Elevated aerosol layer over South Asia worsens the Indian droughts

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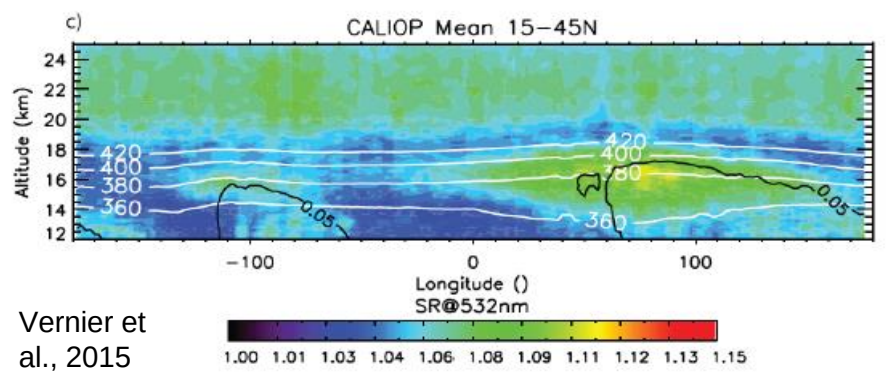
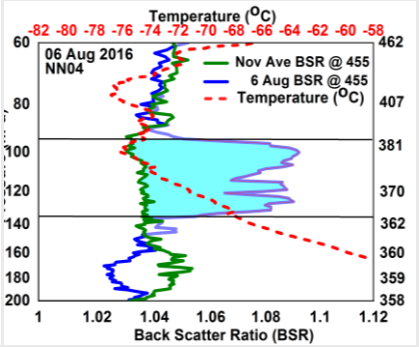
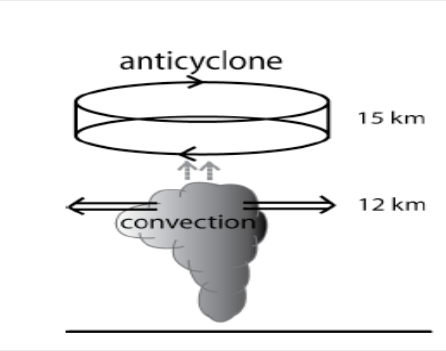


Vernier et al., 2015

Nainital August 2016

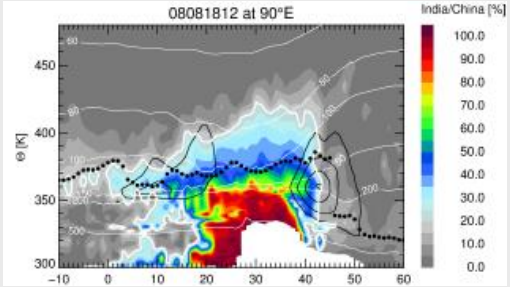




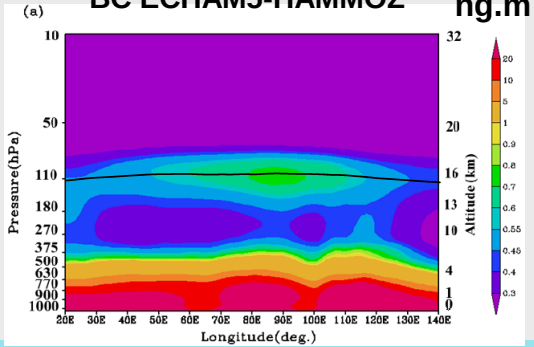
Park et al., 2008

CLAMs simulations, (Vogal et al., 2019)

South Asia and East Asia



BC ECHAM5-HAMMOZ ng.m $^{-3}$



- Monsoon convection lifts BL aerosols to the UTLS.
- It forms aerosol layer (ATAL) in the UT/LS.
- Composition of ATAL is not known yet.

