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# The Use of Reference and Dedicated Radiosondes for the Validation of Satellite Derived Sounding Products

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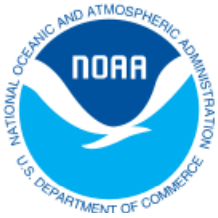
The annual EUMETSAT Meteorological Satellite Conference, Geneva, Switzerland, September 22-26, 2014.



# Outline

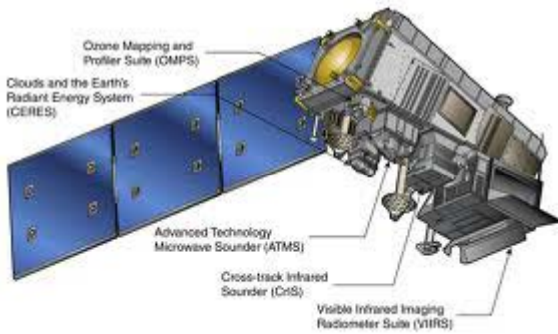
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- 1. NOAA Retrieval Sounding Systems.**
- 2. The NOAA Validation System.**
- 3. The Use of Dedicated/Reference RAOBs.**
- 4. Validation Results using Dedicated/Reference RAOBs.**
- 5. Summary.**

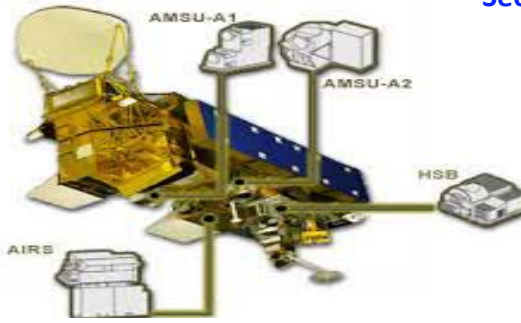


# The NOAA Unique Hyper-spectral (MW/IR) Retrieval Sounder System

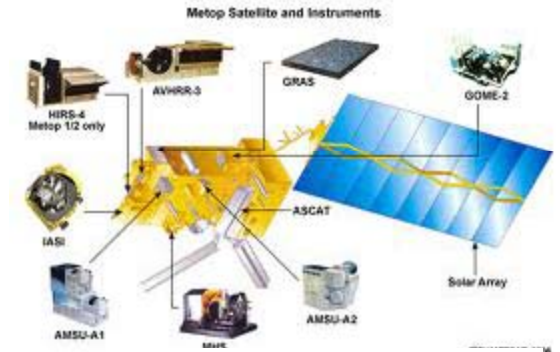
See A. Gambacorta et al., Sep.25 EUMETSAT 2014.



**S-NPP CrIS/ATMS**



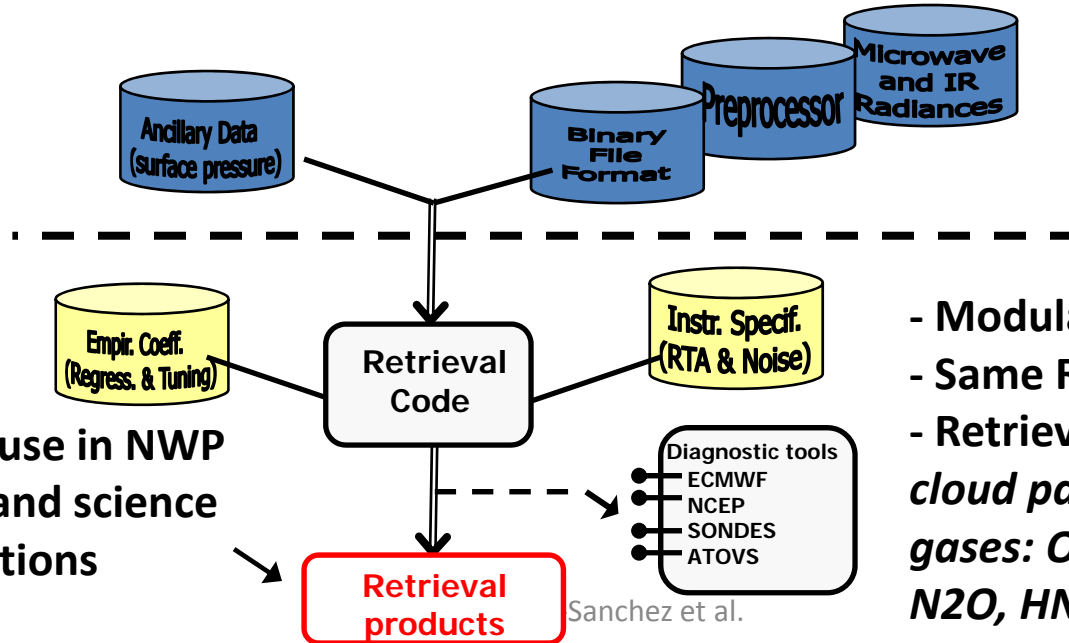
**AQUA AIRS/AMSU**



**Metop-A,B  
IASI/AMSU/MHS**

**NUCAPS**  
NOAA Unique  
CrIS/ATMS  
Processing  
System

**The NOAA Unique Hyper-spectral Retrieval Sounder System**



For potential use in NWP  
assimilation and science  
applications

- Modular design.
- Same Retrieval Algorithm.
- Retrieved Products: T, Q, cloud parameters, trace gases: O3, CO, CH4, CO2, N2O, HNO3, SO2



# The NOAA Microwave Integrated Retrieval System (MiRS)



## Assimilation/Retrieval

MetOp-A AMSU/HSR  
MetOp-B AMSU/MHS

- All parameters retrieved simultaneously
- Valid globally over all surface types
- Valid in all weather conditions
- Retrieved parameters depend on information content from sensor frequencies

DMSP F16 SSMI/S  
DMSP F17 SSMI/S  
DMSP F18 SSMI/S

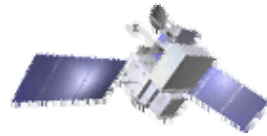
## Inversion Process

- Consistent algorithm across all sensors
- Uses CRTM for forward and jacobian operators
- Use forecast, fast regression or climatology as first guess/background

