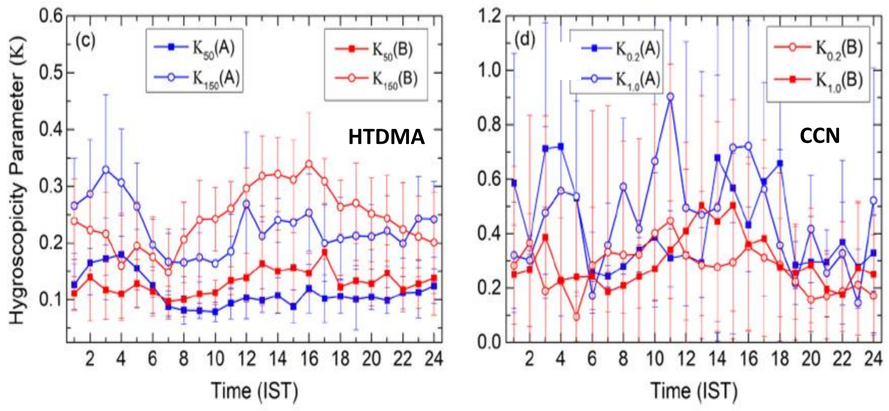
AEROSOL CLOUD PRECIPITATION INTERACTION INSIGHTS FROM CAIPEEX PHASE IV

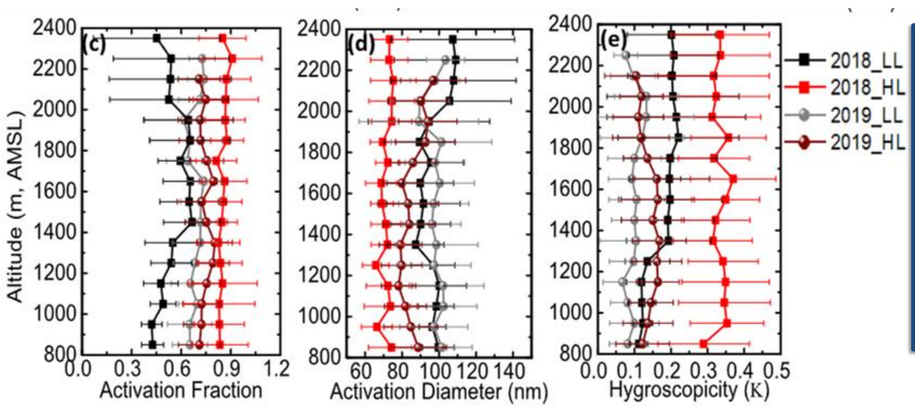
Effect of Aerosols on the Monsoon clouds over the Rain shadow region

Observations of Aerosol Hygroscopicity



- Inter comparison of Aerosol hygroscopicity (K) estimated from two methods (i) using HTDMA to measure the growth of 50 and 150 nm particles and (ii) using CCN observations at 0.1 and 1% SS for wet (A) and dry (B) periods of monsoon
- Most frequently observed hygroscopicity (k) varies between 0.1 to 0.3.

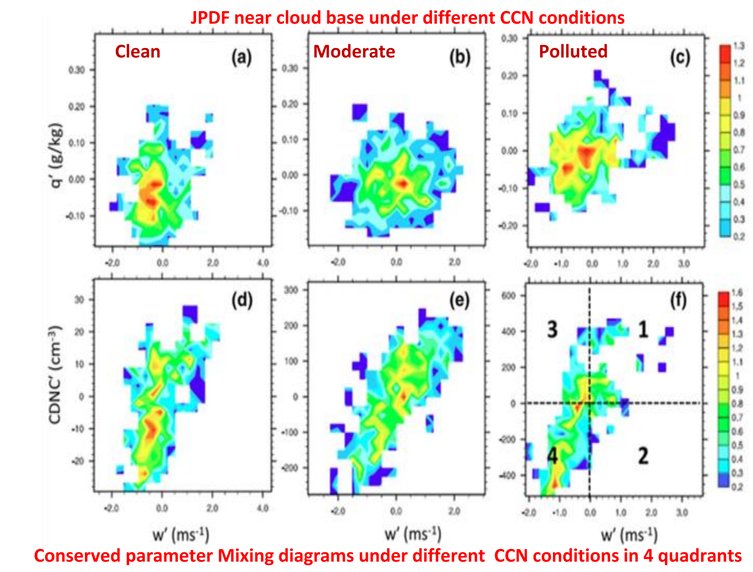
Jayachandran et al., AR 2022 https://doi.org/10.1016/j.atmosres.2021.105976

