Diagnostics from UTLS in-situ observations and comparison with model(s)

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StratoClim

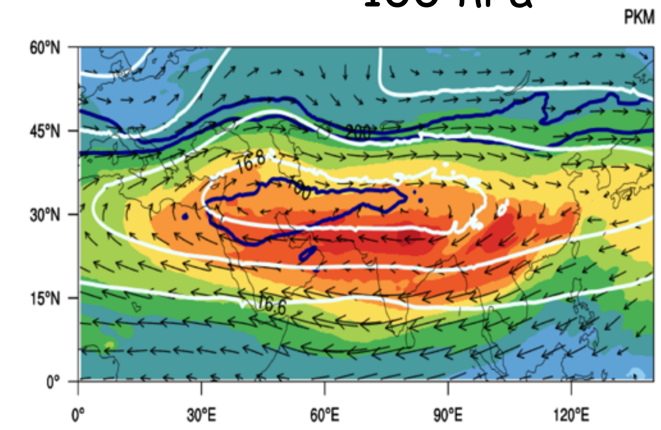
EUMETSAT

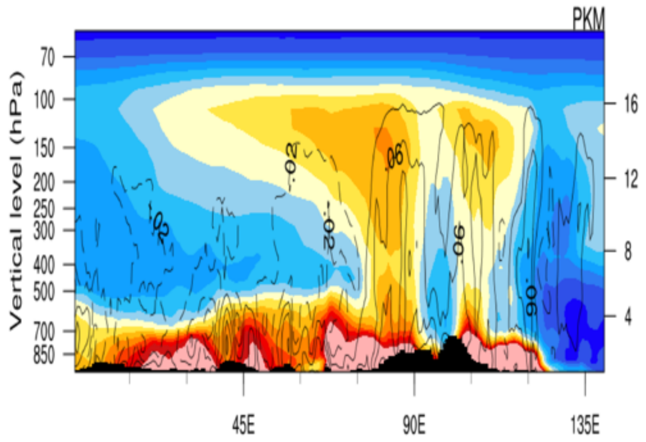
Atmosphere Monitoring

DLR

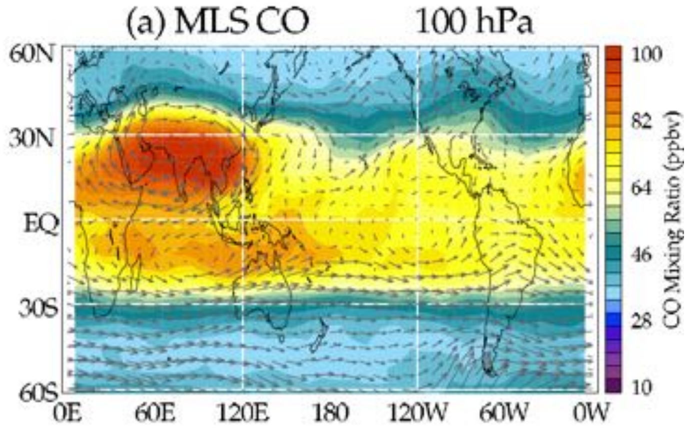
Asian Anticyclone and the global climate

100 hPa

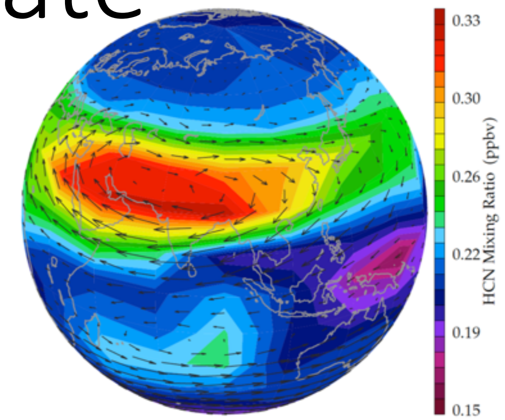




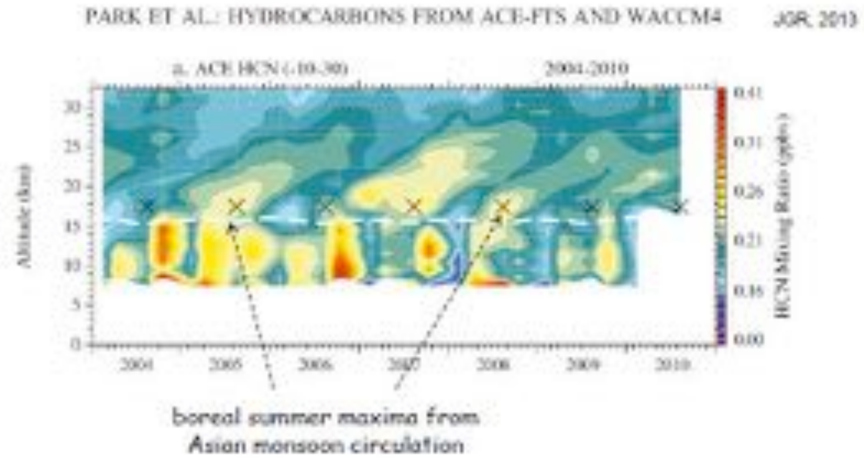
Carbonaceous
aerosol
During peak
monsoon phase



Park and Randel, 2007, 2008



HCN 'tape recorder' from ACE-FTS measurements



Two prominent source regions:
Northern India & Sichuan Basin

Global models need to reproduce that …

www.atmos-chem-phys.net/9/9349/2009/

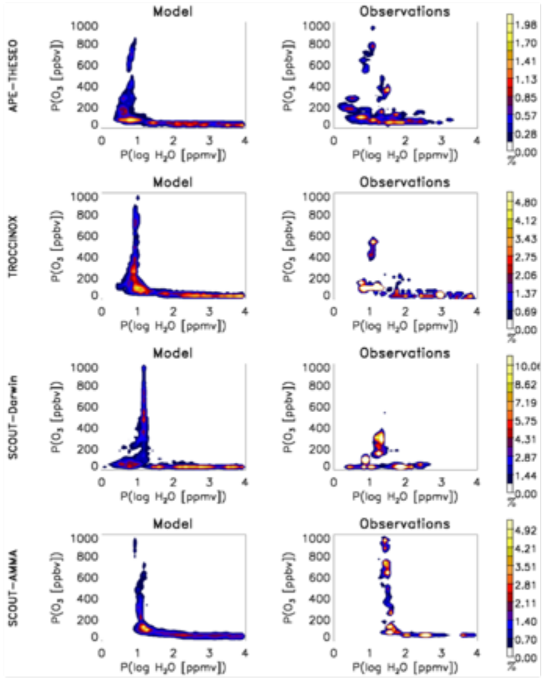


Fig. 9. Joint probability distribution functions (PDFs) of the H_2O-O_3 correlation for the region and time period of each campaign. Left: ECHAM5/MESSy; right: observations.