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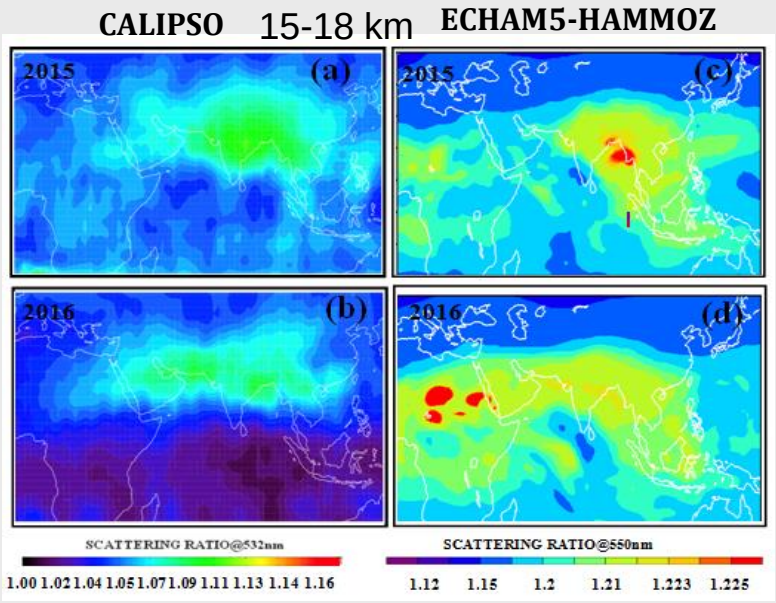
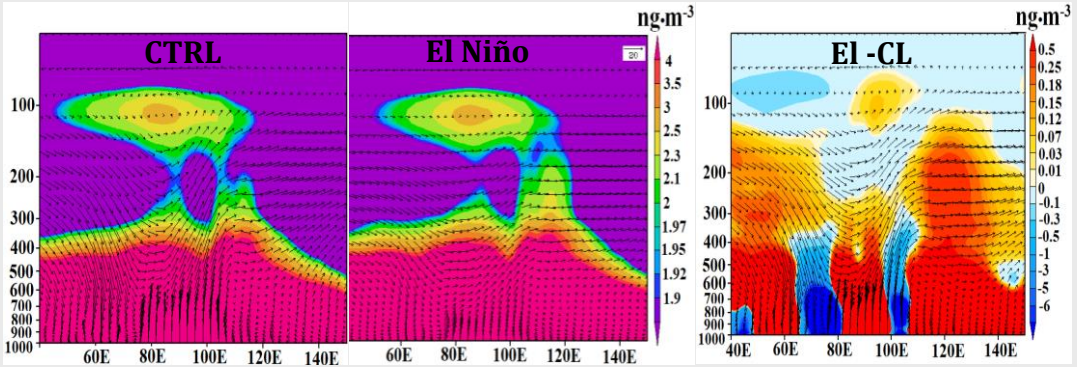
Elevated aerosol layer over South Asia

CALIPSO and ECHAM5-HAMMOZ model simulations



- During El Niño the ATAL is thicker and centered over the Indian region.
- The ATAL is wide spread and thinner during a normal year.



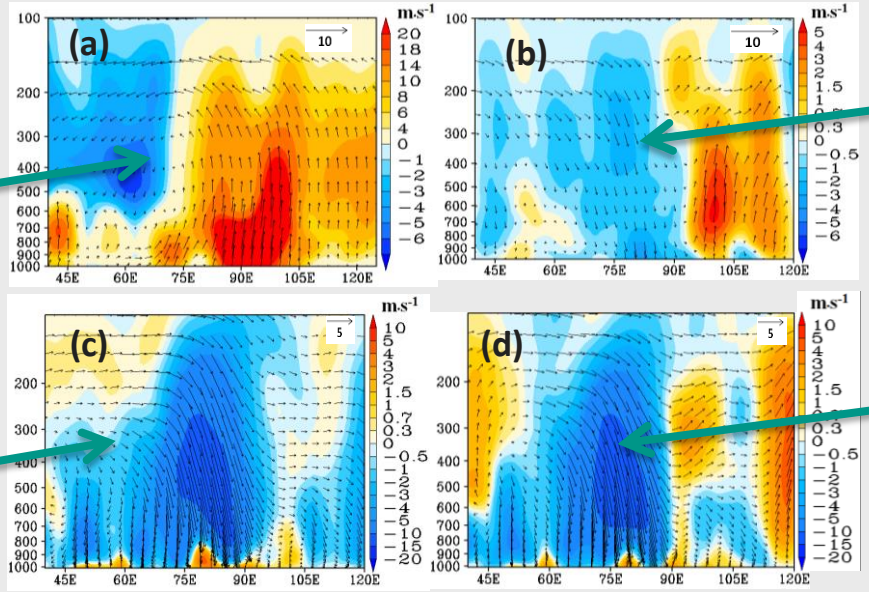
- Aerosols in the ATAL are transported from: (1) South Asia and (2) East-Asia.
- During El Niño aerosols entering the ATAL are mostly from East Asia.

