Mean properties and variability of the Asian Anticyclone
A Stratoclim campaign perspective

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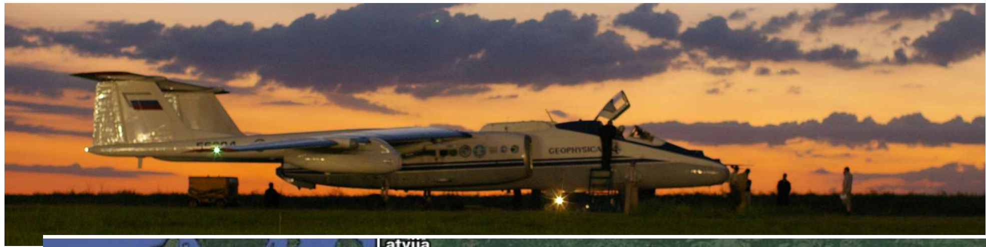
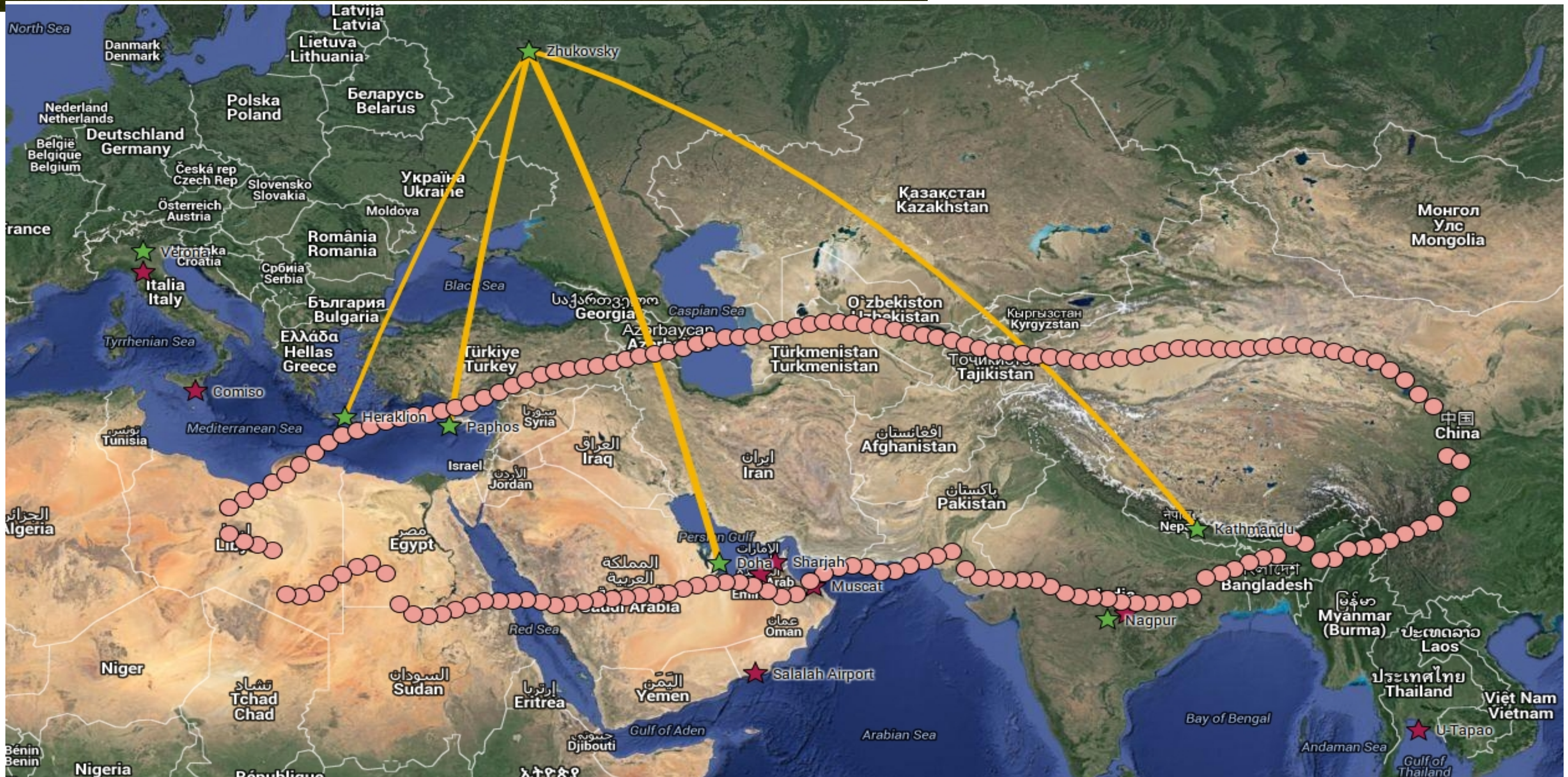
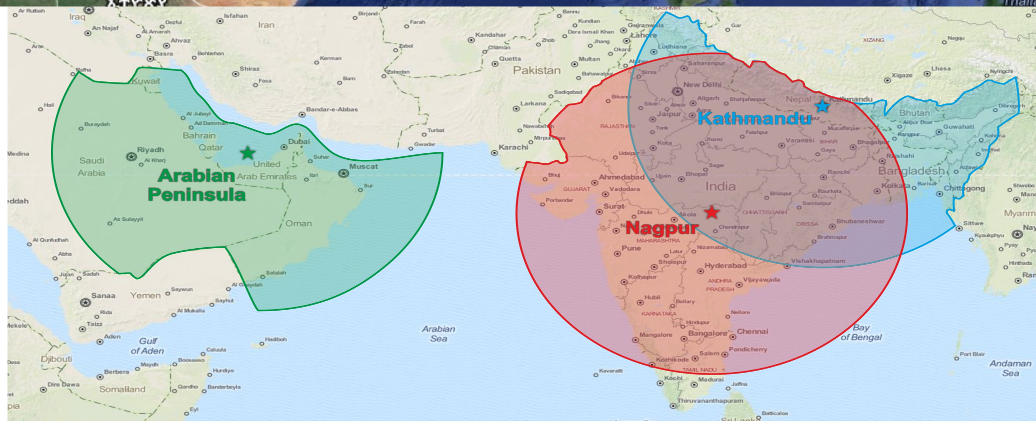
Silvia Bucci, Daniele Galuzzo, Riccardo Biondi

NCAR-ACD – Ground floor coffee machine
Thanks to Rolando Garcia







Courtesy
Fred Stroh FZJ

Outline and tools

Monsoon and the Asian Anticyclone key players of the atmospheric composition budget in the Asian Monsoon UTLS

→ Stratoclim campign focus on these aspects

→ Which scenario we may expect in the campaign sites ?

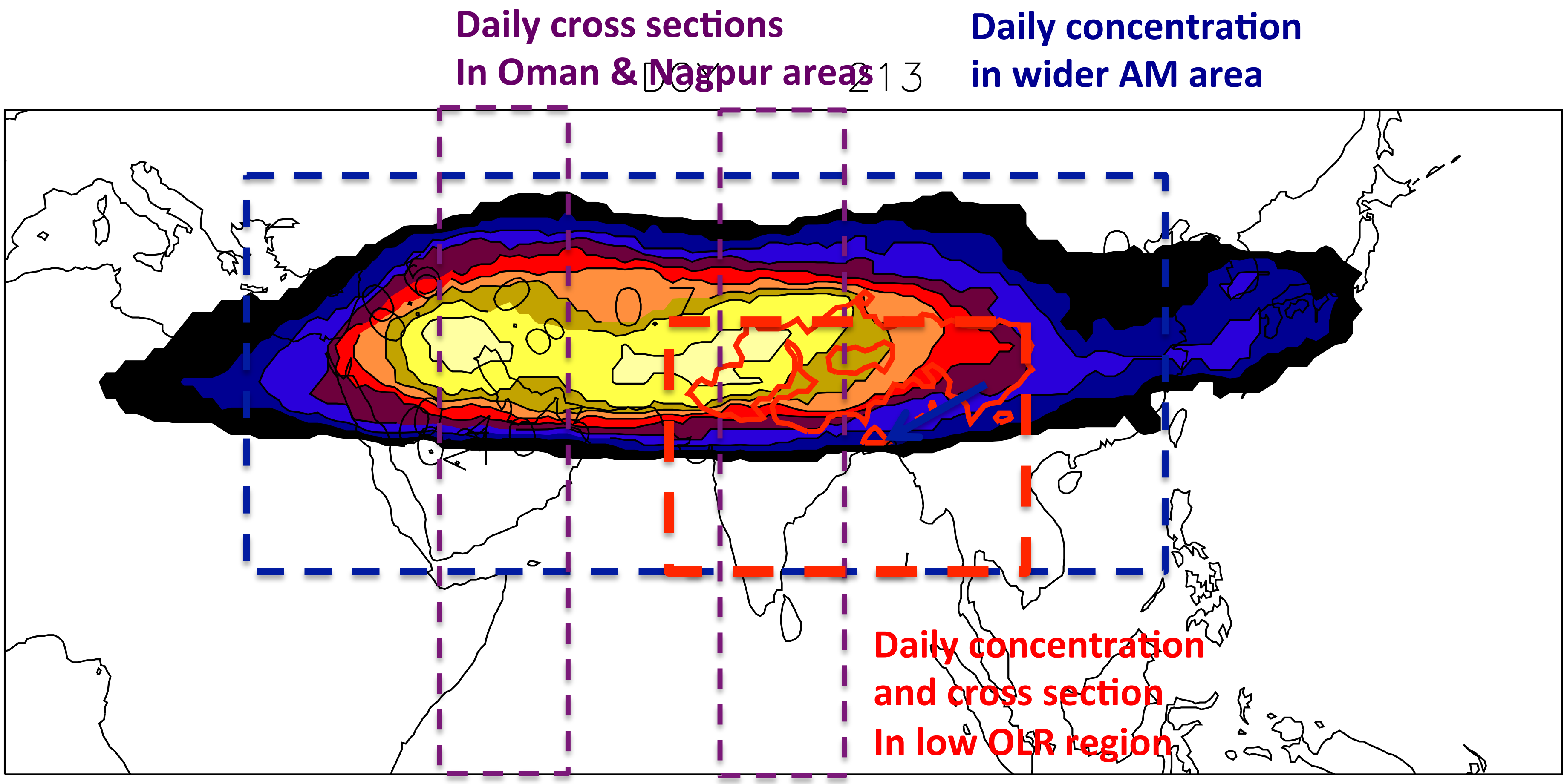
→ Make use of:

MLS-V3.30 & MIPAS-V5R years 2002-2014

Daily OLR from ISSCP to identify deep convection & ERA-INTERIM geopotential for Asian Anticyclone

Diagnostics to evaluate processes and variability → to be applied straightforward to model data sets

Regional scale modelling (WRF) and Lagrangian plumes (FLEXPART-WRF)



Daily cross sections
In Oman & Nagpur areas
Daily concentration
in wider AM area
Day 213
Daily concentration
and cross section
In low OLR region

