RTMA/URMA v2.4.4 Implementation Briefing

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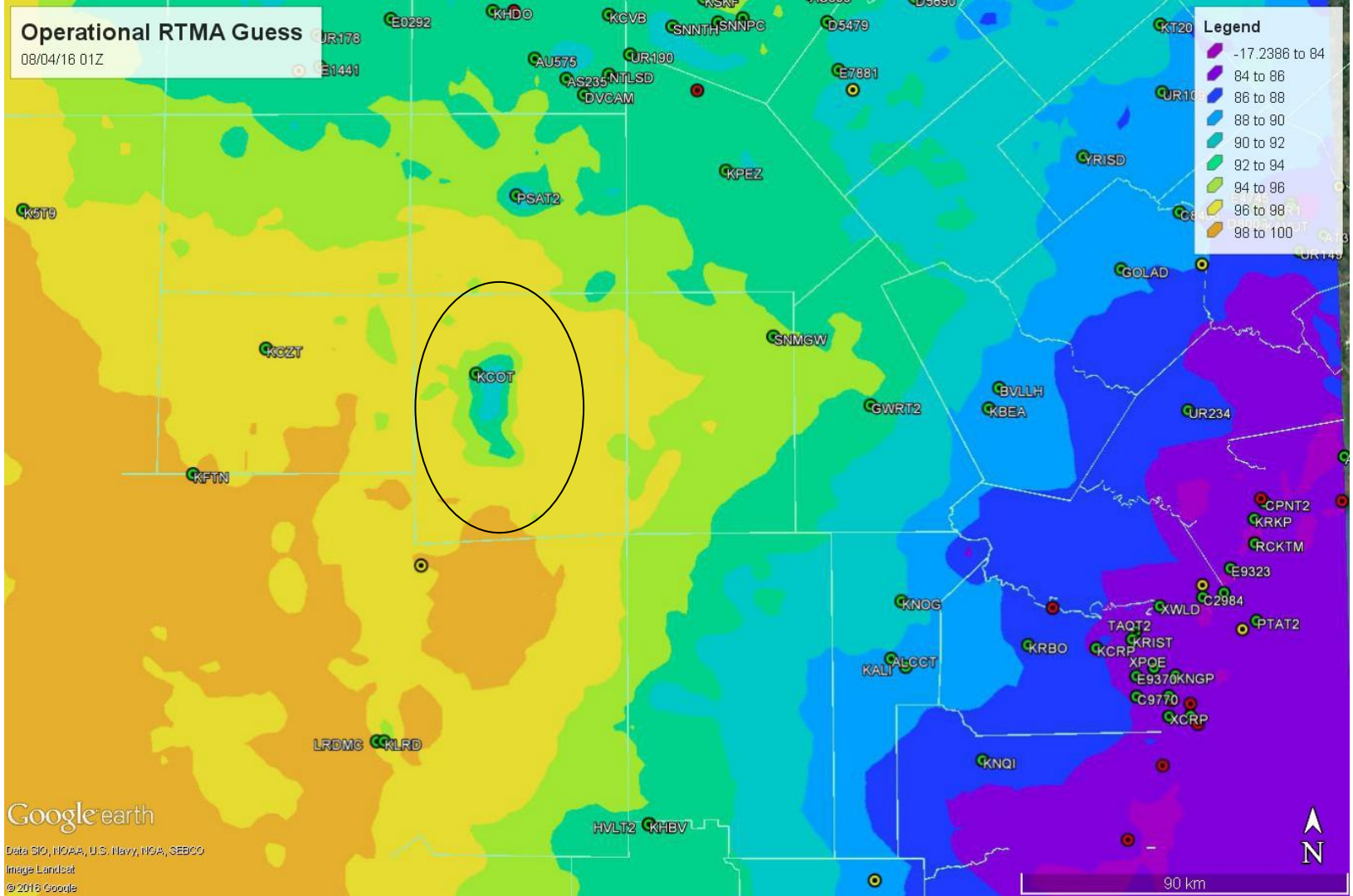
19 August 2016

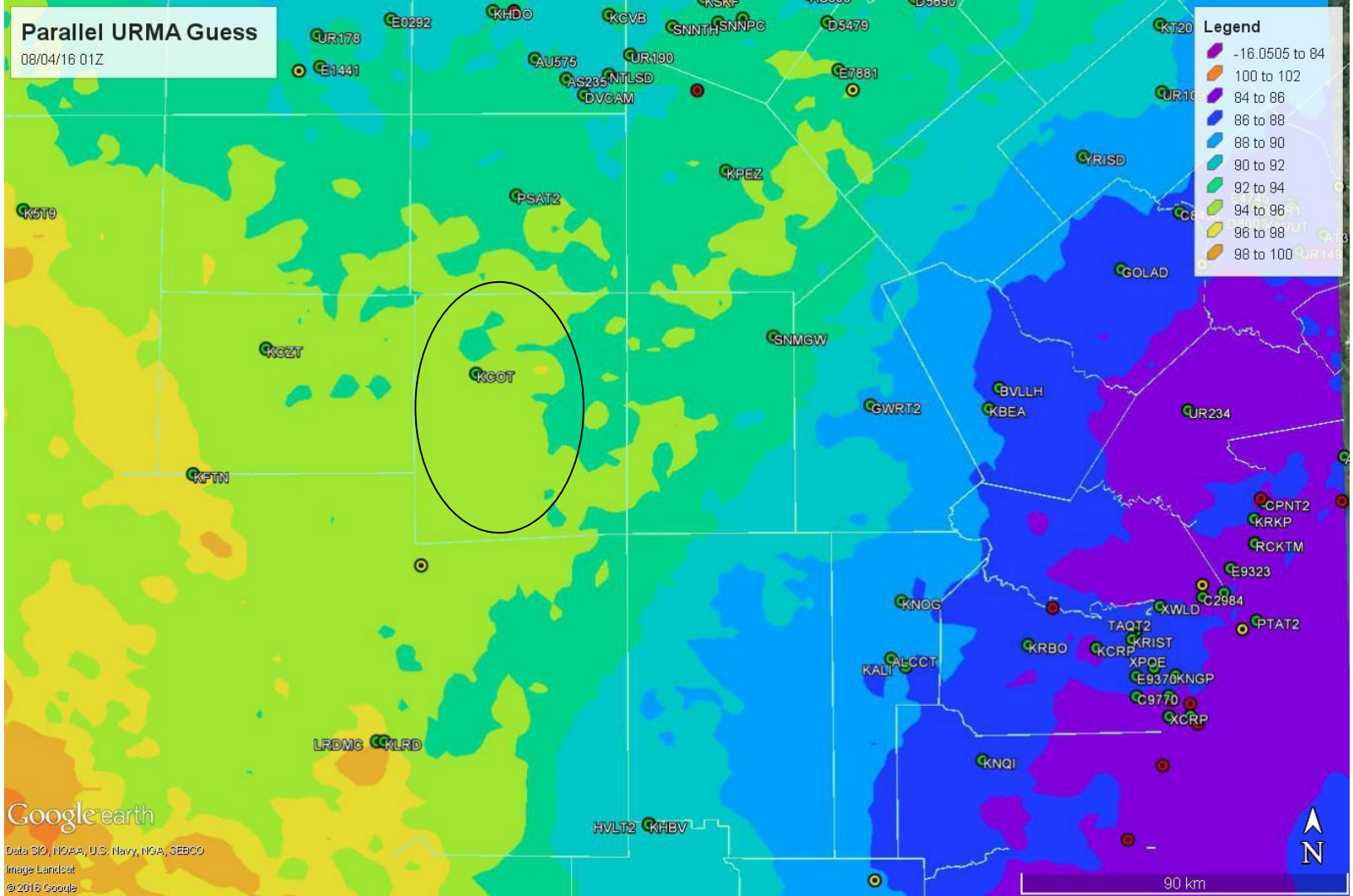
Science Improvements

- Background improvements
  - New RAP/HRRR
  - NAM smartinit/downscaling improvements
- New terrain land/sea mask for CONUS
- New variables
  - Min/maxT for HI and PR (required by NBM)
  - New wind speed (scalar) analysis (requested by ER, other field users)
  - Cloud ceiling height for CONUS (required by FAA)
- Variational QC improvements
- Some ‘quick fixes’ requested from field were possible after hand-off due to delays in getting HRRR parallel up
  - QC/reject list improvements
  - Land/sea mask adjustments (Great Salt Lake, some inland lakes)

RAPv3/HRRRv2 Background

- Smartinit downscaled 1h forecasts are used
- Blended with smartinit NAM forecast to generate RTMA/URMA background over CONUS and AK
- Improvements in low level moisture, temperature allow for generation of better background field
- Spurious features contaminating background field have mostly been removed

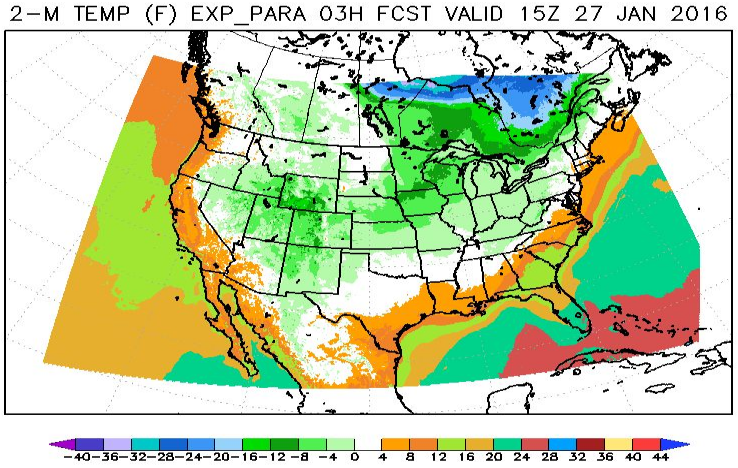

Operational RTMA Guess
08/04/16 01Z
Legend
-17.2386 to 84
84 to 86
86 to 88
88 to 90
90 to 92
92 to 94
94 to 96
96 to 98
98 to 100
E0292
KHDO
KCVB
SNNTH
SNNPC
D5479
KT20
UR178
E1441
AU575
UR190
AS235
NTLSD
DVCAM
E7881
UR19
YRISD
KPEZ
PSAT2
K5T9
GOLAD
KCZT
KCOT
SNMGW
BVLLH
KBEA
GWRT2
UR234
KFTN
CPNT2
KRKP
RCKTM
E9323
C2984
KNOG
XWLD
PTAT2
TAQT2
KRIST
KRBO
KCRP
XPOE
KALI
KLCCT
E9370
KNGP
C9770
XCRP
LRDMC
KLRD
KNQI
HVLT2
KHBV
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
© 2016 Google
N
90 km

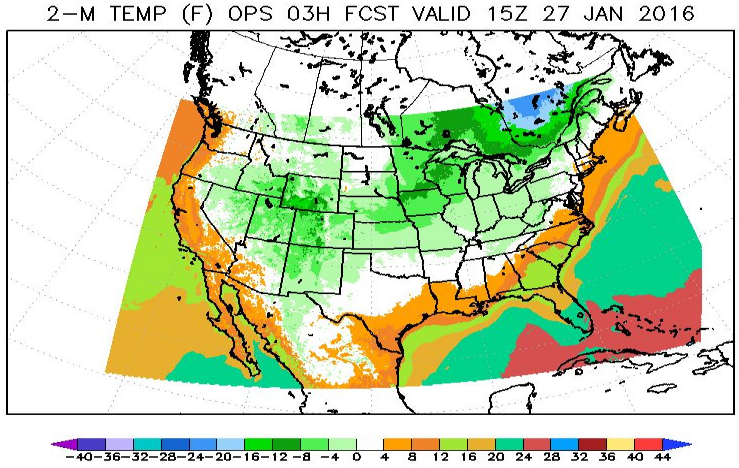

Parallel URMA Guess
08/04/16 01Z
Legend
-16.0505 to 84
100 to 102
84 to 86
86 to 88
88 to 90
90 to 92
92 to 94
94 to 96
96 to 98
98 to 100
E0292
KHDO
KCVB
SNNTH
SNNPC
D5479
UR178
E1441
AU575
UR190
AS235
NTLSD
DVCAM
E7881
KPEZ
YRISD
PSAT2
K5T9
GOLAD
SNMGW
KGZT
KCOT
BVLLH
KBEA
GWRT2
UR234
KFTN
CPNT2
KRKP
RCKTM
E9323
C2984
KNOG
KWLD
PTAT2
TAQT2
KRIST
KRBO
KCRP
XPOE
KALI
ALCCT
E9370
KNGP
C9770
XCRP
LRDMC
KLRD
KNQI
HVLT2
KHBV
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
© 2016 Google
N
90 km

