



# Overview of NOAA Unique CrIS ATMS Processing System (NUCAPS)

*AVTP, AVMP, OLR, IR Ozone, CO, CO<sub>2</sub>, and CH<sub>4</sub> Products*

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C. Barnet, A. Gambacorta, STC  
X. Liu, S. Kizer, NASA/LaRC  
A. Sharma, OSPO

*Sounding EDR Team  
August 25, 2015*



# Outline



- Soundings Cal/Val Team Members
- S-NPP Sounding Products Overview
- Products Online Monitoring, LTM
- JPSS-1 Readiness
- Major Accomplishments
- USERS
- Moving Forwards J1
- Summary
- FY16 Milestone
- J2 and Beyond: Future Improvements



# Algorithm Cal/Val Team Members



PI	Organization	Team Members	Roles and Responsibilities
Quanhua (Mark) Liu	STAR	N. Nalli, C. Tan, F. Iturbide-Sanchez, K. Zhang, J. Smith	Maintain, validation, J1 algorithm development
Chris Barnet	STC	A. Gambacorta	Algorithm improvement, direct broadcast,
Xu Liu	NASA/LaRC	S. Kizer	Science support, independent assessment
Tony Reale	STAR	Bomin Sun, M. Pettey, F. Tilley, C. Brown	NROVS support for NUCAPS EDR validations
P. J. Mather	DOE	D. Holdrige	Dedicated radiosonde launch
D. Tobin	U. Wisconsin	L. Borg, R. Knuteson	Radiosonde launch schedule, radiosonde data analyze
A. Sharma	OSPO	O. Roytburd and W. OConnor	POC, Interact with users and data quality monitoring



# S-NPP Product Overview



- AVMP (L1RD Sup. Table 5.2.3.1) from NDE
- AVTP (L1RD Sup. Table 5.2.4.1) from NDE
- CO (L1RD Sup. Table 5.2.5) from NDE
- CO<sub>2</sub> (L1RD Sup. Table 5.2.6) from NDE
- CH<sub>4</sub> (L1RD Sup. Table 5.2.7) from NDE
- IR ozone (L1RD Sup. Table 5.2.8) from NDE
- OLR (L1RD Sup. Table 5.4.2)
- S-NPP Cal/Val Status
  - AVMP and AVTP Stage-1 Validated Maturity;
  - OLR meets an objective requirement;
  - IR Ozone to reach Validated Maturity;
  - CO, CO<sub>2</sub>, and CH<sub>4</sub> cannot achieve good accuracy for SNPP.

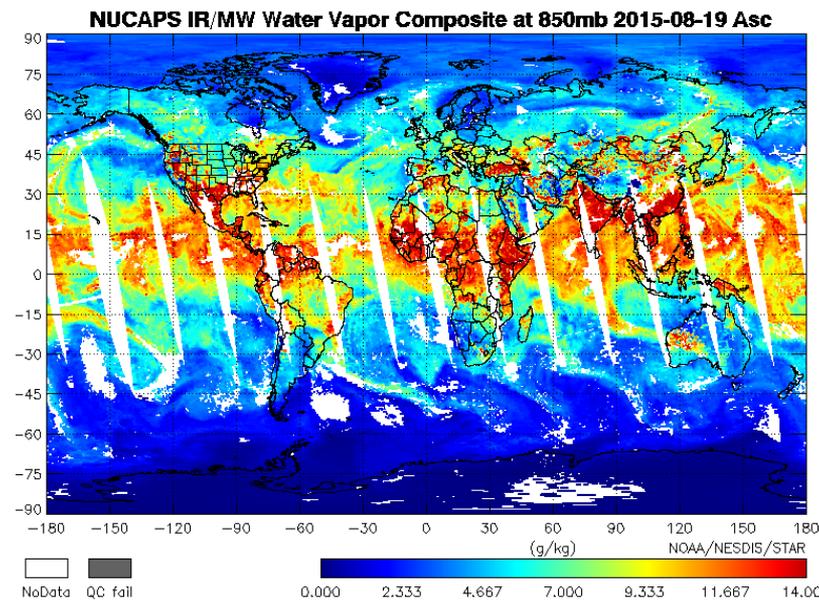
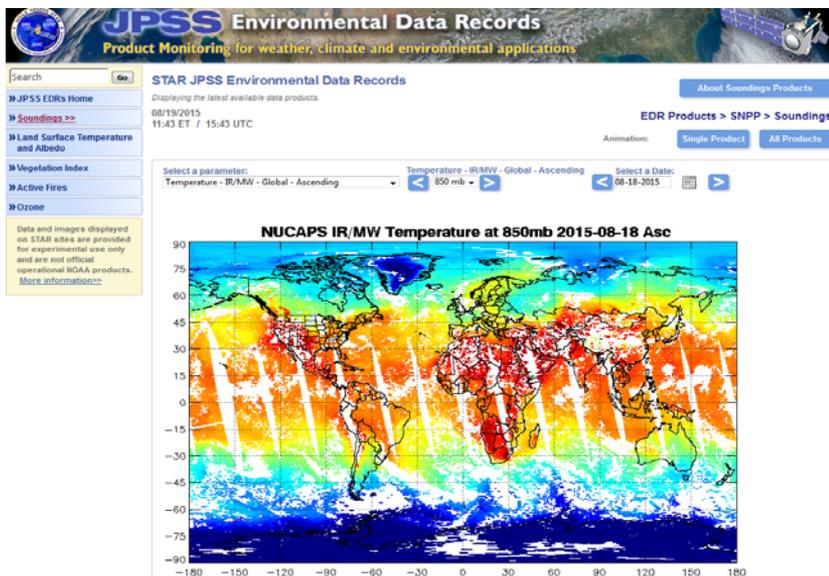
- OSPO