- Understand the potential role on the stratosphere and global climate
- Strategies for Climate model evaluation with campaign data:

  Relevance of in-situ datasets

  Evaluate with specific diagnostics

  Beware of point-to-point comparisons

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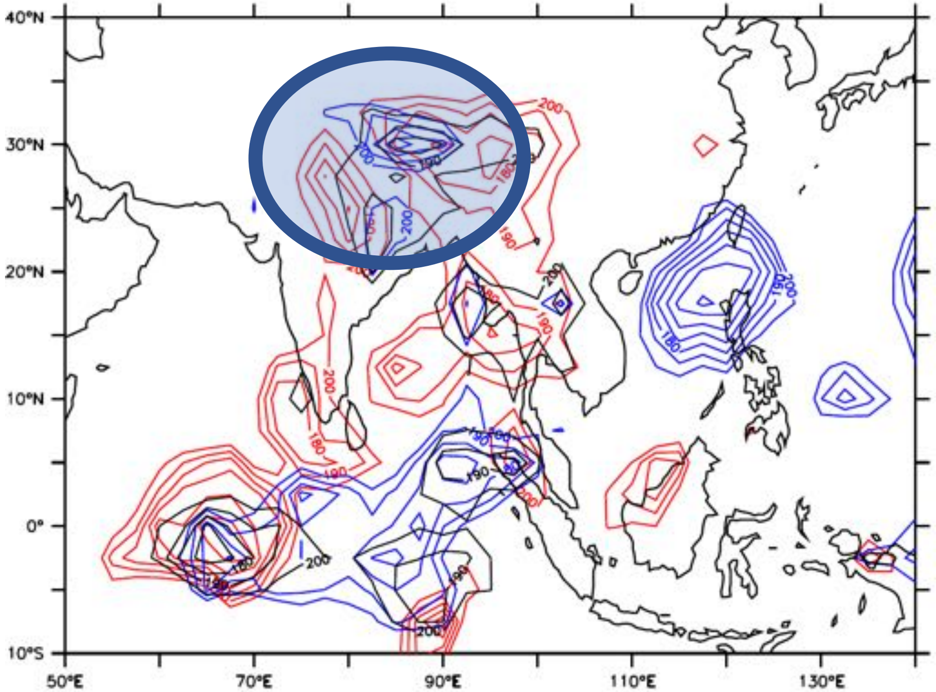
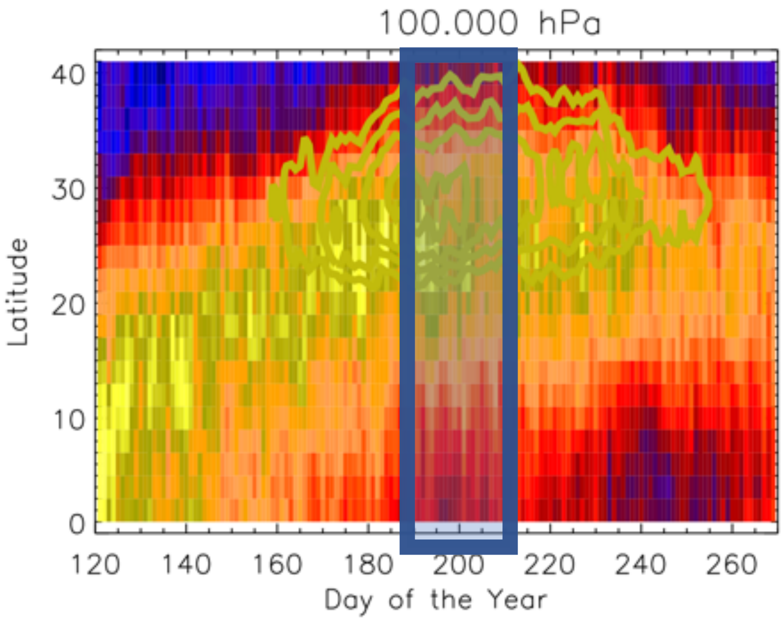
Mean state during STRATOCLIM

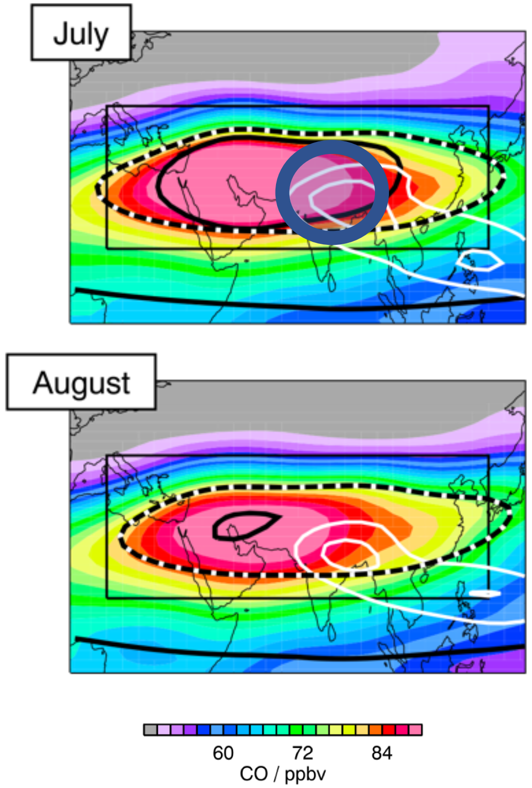


– 27-31 Jul. 17 – 06-10 Aug. 17
– 27 Jul. – 10 Aug. 17

Two distinct phases during the campaign
increasing convection over land in August

