Microphysical Correlations for Instantaneous Retrieval Algorithms

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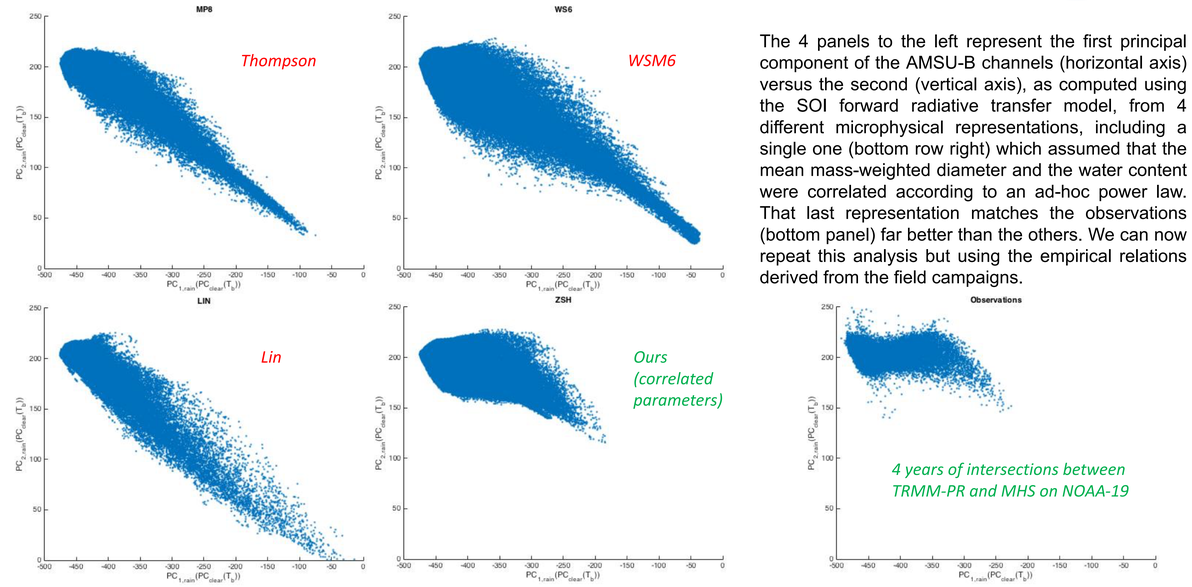
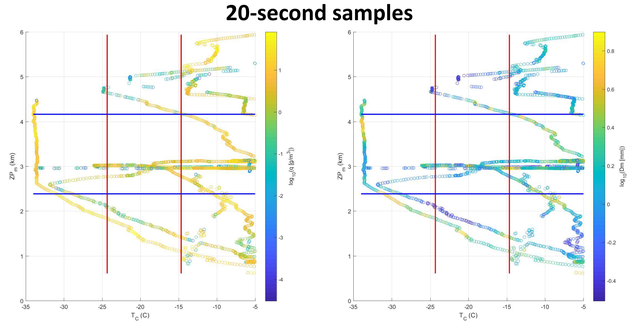
One very important contributor to the difficulty of making quantitative estimates of precipitation from instantaneous microwave measurements is the poorly-characterized variability of microphysical properties within the instrument fields of view. The habit, shape, density, and dimensions of the hydrometeors within the field of view of the different radiometers or even the GPM radars affects the quantitative signatures that the hydrometeors leave in the measurements, be they from absorption/emission or out-of-beam scattering. The fact that these parameters vary from hydrometeor to hydrometeor implies that a characterization of the distribution of the hydrometeors is required, assuming to zeroth order that the distribution is homogeneous at least within a range of vertical height in the field of view. One way to characterize these distribution is to analyze field campaign measurements, using time intervals that are short enough to support the assumption that the precipitation was stationary during the time, and performing separate analyses for different temperature x H_2O content bins.

The results shown here, from the Olympex field campaign, are for two different sampling time intervals, and two different relations between observed hydrometeor shape and mass, one that uses the apparent aspect ratio and another that does not. The main result is that the exponent of the power-law regression between observed condensed water content and observed mass-weighted maximum diameter is almost uniformly around the value 2, with some variability due to height (temperature) but not so much to observed radar reflectivity. This is particularly important because our previous analyses and simulation have demonstrated that the imposition of empirical correlation between the microphysical parameters produce a class of microphysical representations (indexed by the correlation parameters) whose forward-calculated scattering efficiencies match observations far more accurately than previous Marshall-Palmer or (N_0, Λ, μ)-Γ distributions ever do.

