Pre-Launch Characterization of the Cross-track Infrared Sounder/Advanced Technology Microwave Sounder (CrIMSS) Environmental Data Records (EDRs)' Performance

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1. Introduction

The flight sensors for the NPOESS Preparatory Project (NPP) are now undergoing their final pre-launch characterization and calibration. The NPOESS Integrated Program Office (IPO) Data Products Division (DPD) has generated the performance assessments for the CrIMSS Environmental Data Records (EDRs) of the CrIS/ATMS Suite. The CrIMSS EDRs include the Atmospheric Vertical Temperature Profile, Atmospheric Vertical Moisture Profile, and the Atmospheric Vertical Pressure Profile. The AVTP and the AVMP are both NPOESS Key Performance Parameters (KPPs) and being used for initialization of high-resolution NWP models, atmospheric stability, etc.. The EDR Assessments were developed by the NDPD and IPO Subject Matter Experts to collect and track algorithm development status and expected performance against contractual specifications and applicability to user missions.

This paper summarizes the CrIMSS pre-launch assessments and provides an overview of the NPP CrIMSS algorithm and data products. Performance assessment based on the CrIS/ATMS proxy datasets derived from AIRS and IASI will be presented.

2. Heritage Sensors & Data Products

NPOESS Atmospheric Vertical Temperature and Moisture Profiles are derived from infrared radiance measurements from the CrIS and microwave measurements from the ATMS. Additionally, the Atmospheric Vertical Pressure Profile is derived from the AVMP and AVTP EDRs. Together, the CrIS and the ATMS form the Cross-track Microwave Sounder Suite (CrIMSS). As a unit, CrIMSS derives from a long heritage of infrared and microwave sensors flown on several successful satellite missions, with a long heritage of successful cross validation.

The design of the CrIS can be tracked to the High-resolution Infrared Sounder (HIRS), flown on the Polar Operational Environmental Satellites (POES); the Advanced Infrared Sounder (AIRS), flown on NASA's Aqua satellite, and the Infrared Atmospheric Sounding Interferometer (IASI), flown on the European METOP satellites. An indication of the improvement afforded by CrIS is seen by comparing HIRS, which provides about 20 infrared channels of information and is able to characterize atmospheric temperature profiles to an accuracy of 2 – 3 K, to CrIS, which will provide over one thousand spectral channels and will be able to measure temperature profiles with an accuracy approaching 1 K.

The microwave sensor, ATMS, derives from a long heritage that includes well-understood and validated sensors on legacy platforms. Key among these are the Advanced Microwave Sounding Unit (AMSU A&B; flown on POES, METOP, and Aqua), the Microwave Humidity Sounder (MHS), flown on POES and the METOP satellites; and the Humidity Sounder for Brazil (HSB; flown on NASA's Aqua satellite).

Overall, the heritage string for determining atmospheric temperature and moisture profiles flows from HIRS/AMSU to AIRS/AMSU/HSB to IASI/AMSU/MHS to CrIMSS.

3. Algorithm Overview

The CrIMSS EDR retrieval algorithm is an iterative physical retrieval algorithm that simultaneously estimates the geophysical states of both the atmosphere and the surface from the infrared and microwave radiances measurements. It combines a fast and accurate radiative transfer model, a classical constrained inversion model, and a heritage cloud-clearing algorithm to meet the stringent requirements on both latency and accuracy.

The algorithm is normally executed on two distinct stages to fully exploit the radiometric information contained in the microwave and infrared radiance data. In the first stage, retrievals are performed using only the ATMS microwave data and on CrIS Field of Regard which consists of an array of 3x3 CrIS Field of Views (FOV). Since the microwave sensor penetrates through clouds, this step produces a reasonable estimate of the atmosphere and surface states, required to initiate the second-stage processing and to estimate and compensate for the cloud contamination in the infrared radiance data, a process known as cloud clearing. The microwave algorithm is capable of retrieving clouds.

In the second stage, the algorithm performs an inversion by combining the CrIS infrared data and the ATMS microwave data in a maximum likelihood approach that minimizes a cost function on either a single CrIS FOV or a cluster of CrIS FOVs, depending on cloudiness of the scene. Cloud clearing is a key component of the second-stage processing, and accuracy of the cloud-cleared infrared radiance determines the final quality of its output. The cloud-clearing algorithm adopted by the CrIMSS algorithm has consistently shown good performance on both real and simulated data, and the combined retrieval results usually have much improved quality over the microwave-only first stage retrieval results.

4. Predicted Performance

EDR performance estimate matrices based on newly generated proxy data derived from AIRS and IASI as well as simulated data will be summarized and presented in this session.