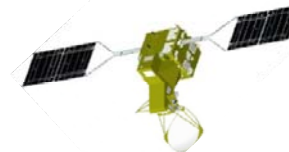
NOAA-18 AMSU/MHS  
NOAA-19 AMSU/MHS

MiRS

TRMM TMI



GPM GMI

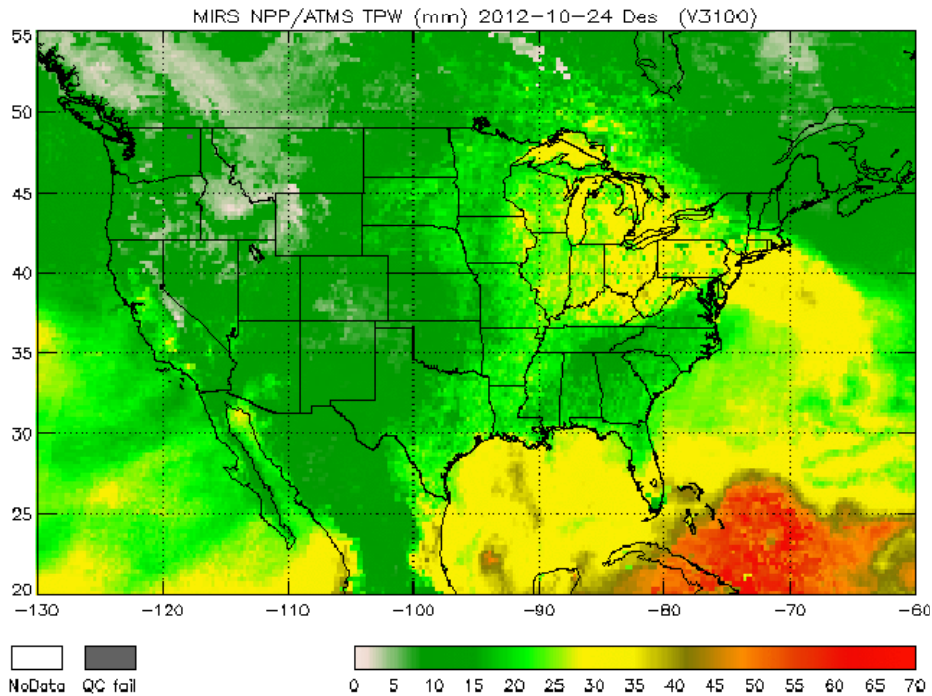


GCOM-W1 AMSR2

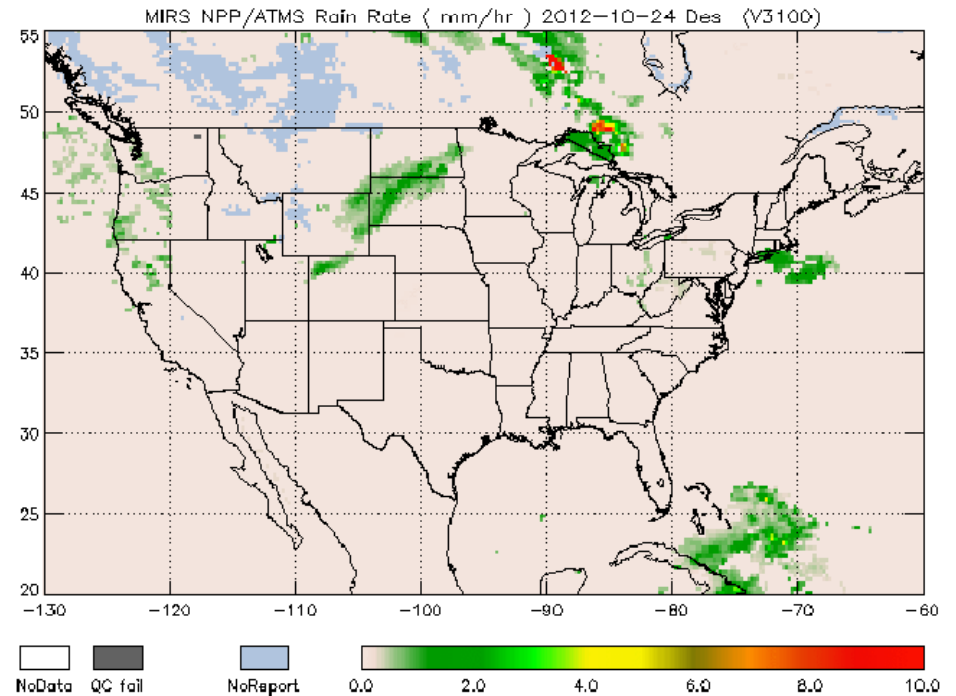


# NOAA Satellite-based Environmental Data Products (EDR) Products: Hurricane Sandy

### MiRS NPP/ATMS TPW



### MiRS NPP/ATMS Rainfall Rate



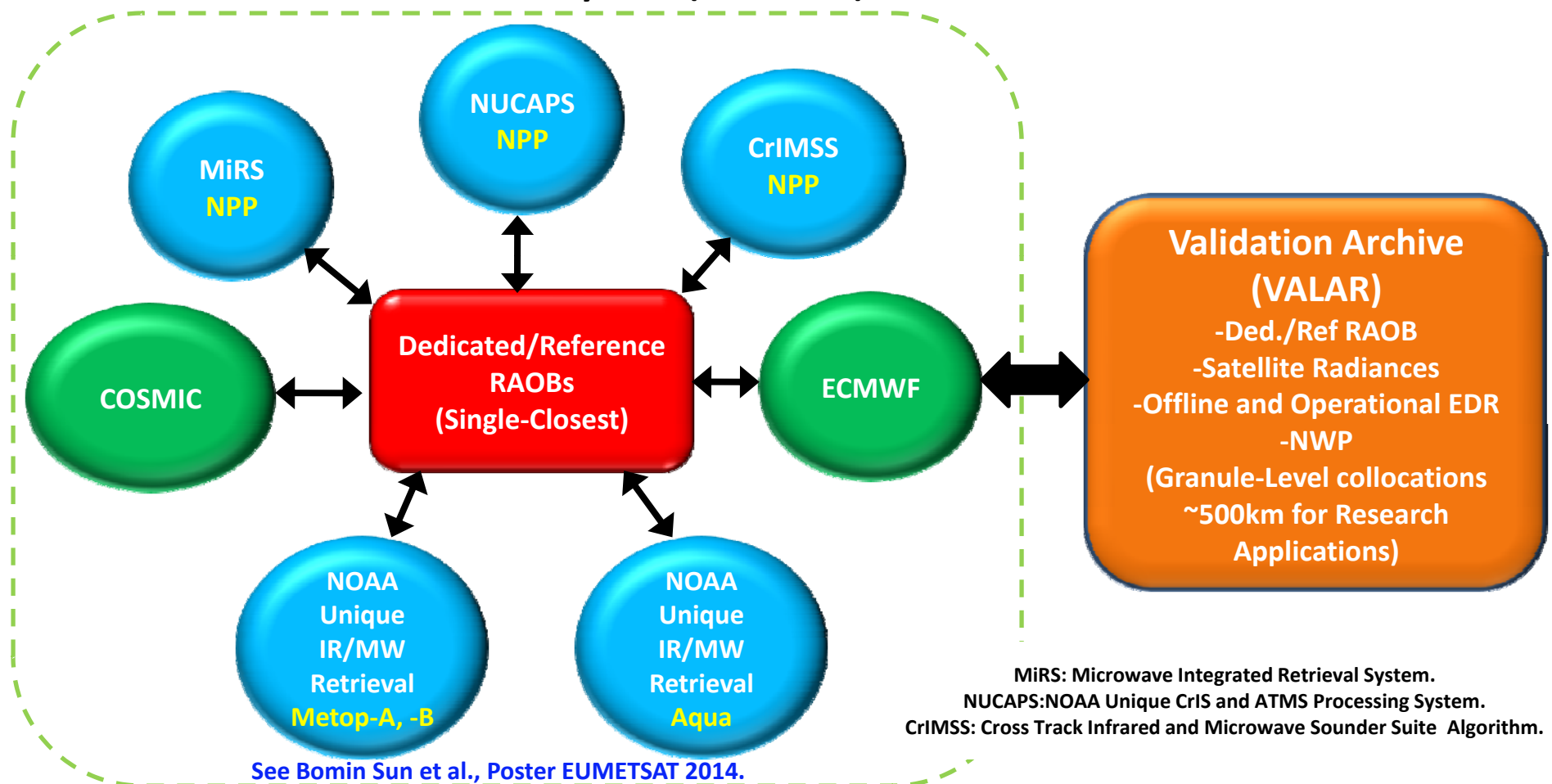
### MiRS: Microwave Integrated Retrieval System