Fadnavis et al., Sci. Reports, 2019

Impact on circulation

Ascending winds
(climatology)

Descending winds
(No aerosols: aeroffEL-
aeroffCL



Descending winds
(El Nino years)

Aerosol induced
descending winds
(aeronEL- aeronCL)

Cross-section of seasonal mean zonal circulation (m•s^{-1}) averaged over 15 – 30 °N for (a) NCEP reanalysis climatology (1948 – 2007), (b) NCEP reanalysis El Niño years anomalies, and simulated (c) aeroffEL- aeroffCL, and (d) aeronEL-aeronCL anomalies

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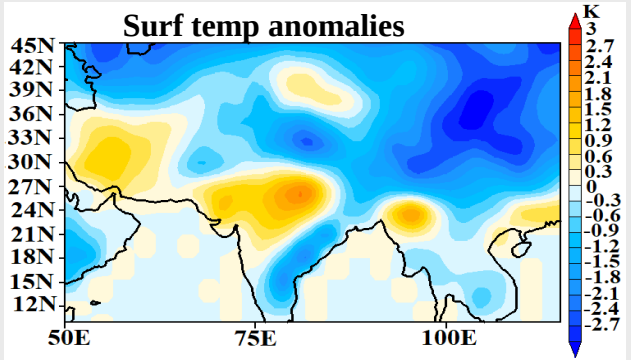
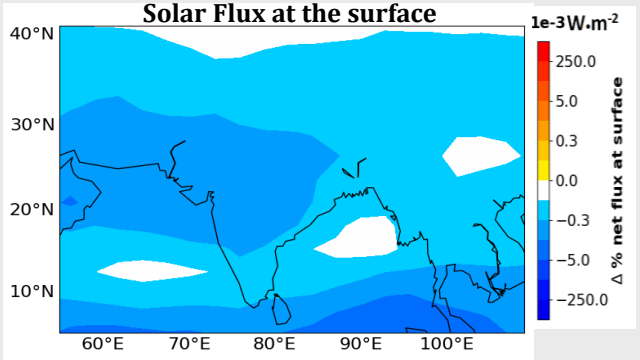
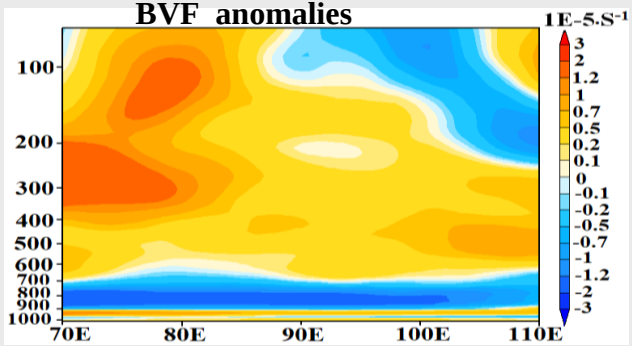
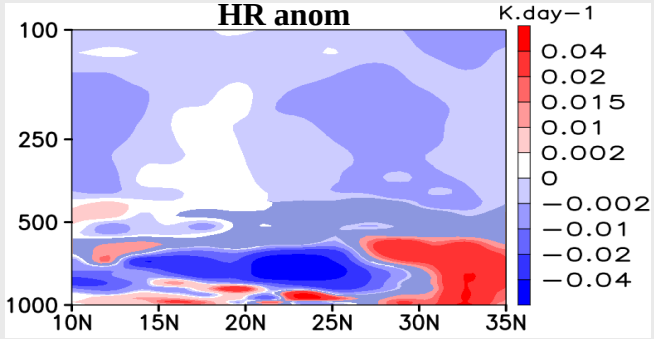
Impact of aerosol layer during El Niño

