The Southern hemisphere has one of the most dynamic ocean areas that are critical for global climate. We compute a high resolution mean dynamical ocean topography (MDT) using geodetic data and our knowledge of ocean dynamics as given by hydrostatic primitive equations finite element ocean model, to derive a detailed model of the global ocean circulation in this crucial area. A geodetic MDT is determined using multi-mission altimeter data and the GRACE/GOCE gravity fields. The two geodetic gravity missions GRACE and GOCE allow the computation of a global geoid with unprecedented accuracy. While GRACE greatly improved the accuracy and global consistency of gravity models at low and medium wavelengths, GOCE is adding highly accurate geoid information in the medium to short wavelength range. A newly derived multi-mission mean sea surface based on 17 years of altimetry completes the MDT computation. Geoid and mean sea surface have been made consistent by a spectral filter. It is represented as spherical harmonic expansion; this allows us to analyze the oceanographic content in different wavelength bands. The analysis is complemented by rigorous error variance-covariance propagation of altimetry and the geoid model.

The geodetic MDT is assimilated in a finite element ocean circulation model configured on a triangular mesh. Various tests are performed in order to assess the characteristics of the assimilation process, the quality of the ocean circulation model and the properties of the derived oceanographic MDT and velocity field. The tests concentrate on the areas of the Antarctic Circumpolar Current (ACC).