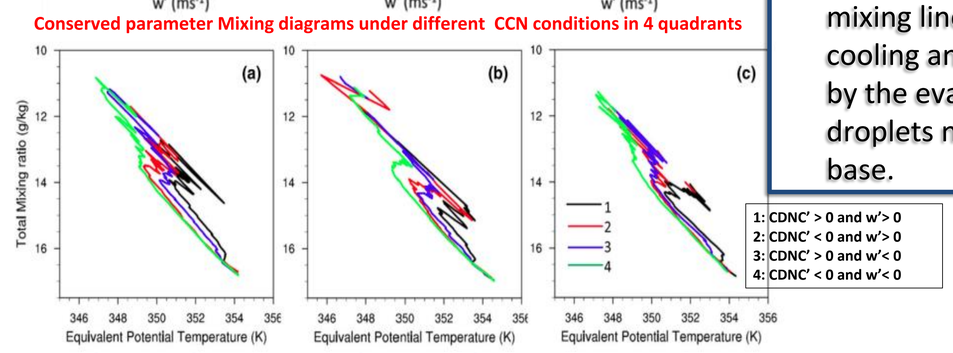


- Aerosol hygroscopicity (K) estimated from airborne CCN observations during two monsoon seasons under low (LL) and high (HL) aerosol loading conditions
- Higher (lower) K during the dry (wet) HL (LL) conditions.

Varghese et al., AR 2023 https://doi.org/10.1016/j.atmosres.2023.106630

CCN and Mixing line structure in shallow cloud regime



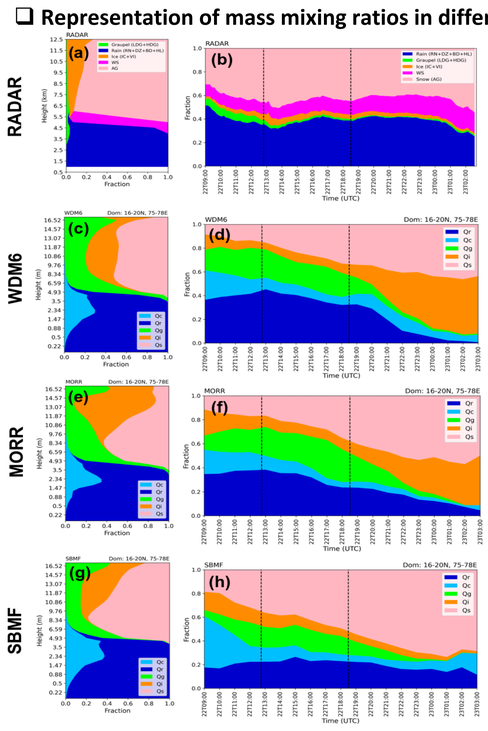


- Large Eddy Simulation (LES) study of shallow cloud regime: JPDF of cloud base turbulence fields: Moistening through downward moving air parcels.
- Increasing CCN concentration impacts double mixing line structure of the cloud-free environment and reduced environmental mixing line through cooling and moistening by the evaporation of droplets near the cloud base.

Malap et al., JESS 2022 https://doi.org/10.1007/s12040-022-01994-y

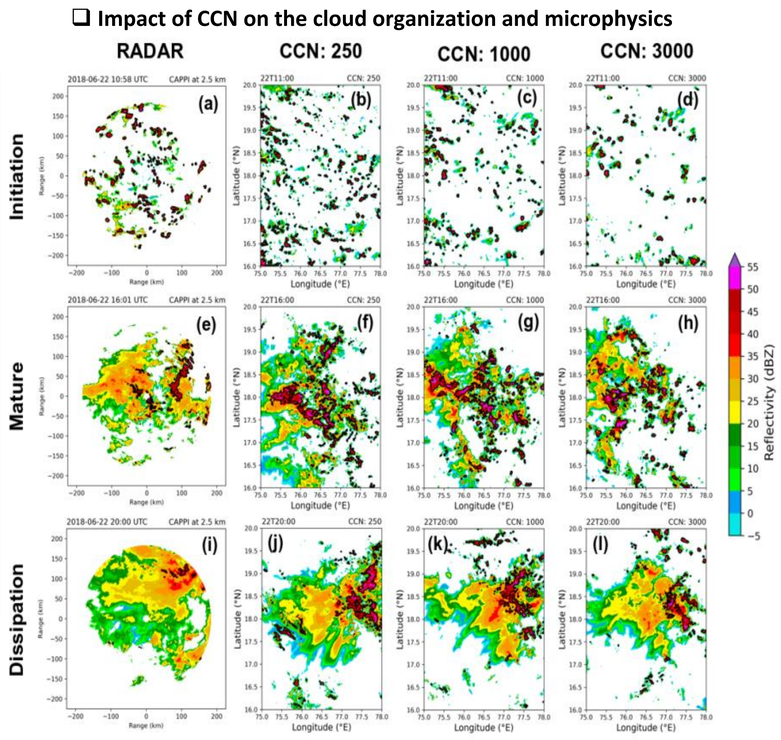
Convection organization and microphysics of a cloud cluster: Numerical simulation and Radar observations

