The Third Workshop on Atmospheric Composition and the Asian Monsoon, June 05-09, 2017, Guangzhou, China

Absorbing aerosol modulation of mesoscale summertime temperature maxima over India: a causality based approach

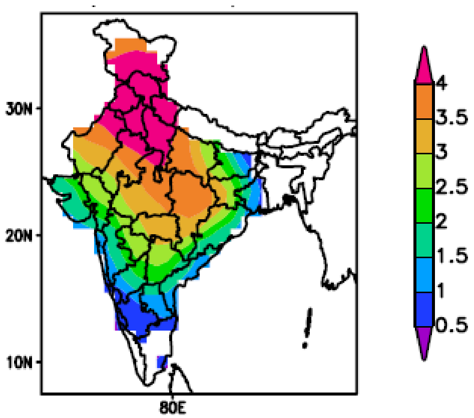
Prashant Dave, Mani Bhushan, Chandra Venkataraman

06th June, 2017

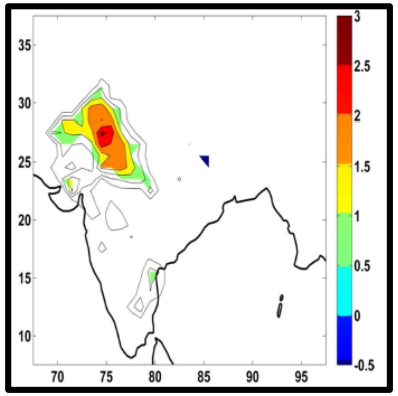
Interdisciplinary Program in Climate Studies
Indian Institute of Technology Bombay, India

Temperature maxima and absorbing aerosols over India

- Large anomalies in summer time temperature maxima (Ratnam et al., 2016)
- An increase in duration, frequency and intensity of heatwave events (Rohini et al., 2016).



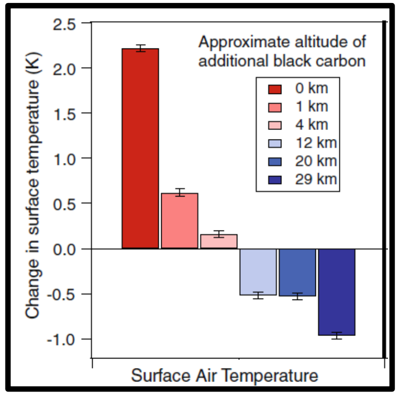
Temperature maxima
(Ratnam et al, 2016)



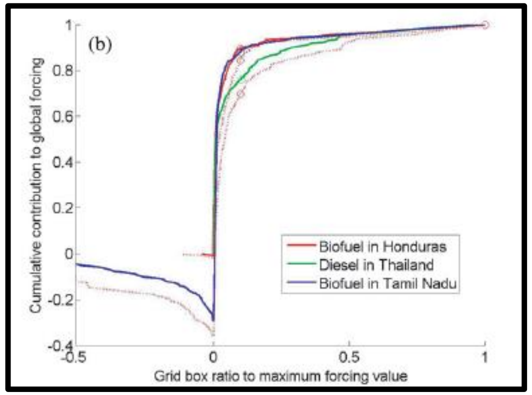
Trends in heatwave duration
(Rohini et al, 2016)

- Attribution: large scale atmospheric anomalies connecting sub-tropical persistent high, quasi-stationary, depleted soil moisture and clear skies etc.

- Absorbing aerosols increases in surface air temperature (Ban-Weiss et al. 2012; Hansen et al. 2005).
- The effect can extend several hundred kilometers around source (Bond et al., 2007).



