Arctic sea ice and oceanic eddies

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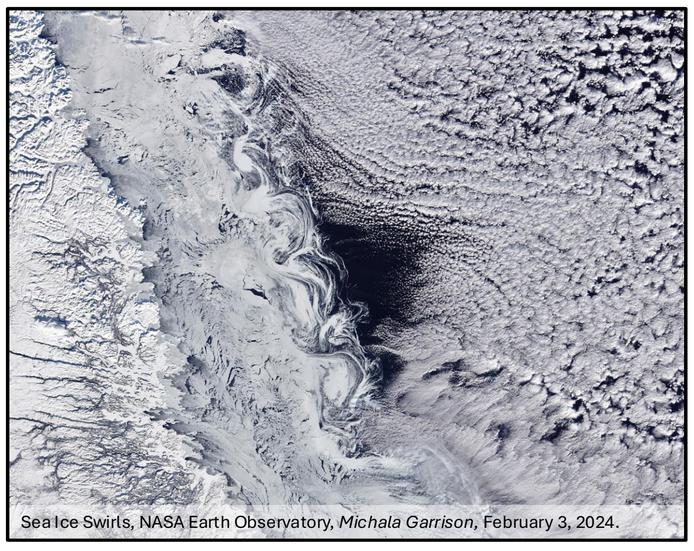


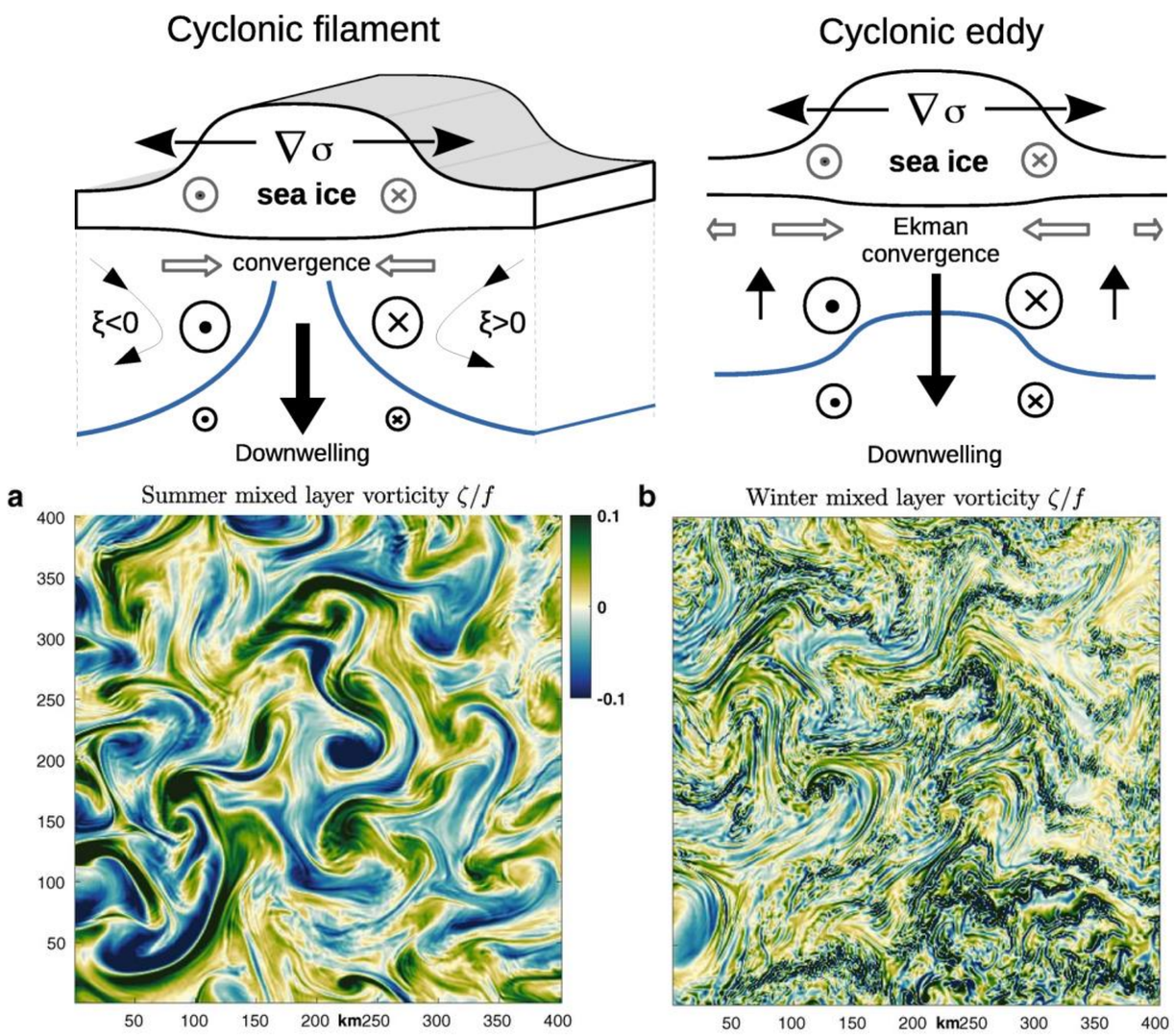
Sea Ice Swirls, NASA Earth Observatory, *Michala Garrison*, February 3, 2024.