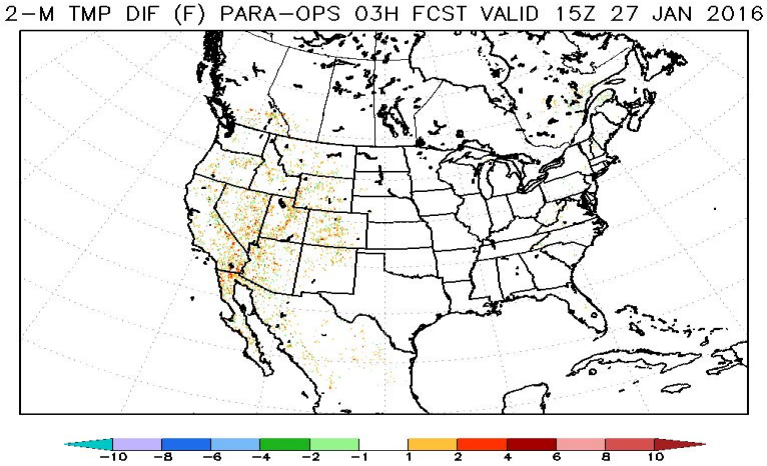
Changes to NAM Smartinit

- New consensus terrain and land/sea mask
- Expanded the CONUS Nest 2.5 km domain (northward and westward)
- Added cloud ceiling height and mean sea-level pressure to the output

NAM Smartinit 2-m Temperature (°F)





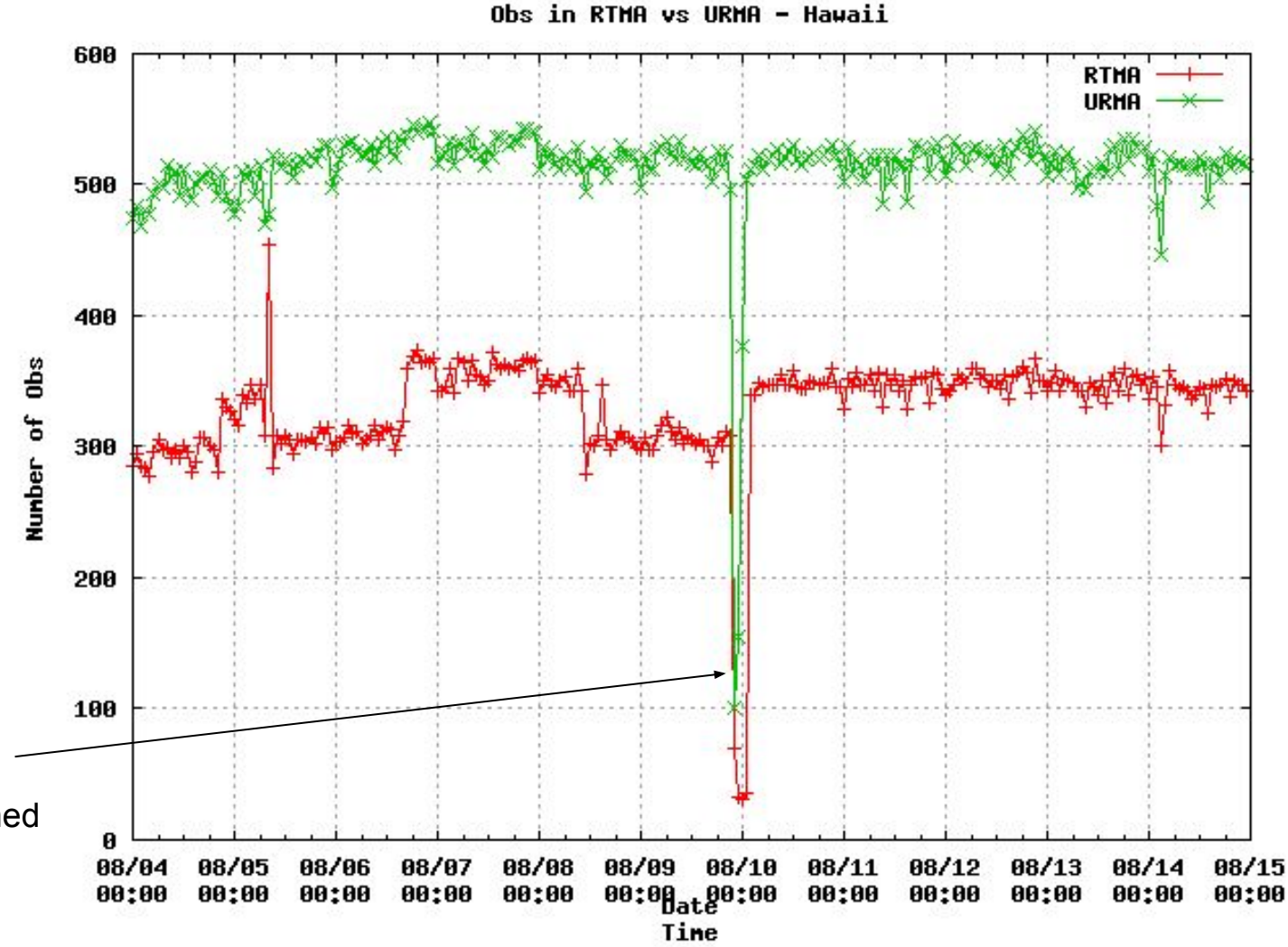


New Consensus Terrain and Land/Sea Mask

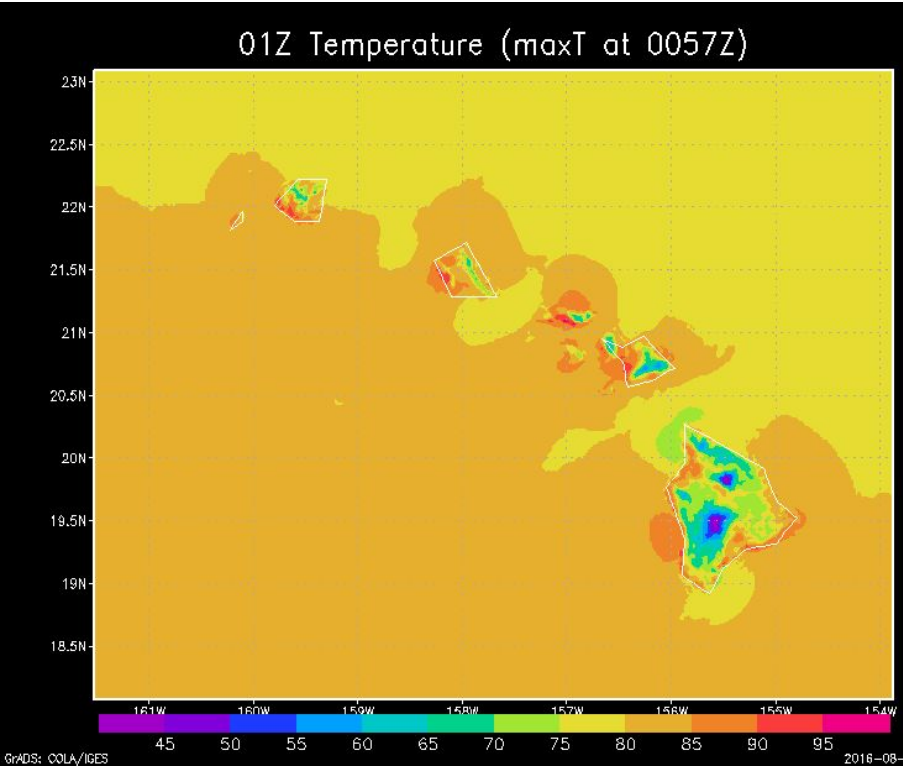
- Developed by MDL, EMC, NWS Regions, and Raytheon as part of National Blend.
- Same terrain for RTMA, NBM, RAP smartinit, NAM smartinit, AWIPS
- Terrain based on USGS GMTED2010 data
  - Upgrade from the GTOPO30 data used now
- Land/sea mask based on AWIPS/GLERL shapefiles and U of MD Land Cover Classification
- Meant to go in for Q1FY16 upgrade, but too many systems to work with at same time
- Quick edits made around Great Salt Lake and small inland lakes by MDL at field request (notably WFO SLC)
  - Possible because of earlier HRRR issues
- Unified field for OCONUS domains to come later
- Local edits to terrain to be made at WFOs later

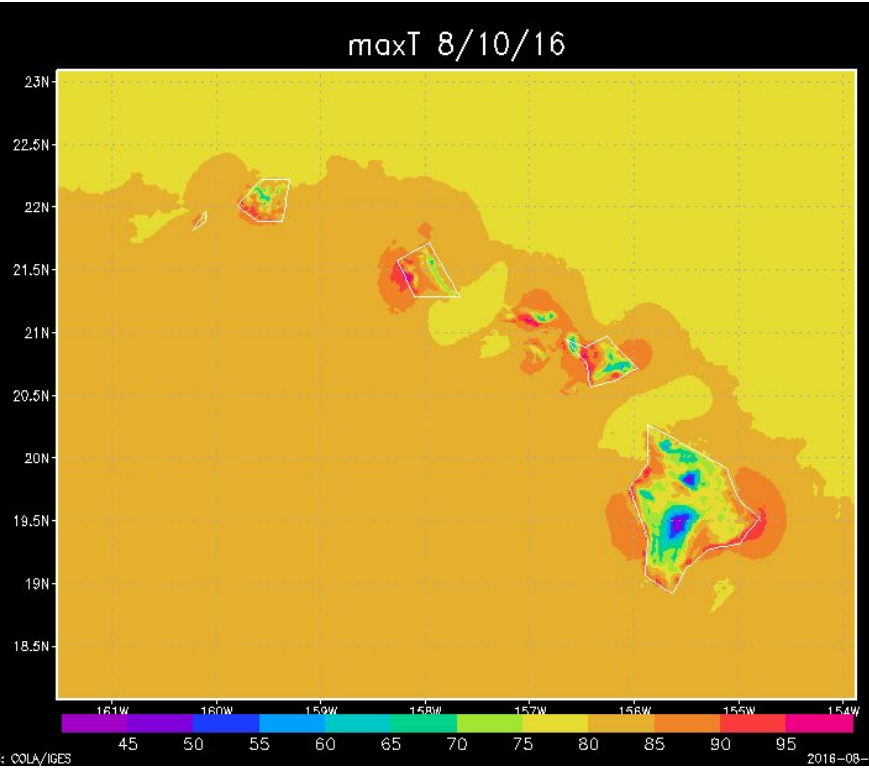
URMA for Hawaii and Puerto Rico

- Requested by National Blend of Models project for use in blend over PR and HI
- Same code as used for CONUS and AK (implemented in January)
- More obs used, min/maxT now available over these regions
  - min/maxT analyses include intra-hour obs



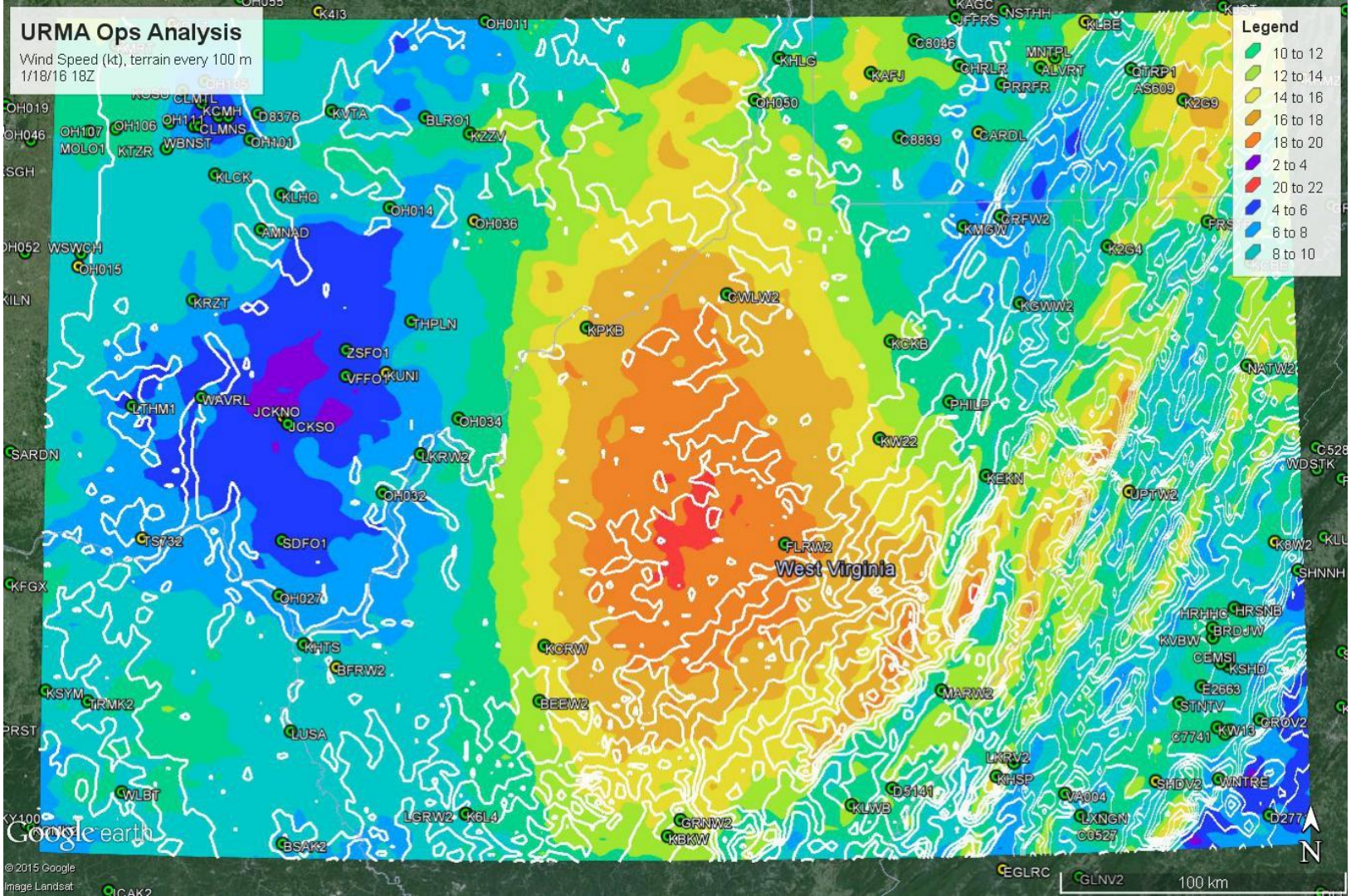
MADIS outage at GSD, feed was switched to IDP

