Effective radius and droplet spectral width from RICO observations

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July 8th 2008
15th International Conference on Clouds and Precipitation
Cancún, Mexico

Motivation and scope of the research

need for parametrizations of links between microphysical and radiative properties of clouds

$$r_{eff} \sim \sqrt[3]{\frac{LWC}{N}} \cdot f(d)$$

$\rightsquigarrow$ assessment on the droplet spectral parameters for RICO cumuli:

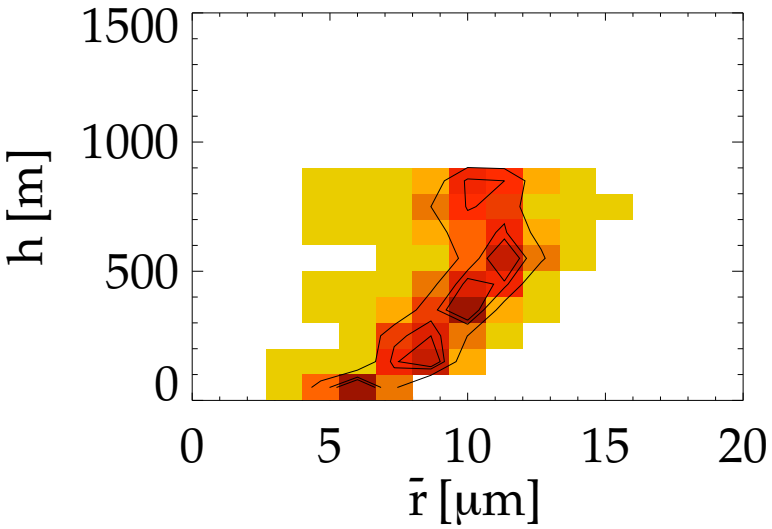
- effective radius r_{eff}
- droplet concentration N
- mean radius $\bar{r}$
- standard deviation σ_r
- relative dispersion $d = \sigma_r / \bar{r}$

Methodology and source of data

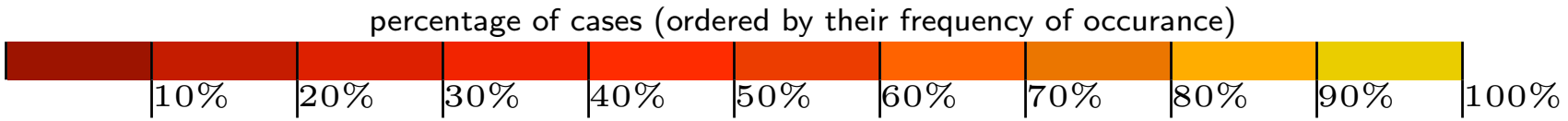
- NSF/NCAR C-130Q flights during RICO
- Fast-FSSP optical droplet spectrometer
  (255-bin description of the 2 to 47 μm droplet size-range)
- 10 Hz averaged data ($\sim 10\,m$ resolution)
- in-cloud data points ($N > 10\,cm^{-3}$)
- non-drizzling ($N_{drizzle} < 10\,l^{-3}$) samples
- flight-long statistics (for research flights 06,07,09,12)

