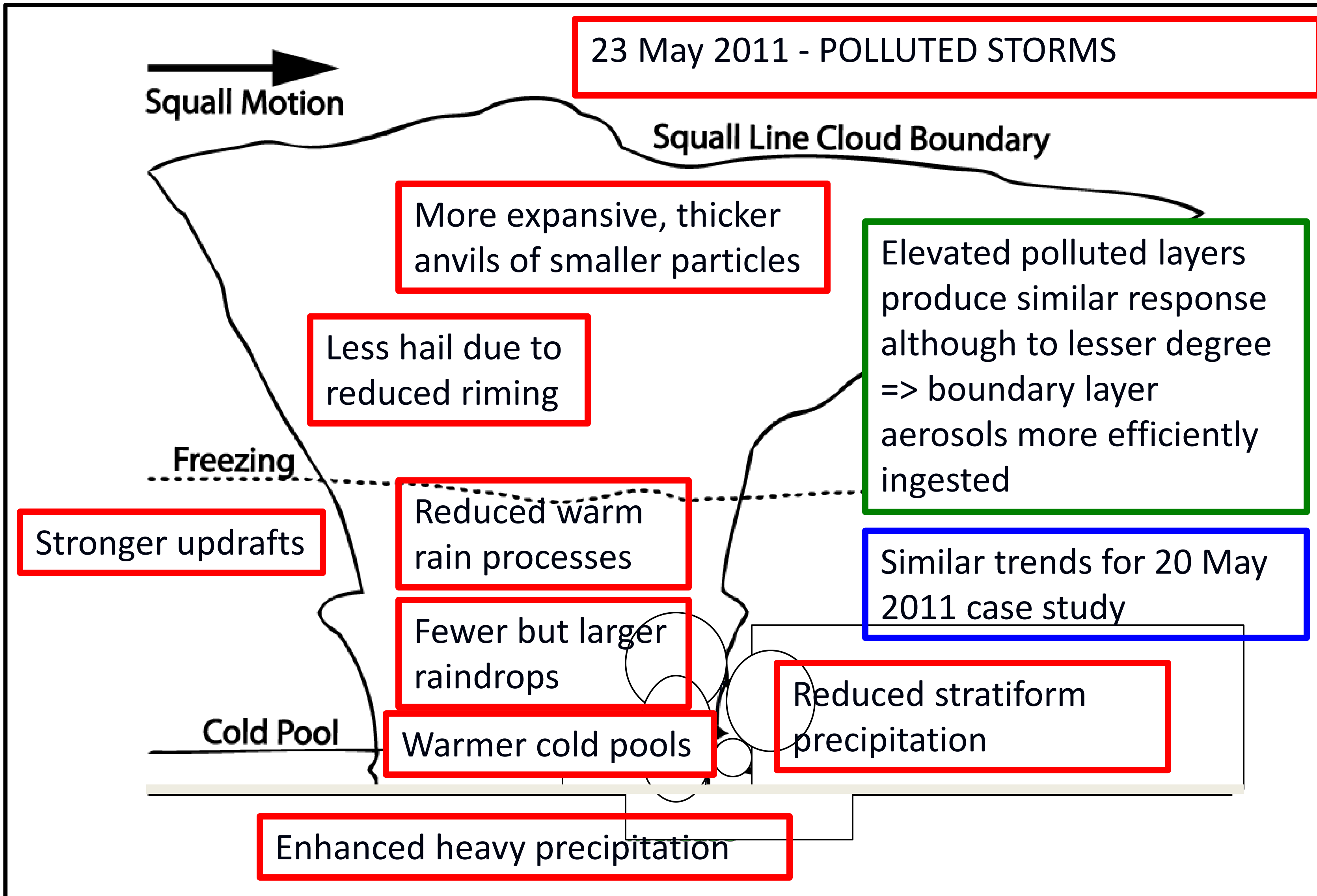
CAPI Breakout Summary

Aerosol Impacts on MC3E Case Studies

S.C. van den Heever, S.M. Saleeby, P. Marinescu, S.M. Kreidenweis, and P.J. DeMott – Colorado State University