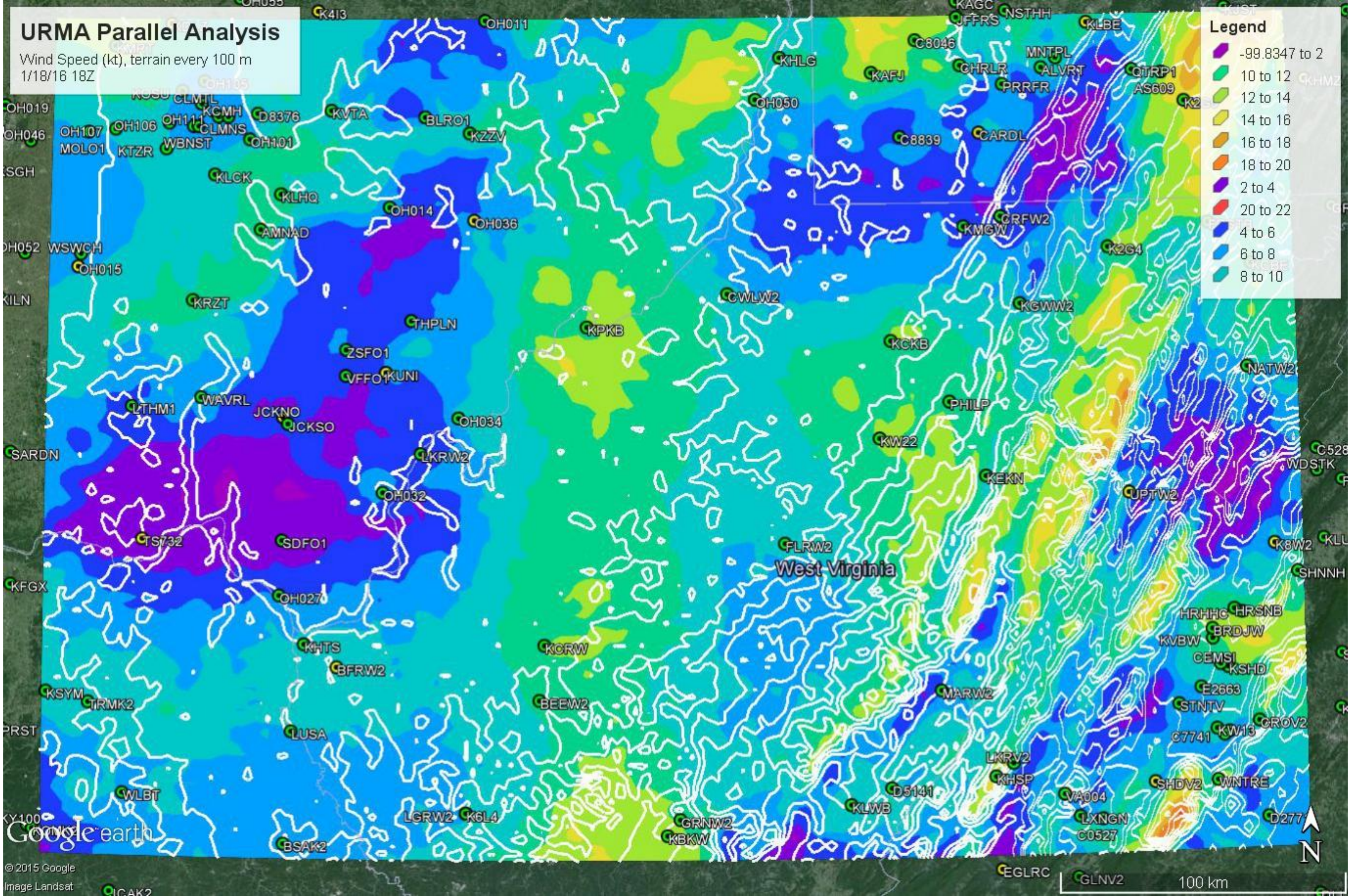

01Z Temperature (maxT at 0057Z)
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
161W
160W
159W
158W
157W
156W
155W
154W
45
50
55
60
65
70
75
80
85
90
95
GrADS: COLA/IGES
2016-08-15-;


maxT 8/10/16
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
161W
160W
159W
158W
157W
156W
155W
154W
45
50
55
60
65
70
75
80
85
90
95
GrADS: COLA/IGES
2016-08-15-20:20

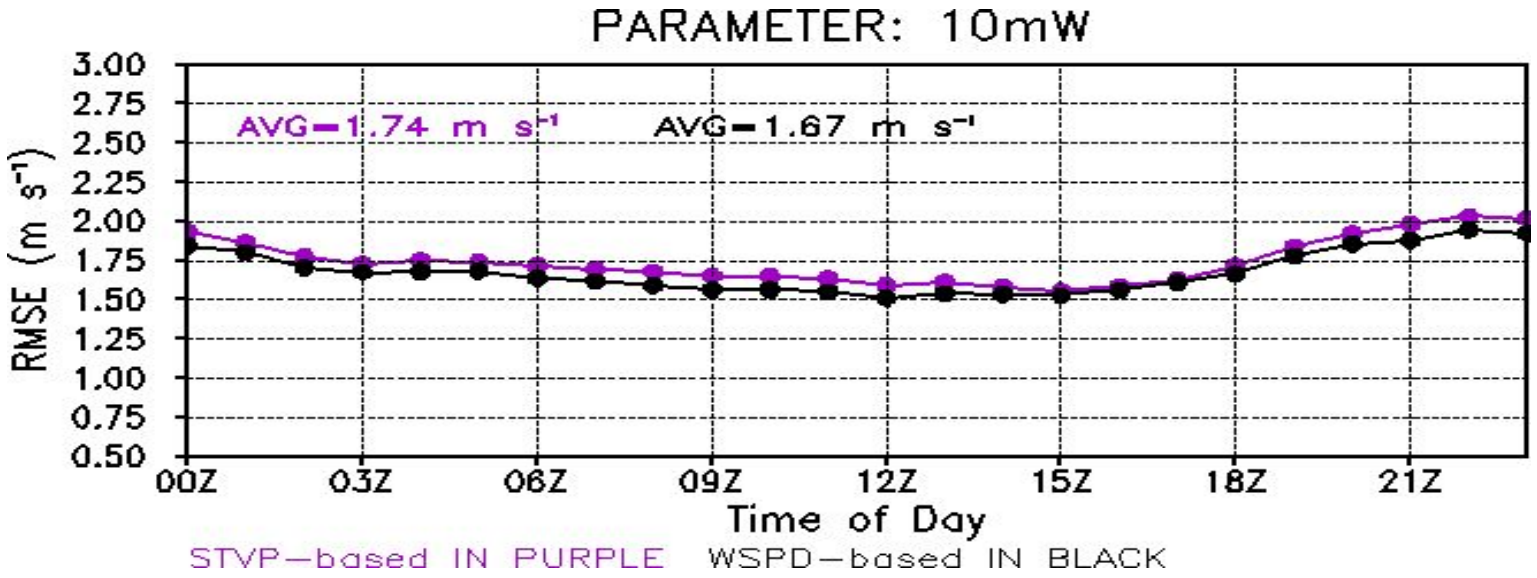
New Wind Speed Analysis

- Current wind analysis does not match obs well, has been known to generate false features (pointed out by WFO's, regions)
- Current analysis method used streamfunction and velocity potential
- New method: analyze wind speed as a scalar
  - Direction still derived from streamfunction/velocity potential
- Analysis now better matches observations, increments in wind speed match terrain, and false/mysterious features have disappeared


URMA Ops Analysis
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
10 to 12
12 to 14
14 to 16
16 to 18
18 to 20
2 to 4
20 to 22
4 to 6
6 to 8
8 to 10
West Virginia
Google earth
© 2015 Google
Image Landsat
100 km
N


URMA Parallel Analysis
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
-99.8347 to 2
10 to 12
12 to 14
14 to 16
16 to 18
18 to 20
2 to 4
20 to 22
4 to 6
6 to 8
8 to 10
West Virginia
100 km
N
Google earth
© 2015 Google
Image Landsat

Cross-validation RMSE for wind speed

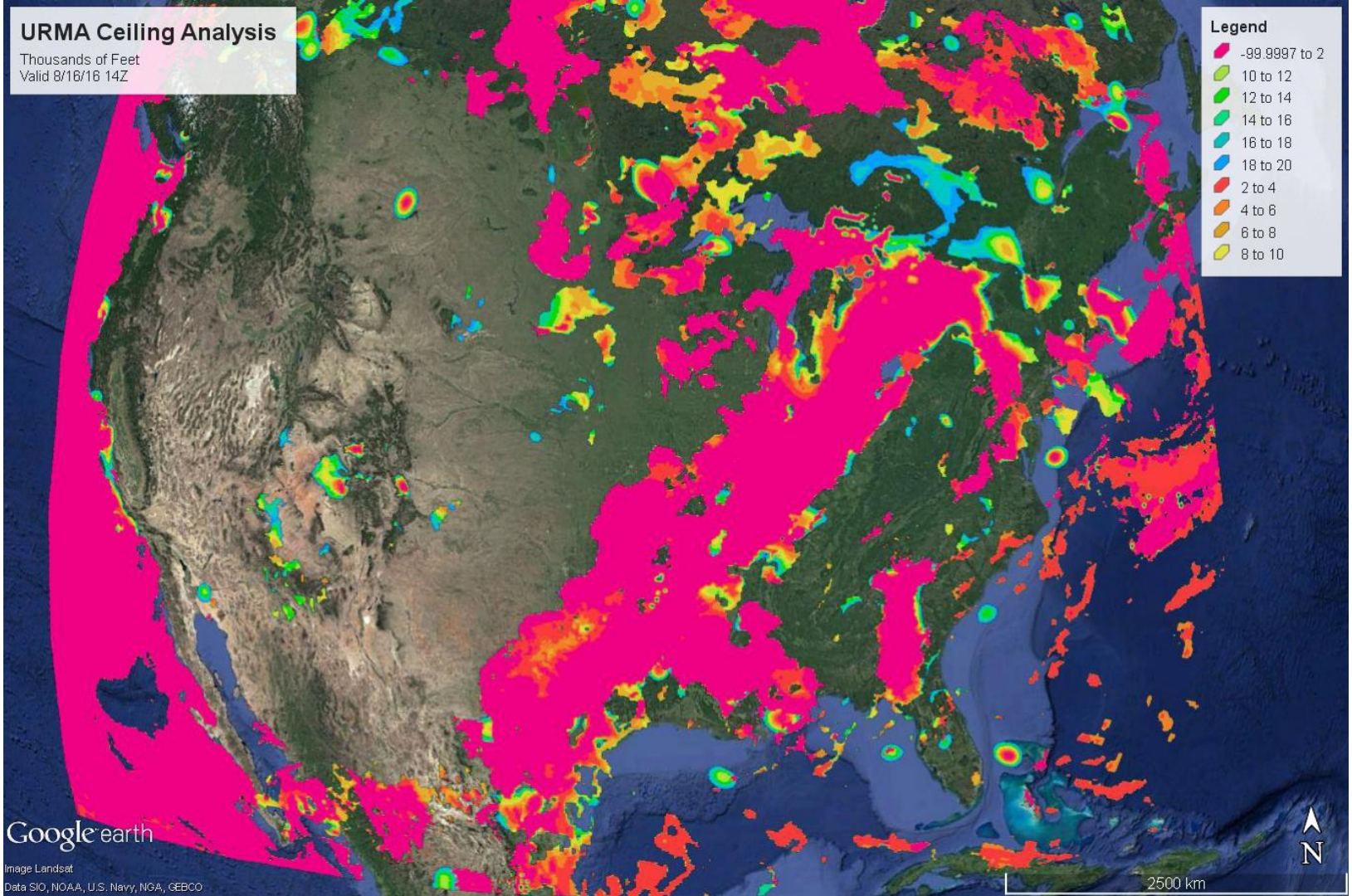


FROM PARA

Plot compares cross-validation scores from the GSI default streamfunction-velocity potential-based wind analysis with those from the use of wind speed as the control variable. The use of the new control variable yields improved cross-validation scores.

