Characterization and Validation of Cloud-Cleared Radiances

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Methodologies

• Develop independent test for cloud contamination
  – *Results of tests empirically derived from clear scene radiances*
• Assess quality based on impact on retrieved products
• Characterize and compare statistical variability
  – *Mean*
  – *Standard deviation*
  – *Covariance (EOF’s)*
Clear Sky Test of CC Radiances

• CC radiances should pass a clear scene test
• Clear scene discriminants were derived empirically
  Discriminants increase with increasing cloud contamination
  – *Perturbation to outgoing thermal IR*
• More than 8 discriminants have been derived
• Validated
  – *Intercomparisons with correlative SST and*
  – *Review of observed – calculated spectra*
• Accurate to 0.1-0.3K
Clear Sky Discriminants

- Approaches (empirical)
  - Comparison of SST in difference spectral windows
  - Extrapolation of lapse rate to surface (4.5 mm)
  - Split-window approach (9 -12 mm)
  - Window channel with reflected-solar correction (SW)
  - Neighboring footprint coherency (LW & SW)
  - Tropical lapse rate (SW)
  - Cirrus signal detection (LW)
Acceptance Rate

- All discriminants produce qualitatively the same result

- Does not address amount of cloud contamination
Quality Assessment Based on Geophysical Intercomparison

- Indirect validation
  - *no direct estimate of amount of contamination*
- Geophysical products are retrieved from CC radiances
- Radiance noise from cloud contamination is correlated
  - *No error cancellation*
  - *1-to-1 correspondence between radiance bias and retrieved temperature*
- Correlative data sources
  - SST from NCEP analysis
  - Mean tropospheric temperature (Sfc – 700 hPa)
SST-based Assessment

Conclusions
- Outlier rate uncorrelated with clear assessment
- SST error density function independent of discriminant
- Many AIRS retrieved SST differ from analysis by more than 1K
- Retrieved product quality not a strong validation source

AIRS is skin, analysis is bulk
Empirical Orthogonal Functions Data

- Train on 826,340 identified clear spectra (11 Focus Days)
- LW temperature sounding channels (470)
Clear and CC Statistics
Mean and Standard Deviation

Clear-Sky

Cloud-Cleared
Clear Sky Eigenvalues
Clear Sky Eigenvectors

Atmospheric Infrared Sounder
Cloud-Cleared Eigenvalues

Atmospheric Infrared Sounder

Cloud-Cleared Radiance

Amplitude (K)

Index

Clear Sky

Cloud Cleared
Latitude Sampling

Atmospheric Infrared Sounder

- Clear Sky
- Cloud-Cleared
Conclusions

- Application of cloud-contamination test
  - *Most of CC radiances past test*
- Assessment of quality based on impact on retrieved products
  - *Outlier rate not dependent on clear test*
    - Suggests outliers do not arise from errors in CC radiances
- Characterize and compare statistical variability
  - *Small differences in most significant eigenvectors*
    - Larger sample of states
  - *Larger eigenvalues at least significant*
    - Evidence of noise amplification
Conclusions
Supplemental Slides
# Clear Scene Prescription

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Location</th>
<th>Time of Day</th>
<th>Default Condition</th>
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<td>SST from SW channels using lapse rate extrapolation</td>
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<td>Tropical Ocean</td>
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<td>Day</td>
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<td>Std Deviation in LW predicted SST</td>
<td>Everywhere</td>
<td>Day/Night</td>
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</table>
Lower Tropospheric Temperature Assessment

Outliers determined from Lower Trop T diff (K)

- **Clear**
- **Cloudy**

Increasing Probability of Cloud Contamination

- $SST_{SW} - SST_{LW}$ (K) [-2392R1]

Outlier Rate (%)

Acceptance Rate (%)
Discriminant Examples

Outliers determined from SST

Outlier Rate (%) vs. Longwave Cirrus and Dust (K)

- Clear
- Cloudy

Increasing Probability of Cloud Contamination

Outlier Rate (%) vs. SST SW solar-corrected - SST LW (K)

- Clear
- Cloudy

Increasing Probability of Cloud Contamination