Surface temperature with BC (Ban-Weiss et al., 2012)



Local effects are only 10-30%, (Bond et al., 2007)

- India, in particular Indo-Gangetic belt, has witnessing increasing emissions of absorbing aerosols (Habib et al., 2006)

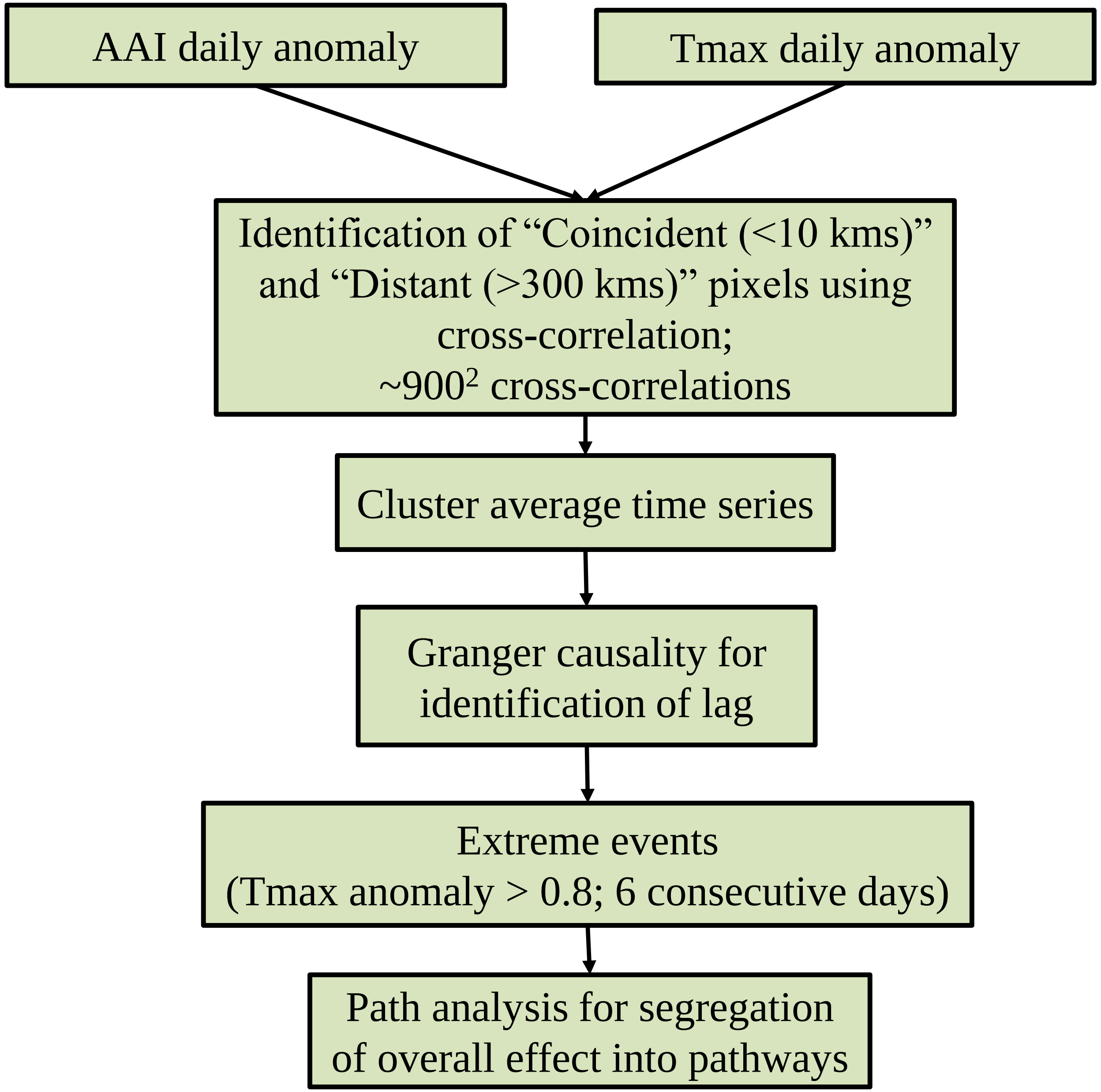
Objectives

- To investigate link between local and distant absorbing aerosols with temperature extremes.
- Identification and quantification of pathways of temperature interaction.

