Transport Associated with Asian Summer Monsoon Anticyclone and its Impact on the Upper Troposphere and Lower Stratosphere

Suvarna Fadnavis , Chaitri Roy, Gayatry Kalita , Ayantika D. C., Rajib Chattopadhyay et al.

Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Pune, India

Influence of enhanced Asian NO_x emissions on ozone in the Upper Troposphere and Lower Stratosphere (UTLS) in chemistry climate model simulations

Chaitri Roy, Suvarna Fadnavis, Ayantika D C. et al., *Atmospheric Chemistry and Physics, 2017, doi:10.5194/acp-17-1297-2017*

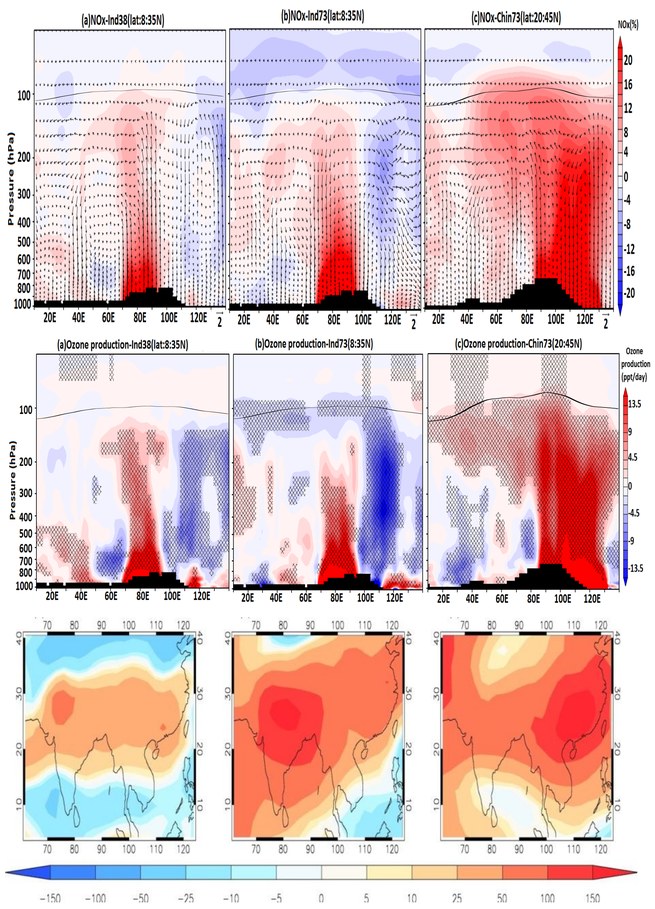

Fig: Distribution anomalies of NOx (%) (top), anomalies of ozone production (ppt/day) (middle), anomalies of ozone RF (mW/m-2) (bottom).

- Asian summer monsoon convection plays an important role in efficient vertical transport from the surface to the upper-level anticyclone.
- In this paper, we investigate the potential impact of enhanced anthropogenic nitrogen oxide (NOx) emissions on the distribution of ozone in the UTLS using the fully-coupled aerosol chemistry-climate model, ECHAM5-HAMMOZ. Simulations for enhanced NOx emissions over India and China for observed trends were performed.
- Model simulations show transport of NOx and ozone into the anticyclone and lower stratosphere.