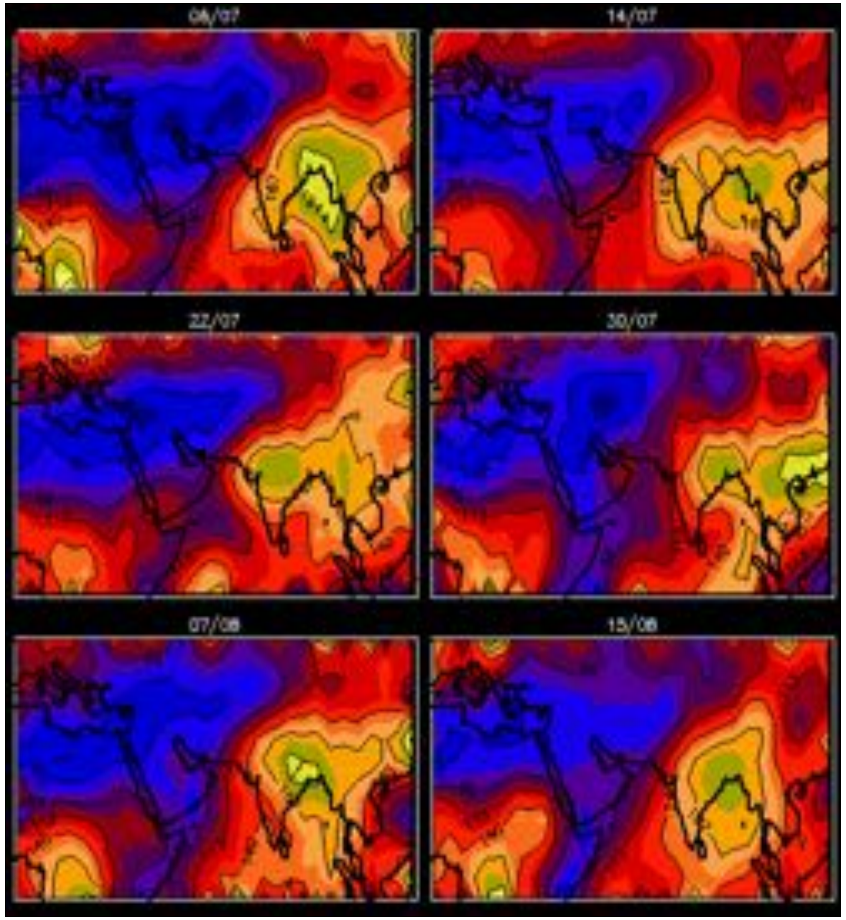


2007-2013 MLS CO mean
Anticyclone from ERA-Interim



Santee et al., 2017
MLS CO at 370 K

Mean state observed during STRATOCLIM

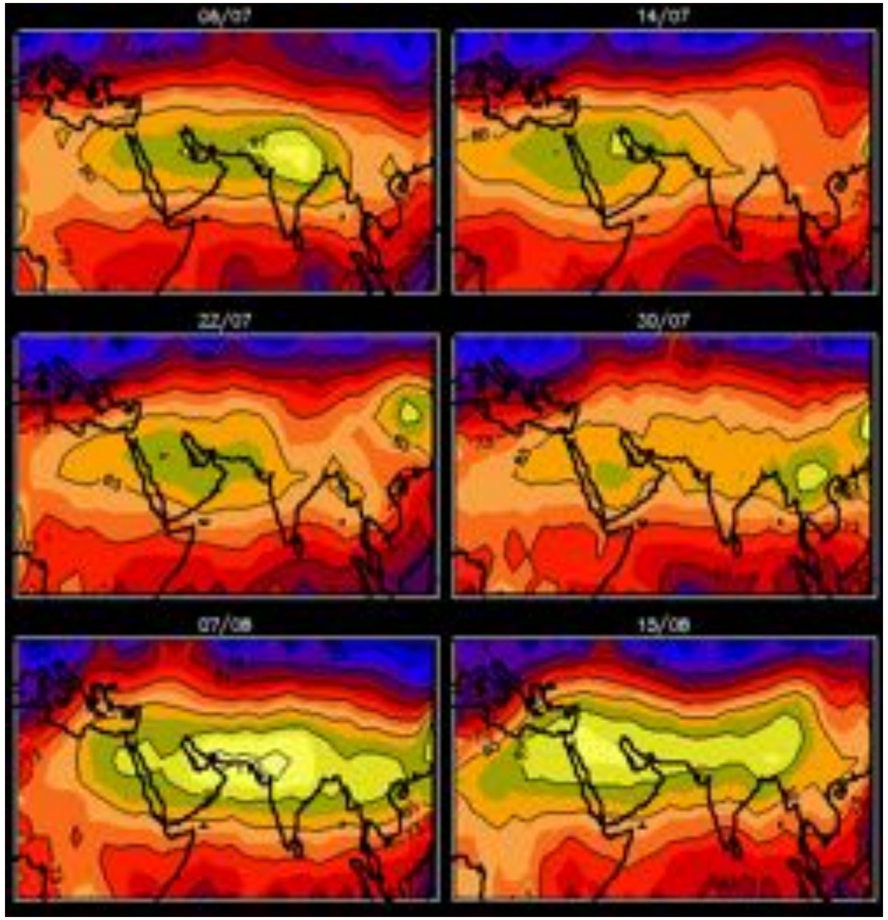


MLS data

215 hPa 100 hPa

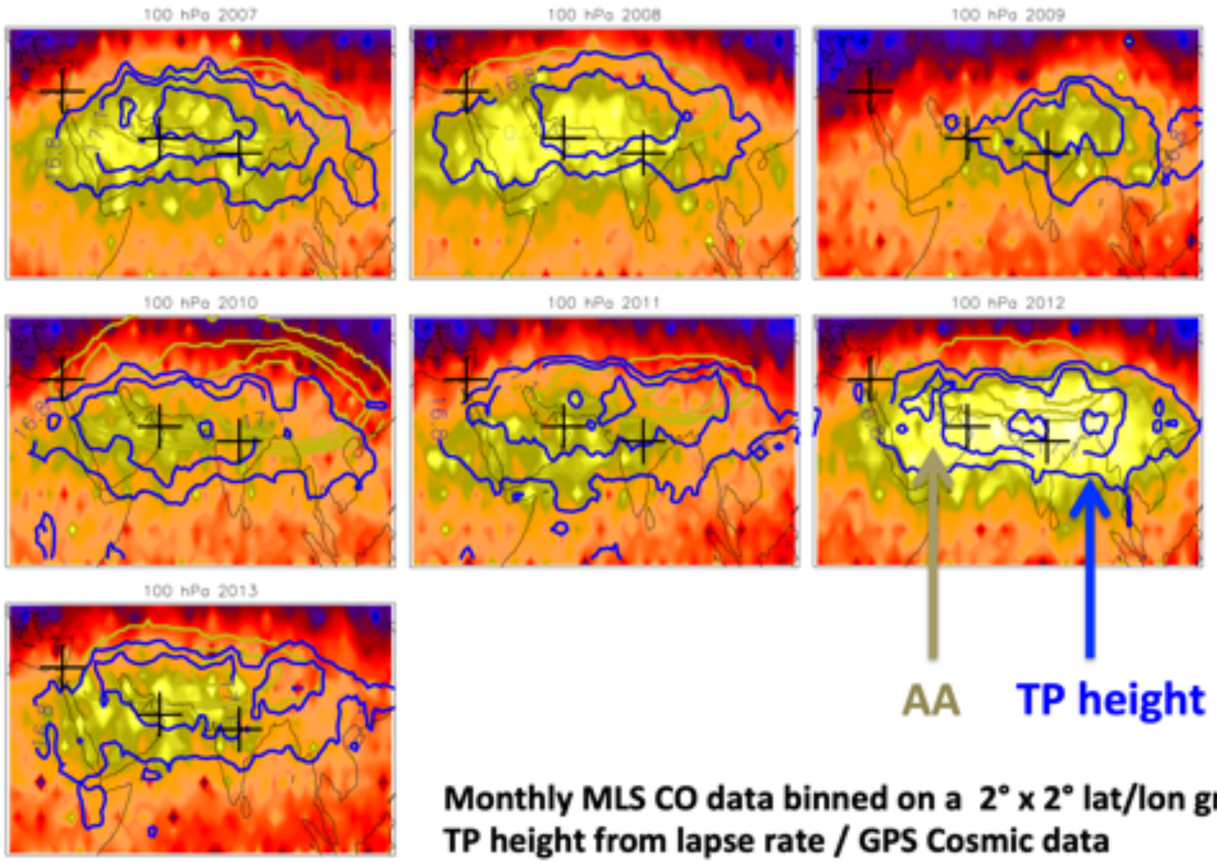
Two distinct phases during the campaign: Increase of CO in the Asian Anticyclone at 100 hPa

