Joint Polar Satellite System (JPSS) validation program for the NPP Cross-track Infrared Microwave Sounding Suite (CrIMSS)

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  - B. Blackwell (MIT)
- JPSS (formerly IPO)
  - H. Kilcoyne and J. Feeley

Outline

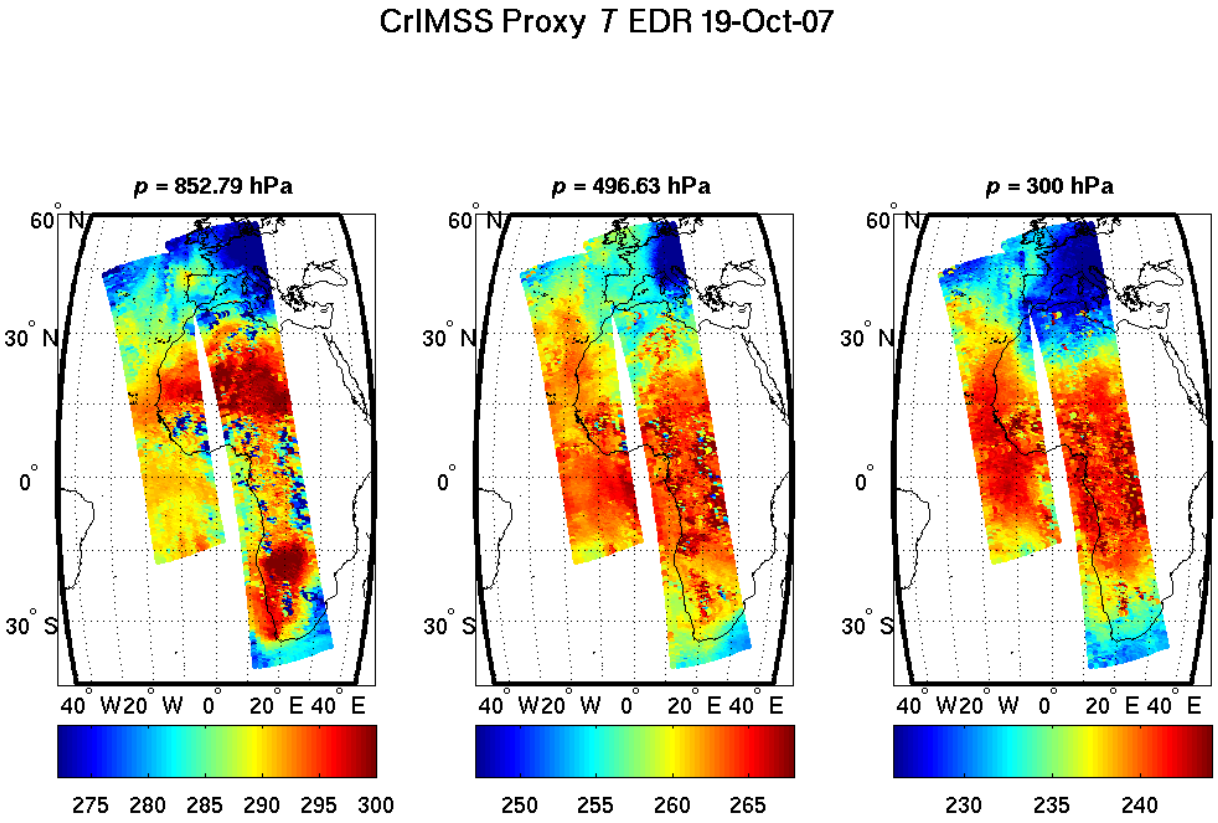
- **CrIMSS (CrIS/ATMS) EDR Product Overview**
- **Cal/Val Plan and Status**
  - Overview
  - Team Members (roles and responsibilities)
  - JPSS CrIMSS Cal/Val Phases
  - Current (Pre-Launch Phase) Efforts

CrIMSS EDR

PRODUCT OVERVIEW

Atmospheric Vertical Temperature Profile (AVTP)

- **EDR** used for initialization of high-resolution NWP models, atmospheric stability, basic science research, etc.
- Non-precipitating scenes
- **Key Performance Parameter (KPP)** for lower tropospheric temperature