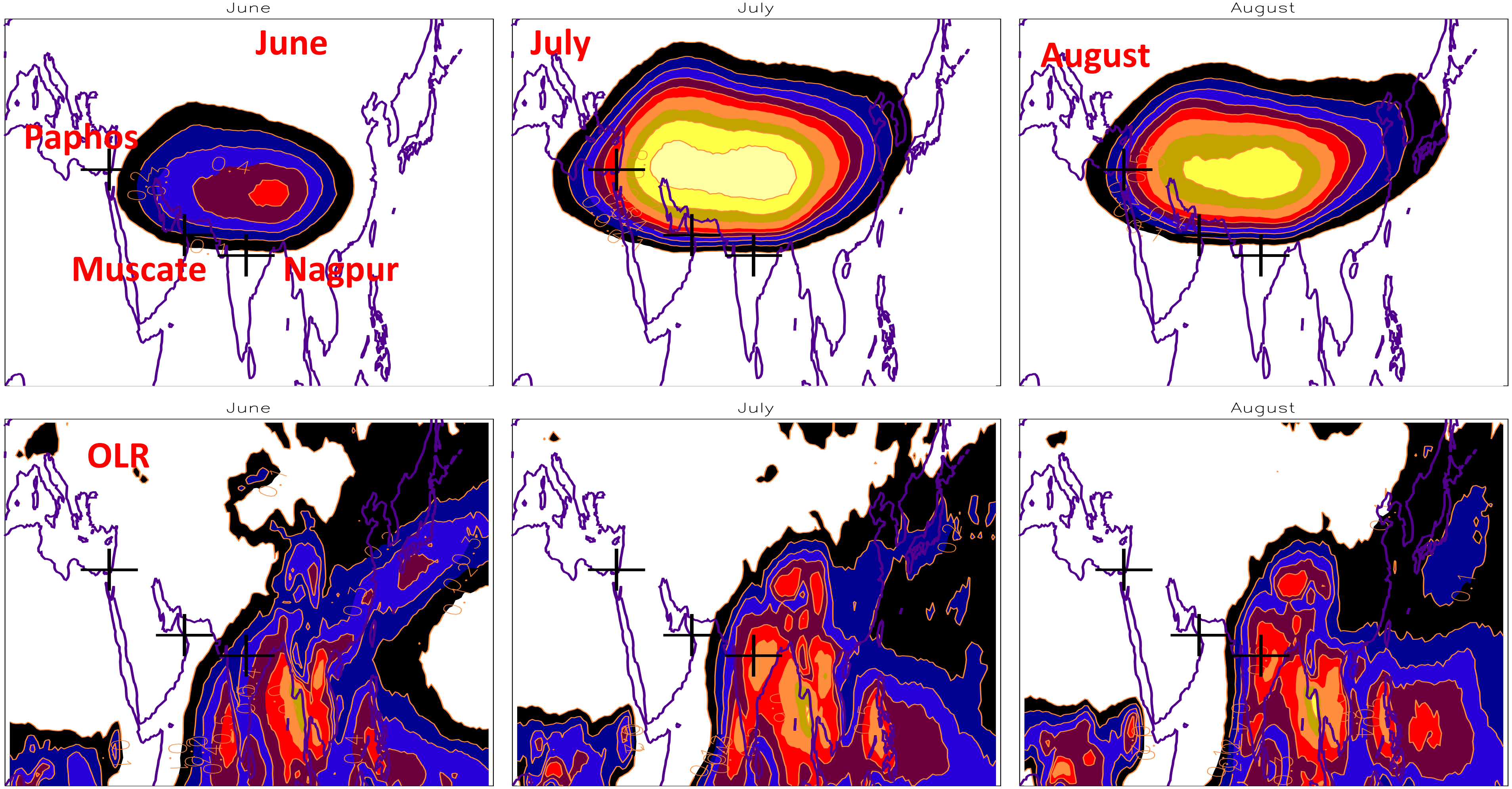
Time and spatial scales

Mean distribution

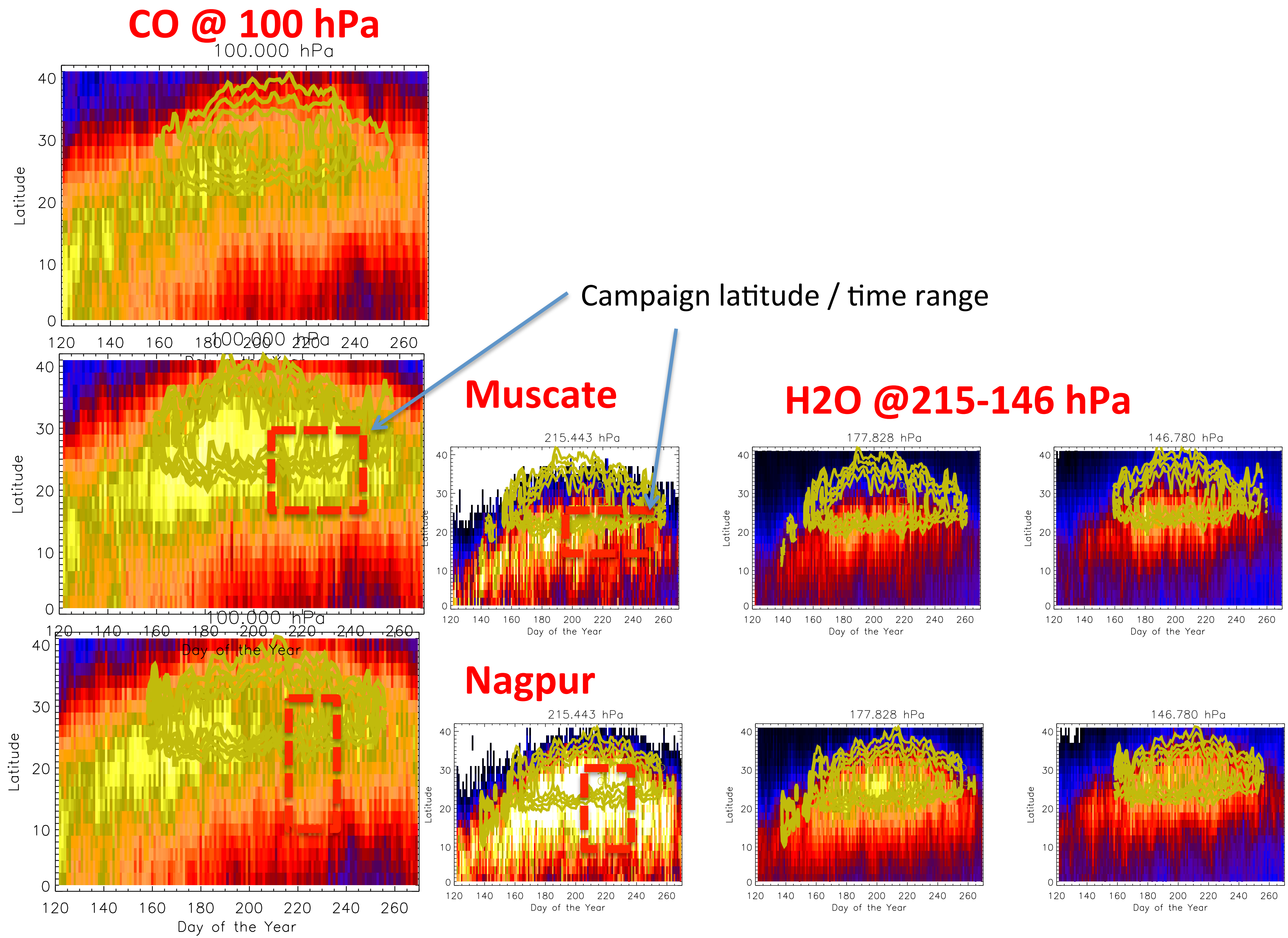
Interannual variability

Intraseasonal variability

Mean state AA and Campaign sites



1992-2013 mean anticyclone frequency – based on geopotential ERA-INTERIM
OLR from ISCCP daily data



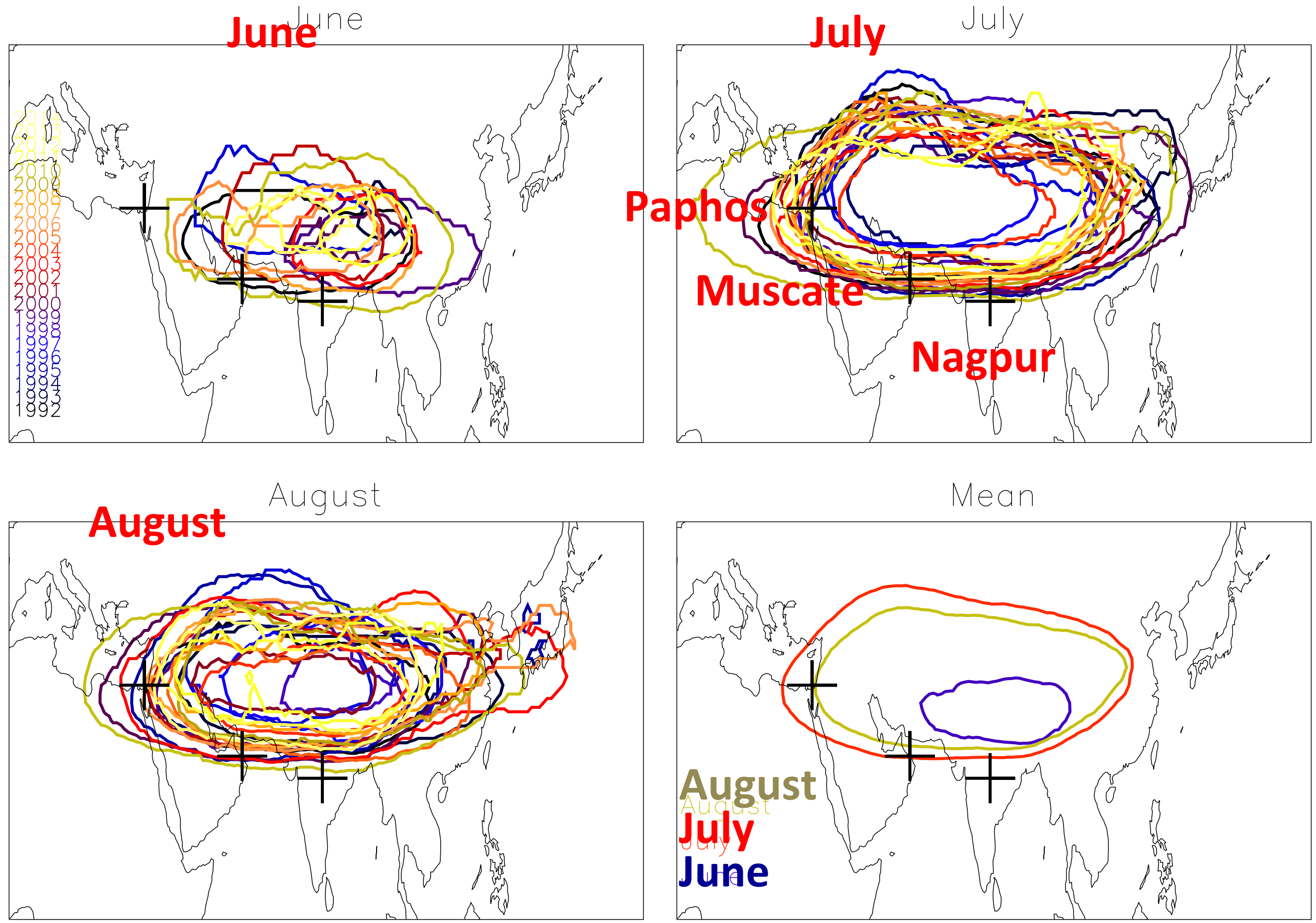
CO @ 100 hPa
100.000 hPa
Latitude
Day of the Year
Campaign latitude / time range
Muscate
H2O @215-146 hPa
215.443 hPa
177.828 hPa
146.780 hPa
Nagpur