Sources are constant



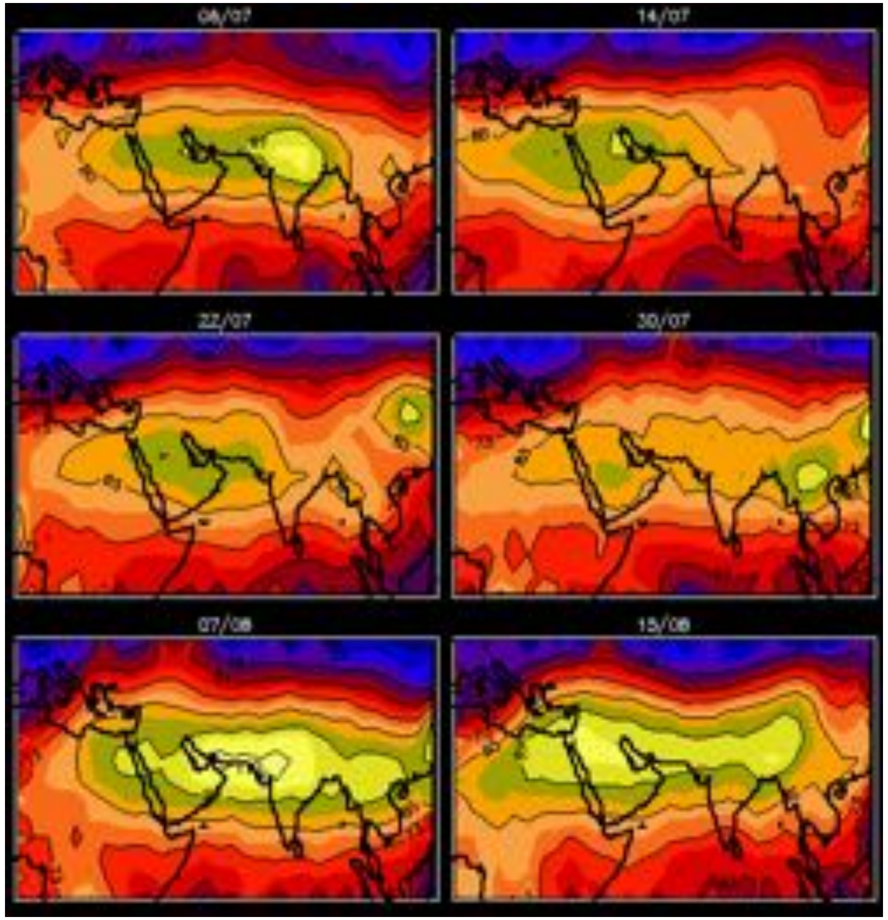
Compare with interannual variability

CO interannual variability
July @100 hPa

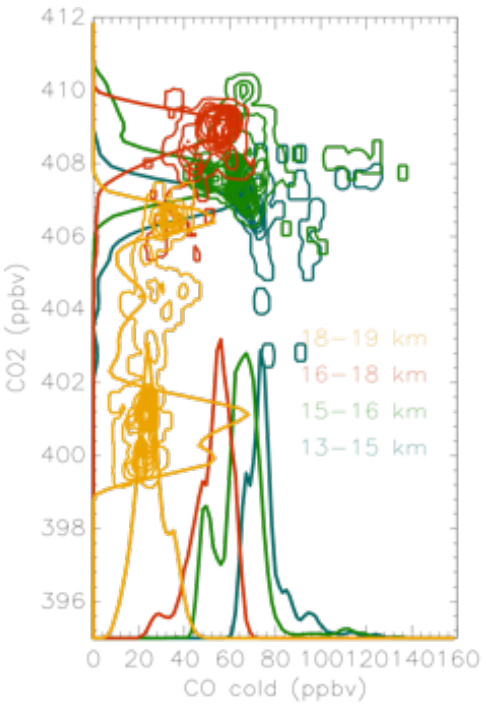


Monthly MLS CO data binned on a 2° x 2° lat/lon grid
TP height from lapse rate / GPS Cosmic data

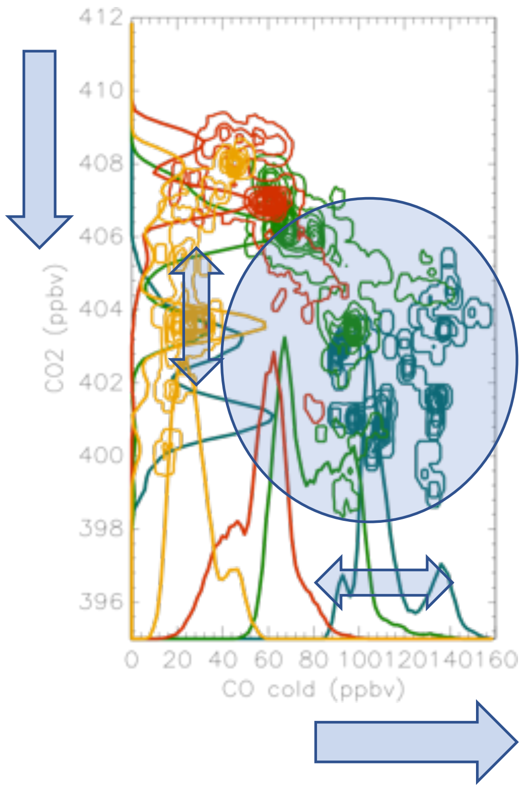
Pa



CO and CO_2 observed mean state



Phase 1
«low convection»
Phase 1
«low convection»



