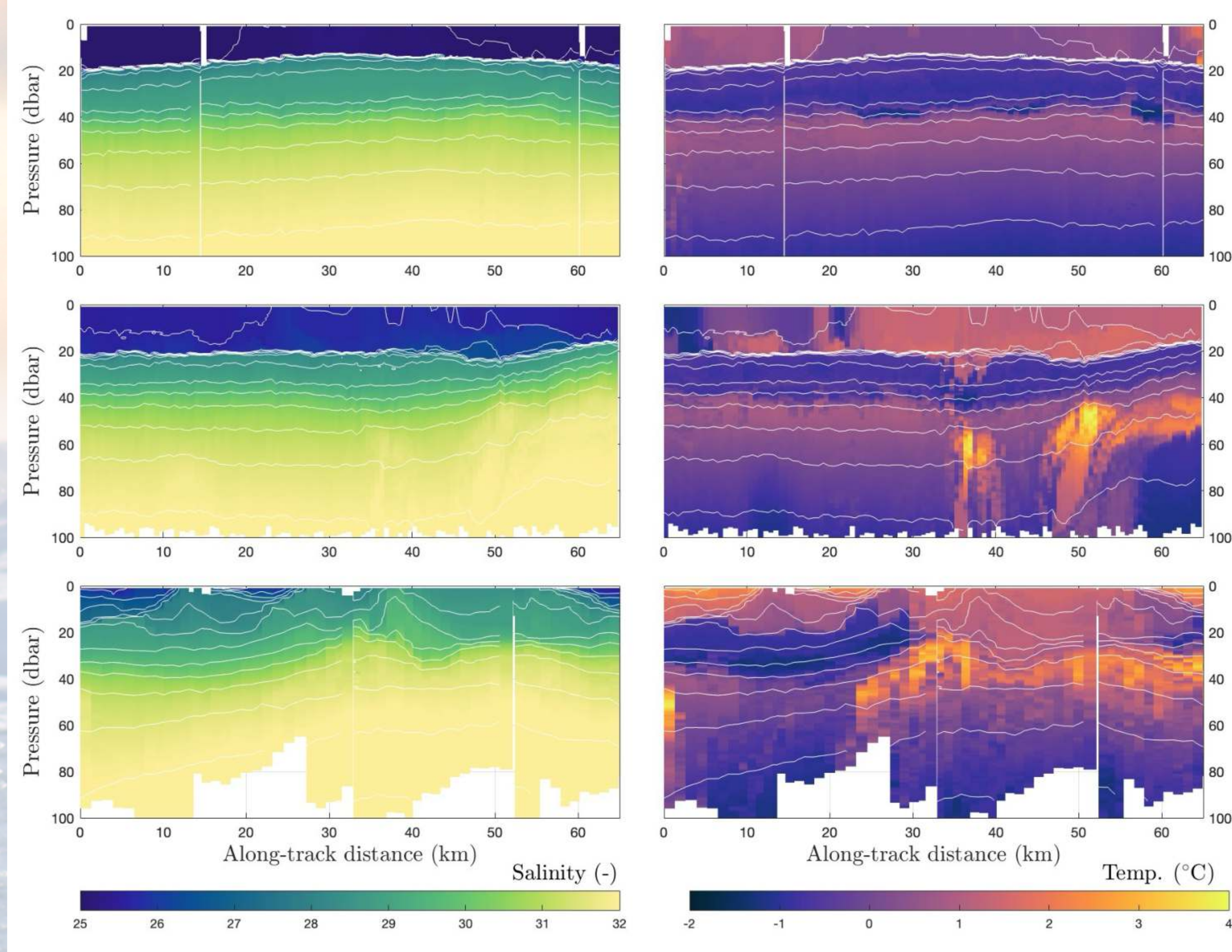