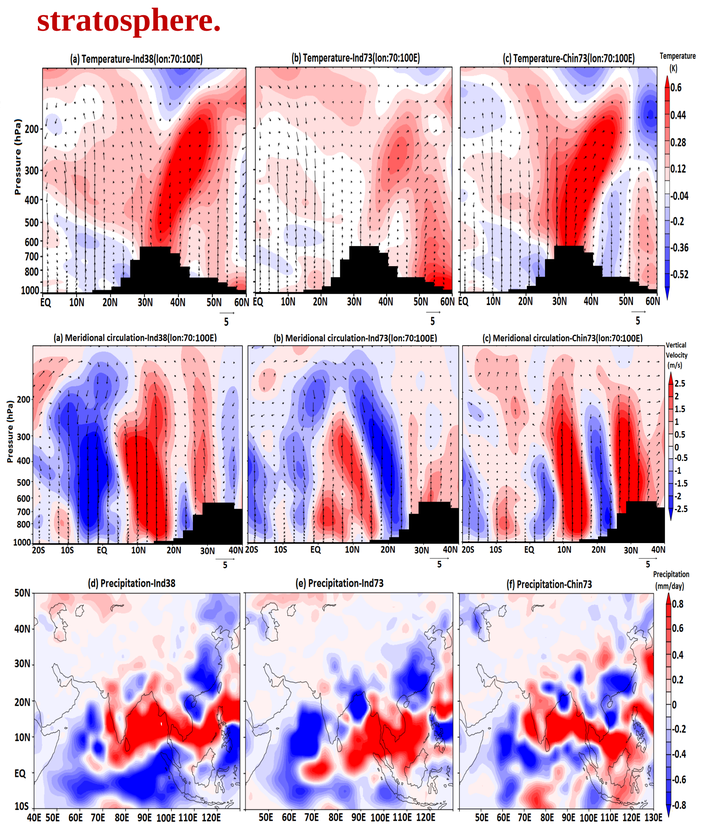

Fig: Anomalies in Temperature (top), meridional circulations (middle) and precipitation (bottom) due to enhanced NO_X emissions averaged for the monsoon season and over 70-100E for (Ind38-CTRL), (Ind73-CTRL) and (Chin73-CTRL) simulations.

- The model simulations with observed trend of NO_x emission produce significant warming over the Tibetan Plateau and increase precipitation over India due to the strengthening of the monsoon Hadley circulation.
- However, further enhancement in NOx emissions over India results in large ozone production over IGP and TP. It induces a reversed monsoon Hadley circulation and negative precipitation anomalies.

Linkages of subtropical stratospheric intraseasonal intrusions with Indian summer monsoon deficit rainfall

Suvarna Fadnavis and Rajib Chattopadhyay, *Journal of Climate, doi: 10.1175/jcli-d-16-0463.1, 2017*

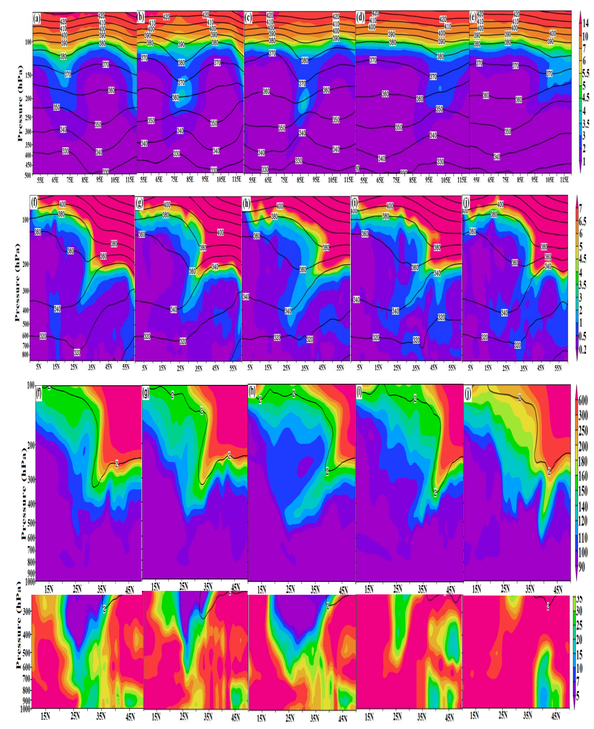

Fig: Zonal and meridional potential vorticity (PV) averaged 25°N-40°N (top two), ozone mixing ratios (ppb) averaged 60°E-75°E (bottom two), (a) 10 June, (b) 12 June, (c) 14 June, (d) 16 June, (e) 18 June 2014.

