RTMA/URMA and NAM Smartinit Q3FY16 CCB

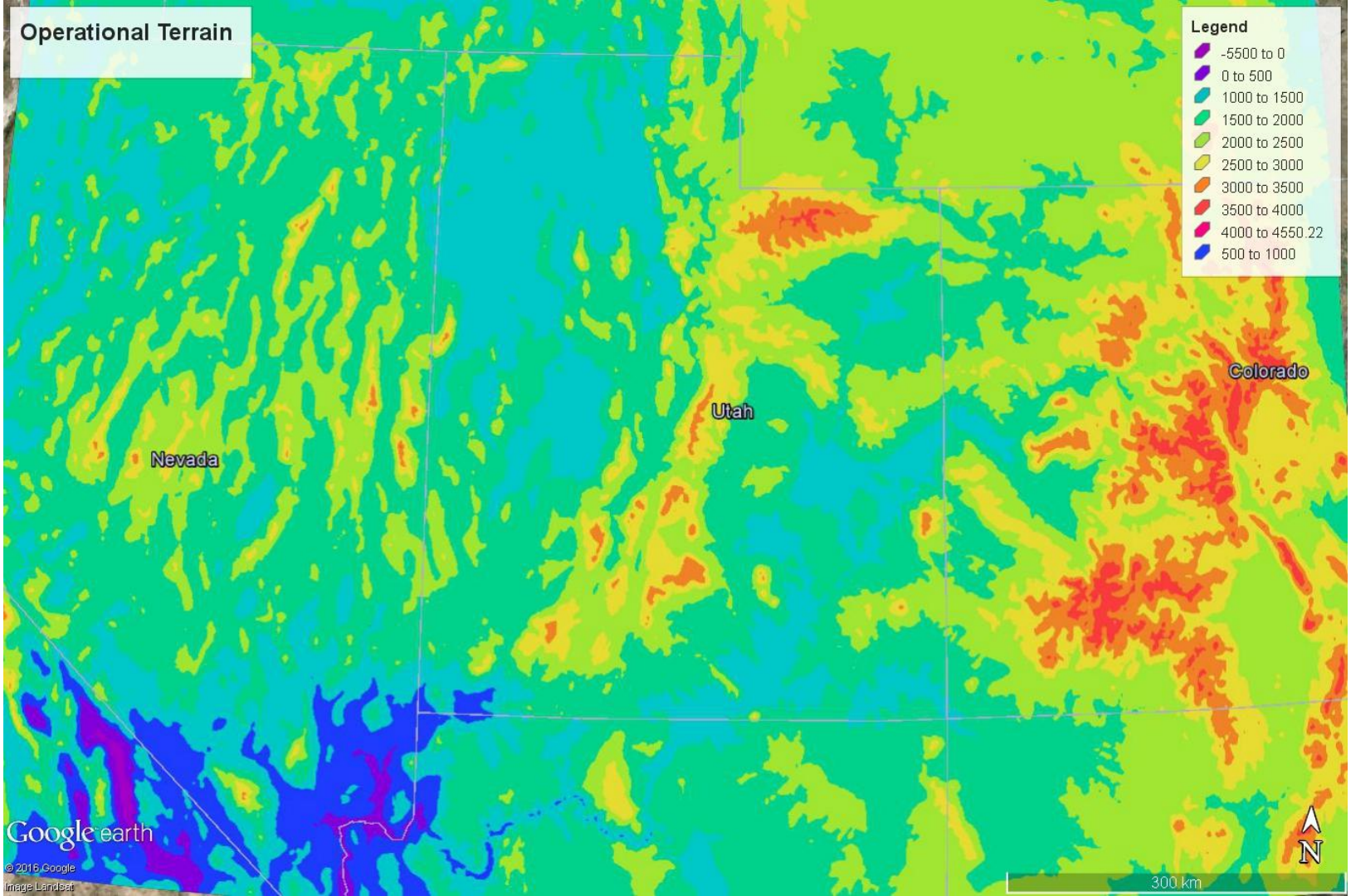
Manuel Pondeca, Steven Levine, Jacob Carley, Ying Lin, Yanqiu Zhu, Jeff McQueen, Geoff Manikin, R. James Purser, Xiujuan Su, George Gayno, Geoff DiMego, Dave Parrish, Runhua Yang, Annette Gibbs

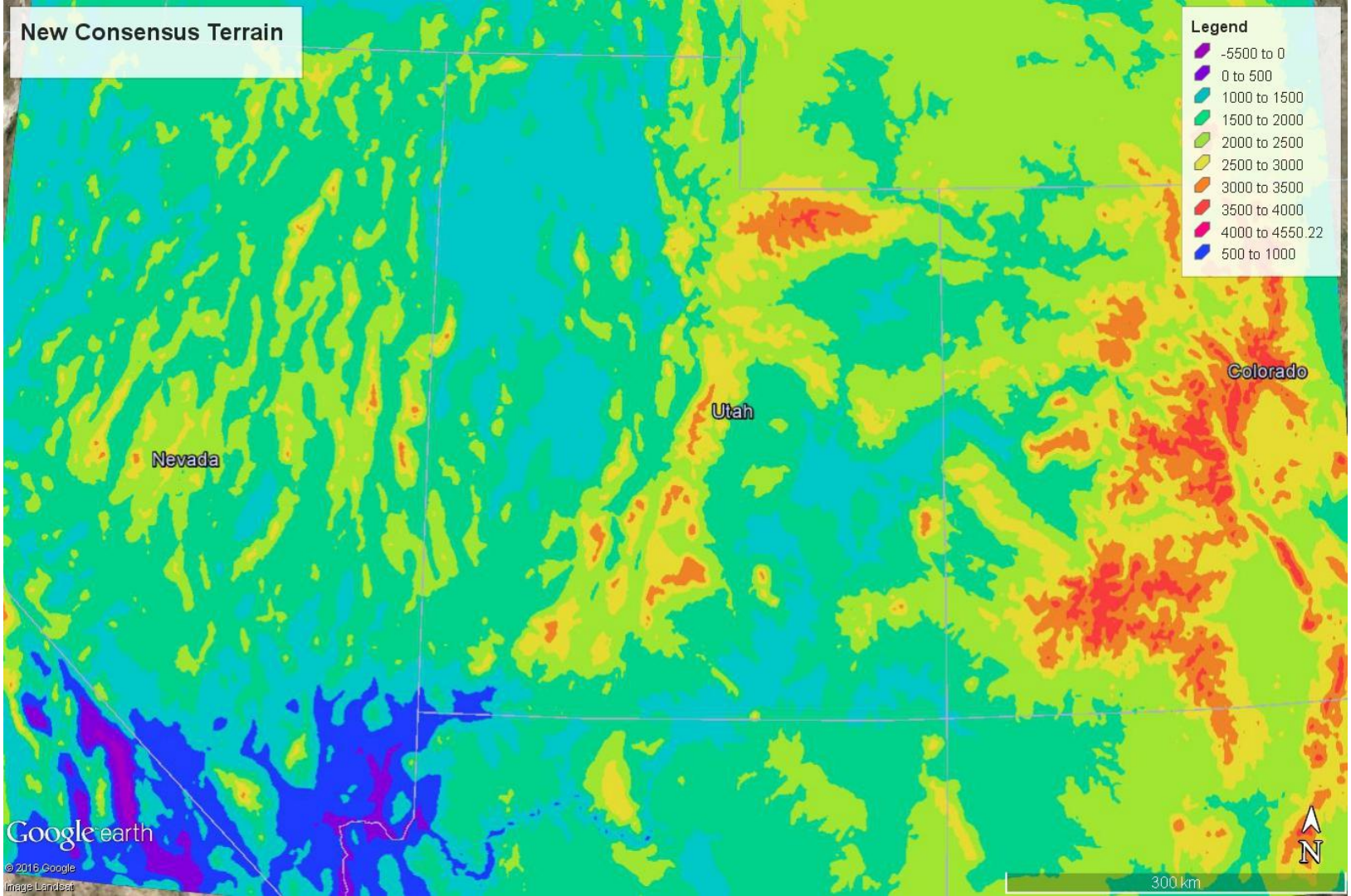
Changes with this Upgrade

- Smartinit for HRRR, RAP, NAM: New consensus terrain and land/sea mask
  - Part of National Blend of Models project
  - Terrain and land/sea mask provided by MDL
- Use of HRRRv2/RAPv3 for background
- URMA (including min/maxT for Hawaii and Puerto Rico)
  - Requested by National Blend of Models project
- New wind speed analysis
  - Wind speed as a scalar, rather than streamfunction and velocity potential
  - Requested by Eastern Region and WFO Charleston, WV after issue was discovered last year
- Variational quality control adjustments
- New variable: cloud ceiling height
  - Requested by FAA, also fulfills NDFD requirement
  - In operations, but considered *experimental output* (no time to evaluate with field)

New Consensus Terrain and Land/Sea Mask

- Developed by MDL, EMC, NWS Regions, and Raytheon as part of National Blend.
- Based on USGS GMTED2010 data, which is an upgrade from the GTOPO30 data used in OPS
- Same terrain for RTMA, NBM, RAP smartinit, NAM smartinit, AWIPS
- Meant to go in for Q1FY16 upgrade, but too many systems to work with at same time
- Terrain will be sent back to local offices for local edits later