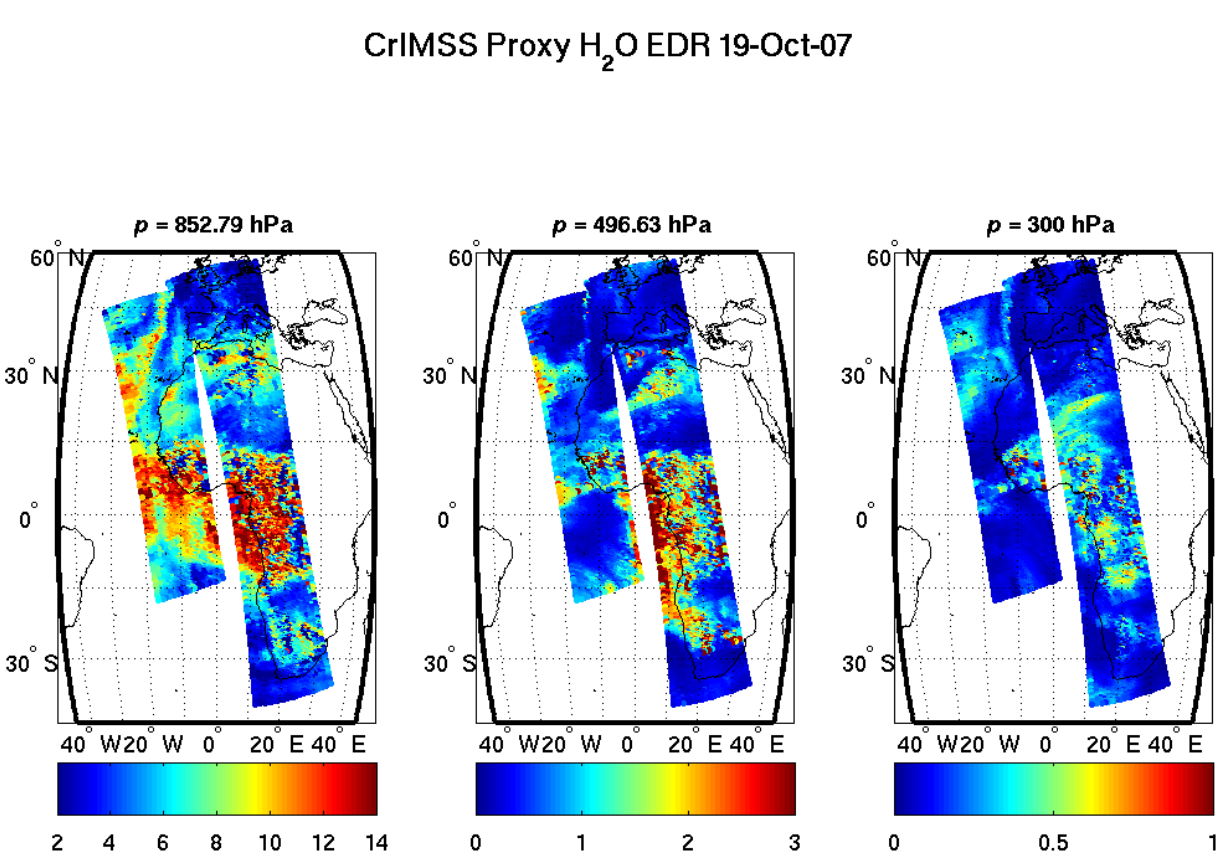


CrIMSS AVTP EDR retrieved from SDR Proxy Data

Acknowledgment to SOAT Members G. Guo, M. Divakarla, X. Liu, S. Kizer, and B. Blackwell

Atmospheric Vertical Moisture Profile (AVMP)

- **EDR** used for initialization of high-resolution NWP models, atmospheric stability, basic science research, etc.
- Non-precipitating scenes
- **Key Performance Parameter (KPP)** for lower tropospheric water vapor



CrIMSS AVMP EDR retrieved from SDR Proxy Data

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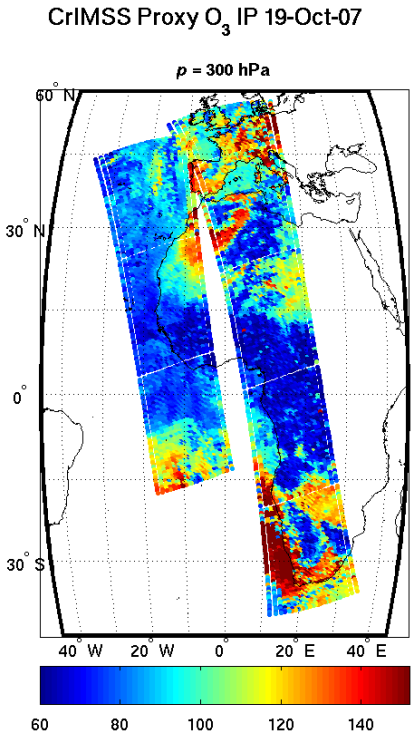
Specification Performance Requirements
to be replaced by JPSS documents

