Understanding and Accounting for the Difference Between Passive and Active Cloud-top Height Retrievals

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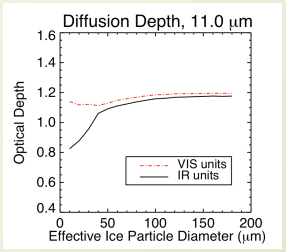
Introduction

Accurate cloud top heights are necessary to compute TOA fluxes in climate models, but passive IR-based satellite retrievals and ground measurements tend to underestimate the top altitude of ice-phase clouds (e.g., anvils).

- IR retrievals underestimate cloud top heights by 1-2 km corresponding to an optical depth of ~1
- Ground radars are attenuated by precipitation and have difficulty detecting small ice particles at cloud top
- Ground-based lidars cannot penetrate deep convective clouds

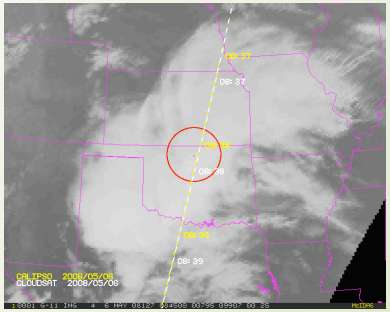


Summary

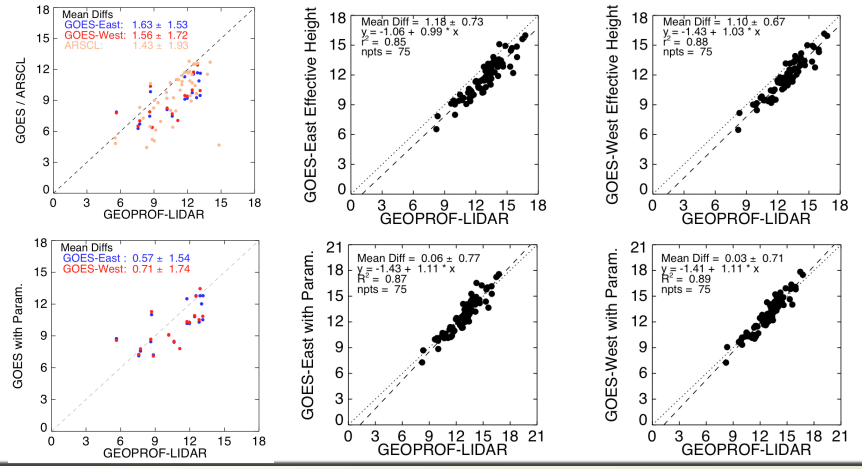
- Active spaceborne sensors detect cloud tops 1-2 km above those obtained from passive and ground-based instruments
- Viewing zenith angle dependence is seen in difference between coincident GOES-East and GOES-West cloud heights
- Ice particle size is expected to have little effect on retrieved heights but further investigation is needed to confirm this hypothesis
- Cloud-top IWC estimation is possible under certain conditions using dual-satellite views

Approach

- Match coincident GOES, ARSCL and CloudSat/CALIPSO anvil and deep convective cloud-top heights within a 120-km radius of the ARM SGP site
- Apply cloud-top parameterization of *Minnis et al.* (2008) and viewing angle correction to GOES cloud heights
- Use dual-GOES observations to estimate cloud-top ice water content (IWC) and compare with CloudSat Radar-Only (CWC-RO) product

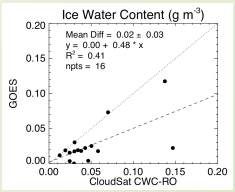


SGP Cloud Heights | **CONUS Cloud Heights**



Results

- Parameterization based on effective radiating height and sensor zenith angle yields cloud-top heights consistent with those observed by CALIPSO
- Dual-angle satellite views over the CONUS were used to estimate cloud-top IWC. Initial validation with CloudSat looks promising given the uncertainty associated with IWC retrievals.



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CloudSat GEOPROF-LIDAR products are available online from Colorado State University at http://www.cloudsat.cira.colostate.edu.

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