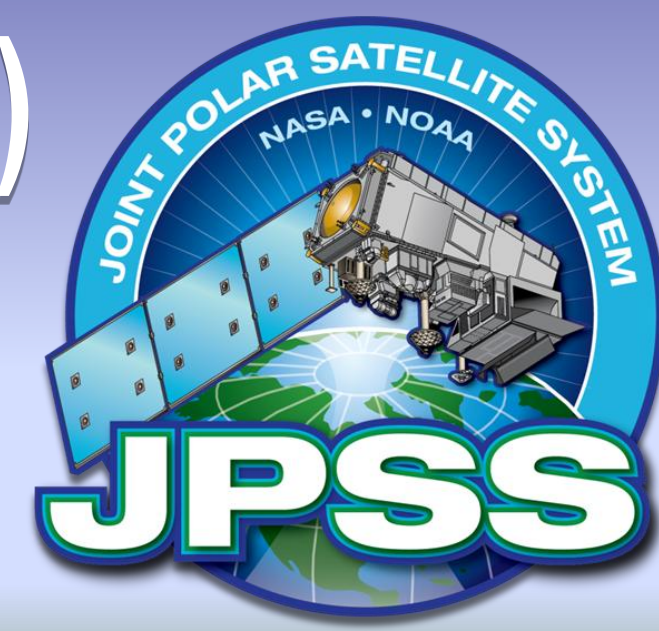


Pre-Launch Characterization of the Cross-track Infrared and Microwave Sounder Suite (CrIMSS) Environmental Data Records (EDRs) Performance



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 With thanks to SOAT members for their contributions.

Introduction

- The Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) are the two sensors that make up the **Cross-track Infrared Microwave Sounder Suite (CrIMSS)** onboard the Joint Polar Satellite System (JPSS) NPP Satellite scheduled to launch in 2011.
- CrIMSS will produce three Environmental Data Records (EDRs) including the Atmospheric Vertical Temperature Profile (AVTP), Atmospheric Vertical Moisture Profile (AVMP), and the Atmospheric Vertical Pressure Profile (AVPP). The AVTP and the AVMP are both JPSS Key Performance Parameters (KPPs).
- The CrIMSS algorithm has been developed, implemented and the EDR performance has been assessed and characterized with the simulated global synthetic data sets.
- Recently, significant progress has been made by the Sounder Operational Algorithm Team (SOAT) on running the CrIMSS code through **proxy data** generated from AIRS/AMSU/HSB and IASI/AMSU/HSB radiances, and comparisons of the results against the current operational products.
- The proxy data capability not only allows characterization of the algorithm performance pre-launch, including diagnosis of issues and fixes, but also provides opportunities to practice the cal/val and algorithm update processes, and demonstrate the algorithm and validation launch readiness.

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 (IR) and microwave (MW) radiance spectral measurements. It combines a fast and accurate radiative transfer model, a classical constrained inversion method, and a heritage "cloud-clearing" algorithm (clear-column IR radiance product) to meet the stringent requirements on both latency and accuracy.

The algorithm is executed in two distinct stages to exploit fully the radiometric information contained in the MW and IR radiance data:

- Stage 1. Retrievals are performed using only the ATMS and CrIS field-of-regard (FOR), which consists of an array of 3×3 CrIS fields-of-view (FOVs) collocated with an ATMS FOV. Because the microwave sensor is relatively insensitive to clouds, this step, based upon heritage AIRS and IASI, produces a reasonable estimate of the atmosphere and surface states.
- Stage 2. The algorithm performs an inversion by combining the CrIS IR data and the ATMS MW 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 IR 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.

CrIMSS EDRs

AVMP: Used for initialization of high-resolution NWP models, atmospheric stability, etc.

