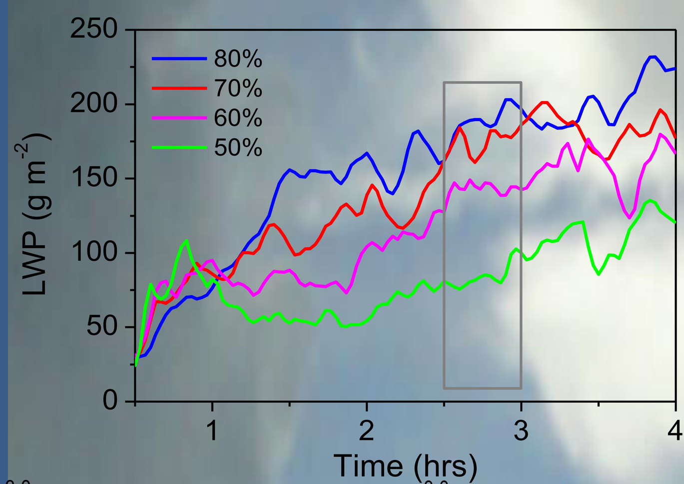
Some salient science results from CAIPEEX

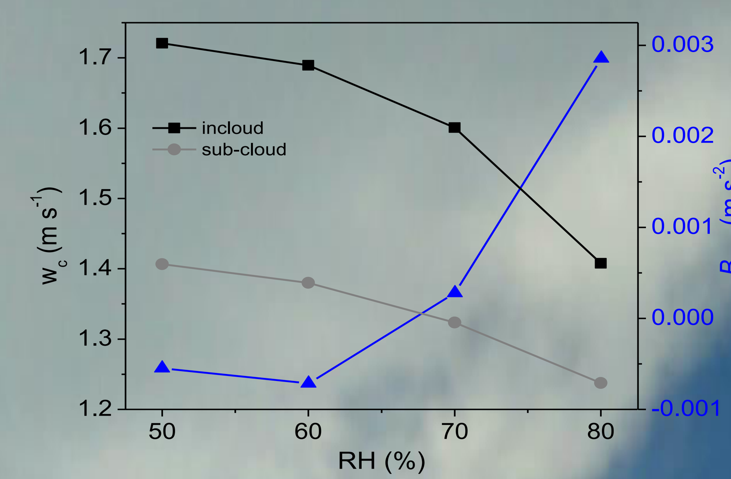
IITM ESSO

CAIPEEX Cloud Aerosol Interaction and Precipitation Enhancement Experiment Phase III 2014

Parameterization of Entrainment Rate and Mass-flux in Cumulus Clouds Using LES Model



Several LES runs were conducted at varying environmental RH (80%, 70%, 60%, and 50%) and the response in cloud liquid water path (LWP) is shown with time variation in the Figure on left and the effect on incloud vertical velocity and buoyancy is shown in the figure on right



Bera and Prabha, 2019, JGR-Atmosphere

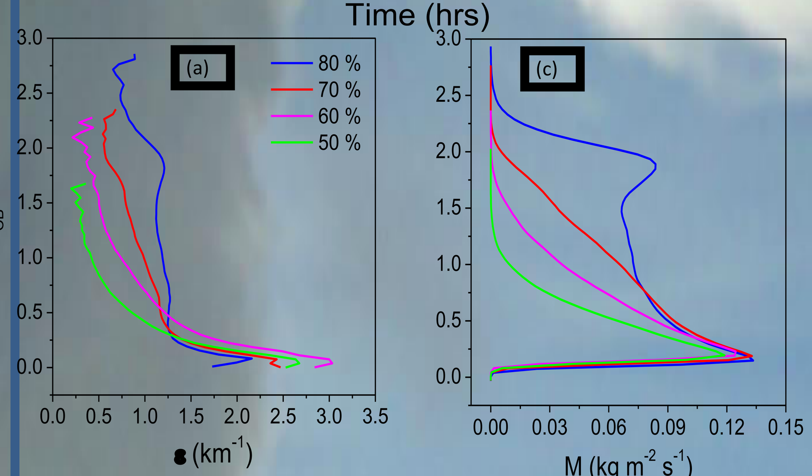
https://doi.org/10.1029/2019JD031078

Summary:

❑ Positive buoyancy in cloud core is reduced, and negative buoyancy at cloud top is enhanced due to the drying of the environmental air, which is resulted in reduced LWP of the clouds in dry conditions

❑ The entrainment and detrainment rates are sensitive to the environmental RH. An increase in environmental dryness led to a reduction in the entrainment rate but an increase in the detrainment rate

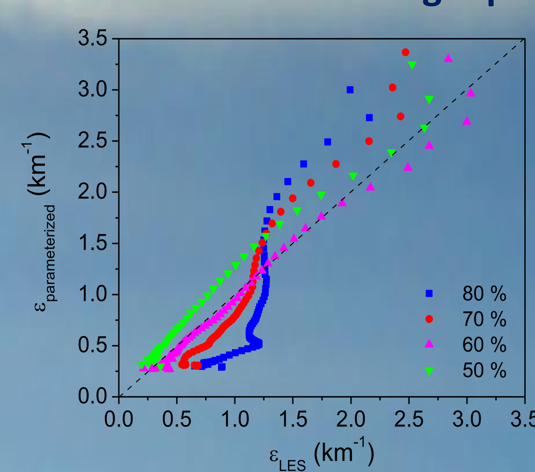
❑ A functional dependence of mass flux and fractional entrainment (and detrainment) rate on the environmental RH and height is proposed in this study and which can be implemented in numerical models.



Functional dependence of entrainment rate (ε) and mass-flux (M) on height (h) for different RH simulations

The entrainment rate and mass-flux is derived using convective plume approach (Betts, 1975)

Entrainment rate parameterized as a function of height (h) and RH as in the following equation



$$\varepsilon = 1.15\times10^{-2}(h-h_{CB}+0.3)^{-1} RH(h)$$

Here h_{CB} is cloud base height in km and RH is height dependant

Comparison of parameterized entrainment rate with LES derived entrainment rate is shown in the figure

Revisiting the role of intermittent heat transport towards Reynolds stress anisotropy in convective turbulence

Chowdhuri S., Kumar S., Banerjee T. 2020, *Journal of Fluid Mechanics* (Under revision)

Thermal plumes are the energy containing eddy motions that carry heat and momentum in a convective boundary layer. The detailed understanding of their structure is of practical interest from quantifying surface-atmosphere flux exchanges to parameterize moisture transport for cloud formation. A novel methodology is developed to provide structural descriptions of thermal plumes based on the concept of persistence. The results obtained from this study can be used to parameterize the heat and momentum transport asscoiated with these plumes