S.-A. Boukabara, K. Garrett, C. Grassotti, F. Iturbide-Sanchez, W. Chen, Z. Jiang, S. A. Clough, X. Zhan, P. Liang, Q. Liu, T. Islam, V. Zubko,3 and A. Mims, "A physical approach for a simultaneous retrieval of sounding, surface, hydrometeor, and cryospheric parameters from SNPP/ATMS," *Journal of Geophysical Research: Atmospheres*, vol. 118, 1–20, Nov. 2013.



# The NOAA Validation System using Dedicated/Reference RAOB

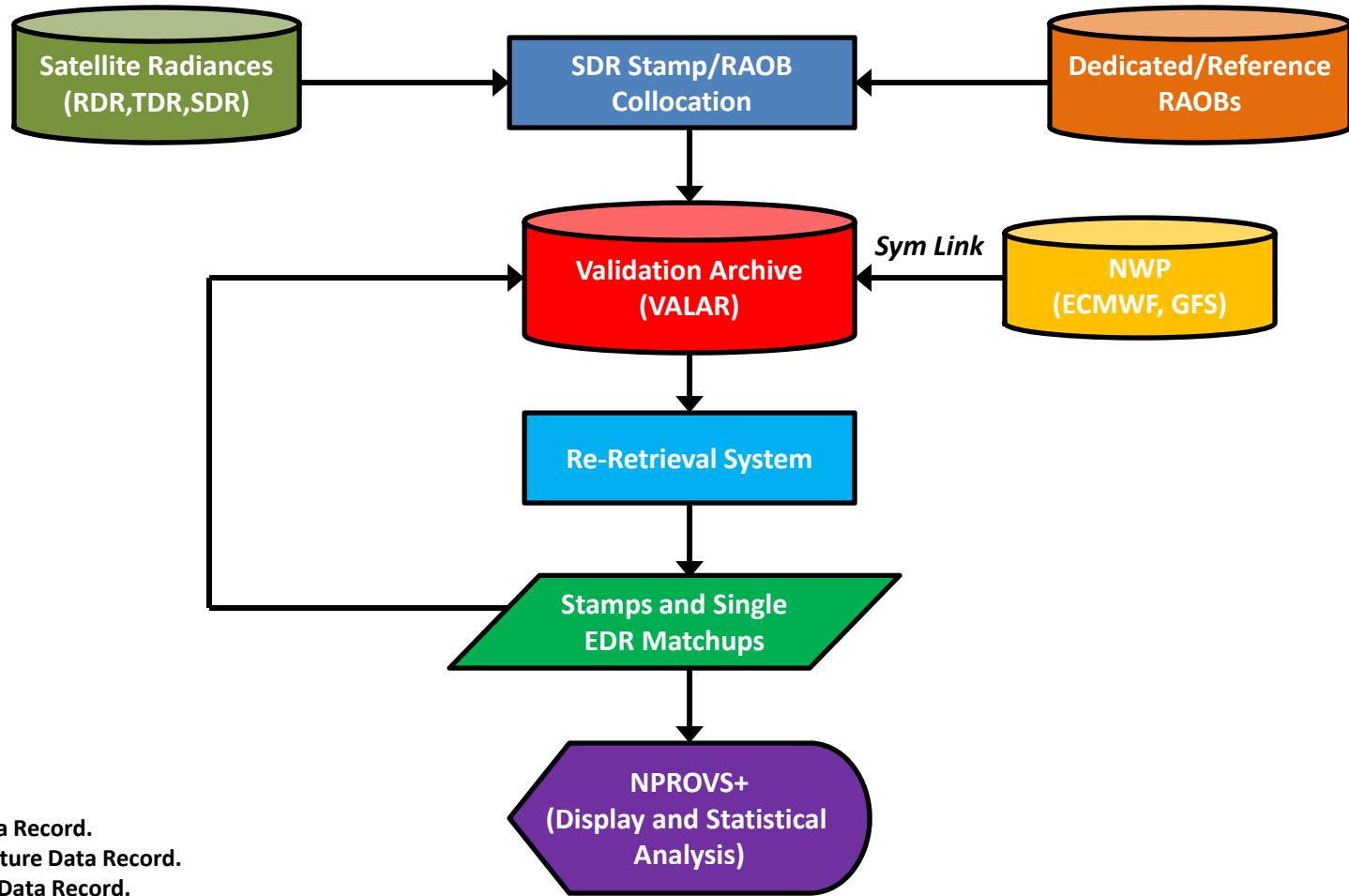
## NOAA Product Validation System (NPROVS+)



- Sondes dedicated to satellite overpasses for the purpose of Validation produce minimal mismatch errors.
- Ideally provide independent correlative data not assimilated into NWP models.
- Support the characterization/monitoring of EDR products over a long-term period.



