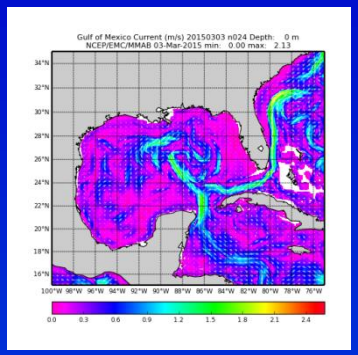
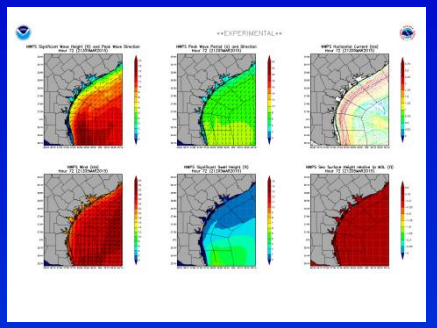




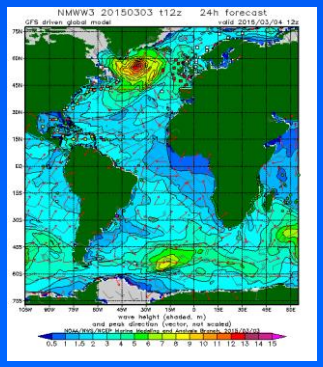
Marine Models

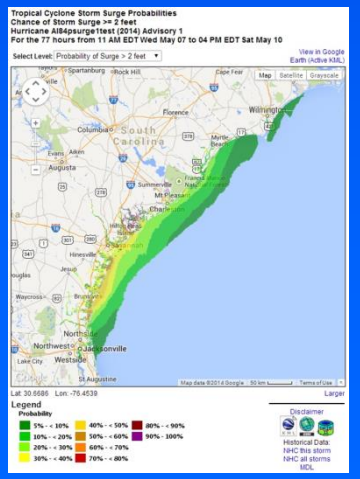
Michael Buchanan

Science and Operations Officer

National Weather Service

Corpus Christi, Texas

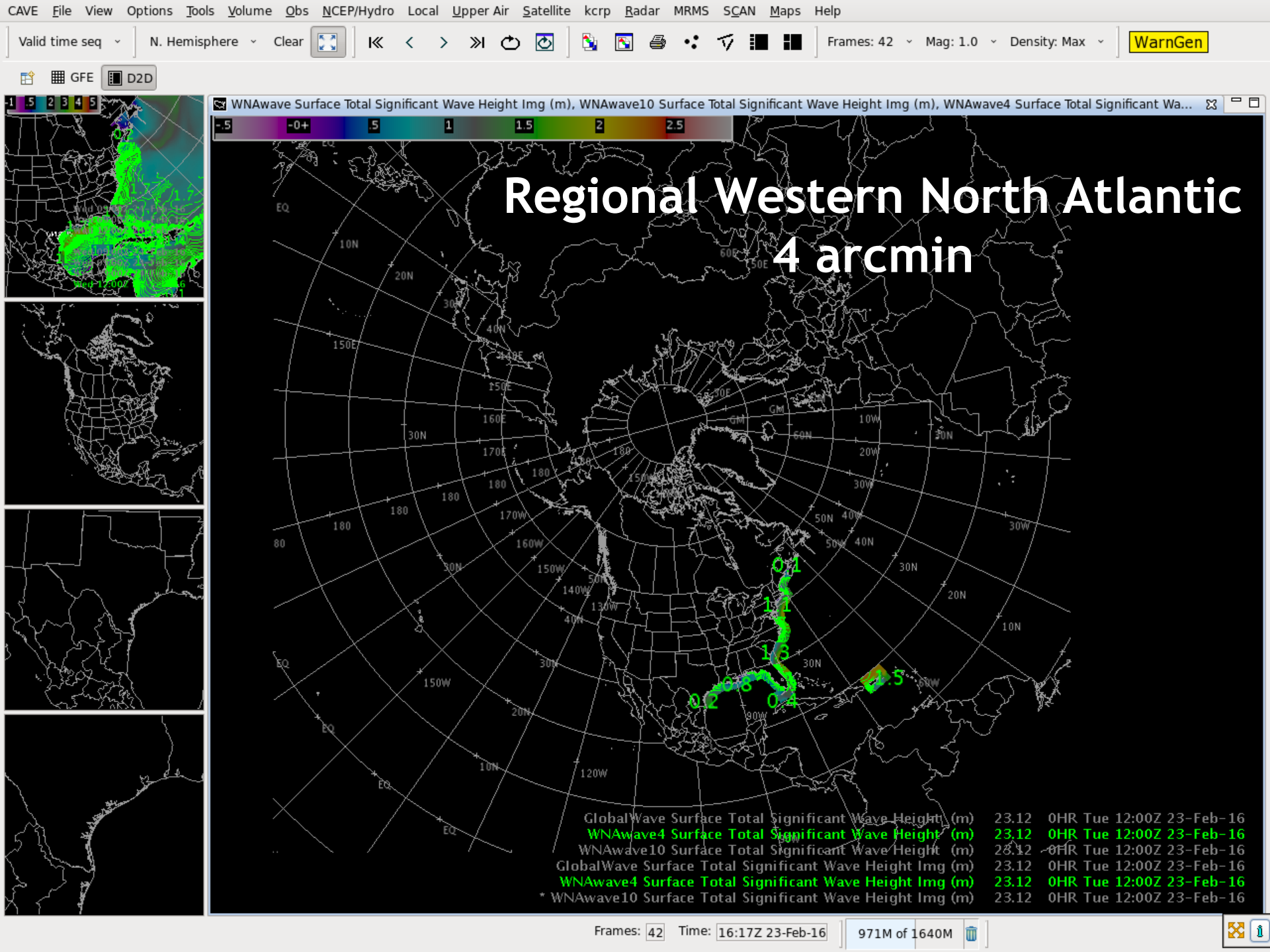


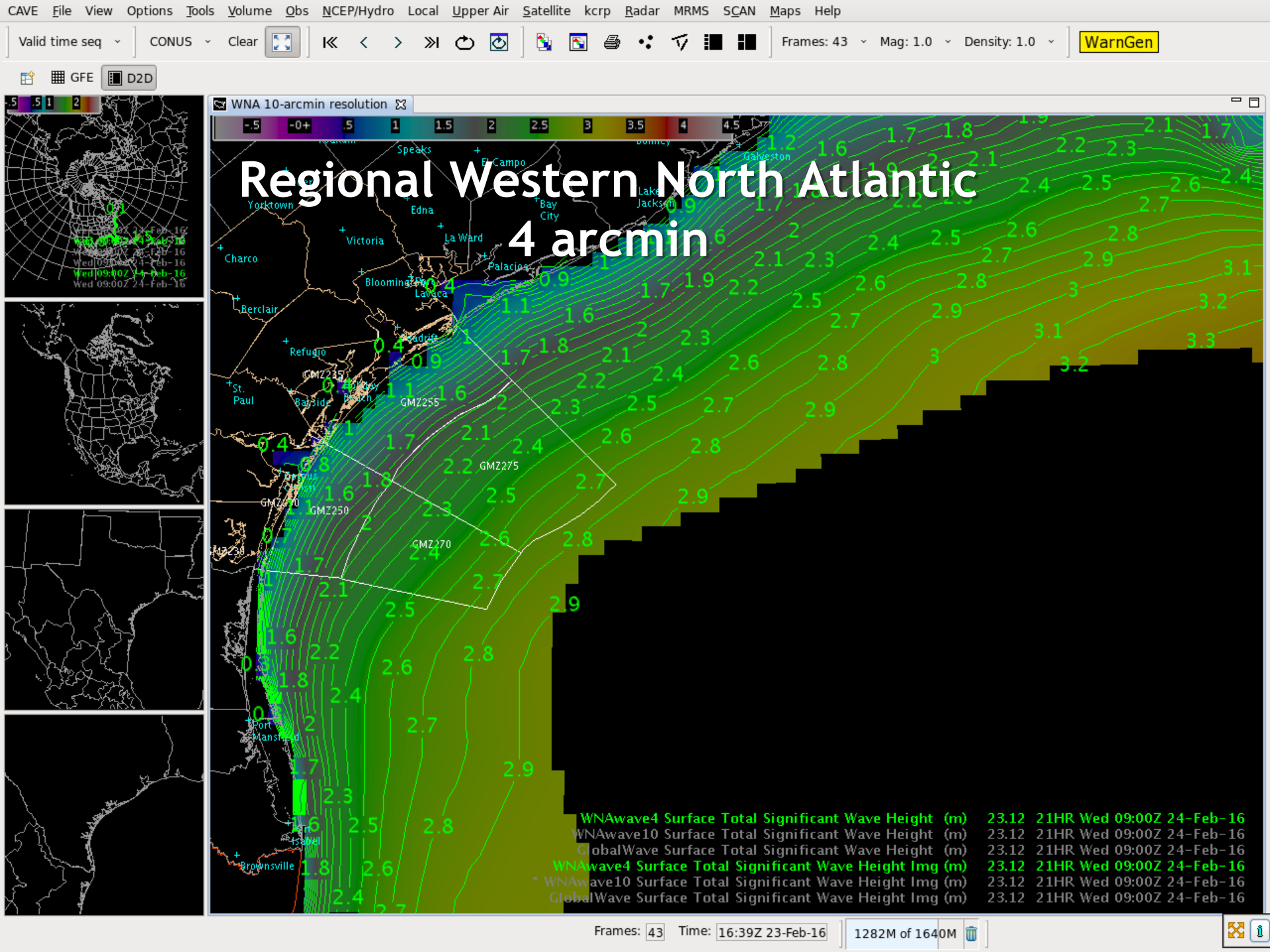


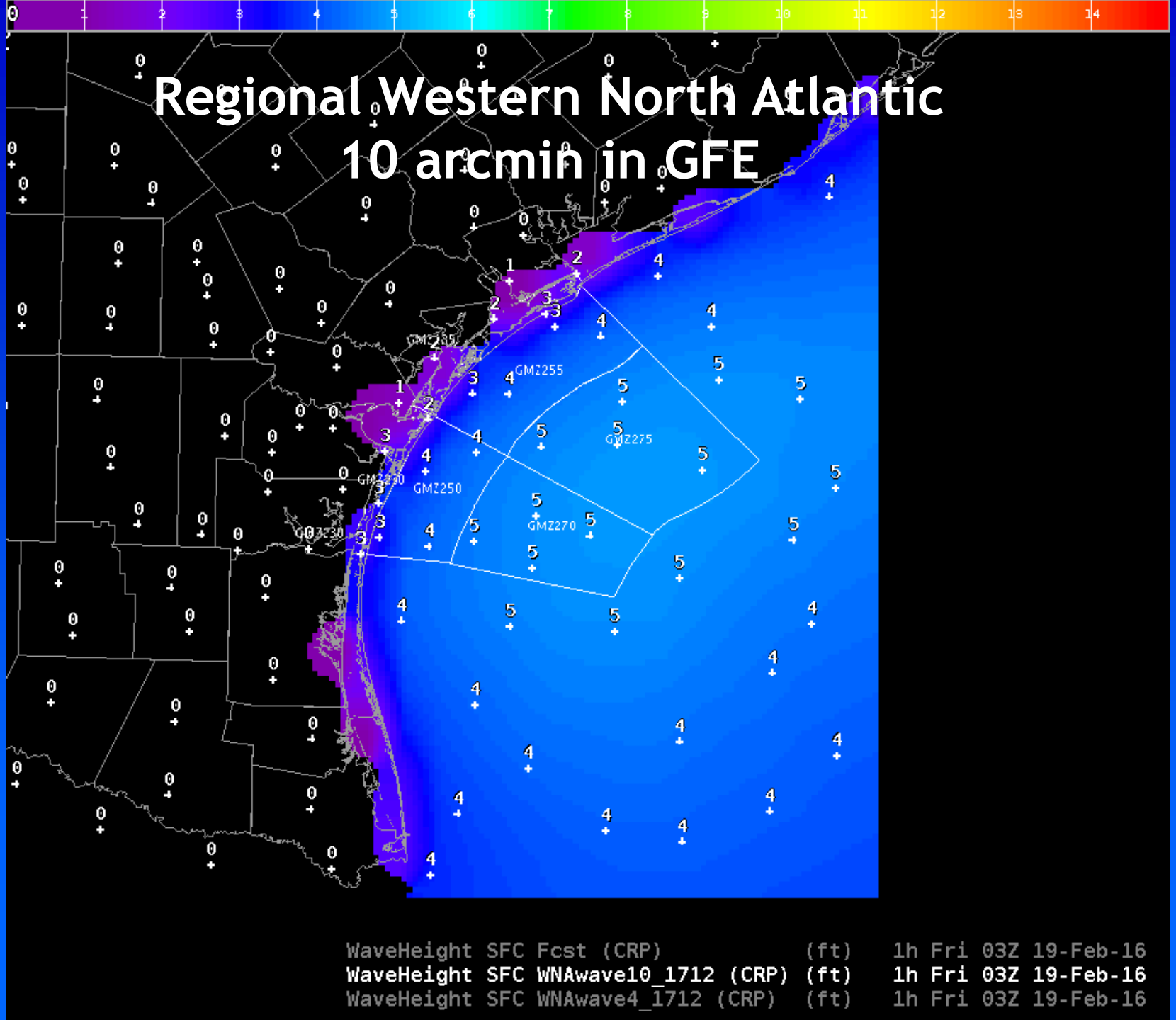
- NOAA's **W**ave**W**atch **III** (**WW3**)
- **S**imulating **WA**ves **N**earshore (**SWAN**)
- **N**earshore **W**ave **P**rediction **S**ystem (**NWPS**)
  - Includes **WW3** and **SWAN**
- TAMUCC-CBI's **A**rtificial **N**eural **N**etwork (**ANN**)
- NOS's **N**orthern **G**ulf of Mexico **O**perational **F**orecast **S**ystem (**NGOFS**)
- Global **R**eal **T**ime **O**cean **F**orecast **S**ystem (**RTOFS**)
- **E**xtratropical **S**urge and **T**ide **O**perational **F**orecast **S**ystem (**ESTOFS**)
- MDL's **E**xtra**T**ropical **S**torm **S**urge Model (**ETSS** or **ET-SURGE**)
- MDL's **S**ea **L**ake and **O**verland **S**urges from **H**urricane (**SLOSH**)

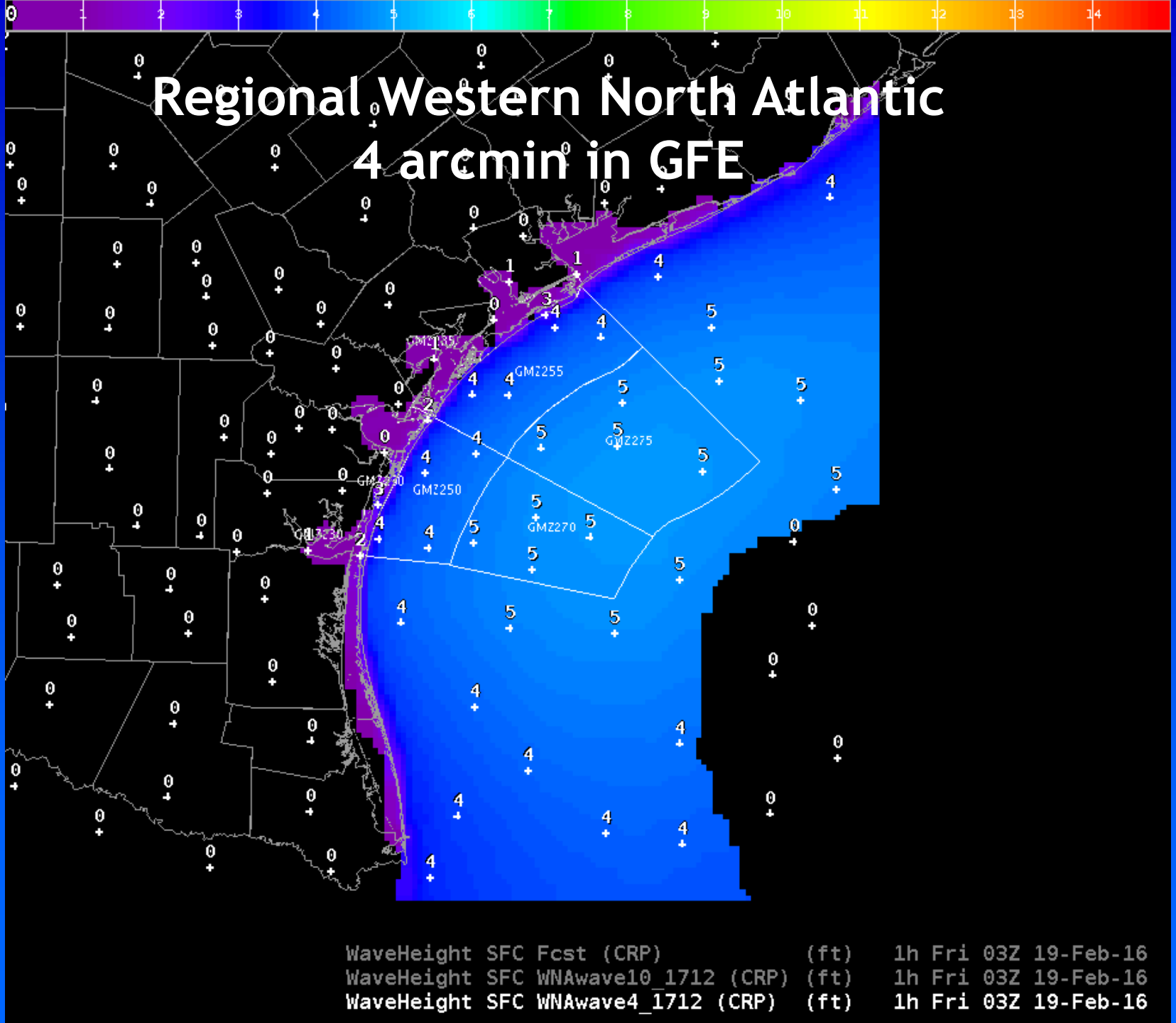
WaveWatch III

- NOAA's 3rd generation wave model.
- Runs 4 times a day.
- Output through 180 hours for every 3 hours.
- 3 different resolutions:
  - 1/2° or 30 arc-minutes
  - 1/6° or 10 arc-minutes
  - 1/15° or 4 arc-minutes
- Uses GFS Winds.
- **W**estern **N**orth **A**tlantic (**WNA**) regional domain.
  - Boundary conditions from the Global WW3.


CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help
Valid time seq
N. Hemisphere
Clear
Frames: 42
Mag: 1.0
Density: Max
WarnGen
GFE
D2D
WNAwave Surface Total Significant Wave Height Img (m), WNAwave10 Surface Total Significant Wave Height Img (m), WNAwave4 Surface Total Significant Wa...
Regional Western North Atlantic
4 arcmin
GlobalWave Surface Total Significant Wave Height (m) 23.12 0HR Tue 12:00Z 23-Feb-16
WNAwave4 Surface Total Significant Wave Height (m) 23.12 0HR Tue 12:00Z 23-Feb-16
WNAwave10 Surface Total Significant Wave Height (m) 23.12 0HR Tue 12:00Z 23-Feb-16
GlobalWave Surface Total Significant Wave Height Img (m) 23.12 0HR Tue 12:00Z 23-Feb-16
WNAwave4 Surface Total Significant Wave Height Img (m) 23.12 0HR Tue 12:00Z 23-Feb-16
* WNAwave10 Surface Total Significant Wave Height Img (m) 23.12 0HR Tue 12:00Z 23-Feb-16
Frames: 42
Time: 16:17Z 23-Feb-16
971M of 1640M


CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help
Valid time seq
CONUS
Clear
Frames: 43
Mag: 1.0
Density: 1.0
WarnGen
GFE
D2D
WNA 10-arcmin resolution
Regional Western North Atlantic
4 arcmin
WNAwave4 Surface Total Significant Wave Height (m) 23.12 21HR Wed 09:00Z 24-Feb-16
WNAwave10 Surface Total Significant Wave Height (m) 23.12 21HR Wed 09:00Z 24-Feb-16
GlobalWave Surface Total Significant Wave Height (m) 23.12 21HR Wed 09:00Z 24-Feb-16
WNAwave4 Surface Total Significant Wave Height Img (m) 23.12 21HR Wed 09:00Z 24-Feb-16
WNAwave10 Surface Total Significant Wave Height Img (m) 23.12 21HR Wed 09:00Z 24-Feb-16
GlobalWave Surface Total Significant Wave Height Img (m) 23.12 21HR Wed 09:00Z 24-Feb-16
Frames: 43
Time: 16:39Z 23-Feb-16
1282M of 1640M

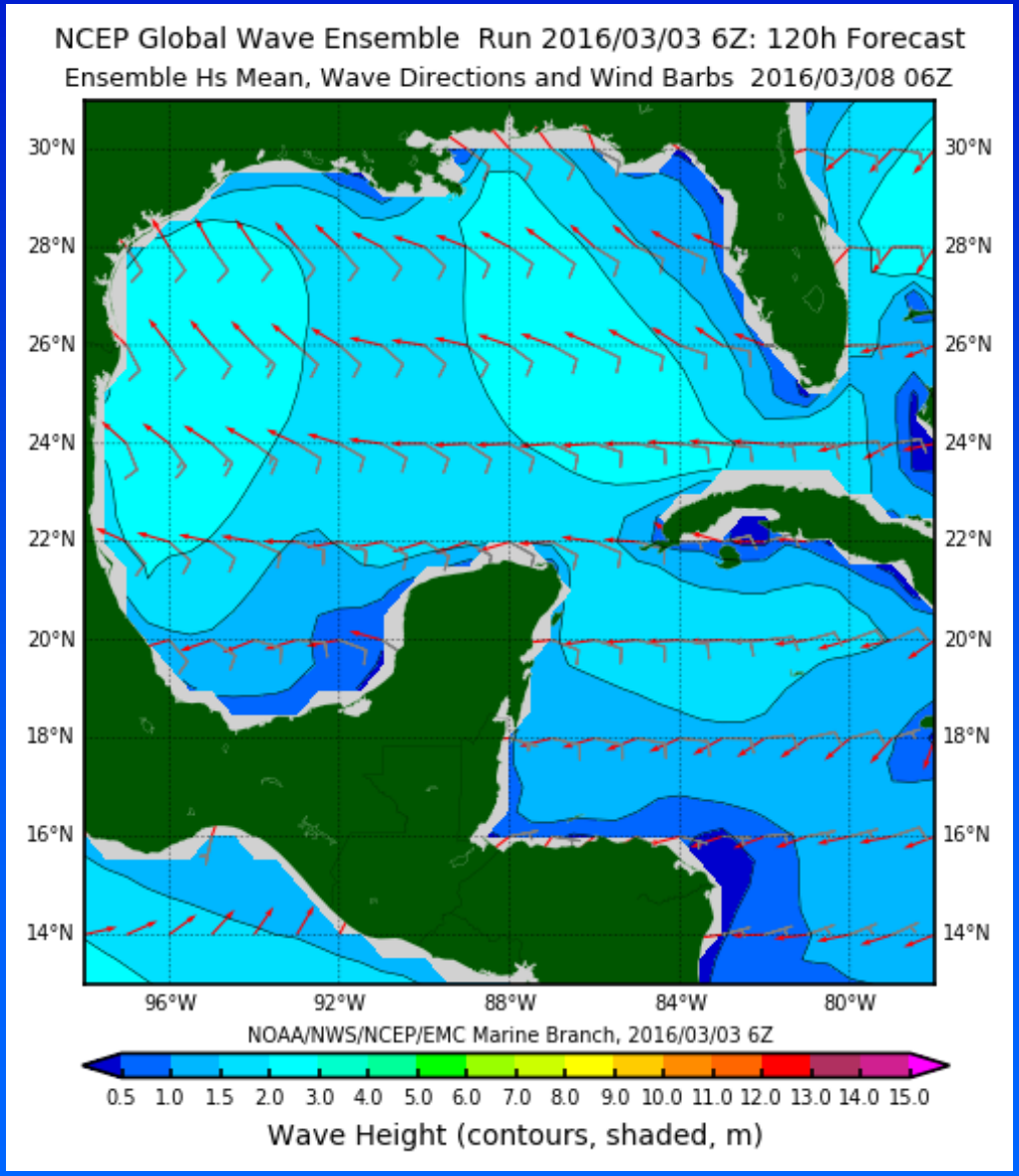

Regional Western North Atlantic
10 arcmin in GFE
GMZ255
GMZ275
GMZ250
GMZ270
WaveHeight SFC Fcst (CRP) (ft) 1h Fri 03Z 19-Feb-16
WaveHeight SFC WNAwave10_1712 (CRP) (ft) 1h Fri 03Z 19-Feb-16
WaveHeight SFC WNAwave4_1712 (CRP) (ft) 1h Fri 03Z 19-Feb-16