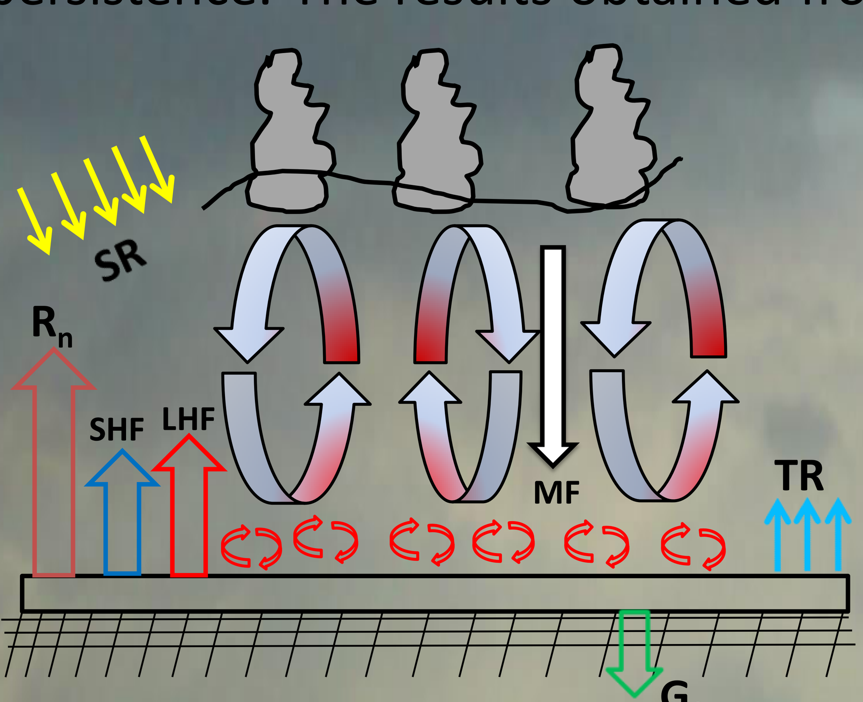
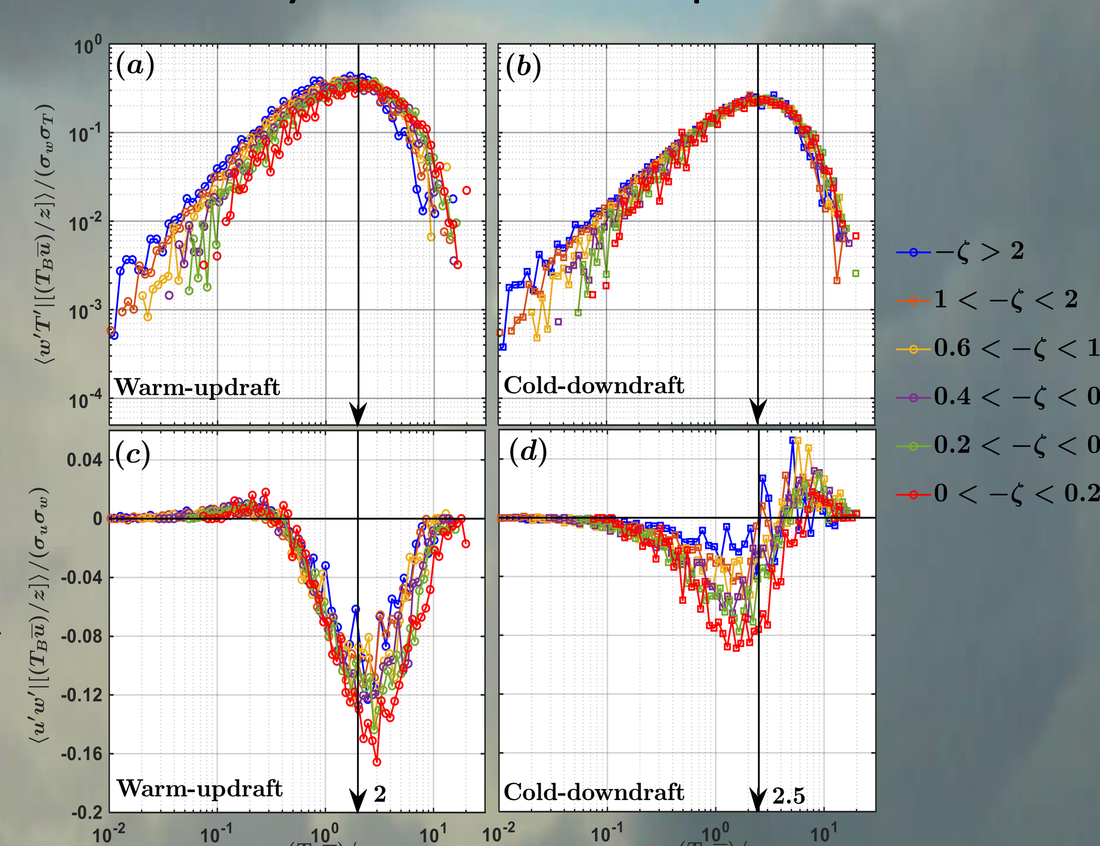
