



Drivers of Antarctic sea-ice expansion and Southern Ocean surface cooling over the past four decades

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Despite global warming, total Antarctic sea-ice coverage has increased overall during the past four decades. In contrast, the majority of CMIP5 models simulate a decline. In addition, Southern Ocean surface waters have largely cooled, in stark contrast to almost all historical CMIP5 simulations. Subantarctic Surface Waters have cooled and freshened while waters to the north of the Antarctic Circumpolar Current have warmed and increased in salinity. It remains unclear as to what extent the cooling and Antarctic sea-ice expansion is due to natural variability versus anthropogenic forcing; due for example to changes in the Southern Annular Mode (SAM). It is also unclear what the respective role of surface buoyancy fluxes is compared to internal ocean circulation changes, and what the implications are for longer-term climate change in the region. In this presentation we will outline three distinct drivers of recent Southern Ocean surface trends that have each made a significant contribution to regional cooling: (1) wind-driven surface cooling and sea-ice expansion due to shifted westerly winds, (2) teleconnections of decadal variability from the tropical Pacific, and (3) surface cooling and ice expansion due to large-scale Southern Ocean freshening, most likely driven by SAM-related precipitation trends over the open ocean. We will also outline the main reasons why climate models for the most part miss these Southern Ocean cooling trends, despite capturing overall trends in the SAM.