Vertical Distribution of Aerosols during Deep-Convective Event in the Himalaya Using WRF-Chem Model at Convection Permitting Scale.

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Background …

- ✓ The Himalayan region is facing frequent cloud bursts and flood events during the summer monsoon season.
- ✓ The Kedarnath flooding of 2013 was one of the most devastating recent events, which claimed thousands of human lives, heavy infrastructure, and economic losses.
- ✓ Previous research reported that the combination of fast-moving monsoon, pre-existing westerlies, and orographic uplifting were the major reasons for the observed cloud burst over Kedarnath.
- ✓ WRF-Chem model simulation was performed starting from one week before (after one week spin up) the event and ending after a week of event.
- ✓ Various combination (with and without aerosols) of simulation was performed at 25 km and 4 km (convection resolving scale).
- ✓ Various ground station data used to evaluate model performance over Kedarnath region.
- ✓ Satellite data used to understand the climatology of precipitation and rate of precipitation on event data.
- ✓ Various satellite data used to understand the cloud properties.

Singh, Prashant, Pradip Sarawade, and Bhupesh Adhikary. "Vertical Distribution of Aerosols during Deep-Convective Event in the Himalaya Using WRF-Chem Model at Convection Permitting Scale." Atmosphere 12.9 (2021): 1092.

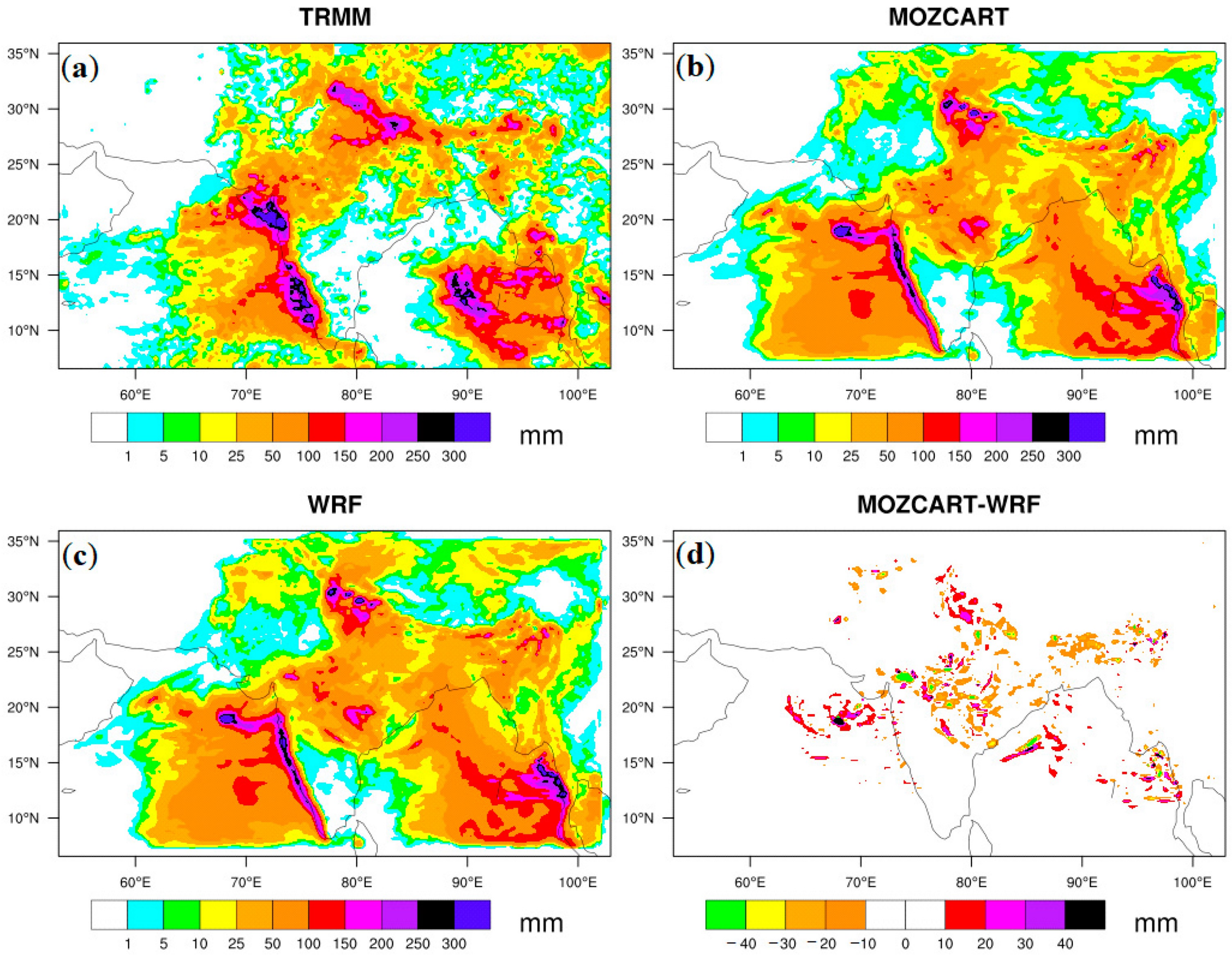

Figure 1:Three days accumulated rain from a) TRMM, and simulation of WRF at 25km resolution b) WC25, c) WRF25 and d) difference of rain produced by aerosols in simulation

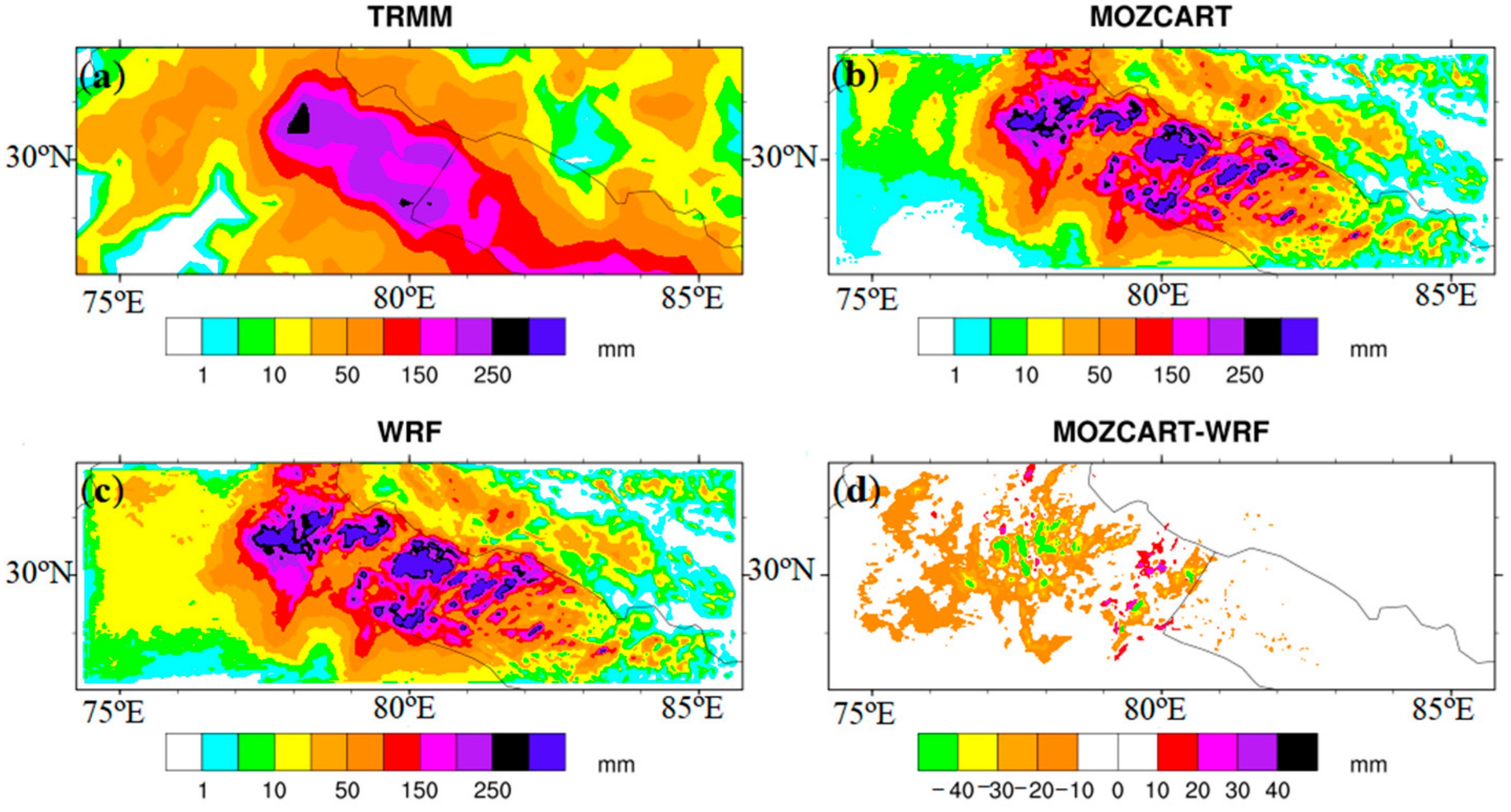

Figure 2: Three days accumulated rain from a) TRMM, and simulation of WRF at 4 km resolution b) WC4, c) WRF4 and d) difference of rain produced by aerosols in simulation

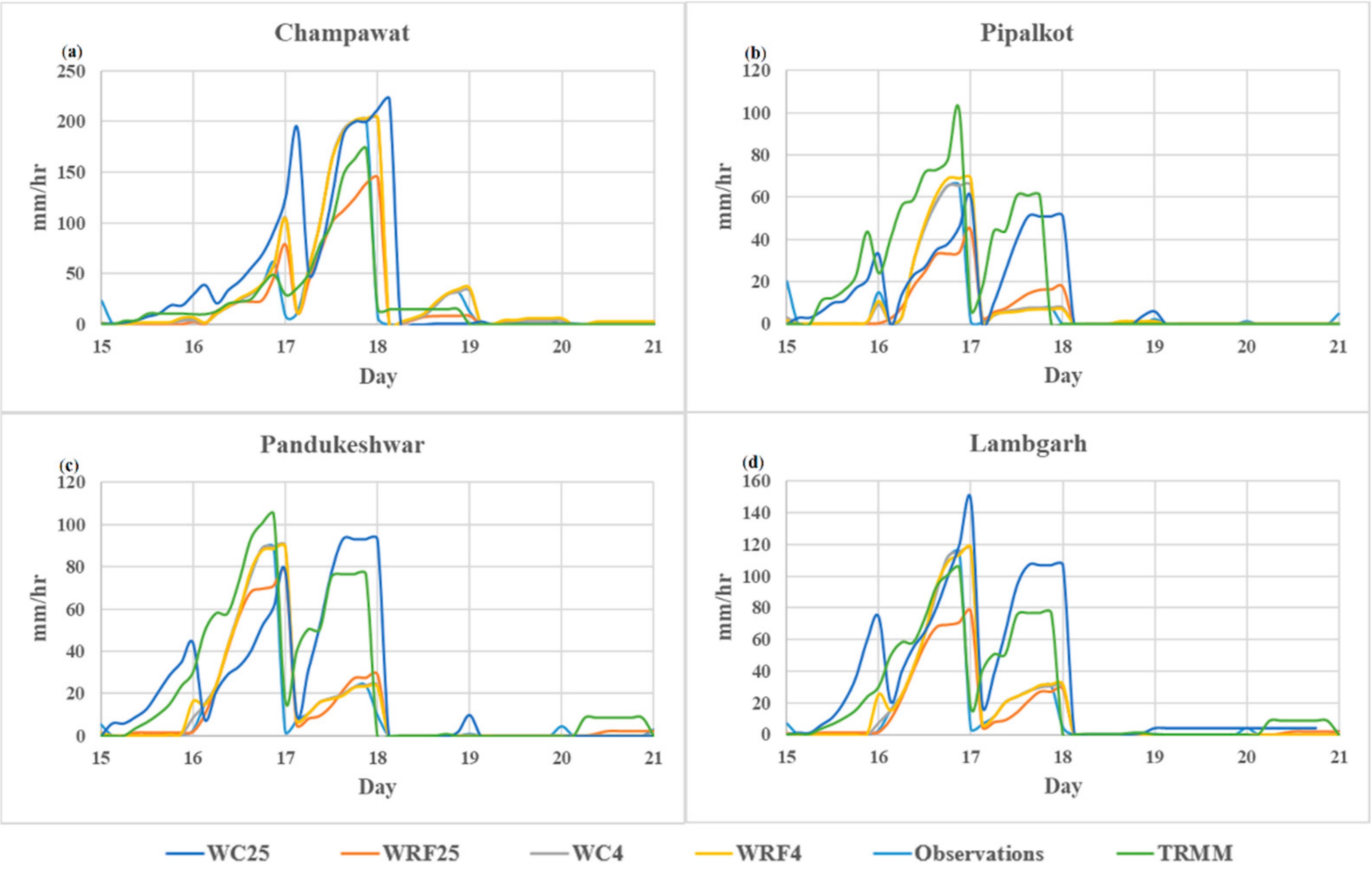

Figure 3: Precipitation from different simulation and observation from 15th - 20th June 2013 for a)Champawat, b)Pipalkoti, c)Pandukeshwar and d) Lambgarh .

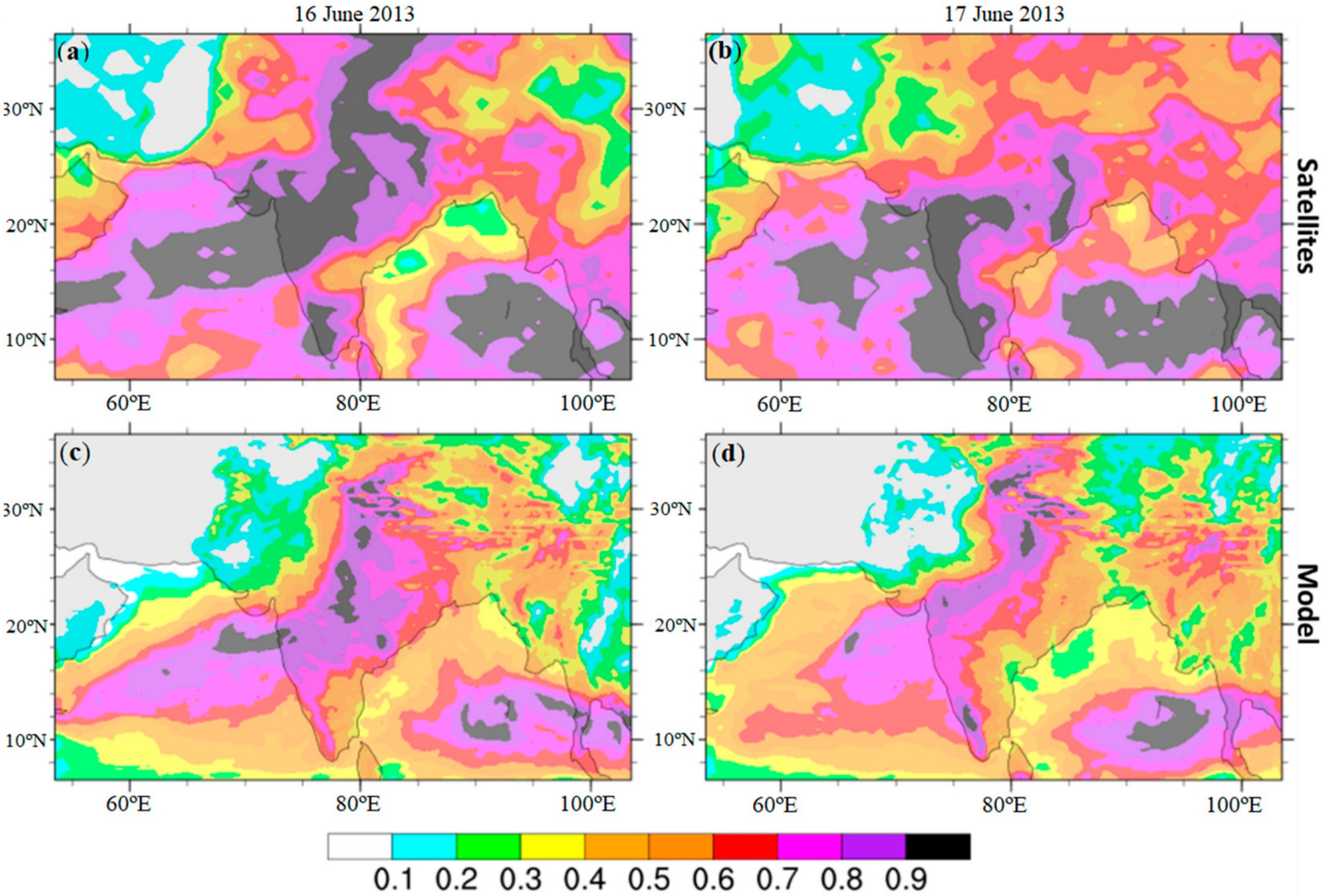

Figure 4: **Average Cloud fraction hPa on 16th and 17th June a) and b) Satellite average from AIRS and MODIS (Aqua and Terra), c) and d) Model respectively**

Figure 5: Wind motion and Figure 6:BC concentration at 850 hPa from 14th - 19th June 2013

Figure 7: BC concentration at 500 hPa and Figure 8: BC concentration at 300 hPa from 14th - 19th June 2013

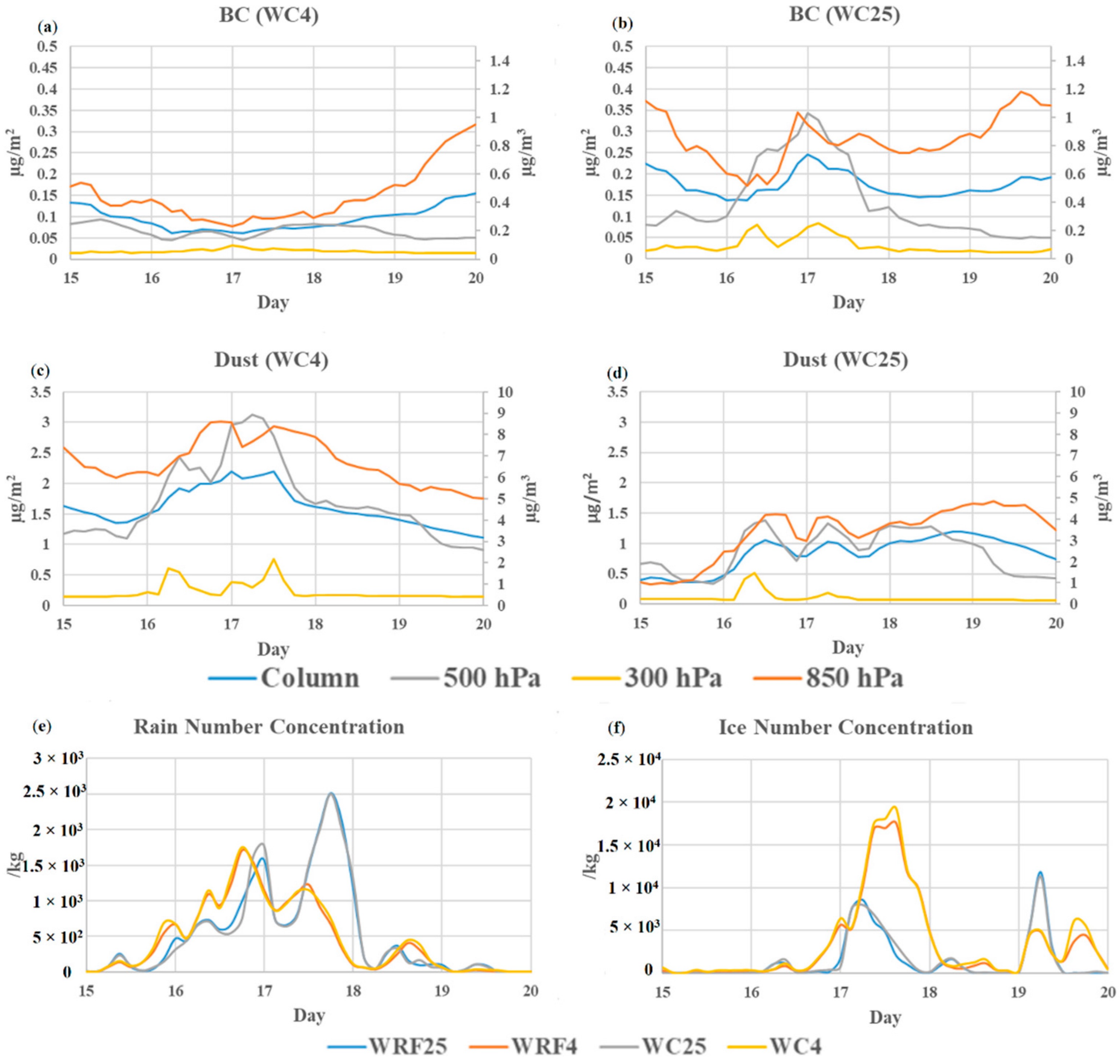

Figure 9: BC concentration from 15th - 19th June 2013 at 500 hPa, 300 hPa and columnar average.

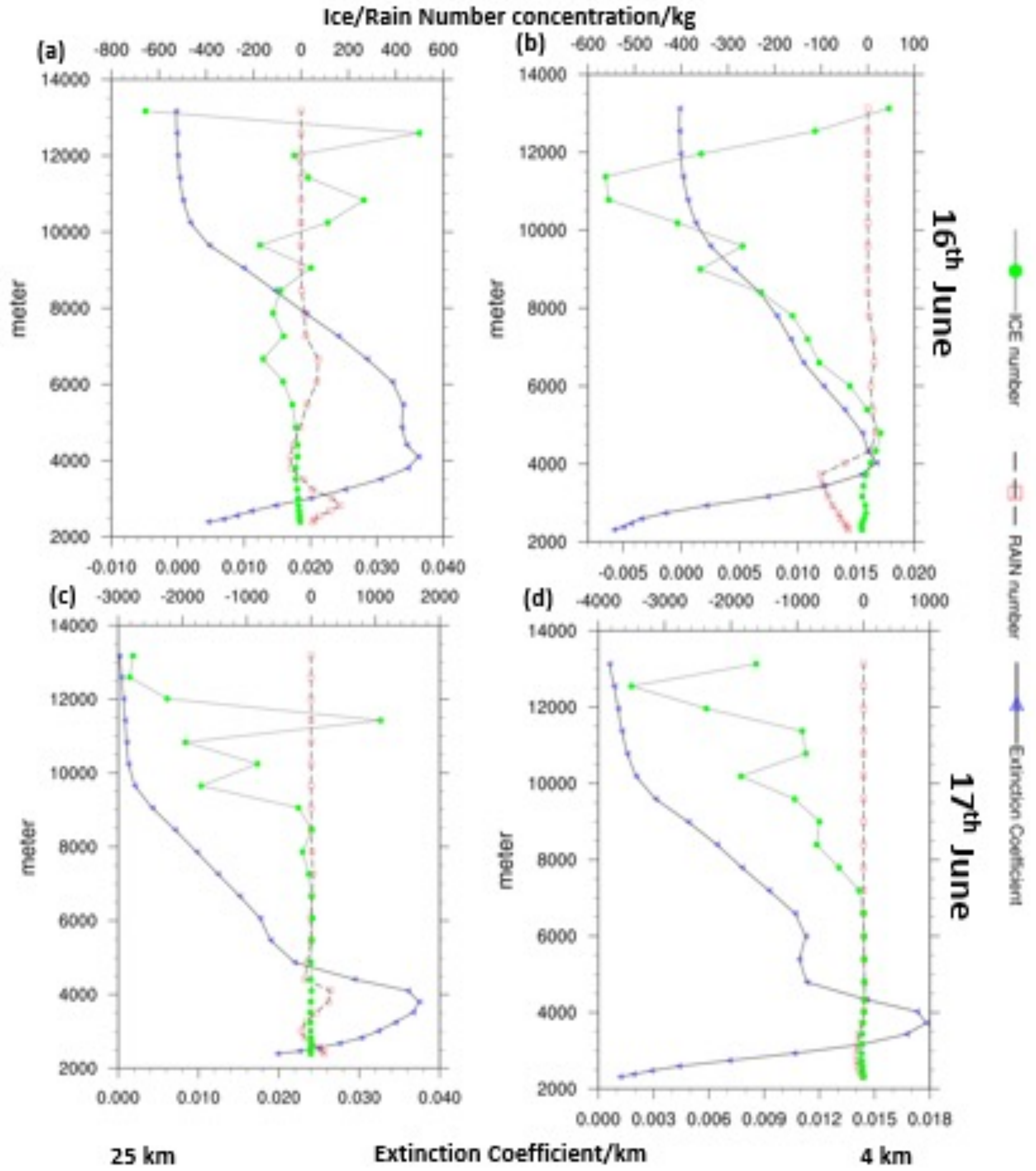

Figure 10: Changes in Extinction coefficient, rain and ice number concentration profile over Kedarnath during (a-b) on 16th June and (c-b) on 17th June 2013 at 25km and 4 km resolution respectively

