Theories of the Southern Ocean meridional overturning circulation (MOC) typically assume a zonally-symmetric structure. Yet, recent observational and numerical studies have highlighted the role of zonally-asymmetric dynamics in determining global Southern Ocean circulation and transport properties. Altimetry data and ocean GCMs show that Southern Ocean fronts undergo rapid transitions downstream of major topographic obstacles. The impact of these topographical transitions zones on transport properties, using both idealised models and altimetry data, is considered here.

Velocity fields from seventeen years of satellite altimetry data are used to advect Lagrangian particles within the Southern Ocean. Particle positions are calculated in sea surface height space and analysed to determine where exchange across the primary fronts (as defined by contours of sea surface height) occurs. Nearly all cross-frontal exchange occurs in isolated locations downstream of major topographical features, such as Kerguelen Island, Campbell Plateau, and Drake Passage.

We further analyse a set of baroclinically-unstable quasi-geostrophic simulations with zonally-varying topography in which multiple jets or fronts form. We focus on the regime where the number of jets, the jet spacing and the jets' vertical structure vary along the path of the mean flow. These front transitions are associated with high eddy kinetic energy levels, and analysis of passively advected particles indicate that exchange across transport barriers (as defined by sharp gradients in potential vorticity) is more likely to occur downstream of topography. Lagrangian estimates of eddy kinetic energy, eddy length scales and eddy fluxes are used to compare the Southern Ocean and QG particle trajectories.