Parameter	IORD-II	NGAS SY15-0007
AVMP Partly Cloudy, surface to 600 mb	Greater of 20% or 0.2 g/kg	14.1% ocean, 15.8% land and ice
AVMP Partly Cloudy, 600 to 300 mb	Greater of 35% or 0.1 g/kg	15% ocean, 20% land and ice
AVMP Partly Cloudy, 300 to 100 mb	Greater of 35% or 0.1 g/kg	0.05 g/kg ocean, 0.1 g/kg land and ice
AVMP Cloudy, surface to 600 mb	Greater of 20% or 0.2 g/kg	15.8%
AVMP Cloudy, 600 mb to 300 mb	Greater of 40% or 0.1 g/kg	20%
AVMP Cloudy, 300 mb to 100 mb	Greater of 40% or 0.1 g/kg	0.1 g/kg

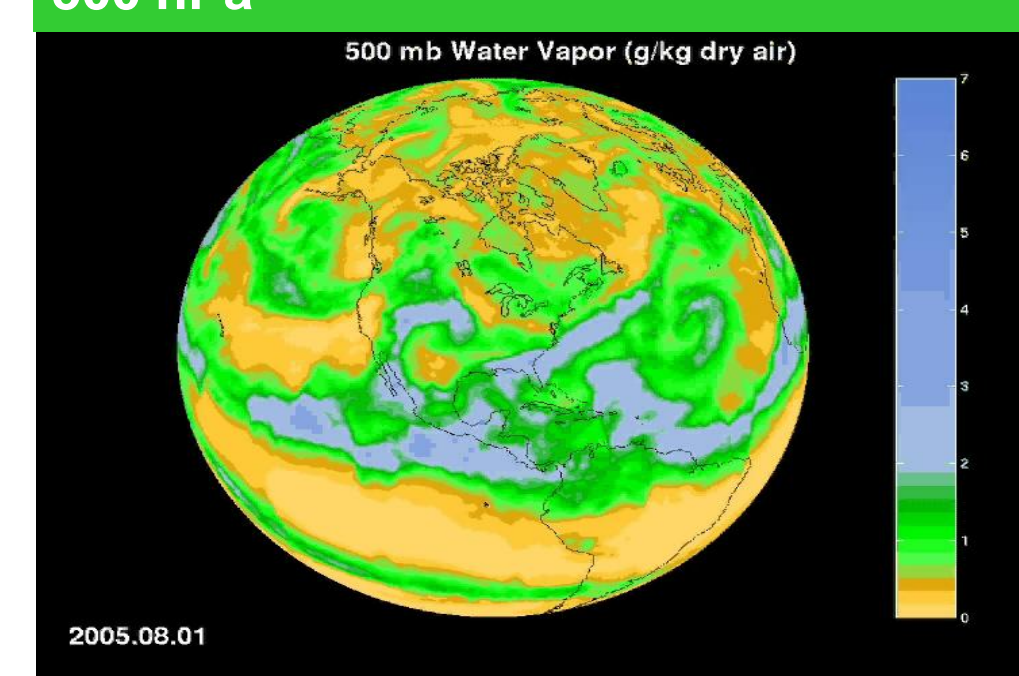
AVTP: Used for initialization of high-resolution NWP models, atmospheric stability, etc.

Parameter	IORD-II	NGAS SY15-0007
AVTP Partly Cloudy, surface to 300 mb	1.6 K/1-km layer	0.9 K/1-km ocean, 1.7 K/1-km land/ice
AVTP Partly Cloudy, 300 to 30 mb	1.5 K/3-km layer	1.0 K/3-km ocean, 1.5 K/3-km land/ice
AVTP Partly Cloudy, 30 mb to 1 mb	1.5 K/5-km layer	1.5 K/3-km
AVTP Partly Cloudy, 1 mb to 0.5 mb	3.5 K/5-km layer	3.5 K/5-km
AVTP Cloudy, surface to 700 mb	2.5 K/1-km layer	2.0 K/1-km
AVTP Cloudy, 700 mb to 300 mb	1.5 K/1-km layer	1.5 K/1-km
AVTP Cloudy, 300 mb to 30 mb	1.5 K/3-km layer	1.5 K/3-km
AVTP Cloudy, 30 mb to 1 mb	1.5 K/5-km layer	1.5 K/5-km
AVTP Cloudy, 1 mb to 0.05 mb	3.5 K/5-km layer	3.5 K/5-km

