Comparing Different Uses of MODIS Data in AIRS Retrievals

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Three Approaches to Clouds

• Version 6: Cloud clearing with Neural Network first guess and multiple cloud formations
• MODCC: Cloud clearing with clear estimation based on MODIS clear pixels in AIRS FOV
• Irion: Single Footprint retrieval with clouds in the forward model
η Determination for Operational Cloud Clearing

\[
R_{CCR}^s(n) = \overline{R(n)} + \sum_{j=1}^{N} \left( \overline{R(n)} - R_{N_j+1-j}(n) \right) \eta_j^s
\]

Find η’s that minimize noise in the cloud cleared radiances

\[
R_{n,est}^s - \overline{R_n} = S_{n,j}^s \eta_j^s
\]

A first guess geophysical state is determined from a neural network which is forward modelled to determine \(R_{est}\)

“AIRS Golfball”

AIRS FOV
AMSU FOR

AIRS Fields of view
Maturity Level

Channels
Determining Estimated Clear Radiance ($R_{est}$)

- Use of radiative transfer requires error estimations for each geophysical term
- This may cause an overestimation of the error covariance term (Weights from previous slide)
- Use of AMSU increases accuracy of neural network
- Cloud clearing iterates, and $R_{est}$ is determined from previous geophysical state
MODIS CLOUD Clearing

1. Identify and aggregate clear MODIS pixels inside AIRS FOV
2. Spectrally convolve AIRS to MODIS bands 31 and 32
3. Determine $\eta$
4. Cloud clear AIRS
5. Quality control based on chi-square between AIRS CCR and MODIS Clear and noise amplification

$$R_{est} = R^1 + \eta(R^1 - R^2)$$

Weights

$$W_{n,n'} = \left( \frac{NAF*I_{n,n'}}{N_a} \right)^{-1}$$
Irion Single Footprint Retrievals

- MODIS provides cloud optical depth, cloud top pressure, and temperature
- Optimal estimation retrieval for temperature, H$_2$O, and O$_3$
- Scattering version of SARTA to compute Jacobians

Maturity Level
Study Site 20130203
Granule Quality Flags

- V6 PGOOD is at the surface except for cold clouds with high cloud fractions
- MODCC has less successful retrievals

- MODCC quality flag is a primitive version based on the v4 Mid tropospheric qc flag
- Retrieval fails when cloud field is overcast
Case 1 Lowest

Statistics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<tbody>
<tr>
<td>AIRS2MOD31 STD</td>
<td>0.2866 K</td>
</tr>
<tr>
<td>PGOOD</td>
<td>1022 hPa</td>
</tr>
<tr>
<td>MODCC</td>
<td>0 (maybe fail?)</td>
</tr>
<tr>
<td>V6 Tsurf</td>
<td>296.2 K</td>
</tr>
<tr>
<td>MODCC Tsurf</td>
<td>296.6 K</td>
</tr>
<tr>
<td>ECMWF Tsurf</td>
<td>296.3 K</td>
</tr>
</tbody>
</table>
Case 2

Statistics

AIRS2MOD31 STD = 0.8869 K
PGOOD = 56 hPa
MODCC = 1 (fake success)
V6 Tsurf = 278.4 K
MODCC Tsurf = 306.1 K
ECMWF Tsurf = 301.9 K
Case 3

Statistics

- AIRS2MOD31 STD = 2.165 K
- PGOOD = 1016 hPa
- MODCC = 1 (success)
- V6 Tsurf = 304.0 K
- MODCC Tsurf = 300.7 K
- ECMWF Tsurf = 299.8 K
Case 4

Statistics

AIRS2MOD31 STD = 2.712 K
PGOOD = 1014 hPa
MODCC = 1 (success)
V6 Tsurf = 302.5 K
MODCC Tsurf = 300.9 K
ECMWF Tsurf = 301.0 K
Case 5

Statistics

AIRS2MOD31 STD = 6.786 K
PGOOD = 1013 hPa
MODCC = 1 (success)
V6 Tsurf = 299.0 K
MODCC Tsurf = 294.5 K
ECMWF Tsurf = 301.3 K
Case 6

Statistics

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<tr>
<td>MODCC</td>
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<td>V6 Tsurf</td>
<td>295.1 K</td>
</tr>
<tr>
<td>MODCC Tsurf</td>
<td>302.3 K</td>
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<tr>
<td>ECMWF Tsurf</td>
<td>301.6 K</td>
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Case 7

Statistics

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<th>Variable</th>
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<tr>
<td>PGOOD</td>
<td>1013 hPa</td>
</tr>
<tr>
<td>MODCC</td>
<td>1 (fake success)</td>
</tr>
<tr>
<td>V6 Tsurf</td>
<td>294.8 K</td>
</tr>
<tr>
<td>MODCC Tsurf</td>
<td>301.3 K</td>
</tr>
<tr>
<td>ECMWF Tsurf</td>
<td>301.2 K</td>
</tr>
</tbody>
</table>
**Case 8**

**Statistics**

- AIRS2MOD31 STD = 22.78 K
- PGOOD = 852.8 hPa
- MODCC = 1 (fake success)
- V6 Tsurf = 283.8 K
- MODCC Tsurf = 300.2 K
- ECMWF Tsurf = 301.2 K
Observations From Study

- MODCC Showed improved skin measurements relative to ECMWF for low heterogeneity fields
- QC flag for MODCC Could be improved
- V6 shows improved temperature retrievals and coverage relative to MODCC for overcast conditions
- Irion’s single FOV retrieval shows ability in overcast low heterogeneity fields where both V6 and MODCC have little success