Cloud Cover Validation using Surface Instruments

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Cloud Mask Evaluation

- Visual using IVICS - subjective
  - Quick feedback for training process
  - Analyst interpretation may be biased
- NNW accuracy
  - Independent samples
  - Hard numbers
  - Analyst may be unable to discern cirrus and sub-resolution cumulus
Cloud Mask Evaluation cont.

- “Validation” using surface instruments
  - Data independent of satellite
  - Minimal analyst interpretation
  - Multiple instruments and sites
  - Applicable to any cloud masking algorithm
  - Expandable database
  - Batch mode processing
  - Integrated with IVICS - user friendly
# Neural Network Classification Accuracy

<table>
<thead>
<tr>
<th>Region</th>
<th>Overall</th>
<th>Cloud Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polar</td>
<td>96</td>
<td>97</td>
</tr>
<tr>
<td>Sunglint</td>
<td>92</td>
<td>99</td>
</tr>
<tr>
<td>Global</td>
<td>94</td>
<td>96</td>
</tr>
</tbody>
</table>
Surface Validation Sites

- Atmospheric Radiation Measurement Program (ARM)

- Explorer of the Seas cruise ship - S.E. Atlantic, Caribbean Sea
ARM Cloud Instruments

- **Southern Great Plains (SGP)**
  - Aug 2000 – Jun 2002  VCEIL, MPL, WSI

- **North Slope of Alaska (NSA)**
  - Aug 2000 – Jun 2002  VCEIL, MPL, WSI
  - Jan – Dec 2000  MMCR (Uttal processed)
Cruise Ship Instruments

- Vaisala Ceilometer, Total Sky Imager (Jan – June 2001)
Surface Instrument Data

- Cloud Cover
  - Vaisala Ceilometer (VCEIL)
  - Micropulse Lidar (MPL)
  - Millimeter Wavelength Cloud Radar (MMCR)
  - Active Remote Sensing of Clouds (ARSCL)
  - Whole / Total sky imager (WSI / TSI)
- Estimated optical depth (EOD) - Normal Incidence Pyrheliometer (NIP)
- Cloud height - VCEIL, MPL, ARSCL
Validation of Cloud Mask

- MODIS data over surface sites
  - Extract pixels for 5, 10, 15 km site radii
  - Classify pixels and create cloud mask
  - Compute cloud cover (spatial)

- Surface cloud cover instrument data
  - Match overpass time +/- 5, 10, 15, and 20 min
  - Compute cloud cover over time interval (WSI and TSI computed spatially at overpass time)

- Intercompare and analyze using height and EOD data (NIP)
UAH

CERES
SGP ARM $\Delta t= 5$ $r= 5$

CERES Mask Cloud Cover % vs. Satellite Mask Cloud Cover %

- Clear
- 1 - 1000
- 1000 - 2000
- 2000 - 3000
- 3000 - 4000
- 4000 - 6000
- > 6000

86%
Summary

- Neural network cloud accuracy > 96%
- NSA cloud cover intercomparison
  - VCEIL, MPL, MMCR agree with mask 72 – 79%
  - ARSCL composite better, agrees 80 – 82%
  - WSI best agreement 83%
- SGP cloud cover intercomparison
  - Lower agreement with satellite, 38 – 76%
  - MPL worst 38% - too much cirrus
  - WSI best 76%
- Cruise ship - preliminary
  - VCEIL 53%, TSI 68%
Conclusion

- Some surface Instruments find more cloud
  - MPL and MMCR more sensitive to thin (cirrus)
  - Satellite mask may be missing some cirrus and sub-resolution cumulus
  - Nonhydrometeors detected as cloud?
- Composite ARSCL data improves agreement if component data is good
- WSI and TSI provide best agreement
- Validation requires multiple instruments / data
- CERES agrees well with ground data at SGP
- CERES and our mask agree to 86 % at SGP
Future Work

- Revise classifier to fix problem areas
- Validation paper submitted to JGR
- Refine interpretation of instrument data
- Distribute database and code
- Free IVICS visualization software
  - [http://www.nsstc.uah.edu/ivics](http://www.nsstc.uah.edu/ivics)