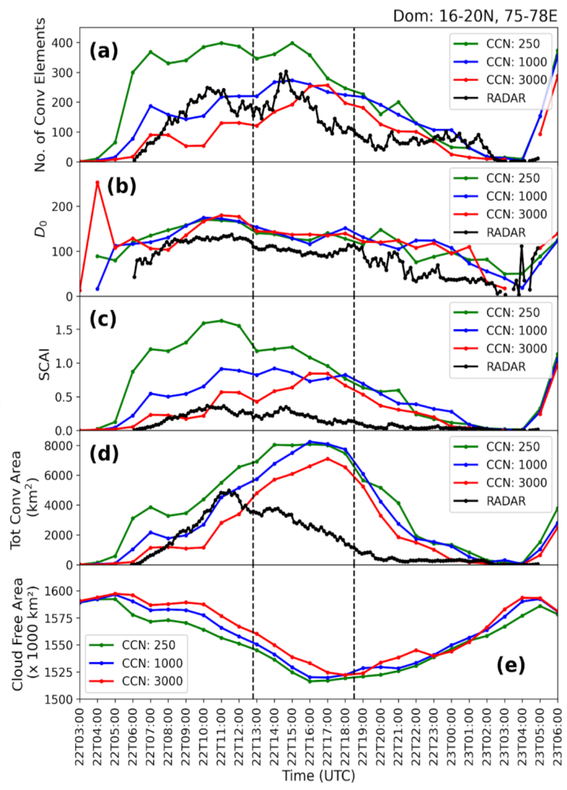
❑ Representation of mass mixing ratios in different hydrometeor classes



Verifying the microphysics schemes: The most sophisticated scheme produced convection, convective clustering, and hydrometeor distribution closer to radar-derived products

❑ Impact of CCN on the cloud organization and microphysics





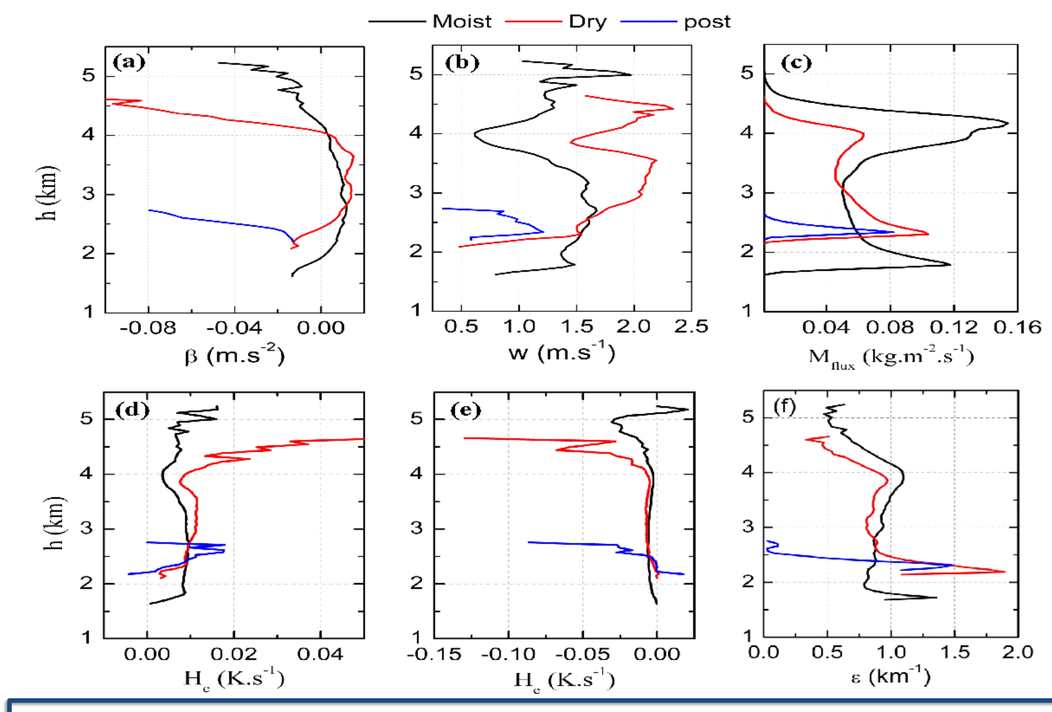
- Increasing aerosol loading in a relatively dry mid-level environment leads to:
  - Reduction in occurrence of shallow clouds and the number of convective cells
  - Enhancement in convective organization and cloud-free area
  - Overall reduction in the area of the cloud cluster.