Atmospheric Vertical Temperature Profile (AVTP)		
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

Atmospheric Vertical Moisture Profile (AVMP)		
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% of 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

Atmospheric Vertical Pressure Profile (AVPP); Trace Gas IP and P³I

- **AVPP is an EDR** derived from AVTP and AVMP that requires validation.
- Trace gas retrievals from sounders are desirable for basic science
  - O3 is an intermediate product (IP) necessary for optimal EDR retrieval
  - CO and CH_4 are experimental (P^3I) products (not funded within cal/val program)



CrIMSS O_3 IP retrieved from SDR Proxy Data

Acknowledgement toSOAT Members G. Guo, M. Divakarla, X. Liu, S. Kizer, B. Blackwell

Specification Performance Requirements		
Parameter	**IORD-II**	**NGAS SY15-0007**
Pressure Profile	**4 hPa threshold, 2 hPa goal**	**3 hPa (with precip and Psurf error exclusions)**
CH4 (methane) column	1% precision, ±5% accuracy	n/a
CO (carbon monoxide) column	3% precision, ±5% accuracy	n/a

CrIMSS EDR

CAL/VAL PLAN AND STATUS

Cal/Val Plan Overview

- The **NPP CrIMSS EDR Validation Plan** is to ensure the data products comply with the requirements of the sponsoring agencies.

- The basis of our approach is **to draw on lessons learned** from validating the **AIRS/AMSU** and **IASI/AMSU/MHS sounding systems**.
  - Concentrate on datasets proven valuable for global validation for AIRS (ECMWF, NCEP/GFS, RAOBs, etc)
  - Build team of **Subject Matter Experts (SMEs)** from both user and science communities to leverage heritage knowledge, experience and tools as well as assure understanding of customer mission success
  - Leverage existing capabilities wherever possible
    - Operational real-time systems (ATOVS, GOES)
    - AIRS and IASI processing and validation systems
    - Routine AIRS and IASI instrument monitoring and characterization
    - Intensive field campaign (aircraft sensor) cal/val experience

- To determine whether the EDRs have met their **global performance specifications**, a **"roll-up" of regional assessments** is envisioned.
  - Typical validation methods characterize the performance of the EDRs in various ensembles of cases.
  - Specifically, this will involve stratifying the specs according to various bins:
    - day/night
    - latitude bands (i.e., polar, midlatitude, tropical)
    - land/ocean/ regional
    - (possibly) altitude and surface characteristics

- Assessments will also be performed against current capabilities using **heritage sensors and algorithms**
  - Hyperspectral AIRS and IASI systems (well established comparable products)
  - ATOVS (HIRS/AMSU) operational products to demonstrate the value of the hyperspectral measurements to the user community

Team Members – Roles & Responsibilities (1/3)

NOAA Team Members

EDR	Name	Organization	Funding Agency	Task
Lead	Chris Barnet	NOAA/NESDIS/ STAR	IPO	Lead CrIS/ATMS EDR Team
AVTP/AVMP	Changyong Cao	NOAA/NESDIS/ STAR	IPO	Coordination w/ GSICS
AVTP/AVMP	Mitch Goldberg	NOAA/NESDIS/ STAR	IPO & NOAA-PSDI	NGAS-code, NUCAPS
AVTP/AVMP	Anthony Reale	NOAA/NESDIR/ STAR	IPO	NPROVS
CrIMSS SDR	John Derber	NOAA/NCEP	IPO	NWP ingest
AVTP/AVMP	Fuzhong Weng	NOAA/NESDIS/ STAR	NOAA-PSDI	MiRS

Team Members – Roles & Responsibilities (2/3)