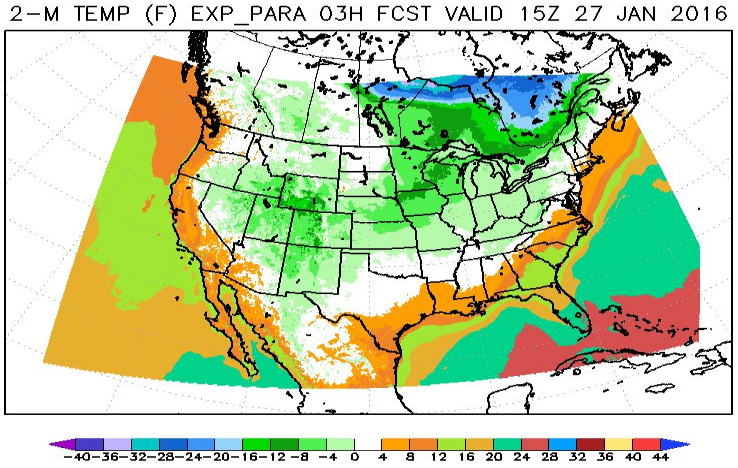

Operational Terrain
Legend
-5500 to 0
0 to 500
1000 to 1500
1500 to 2000
2000 to 2500
2500 to 3000
3000 to 3500
3500 to 4000
4000 to 4550.22
500 to 1000
Nevada
Utah
Colorado
Google earth
© 2016 Google
Image Landsat
300 km
N

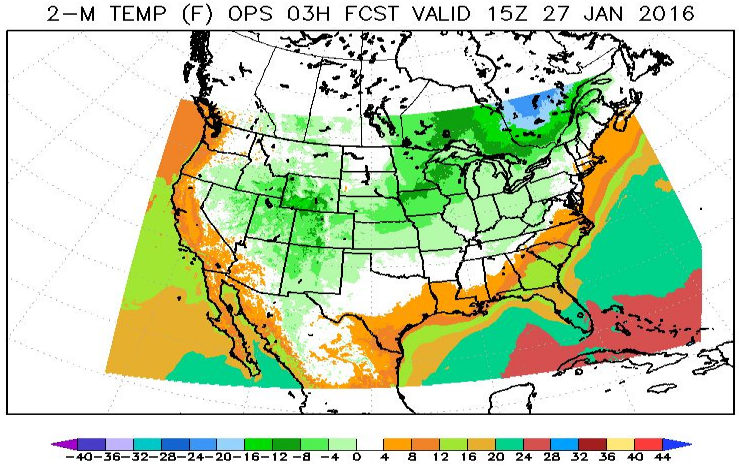

New Consensus Terrain
Legend
-5500 to 0
0 to 500
1000 to 1500
1500 to 2000
2000 to 2500
2500 to 3000
3000 to 3500
3500 to 4000
4000 to 4550.22
500 to 1000
Nevada
Utah
Colorado
Google earth
© 2016 Google
Image Landsat
300 km
N

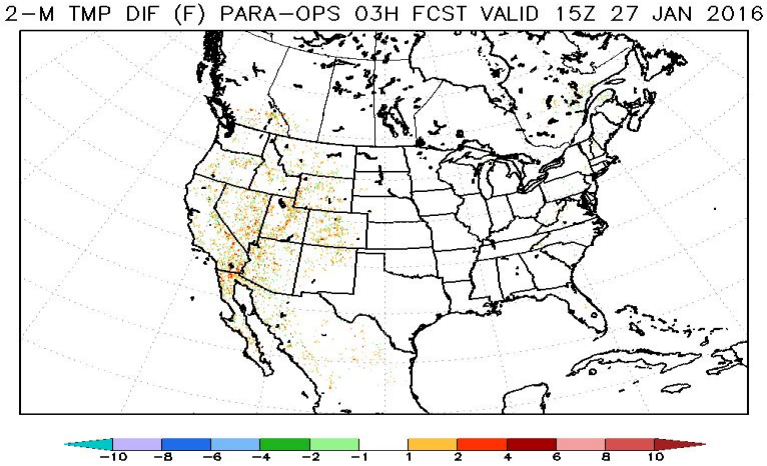
Changes to NAM Smartinit

- 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

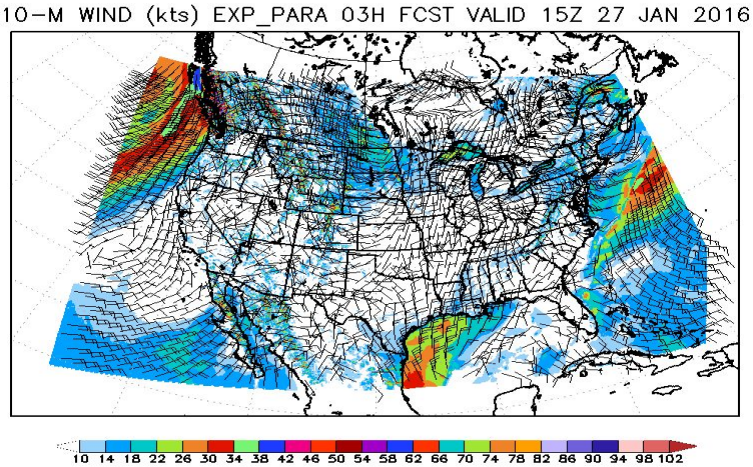
NAM Smartinit 2-m Temperature (°F)

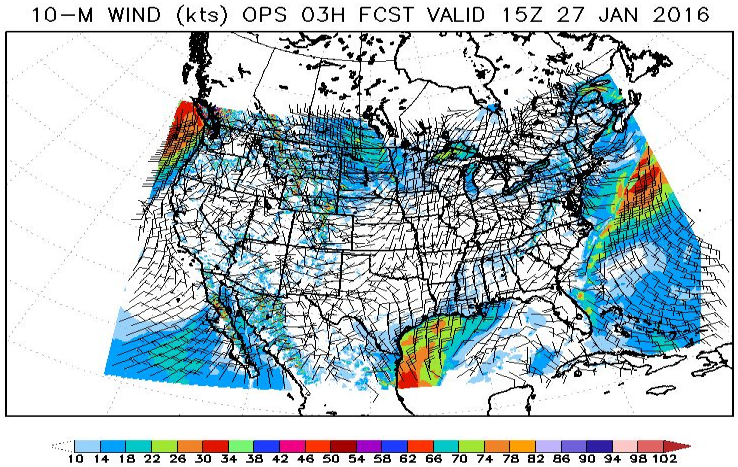


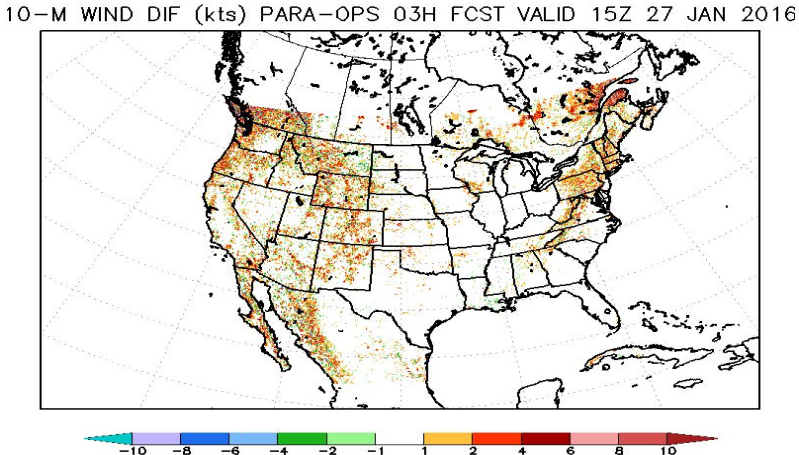




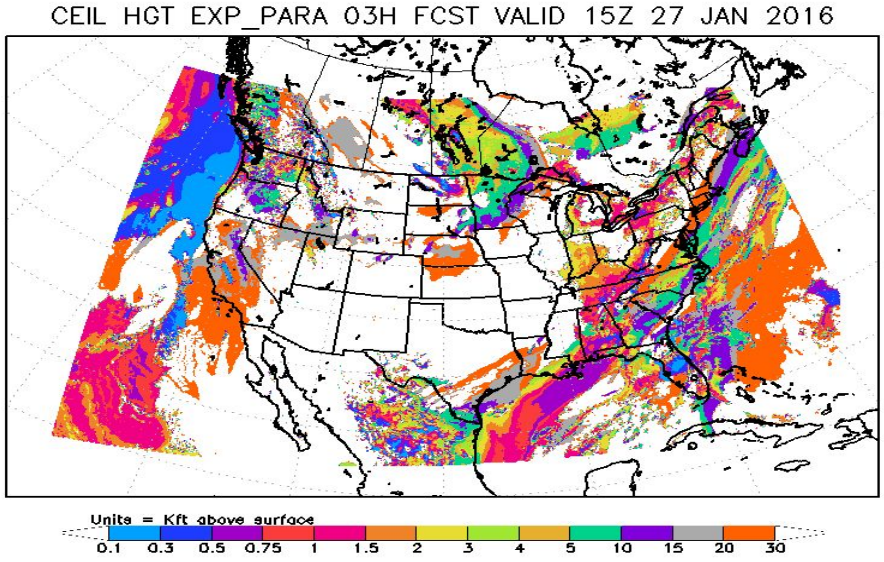
NAM Smartinit 10-m Winds (kts)

