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Circulation in Drake Passage revisited using new current time series and satellite altimetry

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The Drake Passage circulation was examined using in situ velocity time series gathered at five mooring sites across the Yaghan Basin (from January 2006 to March 2009), and at four mooring sites across Ona Basin (from February 2006 to April 2008). The moorings were located under the Jason satellite ground-track #104, allowing precise comparisons with various altimetry products.
The mooring data suggested the existence of a permanent strong deep cyclonic circulation in the northeastern part of the Yaghan Basin and in the Ona Basin. The mean velocity vectors were observed to rotate with depth. Rotations of the mean velocity vector with depth indicated consistent downwelling except at the mooring located at 59°S, in the center of the Ona Basin. Temporal scales of variability observed from the mooring data were analyzed and leading modes of variability were discussed.
The in situ data provided the first opportunity to compare altimetry-derived velocities with high temporal resolution near-surface current meter velocities in a large eddy kinetic energy environment at high latitudes. Globally, altimetry-derived velocities compared rather well with the in situ velocities at 500 m depth both in strength and direction. Correlations were high between the in situ velocities and the surface velocities derived from satellite altimetric data. The quality of the altimetric surface geostrophic velocities being assessed, altimetry was used to further interpret observations at isolated mooring sites and to put them in context of the 18-year-long altimetric time series.
In Yaghan Basin, during the in situ measurement period, the spatial structure of the dominant mode of Mean Sea Level Anomaly was associated to the presence of a strong southward meander of the Subantarctic Front upstream of the mooring section. The 18-year-long altimetry time series revealed that this pattern is robust, dominant and had a strong semi-annual component.
Map of Absolute Dynamic Topography-derived velocity across the crest of the Shackleton Ridge, at the western entrance to the Ona Basin, showed that deep gaps in the ridge control the mean location of the Antarctic Circumpolar Current frontal branches. In the complex area where the Shackleton Fracture Zone intersects the West Scotia Ridge, the Map of Absolute Dynamic Topography maps provided an accurate documentation of the meandering of the Polar Front branches around the seamounts, in remarkable agreement with the current meter data.
The altimetry helped to put the mooring period into perspective and in particular to show that some of the events sampled during the mooring period were exceptional, such as the invasions of water from south of the southern boundary of the ACC over a large part of the Ona Basin. An active ventilation of the Circumpolar Deep Water by water from the south of the southern boundary of the ACC was shown to be associated with cyclonic eddies and their filaments [Provost et al., 2011].