NOAA-External Team Members

EDR	Name	Organization	Funding Agency	Task
CriMSS SDR	Gail Bingham	USU/SDL	IPO	Lead CrIS/ATMS SDR Team
AVTP/AVMP	Bill Blackwell	MIT	IPO	Microwave products
AVTP/AVMP	Allan Larar	NASA/LaRC	IPO	EDR Validation
AVTP/AVMP	Xu Liu	NASA/LaRC	IPO	IASI proxy, EDR validation
AVTP/AVMP	Hank Revercomb	SSEC	IPO	SDR, PEATE
AVTP/AVMP	Dave Tobin	SSEC	IPO	ARM-RAOBS
AVTP/AVMP	Larrabee Strow	UMBC	IPO	OSS validation
AVTP/AVMP	Joel Susskind	NASA/GSFC	IPO	AIRS proxy

Team Members – Roles & Responsibilities (3/3)

NOAA-External Team Members

EDR	Name	Organization	Funding Agency	Task
CrIMSS SDR	Steven Beck	Aerospace Corp.	external	RAOB,LIDAR
CrIMSS SDR	Steven English	UKMET	external	UKMET analysis
CrIMSS SDR	William Bell	ECMWF	external	ECMWF analysis
AVTP/AVMP	Steve Friedman	NASA/JPL	NASA	Sounder PEATE
CrIMSS SDR	Steve Swadley Ben Rustin	NRL	NRL	NOGAPS/ NAVDAS analysis
AVTP/AVMP CrIMSS SDR	Denise Hagan Degui Gu	NGAS	NG Prime	EDR Validation/SDR coordination

Cal/Val Phases

- *Pre-Launch*
- *Early Orbit Checkout (EOC)*
  - *L* + 90 days, as sensors are activated
- *Intensive Cal/Val (ICV)*
  - Stable SDR out to *L* + 24 months
- *Long-Term Monitoring (LTM)*
  - From end of ICV (*L* + 24 months) to the end of operational lifetime
  - Characterization of all EDR products and long-term demonstration of performance

EDR Validation Activities by Phase (1/2)

Pre-Launch – Early Orbit Checkout

- **Pre-launch**
  - **Global synthetic datasets**
    - Tests algorithm for theoretical robustness – self-consistent temperature, moisture, ozone, and cloud water profiles are "controlled"
    - Simulated for a wide range of environmental scenes, including seasonal, diurnal, spatial variability, and actual sensor scanning geometry including FOV rotation
  - **Proxy datasets**
    - Data derived from real measurements from existing satellite systems with similar specs (here AIRS/AMSU and IASI/AMSU)
    - Used to test concepts and exercise CrIMSS algorithm ; support launch readiness (functionality of the code, develop methods of empirical bias correction) and porting of algorithms
    - Aqua/AIRS has advantage of having 9 IR FOVs and 01:30 orbit
    - METOP/IASI has advantage of direct IR radiance spectral transform and MHS channels

- **Early Orbit Checkout**
  - **Model comparisons**
    - Useful at first light and for long-term monitoring
      - Similar to AIRS science team activities using ECMWF and NCEP/GFS
      - Compare forward models, sanity checks on "obs – calc"
  - **Simultaneous nadir overpass and double differencing** of radiances.
    - Methods are becoming mature, high level of confidence from AIRS/IASI work.
  - **Inter-compare** with operational AIRS and/or IASI products.
    - Initially (first light) use off-line versions of CrIMSS products.
      - Even if retrievals are poor, having geophysical state and diagnostics can help identify problems.
    - Useful to identify and mitigate issues with the NGAS EDRs
  - **PCA analysis** of noise characteristics and instrument monitoring.
    - Can be used to verify instrument noise, random and systematic components.
    - Can be used to monitor instrument health.

EDR Validation Activities by Phase (2/2)
Intensive Cal/Val – Long-Term Monitoring

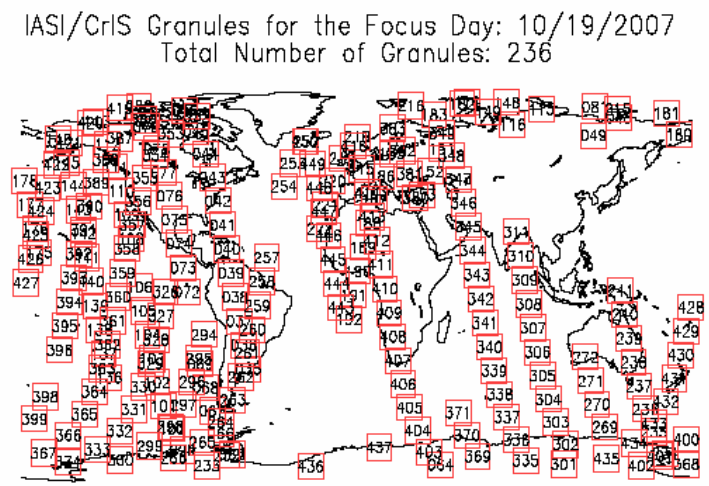
- **Operational RAOBs**
  - Useful for **long-term characterization** and **global latitude representation**. After couple months should begin to have significant statistics.
  - Tony Reale's NOAA Products Validation System (NPROVS)