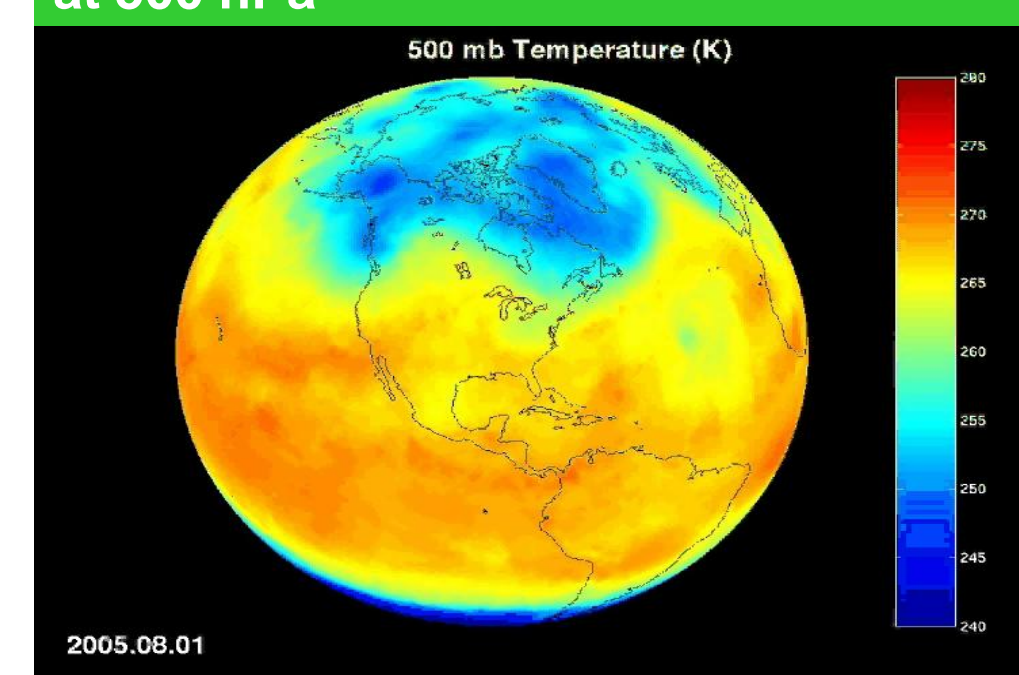
AVPP: Pressure product is a EDR product (derived from AVTP and AVMP) that requires validation. CO and CH₄ are experimental (P³) products derived by science community from SDRs (not part of IPO-funded Cal/Val program).

Parameter	IORD-II	NGAS SY15-0007
Pressure Profile	4 hPa threshold, 2 hPa goal	3 hPa (with precip and Psurf error exclusions)
CH ₄ (methane) column	1% precision, ±5% accuracy	n/a
CO (carbon monoxide) column	3% precision, ±5% accuracy	n/a

