Chemical Feedback from Decreasing Carbon Monoxide Emissions

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**Motivations, data and methods**

- Global surface network from the 90s (Novelli et al. 1998, 2003)
- Northern hemisphere dominated by anthropogenic sources and boreal fires, long term decreasing trends.
- Tropics and southern hemisphere variability governed by Biomass Burning emissions, large interannual variability
- CO sinks has also a strong seasonal cycle

**Satellites measurements since 2000s**
- The main results are in accordance with the surface estimates
- Reanalysis of satellite observations
- Understanding the CO budget
- Developing pre-operational analysis and forecast system
- Explaining variability and long term trends

**Context**

- Simple chemical models for CH4/CO/OH interactions (Prather 2007)
- CH4, CO and OH cannot be treated separately
- Perturbations in CO or CH4 affect the whole systems (‘2opb CO excite all the three models’)
- The CH4 lifetime is 4-0 % longer because of CO
- The atmospheric oxidation capacity is generally not sensitive to perturbations that may arise from variations or trends in emissions of natural and anthropogenic origin (labeled 2016)

**Goal:**

Represent errors in modelling CO

1. Emissions
2. Meteorology
3. Deposition
4. Initial conditions / chemistry

**Observations**

- Meteorological observations
  - DART/CAM (Raeder et al. 2012)
  - MOPITT V51 (Deeter et al., 2013)
- Daytime retrievals of CH4
- Remoted based upper three levels
- Super observations (horizontal): Error weighted average, no observation error correlation
- Relaxation according to the maximum of the averaging kernel

**Impact on tropical CO chemical trends**

- The tropics (between 305 and 30N) contributes to between 60 (summer) to 80 % (winter) of the global tropospheric CH4 oxidation and the global CO chemical production
- We used the widely employed Seasonal Trend decomposition using LOESS (locally weighted scatterplot smoothing), or STL (Cleveland et al., 1990).
  - This method is designed to identify the trend (T) and the seasonal (S) component from a given time series (Y), as well as a second order remainder (e). The general model is to decompose the time series into those 3 additive components as follow:
    \( Y(t) = T(t) + S(t) + e(t) \)
  - The reduction of [CO] across the period is remarkably well-correlated with the CH4 lifetime, confirming the mechanism presented above.
  - The long-term trends provide strong evidence of a positive trend of the CH4 chemical loss and CO chemical production in the MOPITT-Reanalysis.