OSPO has developed websites for: NUCAPS Sounding Products, Global Granules Composite Images, Global Gridded Products, and Retrieval Statistics:

TIME	ACCPD CASES	PRCNT LAND	AVG LAT	AVG LON	SOLAR ZENITH	200-1100 TRUEMEAN	200-1100 WATERBIAS	200-1100 WATERRMS	200-1100 WATERPERERR	200-1100 TEMPBIAS	200-1100 TEMPRMS	520-790 TEMPBIAS	520-790 TEMPRMS
0.007	44	14.08	62.07	-63.38	47.23	0.2770	-0.011300	0.0466	21.166	-0.113	1.187	0.689	1.113
0.016	60	46.75	63.83	-43.81	48.95	0.2560	-0.011400	0.0483	21.961	-0.212	1.342	0.771	1.263
0.024	82	71.04	65.57	-21.42	50.67	0.2810	-0.026600	0.0624	20.120	-0.161	1.574	0.885	1.426

- STAR

[http://www.star.nesdis.noaa.gov/jpss/EDRs/products\\_Soundings.php](http://www.star.nesdis.noaa.gov/jpss/EDRs/products_Soundings.php)





# JPSS-1 Readiness (1)



- J1 Algorithm Summary

- CrIS SDR data will change to the full-spectral resolution, which requires changes in NUCAPS
  - codes,
  - radiative transfer model (SARTA),
  - channel selections,
  - new noise characteristics,
  - new tuning parameters,
  - testing,
  - validation
- New J1 EDRs CO, CO<sub>2</sub>, and CH<sub>4</sub> require
  - accurate trace gas retrieval algorithms,
  - channel optimization,
  - validation data (MLS, OCO-2, aircraft and surface In-situ),
  - validation



# JPSS-1 Readiness (2)



- J1 Cal/Val Overview
  - AVMP, AVTP: L+12 months (assuming validated ATMS and CrIS SDR).
  - OLR and IR ozone: L+18 months (assuming validated ATMS and CrIS SDR)
  - CO, CO<sub>2</sub>, and CH<sub>4</sub>: L+24 months (assuming validated ATMS and CrIS SDR)
  
  - Pre-Launch Calibration/Validation Plans
    - Validation Archive (VALAR) and NOAA Products Validation System (NPROVS) enhancement
    - Radiative Transfer Model (SARTA) for CrIS full-spectral radiance simulation and assessment
    - NUCAPS code change for CrIS full-spectral data
    - Channel selection for each stepwise retrievals in NUCAPS
    - J1 sensor characteristics and tuning data
    - J1 NUCAPS system level testing using synthetic radiance
  
  - Post-Launch Calibration/Validation Plans
    - Validation data (dedicated radiosonde, GFS data, ECMWF data)
    - noise file (including RT modeling error), bias correction coeff, regression coeff
    - Data collocation, analyze, and validation