Frequency by altitude diagrams

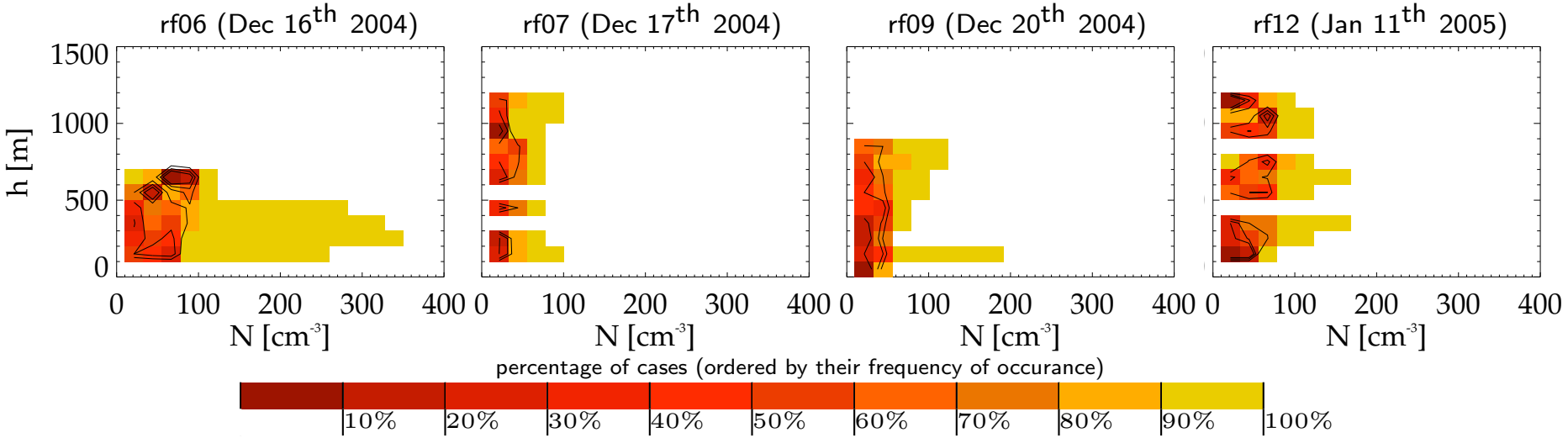
example: mean radius vs. cloud height for rf09



- height above cloud base
- frequency distribution at each level
- 100 m x 1 μm bins (rect. boxes)
- color scale: 10, 20 . . . 100% of most frequent cases
- contours surround: 25, 50, 75% of most frequent cases

