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Antarctic Climate Variability: Covariance of Ozone and Sea Ice in Atmosphere – Ocean Coupled Model Simulations

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Changes in sea ice significantly modulate climate change because of its high reflective and insulating nature. While Arctic Sea Ice Extent (SIE) shows a negative trend. Antarctic SIE shows a weak but positive trend, estimated at 0.127 x 106 km2 per decade.
The trend results from large regional cancellations, more ice in the Weddell and the Ross seas, and less ice in the Amundsen - Bellingshausen seas. A number of studies had demonstrated that stratospheric ozone depletion has had a major impact on the atmospheric circulation, causing a positive trend in the Southern Annular Mode (SAM), which has been linked to the observed positive trend in autumn sea ice in the Ross Sea. However, other modelling studies show that models forced with prescribed ozone hole simulate decreased sea ice in all regions comparative to a control run. A recent study has also shown that stratospheric ozone recovery will mitigate Antarctic sea ice loss.
To verify this assumed relationship, it is important first to investigate the covariance between ozone's natural (dynamical) variability and Antarctic sea ice distribution in pre-industrial climate, to estimate the trend due to natural variability.
We investigate the relationship between anomalous Antarctic ozone years and the subsequent changes in Antarctic sea ice distribution in a multidecadal control simulation using the AO-UMUKCA model. The model has a horizontal resolution of 3.75 X 2.5 degrees in longitude and latitude; and 60 hybrid height levels in the vertical, from the surface up to a height of 84 km. The ocean component is the NEMO ocean model on the ORCA2 tripolar grid, and the sea ice model is CICE.
We evaluate the model's performance in terms of sea ice distribution, and we calculate sea ice extent trends for composites of anomalously low versus anomalously high SH polar ozone column. We apply EOF analysis to the seasonal anomalies of sea ice concentration, MSLP, and Z 500, and identify the leading climate modes controlling the variability of Antarctic sea ice in each case, and study their relationship with SH polar ozone column.