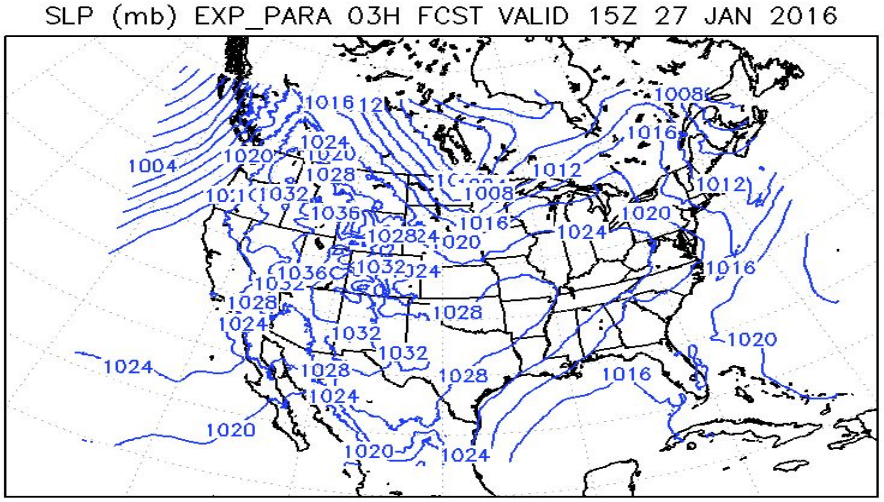






NAM Smartinit
Cloud Ceiling Height and Mean Sea-level Pressure





RAPv3/HRRRv2 Background

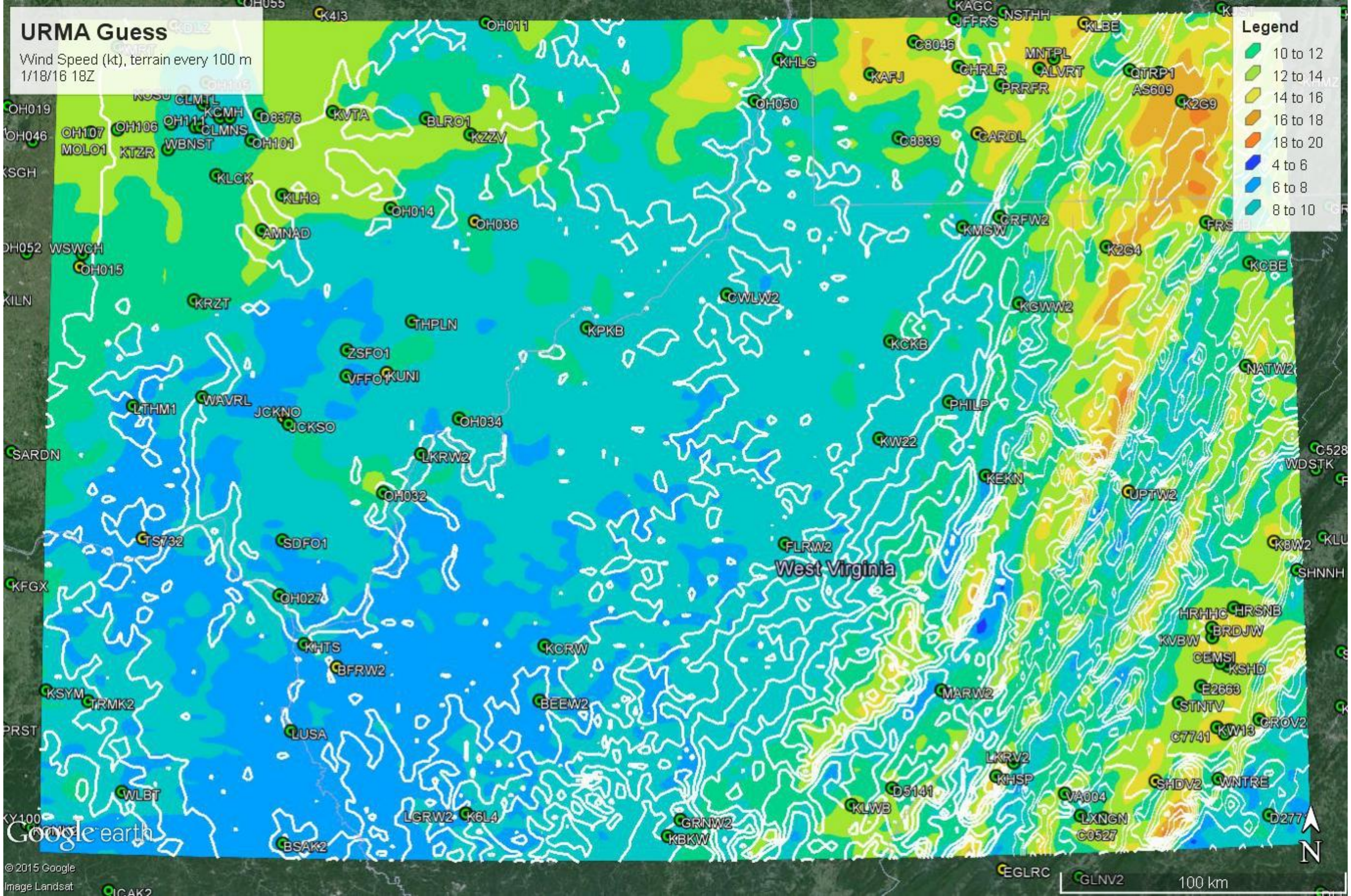
- Smartinit downscaled 1h forecasts are used
- Blended with smartinit NAM forecast to generate RTMA/URMA background
- Improvements in low level moisture, temperature will allow for generation of better background field

