Enterprise EDR Validation at STAR

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STAR Seminar Series
Outline

A brief history of EDR assessment at NESDIS … role of the POP’s

What is “Enterprise Validation” (EV)

Components of an EV Capability

Leveraging Developer Expertise and EDR Oversight … Why bother?

Examples of EV at STAR: NPROVS for T and H20 Soundings

Benefits for timely “sanctioning” of new products … the first carrot

EV feasibility for other EDR’s … more carrots

STAR Plan
### ORA (pre 2000)

#### Product Oversight Panels (POP’s)
- Soundings
- Ozone
- Clouds
- Surface Temperature
- Precipitation
- etc.

#### EDR Development
- Soundings (TOVS, ATOVS, DMSP …)
- Ozone
- Clouds
- Surface Temperature (GOES, polar …)
- Precipitation (Microwave …
- etc.

#### Operational Sanction
STAR (post 2000)

EDR Development (and Assessment)

Soundings (NUCAPS, MiRS, …)
Gases
Clouds
Surface Temperature (GOES, polar …)
Precipitation (Microwave …
Fires
Aerosols
etc.

Operational Sanction
STAR (post 2018)

Quality Assurance
Soundings
Gases
Clouds
Surface Temperature
Precipitation
Fires
Aerosols
etc.

Enterprise Validation

EDR Development
Soundings (NUCAPS, MiRS, GPSRO ...)
Gases
Clouds
Surface Temperature (GOES, polar ...)
Precipitation (Microwave ...)
Fires
Aerosols
etc.

Operational Sanction
What is “Enterprise Validation” (EV)

Enterprise Algorithm: Same science used across different “sensors” to derive a given EDR suite

Enterprise Validation: Same targets used across different “EDR suites” to assess a given suite

Sensors and products of the same “family”… CrIS, IASI, AIRS, ATMS, AMSU, ATOVS, GPSRO … Sounds…
… NUCAPS, EUMET, NASA, MiRS, ATOVS, COSMIC … Soundings

Other families … Gas, Surface temperature …
Components of an EDR EV capability

- Multiple “samesame” EDR product suites (internal, external)
- Ground-truth (or space-based) targets
- Models
- Strategy for collocating products, targets and models
- Data Management

- *Routine (quasi nrt) compilation of collocation (validation) datasets* … dirty work
- *Ongoing Monitoring, Back-processing, Re-processing, Stewardship* … dirty work
- *Seamless integration of new product suites and targets* … dirty work
- *Graphical Tools for Assessment* … dirty work
  - Long term
  - Short term
  - Deep Dive

- Program(s) of “dedicated (at satellite overpass)” targets
- Resources
Leveraging Developer Expertise and EDR Oversight at STAR … Why bother?

- Developer focused on a specific product suite (NUCAPS, MiRS … new product(s))
- Developer focuses on assessment in context of
  - corrective action
  - new science and products
- Oversight focused on multiple product suite monitoring … EV
- Oversight identifies respective areas for corrective action
- Oversight affirms corrective action, new science and products (from Developers, R2O)
- EV capability maintained by STAR to support / guide Developers
  - Comparing operational, test and new products on an equal playing field
  - Timely assessment of new products (i.e. small sats, COSMIC-2 …) from Developers

- EV oversight provides “addition through subtraction” in the context of Developer priorities!
- EV facilitates timely, meaningful assessment using mature, well managed protocols
- EV provides consistent baseline for Maturity Reviews and R2O (SPRB)
NOAA Products Validation System (NPROVS)
supported by JPSS Cal/Val program which also supports EDR Algorithm Development Team
(EV Template for soundings)
Maintain global datasets of collocated RAOB and Satellite Observations
EDGE Analytical Interface ...