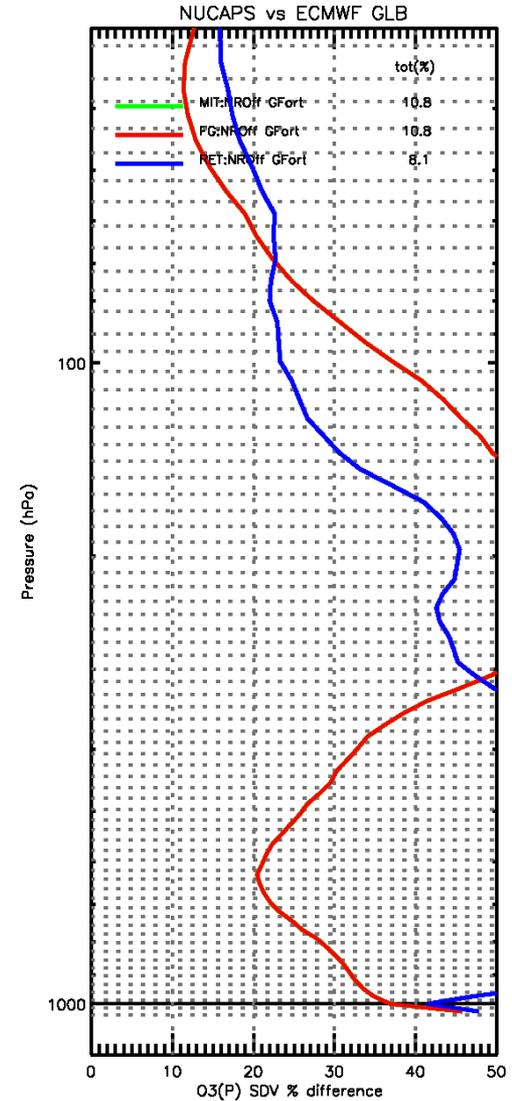
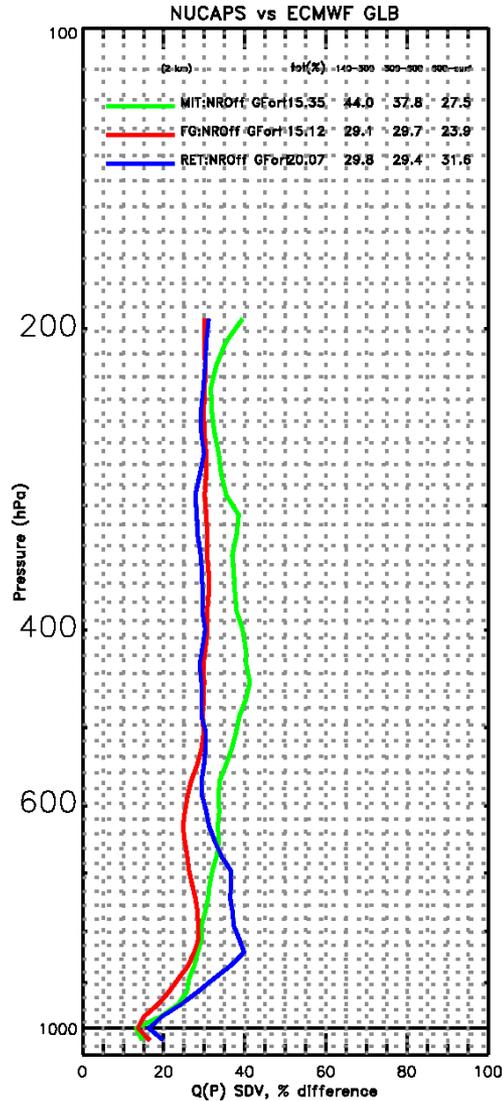
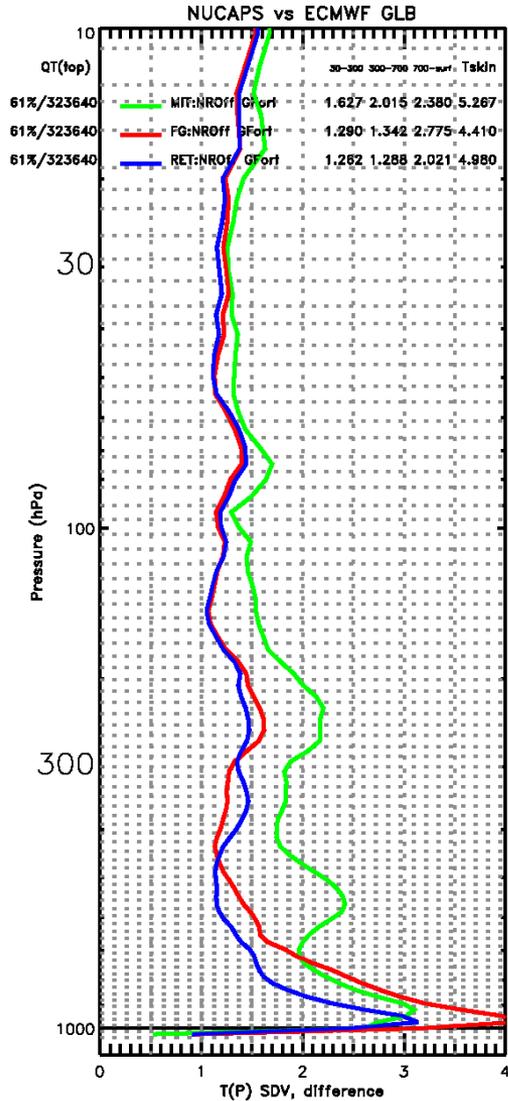
# Major Accomplishments



- AVTP and AVMP achieved validated maturity
- First comparison of SNPP CrIS OLR and CERES OLR
- NUCAPS parallel offline processing at STAR
- Migration of NUCAPS codes for GFORTRAN and IFORT by OSPO/NDE requirement
- Integrated ozonesonde truth dataset for validation of the CrIS ozone profile
- Supported 2015 CalWater/ACAPEX campaign onboard the NOAA Ship *Ronald H. Brown*
- Developed/implemented versatile ATMS/CrIS mapping algorithms
- EDR quality significantly improved after fixed bugs and used new regression coefficients
- Interactions with users: AWIPS, NOAA/CPC, NOAA/ARL

