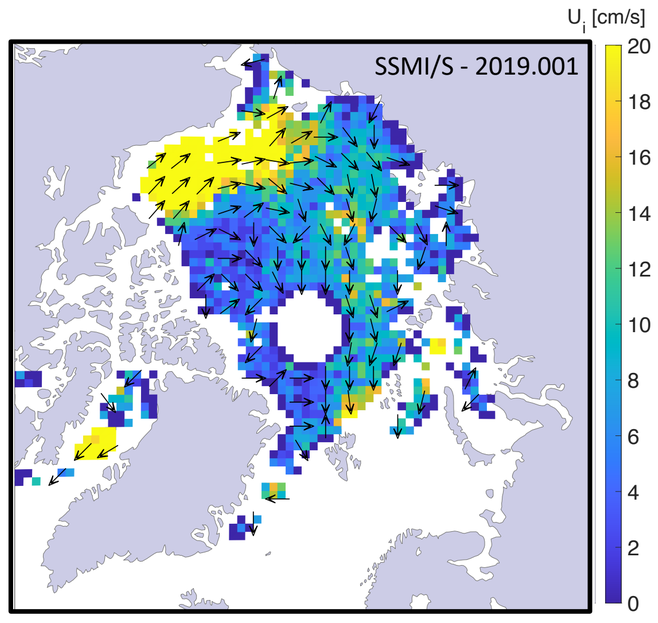
A revamped optimally interpolated sea ice motion dataset

Charles Brunette[1], Bruno Tremblay[1], Robert Newton[2]

[1]McGill University, Montreal, Canada; [2]Lamont-Doherty Earth Observatory (Columbia), Palisades, USA

Corresponding author: charles.brunette@mail.mcgill.ca

Satellite-derived ice motion



- From passive-microwave & radiometer imagery
  - SMMR, 1979-1987, 75 km
  - AVHRR, 1981-2000, 50 km
  - AMSRE, 2002-2011, 37.5 km
  - SSMI, 1987-2006, 75 km
  - SSMI/S, 2007-present, 75 km
- Good spatial coverage in the winter; less coverage in the summer months due to melt ponds, open water, and atmospheric water vapor

Optimal interpolation

- **Objective**: combine sea ice motion vectors from different sources into a **seamless** dataset
- We retrieve the **buoy** and **satellite**-derived ice motion estimates from the *Polar Pathfinder* dataset (NSIDC, Tschudi et al. 2020), and introduce new **free drift** estimates (Brunette et al. 2021).
- Daily, 25 km resolution, merged ice motion vectors calculated as a weighted average, where the weights are based on:

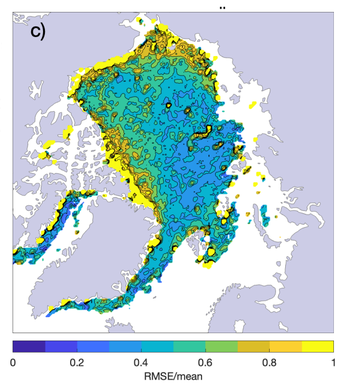
➢ Distance

- Inverse distance weighting options: e^{-d/r_o}; $1/\mathrm{x}^p$; $1-d/r_o$
- Maps of spatial correlation of u_i will define the local r_o

➢ Error

- Taking into account the source-based error (rmse)
- Including the spatial variation of the error (see map) and temporally evolving error (seasonality)

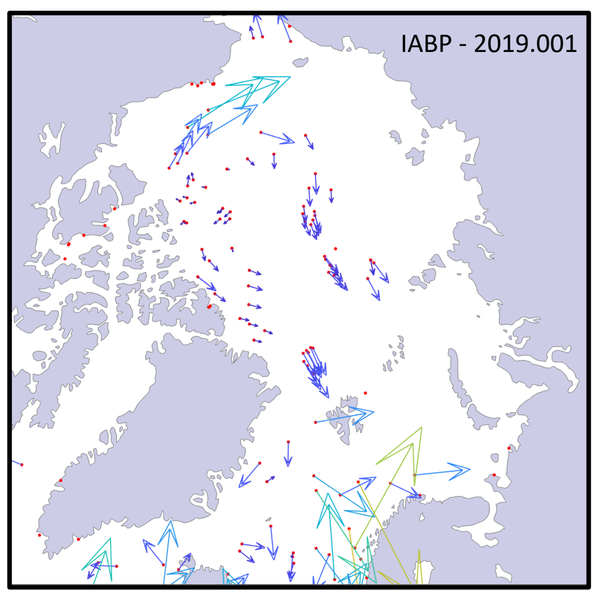
E.g.: Spatial distribution of the error for the free drift estimates