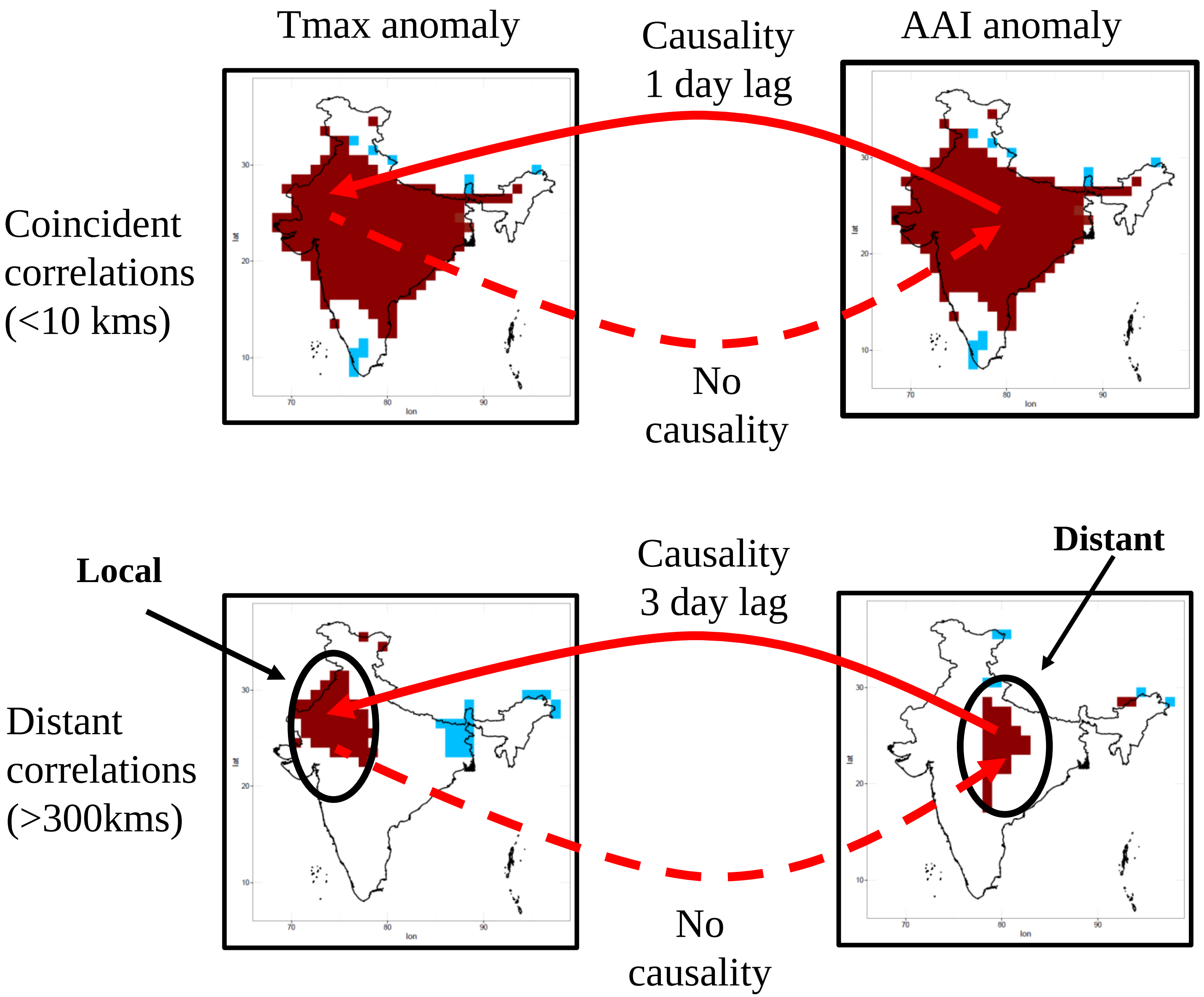
Data and Methodology

Data description

- Maximum surface temperature (Tmax): Indian Meteorological Department
- Absorbing aerosol index (AAI): TOMS and OMI
- Lapse rate: ERA-interim reanalysis (derived from layerwise temperature)
- AAOD: OMI 2004-2013
- Time period: March-June, 1979-2013
- Region: 6.5N-38.5N, 66.5E-100.5E
- ~ 900 pixels



