Sub-mesoscale Wind-Front Interactions: the combined impact of thermal and current feedback

Yue Bai¹, Andrew F. Thompson¹, Ana Beatriz Villas Bôas², Patrice Klein³, Hector S. Torres⁴, and Dimitris Menemenlis⁴

¹California Institute of Technology
²Colorado School of Mines
³Jet Propulsion Laboratory, California Institute of Technology - CNRS
⁴Jet Propulsion Laboratory, California Institute of Technology

June 8, 2023

Abstract

Surface ocean temperature and velocity anomalies at meso- and sub-meso-scales induce wind stress anomalies. These wind-front interactions, referred to as thermal (TFB) and current (CFB) feedbacks, respectively, have been studied in isolation at mesoscale, yet they have rarely been considered in tandem. Here, we assess the combined influence of TFB and CFB and their relative impact on surface wind stress derivatives. Analyses are based on output from two regions of the Southern Ocean in a 4-6 km-resolution coupled simulation. Considering both TFB and CFB shows regimes of interference, which remain mostly linear down to the simulation resolution. The jointly-generated wind stress curl anomalies approach 10⁻⁵ N⁻³, ~20 times stronger than at mesoscale. The synergy of both feedbacks improves the ability to reconstruct wind stress curl magnitude and structure from both surface vorticity and SST gradients by 12-37% on average, compared with using either one alone.