Regional Western North Atlantic
4 arcmin in GFE
GMZ235
GMZ255
GMZ275
GMZ250
GMZ270
GMZ230
WaveHeight SFC Fcst (CRP) (ft) 1h Fri 03Z 19-Feb-16
WaveHeight SFC WNAwave10_1712 (CRP) (ft) 1h Fri 03Z 19-Feb-16
WaveHeight SFC WNAwave4_1712 (CRP) (ft) 1h Fri 03Z 19-Feb-16

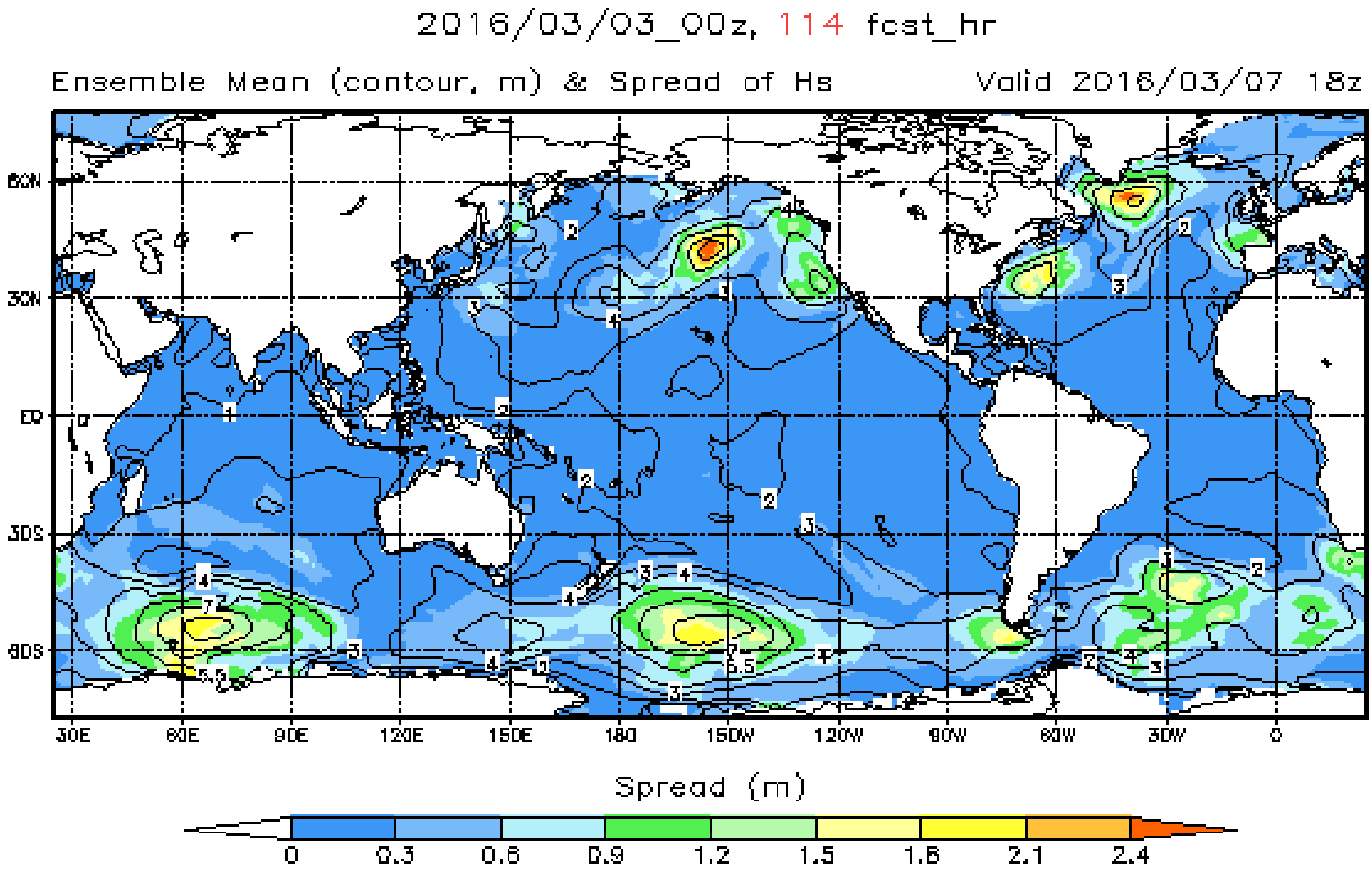
WW3 Variants

- **HUR**ricane **Wave** Model (**HURWave**)
  - Blend of GFS & HWRF winds.
- **G**lobal **E**nsemble **O**cean **Wa**ve **F**orecast **S**ystem (**GEOWaFS**)
  - 1 control member (GFS winds) and 20 perturbed members from the GEFS.
- Combined **N**CEP/**F**NMO**C** Wave **ENS**embles (**NFCENS**)
  - GEOWaFS and Navy Wave Ensembles.
- **N**earshore **W**ave**W**atch (**NWW**) is not yet operational.

Global Wave Ensemble based on GEFS

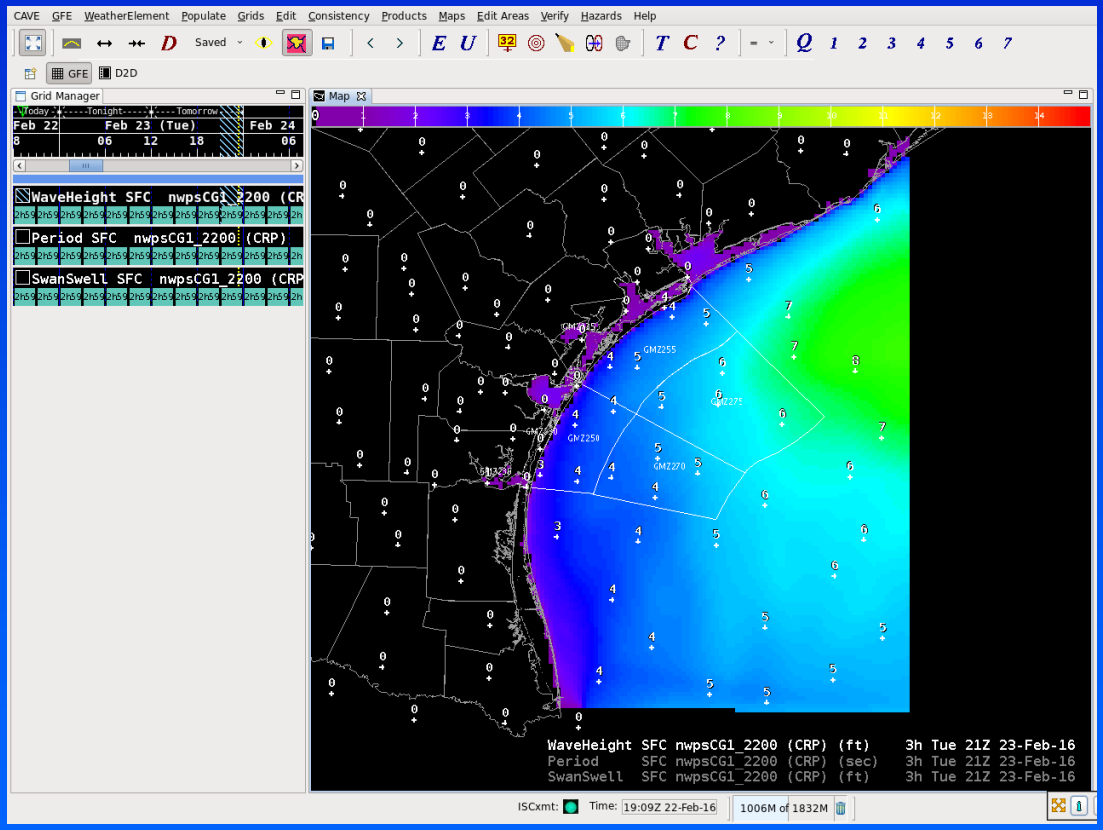


NCEP/FNMOC Wave Ensemble



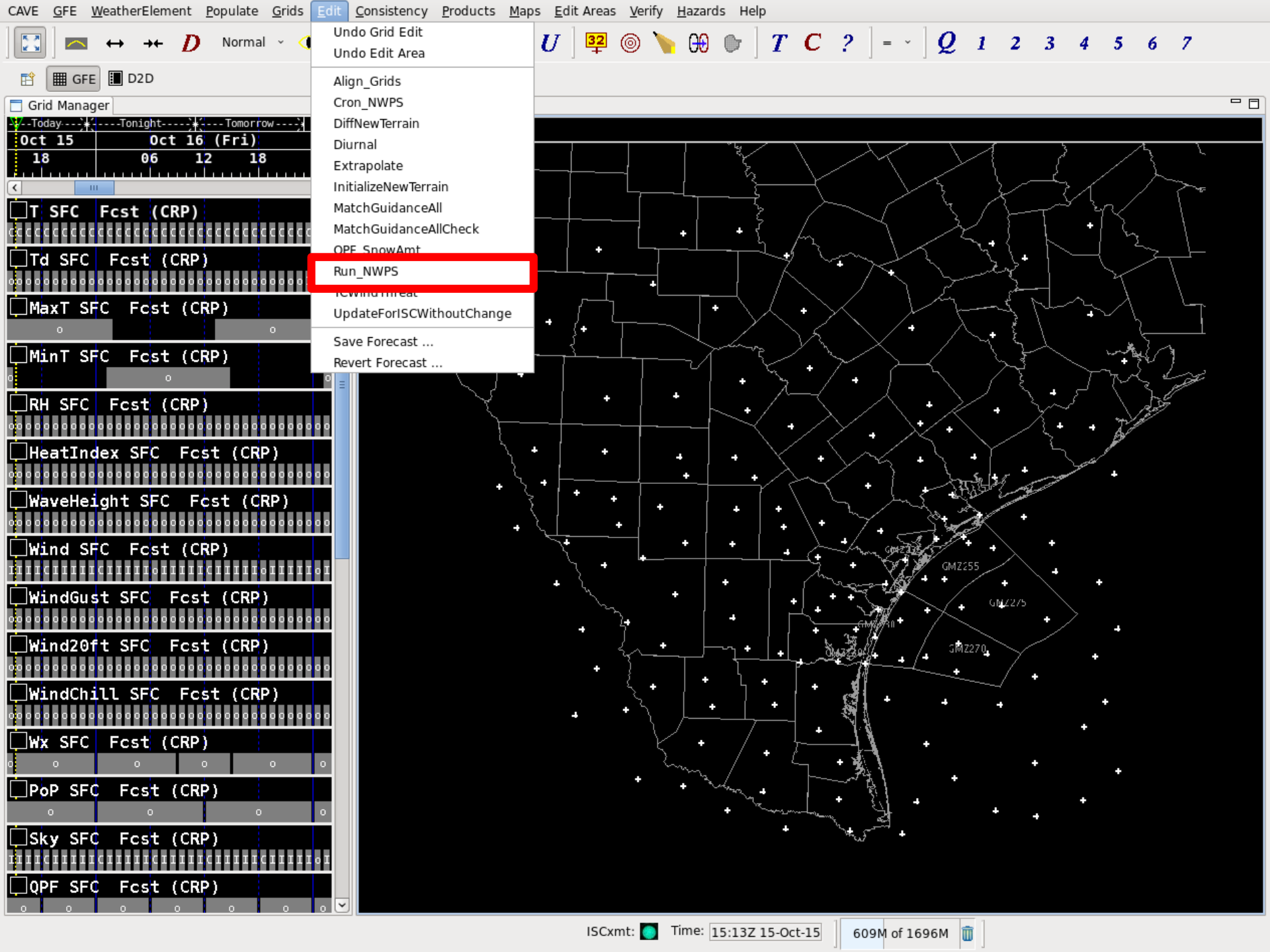
Simulating WAves Nearshore (SWAN)

- 3rd generation wave model developed in the Netherlands.
- Geared towards the “nearshore”.

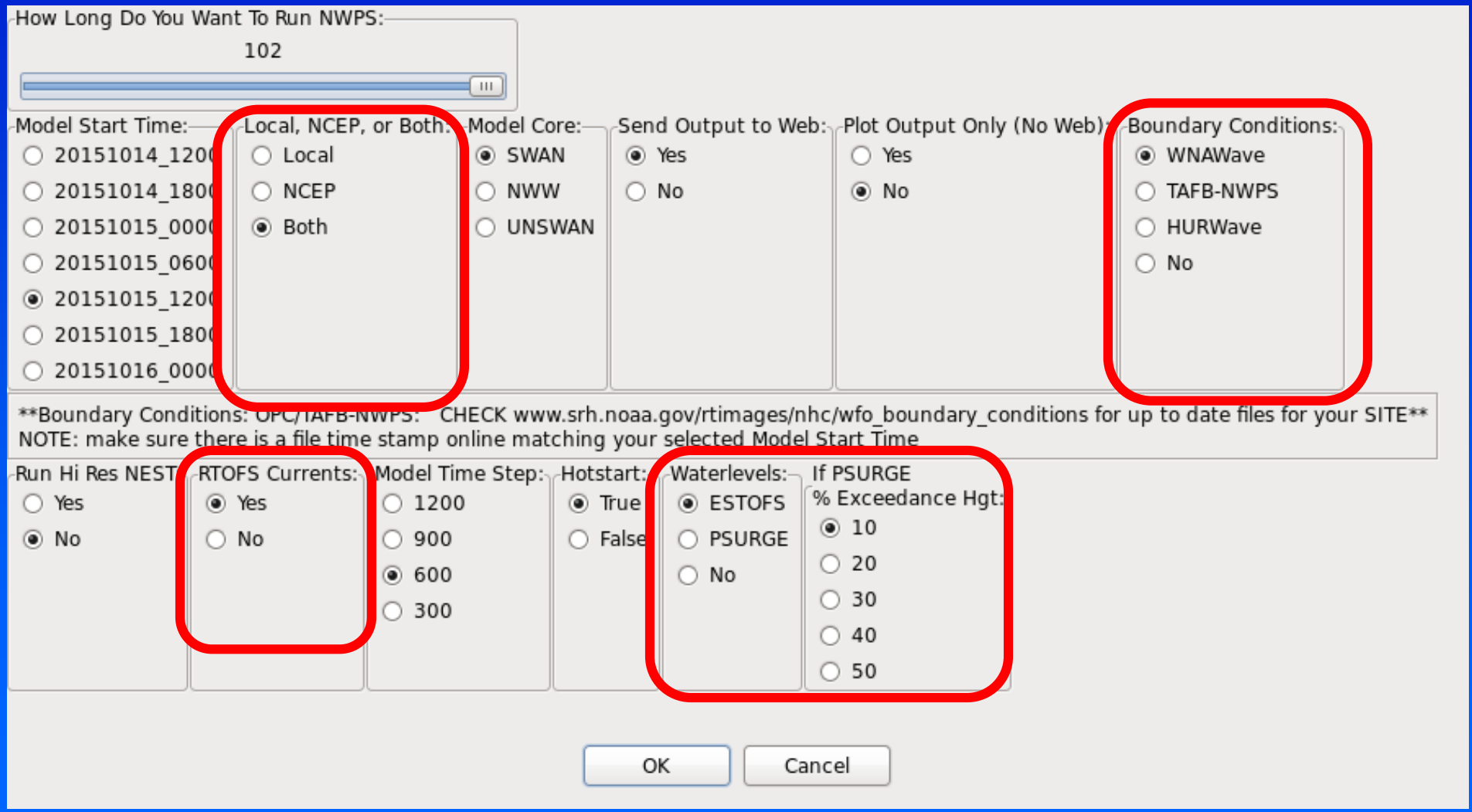


Nearshore Wave Prediction System (NWPS)

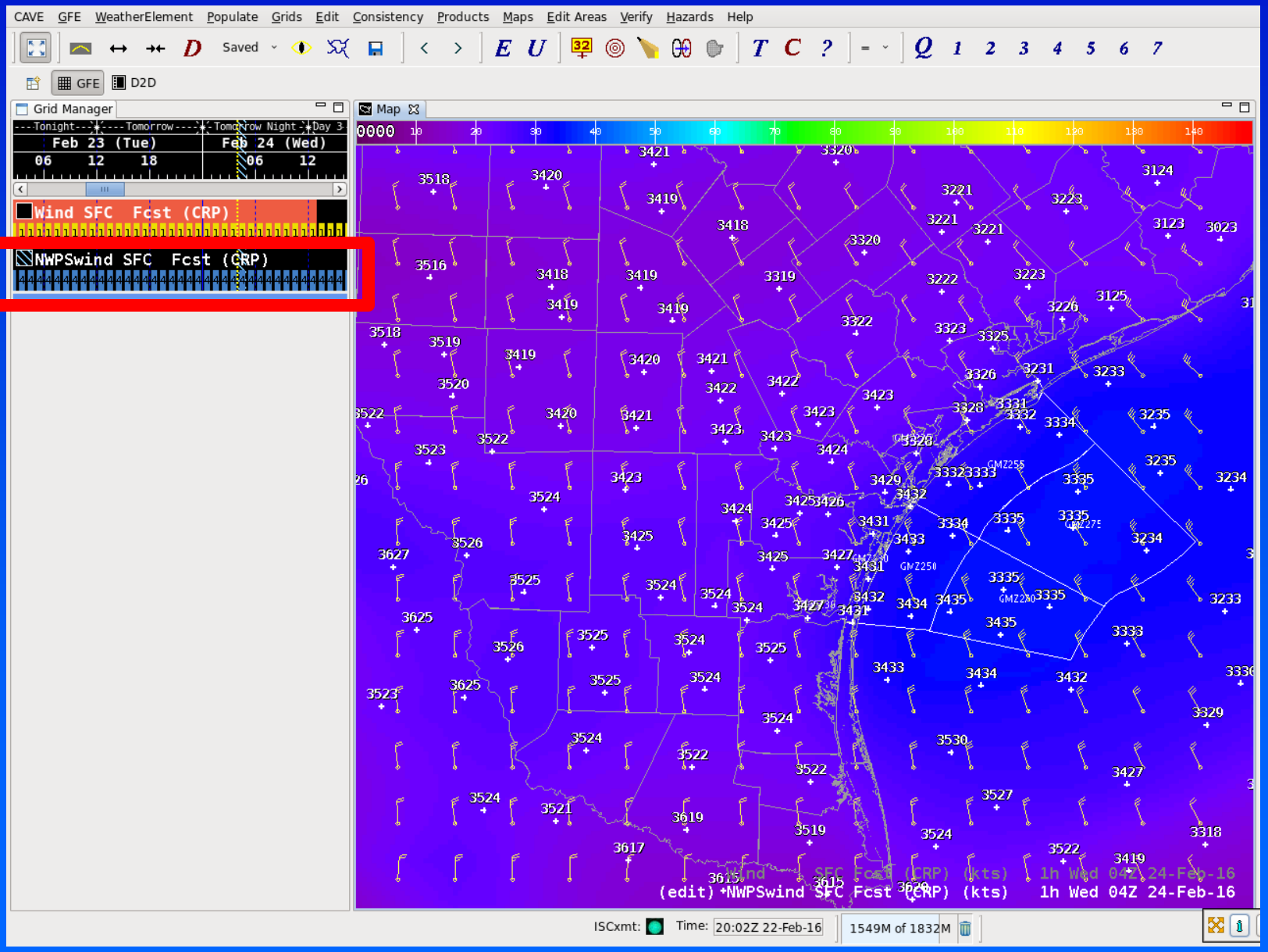
- Uses the SWAN model as its core.
- **Local and NCEP** runs at:
  - **0040, 0340, 0940, 1240, 1540, 2140Z**
- Uses our winds from GFE.
  - NWPSwind element
- 30-40 minutes to run model and post-process.
- High-resolution (~1 arcmin) wave guidance:
  - Significant Wave Height
  - Primary Wave Period
  - Primary Wave Direction
  - Swell Height


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Undo Grid Edit
Undo Edit Area
Align_Grids
Cron_NWPS
DiffNewTerrain
Diurnal
Extrapolate
InitializeNewTerrain
MatchGuidanceAll
MatchGuidanceAllCheck
QPE_SnowAmt
Run_NWPS
UpdateForISCWithoutChange
Save Forecast ...
Revert Forecast ...
Normal
GFE
D2D
Grid Manager
Today
Tonight
Tomorrow
Oct 15
Oct 16 (Fri)
18
06
12
18
T SFC Fcst (CRP)
Td SFC Fcst (CRP)
MaxT SFC Fcst (CRP)
MinT SFC Fcst (CRP)
RH SFC Fcst (CRP)
HeatIndex SFC Fcst (CRP)
WaveHeight SFC Fcst (CRP)
Wind SFC Fcst (CRP)
WindGust SFC Fcst (CRP)
Wind20ft SFC Fcst (CRP)
WindChill SFC Fcst (CRP)
Wx SFC Fcst (CRP)
PoP SFC Fcst (CRP)
Sky SFC Fcst (CRP)
QPF SFC Fcst (CRP)
GMZ255
GMZ270
ISCxmt:
Time: 15:13Z 15-Oct-15
609M of 1696M