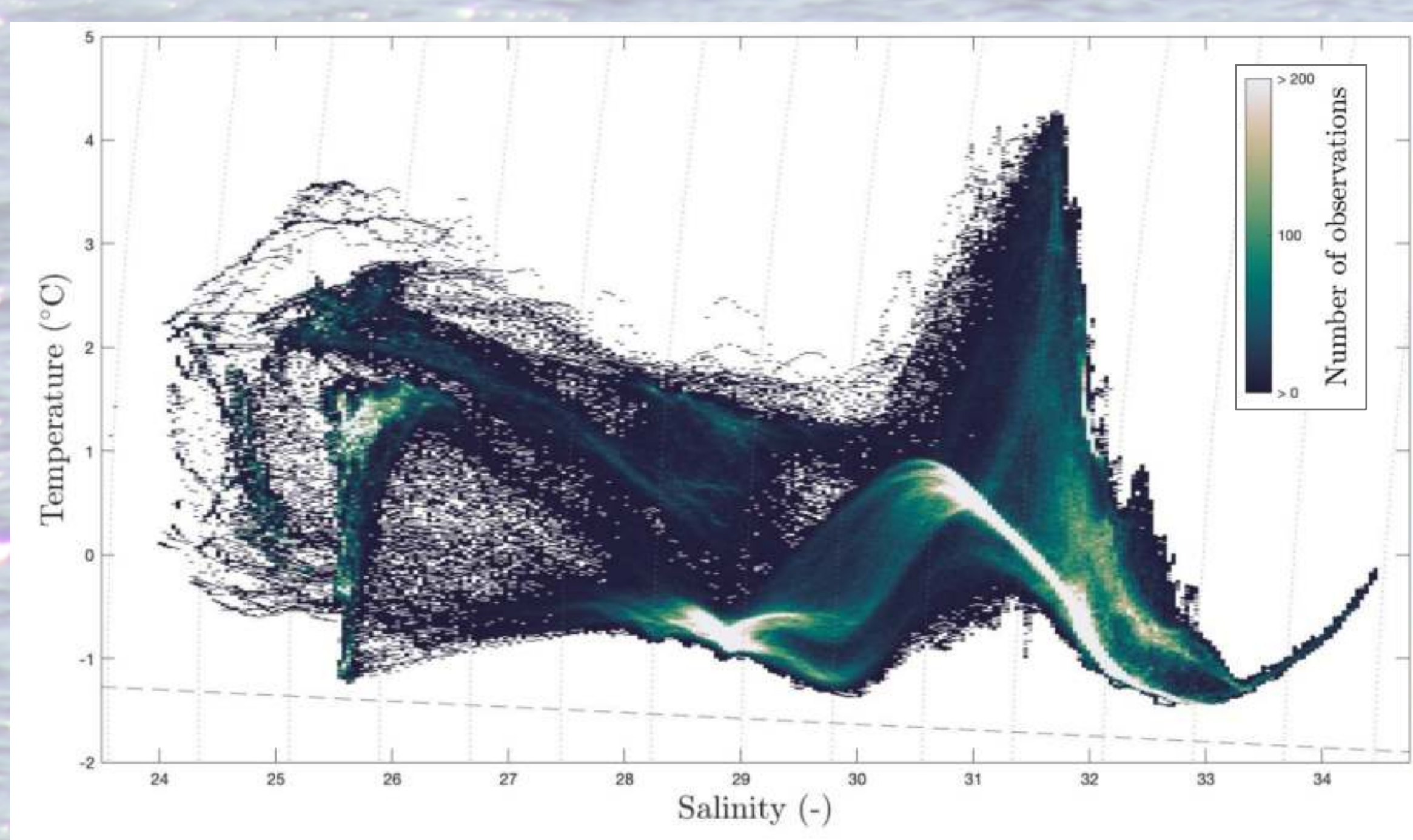
Background