Satellite Retrieving CCN using convective clouds as CCN Chambers

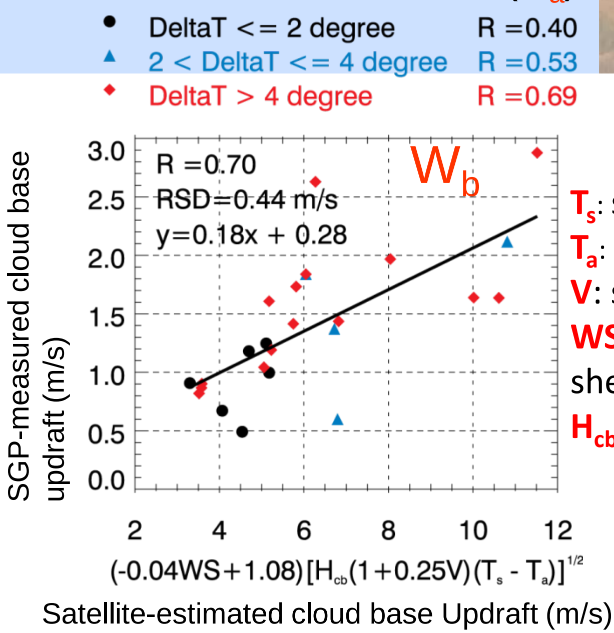
Daniel Rosenfeld, The Hebrew University of Jerusalem

CCN chambers measure the supersaturation (S) and number of activated CCN (N_a).

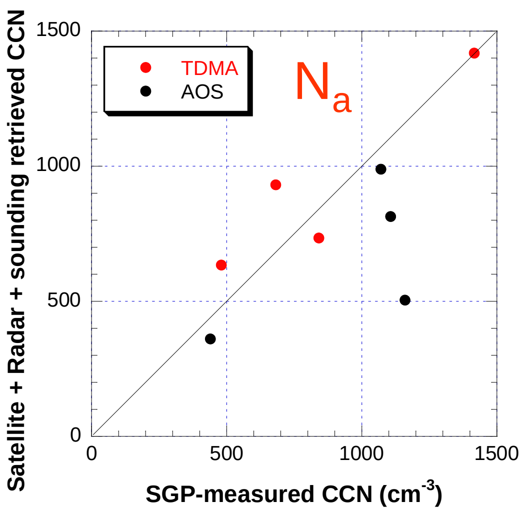
Clouds provide CCN(S) along the following steps:

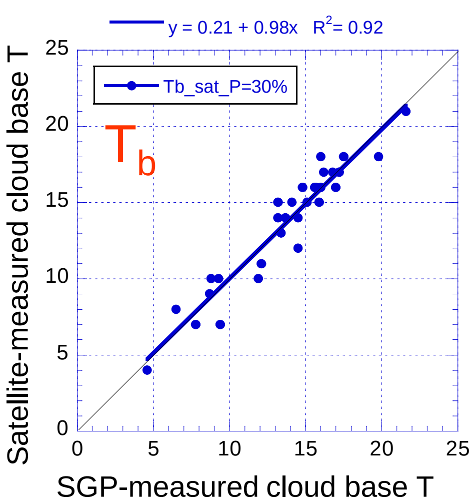
1. N_a is retrieved from the shape of $T\text{-}r_e$ (cloud top temperature – drop effective radius) relationships and cloud base temperature, T_b.
2. S is calculated from the knowledge of N_a and W_b (Cloud base updraft). W_b is retrieved from the difference between surface skin and air temperatures and wind speed.

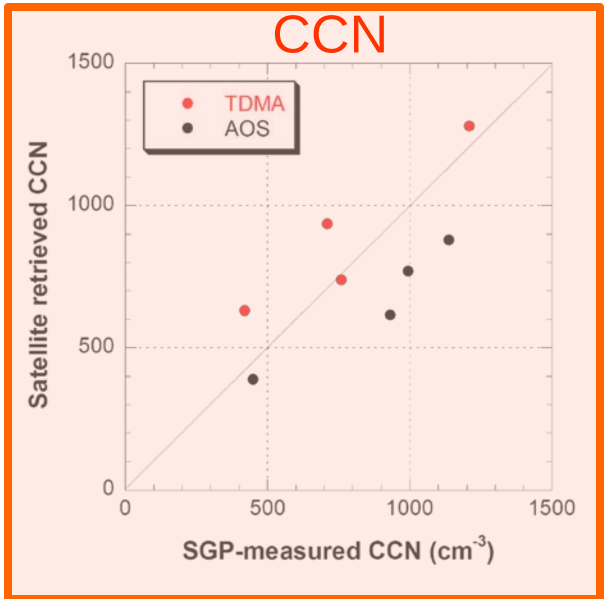
We have validated N_a and W_b and CCN(S) against the SGP measurements.