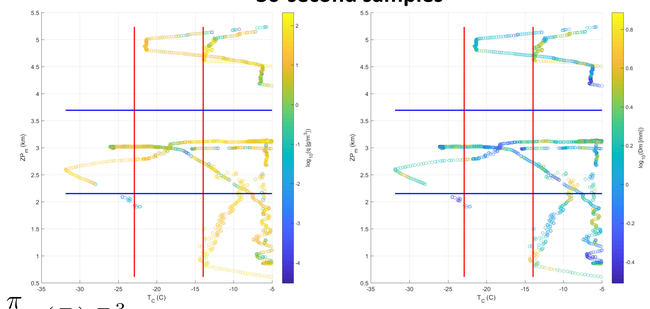


The 4 panels to the left represent the first principal component of the AMSU-B channels (horizontal axis) versus the second (vertical axis), as computed using the SOI forward radiative transfer model, from 4 different microphysical representations, including a single one (bottom row right) which assumed that the mean mass-weighted diameter and the water content were correlated according to an ad-hoc power law. That last representation matches the observations (bottom panel) far better than the others. We can now repeat this analysis but using the empirical relations derived from the field campaigns.

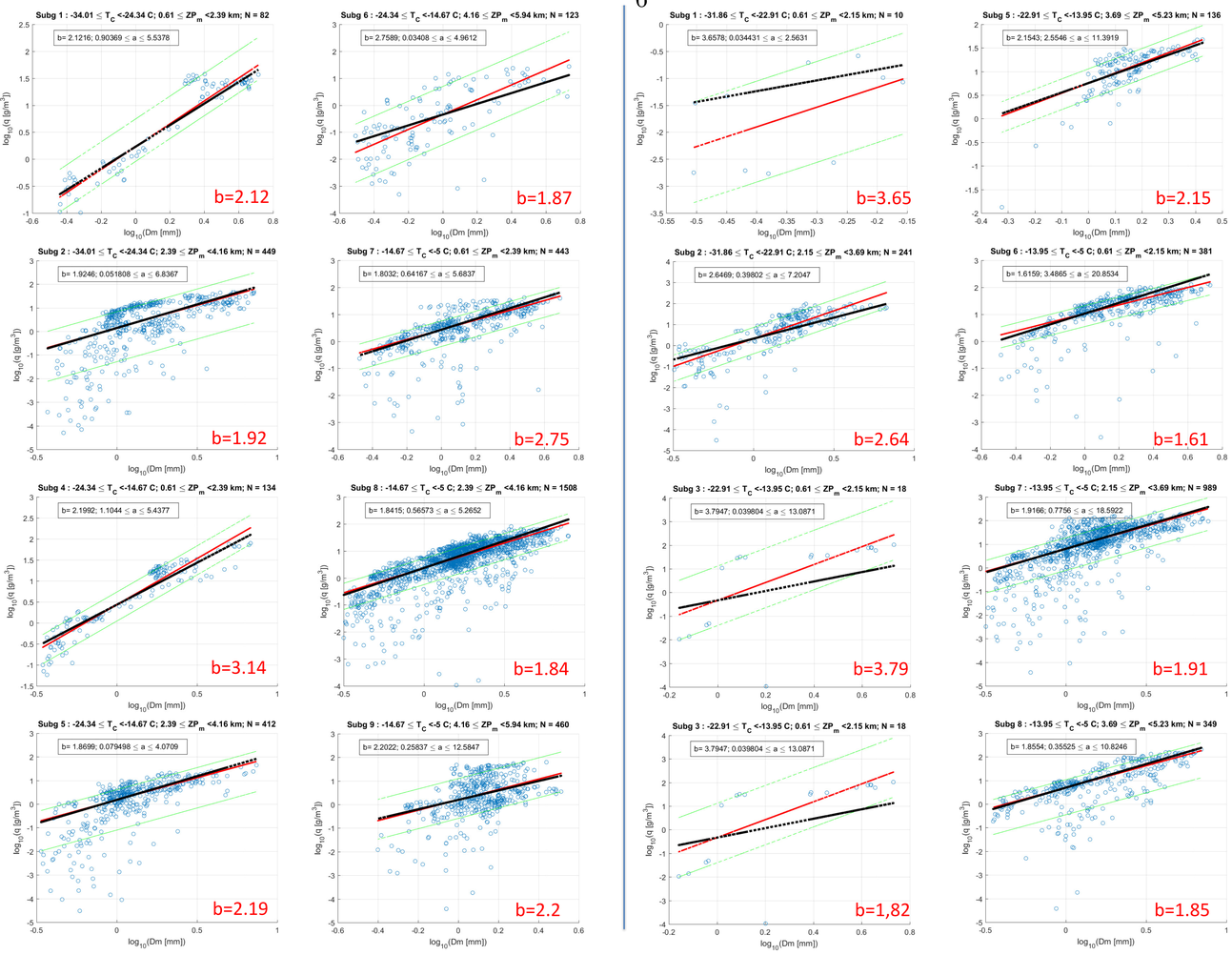
20-second samples



30-second samples



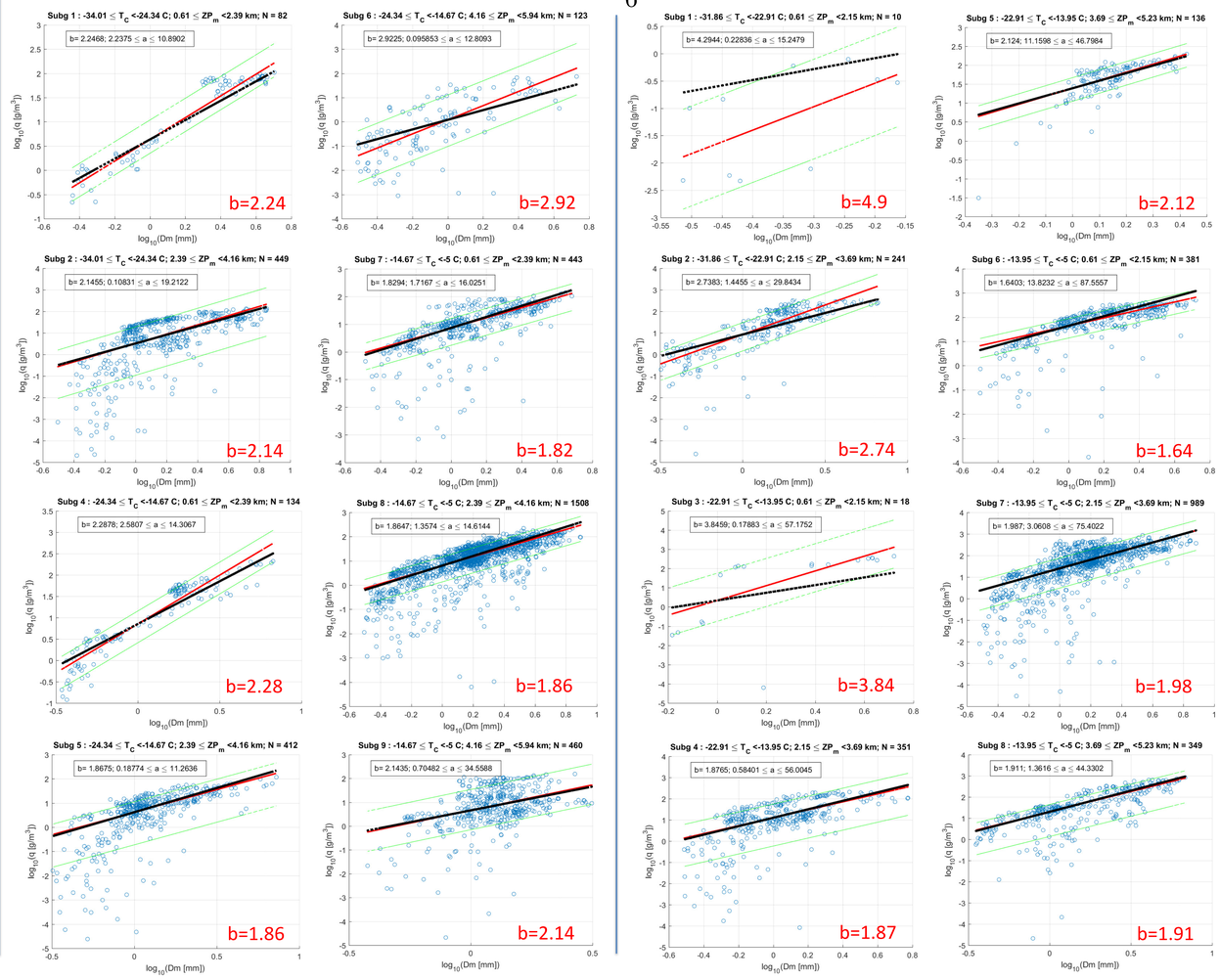
$$mass = \frac{\pi}{6}\,\rho(D)\,D^3$$



20-second samples

$$mass = \frac{\pi}{6}\,\rho(D)\,D^3 \cdot A_{spr}$$

30-second samples



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