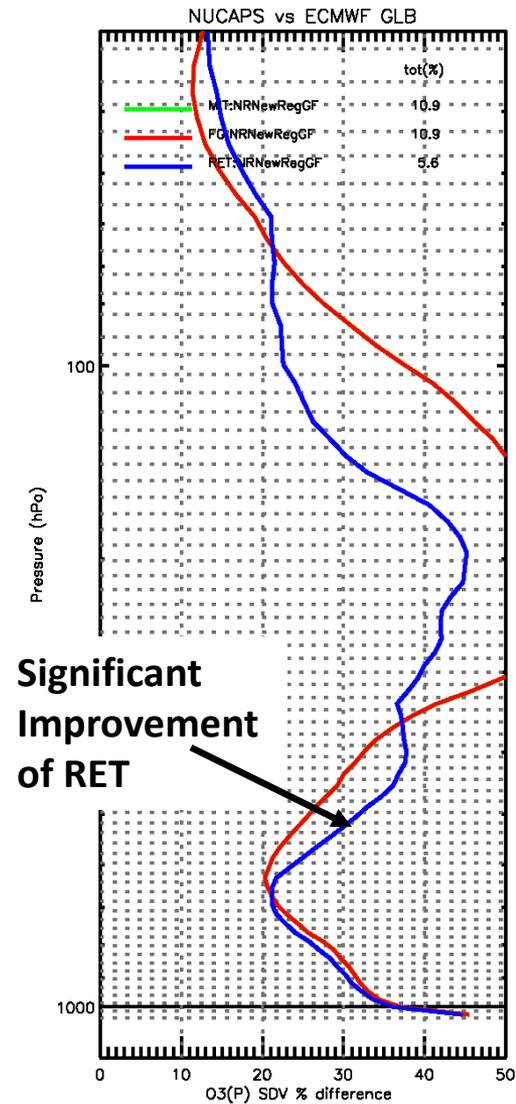
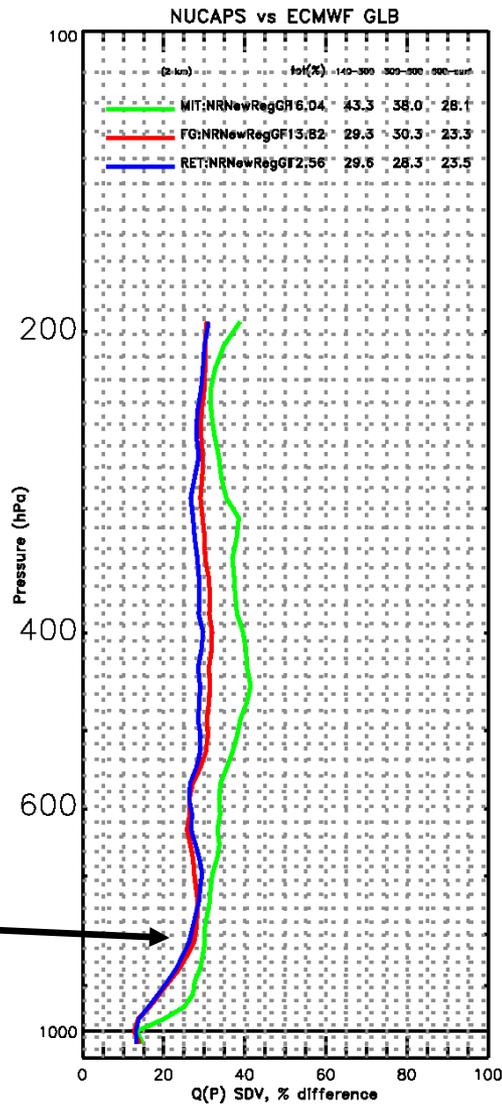
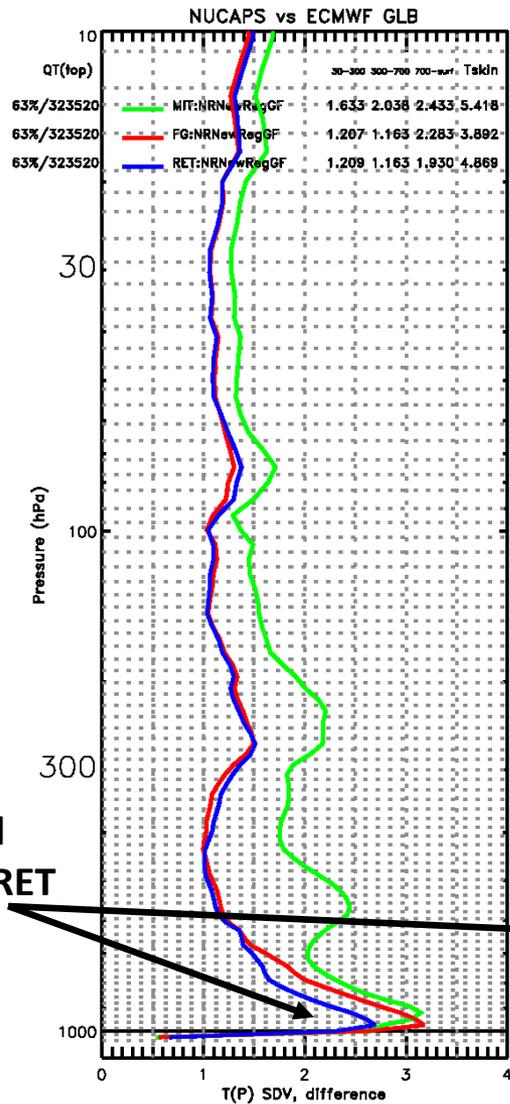