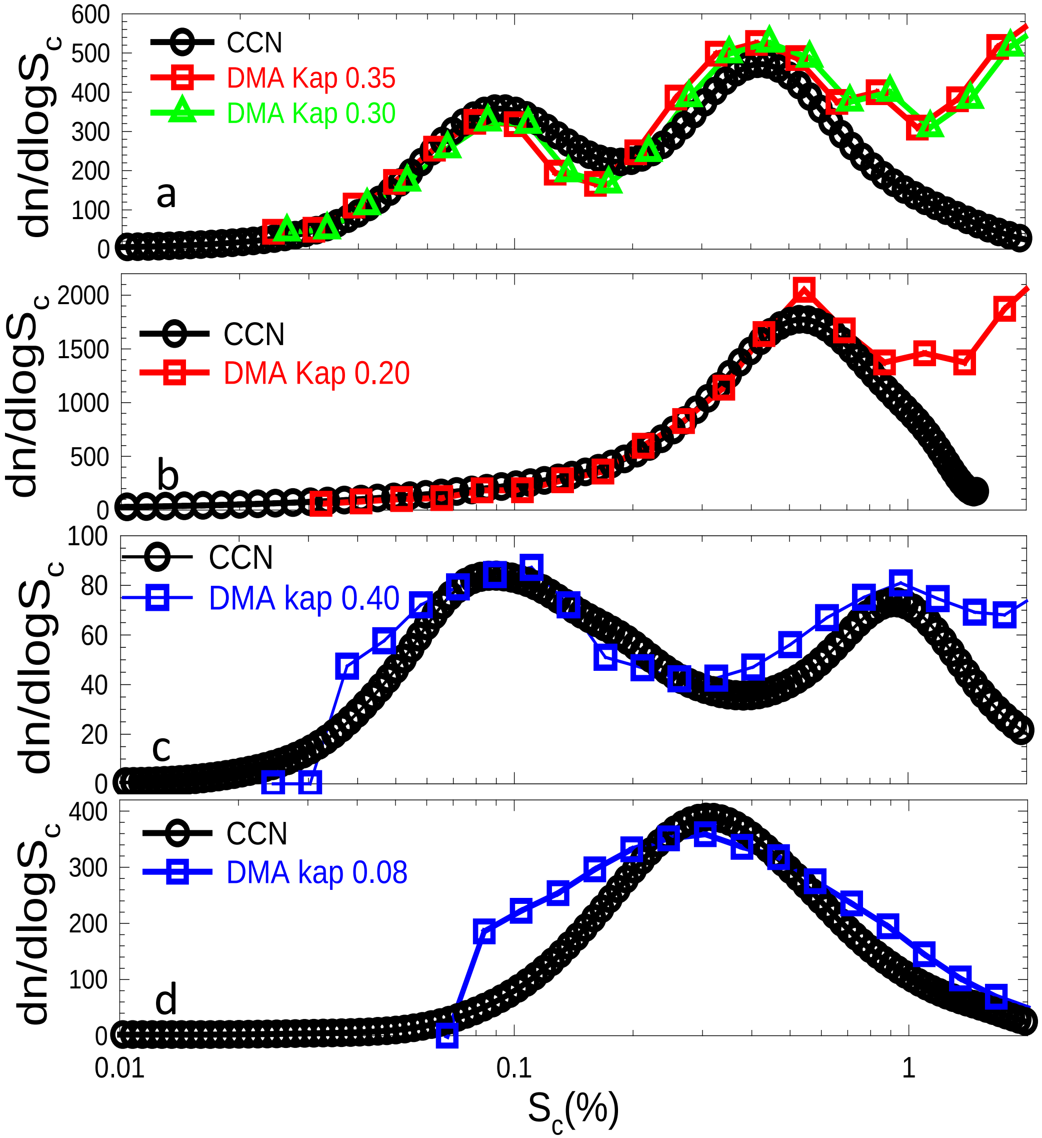
T_s: surface skin temp.
T_a: 2-m air temp.
V: surface wind speed
WS: vertical wind shear
H_{cb}: cloud base height







Jim Hudson DRI



Bimodal, chemical or physical cloud processing made lower S_c mode.