Anomalies EL-CL





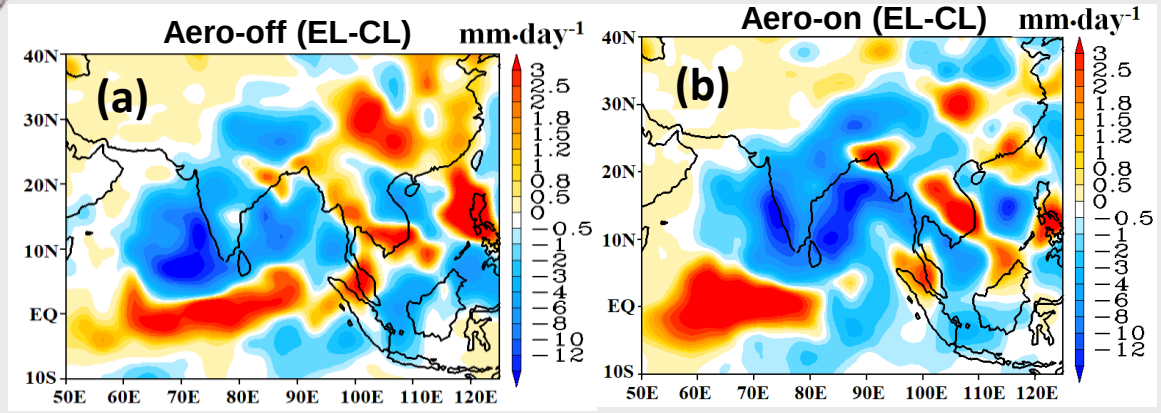


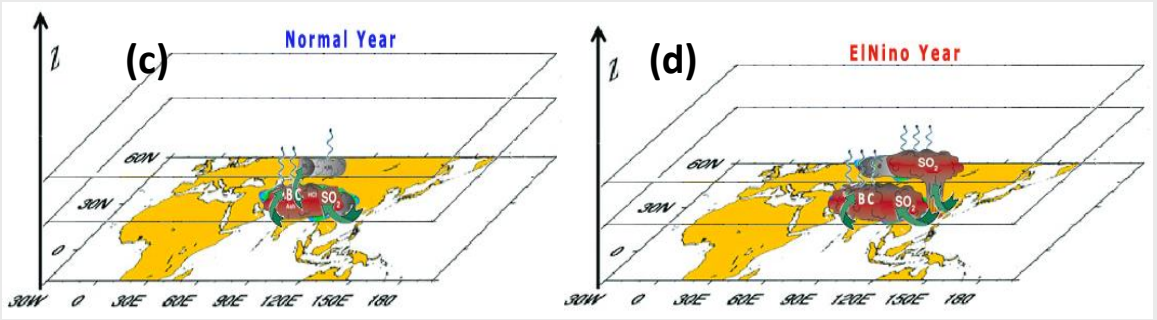


The ATAL induces negative anomalies in solar flux, increases stability of the upper troposphere over NI and TP region.

Fadnavis et al., Sci. Reports, 2019

Impact on precipitation during El Niño





The severity of droughts during El Niño is exacerbated ~17% by changes in aerosols.

- The added blanket of aerosol leads to a weakening of the monsoon Hadley circulation.
- The anomalous large-scale subsidence results in amplifying the severity of monsoon droughts.

Fadnavis et al., Sci. Reports, 2019