# NUCAPS Nom. Res. Offline Old IR Regression Coeff. vs ECMWF: Stdev (2015-02-17)





# NUCAPS Nom. Res. Offline New IR Regression Coeff. vs ECMWF: Stdev (2015-02-17)

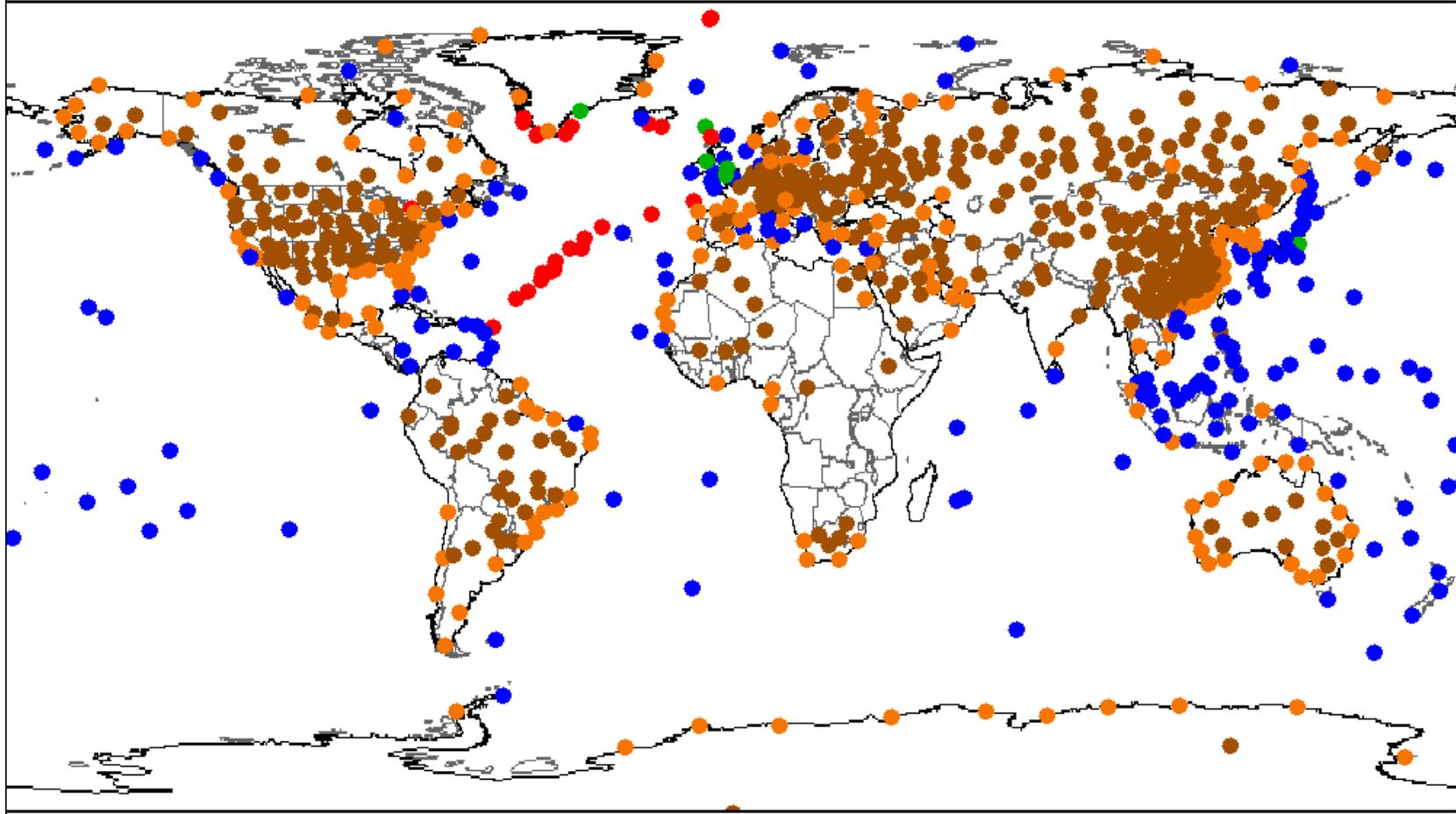


Improved Stdev of RET

## NOAA Products Validation System (NPROVS)

5265 (723) available out of 12414

