Quasi-decadal variability of Antarctic sea ice

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In the last 30 years, contrary to the Arctic sea ice rapid decrease, the Antarctic sea ice extent has been increasing, with significant regional scale increase at the Ross Sea (RS) sector and decrease at Bellingshausen Sea (BS). However latest IPCC models (Coupled Model Intercomparison Project 5) predicted a decrease in Antarctic sea ice extent in this time period, thereby unable to reproduce this observed increasing trend. The long-term Antarctic sea ice variability (~10-30 years) is difficult to examine due to the limitation in the satellite observation record. Hence a high resolution (0.5º x 0.5º in ocean and 1º x 1º in atmosphere) coupled ocean-atmosphere-ice model (CFES Mini), is used to study the sea ice long-term variability in relationship with physical variables such as sea surface temperature (SST) and geo-potential height (Z) along with the observed data. The model does not include the anthropogenic and external (volcanic eruption) effects, which is suitable to examine the natural quasi-decadal variability.

The climatological location of model sea ice edge compares well with that of the observation. As for its variability, some modes of model sea ice concentration (SIC) variability reveal realistic patterns. The second mode of the annual mean SIC [Fig. 1b] exhibits a spatial dipole structure with opposite signed anomalies in the Atlantic and Pacific oceans which is similar to the leading mode of the observed satellite SIC (~4-5 years). Similarly the SST modes also shows the same spatial and temporal relationship. However, the leading mode of SIC [see Fig. 1a] in the model shows an quasi-circumpolar pattern with a dominant time scale of 15-20 years, which is absent in the observations due to its shorter time scale (32 years). The leading SST mode also reveals a similar pattern with the time score showing a high degree of inverse correlation (~-0.9) with the SIC. The model southern annular mode (SAM) projects on well with these leading modes of both SIC and SST with significant correlation. However the SST and SIC in the model are more closely related to each other than with SAM. This indicates that the oceanic natural variability is the key to understand the variability in sea ice.

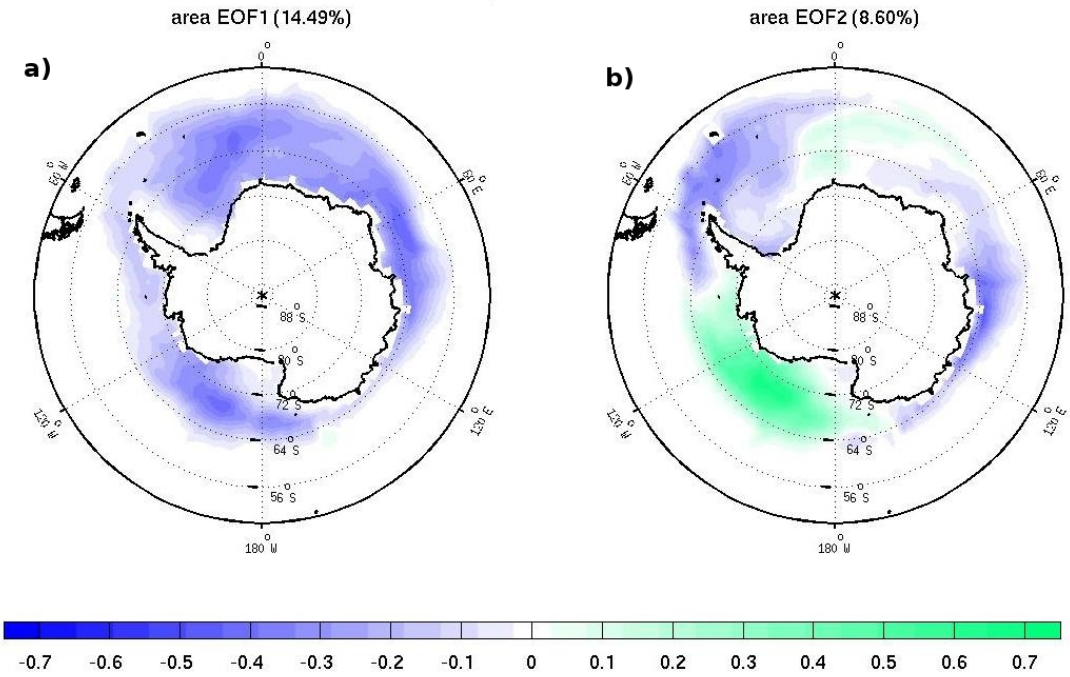

Figure 1. Spatial patterns of leading modes (1 & 2) of annual mean sea ice concentration anomalies from CFES Mini.