Correlated variability of upwelling and tracers near the TTL

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Motivation

- Tropical upwelling magnitude and variability are largely uncertain (no direct measurements), despite their relevance for tracer transport into the stratosphere.
- Sharp vertical gradients across the tropical tropopause enhance the effect of upwelling on tracer concentrations (Randel et al. 2007).
- Time series of temperature show common variability with ozone and carbon monoxide (CO) observations, both on seasonal and sub-seasonal timescales (Fig.1).

Is tropical upwelling mainly driving the observed common variability between temperature and tracers?

Seasonal cycles

- The annual cycle in temperature is associated to upwelling seasonality, not completely balanced by diabatic heating due to the long radiative timescales.
- The analysis of all the terms in the TEM tracer continuity equation can tell us what is mainly driving the seasonality in ozone and CO.

Tracer tendency

- Advection by TEM residual circulation
- Chemical Production - Loss
- Eddy transport

Uncertainties in all terms

Carbon monoxide

- The seasonal cycles in ozone and CO tendencies closely follow the seasonality in vertical advection by tropical upwelling. This is seen both in observations and in WACCM.
- Large residual in ozone balance is mainly due to eddy transport (see Discussion). Smaller residual for CO is consistent with smaller eddy transport in WACCM.

WACCM

Sub-seasonal fluctuations

- Common fluctuations between temperature and tracers on fast timescales are often observed also in upwelling (Fig.7).
- The correlations are statistically significant and reflect the vertical structure of the vertical gradients in tracer concentrations*

WACCM shows consistent results for upwelling, and also reveals the importance of mixing for sub-seasonal tracer variability at lower levels.

Open questions

- Why are our results for ozone seasonality different from Ploeger et al., (2012)?
- How realistic is eddy transport in WACCM?
- What drives variability in upwelling?
- And in eddy transport? -

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References


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