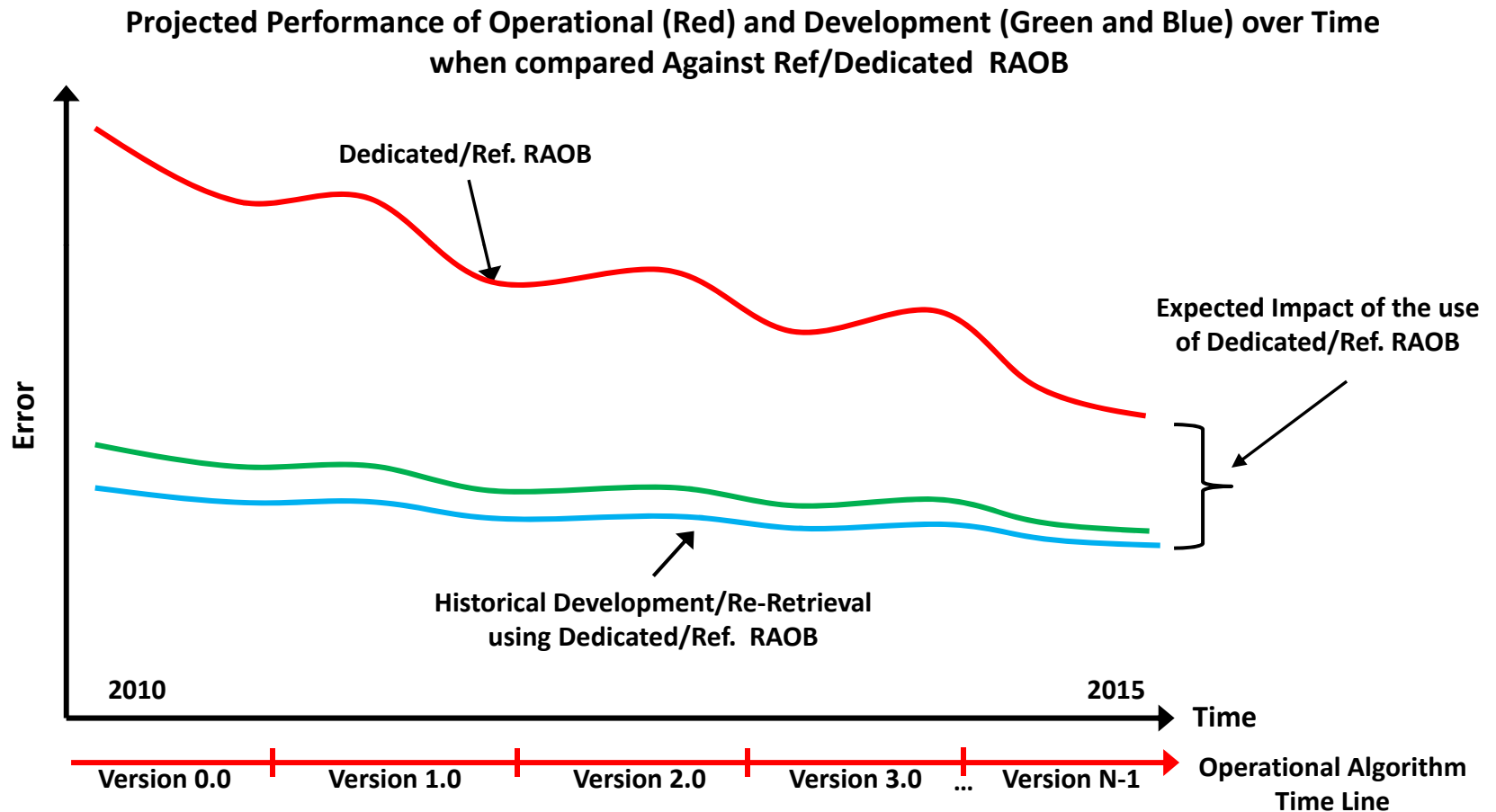
# Description of the Re-retrieval Process Using the Validation Archive (VALAR)



RDR: Raw Data Record.  
TDR: Temperature Data Record.  
SDR: Satellite Data Record.  
EDR: Environmental Data Record.



# Projected Performance of Retrieval Algorithms Using Dedicate/Reference RAOB to Guide EDR Validation and Development



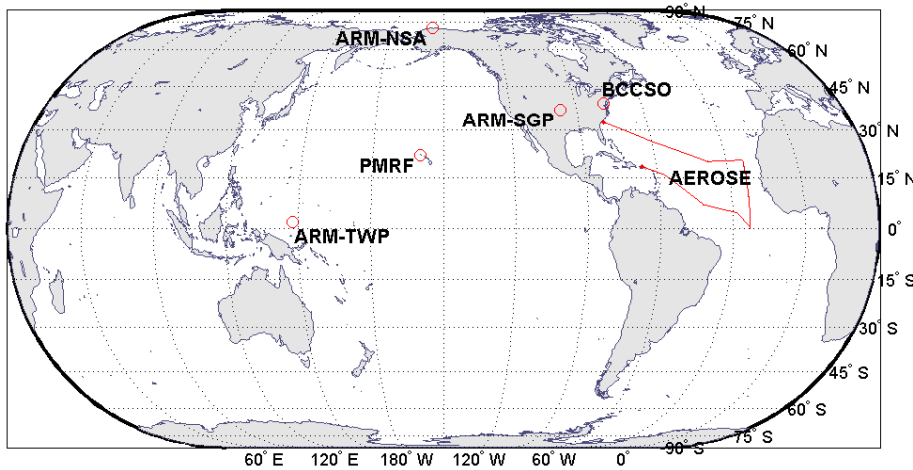




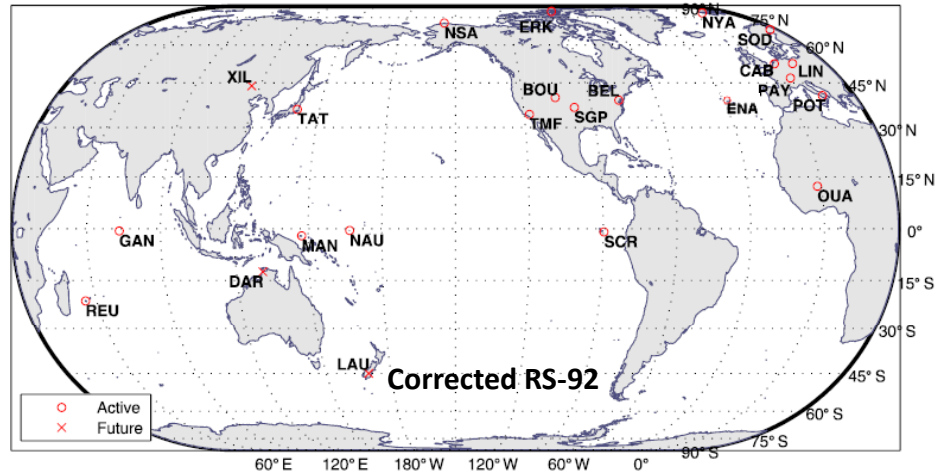
# Location of Dedicated/References Radiosondes

See N. Nalli et al., Sep24 EUMETSAT 2014.

