FNMOC Ensemble Forecast System

20 Mar 2014

Michael Sestak
David Ryglicki
Charles Skupniewicz

Justin McLay, NRL
Carolyn Reynolds, NRL

Current FNMOC Ensemble Forecast System

- Initial conditions from NAVGEM based NAVDAS_AR
- Truncated from T359L50 to T159L42
- 9 latitude band Ensemble Transform perturbations
- NAVDAS based analysis error estimate
- Ensemble transform updated 4 times per day, for 80 members
- Navy Operational Global Atmospheric Prediction System forecast model
- Spectral resolution T159, Vertical levels 42
- 20 members
- Forecasts 0 to 384 hours, 6 hr incrememts
- Run twice per day from 00Z and 12Z
- Bias correction using NCEP decaying average technique
- Wave ensemble using WaveWatch 3 forced by ensemble winds

Current FNMOC EFS Forecast Timeline

Uses 12 Intel Westmere processors per member and takes ~25 min walltime for a complete forecast. Ensemble Transform uses 16 processors for 5 minutes

+0405 ensemble transform begins
+0408 ensemble transform ends
+0409 NOGAPS 0 to 192 forecast hour begins
+0425 NOGAPS 0 to 192 forecast hour ends
+0426 NOGAPS 0 to 192 data transfer begins
+0426 NOGAPS 192 to 384 forecast hour begins
+0435 NOGAPS 0 to 192 data transfer ends
+0435 NOGAPS 192 to 384 forecast hour ends
+0436 NOGAPS 192 to 384 data transfer begins
+0437 WW3 0 to 240 forecast hour begins
+0445 NOGAPS 192 to 384 data transfer ends
+0447 WW3 0 to 240 forecast hour ends
+0442 WW3 0 to 240 data transfer begins
+0452 WW3 0 to 240 data transfer ends

NAVGEM Ensemble System

- Initial conditions from NAVGEM based NAVDAS_AR
- Truncated from T359L50 to T239L50
- 9 latitude band Ensemble Transform perturbations
- NAVDAS_AR climatology analysis error adjustment with scaling to 6 hour forecast error variance
- Ensemble transform updated 4 times per day, for 80 members
- Navy Global Environmental Model (NAVGEM) forecast model (same version as high resolution control)
- Spectral resolution T239, Vertical levels 50
- 21 members including T239L50 control
- Forecasts 0 to 384 hours, 6 hr incrememts
- Run twice per day from 00Z and 12Z
- Bias correction using NCEP decaying average technique
- Wave ensemble using WaveWatch 3 forced by ensemble winds

Proposed FNMOC EFS Forecast Timeline

Uses 96 Intel Xeon processors per member and takes ~70 min walltime for a complete forecast. Ensemble Transform uses 80 processors for 6 minutes

+0405 ensemble transform begins
+0411 ensemble transform ends
+0412 NOGAPS 0 to 192 forecast hour begins
+0444 NOGAPS 0 to 192 forecast hour ends
+0445 NOGAPS 0 to 192 data transfer begins
+0445 NOGAPS 192 to 384 forecast hour begins
+0455 NOGAPS 0 to 192 data transfer ends
+0513 NOGAPS 192 to 384 forecast hour ends
+0514 NOGAPS 192 to 384 data transfer begins
+0514 WW3 0 to 240 forecast hour begins
+0524 NOGAPS 192 to 384 data transfer ends
+0524 WW3 0 to 240 forecast hour ends
+0525 WW3 0 to 240 data transfer begins
+0535 WW3 0 to 240 data transfer ends

Still well before NAEFS deadline of +610
But the optest will include running off prelim (starts 0200Z/1400Z)

NAVGEM EFS OPTEST SCORECARD

Variables	10 m (surface) wind speed (V_{sfc}) 250 hPa wind speed (V_{250}) 500 hPa geopotential height ($Ø_{500}$) 2 m (surface) air temperature (T_{sfc}) 850 hPa air temperature (T_{850})
Regions	Tropics (TR) Southern Hemisphere (SH) Northern Hemisphere (NH)
Lead times	24h, 48h, 120h, 240h
Metrics	RMSE: Root-mean-square error of the ensemble mean, CRPS: Continuous ranked probability score of the raw ensemble cumulative distribution function. Binning: Slope of the linear regression line between bin-average ensemble variance and bin-average squared-error of the ensemble mean

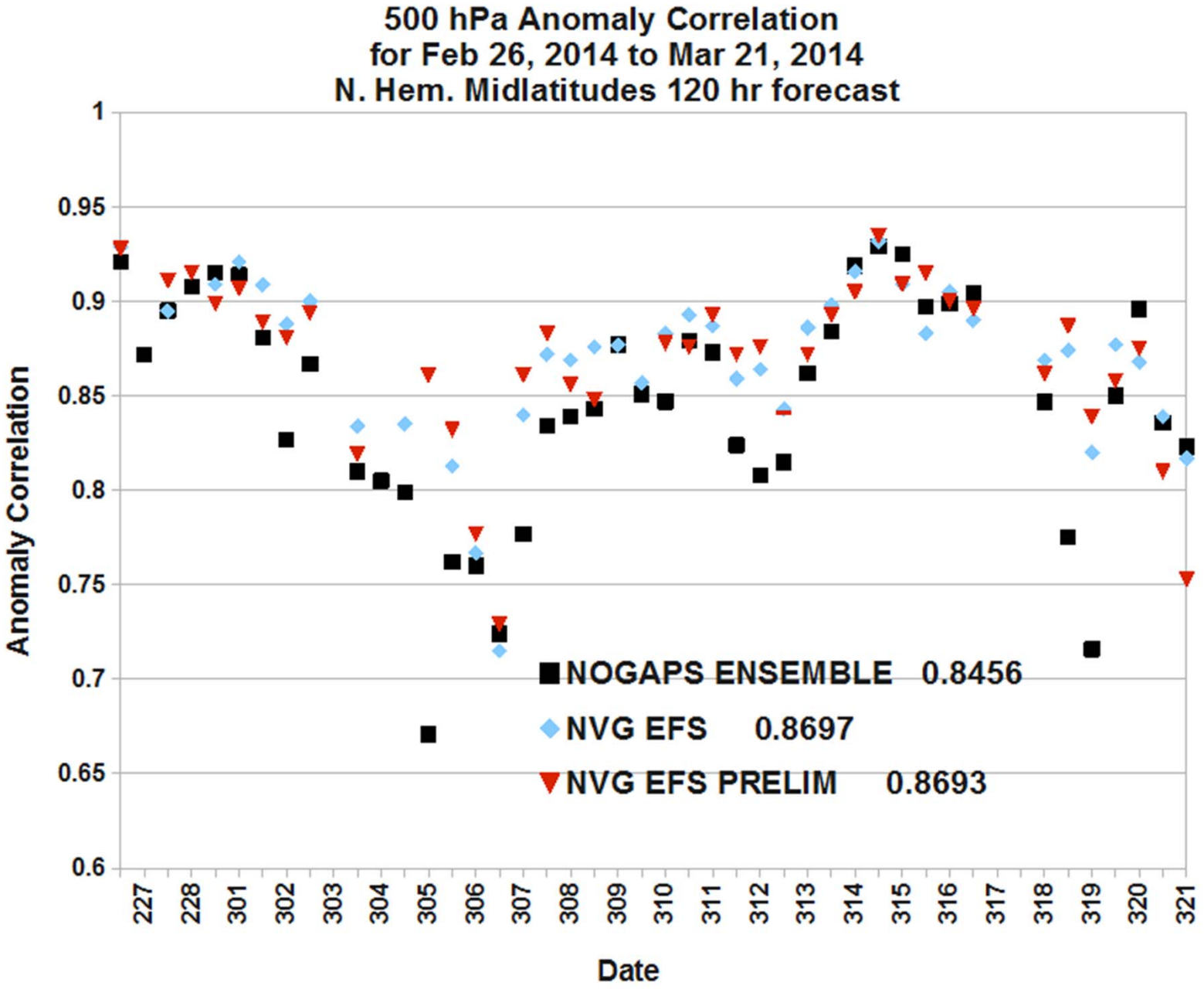
Operational Test in progress

Forecast vs analysis (UKMET) metrics

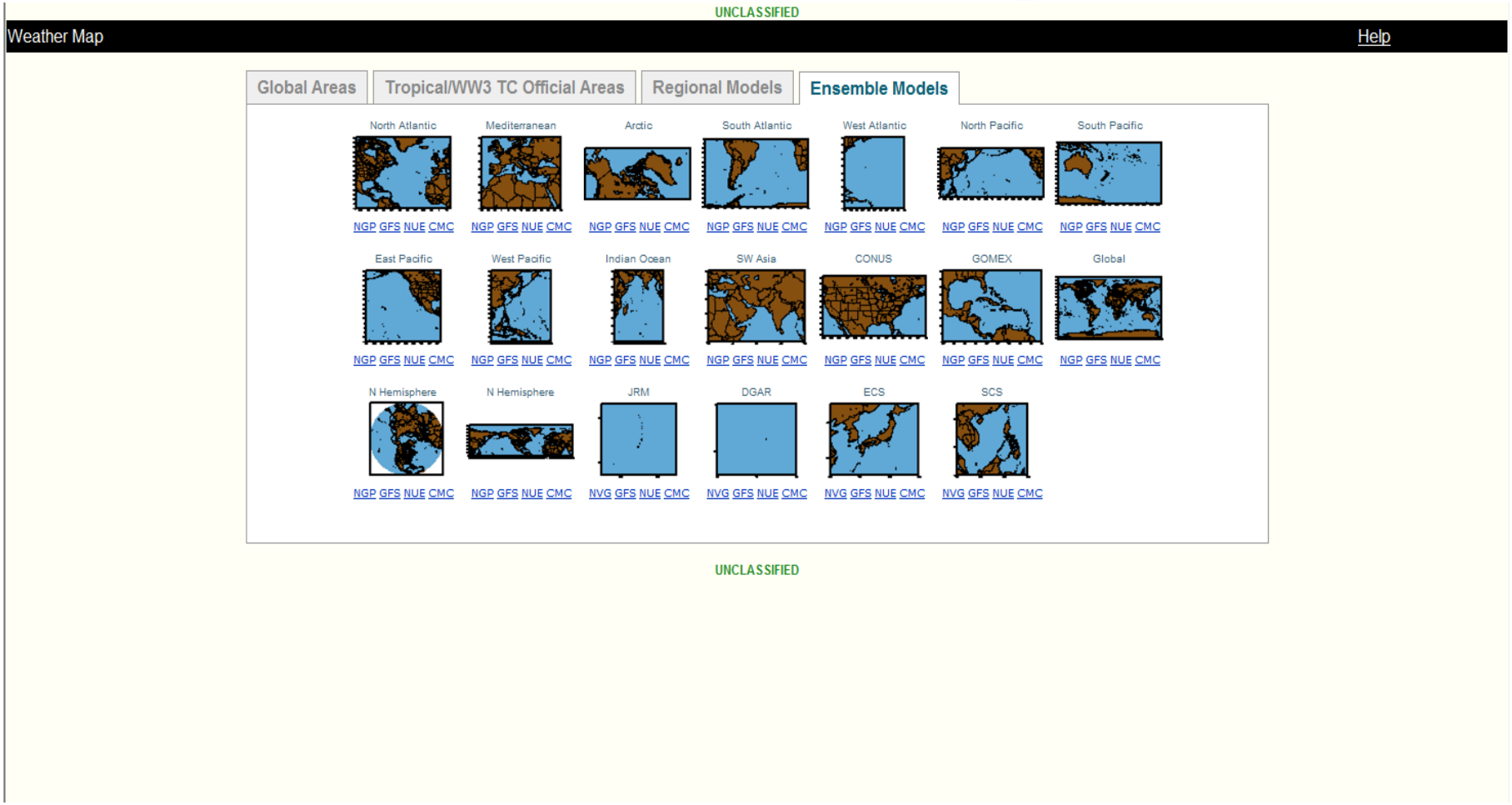
- **500 hPa Geopotential Height RMSE, CRPS, Binning**
- **10 m U Wind Speed RMSE, CRPS,**
- **850 hPa Air Temperature RMSE, CRPS**
- **2 m Air Temperature RMSE, CRPS**

Forecast vs observation metrics

- **10 m U Wind Speed RMSE, CRPS**
- **850 hPa Air Temperature RMSE**
- **10 m U Wind > 15 kt Brier Score**


500 hPa Anomaly Correlation
for Feb 26, 2014 to Mar 21, 2014
N. Hem. Midlatitudes 120 hr forecast
Anomaly Correlation
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
NOGAPS ENSEMBLE 0.8456
NVG EFS 0.8697
NVG EFS PRELIM 0.8693
227
228
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
Date

FNMOC Public Ensemble Weather Graphics Web Page
http://www.fnmoc.navy.mil/wxmap_cgi/



Models ▾ Help

Model: NOGAPS Ensemble, WW3 Ensemble
Area: North Atlantic
Product Sets: EFS

DTG: 2014031900
Resolution: 1 deg
ENSEMBLE VERIFICATION

EFS Products	Loop	Tau	000	006	012	018	024	030	036	042	048	054	060	066	072	078	084	090	096	102	108	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240
			all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all
Pressure reduced to Mean Sea Level	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2m Temperature	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
850mb Temperature	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1000mb Geopotential Height	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
500mb Geopotential Height	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
700mb Relative Humidity	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
850mb Relative Humidity	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
850mb Relative Vorticity	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
1000mb-500mb Atmospheric Thickness	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
6-hr Total Precipitation	●	all	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
10m Horizontal Wind	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
250mb Horizontal Wind Speed	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
700mb Vertical Velocity	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
850mb Vertical Velocity	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of 10m Horizontal Winds > 20 kts	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of 10m Horizontal Winds > 25 kts	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of 10m Horizontal Winds > 35 kts	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of 10m Horizontal Winds > 50 kts	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Significant Wave Height	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 4 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 8 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 10 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 12 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 18 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Probability of Significant Wave Heights > 24 ft	●	all	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

●:Image from selected DTG. ○:12-Hour old image. ●:24-Hour old image. ⊘:No image in last 2 model runs.

Available DTGs
2014031700 2014031712
2014031800 2014031812
2014031900 2014031912

Multi-model Ensemble (FNMOC, CMC, NCEP)
Probability of surface winds > 25 kt, 72 hour forecast
for 20140319 1800Z

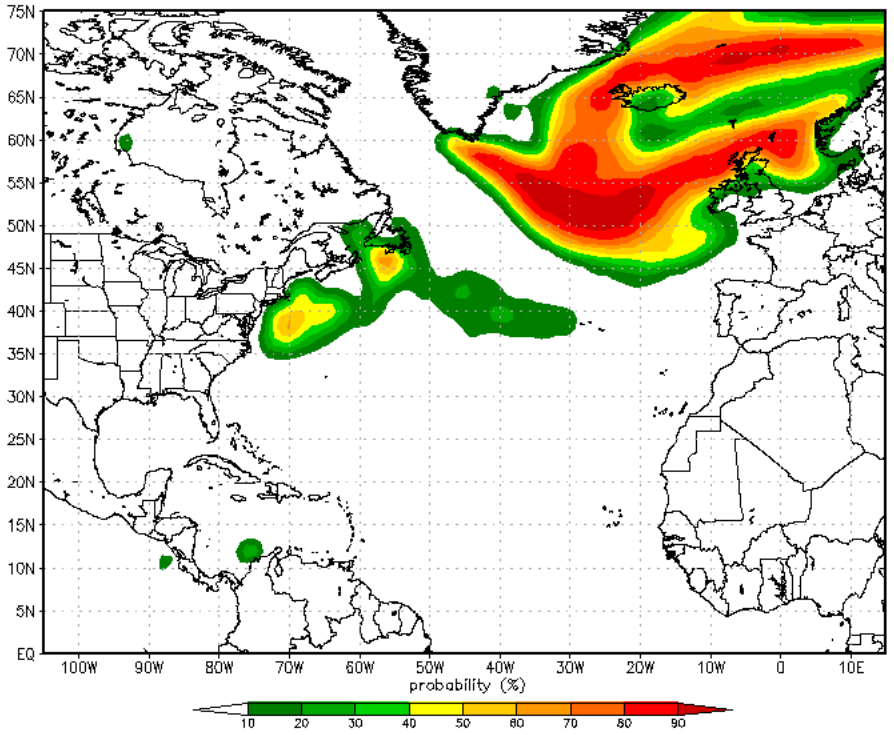
Models | Product List | Help

Model, Area : Multi-Model Ensemble, North Atlantic, 1 deg
Compare : GFS Ensemble N Atl CMC Ensemble N Atl

DTG : 2014031812
Run :

Tau 000 006 012 018 024 030 036 042 048 054 060 066 072 078 084 090 096 102 108 114 120 126 132 138 144 150 156 162 168 174 180 186 192 198 204 210 216 222 228 234 240

Other Products	
MSL Pressure	loop
500mb Height	loop
1000mb Height	loop
6-hr Precip	loop
2m Temperature	loop
700mb Rel Hum	loop
700mb Vert Vel	loop
850mb Temperature	loop
850mb Rel Hum	loop
850mb Rel Vort	loop
850mb Vert Vel	loop
10m Horizontal Wind	loop
250mb Wind Speed	loop
500mb Rel Vort	loop
1000mb-500mb Thickness	loop
Prob 10m Wind Speed > 20 kts	loop
Prob 10m Wind Speed > 25 kts	loop
Prob 10m Wind Speed > 35 kts	loop
Prob 10m Wind Speed > 50 kts	loop
Other Models	
Nogaps Ensemble N Atl	
GFS Ensemble N Atl	
CMC Ensemble N Atl	

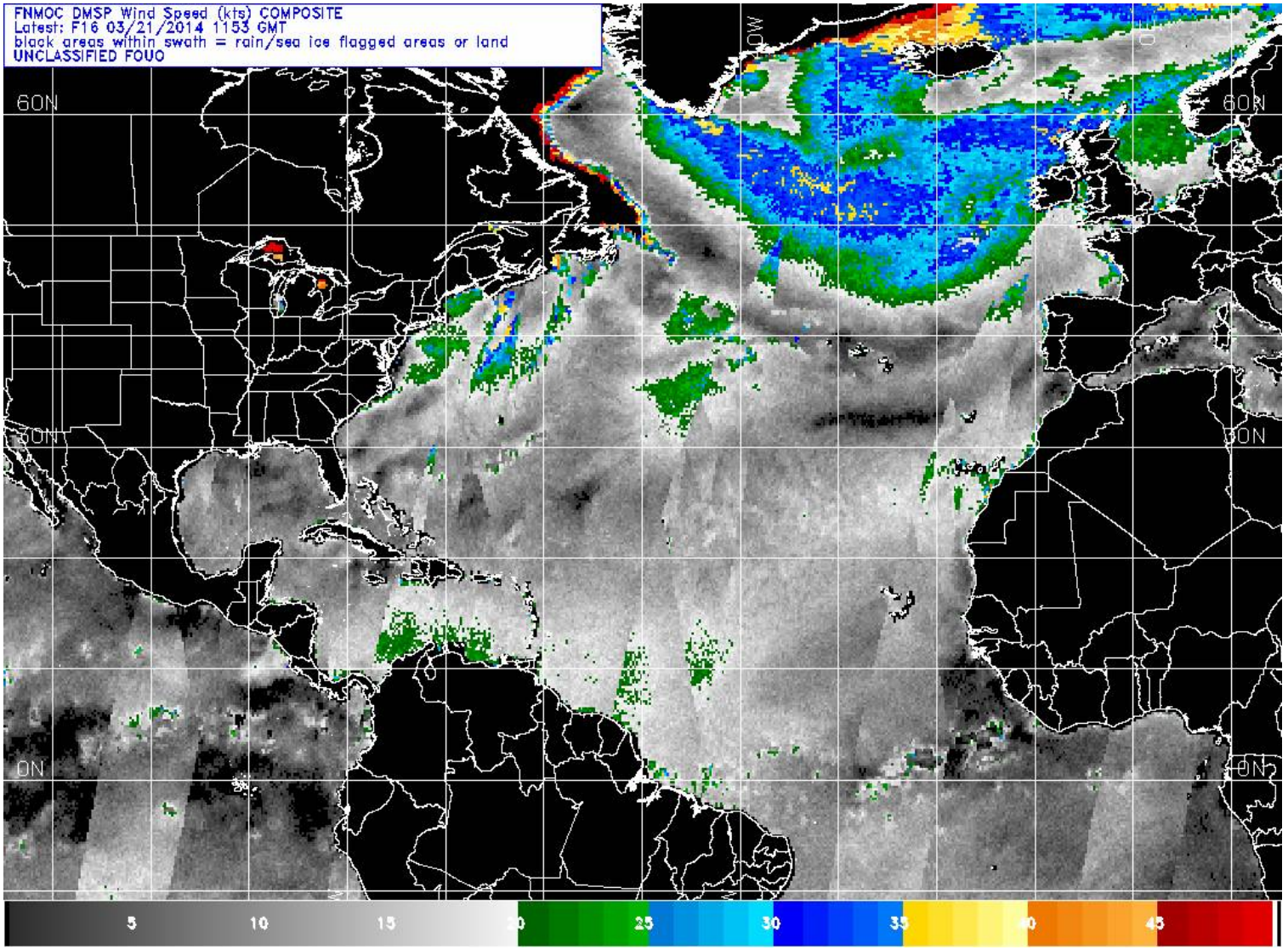


VT: Fri 12Z 21 MAR 14
FNMOC EFS (U): Probability of 10m Wind > 25 kts
Run: 2014031812Z Tau: 72

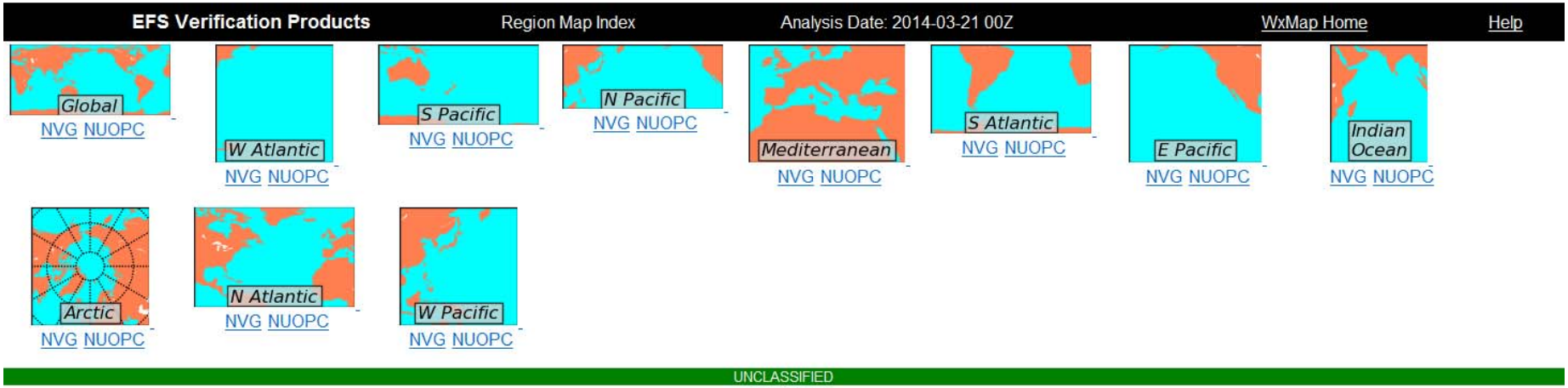
Members Available: NGP 20 GFS 20 CMC 19

Approved for public access. Distribution is unlimited.

SSMI Surface Winds for 20140319 1619Z



FNMOC Ensemble Verification Web Page
http://www.fnmoc.navy.mil/efs_verif/



Realtime single and multimodel verification against analysis and observations (more details on Thursday)

UNCLASSIFIED

EFS Verification | Statistics | Map Index | WxMap Home | Help

WxMap product missing

Verify: Observations

raw bias-correct

Model: NVG

Model Run: 2014-03-21 00 Z

Region: N Atlantic

Field: surface wind

Threshold: >20.0 knots

Metric: Reliability

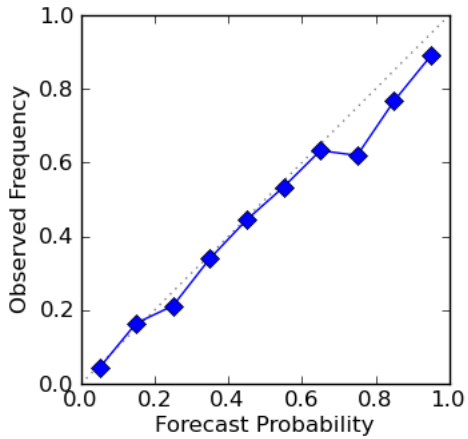
Color Graphs

Multi-Line Graphs

Save Graph

Reliability for N Atlantic/NVG/raw

surface wind (all) >20.0 knots (Observations)
30 days ending: 21-Mar-2014 00Z
Forecast: 18-Mar 00Z, Tau=072



P	N
.05	140799
.15	10079
.25	7958
.35	6981
.45	5807
.55	4593
.65	4010
.75	4263
.85	3833
.95	5624

UNCLASSIFIED

Thanks!

Questions?