Phase 2
«high convection»

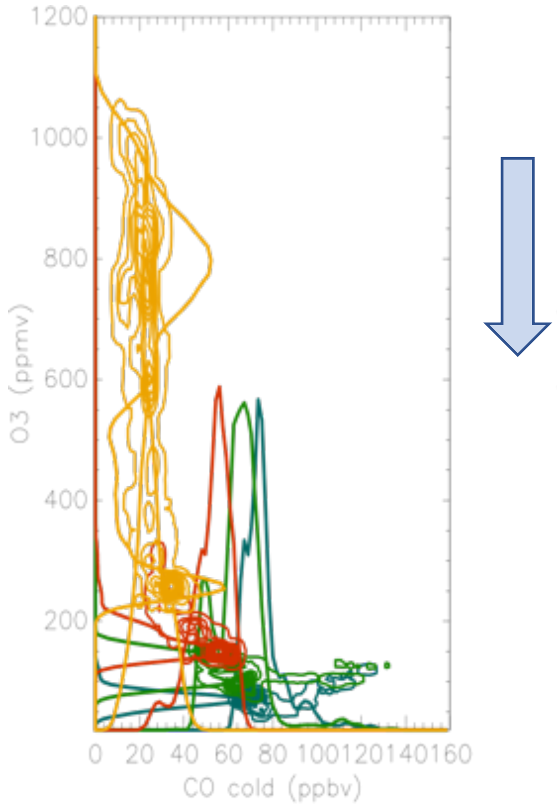
Probability Density Functions

Shift towards higher CO below 17 km layer

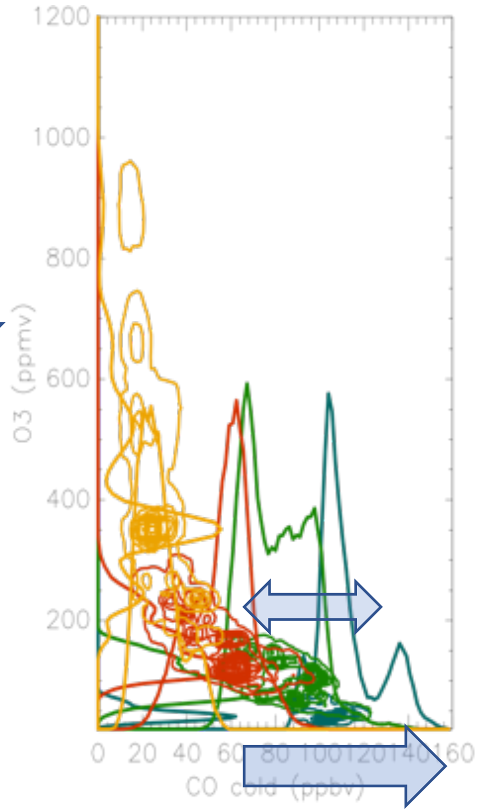
Generation of a bimodal PDF

Lower values for CO2 in convective condition

CO and O_3 observed mean state



Phase 1
«low convection»



Phase 2
«high convection»

