

Satellite measurements of CCN using clouds as CCN chambers



Daniel Rosenfeld, The Hebrew University of Jerusalem

CCN chambers measure the number of activated CCN (N_a) for a given super-saturation (S).

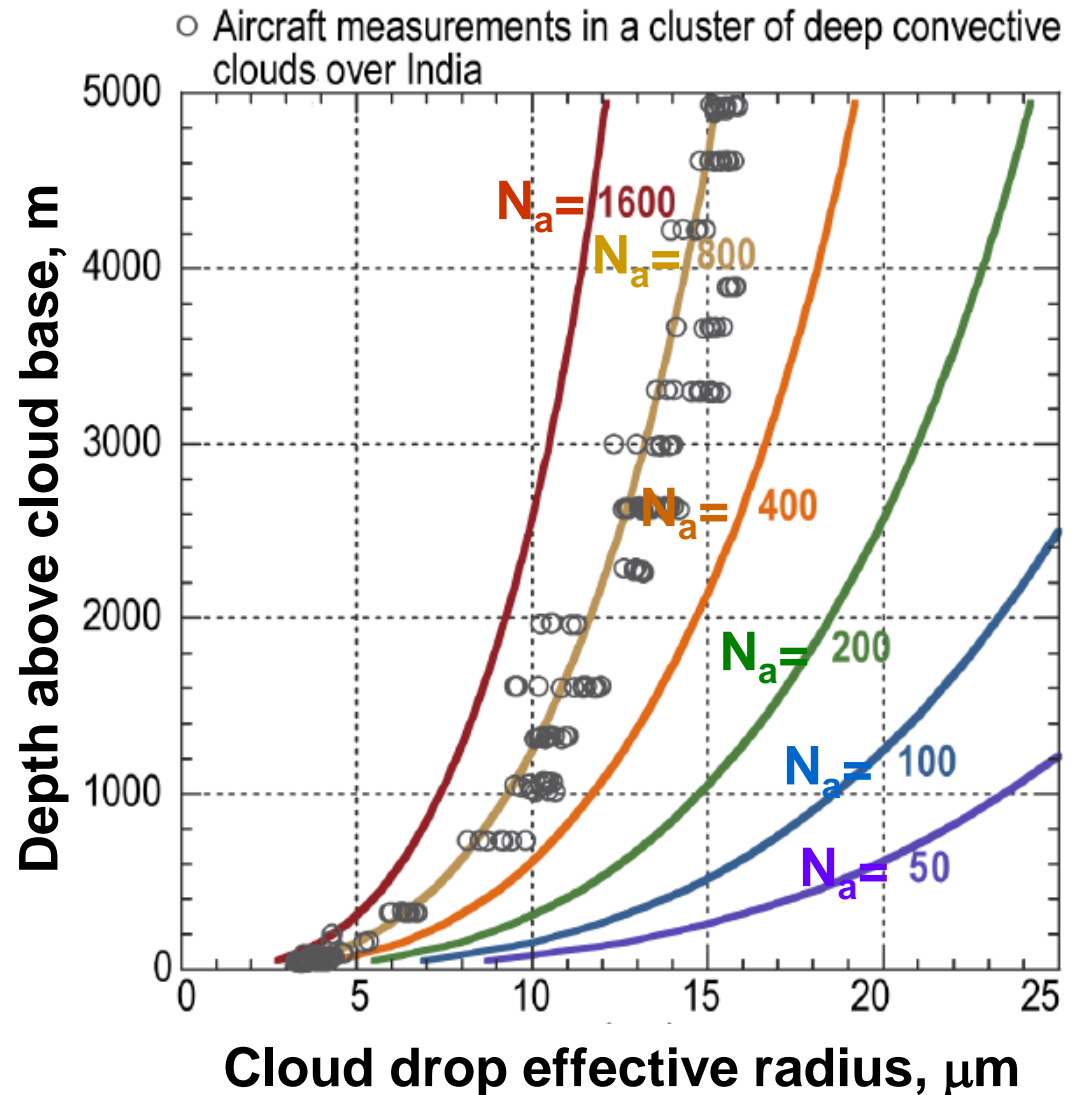
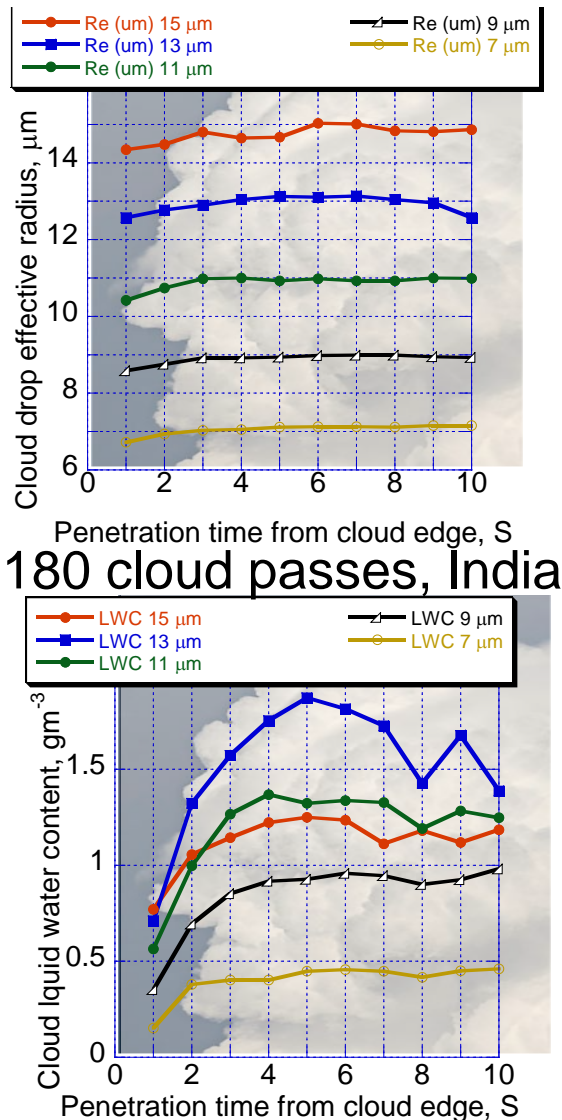
Measuring N_a and S in clouds can provide $CCN(S)$:

It will be shown here that both N_a and S can be retrieved from high resolution (375 m) NPP/VIIRS satellite data, and validated against the SGP measurements.

Having both $CCN(S)$ and W_b provides us with the possibility to separate aerosol from meteorology effects on cloud radiative effects.



1. N_a is retrieved from the $T-r_e$ (cloud top temperature – drop effective radius), due to nearly inhomogeneous cloud mixing, resulting in nearly adiabatic r_e .



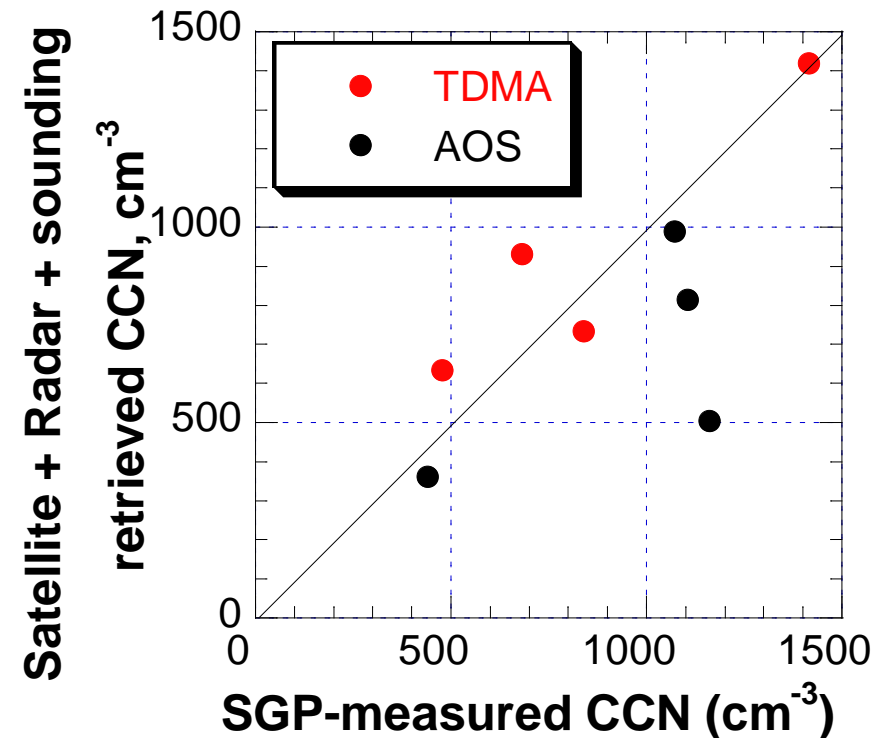
2. **S** is calculated from the knowledge of **N_a** and **W_b**
(Cloud base updraft). **S** = **C(T,P)W_b^{3/4}N_a^{-1/2}**

W_b is retrieved from SGP radar;