Cloud Ceiling Height

- Going into operations but **considered experimental**
- Requested by FAA
- Use of METAR obs
  - Ceiling height derived: lowest level of cloud cover >50%
- RAP based background
- Maximum value: 20 km (65,600 feet)
- Available over CONUS only


URMA Ceiling Analysis
Thousands of Feet
Valid 8/16/16 14Z
Legend
-99.9997 to 2
10 to 12
12 to 14
14 to 16
16 to 18
18 to 20
2 to 4
4 to 6
6 to 8
8 to 10
Google earth
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
2500 km

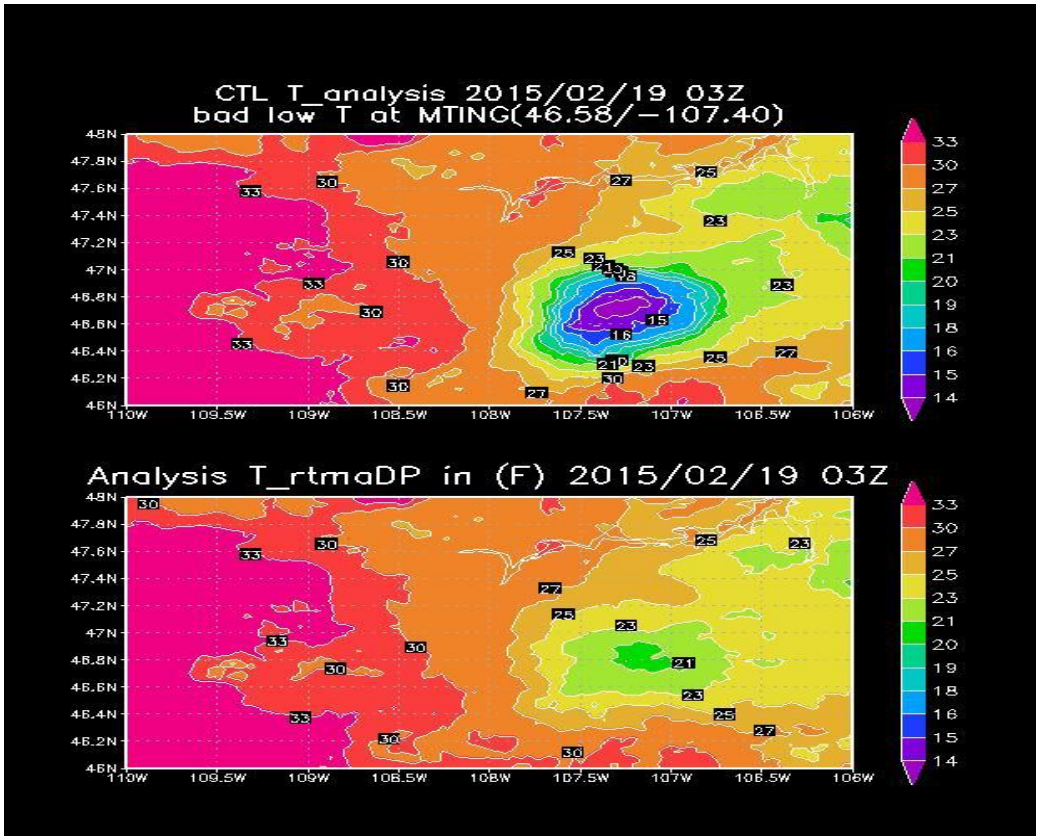
VarQC example: erroneous low temperature data over Montana 03z 02/19/2015

Top*:* without new varqc Temperature analysis

The bull's-eye reflects an erroneous low temperature observation

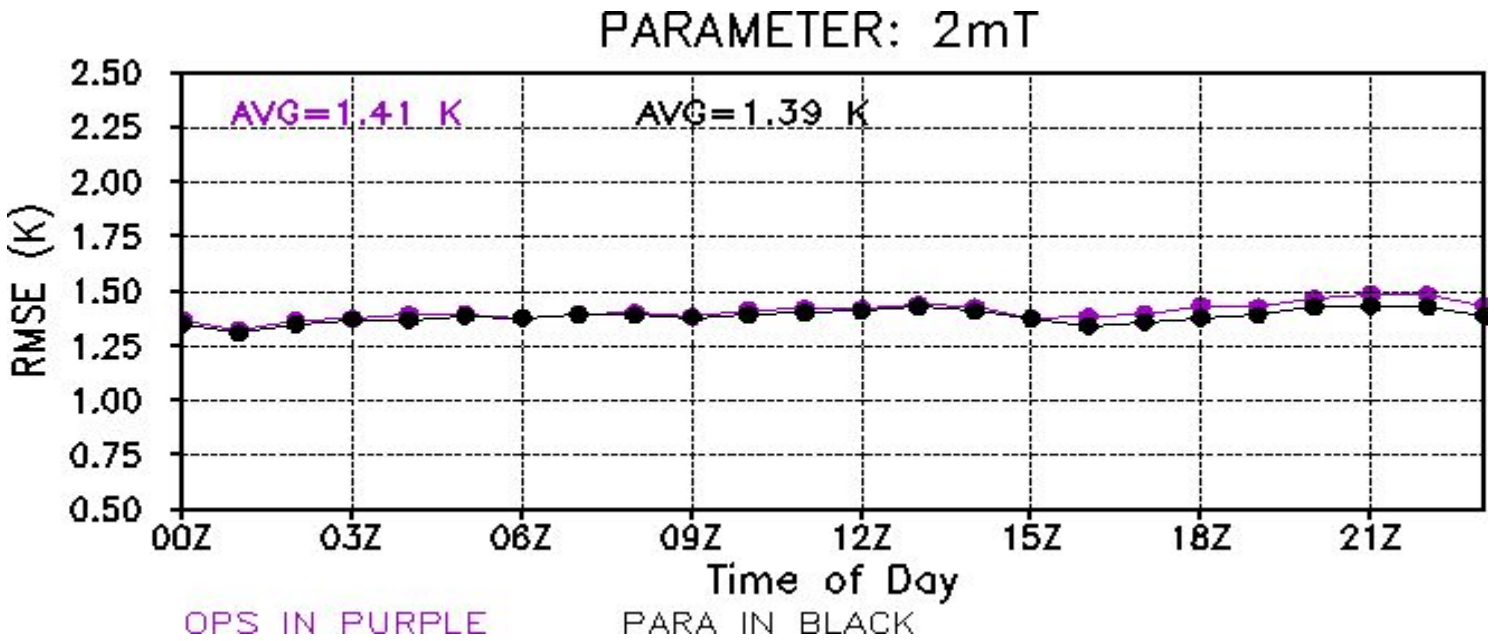
Bottom: with new varqc along with the tuned parameters

The bull's-eye is gone

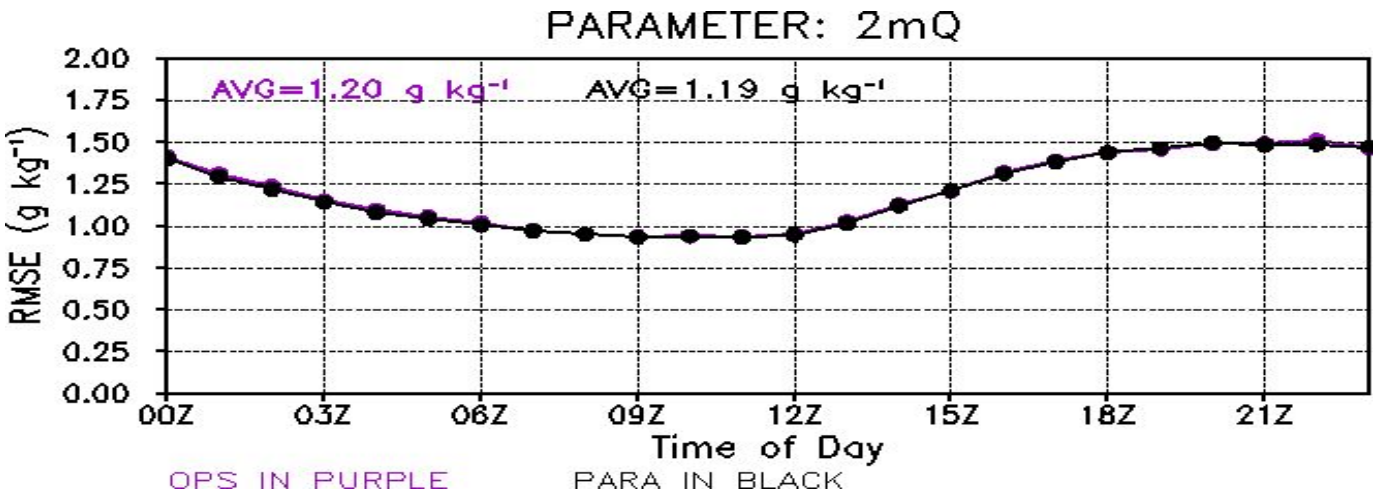


Cross-Validation

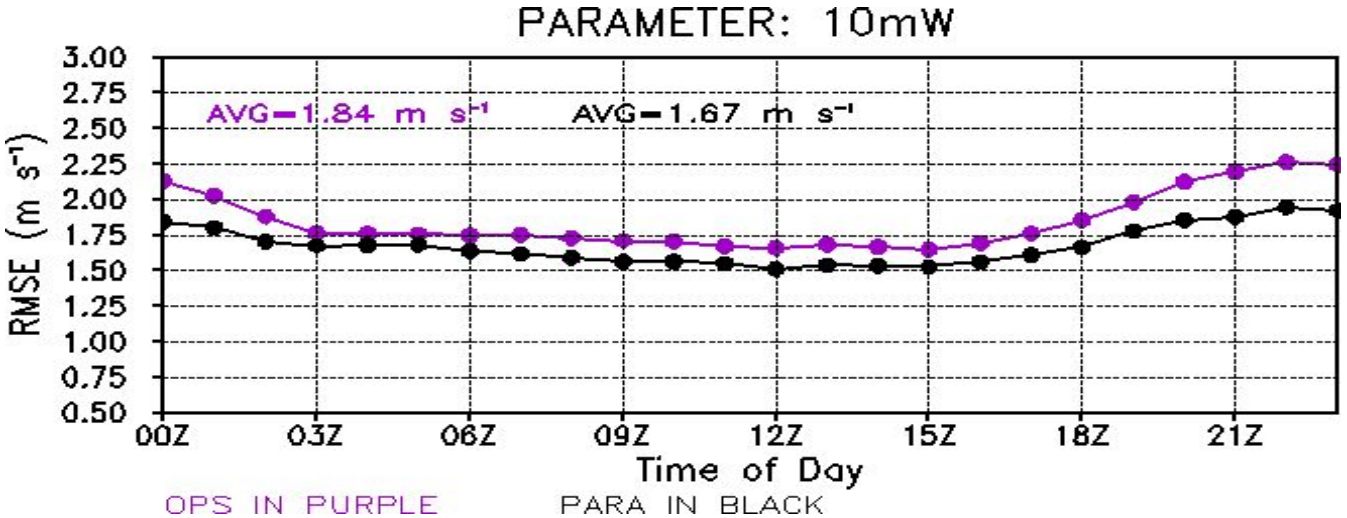
domain and time-of-day averages for the 35-day period
00Z 11 Jul 2016-23Z 14Aug 2016



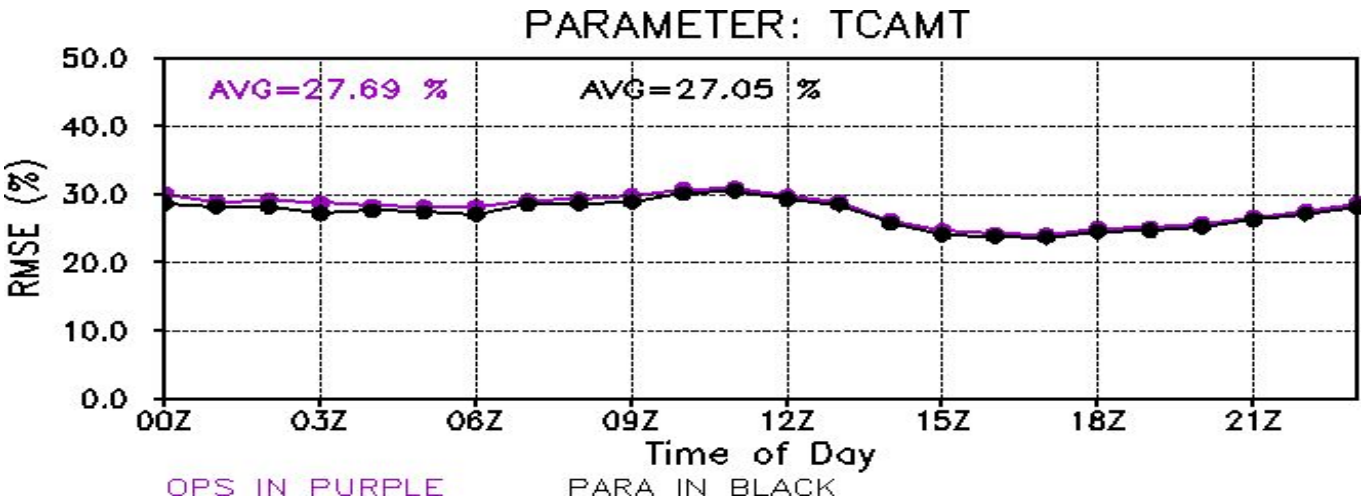
Slight improvement of PARA over OPS for 2mT