Example of AIRS moisture product at 500 hPa*



Example of AIRS temperature product at 500 hPa*



*AIRS Products courtesy of Tom Pagano, NASA/JPL

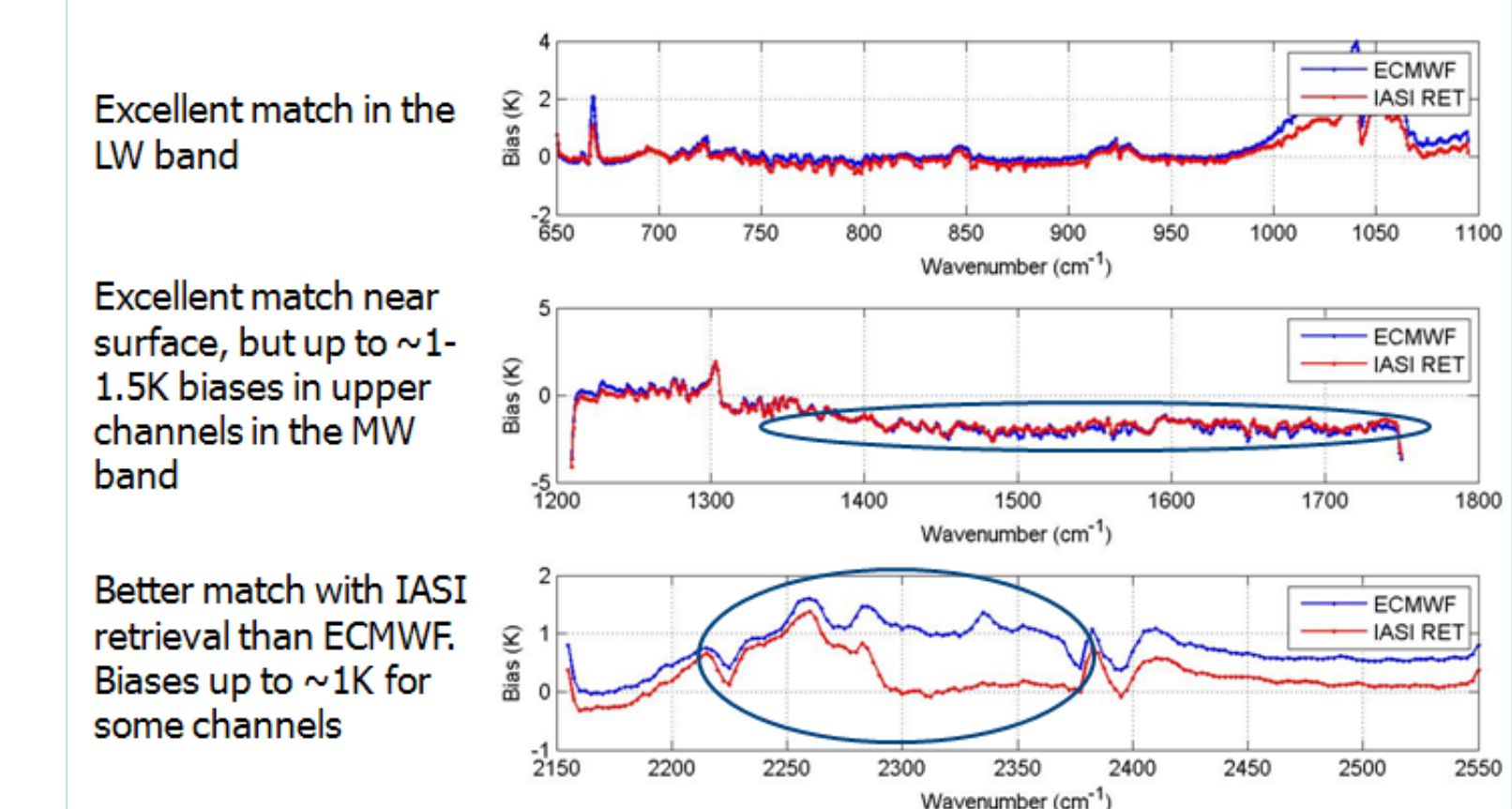
Sounding Products Validation Tools

Tools	Description	EDRs	Source
NOAA Unique CrIS/ATMS Processing System (NUCAPS)	Provide CrIMSS NOAA Unique Products (PCS/CCR/Trace Gas) to NWP Centers, DOD, and CLASS; Validate IDPS-EDRs for IPO.	AVMP, AVTP (CrIMSS)	NESDIS/STAR
ATMS-only EDR performance tool	MATLAB ATMS EDR Performance Tool	AVMP, AVTP (ATMS)	MIT/LL
CrIMSS neural network EDR performance tool	MATLAB CrIMSS EDR Performance Tool	AVMP, AVTP (CrIMSS)	MIT/LL
Routine satellite matchup data acquisitions	Routine satellite matchup data acquisitions	AVMP, AVTP (CrIMSS)	UW/CIMSS
Create ARM Best Estimate Product	Create ARM Best Estimate Product	AVMP, AVTP (CrIMSS)	UW/CIMSS
Monitor Trends in Retrieved Temperature and Moisture Profiles	EDR Trend Monitoring	AVMP, AVTP (CrIMSS)	UW/CIMSS
The NOAA PRODUCTS (integrated) Validation System (NPROVS)	Match up and Validation Tool	Sounding EDRs	NESDIS/STAR
McIDAS-V	Visualization Tool	AVMP, AVTP	UW/CIMSS