Mean distribution

Interannual variability

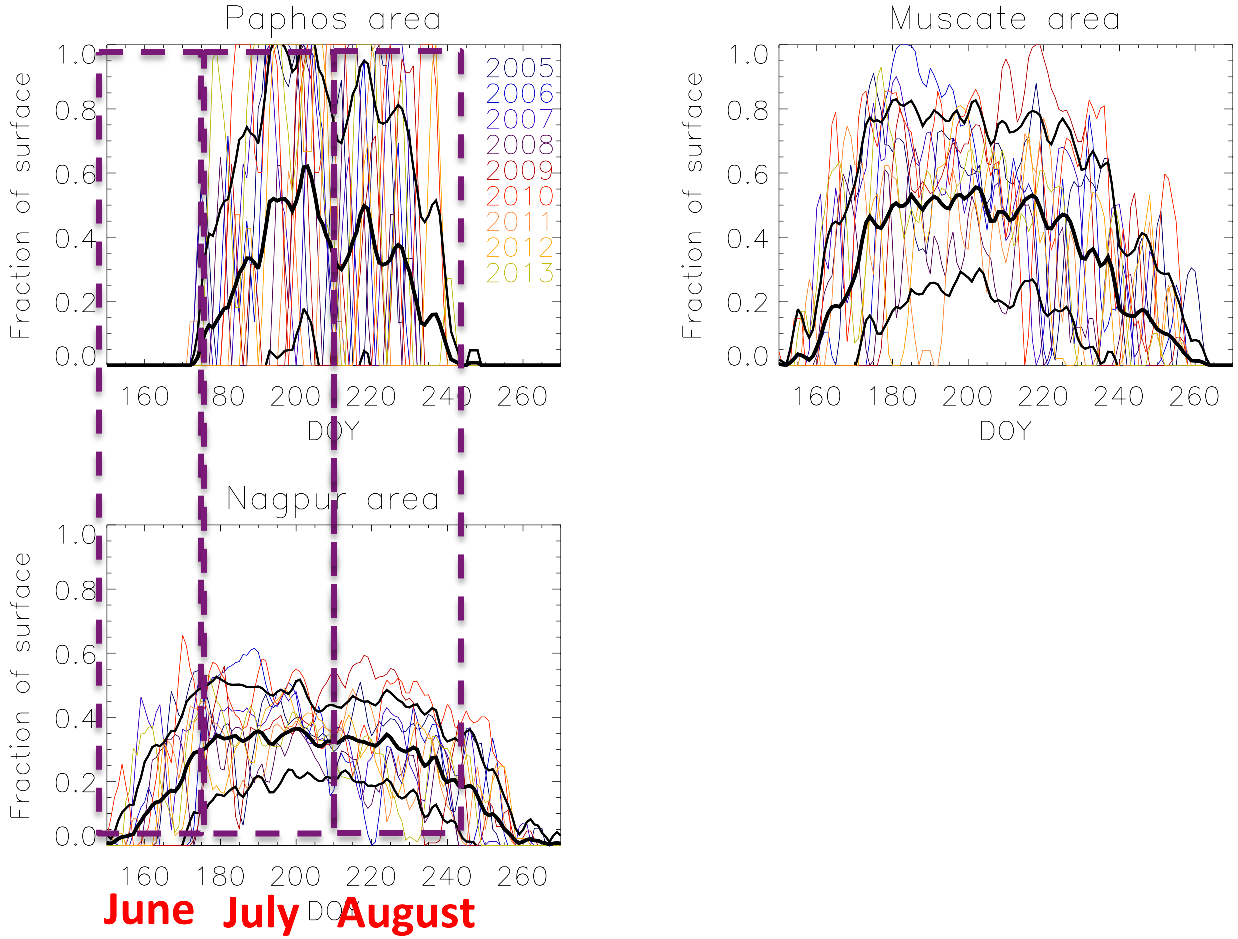
Intraseasonal variability

AA variability

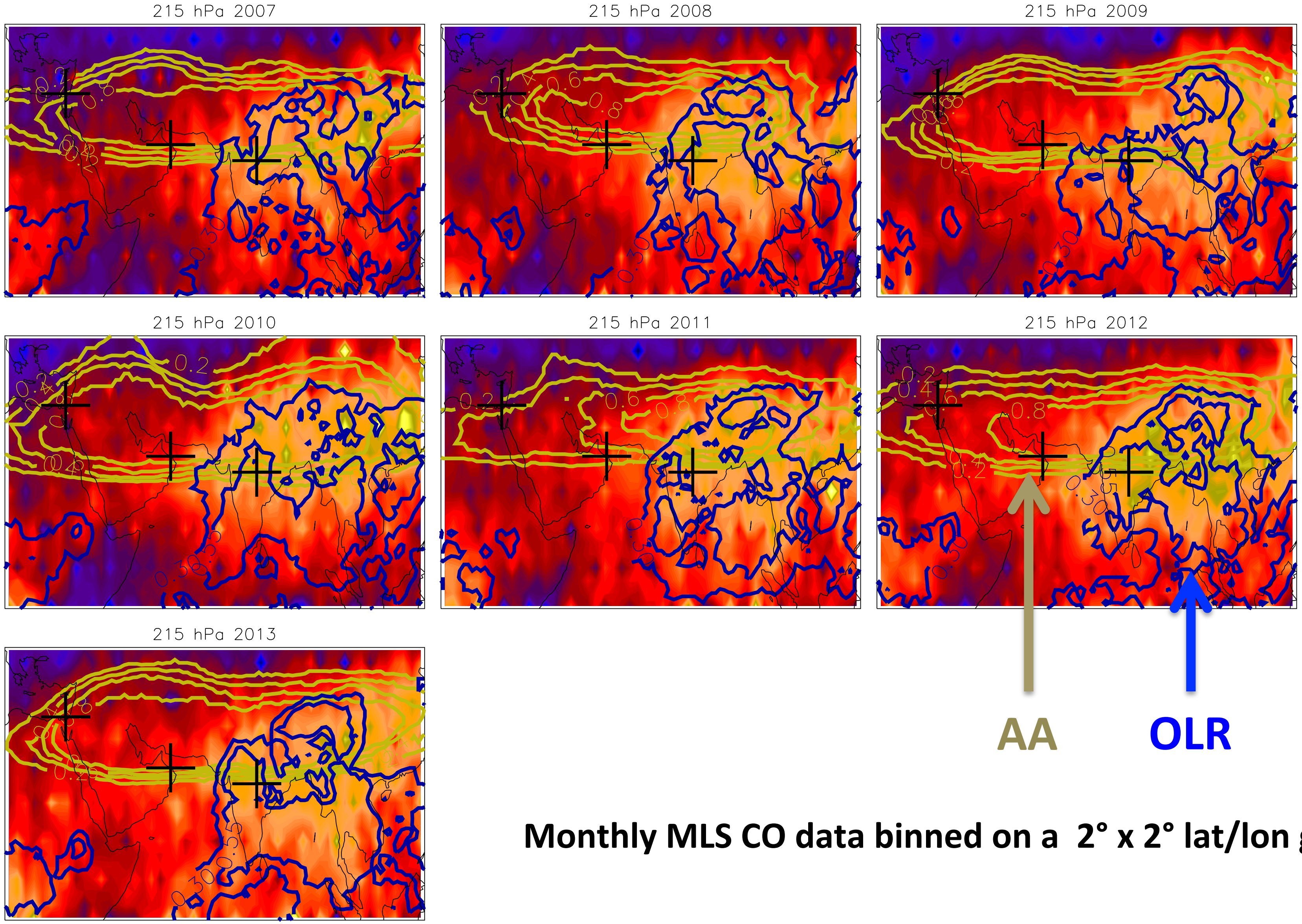


1992-2013 mean anticyclone frequency – based on geopotential ERA-INTERIM
OLR from ISCCP daily data

Campaign sites variability

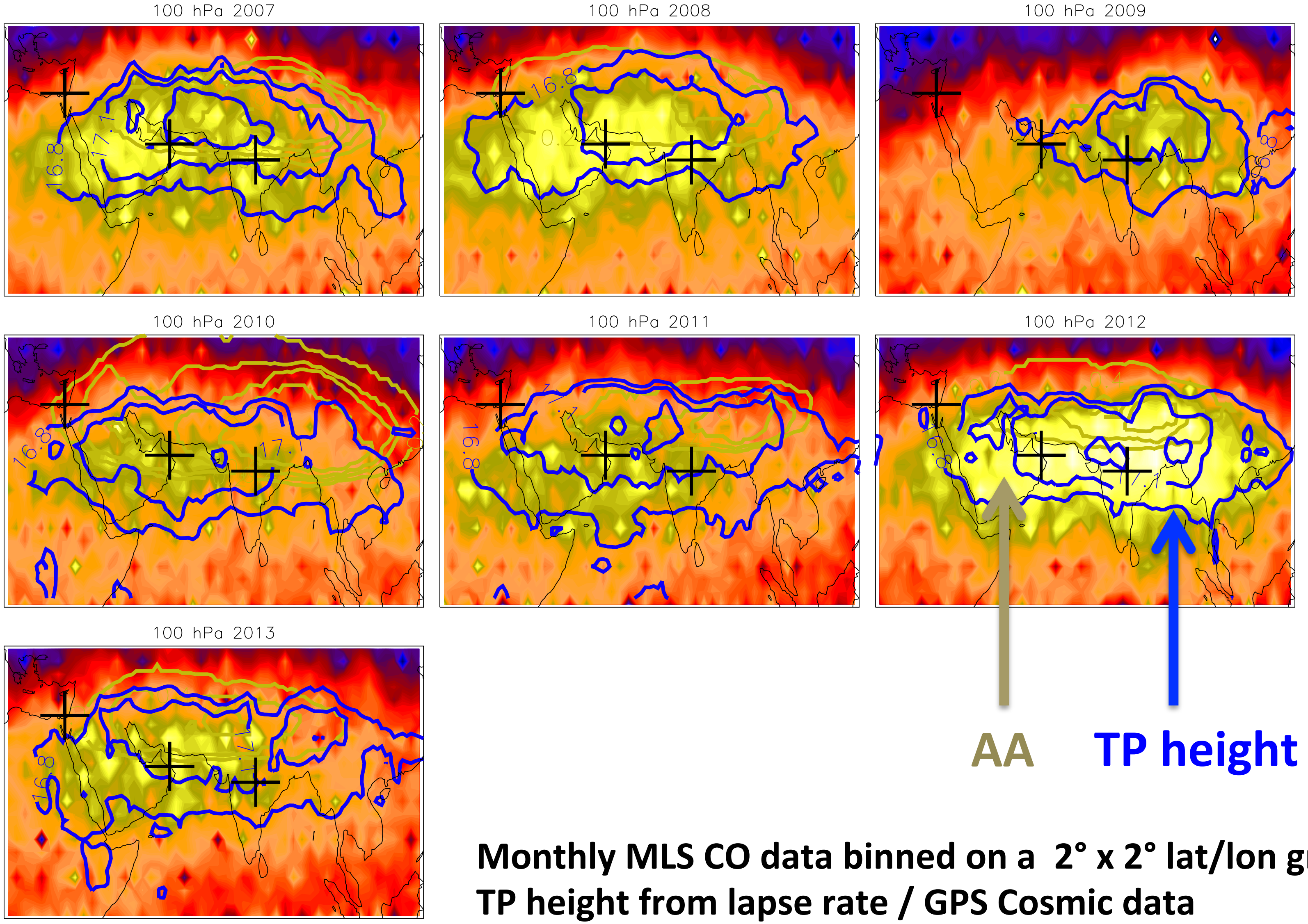


CO interannual variability
July @ 215 hPa



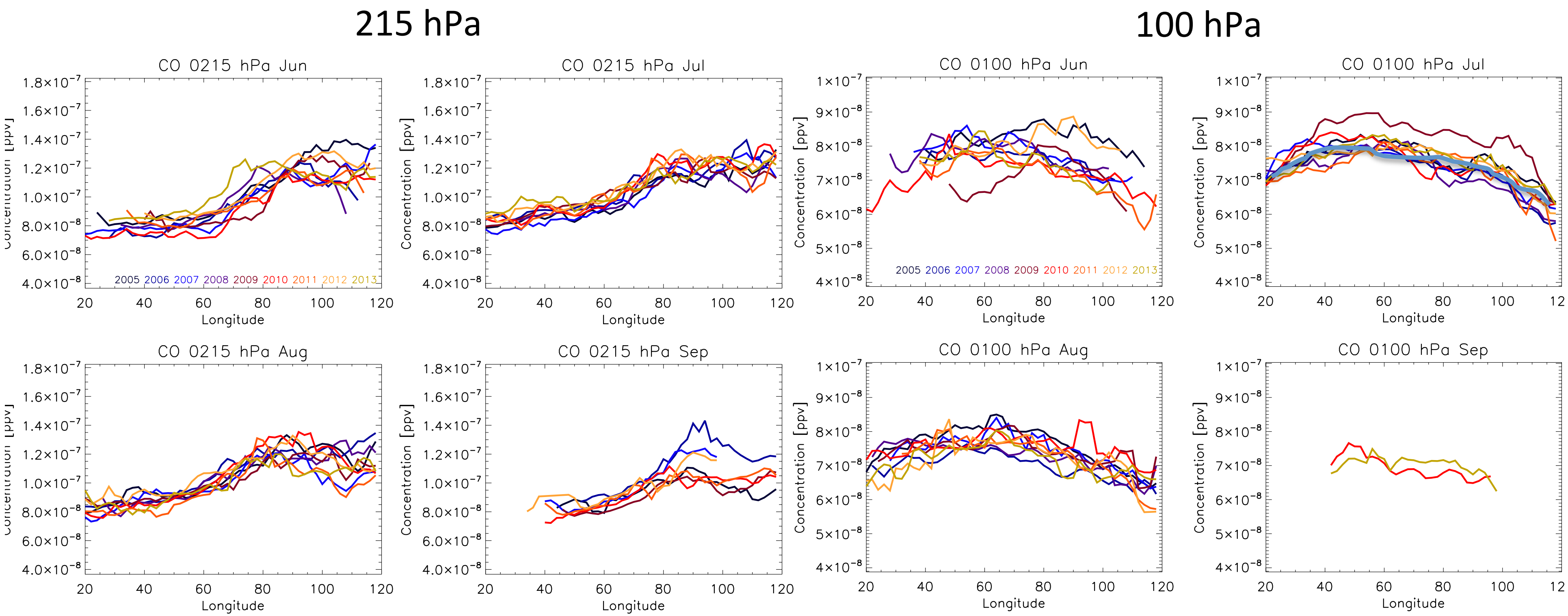
Monthly MLS CO data binned on a 2° x 2° lat/lon grid

CO interannual variability
July @100 hPa



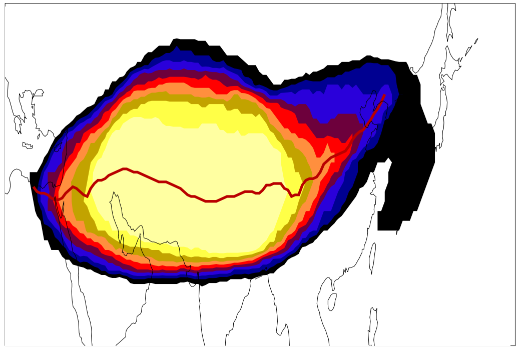
Monthly MLS CO data binned on a 2° x 2° lat/lon grid
TP height from lapse rate / GPS Cosmic data