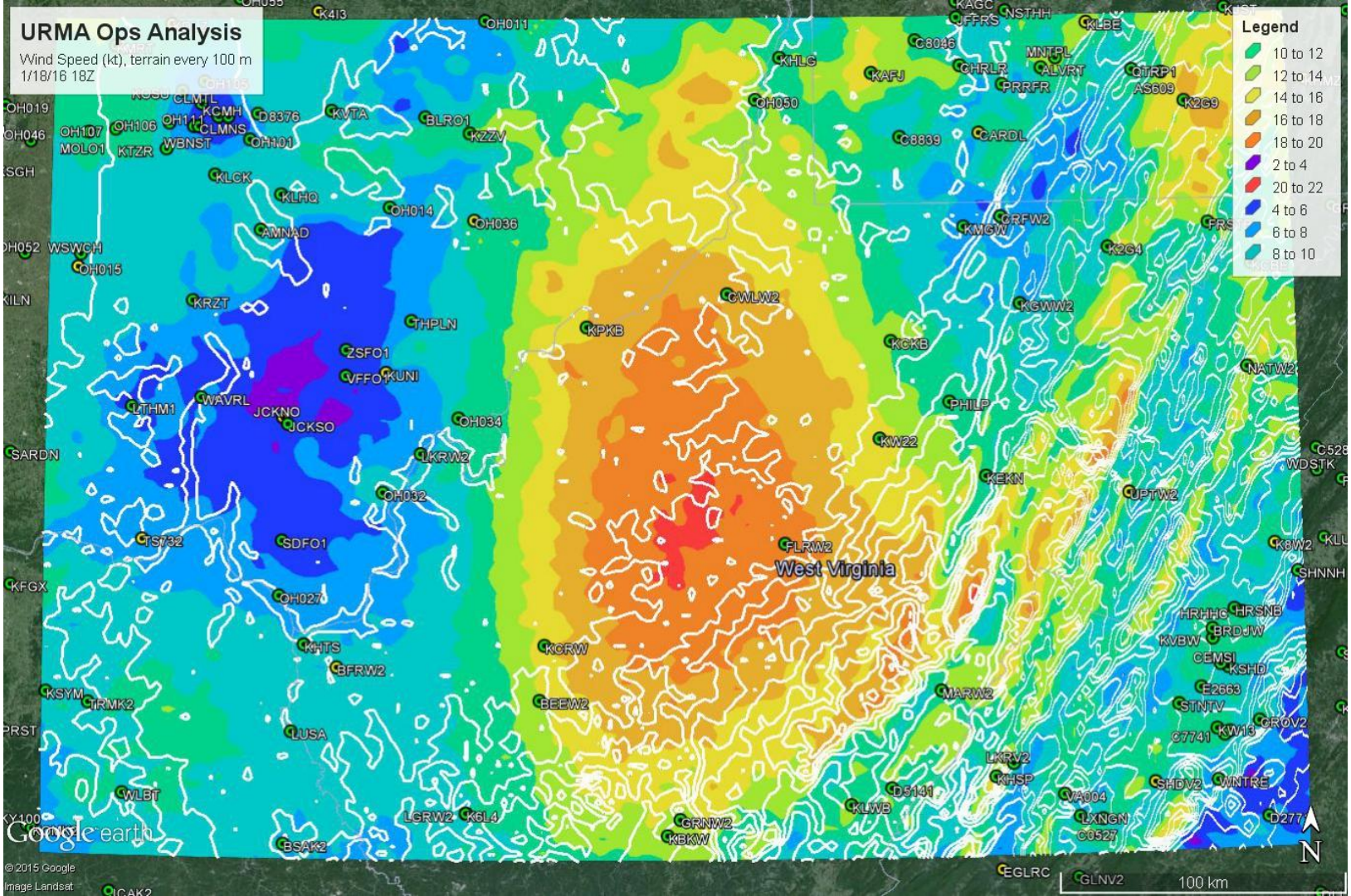
New Wind Speed Analysis

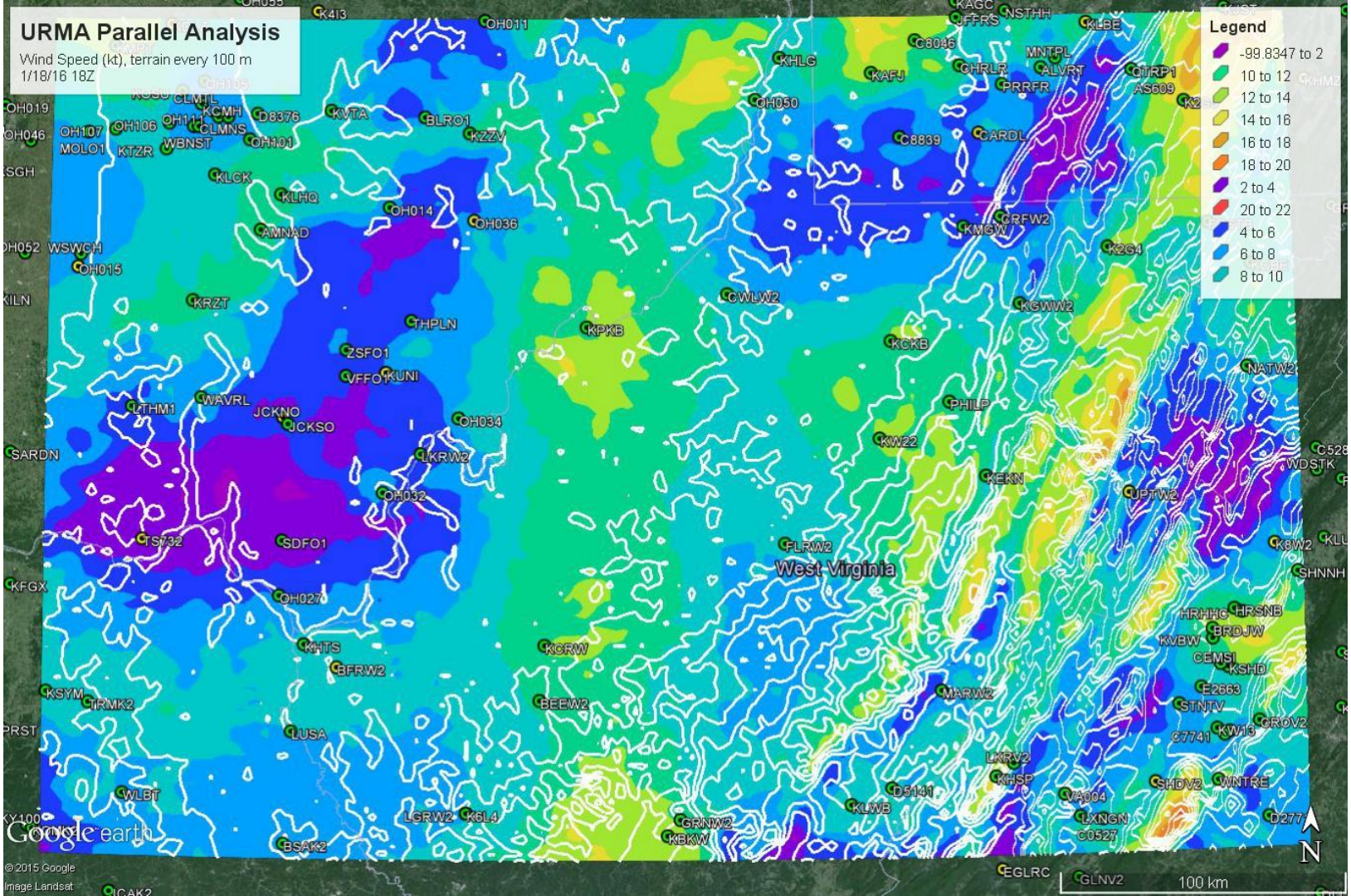
- Current wind analysis does not match obs well, has been known to generate false features (pointed out by WFO's, regions)
- Current analysis method used streamfunction and velocity potential
- New method: analyze wind speed as a scalar
  - Direction still derived from streamfunction/velocity potential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

URMA Wind Speed Analysis over WV

18 January 2016, 18Z
Operational (old): old wind speed (psi/chi)
Parallel (new): new wind speed (as scalar)


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
© 2015 Google
Image Landsat


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

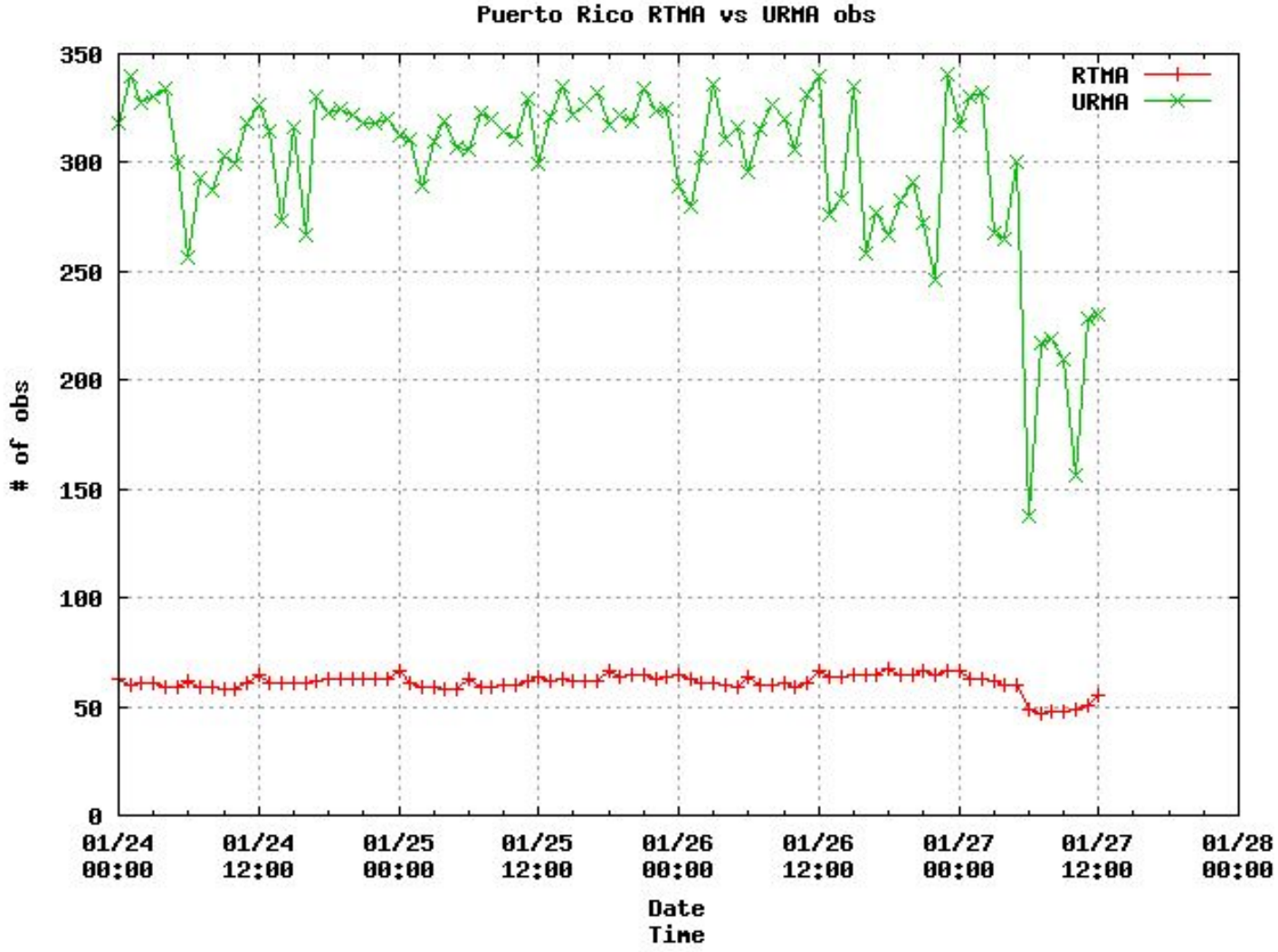

URMA Parallel Analysis
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
-99.8347 to 2
10 to 12
12 to 14
14 to 16
16 to 18
18 to 20
2 to 4
20 to 22
4 to 6
6 to 8
8 to 10
West Virginia
Google earth
© 2015 Google
Image Landsat
100 km
N

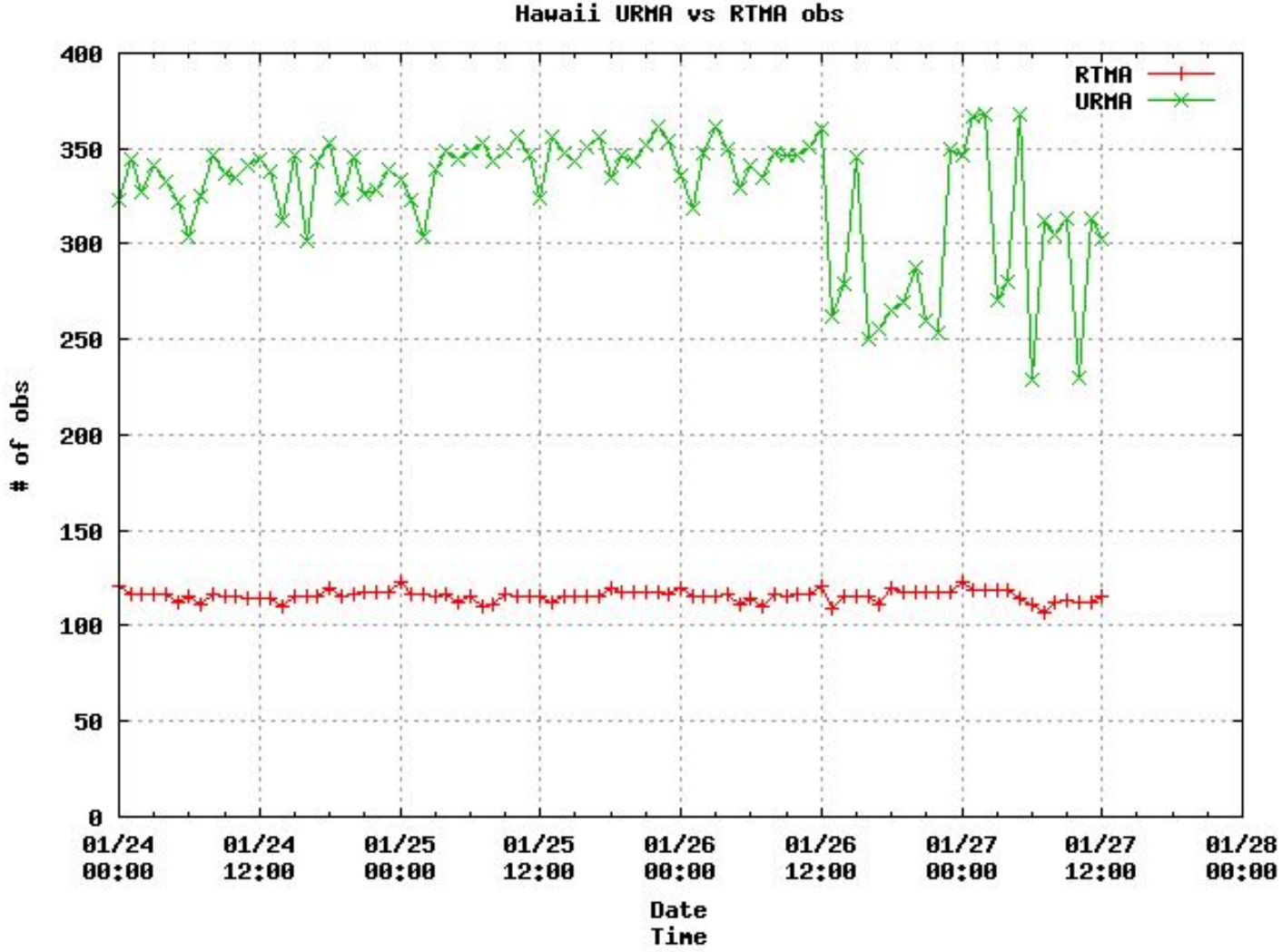
Values at selected sites (mph)

