

Supplementary Material for Changing Northeast India Summer Monsoon Onset Dynamics in a Warming World

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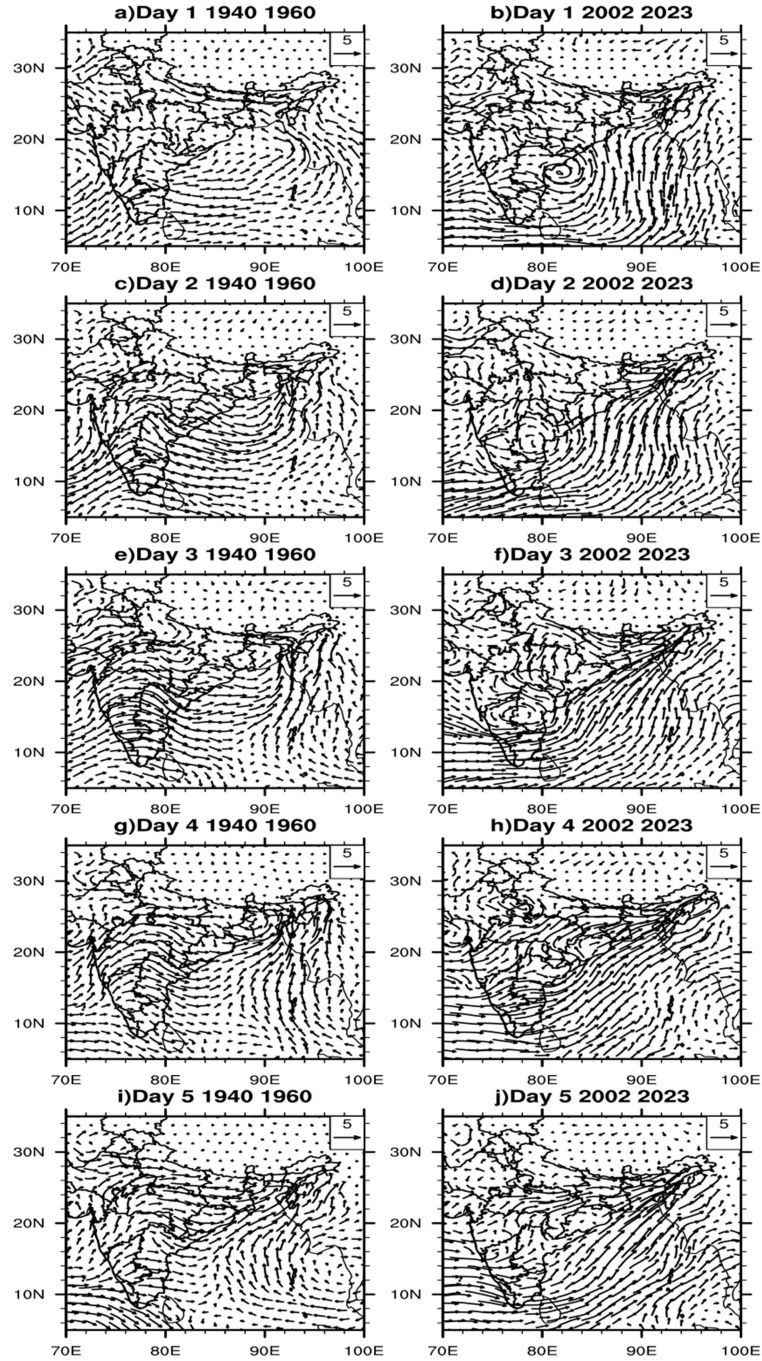


Figure S1 : (a) Composite of wind anomalies for day 1 of the 5 day wet spells during 1940-1960. Unit: mm/day. (b) Same as (a) but for the period 2002-2023. (c) Same as (a) but for day 2. (d) Same as (b) but for day 2. (e) Same as (a) but for day 3. (f) Same as (b) but for day 3. (g) Same as (a) but for day 4. (h) Same as (b) but for day 4. (i) Same as (a) but for day 5. (j) Same as (b) but for day 5.

