NOAA Products Validation System + (NPROVS+)
Outline

• GRUAN data
• Dedicated Data
• Routine Processing
• EDRs and SDRs
• Analytic Interface (EDGE)
• Collocation Strategy
• “K” uncertainty Analysis
• Results / Outreach
GCOS “Reference” Upper AIR Network (GRUAN)

GRUAN 6th International Coordination Meeting (ICM-6) March 10-14, GreenBelt, Hilton
... special Tuesday session on satellite synergies

... sites provide reference radiosonde (RS92) plus ancillary ground (lidar, MWR, FTIR ...) observations, adherence to best measurement practices GRUAN Manual and Measurement Guideline documents) including specification of “Measurement Uncertainty” with plans for up to 40 sites (5+ years)
EDR Validation

Dedicated S-NPP RS92 RAOB funded by JPSS CrIMSS Project

<table>
<thead>
<tr>
<th>Location</th>
<th>ARM-TWP</th>
<th>ARM-SGP</th>
<th>ARM-NSA</th>
<th>Location</th>
<th>ARM-TWP</th>
<th>ARM-SGP</th>
<th>ARM-NSA</th>
<th>PMRF</th>
<th>BCCSO</th>
<th>NOAA</th>
<th>AEROSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manus Island, Papua New Guinea</td>
<td>Ponca City, Oklahoma, USA</td>
<td>Barrow, Alaska, USA</td>
<td>Location</td>
<td>Manus Island, Papua New Guinea</td>
<td>Ponca City, Oklahoma, USA</td>
<td>Barrow, Alaska, USA</td>
<td>Kauai, Hawaii, USA</td>
<td>Beltsville, Maryland, USA</td>
<td>Tropical North Atlantic Ocean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regime</td>
<td>Tropical Pacific Warm Pool, Island</td>
<td>Midlatitude Continent, Rural</td>
<td>Polar Continent</td>
<td>Regime</td>
<td>Tropical Pacific Warm Pool, Island</td>
<td>Midlatitude Continent, Rural</td>
<td>Polar Continent</td>
<td>Tropical Pacific, Island</td>
<td>Midlatitude Continent, Urban</td>
<td>Tropical Atlantic, Ship</td>
<td></td>
</tr>
<tr>
<td>Planned N</td>
<td>90</td>
<td>180</td>
<td>180</td>
<td>Planned N</td>
<td>90</td>
<td>180</td>
<td>180</td>
<td>40</td>
<td>—</td>
<td>60–120</td>
<td></td>
</tr>
<tr>
<td>Launched n</td>
<td>42</td>
<td>92</td>
<td>93</td>
<td>Launched n</td>
<td>42</td>
<td>92</td>
<td>93</td>
<td>40</td>
<td>23</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Launch n 1</td>
<td>—</td>
<td>88</td>
<td>90</td>
<td>Launch n 1</td>
<td>—</td>
<td>88</td>
<td>90</td>
<td>—</td>
<td>—</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

NPP CrIMSS EDR ICV Dedicated RAOB Sites

... ongoing re-structure of ARM scheduling to provide “sustained” year round coverage
STAR (Tilley) and LC (Sommer) coordinate on access of RS92 from ARM and their access for NPROVS+ via LC

STAR and CIMSS (Tobin, Borg) oversee the scheduling and launches of dedicated launches at ARM sites, recently modified to provide year round coverage; JPSS funded provided through sounding product cal/val program

Similarly, JPSS supports AEROSE campaign (and PMRF) launches (N Nalli)
NOAA Products Validation System (NPROVS)

2278 (13) available out of 2278

CoastLandIsland (Coast) Island (Inland) ShipDropsonde

July 14, 2013 to January 19, 2014

378 dedicated, 1900 GRUAN
NOAA Products Validation System (NPROVS)

2430 (149) available out of 12728

CoastLand Island (Coast) Island (Inland) Ship Dropsonde

September 30, 2013 (14s) to October 10, 2013 (23s)

GUAN Monitoring
EDR Validation

NPROVS+ Collocation Dataset

- MiRS NPP
- NUC NPP
- IDPS NPP
- ECMWF
  - GTS (CFSR+GFS)

- Dual Reg
- Dedicated + Reference + COSMIC

- IASI (NOAA)
- AIRS v6

- Daily; 14-day delay
  - (NetCDF / HDF5)

- NUCAPS stamp
- IDPS stamp
- AIRS stamp
- IASI stamp

SDRs: CrIS, ATMS, VIIRS, AIRS, MODIS, IASI, AVHRR...

