



Causes of sea level variations in the Southern Ocean: analyses of sea level and a barotropic model.

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We analyze a decade of sea surface height (SSH) measurements in the Southern Ocean from the TOPEX/Poseidon and ERS altimeters, with a focus on the variability at time scales shorter than two years. Different processes contributing to large scale SSH variations are examined. Schematically, in this range of time scales, the barotropic response to the winds is the dominant contribution poleward of 50S while thermosteric processes dominate equatorward except for resonant basins for the barotropic modes and regions of intense eddy activity (western boundaries). A finite element model, forced with ECMWF winds from the ERA40 reanalysis, has been developed to examine the barotropic response of the ocean and analyze the vorticity budget. The SSH from the model agrees well with observations. The leading barotropic mode found in the model (65% of the barotropic SSH variance), which is annular, confined near Antarctica and responsible for most of the barotropic circumpolar transport, is coherent with the zonal integral of the eastward wind stress consistent with a free mode response. Although previously evidenced in bottom pressure data, this “southern mode” can only partially be seen in altimeter data due to ice coverage. It nevertheless distinctly appears above the Pacific Ridge where it expands meridionally up to mid-latitudes. The geographical disparity of the barotropic response is discussed in the rest of the domain, and several regions coherent with the wind stress curl are found. These are deep basins isolated by f/H contours. An analysis of the local vorticity budget shows that over most of the basin, topographic Sverdrup balance is the leading process for periods longer than 50 days, but in some regions (particularly regions of resonance) diffusive and non stationary terms are important. A comparison with a steady state run suggests that transients redistribute energy along f/H wave guides, contributing to drain resonant regions, as was hypothesized in previous works.