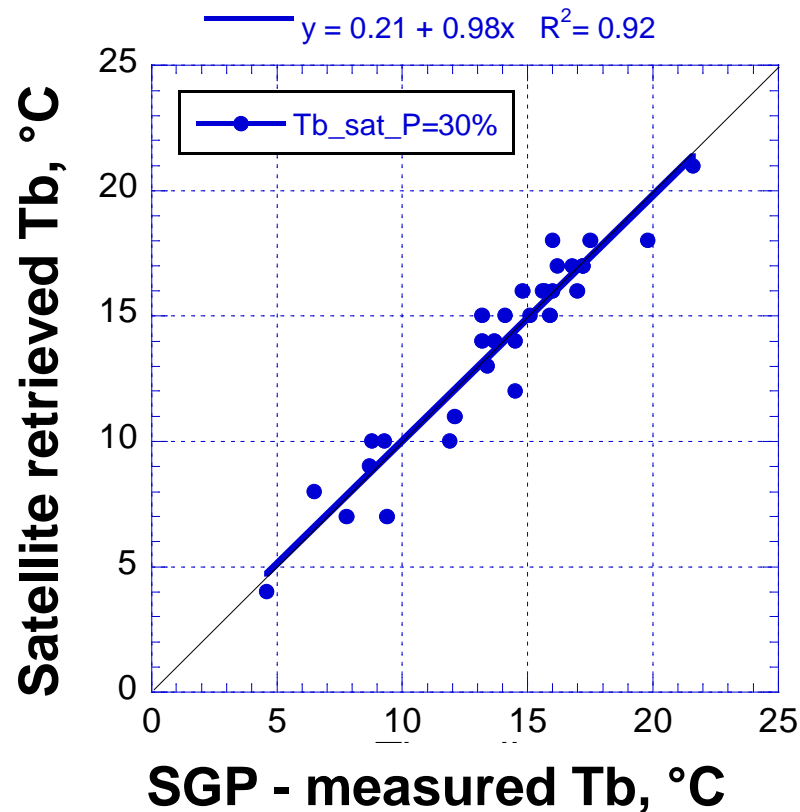
N_a calculation is based on
calculated adiabatic water
(**LWC_a**) vs. Satellite retrieved
assumed-adiabatic **r_e**.

LWC_a is based on radiosonde
and ceilometer retrieved
cloud base temperature (**T_b**).

CCN(S) is validated against SGP
measured AOS and TDMA.



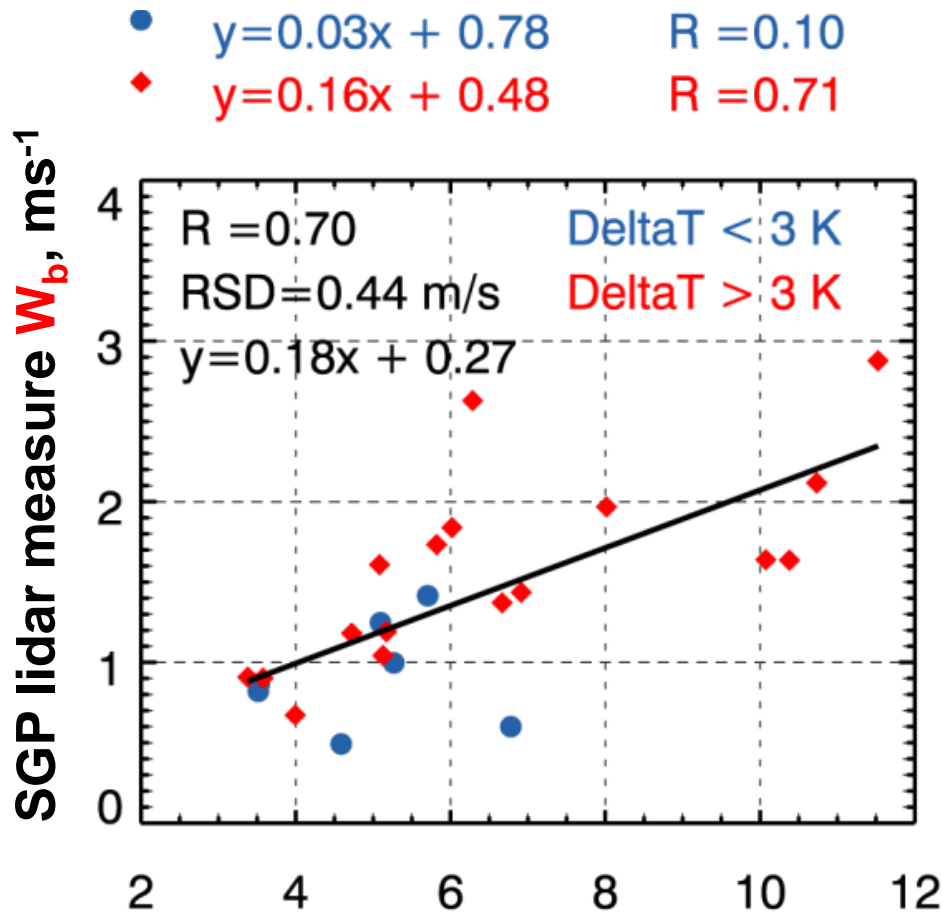
Satellite-only **CCN(S)** requires retrieving **T_b** and **W_b**



