

Satellite-derived Ocean-Surface Stress and Ekman Circulation in the Arctic

Chao LIU, Lisan YU
Woods Hole Oceanographic Institution

- The persistent decline in Arctic sea ice extent has altered ocean-surface stress, τ_o , across both ice-free and ice-covered regions, impacting ocean circulation and freshwater distribution primarily through Ekman transport.
- Mapping τ_o and associated Ekman circulation using available satellite observations is important for understanding Arctic dynamics and climate change.
- τ_o is the sum of the air-water stress (τ_{aw}) for the open water and the ice-water stress (τ_{iw}) for the water covered by ice: $\tau_o = \alpha\tau_{iw} + (1-\alpha)\tau_{aw}$, where α is sea ice extent.
- τ_{aw} and τ_{iw} are both parameterized using a quadratic drag law:

$$\tau_{aw} = \rho_a C_{D,aw} |\mathbf{U}_{10}| \mathbf{U}_{10} \quad \text{and} \quad \tau_{iw} = \rho_w C_{D,iw} |\mathbf{U}_{ice} - \mathbf{U}_E - \mathbf{U}_g| (\mathbf{U}_{ice} - \mathbf{U}_E - \mathbf{U}_g)$$
 where C_D are drag coefficients, \mathbf{U}_{10} is the wind velocity vector at 10m, \mathbf{U}_{ice} is sea ice motion, \mathbf{U}_E is Ekman velocity, and \mathbf{U}_g is geostrophic velocity.
- Based on above equations, τ_o can be estimated using the following four datasets:

Variable	Product	Resolution
\mathbf{U}_{10}	OAFlux2 Satellite Ocean-Surface Winds	Daily 0.25°, 1988-present
\mathbf{U}_{ice}	Polar Pathfinder Sea Ice motion V4	Daily 25 km, 1978-present
\mathbf{U}_g	CLS multi-mission Ocean Altimeter SSH	3-Day 25 km, 2011-2021
α	Goddard/NSIDC Sea Ice Concentrations V2	Daily 25 km, 1978-present