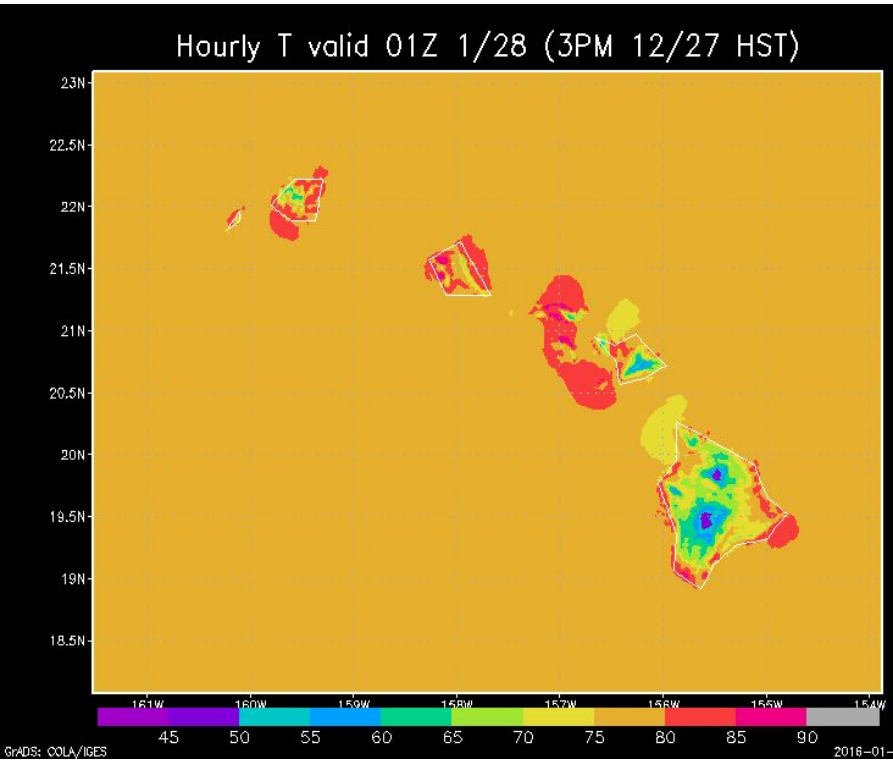
Site	Observed	Background	Old Anl	New Anl
KPKB	15.0	10.2	19.1	13.7
CWLW2	8.1	10.2	19.9	9.8
FLRW2	8.1	10.2	22.1	9.7
KCRW	14.9	9.5	17.9	13.7
BEEW2	10.0	9.0	15.9	12.1
KW22	21.0	11.3	17.5	14.3

URMA for Hawaii and Puerto Rico

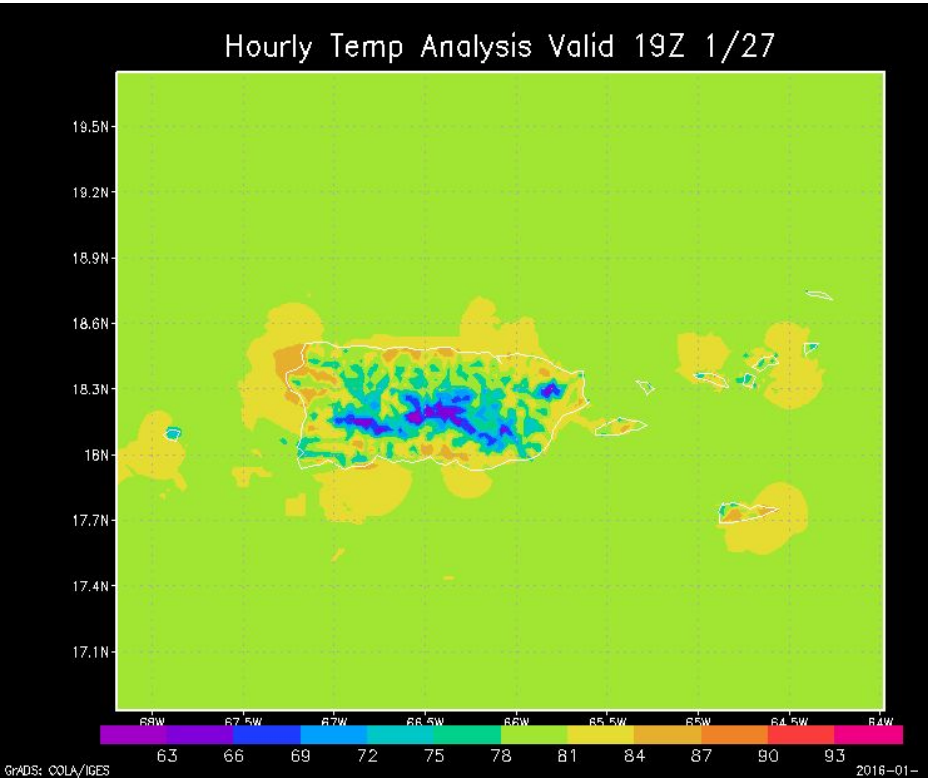
- Requested by National Blend of Models project for use in blend over PR and HI
- Same code as used for CONUS and AK (implemented in January)
- More obs used, min/maxT now available over these regions
  - min/maxT analyses include intra-hour obs

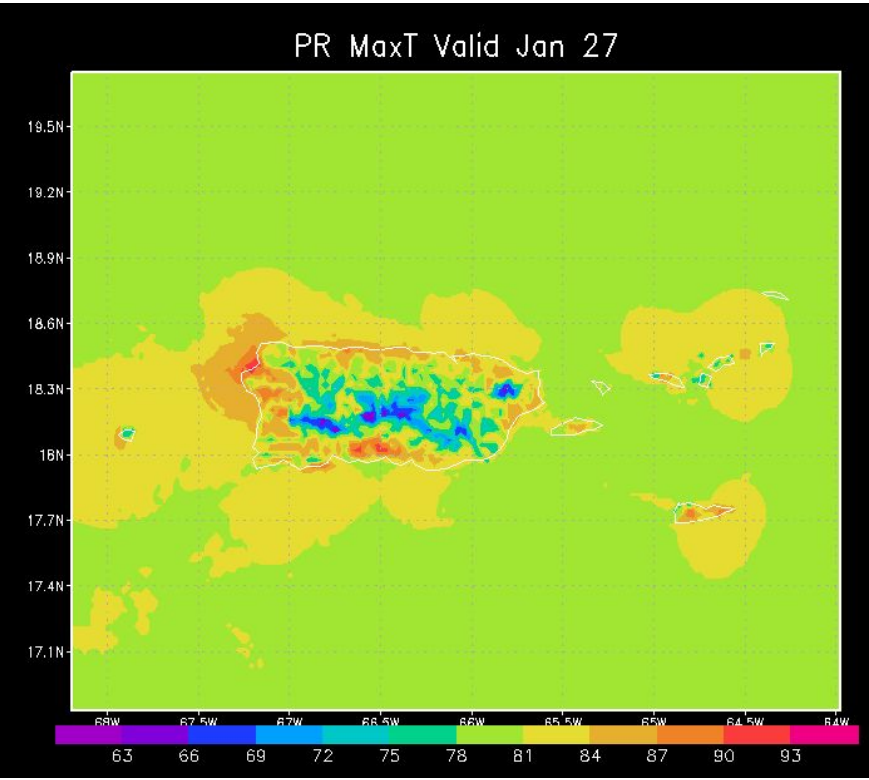

Puerto Rico RTMA vs URMA obs
RTMA
URMA
# of obs
350
300
250
200
150
100
50
0
01/24 00:00
01/24 12:00
01/25 00:00
01/25 12:00
01/26 00:00
01/26 12:00
01/27 00:00
01/27 12:00
01/28 00:00
Date Time


Hawaii URMA vs RTMA obs
RTMA
URMA
# of obs
400
350
300
250
200
150
100
50
0
01/24 00:00
01/24 12:00
01/25 00:00
01/25 12:00
01/26 00:00
01/26 12:00
01/27 00:00
01/27 12:00
01/28 00:00
Date Time


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
65
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

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.