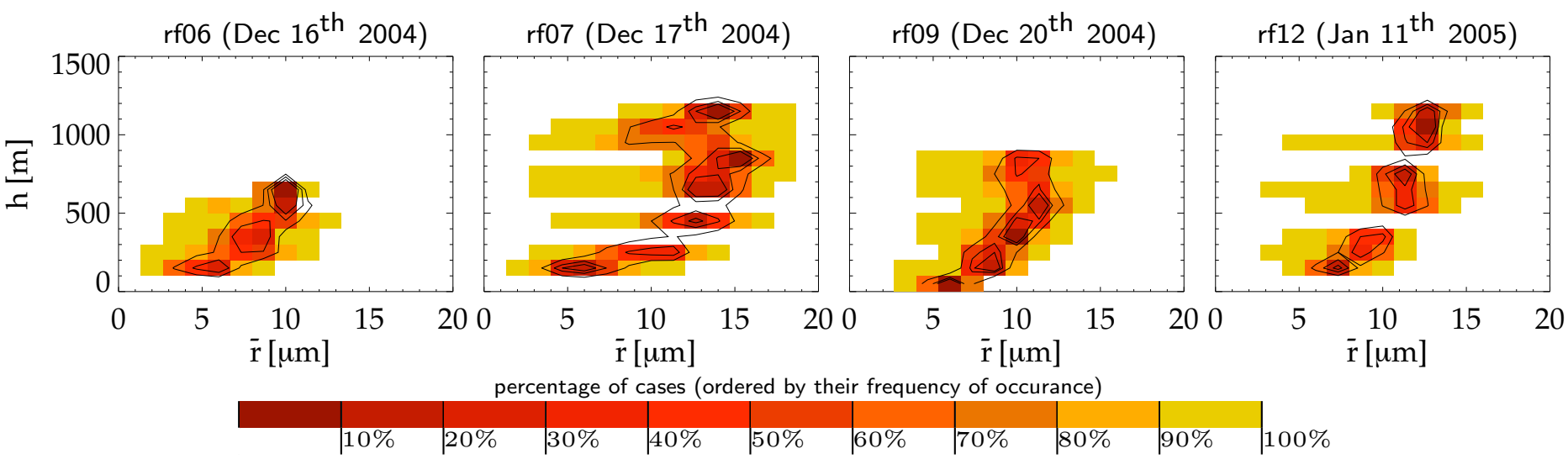


Droplet concentration N



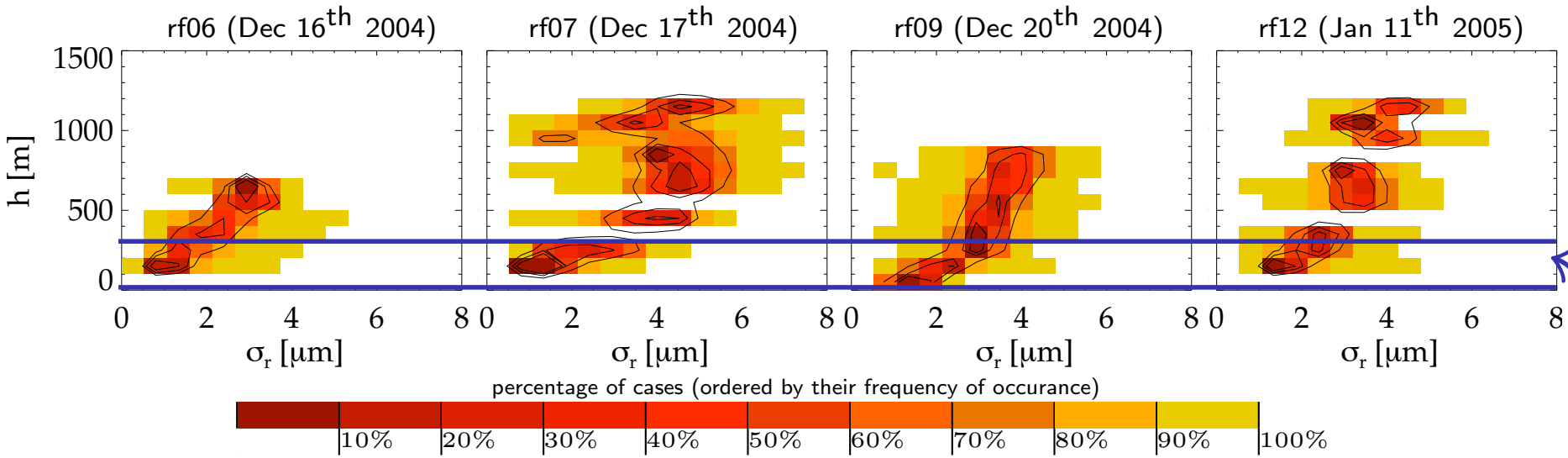
- concentrations lower than $100\,cm^{-3}$ ($N < 50\,cm^{-3}$ for rf07 & rf09)
- fairly constant with height
- variations in vertical extent of the cloud field (700 to 1200 m)

Mean droplet radius $\bar{r}$



- gradual increase of droplet size
- increase less pronounced in upper parts
- wide histograms (signature of entrainment and mixing)

Droplet radius standard deviation σ_r



- growth with height as for $\bar{r}$
- $h < 200\,m$ as in ACE-2 atlantic Sc
- large values in the upper parts $\rightsquigarrow$ signature of entrainment/mixing