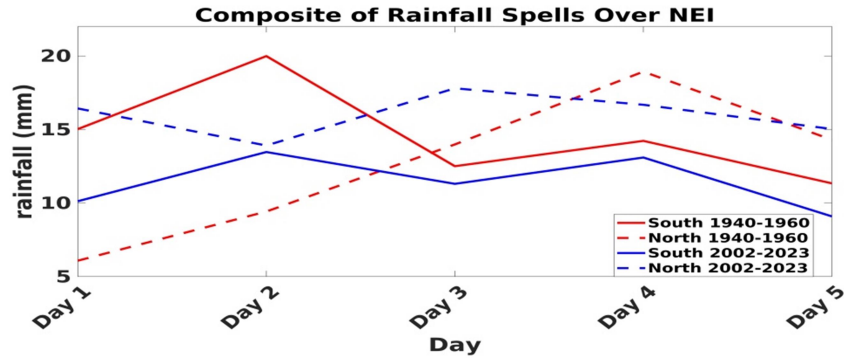


Figure S2: Composite of rain spells over NEI region averaged over the North ($26.5\text{--}29^\circ\text{N}$ & $93\text{--}98^\circ\text{E}$) and South ($23\text{--}26^\circ\text{N}$ & $90\text{--}94^\circ\text{E}$) region.

Composite of PV at 200hPa (2002-2023)