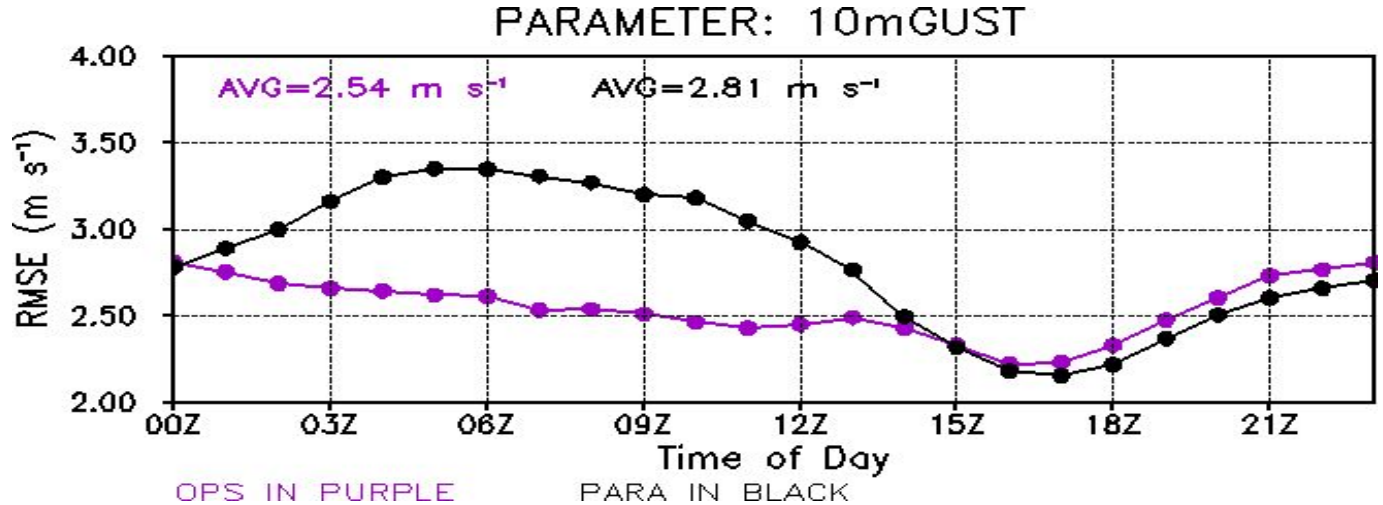
PARA and OPS yield nearly identical results for 2mQ



PARA yields improved 10m wind speed



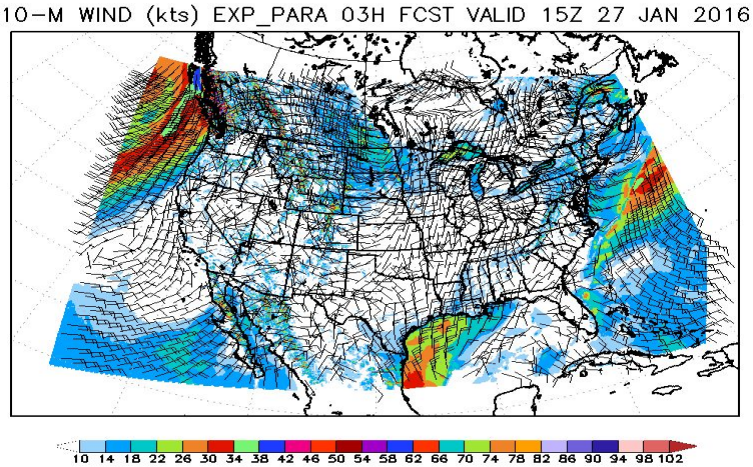
PARA and OPS yield nearly identical results for Total Cloud Amount

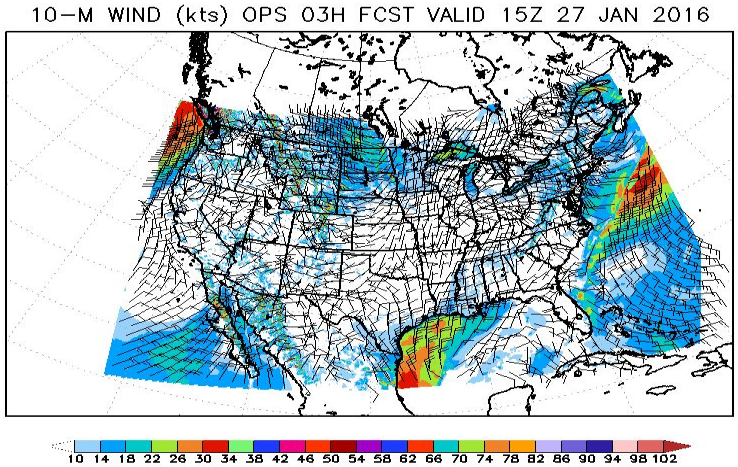


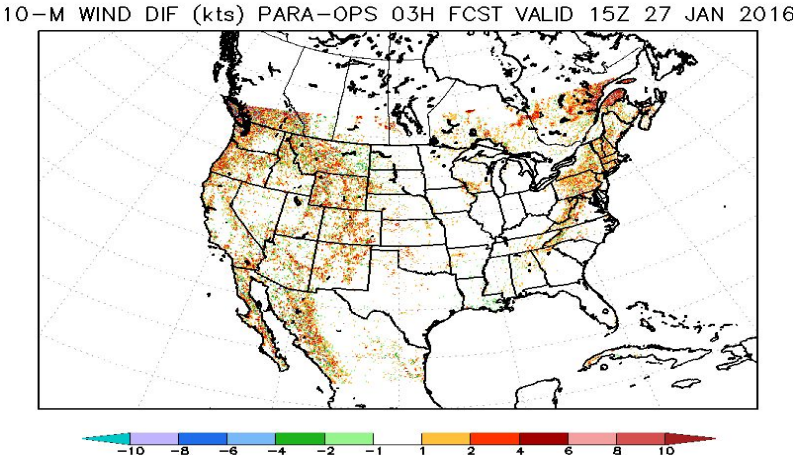
PARA did worse than OPS for wind gust from 01z through 15Z. Background field had very large errors (see backup slides). PARA did better than OPS between 15Z and 00Z.

BACKUP SLIDES

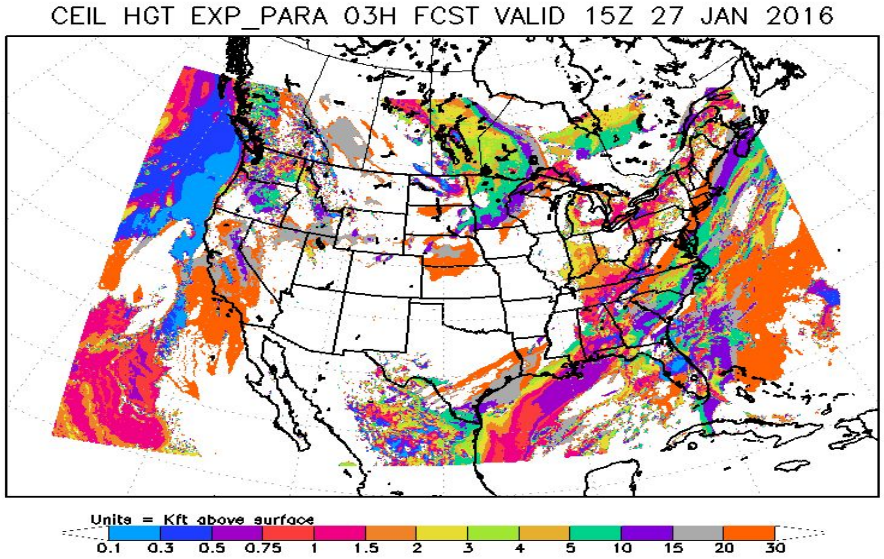
NAM Smartinit 10-m Winds (kts)

