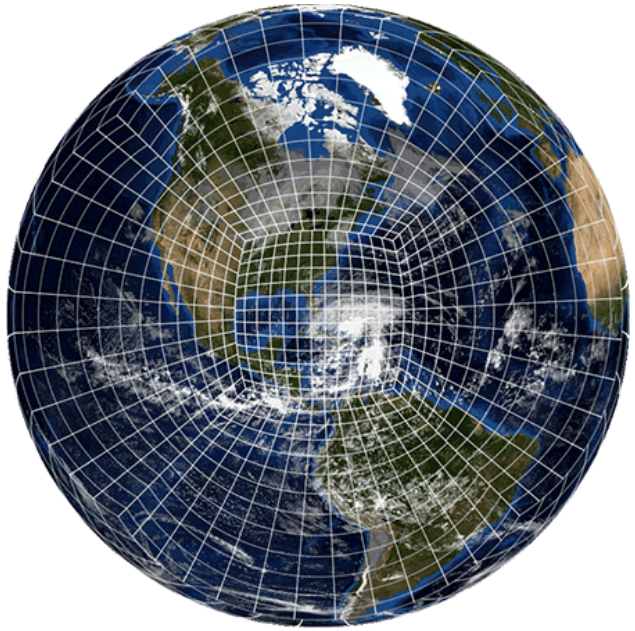
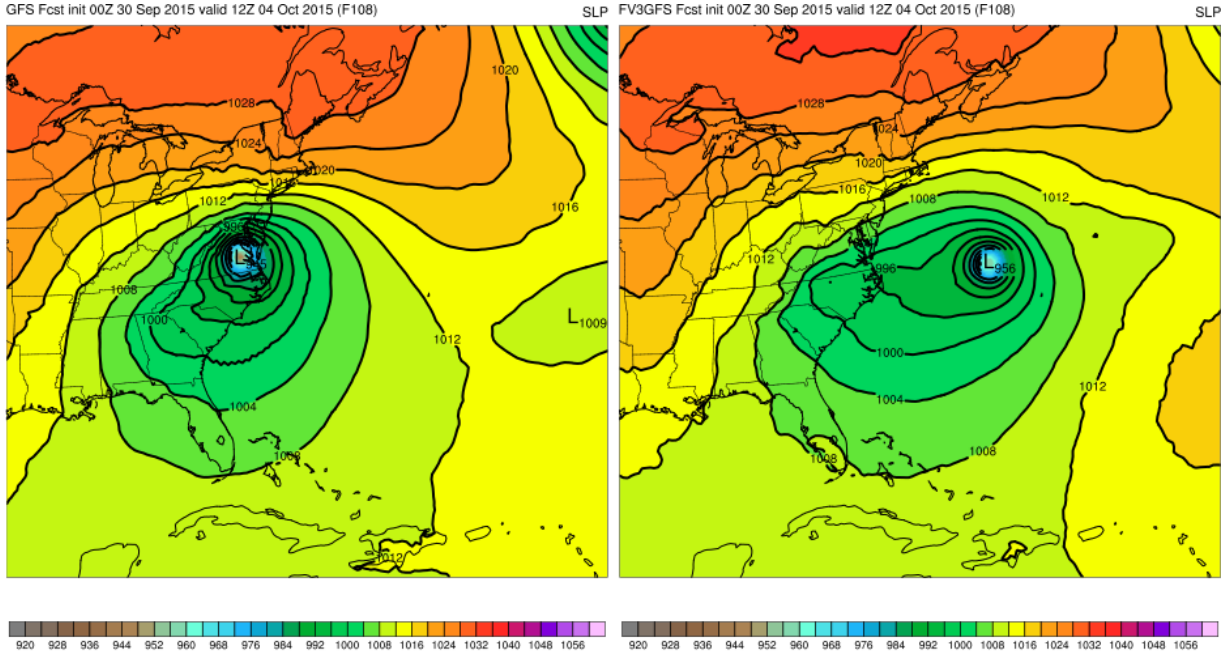
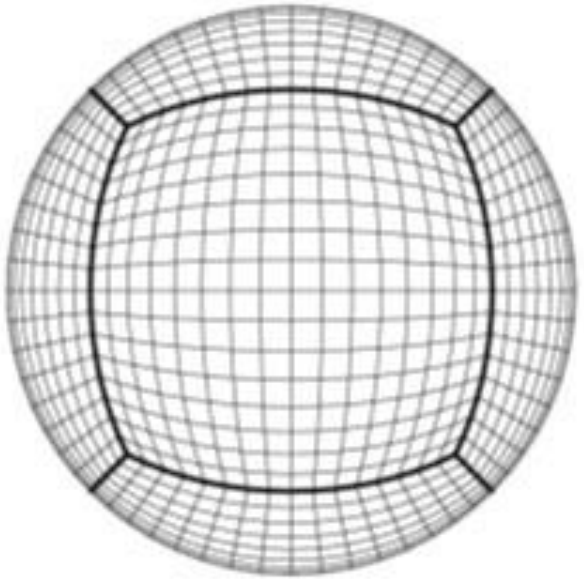
THE EMC MODEL EVALUATION GROUP ASSESSMENT of GFSv15







Geoff Manikin, Alicia Bentley, Logan Dawson, Tracey Dorian

Strategic Implementation Plan Coordination Meeting

14 May 2019

Additional materials provided by Fanglin Yang, Vijay Tallapragada, Mark Klein, Ying Lin, and Avichal Mehra

EMC's Model Evaluation Group

- Established in 2012; now part of EMC's Verification, Post Processing, & Product Generation Branch www.emc.ncep.noaa.gov/users/meg/home
- **OUTREACH** – the MEG serves as the "customer service" function of EMC with webinars, direct communication, and visits to WFOs
- Supplements the center's statistical verification/validation efforts by assessing model performance from the perspective of the forecasting community
- Organized evaluation of EMC parallels and experiments
- **Provides critical feedback to modelers and management and keeps customers "in the loop" regarding model changes, verification, and forecast issues**
- Provides streamlined feedback to outside users with model concerns – EMC is listening to customer/stakeholder feedback
- Can rapidly generate critical case studies (2012 Mid-Atlantic derecho, Superstorm Sandy, 2013 El Reno tornado/OKC flood, 2016 IAH and BTR floods, 2016 Matthew, 2017 PDX surprise snow, 2017 Harvey, Irma, and Maria, 2018 Florence and Michael)
- Conducts weekly-ish webinars, open to the field

The Evaluation of the FV3GFS (GFSv15)
An Unprecedented Evaluation of an NCEP Upgrade in Terms of Scope and Transparency

- Comprehensive central web site
- Retrospective runs covering 3 cold and 3 warm seasons
- Full statistics covering all retro and real-time periods
- **13 MEG webinars featuring 18 separate presentations covering the evaluation period and 3 more webinars on recent issues with cold bias**
- 2D, plume, and soundings graphics generated on web sites for real-time parallel
- The MEG generated graphics on web site for 32 high-impact retrospective cases covering tropical cyclones, winter storms, QPF, wind storms, excessive heat, atmospheric rivers, severe weather, and cold air outbreaks
- Vlab forum for feedback and general discussion

Official Evaluation Website

http://www.emc.ncep.noaa.gov/users/meg/fv3gfs

TIMELINE

FV3GFS Code Frozen	Parallel Runs Begin	Evaluation Period (Start - End)	Recommendations from Field Due	NCEP Director Briefing	Code Handoff to NCO	IT Test Period (Start - End)	Implementation Date
3/7/18	4/1/18	5/25/18 - 9/10/18	9/24/18	10/1/18	4/5/19	5/3/19 - 6/1/19	6/12/19

SUMMARY

FV3GFS MEG Evaluation Summary - Presented by Geoff Manikin (9/20/18 MEG Meeting)
NCEP/EMC CCB Presentation - Presented by Fanglin Yang (9/24/18 CCB Meeting)
FV3GFS NOAA/NWS Evaluation Summary - Presented by Logan Dawson (9/27/18 MEG Meeting)

INFORMATION

FV3 Dynamical Core Information - Developed by GFDL
FV3GFS Evaluation Overview - Presented by Geoff Manikin (5/3/18 MEG Meeting)
FV3GFS SST Issue and Fix - Presented by Geoff Manikin (5/24/18 MEG Meeting)
FV3GFS Soil Moisture, Reflectivity, Visibility - Presented by Geoff Manikin (5/31/18 MEG Meeting)
FV3GFS Statistical Update - Presented by Logan Dawson (6/14/18 MEG Meeting)
FV3GFS Inst. Precip. Rate, Reflectivity, Visibility - Presented by Alicia Bentley/Logan Dawson (6/28/18 MEG Meeting)
MEG Evaluation of FV3GFS Retrospectives - Presented by Logan Dawson (7/19/18 MEG Meeting)
FV3GFS Statistical Update - Presented by Alicia Bentley (8/9/18 MEG Meeting)
FV3GFS East Coast Winter Storm Retrospectives - Presented by Tracey Dorian/Alicia Bentley/Logan Dawson (8/16/18 MEG Meeting)
FV3GFS Tropical Cyclone Status Update - Presented by Vijay Tallapragada (8/16/18 NHC Briefing)
FV3GFS North Atlantic/East Pacific TC Retrospectives - Presented by Geoff Manikin (8/23/18 MEG Meeting)
FV3GFS Western U.S. Retrospectives - Presented by Alicia Bentley (9/6/18 MEG Meeting)
FV3GFS Alaskan Retrospectives - Presented by Tracey Dorian (9/6/18 MEG Meeting)
FV3GFS Cold SST Concerns (e.g., Alaska's Cook Inlet) - Presented by Logan Dawson (9/6/18 MEG Meeting)
FV3GFS Products Update - Presented by Logan Dawson (9/13/18 MEG Meeting)
FV3GFS QPF Statistics - Presented by Tracey Dorian (9/13/18 MEG Meeting)
FV3GFS QPF Retrospectives - Presented by Alicia Bentley (9/13/18 MEG Meeting)

DATA

FV3GFS Data - Available on Para NOMADS
List of New Output Parameters - Maintained by Hui-ya Chuang

REAL-TIME GRAPHICS/OUTPUT

FV3GFS Analyses and Guidance (Note: GFS = FV3GFS) - Maintained by NCEP/NCO
GFS vs. FV3GFS Forecast Comparisons - Maintained by Geoff Manikin
GFS vs. FV3GFS Plume Comparisons - Maintained by Tracey Dorian
GFS vs. FV3GFS Sounding Comparisons - Maintained by Tracey Dorian
NAM vs. FV3GFS vs. GFS Comparisons - Maintained by Eric Rogers
FV3GFS vs. GFS MOS Comparisons - Maintained by NOAA/NWS/MDL

VERIFICATION

NCEP/EMC Model Evaluation Group (MEG) - Maintained by Geoff Manikin
NCEP/EMC MEG Past Presentations - Available to NOAA email addresses only
NCEP/EMC QPF Verification Scores for FV3GFS Runs - Maintained by Ying Lin
NCEP/EMC Daily Precipitation Verification (FV3GFS included) - Maintained by Ying Lin
NCEP/EMC Fit-to-Observations (Fit2Obs) for FV3GFS - Maintained by Suranjana Saha and Jack Woollen

NCEP/EMC Global Model Experimental Forecast Performance Statistics (Real-time Parallel) - Maintained by FV3GFS Parallel Execution Group
Retrospective Forecast Performance Statistics [Full Period (June 2015-September 2018)]
Retrospective Forecast Performance Statistics [December 2017-May 2018]
Retrospective Forecast Performance Statistics [May 2017-November 2017]
Retrospective Forecast Performance Statistics [December 2016-May 2017]
Retrospective Forecast Performance Statistics [May 2016-November 2016]
Retrospective Forecast Performance Statistics [December 2015-May 2016]
Retrospective Forecast Performance Statistics [May 2015-November 2015]

RETROSPECTIVES

FV3GFS Retrospective Case Studies - Images by NCEP/EMC MEG
MEG Evaluation of FV3GFS Retrospectives - Presented by Logan Dawson (7/19/18 MEG Meeting)
FV3GFS East Coast Winter Storm Retrospectives - Presented by Tracey Dorian/Alicia Bentley/Logan Dawson (8/16/18 MEG Meeting)
FV3GFS North Atlantic/East Pacific TC Retrospectives - Presented by Geoff Manikin (8/23/18 MEG Meeting)
FV3GFS Western U.S. Retrospectives - Presented by Alicia Bentley (9/6/18 MEG Meeting)
FV3GFS Alaskan Retrospectives - Presented by Tracey Dorian (9/6/18 MEG Meeting)
FV3GFS QPF Retrospectives - Presented by Alicia Bentley (9/13/18 MEG Meeting)

FEEDBACK

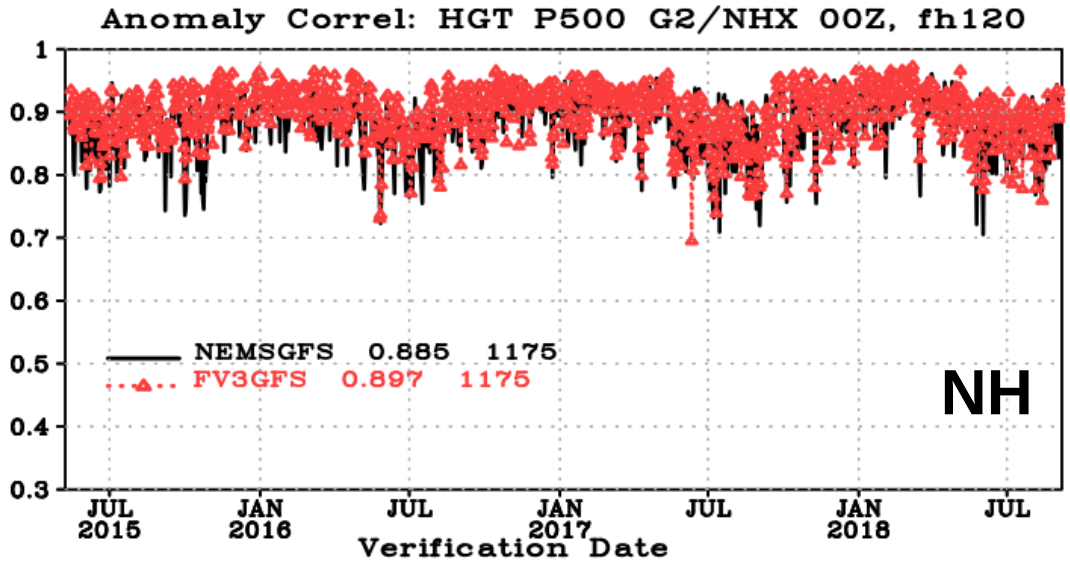
VLAB - FV3 Evaluation Forum - Monitored by NCEP/EMC MEG

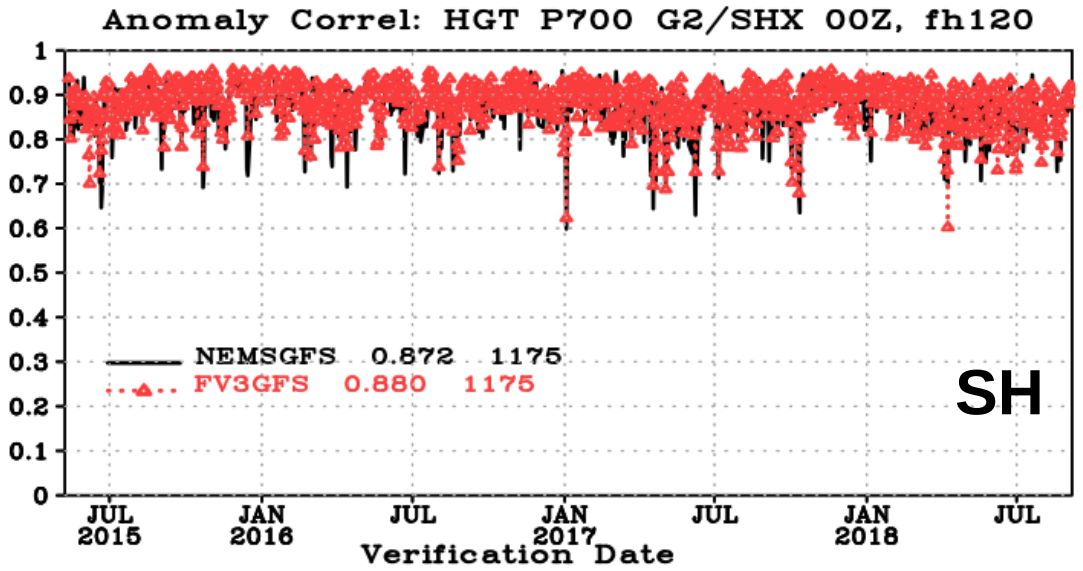
Update:
1. If you email FV3GFS-Feedback.VLab@noaa.gov, a post will appear in the forum and forum subscribers will get an email from vlab.notifications@noaa.gov.
2. If you reply to the email from vlab.notifications@noaa.gov, forum subscribers will get an email and your response will appear in the forum.
Non-VLab members who email the forum will be identified as "Anonymous". If you write to the forum as a non-VLab member, please identify yourself in your email.

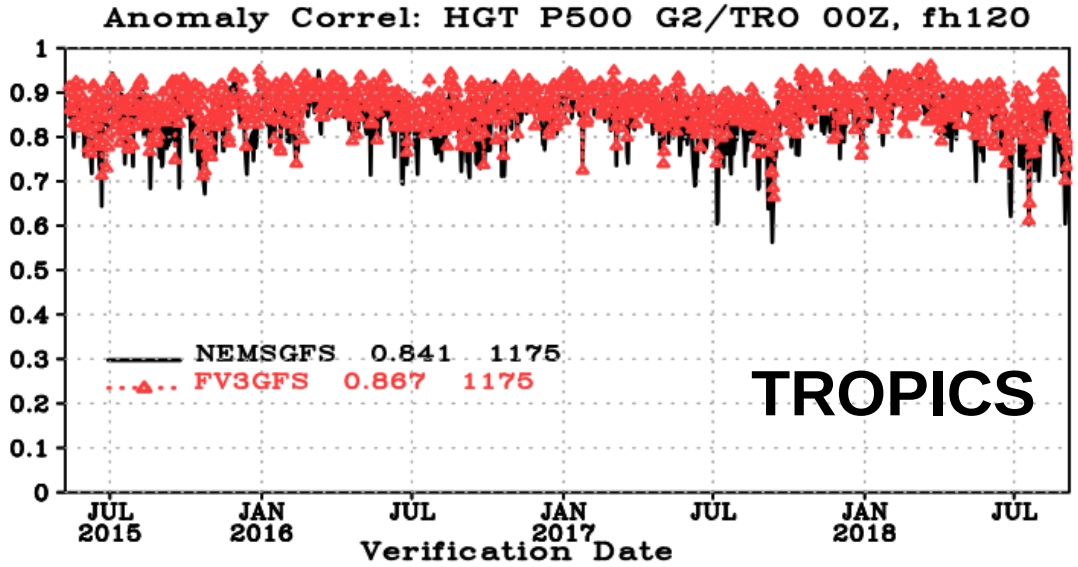
THE IMPROVEMENTS SEEN IN GFSv15

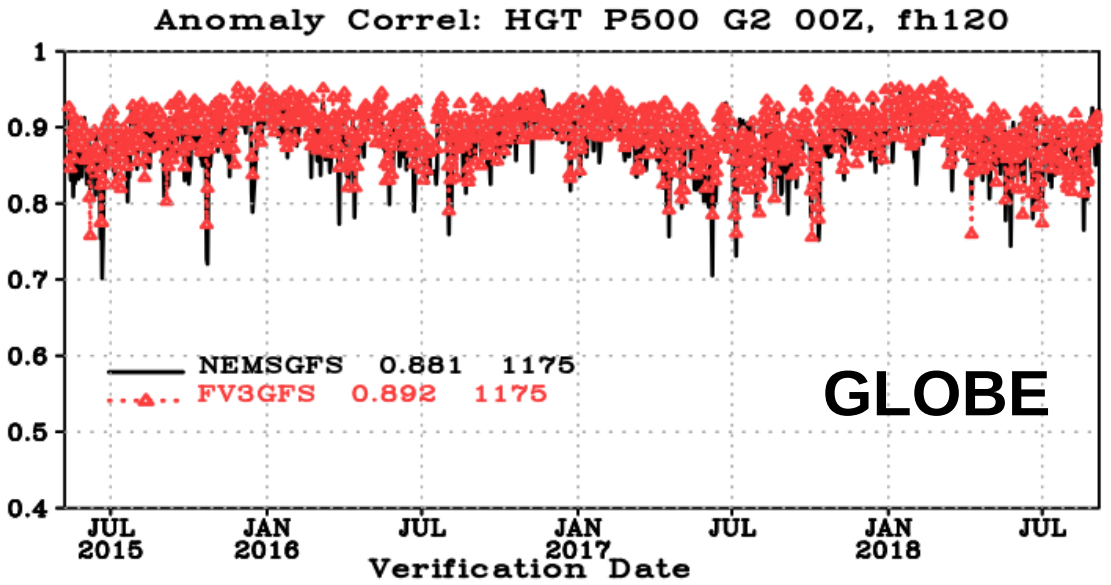
SYNOPTIC STATS

RETROSPECTIVES DAY 5 500 mb AC SCORES

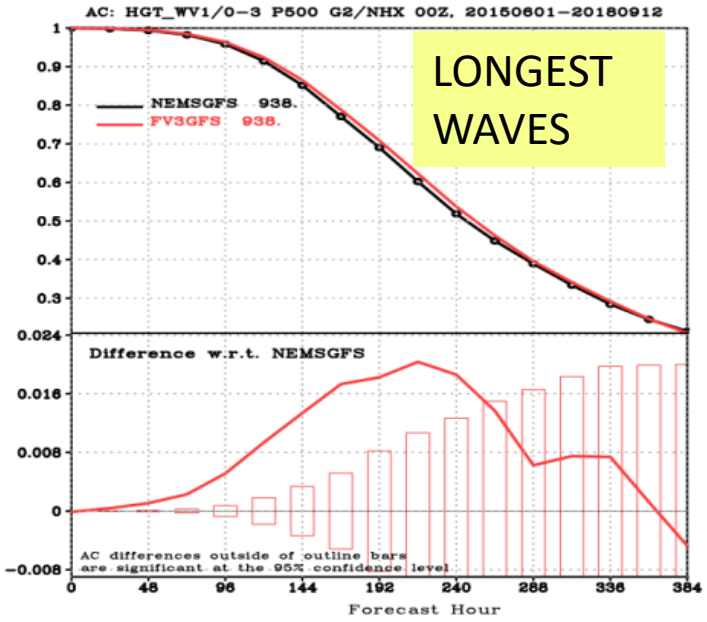




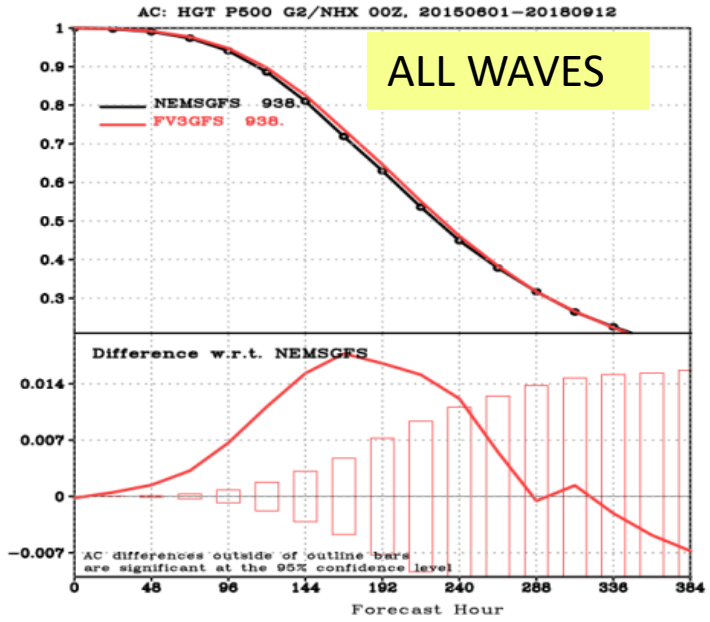




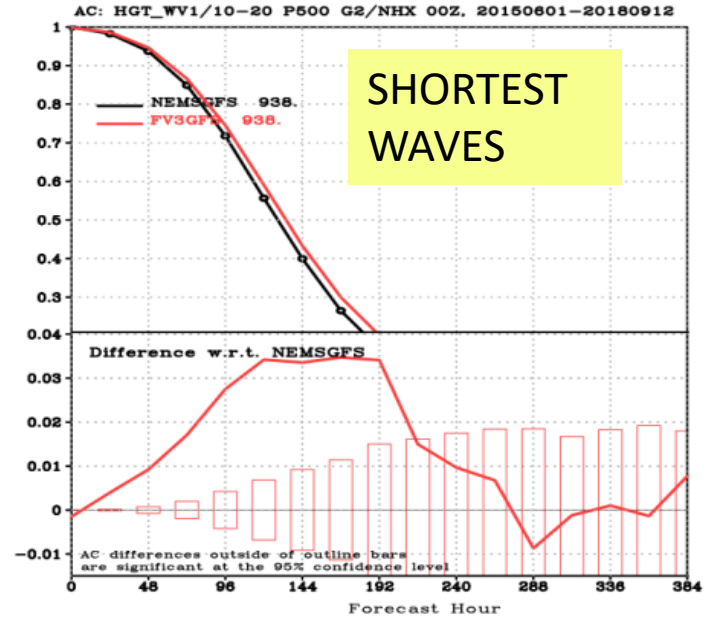
RETROSPECTIVE DIEOFF CURVES – NORTHERN HEMISPHERE



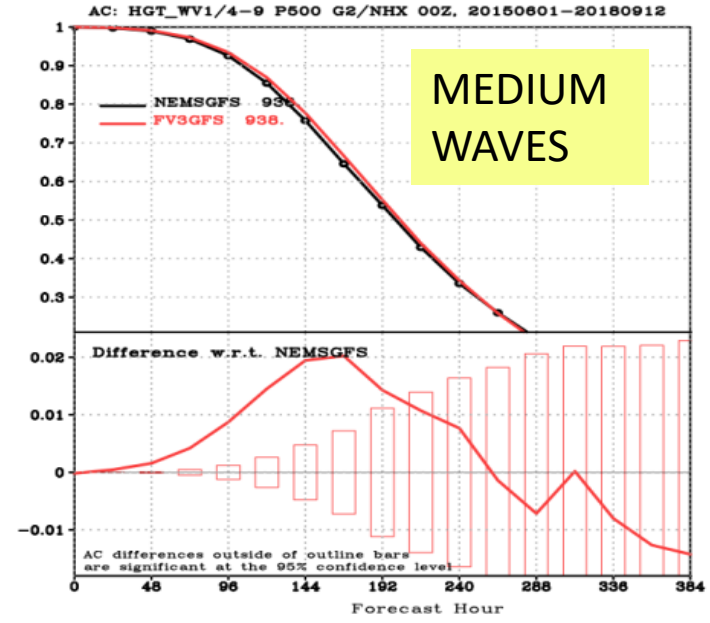
LONGEST WAVES



ALL WAVES



SHORTEST WAVES

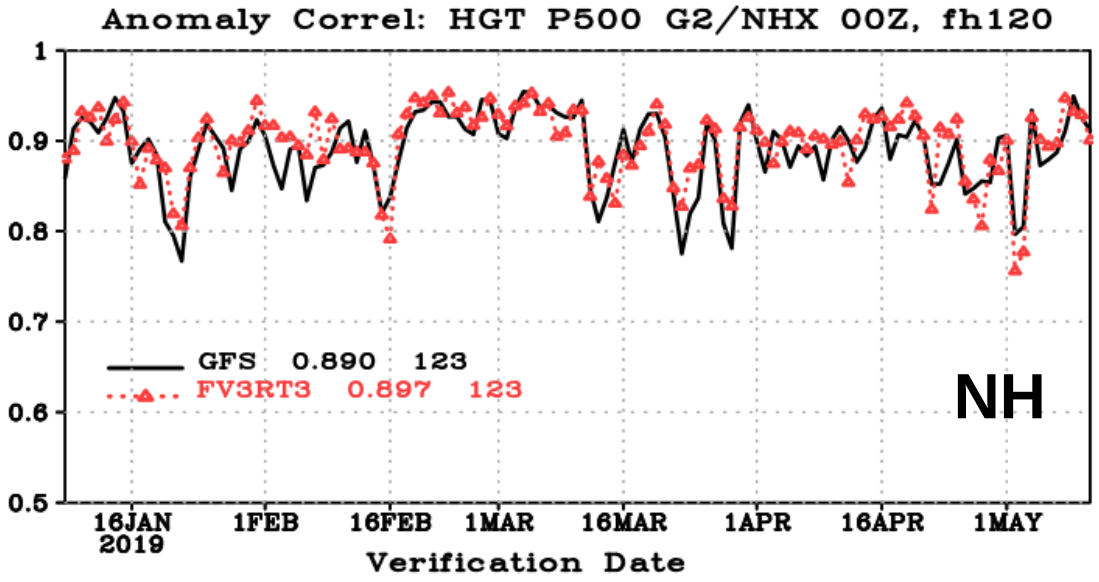


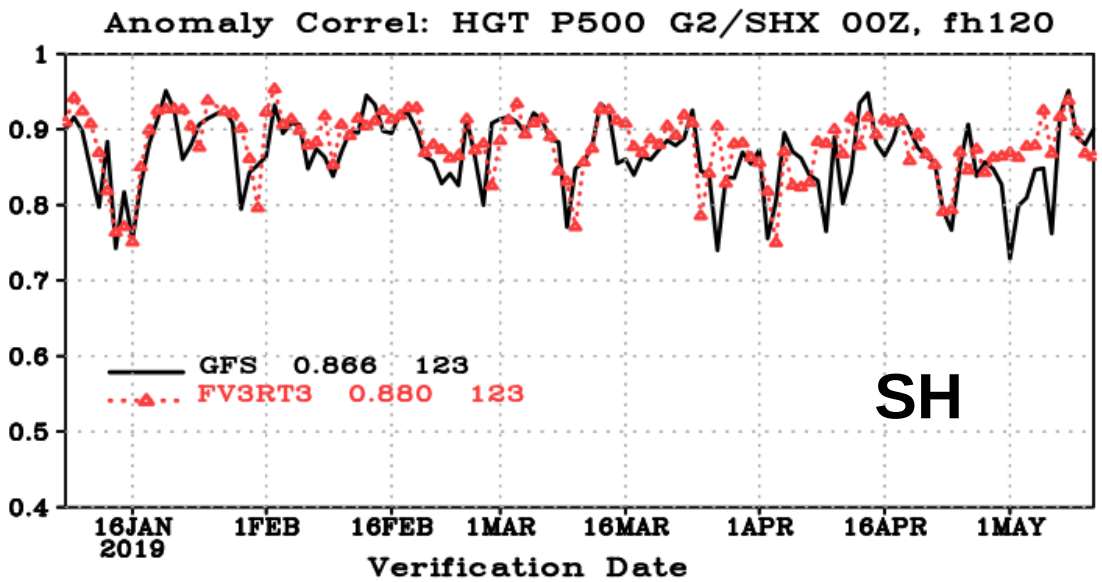
MEDIUM WAVES

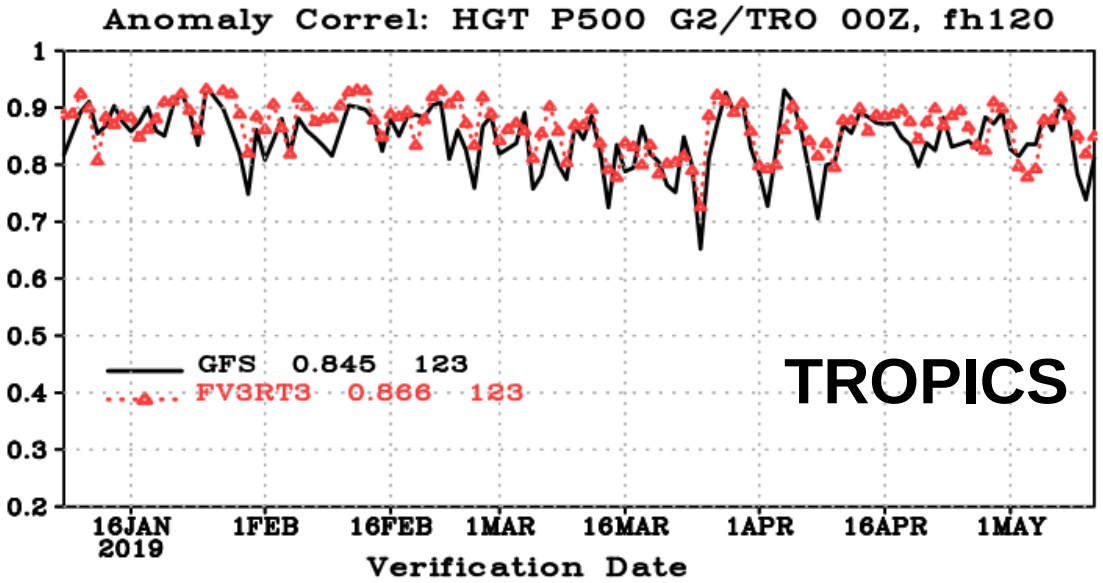
FV3GFS IMPROVEMENT OVER GFS is SIGNIFICANT OUT TO:

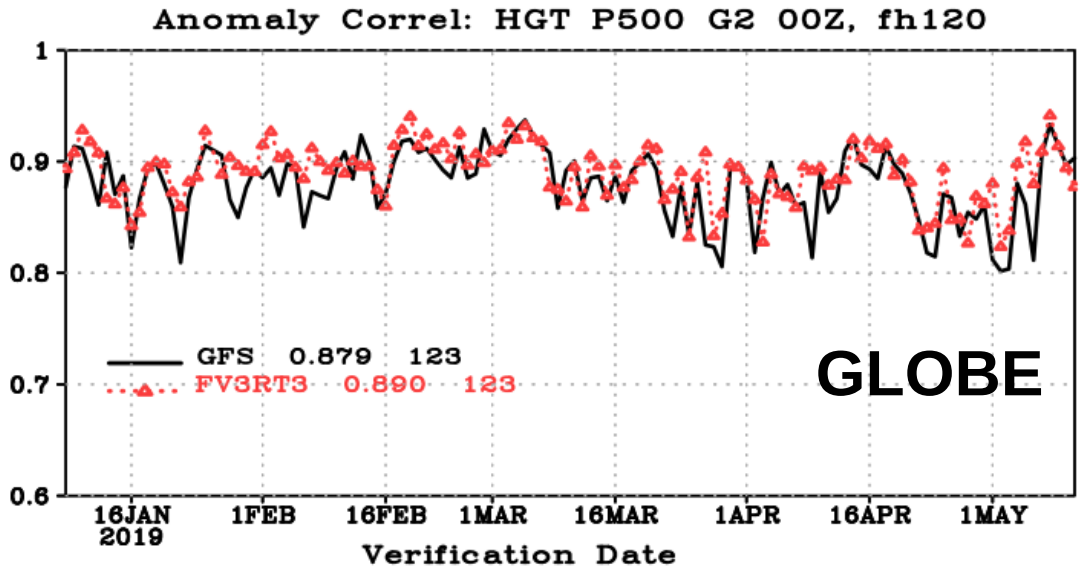
DAY 10.5 for WAVES 0-3
DAY 8.5 for WAVES 4-9
DAY 9 for WAVES 10-20

RECENT DAY 5 500 mb AC SCORES



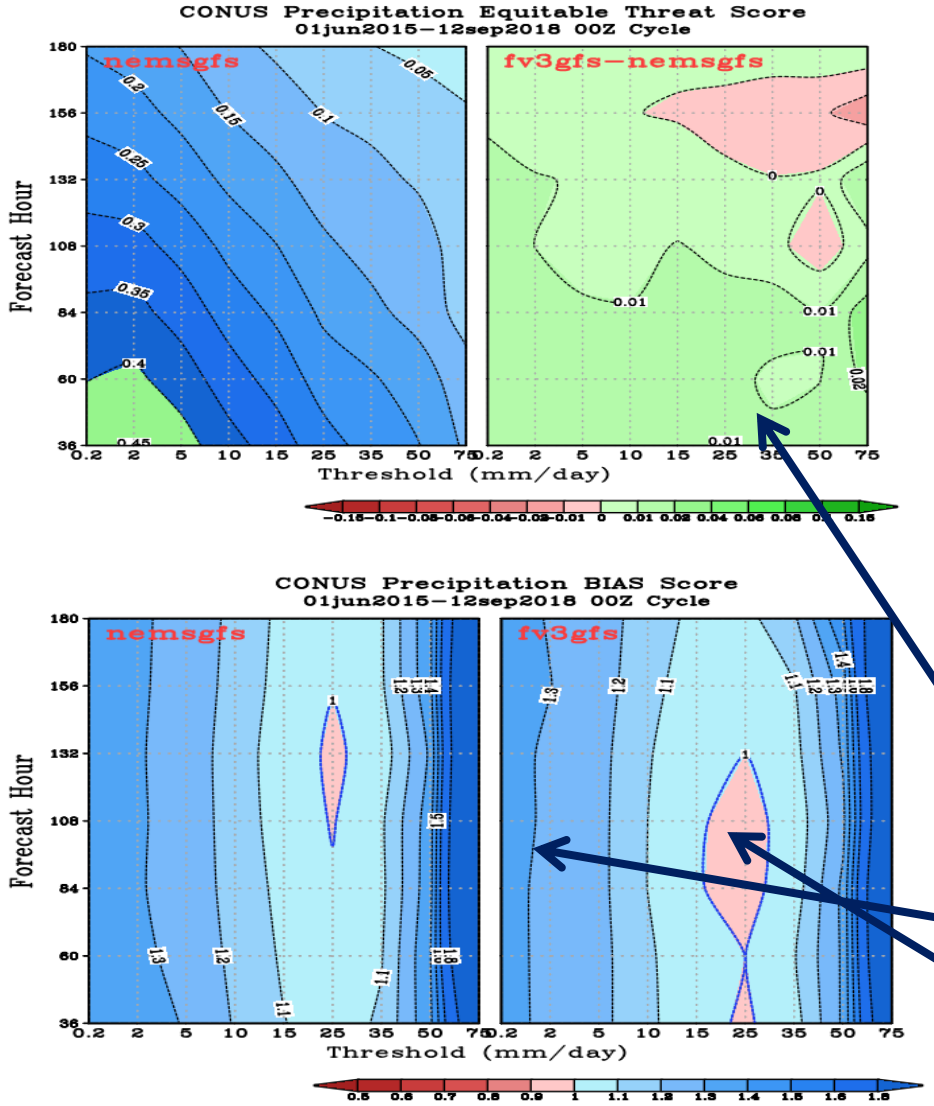






CONUS Precip ETS and BIAS SCORES

00Z Cycle, verified against gauge data, 20150601~ 20180912

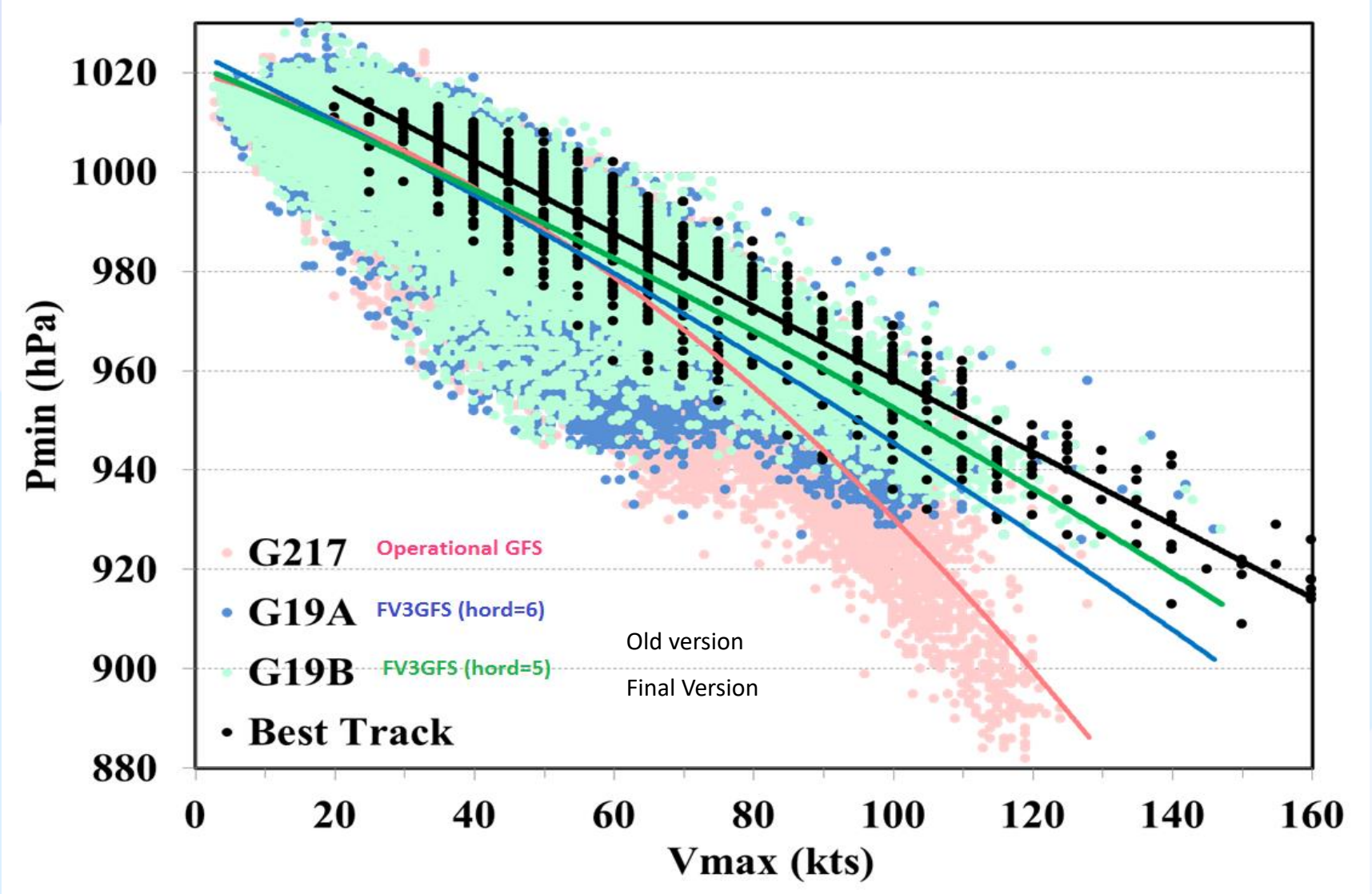


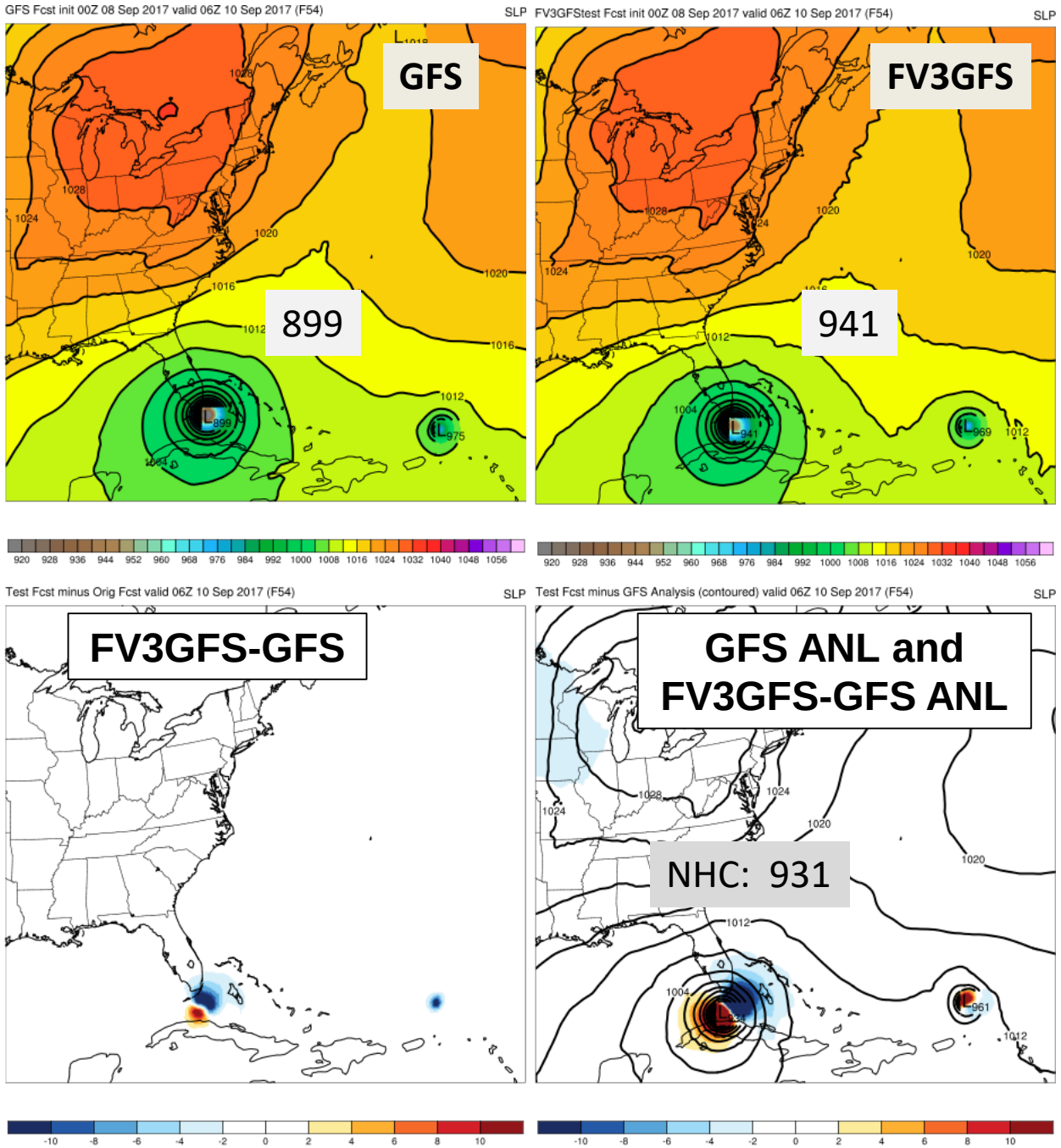
- Improved ETS scores for almost all thresholds and at all forecast length
- Reduced wet bias for light rains
- Slightly worsened dry bias for moderate rain categories

SIGNIFICANTLY IMPROVED WIND-PRESSURE RELATIONSHIP WITH TROPICAL CYCLONES LEADING TO IMPROVED INTENSITY FORECASTS

Wind-Pressure Relationship

Much improved W-P relationship with GFSv15 (hord=5) compared to operational GFS and older runs of GFSv15 (hord=6)





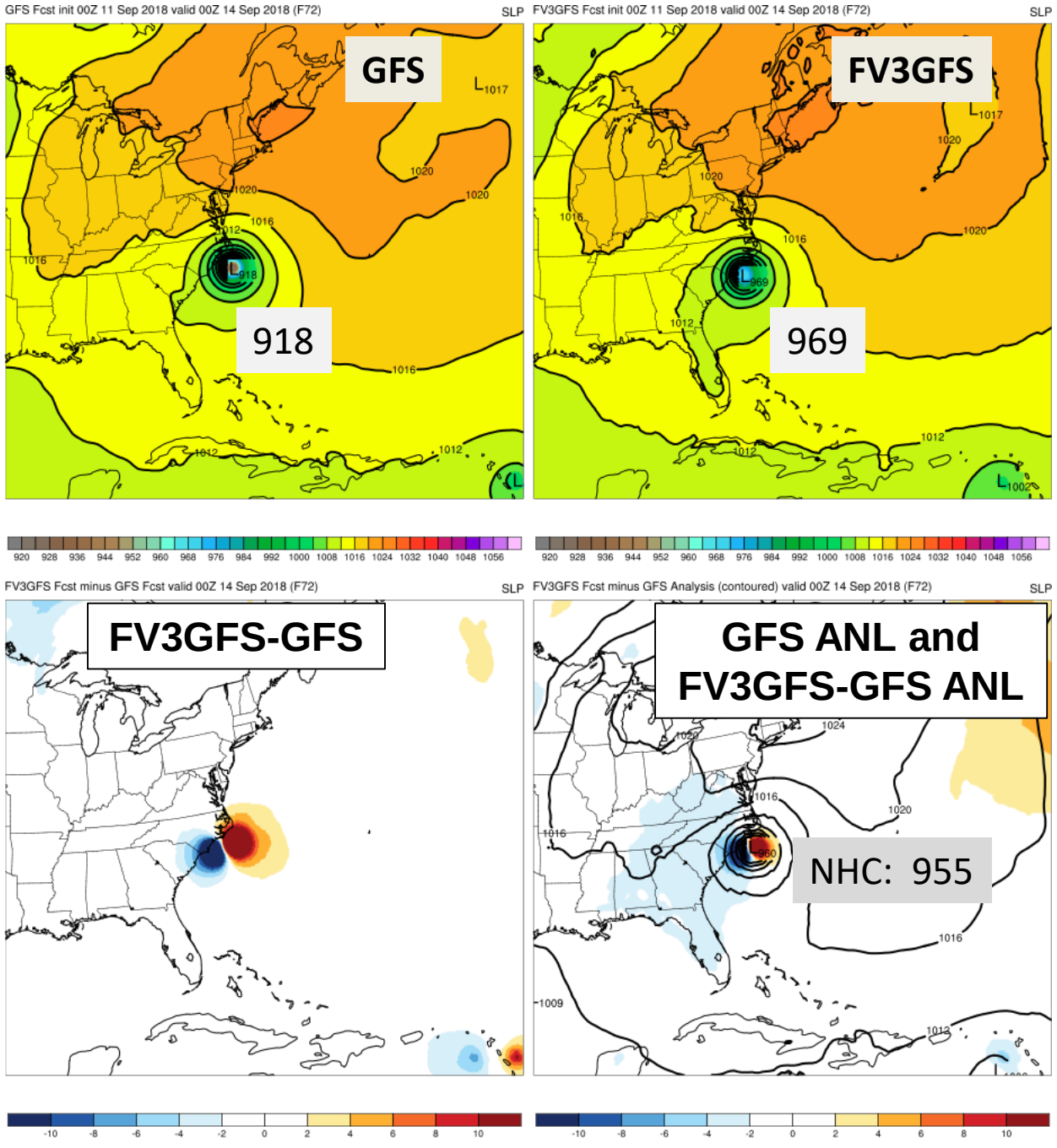
IRMA

00z 9/8/17 F54

KEY:

Blue = GFSv15 is stronger (lower MSLP)

Red = GFSv15 is weaker (higher MSLP)



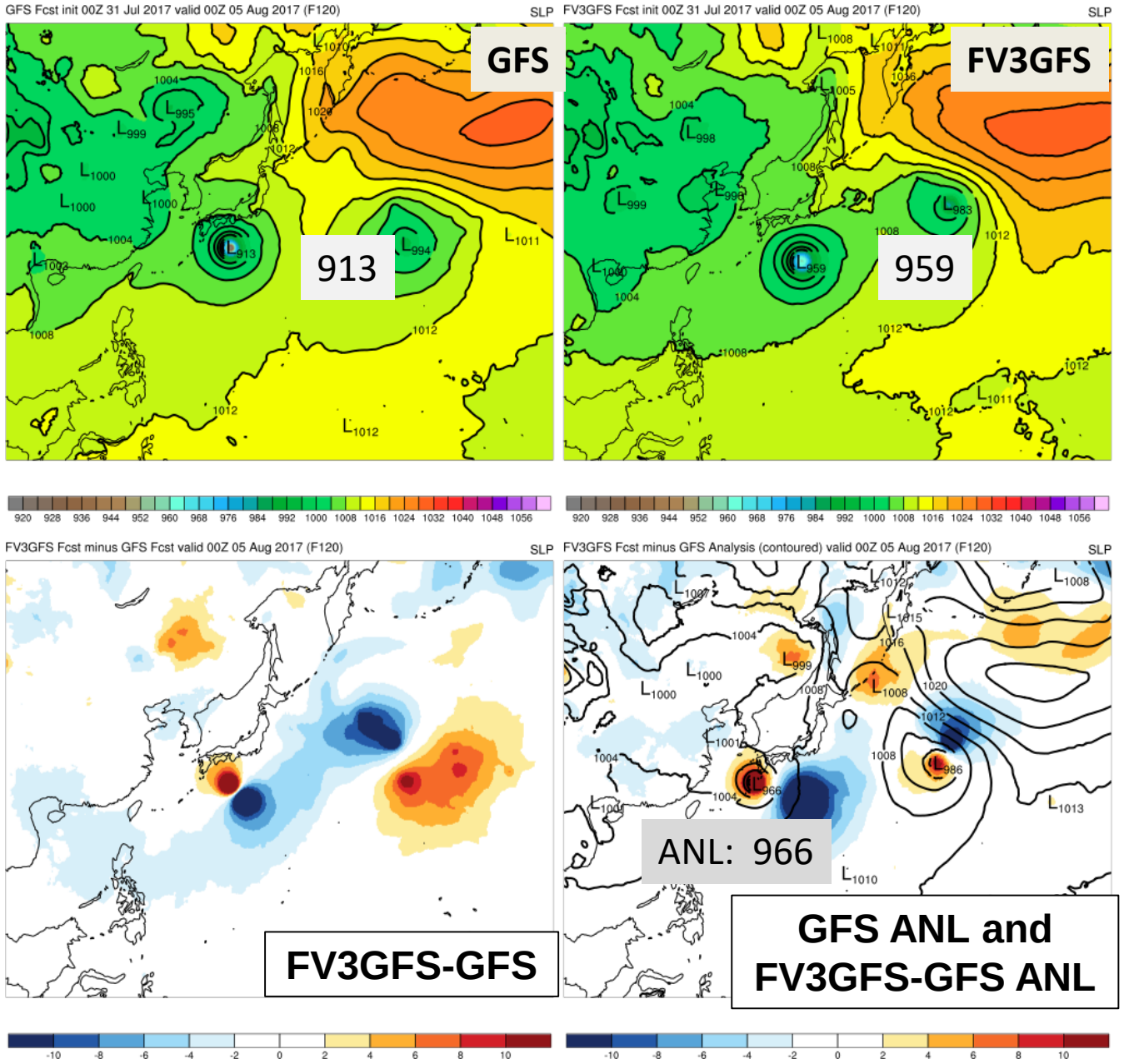
FLORENCE
00z 9/11/18 F72

KEY:

Blue = GFSv15 is stronger (lower MSLP)

Red = GFSv15 is weaker (higher MSLP)

Cycle 00Z 7/31/17 f120 valid 00Z 8/05/17



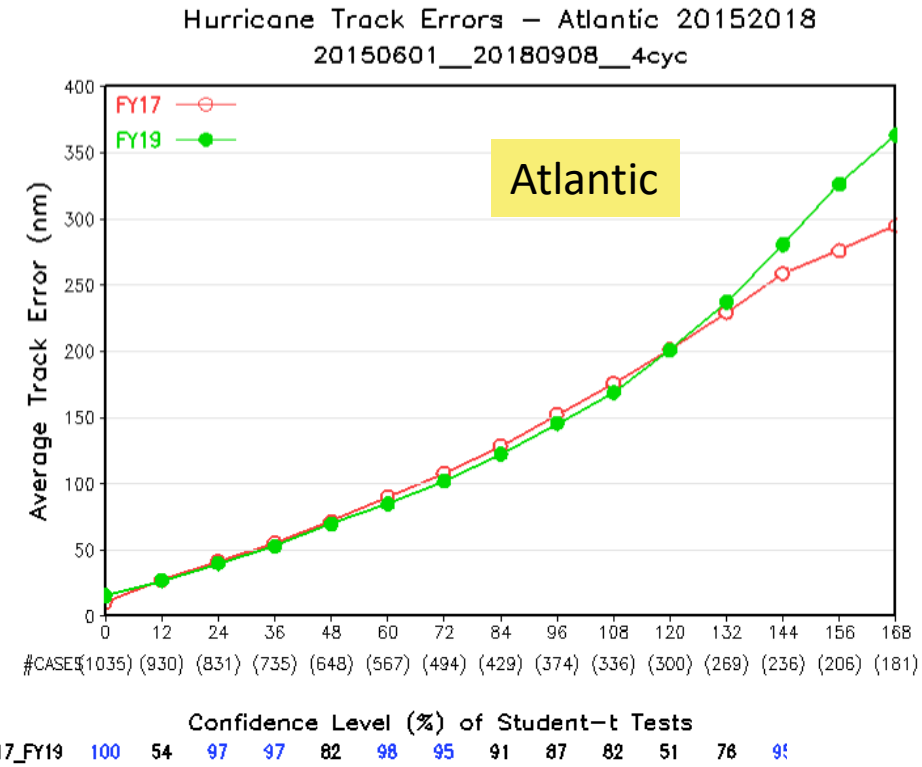
TYPHOON NORU
00z 7/31/17 F120

KEY:

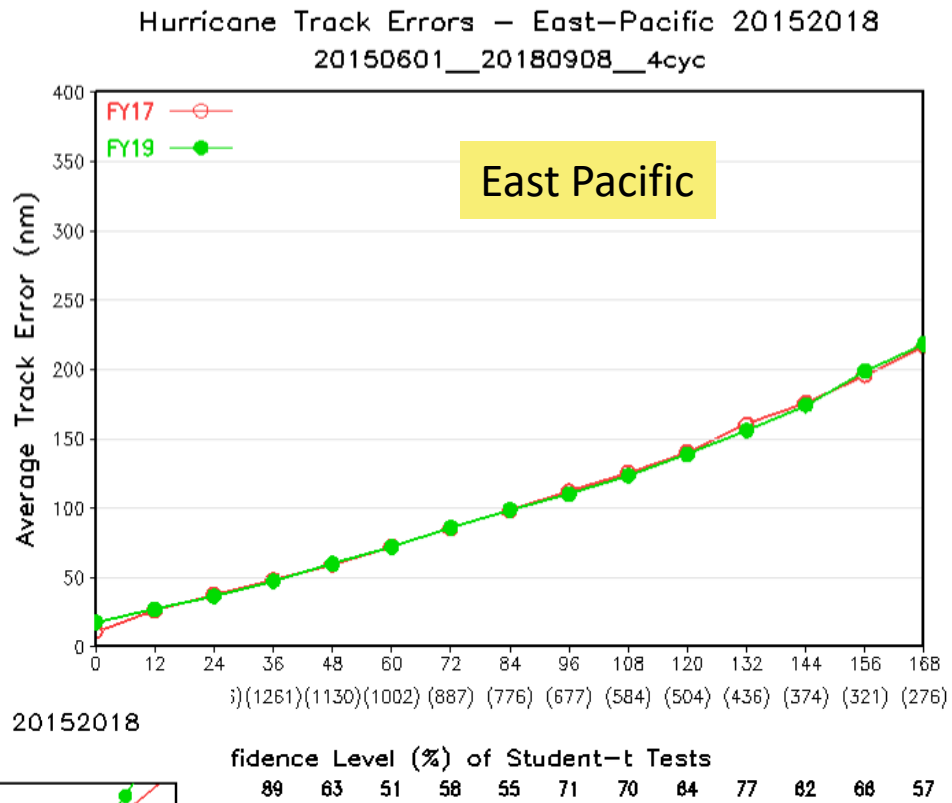
Blue = GFSv15 is stronger (lower MSLP)

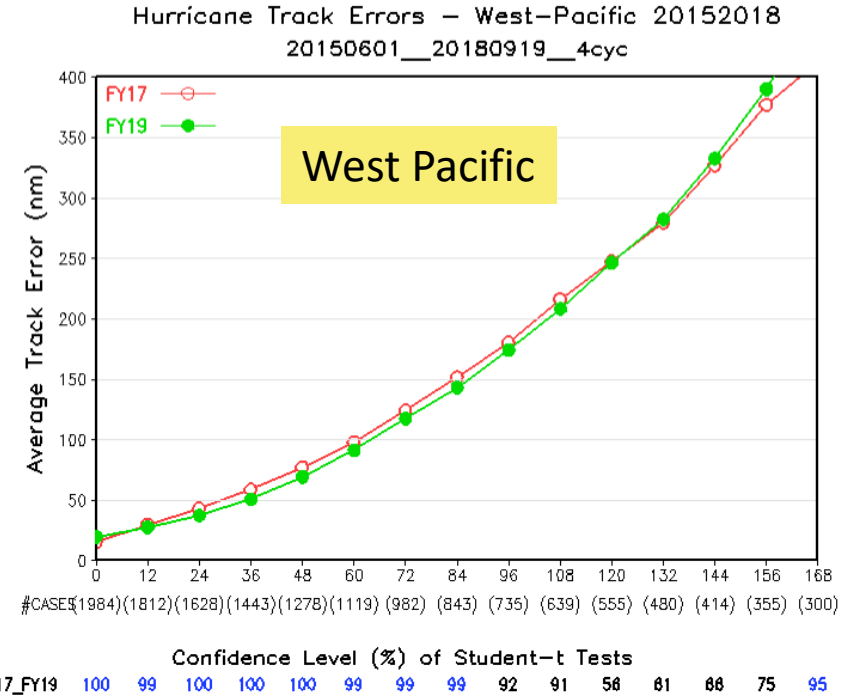
Red = GFSv15 is weaker (higher MSLP)

IMPROVED TROPICAL CYCLONE FORECAST TRACKS (THROUGH DAY 5)



