Transport and Scale Interactions in Geophysical Flows

Oberwolfach Workshop 2329

July 16–22, 2023

Geophysical fluid flow is fundamentally intertwined with transport in different ways. Passive transport of buoyancy, tracers, and solid particles is one of the more visible aspects. Other transported quantities are "active", interacting with themselves, other scalars, or the flow. In geophysical flows, the arguably most prominent active scalar is the potential vorticity which dominates the dynamics of rotating stratified flow. It connects transport to geostrophic turbulence, its characteristic feature being the cascade of energy to large scales, a process which favors the emergence of large-scale, coherent structures which, in turn, determine mixing and transport of other Lagrangian quantities.

This workshop looks at transport and scale interactions in geophysical fluid dynamics through the lens of dynamical systems methods. The range of problems includes the analysis of scale interaction, the parameterization of unresolvable scales and unresolvable physics in computational models through surrogate models or consistent closures, emergence and dynamics of coherent structures, the characterization of coherent structures as nonlinear waves as well as through data-driven methods, and their interaction with secondary processes such as solid particles and complex bio-geochemistry.

Particular emphasis is given to approaches that bridge between subfields, exemplified by the emergence of Eulerian stochastic PDEs from Lagrangian particle dynamics, the connection between asymptotic and data-driven methods in weakly coupled systems, and the emerging use of transfer operator techniques for black-box modeling of dynamical systems.