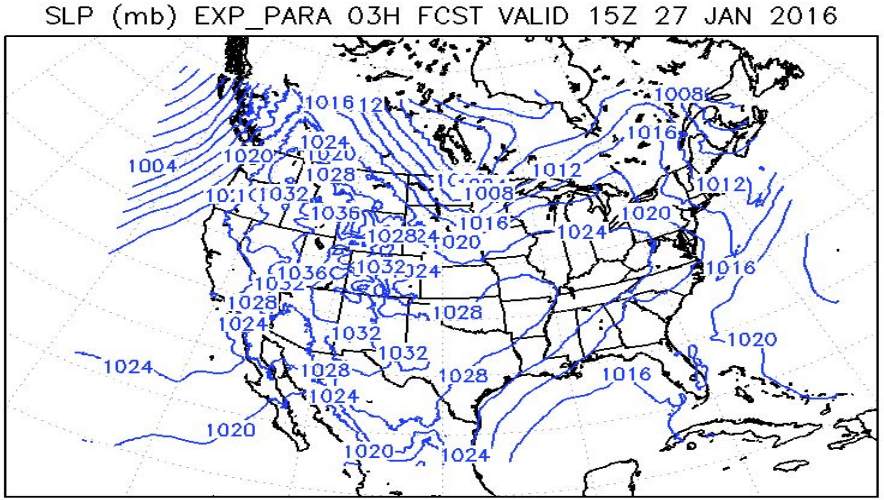


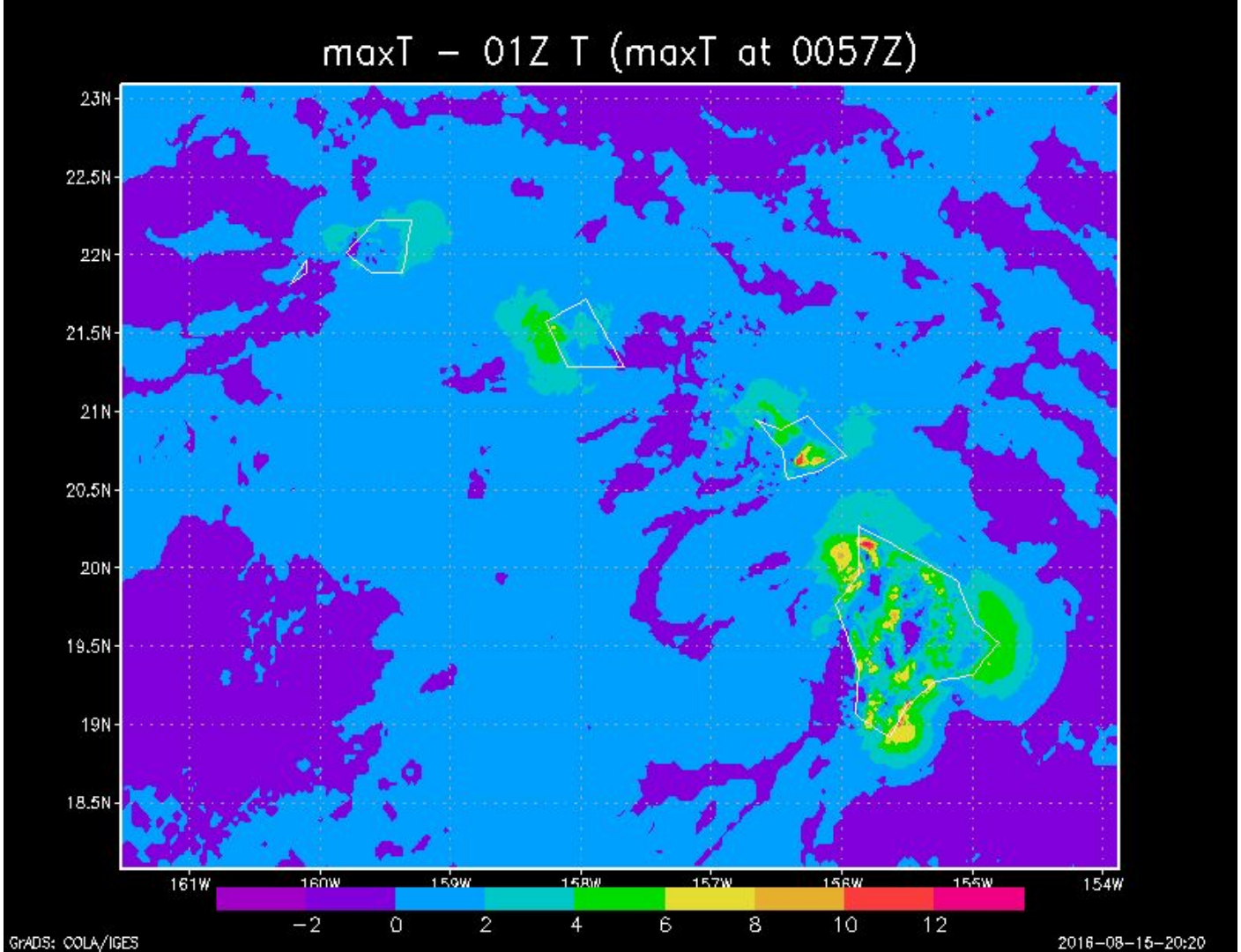


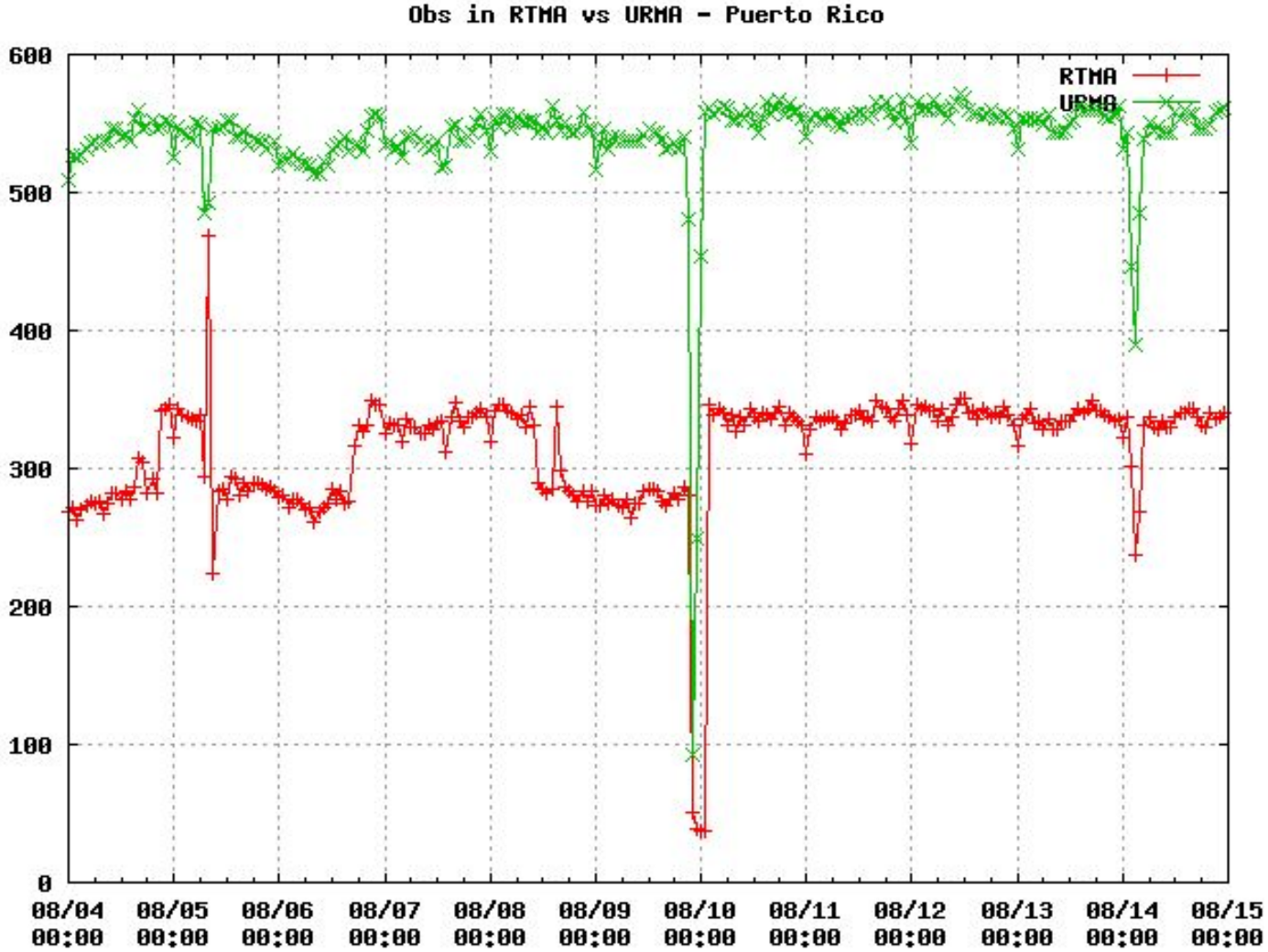


NAM Smartinit
Cloud Ceiling Height and Mean Sea-level Pressure






maxT - 01Z T (maxT at 0057Z)
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
161W
160W
159W
158W
157W
156W
155W
154W
−2
0
2
4
6
8
10
12
GrADS: COLA/IGES
2016-08-15-20:20


Obs in RTMA vs URMA - Puerto Rico
RTMA
URMA
600
500
400
300
200
100
0
08/04 00:00
08/05 00:00
08/06 00:00
08/07 00:00
08/08 00:00
08/09 00:00
08/10 00:00
08/11 00:00
08/12 00:00
08/13 00:00
08/14 00:00
08/15 00:00

Features of new nonlinear quality control (Purser, 2011 NOAA office Note 468)

1. *It fits to the histogram of innovation better. Innovation is the difference between observation and model first guess.*
2. *it is "Gaussian Mixture" probability distribution function. When the observation data are far away from the first guess, the method gives them less weight in the analysis process, so mitigate their impact on analysis results (further explanation follows)*

The logarithm of the probability is proportional to:

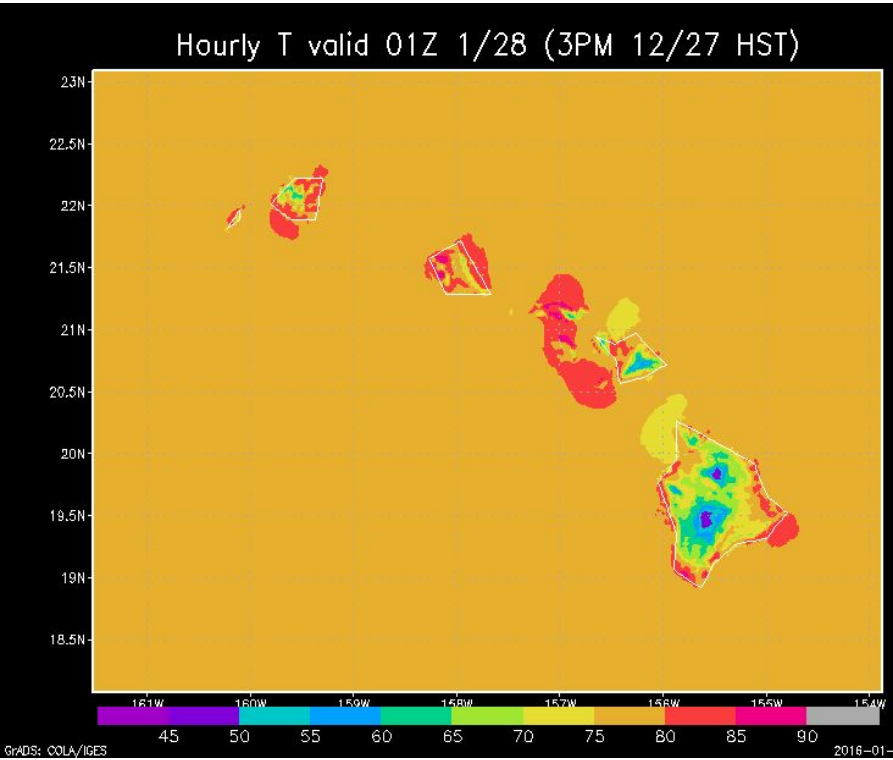
$2b \times \ln(\cosh((O-F)/(\sqrt{2b} \times \theta))$

Here, b and θ are the two parameters of the scheme, denoting the degree of non-Gaussian shape, and the nominal standard deviation of observation error, respectively.

When and how can the new varqc help?

- (a) If there are a few isolated bad observations among good data, which happens often, new varqc assigns less weights to the bad observations during the analysis process; therefore, mitigates the effect of the bad observations .
- (b) If the observed data are of good quality, but the first guess is not, those data can be used in analysis process, and therefore pull analysis solution close to the true status. Without VarQC, such good obs were often rejected

In short, with new varqc, we can relax the gross error criterion to let more data get into the analysis without degrading the results.


Hourly T valid 01Z 1/28 (3PM 12/27 HST)
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
161W
160W
159W
158W
157W
156W
155W
154W
45
50
55
60
65
70
75
80
85
90
GrADS: COLA/IGES
2016-01-28-23:3