**S-NPP CrIMSS EDR ICV Dedicated RAOB Sites (Year 1)**



**GRUAN RAOB Sites for Sounder EDR ICV**



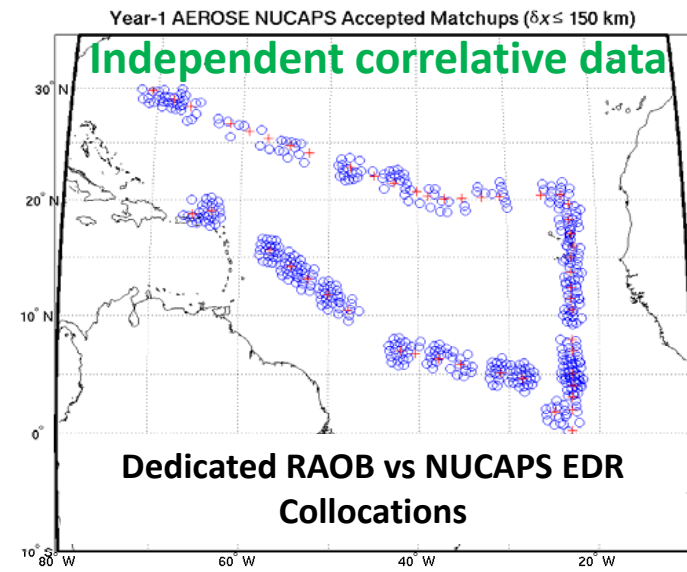
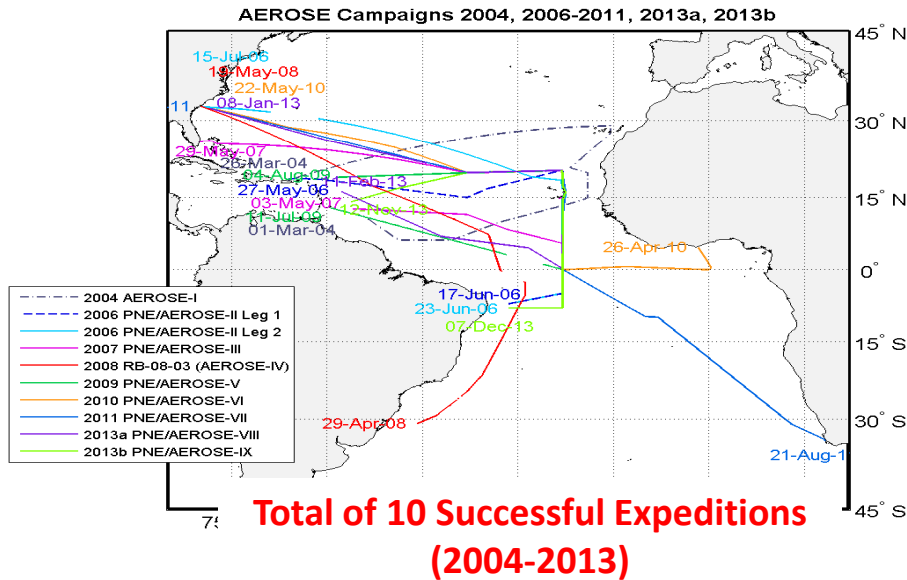
N. Nalli et al., JGR, Validation of satellite sounder environmental data records, Dec. 2013.

## Suomi National Polar-orbiting Partnership (S-NPP) Dedicated RAOB Sites Year 1 for EDR Intensive Cal/Val (ICV)

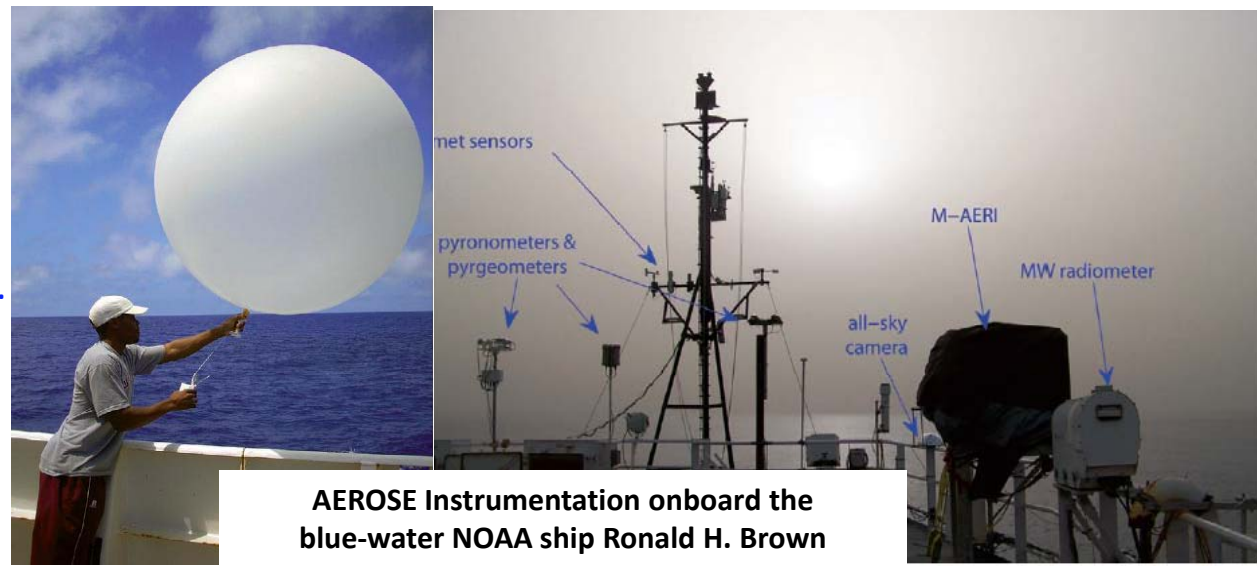
	ARM-TWP	ARM-SGP	ARM-NSA	PMRF	BCCSO	NOAA AEROSE
<b>Location</b>	Manus Island, Papua New Guinea	Ponca City, Oklahoma, USA	Barrow, Alaska, USA	Kauai, Hawaii, USA	Beltsville, Maryland, USA	Tropical North Atlantic Ocean
<b>Regime</b>	Tropical Pacific Warm Pool, Island	Midlatitude Continent, Rural	Polar Continent	Tropical Pacific, Island	Midlatitude Continent, Urban	Tropical Atlantic, Ship
<b>n Planned</b>	90	90 × 2	90 × 2	40	Ad hoc	≈ 60–100
<b>N acquired</b>	94	95 + 93	95 + 91	40	31	69
<b>N<sub>BE</sub> acquired</b>	80	89	90	—	—	—
<b>Time Frame</b>	Aug 2012 – Jun 2013	Jul–Dec 2012	Jul–Dec 2012	May, Sep 2012	Jun 2012 – Feb 2013	Sep 2012 Jan–Feb 2013



# Dedicated RAOBs: The NOAA Aerosols and Ocean Science Expeditions (AEROSE)



N. Nalli et al., BAMS, Jun 2011.



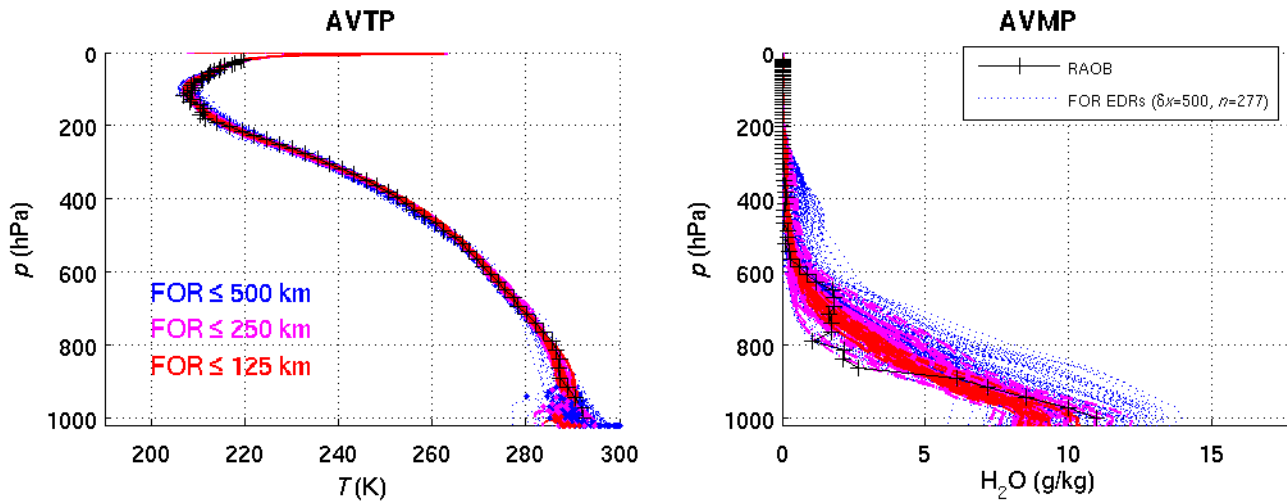
**AEROSE Instrumentation onboard the blue-water NOAA ship Ronald H. Brown**