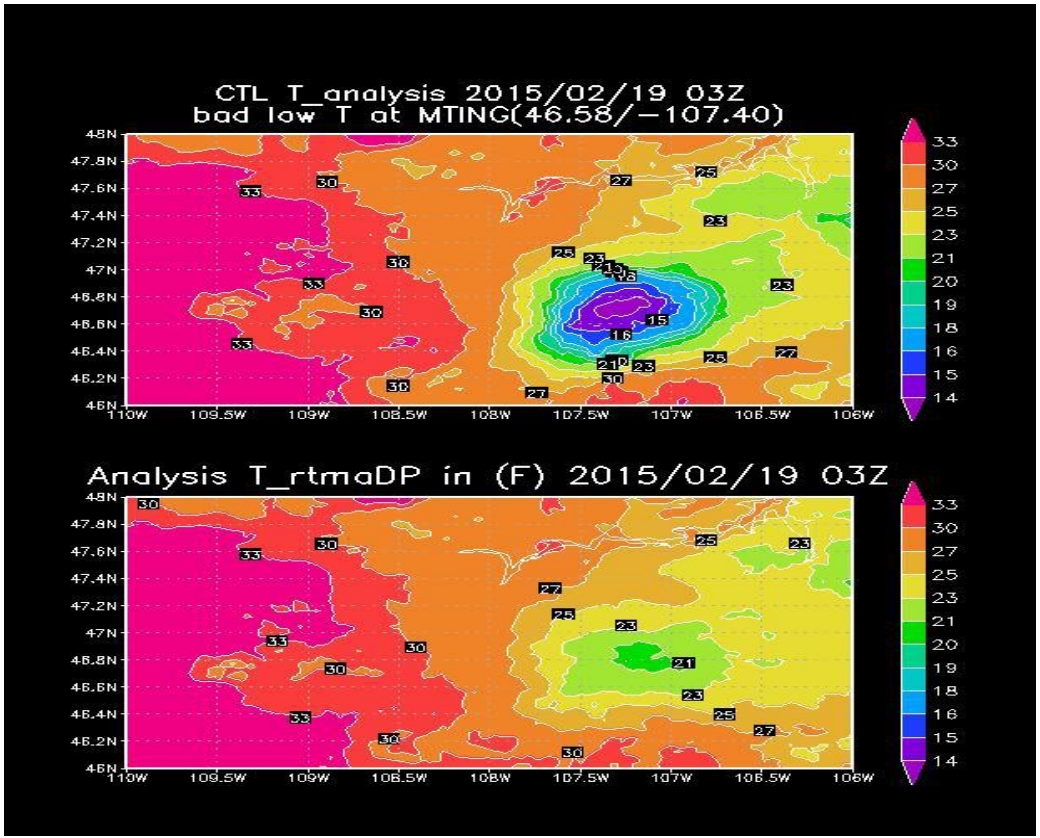
Case one: erroneous low temperature data over Montana 03z 02/19/2015

Top*:* without new varqc Temperature analysis

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

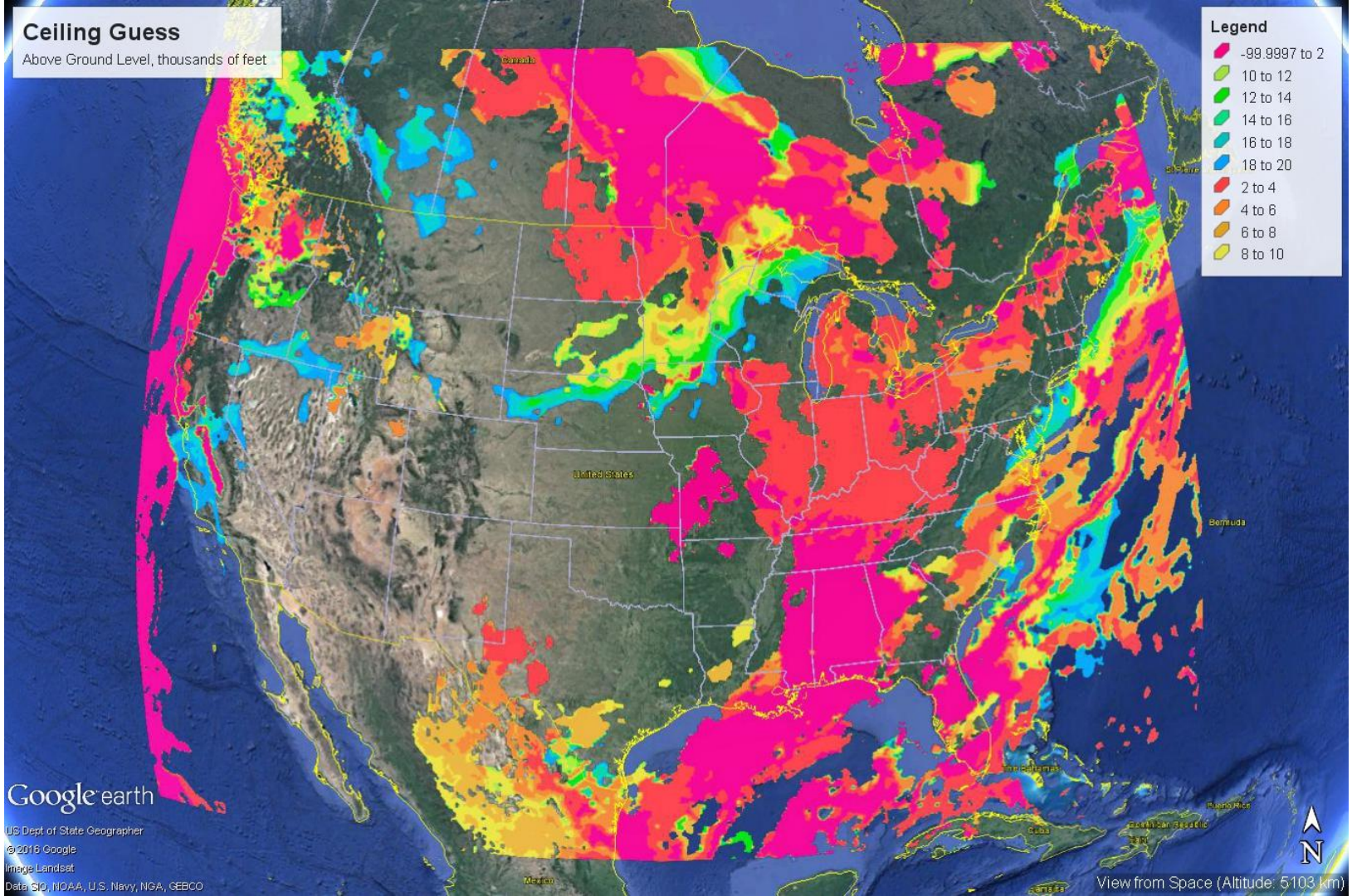
Bottom: with new varqc along with the tuned parameters

