Performance of the As-delivered NPOESS Preparatory Project (NPP) CrIS Sensor

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Introduction

The Cross-track Infrared Sounder (CrIS) will be flying on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and its Preparatory Project (NPP) satellites. It is designed to produce in conjunction with ATMS three Environmental Data Record (EDR) products, i.e., the Atmospheric Vertical Temperature Profiles (AVTP), Atmospheric Vertical Moisture Profiles (AVMP) and Atmospheric Pressure Profiles. The combination of ATMS (Advanced Technology Microwave Sounder) and CrIS is called CrIMSS (Cross-track Infrared Microwave Sounder Suite). CrIS has been extensively tested and had demonstrated excellent performance, meeting or exceeding most of its important performance parameters.

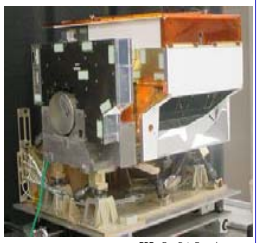
CrIS Sensor Overview

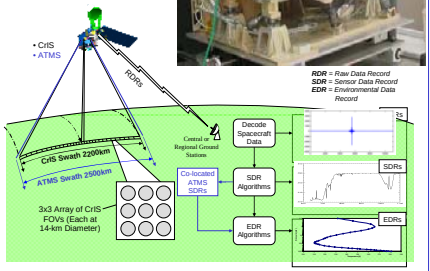
- The Cross-track Infrared Sounder (CrIS) is a Key Sensor for NPP and NPOESS
  - Fourier Transform Spectrometer providing high resolution IR spectra:

Band	Wavelength Range (cm-1)	Wavelength Range (μm)	Sampling (cm-1)	No. Chan.
SWIR	2155-2550	4.64-3.92	2.5	159
MWIR	1210-1750	8.26-5.71	1.25	433
LWIR	650-1095	15.38-9.14	0.625	713

  - Fields of Regard with 3 x 3 FOVs
  - Photovoltaic Detectors in all 3 bands
  - 4-Stage Passive Detector Cooler
  - 14 km nadir FOV spatial resolution
  - 2200 km swath width
  - On-board internal calibration target
- Supplier: ITT Industries
- Key subcontractors:
  - ABB Bomem: Interferometer, ICT, SDR Algorithm
  - DRS: Detectors
  - AER: EDR Algorithm

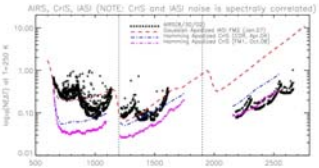
	CBE
Mass, kg	147
Average Power, W	110
Average Data Rate, Mbps	1.44
Envelope	80x47x66 cm





RDR = Raw Data Record
SDR = Sensor Data Record
EDR = Environmental Data Record

CrIS and Heritage Sensors

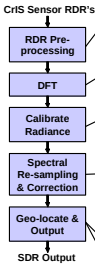


From a Chris Barnet briefing at the Atmospheric Sounding Science Team Meeting in October

	CrIS (on NPP)	AIRS (on EOS Aqua)	IASI (on MetOp)
Weight (kg)	147	177	236
Size (cmxcmxcm)	80x47x66	116.5x80x95.3 116.5x158.7x95.3 (deployed)	120x110x110
Power (Watts)	110	220	210
Data Rate (Mbits/sec)	1.44	1.28	1.5

CrIS as-built has lower noise levels is smaller, has less mass and consumes less power then AIRS or IASI

CrIS SDR Algorithm

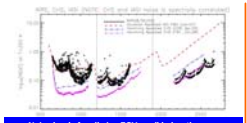


- Prepare Interferogram Data
  - CCSDS unpacking & remove data compression (bit trim)
  - Laser metrology calibration using neon reference
  - Quality control tests (rejects bad data)
- Convert Interferograms to Spectra and Correct Non-linearity
  - DFT
  - Detect/correct metrology fringe count error (rare)
  - Correct non-linearity
- Calibrate Radiance Scale
  - ICT & DS moving window average (2 point calibration reference)
  - Calculate ICT radiance & correct for environment
  - Remove background offset & phase dispersion
- Spectral Re-sampling & Correction
  - Apply post-calibration filter
  - Resample FTS channel centers to EDR channel centers
  - ILS correction
  - Apply apodization (if selected)
- Compute LOS Relative to S/C Body Frame (each FOV)
- Format Output

