Characterization of Infrared Imager/Sounder and Infrared/Microwave Sounder Synergistic Cloud-Cleared Infrared Radiances

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ABSTRACT
• To evaluate the characteristics of these cloud-cleared radiances and their potential for improvements of numerical weather prediction and cloudy sounding applications.
• Preliminary results have shown that these two approaches, though quite different in character, and processing methodology, are both effective and have certain unique characteristics and deficiencies.
Case Granule Dataset Used

- 4 Granules of Collocated AIRS & MODIS Data
- MODIS 1-km Cloud Mask
- AIRS C.M. (from MODIS)
- No ancillary data used

Australia Granule
2 Sep. 2002
AIRS Focus Day

Wisconsin Granule
17 Sep. 2003

South Africa Granule

Hurricane Isabel Granule
AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

58_20020906 MODIS Band22 JPL C.C. V3.5-V4.0

MODIS Band 22
3.95 microns
Without Q.C.

X-axis:
V3.5 C.C. Bt.- Blue circle
V4.0 C.C. Bt. – Red cross
Y-axis: Clear MODIS Bt.
AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

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Q.C. filtered most of the unreliable data as well as some good data.

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MODIS Band 28
7.3 microns

Without Q.C.

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V3.5 C.C. Bt.- Blue Circle
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AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

MODIS Band 33
13.33 microns
Without Q.C.

X-axis:
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V4.0 C.C. Bt. – Red Cross
Y-axis: Clear MODIS Bt.
AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

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13.33 microns
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V4.0 C.C. Bt. – Red Cross
Y-axis: Clear MODIS Bt.
## MODIS/AIRS Synergistic N* Cloud Clearing

<table>
<thead>
<tr>
<th></th>
<th>MODIS Bands Used in C.C.</th>
<th>MODIS Bands Used in Q.C.</th>
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</thead>
<tbody>
<tr>
<td><strong>Multi-band N</strong>*</td>
<td>22 24 25 28 30 31 32 33 34</td>
<td>22 24 25 28 30 31 32 33 34</td>
</tr>
<tr>
<td><strong>Single-band N</strong></td>
<td>31 or 22</td>
<td>22 24 25 28 30 31 32 33 34</td>
</tr>
</tbody>
</table>

**Threshold for AIRS Pair C.C. Retrieval:**

Each AIRS footprint within the C.C. pair (2 by 1) must have at least 15 MODIS confident clear (P=99%) pixel (partly cloudy)
MODIS/AIRS Synergistic Single-Channel N* Cloud-Clearing General Principal

\[ R_c(\nu) = \frac{R_1(\nu) - N^* R_2(\nu)}{1 - N^*} \]

Where;
\[ N^* = \frac{N_1}{N_2}. \]

\[ N^* = \frac{srf[R_1(w)] - R_c(w)}{srf[R_2(w)] - R_c(w)} \]

\[ srf[R_i(w)] = \int \theta(w, \nu)R_i(\nu)\,d\nu \]

Filter: Or Q.C.

\[ \Sigma \{srf[R_c(\delta\nu_j)] - R_c(\delta\nu_j)\}^2 \leq \varepsilon \]

After Smith
MODIS/AIRS Synergistic Multi-Channel N* Cloud Clearing

General Principal

\[ J(N^*) = \sum_i \frac{1}{\sigma_i} [(R_{M_i}^{clr} - f_i(R_{v}^{cc}))^2] \]

\[ J(N^*) = \sum_i \frac{1}{\sigma_i} [(R_{M_i}^{clr} - f_i(\frac{R_1^1 - R_2^2 N^*}{1 - N^*}))^2] \]

\[ \frac{\partial J(N^*)}{N^*} = 0 \]

\[ N^* = \frac{\sum_i \frac{1}{\sigma_i^2} [f_i(R_1^1) - R_{M_i}^{clr}] [f_i(R_1^1) - f_i(R_2^2)]}{\sum_i \frac{1}{\sigma_i^2} [f_i(R_2^2) - R_{M_i}^{clr}] [f_i(R_1^1) - f_i(R_2^2)]} \]

Li et al, 2005, IEEE-GRS
MODIS/AIRS Synergistic N* Cloud Clearing
Over Sampling Strategy

8 possible AIRS pairs (2 FOVs)

Pseudo Single AIRS FOV
MODIS/AIRS Synergistic N* Cloud Clearing

Over Sampling Strategy

8 possible AIRS pairs (2 FOVs)

Pseudo Single AIRS FOV
MODIS/AIRS Synergistic N* Cloud Clearing
Over Sampling Strategy

8 possible AIRS pairs (2 FOVs)

Pseudo Single AIRS FOV
Multi-Channel N* Desert vs. Land C.C. Error Comparison

MODIS/AIRS Synergistic Cloud-Clearing (M-ch.; Q.C. = 0.5K)
AIRS G#126–Desert & G#193–Land/Lake; 09/02/2002

G-126: Desert (C.C.S.R. = 45.28%; Yields = 16.47% + 31.83% = 48.30%)
G-193: Land/Lake (C.C.S.R. = 65.54%; Yields = 28.03% + 35.16% = 63.19%)
Wisconsin Granule

AIRS/AMSU C.C. (3 by 3 AIRS FOV) V4.0 - Blue
AIRS/MODIS C.C. (1 by 2 AIRS FOV) Multi-Ch. - Black
Single-Ch.: Band 31 – Green; Band 22 - Red
AIRS/MODIS Synergistic C.C. can Supplement AIRS/AMSU C.C. Especially over Desert Region

AIRS/AMSU C.C.
(3 by 3 AIRS FOV)
V4.0 - Blue

AIRS/MODIS C.C.
(1 by 2 AIRS FOV)
Multi-Ch. - Black
Single-Ch.: Band 31 – Green
Band 22 - Red

Australia Granule
AIRS/MODIS Synergistic C.C. can Supplement AIRS/AMSU C.C. Especially over Desert Region

AIRS/AMSU C.C. (3 by 3 AIRS FOV) V4.0 - Blue

AIRS/MODIS C.C. (1 by 2 AIRS FOV) Multi-Ch. - Black Single-Ch.: Band 31 – Green Band 22 - Red

South Africa Granule
Synergistic AIRS/MODIS C.C. Summary

- Synergistic AIRS/MODIS C.C. could provide cloud-cleared radiances over non-oceanic scenes with good yield and performance at high spatial resolution (pseudo single AIRS FOV)

- Synergistic AIRS/MODIS C.C. could also provide additional pseudo-clear AIRS single FOV radiances (without conducting actual C.C.) (not presented here)

- MODIS can provide additional Q.C. to refine/enhance AIRS/AMSU C.C. performance
Here we are.!!!!
Aqua MODIS 2005/05/24
500 meter true color