Run_NWPS GFE Procedure



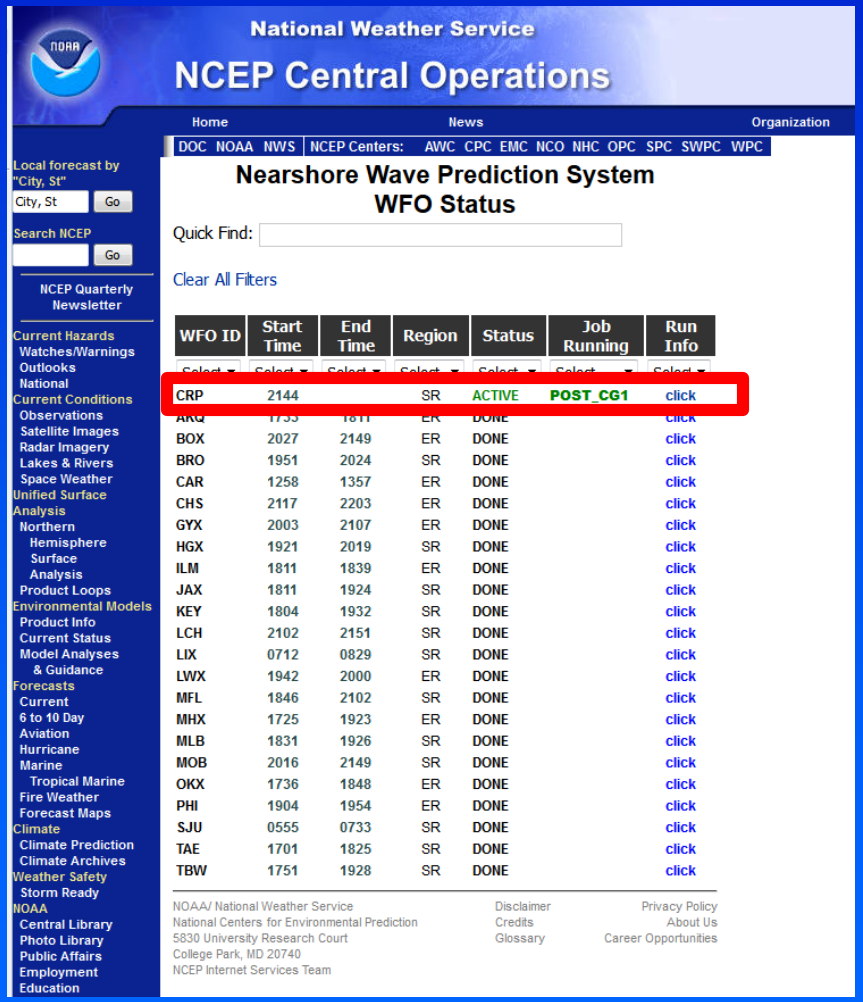
NWPSwind


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Saved
GFE D2D
Grid Manager
Tonight Tomorrow Tomorrow Night Day 3
Feb 23 (Tue) Feb 24 (Wed)
06 12 18 06 12
Wind SFC Fcst (CRP)
NWPSwind SFC Fcst (CRP)
Map
0000 10 20 30 40 50 60 70 80 90 100 110 120 130 140
(edit) NWPSwind SFC Fcst (CRP) (kts) 1h Wed 04Z 24-Feb-16
ISCxmt:
Time: 20:02Z 22-Feb-16
1549M of 1832M

NWPS NCEP runs

http://www.nco.ncep.noaa.gov/pmb/spa/nwps/

- Operational on WCOSS since 2/9/16.
- Ability to process NCEP runs in 16.2.1.
  - ~May
- Ability for backup WFOs to process NCEP runs in 16.2.2.
  - ~Summer



If the WCOSS run fails…

Nearshore Wave Prediction System
WFO Status

Quick Find:

Clear All Filters

WFO ID	Start Time	End Time	Region	Status	Job Running	Run Info
TBW	1731		SR	ABORTED		click
MFL	1859		SR	ACTIVE	FORECAST_CG1	click
KEY	1819		SR	ACTIVE	FORECAST_CGN	click
MHX	1806		ER	ACTIVE	FORECAST_CGN	click
LCH	1852		SR	ACTIVE	POST_CG1	click
PHI	1904		ER	ACTIVE	POST_CG1	click
JAX	1811		SR	ACTIVE	POST_CGN	click
LIX	1812		SR	ACTIVE	POST_CGN	click
AKQ	1754	1844	ER	DONE		click
BOX	0717	0841	ER	DONE		click
BRO	0721	0754	SR	DONE		click
CAR	1258	1402	ER	DONE		click
CHS	1751	1836	ER	DONE		click
CRP	1544	1621	SR	DONE		click
GYX	1402	1508	ER	DONE		click
HGX	0711	0810	SR	DONE		click
ILM	1831	1911	ER	DONE		click
MLB	0732	0828	SR	DONE		click
MOB	0746	0921	SR	DONE		click
OKX	1756	1908	ER	DONE		click
SJU	0647	0823	SR	DONE		click
TAE	1741	1906	SR	DONE		click

National Weather Service Weather Forecast Office

Corpus Christi, TX

weather.gov

Home | Site Map | News | Organization | Search for: NWS All NOAA Go

Social Media Dashboard

Local forecast by "City, St" or Zip Code

City, St Go

XML RSS Feeds

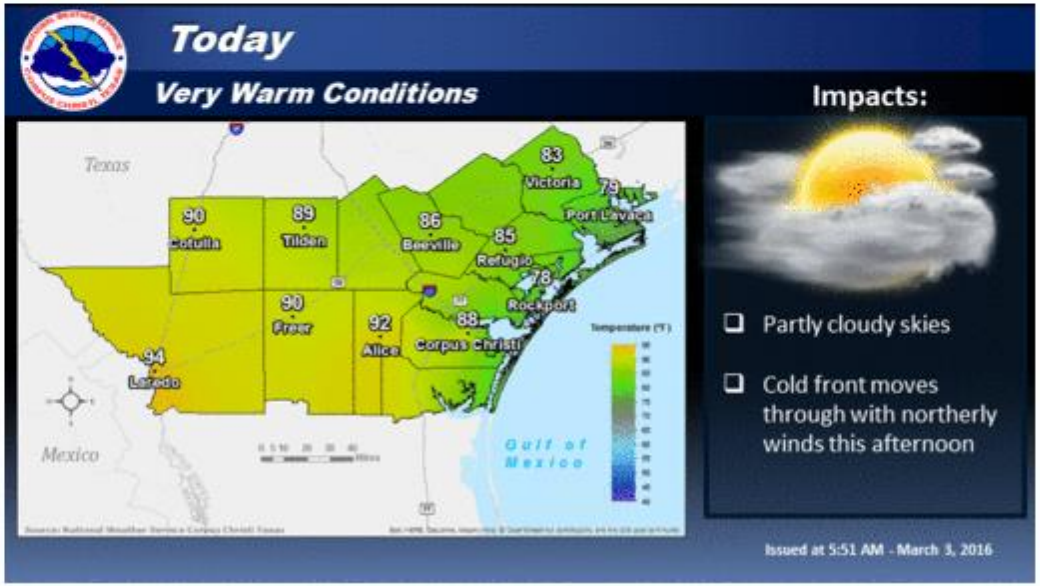
Current Hazards
- Local
- Nationwide
- Outlooks
- Drought

Forecasts
- Local
- Forecast Discussion
- Activity Planner
- Graphical
- Tropical Weather
- Fire Weather
- Aviation Weather
- Marine Weather
- Tide Data
- Quick Forecast
- Hurricane Center
- Storm Surge Threat
- NWPS

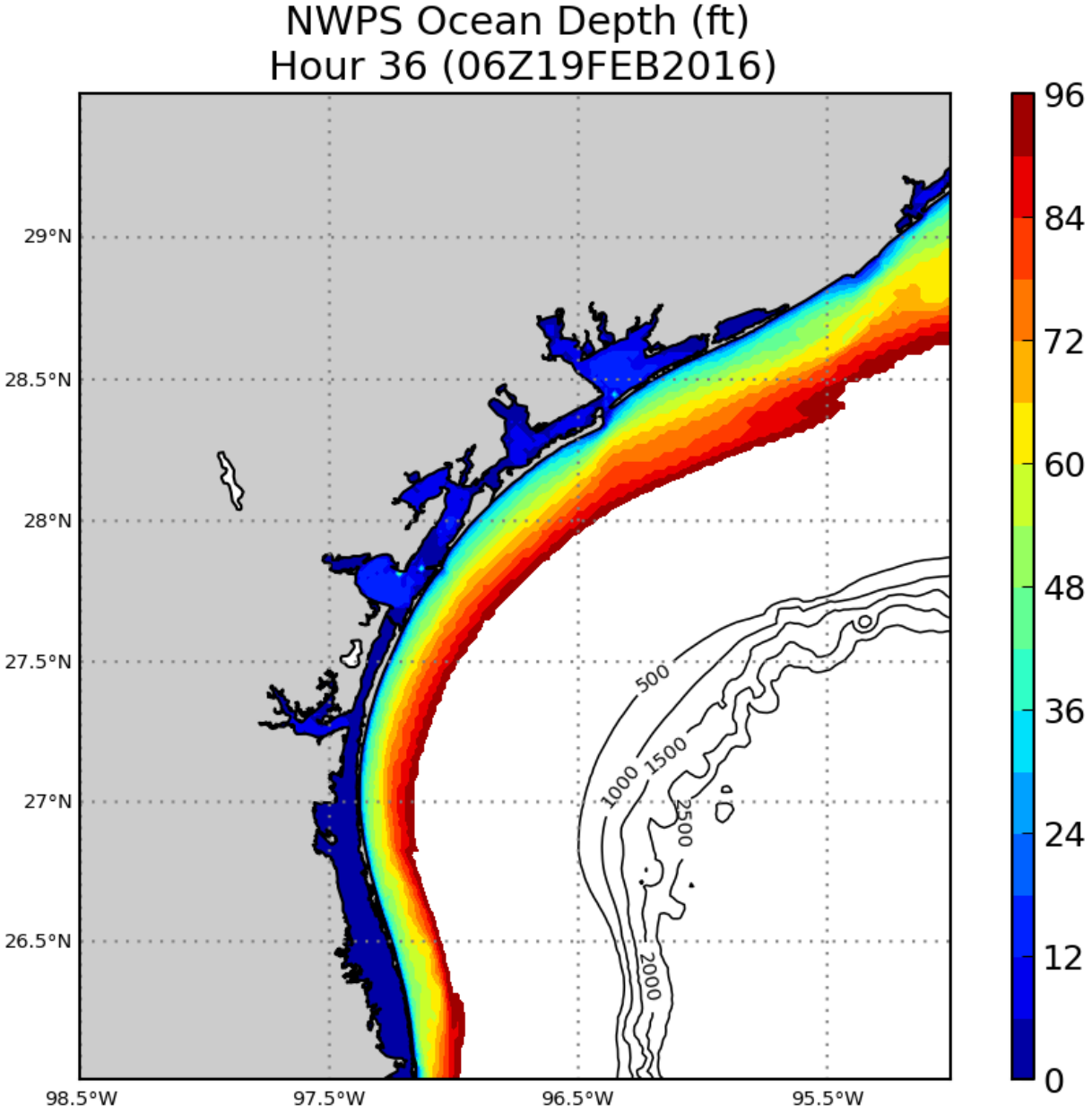
Top News of the Day

- 2016 Skywarn Storm Spotter Training Schedule
- Texas A&M Corpus Christi will begin a Bachelor of Science program in Atmospheric Science in the Fall of 2016

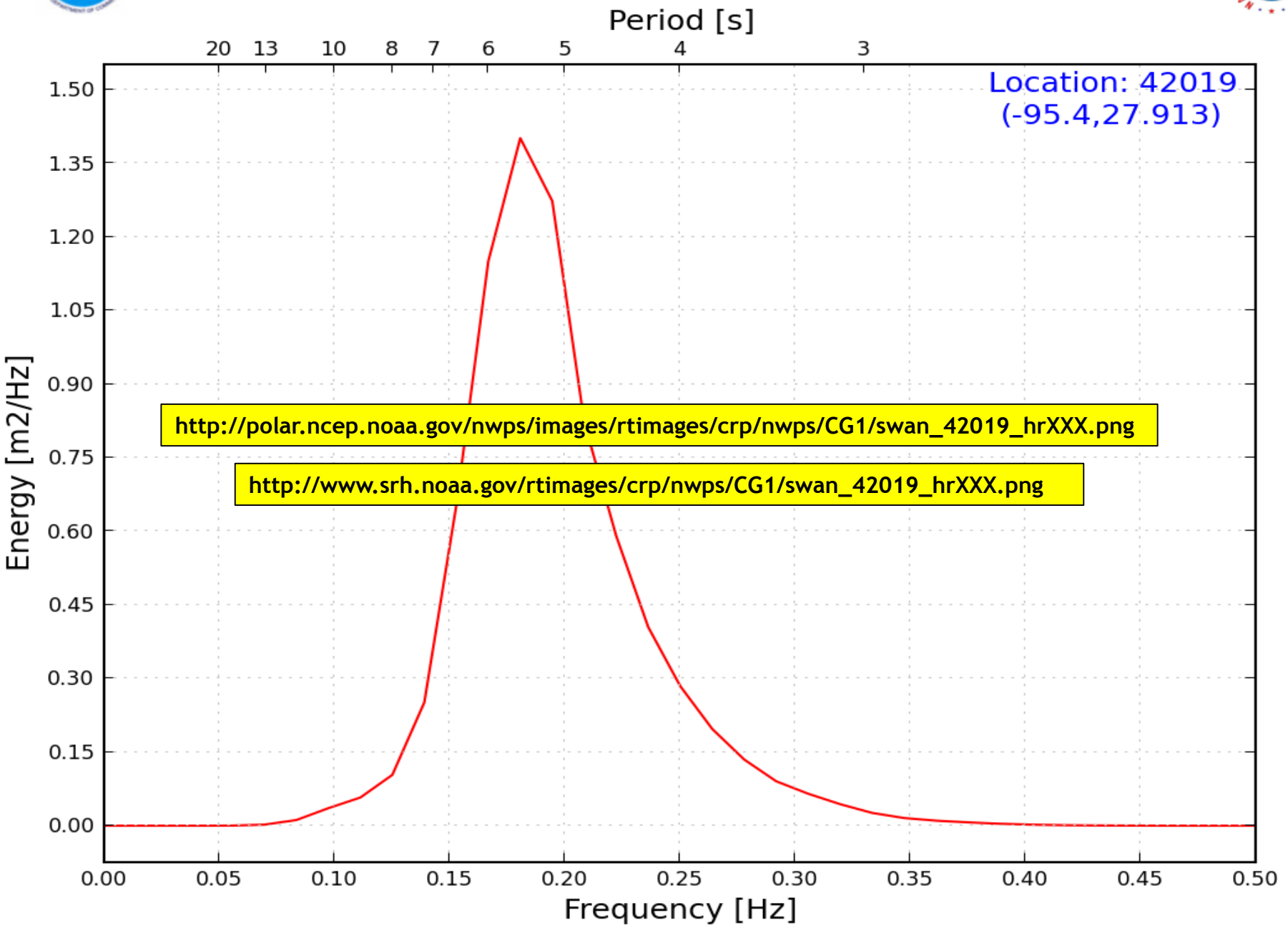
Today | Tonight | Extended Forecast

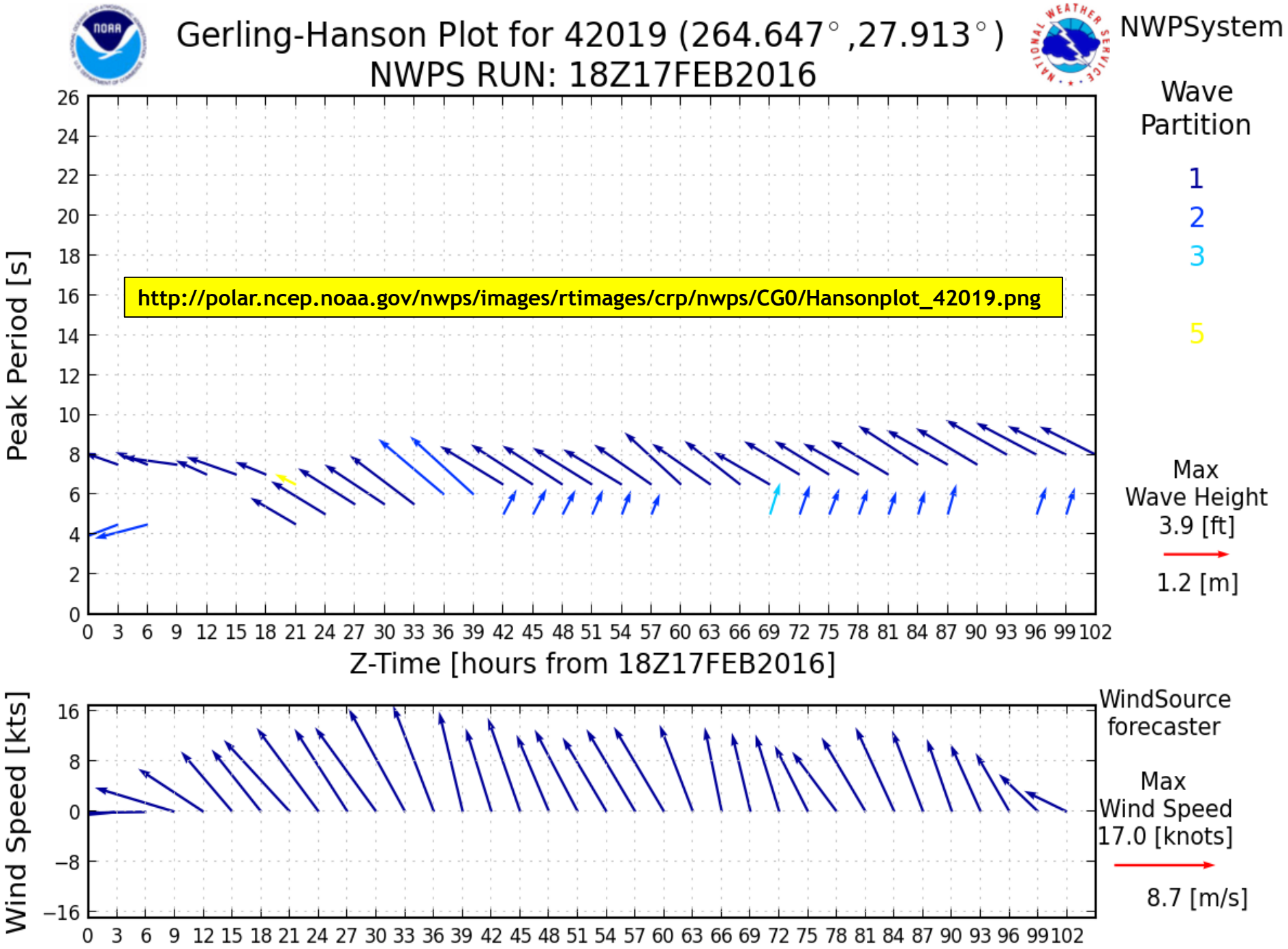


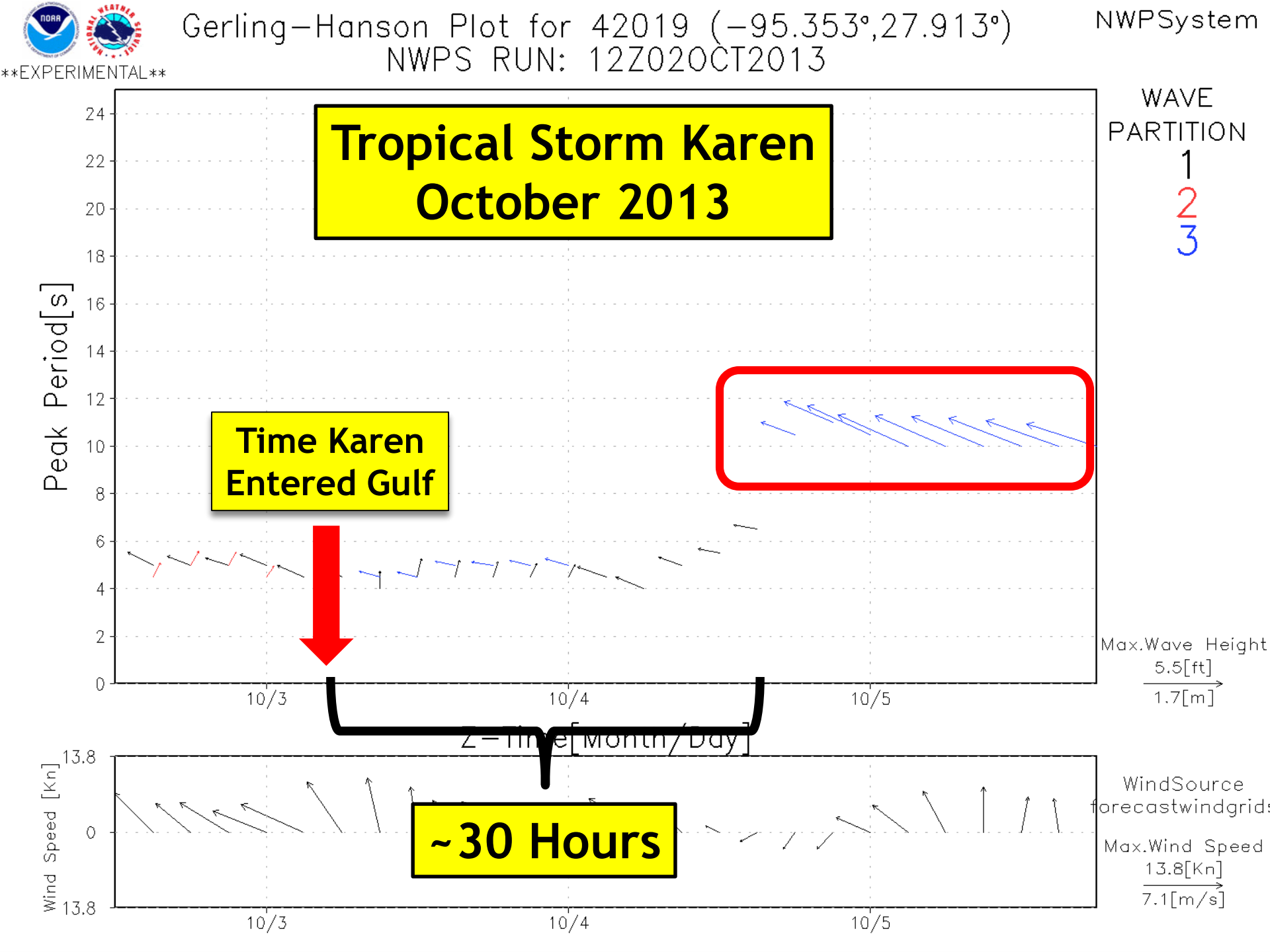
Show Caption

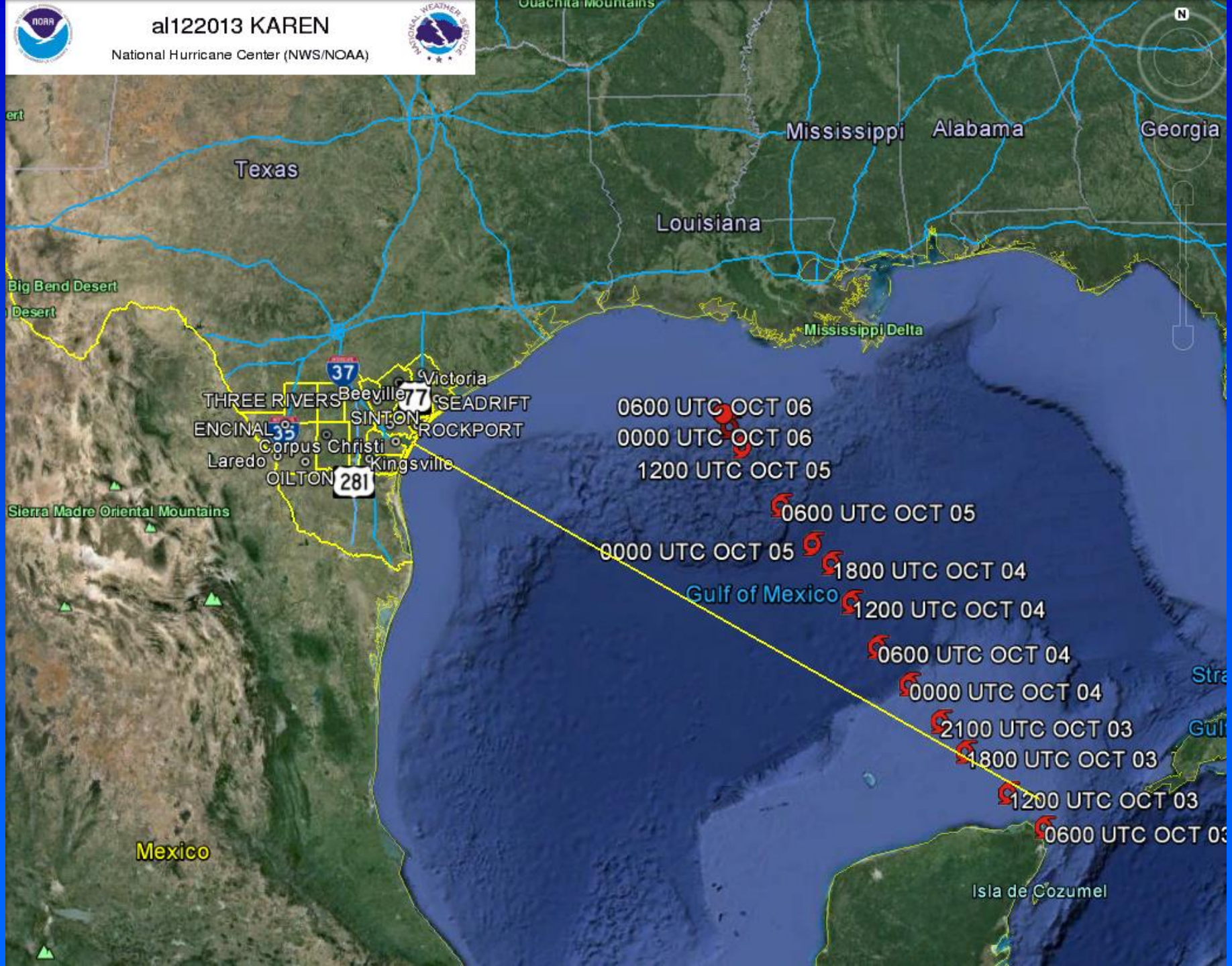

NWPS Ocean Depth (ft)
Hour 36 (06Z19FEB2016)
29°N
28.5°N
28°N
27.5°N
27°N
26.5°N
98.5°W
97.5°W
96.5°W
95.5°W
500
1000
1500
2000
2500
96
84
72
60
48
36
24
12
0