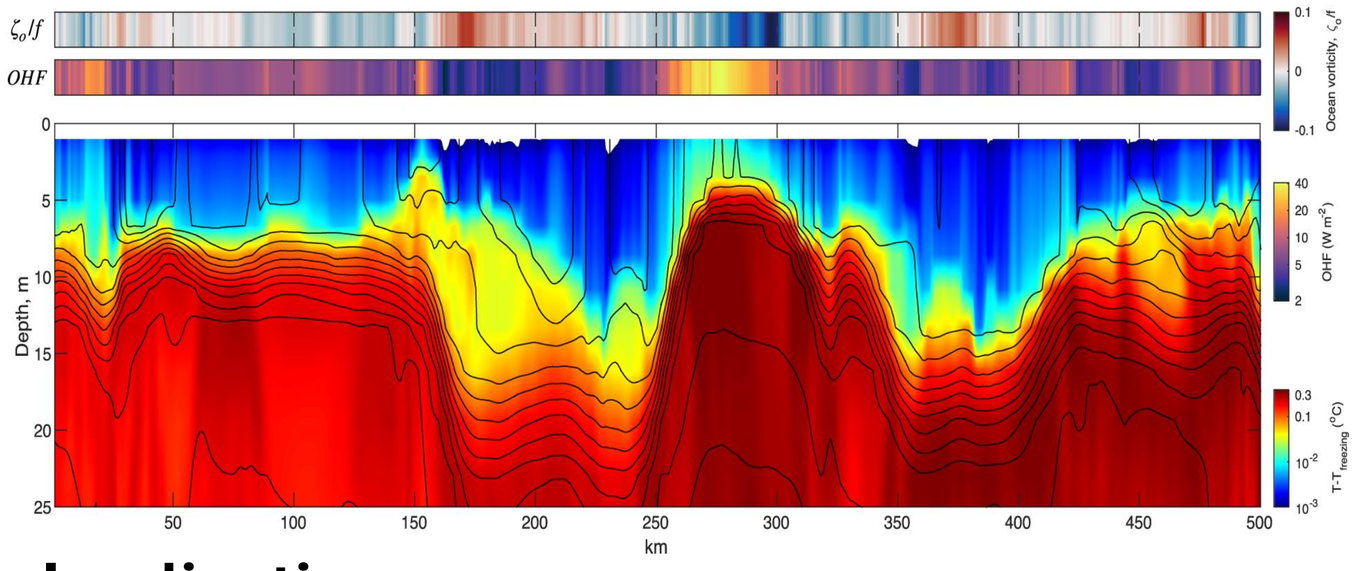
Motivation

Arctic sea ice is important for ecosystems, indigenous communities, shipping and as a driver of regional and global climate. Climate models consistently underperform in sea ice simulations due to the complex multi-scale air-ice-sea interactions. Field observations are complicated and sparse in the region, limiting our understanding. This poster presents the results of a newly developed ice-ocean interaction model used to investigate mesoscale and sub-mesoscale interactions between ocean eddies and sea ice, revealing an important climate feedback.