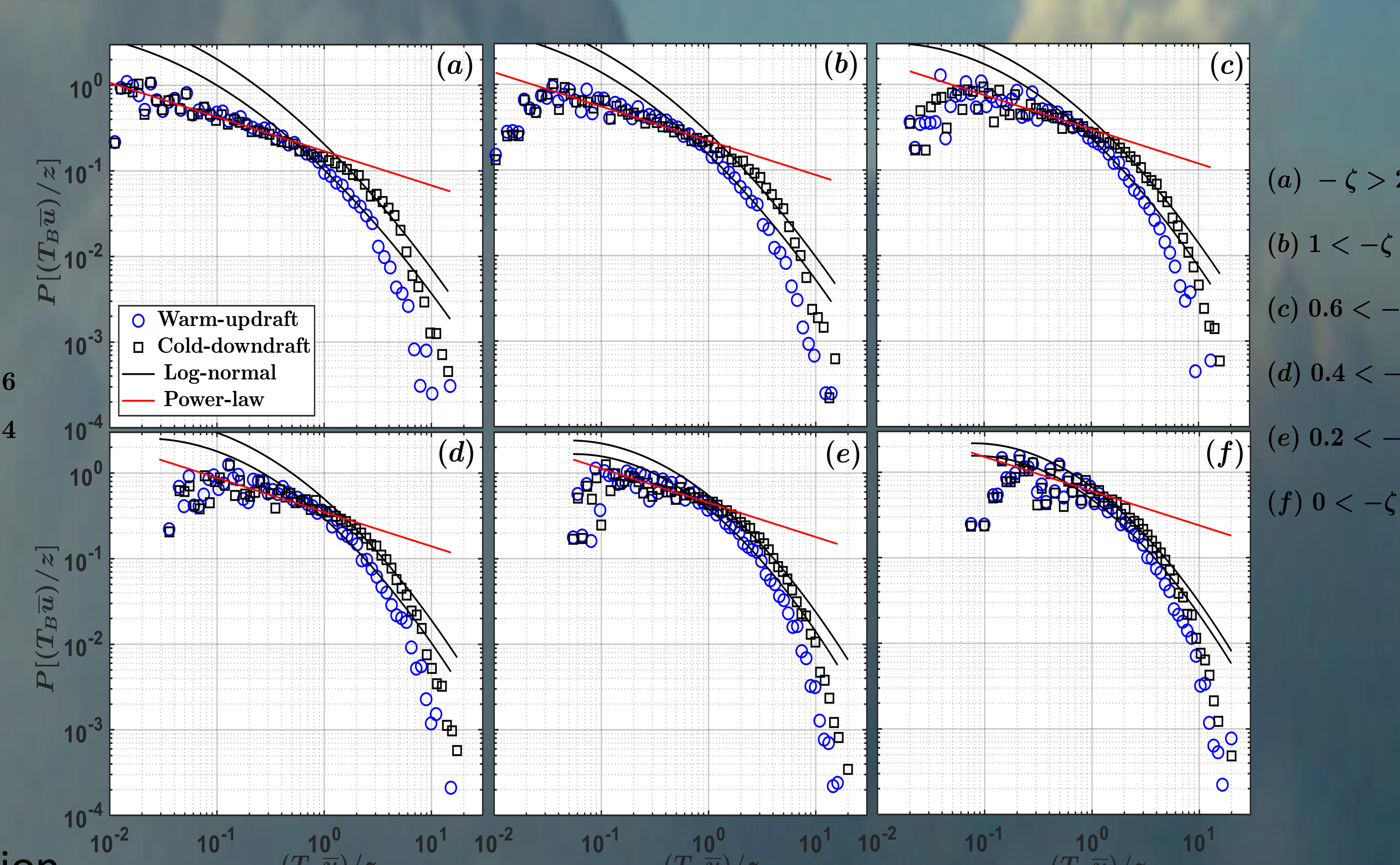


