1. Introduction:

The air-sea flux of mechanical energy can be computed via the dot product between the wind stress and surface current velocity vectors, \( P = \mathbf{u} \cdot \mathbf{\tau} \).

Assuming 
\( \mathbf{u} \) can be decomposed into geostrophic and Ekman components, \( P \) can be expanded as 
\[ P = P_{g} + P_{e} \]

where \( P_{g} \) is the geostrophic component resulting from the wind forcing, while \( P_{e} \) is the Ekman part arising from the wind-driven circulation.

Recent numerical studies showed that mesoscale air-sea coupling mechanisms, arising from the \( \mathbf{u} \) dependence on \( \mathbf{\tau} \) and SST-driven anomalies in wind speed, can influence the time-dependent components of \( P_{e} \) with strong feedbacks to the evolution and decay of mesoscale ocean variability [e.g. 1, 2].

While there is a building consensus that current-driven coupling both reduces \( P_{e} \) and exerts a net damping effect on the ocean eddy field, model-based results diverge on the role of the SST-driven coupling.

Observational evidence for both effects is scarce, potentially due to deficiencies of altimeter data and the complexity of the coupling mechanisms, arising from the interaction of the geostrophic and Ekman parts of \( P \).

5. Conclusions:

- The time-averaged \( P \) inferred from drifter and satellite observations is of 2.14 TW, partitioned as 1.15 TW in \( P_{e} \) and 0.99 TW in \( P_{g} \).
- Wind power input to the Ekman circulation (\( P_{e} \)).
  - Time-mean and time-dependent components contribute about equally to the global integral.
  - Due to the vertical shear of Ekman currents, and since GDP drifters measure the flow at 15-nm depth rather than at the surface, results are interpreted as lower-bound estimates.
- Wind power input to the geostrophic ocean circulation (\( P_{g} \)).
  - Globally-integrated power of about 1 TW is similar to altimeter-based estimates.
  - In contrast with the altimeter estimates, drifter-based results indicate that, while the wind supplies 1.22 TW to the ocean circulation via the time-mean and seasonal components of \( P_{g} \) (\( \mathbb{P}_{g} \) and \( \mathbb{P}_{g}^{?} \), respectively), about 0.22 TW is lost back to the atmosphere via the eddy component (\( \mathbb{P}_{g}^{?} \)).
- Negative energy fluxes in \( \mathbb{P}_{g} \) can largely be explained by the influence of the current-driven air-sea coupling mechanism.
- The influence of SST-driven coupling mechanism is detectable and produces well-defined large-scale patterns in the energy fluxes, however with magnitudes about 30 times smaller than those driven by the ocean-current effect.

These results provide observational evidence that the current-driven coupling gives rise to a non-negligible sink of kinetic energy for the oceanic mesoscale variability, and may serve as a basis to evaluate the competing conclusions of recent numerical experiments on the impact of the SST-driven coupling mechanism to ocean energetics.

6. References: