

Background and Aim

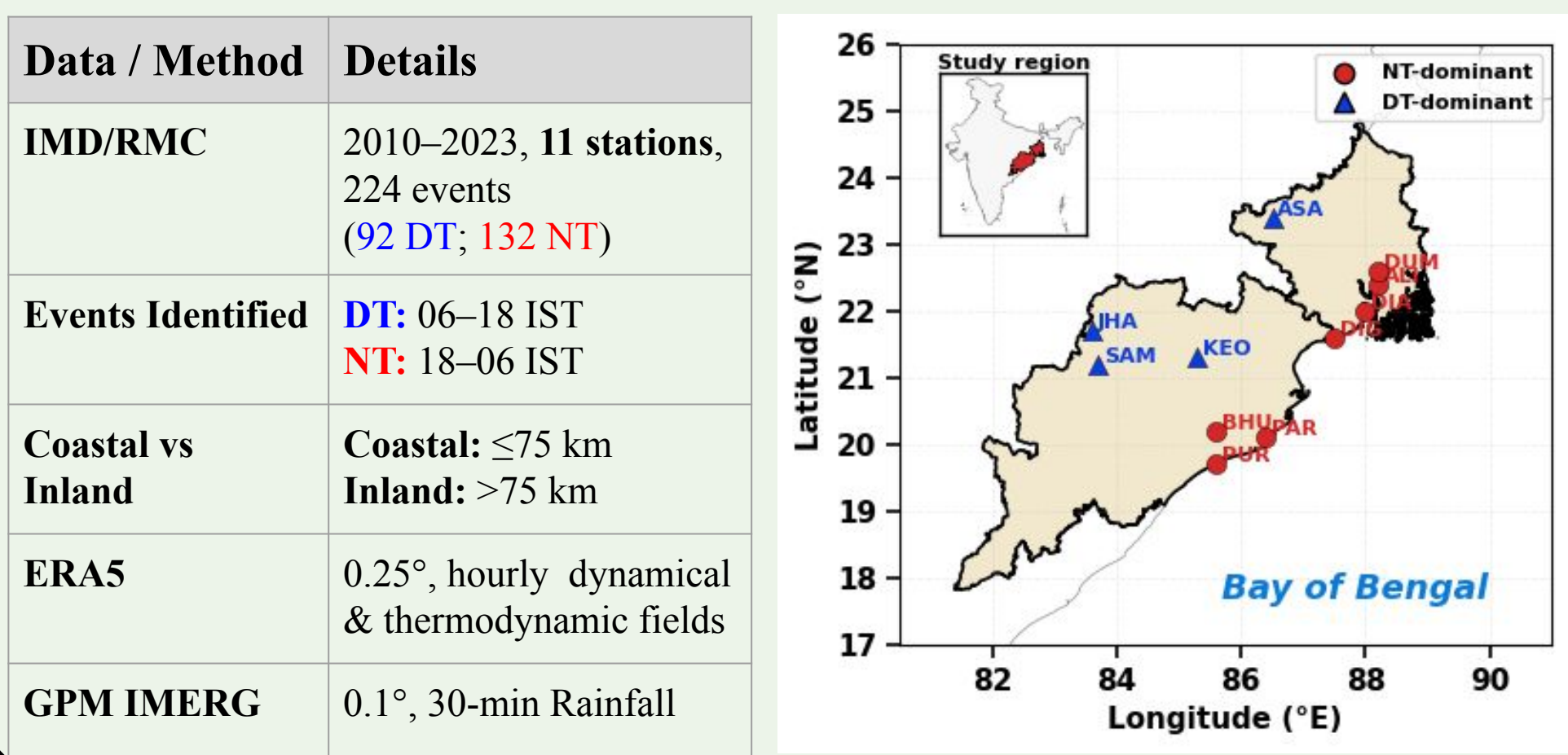
- Pre-monsoon thunderstorms over eastern India exhibit pronounced **day–night** and **coastal–inland** variability.
- While daytime convection is closely linked to surface heating, nighttime thunderstorms can develop after sunset.
- The roles of **thermodynamic instability**, **moisture transport**, **convergence**, and **atmospheric dynamics** in these contrasting regimes remain poorly understood.

Research Question

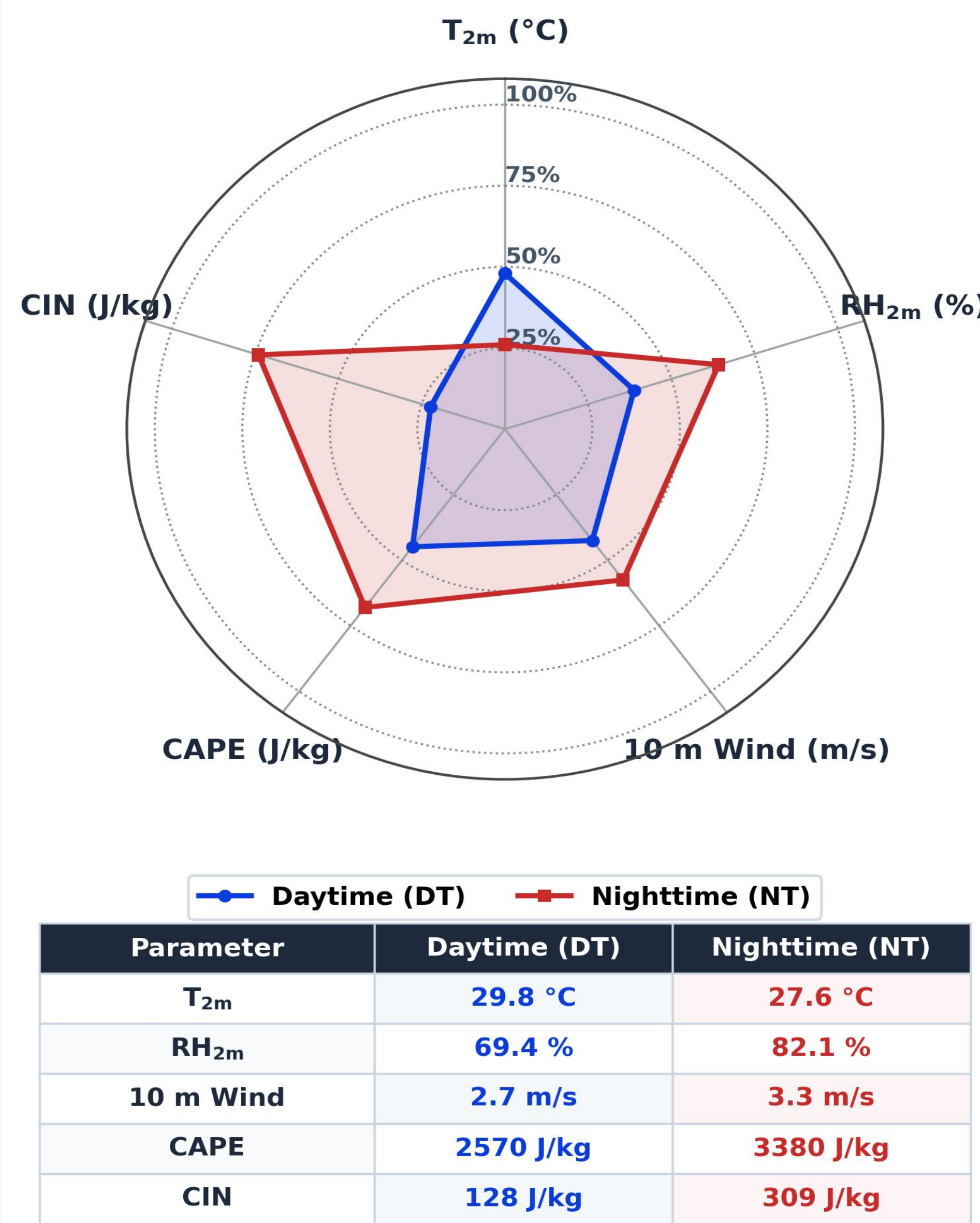
What environmental processes control the contrasting occurrence and persistence of daytime and nighttime thunderstorms over Odisha and Gangetic West Bengal?

Objective

To identify the thermodynamic, moisture, and dynamical controls that distinguish daytime and nighttime thunderstorms and explain their coastal–inland variability.



3. Environmental Parameter Fingerprint



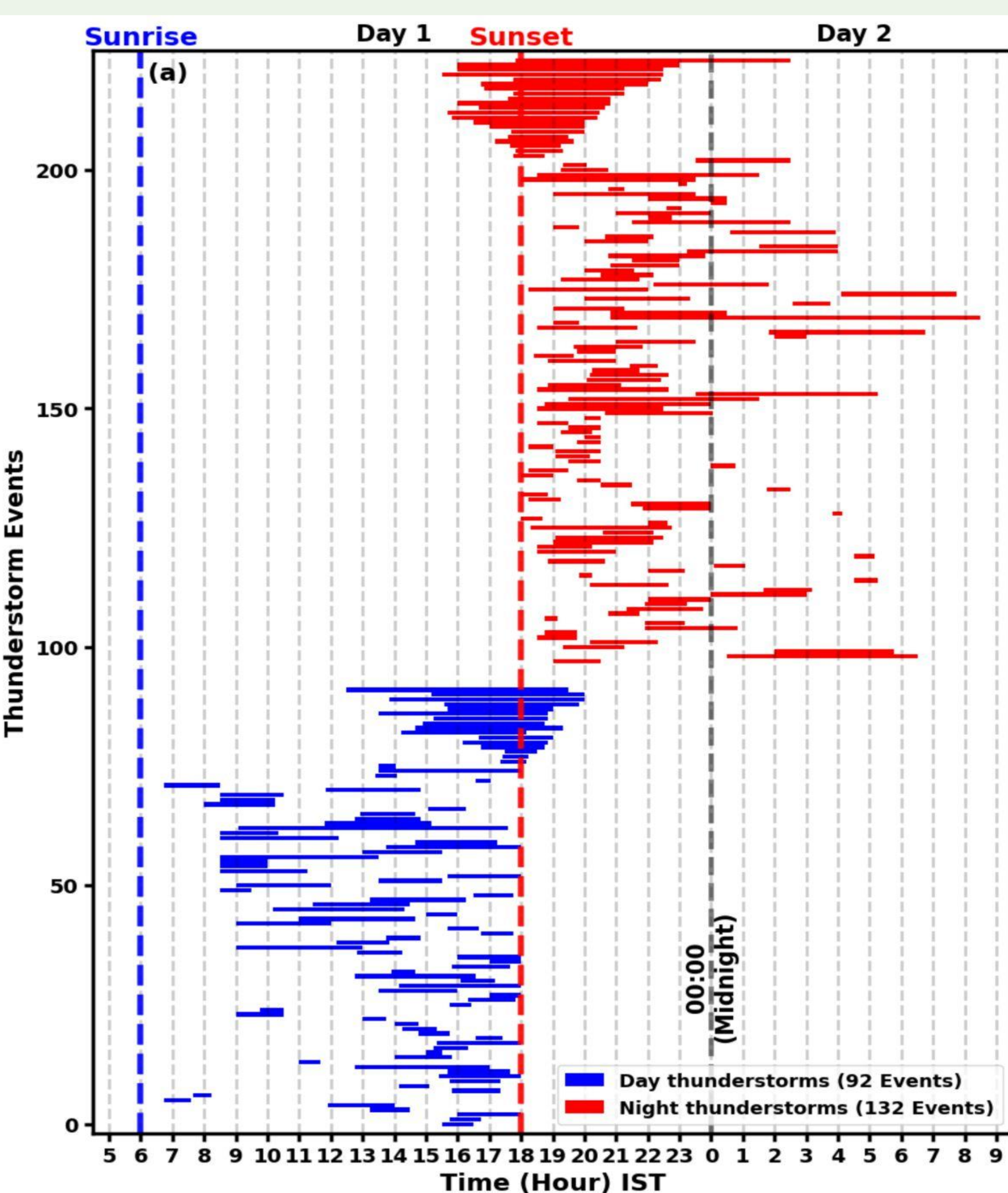
4. Vertical Profile Structure

	Humidity RH (%)	Rising air −ω (Pa s ^{−1})	Moist energy θe (K)	Divergence (×10 ^{−5} s ^{−1})
100	−7	−0.01	+3	−1.1
200	+0	−0.03	−1	−0.7
300	−4	−0.03	−1	+0.2
400	+2	−0.04	−1	−0.1
500	+0	−0.04	+0	−0.2
600	+0	−0.04	+1	+0.9
700	−9	−0.03	+1	+0.0
800	−12	−0.04	+1	−0.7
900	−6	−0.03	+1	+0.1
1000	+12	−0.03	+4	−0.2

A - Moisture near the ground (+12 % RH),
 B - Drier air at 700–900 hPa (< 12%)
 C - Weaker rising motion at 400–600 hPa,
 D - More convergence at 800 hPa

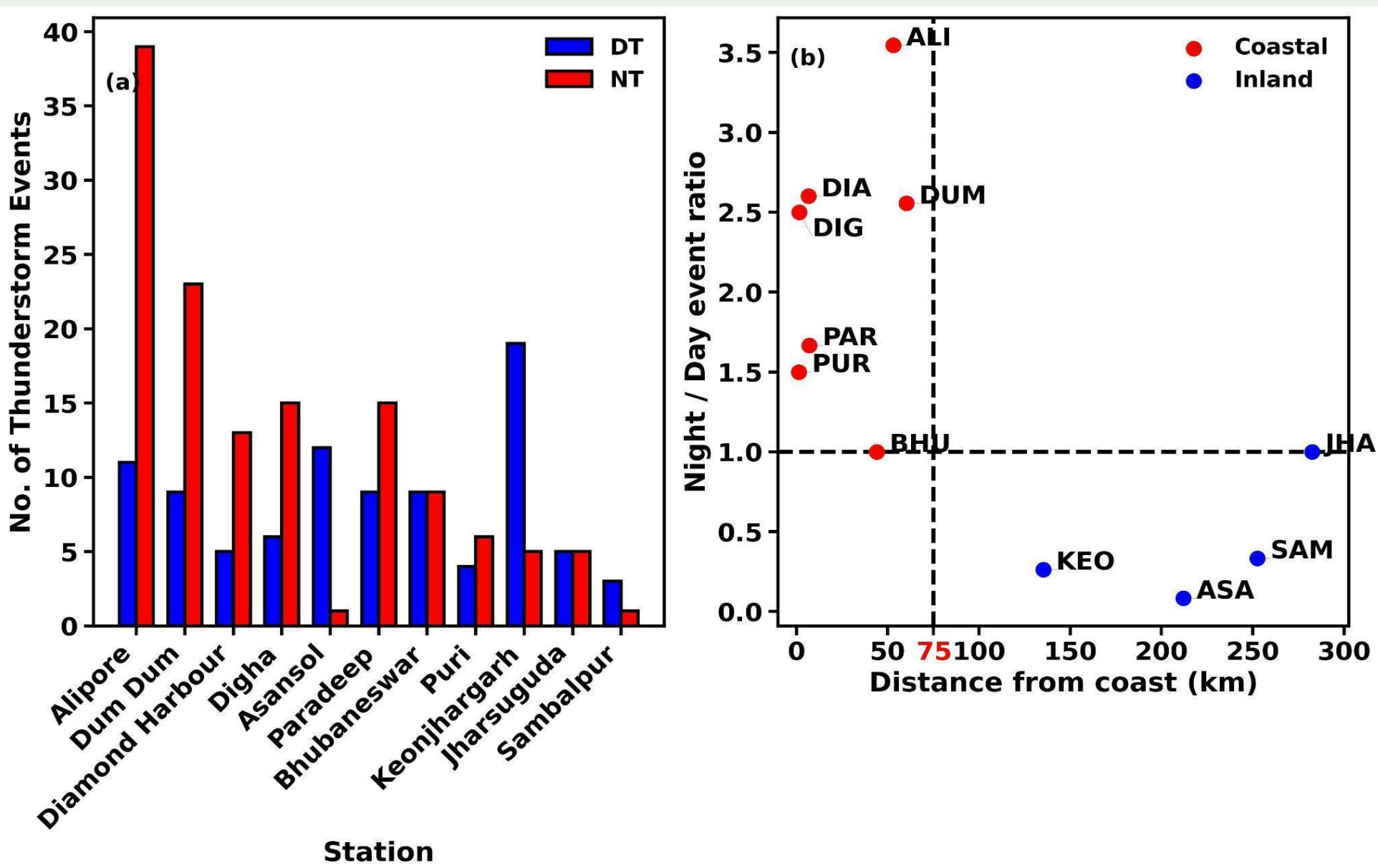
- **NT** environments are markedly more moist in the lower troposphere, with higher low-level θe, while both regimes exhibit predominantly upward motion.
- **DT** shows stronger large-scale ascent and upper-level divergence, whereas **NT** exhibits more persistent mid-level convergence (800–600 hPa).

1. Diurnal Regimes



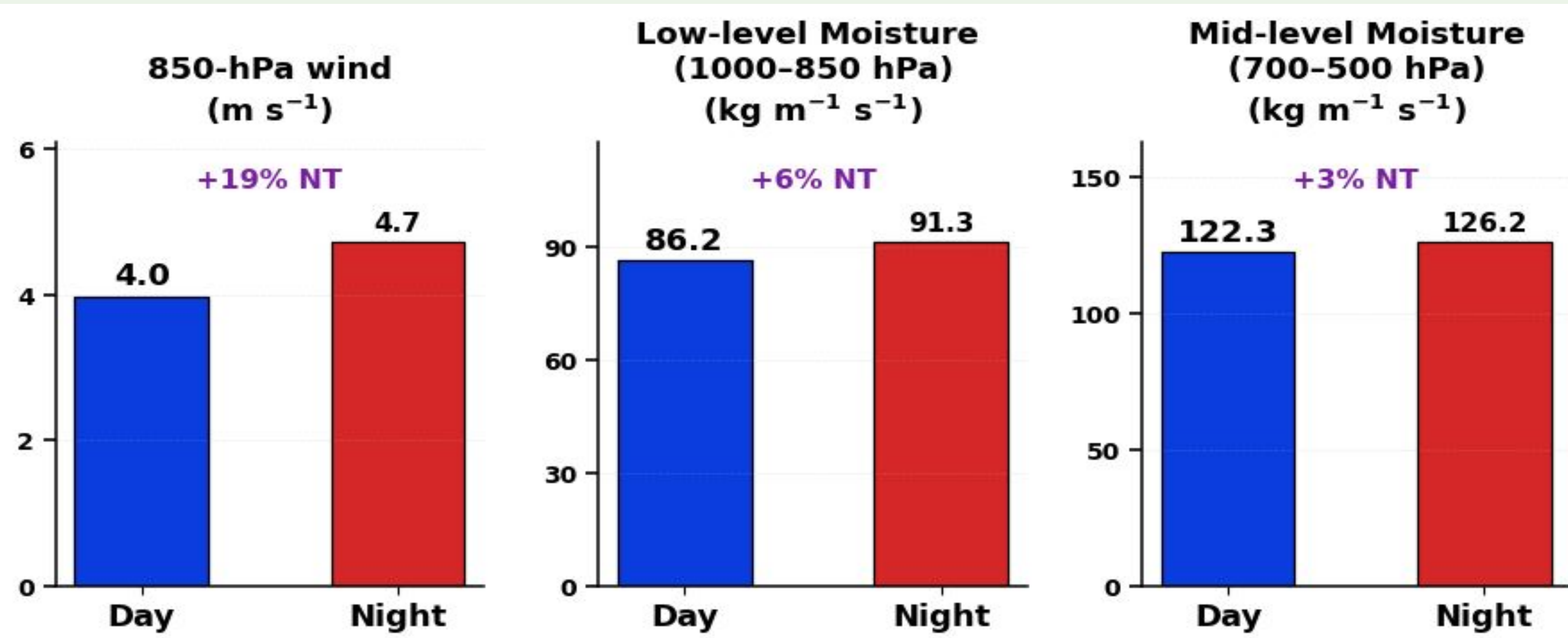
- **DT** thunderstorms predominantly initiate after 08:00 IST, with peak activity during 12:00–16:00 IST.
- **NT** events cluster shortly after sunset (18:00–21:00 IST), with a weaker early-morning peak.

2. Coastal-Inland Gradient



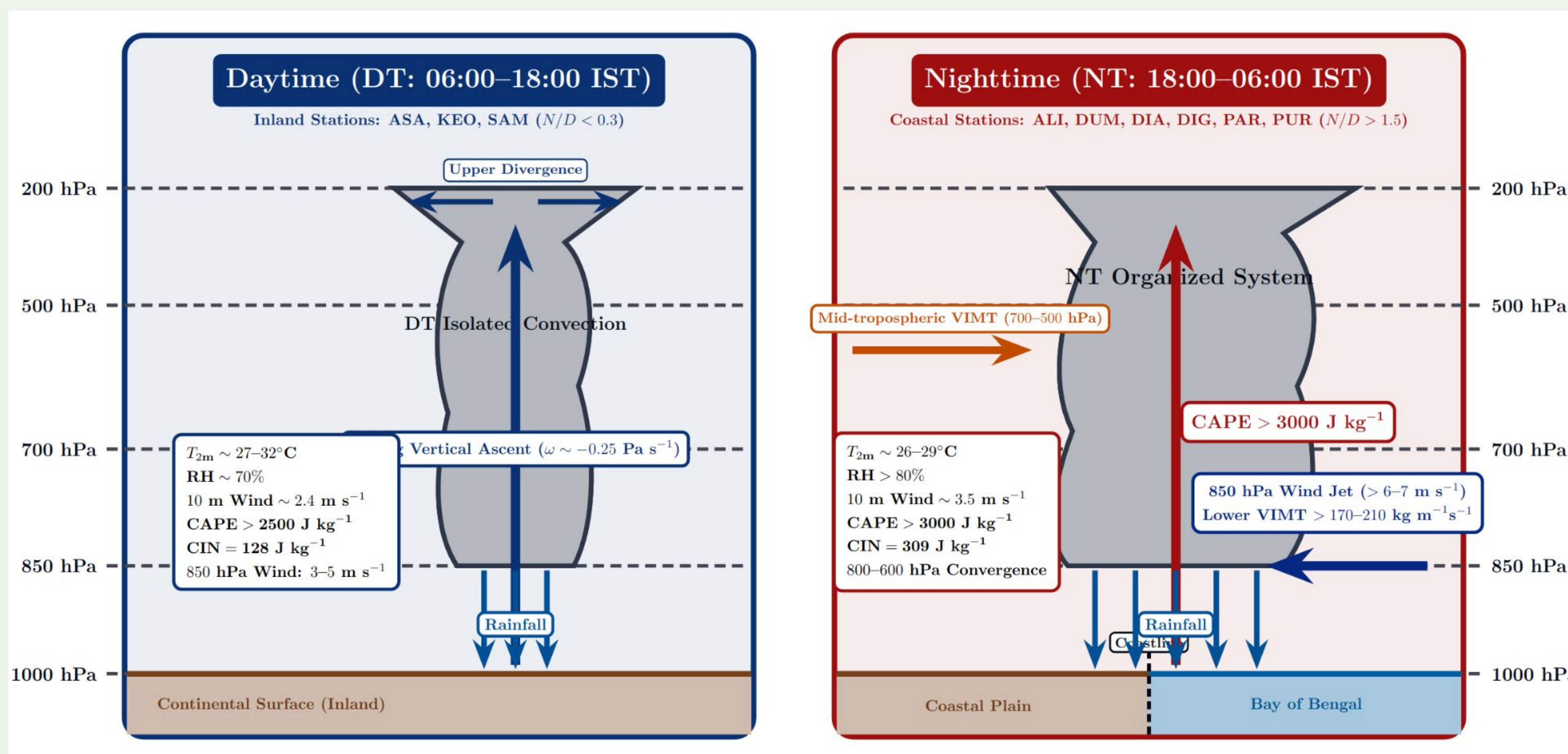
- **NT** thunderstorms dominate at coastal stations, while **DT** activity is more prominent inland.
- The **NT/DT** ratio decreases with distance from the coast, indicating a shift from nighttime to daytime thunderstorm preference inland.

5. Moisture Transport



- **NT** events exhibit stronger 850-hPa winds (+19%) and modestly higher low- and mid-level moisture transport (+6% and +3%).
- The enhanced low-level flow and moisture supply provide greater environmental support for **NT** convection.

6. Summary



- Pre-monsoon thunderstorms over eastern India exhibit distinct day–night and coastal–inland variability.
- DT** events peak during 12:00–16:00 IST and are associated with stronger surface heating and lower CIN.
- NT** events peak during 18:00–21:00 IST and are characterized by higher CAPE, higher CIN, stronger winds, and enhanced low moisture transport.
- Daytime convection is primarily thermally favoured, whereas nighttime convection occurs in a more moist and dynamical supported environment.

Acknowledgment

- Trushnamayee gratefully acknowledges NIT Rourkela for institutional support and IITM, Pune, for providing accommodation.
- I thank IMD for providing thunderstorm reports and acknowledge ECMWF and NASA for the ERA5 and GPM IMERG datasets.

References:

- Sasanka et al., 2023,
- Madhulatha et al., 2024,
- Raman et al., 1961,
- Sen et al., 2007

