



The origin of Carbon Monoxide in the Asian Monsoon Anticyclone

GEOS-Chem / FLEXPART and IASI / IAGOS observations

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Documentation of the AMA composition

Satellites

(MLS/ACE/MIPAS/AIRS/MOPITT)

Global coverage and Multi-annual datasets

 ⇒ Isolation of the AMA with high pollutant (CO, HCN) concentrations
 ⇒ Large scale and inter-annual variabilities, transport pathways to the stratosphere

- Low vertical resolution / sensitivity to clouds
- Limb sounders limited to UT

Airborne obs. (CARIBIC):

Asia to Europe routes
Many species (CO, O3, CH3CN, NOy, NMHCs...)

⇒Type of pollution (biofuel, urban/industrial)
⇒ age of the air parcels

Low flights frequency (2/month)
Limited altitude range (>200 hPa)









IASI and GEOS-Chem

Chemistry transport model

- Assimilated Meteorology (NASA GMAO)
- Convection: Arakawa Schubert scheme
- O₃-NO_x-VOC chemistry
 - Li-NOx: CTH + injection profiles + LIS-OTD rescaling
 - ✓ BB: GFED-3 inventory
 - Anthropogenic: EDGAR + regional inventories (STREETS, BRAVO, EMEP...)
- Linearized stratospheric chemistry (LINOZ)

Metop/IASI observations



- nadir FTS / thermal IR (Metop-A 2006-...)
- overpass twice daily / 12 km pixel
- CO retrievals with 2 pieces of information in
 - ✓ lower troposphere (750 hPa)
 - ✓ UTLS (200 hPa)

GEOS-Chem versus IASI: CO



GEOS-Chem versus IASI: CO



GEOS-Chem versus IASI: CO



CO budget with GEOS-Chem



AMA 3D boundaries

AMA = PV or GH anomaly which depends on altitude/pressure level \Rightarrow need to define an anomaly that is not altitude dependent



AMA CO budget





<u>East Asia</u>

- Lower contribution
- Inside ~ outside AMA

=> Convection not collocated with emissions

<u>South Asia</u>

- Largest contribution
- Inside AMA > outside AMA

=> Convection collocated with emissions

(Barret et al., ACPD, 2016)

MOZAIC - IAGOS programs

- in-situ measurements from AIRBUS aircrafts since 1994
- tropospheric profiles + UTLS
- 21 years of O_3/H_2O , 13 years of CO, 5 years of NOy
- to come: cloud droplets, aerosols, GHG, NOx and NOy



IAGOS data within the AMA



Pressure range used : 275-200 hPa

Asian UT CO variability



1PVU - 80 ppbv CO => boundary between tropical and midlatitude air masses

- Pre and post-monsoon ~25°N
- Monsoon 37°N

Asian UT CO variability



Methodology to determine the origin of CO



Methodology to determine the origin of CO









- AMA: good agreement between GEOS-Chem and FLEXPART method
 Out: GEOS-Chem > twice larger than FLEXPART
- => AMA definition different: 3D with GC and along UT flight with FLEXPART

Conclusions

Global scale:

- GEOS-Chem: good representation of CO variations and AMA maximum
- IASI detects enhanced convective CO during the ASM
- South-Asian contribution to CO in the AMA twice larger than East-Asian: emissions/convection/AMA

• IAGOS

- Seasonal variations of CO in the Asian UT
- South Asian emissions have a contribution to CO in the AMA almost twice larger than East Asian emissions
- FLEXPART- (20d CO) and IAGOS in good agreement for (AMA-Out)

Perspectives







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