- Intrusions spread dry, cold and ozone rich air in the UT (~500 hPa). It persisted until the end of June 2014.
- The stratospheric intrusion period is marked by an abrupt increase in static stability of the troposphere.
- Anomalously dry and cold upper troposphere weakens the north-south temperature gradient in the UT.
- This might have inhibited northward propagation of large scale convection and is responsible for India monsoon deficit during June 2014.

- This paper reports that the subtropical stratospheric intrusion is likely to aid the development of longer spells of subdued rainfall during the Indian summer monsoon season.
- A deep stratospheric intrusion occurs due to RWB over NI and adjacent region during 10-18June 2014.
- Intrusion traverses the NI along the subtropical westerly jet and sheds eddy.

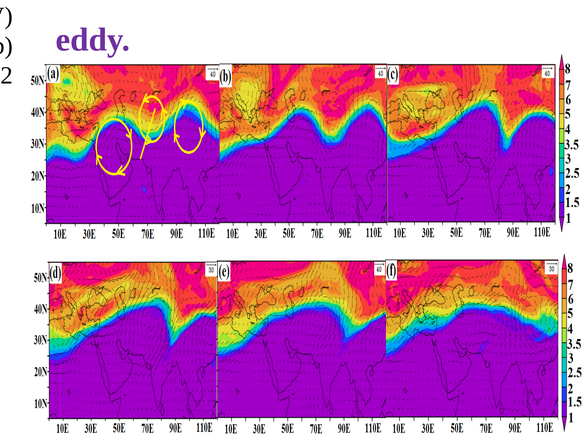

Fig: Distribution of PV at 350K level during 10-18 June 2014(alternate day) indicating RWB.

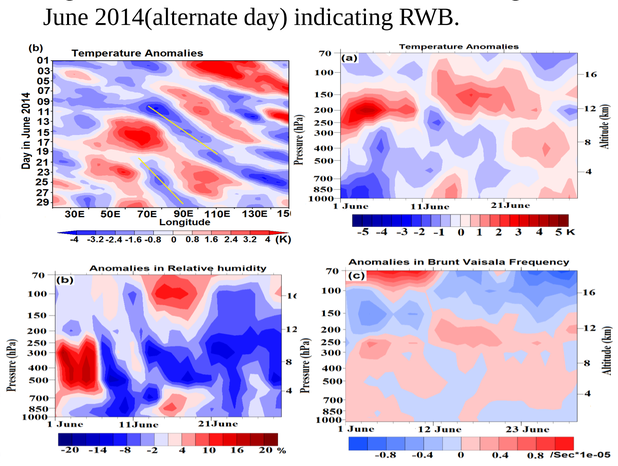

Fig: Anomalies in daily temperature (K) at 400 hPa, Time-pressure cross section of anomalies in (a) temperature (K), (b) RH (%), (c) square of Brunt Väisälä frequency (per sec*1E-5).

Potential impact of carbonaceous aerosol on the Upper Troposphere and Lower Stratosphere (UTLS) and precipitation during Asian summer monsoon in a global model simulation

Suvarna Fadnavis, Gayatry Kalita et al., , *Atmos. Chem. Phys., doi:10.5194/acp-2017-197, 2017*