Probability Density Functions

Shift towards higher CO below 17 km layer

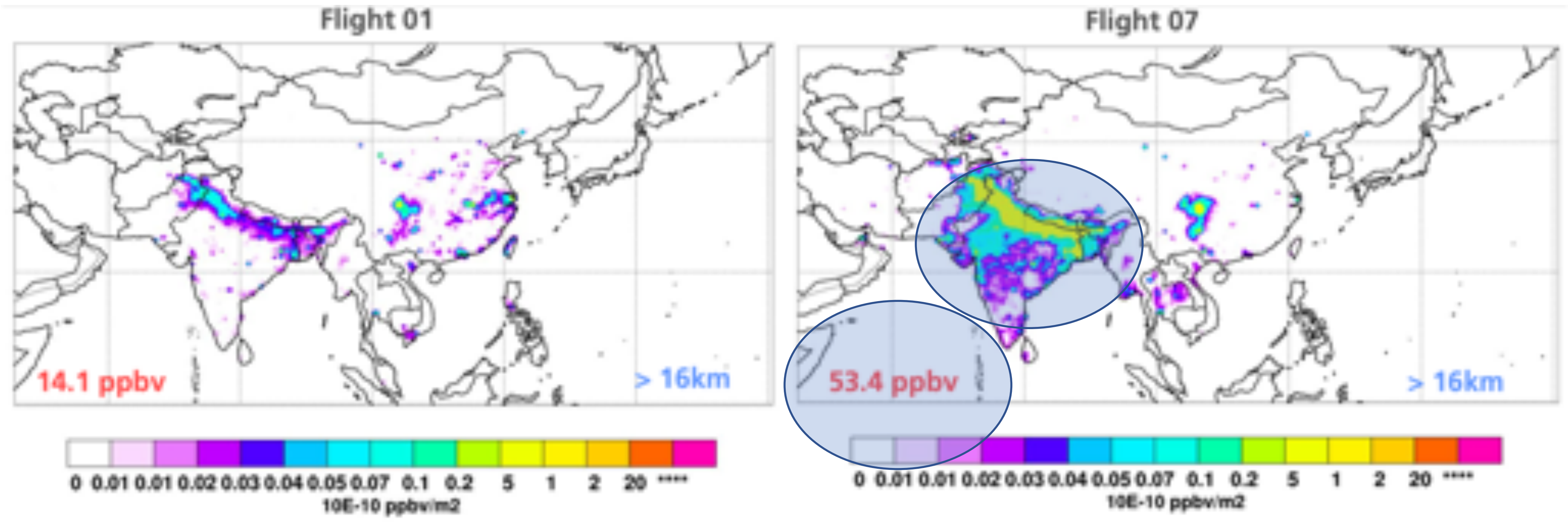
Generation of a bimodal PDF

Lower values for lowermost stratospheric O_3 in convective condition

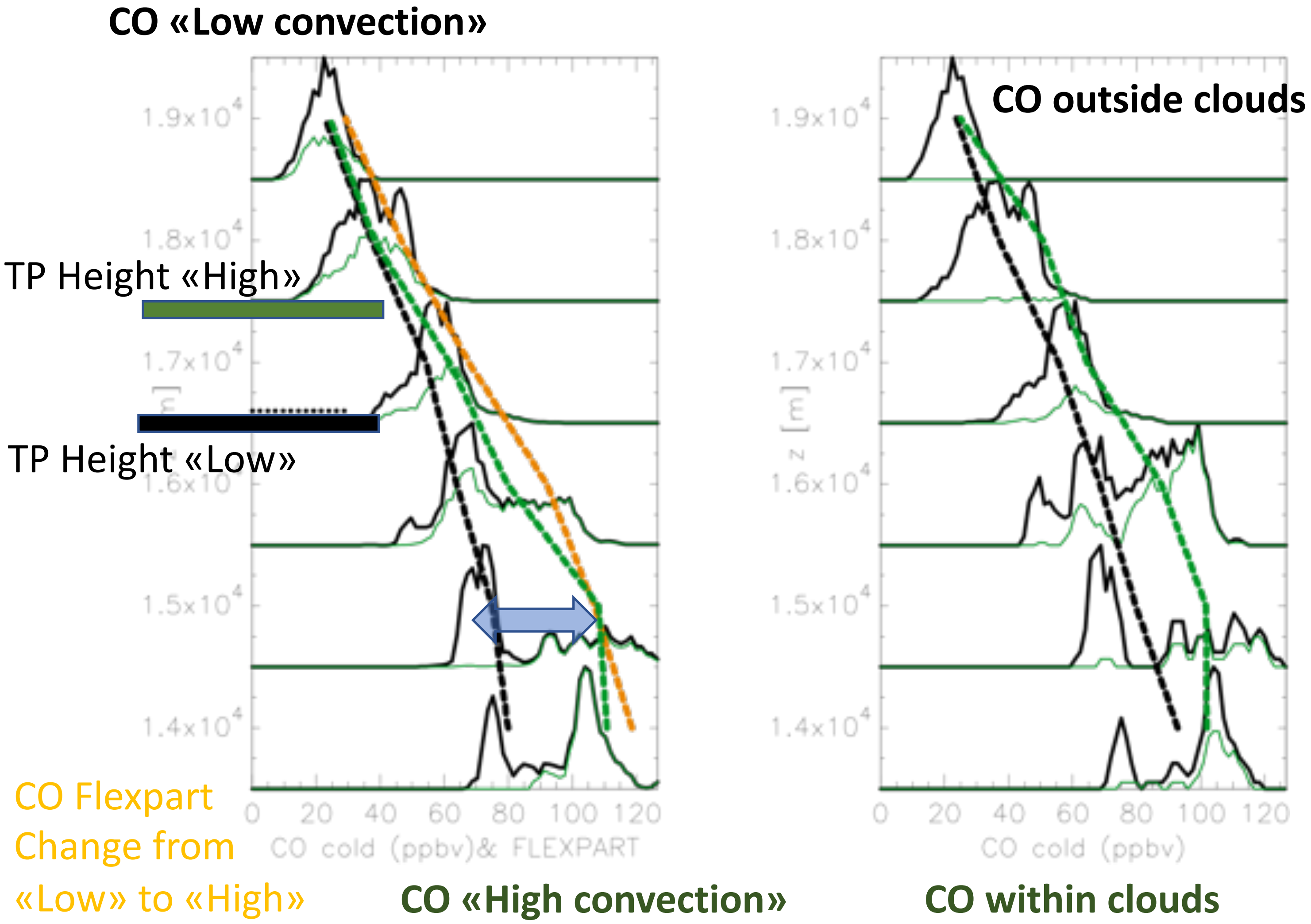
CO contribution estimate using FLEXPART

- Dynamics: operational analyses from the European Centre for Medium-RangeWeather Forecasts (ECMWF)
- Emissions: EDGARv4.3.2 (Janssens-Maenhout et al., 2017)

See also Bucci et al. talk



CO vertical profile



ΔCO = 30 ppbv

Shift towards higher CO below TP height

CO increase 30 ppbv

FLEXPART agree

Fresh convection – CO enhanced in cloud outflow

Cloud = yes
If lidar SR > 1.3

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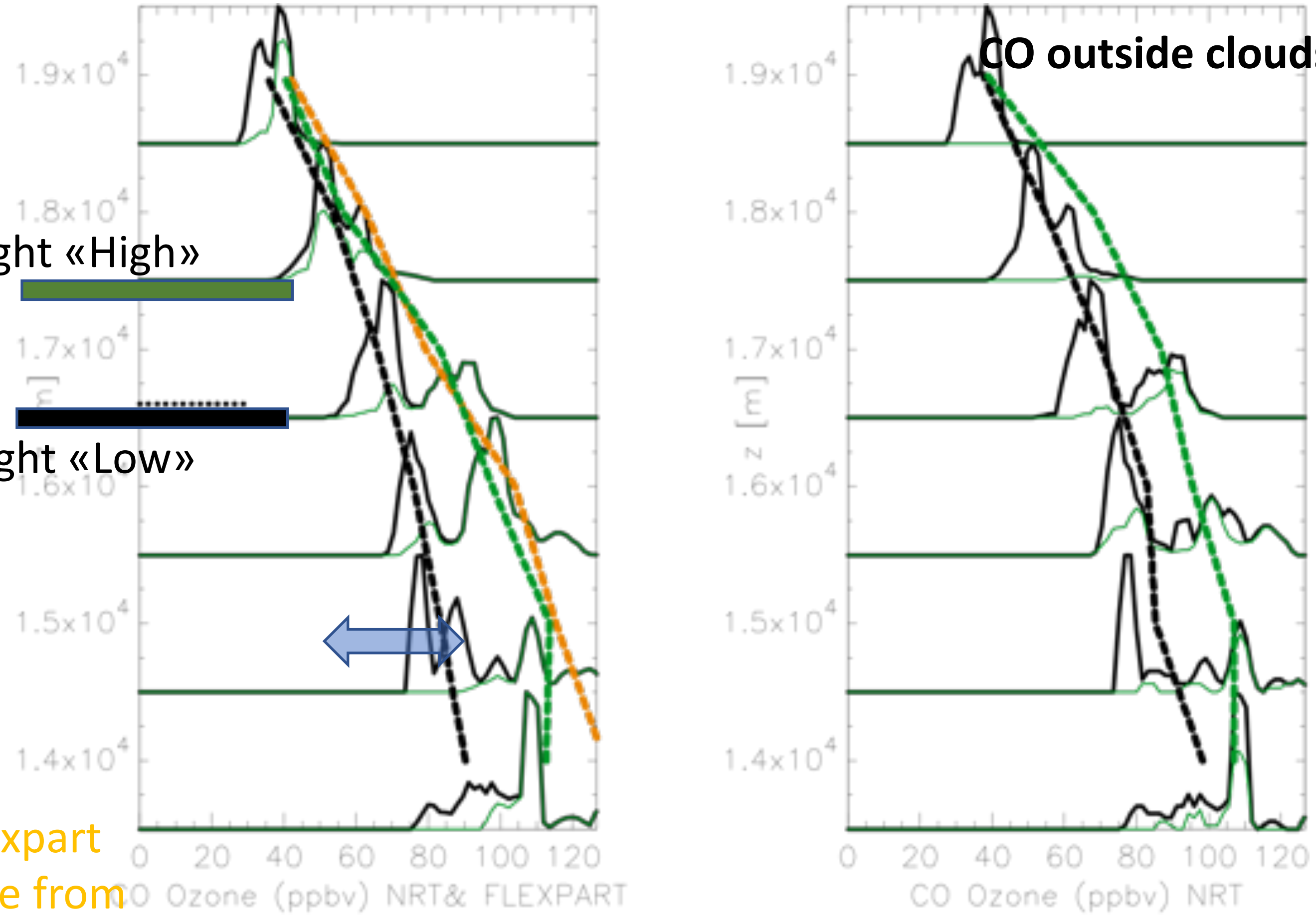
CO vertical profile - CAMS