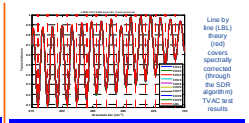
CrIS EDR Algorithm

- **The iterative physical CrIMSS EDR retrieval algorithm was developed by AER**
- Applies a modified maximum likelihood inversion model to search for a set of atmospheric and surface parameters that can feed into a forward model to "produce" the radiance data measured by CrIMSS
  - The forward model is based on AER's OSS (Optimal Spectral Sampling) radiative transfer model
  - The solution is further constrained to be physically feasible
- **Key features of the CrIMSS EDR algorithm include:**
  - Empirical Orthogonal Function (EOF) transformation of retrieved variables that provides inversion stability and speed
  - Iterative minimization that accounts for non-linearity

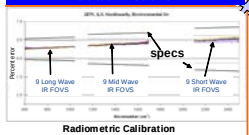
CrIS Has Been Fully Tested and Demonstrated Excellent Performance



Noise levels for all nine FOVs well below the spec and below AIRS and IASI

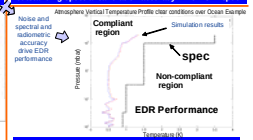


Theory and test measurements very close demonstrating outstanding spectral calibration accuracy which is in spec



Radiometric Calibration

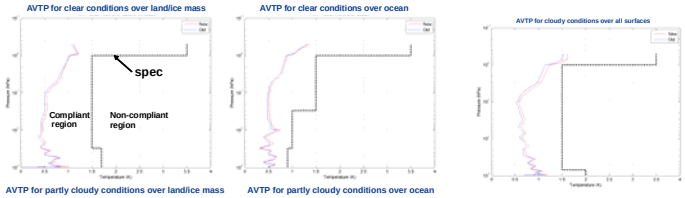
All nine fields of view (FOVs) have excellent radiometric calibration within spec limits

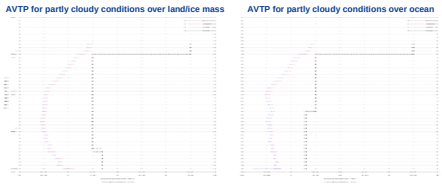


Atmosphere Vertical Temperature and Moisture Profile KPP EDRs met with margin

Outstanding performance in three key areas provide SDRs that lead to predicted EDR performance meeting requirements

AVTP Performance





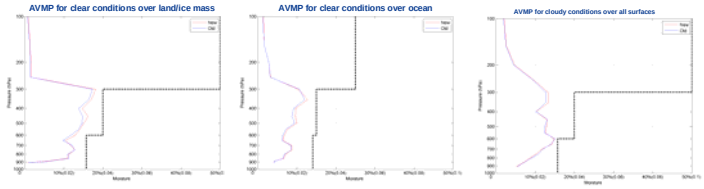
Red curves (marked new) utilize most recent measurements of NEdN on FM1

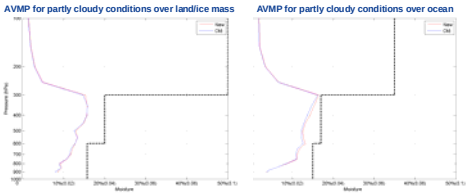
Specs are given by black curves

Performance determined from worst case altitude bin

Analysis used drop 2.2 CrIMSS EDR Algorithm and NGST global test data set 010701_2130

AVMP Performance





Uncertainty requirements have been stratified by cloud cover into clear, partly cloudy and cloudy

further stratification is by surface type (ocean vs. land or ice mass)

Conclusions

- The CrIS sensor has demonstrated excellent performance throughout its completed bench, vibe, EMI, and thermal vacuum testing
- Analyses using simulated test data yield retrieved moisture, temperature and pressure profile EDRs that all meet the NPOESS/NPP EDR quality requirement specifications
- The CrIS sensor will be delivered to NASA in January for integration into the NPP spacecraft