Retrieving Infrared Land Surface Emissivity
With AIRS Observations

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Outline

Sensitivity study for land surface emissivity
Sensitivity study for atmospheric and surface parameters
The retrieval method: MLEV
Case study
Future plan
Sensitivity Study for Land Surface Emissivity

Fast Model: SARTA (Stand-Alone Rapid Transmittance Algorithm) developed by L.L. Strow, S. Hannon, and H. Mottler

Profiles: six model profiles

Parameters: zero satellite angle

sea level surface for 6 model profiles

increment of LSE from 0.97 to 0.98

others
Delta TB from Delta EMIS = 0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for 1976 U.S. Standard Atmosphere

Spectral Distribution of Surface Emissivity Increment of 0.01 for Tropical Atmosphere
Delta TB from Delta EMIS = 0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for Midlatitude Summer

Mid-Latitude summer

Spectral Distribution of Surface Emissivity Increment of 0.01 for Midlatitude Winter

Mid-Latitude Winter
Delta TB from Delta EMIS=0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for Subarctic Summer

Subarctic Summer

Spectral Distribution of Surface Emissivity Increment of 0.01 for Subarctic Winter

Subarctic Winter
Sensitivity Study for Atmospheric and Surface Parameters

Fast Model: SARTA


Increment/Decrement: (700hPa—1000hPa for Low Trop)

- Increase of surface temperature by 1K;
- Increase of low troposphere temperature by 1K;
- Decrease of low troposphere humidity by 15%;
- Decrease of ozone by 10%.
Spectral Distribution of Surface Temperature Increment of 1K for 1976 U.S. Standard

Delta TB from Delta TS=1 K

Spectral Distribution of Low Troposphere Temperature Increment of 1K for 1976 U.S. Standard

Delta TB from Delta Tropospheric T=1 K
Delta TB from Delta lnO3 = 10%

Delta TB from Delta lnq = 15%
Retrieval LSE with LMEV Method

\[ \varepsilon_v = \frac{R_v^{obs\uparrow} - R_v^{atm\uparrow} - \tau_v \bar{R}_v}{\tau_v \left(B_v(T_s) - \bar{R}_v\right)} \]
Best fit to LST/LSE when Local Spectral Variance in Emissivity is Minimum

(Robert Knuteson etc)

\[ \varepsilon_v = \frac{R_v^{obst} - R_v^{atm\uparrow} - \tau_v \bar{R}_v}{\tau_v \left( B_v(T_S) - \bar{R}_v \right)} \]
TB from constant emissivity spectrum of 0.98

TB from a rock emissivity spectrum of observation
EMIS spectra derived with the correct/wrong Ts

TB from rock EMIS

<table>
<thead>
<tr>
<th>Ts+1.0</th>
<th>Ts</th>
<th>Ts-1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.34</td>
<td>1.03</td>
<td>1.38</td>
</tr>
</tbody>
</table>
A Case Study

Retrieval Algorithm: LMEV
AIRS Fast Model: SARTA
AIRS L1B Data: Granule 182 (6mins, 118MB)
Sept.6,2002 18:11-18:17 (GMT)
Atmospheric Profile: ECMWF profile of Sept.6,2002 at 18Z
AIRS Clear Flag from MODIS Cloud Mask

<table>
<thead>
<tr>
<th>Not Determined</th>
<th>Cloudy</th>
<th>Uncertain</th>
<th>Probably Clear</th>
<th>Confident Clear</th>
</tr>
</thead>
</table>

\[
\frac{\text{# cloudy}}{\text{# total}} = 1
\]

\[
\frac{\text{# confident clear}}{\text{# total}} = 1
\]
AIRS Clear Flag from MODIS
Cloud Mask for G182
Mean and Std. of the Obs-Calc AIRS Brightness Temperature for G182

(1391 Clear FOVs/12150)

Mean of the Obs-Calc AIRS Brightness Temperature for Granule 182

Std of the Obs-Calc AIRS Brightness Temperature for Granule 182
The Upwelling/Downwelling Radiance and Total Transmittance
The Retrieved LSE Spectral with MLEV

Minimum Std. Variance

A retrieved EMIS spectrum

Spectra of Land Surface Emissivity for a Clear FOV of Granule 182
The Comparison Between Obs. and Calc. BT with Unit/Retrieved LSE

The Observed AIRS Brightness Temperature Minus the Calculated BT With Unit Emissivity

Obs – Calc with EMIS=1

The Observed AIRS Brightness Temperature Minus the Calculated BT With Retrieved Emissivity

Obs – Calc with LMEV retrieved EMIS
Future Plan

Update of model: Fast Model and Retrieval Algorithm

Initial Guess of LSE:

1) in accordance with IGBP Atlas
2) in accordance with NDVI

Validation
NDVI Distribution Over China
18 Classes of IGBP Surface Type
Thanks!