CO «Low convection»

TP Height «High»

TP Height «Low»

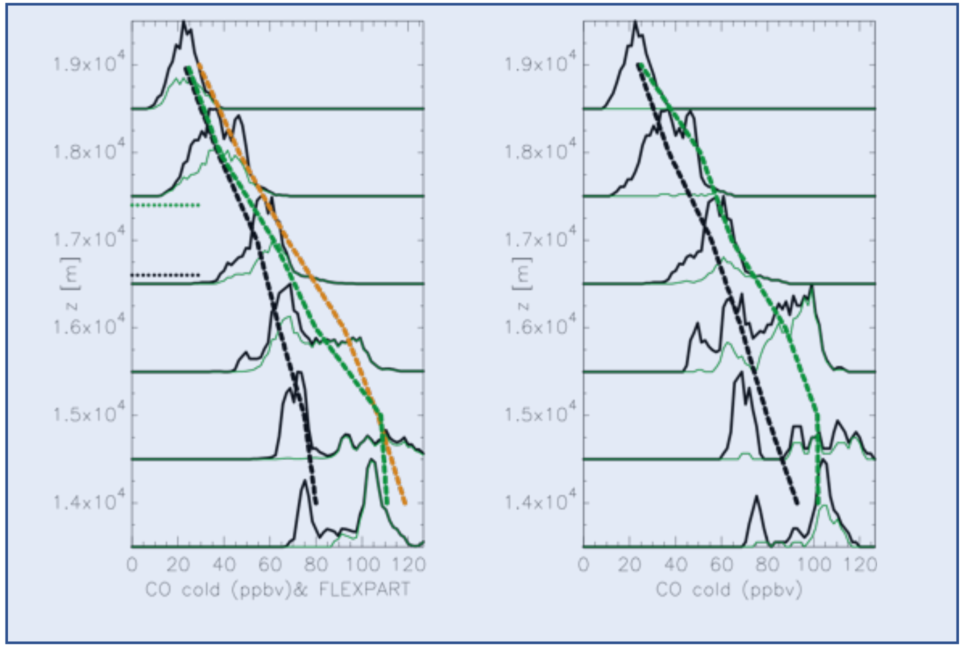


CO Flexpart
Change from «Low» to «High»

CO «High convection»

CO within clouds

ΔCO = 30 ppbv



Reminder OBS

CAMS CO forecast
See Mark Parrington's talk

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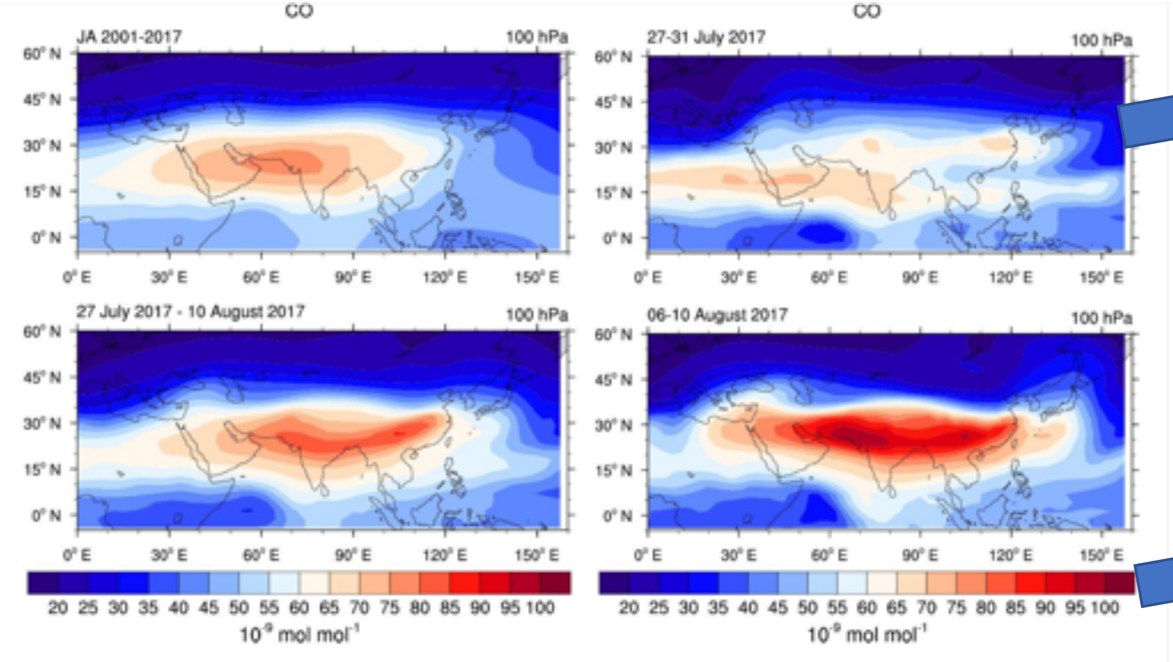
CO from EMAC simulation