Daily
Weekly

Seasonal

NARCS

Orbital

ODS

... routine monitoring to deep dive
Conventional NARCS

Sonde GFS Fcst All Terrain(Passed) - Sonde All Terrain

Temperature Bias (deg K)

Aircraft Bias Correction

GFS 6-hour Forecast
Conventional NARCS

NUCAPS NPP IR + MW All Terrain(Passed) - Sonde All Terrain

Temperature Bias (deg K)

SNPP NUCAPS v1.5 NSR

FSR v2.1.2
Conventional NARCS

EUMETSAT MetOp-B IR + MW All Terrain(Passed) - Sonde All Terrain

Temperature Bias (deg K)

Pressure (hPa)

8/03/14 12/14/14 4/26/15 9/06/15 1/17/16 10/9/16 2/19/17 7/02/17 11/12/17 3/25/18 8/05/18

MetOp-B EUMETSAT v6.2 v6.4
Conventional PDISP
Temperature (sat - baseline) deg K
August 22, 2017 to October 10, 2017

NUCAPS v1.5
NUCAPS v2.1.2
IR+MW Pass QC)
Temperature RMS

Baseline: SONDE

Global Weighted Sample: IR+MW Pass QC; Specification
Conventional PDISP
Water Vapor (sat - baseline) % error
August 22, 2017 to October 10, 2017

NUCAPS v1.5
NUCAPS v2.1.2
IR+MW
H2O Vapor Fraction (%)
RMS

Global Weighted Sample: IR+MW Pass QC; Specification
IR-based sounding yields increase; August 2017 ... ODS

NUCAPS NSR (left) and FSR (right) IR+MW pass QC (blue) increase 60% to 85%; Good!!
however, super-saturated soundings “discovered” west of Florida; Harvey Case Study ... ODS

H2O Vapor (g/kg) @741 hPa for IR pass QC:
NUCAPS 1.5, NUCAPS 2.1.2,
NUCAPS IASI-B, MiRS (NPP) Rain Rate
1330 LST SNPP; 1030 LST MetOp; August 25th
Supersaturated: **Sounding, First Guess, Both** also increase; Bad
<table>
<thead>
<tr>
<th>Week</th>
<th>Case #</th>
<th>Date</th>
<th>Weather Region</th>
<th>Product</th>
<th>Success/Failed</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>5/3/2018</td>
<td>Albany, NY</td>
<td>CAPE</td>
<td>Success</td>
<td>• Overpass well timed for East Coasts &lt;br&gt;• Modification was not necessary for this case</td>
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<tr>
<td></td>
<td>2</td>
<td>4/30/2018</td>
<td>Amarillo, TX</td>
<td>CAPE</td>
<td>Failed</td>
<td>• Unusually high CAPE &lt;br&gt;• Modification was too high as well</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5/10/2018</td>
<td>Eastern Wyoming</td>
<td>Mid-Level Moisture</td>
<td>Success</td>
<td>• NUCAPS sounding captured higher moisture levels better than NAM12 &lt;br&gt;• NUCAPS helped forecaster diagnose storm mode and indicating where the mixing is occurring ahead front</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5/9/2018</td>
<td>South Central Illinois</td>
<td>CAPE</td>
<td>Failed</td>
<td>• NUCAPS CAPE was very high, however severe storms did not occur &lt;br&gt;• CAPE anomaly sounding near Newton, IL</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>5/14/2018</td>
<td>Texas panhandle up to Kansas City</td>
<td>CAPE</td>
<td>Success</td>
<td>• NUCAPS CAPE closer to high resolution guidance than AllSky CAPE</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5/17/2018</td>
<td>Amarillo, TX</td>
<td>Lapse Rates</td>
<td>Failed</td>
<td>• Gridded NUCAPS lapse rates were not steep enough compared to models</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>5/24/2018</td>
<td>North East USA</td>
<td>Lapse Rates</td>
<td>Success</td>
<td>• Lapse rate patterns in Canada and NE USA match GFS and NAM</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>5/24/2018</td>
<td>North East USA</td>
<td>Lapse Rates</td>
<td>Failed</td>
<td>• NUCAPS lapse rates missed an EML (elevated mixed layer) moving from SD up into SW MN &lt;br&gt;• Models suggest higher lapse rates</td>
</tr>
</tbody>
</table>
Collocations including at Amarillo on May 17 Case Study day
NOAA Products Validation System (NPROVS)

Dewpoint / Temperature (deg K)