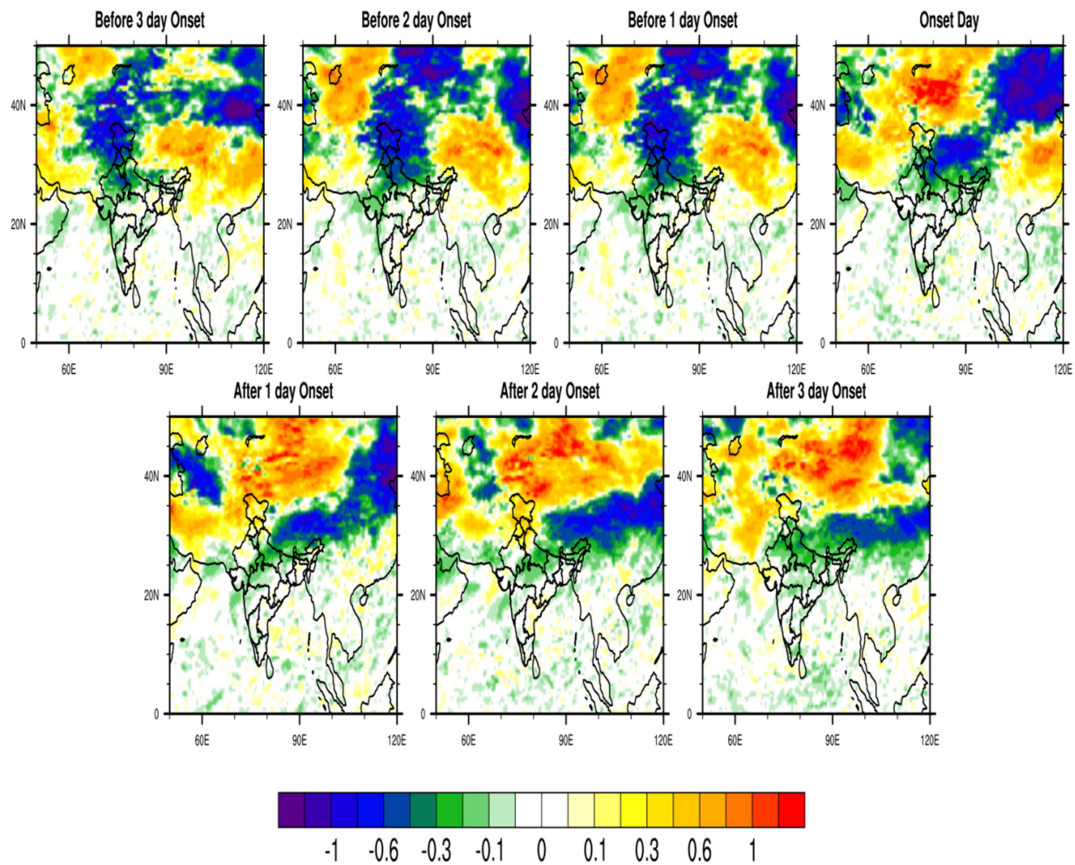


Figure S3. Lead-lag composites of Potential Vorticity (PV units) anomaly at 200hPa over region with respect to onset dates (ODs) for all years between 2002 and 2023 using ERA5 data. The seven panels show PV anomaly composites from all 3 day before onsets to all 3 day after onset.

Composite of PV at 200hPa (1940 1960)

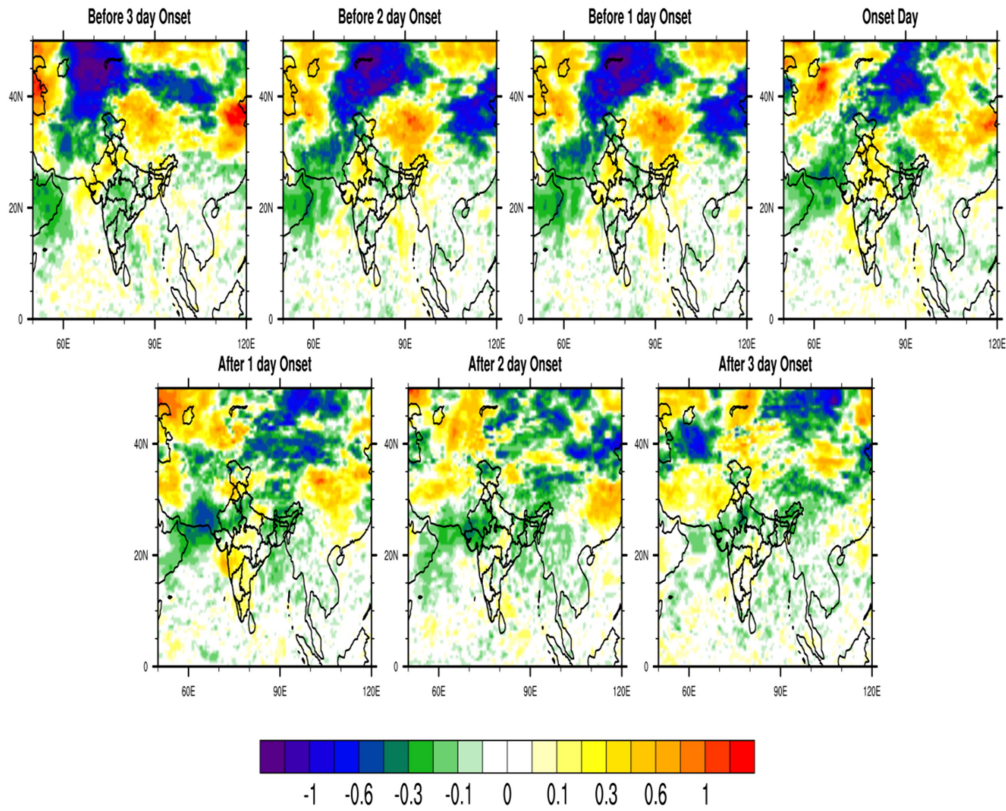


Figure S4. Lead-lag composites of Potential Vorticity (PV units) anomaly at 200hPa over region with respect to onset dates (ODs) for all years between 1940 and 1960 using ERA5 data. The seven panels show PV anomaly composites from all 3 day before onsets to all 3 day after onset.

