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The impact of volcanic events and ENSO on the detection of the solar cycle signal in the tropical lower stratosphere

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Previous studies using a multiple linear regression model to fit both observations and reanalysis data pointed to a significant 11 year solar cycle response in the tropical stratosphere. Temperature and ozone increase during solar maximum, with the largest relative response near 20 and 45 km altitude. However, continuous satellite data has only been available since 1978, which means that the analysis period covers at most three solar cycles. This hinders a clean separation of a solar signal from other natural sources of variability. In particular, in the tropical lower stratosphere part of the decadal variability in this region is due to ENSO and major volcanic events (e.g., El Chichon in 1982 and Pinatubo in 1991 occurred during the peak of solar activity).

We investigate the relative contribution of volcanic eruptions and ENSO in the quasi-decadal signal commonly attributed to the 11 year solar cycle. For this purpose, we present results from transient simulations with the Whole Atmosphere Community Climate Model, which were carried out with observed forcings, including the 11 year solar cycle in irradiance. In one simulation, we exclude the ENSO variability by prescribing climatologically varying sea surface temperatures. In the second simulation, we exclude volcanic aerosol forcing. We compare the solar signal in both simulations, with a focus on the tropical lower stratosphere, to the signal in simulations run with all natural and anthropogenic forcings. Differences in the derived solar response quantify the impact ENSO and volcanic events have in correctly attributing decadal changes to the solar cycle in the relatively short observational record.