Fig 1: A schematic view of a convective cloud-topped boundary layer. SR= Solar radiation, TR= Terrestrial radiation, R_n= Net radiation, G_0= Soil heat flux, SHF= Sensible heat flux, LHF= Latent heat flux, MF= Momentum flux.



The scaled heat and momentum flux distribution plotted against the normalized streamwise sizes T_B ū/z, corresponding to warm updrafts and cold downdrafts

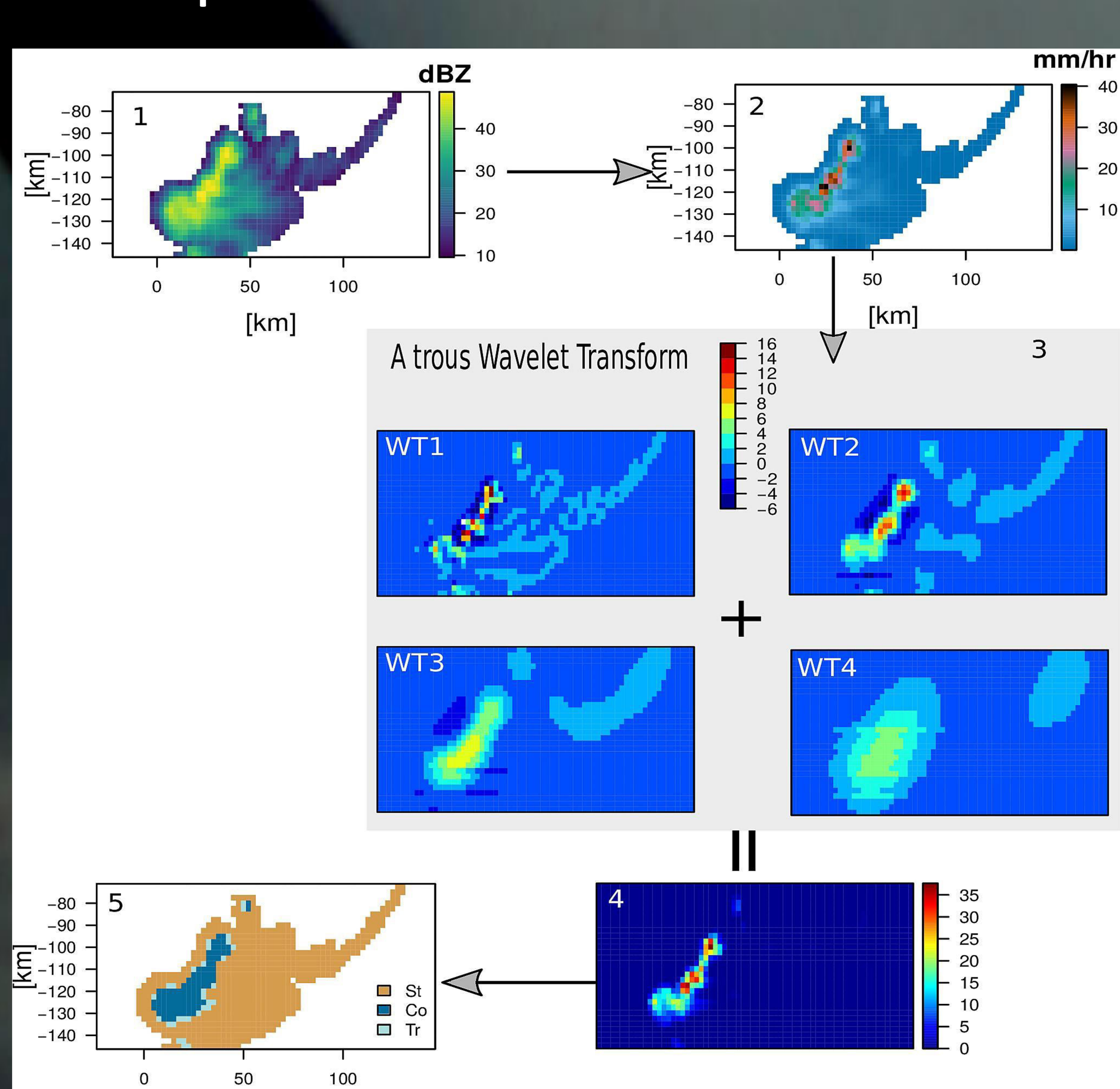


The PDF of normalized streamwise sizes T_B ū/z, corresponding to warm updrafts and cold downdrafts

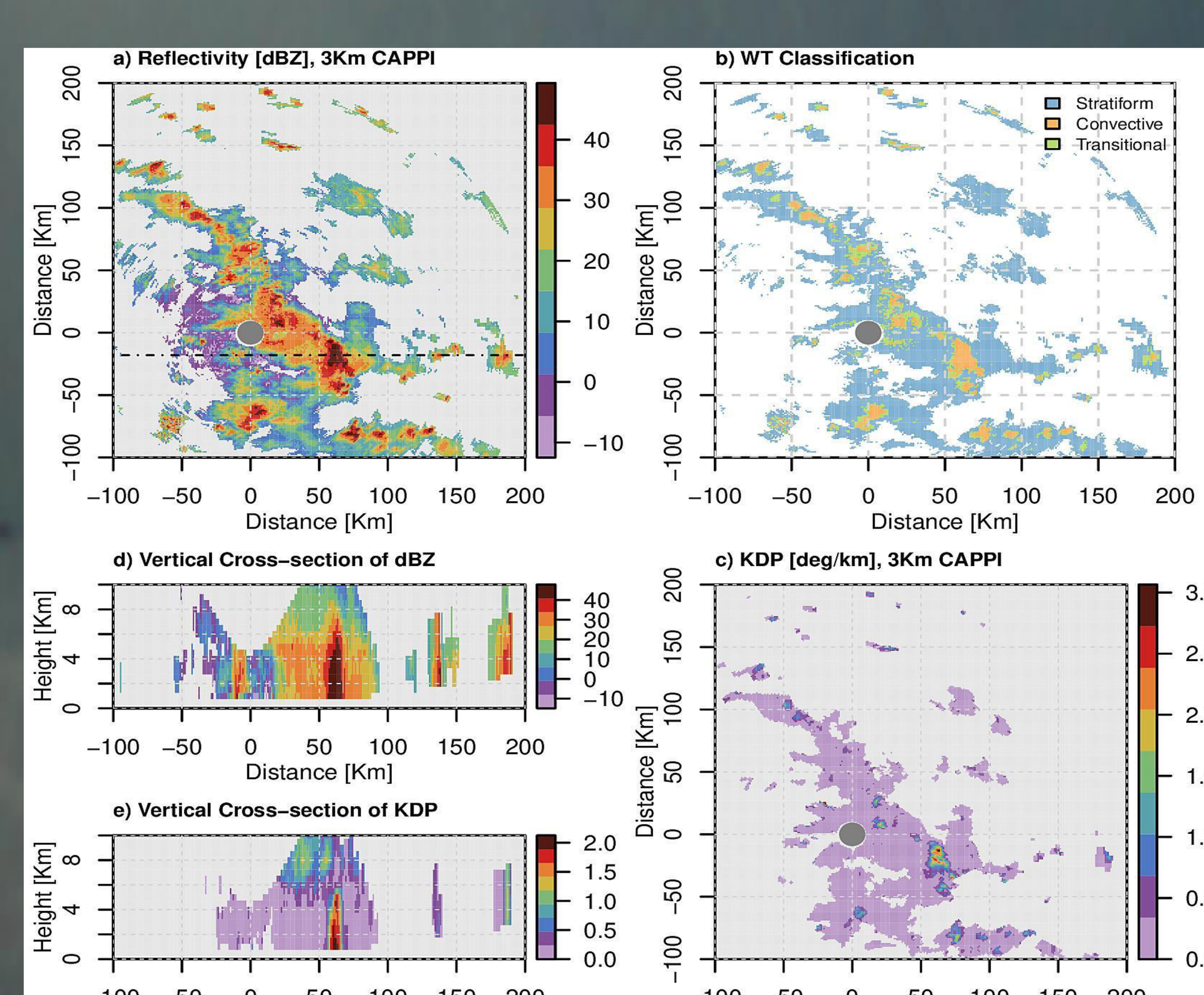
Classification of Radar Echoes Using Scale Criterion