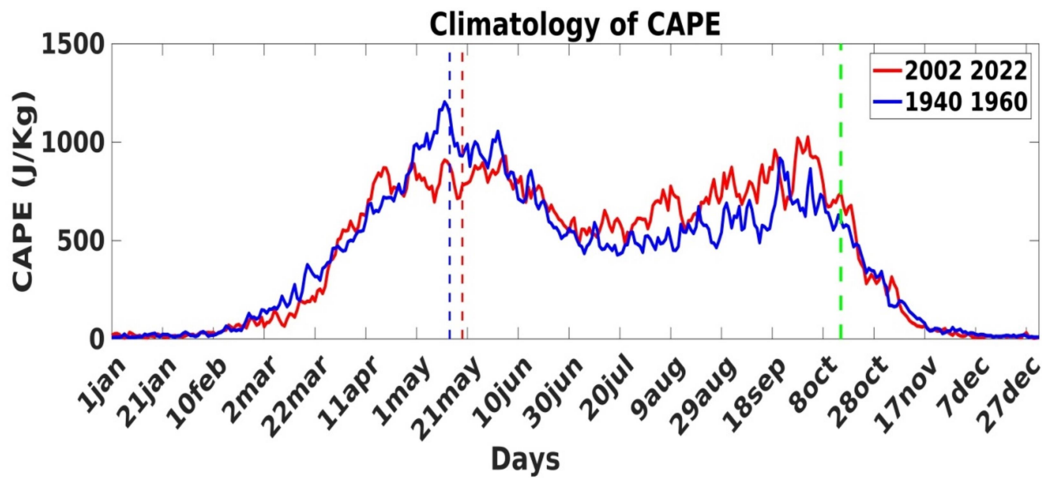


Figure S5. Daily climatology of Convective available potential energy (CAPE) during the period 1940-1960 and 2002-2023. CAPE is calculated over the box 88°E to 100°E and 22°N to 29.5°N for the mentioned period. The unit of CAPE is Jkg^{-1} .