# Sensitivity of Collocations to Distance Threshold

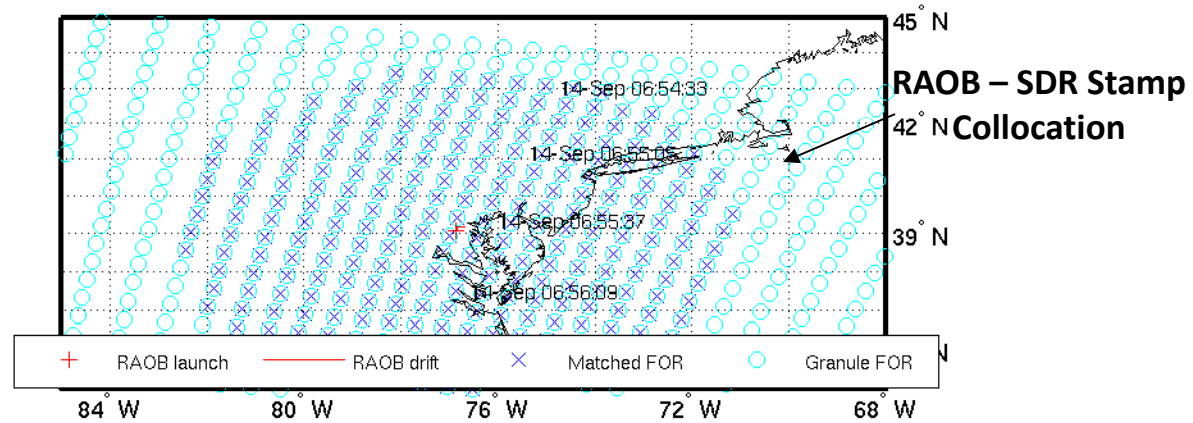
## NUCAPS vs Dedicated RAOBs

BCCSO RAOB 14-Sep-2012 06:25:00



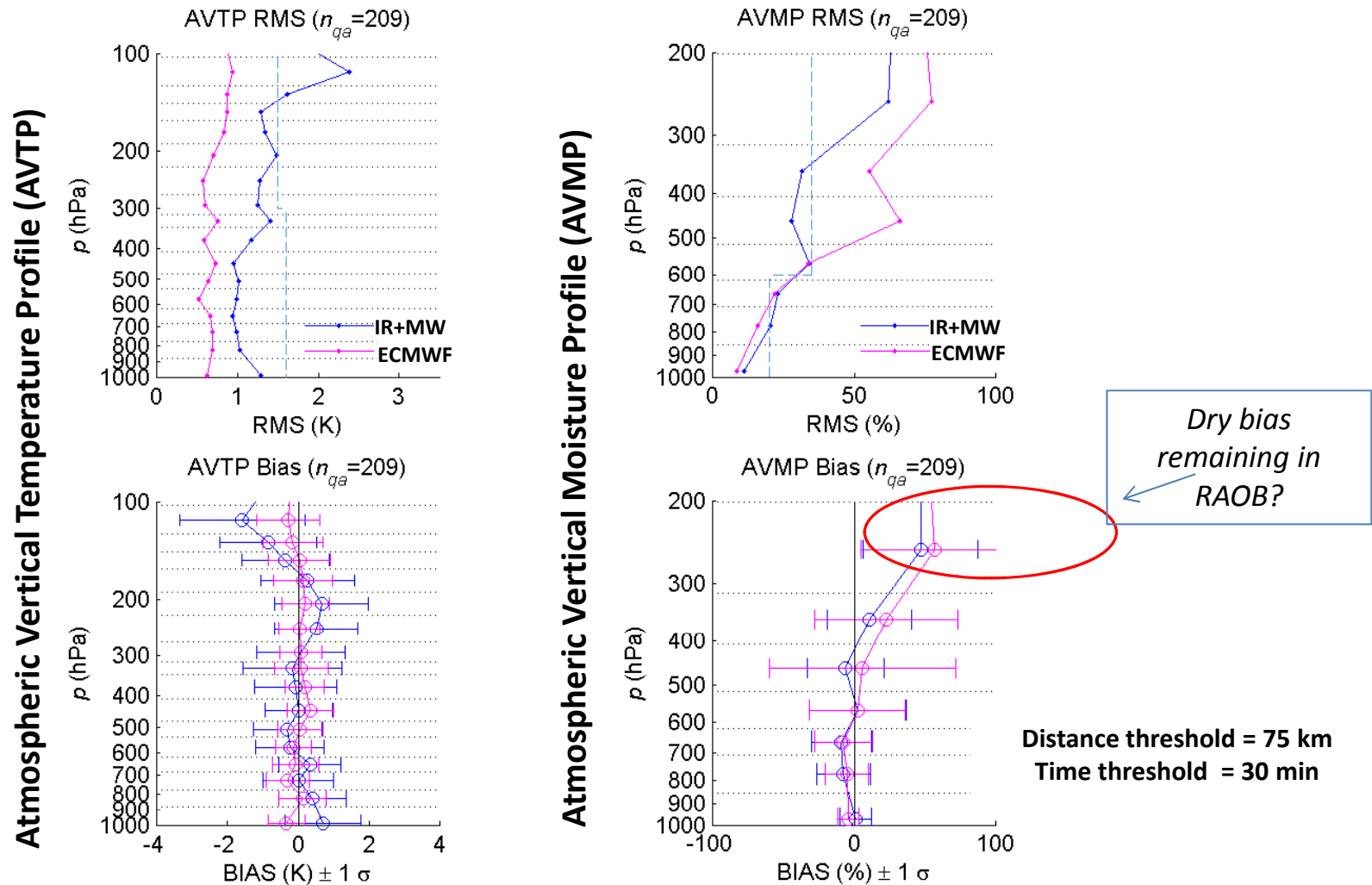
RAOB Launch Locations and CrIMSS FOR

Time threshold  $< \pm 45$  min



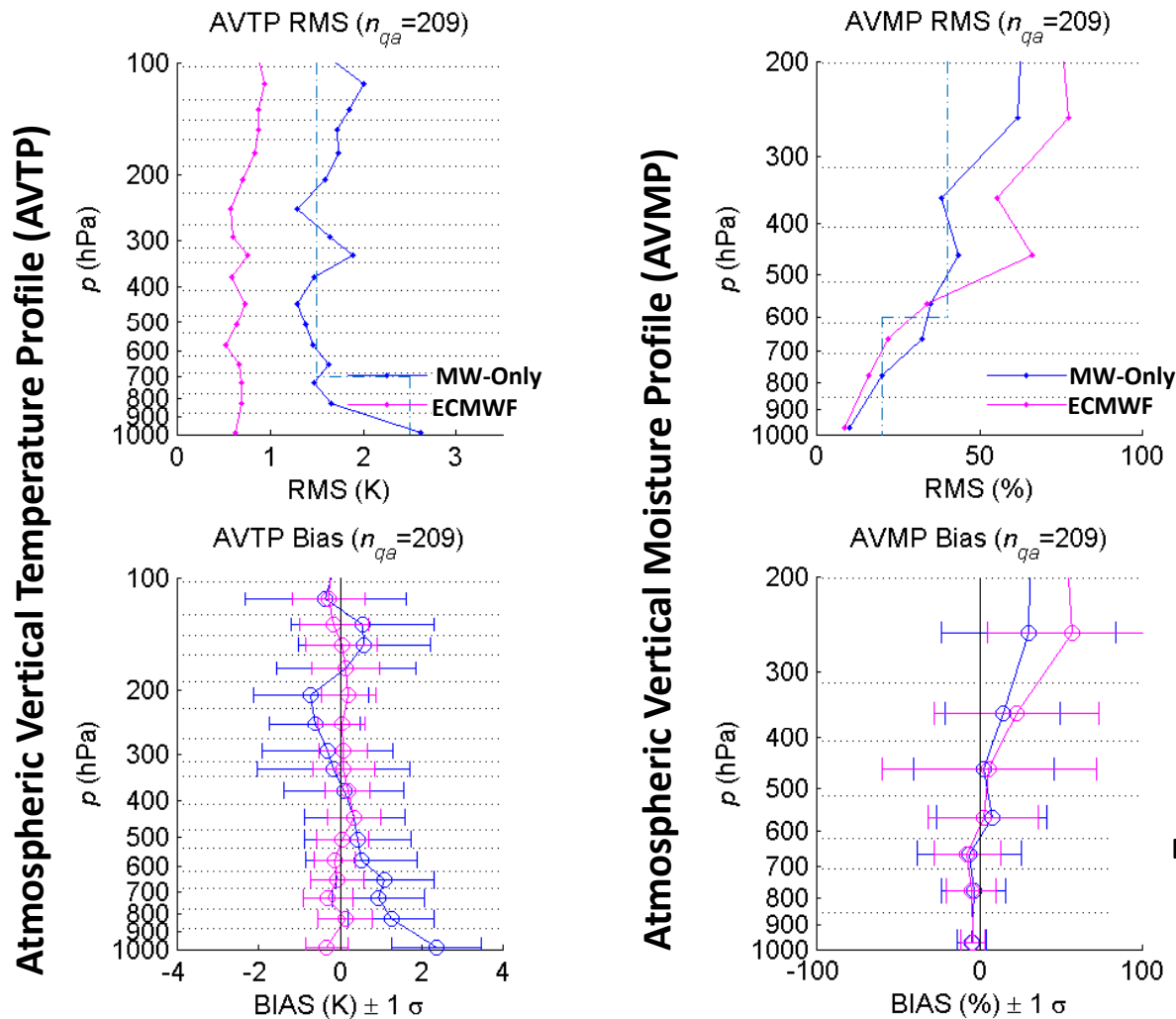


# Validation of the *Offline NUCAPS v1.0 IR+MW* versus AEROSE Dedicated/GRUAN-Corrected (Jan-Feb, Nov-Dec 2013)



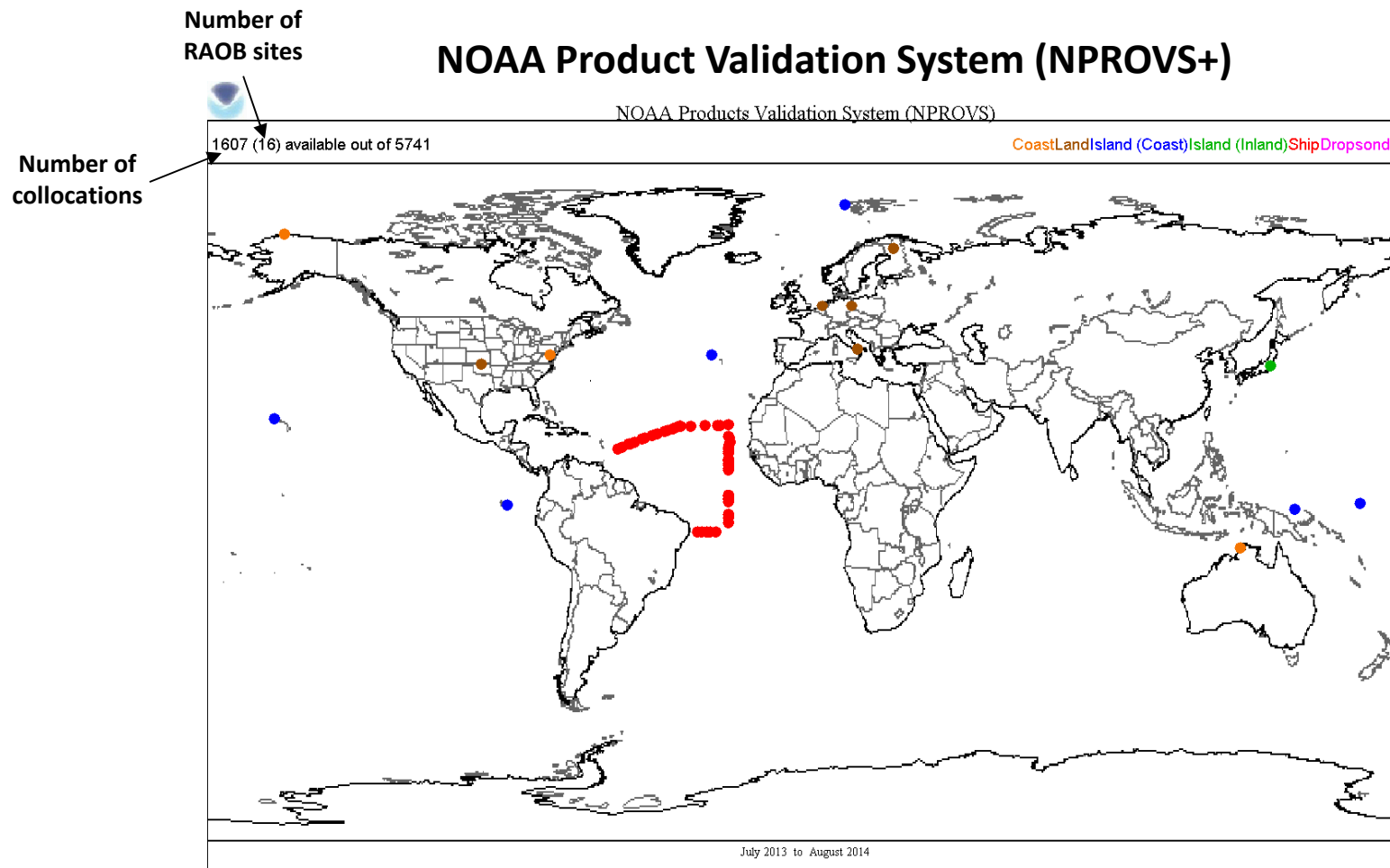


# Validation of the *Offline NUCAPS v1.0 MW-Only* versus AEROSE Dedicated/GRUAN-Corrected (Jan-Feb, Nov-Dec 2013)





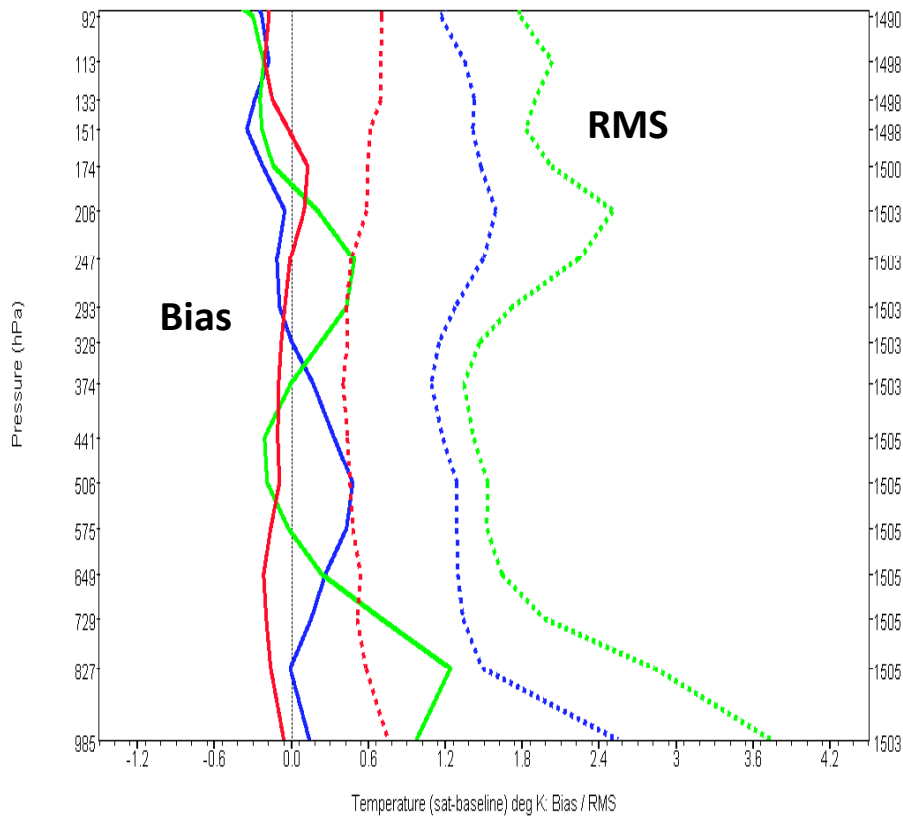
