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Barotropic and baroclinic processes in the transport variability of the Antarctic Circumpolar Current

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Variability of the Southern Ocean wind field result in transport variations of the Antarctic Circumpolar Current (ACC). It is observed that these transport fluctuations are highly coherent with the bottom pressure field all around the Antarctic continent in the high-frequency range. The coherence pattern, in contrast to the steady state ACC, is steered by the geostrophic f/h contours passing through Drake Passage and circling closely around the continent. At lower frequencies, with interannual and decadal periods, the correlation with the bottom pressure continues but baroclinic processes gain importance. For periods exceeding a few years, variations of the ACC transport are in geostrophic balance with pressure field associated with the baroclinic potential energy stored in the stratification while bottom pressure plays a minor role.

To clarify the dynamic processes we apply a circulation model with simplified physics (the BARBI model) and use two types of wind forcing: the NCEP wind field with integrations spanning three decades, and an artificial wind field constructed from the first three EOFs of NCEP combined with a temporal variability according to an autoregressive process. We analyze the spin-up, trends and variability of the model runs. Particular emphasis is placed on coherence and correlation patters between the ACC transport, the wind forcing, the bottom pressure field and the pressure associated with the baroclinic potential energy. A stochastic dynamical model is developed which describes the dominant barotropic and baroclinic processes and represents the spectral properties for a wide range of frequencies, from monthly periods to hundreds of years.