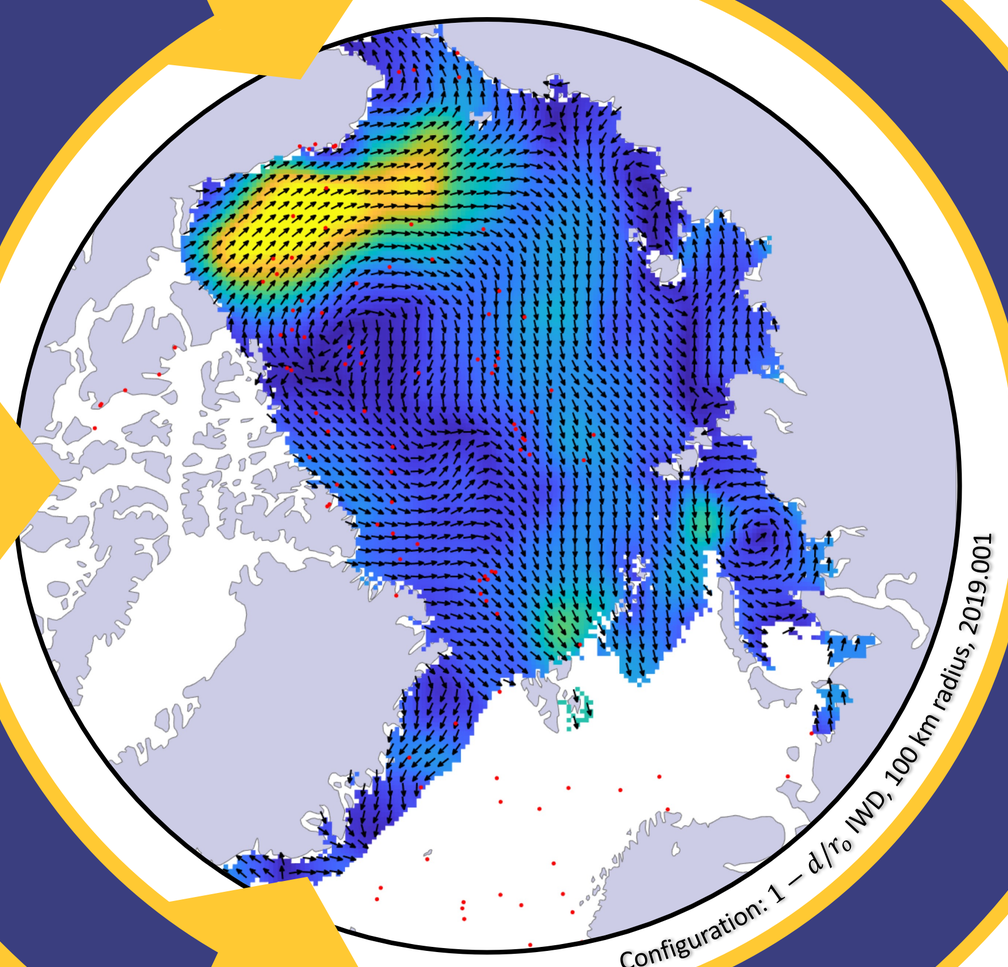


- Resulting sea ice motion vectors will be validated against independent buoy data (ITPs).

Buoy data

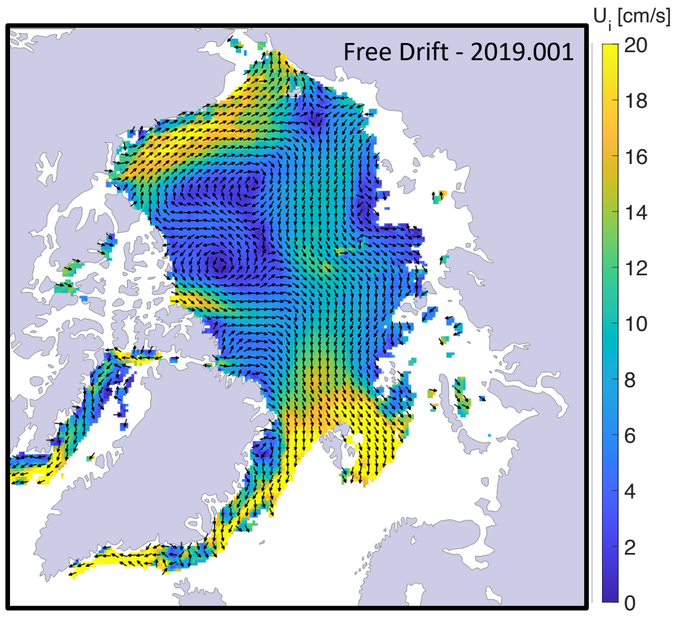
- International Arctic Buoy Programme
- 1979-present, daily
- We take buoy drift as truth





Free drift estimates

- First order momentum balance, sea ice motion in response to the atmospheric and oceanic stresses: $\vec{u}_i = \alpha(h_i)\vec{u}_a + \vec{u}_o$



- Atmospheric forcing from ERA5 10 m winds
- Climatology of the surface ocean current calculated as a residual
- Wind-ice transfer coefficient is linearly dependent on ice thickness (PIOMAS)
- 1979-present, daily, 25 km
- Ref: Brunette et al. (2021)

Outcomes

- **Improved accuracy** of sea ice velocity estimates
- Important innovation is expected in the **summer months;** with less satellite-derived vectors, the merged ice velocity estimates rely more heavily on free drift.
- Support applications based on **Lagrangian tracking**, which include retrieving sea ice age, investigating mechanisms for seasonal forecasting, informing socio-environmental studies by quantifying pollutant transport, etc.

A. McCreesh

"Sometimes when there are strong winds, the new ice and the land-fast ice cannot come in contact with each other because the northerly winds cause the newly formed ice to break up and drift away. After the winds die down and the weather improves, the resultant open water freezes again and the current will move the new ice back and forth against the land-fast ice. [...] This is true, and that is the nature of the moving ice ."
-Elder Aipilik Inuksuk, Igloolik, Nunavut

- Brunette, C., Tremblay, L. B., & Newton, R. (in preparation), *An optimal interpolation method for a seamless Arctic sea ice motion vector dataset*
- Brunette, C., Tremblay, L. B., & Newton, R. (2021). *A new sea ice state dependent parameterization for the free drift of sea ice*. The Cryosphere Discussions, 1-34.
- Tschudi, M. A., Meier, W. N., & Stewart, J. S. (2020). *An enhancement to sea ice motion and age products at the National Snow and Ice Data Center (NSIDC).* The Cryosphere, *14*(5), 1519-1536.

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