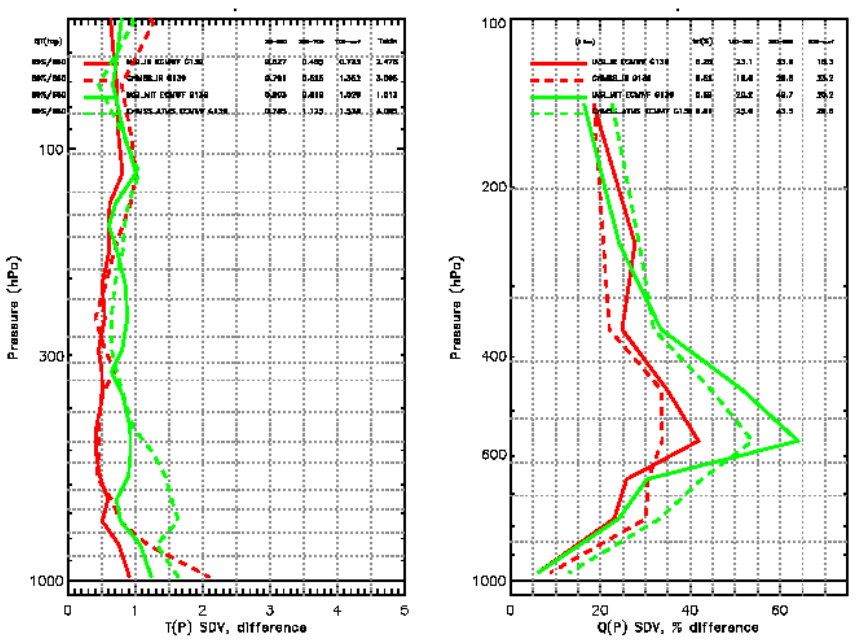
- **Dedicated RAOBs**
  - Useful for **regional characterization**.
  - Will take many months (years?) to accumulate enough statistics.
  - Need site support and funding for large number of RAOBs.
  - Ideally coordination through GCOS Reference Upper Air Network (GRUAN)

- **Intensive Field Campaigns** (e.g., *Tobin et al.* 2006, *JGR,* **111**; *Taylor et al.* 2008, *BAMS,* **89**; *Blackwell et al.* 2001, *TGARS,* **39**)
  - Useful for **SDR cal/val**; **state specification** for thorough "**cal/val dissection**".
  - Will attempt coordination (as much as possible) with other cal/val leads (e.g., VIIRS clouds).
  - Scientific campaigns of opportunity
    - Low cost, low risk; has advantage of exploiting scientific participation; crude "dress-rehearsal"
    - **NOAA Aerosols and Ocean Science Expeditions (AEROSE)** (*Nalli et al.* 2006, *JGR,* **111**), linkage to GOES-R program

Current Pre-Launch Phase Efforts (1/2)

- The CrIMSS EDR AVTP and AVMP products have been shown to **satisfy requirements** based on global synthetic datasets
- The SOAT is preparing for NPP launch with proxy datasets and methods of evaluation
  - **Proxy Data Package for 19-Oct-07 "Focus Day"** has been generated by SOAT team effort (LaRC, MIT, NASA, and NOAA)
    - CrIMSS EDR algorithm has demonstrated good convergence
    - Have obtained initial estimates of OSS RTM biases
    - Statistics of AVTP and AVMP differences ECMWF analysis show reasonable performance (right bottom plots)
      - **Cf. Poster #571 *Divakarla et al*.**