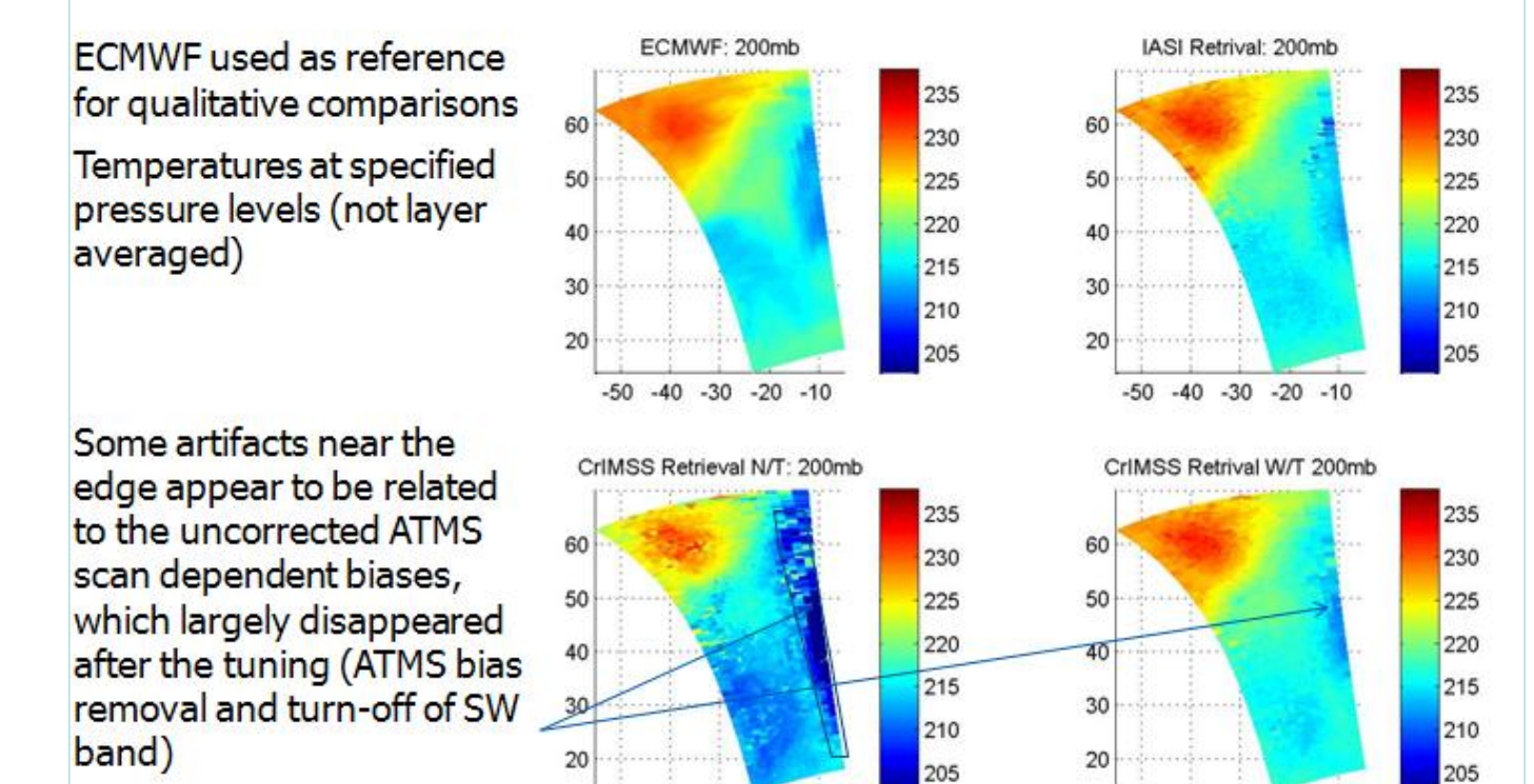
CrIMSS Test Runs Using IASI

Estimates of OSS RTM Biases

Simulated CrIS radiances using ECMWF/IASI retrieval to estimate OSS RTM error



Retrieved Temperature Profiles (200 hPa)
 Seen to be generally consistent with NWP forecast



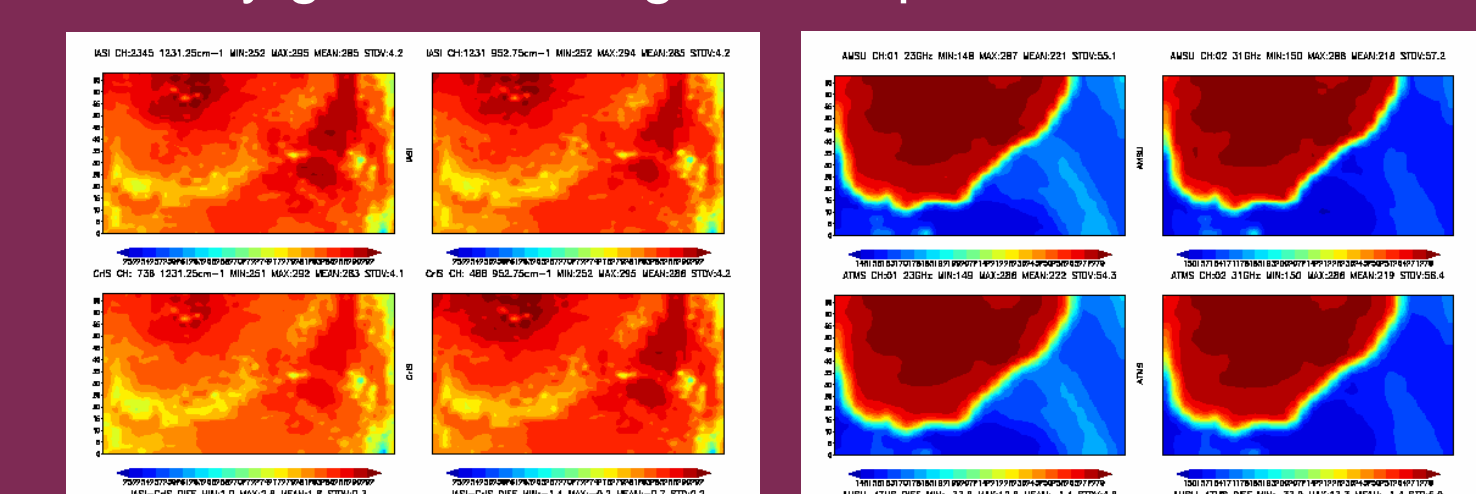
Datasets Used for CrIMSS Pre-Launch Characterization

Proxy data generated using AIRS L2

- Input data to CrIMSS forward model
 - AIRS temperature, moisture, and ozone profiles, cloud information, and surface emissivities for both MW and IR
- The proxy data is used to test the CrIMSS Operational code
 - Convergence is good; EDR performance can be evaluated with more realistic scenes; Issues identified

Proxy data from IASI/AMSU/MHS

- Highly realistic SDR proxy data
- Have successfully ingested into the CrIMSS OPS code
- Proxy generation algorithm operational



Global Synthetic Datasets (GSD)