CO Horizontal distribution - gradients

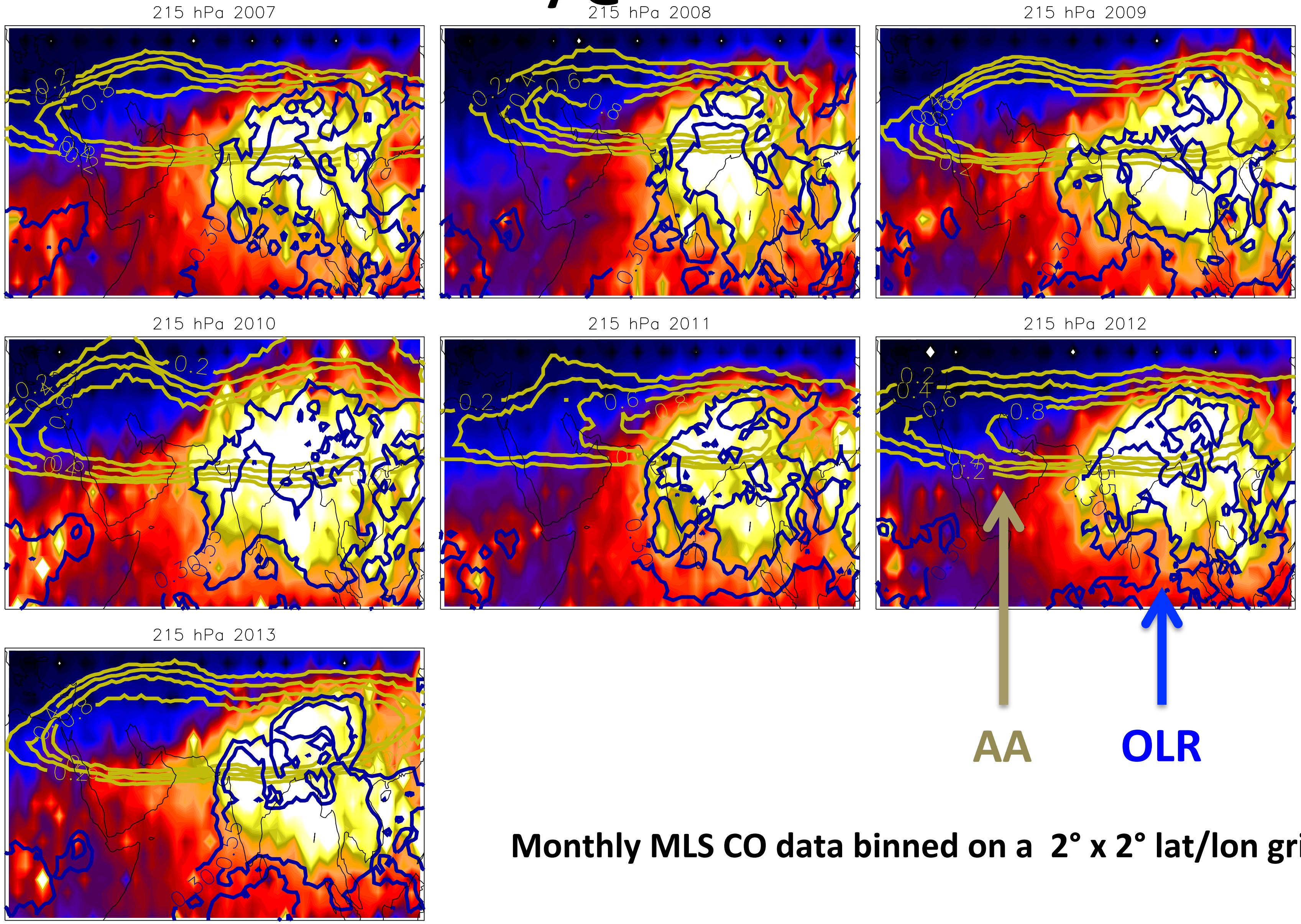


Monthly MLS CO data binned on a 2° x 2° lat/lon grid

CO Data along the AA spine derived as maximum frequency line

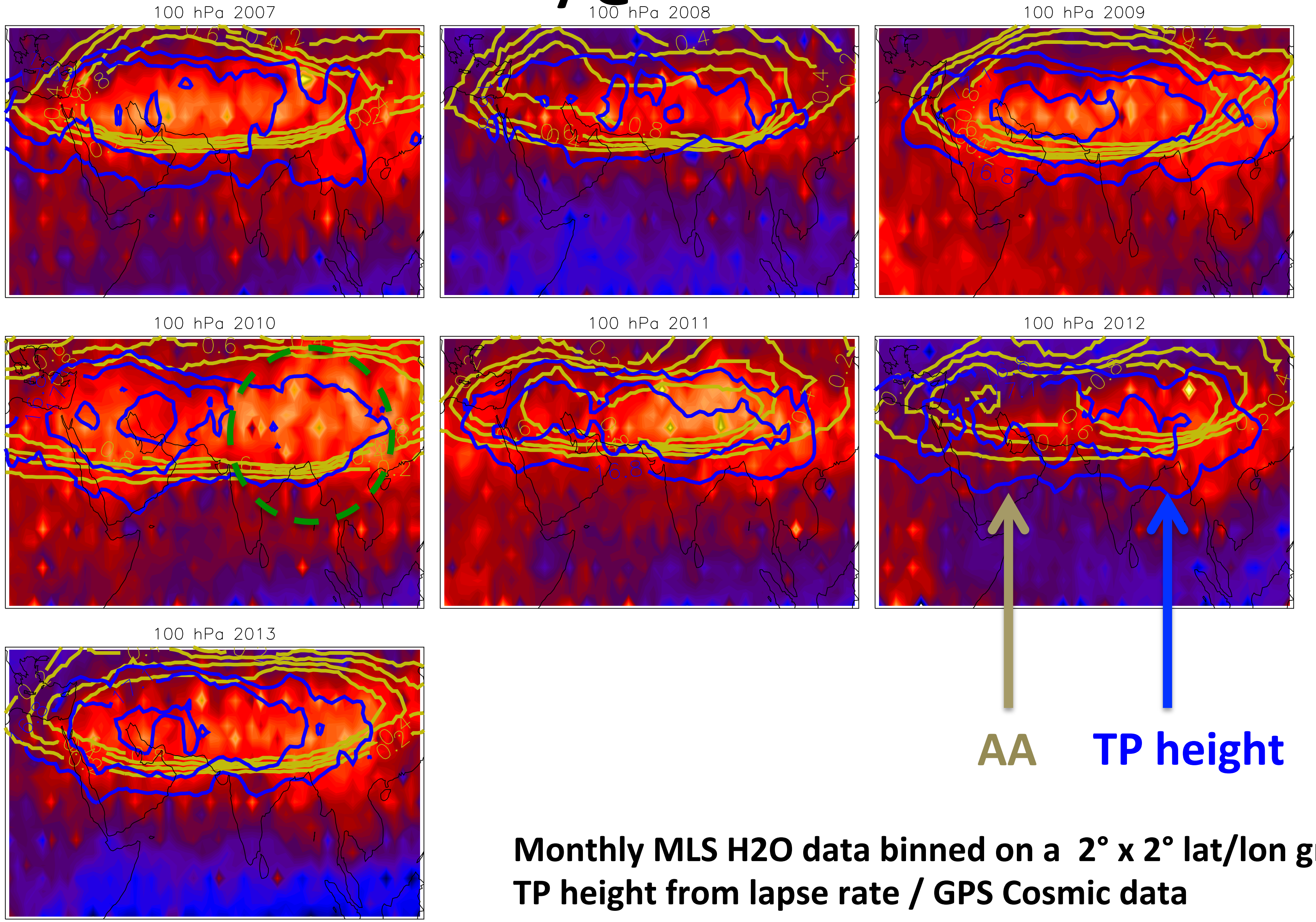


Water vapour interannual variability
July @ 215 hPa



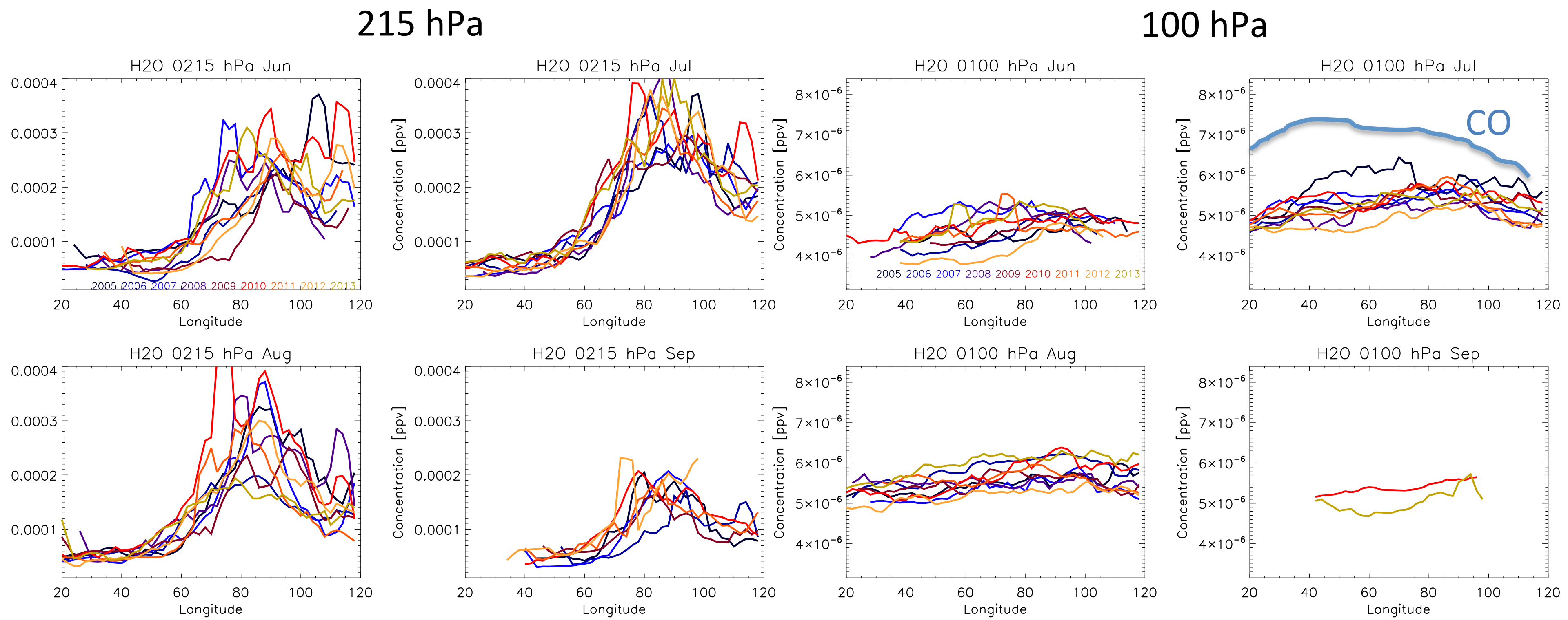
Monthly MLS CO data binned on a 2° x 2° lat/lon grid

CO interannual variability
July @100 hPa



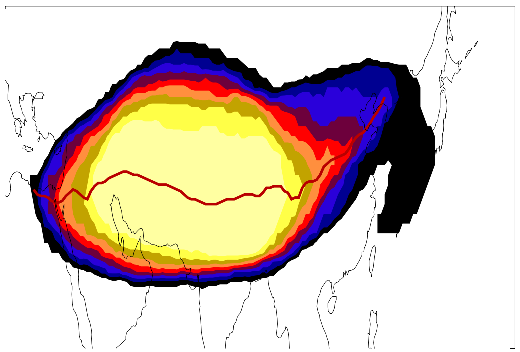
Monthly MLS H2O data binned on a 2° x 2° lat/lon grid
TP height from lapse rate / GPS Cosmic data

