A Comparison of CRYSTAL-FACE Satellite-Derived Cloud Properties with Surface Measurements

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OBJECTIVES

Compare NASA LaRC satellite-derived cloud products with available surface data

• Cloud Fraction comparison with TSI at the western ground site

• Cloud property comparisons with RADAR retrievals (cloud boundaries, optical depth, ice water path and particle size) at the eastern and western sites
SATELLITE CLOUD PROPERTY COMPARISON WITH RADAR DERIVED PROPERTIES

NASA LaRC Cloud Properties

• 15 minute resolution GOES products (run in R/T during CF)
  - 4 km pixel-level products

RADAR Reflectivity techniques

• NOAA ETL MMCR (Eastern Site)    Shupe (later today)
• PARSL 94 GHz radar (Western Site) Comstock (poster)
  + UW AERI
# Matching Satellite with Surface Data

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Radar</th>
<th>TSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low frequency</td>
<td>• High frequency (1-min)</td>
<td>• High frequency (1-min)</td>
</tr>
<tr>
<td>• 4 km FOV</td>
<td>• Narrow FOV</td>
<td>• Hemispheric FOV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Depends on cld hgt</td>
</tr>
</tbody>
</table>

Simple procedure adopted here:
- Satellite pixel products averaged in 10 km radius centered over ground sites
  - minimizes NAV errors (4-8 km), Parallax error (up to 8 km)
- Radar retrievals time averaged over 15 minutes centered at Satellite time

Future analyses: line average satellite along wind
  - match cloud height with wind profile data
Satellite/Surface Comparison    July 23, 2002

**NOAA-ETL RADAR**

- Reflectivity
- Height (km)

**Optical Depth**

- Time (UTC)
- Optical Depth
- GOES (Total Cloud)
- NOAA-ETL

**Cloud Height**

- Cloud Height (km)
- Time (UTC)
- GOES (Total Cloud)
- NOAA-ETL
- GOES (Ice Cloud)

**Ice Water Path**

- IWP (g/m²)
- Time (UTC)
- GOES
- NOAA-ETL
Satellite/Surface Comparison    July 24, 2002

NOAA-ETL RADAR

Optical Depth

Cloud Height

Ice Water Path

NIGHTTIME
Seek improved knowledge relating Satellite effective parameters to vertical distribution of cloud mass
More on Cloud-Top Discrepancy

GOES 11um $\tau_{\text{vis}}, \varepsilon$ Effective (radiating center) Cloud Temperature

Empirical formula

Cloud Top Temperature

Cloud Height

Cumulative Optical Depth from Radar
July 25, 2002 Western Site
July 24, 2002 Western Site
(see Comstock poster)
STATISTICAL COMPARISON
(4 cases : Jul 19, 23, 24, 30)

All Points:

<table>
<thead>
<tr>
<th></th>
<th>GOES</th>
<th>NOAA-ETL RADAR</th>
<th>Mean Difference</th>
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</thead>
<tbody>
<tr>
<td>Tau</td>
<td>7.1</td>
<td>5</td>
<td>2.1 +/- 7.0</td>
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<tr>
<td>IWP(g/m²)</td>
<td>158</td>
<td>184</td>
<td>-25.7 +/- 196</td>
</tr>
<tr>
<td>Z-top (km)</td>
<td>9.3</td>
<td>11.5</td>
<td>-2.2 +/- 2.5</td>
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</tbody>
</table>

All Points: ΔTau <5

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</thead>
<tbody>
<tr>
<td>Tau</td>
<td>4.8</td>
<td>3.6</td>
<td>1.2 +/- 2.1</td>
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<tr>
<td>IWP(g/m²)</td>
<td>99</td>
<td>132</td>
<td>-32.9 +/- 85</td>
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<tr>
<td>Z-top (km)</td>
<td>9.1</td>
<td>11.4</td>
<td>-2.3 +/- 2.6</td>
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SUMMARY/FUTURE WORK

- Initial comparisons between satellite and radar cloud properties are very encouraging.
- Need more comparisons with all parameters, particularly particle size and with other radar techniques.
- More comparisons with in-situ data (see Duda poster).
- Need to rectify size definition differences.
- Need best estimate of cloud boundaries (radar, lidar, ceilometer (i.e. Clothiaux technique).
- Develop new empirical formula to improve satellite top heights.
- More work comparing satellite effective parameters with radar vertical profiles to understand how passive satellite-derived parameters can be related to vertical cloud structure.