Scanning High-resolution Interferometer Sounder (S-HIS) Radiometric Calibration and Performance

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Absolute Accuracy

The S-HIS/NIST TXR Radiance Intercomparison

End-to-end radiance evaluations of the S-HIS were conducted at UW-SSEC, under flight-like conditions using the NIST TXR in a thermal chamber. A UW developed AERI Blackbody was run at various temperatures and viewed by the NIST TXR and the S-HIS. Calculated radiances from the AERI BB were compared with measured radiances from the S-HIS and the TXR. These intercomparison measurements provide the basis for satellite validation analyses that are traceable to the NIST radiance scale. A mean agreement between TXR channel 2 and S-HIS of ~40 mK was demonstrated, well less than the propagated 3-σ uncertainties [Best 2007, Taylor 2007].

S-HIS/NIST TXR Radiance Intercomparison

Calibration Uncertainty Budget

For $T_R > 220K$, the design requirement for absolute radiometric accuracy is < 0.5K with reproducibility better than 0.2 K (both 3-σ, not to exceed). An RSS of the error contributions indicates expected uncertainties that are about half of these values over much of the spectrum. Ground tests with a third blackbody confirm this tighter expectation. These are conservative estimates of the uncertainty, with the absolute accuracy representing a not-to-exceed value.

S-HIS Radiometric Calibration

The blackbody reference sources for the S-HIS are high emissivity cavities (normal emissivity ≈ 0.999) carefully designed, fabricated, and characterized at the UW-SSEC. The UW-SSEC AERI, S-HIS, GFTS, and ARI blackbodies share a common design, with the design scaled to the required aperture for each application. The formal 3-σ (i.e., not to exceed) absolute uncertainties for S-HIS blackbody temperature and emissivity are 0.10 K and 0.001 [Best 1997, 2003], respectively.

Absolute Accuracy

Radiometric Calibration

UW-SSEC Spectrometer and Blackbody Heritage and Ties to NIST

The S-HIS is an advanced version of the High-resolution Interferometer Sounder (HIS) NASA ER-2 instrument and was developed between 1996 and 1998 at the UW-SSEC with the combined support of the US DOE, NASA, and the WP-3D Integrated Program Office. It was originally designed for UW use, which imposed significant constraints on the mass, power, and size requirements.

Instrument Overview

The S-HIS has participated in 24 field experiments on multiple airborne platforms, each with significantly different instrument operating environments. Independent of airborne platform, the S-HIS has provided hyper spectral infrared radiance measurements with high absolute accuracy and low noise.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Type</th>
<th>Scenario Coverage</th>
<th>Spectral Coverage</th>
<th>Spectral Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interferometer</td>
<td>Modified ABB Bomem DA-5</td>
<td>Programmable 45° scene mirror (10 mrad typical)</td>
<td>LW HgCdTe, 1500 - 2000 cm⁻¹</td>
<td>0.5 cm⁻¹</td>
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<tr>
<td>Scene Coverage</td>
<td>110 mrad (3 km @ 20 km, nadir)</td>
<td>MW(HgCdTe), 1000 - 1820 cm⁻¹</td>
<td>I2(HgCdTe), 1750 - 3000 cm⁻¹</td>
<td></td>
</tr>
<tr>
<td>Spectral Coverage</td>
<td>0.25 cm⁻¹</td>
<td>SW (InSb), 1750 - 3000 cm⁻¹</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The plots above show the difference between the predicted AERI BB radiance and the measured S-HIS radiance (at both 5 µ and 10 µ) and the AERI Blackbody minus the measured TXR radiance at 10 µ (the TXR 5-µ analysis is not yet complete). At 10 µ the differences between the NIST TXR and S-HIS are in excellent agreement - on the order of 40 mK.

Calibration Configuration: 46°C – 60°C

Example laboratory end-to-end calibration verification. Calibration verification is completed in the lab per and post mission. The plots show the difference between the predicted target blackbody radiance and the S-HIS measured radiance for 5 blackbody temperatures (273.15 K, 295 K, 317.97 K, 333.06 K).

Residual nonlinearity is the dominant contributor to the difference for the 273.15K target observation in the lab configuration.