CoastLandIsland (Coast)Island (Inland)ShipDropsonde

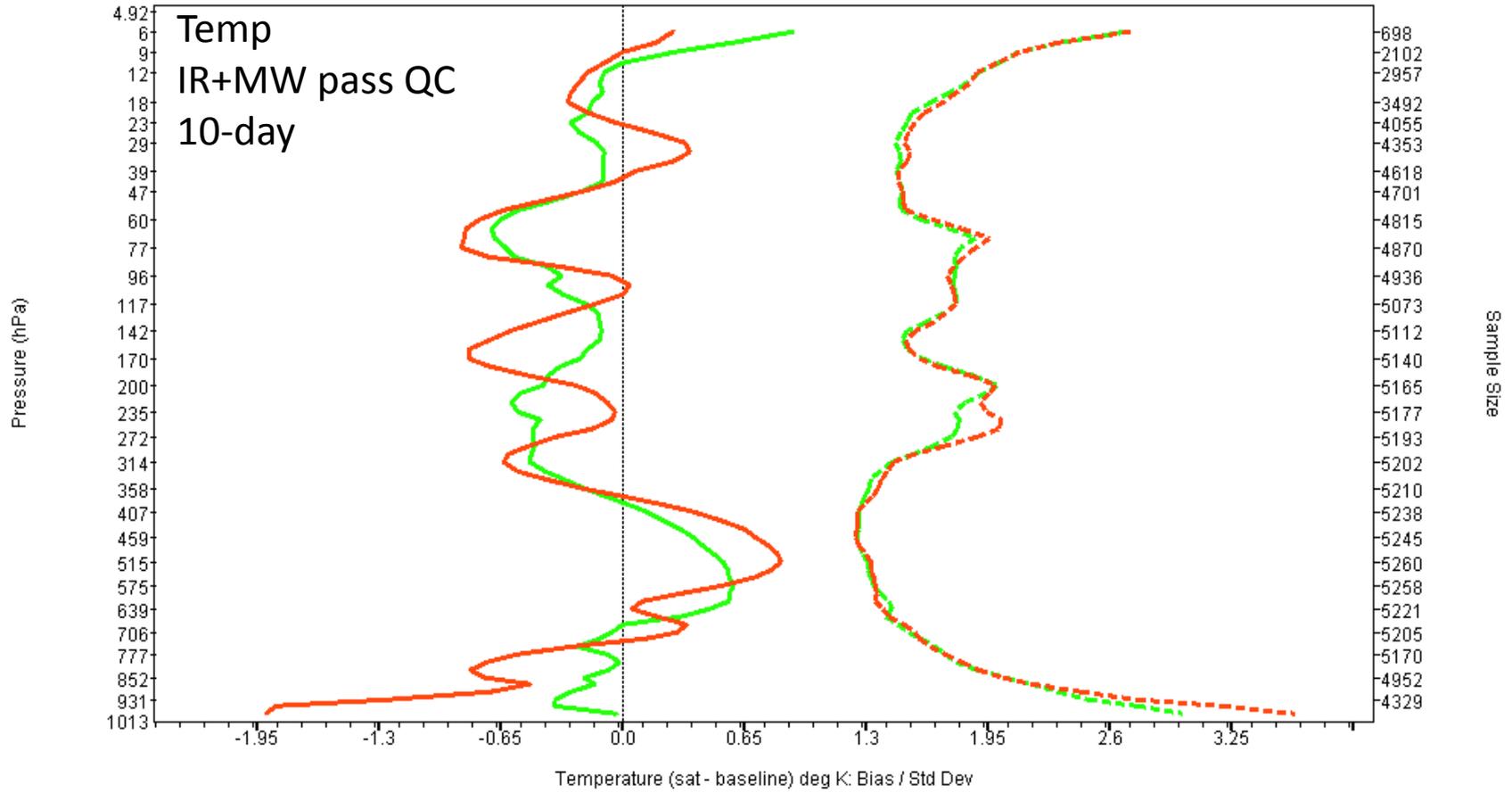


July 15, 2015 (14z) to July 25, 2015 (14z)

10-day sample collocated with NUCAPS IR+MW pass QC including newly deployed NUCAPS parallel (test) system