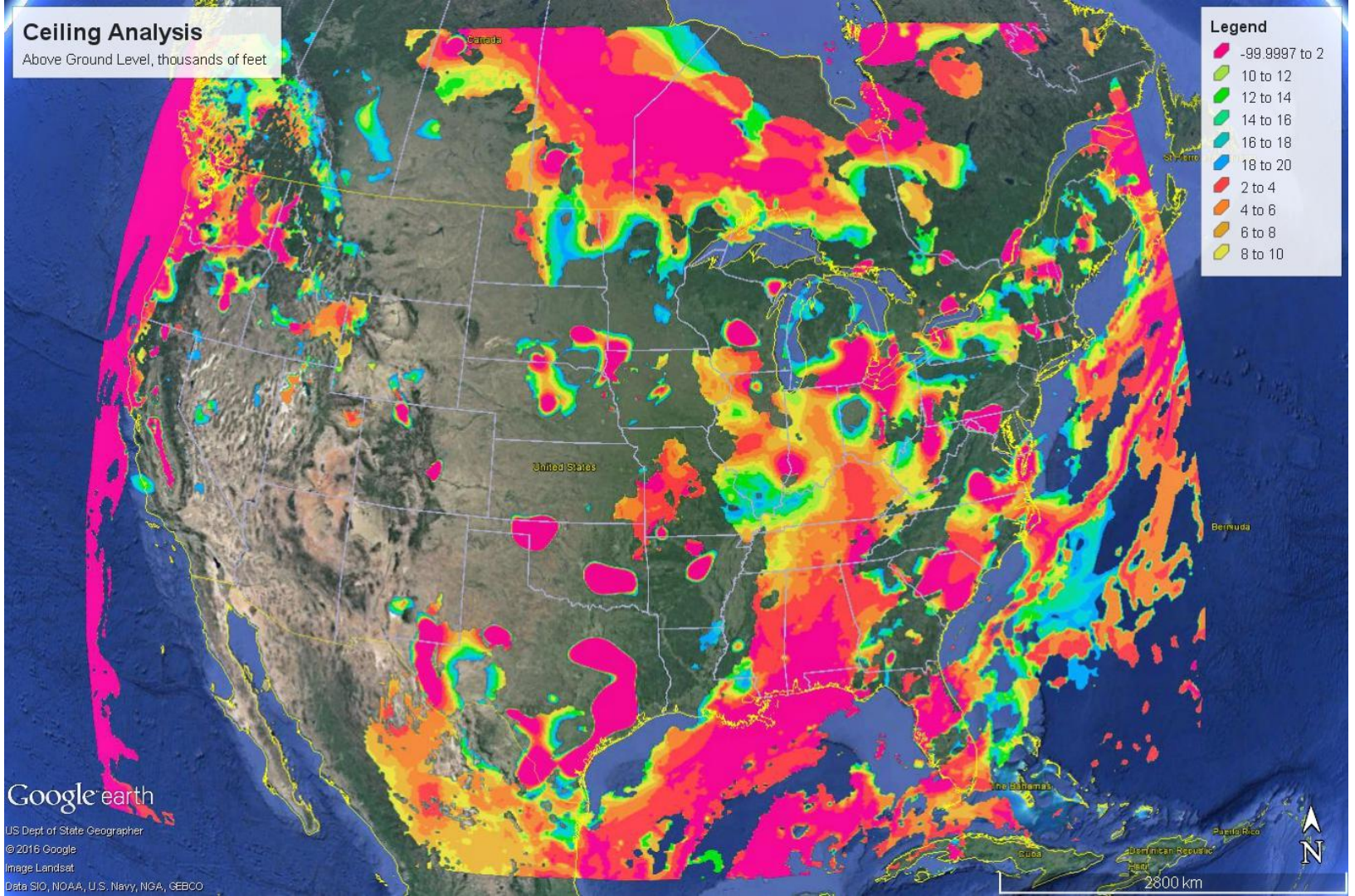
The bull's-eye is gone

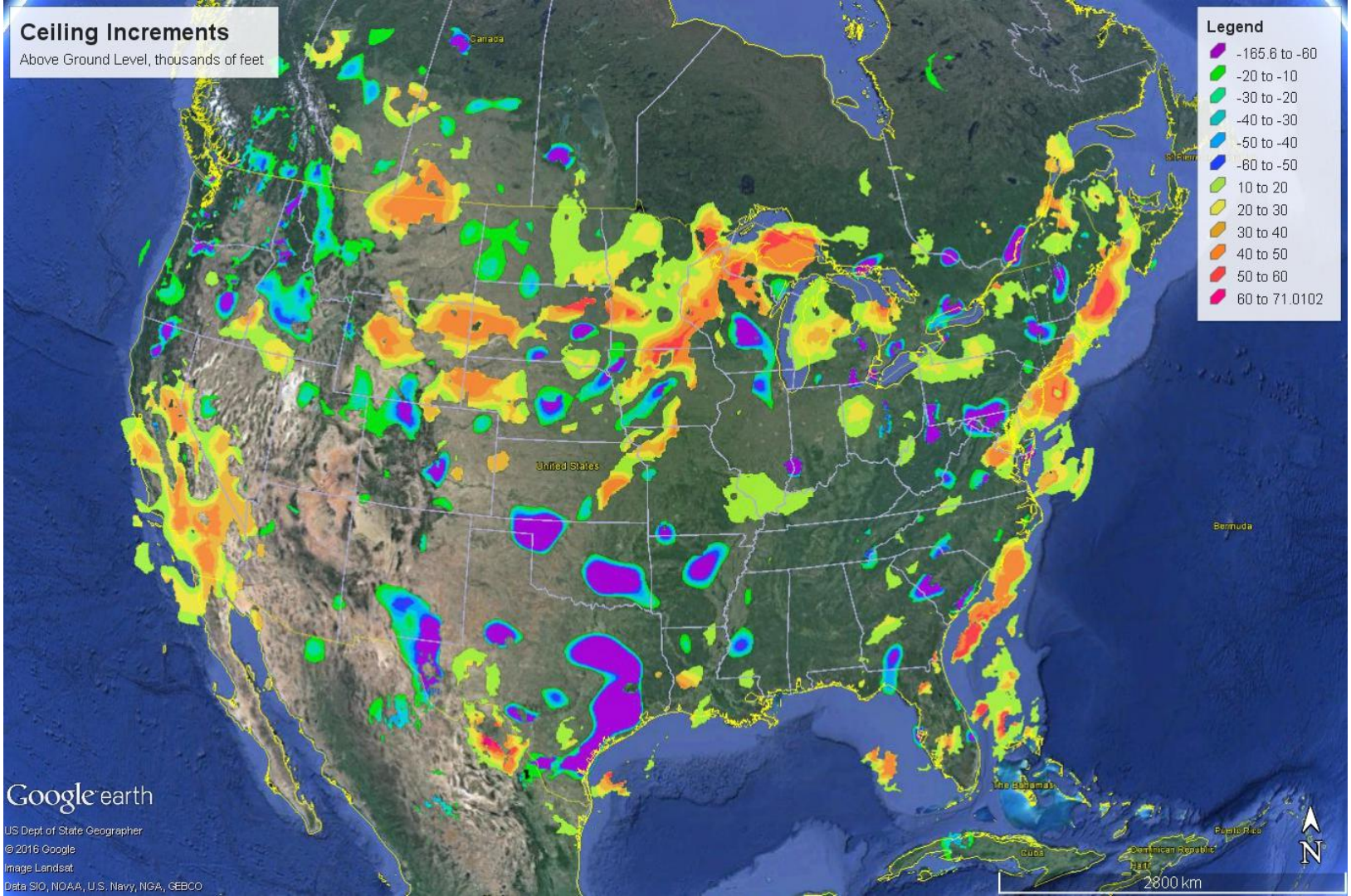


Cloud Ceiling Height

- 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


Ceiling Guess
Above Ground Level, thousands of feet
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
Canada
United States
Bermuda
Mexico
Google earth
US Dept of State Geographer
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
View from Space (Altitude: 5103 km)


Ceiling Analysis
Above Ground Level, thousands of feet
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
Canada
United States
Bermuda
The Bahamas
Cuba
Dominican Republic
Haiti
Puerto Rico
Google earth
US Dept of State Geographer
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
2800 km


Ceiling Increments
Above Ground Level, thousands of feet
Legend
-165.6 to -60
-20 to -10
-30 to -20
-40 to -30
-50 to -40
-60 to -50
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 71.0102
Canada
United States
Bermuda
The Bahamas
Cuba
Dominican Republic
Haiti
Puerto Rico
Google earth
US Dept of State Geographer
© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
2800 km