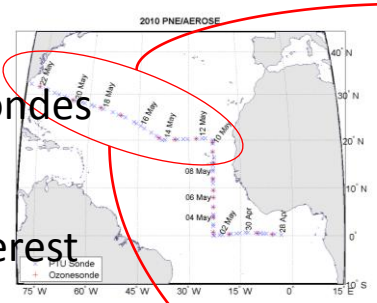


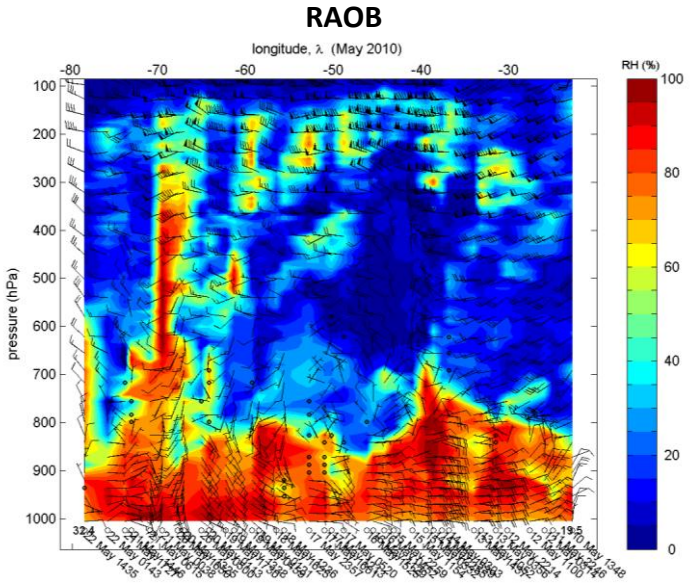


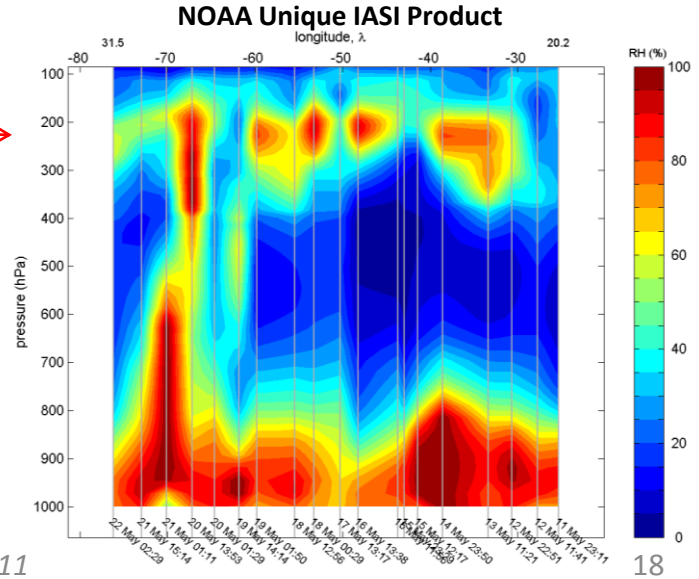
Figures courtesy of SOAT team effort: G. Guo, M. Divakarla, X. Liu, S. Kizer, B. Blackwell

Current Pre-Launch Phase Efforts (2/2)

- **NOAA PNE/AEROSE Campaigns**
  (cf. Poster #632, *Nalli et al.*)
  - Pre-launch phase test of deployment of **scientific validation campaigns** of opportunity.
  - Ship-based dedicated radiosondes and ozonesondes over the **tropical North Atlantic Ocean**.
  - **Region** is of scientific interest **germane to the CrIMSS mission**.
    - Saharan air layer (SAL) and tropical cyclogenesis
    - Dust and biomass burning aerosols
    - Tropospheric ozone dynamics
- AEROSE 2010 is to be used as a field campaign proxy dataset to be developed by NOAA/MIT/LaRC







Summary

- The status of the **NPP CrIMSS EDR Validation Plan** for Sounding EDRs was overviewed in this presentation.
  - The Validation Plan is to ensure the data products comply with the requirements of the sponsoring agencies
    - JPSS specifications for the AVTP, AVMP and AVPP EDR products to replace IORD/NGAS specs
  - Cal/Val Team Members include subject matter experts from both the user and science communities.
    - Draw upon wealth of experience from hyperspectral AIRS/IASI programs
    - Forums for coordination/communication among Team Members and participants include regular SOAT Meetings
  - Cal/Val activities have been organized under pre-launch, Early Orbit Checkout (EOC), Intensive Cal/Val (ICV) and Long-Term Monitoring (LTM) phases.

- **Pre-launch Cal/Val efforts are currently underway** including the development of "proxy datasets" using IASI granules and RTM calculations and initial tests of the IDPS EDR algorithm.