Remote sensing cloud sides of deep convective clouds

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Convection microphysics



T [°C] -10 30 -20 40 20 10 from Rosenfeld and Woodley (2003) 10 15 20 25 30 Mixed Phase r_{eff} [μ m] Diffusional growth oalescence 35

Current measurements

precipitation and aerosol effects formation of droplets, and their vertical profile are needed to understand the onset of Insights into the microphysics of clouds, the

- concentrates on cloud top satellite passive remote sensing

carries large uncertainties.

Proposed measurements

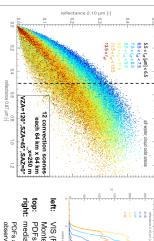
"classical" cloud top remote sensing, it is

behind the sensor). in the solar principle plain (with the sun

- in-situ is limited in temporal and spatial extent and mainly shallow types of clouds
- active remote sensing, either
- with microwave (ARM's proposed AVA single radar reflectivity profiles
 or dual-wavelength systems combined

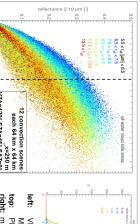
depends on strong assumptions and

CLAIM -3D is the recently proposed "cloud aerosol interaction mission in 3-D". Unlike



First results of our feasibility study

- and TIR provide additional information on the microphysics of deep convection. Ground-based measurements of radiances reflected from cloud sides in the VIS, NIR
- A combination of VIS and NIR gives a signature of droplet and ice crystal $r_{\mbox{\scriptsize eff}}$ and $_(\mathsf{r}_{\mathsf{eff}})$. Additional NIR and thermal IR channels provide particle phase and height.
- 3D radiative transfer simulates observations based on realistic 3D distributions of cloud microphysics of deep convection from the Goddard CRM

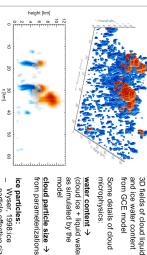


VIS $(R_{0.87})$ vs. NIR $(R_{2.1})$ cloud side reflectances calculated by Monte Carlo. PDFs of r_{eff} for several R_{2.1} bins at R_{0.87}=0.5;

right: median values of $r_{\rm eff}$ in 6 $R_{2.1}$ bins (± _ for $R_{0.87}$ =0.5)

PDFs are the basis for the cloud side microphysics retrieval: e.g., observations $R_{0.87}$ =0.5±0.03 and $R_{2.1}$ =0.25±0.015 \rightarrow $r_{\rm eff}$ = 8 ±1.5 _m.

Goddard Cumulus Ensemble Model Cloud data



from GCE model as simulated by the (cloud ice + liquid water) water content → microphysics: Some details of cloud and ice water content

liquid cloud water,

water content and reff for ice and

main absorbers,

standard atmosphere including all

from parameterizations cloud particle size →

particles

on Key et al. (2002) for ice

droplets, parameterization based Mie calculations for water phase functions:

temperature and IWC as function of Wyser, 1998:ice particle effective size

growth in adiabatic assumption of droplet

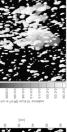
water (ratio≈0.8) and ice clouds

Mixing of the air adiabatic bulk WC is subair parcels even if the (ratio<0.5)

height [km]

lquid

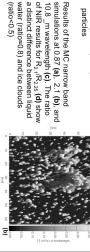
s content [g/m²]

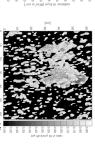


 $r_{eff}(z) = 0.9 r_{eff,adiab}(\Delta z)$

 $\Delta r_{
m eff.\,gaussian\,noise}$

by a constant factor parcel is considered





Measurements from aircraft

an *airborne platform* show comparable observed data from These images (Martins et al., 2007)

viewing zenith angle (60° elevation Monte Carlo RT simulation for a 120°

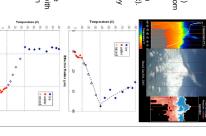
Simulation of remote sensing **MYSTIC Monte Carlo RT**

the thermal IR information (top-left) Height information is retrieved from

the ratio R_{2.1}/R_{2.25} (top-right). The cloud phase is characterized by

profiles of cloud size (center) and $R_{2,1}/R_{2,25}$ (bottom). A preliminary retrieval illustrates

These first real world results for the CLAIM-3D idea show nice match with poster's top-left corner) and freezing processes (see the the theories of cloud particle growth



, 2007.

, 2007.

model, in I3RC: Abstracts of the 1st and 2nd int

Ratio R₂₁/R₂

2002. radius in ice clouds, JC, 11, 1793–1802, 1998.

tion and surface processes in the Goddard Cumulus