Stratus, MASE

off central California

Monomodal, no cloud processing

Bimodal, chemical or physical cloud processing made lower S_c mode.

Caribbean Cumuli, ICE-T

Monomodal, no cloud processing

Differential CCN and DMA concentrations against critical supersaturation (S, S_c). DMA sizes transposed to S_c by assuming κ (kap; hygroscopicity). In panel a κ 0.30 fits lower S_c mode (cloud-processed); κ 0.35 fits higher S_c mode (unprocessed). Hoppel minimum between modes implies cloud S 0.20% for panel a, 0.40% for panel c.

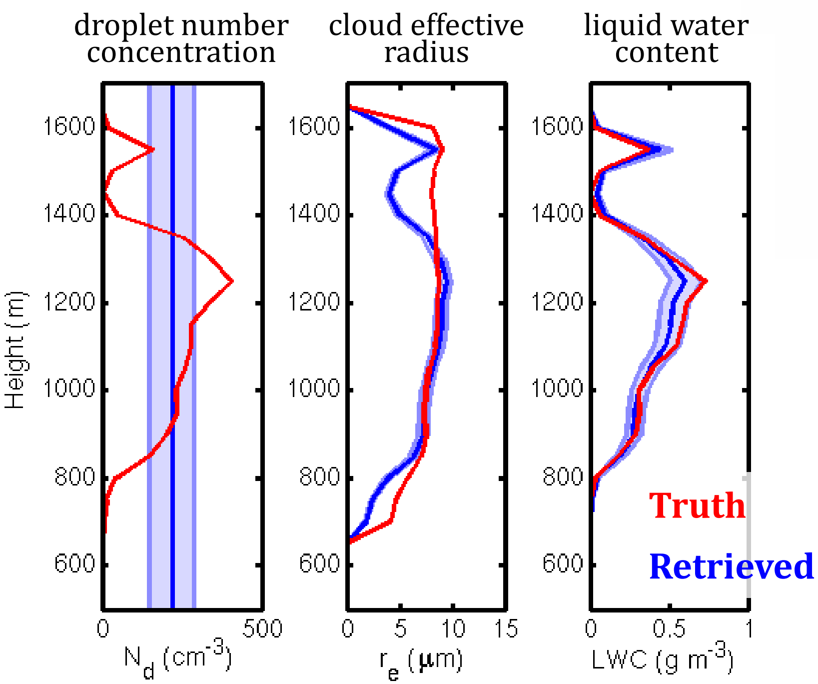
New retrievals – 3D fields of cloud effective radius for studying aerosol impacts on warm low clouds

Mark Fielding, Christine Chiu, Robin Hogan / University of Reading
Graham Feingold / NOAA