H_2O Horizontal distribution - gradients

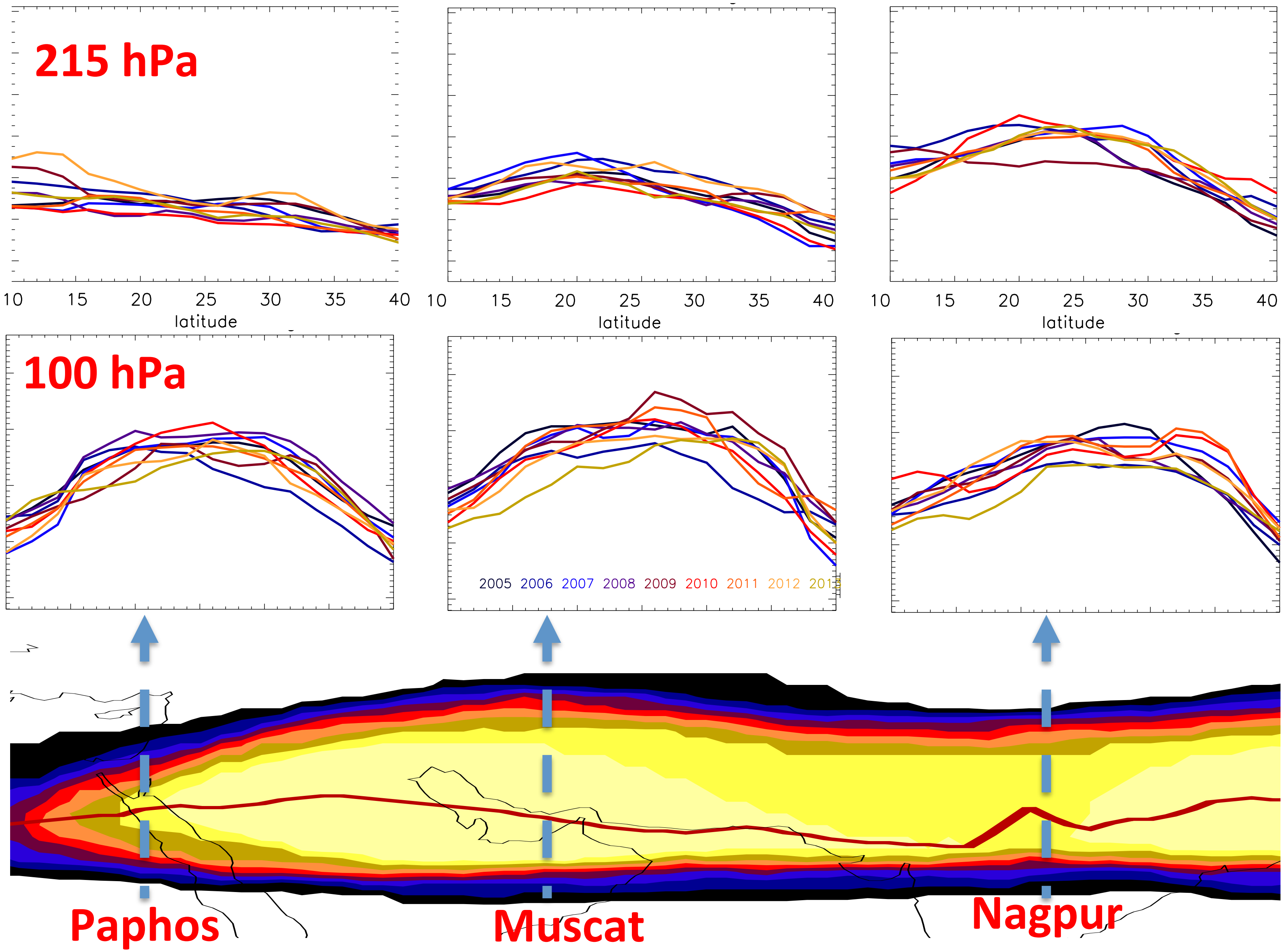


Monthly MLS CO data binned on a 2° x 2° lat/lon grid

CO Data along the AA spine derived as maximum frequency line

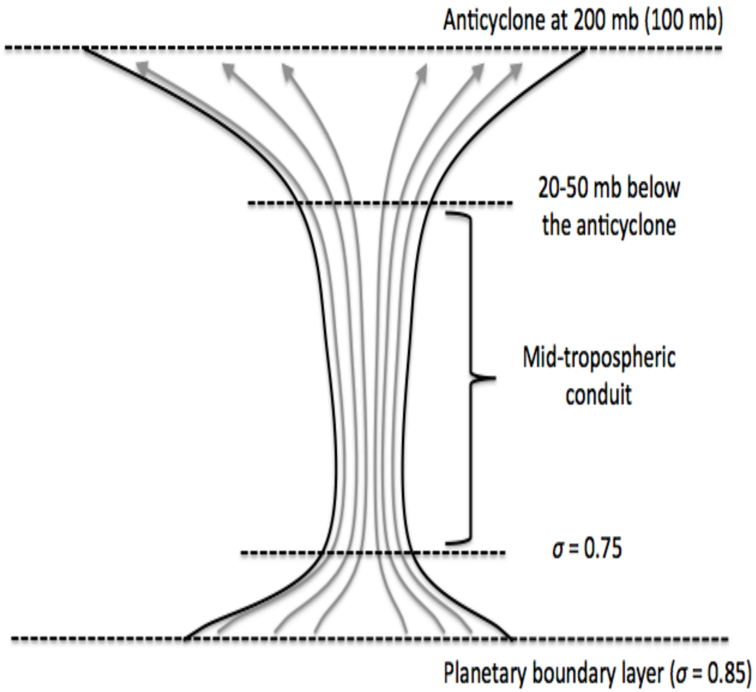


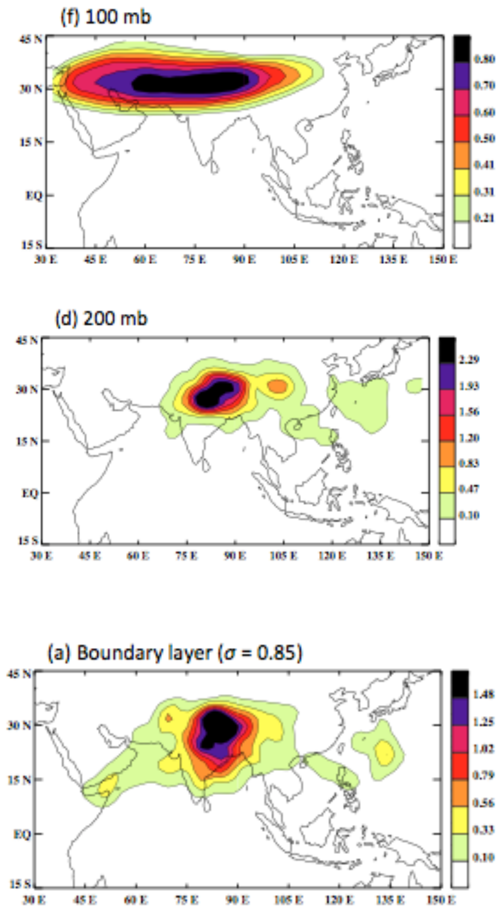
MLS CO meridional cross sections



Transport (1) - the role of a conduit ?

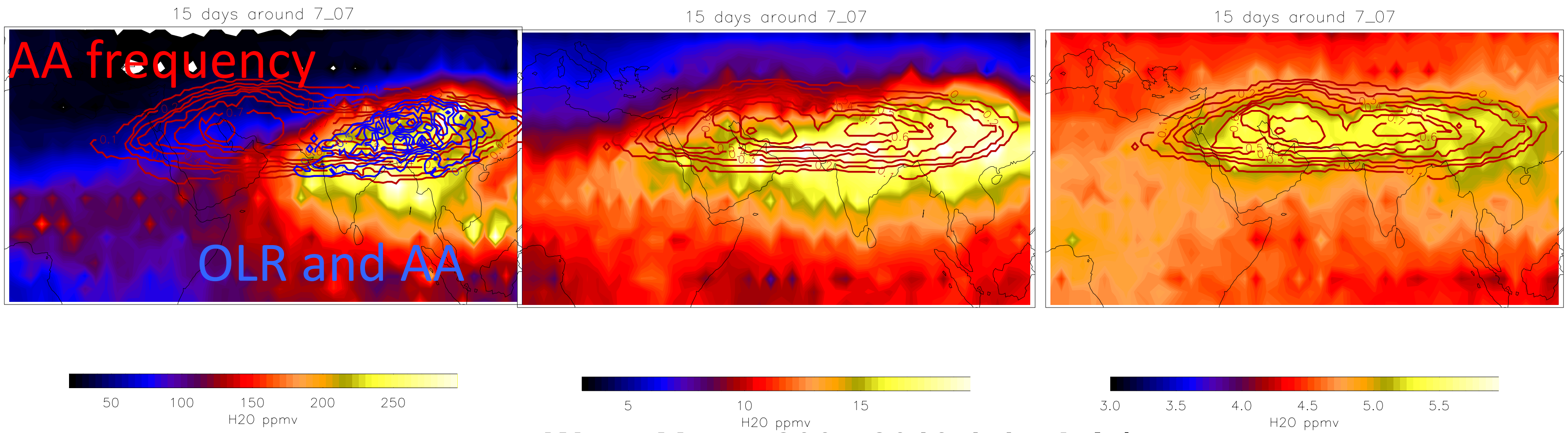
Air parcels transported to the ASM anticyclone from the PBL travel through a vertical conduit



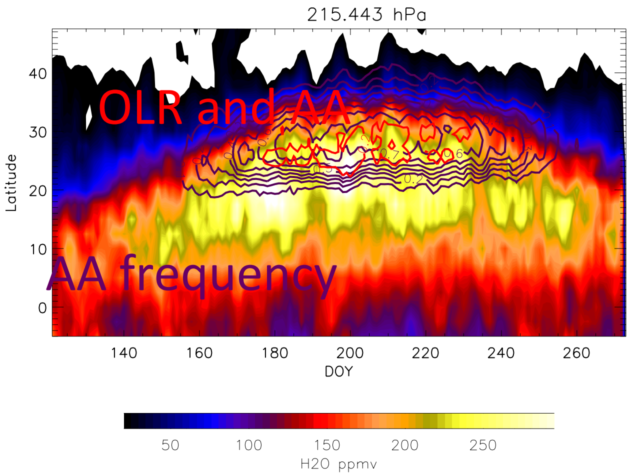


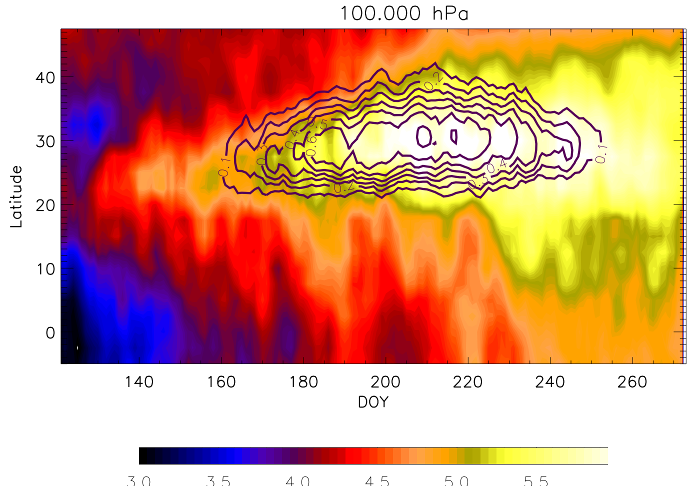
Bergman et al. 2013

Conduit from MLS H2O data



- **Water Vapor 2005-2013 1-15 July)**
- **Enhanced WV in the monsoon area at 215 hPa (10-25 N)**
- **Confinement inside the AA at 100 hPa**
- **Confirm the hypothesis of a conduit (Bergman, Fierli 2013)**





Transport 2 - Pathways to the LS ?