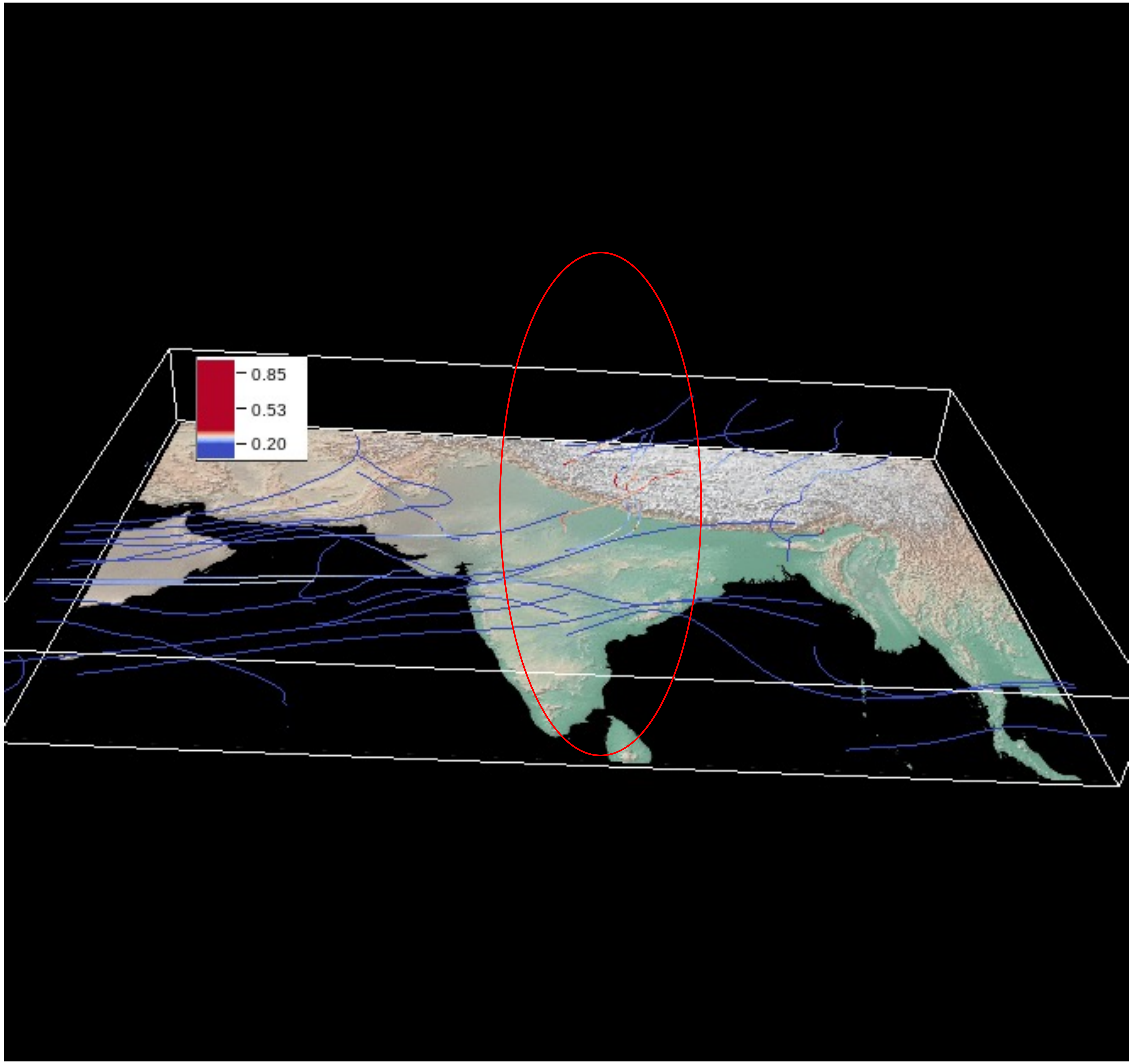

Figure 11: Hydrophobic Black Carbon volume flow on 17th June 2013, 25km resolution

