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ENSO effects on stratospheric trace gases: How do we capture reality?

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The El Niño/Southern Oscillation (ENSO) phenomenon is an important pacemaker for interannual variability in the Earth's atmosphere. ENSO impacts on trace gases have been observed and modelled for the stratosphere and the troposphere. However, unambiguous attribution is often difficult due to the limited length of homogenous observational records and thus long-term (decadal) trends are sometimes difficult to detect. Generally ENSO impacts in low latitudes are easier to detect, because the response emerges close (temporally and spatially) to the forcing. Moving from low to high latitudes it becomes increasingly difficult to isolate ENSO driven variability, due to time-lags involved and many other modes of variability playing a role as well. Here, we use a nudged version of the EMAC chemistry-climate model to evaluate ENSO impacts on trace gases over the last 35 years (a so-called Ref-C1SD integration) and contrast the nudged model with its free running counterpart. We use water vapour and ozone observations from the MIPAS instrument on ENVISAT from 2002 to 2012 to test the model performance. Using lagged correlations for the longer model time-series we trace the ENSO signal from the tropical lower troposphere to the polar lower and middle stratosphere and provide a framework for simple attribution of the ENSO signal in trace gases. This concise characterisation of the ENSO impact on trace gases aids improved trend detection in temporally limited time series.