# EDR Validation Results using *Single-Closest* Matchups with Dedicated/Reference RAOBs Globally Distributed over 1-Year





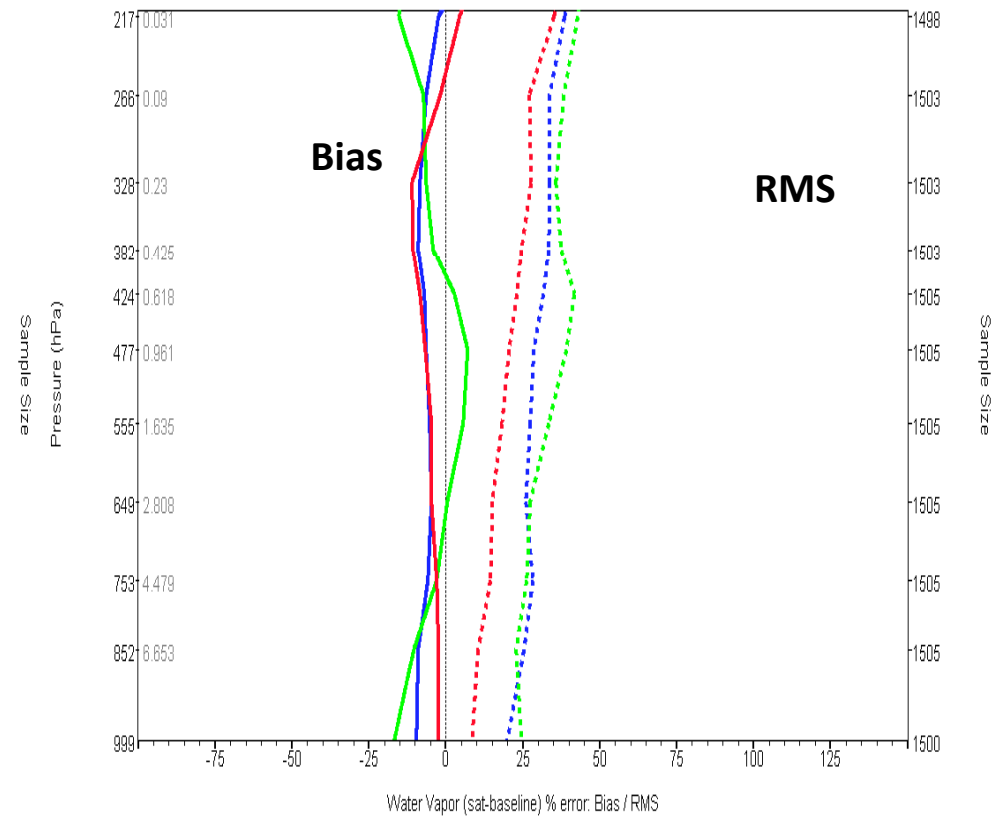
# Performance of NOAA Retrieval Sounding Systems Against Dedicated/Reference RAOBs over 1-Year

## Atmospheric Temperature



Baseline: REFERENCE GRUAN RAOB

## Atmospheric Water Vapor



Baseline: REFERENCE GRUAN RAOB

ECMWF-Analysis MiRS NPP (MW) NUCAPS (IR+MW)

ECMWF-Analysis MiRS NPP (MW) NUCAPS (IR+MW)

Based on 30-layers profiles

24/10/2014

F. Iturbide-Sanchez et al.

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# Summary

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- **At NOAA/NESDIS/STAR we are implementing tools and datasets for the validation of Satellite Derived Sounding Products using Dedicated/Reference RAOBs.**
- **We are creating a global data set of Dedicated/Reference RAOBs (VALAR) for the long term evaluation of satellite derived products (seasonal and regional studies).**
- **The validation system is intended to support the development and improvement of current and future satellite derived sounding products.**