STATS FOR FULL SET OF RETRO CASES COMPARING GFSv14 to GFSv15



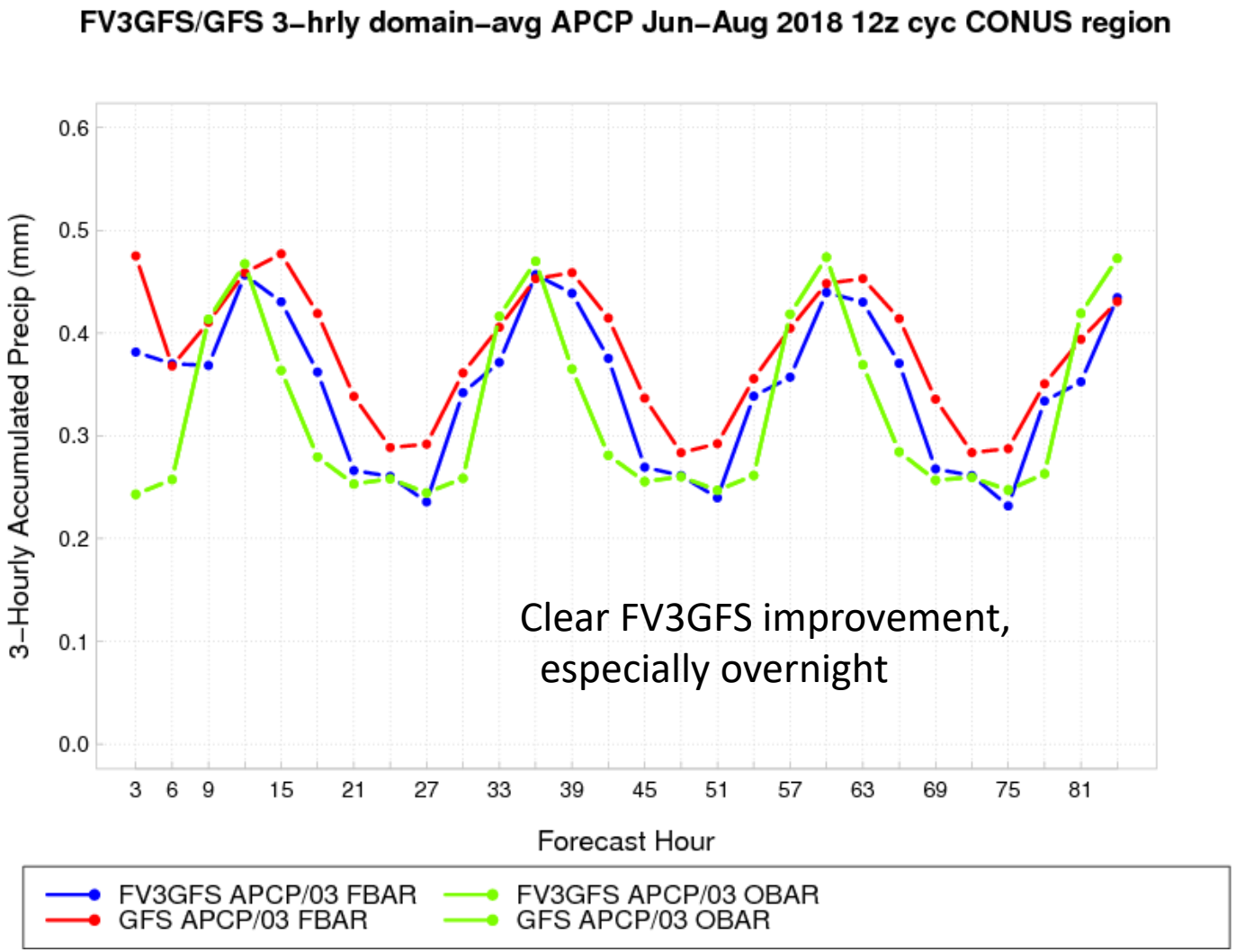


GFSv14

GFSv15

IMPROVEMENT with WARM SEASON DIURNAL PRECIP CYCLE

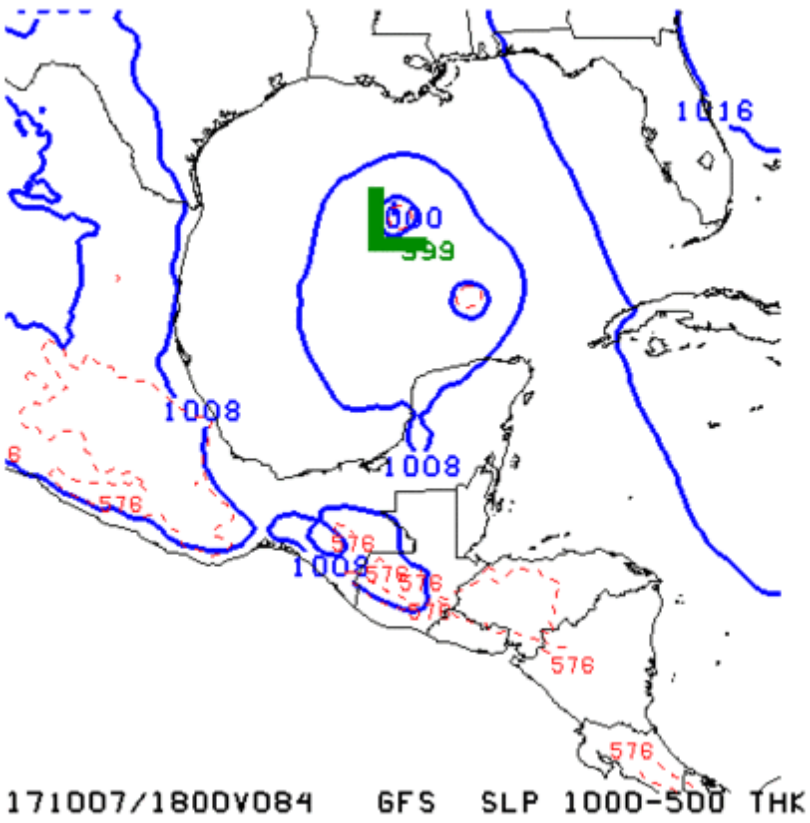
SUMMER 2018 CONUS DOMAIN-AVG PCP

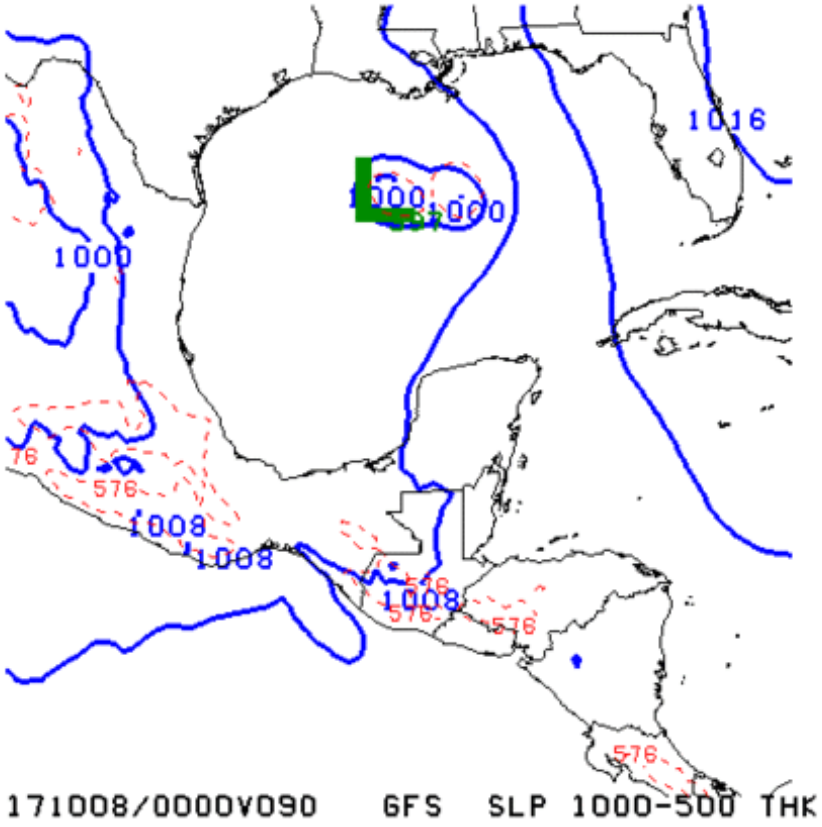


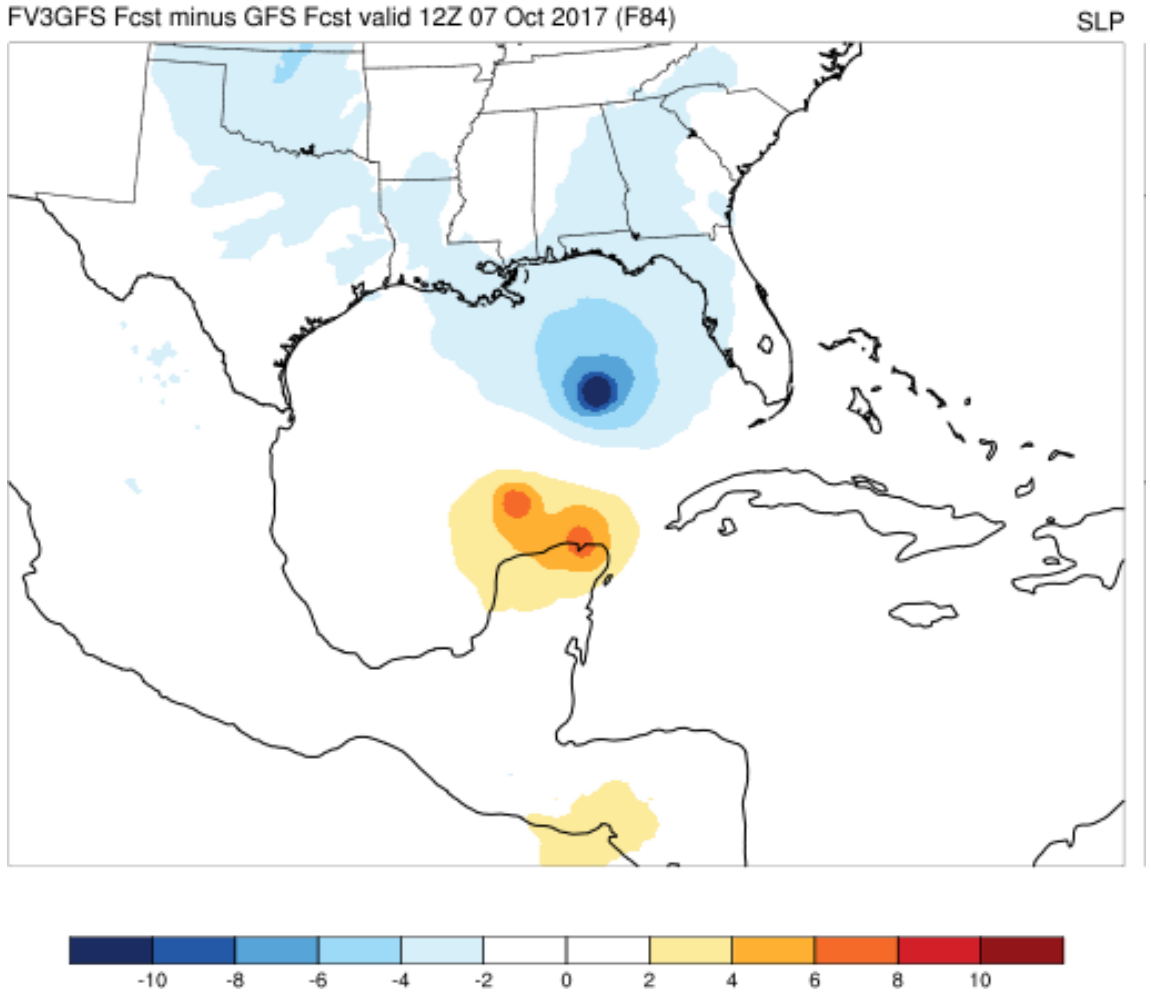
GFSv15 **GFSv14** **OBS**

MULTIPLE TROPICAL CYCLONE CENTERS (FOR SINGLE STORM) GENERATED BY OPS GFS NOT SEEN IN GFSv15 FORECASTS OR ANALYSES

OPS GFS FORECASTS FOR HURRICANE NATE (OCTOBER 2017)







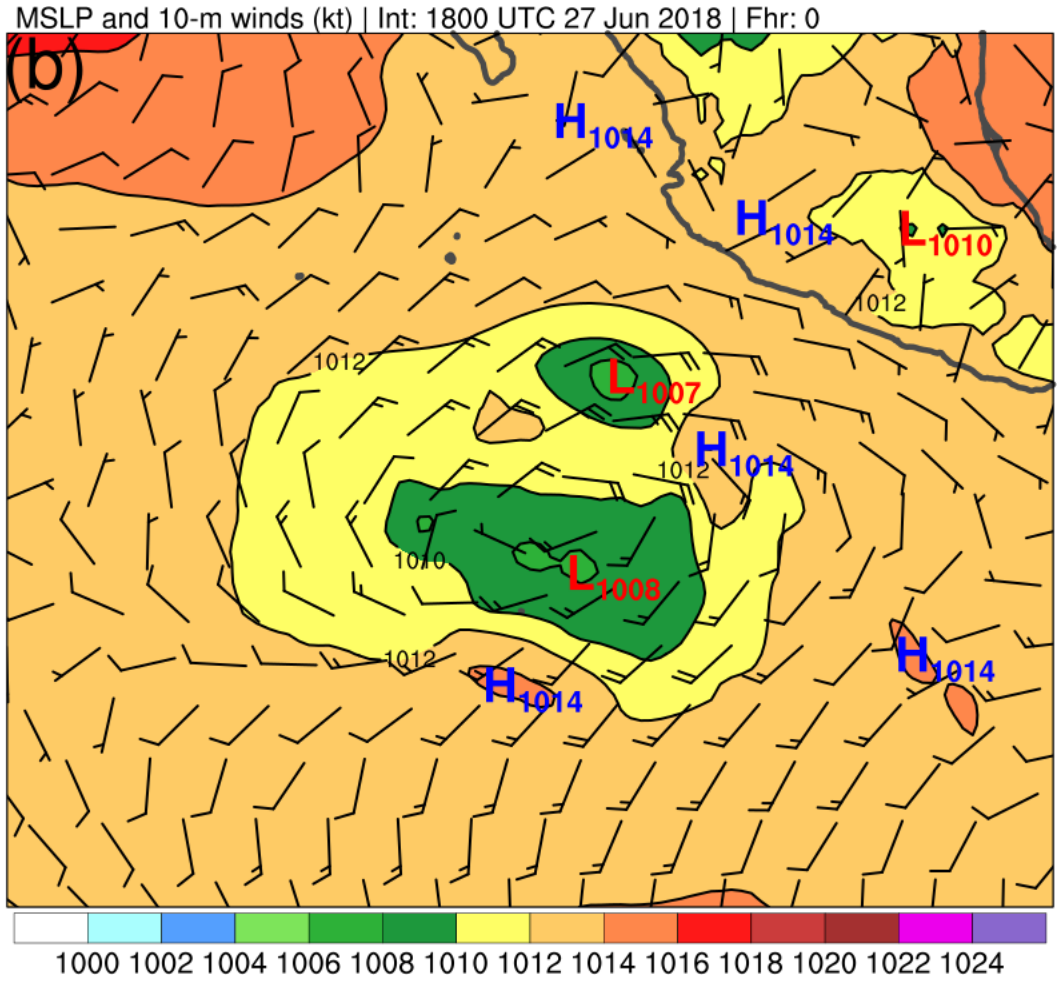
GFSv15 – GFSv14 SLP DIFFERENCE PLOT:

GFSv14 HAD PROBLEMS WITH DOUBLE LOW STRUCTURE THAT WERE MUCH LESS PREVALENT IN v15

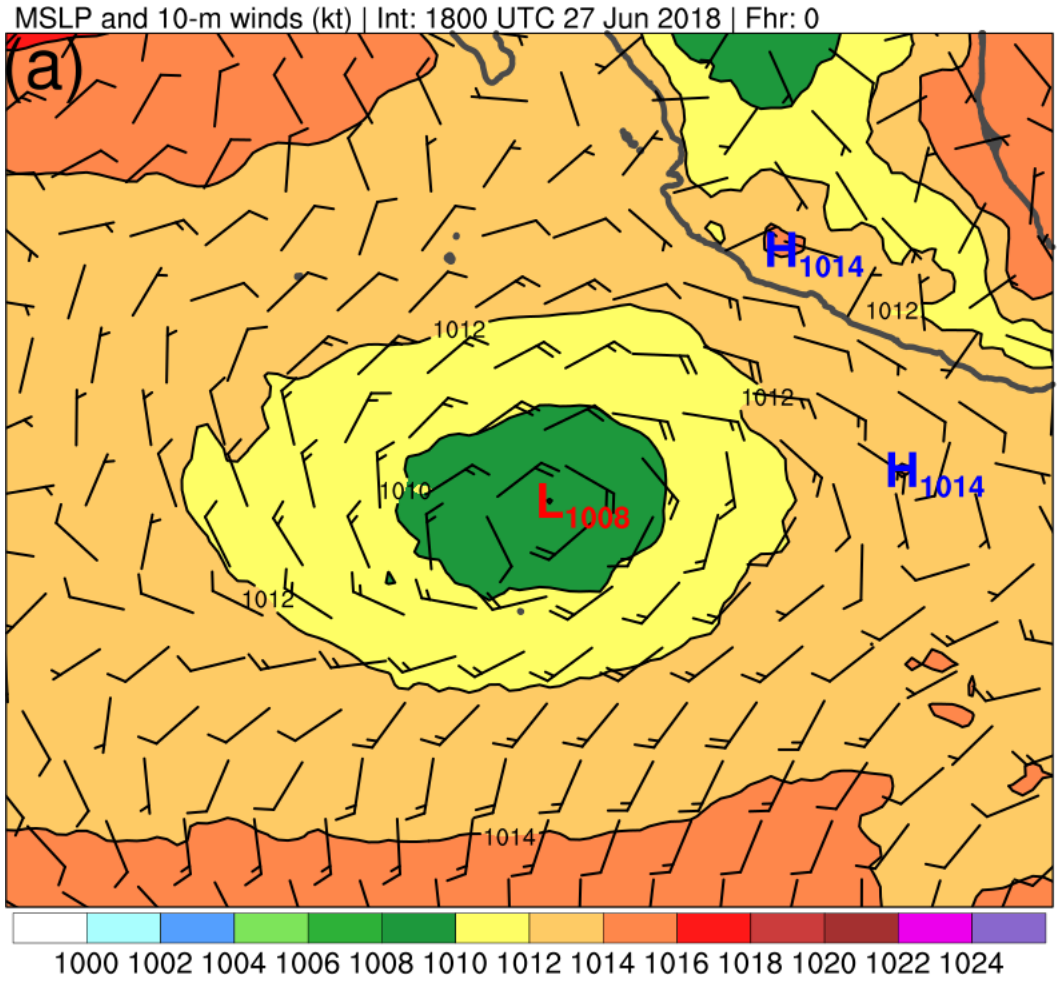
But also note a position difference that we'll revisit later

6/27/18 18z F00

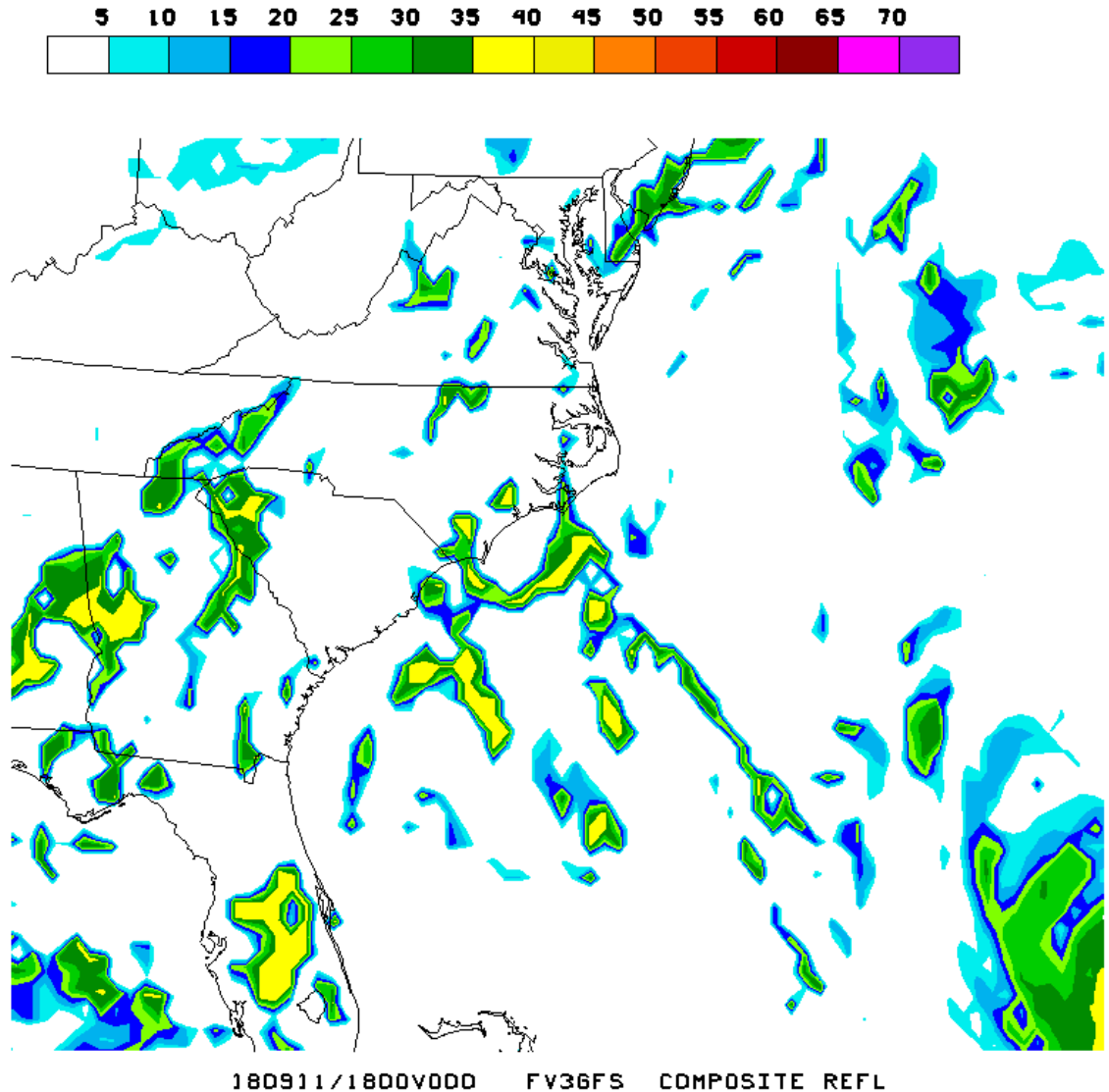
GFSv14



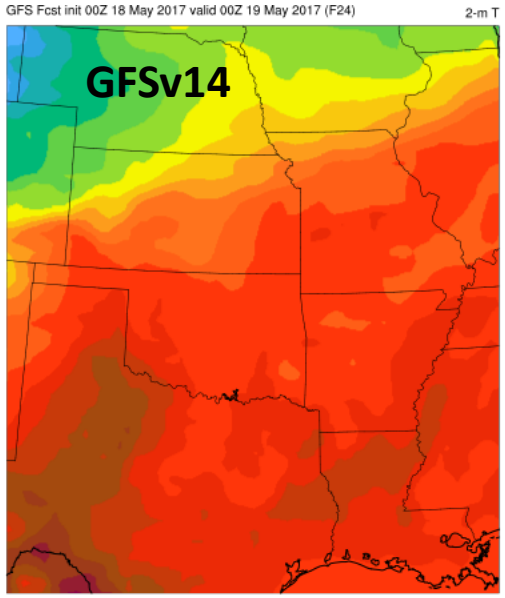
GFSv15

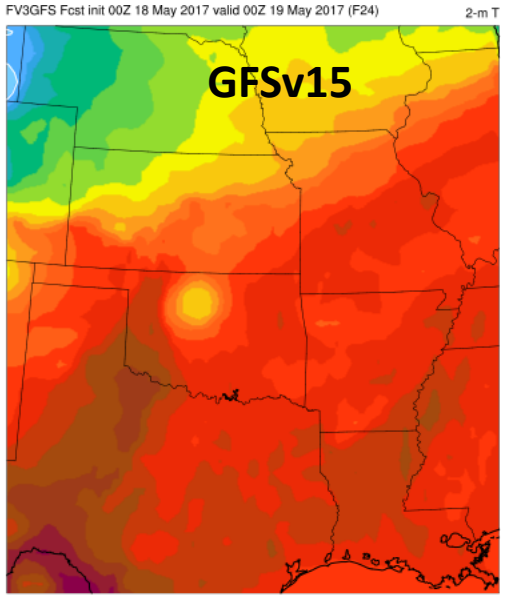


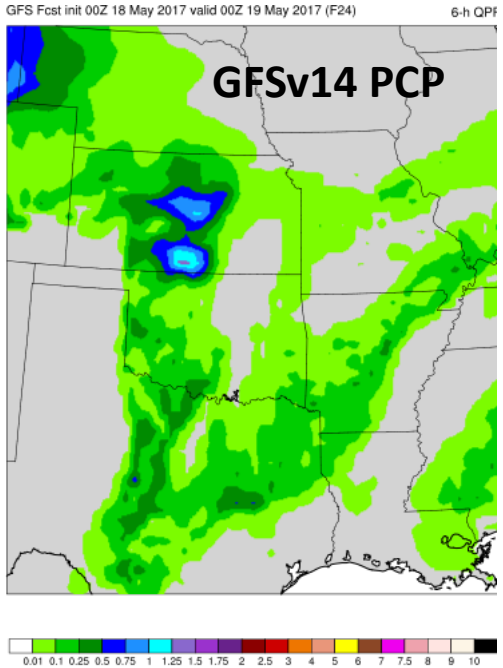
ADDITION of SIMULATED COMPOSITE REFLECTIVITY PARAMETER

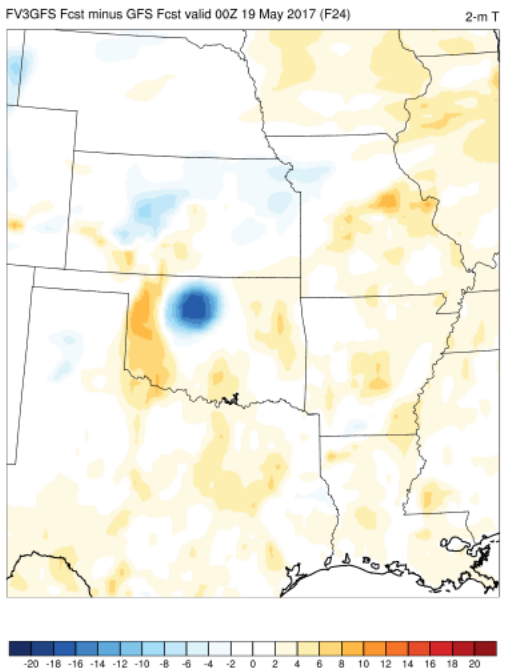

5 10 15 20 25 30 35 40 45 50 55 60 65 70
180911/1800V000 FV3GFS COMPOSITE REFL

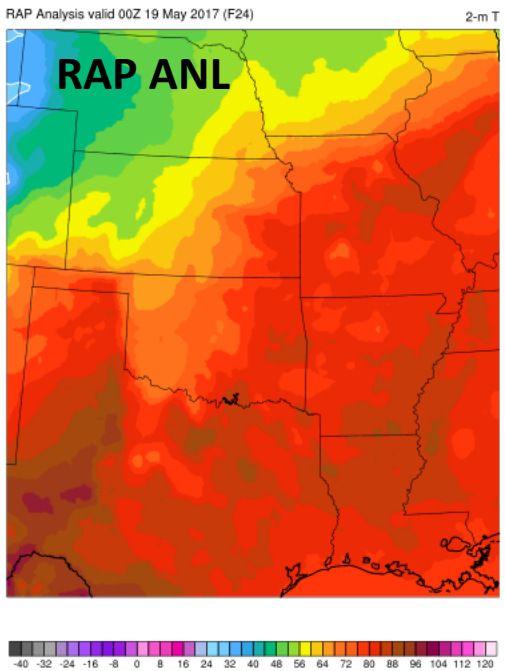
ABILITY TO GENERATE MODEST SURFACE COLD POOLS FROM SIGNIFICANT CONVECTION

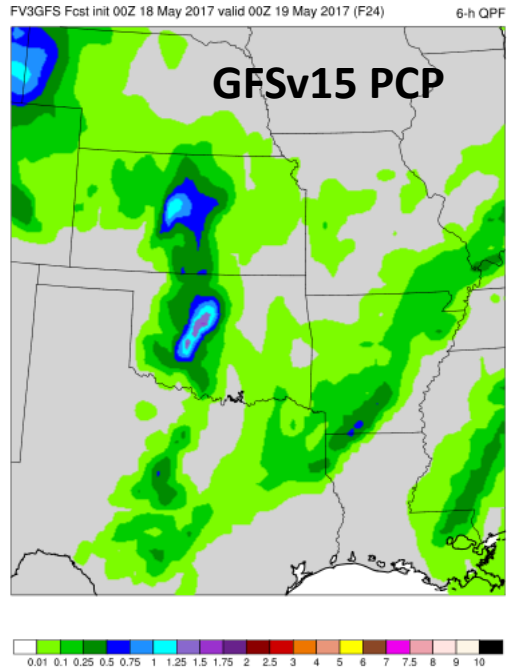

GFS Fcst init 00Z 18 May 2017 valid 00Z 19 May 2017 (F24)
2-m T
GFSv14
-40 -32 -24 -16 -8 0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120


FV3GFS Fcst init 00Z 18 May 2017 valid 00Z 19 May 2017 (F24)
2-m T
GFSv15
-40 -32 -24 -16 -8 0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120


GFS Fcst init 00Z 18 May 2017 valid 00Z 19 May 2017 (F24)
6-h QPF
GFSv14 PCP
0.01 0.1 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.5 3 4 5 6 7 7.5 8 9 10


FV3GFS Fcst minus GFS Fcst valid 00Z 19 May 2017 (F24)
2-m T
-20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20

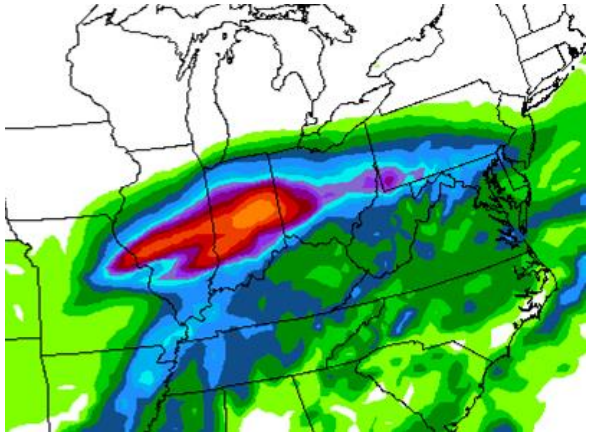

RAP Analysis valid 00Z 19 May 2017 (F24)
2-m T
RAP ANL
-40 -32 -24 -16 -8 0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120


FV3GFS Fcst init 00Z 18 May 2017 valid 00Z 19 May 2017 (F24)
6-h QPF
GFSv15 PCP
0.01 0.1 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.5 3 4 5 6 7 7.5 8 9 10

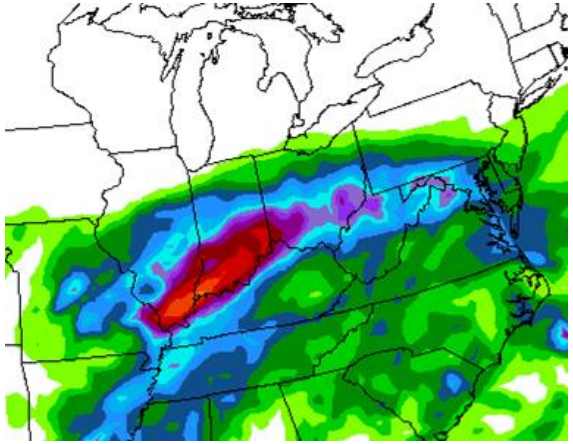
QPF Evaluation - Positives

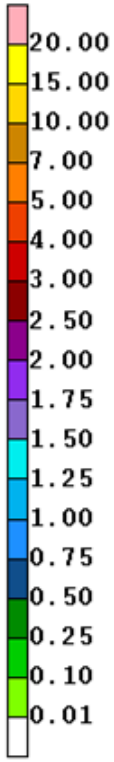
Reduces the operational run's northward precipitation bias

GFS 60-hr forecast

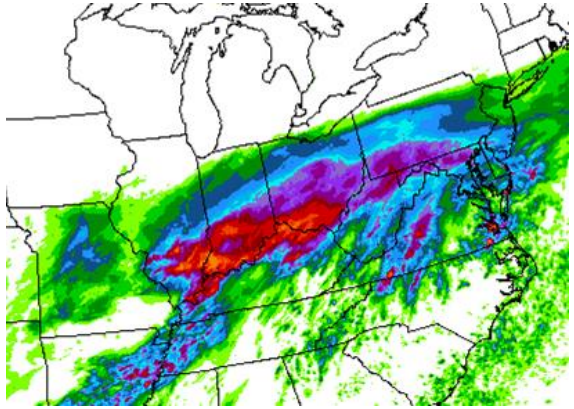


GFS-FV3 60-hr forecast





24-hour Stage IV QPE valid 12Z 9/9/2018



Precip focused on outflow boundary

Other GFSv15 Improvements

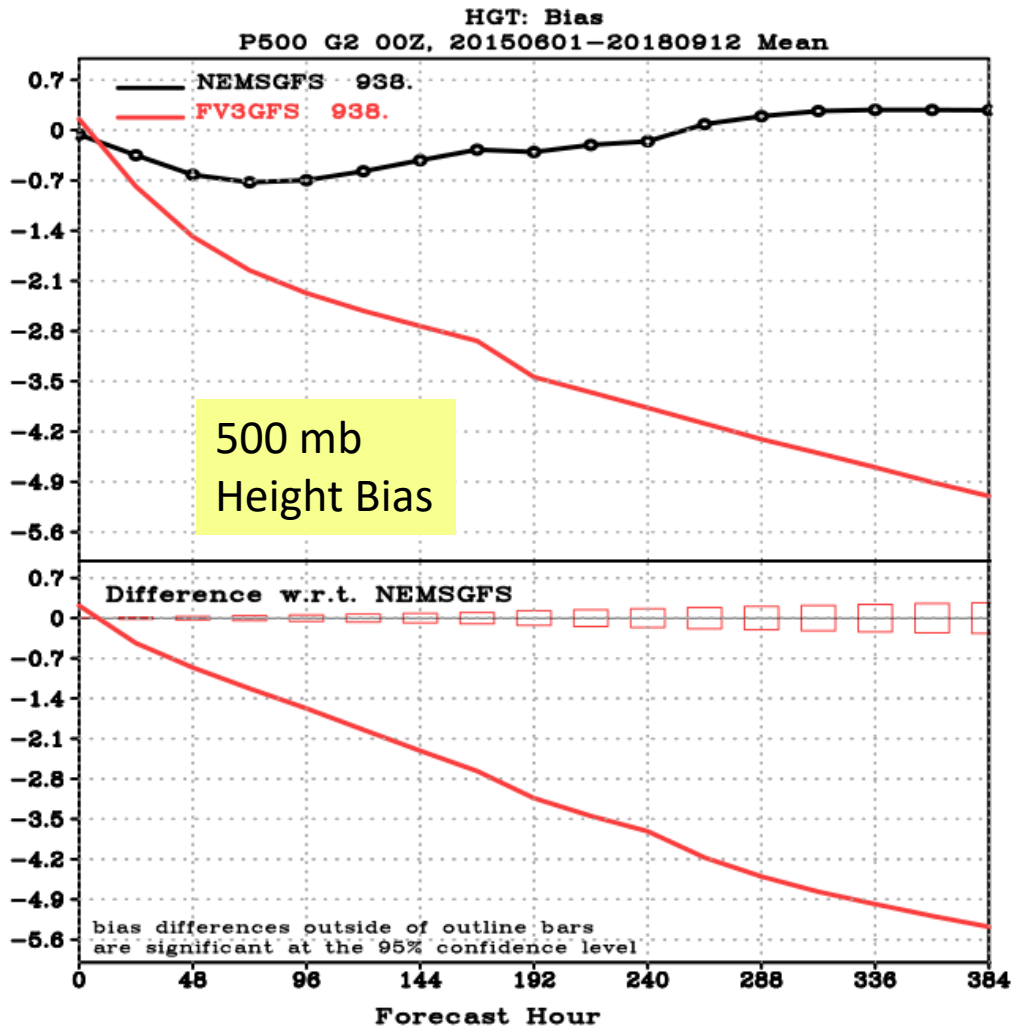
- General improvement in HWRF & HMON runs
- Improved ozone and water vapor physics and products
- GFSv15, running with the advanced GFDL MP, provides better initial and boundary conditions for driving the stand-alone regional FV3, and for running downstream models that use advanced MP
- FV3-based GEFSv12 showed significant improvements when initialized with GFSv15

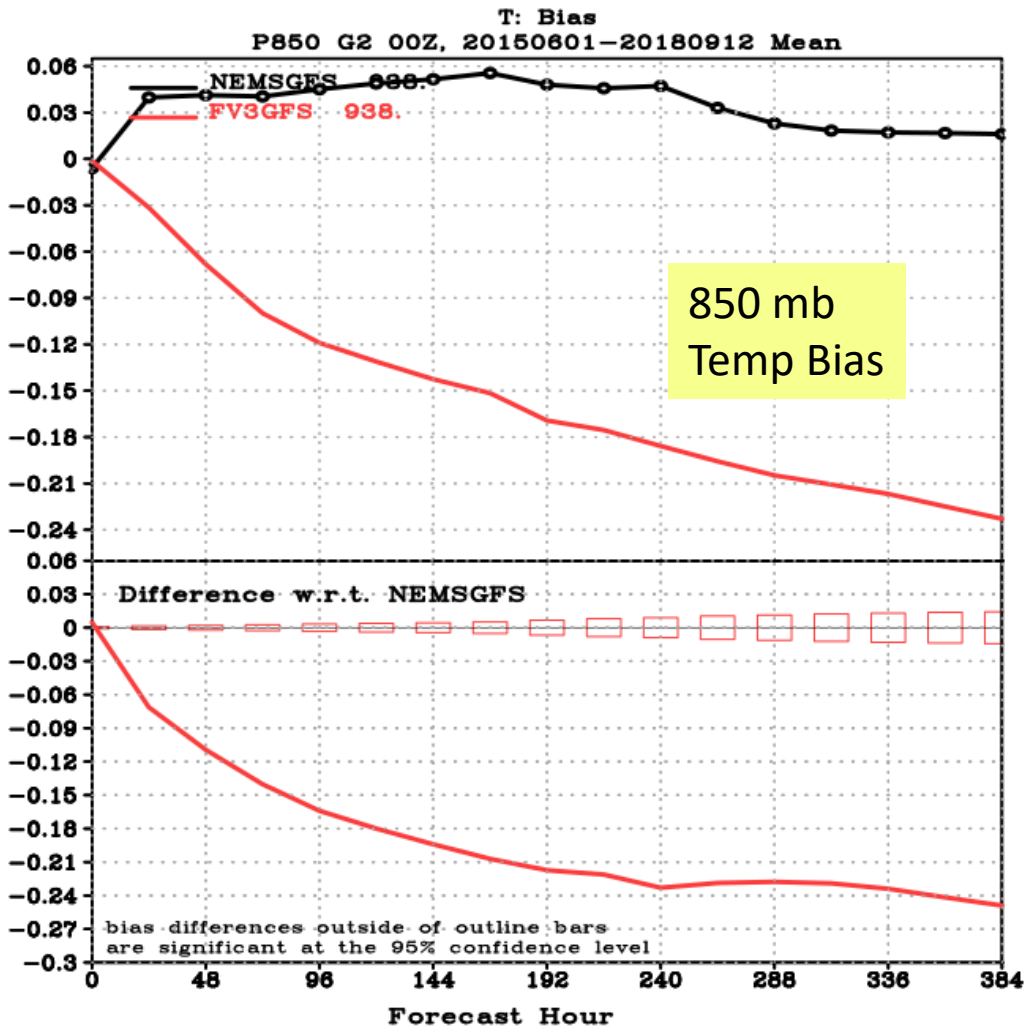
CONCERNS WITH GFSv15

A LOW-LEVEL COLD BIAS GROWS WITH FORECAST LENGTH

From the MEG evaluation report last fall:

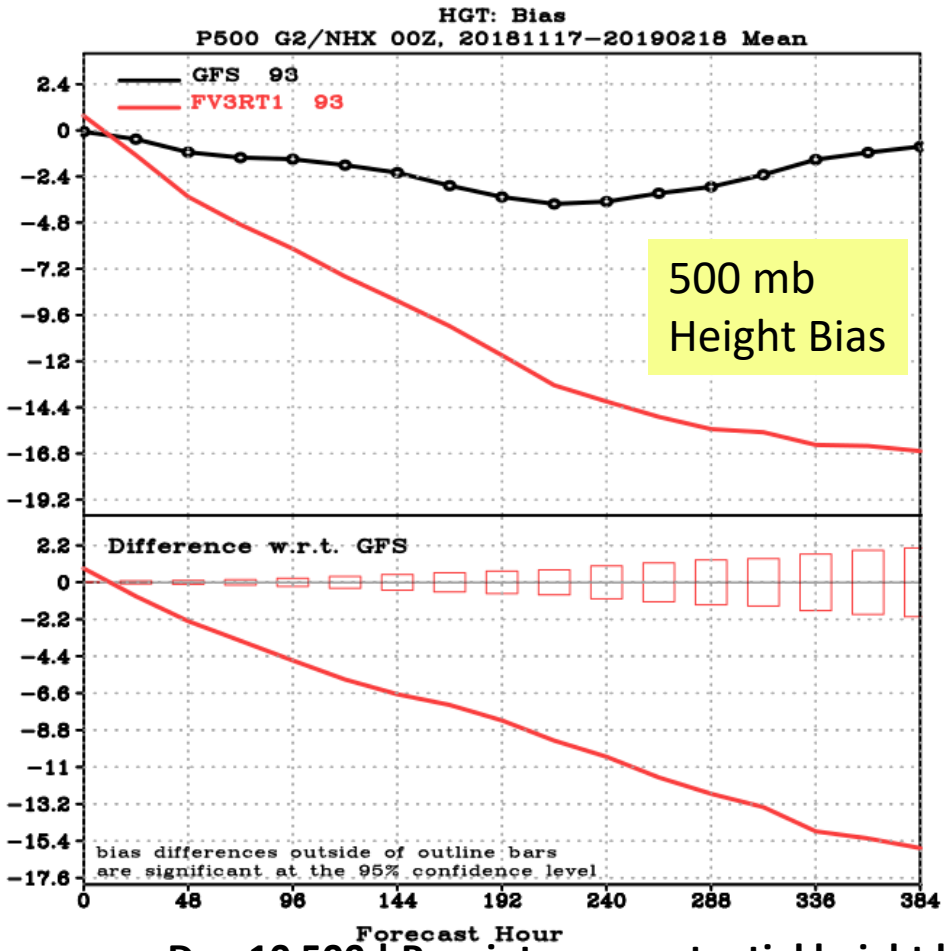
GFSv15 GFSv14





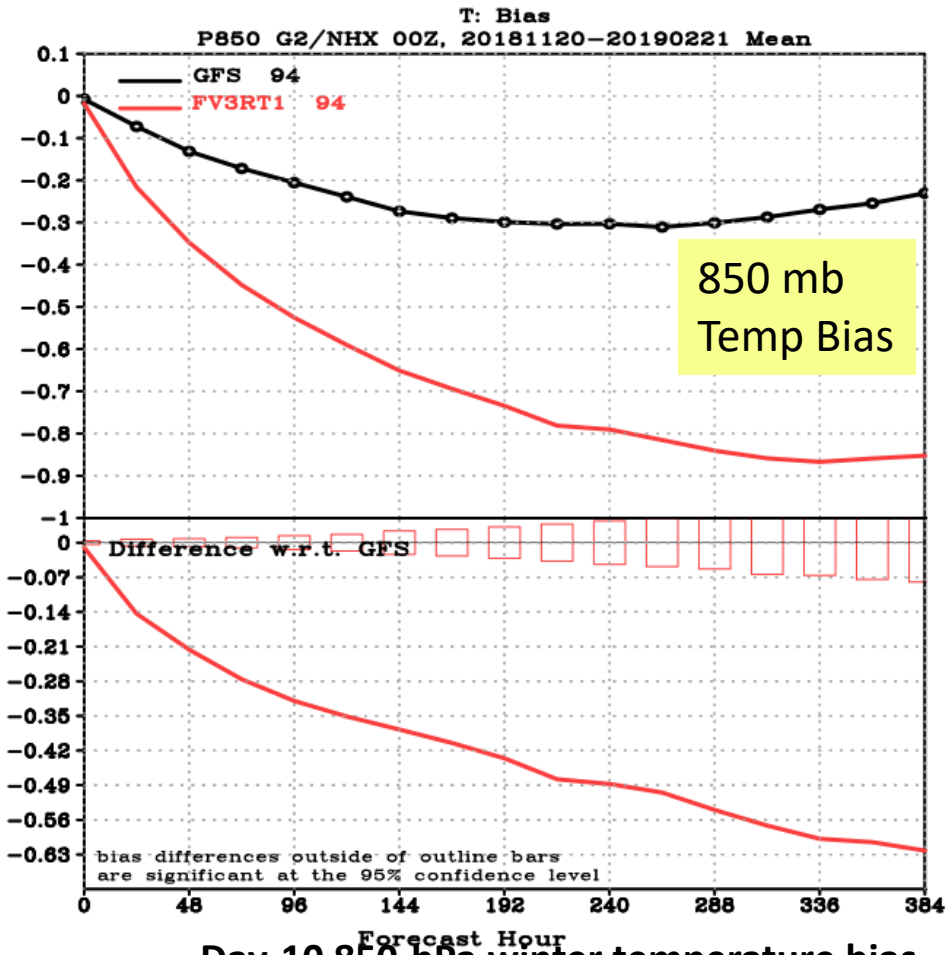
The increasing bias with time was a concern, but the magnitude was fairly small

MAGNITUDE INCREASED SIGNIFICANTLY THIS WINTER



GFSv14

GFSv15

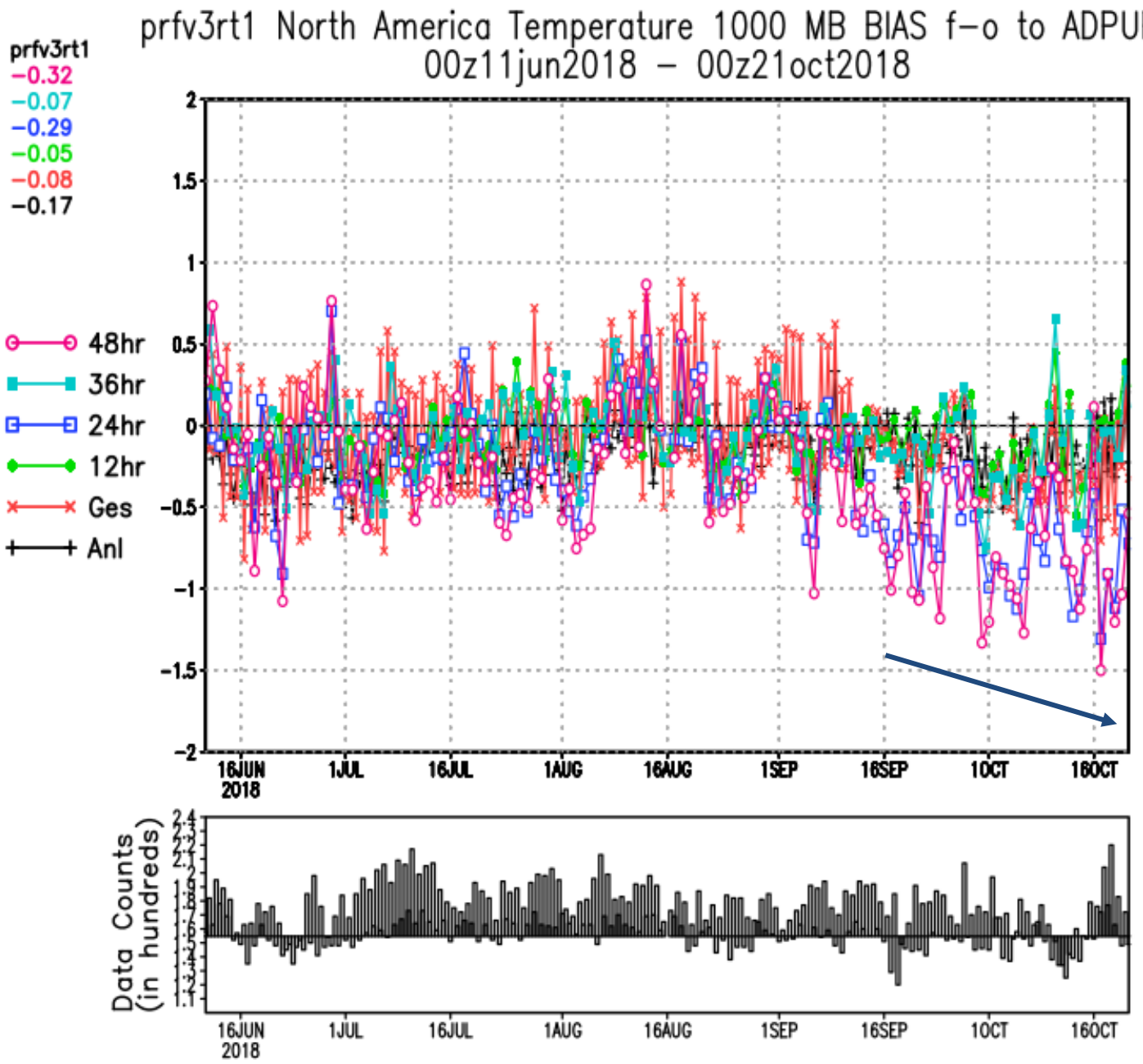


Day-10 500-hPa winter geopotential height bias

(2015–2016) -4.5 m
(2016–2017) -5.0 m
(2017–2018) -3.2 m
(2018–2019) -14.4 m

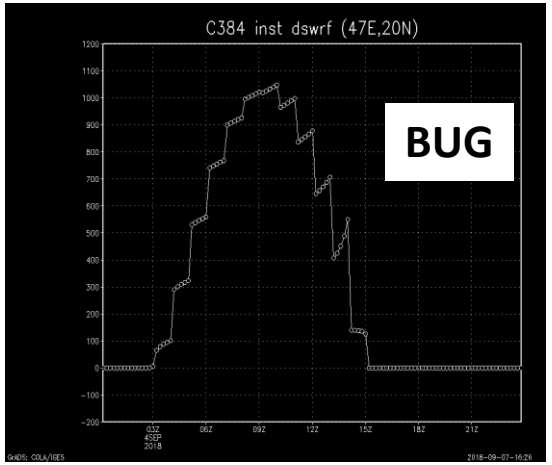
Day-10 850-hPa winter temperature bias

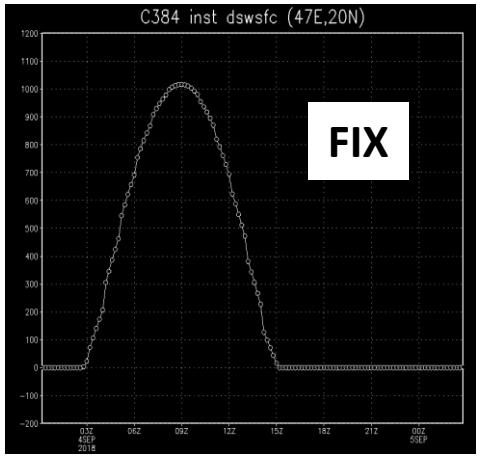
(2015–2016) -0.27°C
(2016–2017) -0.35°C
(2017–2018) -0.23°C
(2018–2019) -0.77°C



GFSv15 change @ 18z 9-17-18 to correct radiation error

Temperature bias trends more negative (cooler with respect to observations) after change





Mitigation of the cold bias

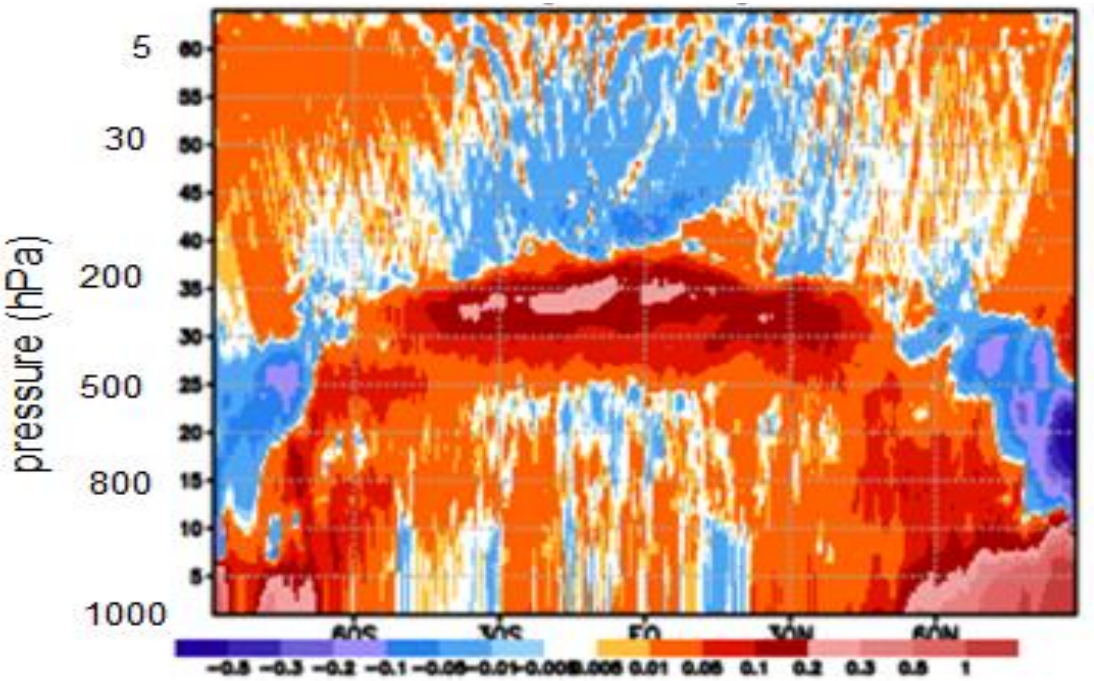
Physics:

- Adopting an improved cloud radiation interaction in the new configuration reduces long-wave cooling in the troposphere, and indirectly increases heating in the PBL and near-surface due to mixing, warming the troposphere.

Data Assimilation:

- Adjustment to supersaturation constraint in the new configuration reduces the cold bias in the polar regions near surface.

Zonal Mean Temperature Difference
Lat-HGT Cross Section, 24hr Forecast

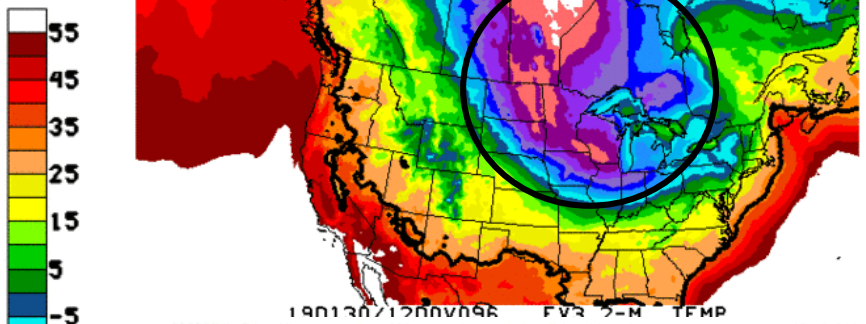


Impact of improved cloud-radiation interactions: Warm the atmosphere (recovers some of the cold bias in the lower troposphere)

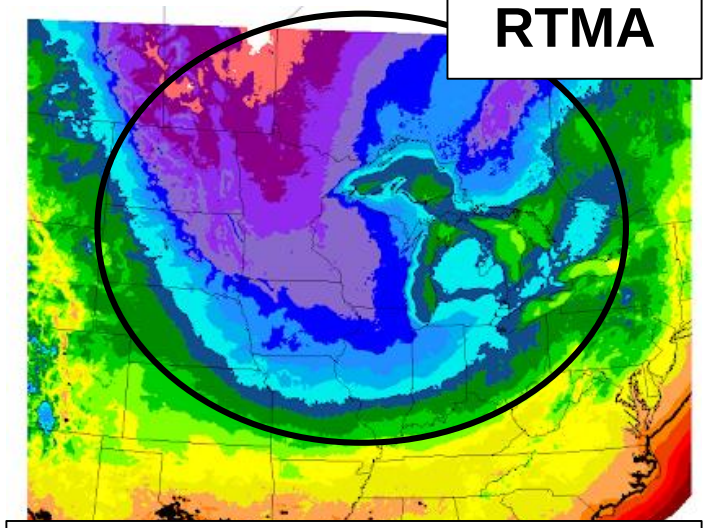
GFDL is acknowledged for their contribution to the implementation of the improved cloud-radiation interaction scheme in the new configuration.

Example: Arctic Blast of Late January 2019

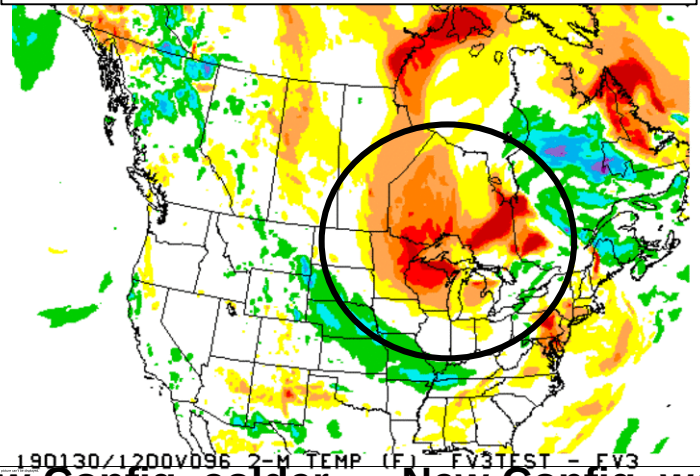
Real-time Parallel



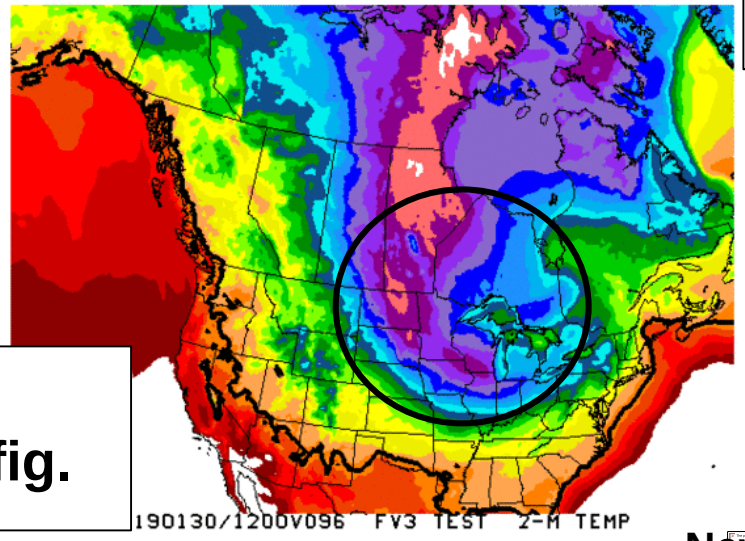
RTMA



New Config. – Parallel



New Config.



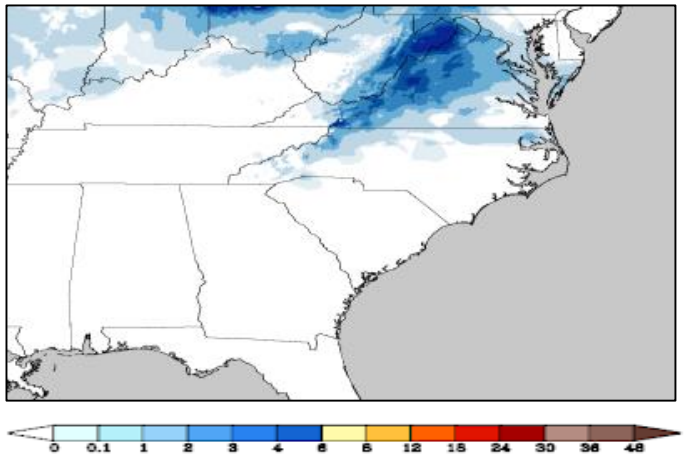
New Config. colder **New Config. warmer**

Init: 1200 UTC 26 Jan 2019
Val: 1200 UTC 30 Jan 2019

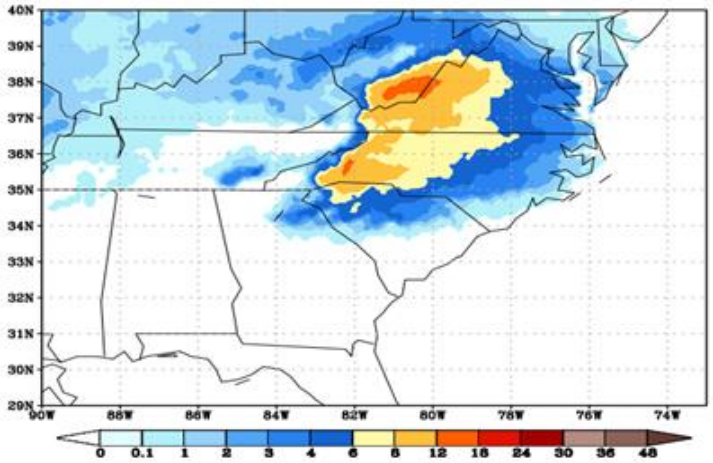
- **New Configuration** is warmer than the Real-time Parallel over the Great Lakes and Upper-Midwest
- While still too cold relative to the RTMA analysis, the **New Configuration** shows a clear improvement

Excessive 24-h Snowfall Totals at Day 5 (Valid: 12Z 2/20/19)

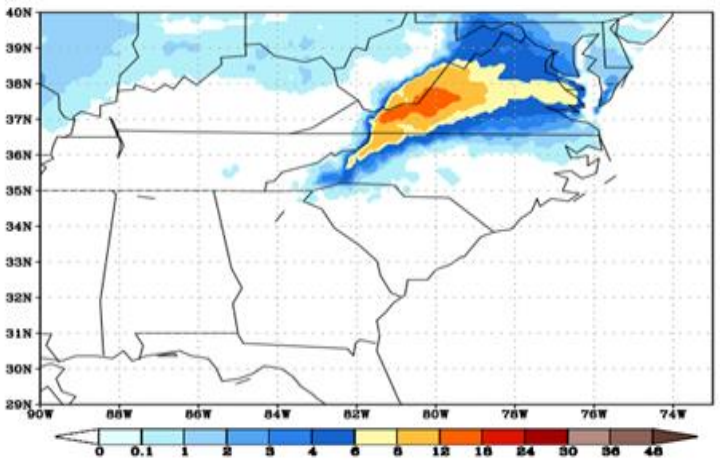
NOHRSC Analysis



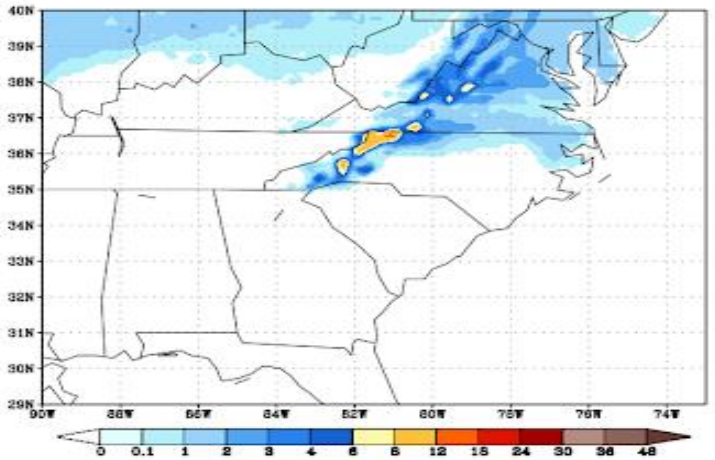
Real-time Parallel



New Configuration



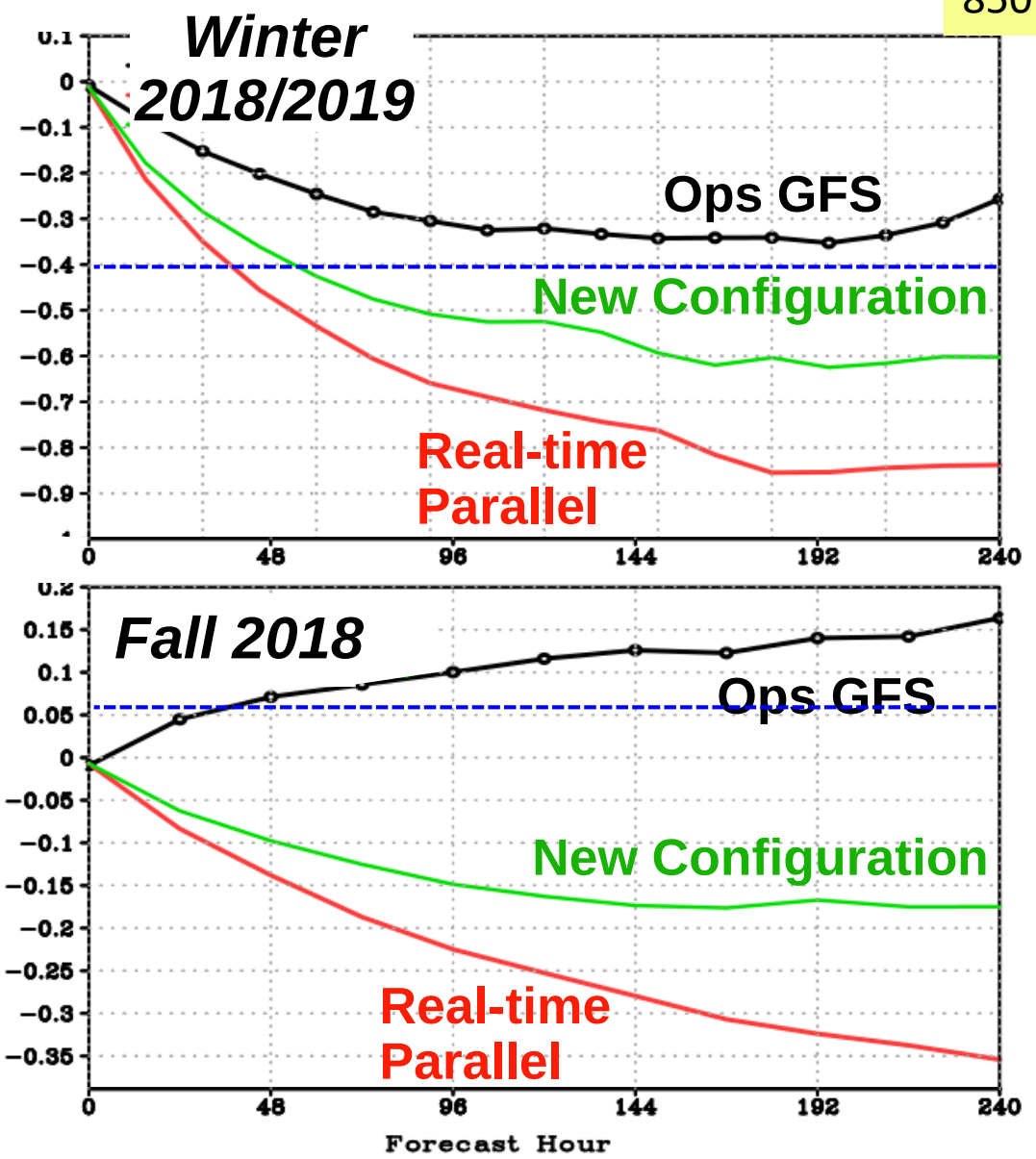
Operational GFS

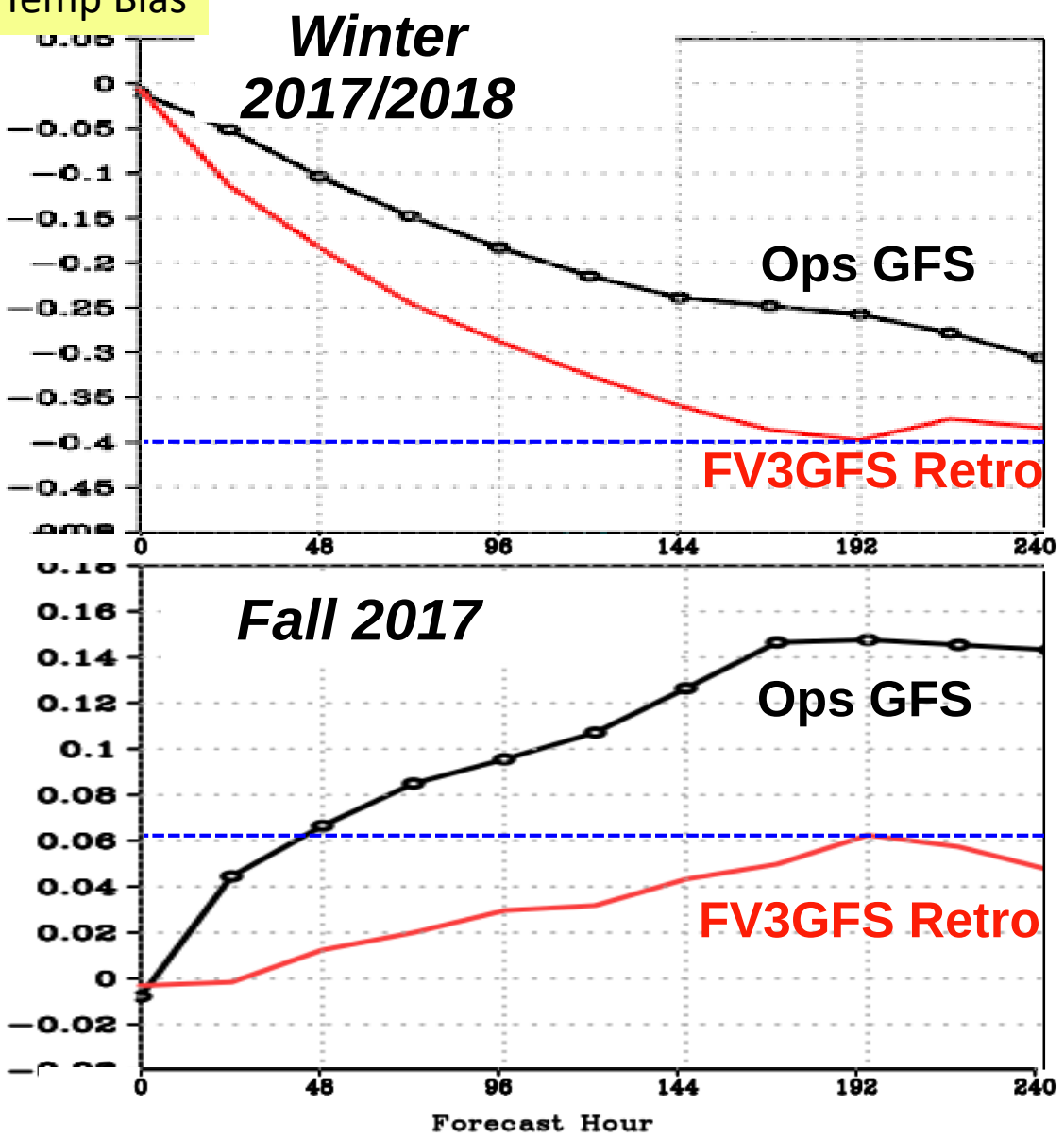


- **New Configuration** has correct areal coverage of snowfall, and coverage of higher amounts is significantly reduced from the real-time parallel run but are still too high

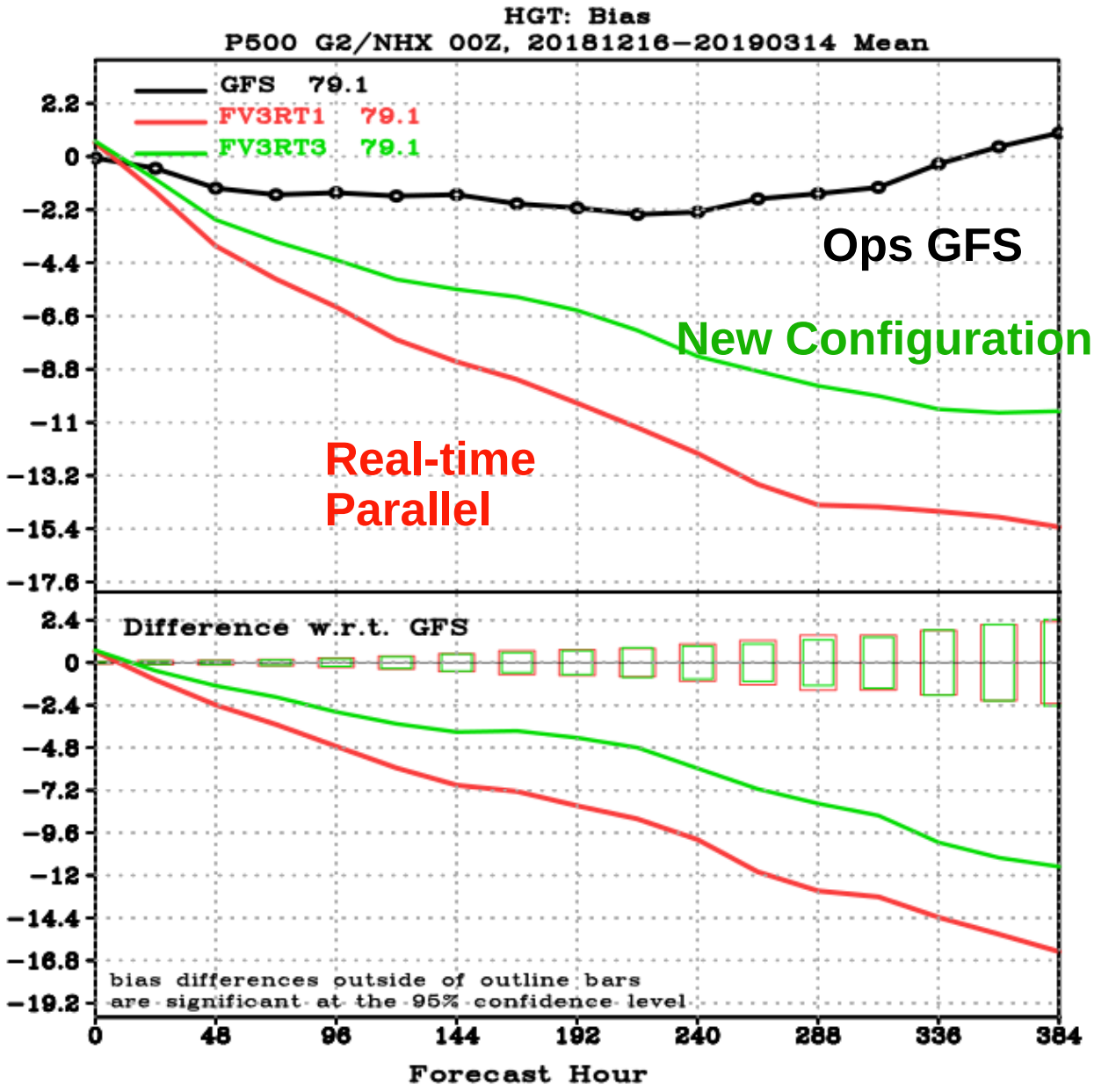
Mitigation of Cold Bias

850 hPa Temp Bias

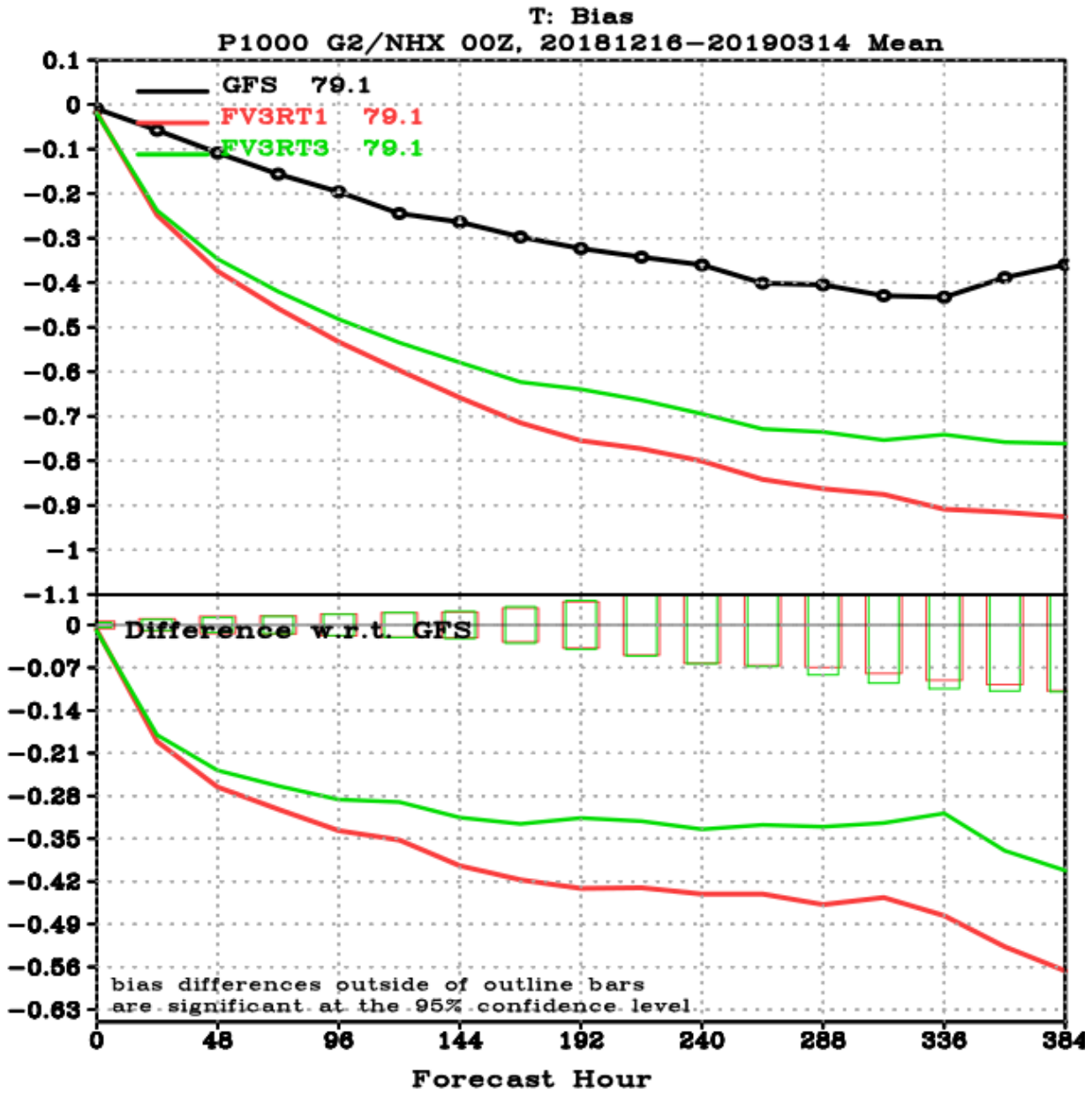




500 hPa Height Bias



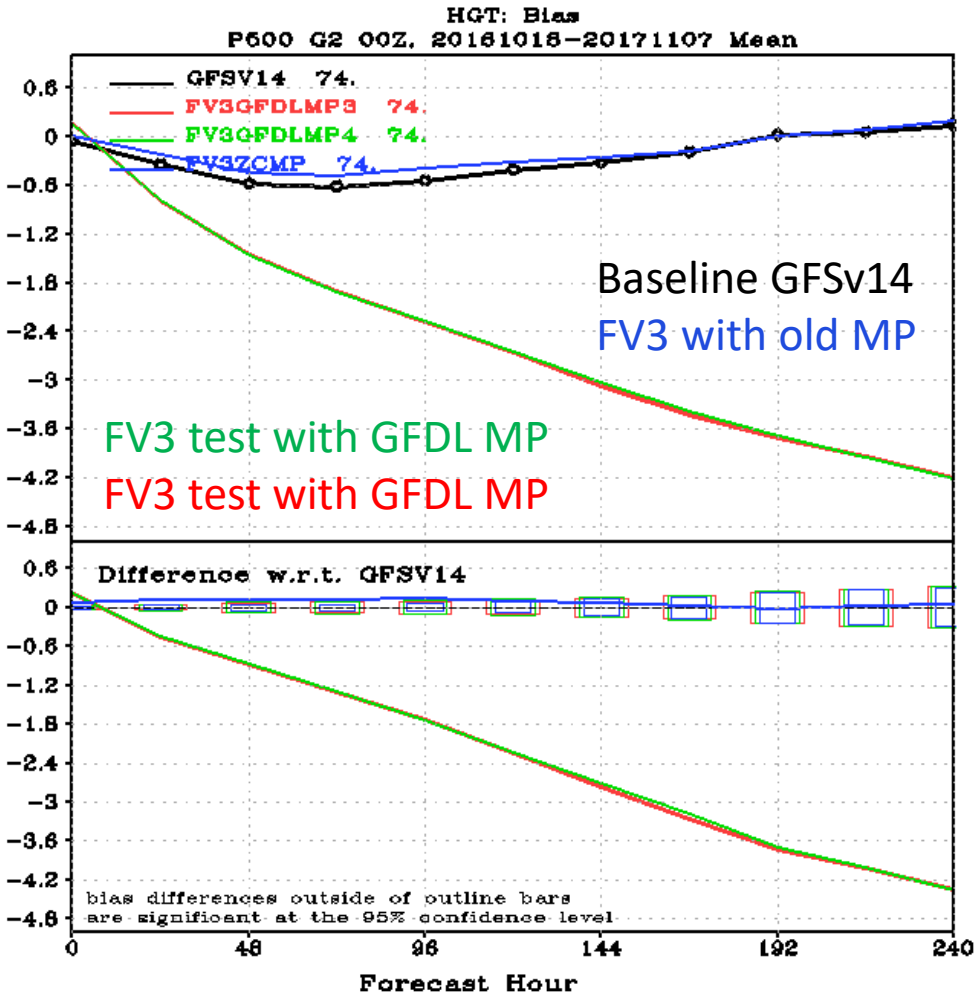
1000 hPa Temp Bias



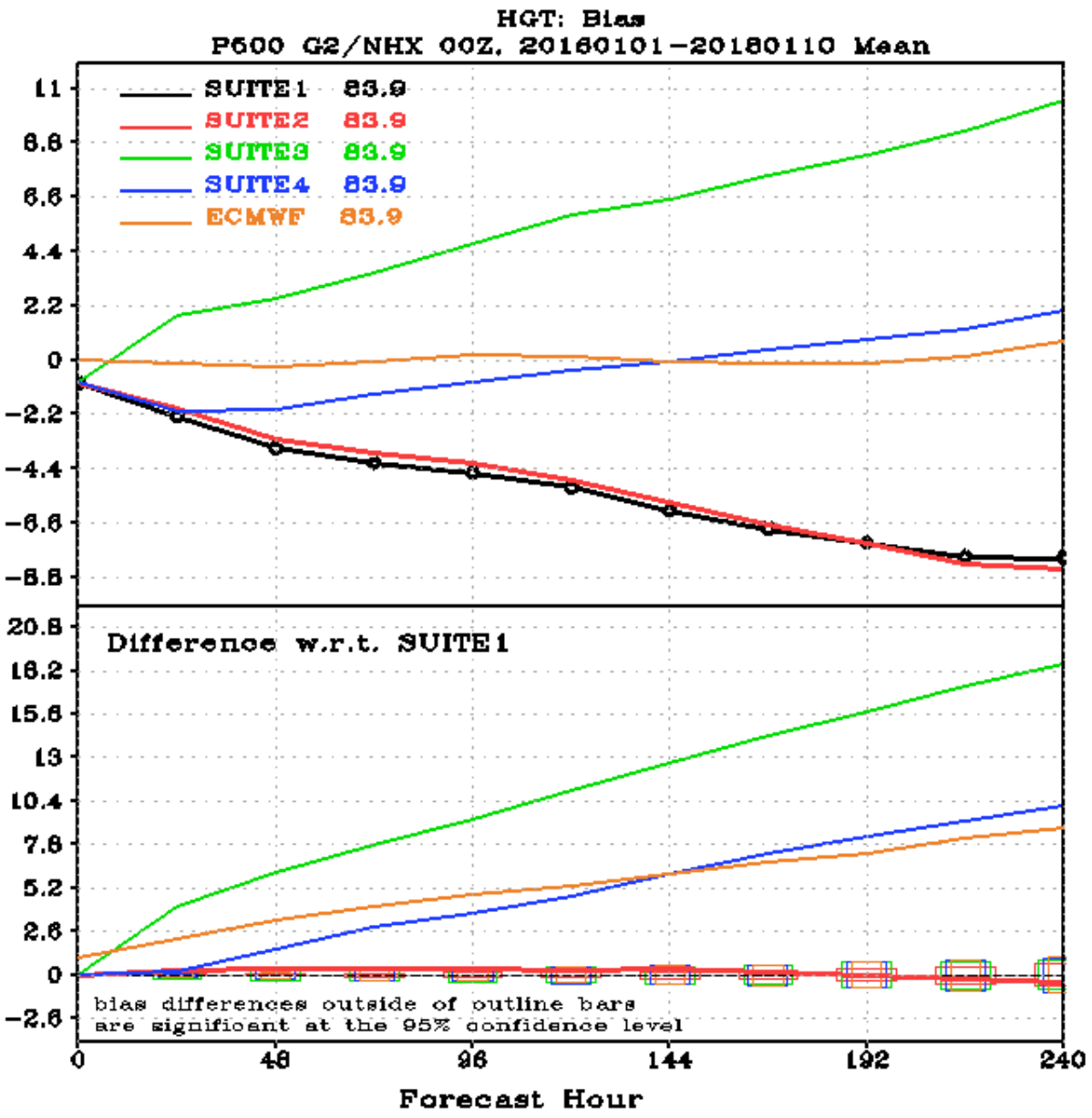
What is the Cause of This Cold Bias?

A possible clue from early testing of the global system with the FV3 core

The runs with the Zhao-Carr microphysics don't display the increasing cold bias; the introduction of the GFDL microphysics seems to introduce the bias



500-hPa Geopotential Height Bias from the Physics Suites Testing



SUITE 1 **SUITE 3** **ECMWF**

SUITE 2 **SUITE 4**

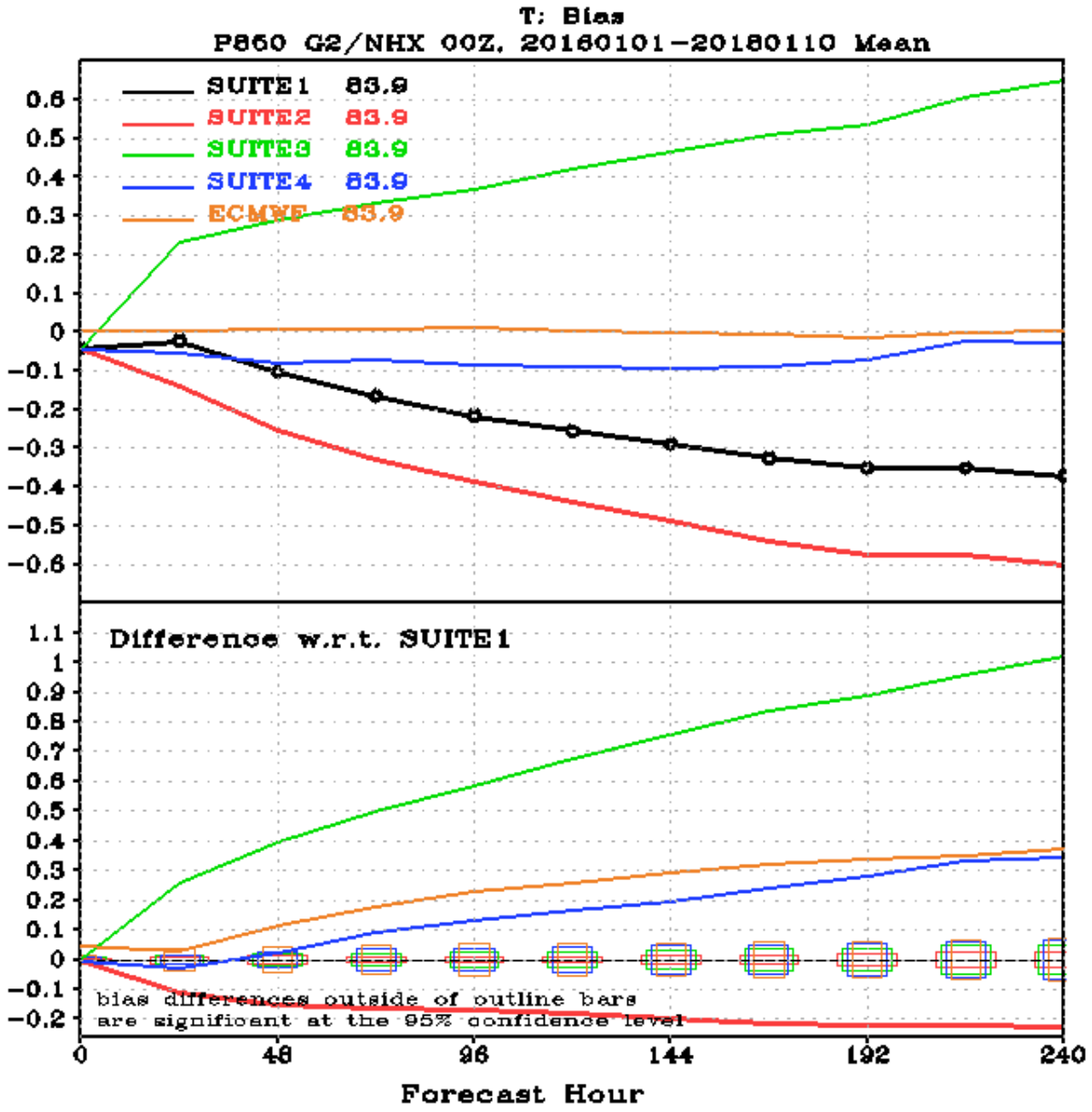
KEY POINTS:

- Suites 1 and 2 (with GFDL MP) have a nearly identical low bias that increases with forecast lead time

- Suite 3 (Morrison-Gettleman MP) has a high bias that increases with forecast lead time

- Suite 4 (Thompson MP) has the smallest average 500-hPa height bias at almost all forecast hours

850-hPa Temperature Bias



SUITE 1 **SUITE 3** **ECMWF**

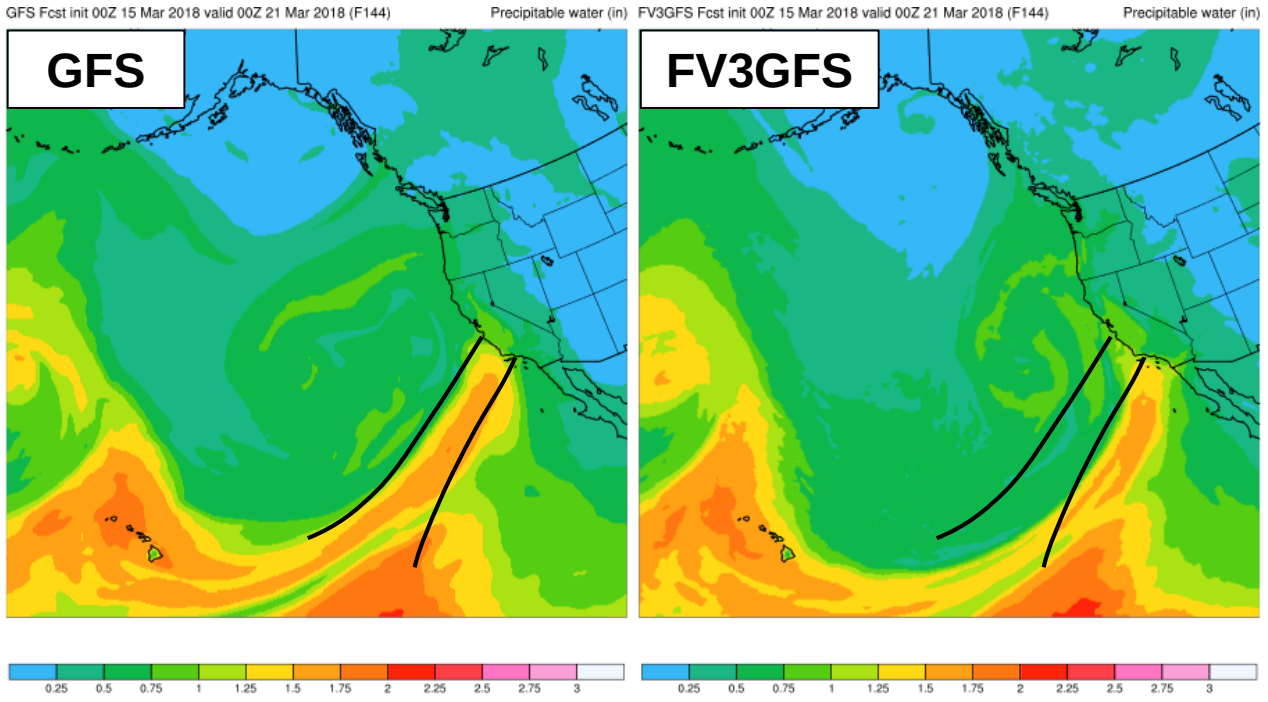
SUITE 2 **SUITE 4**

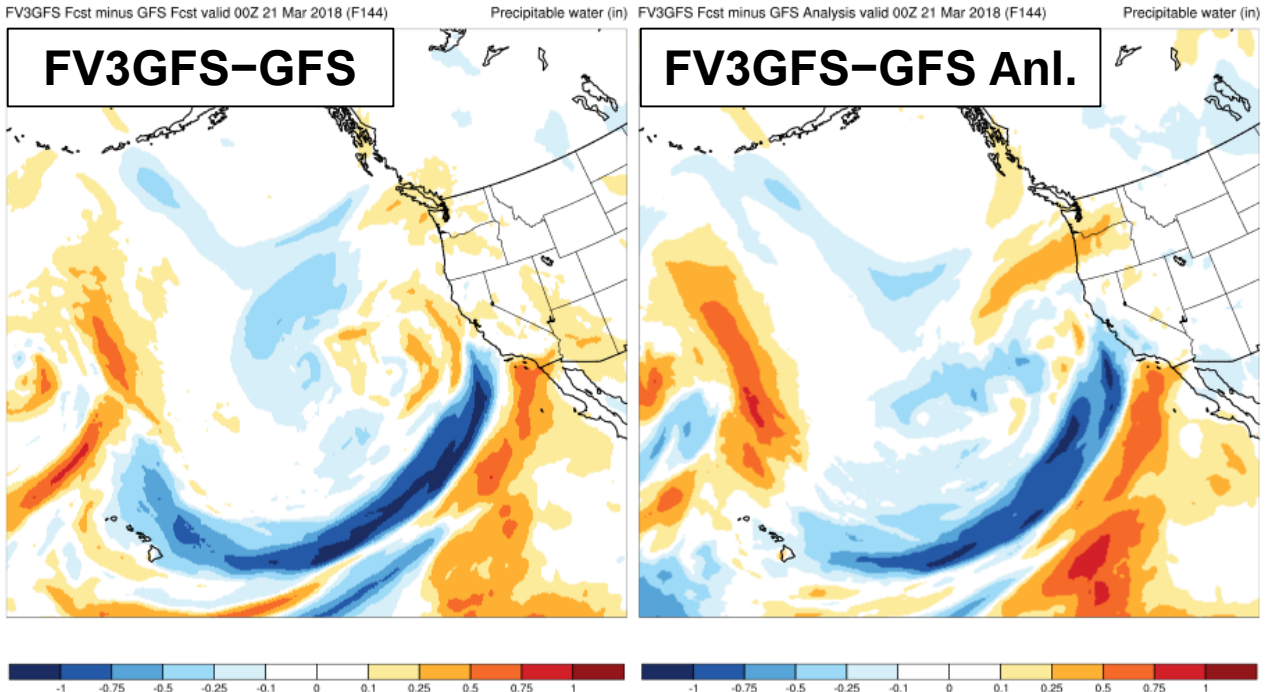
KEY POINTS:

- Suites 1 and 2 (GFDL MP) have a cold bias that increases with lead time

- **The suites without GFDL microphysics do not show a cold bias increasing w time**

SYNOPTIC PROGRESSIVENESS WITH CUTOFF UPPER LOWS RAPIDLY RE-ENTERING THE MIDLATITUDE FLOW





3/15/18 00Z F144

MAIN POINTS:

- GFSv14 shifts AR west before GFSv15
- GFSv15 is more progressive with AR than GFS

KEY:

Blue = GFSv15 is drier (lower PW)

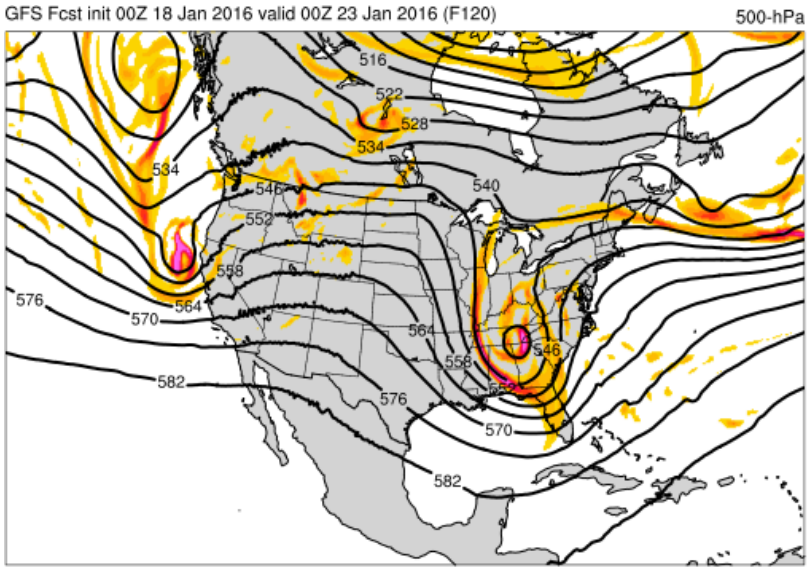
Red = GFSv14 is wetter (higher PW)

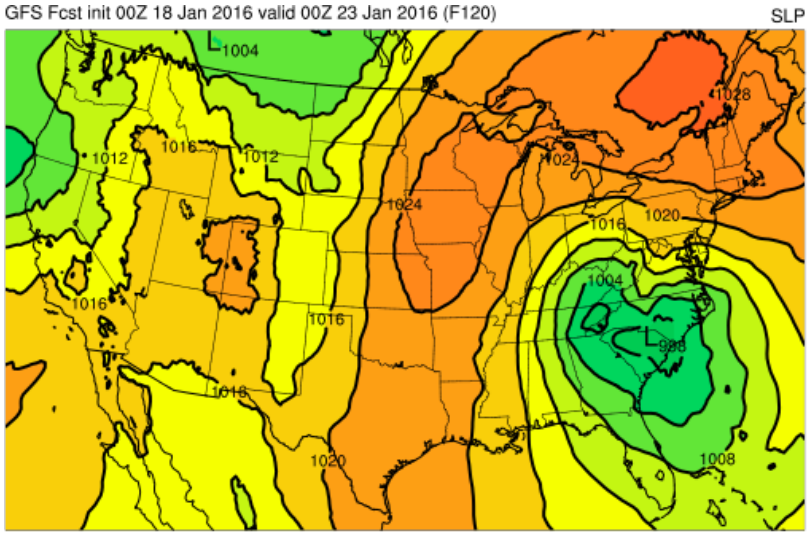
Black lines denote analyzed AR axis

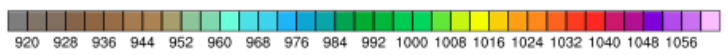
BLIZZARD of 2016

00z 1/2/16 cycle F144

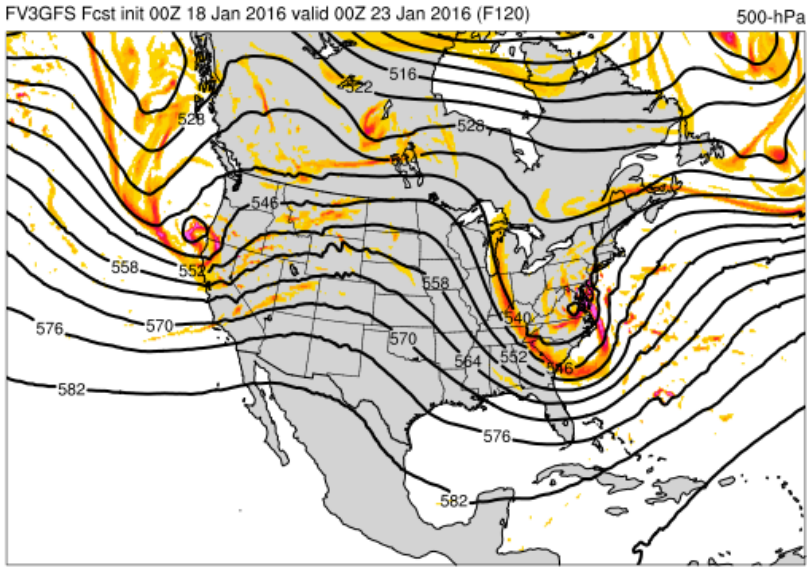
GFSv14

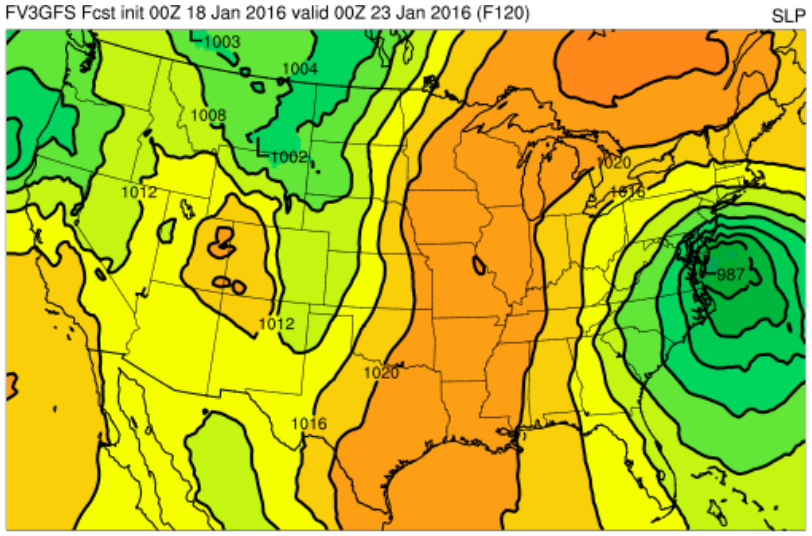


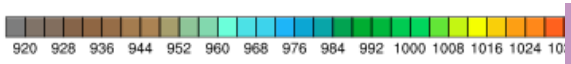




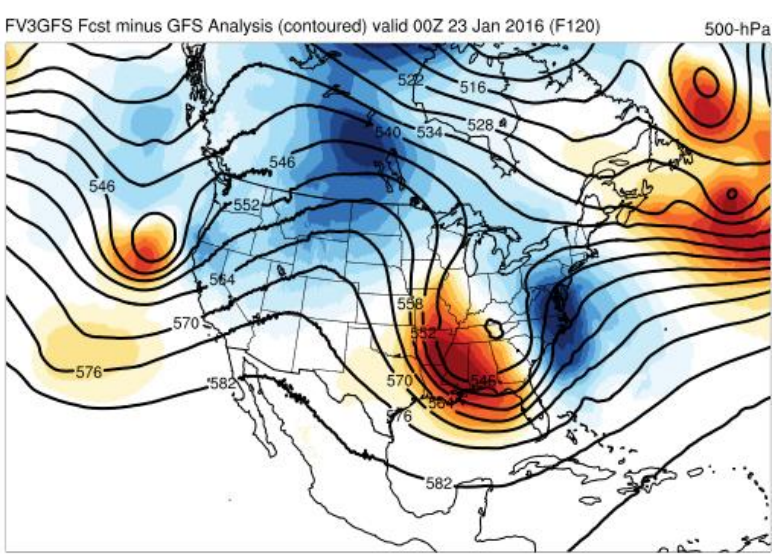
GFSv15

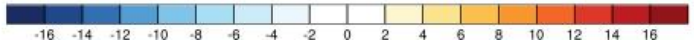


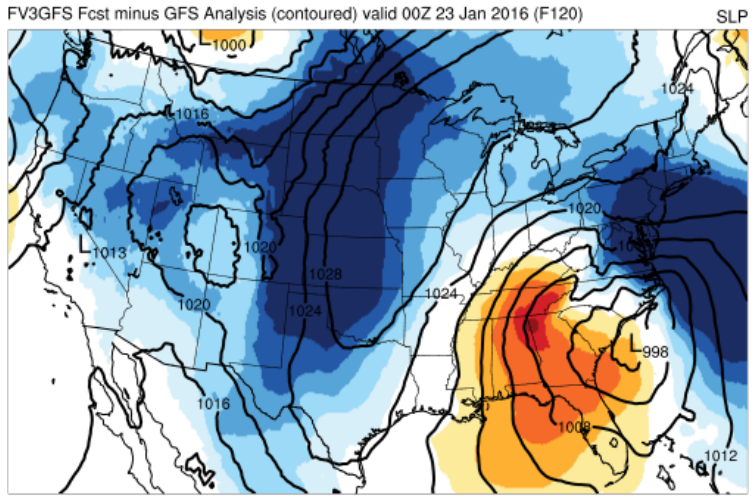


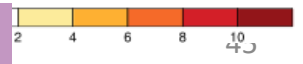


ANL, v15 – v14

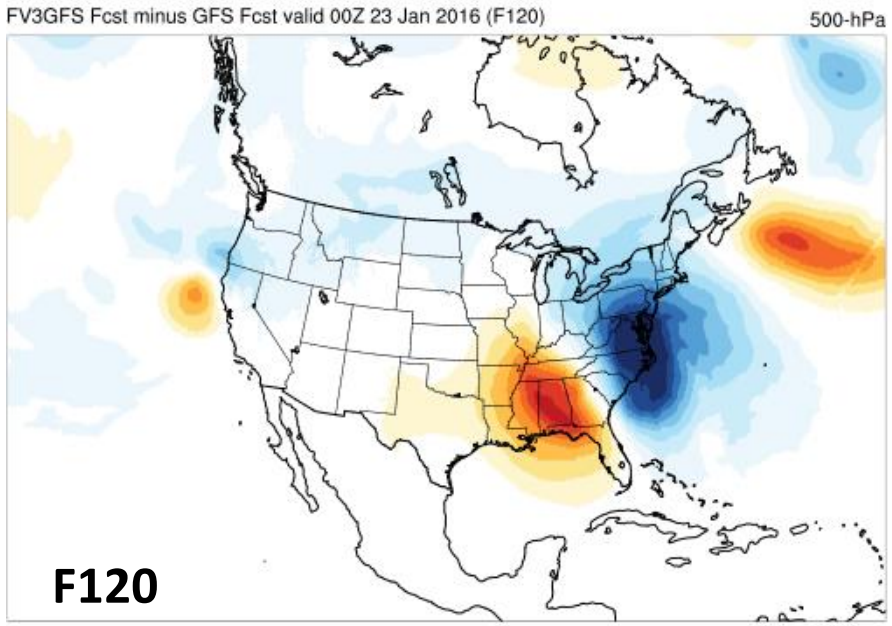


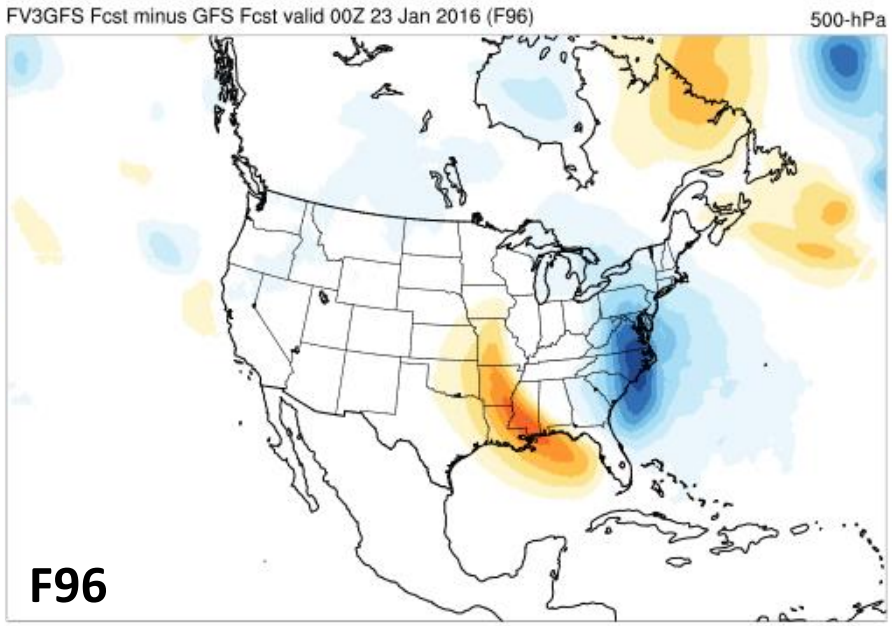


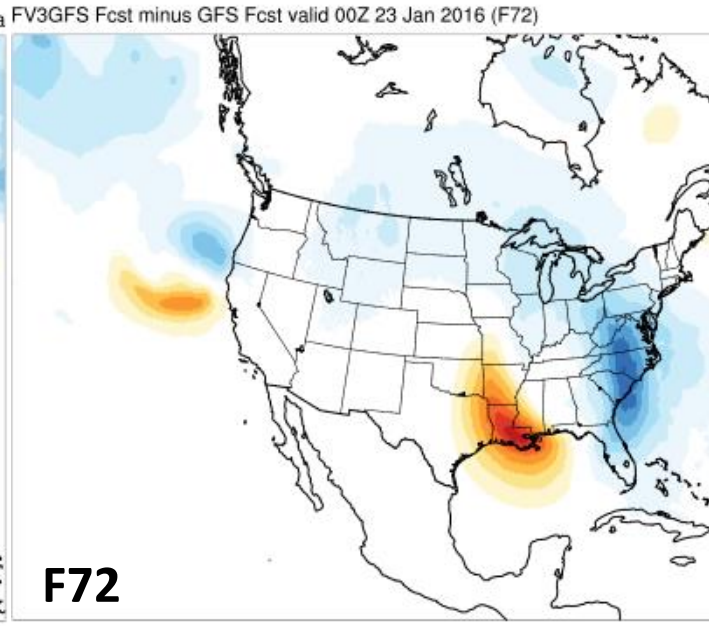




FV3GFS is ONE DAY FAST



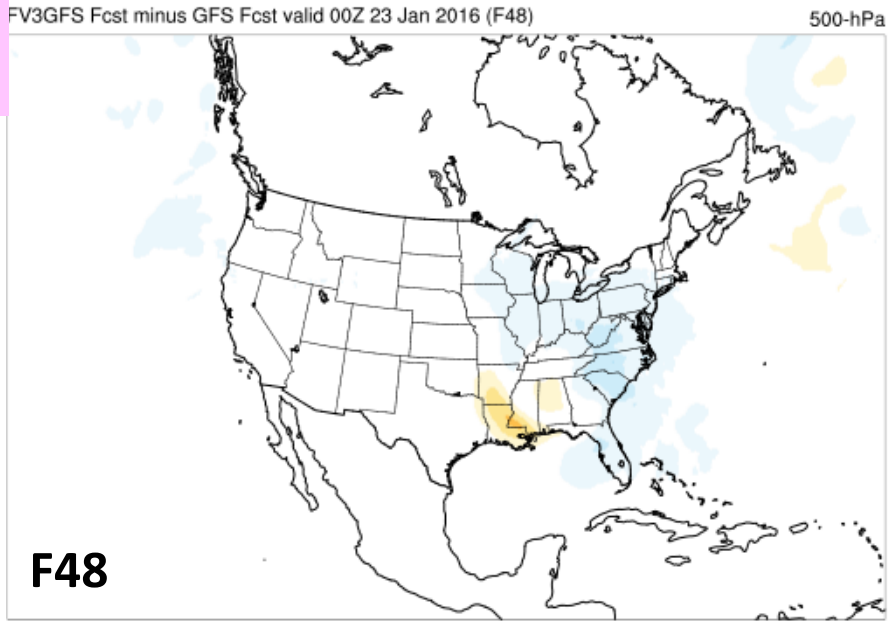


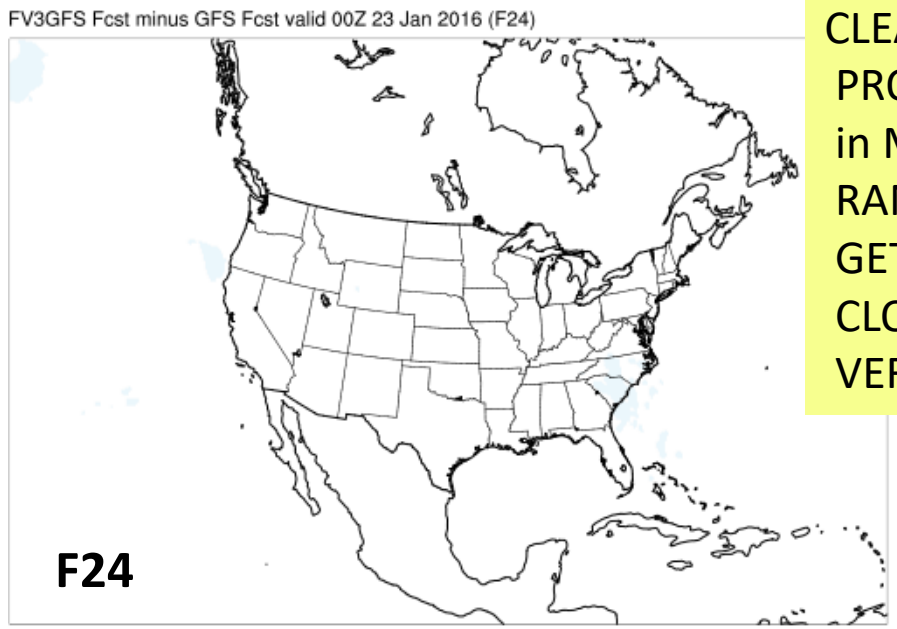


v15 – v14 500mb BLIZZARD of 2016

Blue = v15 has lower heights

Red = v15 has higher heights

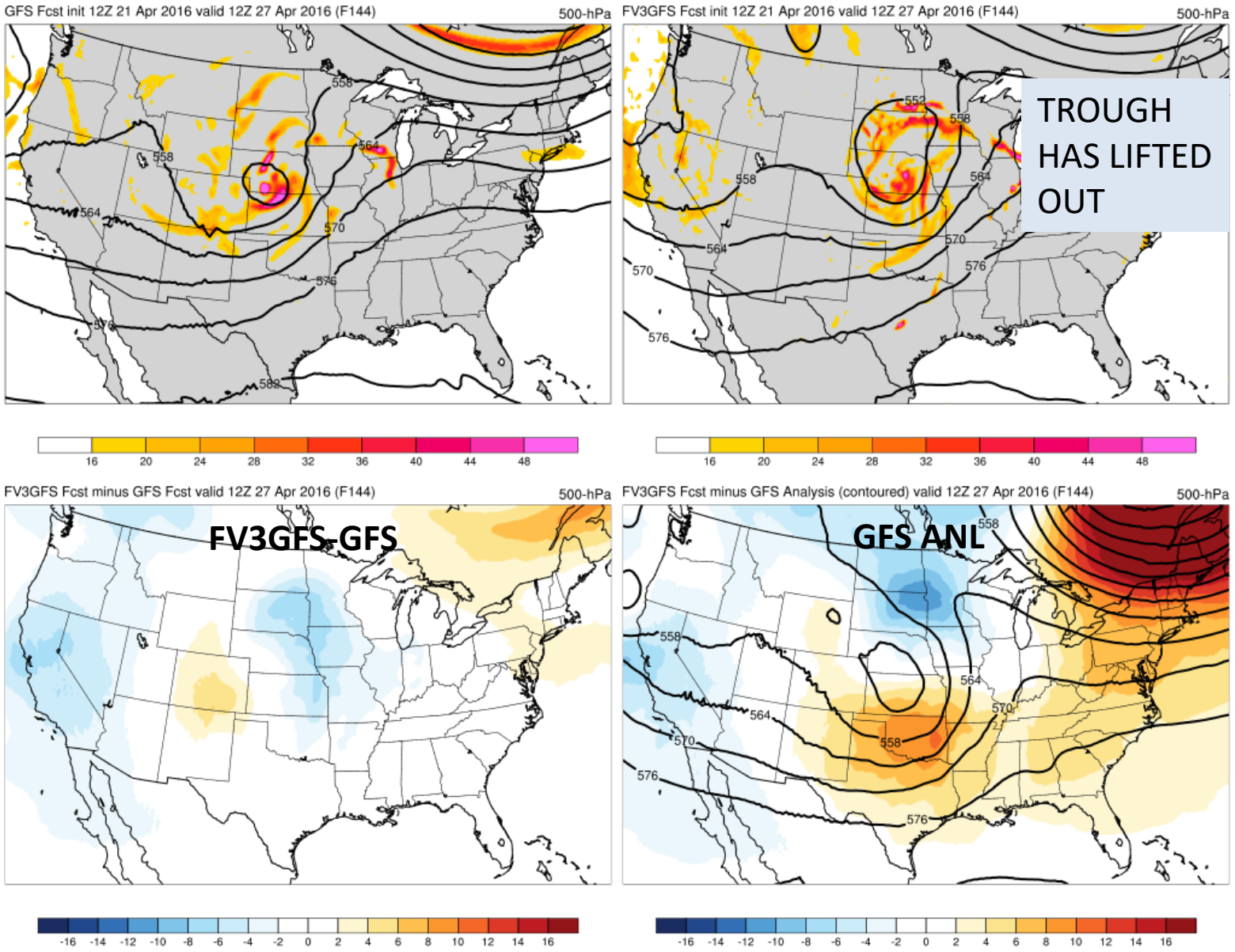




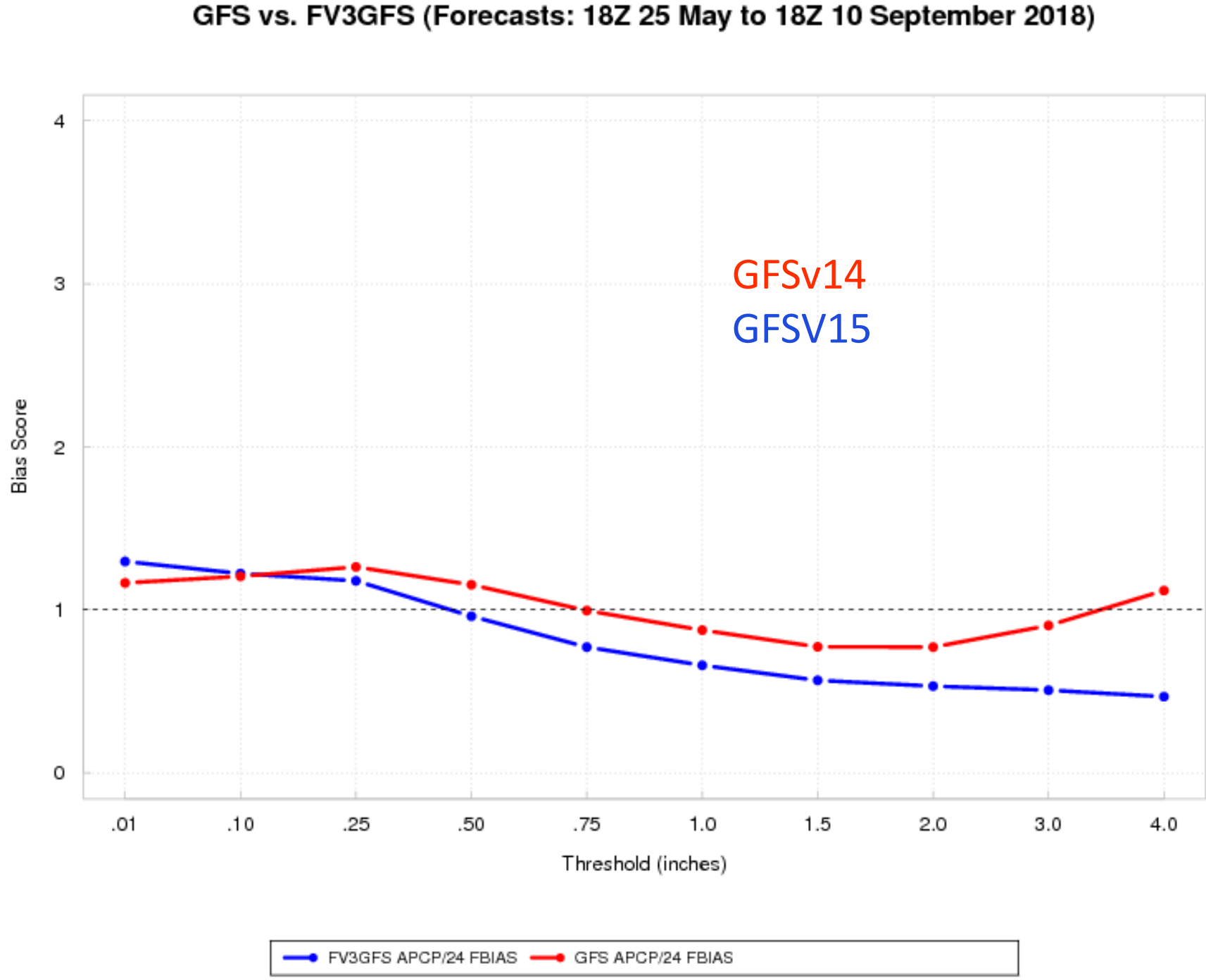
CLEARLY TOO PROGRESSIVE in MEDIUM RANGE; DIFFS GET SMALLER CLOSER to VERIFYING TIME

APR 2016 SVR OUTBREAK

GFSv14 **GFSv15**



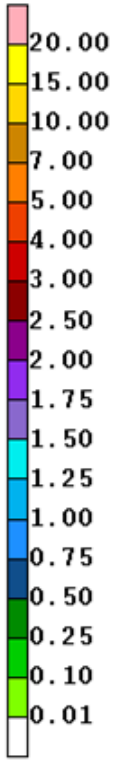
WARM SEASON DRY BIAS


GFS vs. FV3GFS (Forecasts: 18Z 25 May to 18Z 10 September 2018)
GFSv14
GFSV15
Bias Score
4
3
2
1
0
.01
.10
.25
.50
.75
1.0
1.5
2.0
3.0
4.0
Threshold (inches)
FV3GFS APCP/24 FBIAS
GFS APCP/24 FBIAS

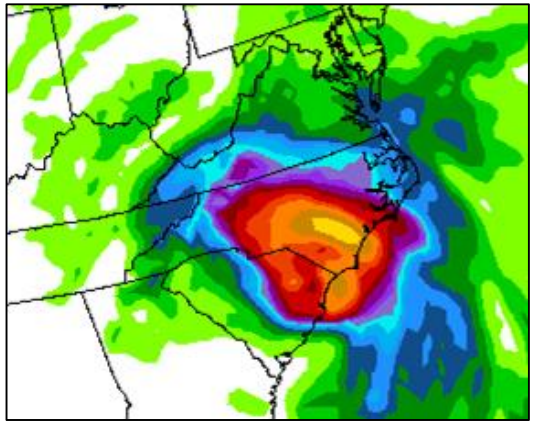
QPF Evaluation - Concerns

Low bias for higher QPF thresholds

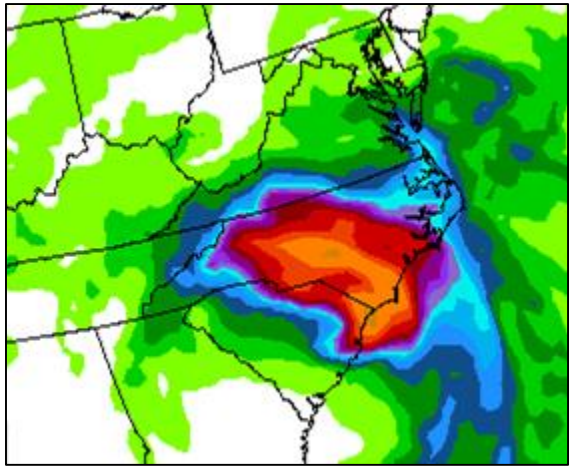
24-hour QPF from the 00Z Sep 14 runs valid 12Z Sep 16 (F060)



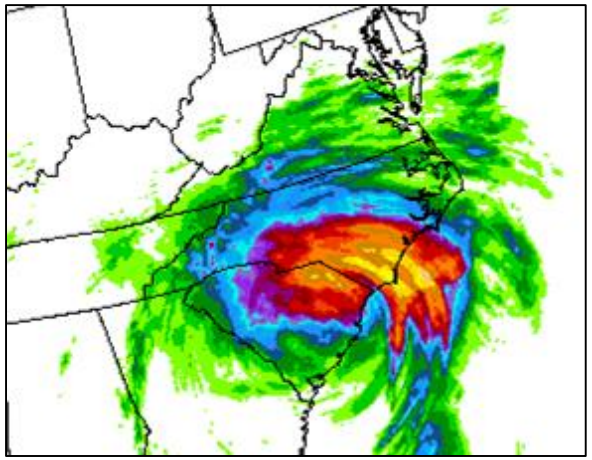
GFS



FV3



Stage IV QPE

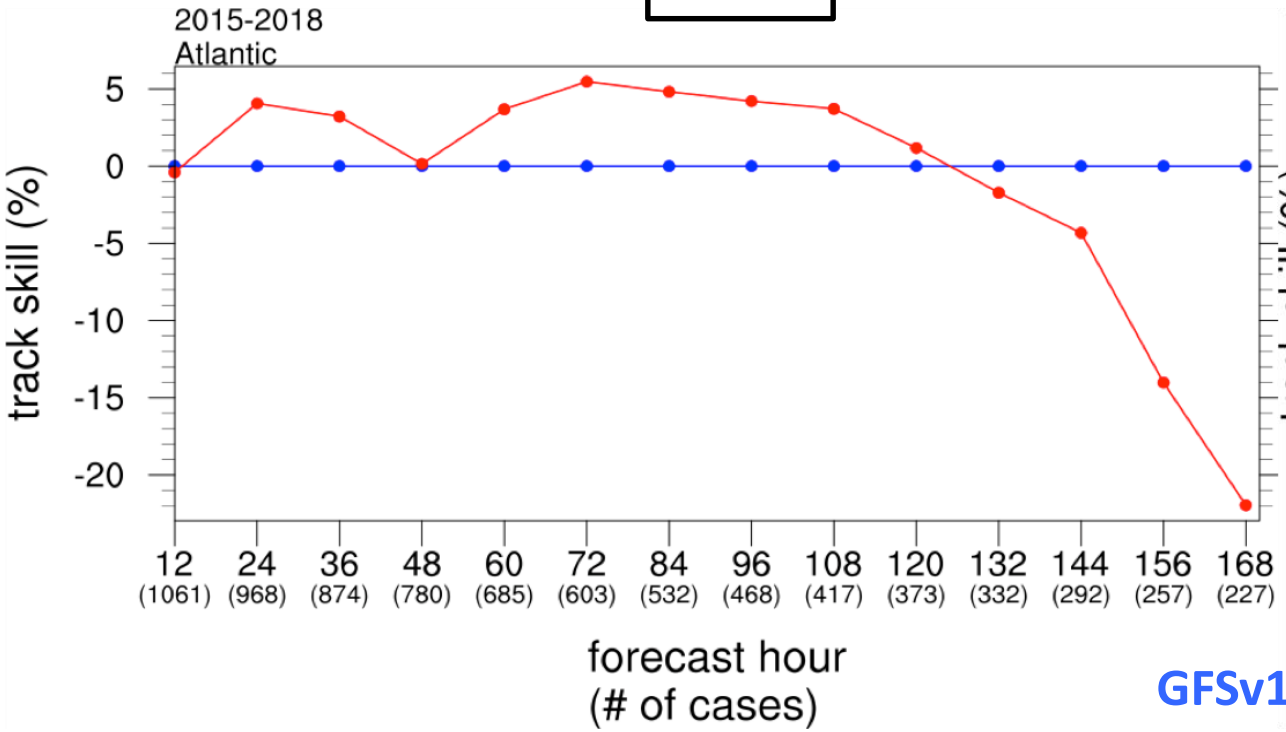


SPEED OF NORTHWARD MOVING HURRICANES

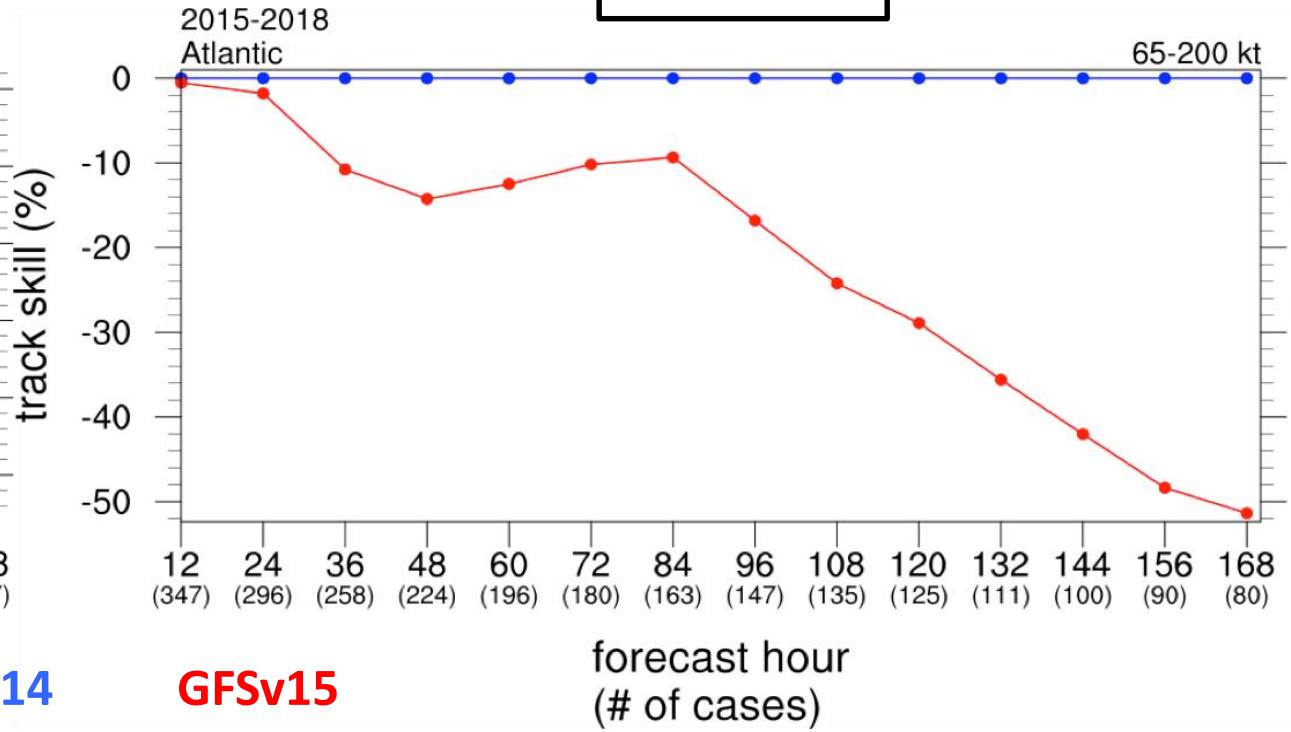
GFSv15 Track Skill Relative to Older GFS for 2015-18 Atlantic TCs and Hurricanes

From NHC Evaluation of GFSv15

All TCs



Hurricanes

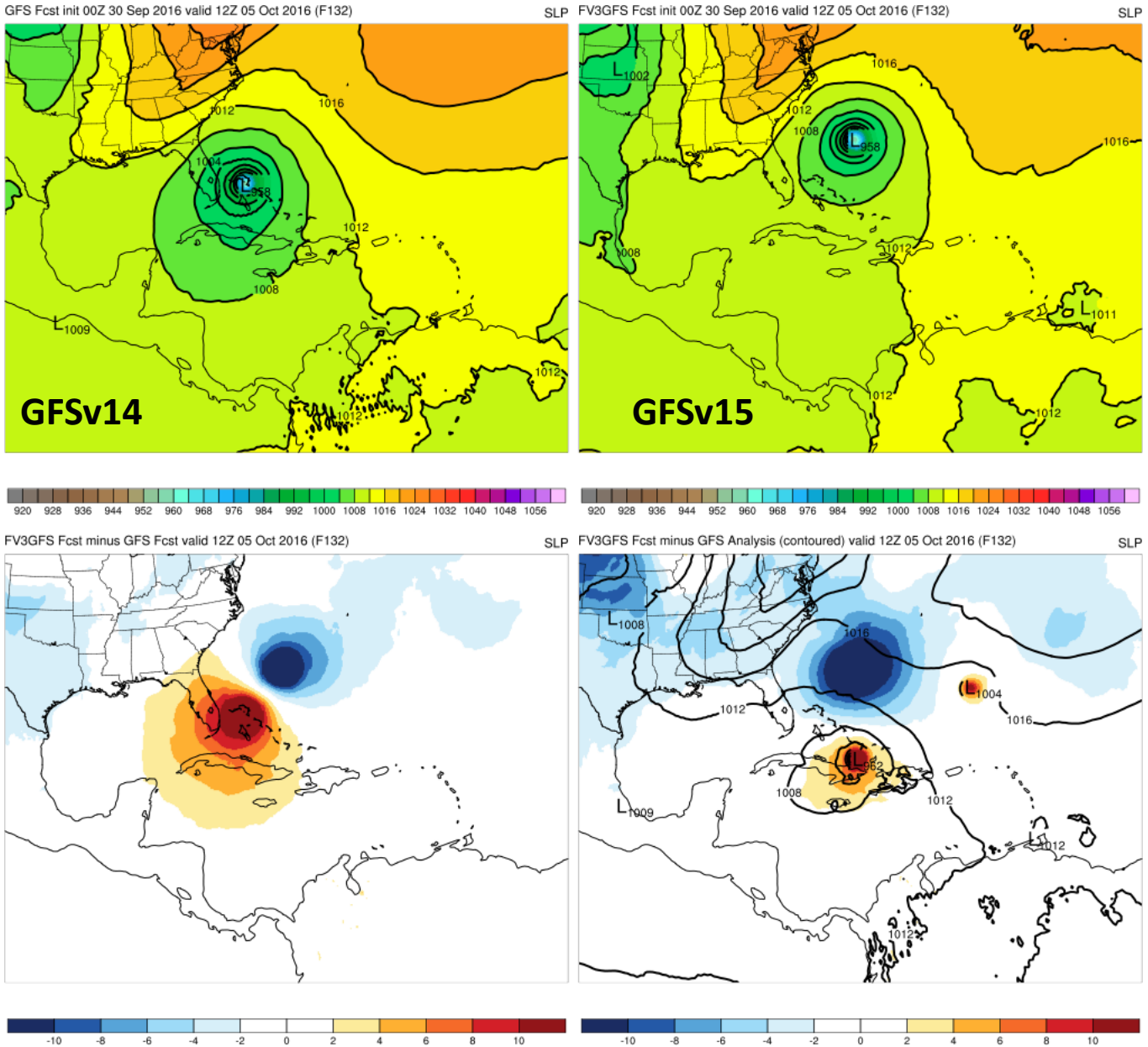


GFSv14 **GFSv15**

- For all 2015-2018 Atlantic TCs (left), modest improvement in track forecasts through Day 5
- Clear degradation by Day 6 with significant degradation at Day 7

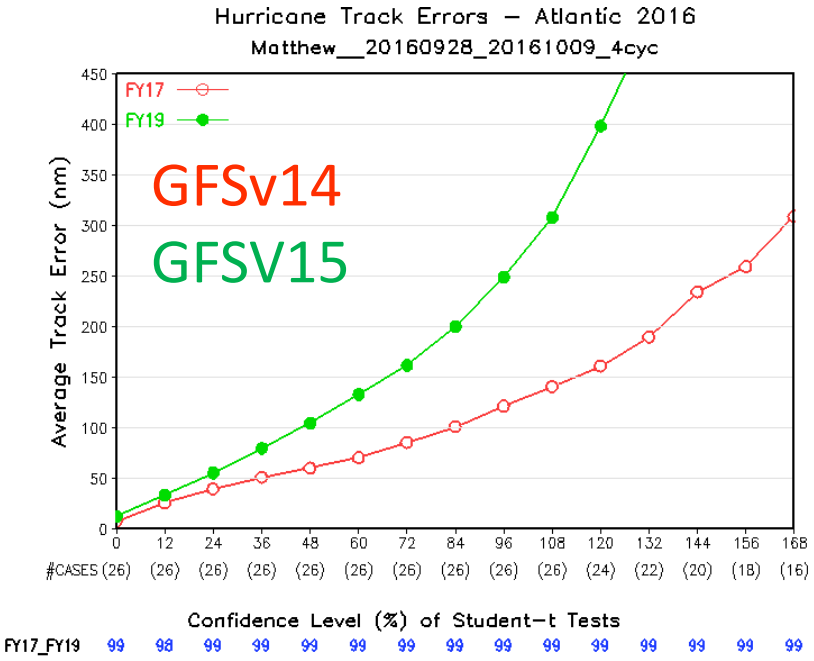
- For all 2015-2018 Atlantic **<u>hurricanes</u>** (right), track forecasts were degraded at all lead times

9/30/16 12z F132



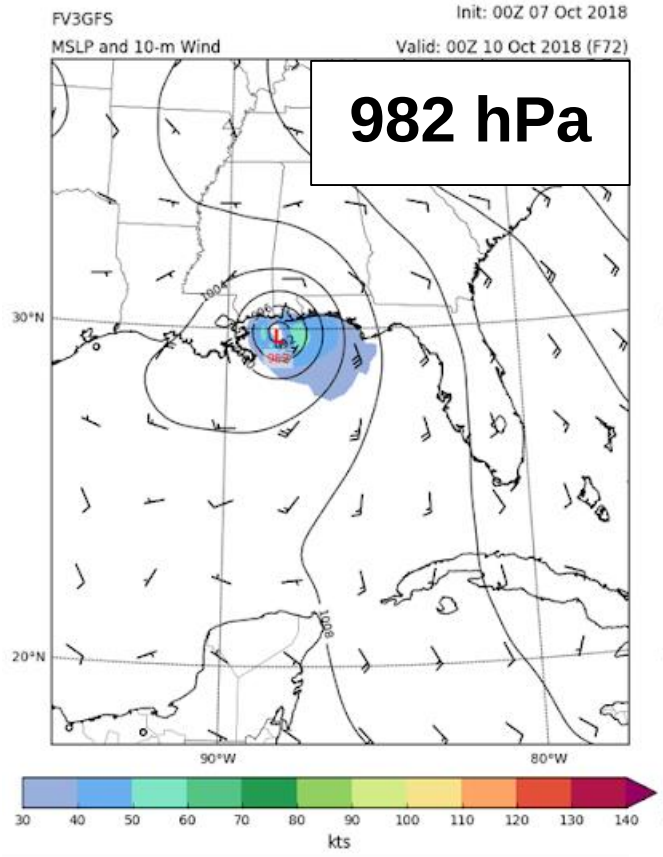
HURRICANE MATTHEW - 2016

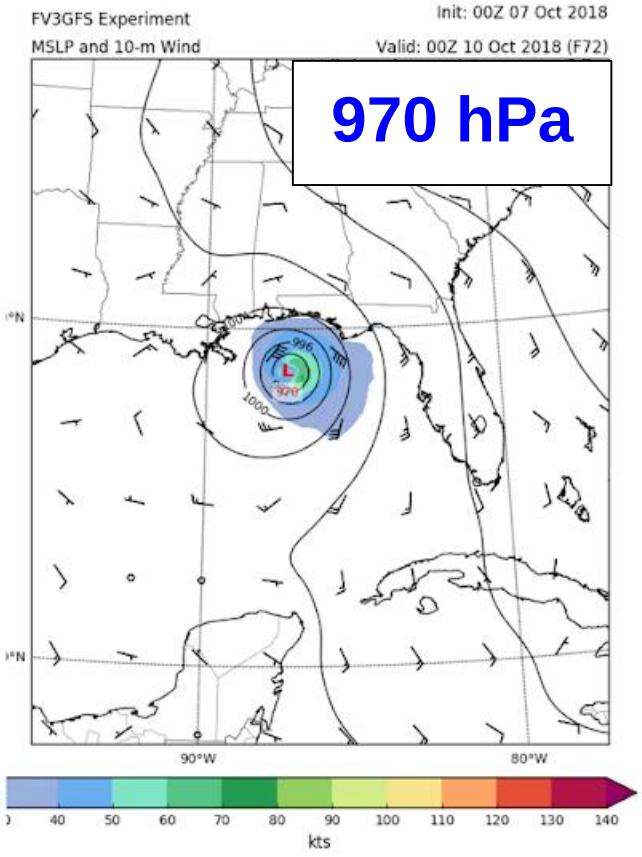
GFSv15 FASTER and TOO FAR
EAST WITH TRACK