- Under anthropogenic climate change, the Arctic Ocean is experiencing significant declines in sea ice extent and shifts in seasonality, impacting ocean dynamics, Arctic ecosystems and communities, and global climate.
- Accurately describing the present state of the Arctic Ocean and projecting future changes requires a detailed description of temperature and salinity at small scales.
- The underway conductivity-temperature-depth (uCTD) instrument samples ocean state variables at high spatial resolution (0.5-1km in horizontal and 10cm in vertical) providing insight into the processes shaping ocean stratification and heat content.
- Here, we showcase hydrographic observations collected by the uCTD instrument during the NASA Salinity and Stratification at the Sea Ice Edge (SASSIE) field campaign, and highlight research using this dataset.



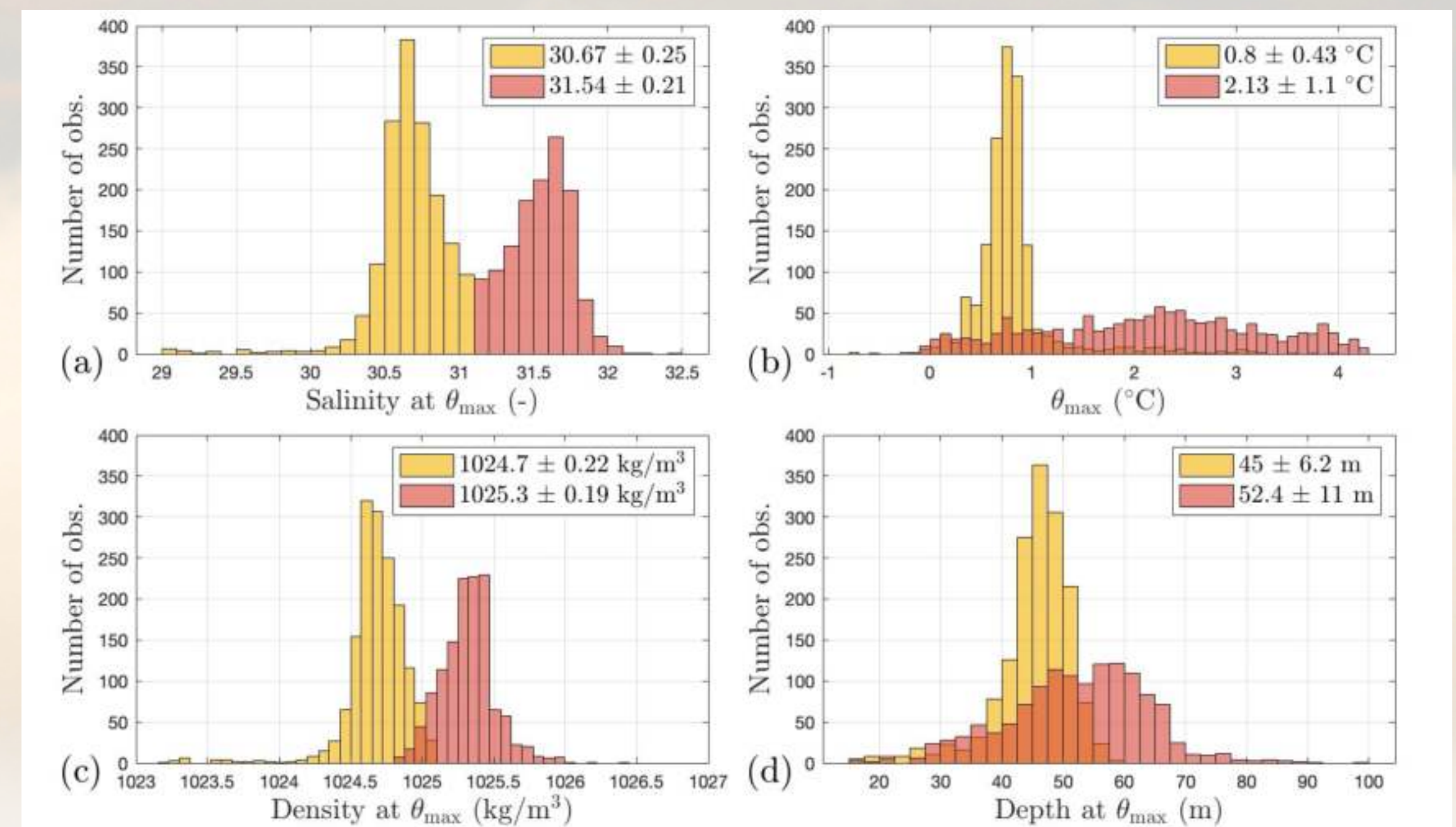
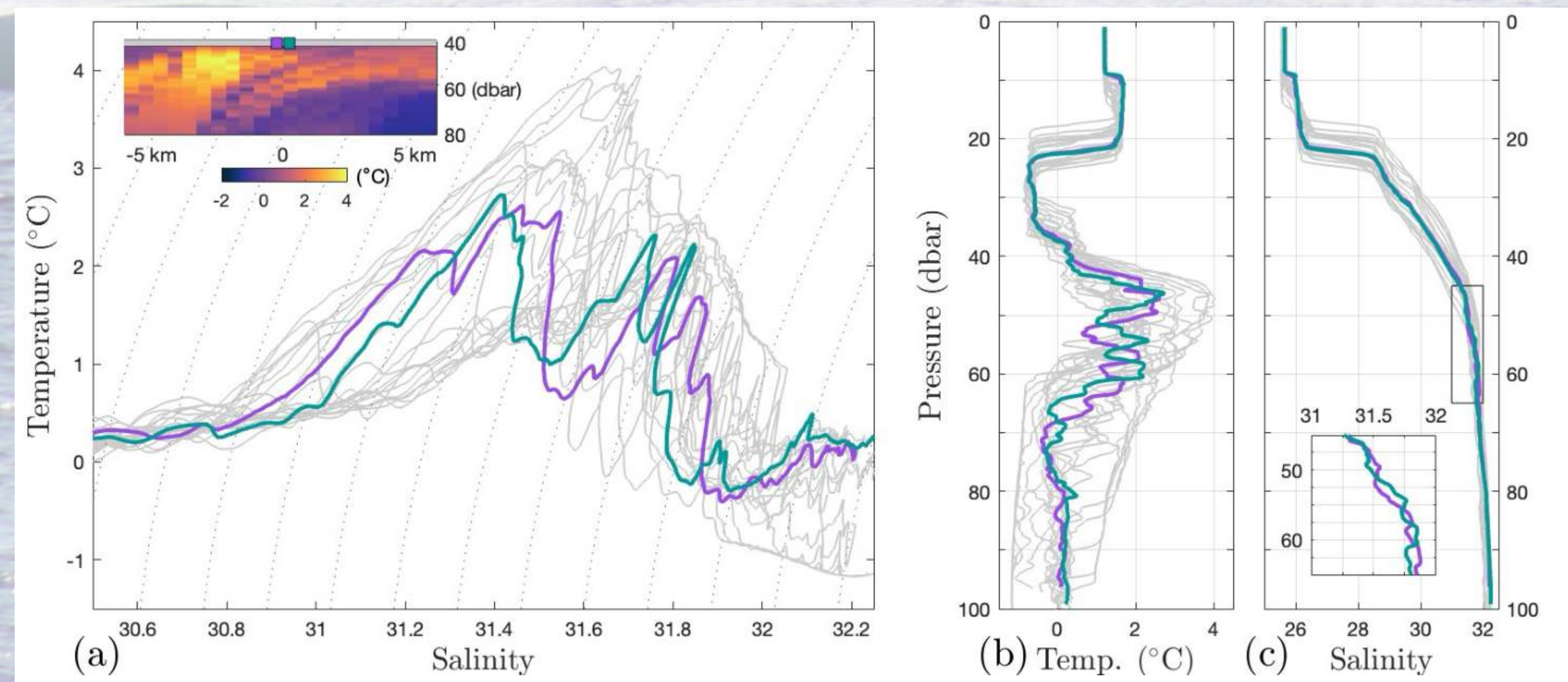
SASSIE uCTD data collection locations (above). Locations of uCTD casts (red dots) overlaid on SASSIE ship track (black line). Sea surface contours show September average sea ice concentration from NWS ice product (Pacini et al. 2025).

