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How to detect the ENSO signal in tropical ozone: Using models to understand observations

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Attributing forced ozone variability on different time scales is a prerequisite for the detection of small trends. In tropical regions the quasi-biennial oscillation (QBO) and the El Niño/Southern Oscillation (ENSO) are important pacemakers for interannual ozone variability. However, unambiguous attribution of ozone changes due to the QBO or the ENSO cycle is often difficult, due to the limited length of homogenous observational records and thus long-term (decadal) trends are difficult to detect. For example, ozone data observed over a decade is not enough for an unambiguous detection of an ENSO signal.

Here we will use model data in conjunction with observational records to attribute tropical ENSO variability. Model integrations with chemistry-climate models (CCMs) can be performed for longer time periods than exist from the observational records, allowing us to test the model for overlap periods and to inter- and extrapolate in time (knowing about the deficits of the model from the overlap period). In addition a CCM can be run in two modes for the recent past: Nudged (also called "specified dynamics") or free running. In the nudged case the meteorology of the model is constrained with ERA-Interim data, in the free running case the model is only constrained by boundary values (in particular sea-surface temperatures and sea-ice). In both cases ozone variability results from the chemical boundary conditions (which are identical) and the dynamical and thermodynamical drivers. By comparing the free running and nudged model with observational data for the overlap period, e.g. Ozone_CCI column ozone or MIPAS on ENVISAT height resolved ozone mixing ratios, we can attribute ENSO induced ozone variability better. With the continuous model representations of the recent past, both nudged and free running, we can thus detect residual long-term trends in tropical ozone with more confidence. However, we will also discuss caveats for using the model as a transfer standard and as an interpolator and extrapolator of data.