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Effect of Recent Sea Surface Temperature Trends on the Springtime Cooling Trend of the Arctic Stratospheric Vortex

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The springtime Arctic polar vortex has cooled significantly over the satellite era, with consequences for ozone concentrations in the springtime transition season. The causes of this cooling trend are deduced by using comprehensive chemistry-climate model experiments.

Approximately half of the satellite era early springtime cooling trend in the Arctic lower stratosphere was caused by changing sea surface temperatures (SSTs). An ensemble of experiments forced only by changing SSTs is compared to an ensemble of experiments in which both the observed SSTs and chemically- and radiatively-active trace species are changing. By comparing the two ensembles, it is shown that warming of Indian Ocean, North Pacific, and North Atlantic SSTs, and cooling of the tropical Pacific, have strongly contributed to recent polar stratospheric cooling in late winter and early spring, and to a weak polar stratospheric warming in early winter.

When concentrations of ozone-depleting substances and greenhouse gases are fixed, polar ozone concentrations show a small but robust decline due to changing SSTs. Ozone changes are magnified in the presence of changing gas concentrations.

The stratospheric changes can be understood by examining the tropospheric height and heat flux anomalies generated by the anomalous SSTs. Finally, recent SST changes have contributed to a decrease in the frequency of late winter stratospheric sudden warmings.