Histogram of all SASSIE uCTD data in T-S space (below). Brighter colors correspond to greater data density. Dotted contours show isopycnals, and dashed line shows the freezing temperature at varying salinities.



Along-track uCTD observations (above). Lefthand panels show salinity, and righthand panels show temperature. Density is contoured in white with levels every 0.5 kg/m³. Each transect is 65 km in length, and shows rich variability in the T-S structure of the upper water column. The warmest waters (located around 50 dbar) correspond to Pacific Summer Water.

Detail of thermohaline interweaving in the Pacific Summer Water layer (below). Panel (a) shows profiles in T-S space, and panels (b, c) show temperature and salinity plotted against depth. Profiles are collected from a region spanning approximately 10 km, with two profiles showing strong interweaving highlighted in purple and teal. The inset in panel (a) shows a shaded plot of temperature structure, and the inset in panel (b) shows detail of small-scale salinity inversions.

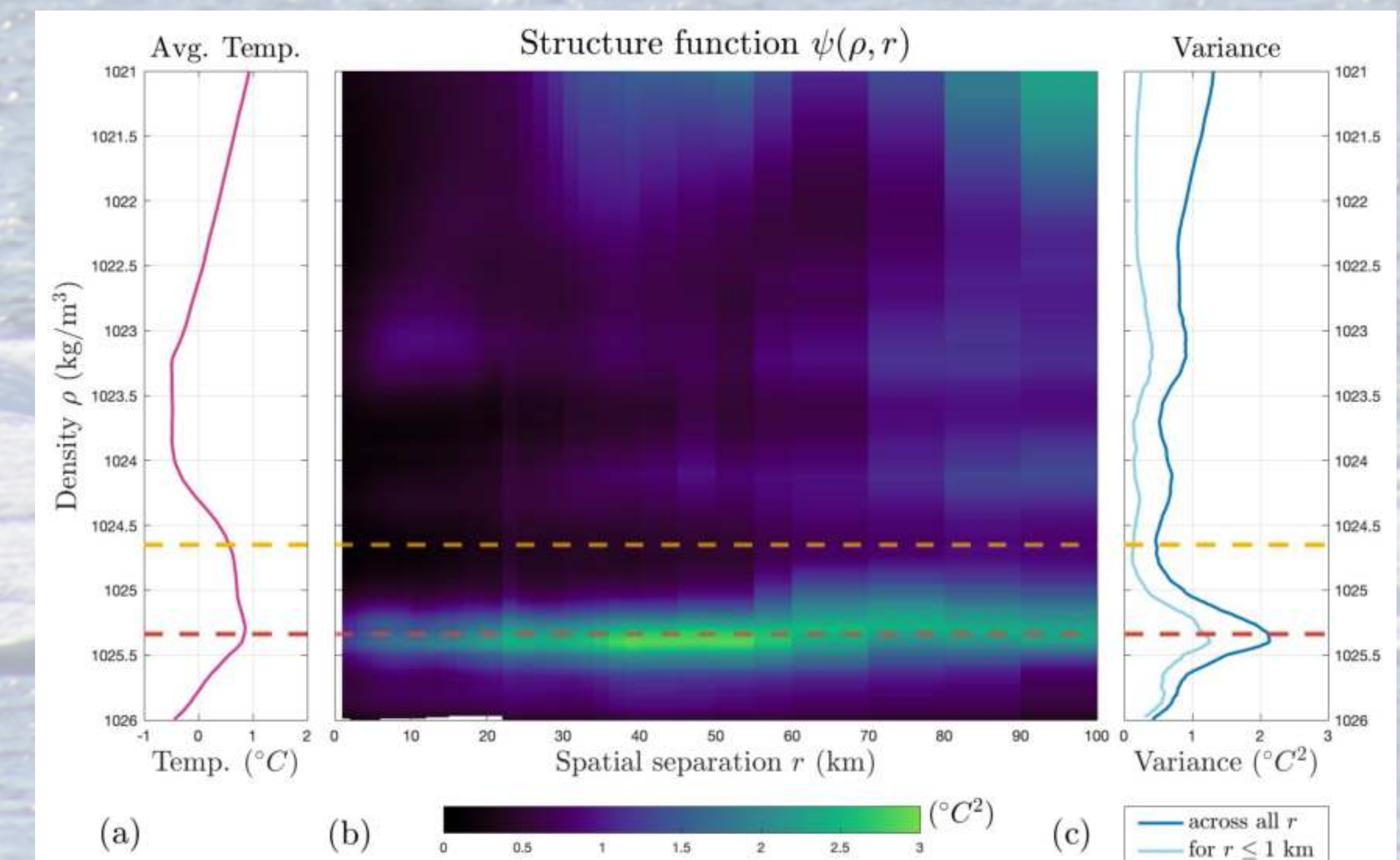


Histograms of Pacific Summer Water (PSW) hydrography from uCTD data (above). PSW is characterized by its salinity at its subsurface temperature maximum θ_{max} (panel a). Using the salinity at θ_{max} to delineate between PSW types, we compare the temperature, density, and depth at θ_{max} between these two varieties of PSW across all uCTD profiles collected during SASSIE.

Structure function for isopycnal temperature variance (below). Panel (a) shows the average temperature profile across all uCTD data. Panel (b) shows the two-dimensional, second-order structure function for temperature in isopycnal coordinates, computed according to:

$$\psi(\rho, r) = \langle (T(\rho, x) - T(\rho, x + r))^2 \rangle,$$

where r is the separation between data pairs and $\langle \dots \rangle$ denotes an ensemble average. Panel (b) shows temperature variance across all uCTD data pairs (dark blue) and across data pairs separated by 1 km or less (light blue). Yellow and red dashed lines correspond to the densities of the two PSW types determined by the hydrographic analysis (shown in figure above).



Future work

- The uCTD is an invaluable tool to sample the upper ocean during ship-based surveys, especially in remote Arctic regions where data limitations constrain our ability to understand fundamental processes governing ocean and sea ice dynamics.
- The uCTD can be deployed from a variety of crafts and configured to include additional sensors (such as chlorophyll fluorescence), making it highly adaptable to a wide array of research goals.

Questions, comments, or ideas? Please reach out to Carlyn at crschmid@uw.edu and I would love to connect with you. Thank you!