A 150-year reconstruction of the Southern Annular Mode

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Southern Hemisphere climate variability is dominated by two oscillating drivers: the Southern Annular Mode (SAM) and the El Nino Southern Oscillation (ENSO). Combined, the two forcings can enhance or partially off-set their influence on Southern Hemisphere climate.

An ice core from coastal Victoria Land in the Ross Sea Region, spanning the past 150 years, provides insights into the relationship between regional temperature, sea-ice extent, SAM, and ENSO. Our results record (d18O, dD, deuterium excess, major ion and trace elements) show that more than 50% of the regional temperature variability can be explained by combined SAM and ENSO forcing. Sea-ice extent is negatively correlated to temperature variability with more (less) extensive sea-ice during warmer (colder) years. This inverse relationship is explained by a positive ENSO forcing of sea-surface temperatures and a negative ENSO forcing of regional air temperature. Transfer functions are used to convert water isotope and deuterium excess records into a proxy index for SAM. Our data suggest that over the last 150 years mean annual SAM increased overall by almost 1 sigma standard deviation. The increase occurs predominantly during 1868-1944 and 1971-present. We conclude that ozone depletion can only partially explain the observed intensification of the polar vortex.

However, to test the reliability of our record and its regional significance, it is necessary to correlate our data with high resolution ice core records from other Antarctic sites. The ITASE data set is a unique and excellent dataset to permit such an evaluation and improvement of our data interpretation.