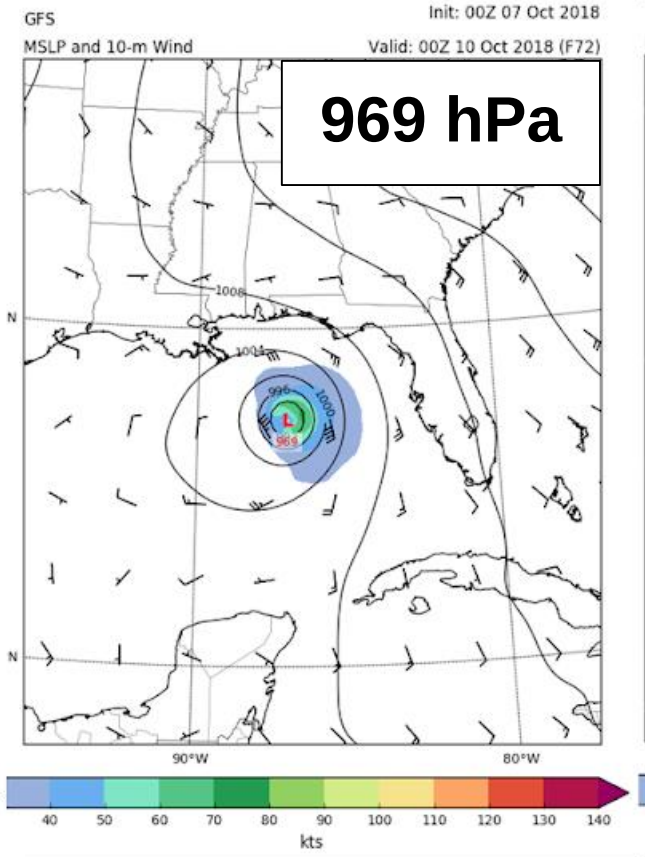


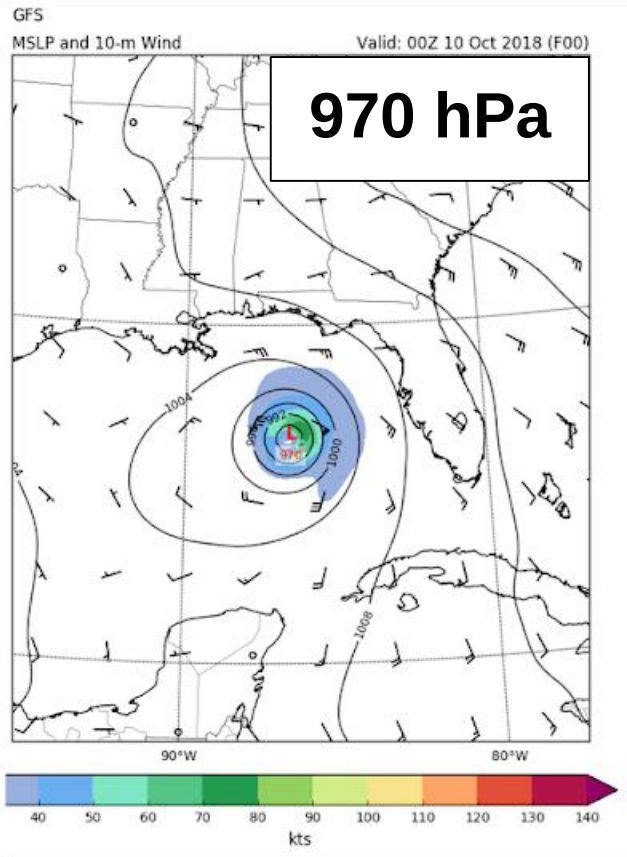
Example: TC Michael (2018)

72-h Forecast | Init: 0000 UTC 7 Oct 2018 | Valid: 0000 UTC 10 Oct 2018









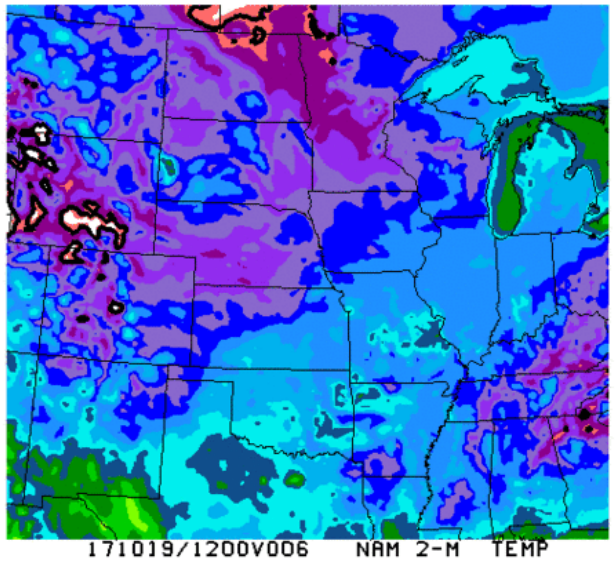
FV3GFS Real-Time | **New Configuration** | **GFS FCST** | **GFS ANL**

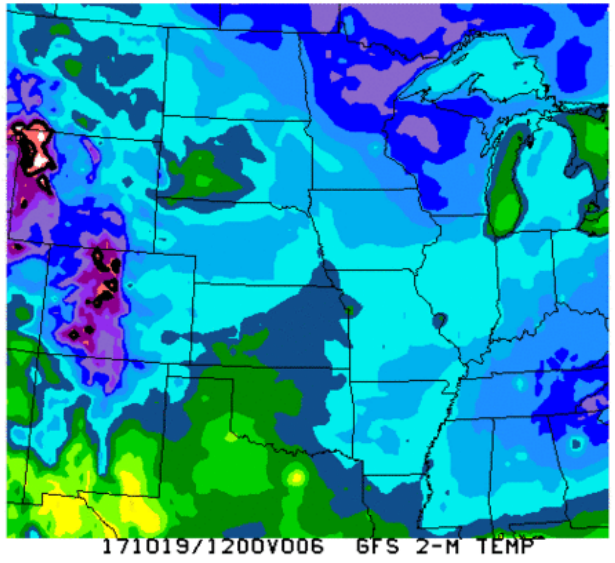
New Configuration is slower than Real-time Parallel (still too fast)
and has a better (i.e., lower) central pressure

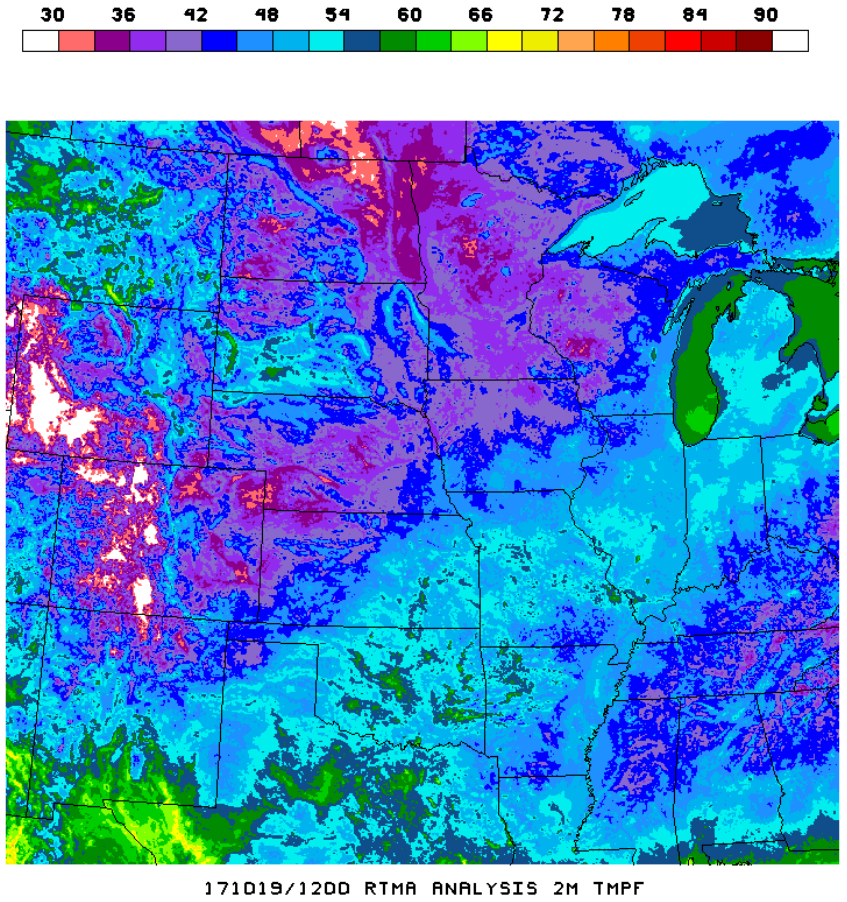
CONCERNS WITH THE GFS THAT EXISTED PRIOR TO V15

STRUGGLES WITH INVERSIONS

MAJOR IMPACTS on EARLY MORNING 2m TEMPS

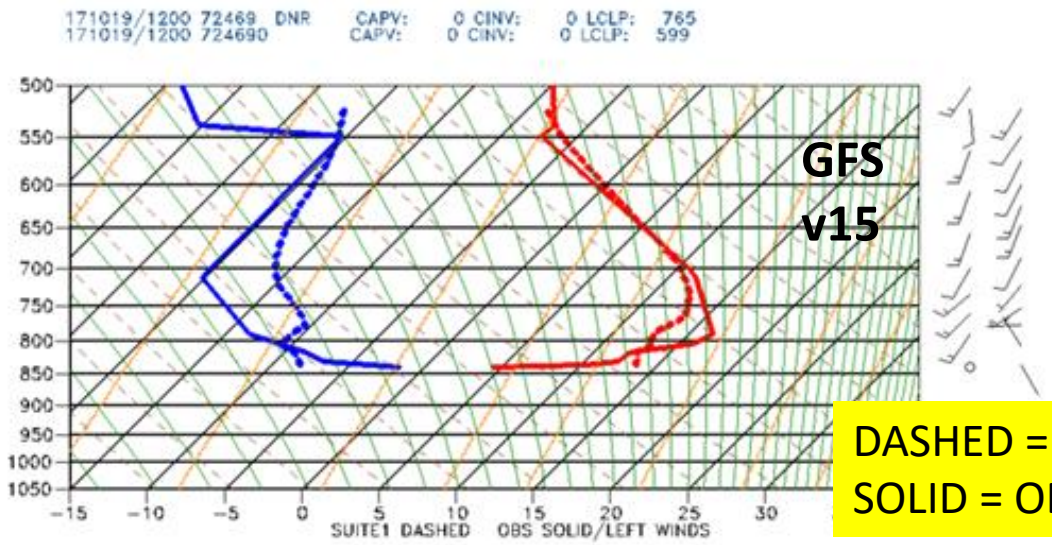


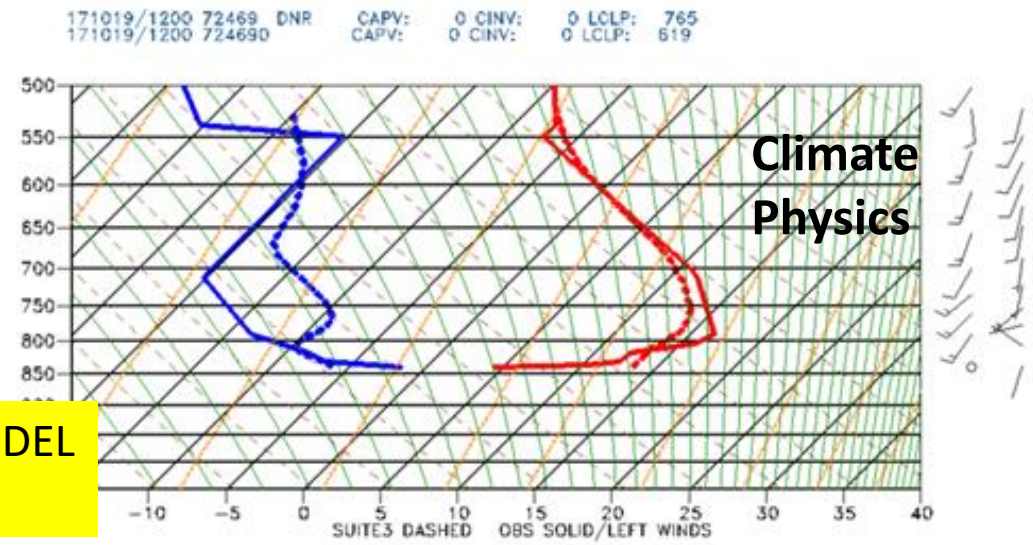




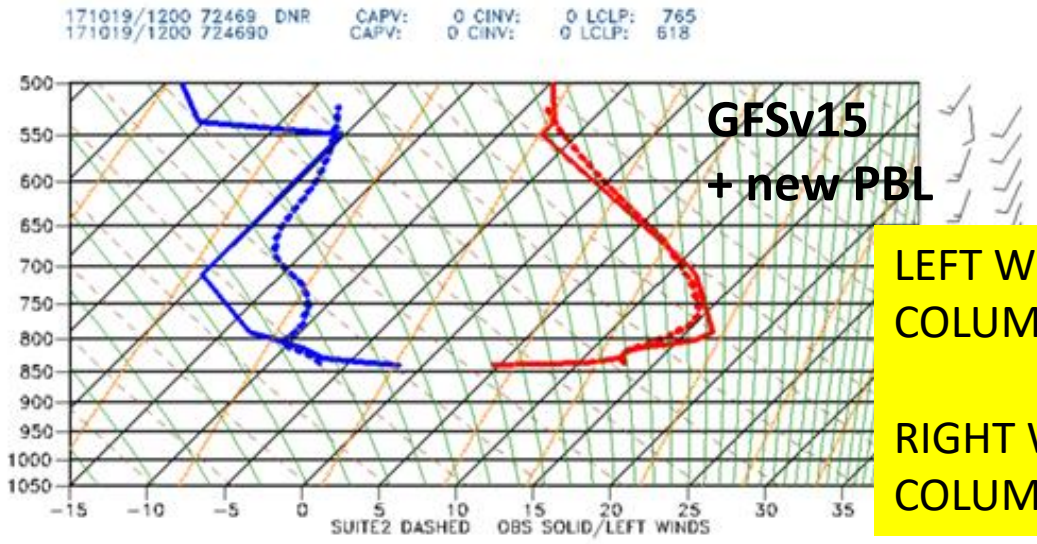
OPS GFS has 6h 2-m temp errors exceeding 15F

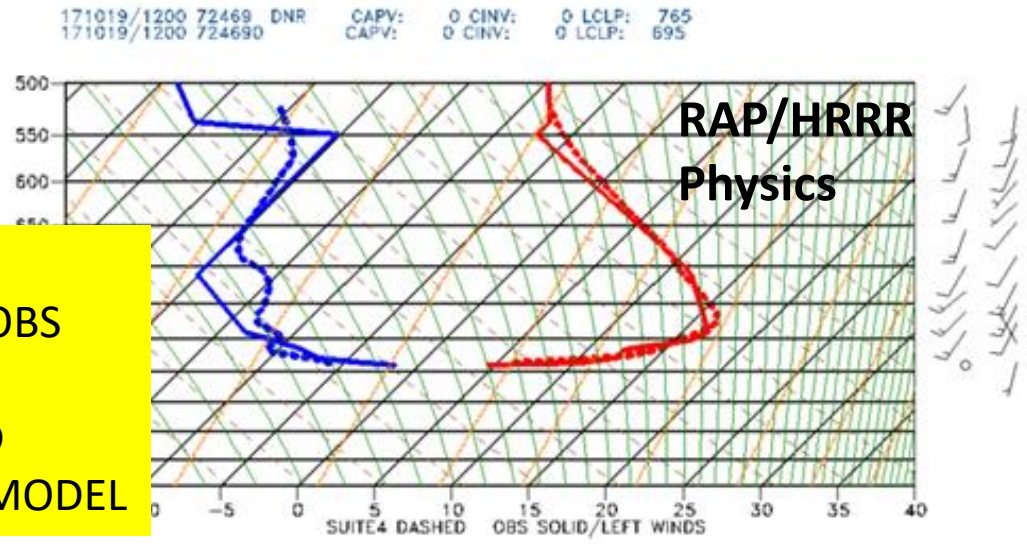
MOST COMMON INVERSION FINDING: Suite 4 handles inversions the best, Suite 1 struggles the most, Suite 2 offers some level of improvement over 1, and Suite 3 sometimes offers modest improvement over 1





DASHED = MODEL
SOLID = OBS

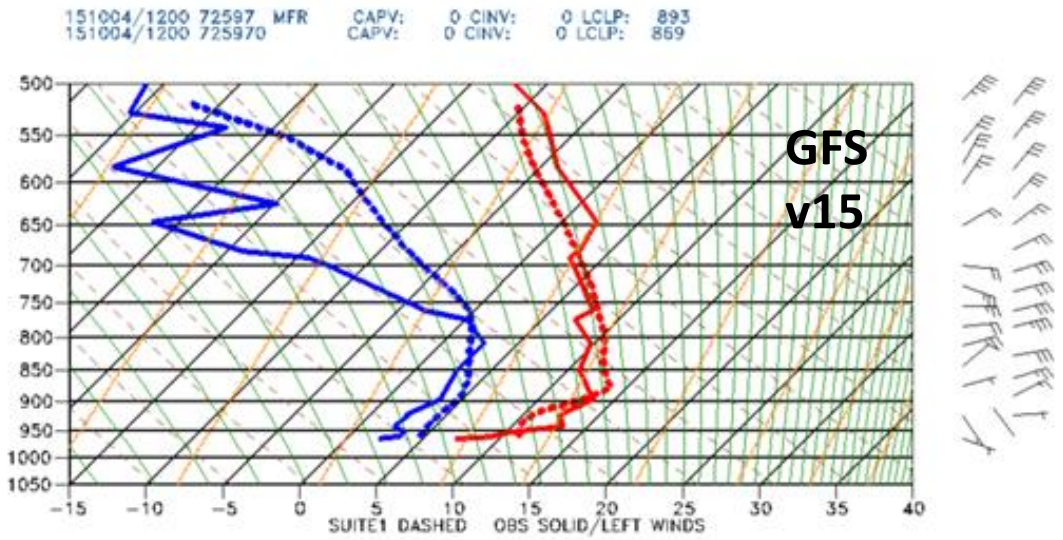


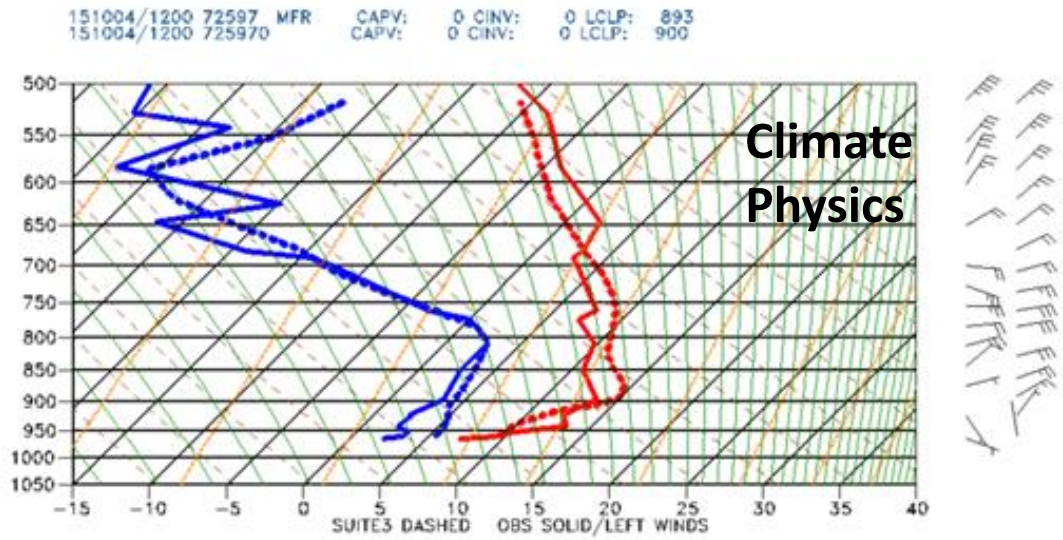


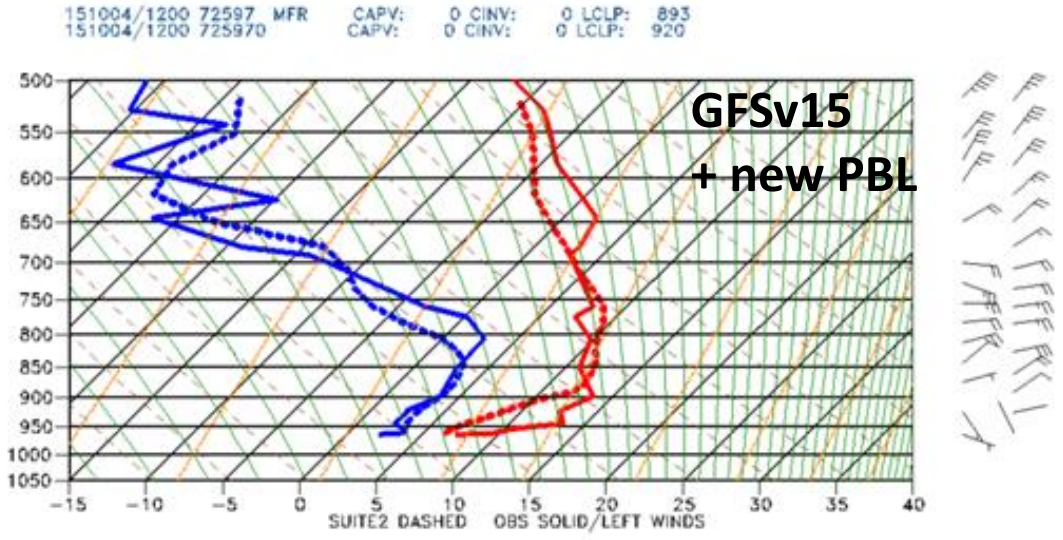
LEFT WIND
COLUMN = OBS

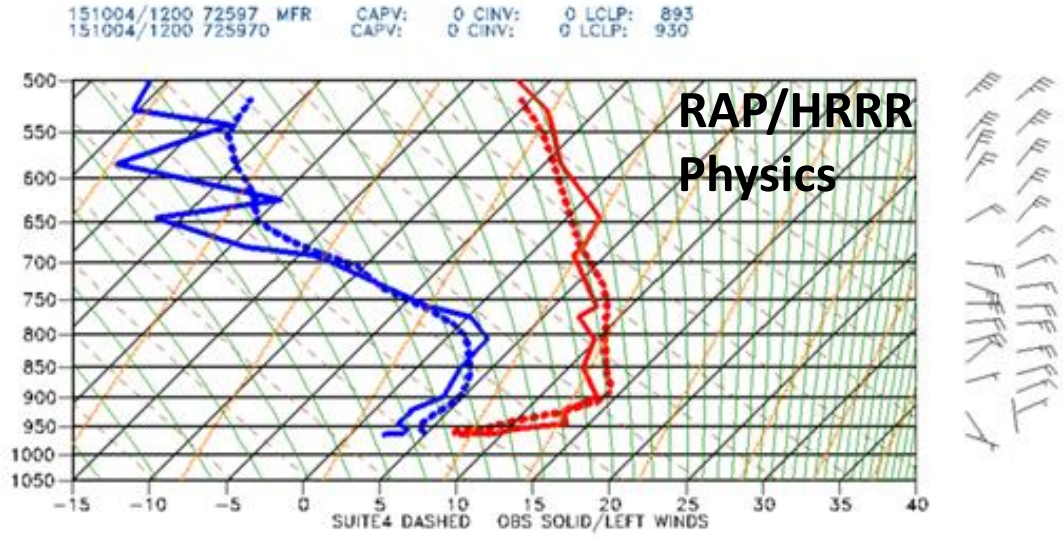
RIGHT WIND
COLUMN = MODEL

MOST COMMON INVERSION FINDING: Suite 4 handles inversions the best, Suite 1 struggles the most, Suite 2 offers some level of improvement over 1, and Suite 3 sometimes offers modest improvement over 1



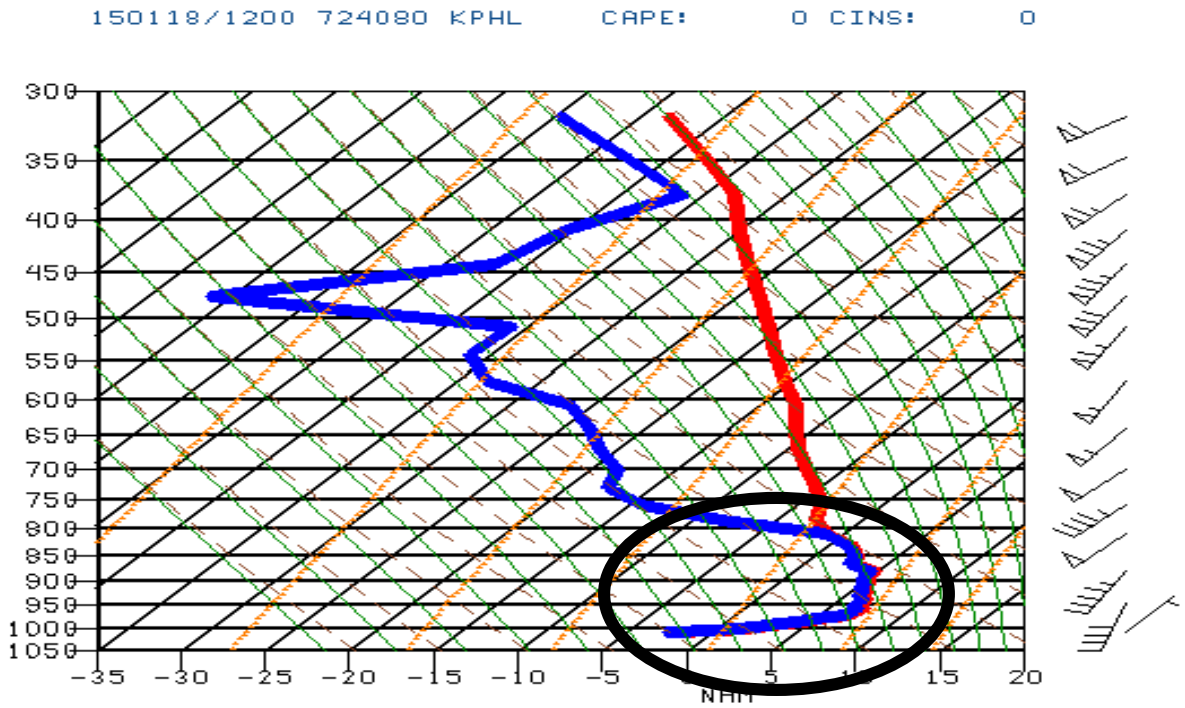




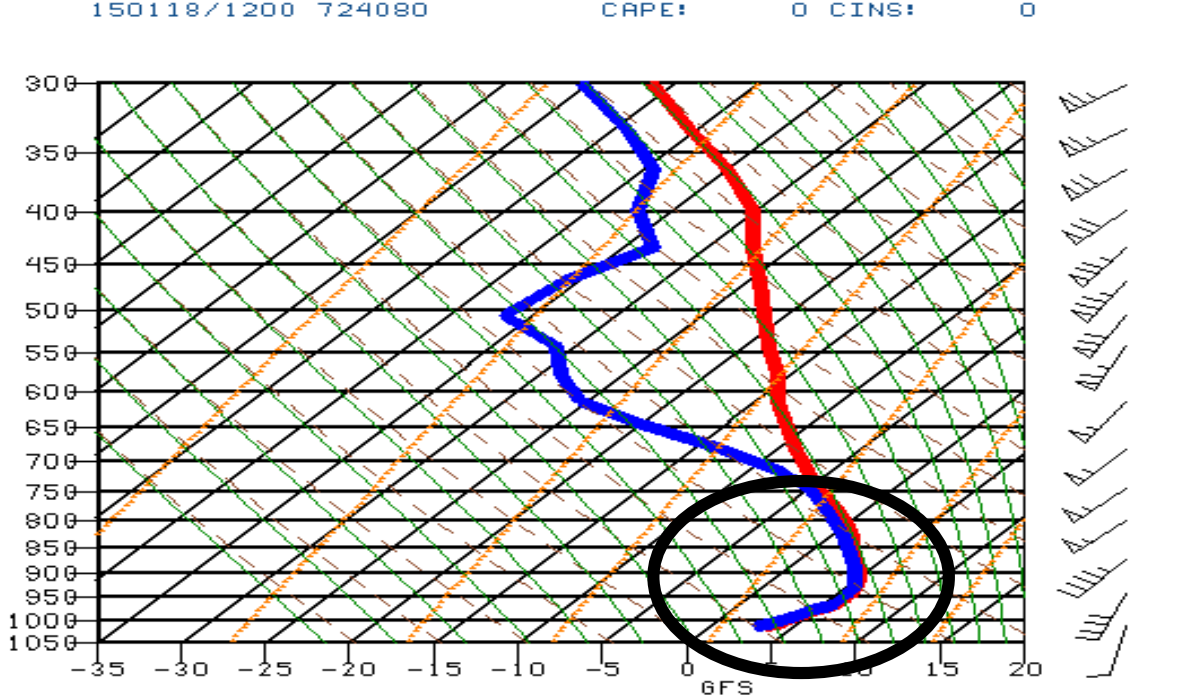


BAL-PHL-NYC Corridor
1/22/15 Ice Event

NAM



GFS

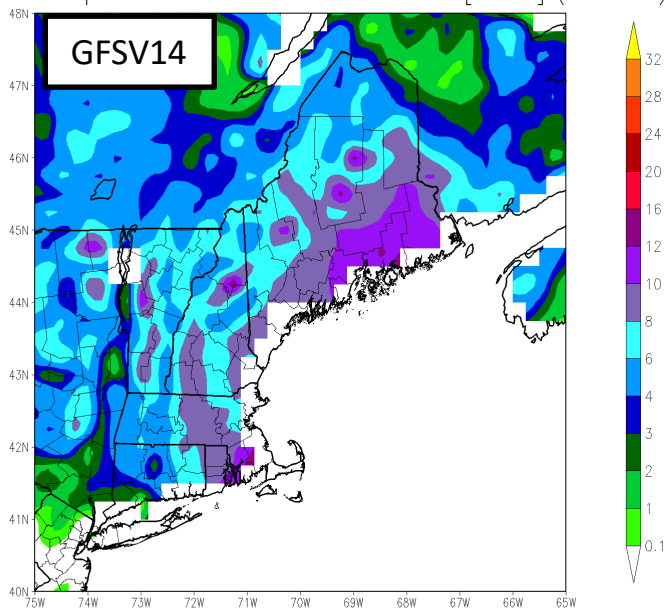


12-hr FCST SOUNDINGS for PHILADELPHIA,PA VALID 12z SUNDAY

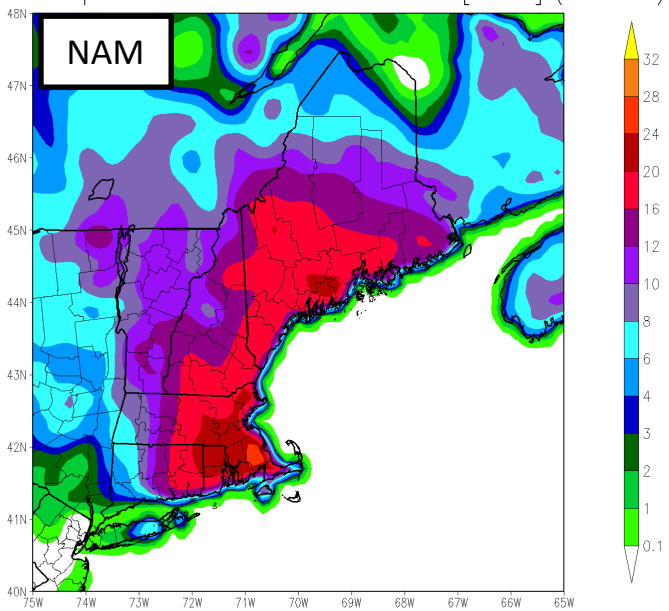
GFS OFTEN HAS TOO LITTLE PRECIP on the NORTHWEST SIDE OF EAST COAST CYCLONES

Water Equiv Snow Depth 10:1

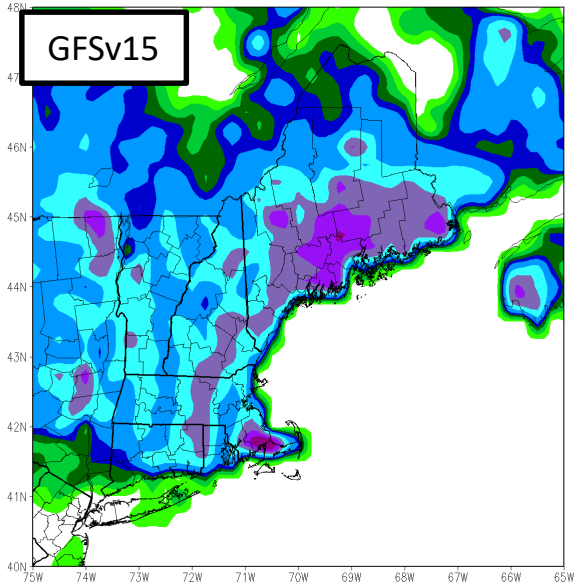
GFS Cycle 2018031300 f36 Valid 2018031412
36-h Water Equivalent Surface Accumulated Snow [inches] (10:1 SLR)