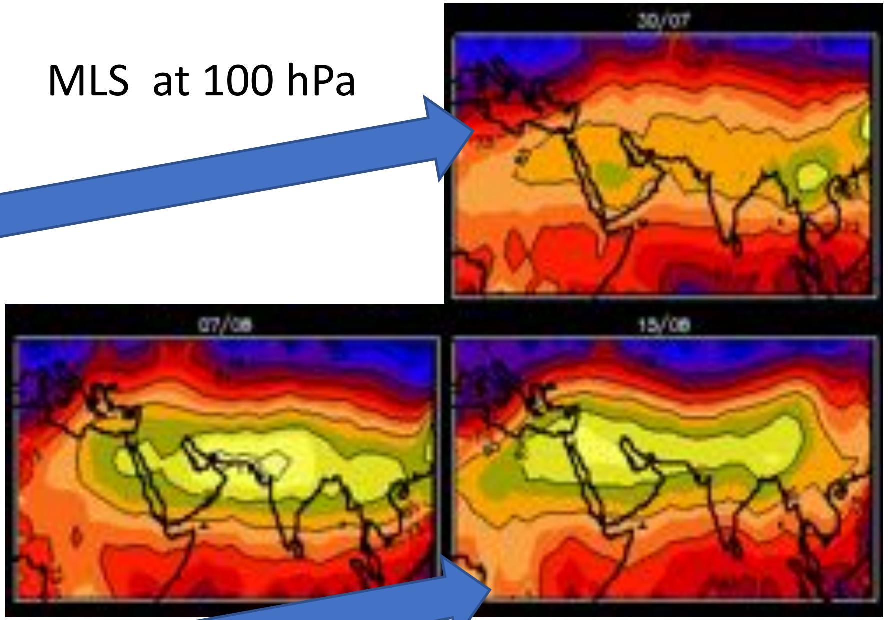
Chemistry-climate-model: EMAC (ECHAM5 MESSy Atmospheric Chemistry; see Roeckner et al., 2006 and Jöckel et al., 2016)

- Boundary conditions: SST and SIC data from ERA-Interim (Dee et al., 2011)
- Dynamics: relaxation to ERA-Interim (not for wave-0 temperature)
- Resolution: T42L90-MA roughly 300 km spatial resolution, up to 0.01hPa, 500 m in the vertical resolution around the TTL (cf. Jöckel et al. 2016)
- Time period: started in 2000 and continuously extended
- Emissions: MACCity (Granier et al., 2011) until 2010, then RCP 8.5 (van Vuuren et al., 2011); other emissions as in Jöckel et al. (2016)



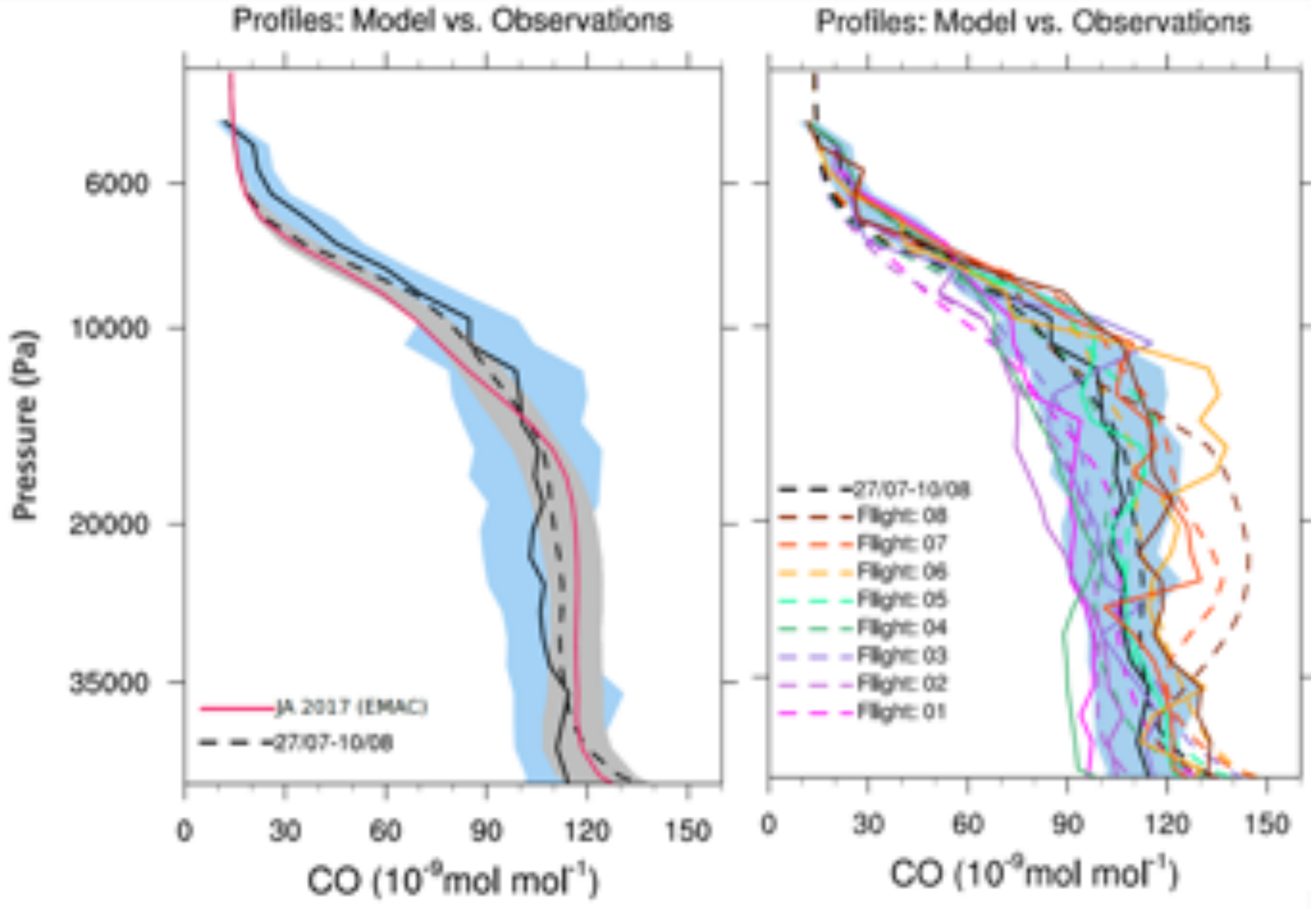
EMAC captures the two phases and the CO evolution

MLS at 100 hPa



CO from EMAC simulation: vertical

- Left: mean measurement (solid black, one-sigma shaded in blue) and EMAC (dashed black, solid red) CO profiles
- Left: measurement (solid lines, one-sigma shaded in blue) and EMAC (dashed lines) CO profiles



Conclusions

- Use two phases of campaign to identify convective perturbation
- Clear signature on different tracers
- CO reconstruction agrees and indicate that IGP sources may dominate
- CO is increased by 30 ppbv in the UT – small signature on average above the tropopause
- Diagnostics adapted to compare with model(s) – first results encouraging with good performance

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