The Trade-off Study for Geostationary Hyperspectral IR Sounder

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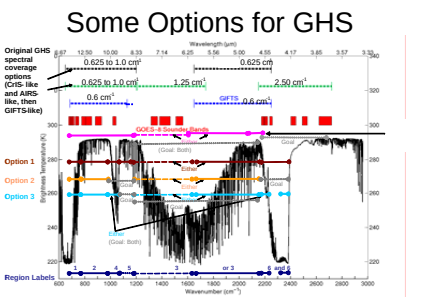
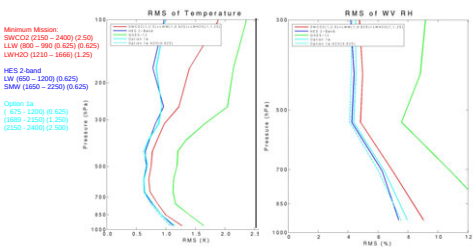
Geostationary hyperspectral IR Sounder (GHS) is being researched due to the de-manifestation of the HES on the GOES-R series. Following topics are covered on this trade-off study.

Spectral coverage and spectral resolution
Spatial and temporal resolutions
Signal to noise ratio
Detector Optical Ensqaured Energy
Comparison with current GOES Sounder

1. Spectral coverage

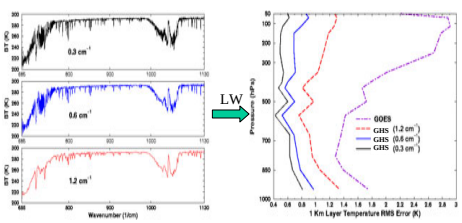


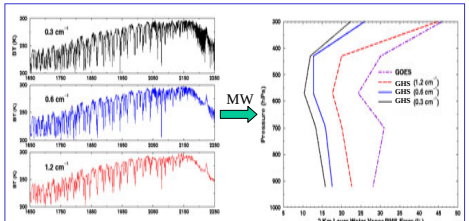


Hyperspectral IR retrieval simulation for temperature and moisture with different options.

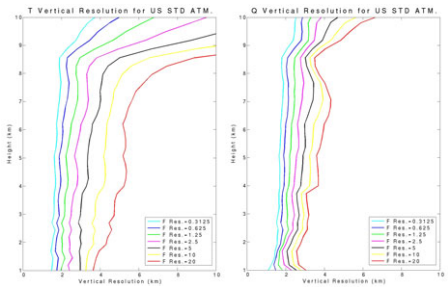
2. Spectral resolution

High spectral resolution of Geo IR sounder is very important to
(1) achieve the fine structure (good vertical resolution) of atmospheric temperature and moisture profile, and
(2) retrieve sounding profile with high accuracy.





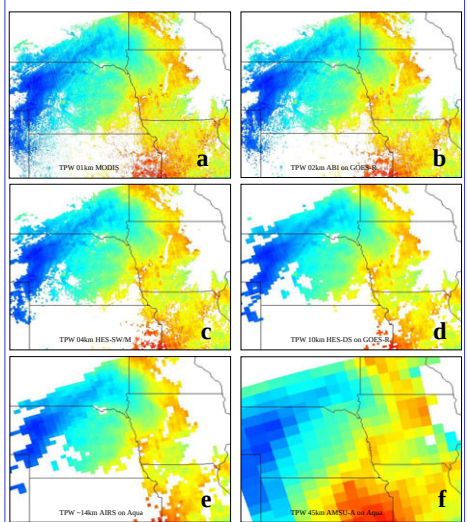
Simulated temperature (K) and moisture (% of g/kg) retrieval RMSE from HES 2-band radiances with spectral resolution of 0.3, 0.6 and 1.2 cm-1.



Temperature (left) and moisture (right) vertical resolution analysis with various spectral resolutions, GHS 2-band option is used in analysis.

3. Spatial resolution

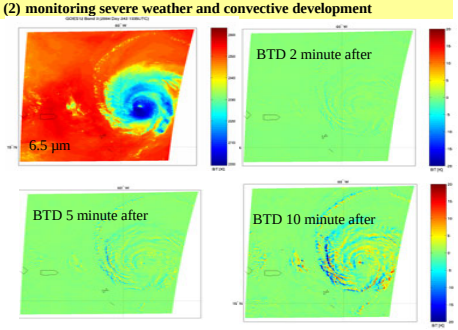
High spatial resolution IR sounder
(1) depicts the mesoscale moisture structure
(2) retains more clear soundings



The 1km MODIS TPW at 1900UTC on July 20, 2002 from EOS' AQUA satellite and a number of reduced spatial resolutions for IR imager/sounders.

