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The Semiannual Oscillation of Southern Ocean Sea Level

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The atmospheric Semiannual Oscillation (SAO) is a half-yearly wave in mean sea level air pressure, which exhibits equinoctial maxima between 45°S and 50°S and solstitial maxima between 55°S and 65°s, with a phase reversal occurring at around 60°S. Its existence has been attributed to a phase difference in the annual temperature cycle between mid- and high-latitudes which sets up meridional temperature and pressure gradients that are largest during September and March, enhancing atmospheric baroclinicity and inducing equinoctial maxima in the Southern Hemisphere Westerlies.
In this study, we use harmonic analysis of atmospheric and oceanic Southern Ocean datasets to show that this atmospheric SAO induces oceanic counterparts in sea level and circumpolar transport. This aspect of atmosphere–ocean interaction is particularly important, given the capacity of the Antarctic Circumpolar Current (ACC) to influence regional climate through the exchange of heat, fresh water and nutrients to each of the major ocean basins. We examine the relative contributions of local and regional semiannual atmospheric fluctuations in explaining the observed sea level response at 20 Southern Ocean and South Atlantic tide gauge stations and find that the oceanic SAO is associated with a modulation of zonal surface wind strength at key latitudes between ∼55°S and 65°S. We also explore whether a seasonal inequality in SAO amplitude might facilitate the deduction of the timescales upon which Southern Ocean ‘eddy saturation’ theory might operate. However, though we find evidence of biannual fluctuations in eddy kinetic energy, regional variations in the phases and amplitudes of these emergent harmonics prevent us from elucidating the possible timescales upon which an eddy response to the atmospheric SAO might arise.