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Decadal trends in the Antarctic sea ice extent ultimately controlled by ice-ocean feedback

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The large natural variability of the Antarctic sea ice is a key characteristic of the system that might be responsible for the small positive trend in sea ice extent observed since 1979. In order to gain insight in the processes responsible for this variability, we have analysed in a control simulation performed with a coupled climate model a positive ice-ocean feedback that amplifies sea ice variations. When sea ice concentration increases in a region, in particular close to the ice edge, the mixed layer depth tends to decrease. This can be caused by a net inflow of ice, and thus of freshwater, that stabilizes the water column. A second stabilizing mechanism at interannual time scales is associated with the downward salt transport due to the seasonal cycle of ice formation: brine is released in winter and mixed over a deep layer while the freshwater flux caused by ice melting is included in a shallow layer, resulting in a net vertical transport of salt. Because of this stronger stratification due to the presence of sea ice, more heat is stored at depth in the ocean and the vertical oceanic heat flux is reduced, which contributes to maintain a higher ice extent. This positive feedback is not associated with a particular spatial pattern. Consequently, the spatial distribution of the trend in ice concentration is largely imposed by the wind changes that can provide the initial perturbation. A positive freshwater flux could alternatively be the initial trigger but the amplitude of the final response of the sea ice extent is finally set up by the amplification related to ice-ocean feedback. Initial conditions have also an influence as the chance to have a large increase in ice extent is higher if starting from a state characterized by a low value.