MaxT valid 1/27
23N
22.5N
22N
21.5N
21N
20.5N
20N
19.5N
19N
18.5N
161W
160W
159W
158W
157W
156W
155W
154W
45
50
55
60
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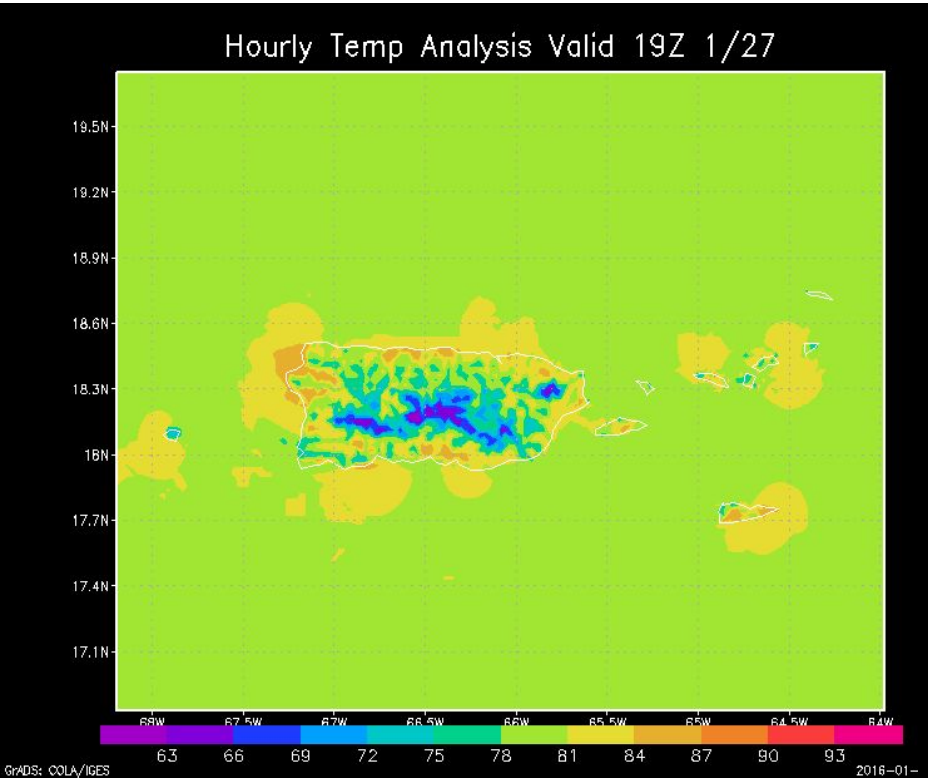
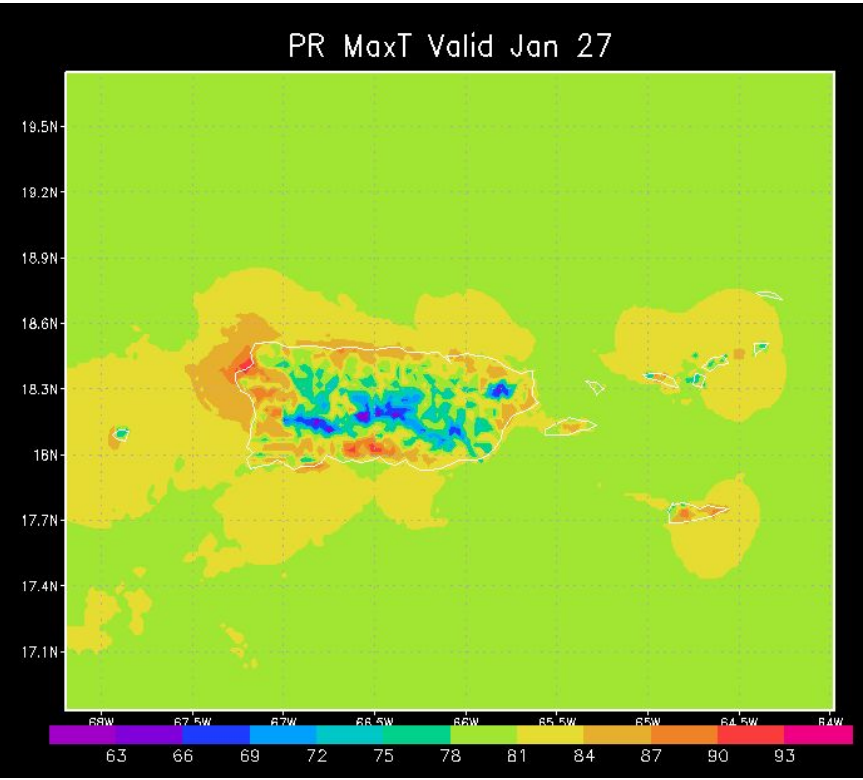
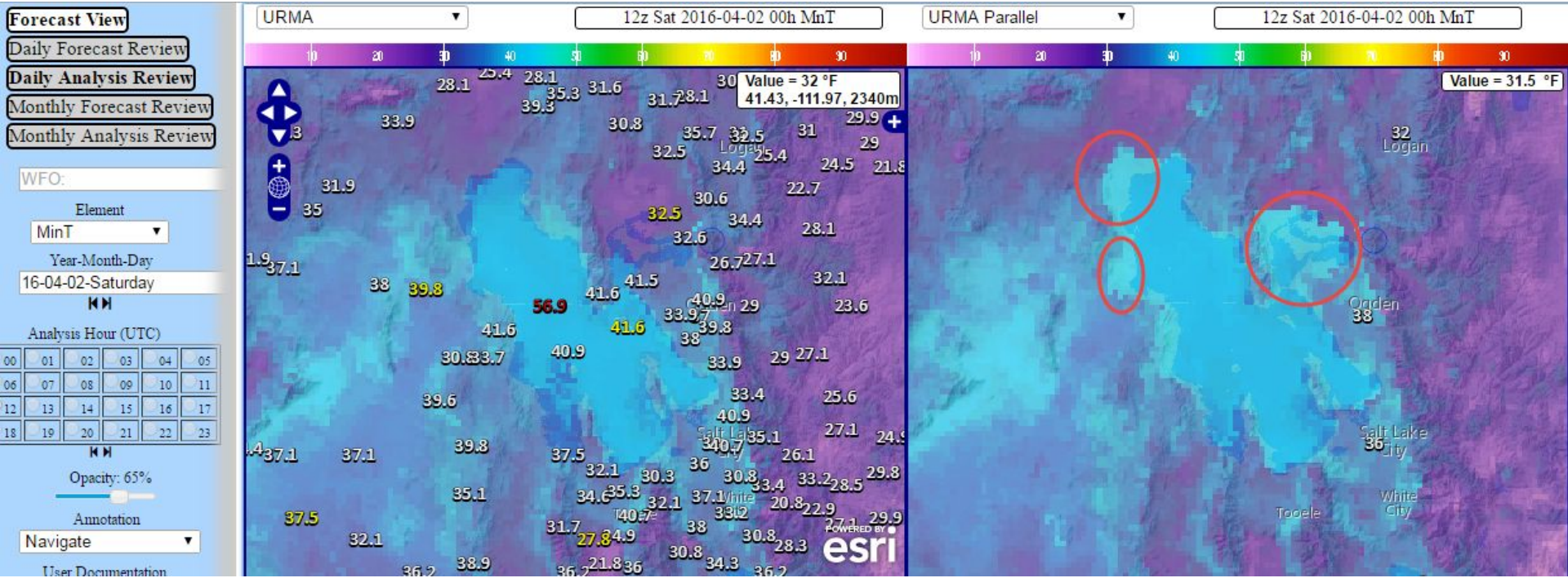
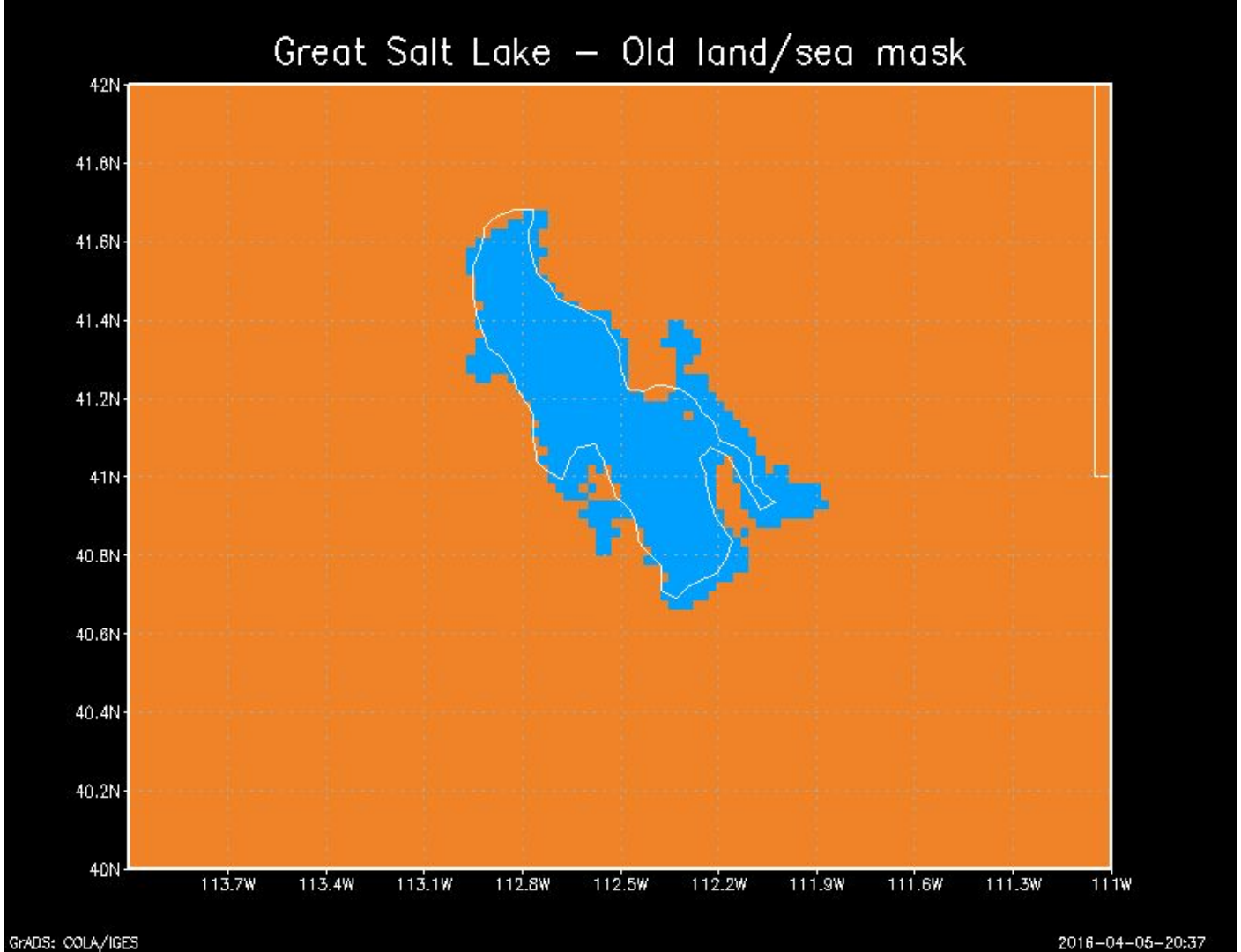
70
75
80
85
90
GrADS: COLA/IGES
2016-01-28-23:37

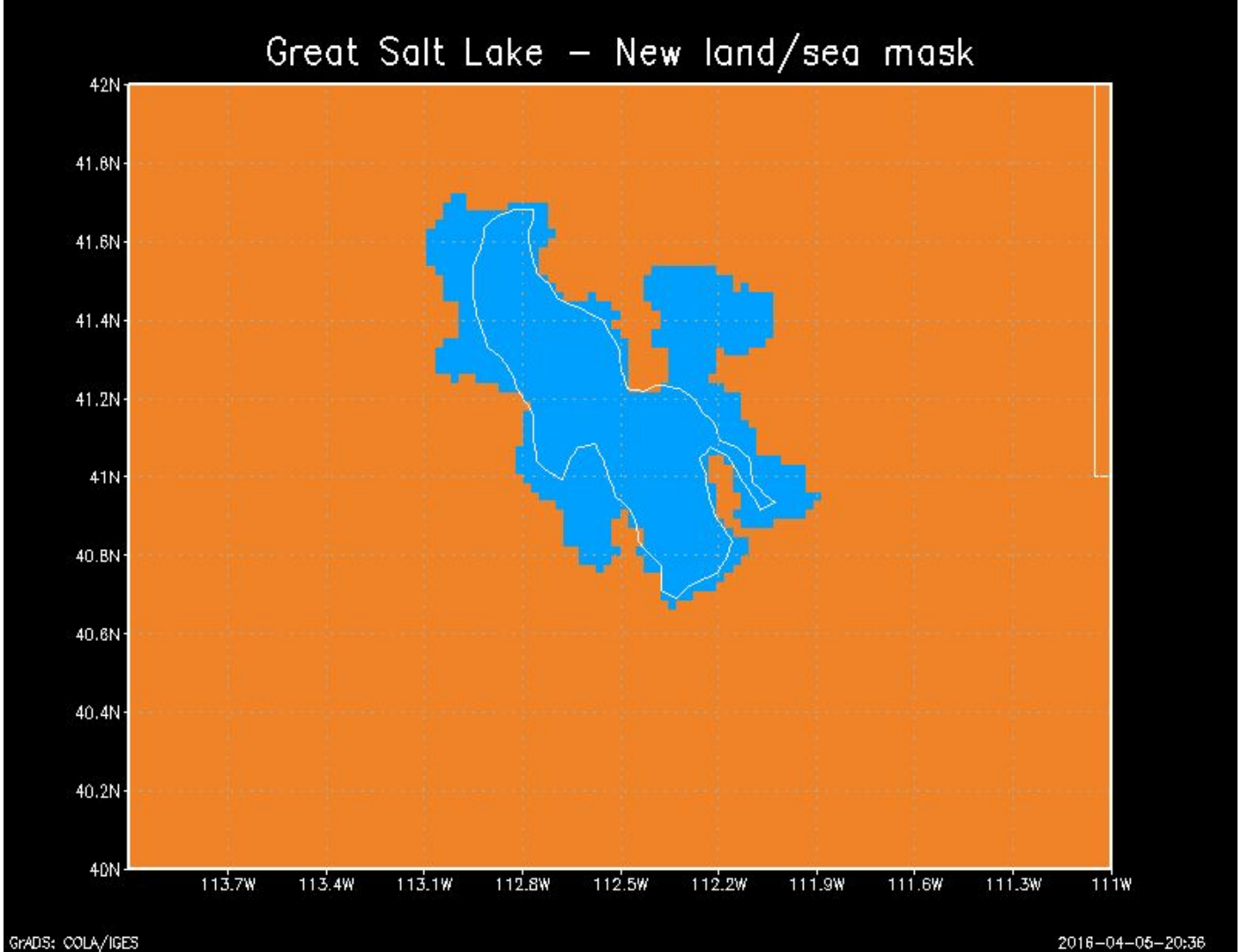

Hourly Temp Analysis Valid 19Z 1/27
19.5N
19.2N
18.9N
18.6N
18.3N
18N
17.7N
17.4N
17.1N
68W
67.5W
67W
66.5W
66W
65.5W
65W
64.5W
64W
63
66
69
72
75
78
81
84
87
90
93
GrADS: COLA/IGES
2016-01-

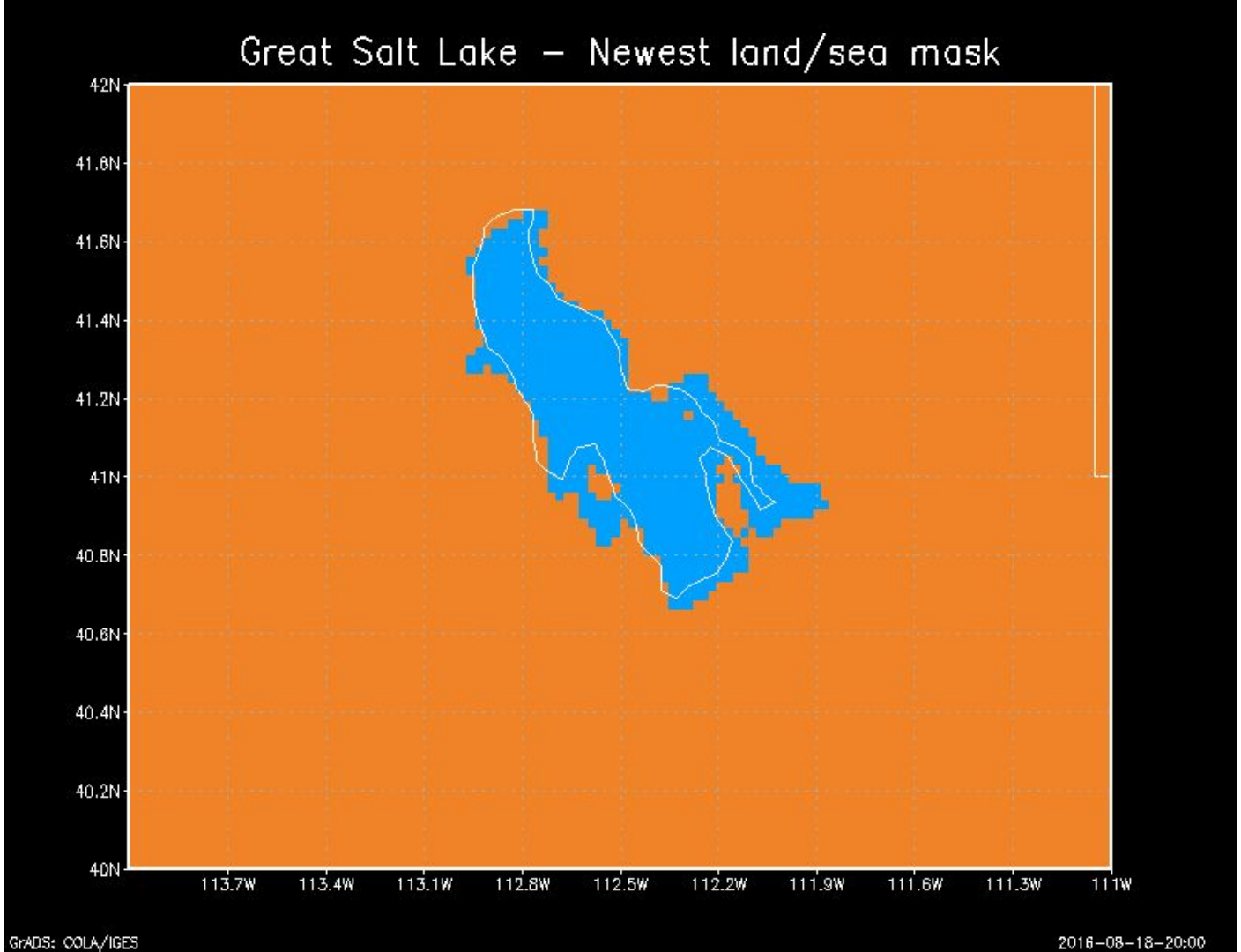

PR MaxT Valid Jan 27
19.5N
19.2N
18.9N
18.6N
18.3N
18N
17.7N
17.4N
17.1N
68W
67.5W
67W
66.5W
66W
65.5W
65W
64.5W
64W
63
66
69
72
75
78
81
84
87
90
93