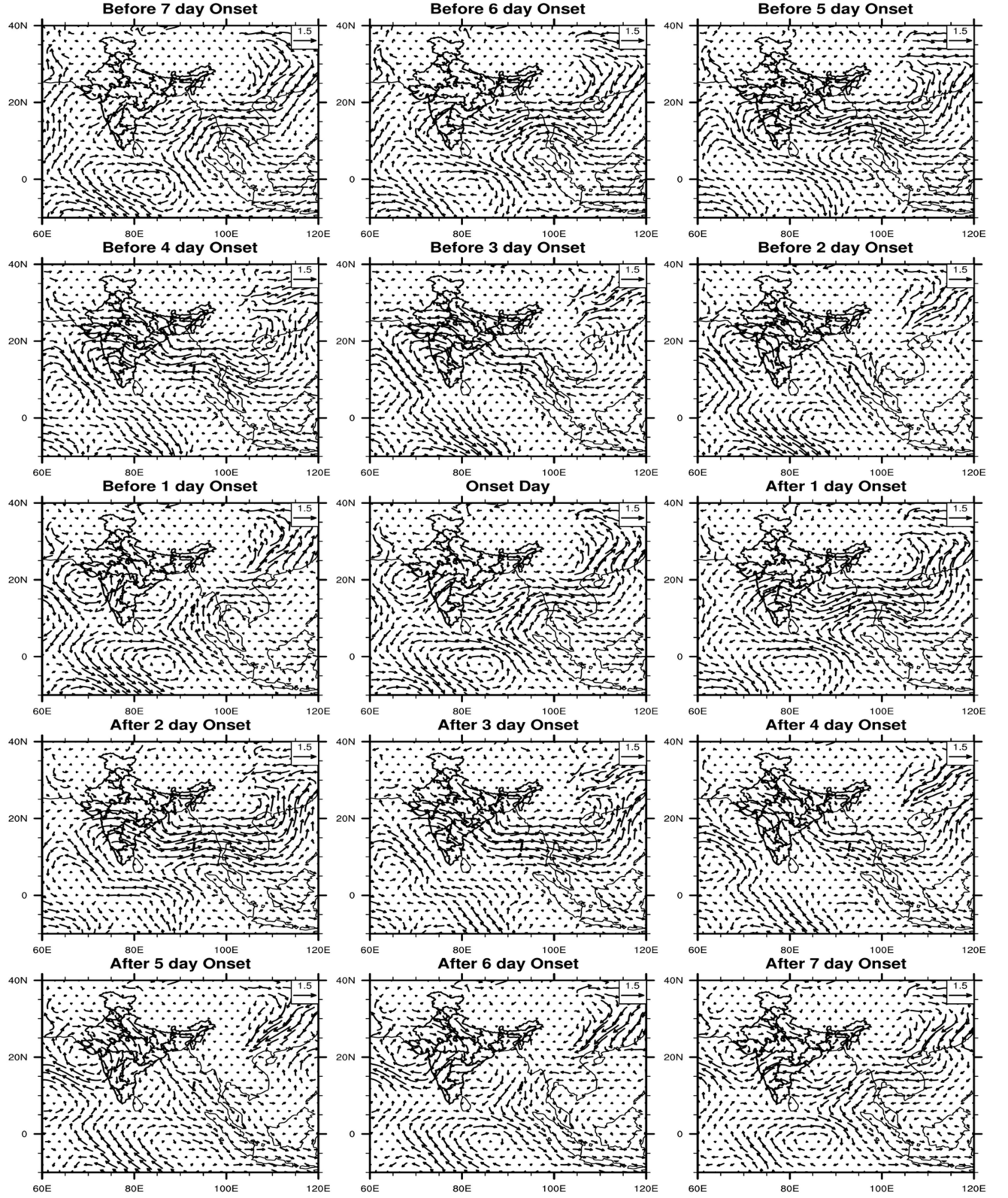


Figure S6: Lead-lag composite of 10-20 day filtered wind anomalies at 850hPa from 7-days before to 7 days after the onset over the periods: 2002-2023.

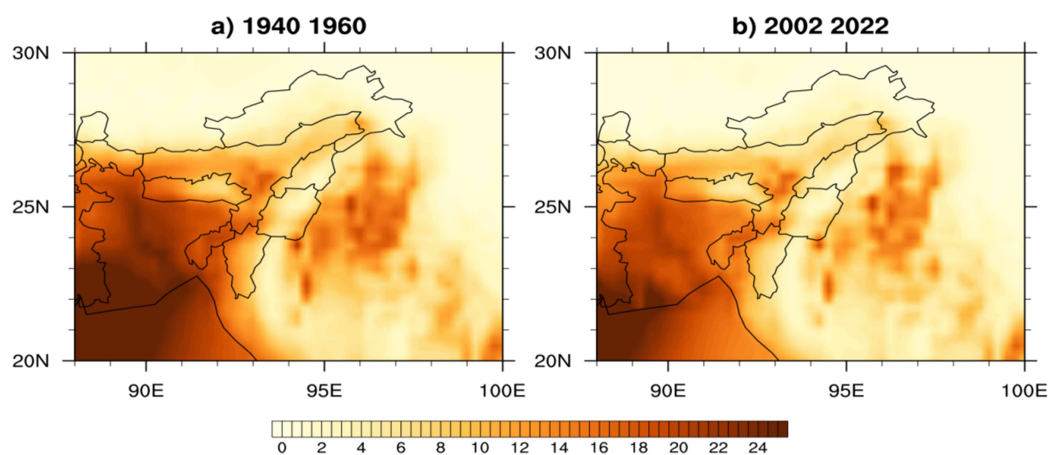


Figure S7. Spatial structure of CAPE over NEI region compared with the two periods 1940-1960 and 2002-2023 in the month of May (x 100)