Bhupendra A. Raut , V. Louf , K. Gayatri , P. Murugavel , M. Konwar , and T. Prabhakaran (2020) , *IEEE Trans. Geosci. Remote Sens.* DOI: 10.1109/TGRS.2020.2965649

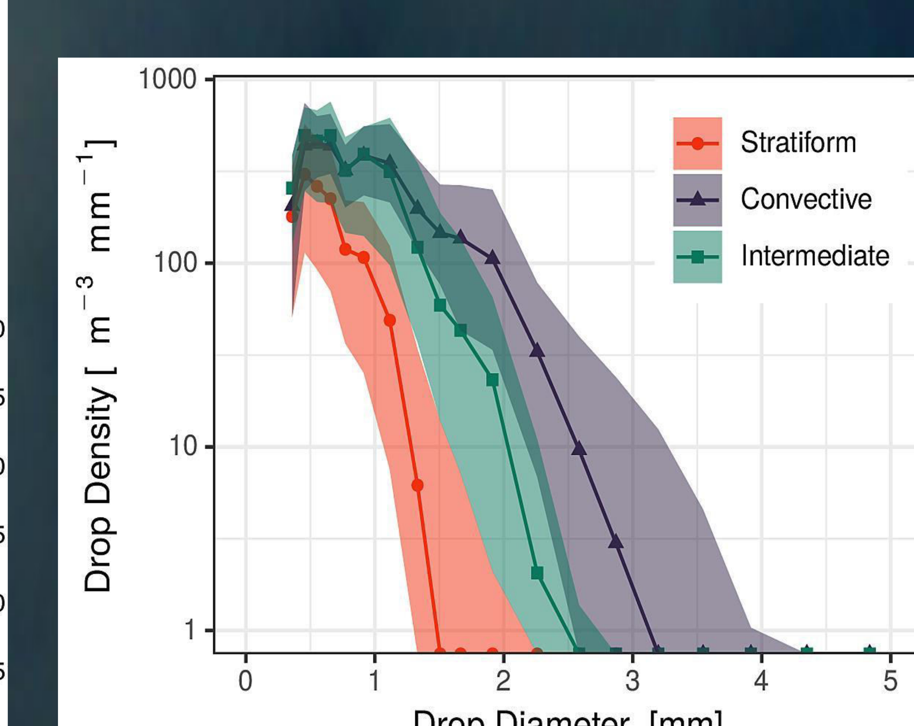
1. The wavelet scale analysis of radar reflectivity field is used to separate convective, stratiform and intermediate echoes in C-band dual polarization radar over Solapur.



2. The Example shows CAPPI data at 3km height on August 15, 2018 at 11:08 UTC. Active convection (orange in b) is associated with high LWC (higher KDP in c). Stratiform field (blue in b) is smoother and it has less LWC.



3. The stratiform precipitation has smaller drops and lowest drop density in surface observation, whereas convection has high drop density and abundance of large drops. The intermediate rain has a large number of small and medium drops and a lack of large drops (>3mm).



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