Compounding Tropical and Stratospheric Forcing of the Record Low Antarctic Sea-Ice in 2016

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During extended austral spring 2016, Antarctic sea ice extent (SIE) dramatically declined, reaching a record low level. Here we show that a combination of seasonal and subseasonal atmospheric circulation anomalies, driven laterally by anomalies in tropical convection over the Indian and western Pacific Oceans and vertically by anomalous weakening of the polar stratospheric vortex, played primary roles for promoting and maintaining this SIE decline.

During September-October 2016 a strong negative Indian Ocean dipole accompanied by a weak La Niña in the Pacific promoted record convective anomalies over the equatorial eastern Indian and western Pacific Oceans. These convective anomalies excited Rossby wave trains that generated favourable conditions for sea-ice decline over the Pacific to west Ross Sea and the Bellingshausen Sea sectors of Antarctic. The sea-ice decline was accelerated in November by development of a record strong easterlies along the sea-ice edge associated with the negative phase of the Southern Annular Mode (SAM), which appears to have been induced by a strong Madden-Julian Oscillation convective event that traversed the Indian Ocean in November 2016. The negative SAM was supported and maintained by rapid weakening of the Antarctic stratospheric polar vortex beginning in October, whose anomalies extended downward to affect the surface circulation in November and December.

Although the record strength of both the SAM-related wind anomalies in November-December and the tropical convective anomalies in September-October are not well separated individually from their previous records, their sequential combination clearly is an outlier. These processes primarily reflect internal variability of the atmosphere, but the influence of anthropogenic forcing in the long-term warming of the Indian Ocean may have contributed to the severity of the decline in 2016.

Key words: Antarctic sea ice decline