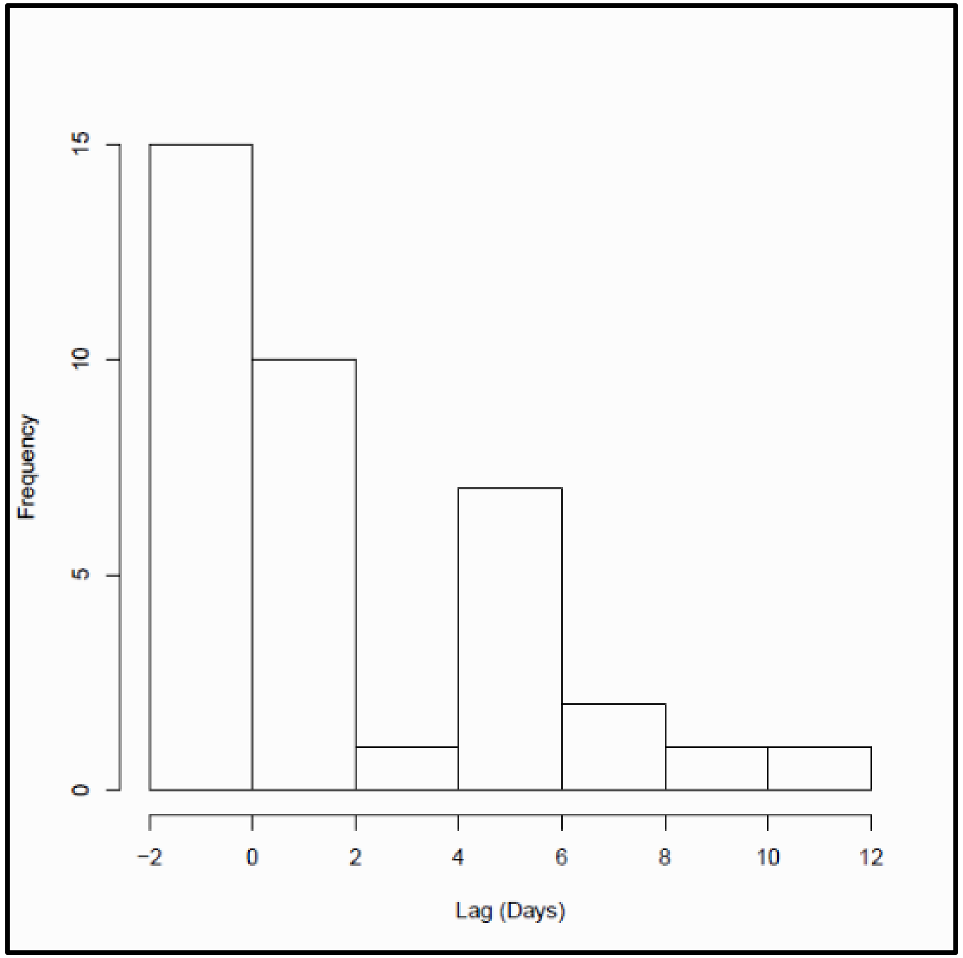
Results



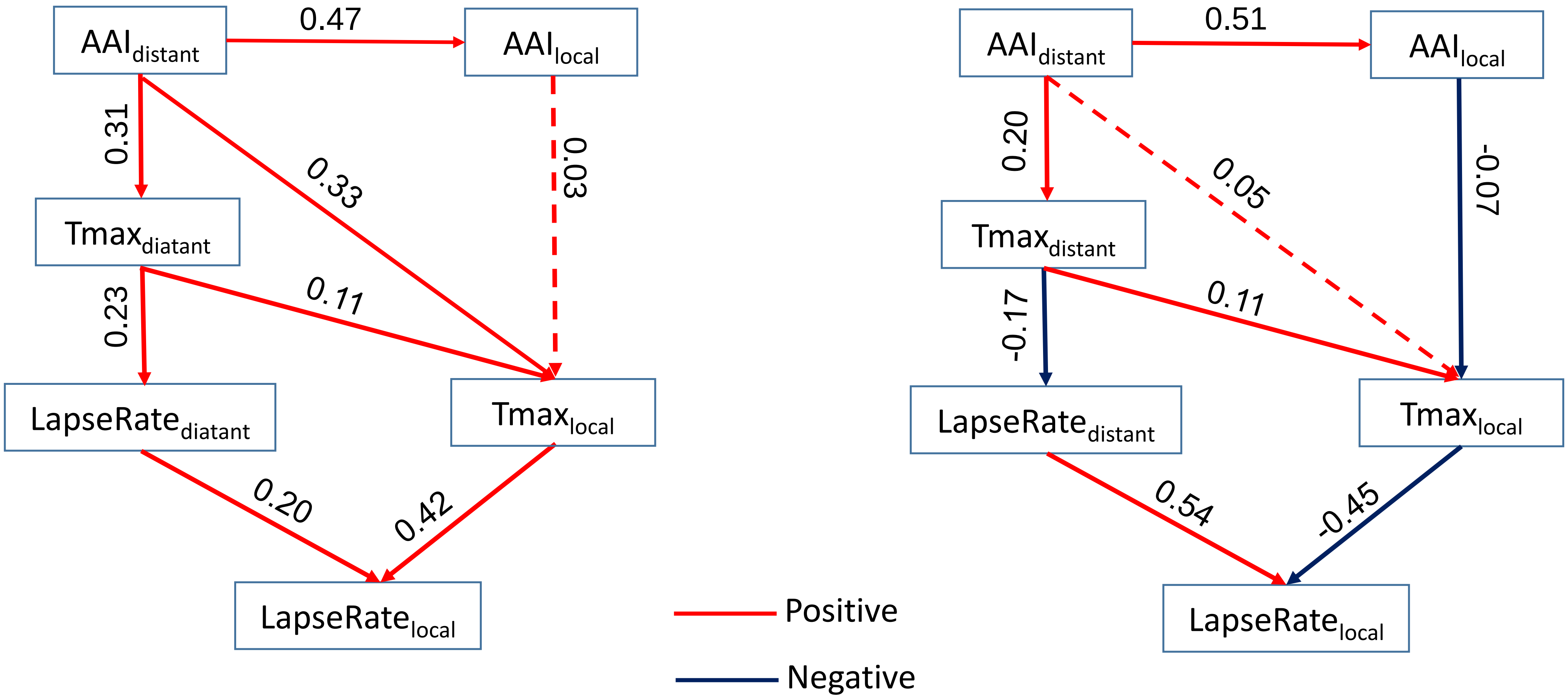
- Dark red shows positive while blue shows negative correlation.
- Tmax cluster (Local region) matches with Ratnam et al. (2016) box used for studying heat waves.
- Using cluster average, causality of upto 3-days was found from AAI anomaly (Distant region) to Tmax anomaly (Local region)
- Regions distant and local were selected for further analysis.
- If causality exits at multiple lags, lag with maximum correlation was selecte for the analysis.

Implications on heat wave

- Using Tmax daily anomaly, extreme maximum temperature days of local region were identified for every year.
- For every year using causality was tested, and lag between AAI anomaly (distant region) and Tmax anomaly (local region) were identified.
- Similar to all years together results, causality was found from AAI to Tmax anomalies and not other way around.
- Lag order varied from 1-11 days.



