Testing and Tuning CrIMSS EDR Algorithm with Proxy Data in Preparation for NPP Post-launch EDR Product Validation

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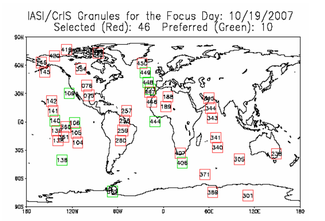
The Cross-track Infrared and Microwave Sounder Suite(CrIMSS) flying on NPP satellite consists of two sensors: Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS). It is designed to produce three Environmental Data Records (EDR) products, i.e., Atmospheric Vertical Temperature Profiles (AVTP), Atmospheric Vertical Moisture Profiles (AVMP) and atmospheric Pressure Profiles. In this paper, we present the results from our pre-launch testing and tuning of the CrIMSS EDR retrieval algorithm using the high quality proxy data generated from operational satellite data. A complete assessment of the retrieval algorithm and EDR product quality is being conducted using the collocated NWP model data, heritage EDR product, and radiosonde data. Essential tools are being developed for the characterization of radiance calibration errors, tuning of Radiative Transfer Models (RTM) bias errors, tuning of algorithm processing coefficients and Look-Up-Tables (LUT), and computation of EDR quality performance statistics. In the process several algorithm software errors have been uncovered and fixed, and some science enhancements are being developed and tested. After the preliminary tuning, the CrIMSS algorithm shows excellent performance and the retrieved EDRs are close to meet the requirement specifications. In addition, important lessons have been learned that will directly benefit the post-launch CrIMSS EDR product validation.

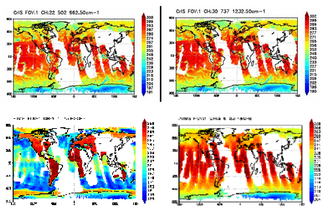
CrIMSS EDR Retrieval Algorithm

- The CrIMSS EDR algorithm was developed by Atmospheric Environmental Research (AER) and modified by Northrop Grumman Aerospace Systems to produce AVTP and AVMP EDRs from CrIMSS Sensor Data Records (SDR), using the Numerical Weather Prediction (NWP) surface pressure forecast data and other ancillary information. The Pressure Profile EDR is derived from the retrieved AVMP and AVTP EDRs
- The CrIMSS EDR algorithm was largely based on the heritage EOS AIRS retrieval algorithm with some significant improvements
  - Simultaneous retrieval of atmospheric temperature, moisture and ozone profiles and surface skin temperature and spectral emissivity
  - Fast and accurate Optimal Spectral Sampling (OSS) RTM
  - Using the Empirical Orthogonal Functions (EOFs) to characterize and measure the retrieved geophysical parameters
  - Using *a priori* constraints (background and covariance) derived from a blended training dataset composed of NCEP, ECMWF and NOAA88 radiosonde data
- The CrIMSS EDR algorithm consists of 7 modules
  - Initialization
  - Input and Pre-processing
  - Microwave-only (MW) Retrieval
  - Scene Classification
  - Microwave and Infrared Combined (MW+IR) Retrieval
  - Quality Control
  - Output and Post-processing
- The retrieved parameters include
  - Temperature profile (reconstructed from 20 temperature EOFs)
  - Moisture profile (reconstructed from 10 moisture EOFs)
  - Surface temperature
  - Surface MW emissivity (reconstructed from 5 MW emissivity EOFs)
  - Surface IR emissivity (at 12 frequency hinge points)
  - Surface IR reflectance (at 12 frequency hinge points)
  - MW cloud top pressure and cloud liquid water path
  - Ozone profile (reconstructed from 7 EOFs)

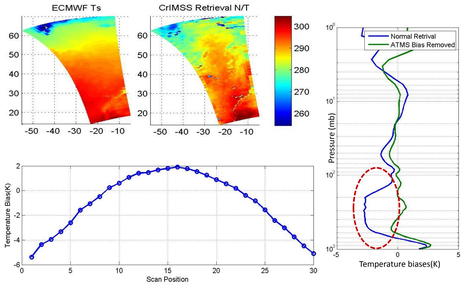
Test Data Generation and Initial Test Results

- Proxy data generation algorithms
  - CrIS proxy data from IASI: Xu Liu and Kizer (LaRC)
  - ATMS proxy data from AMSUA/MHS: Bill Blackwell (MIT)
  - Algorithms implemented at NOAA/STAR
- Focus Day (10/19/2007) matched data sets generated by NOAA/STAR
  - MetOp IASI/AMSU-A/MHS, ECMWF, AVN and some RAOBs
  - NOAA-IASI operational retrievals from NUCAPS
  - Matched ancillary data (surface pressure and land fraction) needed to run the CrIMSS EDR retrieval algorithm



