1. Introduction

Carbon monoxide (CO): important role in atmospheric chemistry and radiation balance; produced by incomplete combustion of carbon-based fuels; lifetime of 1-2 months in the troposphere, used as a good tracer.

UT CO Transport pathway:

I. Local convection (e.g., Thompson et al. 1996)
II. LT advection → convection (e.g., Folkins et al. 1997)
III. UT Advection (e.g., Ray et al. 2004)

Three pathways for transporting biomass burning generated CO to the upper troposphere (UT) CO center:

- CO emissions at the surface peak during boreal fall and winter, while convective activity peaks during boreal summer and winter.
- UT CO peaks during boreal fall, and is higher during boreal spring than during summer.
- The lack of correlations among peaks in UT CO and peaks in surface emission and convective activity highlights the potential importance of transport pathways.

2. Data and Methodology

- Aura TES L2 CO: 5.3 × 8.3 km (3.2-15.4 μm)
- Aura MLS L2 CO: 300-400 × 4km (240 GHz)
- Cloudsat CWC: 1.3 km × 1.7 km × 240m (94 GHz)

GFED V2.1: 1° × 1° gridded, derived from MODIS fire counts
- Local convection pathway: CO emission, deep convection and increase of CO in the UT are simultaneously detected during an 8-day period.
- LT Advection → convection pathway: deep convection and increase of CO in the UT are simultaneously detected without co-located surface CO emission during an 8-day period.
- UT advection pathway: increase of CO in the UT is detected in the absence of co-located deep convection during an 8-day period.

The influence of transport fluxes on UT CO concentration is diagnosed by evaluating the change in mean CO concentrations at 215 hPa between two consecutive 8-day periods.

- Vertically integrated CloudSat cloud water content (CWC) above 6 km is used to represent the strength of deep convective activity during the 8-day period.

The threshold of UT CO increase is 10 ppbv.

The threshold of CWC to determine deep convection is 100 mg m–3.

The seasonality of the CO concentration in the tropical UT is more significant than that in the tropical LT.

3. Two Case Studies

Over Central Africa, CO appears to be transported to the UT via the “LT advection → convection” and “local convection” pathways. Over northern Africa, CO is transported via the “UT advection” pathway.

The locations of strongest CO emissions and strongest deep convective activity are in opposite hemispheres relative to boreal winter, which causes a similar reversal in the preferred hemispherical locations of the pathways over Central Africa.

4. Seasonal Distribution of CO Transport Pathways

The primary fire regions and the centers of high UT CO were located in opposite hemispheres.

“LT advection → convection” was the dominant pathway for transporting CO to the UT over South America.

The “local convection” pathway was not as prevalent over Central Africa as over South America, and “UT advection” played a more central role in this region.

5. Year 2007 Analysis

The seasonality of the CO over Central Africa and South America does not follow those of CO surface emission or deep convective activity. Rather, it primarily follows the seasonality of CO transport by the “local convection” pathway.


The multi-year analysis also suggested the seasonality of the CO concentration in the tropical UT mainly follows the seasonality of “local convection” transport pathway.

During each year (2005 - 2010), the “local convection” pathway is more effective in transporting CO from surface to UT than the “LT advection → convection” pathway.

7. Conclusions

- We have developed a method for detecting UT CO transport pathways on seasonal to interannual scales using Aura MLS, CloudSat and MODIS data.
- Dominant UT CO transport pathways vary both geographically and seasonally.
- The seasonality of the CO concentration in the tropical UT mainly follows the seasonality of “local convection” transport pathway, because “local convection” pathway is more efficient than “LT advection → convection” pathway.

References