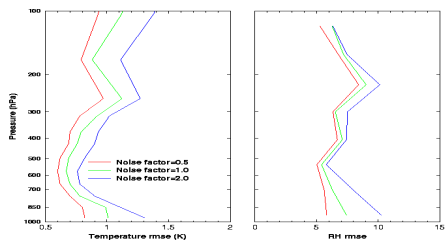
4. Temporal resolution

High temporal resolution IR enables
(1) monitoring the evolution of water vapor and clouds
(2) monitoring severe weather and convective development



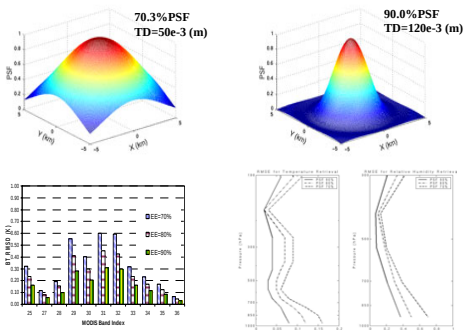
5. Signal-to-noise ratio

GHS signal-to-noise is very important to achieve the good accuracy of atmospheric temperature and moisture profiles. The signal-to-noise analysis has been performed on GHS 2-band option with a noise factor of 0.5, 1.0, and 2.0 cm-1, respectively (TRD noise was used).



Signal-to-noise impact on temperature (left panel) and moisture (right panel) from simulated GHS radiances. GHS example 1 (see Figure 1a) is used.

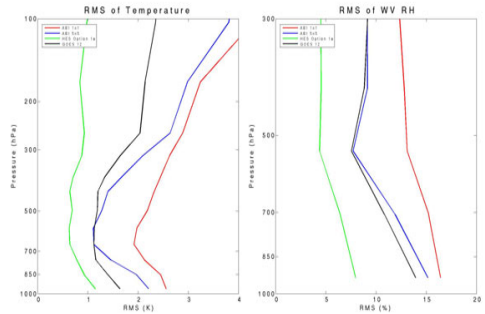
6. Blurring due to Point Spread Functions



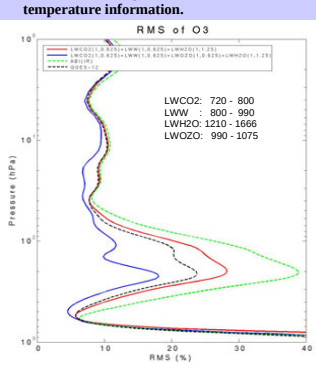
The BTD between 100%EE and 70%, 80%, 90%EE, respectively, for the MODIS IR spectral bands (lower left), and the temperature and relative humidity (RH) additional retrieval error due to 90%, 80% and 70%EE, respectively (lower right).

7. Comparison with current GOES Sounder

GHS can improve very much in both temperature and water vapor retrievals comparing with the current Sounder. The retrieval accuracy can achieve 1K for temperature and 10% for relative humidity. ABI alone has the similar ability in moisture retrieval to the GOES-12, but not in temperature.



Hyperspectral IR Sounder including spectral coverage on ozone band can improve both ozone profile and total column ozone retrievals. ABI alone will degrade the ozone retrievals due to its lack of temperature information.



Total Column Ozone

LWCO2+LWW+LWh2O:
R=0.96
bias=-0.18 DU
rmsd=3.724.4%

LWCO2+LWW+LWOZO+LWH2O
R=0.98
bias=0.02 DU
rmsd=2.79%

ABI alone
R=0.90
bias=-3.41 DU
rmsd=6.61%

GOES 12:
R=0.96
bias=-1.05 DU
rmsd=4.02%

Summary

A high spectral resolution with good signal-to-noise ratio is important for achieving high vertical resolution temperature and moisture soundings with high accuracy. Spatial and temporal resolution need to be balanced. Point Spread Function need to be considered.

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