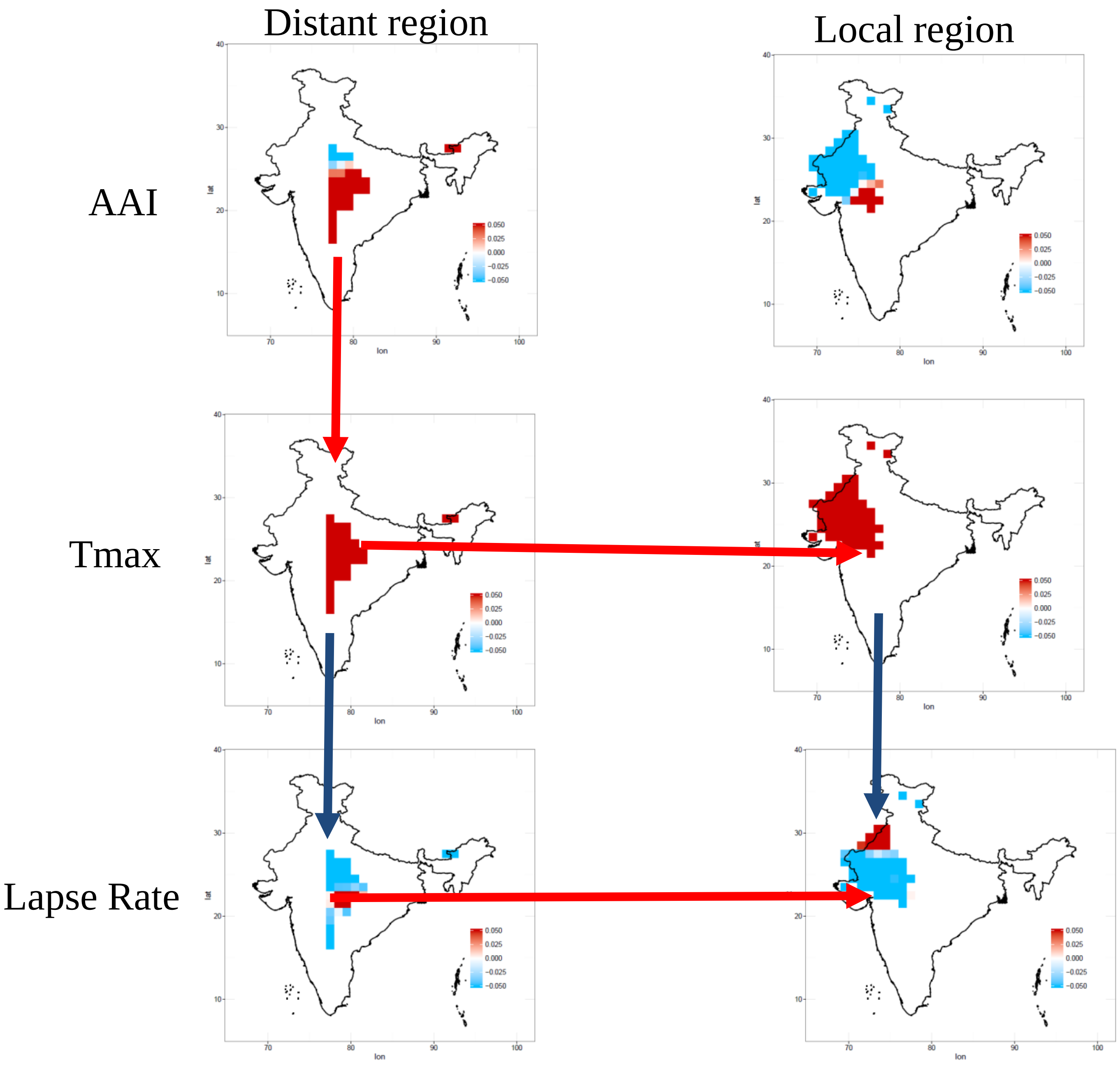
Path analysis



Normal conditions

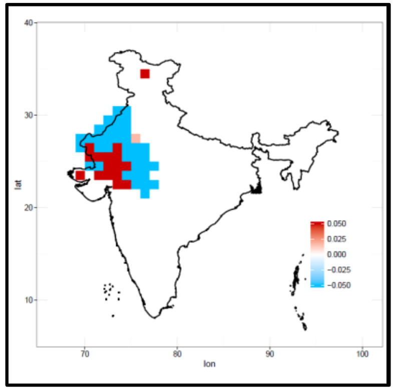
Extreme conditions

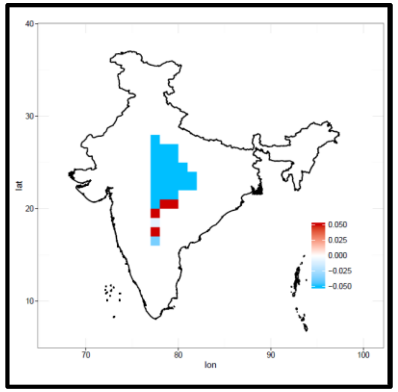
Composite of AAI, Tmax and Lapse rate



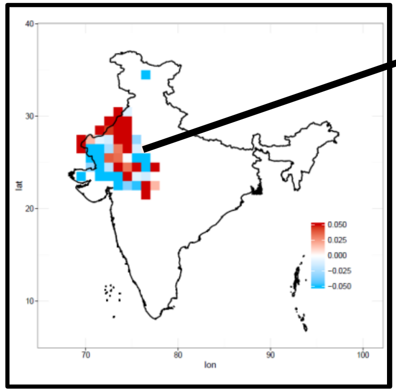
- Increase in AAI at distant region increases Tmax at local region.
- Increased Tmax at distant region decreases Lapse Rate at distant region and increases Tmax at local region.
- Increase in Tmax at local region contributes to decrease in Lapse Rate at local region.
- Decreased Lapse Rate at distant region also contributes to decrease in Lapse Rate at local region.
- AAI at distant region contributes to increase in Tmax as well as in decrease in Lapse Rate while AAI at local region does not contribute.

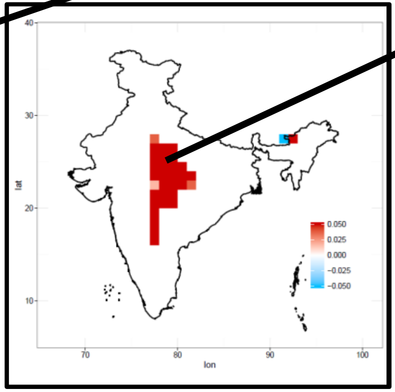
