

Attribution of the 11-Year Solar Cycle in Lower-Stratospheric Temperature and Ozone

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The effects of the 11-year solar cycle on ozone and temperature in the stratosphere have been well documented. In the tropics the observed response consists of statistically significant warming and ozone increase in the upper (~50 km) and lower (~25 km) stratosphere. Several chemistry-climate models reproduce this double-peak in the temperature and ozone response. However, there are concerns about the origin of the lower peak due to potential aliasing with ENSO events or volcanic eruptions.

We focus on the attribution of the solar cycle in lower-stratospheric temperature and ozone time series from reference simulations performed with the chemistry-climate model SOCOL within the framework of IGAC/SPARC Chemistry-Climate Model Initiative. The solar cycle is attributed in a classical way using a multiple linear regression model with statistical rigor in terms of residual modeling. In addition, we analyze three sensitivity simulations to examine the influence of sea surface temperatures and volcanic eruptions on the lower stratospheric solar cycle signal.

Our results show how the solar signal is strongly affected by volcanic eruptions, following the large Mt. Agung volcanic eruption in 1963. This implies that the lower-stratospheric temperature and ozone response is not purely solar in origin. Therefore, its proper characterization requires either longer time series or periods not contaminated by volcanic aerosols. We explain how the solar signal could be misattributed to another signal due to their collinearity (aliasing) and how the amplitude of the signal may be dependent on the method of analysis.