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Surface-Layer Mean Velocities and Mesoscale Variability in Drake Passage

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High resolution acoustic Doppler current profiler observations of surface-layer velocities in Drake Passage, comprising 115 sections spanning 5 years, are used to study the Antarctic Circumpolar Current (ACC). Three jets are observed in the gridded Eulerian mean velocities. These jets are coincident with mean positions of the Subantarctic Front (SAF), Polar Front (PF) and Southern ACC Front determined from repeat expendable bathythermograph (XBT) upper ocean temperature measurements. In a mean vertical section of horizontal velocities, comprising 29 exact-repeat transects, the frontal jets appear uniform over the top 300 m with very little vertical shear. Shear variance is low, with slightly elevated values at about 100 m depth south of the Polar Front, corresponding well with the depth and lateral extent of Antarctic Surface Water. On seasonal timescales, the higher shear variance generally coincides with the average summer mixed layer depth, except at the mean locations of the SAF and PF where currents are mainly barotropic. Along-track horizontal wavenumber spectra are computed for velocities oriented along- and cross- Drake Passage. The spectra show that the down passage velocities, dominated by the mean flow, have the characteristic lengthscales of O(200 km) and are significantly more energetic than the cross-passage velocities, dominated by mesoscale eddies and meanders, which have similar lengthscales. Velocity variance is higher in northern Drake Passage than in the south.

Streamwise coordinates are derived from streamlines of the gridded Eulerian mean surface circulation. Eddy momentum fluxes are estimated by ensemble averaging Reynolds stresses along mean streamlines and compared to averaging the stresses parallel to the mean orientation of Drake Passage. Our EKE estimates in northern Drake Passage are O(600 cm ^{2}s^{-2}), significantly higher than estimates inferred from satellite altimetry.