Space-Time Variability of UTLS Chemical Distribution in the Asian Summer Monsoon Viewed by Limb and Nadir Satellite Sensors

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Asian summer monsoon anticyclone (ASM)
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Randel and Park, 2006
Park et al., 2007
Zhang et al., 2007
Intra-seasonal variability of CO in UTLS

WACCM-SD CO at 100 hPa

Pan et al., 2016
Motivation and Objective

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• The goal of this study is to see whether the denser sampled nadir sounding can show the ASM impact on the UTLS tracer distributions and variabilities.
Limb sounder (MLS) and Nadir sounder (OMI/IASI)
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Key Questions

- Do nadir view instruments have sufficient information to show the ASM dynamics driven trace gas distributions and variability at the UTLS levels?

- Are the data from nadir sensors consistent with the limb-viewing data on sub-seasonal scales with respect to dynamical variability of tracers in the ASM region?

- What can we learn from the complementary information from limb and nadir viewing instruments?
Seasonal mean CO distribution (MLS at 147 hPa and IASI at 12-16 km)

IASI CO data is capable of showing the impact of the ASM circulation on UT CO on seasonal scale
Consistency of MLS and IASI CO variability

Co-located bin averages from IASI CO to MLS CO in the monsoon region during JJA

IASI layer averaged CO have a smaller range of variability than MLS. It may be influenced by a weaker detection sensitivity in UT.
What about sub-seasonal scales?
Original level 2 data and interpolated data

5° x 5° Gaussian smoothing
Daily maps of MLS CO mixing ratio at 147 hPa

White contours indicate the location of the anticyclone

MLS successfully captures the day to day co-variability of CO with dynamical fields
Daily maps of IASI CO mixing ratio at 12-16 km

IASI UT CO provides additional eastward shedding over the western Pacific, which subsequently migrates southward.
Latitudinal-Pressure cross section of IASI CO and dynamical fields

Enhanced CO in UT is consistent with upward transport

At 90° E, over Tibetan Plateau

White dots indicate tropopause
terrain
Hovmoller diagrams of GPH and MLS/IASI CO anomalies

Anomalies are calculated with respect to the regional mean (15-35° N, 0-150° E) for 2012

Westward oscillation is evident while the amplitudes and timing are different
Time series of dynamics and MLS/IAIS CO

Averaged anomalies over 60-90° E

Correlation coefficients:
- MLS CO and IASI CO: 0.80
- GPH and MLS CO: 0.67
- GPH and IASI CO: 0.50
Conclusions

- IASI UT (12-16 km) CO distribution highlights the significant role of ASM dynamics in controlling the UTLS tracer distribution;
- The UT CO enhancement in IASI data displays finer scale structures in daily maps, and shows additional transport of CO enhanced air over the western Pacific and spreading equatorward following the anticyclonic flow;
- It also adds information to the vertical CO structure in ASM region;
- The analysis demonstrates the value of high horizontal sampling density from the nadir viewing sensors in capturing the dynamical variability of UTLS tracer distributions.