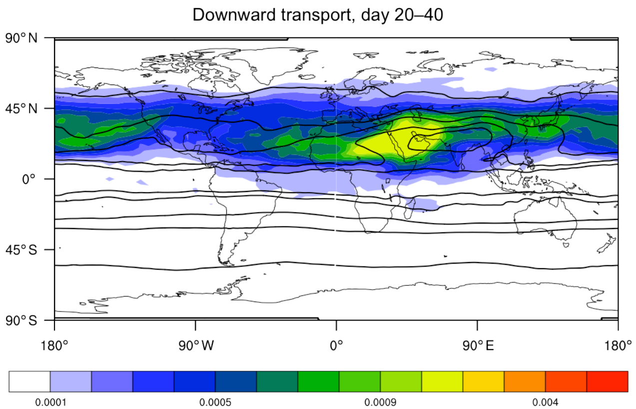


Figure 13. Mean JJA distribution of diabatic trajectories (in percentage of total number of trajectories) that are transported downward (to > 250 hPa) averaged over day 20 to 40 after their release in the anticyclone at 360 K, overlaid with mean JJA PV (contours at ±0.7, 1, 2, 4 and 8 PVU).

of deep convection. Therefore, we speculate that the persistent downward transport of air from within the anticyclone, and thus from the region of convective outflow, might contribute to the buildup of ozone in the middle troposphere over

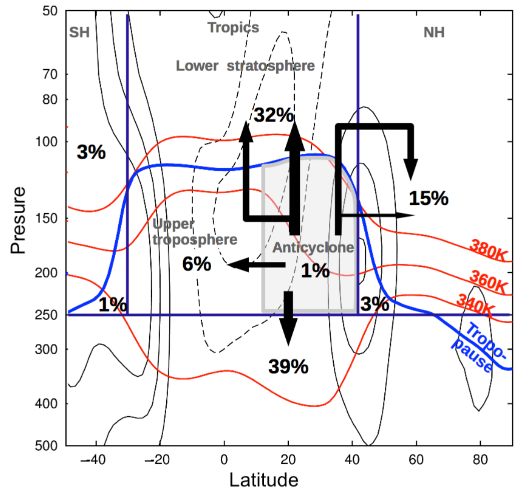
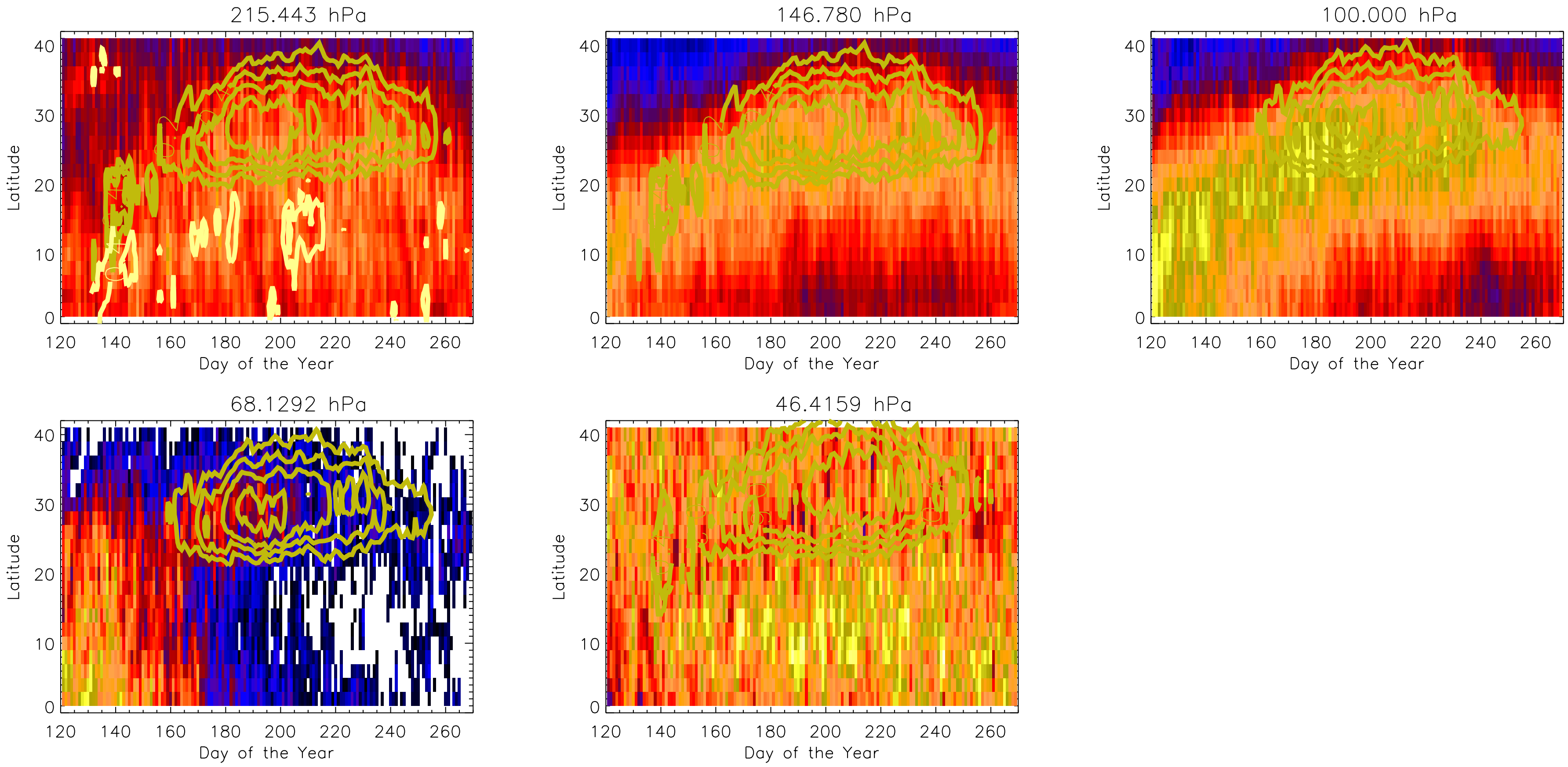


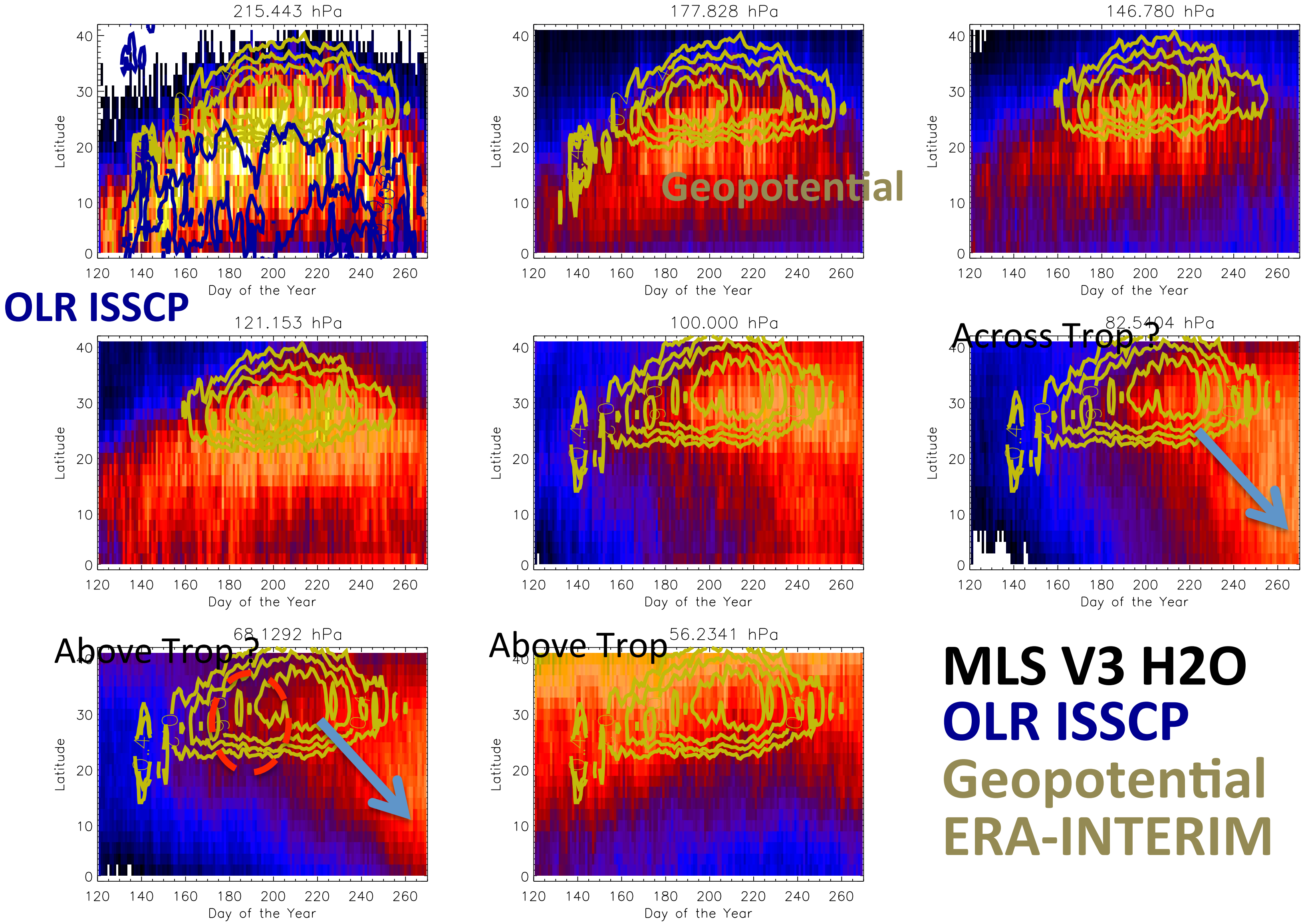
Figure 14. Schematic of the most prominent transport pathways of air originating in the upper-tropospheric anticyclone around 360 K (gray box). Numbers indicate fraction of trajectories (in percentage) that are located in the respective regions after 60 days for diabatic transport. The width of the arrows reflects the importance of the respective pathway. Contours show the zonal mean wind (black solid: positive; black dashed: negative), the tropopause (blue) and the 340, 360 and 380 K isentrope (red) averaged over 20–120° E.