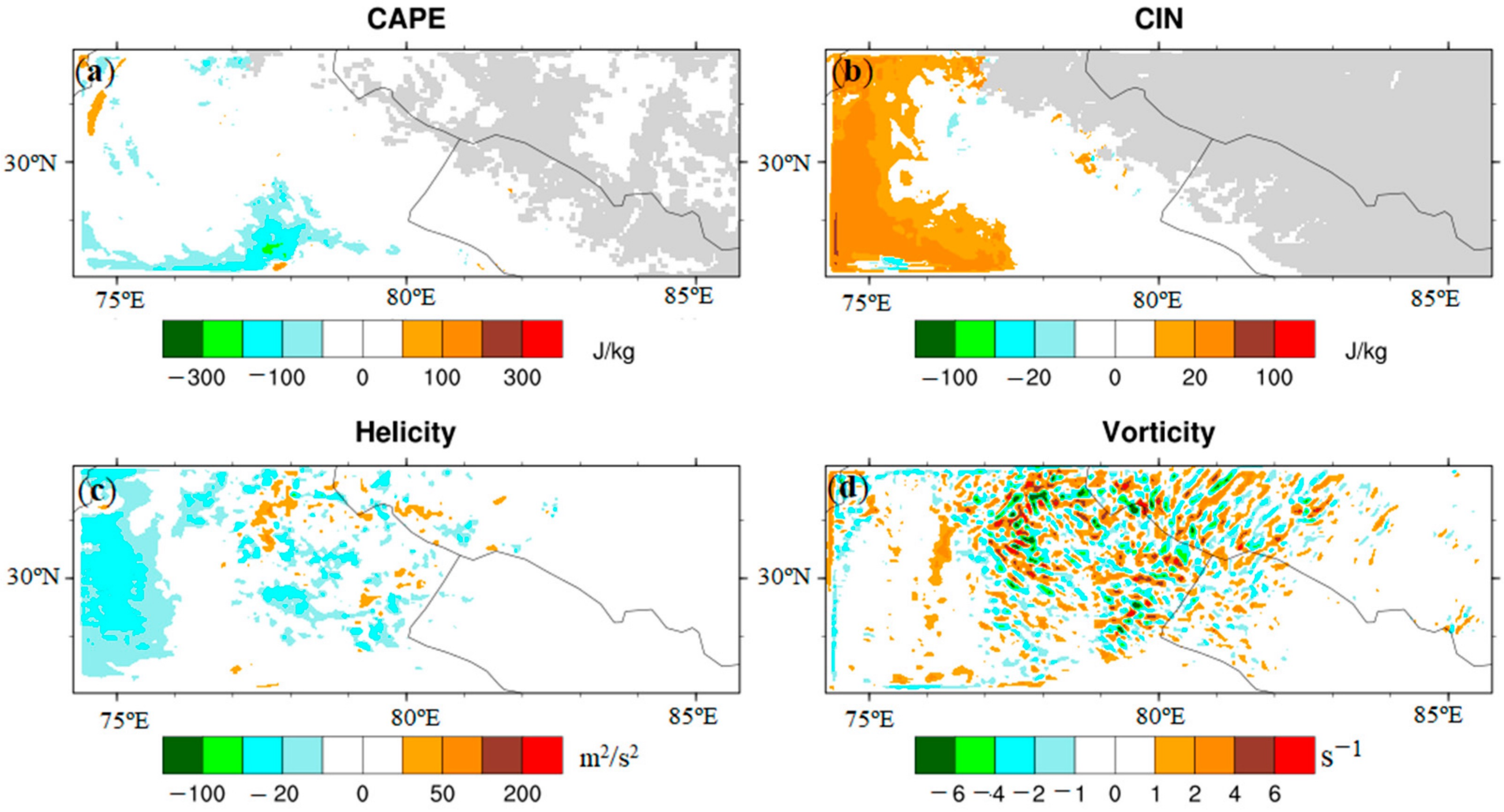

Figure 12: Effect of aerosols on a) CAPE, b) CIN, c) helicity and d) vorticity at 4 km resolution (WC4-WRF4) during 17th June.

Summary and Conclusion …

- Model simulation shows deep clouds (above 500 hPa) over Kedarnath and some other parts over ocean on 16^{th} and 17^{th}.
- Model analysis suggest presence of aerosols above 500 hPa which may act as CCN/IC. High amount of RNC and ICC over Kedarnath on 16^{th} and 17^{th} explain the role of aerosols in heavy precipitation event over Kedarnath.
- Some the station shows 100 mm/day increase in rain due to presence of aerosols, most of the station shows ~±40 mm/day difference.
- At 25 km and 4 km presence of aerosols shows (≥± 300 J/kg) changes in CAPE, (≥± 50 J/kg) CIN, (≥± 100 m^2/s^2) helicity, and (≥± 6 $10^{-5}/s$) vorticity values over many part in the domain of simulation. Over Uttarakhand presence of aerosols increased ~200 J/kg in CAPE, ~20 J/kg in CIN, up to 100 m^2/s^2 in helicity and above 4 $10^{-5}/s$ in vorticity.
- Himalayan orographic lifting, fast moving monsoon due to low pressure generated from 15^{th} – 18^{th} June 2013, active westerlies and aerosols effect on cloud formation due to direct as CCN/IN and indirect radiative effect made this event so devastating.

Thank You …!!