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Heat fluxes in the Drake Passage

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In contrast to a long-standing belief, observations in the Antarctic Circumpolar Current (ACC) show that mean velocity vectors rotate with depth, thus suggesting a possible importance of the time-mean flow for the local poleward heat transport [Sekma et al., 2012].

The respective contributions of the eddy and mean flows to the heat flux across the ACC in the Drake Passage are investigated using in situ measurements collected during the DRAKE 2006-9 project (from January 2006 to March 2009) and available observations from the historical DRAKE 79 experiment.

DRAKE 2006-9 current meter records, obtained from a current meter array deployed on the eastern side of the Shackleton Fracture Zone (SFZ), revealed a vertical consistency of the velocity and temperature variations. However, the rotation of the mean velocity vector with depth indicated consistent downwelling through the entire water column practically all along the mooring line.

In situ temperature and velocity time series from the DRAKE 2006-9 project were combined with the year-long historical DRAKE 79 experiment data set in order to analyse the eddy and mean flow contributions to the meridional heat flux across in the Drake Passage. Estimated cross-stream heat fluxes caused by the rotation of the mean flow with depth were found to be at least an order of magnitude larger than eddy heat ?uxes. Equatorward heat fluxes caused by the mean flow found downstream the SFZ were in agreement with the general downwelling observed along the DRAKE 2006-9 project mooring array. Upstream the SFZ, however, the distribution of equatorward and poleward fluxes was puzzling. This distribution was analyzed using model outputs.

Heat flux due to the mean ?ow estimated from the high resolution model outputs were similar to those obtained from in situ data and exhibited small spatial scales. The rough topography in Drake Passage likely promotes associated small spatial scales of vertical velocities and heat fluxes. The model-estimated heat flux due to the mean flow across the Southern ACC Front in Drake Passage (covering about 3% of the circumpolar longitudes between 48˚W and 64˚W) is on the order of 10% of the heat lost to the atmosphere south of 60˚S.