Remote and local processes controlling decadal sea-ice variability in the Weddell Sea

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Physical mechanisms underlying decadal sea-ice variability over the Weddell Sea are investigated using a state-of-the-art coupled general circulation model (CGCM). Observational analysis during the satellite period (1982-2018) shows that decadal increase in sea-ice concentration (SIC) over the Weddell Sea is preceded by easterly wind anomalies. A 300-yr simulation of the CGCM confirms the observed relationship and demonstrates that the easterly wind anomalies act to weaken upwelling of warm water from the subsurface ocean and the associated ocean mixing/diffusion, and lower the near-surface ocean temperature thereby inducing the SIC increase. The zonal wind variability exhibits a close link to atmospheric intrinsic variability in the mid-high latitudes, called the Southern Annular Mode. Another sensitivity experiment with 300-yr simulation, in which interannual sea-surface temperature (SST) variations are suppressed outside the South Atlantic and the Weddell Sea, reveals that anomalous cooling of near-surface ocean temperature is induced by anomalous northward outflow of warm water from the northern Weddell Sea linked with the zonal wind variability and anomalous westward inflow of cold water from the eastern Weddell Sea accompanied by strengthening of the Weddell Gyre. The strengthening of the Weddell Gyre is associated with an increase in ocean density, which is mostly due to an increase in salinity induced by enhanced surface evaporation during the transition period of low to high sea-ice. These results indicate that remote atmospheric forcing together with the local ice-ocean interaction is greatly important for generation of decadal sea-ice variability over the Weddell Sea.

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