## Cross-scale Interactions in Ocean Turbulence

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**ABSTRACT**: The Earth's ocean is home to turbulent phenomena spanning lengthscales from hundreds of kilometres to a few centimetres and timescales from centuries to seconds. Large, coherent features such as the Gulf Stream vary slowly across space and time, alongside a rapidly fluctuating collection of smaller-scale waves and eddies. The evolution of our climate system depends on interactions between these two types of structures: large versus small, slow versus fast, and coherent versus incoherent. These interactions challenge our ability to understand and predict important aspects of the climate.

This talk will focus on the cross-scale interactions occurring between the ocean's slowly varying mesoscale eddies (MEs, with lengthscales ~100km and timescales ~1 month) and rapidly fluctuating near-inertial waves (NIWs, with lengthscales ~100-1000km and timescales ~1 day). Both MEs and NIWs contribute substantially to the ocean's total kinetic energy: MEs dominate the low frequency band, while NIWs are associated with a highly energetic spectral peak near the daily timescale. MEs also transport `passive tracers' such as dissolved carbon dioxide; this transport in turn influences the global ocean uptake of carbon from the atmosphere, which influences the rate of climate warming. Although MEs and NIWs have each been understood individually, their cross-scale fast/slow interactions remain mysterious, as does the impact of these interactions on tracer transport and NIW-ME energy exchange. Recently, a promising multi-scale asymptotic theory has been developed to tease apart these interactions, but much remains to be understood.

In this talk I will resolve recent questions regarding the energetics of NIW-ME interactions by demonstrating that energy exchanges can be correctly captured by extending the previous theory to the next asymptotic order. I will also show how this theoretical framework can be extended to predict the behavior of passive tracers, and that NIWs can significantly suppress tracer transport by extracting energy from the ME field. This work demonstrates that cross-scale NIW-ME interactions can be mechanistically understood by taking advantage of the separation of timescales, advancing our understanding of ocean dynamics and its connection to climate.

ALL ARE WELCOME!