Mean CO in the wider monsoon area

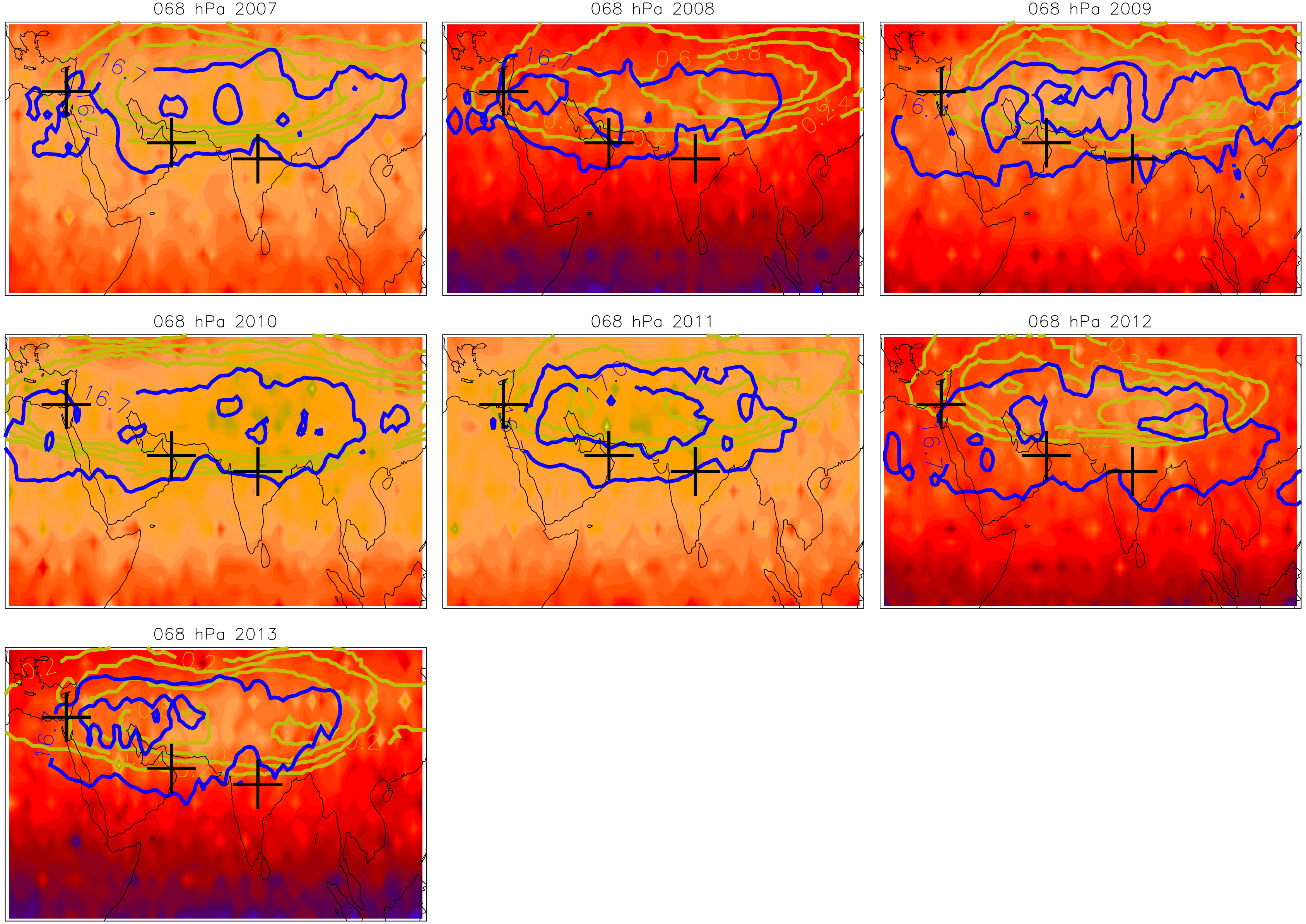


MLS V3 H2O

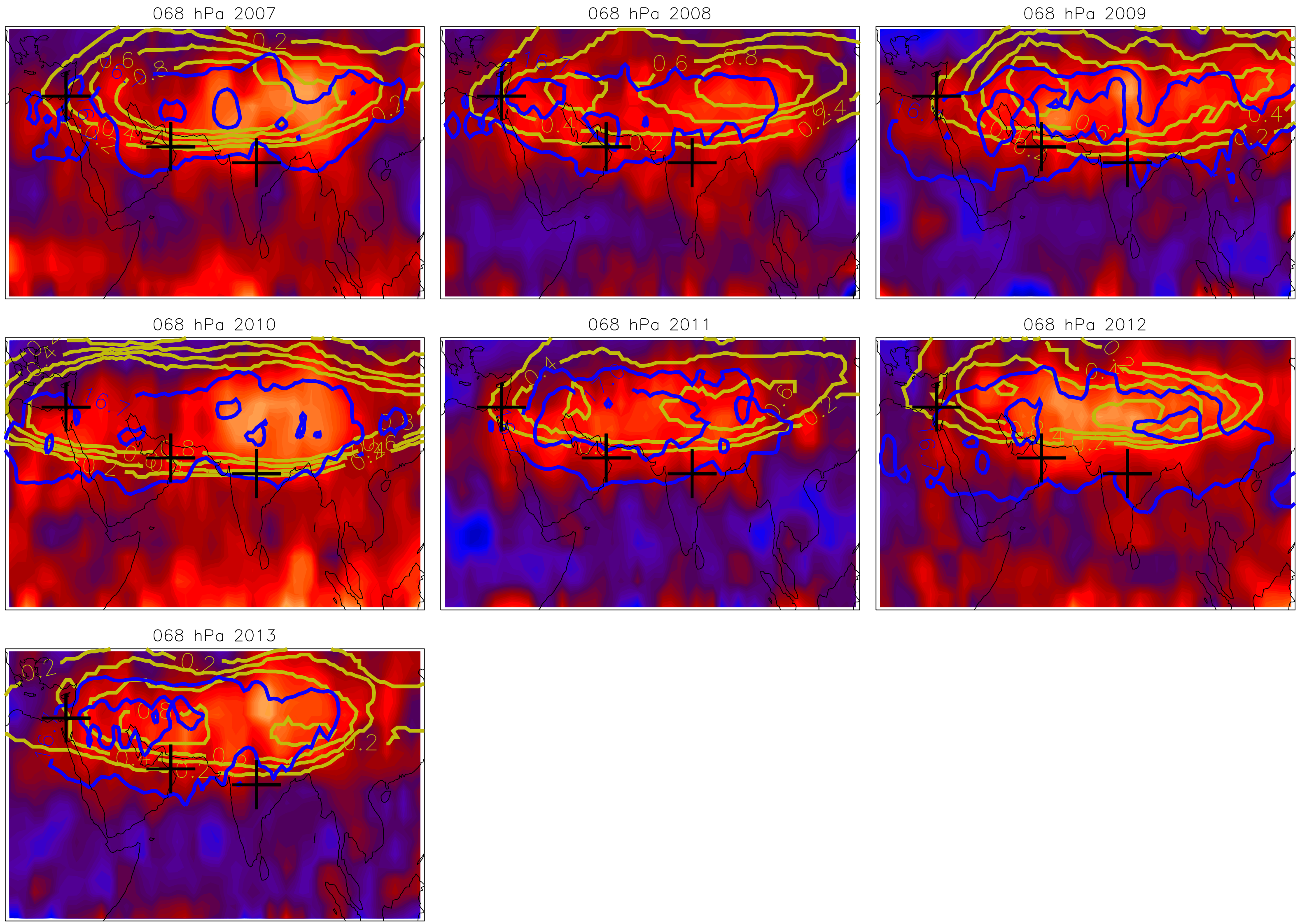
Mean H_2O in the wider monsoon area



H2O interannual variability Aug @68 hPa



CO interannual variability Aug @68 hPa



Mean distribution

Interannual variability

Intraseasonal variability

Intraseasonal variability: Role of single convective systems

N. K. Heath and H. E. Fuelberg: Convective transport in the Asian summer monsoon

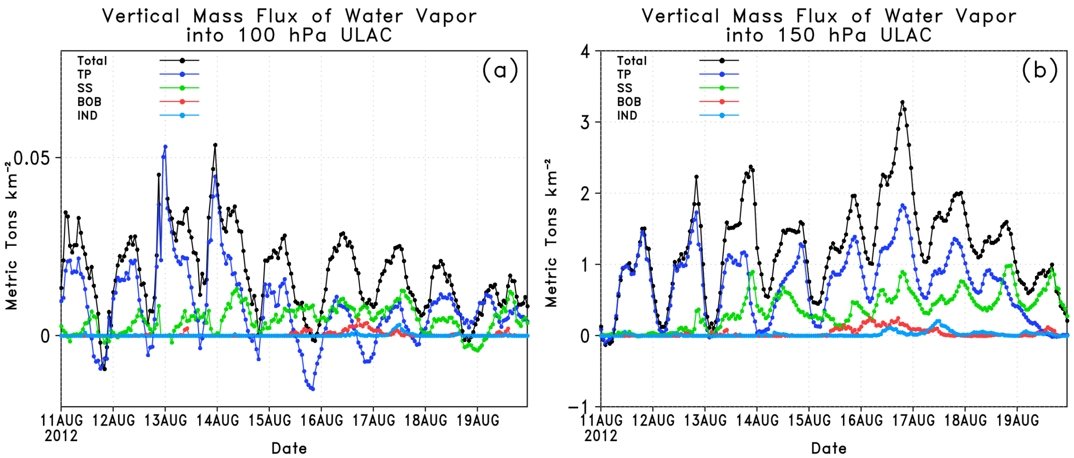


Fig. 11. Vertical water vapor mass flux (metric tons km^{-2}) into the ULAC at 100 hPa **(a)** and 150 hPa **(b)**. The black line indicates the total mass flux, and the colors indicate the amount from each defined region (Fig. 7). Note the two-orders-of-magnitude change between 150 and 100 hPa.

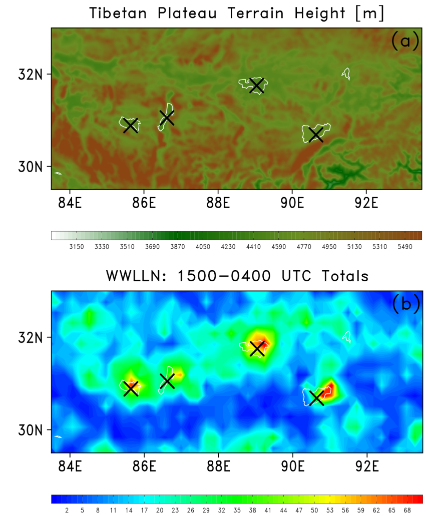
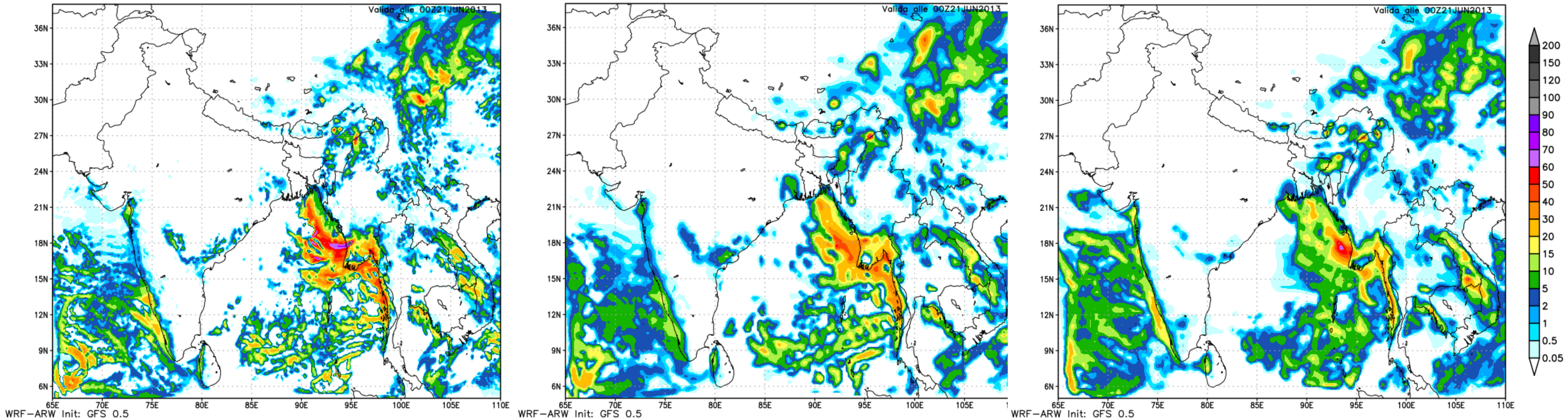


Fig. 13. (a) Terrain (m) of the Tibetan Plateau with black Xs denoting the locations of lakes. **(b)** Six year (2007–2012) WWLLN lightning totals for 15:00–04:00 UTC for August and September showing "hot spots" of lightning (deep convection) near the lakes (black Xs). The lightning data were binned into 25 km × 25 km grid boxes.

Season 2013 WRF+FLEXPART-WRF
Choice of the resolution



12,5 x 12,5 km – 30 LEV

25 x 25 km – 60 LEV

25 x 25 km – 30 LEV

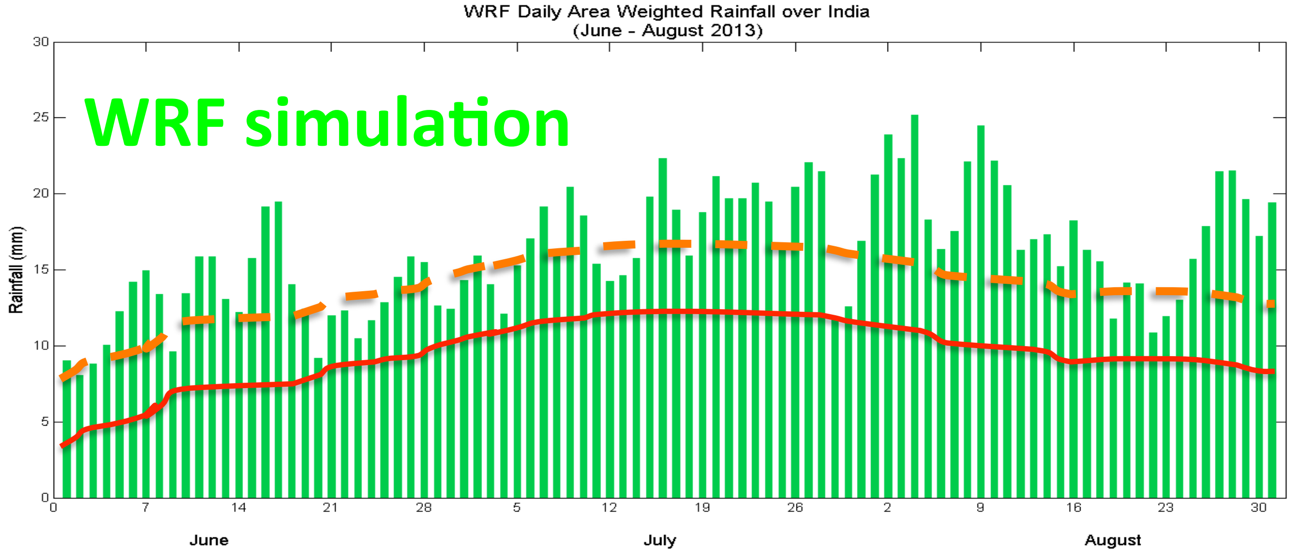
6 Hour Cumulated Precipitation [mm] 2013/06/21

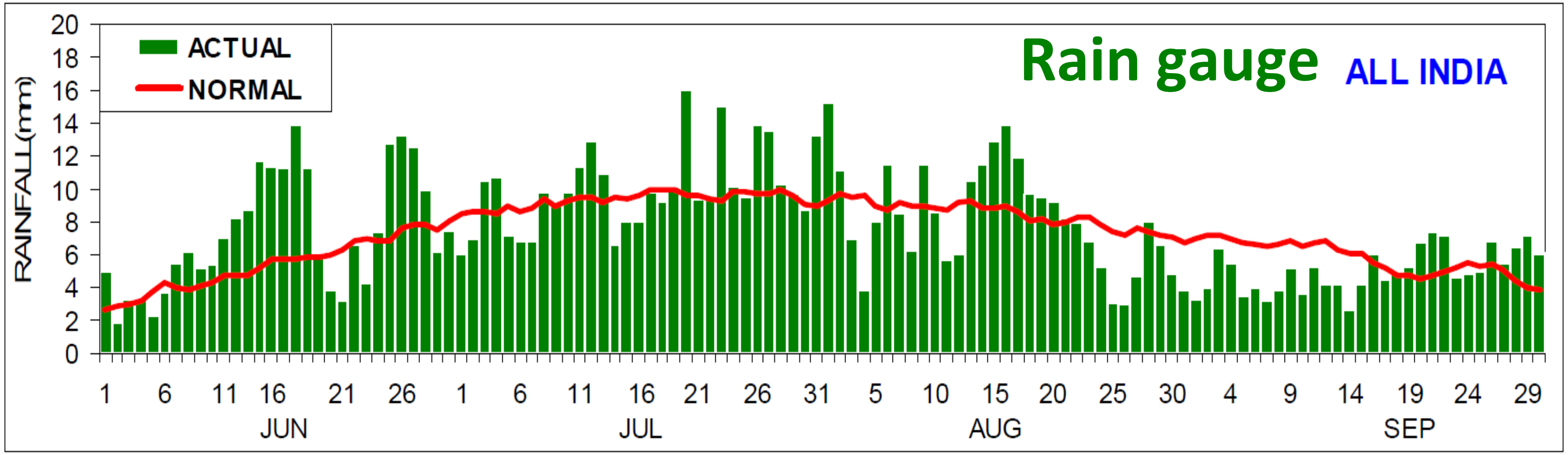
Necessary trade-off between resolution and computing time (model will work in forecast mode for the campaign)