NWPS Spectral Density at Hr 36 from 06Z Feb 19,2016



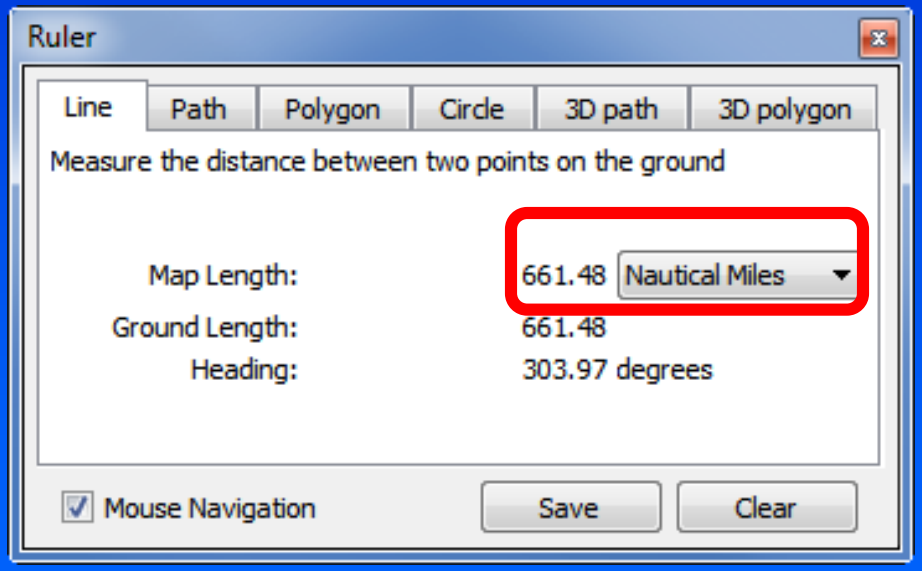

Gerling-Hanson Plot for 42019 (264.647° ,27.913°)
NWPS RUN: 18Z17FEB2016
NWPSystem
Wave Partition
1
2
3
5
http://polar.ncep.noaa.gov/nwps/images/rtimages/crp/nwps/CG0/Hansonplot_42019.png
Peak Period [s]
Max Wave Height 3.9 [ft]
1.2 [m]
Z-Time [hours from 18Z17FEB2016]
Wind Speed [kts]
WindSource forecaster
Max Wind Speed 17.0 [knots]
8.7 [m/s]


EXPERIMENTAL
Gerling–Hanson Plot for 42019 (–95.353°,27.913°)
NWPS RUN: 12Z20OCT2013
NWPSystem
Tropical Storm Karen
October 2013
WAVE
PARTITION
1
2
3
Peak Period[s]
Time Karen
Entered Gulf
Max.Wave Height
5.5[ft]
1.7[m]
10/3
10/4
10/5
Z–Time[Month/Day]
~30 Hours
Wind Speed [Kn]
13.8
0
13.8
WindSource
forecastwindgrids
Max.Wind Speed
13.8[Kn]
7.1[m/s]


al122013 KAREN
National Hurricane Center (NWS/NOAA)
Texas
Louisiana
Mississippi
Alabama
Georgia
Big Bend Desert
Mississippi Delta
Victoria
Beeville
THREE RIVERS
SEADRIFT
SINTON
ROCKPORT
ENCINAL
Corpus Christi
Laredo
Kingsville
OILTON
281
Sierra Madre Oriental Mountains
Gulf of Mexico
Mexico
Isla de Cozumel
0600 UTC OCT 06
0000 UTC OCT 06
1200 UTC OCT 05
0600 UTC OCT 05
0000 UTC OCT 05
1800 UTC OCT 04
1200 UTC OCT 04
0600 UTC OCT 04
0000 UTC OCT 04
2100 UTC OCT 03
1800 UTC OCT 03
1200 UTC OCT 03
0600 UTC OCT 03

Estimating Tropical Cyclone Swell Arrival Time with NWPS

- Period of deep water waves:
  - 11 seconds



- Deep Water Wave equation:
  - **Speed = 1.56 * Period**
  - Speed = 1.56 * 11
  - Speed = 17 kts
- Time = Distance/Speed
  - Time = 662 nm/17 kts
  - Arrival Time = ~ 39 hours

Volume Browser

File Edit Tools Plan view Time

Sources **Fields** **Planes**

ensity: 1.0 WarnGen

File Edit Tools Plan view Time

Sources **Fields** **Planes**

Volume SfcGrid Local Point

Hgt/Pres Temp Moist Stability Forcing Wind Vort

Isent Precip Winter T-Storms Radar Ensemble Misc

Pres Theta Hgt

Temp Radar Misc

nwpsCG1

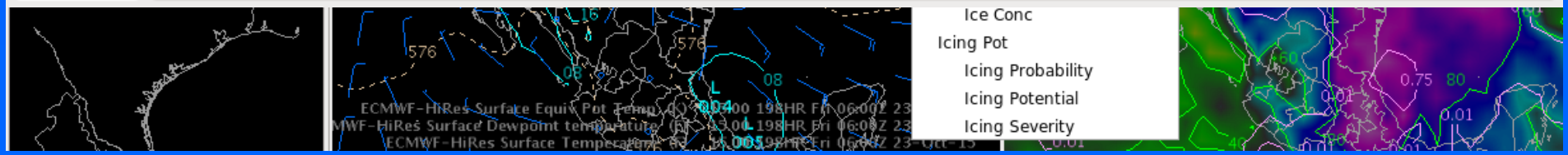
Sig Wave Hgt
Swell Hgt
Prim Wave Dir
Prim Wave Pd

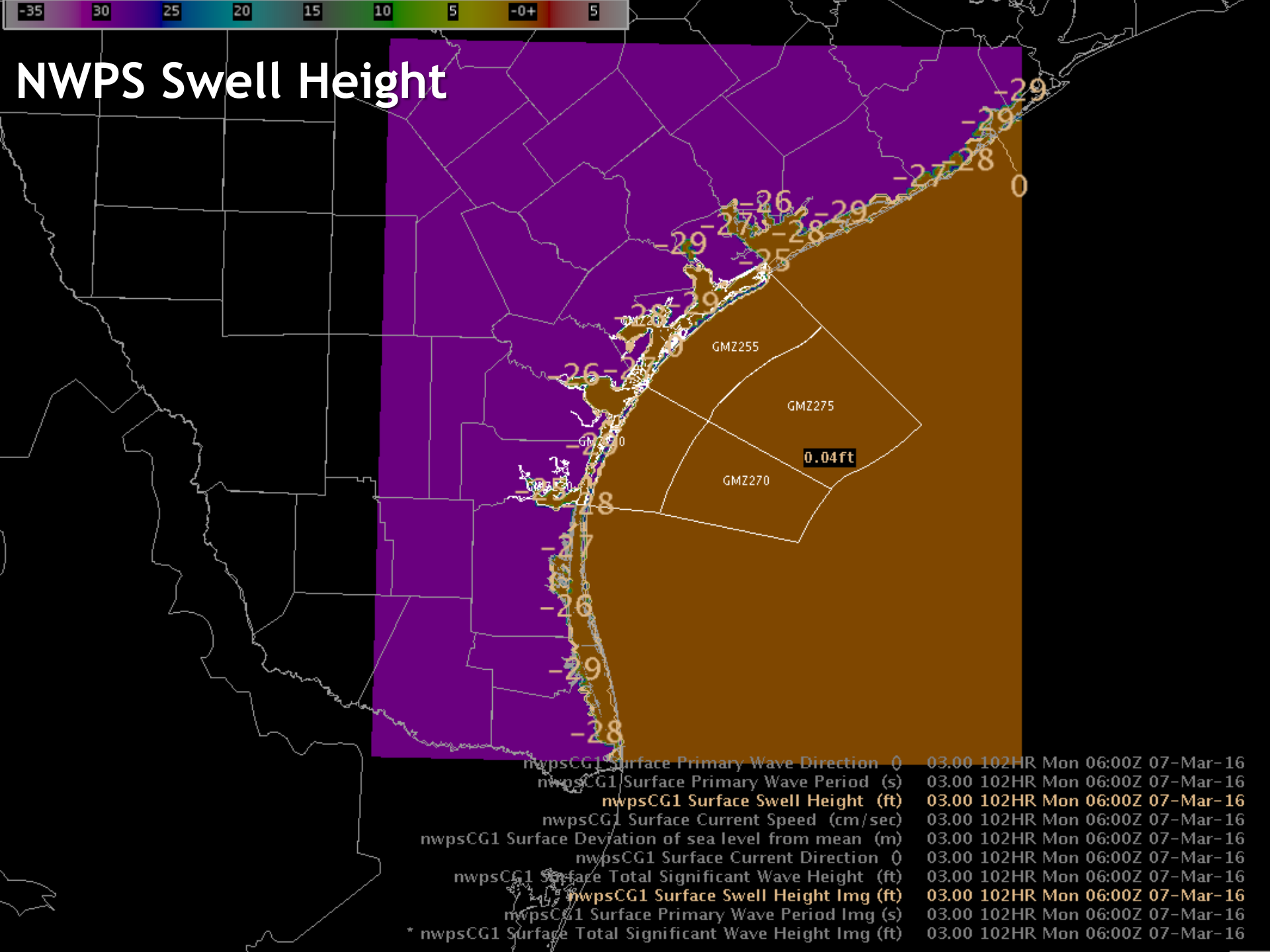
Surface

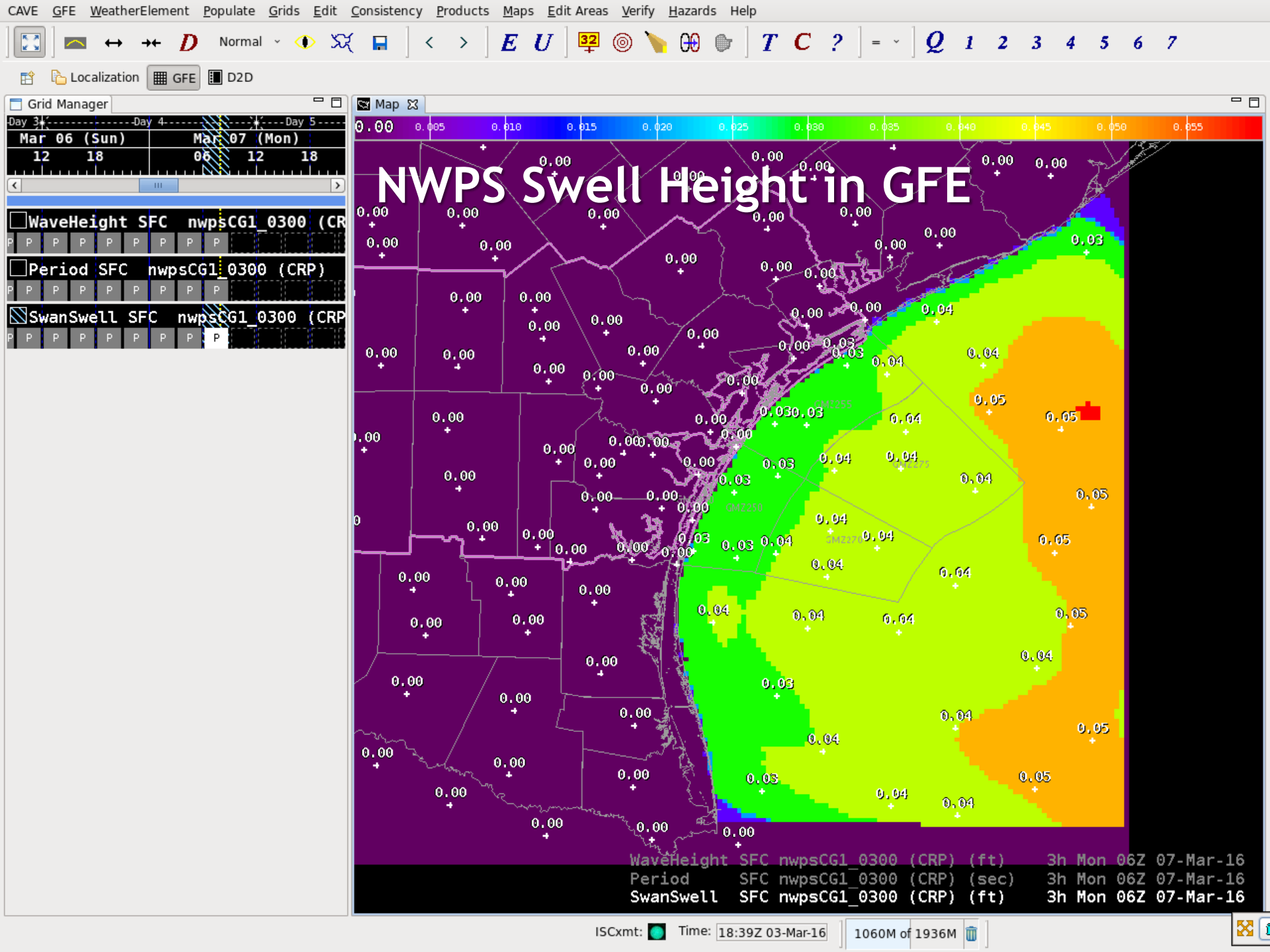
Times	Product Selection List
14.1800	nwpsCG1 Surface Sig Wave Hgt (ft)
14.1800	nwpsCG1 Surface Swell Hgt (ft)
14.1800	nwpsCG1 Surface Prim Wave Dir ()
14.1800	nwpsCG1 Surface Prim Wave Pd (s)

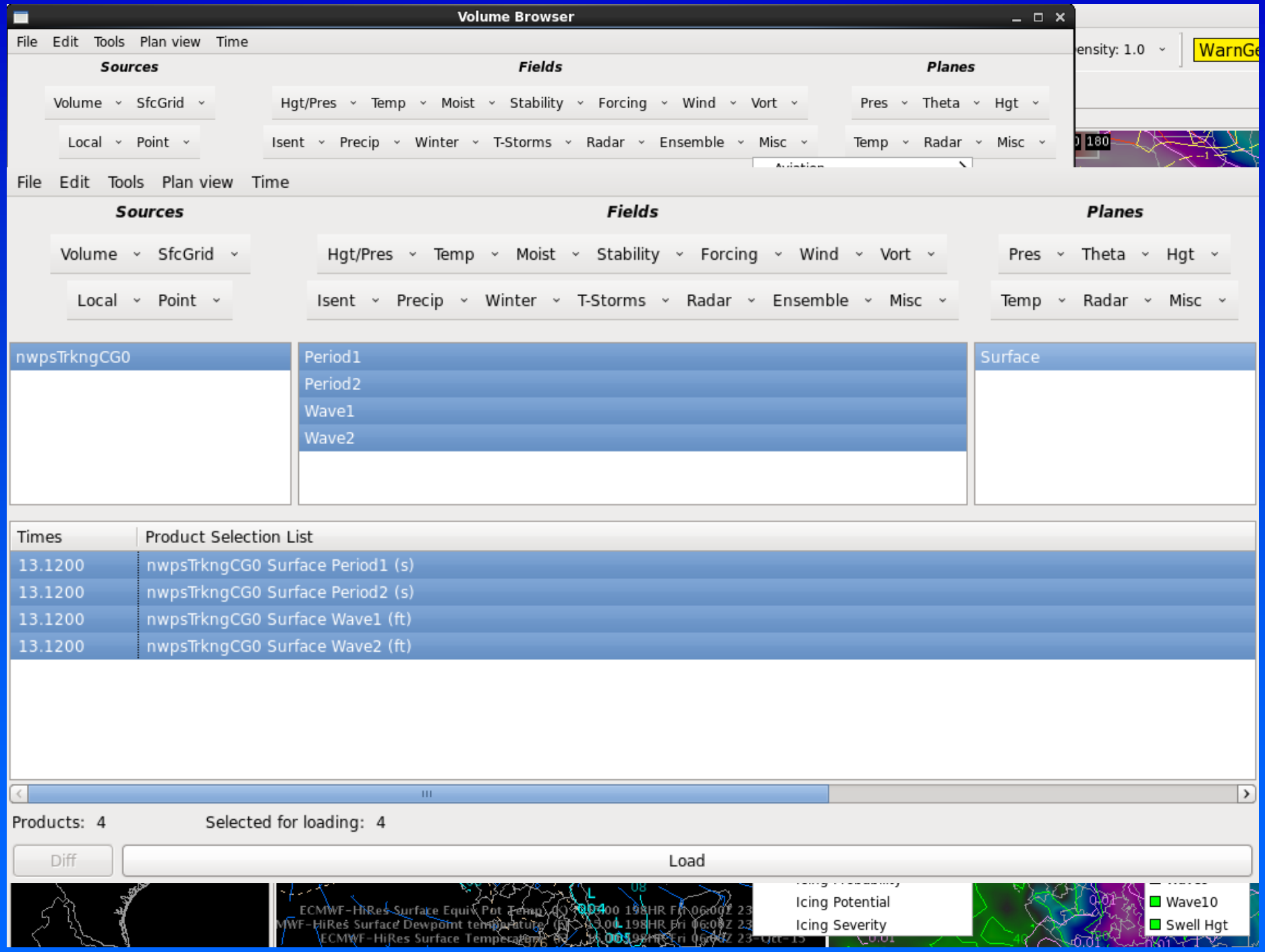
Products: 4 Selected for loading: 4

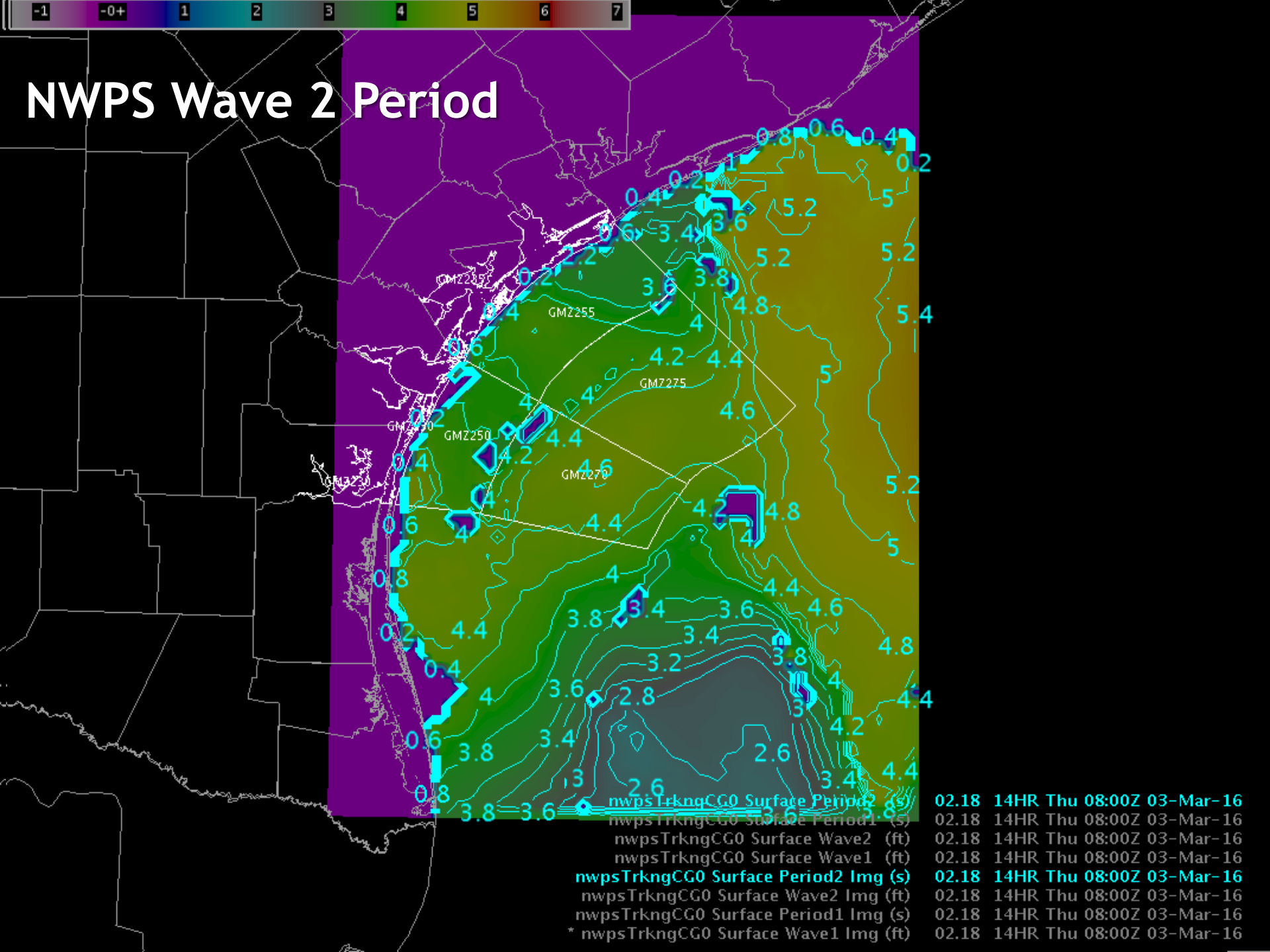
Diff Load

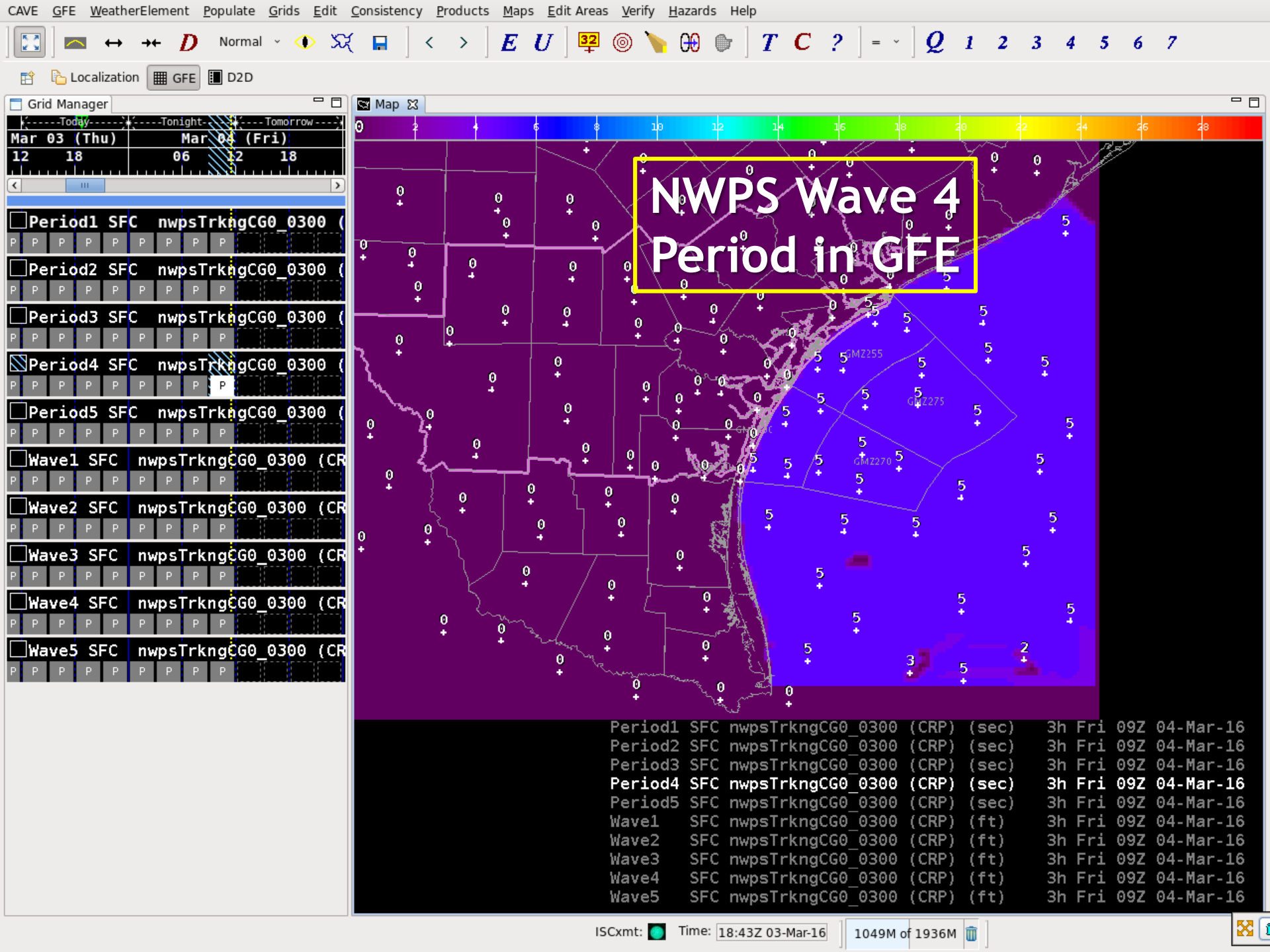



-35 30 25 20 15 10 5 -0+ 5
NWPS Swell Height
GMZ255
GMZ275
GMZ270
0.04ft
nwpsCG1 Surface Primary Wave Direction (03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Primary Wave Period (s) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Swell Height (ft) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Current Speed (cm/sec) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Deviation of sea level from mean (m) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Current Direction (03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Total Significant Wave Height (ft) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Swell Height Img (ft) 03.00 102HR Mon 06:00Z 07-Mar-16
nwpsCG1 Surface Primary Wave Period Img (s) 03.00 102HR Mon 06:00Z 07-Mar-16
* nwpsCG1 Surface Total Significant Wave Height Img (ft) 03.00 102HR Mon 06:00Z 07-Mar-16


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Normal
Localization GFE D2D
Grid Manager
Day 3 Day 4 Day 5
Mar 06 (Sun) Mar 07 (Mon)
12 18 06 12 18
WaveHeight SFC nwpsCG1_0300 (CR
Period SFC nwpsCG1_0300 (CRP)
SwanSwell SFC nwpsCG1_0300 (CRP
Map
0.00 0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050 0.055
NWPS Swell Height in GFE
WaveHeight SFC nwpsCG1_0300 (CRP) (ft) 3h Mon 06Z 07-Mar-16
Period SFC nwpsCG1_0300 (CRP) (sec) 3h Mon 06Z 07-Mar-16
SwanSwell SFC nwpsCG1_0300 (CRP) (ft) 3h Mon 06Z 07-Mar-16
ISCxmt:
Time: 18:39Z 03-Mar-16
1060M of 1936M

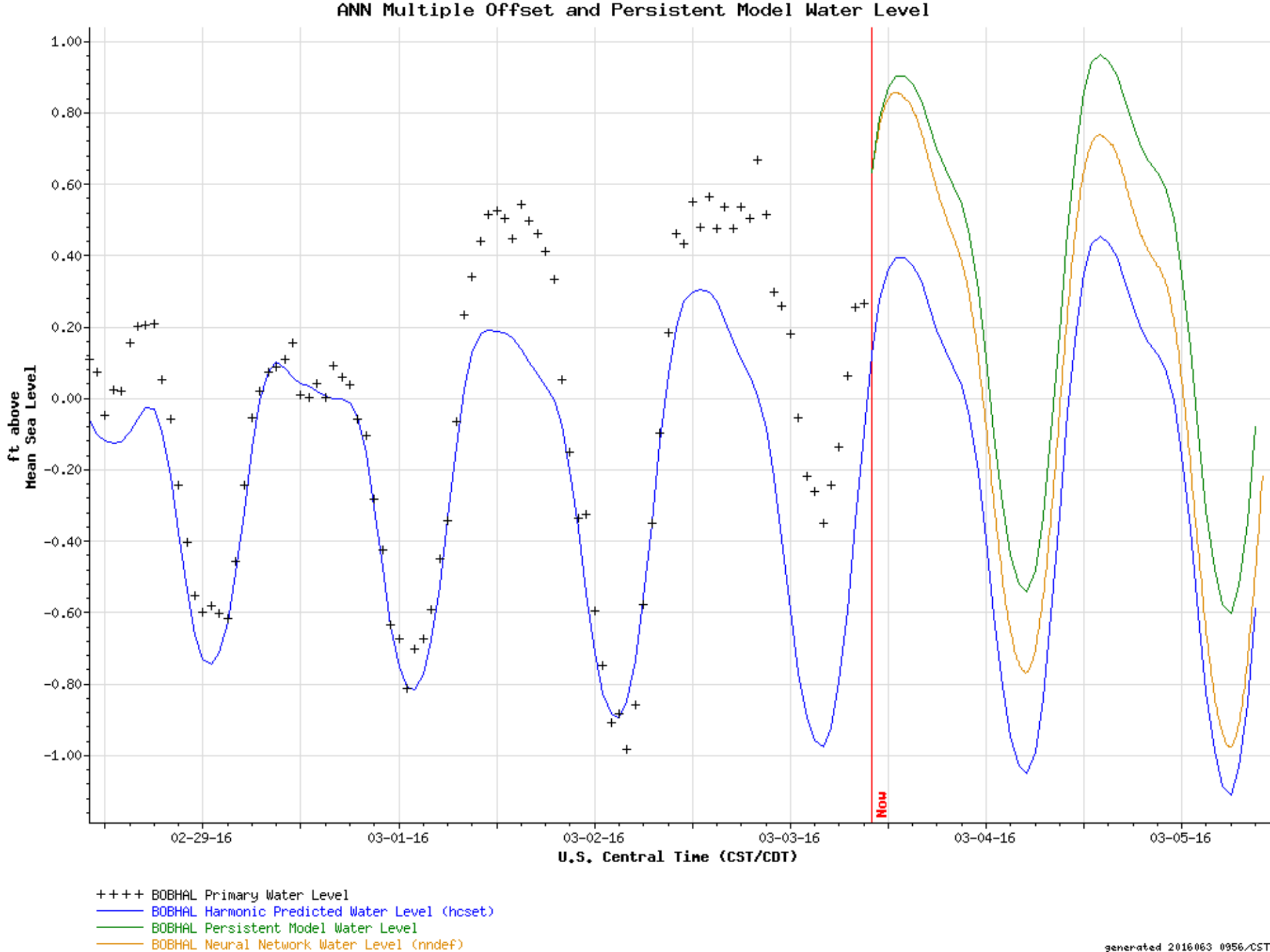

Volume Browser
File Edit Tools Plan view Time
Sources
Volume SfcGrid
Local Point
Fields
Hgt/Pres Temp Moist Stability Forcing Wind Vort
Isent Precip Winter T-Storms Radar Ensemble Misc
Planes
Pres Theta Hgt
Temp Radar Misc
File Edit Tools Plan view Time
Sources
Volume SfcGrid
Local Point
Fields
Hgt/Pres Temp Moist Stability Forcing Wind Vort
Isent Precip Winter T-Storms Radar Ensemble Misc
Planes
Pres Theta Hgt
Temp Radar Misc
nwpsTrkngCG0
Period1
Period2
Wave1
Wave2
Surface
Times
Product Selection List
13.1200 nwpsTrkngCG0 Surface Period1 (s)
13.1200 nwpsTrkngCG0 Surface Period2 (s)
13.1200 nwpsTrkngCG0 Surface Wave1 (ft)
13.1200 nwpsTrkngCG0 Surface Wave2 (ft)
Products: 4
Selected for loading: 4
Diff
Load
Icing Potential
Icing Severity
Wave10
Swell Hgt

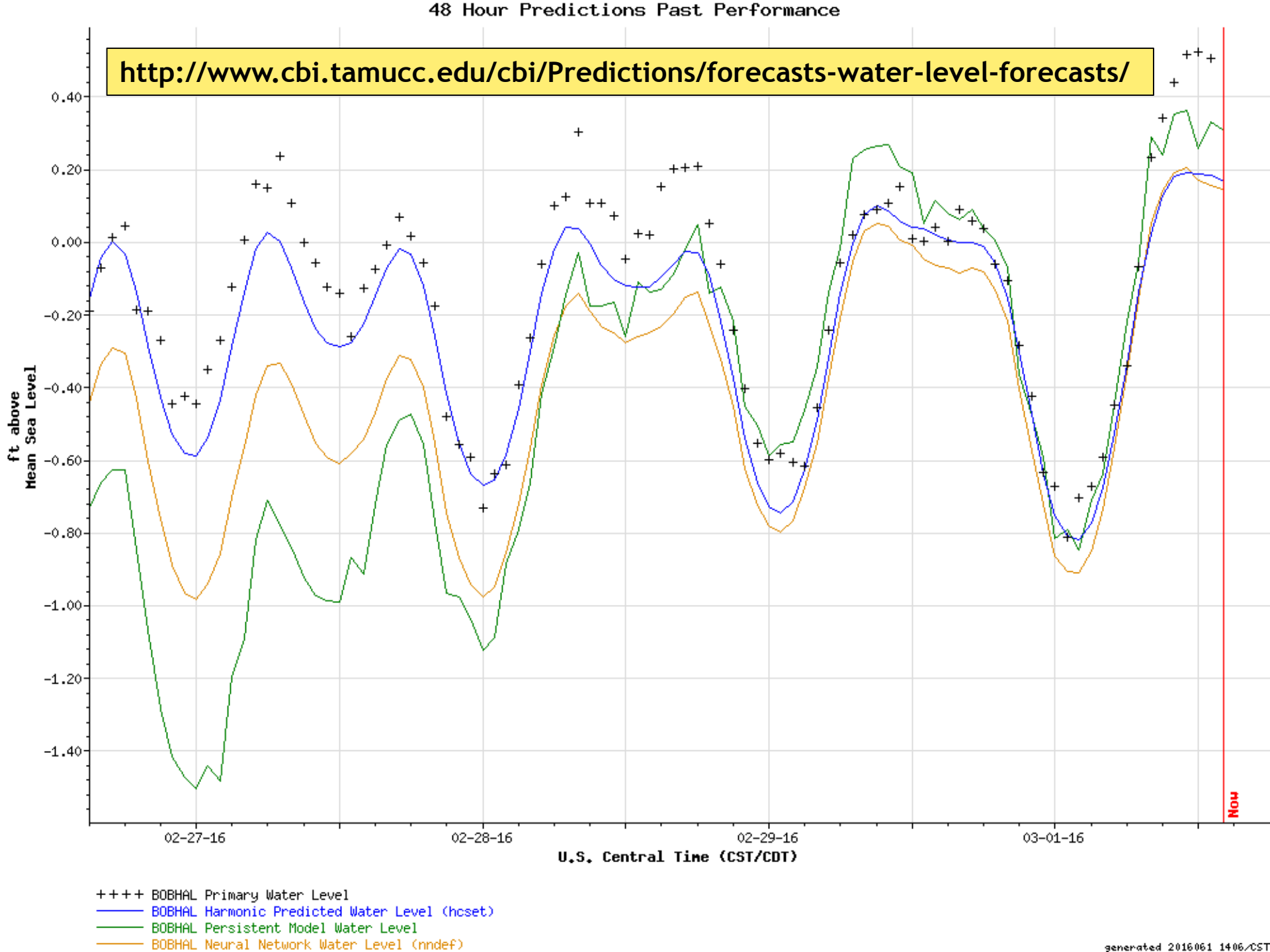

-1
-0+
1
2
3
4
5
6
7
NWPS Wave 2 Period
GMZ235
GMZ255
GMZ275
GMZ250
GMZ270
nwpsTrkngCG0 Surface Period2 (s) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Period1 (s) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Wave2 (ft) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Wave1 (ft) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Period2 Img (s) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Wave2 Img (ft) 02.18 14HR Thu 08:00Z 03-Mar-16
nwpsTrkngCG0 Surface Period1 Img (s) 02.18 14HR Thu 08:00Z 03-Mar-16
* nwpsTrkngCG0 Surface Wave1 Img (ft) 02.18 14HR Thu 08:00Z 03-Mar-16


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Normal
Localization GFE D2D
Grid Manager
Today Tonight Tomorrow
Mar 03 (Thu) Mar 04 (Fri)
12 18 06 12 18
Period1 SFC nwpsTrkngCG0_0300 (
Period2 SFC nwpsTrkngCG0_0300 (
Period3 SFC nwpsTrkngCG0_0300 (
Period4 SFC nwpsTrkngCG0_0300 (
Period5 SFC nwpsTrkngCG0_0300 (
Wave1 SFC nwpsTrkngCG0_0300 (CR
Wave2 SFC nwpsTrkngCG0_0300 (CR
Wave3 SFC nwpsTrkngCG0_0300 (CR
Wave4 SFC nwpsTrkngCG0_0300 (CR
Wave5 SFC nwpsTrkngCG0_0300 (CR
Map
NWPS Wave 4
Period in GFE
GMZ255
GMZ275
GMZ270
Period1 SFC nwpsTrkngCG0_0300 (CRP) (sec) 3h Fri 09Z 04-Mar-16
Period2 SFC nwpsTrkngCG0_0300 (CRP) (sec) 3h Fri 09Z 04-Mar-16
Period3 SFC nwpsTrkngCG0_0300 (CRP) (sec) 3h Fri 09Z 04-Mar-16
Period4 SFC nwpsTrkngCG0_0300 (CRP) (sec) 3h Fri 09Z 04-Mar-16
Period5 SFC nwpsTrkngCG0_0300 (CRP) (sec) 3h Fri 09Z 04-Mar-16
Wave1 SFC nwpsTrkngCG0_0300 (CRP) (ft) 3h Fri 09Z 04-Mar-16
Wave2 SFC nwpsTrkngCG0_0300 (CRP) (ft) 3h Fri 09Z 04-Mar-16
Wave3 SFC nwpsTrkngCG0_0300 (CRP) (ft) 3h Fri 09Z 04-Mar-16
Wave4 SFC nwpsTrkngCG0_0300 (CRP) (ft) 3h Fri 09Z 04-Mar-16
Wave5 SFC nwpsTrkngCG0_0300 (CRP) (ft) 3h Fri 09Z 04-Mar-16
ISCxmt:
Time: 18:43Z 03-Mar-16
1049M of 1936M

TAMUCC-CBI's Artificial Neural Network Water Level Forecasts (ANN)

- One of the "more accurate" water level forecasts.
- Uses NAM winds.
- Tidal/Water levels in the Coastal Bend are forced mostly by wind.
  - Small astronomical influence

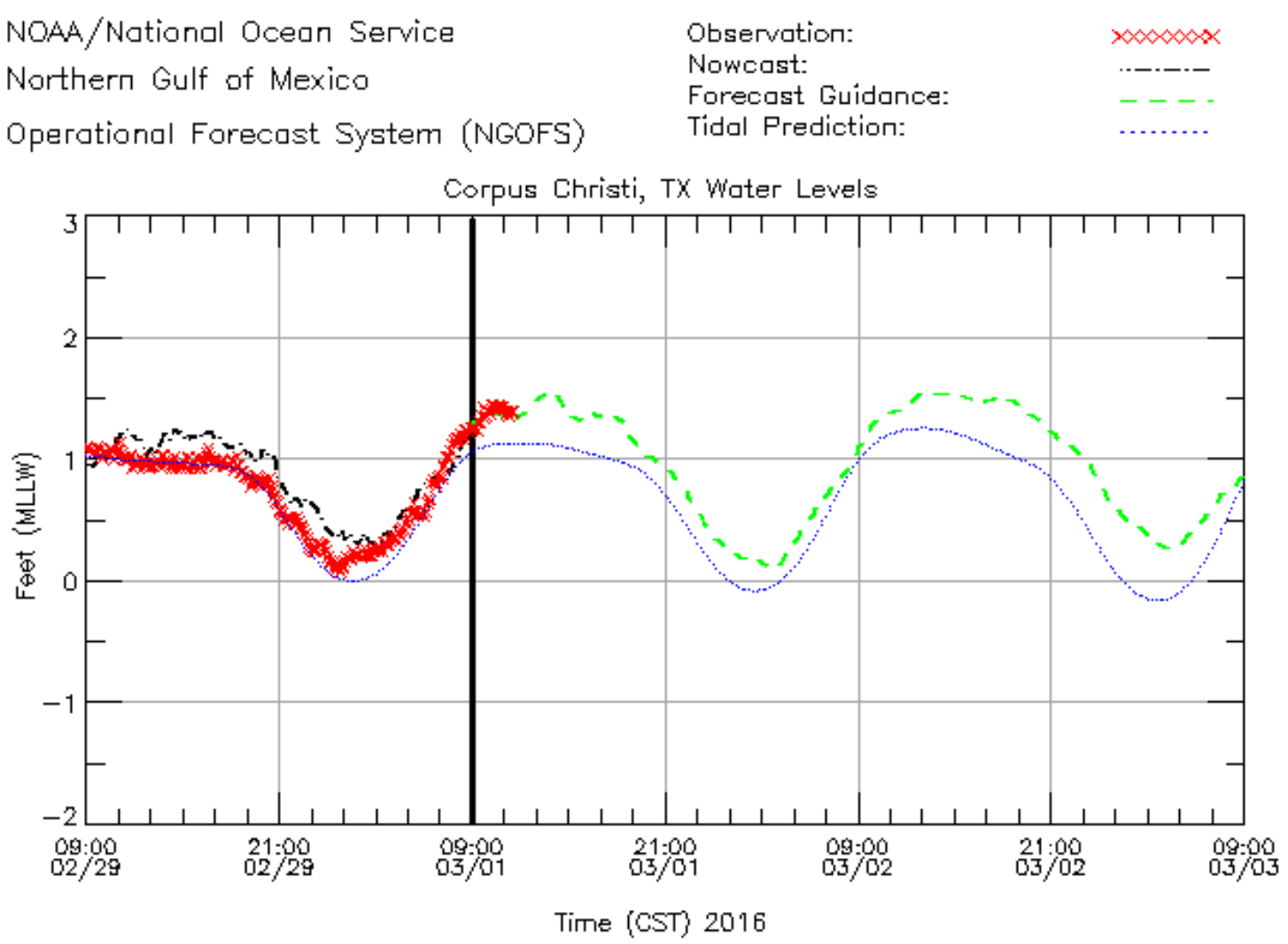

ANN Multiple Offset and Persistent Model Water Level
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
ft above
Mean Sea Level
Now
02-29-16
03-01-16
03-02-16
03-03-16
03-04-16
03-05-16
U.S. Central Time (CST/CDT)
++++ BOBHAL Primary Water Level
BOBHAL Harmonic Predicted Water Level (hcset)
BOBHAL Persistent Model Water Level
BOBHAL Neural Network Water Level (nndef)
generated 2016063 0956/CST


48 Hour Predictions Past Performance
http://www.cbi.tamucc.edu/cbi/Predictions/forecasts-water-level-forecasts/
ft above Mean Sea Level
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
02-27-16
02-28-16
02-29-16
03-01-16
Now
U.S. Central Time (CST/CDT)
++++ BOBHAL Primary Water Level
BOBHAL Harmonic Predicted Water Level (hcset)
BOBHAL Persistent Model Water Level
BOBHAL Neural Network Water Level (nndef)
generated 2016061 1406/CST

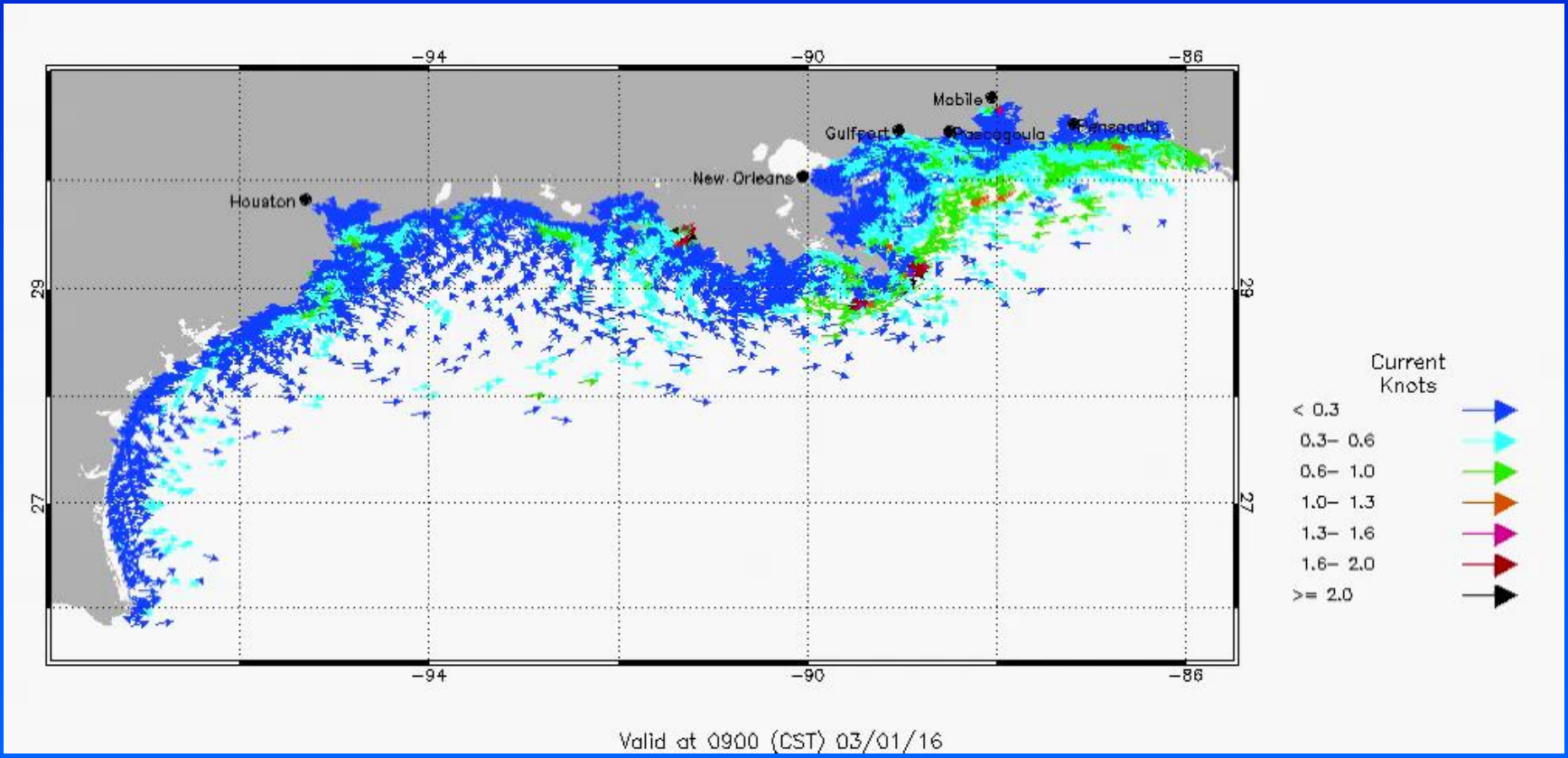
National Ocean Service's
Northern Gulf of Mexico Operational Forecast System (NGOFS)

- Finite Volume Coastal Ocean Model (FVCOM)
- Uses NAM winds.
- Inputs from RTOFS, ETSS, ADCIRC, USGS, and CO-OPS.
- Runs 4 times a day.
- Produces 0-48 hour forecasts of:
  - Water Levels
  - Currents
  - Water Temperature
  - Salinity

NGOFS Water Level Forecast



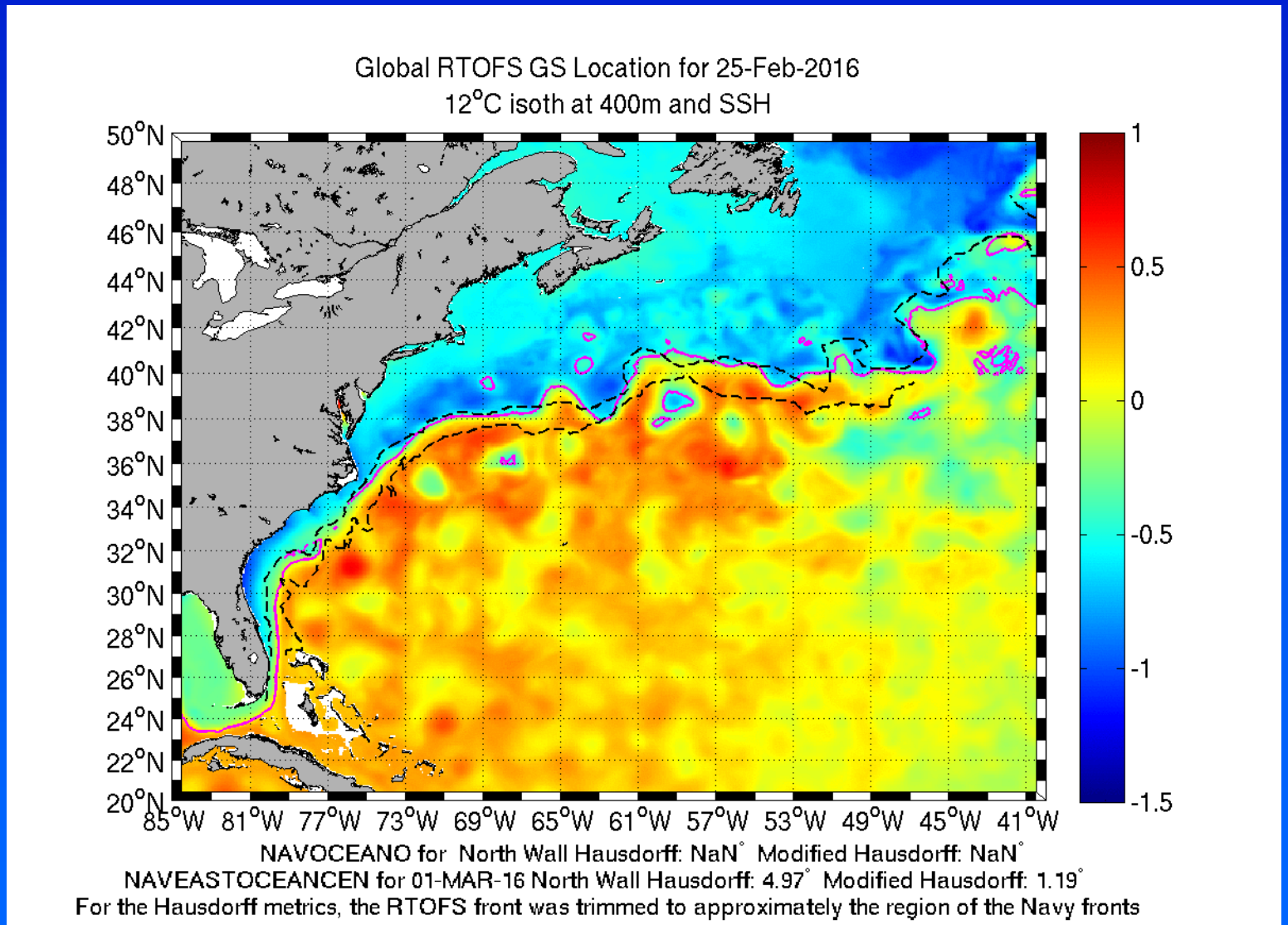
NGOFS Currents Forecast



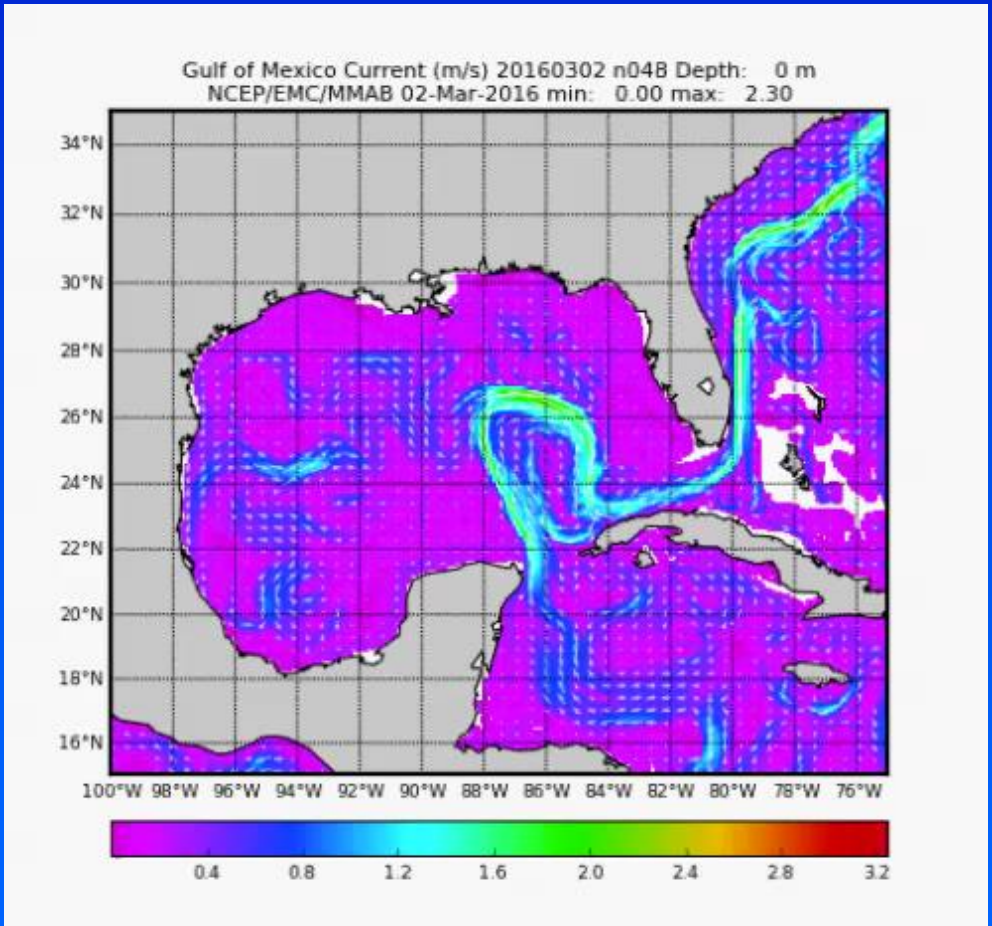
Global Real Time Ocean Forecast System (RTOFS)

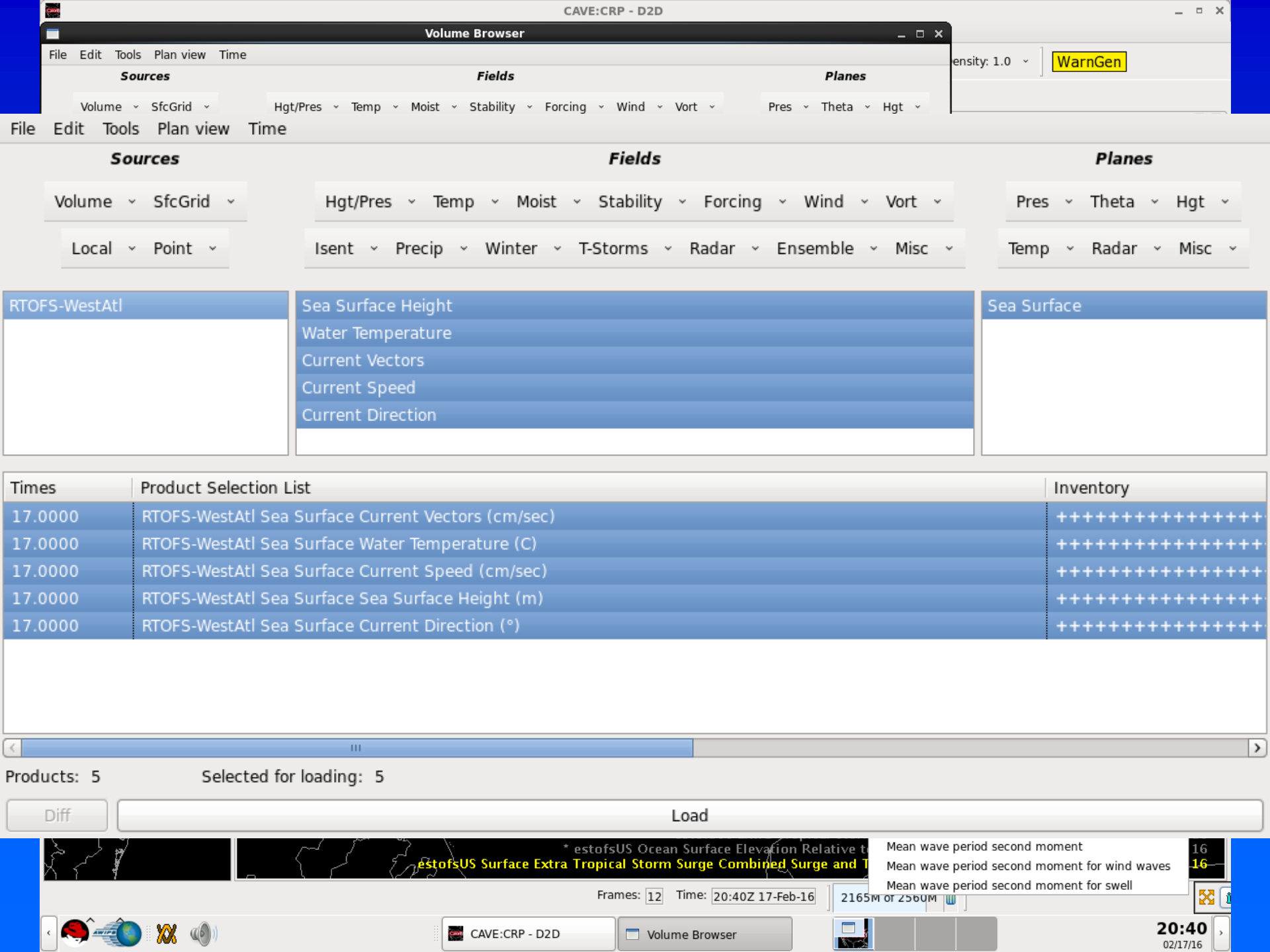
- Based upon a global Hybrid Coordinates Ocean Model (**HYCOM**) at 1/12° resolution.
- Runs once a day.
- 2-day nowcasts.
- 6-day forecasts.
- Outputs variables such as:
  - **Currents (Used by NWPS)**
  - Water Temperature
  - Salinity
  - Sea Surface Height
  - Ice Thickness/Cover
  - Mixed Layer

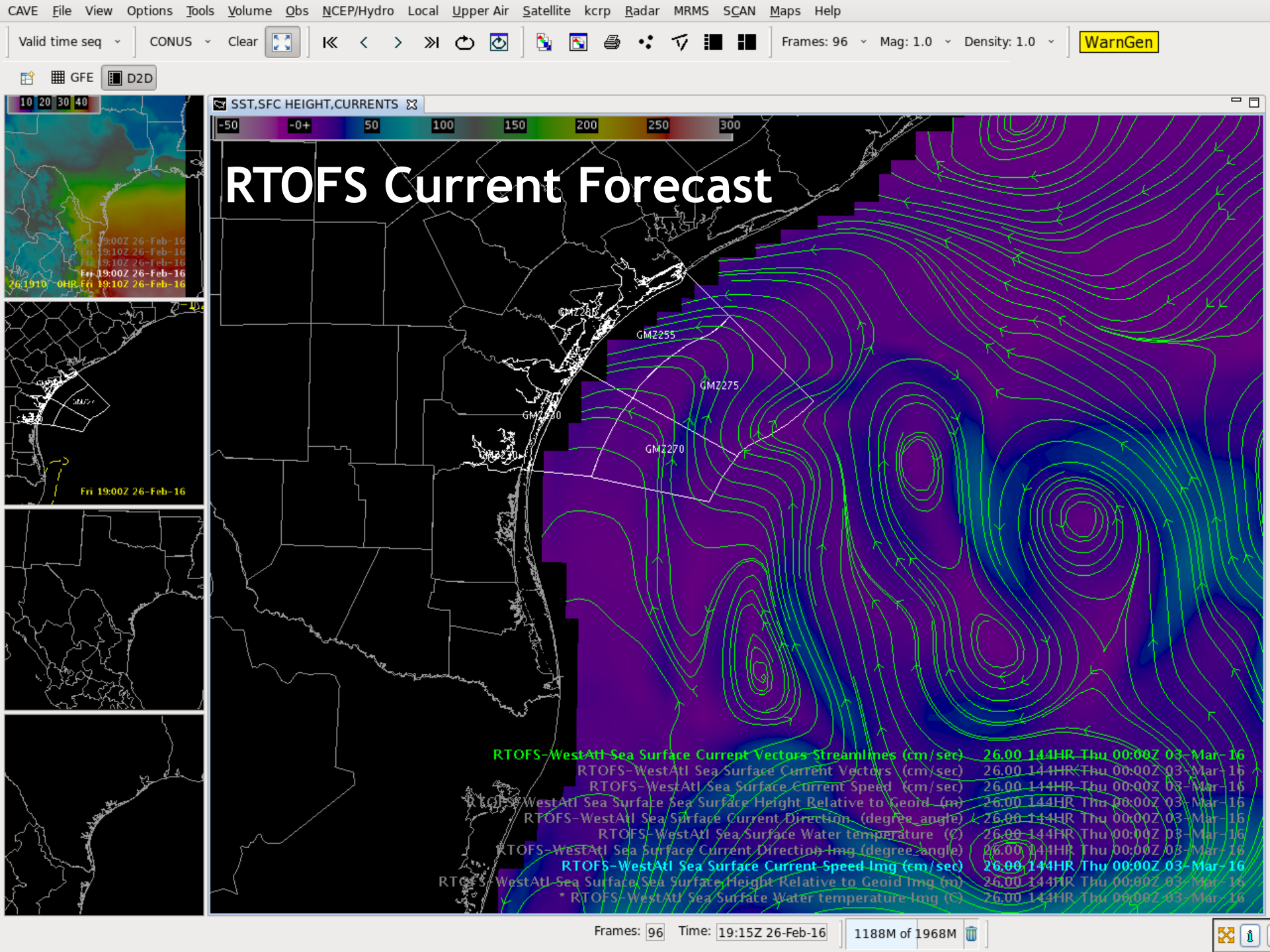
RTOFS Output



RTOFS Gulf Current Forecast

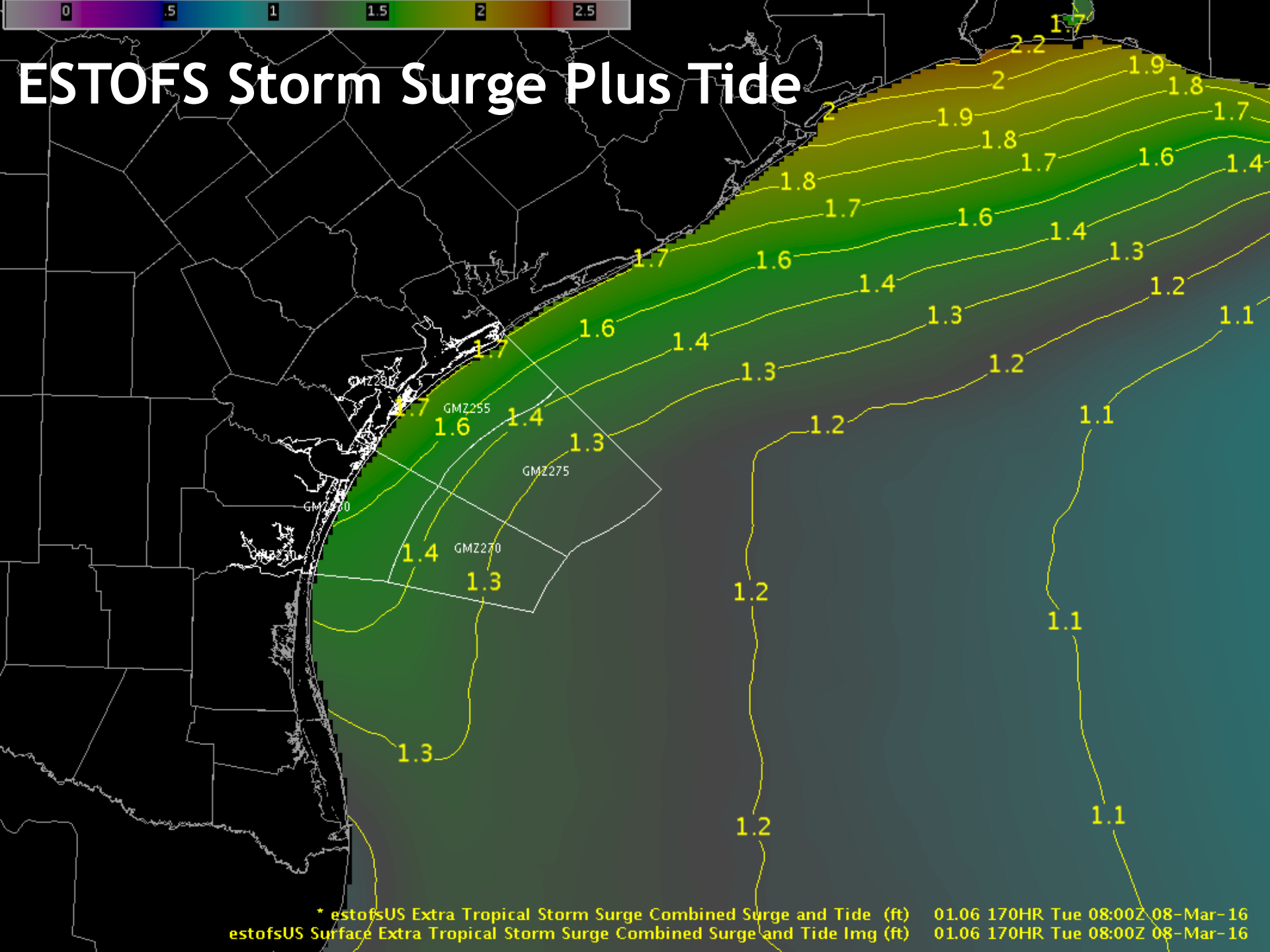


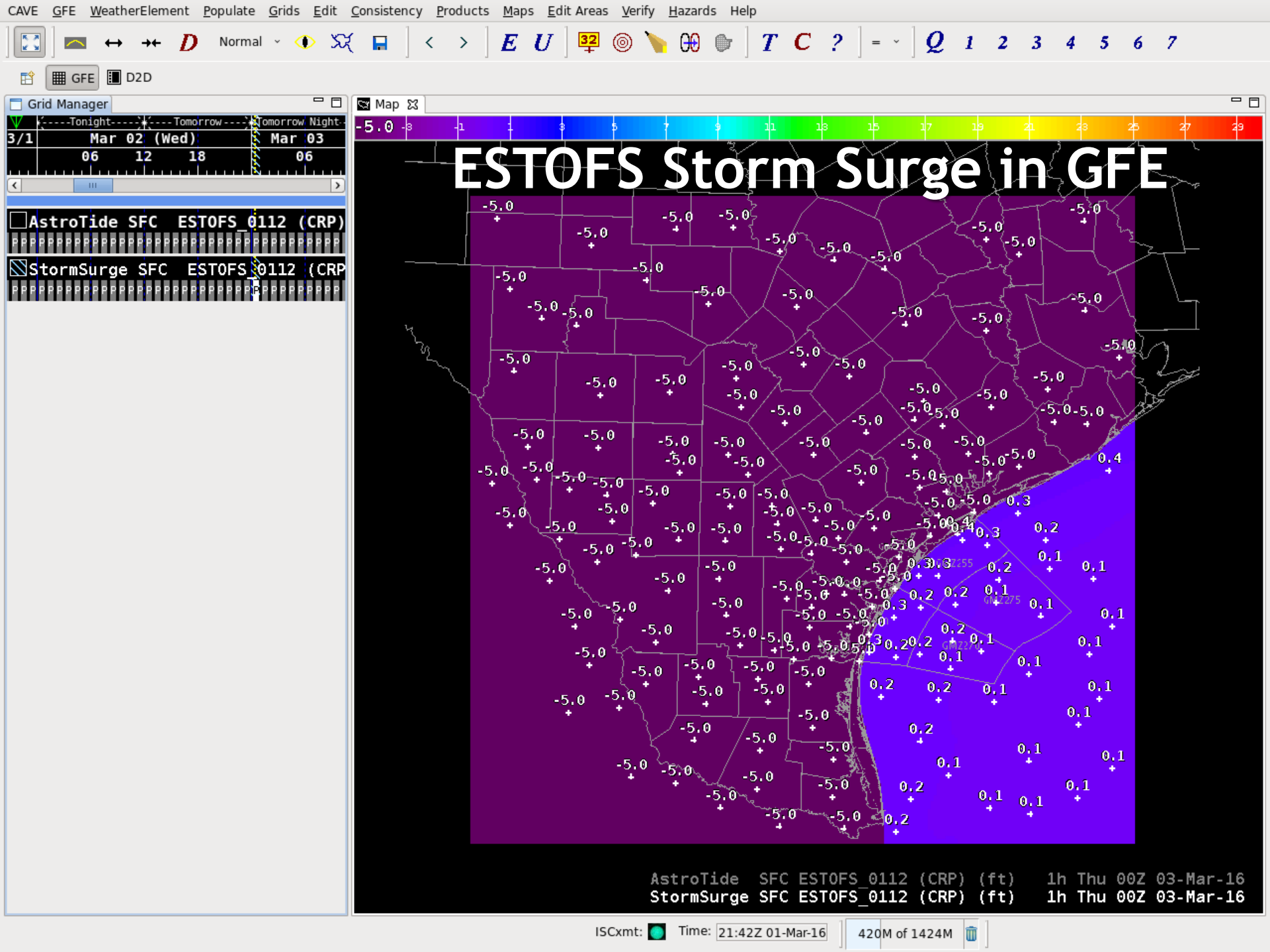

CAVE:CRP - D2D
Volume Browser
File Edit Tools Plan view Time
Sources
Fields
Planes
Volume SfcGrid
Hgt/Pres Temp Moist Stability Forcing Wind Vort
Pres Theta Hgt
WarnGen
File Edit Tools Plan view Time
Sources
Fields
Planes
Volume SfcGrid
Hgt/Pres Temp Moist Stability Forcing Wind Vort
Pres Theta Hgt
Local Point
Isent Precip Winter T-Storms Radar Ensemble Misc
Temp Radar Misc
RTOFS-WestAtl
Sea Surface Height
Water Temperature
Current Vectors
Current Speed
Current Direction
Sea Surface
Times
Product Selection List
Inventory
17.0000 RTOFS-WestAtl Sea Surface Current Vectors (cm/sec)
17.0000 RTOFS-WestAtl Sea Surface Water Temperature (C)
17.0000 RTOFS-WestAtl Sea Surface Current Speed (cm/sec)
17.0000 RTOFS-WestAtl Sea Surface Sea Surface Height (m)
17.0000 RTOFS-WestAtl Sea Surface Current Direction (°)
Products: 5
Selected for loading: 5
Diff
Load
estofsUS Surface Extra Tropical Storm Surge Combined Surge and T
Mean wave period second moment
Mean wave period second moment for wind waves
Mean wave period second moment for swell
Frames: 12
Time: 20:40Z 17-Feb-16
CAVE:CRP - D2D
Volume Browser
20:40
02/17/16


CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help
Valid time seq
CONUS
Clear
Frames: 96
Mag: 1.0
Density: 1.0
WarnGen
GFE
D2D
SST,SFC HEIGHT,CURRENTS
-50 -0+ 50 100 150 200 250 300
RTOFS Current Forecast
GMZ255
GMZ275
GMZ270
RTOFS-WestAtl Sea Surface Current Vectors Streamlines (cm/sec) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Current Vectors (cm/sec) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Current Speed (cm/sec) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Sea Surface Height Relative to Geoid (m) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Current Direction (degree_angle) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Water temperature (C) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Current Direction Img (degree_angle) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Current Speed Img (cm/sec) 26.00 144HR Thu 00:00Z 03-Mar-16
RTOFS-WestAtl Sea Surface Sea Surface Height Relative to Geoid Img (m) 26.00 144HR Thu 00:00Z 03-Mar-16
* RTOFS-WestAtl Sea Surface Water temperature Img (C) 26.00 144HR Thu 00:00Z 03-Mar-16
Fri 19:00Z 26-Feb-16
Frames: 96
Time: 19:15Z 26-Feb-16
1188M of 1968M

Extratropical Surge and Tide Operational Forecast System (ESTOFS)

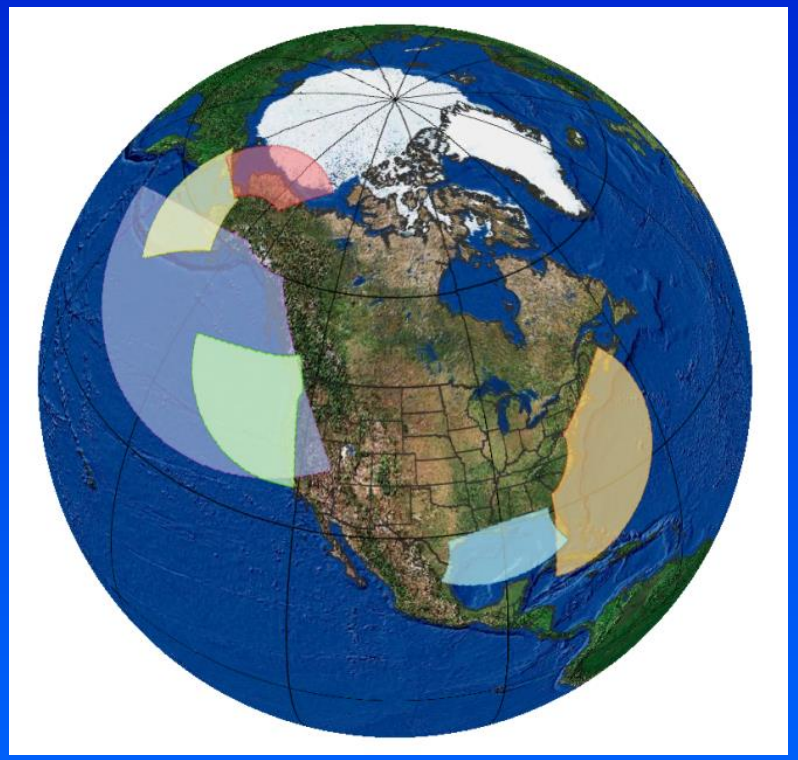
- Uses the ADCIRC model.
- Runs 4 times a day out to 180 hours.
- 2.5 km resolution.
- Uses GFS winds and pressure.
- Outputs:
  - **Storm Surge Plus Tide (Used by NWPS)**
  - Storm Surge
  - Tide
- NOT to be used for Tropical Cyclones.


0
.5
1
1.5
2
2.5
ESTOFS Storm Surge Plus Tide
GMZ255
GMZ275
GMZ270
* estofsUS Extra Tropical Storm Surge Combined Surge and Tide (ft) 01.06 170HR Tue 08:00Z 08-Mar-16
estofsUS Surface Extra Tropical Storm Surge Combined Surge and Tide Img (ft) 01.06 170HR Tue 08:00Z 08-Mar-16


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Normal
GFE D2D
Grid Manager
Tonight Tomorrow Tomorrow Night
3/1 Mar 02 (Wed) Mar 03
06 12 18 06
AstroTide SFC ESTOFS_0112 (CRP)
StormSurge SFC ESTOFS_0112 (CRP
Map
-5.0
ESTOFS Storm Surge in GFE
AstroTide SFC ESTOFS_0112 (CRP) (ft) 1h Thu 00Z 03-Mar-16
StormSurge SFC ESTOFS_0112 (CRP) (ft) 1h Thu 00Z 03-Mar-16
ISCxmt:
Time: 21:42Z 01-Mar-16
420M of 1424M

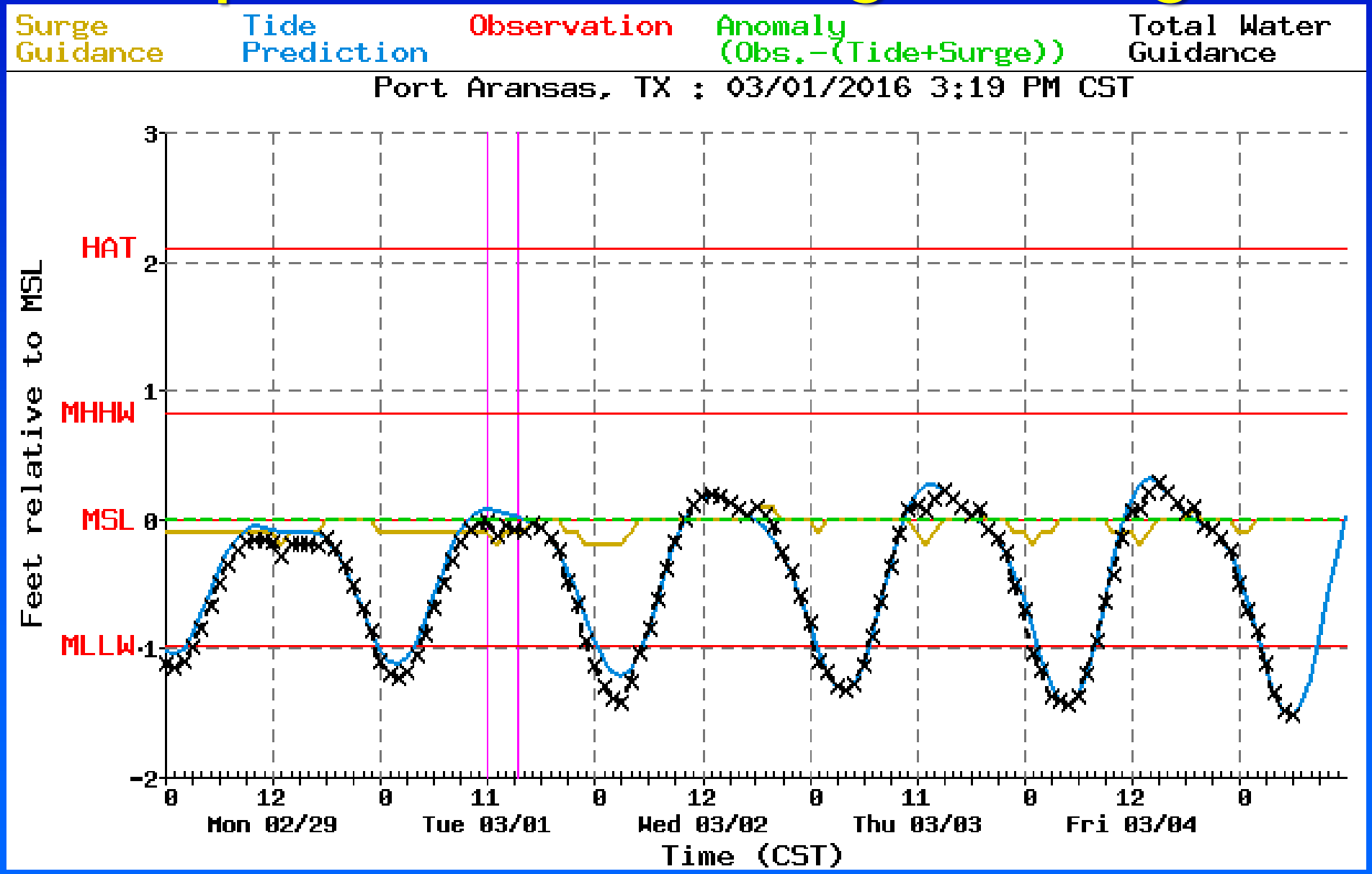
MDL's ExtraTropical Storm Surge (ETSS or ET-SURGE)

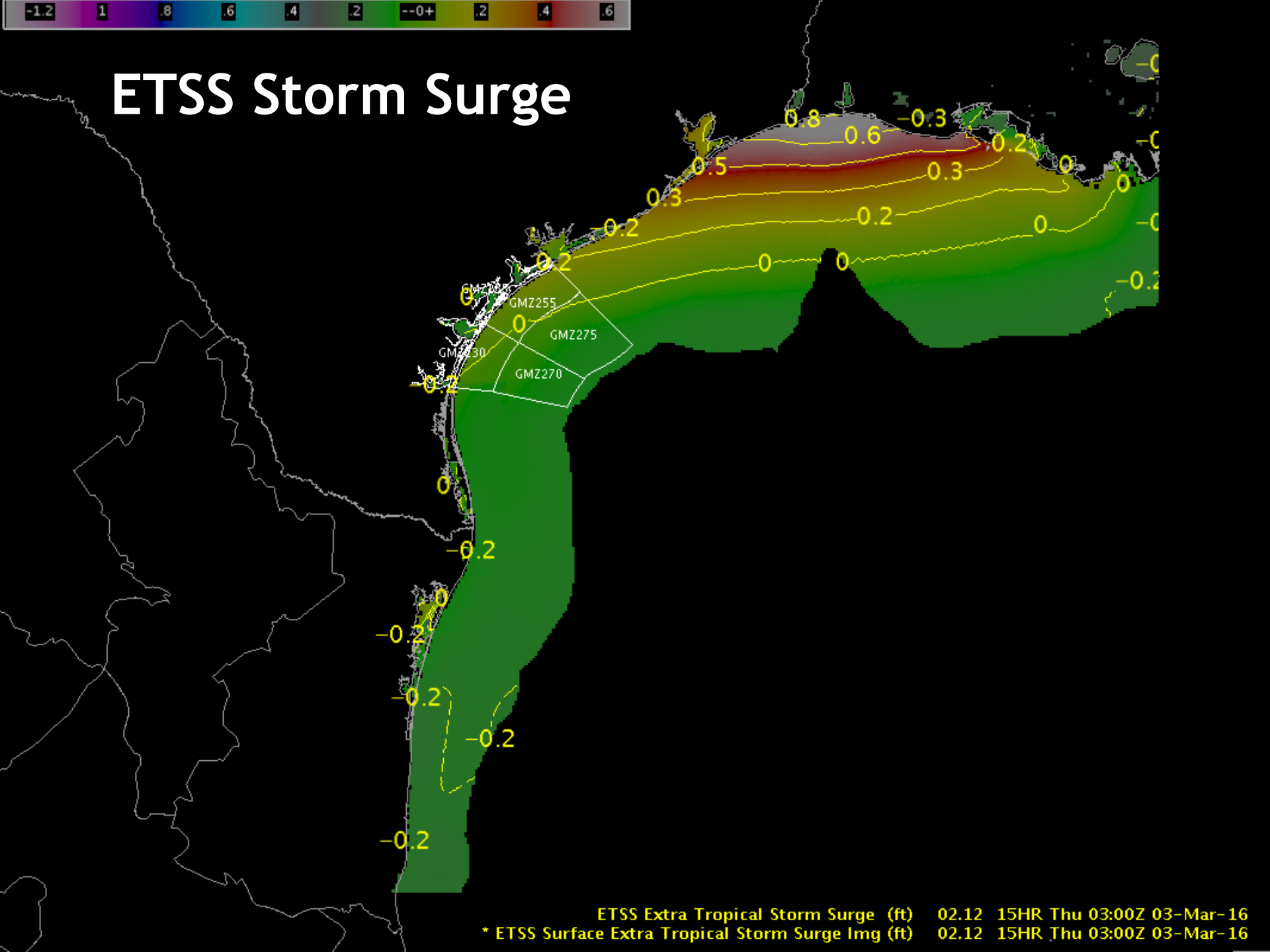
- Based upon SLOSH.
- Runs 4 times a day out to 96 hours.
- 5 km resolution.
- Uses GFS winds and pressure.
- Outputs Storm Surge only.
  - Areal
  - Point
- NOT to be used for Tropical Cyclones.

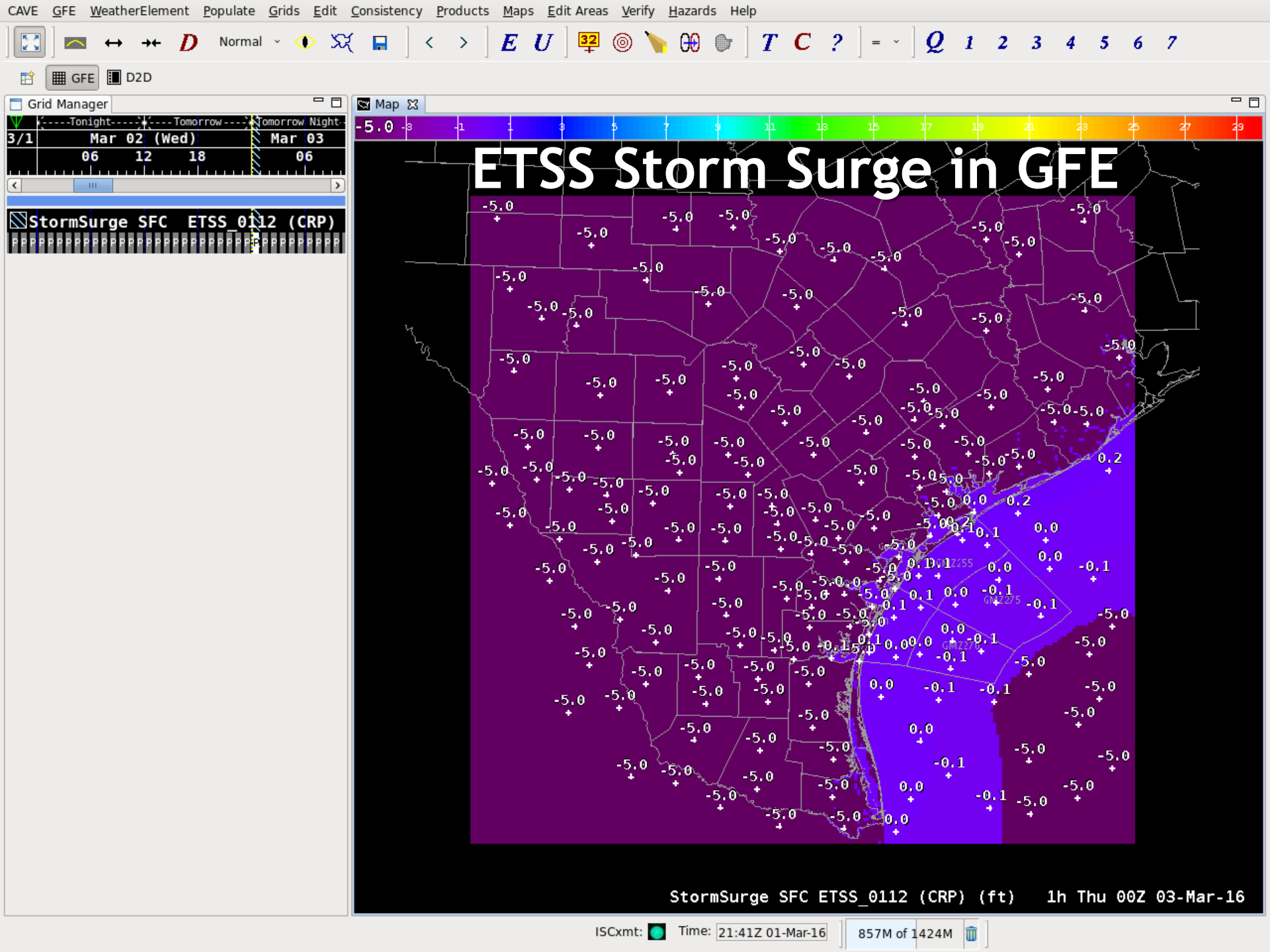


ETSS Point Output

http://slosh.nws.noaa.gov/etsurge/




-1.2
1
.8
.6
.4
.2
--0+
.2
.4
.6
ETSS Storm Surge
GMZ255
GMZ275
GMZ270
ETSS Extra Tropical Storm Surge (ft) 02.12 15HR Thu 03:00Z 03-Mar-16
* ETSS Surface Extra Tropical Storm Surge Img (ft) 02.12 15HR Thu 03:00Z 03-Mar-16


CAVE GFE WeatherElement Populate Grids Edit Consistency Products Maps Edit Areas Verify Hazards Help
Normal
GFE D2D
Grid Manager
Tonight Tomorrow Tomorrow Night
3/1 Mar 02 (Wed) Mar 03
06 12 18 06
StormSurge SFC ETSS_0112 (CRP)
Map
-5.0
ETSS Storm Surge in GFE
StormSurge SFC ETSS_0112 (CRP) (ft) 1h Thu 00Z 03-Mar-16
ISCxmt:
Time: 21:41Z 01-Mar-16
857M of 1424M

MDL's SLOSH

- **S**ea, **L**ake, and **O**verland **S**urges from **H**urricanes
- Began in the late 60s/early 70s.
- Estimate storm surge from historical, hypothetical, and/or predicted hurricanes.
- Factors affecting storm surge are incorporated.
- Run on specific basins.