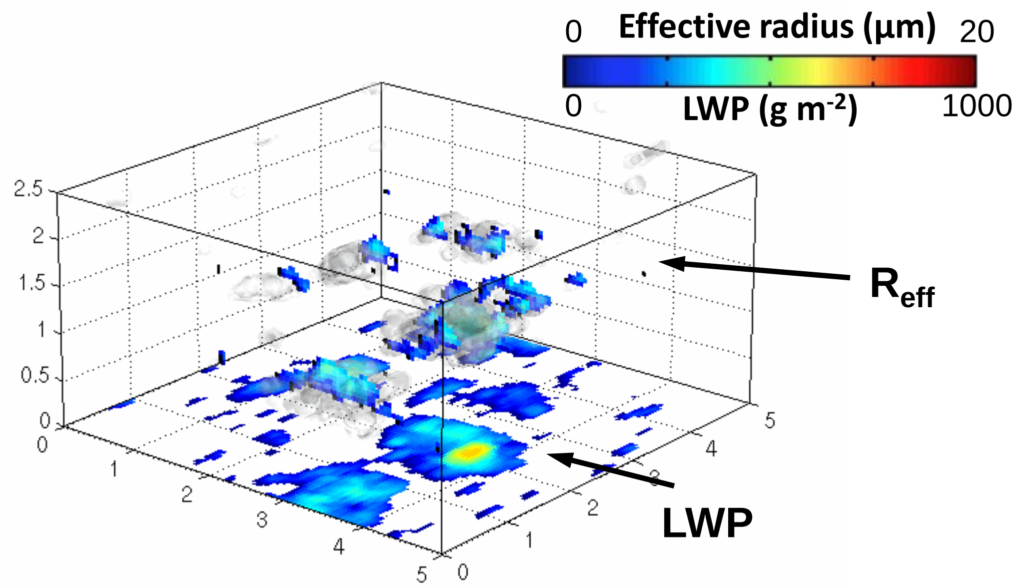
Method

- Novel approach that combines scanning ARM cloud radars (**SACR**) and zenith radiances (**SAS-Ze/2NFOV**) with 3D radiative transfer

Evaluation using LES



Real data: 3D cloud fields on 21 Nov. AMF1 (Azores)



Key Accomplishment

New **3D LWC, Reff** and **2D N$_d$** retrievals in both overcast and broken sky conditions

Publications

Fielding et al., 2013: 3D cloud reconstructions: Evaluation of scanning radar scan strategy with a view to surface shortwave radiation closure, *J. Geophys. Res.*

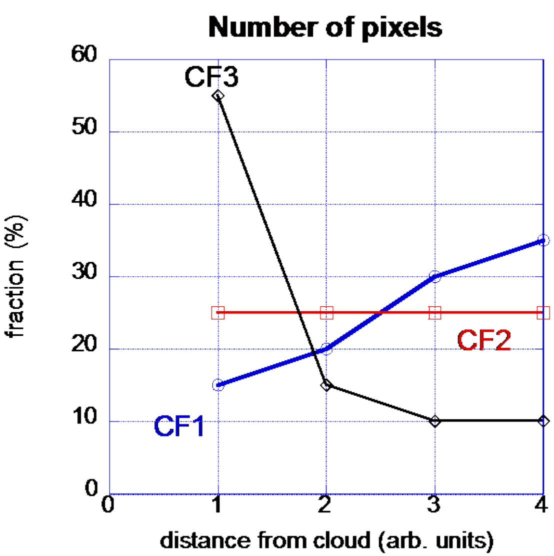
Fielding et al., 2014: A novel ensemble method for measuring cloud properties in 3D using ground-based scanning radar and radiances, submitted to *J. Geophys. Res.*

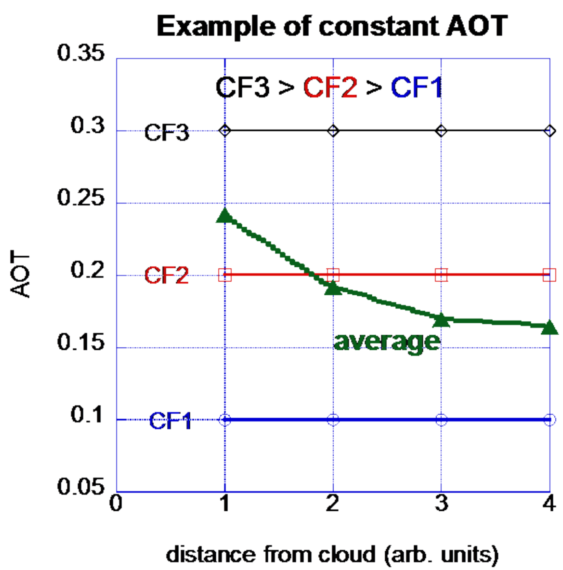
Near cloud observations of Aerosols

A. Marshak (NASA GSFC), T. Varnai (JCET), W. Yang, P. McBride (GESTAR)

Passive and active measurements show that radiation is bigger near clouds.
But radiation is not identical to AOT.
Increase in *apparent* AOT near clouds,
cloud fragments detrained from a nearby cloud or 3D radiative effects.

Sampling issue: pixels from different large-scale meteorological conditions are mixed together resulting in more higher humidity samples near clouds. This effect can be substantial (30% to 70%).





Combining areas with different Cloud Fractions may lead to an exaggerated increase of AOT near clouds (30-70%)

Removing the statistical effect of sampling may reduce the difference between the AOTs near and far from cloud by factor of 1.5-3.