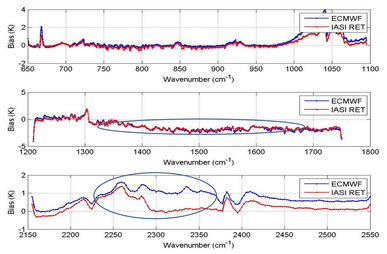


Initial results from CrIMSS code appeared to be reasonable, but also revealed several algorithm/LUT issues that need to be addressed, in particular the scan dependent biases in ATMS data, to a lesser degree the inconsistency between CrIS radiances and RTM, and the cloud clearing not functioning properly due to CrIS noise file inconsistent with the proxy data



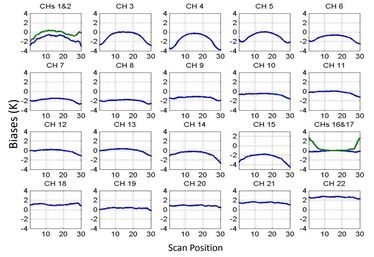
CrIS RTM Tuning

- ECMWF and IASI retrieval as the truth
- LW: Excellent match
- MW: ~1.5K biases in upper channels
- SW: ~1K biases for some channels



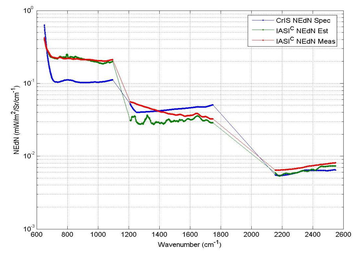
ATMS Bias Correction

- Started with using ECMWF and IASI retrieval as truth (Ch1-15 only)
- Further tuned with clear CrIMSS retrievals
- Surface channels more difficult



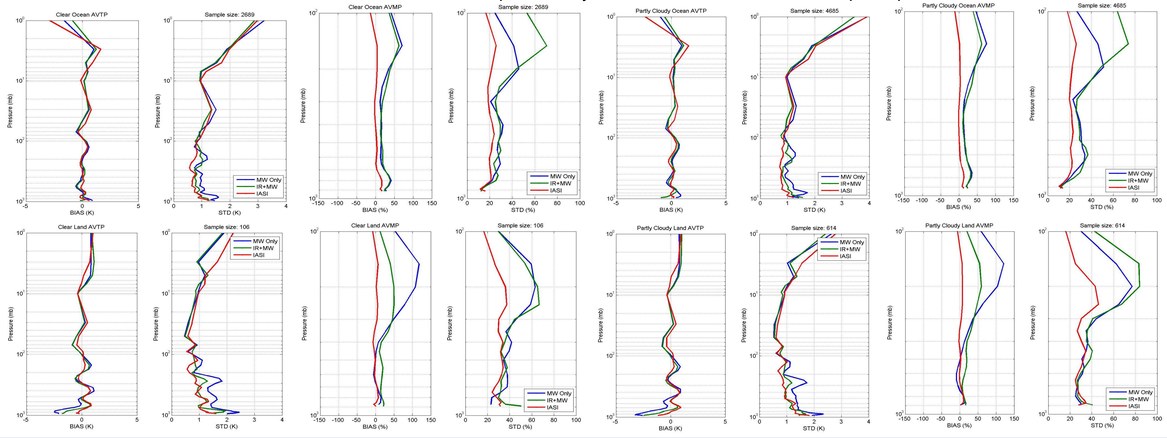
Sensor Noise Tuning (CrIS)

- Input for CrIMSS EDR algorithm
- Estimated from uniform scenes
- Cross compared to sensor test results
- IASI noise scaled to CrIS resolution



EDR Quality Performance Assessment

Cloud detection parameters tuned; Error related to RTM error handling fixed; ATMS scan dependent biases removed; CrIS RTM biases removed; Estimated CrIS sensor noise; Results preliminary; ECMWF used as truth to computer performance statistics



Conclusions and Next Steps

- **The CrIMSS EDR retrieval algorithm is being tested using the proxy test data generated from MetOp IASI/AMSU-A/MHS and the preliminary results are very promising; Important lessons learned to adjust algorithm LUTs and improve algorithm science in preparation for post-launch intensive CalVal**
- Plan to continue to assess CrIMSS algorithm performance with radiosonde matchup datasets and refine the tuning process; investigate other algorithm improvement opportunities: surface emissivity hinge-points, cloud clearing using both MW and collocated IR imager data