# NOAA Products Validation System (NPROVS)



Baseline: Radiosonde Radiosonde

NUCAPS

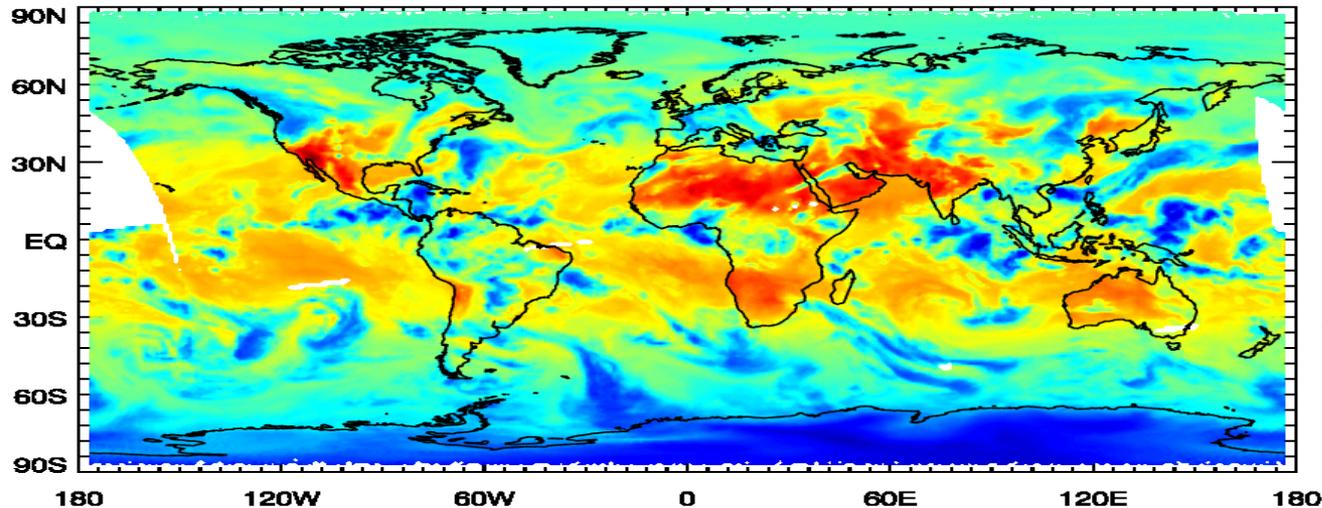
NUCAPS Test



# SNPP CrIS OLR vs CERES OLR, May 21, 2012



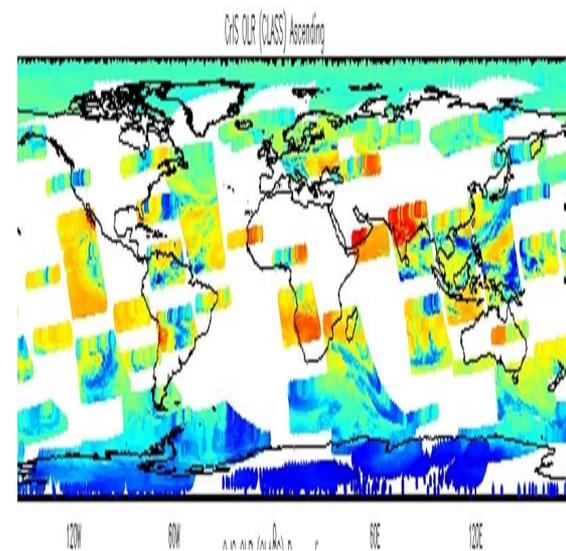
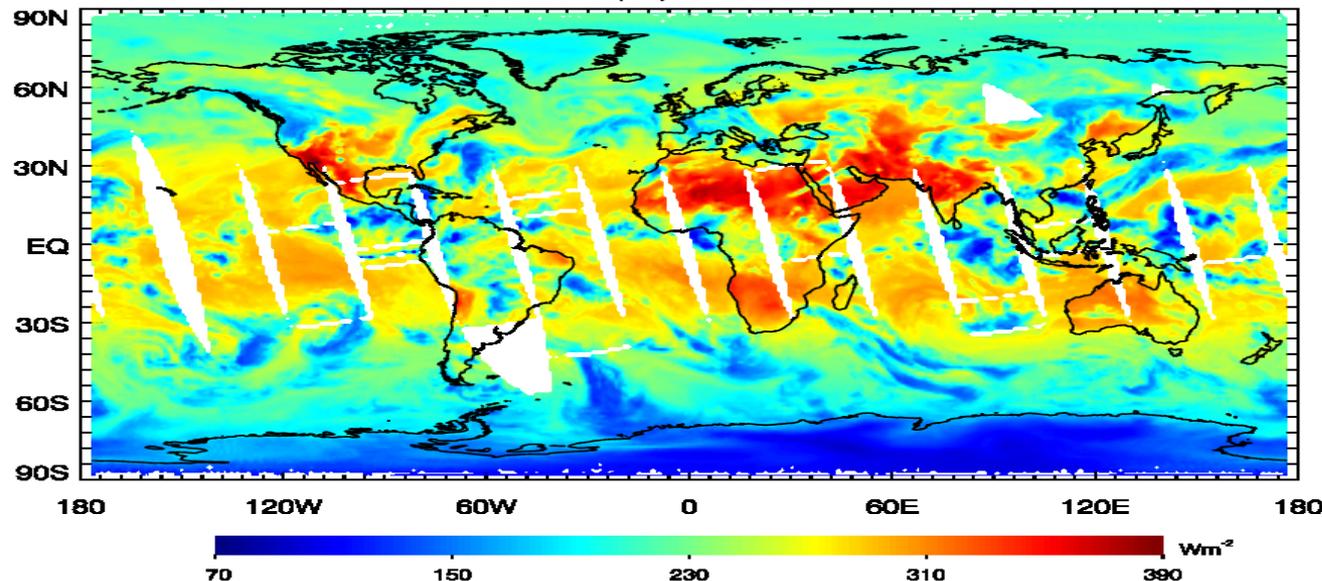
ceres OLR 05/21/2012 ASCENDING



CERES S-NPP FM5 online  
Available from  
January 27 to May 31, 2012.

CrIS SDR has quality before  
June 2012 (see figure below)  
STAR AIT team re-process  
CrIS SDR data using current  
calibration method.

CrIS OLR 05/21/2012 ASCENDING





# Users



- AWIPS-II (Soundings)
  - Atmospheric stability condition for severe storms
  - Nowcasting
  - Alaska (cold core)
  - Monthly telecon with AWIPS forecasters (Bill Sjoberg)
- NOAA/CPC (OLR)
- NOAA/ARL (IR ozone and trace gases)
- TOAST (IR ozone)
- Support CrIS future missions: close spectral gaps between bands, and improve spatial resolution.
- Basic and applied geophysical science research/investigation
  - Users via NOAA CLASS
  - Universities and peer-review publications



# Moving Towards J1



1. Radiative transfer assessment for CrIS full-spectral data
2. NUCAPS upgrade for CrIS full-spectral data
3. Channel selections/subsets
4. Regression coefficient generation
5. Error/uncertainty characterization
6. Product tuning
7. NUCAPS ozone retrieval algorithm improvement and validation
8. Trace gas (CO, CO<sub>2</sub>, and CH<sub>4</sub>) algorithm development for JPSS CrIS
9. J1 product validation (soundings, OLR, trace gases...)
10. Dedicated testbed(s) and intensive field campaigns data for validation



# Summary



- The accuracy of the offline NUCAPS EDRs has been improved.
- NUCAPS development, maintenance, and delivery are on track.
- Unified algorithm is now used for ATMS/CrIS and IASI/AMSU/MHS.
- First comparison between SNPP CrIS OLR and CERES OLR is conducted.
- NUCAPS parallel offline processing at STAR

## Issues:

- Few validation data for trace gas EDRs.