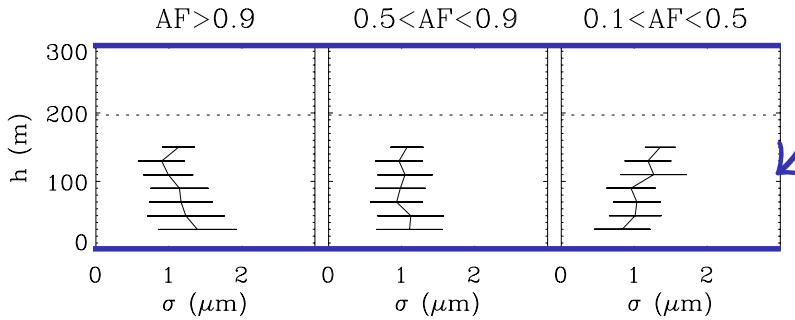
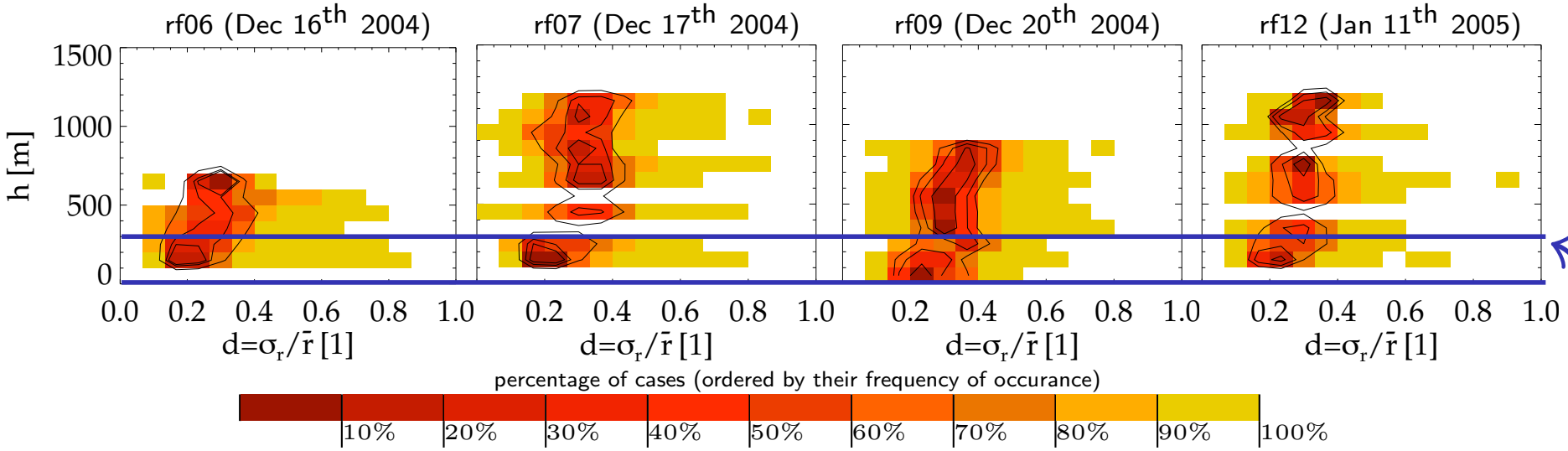
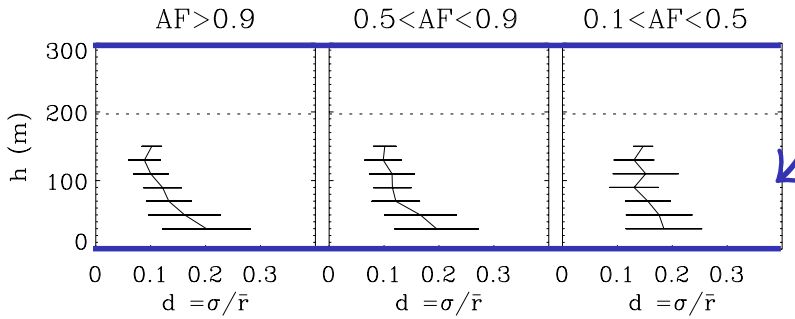


Fig. 2 in Pawlowska et al. (2006)

Droplet radius relative dispersion $d = \sigma_r/\bar{r}$



- relatively constant with height with values of $d \sim 0.3$
- $h < 200\,m \rightsquigarrow$ as in ACE-2 Sc case (higher spread of values in RICO)
- useful for parametrizing $r_{eff} \sim \sqrt[3]{LWC/N} \cdot f(d)$