Methods and key mechanisms

This research utilizes high-resolution numerical modelling, combining idealized MITgcm simulations to isolate sub mesoscale instabilities with a global eddy-resolving model that incorporates tides and internal gravity waves. Key mechanical interactions center on a transition at sea ice concentrations below around 80%, where the ice enters a "weak rheology" regime and its vorticity becomes highly correlated with the underlying ocean turbulence. In this regime, sea ice is effectively trapped within cyclonic eddies and filaments due to confluence-driven surface convergence and ice-stress-driven Ekman pumping.





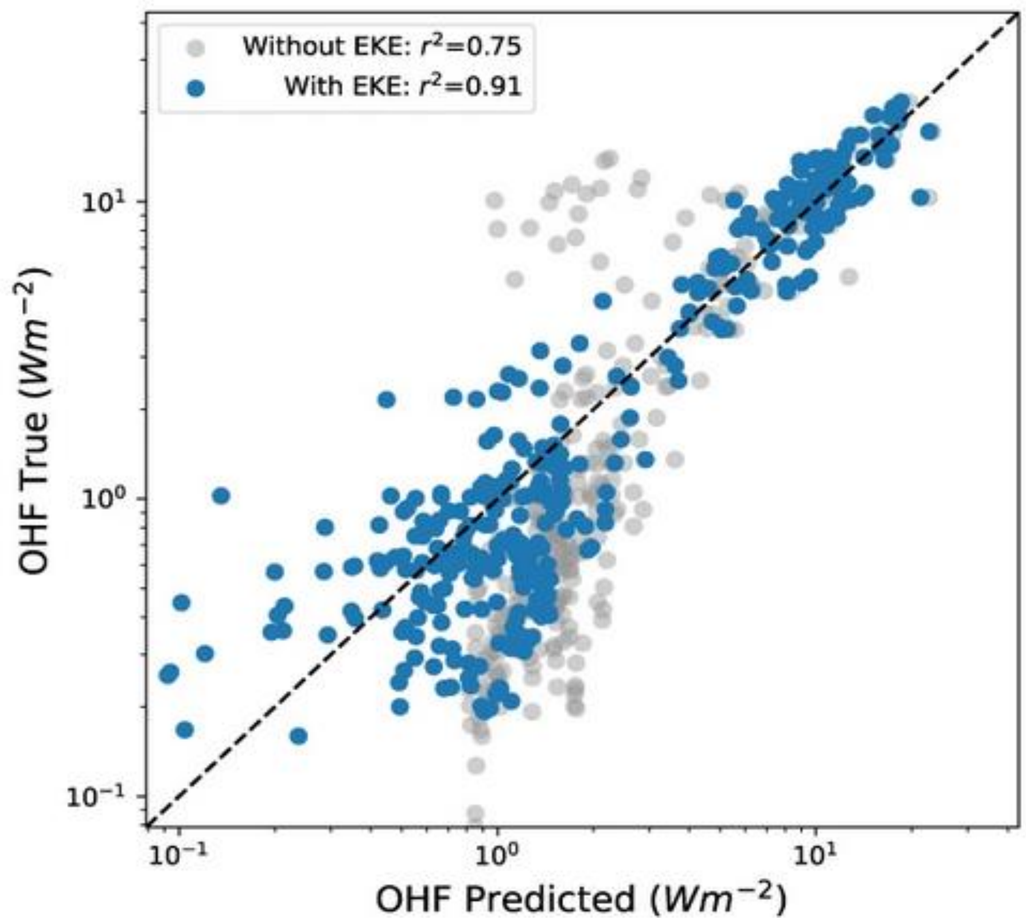
Key results

- Warm-core anticyclonic eddies lead to an increased ocean heat flux.
- A higher sea ice concentration inhibits eddy activity.
- There is a higher concentration of anticyclonic eddies
- Including eddy kinetic energy greatly increases the accuracy of predicted ocean heat fluxes.

Implications

An important climate feedback is identified between sea ice and ocean eddies which highlights the complexity and need for better sea ice parametrizations in climate simulations.

To better understand this ice-ocean system we require better and more in-situ observations of sea ice (e.g. through ice-bound profilers) as well as an improvement in the theoretical aspects of air-ice-sea interactions.



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