# FY16 SNPP Milestone



- Outgoing long-wave radiation (OLR) EDR validation review
- CrIS ozone algorithm improvement
- IR ozone validation review (provisional)
- NUCAPS upgrades including CrIS full-spectral data
- Trace gas EDRs (CO, CO<sub>2</sub>, CH<sub>4</sub>) algorithm development/improvement
- Aircraft, satellite, dedicated radiosonde campaign for NUCAPS validation
- Maintain dedicated radiosonde for NUCAPS validation



# J2 and Beyond: Future Improvements



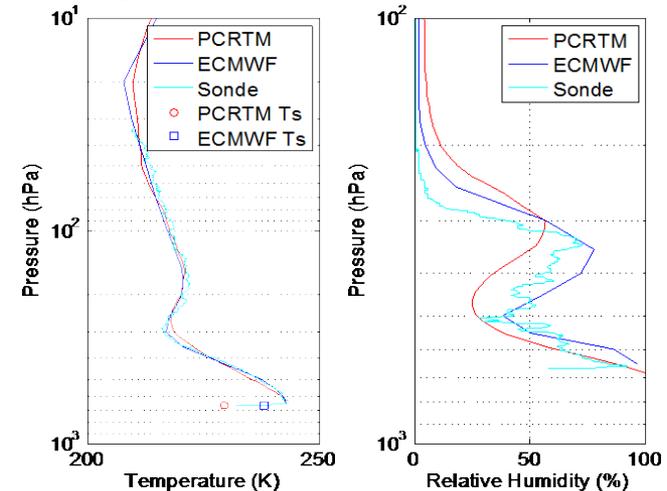
- We support CrIS SDR team and the SDR team studying
  - Close spectral gap: more information for trace gas retrievals
  - More FOVs (6x6 vs 3x3): increase homogeneous observations, significantly increase clear-sky hunting and overcast hunting.
- ATMS/CrIS/VIIRS Retrieval
  - Add cloud information to improve EDRs over cloudy areas
  - High spatial resolution for small-scale severe weather
- Customized Retrievals
  - Better trace gas EDR for air quality studies
  - Fine spatial resolution for small-scale severe weather
  - Selected super retrievals



# Aircraft NAST-I / S-HIS and dropsonde for SNPP EDR Validation



- **SNPP-2 Field Validation Campaign conducted from March 7 to March 31, 2015 over Iceland and Greenland**
    - NUCAPS EDR products
    - METOP-A IASI/AMSU/MHS Level 1 products
    - METOP-B IASI/AMSU/MHS Level 1 products
    - NAST-I hyperspectral IR radiance spectra
    - ECMWF reanalysis data interpolated to CrIS/ATMS, IASI, and NAST footprints
    - Sondes collected for the overpass days
  - **SNPP-1 Field Cal/Val Campaign campaign was conducted during May 2013**
- D. Zhou, X. Liu et al., 2015: First Suomi NPP Cal/Val Campaign: Inter-comparison of Satellite and Aircraft Sounding Retrievals.
- **Single FOV all-sky Retrieval**





# Sounding Session Wednesday Afternoon and Thursday Morning



1550 - 1730	<b>Session 7b: Soundings Breakout Chairs: Mark Liu and Tony Reale Conference Room B/C</b>		
1550 - 1610	<b>JPSS Soundings Product Program and Future Development</b>	Mitch Goldberg	JPSS Program
1610 - 1630	<b>NPROVS Utility in a Variety of Meteorological Cal/Val Scenarios</b>	Tony Reale	STAR
1630 - 1650	<b>Recent Algorithm Enhancements to NUCAPS</b>	Antonia Gambacorta	STC
1650 - 1710	<b>MiRS ATMS Retrievals: Algorithm Updates, Product Assessment, and Preparations for JPSS-1</b>	Chris Grassotti	UMD/ESSIC (STAR)
1710 - 1730	<b>Current SNPP Sounding Products from the Operational System and Way Forward for the JPSS-1 CrIS/ATMS Product</b>	Awdhesh Sharma	OSPO
0830 - 0850	<b>Atmospheric Soundings from JPSS - Retrievals for NWP Data Assimilation</b>	Bill Smith	UW,NASA SSAT
0850 - 0910	<b>Status and Plans for the Processing of CrIS/ATMS at the GSFC SRT</b>	Joel Susskind	NASA GSFC
0910 - 0930	<b>The MTG-IRS Level 2 Processor: Physical Basis, Selected Results, and Planned Evolution</b>	Stephen A. Tjemkes	EUMETSAT
0930 - 0950	<b>An Overview of NASA's Orbiting Carbon Observatory-2 (OCO-2)</b>	Lesley Ott	NASA GSFC
0950 - 1010	<b>NUCAPS Product Validation</b>	Nick Nalli	IMSG (STAR)
1010 - 1030	<b>Break</b>		
1030 - 1050	<b>Evaluation of NUCAPS within high impact mesoscale events: overview of the CalWater-2015 field campaign</b>	Chris Barnet	STC
1050 - 1110	<b>Applications Using Satellite Sounder Products at the NASA SPoRT Center</b>	Emily Berndt	NASA SPoRT
1110 - 1130	<b>NUCAPS Demonstration at the HWT 2015 Spring Experiment</b>	Bill Line	SPC
1130 - 1150	<b>The Utility of NUCAPS in Operational Forecasting</b>	Dan Nietfeld	NWS
1150 - 1210	<b>OLR for NOAA Precipitation Verification</b>	Pingping Xie	CPC
1210 - 1230	<b>Trace Gas Applications to Air Quality Forecasting</b>	Pius Lee	ARL