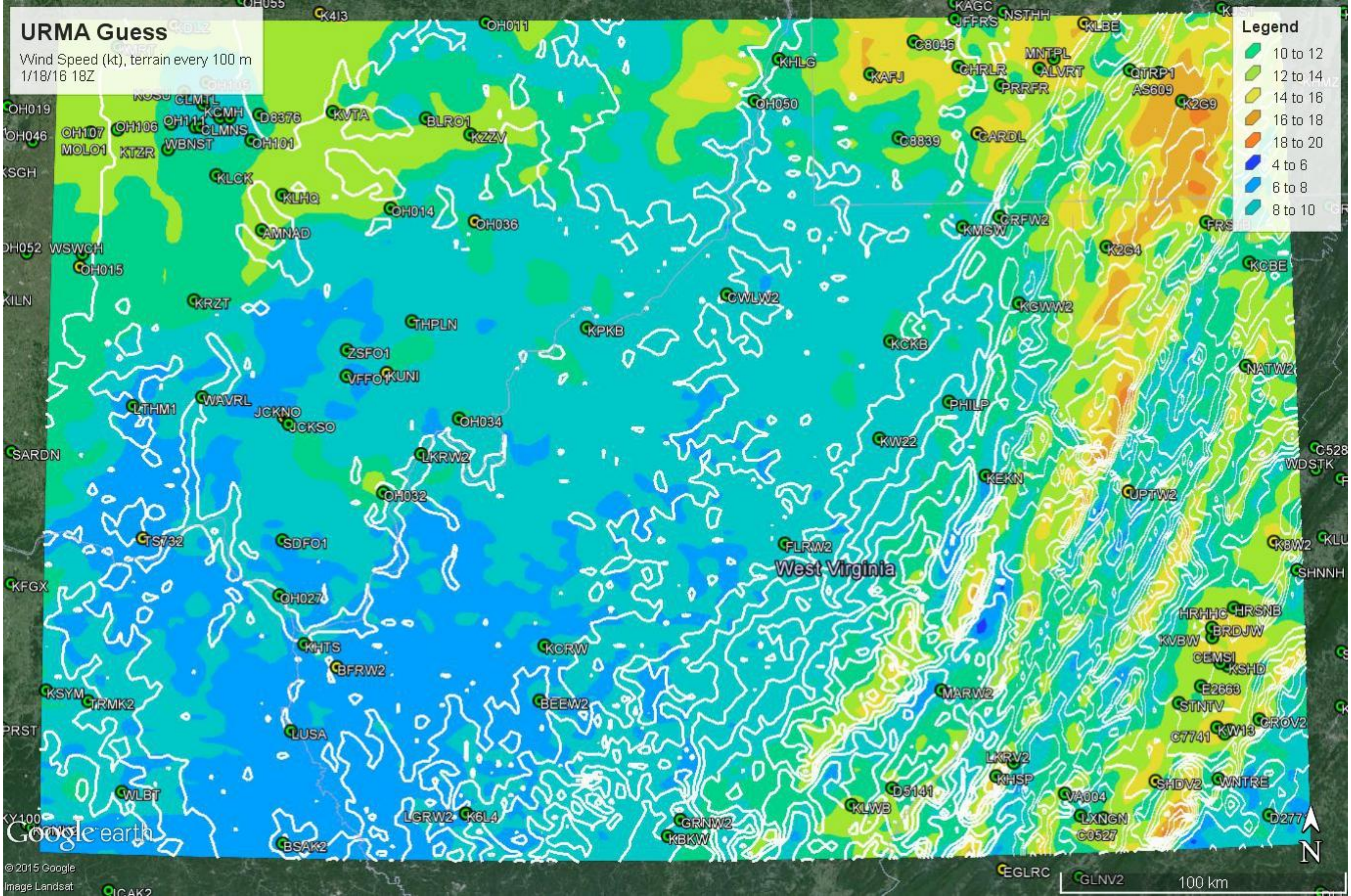
Land/Sea Mask Issue
From WFO Salt Lake City




Great Salt Lake – Old land/sea mask
42N
41.8N
41.6N
41.4N
41.2N
41N
40.8N
40.6N
40.4N
40.2N
40N
113.7W
113.4W
113.1W
112.8W
112.5W
112.2W
111.9W
111.6W
111.3W
111W
GrADS: COLA/IGES
2016-04-05-20:37


Great Salt Lake – New land/sea mask
42N
41.8N
41.6N
41.4N
41.2N
41N
40.8N
40.6N
40.4N
40.2N
40N
113.7W
113.4W
113.1W
112.8W
112.5W
112.2W
111.9W
111.6W
111.3W
111W
GrADS: COLA/IGES
2016-04-05-20:36


Great Salt Lake – Newest land/sea mask
42N
41.8N
41.6N
41.4N
41.2N
41N
40.8N
40.6N
40.4N
40.2N
40N
113.7W
113.4W
113.1W
112.8W
112.5W
112.2W
111.9W
111.6W
111.3W
111W
GrADS: COLA/IGES
2016-08-18-20:00



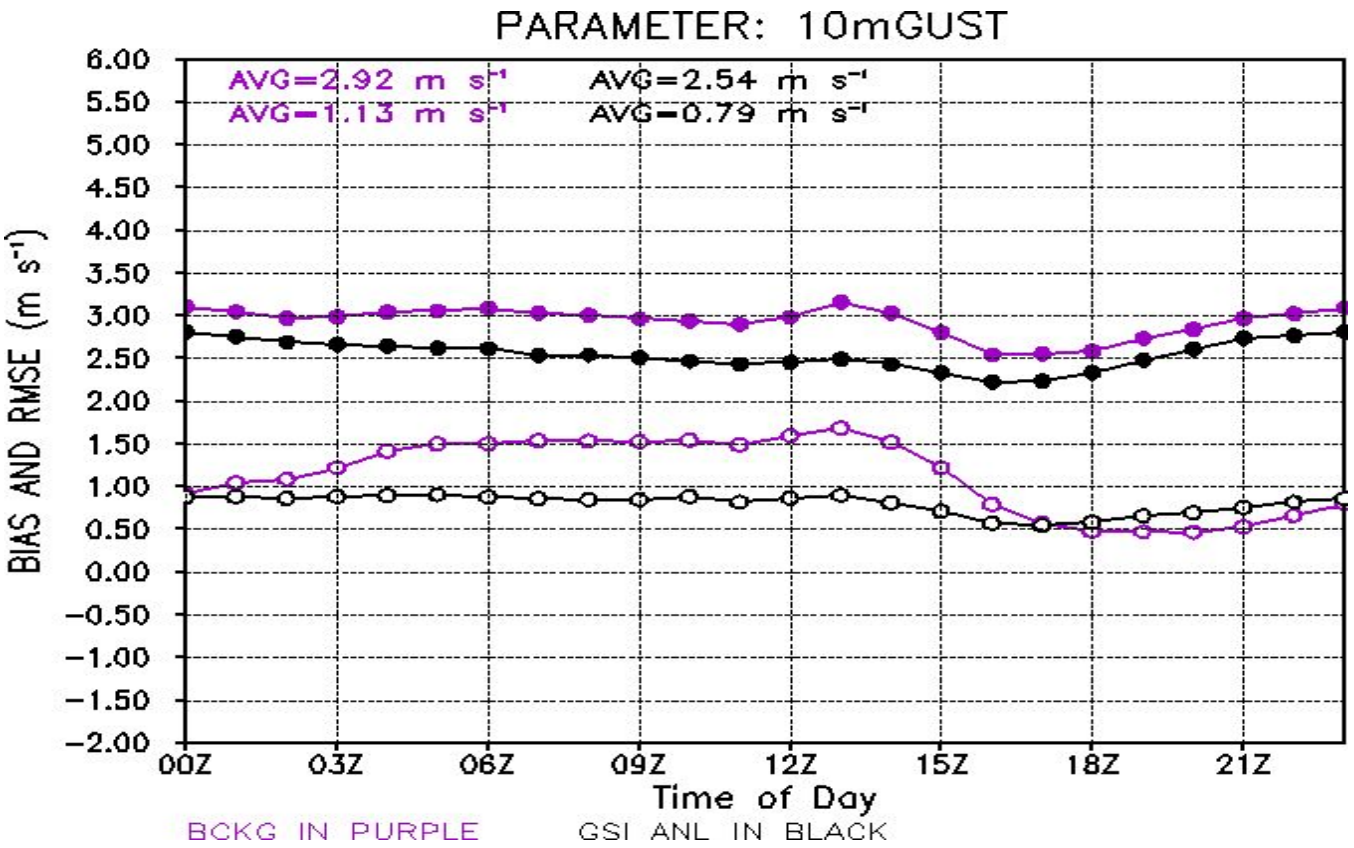
URMA Guess
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
10 to 12
12 to 14
14 to 16
16 to 18
18 to 20
4 to 6
6 to 8
8 to 10
West Virginia
100 km
N
Google earth
© 2015 Google
Image Landsat

FOR WIND SPEED ANALYSIS CASE OVER WEST VIRGINIA

Values at selected sites (mph)

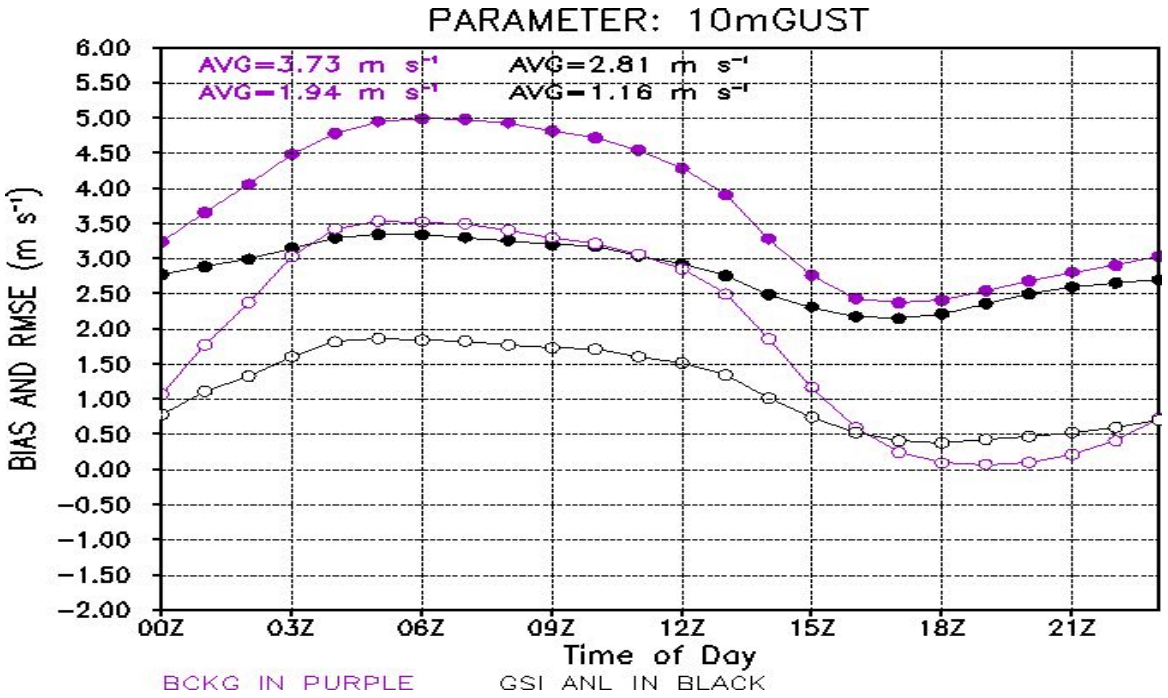
Site	Observed	Background	Old Anl	New Anl
KPKB	15.0	10.2	19.1	13.7
CWLW2	8.1	10.2	19.9	9.8
FLRW2	8.1	10.2	22.1	9.7
KCRW	14.9	9.5	17.9	13.7
BEEW2	10.0	9.0	15.9	12.1
KW22	21.0	11.3	17.5	14.3

Cross-validation BIAS and RMSE for Wind GUST



FROM OPS

Cross-validation BIAS and RMSE for Wind GUST



FROM PARA

Background shows large errors for 01Z through 15Z