- Simulated for a wide range of environmental scenes
 - Seasonal, diurnal, and spatial variability
 - Self-consistent temperature, moisture, ozone, and cloud water profiles
 - Actual sensor scanning geometry including FOV rotation
- Simulated sensor effects based on actual sensor performance characterization results

Proxy Data Package for 'Focus Day'

Proxy Data Package generated by NOAA/NESDIS and shared with SOAT team members, package including:

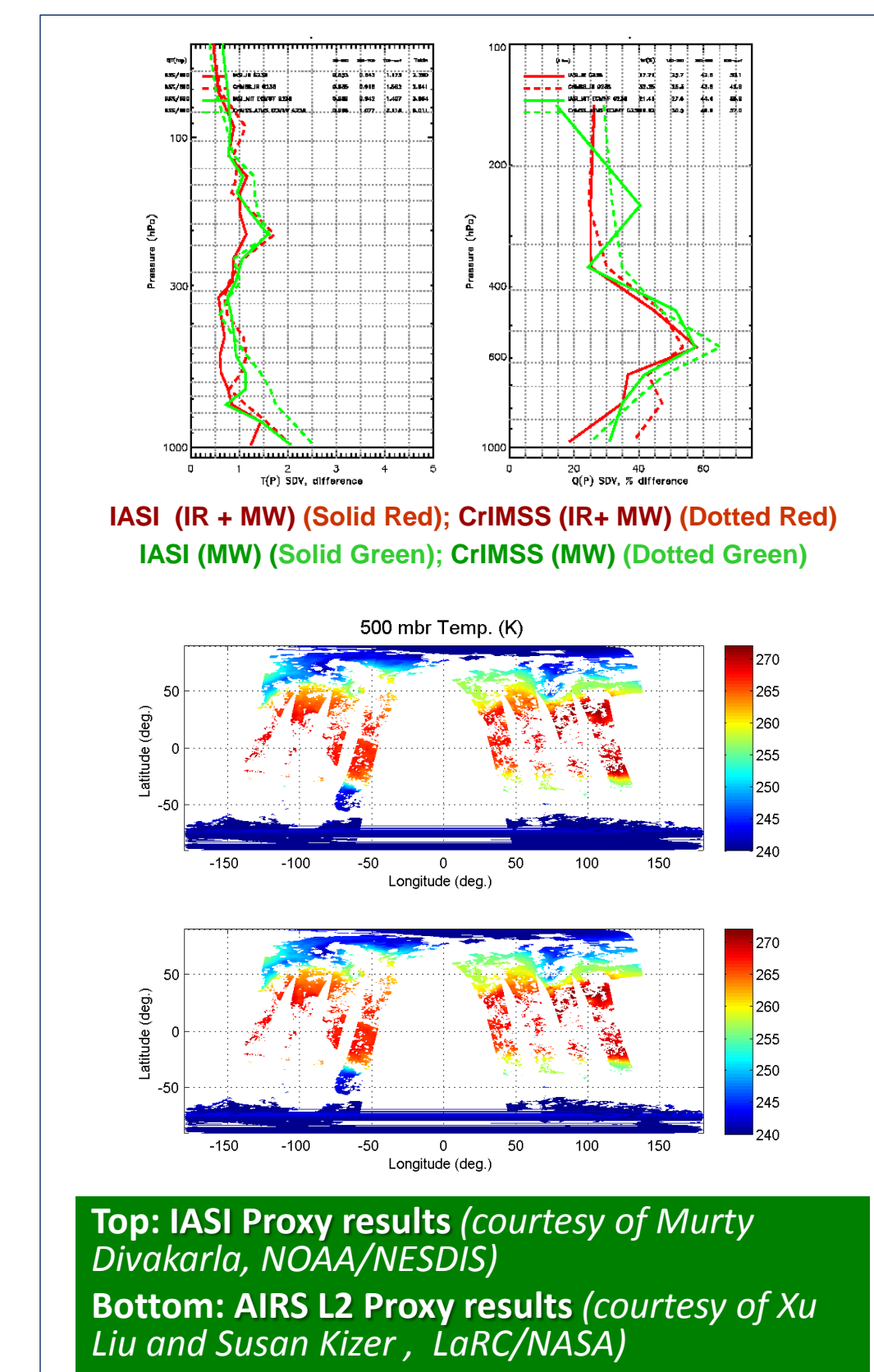
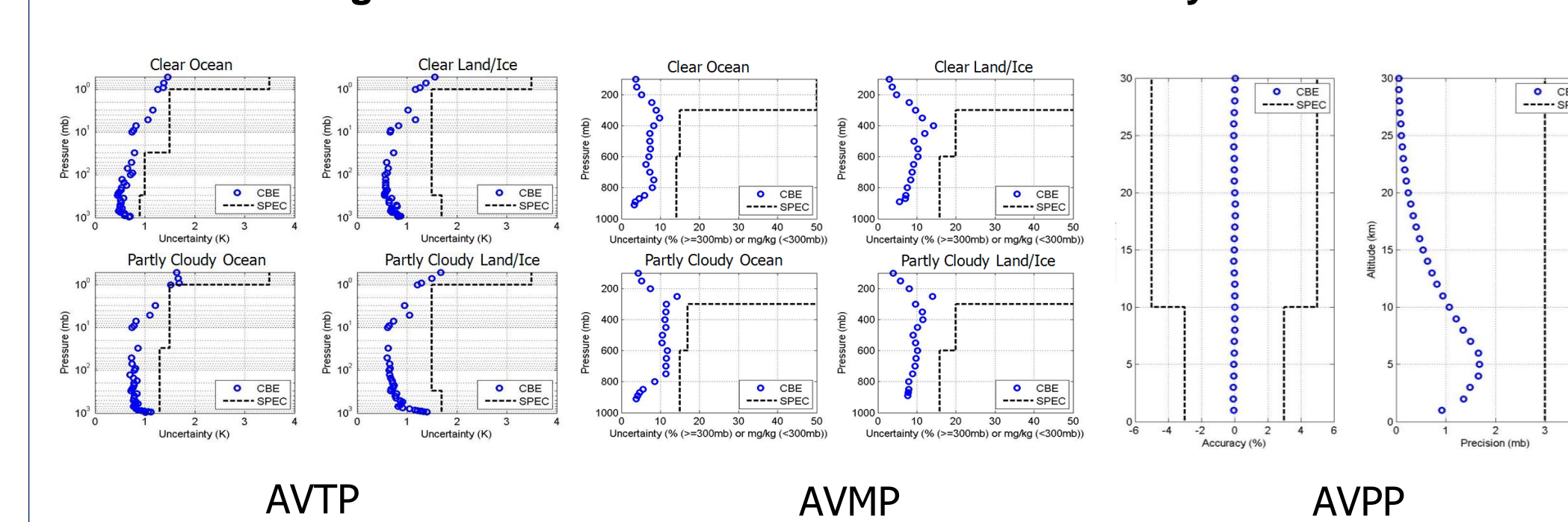
- CrIS/ATMS Proxy Data from IASI/AMSU/MHS
- IASI/AMSU-A/MHS Data
- IASI EDR Products from NOAA IASI Operations
- NCEP-GFS and ECMWF Analysis Fields
- RAOB Matches
- SDR and EDR File Readers/Writers

Pre-Launch Characterization of CrIMSS Algorithm

Summary:

- The CrIMSS EDR AVTP and AVMP products have been shown to satisfy requirements based on global synthetic datasets.
- The CrIMSS EDR algorithm demonstrates good convergence based on testing with proxy data from AIRS and IASI.
- The SOAT is preparing for NPP launch with proxy datasets and methods of evaluation.

CrIMSS Algorithm Performance Based on the Global Synthetic Data sets



Top: IASI Proxy results (courtesy of Murty Divakarja, NOAA/NESDIS)
 Bottom: AIRS L2 Proxy results (courtesy of Xu Liu and Susan Kizer, LaRC/NASA)