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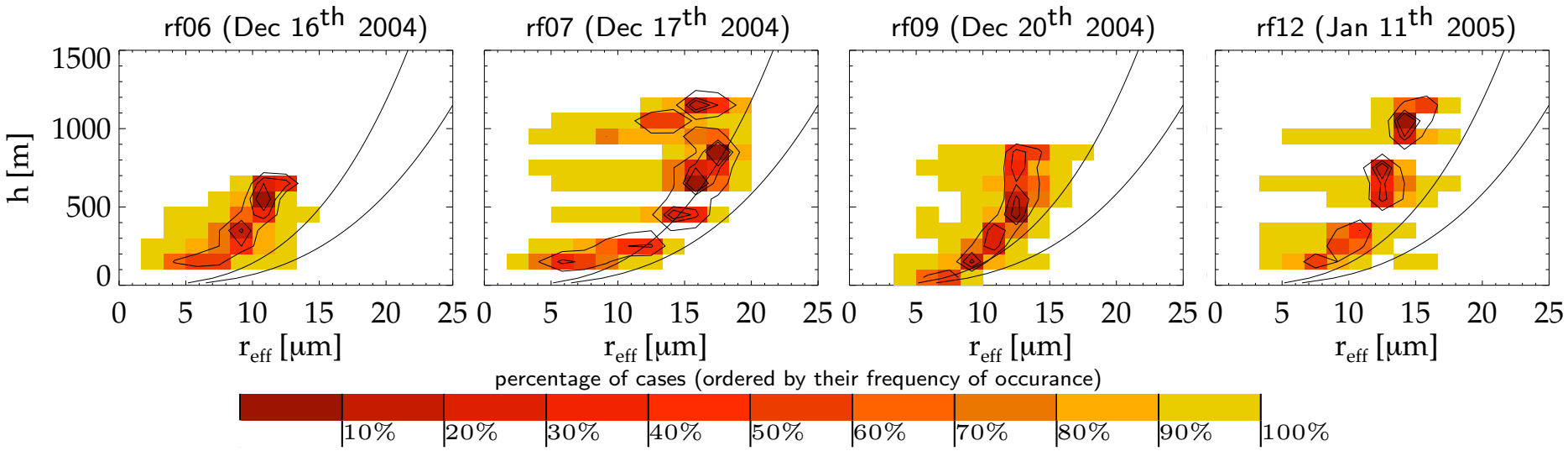
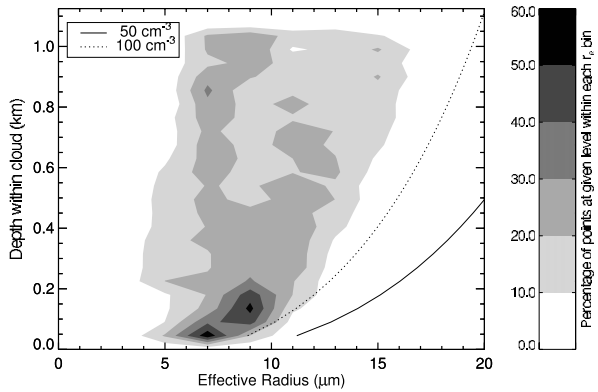
Effective radius r_{eff}



- lines represent adiabatic values for constant $f(d)$ and constant N of 50 and 100 cm^{-3}
  $r_{eff_{ad}} \sim \sqrt[3]{LWC_{ad}/N} \cdot f(d)$
- comparable with the pacific remote sensing observations (save for the bi-modality in deeper parts)



Nauru ARM remote sensing retrievals (McFarlane and Grabowski, 2007)

Summary

- statistical assessment of selected microphysical parameters of pristine-air trade-wind cumuli
- in context of usage in parametrizations of microphysics–radiation links
- based on airborne *in-situ* measurements with the Fast-FSSP
- comparison with ground-based remote sensing retrievals

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Thank you for your attention