GTS (CFSR+GFS)

Daily; NRT (conventional)
EDR Validation

User ARCHIVE

14-day delay
Ded / Ref Collocations

Operation

Append Stamps (granule, SDR ...)

Project

Re-Retrieve

VALAR
Ded / Ref Collocation, ReRet (1, i)

Algorithm Development

"single closest"

NPROVS+ ... unified validation and development

PDISP, NARCS, ODS, other...

NUMAPS, IDPS, IASI, AIRS, DualR ... MiRS
ICVS: Long-Term Sensor Calibration/Validation Monitoring (SDR) from Space (http://www.star.nesdis.noaa.gov/icvs/index.php)
• Sounding is performed on 50 km field of regard (FOR).
• FOR is currently defined by the size of the microwave sounder footprint.
• IASI/AMSU has 4 IR FOV’s per FOR
• AIRS/AMSU & CrIS/ATMS have 9 IR FOV’s per FOR.
• ATMS is spatially over-sampled and can emulate an AMSU FOV.
NPROVS Analytical Interface …

... routine monitoring to deep dive
Collocation Strategy

- Reference/dedicated RAOB (RS92) is anchor
- Raw, Digicora, GRUAN, GTS (4 flavors)
- Append Ancillary
- Compress to 1km layers (also retain original hi-density)
- Single closest satellite EDR
- NWP (GFS 6-hr, CFSR and ECMWF Anal) …
- For hyperspectral (S-NPP, MeTop, Aqua) append all EDRs within 500km of RAOB
- Append SDR (traceable to ICVS) within 500km
EDR Validation

NPROVS+

NOAA Products Validation System (NPROVS)

2141 (12) available out of 2141

CoastLand Island (Coast) Island (Inland) Ship Dropsonde

July 14, 2013 to December 18, 2013

2050 collocations (350 Dedicated, 1700 GRUAN) ... 5mos
GRUAN Reference Measurement Principles

Consistency in a Finite Atmospheric Region

Co-location / co-incidence:

Determine the variability ($\sigma$) of a variable ($m$) in time and space from measurement or model

Two observations on different platforms are consistent if

$$|m_1 - m_2| < k \sqrt{\sigma^2 + u_1^2 + u_2^2}$$

... at this preliminary stage:

$$K = \frac{\text{ABS}(X - \text{GRUAN})}{\text{Uncertainty (u1)}}$$

where “$X$” either SAT or NWP

“need uncertainty estimates for EDR”
EDR Validation Results

NOAA Products Validation System (NPROVS)

July 14, 2013 to December 18, 2013

RMS

“K”

Baseline: REFERENCE SONDE GRUAN RAOB

CRIMSS NPP Infrared (IP)  ECMWF ANALYSIS  NUCAPS NPP TEST

Baseline: REFERENCE SONDE GRUAN RAOB

CRIMSS NPP Infrared (IP)  ECMWF ANALYSIS  NUCAPS NPP TEST

GRUAN only ... Include Uncertainty Estimates ... “K” Profiles
EDR Validation Results

COSMIC / GRAS
(Stratosphere Reference from Space ...)

Illustration of the closest (black square), circular (blue circle), and ray path (red dots) methods for a single GPS profile (green) for the circle centered at the GPS RO level of 100 hPa

http://www.cosmic.ucar.edu/launch/GPS_RO_cartoon.jpg

One Day of COSMIC Profiles

courtesy Knuteson / Feltz CIMSS
• Integrate STAR (Weng, Reale) and CIMSS (Knuteson / Feltz) approaches

• EDR and SDR

• GPS RO provides Reference for EDR, SDR and RTM
Lin, 0Z, nite
Vaisala RS92

difference from COSMIC T

All sample

Pressure (hPa)

Raob-minus-COSMIC

57,200 profiles

Sun angle

night
day

ΔT (K)
Seasonal variation in bias is bigger at nighttime:
Summer relatively warmer than winter
NPROVS
Profile evaluation

- Comparison of IASI and NWP forecast with RAOB.