Lidar Based Cloud Droplet Concentration Retrievals

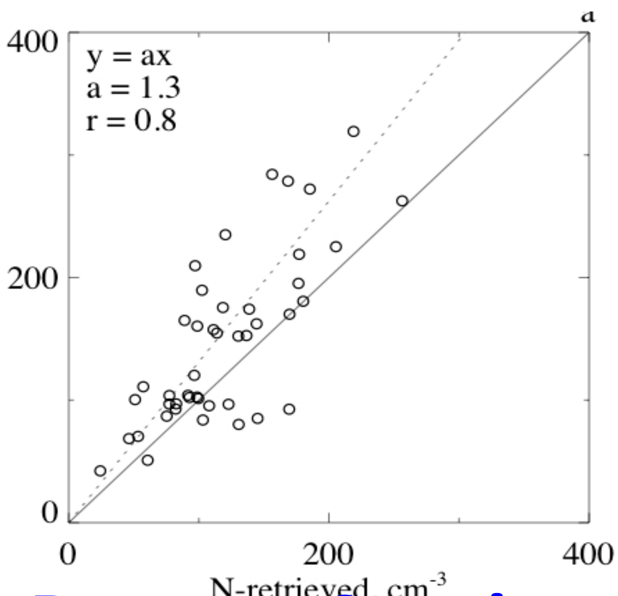
Zhien Wang, Tao Luo, Damao Zhang, and Jeff Snider
University of Wyoming

The General Approach

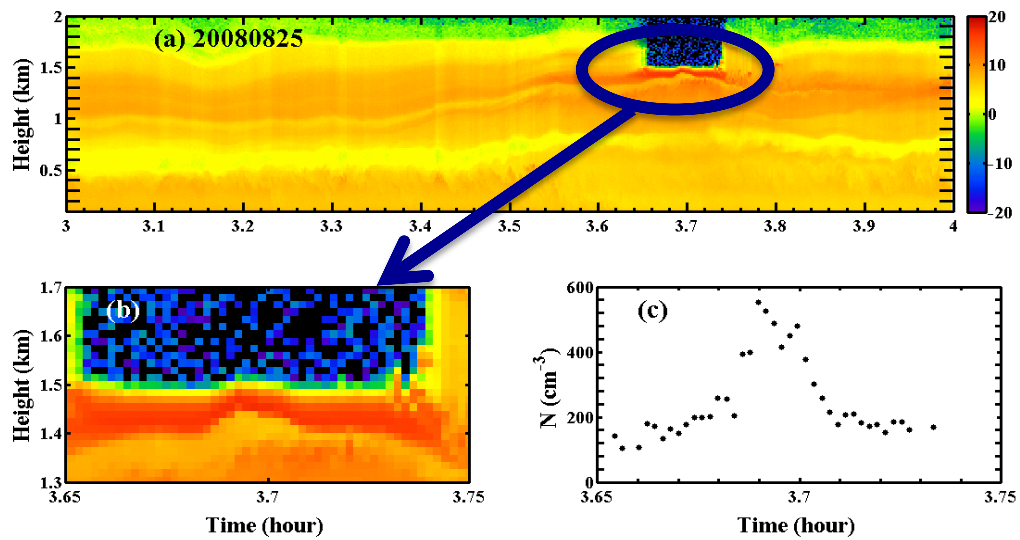
Combine lidar derived extinction with adiabatic LWC to estimate number concentration assuming log-normal size distributions.