Denser levels in the UTLS region

Choice of adapted parametrizations

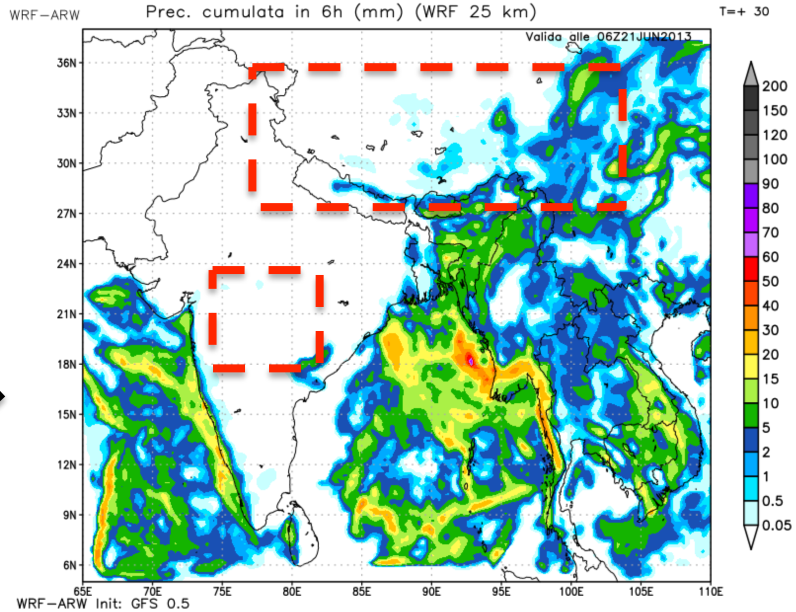
2013 WRF vs obs. precipitation over India



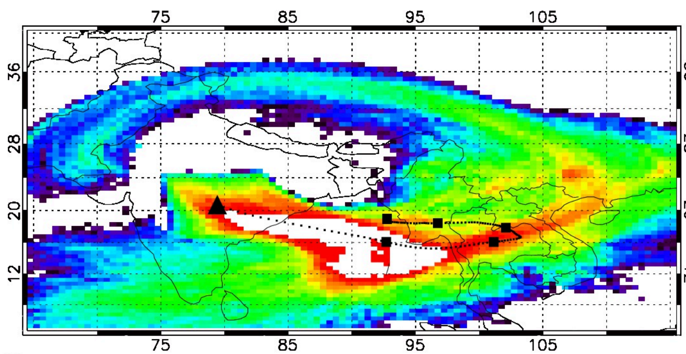


Flexpart-WRF analysis

WRF forecast:
From **day0** to
day0+d_day



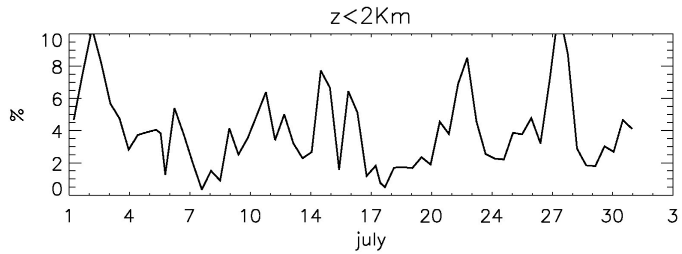
Run Flexpart
each 3 hours
(Box Nagpur)

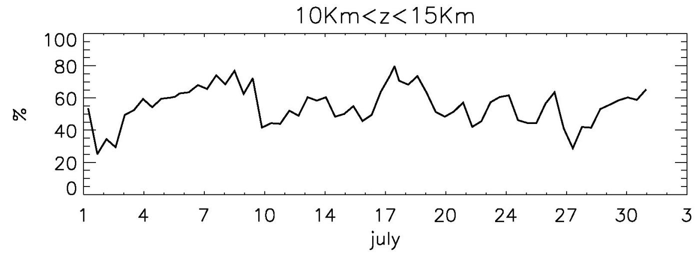


Integrating the fraction of particles on each box for each release day…

Derive diagnostics

PBL Air



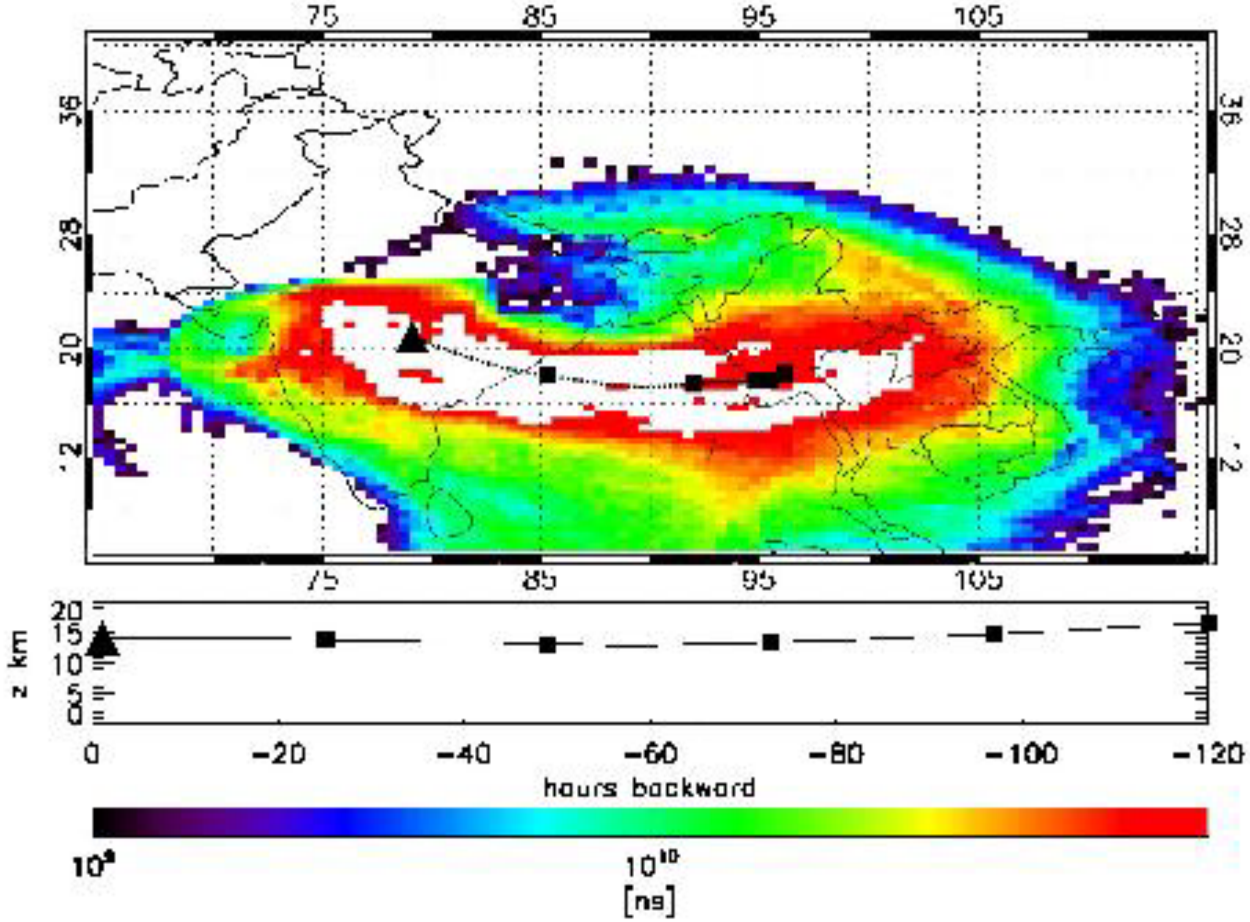


Upper Trop air

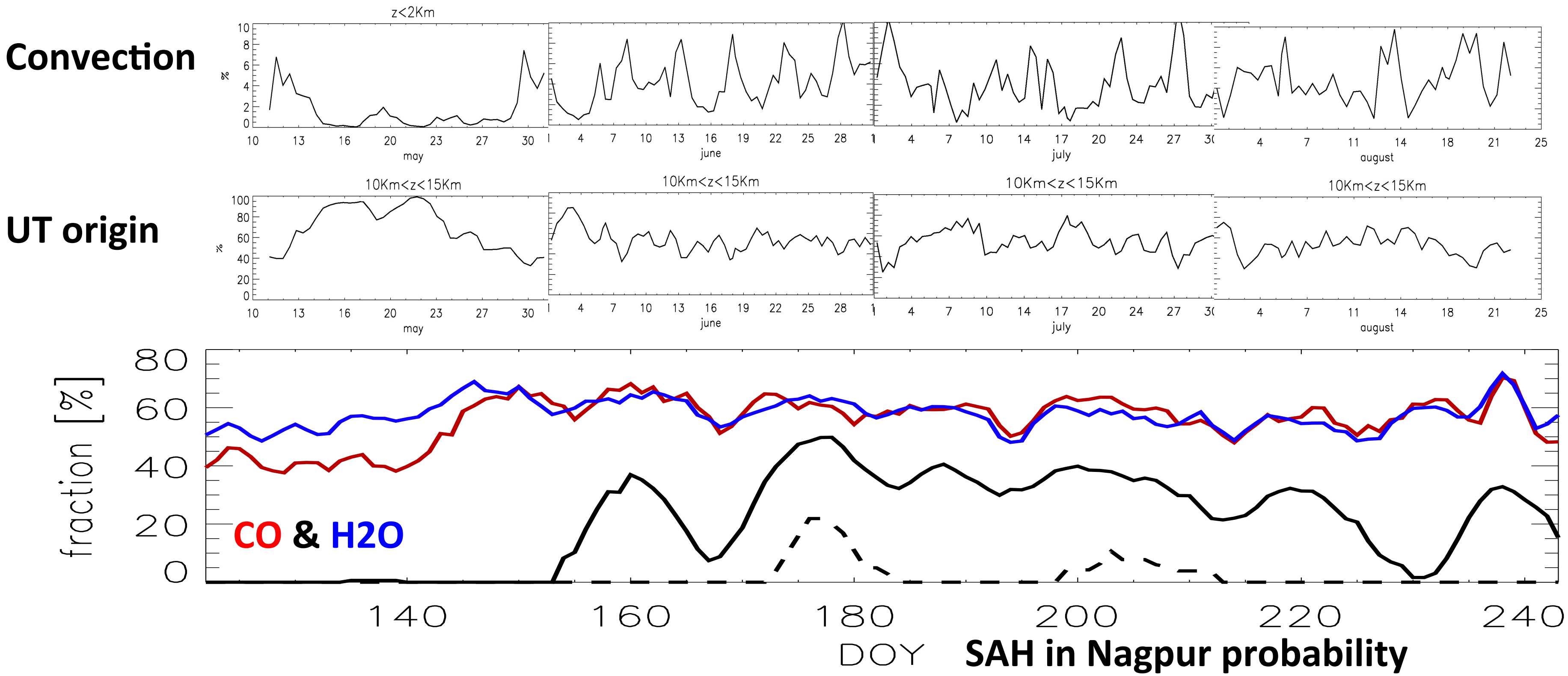
Convection vs UT transport in Nagpur

Back plumes Footprint
7 days mean

Alternance phases
Inside / Outside AA



Convection vs UT transport in Nagpur



Outlook

- From the local to the global

To which extent single events/phases of the Monsoon can drive concentrations in the AA ? (Includes Typhoons)

- From the ground to the Stratosphere

Which is the fate of the enhanced pollutants before and after AA breakup and which is the pathway ?

Is the AA the most effective entrance ? Shedding / permeability ?

- A blending of emissions

Are there preferential regions and how this will impact on the composition ?

ATAL -

AS3.20
Atmospheric Composition and Asian Monsoon
Convener: Federico Fierli
Co-Conveners: Gabriele Stiller, Ritesh Gautam
Session Details