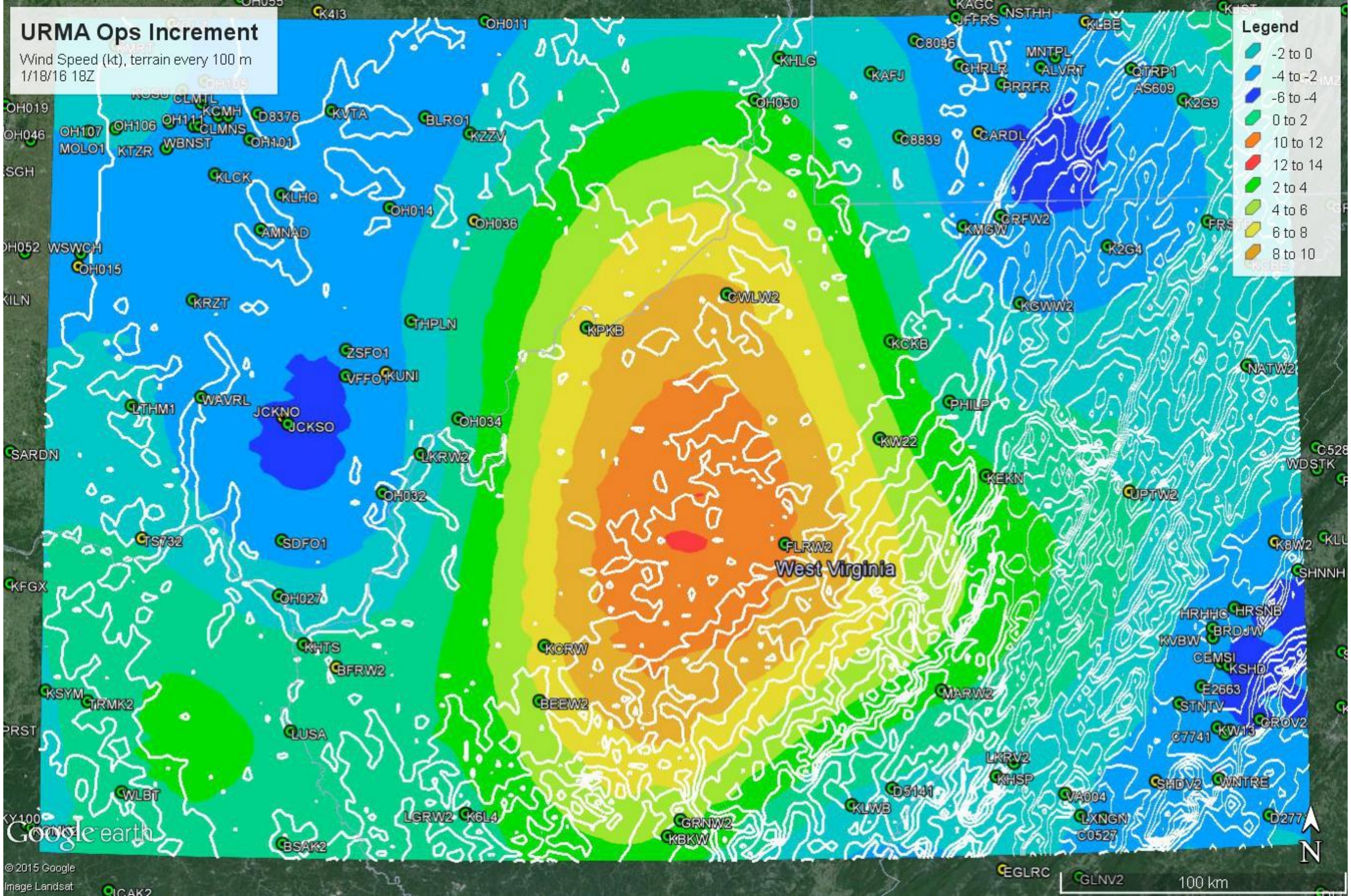
Ongoing Issues

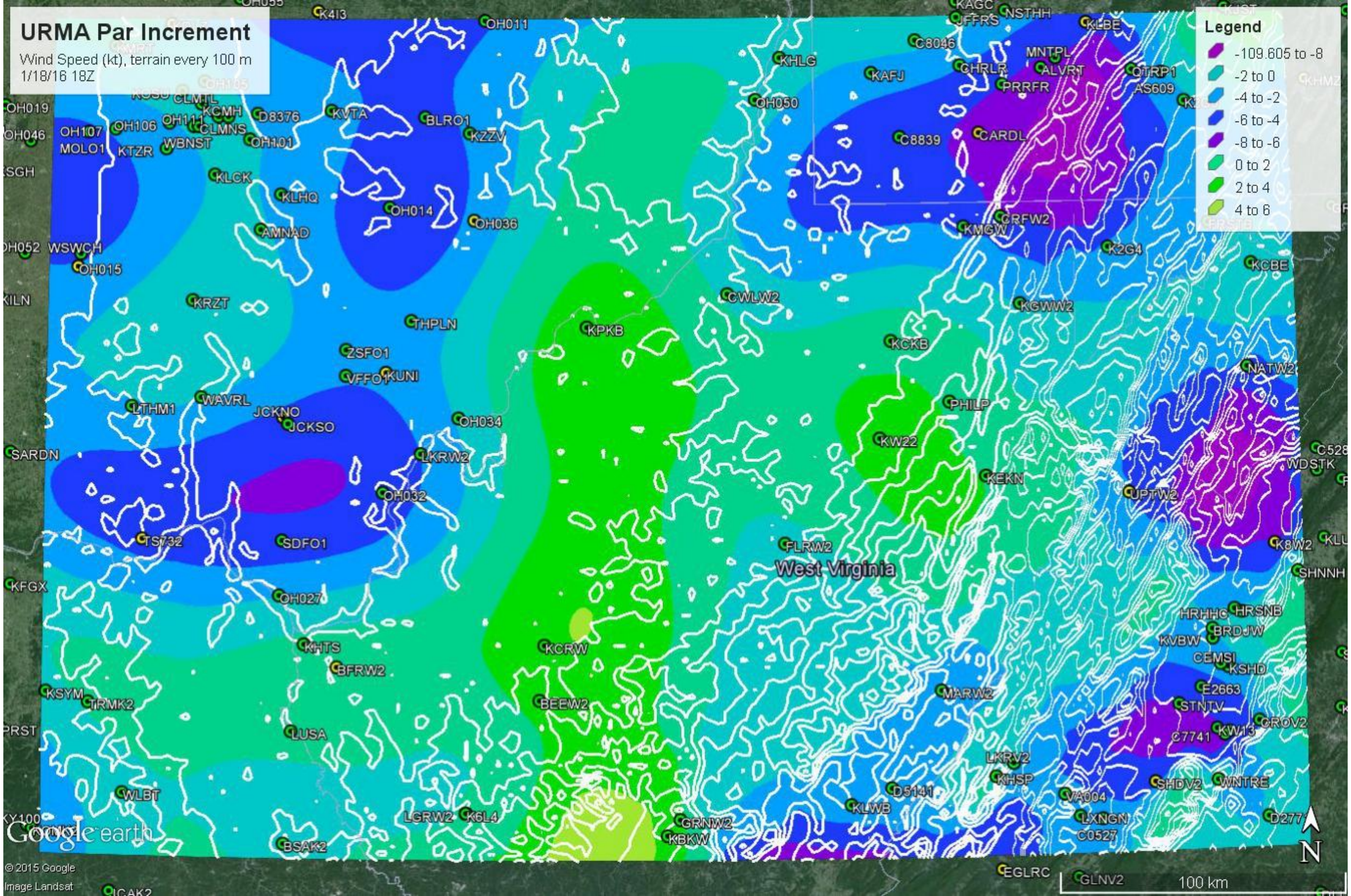
- O-A differences
  - Some forecasters expect analysis to perfectly match METAR obs...this will never happen
- HRRR vs NAM spread
  - Less accurate background
- Ob representivity/quality control

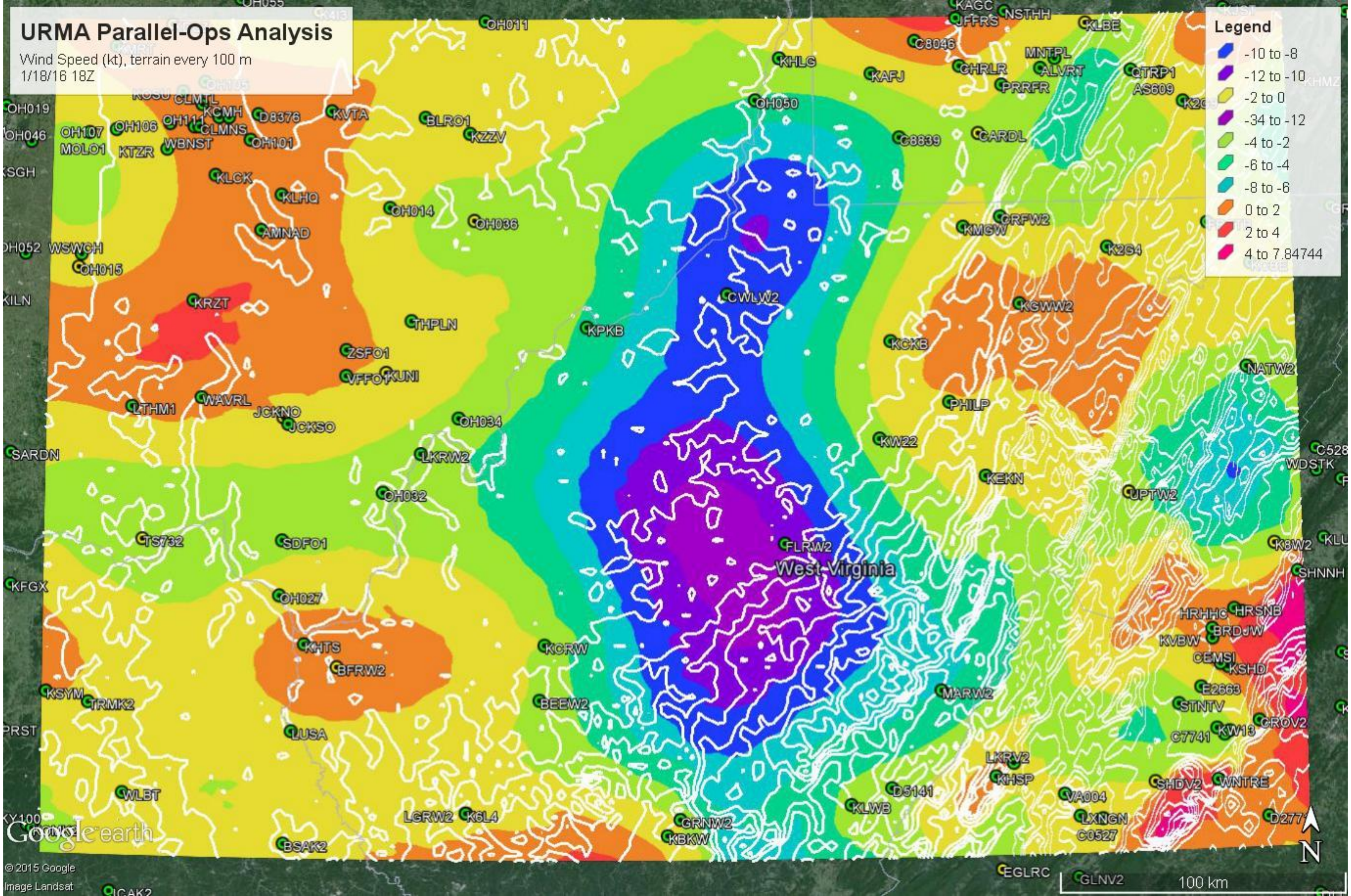
What's Next

- GLERL adjustment over Great Lakes (support wave models)
- 15 minute updates for ceiling and visibility (support FAA)
- New variable: significant wave height
- Westward expansion of grid (support OPC)?
- STI SOO/DOH RTMA/URMA project team
- Continued coordination with MDL/NBM

BACKUP SLIDES


URMA Ops Increment
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
-2 to 0
-4 to -2
-6 to -4
0 to 2
10 to 12
12 to 14
2 to 4
4 to 6
6 to 8
8 to 10
West Virginia
100 km
N
Google earth
© 2015 Google
Image Landsat


URMA Par Increment
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
-109.605 to -8
-2 to 0
-4 to -2
-6 to -4
-8 to -6
0 to 2
2 to 4
4 to 6
West Virginia
100 km
N
© 2015 Google
Image Landsat
Google earth


URMA Parallel-Ops Analysis
Wind Speed (kt), terrain every 100 m
1/18/16 18Z
Legend
-10 to -8
-12 to -10
-2 to 0
-34 to -12
-4 to -2
-6 to -4
-8 to -6
0 to 2
2 to 4
4 to 7.84744
West Virginia
100 km
N
Google earth
© 2015 Google
Image Landsat

VarQC Case two: an erroneous low Td data over Montana 13Z 5/27/2015

Top: without new varqc: dew point analysis
The bull's-eye reflects an erroneous low dew-point observation

Bottom: with new varqc along with the tuned parameters

The bull's-eye is gone.