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Sea surface temperature variability over the western Indian Ocean sector of Antarctica during the past two centuries and its linkages to tropical-extratropical climate modes

Content

Sea Surface Temperature (SST) is a crucial climate parameter to understand the response of ocean to the climate change. Annual to decadal variability of Southern Ocean temperature is poorly understood on a longer time scale. In this study, we have reconstructed a long-term SST record of western Indian Ocean sector of Antarctica using an annually resolved Deuterium excess (d-excess) profile for the past two centuries (1809–2013 CE) from an ice core (IND33) from the Dronning Maud Land (DML) coast of East Antarctica. Spatial correlation between d-excess and ERA-5 SST anomaly records during 1979-2013 CE clearly shows that ice core d-excess records in the coastal DML region are primarily related to past SST variability in the Western Indian Ocean Sector (WIOS) of Antarctica. A similar correlation was also observed between ECHAM5-wiso model derived d-excess and SST variation over this region. This relationship enabled us to reconstruct, for the first time, a long-term (1809–2013 CE) annual SST anomaly records for the WIOS region based on a linear regression equation obtained between d-excess and ERA-5 SST anomaly data. The long-term reconstructed SST anomaly (1809–2013 CE) over WIOS, combined with the available ERA-5 SST anomaly, shows a slightly increasing trend (–0.004 ± 0.001°C decade-1) during 1809–1969 CE. However, a significant declining trend in SST anomaly (–0.028 ± 0.009°C decade-1) is found during 1981–2014 CE. The spectral and wavelet analyses suggest that variability in ice core-based SST anomaly record is dominated by a 40 year cyclicity, potentially controlled by the Pacific Decadal Oscillation (PDO). This suggests that the decadal variability of SST over the WIOS region is dominantly influenced by PDO. However, a recent decline in SST anomaly over the WIOS region reveals a strong anti-phase relation with Southern Annular Mode (SAM) index during 1979–2015 CE. Our investigation suggest that this recent decline in SST anomaly is related to the accumulation of wind-derived sea ice concentration over the WIOS region during the positive shift in SAM.

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