Samanta et al., (Under review)

Samanta et al., AR 2023 https://doi.org/10.1016/j.atmosres.2022.106464

Cloud Dynamics and Rain Microphysics over the Rain shadow region

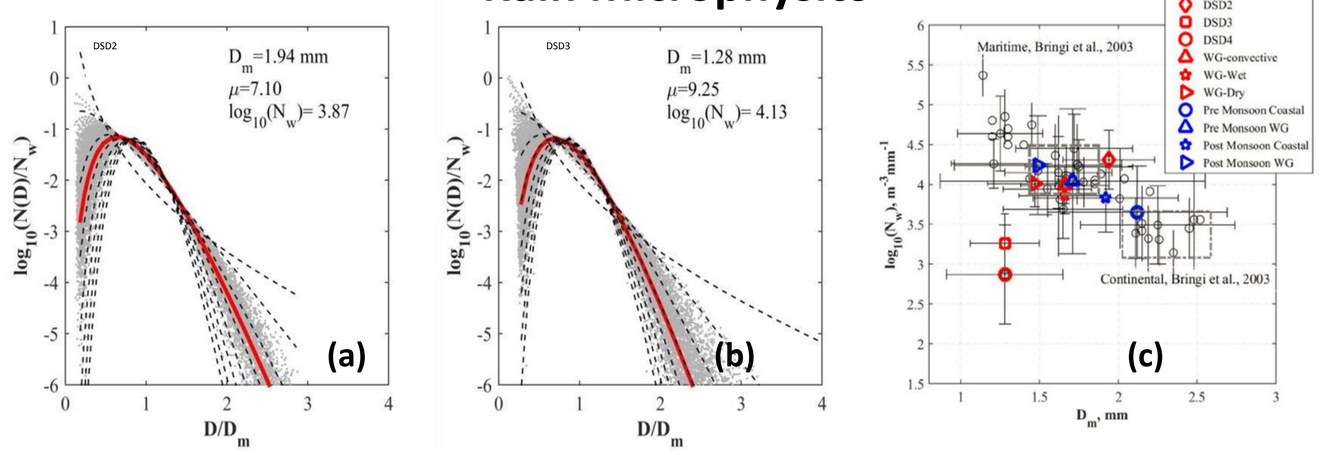
Cloud Dynamics in Different Monsoon Environments



- Dry-monsoon environments produce higher buoyancy and stronger updraft in cloud core region compared to moist-monsoon condition.
- Lateral entrainment rate and convective mass-flux are relatively higher in moist-monsoon environment
- Latent heating in cloud core and latent cooling at cloud edge are higher in dry-monsoon environment.)

Bera et al., (Under review)

Rain Microphysics



Normalized DSDs (a,b), ($\log_{10}(N(D)/N_w)$) versus scaled diameter (D/D_m) . DSDs (red color) are shown on each figure. N_w is Normalized intercept parameter and D_m is mass weighted mean diameter. Global distribution of DSD parameters (c) for Heavy convective rain with ice processes (DSD2), moderate convective rain (DSD3), transition or intermediate types (DSD4) over Solapur. WG stands for Western Ghats.

- Normalized Gamma DSD parameters are found.
- Collision-Coalescence dominates among the raindrops falling from non-convective, shallow convective, deep convective, and mixed types of precipitating systems .
- Equilibrium DSDs are found in an event of intense rainfall.
- The convective type of clusters appeared to be between the zones of maritime and continental clusters
- Continental and maritime properties of DSD. Heavy convective rain with ice processes (DSD2), moderate convective rain (DSD3), transition rain (DSD4).

Konwar et al., AR 2022 https://doi.org/10.1016/j.atmosres.2022.106224

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