Composite of AAOD





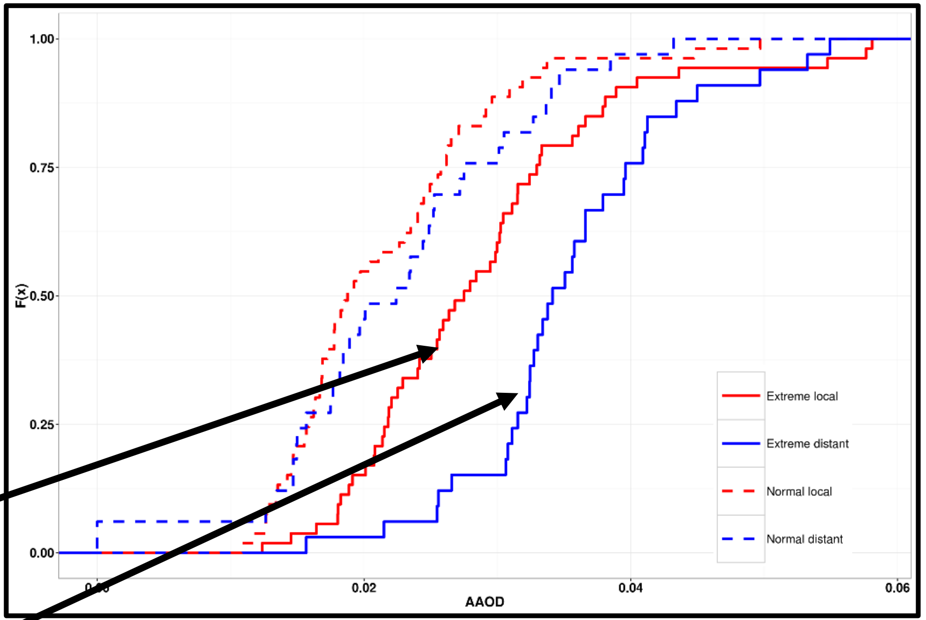
Normal conditions





Extreme conditions

AAOD anomaly



AAOD absolute value CDF

- For the period of 2004-2013.
- Higher AAOD absolute and anomaly was found in Extreme distant region.
- Supporting the arguments of presence of high absorbing aerosol in distant regions during extreme conditions

Conclusions and future direction

- **Non-local aerosols** play role in affecting distant temperature.
- Plays prominent role in effecting extreme heat events.
- Correlation between layer wise temperature and winds, with AAI can help in revealing the complete mechanisms.
- Identification of days with high relative humidity along with temperature extreme can further help in understanding the heat wave mechanisms.

Thank you.