T_b RMS error = 1.1 °C

Validation of VIIRS retrieved cloud base temperature (°C) against SGP ceilometer and sounding based measurements.

Satellite-only **CCN(S)** requires retrieving T_b and **W_b**



$$W_b = (-0.04WS + 1.08)[H_{cb}(1 + 0.25V)(T_s - T_a)]^{1/2}$$

NPP Satellite retrieved cloud base updraft, W_b

$$W_b = \sum \frac{N_i W_i^2}{N_i W_i} |W_i| > 0$$

N_i stands for the frequency of occurrence of W_i .

DeltaT: Temperature difference between cloud base and cloud top.

T_s : surface skin temp.

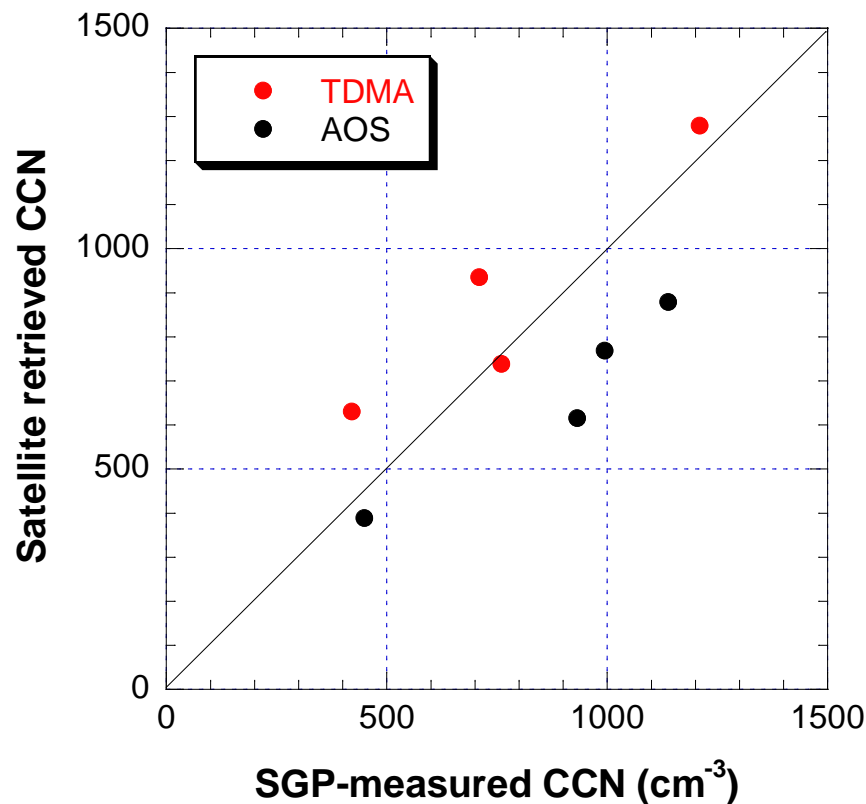
T_a : 2-m air temperature

V : surface wind speed

WS : vertical wind shear

H_{cb} : cloud base height

Validation of Satellite-only CCN(S)



These are all the cases for which full validation data are available so far during times of convective clouds and NPP/VIIRS overpass at a viewing angle of nearly solar back scatter.

Conclusions and next steps

- We have proved the concept of retrieving **CCN(S)** by using clouds as CCN chambers.
- Other important results are the satellite retrievals of:
 - Convective cloud base drop concentrations, **N_a** .
 - Cloud base temperature, **T_b** , which allows the calculation of boundary layer vapor mixing ratio.
 - Cloud base updraft, **W_b** , based on satellite retrieved surface skin and air temperatures.
- Next, this has to be expanded to other areas.
- Eventually to be applied to the ultimate goal of disentangling the updraft from aerosol effects on cloud radiative effects.