NOAA Products Validation System (NPROVS)

December 1, 2010 to December 31, 2011

Water Vapor (sat-baseline) % error: Bias

Baseline: RAOB Radiosonde

RAOB CFSR Forecast
GRUAN RAOB GRUAN RAOB
IASI NOAA

RAOB CFSR Analysis
COSMIC UCAR

RAOB GFS Forecast
COSMIC UCAR GFS Forecast

Courtesy: Tony Reale et al., NOAA, presented at GRUAN ICM5
Building High-Quality Climate Data Records from Operational Satellites

Fuzhong Weng
NOAA Center for Satellite Applications and Research

Seminar at ESSIC/UMD
March 5, 2014, 12:00pm - 01:00pm
1D-Var Derived Temperature Trend

Summary

• NPROVS+ on 14-day delay

• EDR and SDR collocated to each Reference

• Open to expansion

• Collocation sampling through

• Results
Characterization of atmospheric column well suited to assess satellite product
EDR Validation

User ARCHIVE

14-day delay
Ded / Ref Collocations

web

Append Stamps (granule, SDR ...)

Operation

PDISP, NARCS, ODS

Project

“single closest”

Algorithm Development

Re-Retrieve

NUCAPS, IDPS, IASI, AIRS, DualR ... MiRS

NPROVS+ ... unified validation and development
Brief History NOAA Program for Soundings

**S P O P**

**soundings assimilation**

HIRS/MSU TOVS

(SSM/T1)

(SSM/T2)

HIRS/AMSU-A

(AMSU-B only)

ATOVs

**N P R O V S**

**soundings**

**CLIMATE**

**radiance assimilation**

- MIRS
- AIRS/AMSU
- IASI/ATMS
- CrIS/ATMS
- J1

**Project Oriented Validation**


**NOAA OPERATIONS OVERSIGHT**

Restore Project Independent NOAA PROduct OVerSight
EDR Validation Results

- MiRS NPP
- NUC NPP
- IDPS NPP
- ECMWF 137
- IASI (NOAA)
- AIRS v6

Daily; 14-day delay (NetCDF / HDF5)

SDRs: CrIS, ATMS, VIIRS, AIRS, MODIS, IASI, AVHRR...

... exclusive anchor to Ref / Ded RAOB and GPSRO....
Vaisala RS92
difference from COSMIC T

All sample

Sun angle

57,200 profiles
Seasonal variation in bias is bigger at nighttime: Summer relatively warmer than winter? GRUAN interest ...
Lin, 12Z, day
Lin, OZ, nite
Building High-Quality Climate Data Records from Operational Satellites

Fuzhong Weng
NOAA Center for Satellite Applications and Research

Seminar at ESSIC/UMD
March 5, 2014, 12:00pm - 01:00pm
Outline

• Background on Climate Trend Analysis

• Instrument CalVal for Advanced Weather and Climate Research

• New Analysis of Atmospheric Temperature Trend from MSU and AMSU through non-Linear Trending

• Effects of Clouds and Precipitation on AMSU Derived Climate Trending

• Atmospheric Temperature Trend from 1DVar Retrieval

• Summary and Conclusions
Three Generations of Microwave Sounding Instruments from MSU to AMSU/MHS to ATMS

ATMS Field of View Size for the beam width of 2.2° – black line

ATMS Resample to the Field of View Size for the beam width of 3.3°- blue line
Biases in the Tropics (NOAA-15, MetOp-A, SNPP)

before

after

ATMS channel 10

ATMS channel 11

ATMS channel 13

ATMS channel 14

NOAA-18 is subtracted. The pentad data set within ±30° latitudinal band.
1D-Var Derived Temperature Trend

EDR VALIDATION

NOAA Products Validation System (NPROVS)

12335 (781) available out of 12335

December 16, 2013 (14z) to December 26, 2013 (13z)

NPROVS Collocations 12/16 to 12/26 2013 ... 12,335
1) Determine the variability ($\sigma$) of a variable ($m$) in time and space from measurement or model.

2) Two observations on different platforms are consistent if

$$|m_1 - m_2| < k\sqrt{\sigma^2 + u_1^2 + u_2^2}$$

... at this preliminary stage:

$$K = \frac{\text{ABS (X – GRUAN)}}{\text{Uncertainty (u1)}}$$

where “X” either SAT or NWP

“need uncertainty estimates for EDR”
Mainly Vicinity of Lindenberg, Germany

GRUAN Sonde and COSMIC-minus-GTS Sonde

1DVAR mimics NWP
NWP independent of Raob
EDR VALIDATION

Centralized Radiosonde and Collocation Processing

6-hour

250km

RADIASONDE DROPSONDE NWP

Collocated radiosonde and satellite products dataset

Conventional RAOB

NOAA Products Validation System (NPROVS)

NWP:
GFS 6-hr
CFSR
CFSR (Back)

April 2008...