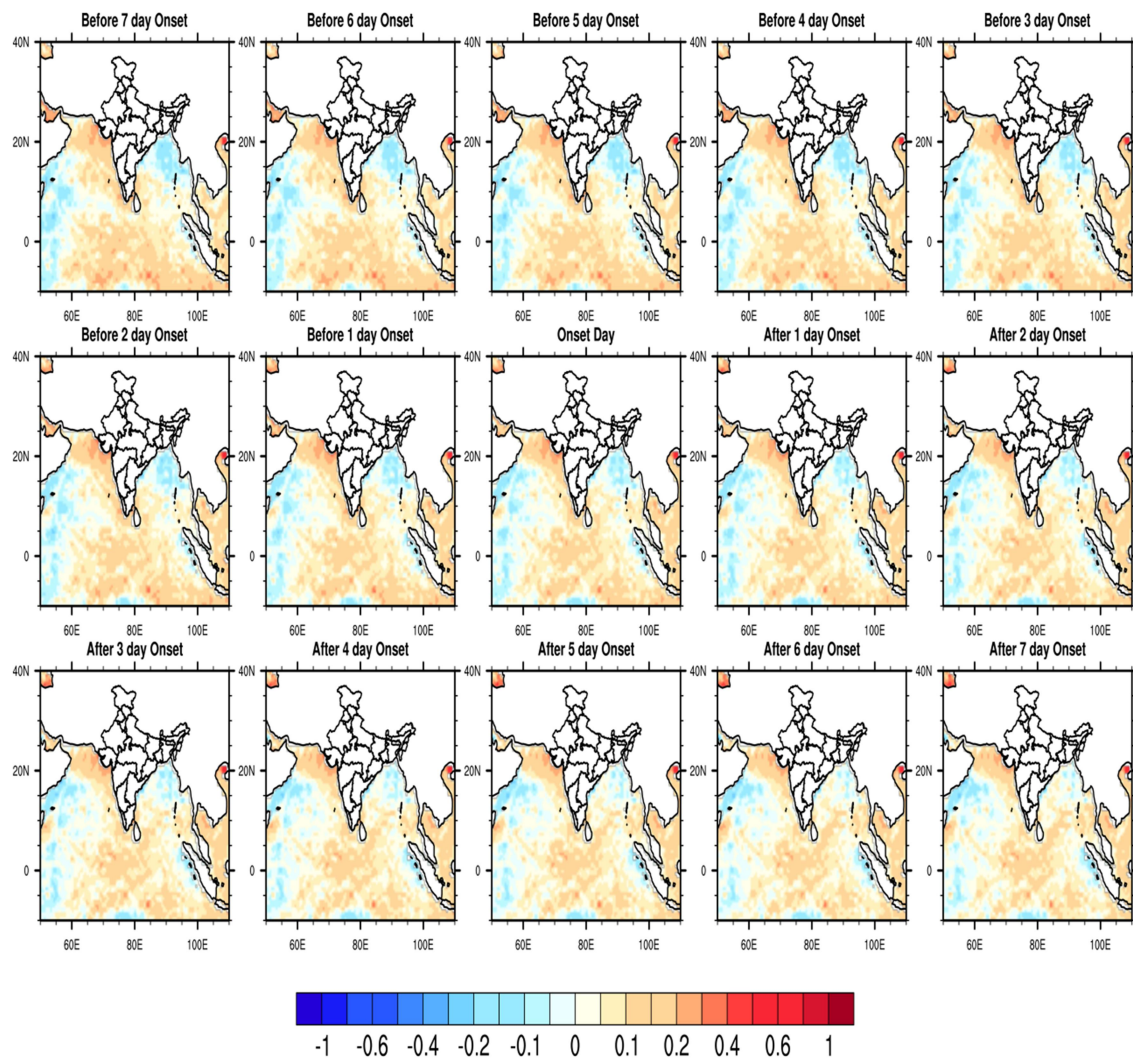


Figure S8: Lead-lag composite SST over Indian Summer Monsoon Region from 7-days before to 7-days after the onset over the periods: 1940-1960.

