SIMULATION OF AMSU TEMPERATURE PROFILING ERRORS DUE TO UNCERTAINTY IN MICROWAVE LAND SURFACE EMISSIVITY

Barbara A. Burns
GenCorp Aerojet
Azusa, USA

1. INTRODUCTION
One of the major advances of AMSU over previous microwave sounders is the higher spatial resolution. This will improve delineation of temperature and humidity fronts and features associated with storm events under both clear and cloudy conditions. However with this improvement also comes greater sensitivity to variations in surface emissivity, especially over land. With previous sensors (MSU, SSM/T1) these variations averaged out over the relatively large footprint such that a "mean" emissivity for all land surfaces and an empirical limb-correction could be applied. In the case of AMSU, the presence of water bodies, topography, and transitions between land-use types within the footprint will have greater impact on measured brightness temperature. The purpose of this paper is to quantify the expected error in temperature profile retrievals due to errors in estimating the microwave surface emissivity.

2. SIMULATED DATA
Radiosonde observations and realistic maps of land surface emissivity form the basis for simulating AMSU brightness temperatures. Temperature and humidity profiles from a single radiosonde typical of midlatitude clear-sky conditions were used as input to Aerojet's atmospheric transmittance model. Surface temperature was assumed known and constant over the sensor footprint. To derive the emissivity maps, a 50-GHz emissivity value was assigned to each of the 13 land-use classes in the MM5 terrain database (UCAR, 1998). Model estimates (Karam,1997; Bauer & Grody,1995) for standard surfaces (i.e. grass, forest, bare soil, water), with account taken of scan angle and polarization, were used for this purpose. A weighted average on the 10° grid of the database was then calculated using the land-use percentages for each grid cell (Fig. 1a). This result was then convolved with the AMSU antenna pattern to produce the final maps for near nadir (Fig. 1b) and near scan-edge (Fig. 1c). Top-of-atmosphere brightness temperatures for all AMSU frequencies were calculated at all grid positions in the emissivity...
maps. Gaussian noise appropriate to each AMSU channel (Mo, 1996) was added to simulate realistic satellite observations.

Figure 1. Emissivity maps at 10' resolution, as in (a), have been convolved with AMSU-A antenna patterns to produce effective emissivity maps at nadir (b) and scan-edge (c). Note the emissivity contrast due to the Mississippi River system.

3. RETRIEVAL RESULTS
The simulated AMSU brightness temperatures were then used in the variational inversion approach of Eyre (1989) to retrieve temperature profiles. Retrievals were first carried out using the correct emissivity for a given AMSU field-of-view (FOV), then repeated with four different methods currently in use to account for the surface contribution: (1) assume constant emissivity (0.95 for land, 0.57 for water at nadir); (2) apply a priori regression correction; (3) include emissivity in retrieval vector; and (4) derive emissivity from 50 GHz observed brightness temperature. Retrieved temperature profiles were compared to the known temperature profile from the radiosonde. Figure 2 shows the error in the retrieved temperature (retrieved minus known) versus the error in estimated emissivity for the constant emissivity method. Even at 700 mb, temperature errors of >15K result from emissivity errors of < 0.1 when water bodies partially fill the FOV. Errors using the other methods are much smaller. Table 1 gives the RMS errors over all the emissivity values. The results show that for a clear-sky case all methods except the "constant emissivity" perform as well as using the actual emissivity given the statistical errors of the retrieval system (errors in first-guess, forward model, observations).
Figure 2. Retrieved temperature error vs. emissivity error. Error bars represent temperature error inherent in retrieval process.

<table>
<thead>
<tr>
<th>Pressure Level (mb)</th>
<th>correct emissivity</th>
<th>constant emissivity</th>
<th>regression</th>
<th>retrieved</th>
<th>50-GHz derived</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>1.80</td>
<td>18.7</td>
<td>1.80</td>
<td>1.58</td>
<td>2.36</td>
</tr>
<tr>
<td>850</td>
<td>1.17</td>
<td>5.89</td>
<td>1.71</td>
<td>1.41</td>
<td>1.58</td>
</tr>
<tr>
<td>700</td>
<td>0.82</td>
<td>5.57</td>
<td>0.66</td>
<td>0.67</td>
<td>0.85</td>
</tr>
<tr>
<td>500</td>
<td>1.23</td>
<td>2.83</td>
<td>1.50</td>
<td>1.28</td>
<td>1.42</td>
</tr>
</tbody>
</table>

4. CONCLUSIONS

Using an operationally-available land-cover database, realistic maps of land surface emissivity as "seen" by the AMSU-A sensor have been produced. Even after antenna-pattern averaging, large variations in emissivity are observed especially when water bodies partially fill the AMSU-A FOV. Not accounting for these variations can lead to errors in retrieved temperature profiles of ~20K RMS at 1000 mb and ~5K RMS at 700 mb. For the clear-sky case considered, all methods currently in use to account for surface
emissivity variability perform as well as using the actual emissivity. In the future this analysis will be repeated for retrievals under cloudy-sky conditions, which have been shown to be more sensitive to accurate emissivity estimates (English, 1999).

5. REFERENCES


TECHNICAL PROCEEDINGS OF THE TENTH
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