SONDE 72363 (182) SONDE 5/17/2018 11:06:00Z 35.2 N / 101.7 W
SONDE 72363 (182) GFS 6 Hour 5/17/2018 11:06:00Z 35.2 N / 101.7 W
NUCAPS NPP 5/17/2018 8:09:08Z (-2.9 hours) 35 N / 101.6 W (30.8 km)
NUCAPS NPP First Guess 5/17/2018 8:09:08Z (-2.9 hours) 35 N / 101.6 W (30.8 km)
NUCAPS NPP TEST 5/17/2018 8:09:08Z (-2.9 hours) 35 N / 101.6 W (30.8 km)

NUCAPS IR+MW pass QC
Dedicated *(at satellite overpass)*

Ground Truth Programs

**JPSS/ARM Dedicated Radiosonde Program** conducts on average *two launches per week* at 3 ARM sites since 2006 … **$100K**

**RIVAL** leverages above program to provide *weekly*, dedicated, twin (RS41 and RS92) radiosonde launches, began February 2018 (2yrs) … **$0K**

**AEROSE** dedicated radiosondes (NOAA Ship RHB) in conjunction with Saharan Air Layer since 2013 provides up to *4 launches daily* from tropics … **$30K**

**CALWATER** dedicated radiosondes monitor Atmospheric Rivers (RHB)… **$0K**

All above collocated with “multiple” satellite EDR and stored/assessed via NPROVS EV

Promotes synergy across international satellite, weather forecast and climate communities:

- NOAA (STAR, SSEC, CICS …)
- DOE-ARM
- GRUAN
- GSICS
Global datasets of collocated Special RAOB and Satellite EDR; 50,000 since 2013 (ARM sites, AEROSE, CALWATER dedicated campaign in Green Boxes)
650 hPa H2O Vapor

NUCAPS IR+MW

NUCAPS MW-only

MIRS NPP

ECMWF ANL

CALWATER (ACAPEX) 2015 .... AWIPS-2
RAOB @ 2032Z … SAT @ 2123Z … ECMWF @ 00Z

CALWATER RAOB
ECMWF Analysis
MIRS NPP
NUCAPS v1.5

650 hPa
NUCAPS captures circulation regimes of the central pacific tropical/sub-tropical region
Reference radiosonde with fully characterized uncertainty
Benefit: Timely “sanctioning” of New Products (to be demonstrated for sounding)

- Small SATs
- Evolving AI systems
- KOMPSAT
- Identify/integrate new/existing dedicated target (radiosonde, etc.) programs

- **Routine (quasi nrt) compilation of collocation (validation) datasets** … leveraged
- **Ongoing Monitoring, Back-processing, Re-processing, Stewardship** … leveraged
- **Seamless integration of new product suites and targets** … leveraged
- **Graphical Tools for Assessment**
  - Long term
  - Short term
  - Deep Dive

- NPROVS leveraged
EV feasibility for “other” EDR

- Precipitation (TPW, rainfall rate)
- GAS (O3, CO2, CO …)
- Surface temperature (LST and SST)
- Associated Models per …
- Collocation Strategy per …
- Dedicated targets per …

- Routine (quasi nrt) compilation of collocation (validation) datasets … needed
- Ongoing Monitoring, Back-processing, Re-processing, Stewardship … needed
- Seamless integration of new product suites and targets … needed
- Graphical Tools for Assessment … needed
  - Long term
  - Short term
  - Deep Dive

- Leverage Developer /NPROVS to create STAR EV per “qualifying” EDR
STAR Plan

- RTMEE … Enterprise Validation (18 months)
- Expand NPROVS EV for Sounding to integrate / assess
  - AI retrieval (MW, IR)
  - Small Sats (as available)
  - GFS Analysis
  - KOMPSAT (GPSRO)
- Collaboration with Developers for EV for “other” EDR
  - TPW / Precipitation / Rain-Rate
  - Gas (Ozone, CO2, CO …)
  - Surface Temperature
- Demonstrate expanded EV for Soundings
- Demonstrate EV for selected “Other(s)”
Summary

Historical perspective of EDR assessment at NESDIS

What is “Enterprise Validation” and what does it entail

Enterprise Validation as addition through subtraction in context of Developer …

Examples of EV at STAR using NPROVS (Temp and H20 Sounding) … Long Term Global to Deep Dive

Timely assessment / sanctioning of new products (soundings) … the first carrot

EV feasibility for other EDR’s … more carrots

STAR Plan