Evaluation with VOCALS data

In-situ

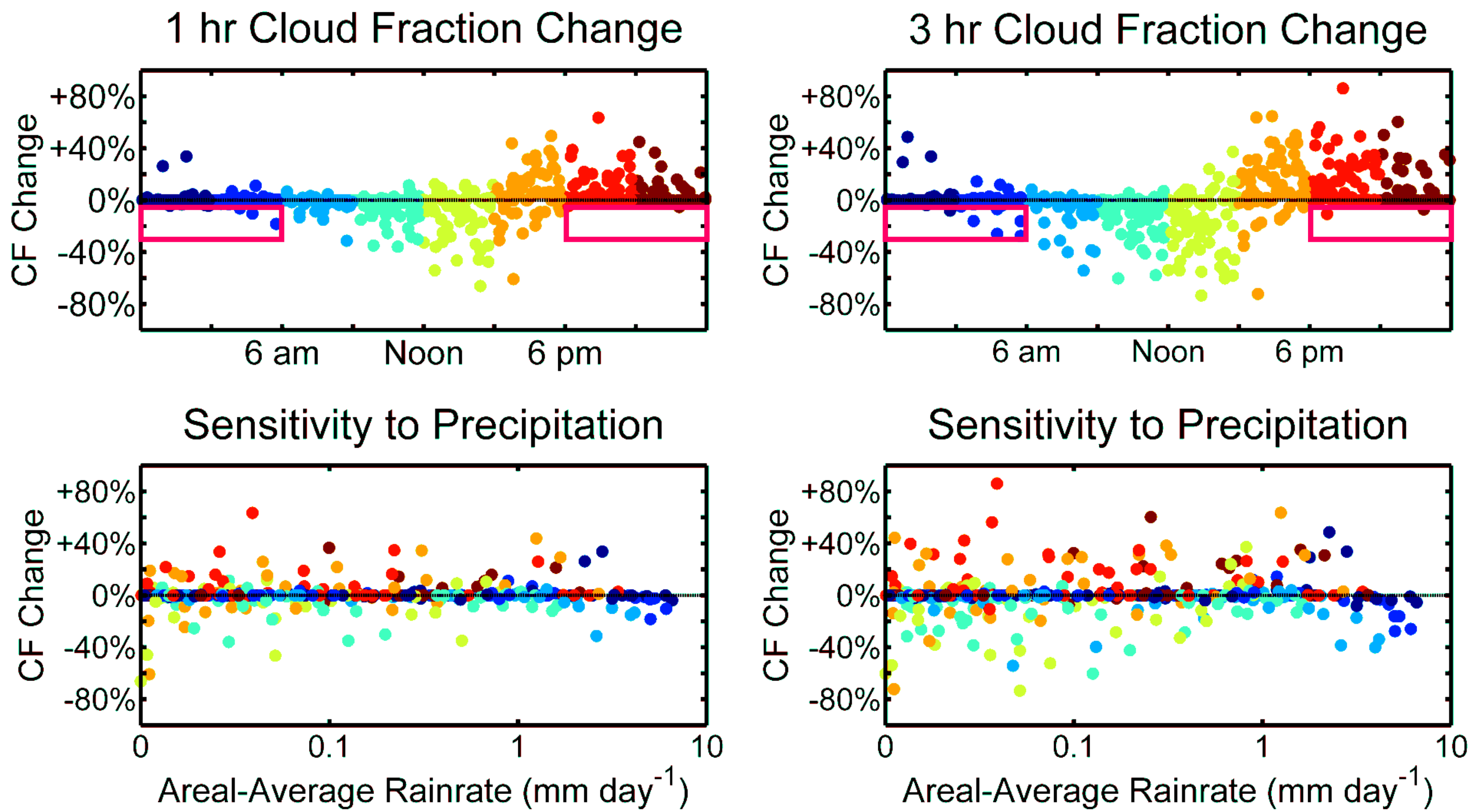


Remote Sensing



A MPL retrieval example shows aerosol and dynamics control of droplet concentration.

Diurnal cloud amount changes and lack of sensitivity to areal precipitation



>5% CF decrease overnight (6pm to 6am) in only 4 out of 289 1-hr samples (1%) and 9 out of 306 3-hr samples (3%)