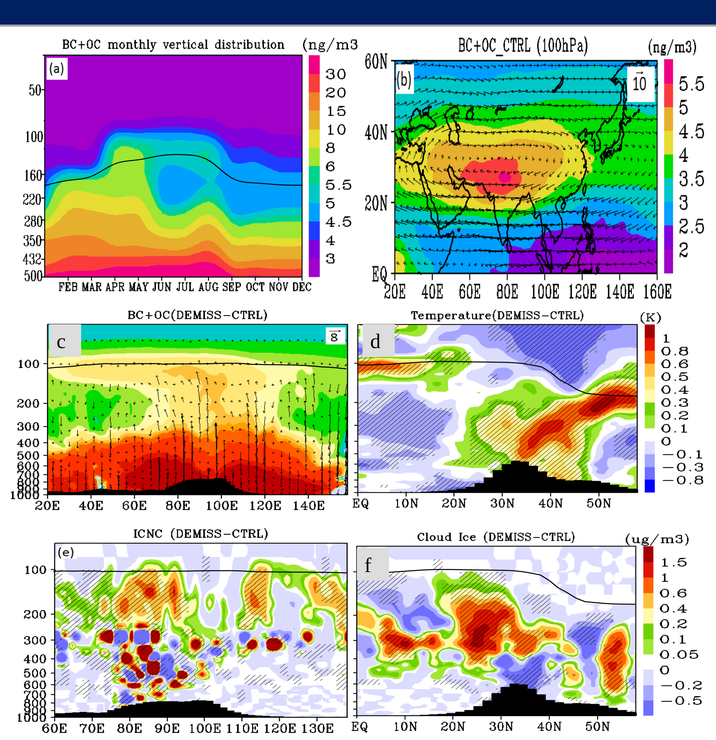

Fig: Distribution of BC+OC (a) monthly vertical profile, (b) 100hPa, (c) anomalies (avg:15:35N), (d) anomalies of temperature (avg:80:110E), (e) anomalies of ICNC (avg:15:35N) and (f) anomalies of cloud ice (avg:80:110E).

- ➢ The ECHAM6 HAM simulations show strong monsoon convection over the Bay of Bengal and the South China Sea and southern slopes of the Himalayas lifts the boundary layer carbonaceous aerosols into the anticyclone.
- ➢Carbonaceous aerosol emission increases heating rate anomalies in the anticyclone by 0.02 - 0.03 K/day.
- ➢Enhancement of carbonaceous aerosols produce significant warming in the mid/upper troposphere, enhances vertical velocities and thereby anomalies of cloud ice and ICNC in the UTLS.
- ➢Anomalous warming over the TP induces the relative strengthening of the monsoon Hadley circulation and elicit enhancement in precipitation over India and northwest China.

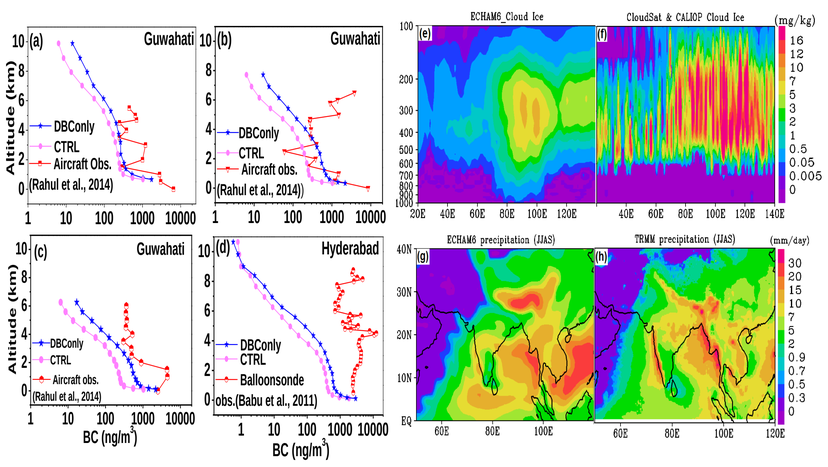

Fig: (a-d) Comparison of BC vertical profile with observation s of aircraft (Rahul et al., 2014) and balloonsonde (Babu et al., 2011), (e-f) comparison of cloud ice from CTRL simulation and CloudSat and Calipso measurements, (g-h): comparison of simulated and TRMM precipitation.

- ➢Comparison of simulated BC vertical profile, cloud ice and precipitation shows reasonable agreement with in situ and satellite measurements.