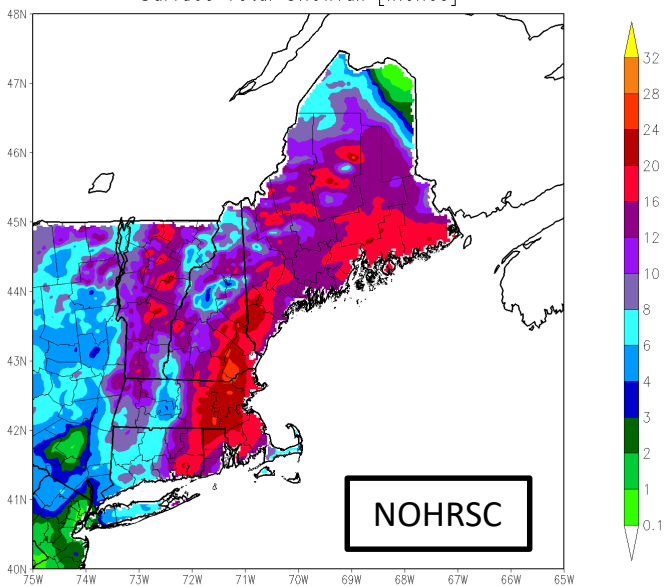
NAM Cycle 2018031300 f36 Valid 2018031412
-h Water Equivalent Surface Accumulated Snow [inches] (10:1 SLR)



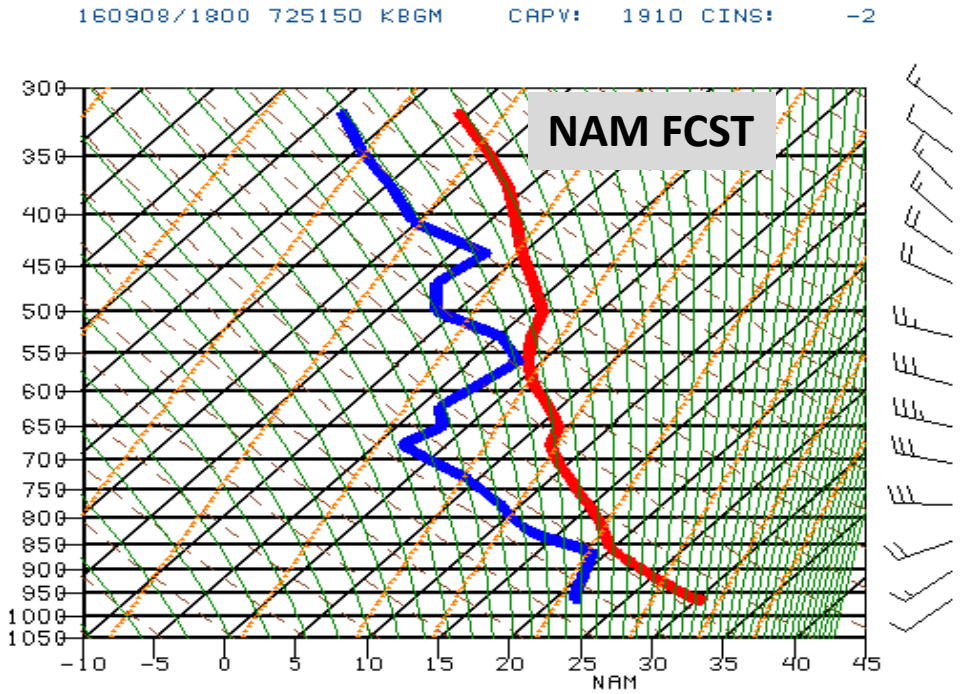
FV3 (fully-cycled) Cycle 2018031300 f36-f00 Valid 201803141
36-h Water Equivalent Surface Accumulated Snow [inches] (10:1

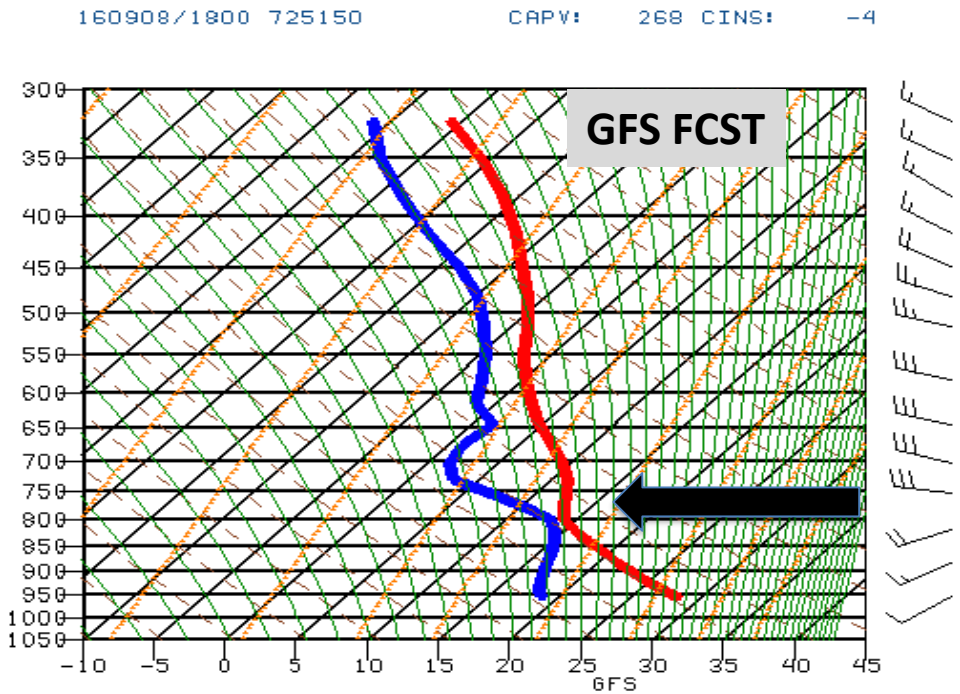


NOHRSC 36-hour Snow Accumulation Valid 2018031300-2018031412
Surface Total Snowfall [inches]

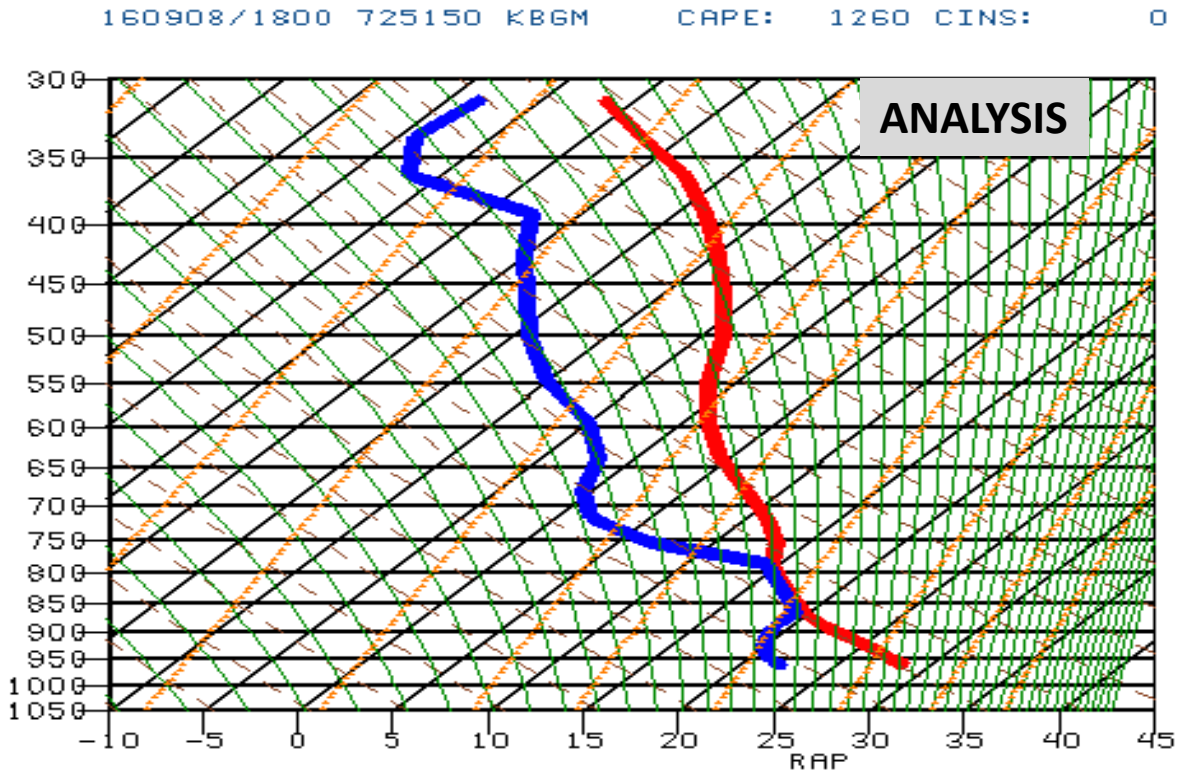


STRUGGLES WITH INSTABILITY





We've long documented that the GFS underdoes instability due to poor lapse rates and overmixing of the PBL



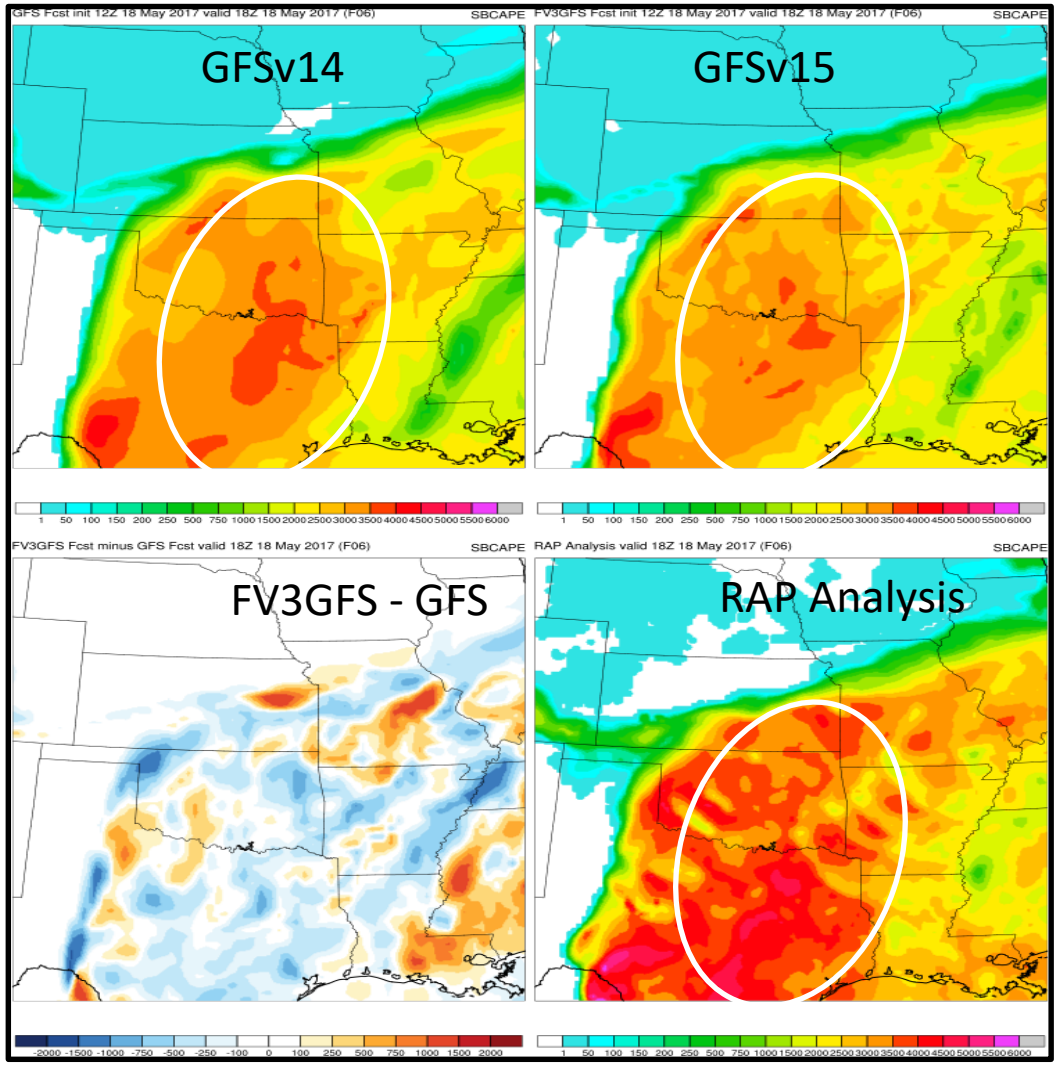
very weak lapse rates

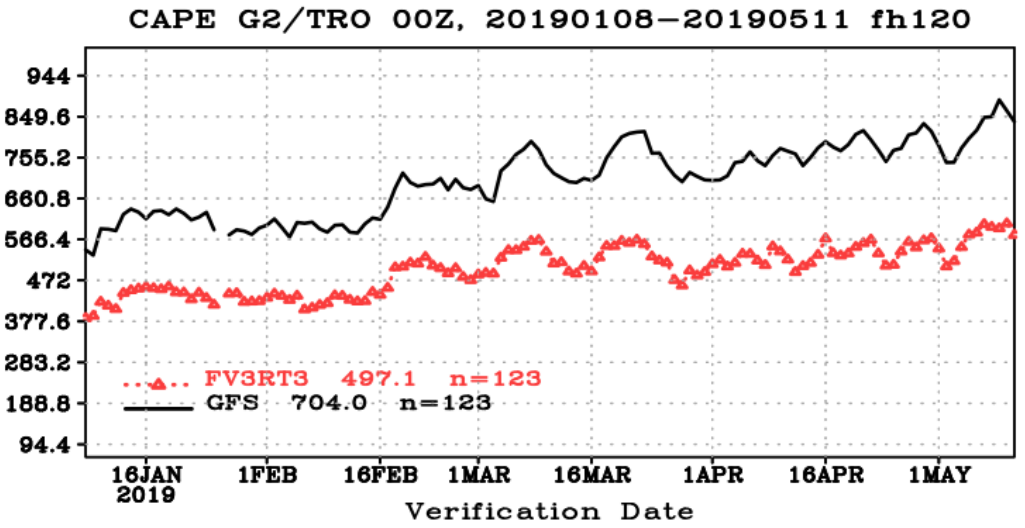
The drier and deeper GFS PBL also contributes to low cape

18 May 2017 High Risk

6-h SBCAPE Forecasts Valid 18Z

Sfc-Based Cape





Sfc Cape Regional Mean - TROPICS

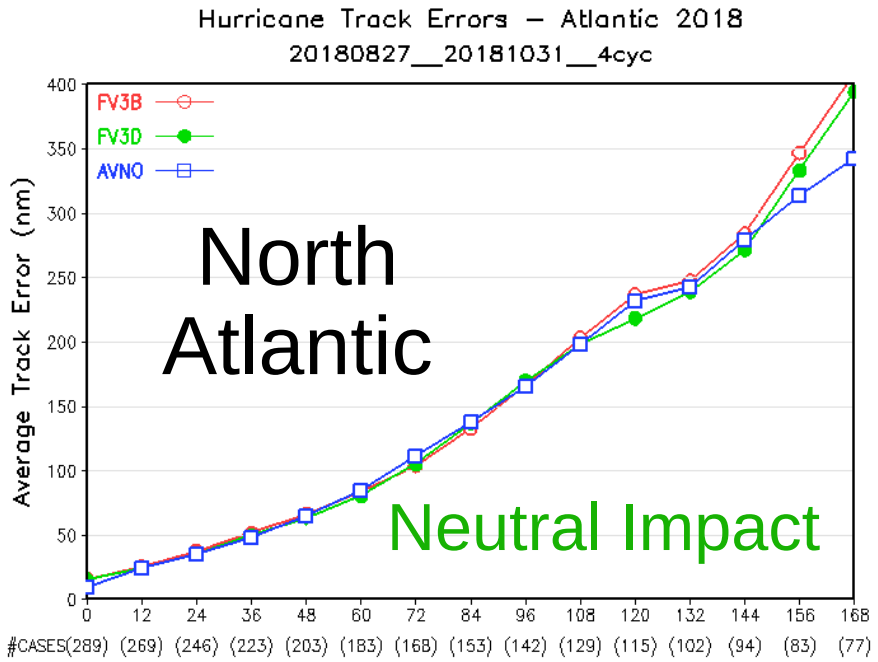
FINAL THOUGHTS

- There are many significant positives from GFSv15, highlighted by improved synoptic scores, a much-improved TC wind-pressure relationship, and a better diurnal cycle for precipitation
- The most pressing new issue is the low-level cold bias that increases with time
- The issue with northward-moving TCs (possibly a major contributor to worse hurricane tracks) also requires attention
- The long-standing struggle with low-level inversions is the most critical long-standing issue and likely stands in the way of turning off the NAM (and SREF); physics suite testing shows some progress
- Other long-term issues include underdoing instability (tied to lapse rates?) and precip on northwest side of east-coast winter storms (tied to weaker low-level jet?)

EXTRA SLIDES

Fall 2018 Tropical Cyclone Mean Track Errors With New Config

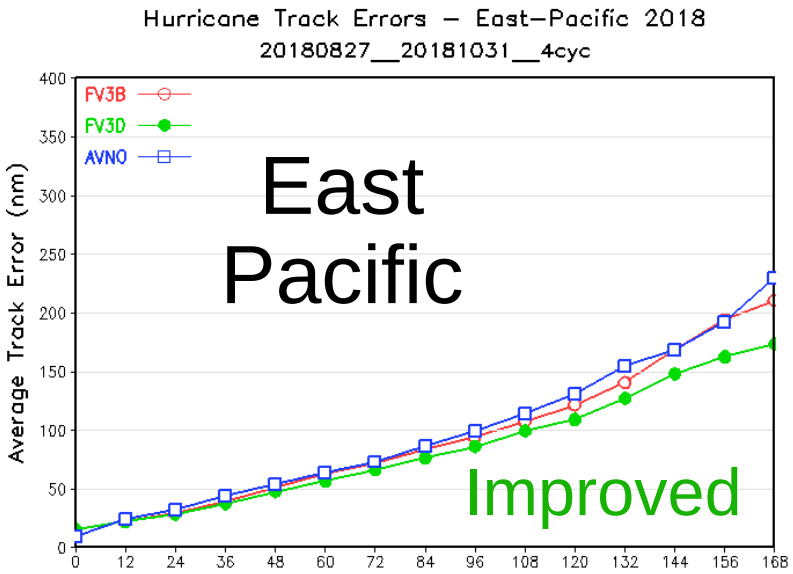
NH Hurricane Season (8/27/18–10/31/18)

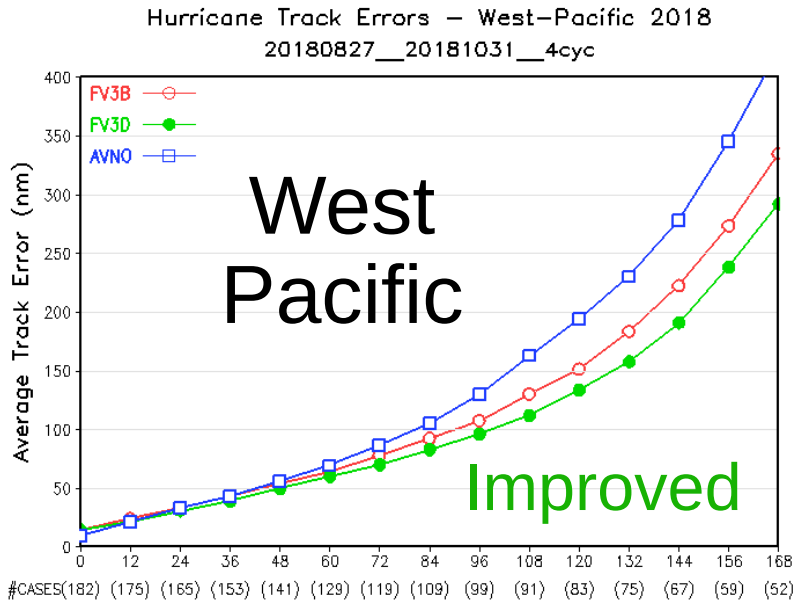


Confidence Level (%) of Student–t Tests

FV3B_FV3D	87	97	97	90	91	84	60	76	62	67	92	75	79	74	71
FV3B_AVNO	100	90	93	96	71	54	89	76	57	67	64	62	60	92	98
FV3D_AVNO	100	59	52	78	68	78	82	53	64	50	80	59	68	84	98

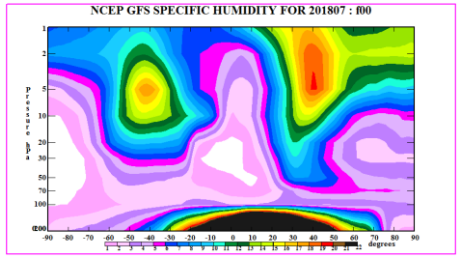
FV3B: Real-time Parallel
FV3D: New Configuration
AVNO: Operational GFS



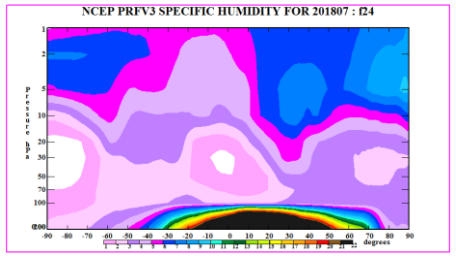


CPC FV3GFS Evaluation: Stratospheric Prediction

Specific Humidity Comparison:

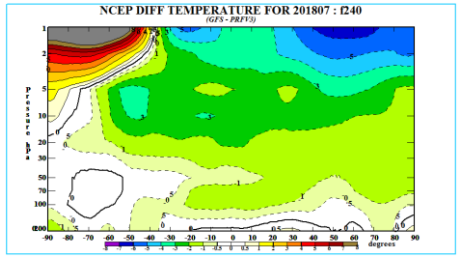


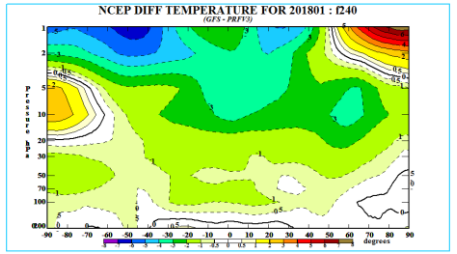
Unrealistically high values



Values agree more with climatology

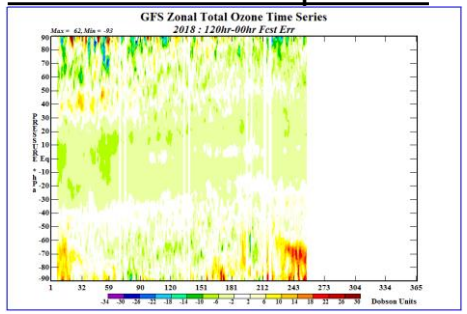
Zonal Mean Temperature Comparison (GFS-FV3):

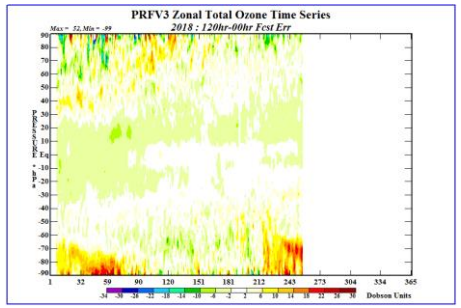




FV3 is warmer (colder) in upper strat at most latitudes (winter polar region)

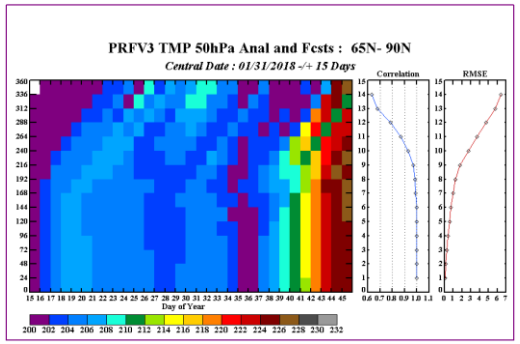
Total Ozone Comparison

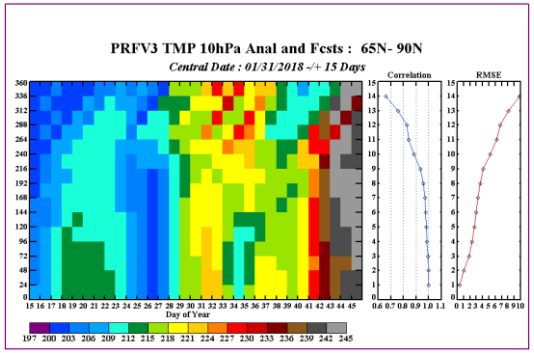




FV3 has smaller 5 day forecast total ozone errors outside of polar regions.

SSW Detection:





Both GFS and FV3 capture warming @192 and @240 hours and show similar correlation and RMS scores

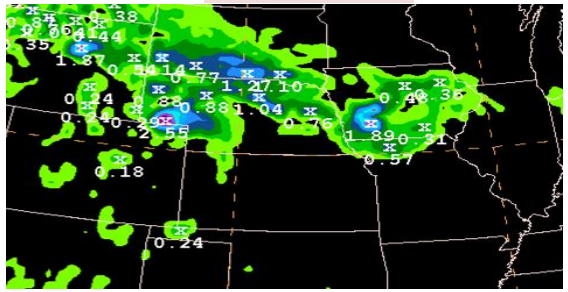
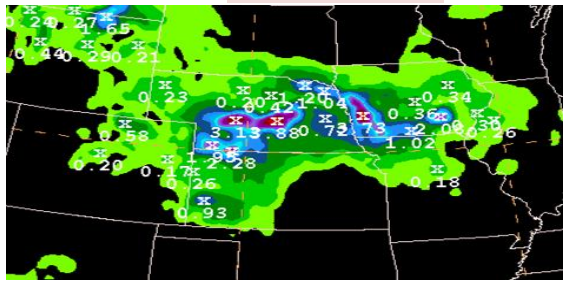
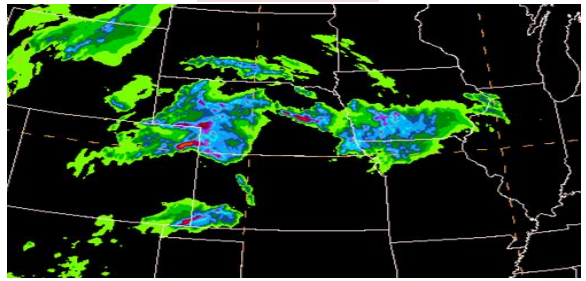
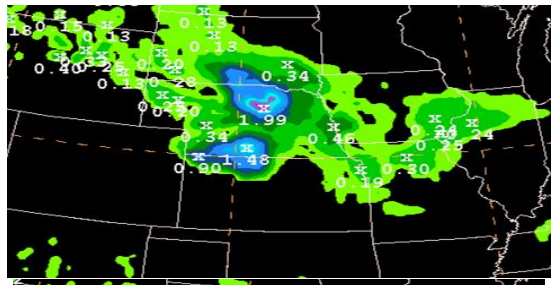
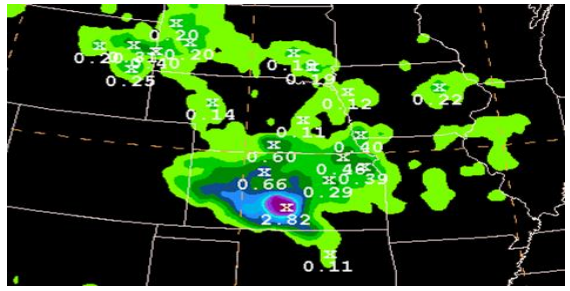
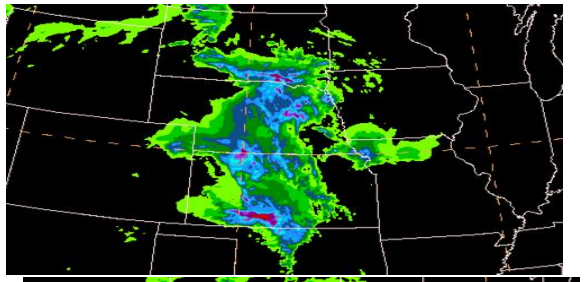
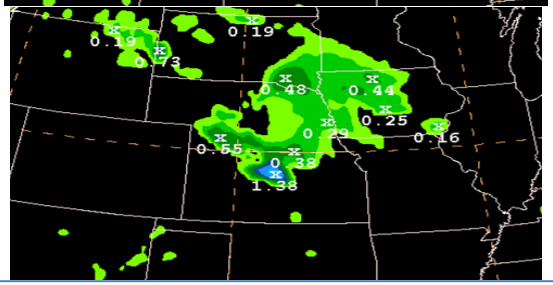
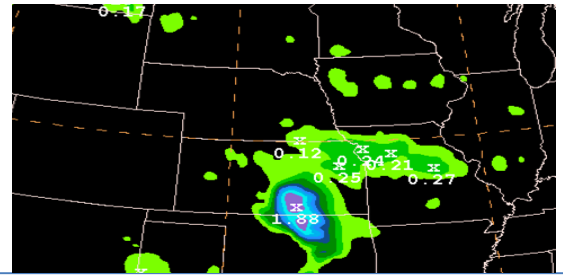
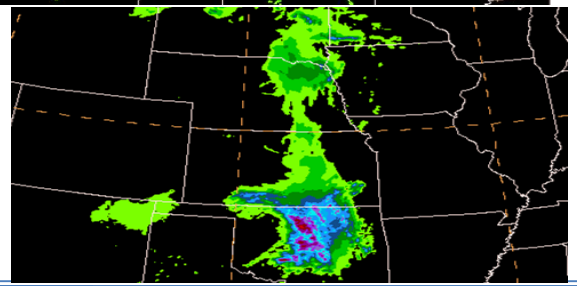
Key Results:

- FV3GFS temps are similar to operational GFS in middle/lower stratosphere but warmer in upper stratosphere.
- FV3GFS temperature forecasts in winter hem upper strat high lats are colder
- Polar jet winds differences reflect greater temp gradient in winter hem.
- Ozone mixing ratio analyses and fcsts are similar at most locations
  - FV3GFS has slightly higher values in winter polar region.
- FV3GFS total ozone fcsts are slightly better outside polar regions.
  - Both forecast too high ozone in ozone hole region.
- FV3GFS Specific Humidity is much more realistic
- FV3GFS is similar to GFS forecasting the 2018 SSW

QPF Evaluation - Positives

Improved handling of convective cold pools

6-hour QPFs valid from 06Z-18Z June 7, 2018

	GFSv14	GFSv15	MRMS
F006			
F012			
F018			

QPF Evaluation - Positives

Improved handling of convective cold pools

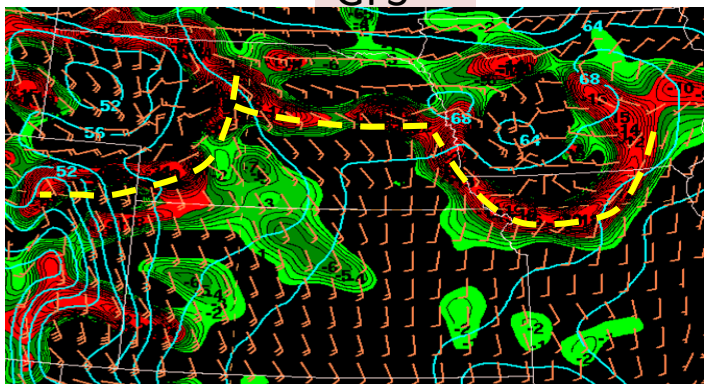
Boundary layer moisture convergence and 2-m dew point

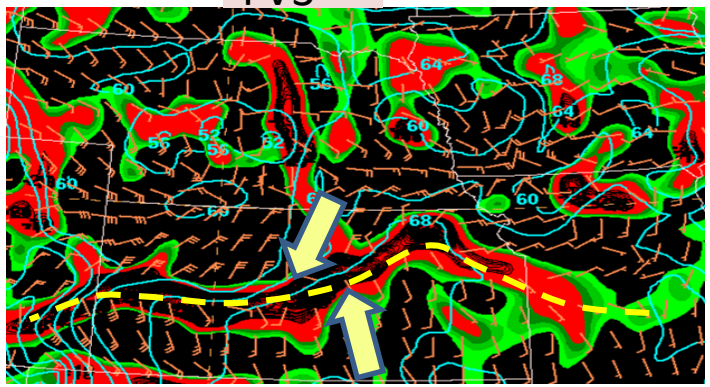
GFS

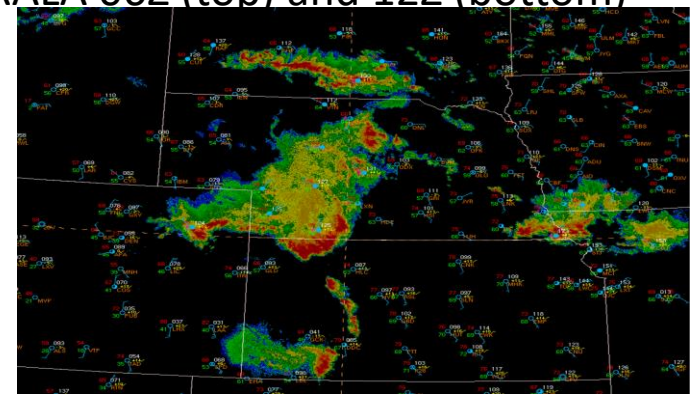
FV3

RALA 06Z (top) and 12Z (bottom)

F006







F012