Sandra Yuter UNC

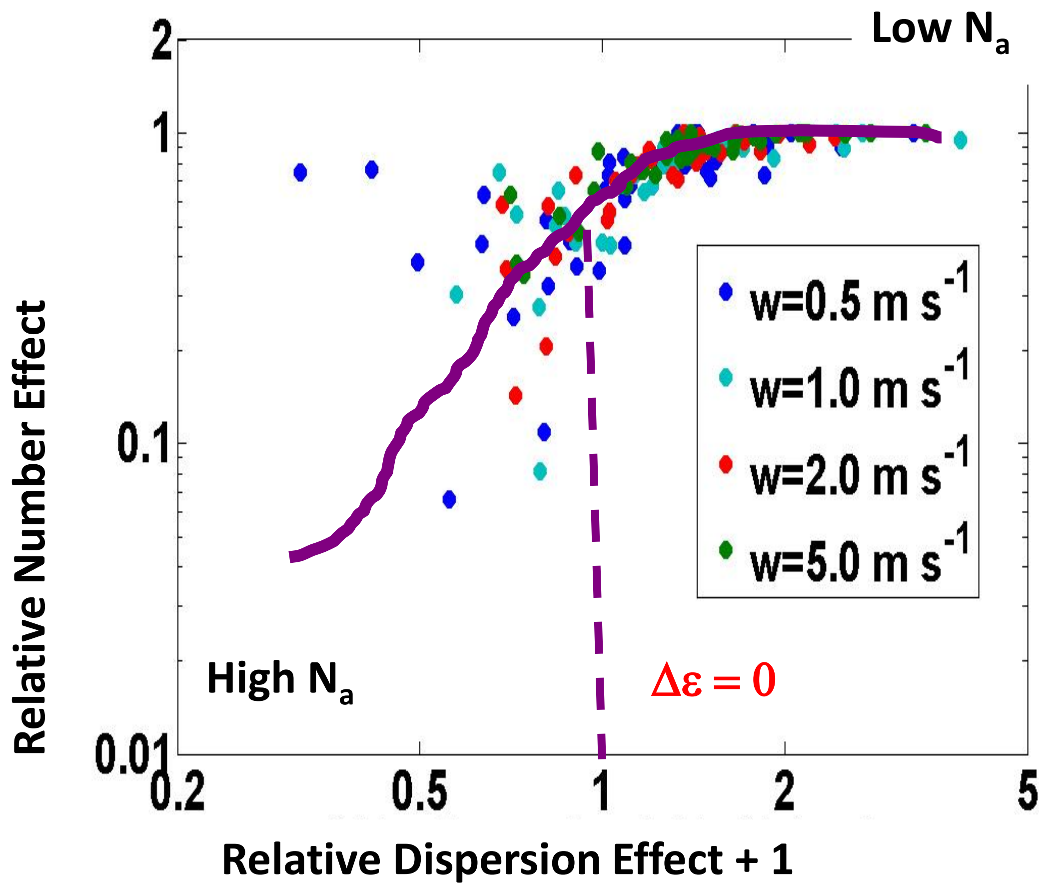
Compensating Microphysical Responses to Aerosol Change Reduce Large Uncertainty in Model AIE Estimate

Relative Number Effect:

$$\frac{\Delta N_c}{N_c}\frac{N_a}{\Delta N_a}$$

Relative Dispersion Effect:

$$\frac{\Delta \varepsilon}{\varepsilon}\frac{N_a}{\Delta N_a}$$



Dispersion effect acts to offset the cooling effect when the number effect is large but acts to enhance the cooling when the number effect is small.

(Contributed by Yangang Liu/BNL)

A New WRF-Chem Treatment for Studying Cloud-Aerosol Interactions in Parameterized Cumuli

Larry Berg/Pacific Northwest National Laboratory

Science Question

What are the regional scale impacts of cloud-aerosol interactions?

Approach

New treatment of cloud-aerosol interactions in WRF-Chem for both shallow and deep cumuli.

- Cloud droplet number mixing ratio
- Cloud microphysical and macrophysical properties
- Vertical transport, activation/resuspension, aqueous chemistry and wet removal of aerosol and trace gases.

Change in Column Integrated Aerosol Mass Loading

BC

Sulfate

Increase in sulfate due to shallow cumuli

Reduction in BC due to wet removal

WRF-Chem simulations valid at 20 UTC on 25 June, 2007

Fractional Difference in Column Integrated mass Loading

Key Accomplishments

- A new tool for studying regional scale impacts of cloud-aerosol interactions
- Cloud-aerosol interactions lead to a: decrease in BC, sulfate and OA in precipitating clouds (wet removal) and an increase in sulfate aerosol in regions with shallow, nonprecipitating cumuli.
- Simulated aerosol chemical composition and indirect effects are consistent with observations.

Publication

Berg, L.K., et al., 2014: A new WRF-Chem treatment for studying regional scale impacts of cloud-aerosol interactions in parameterized cumuli. Submitted to *Geophysical Model Development Discussions*.