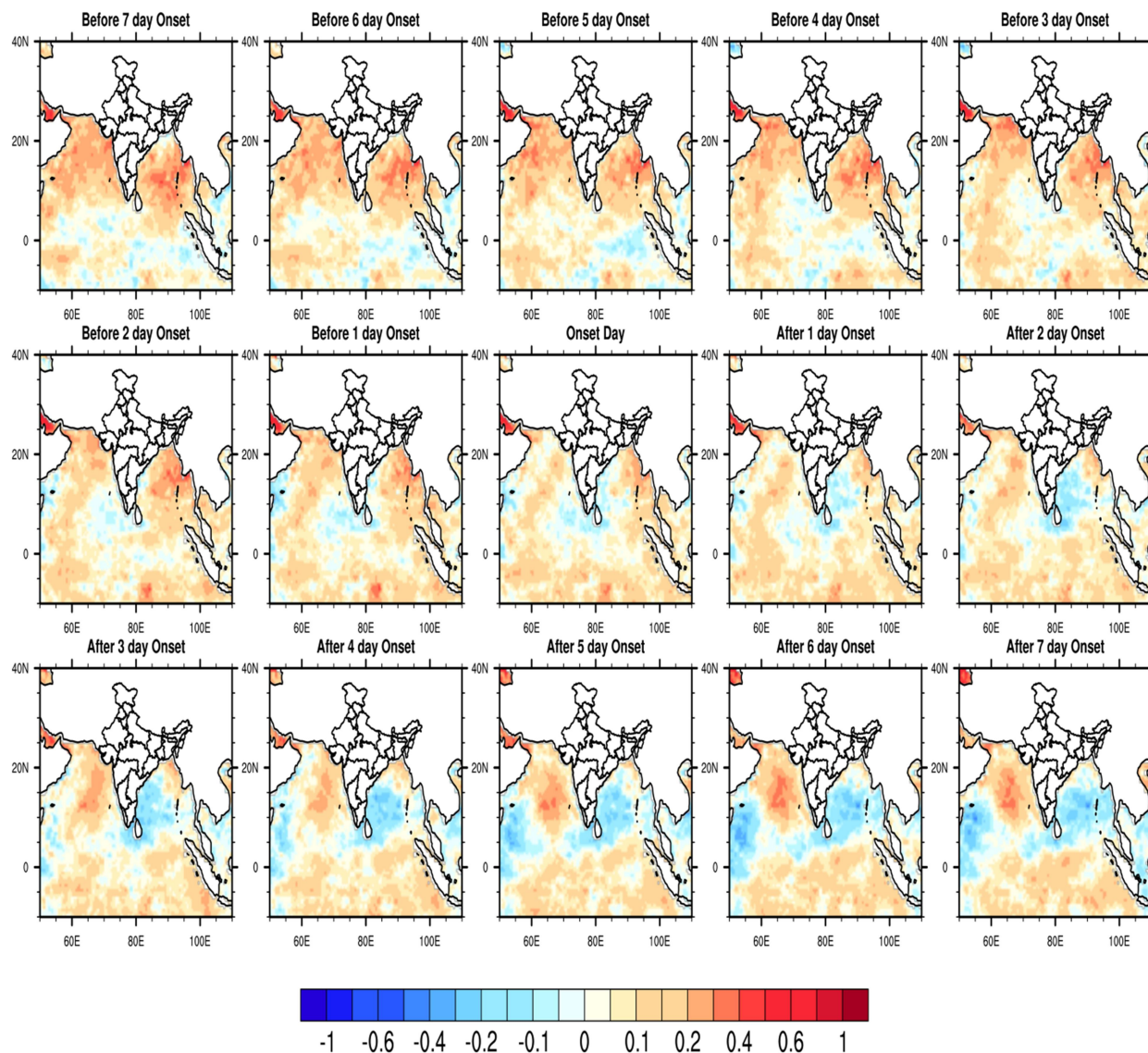


Figure S9. Lead-lag composite SST over Indian Summer Monsoon Region from 7-days before to 7-days after the onset over the periods: 2002-2023.