Transport analysis and source attribution of the tropical CO variability in the UT/LS

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CO Tape Recorder

CO tape recorder: first identified by Schoeberl et al. (2006) using MLS data, GCM model analysis by Duncan et al. (2007).

**Objectives:**

- To understand the processes that determine observed temporal and spatial variability in CO in the UT/LS.
- To evaluate vertical transport in CTMs driven by GEOS-4 and GEOS-5 archived fields.
MLS observations and GEOS-Chem Model

**MLS V3.3 level 2 data**
- the factor of 2 high bias in MLS v2.2 has been eliminated

**Standard chemistry run:**
- GEOS-Chem v8-02-04, 4° × 5° horizontal resolution
- Two runs driven by archived GEOS-4 (2005-06) or GEOS-5 (2005-08) assimilated met. fields
  - diff. convection parameterization
- Model profiles applied with the MLS AK.

**Tagged CO run:**
- 2° × 2.5° horizontal resolution
- OH fields from chemistry run
- CO (P-L) rate in stratosphere from GMI model
CO tape recorder (12°N-12°S)
Inter-annual variations (IAV) driven by fire emissions

The GEOS-Chem models capture the main features in MLS data.

CO from Indonesian fires in late 2006

IAV of CO peaks in NH fire season apparent (Jan.-Apr.).

4-yr mean is subtracted from time series
Temporal overlapping of surface BB from different continents generates the semi-annual cycle at ~200 hPa.

IAV driven by CO fire emissions, especially from Indonesia.
CO fall peaks propagate slower than the winter/spring peaks – causing the semi-annual cycle to shift to an annual cycle around 70 hPa.

max. in Feb-Apr, min. in Jul-Aug.
GEOS-4 stronger than GEOS-5

4-yr mean is subtracted from time series
GEOS-5: vertical transport too weak

Much less CO has been lofted in GEOS-5.

GEOS-5:
100-75 hPa - Transport too low in all seasons, especially in summer.

GEOS-4:
Comparable vertical transport in fall-winter below 90 hPa.
Weaker vertical transport in summer below 90 hPa – possibly causing the damped seasonal cycle in the model.

Vertical velocity deduced from heating rates (obs. H₂O and O₃ Radiative transfer model)

Yang et al., 2008
Conclusion

- Semi-annual cycles of CO below 80 hPa in the TTL - determined by the temporal overlapping of surface BB emissions from different continents.

- Transition from semi-annual to annual cycles around 80 hPa – induced by a combination of the signal at the tropopause and the annual cycle of BDC in the LS.

- Strong interannual variation with a CO maximum in boreal fall 2006, mainly caused by fires in the Indonesian region.

- GEOS-5: too weak vertical transport.

- GEOS-4: possibly weaker vertical transport in summer-fall - decreasing the amplitude of the seasonal cycle.
Spatial-temporal decompositions (EOFs) – annual cycle

Model doesn’t catch the slower upward propagation of CO fall peak – possibly causing the damped seasonal cycle in the model.