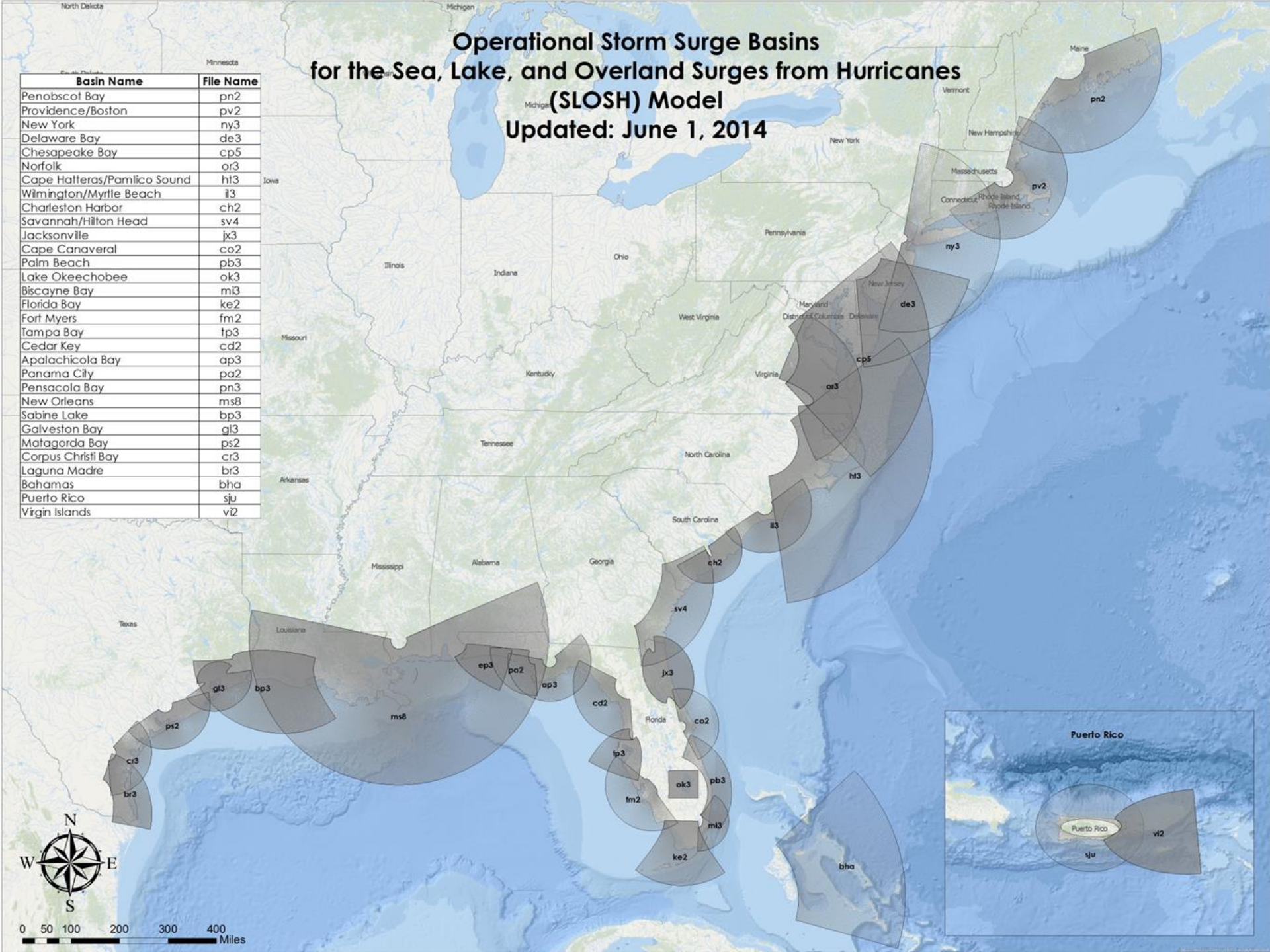
Factors Affecting Storm Surge

- Intensity
- Size (Radius of Maximum Winds)
- Central Pressure
- Forward Speed
- Angle of Approach
- Width and Slope of Shelf
- Shape of Coastline
- Local Features
  - Bays, rivers, islands, sounds, inlets

Operational Storm Surge Basins for the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model

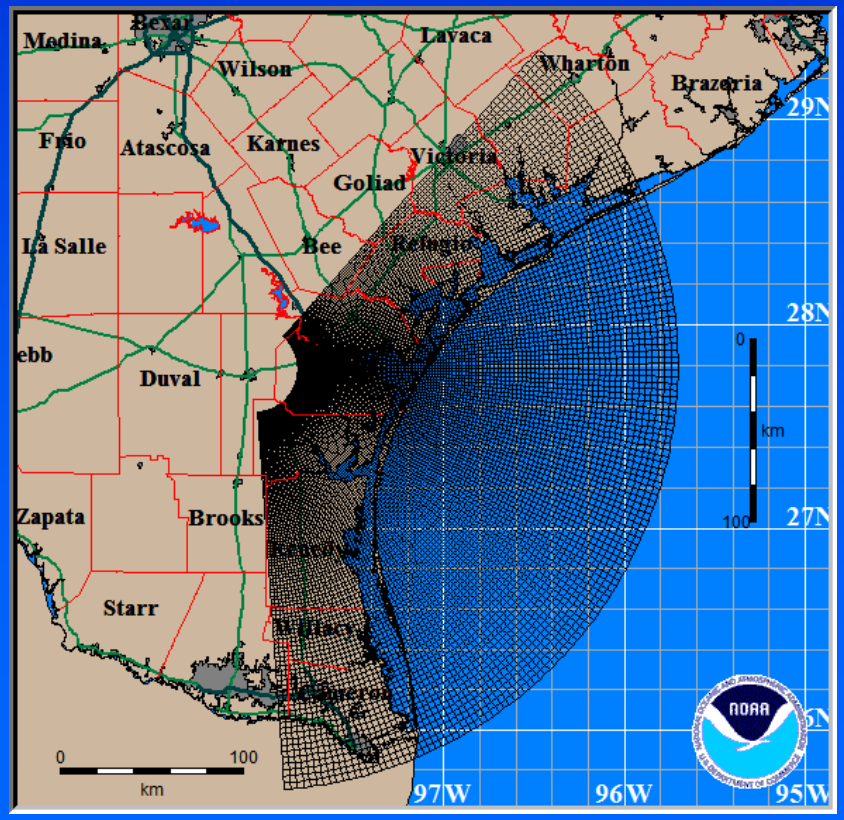
Updated: June 1, 2014

Basin Name	File Name
Penobscot Bay	pn2
Providence/Boston	pv2
New York	ny3
Delaware Bay	de3
Chesapeake Bay	cp5
Norfolk	or3
Cape Hatteras/Pamlico Sound	ht3
Wilmington/Myrtle Beach	il3
Charleston Harbor	ch2
Savannah/Hilton Head	sv4
Jacksonville	jx3
Cape Canaveral	co2
Palm Beach	pb3
Lake Okeechobee	ok3
Biscayne Bay	mi3
Florida Bay	ke2
Fort Myers	fm2
Tampa Bay	tp3
Cedar Key	cd2
Apalachicola Bay	ap3
Panama City	pa2
Pensacola Bay	pn3
New Orleans	ms8
Sabine Lake	bp3
Galveston Bay	gl3
Matagorda Bay	ps2
Corpus Christi Bay	cr3
Laguna Madre	br3
Bahamas	bha
Puerto Rico	sju
Virgin Islands	vi2

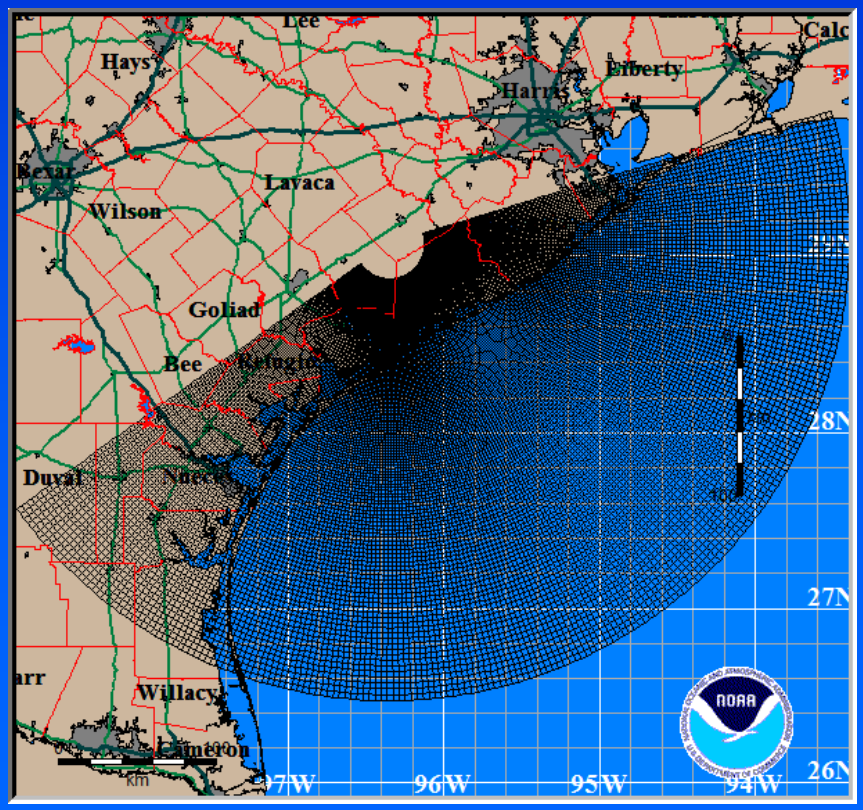


SLOSH Basins

Corpus Christi Bay Basin

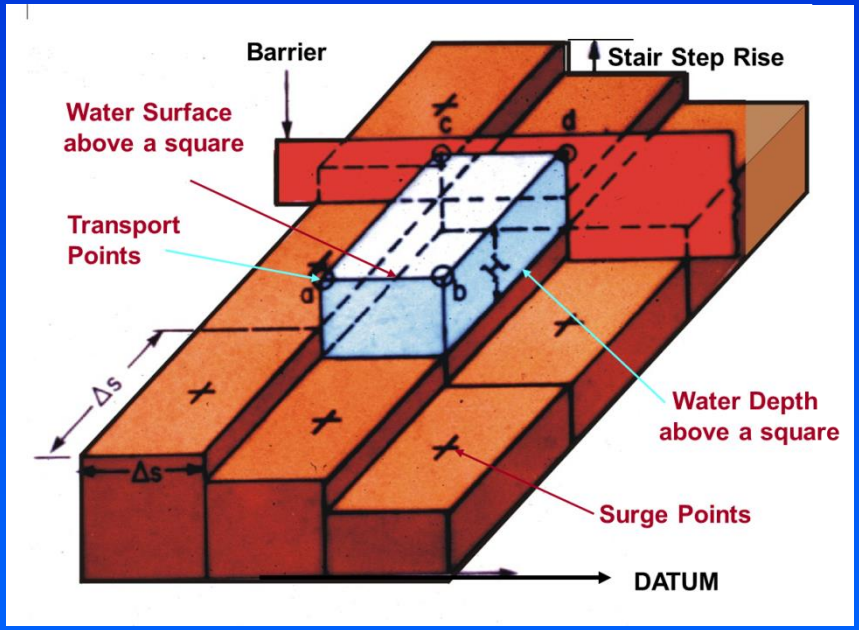


Matagorda Bay Basin



SLOSH Strengths

- Flow through barriers, gaps, and passes.
- Inland inundation.
- Overtopping of levees.
- Astronomical tide.
- Computationally efficient.
- **Ensemble Approach.**



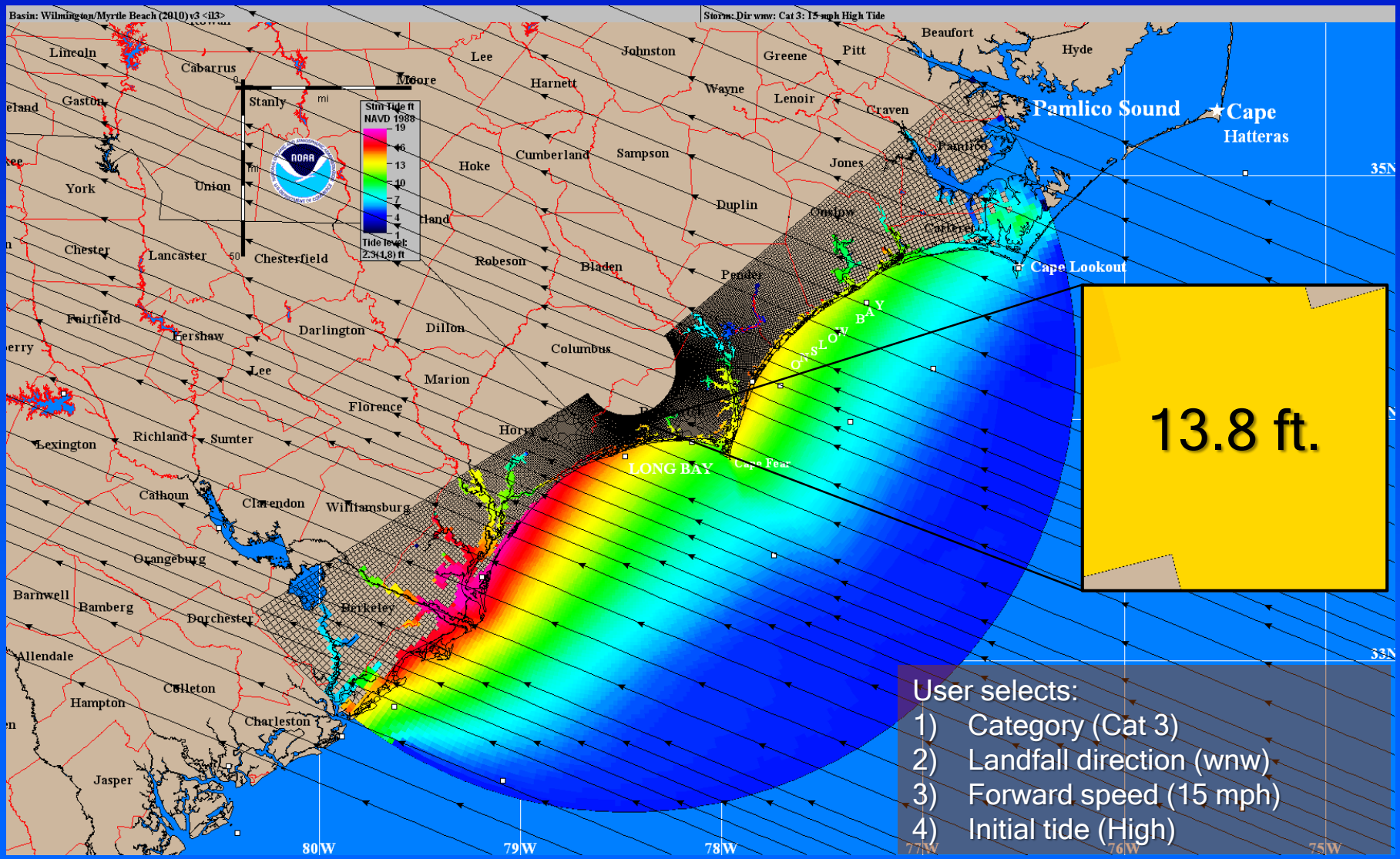
SLOSH Limitations

- Does not account for Wave action.
  - Wave Setup or Runup
- Does not account for Freshwater Flow.
  - Rivers
  - Rainfall
- **Total Water = Storm Surge + Tides + Waves + Freshwater Flow**

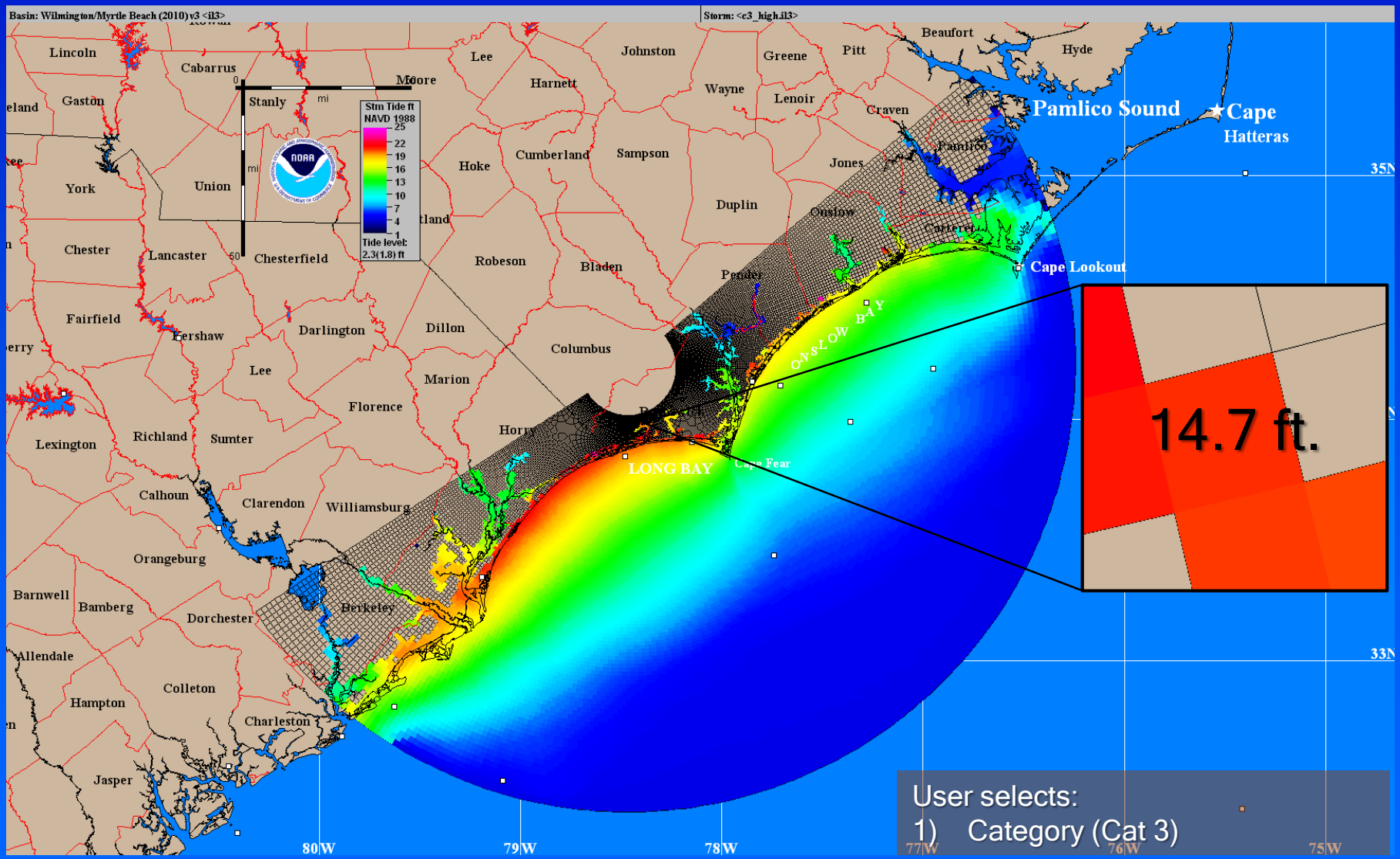
SLOSH Products

- **M**aximum **E**nvelopes **O**f **W**ater – **MEOWs**
- **M**aximum **O**f the **M**EOWs – **MOMs**
- **P**robabilistic Storm **Surge** – **P-Surge**

Maximum Envelopes of Water (MEOW)



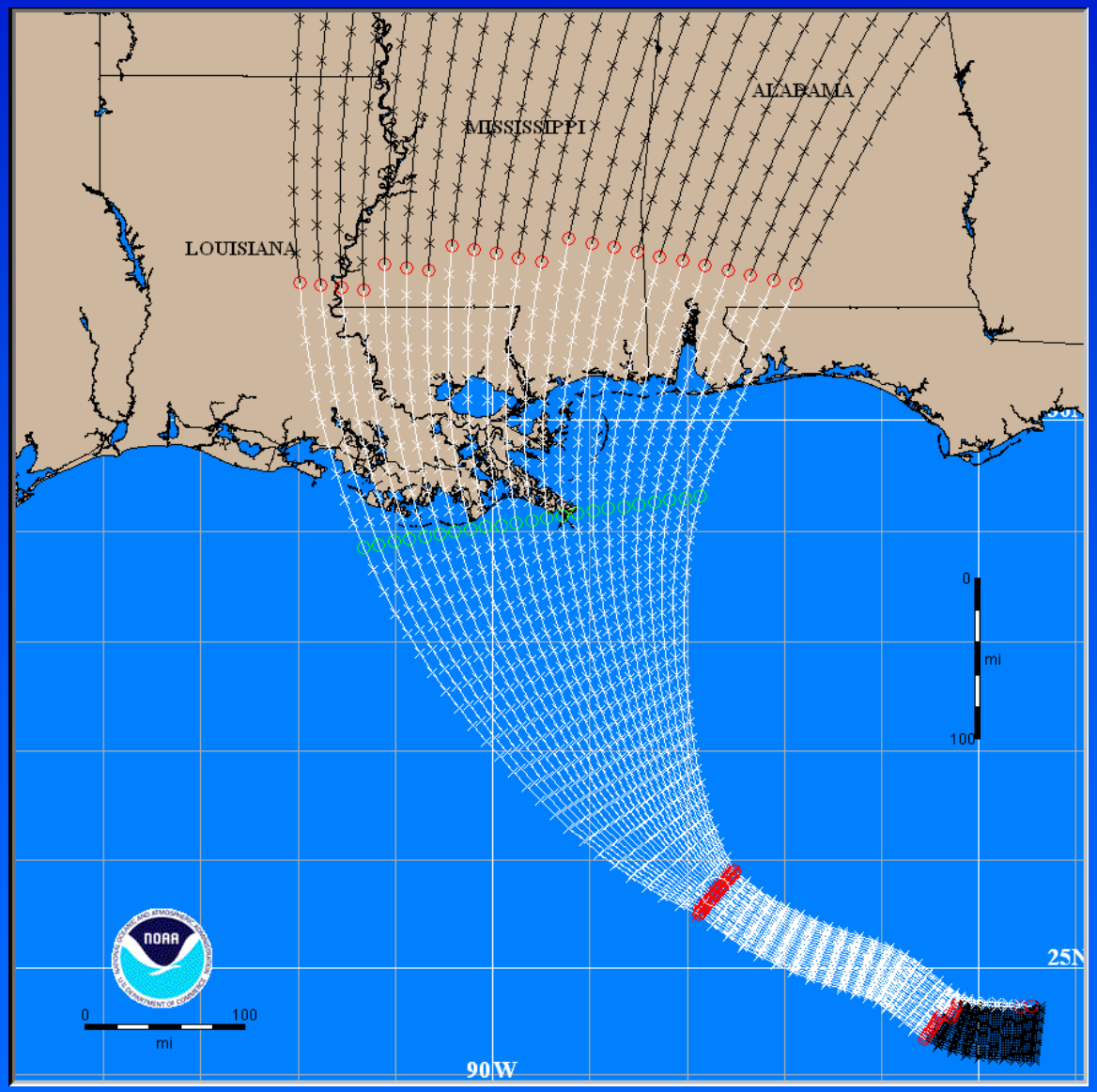
Maximum of the MEOWs (MOMs)



Probabilistic Storm Surge (P-Surge)

- Based on the official NHC forecast.
- Incorporates cross-track, along-track, and intensity historical errors.
- Incorporates different storm sizes.
- Potentially, thousands of hypothetical storms are produced.

Cross-Track Error



P-Surge Products

- Probability product
  - Probability of storm surge greater than **X feet**.
- Exceedance product
  - Storm surge value exceeded by **Y%** of storms.

Inundation

- (Storm Surge + Astronomical Tide) - Elevation = Inundation

Storm Tide

- (15 ft Storm Surge + 1 ft Tide) - 10 ft Elevation = 6 ft Inundation

- Probabilistic Hurricane Inundation Surge Height - **PHISH**

ABOUT

Experimental P-Surge 2.0: Probabilistic Hurricane Storm Surge (with tide)

MDL

Click Map to Zoom
Archive data HERE

Storm and Year
Bill2015

Advisory
2

Type
10% Exceedance Ht.

Datum
Above Ground

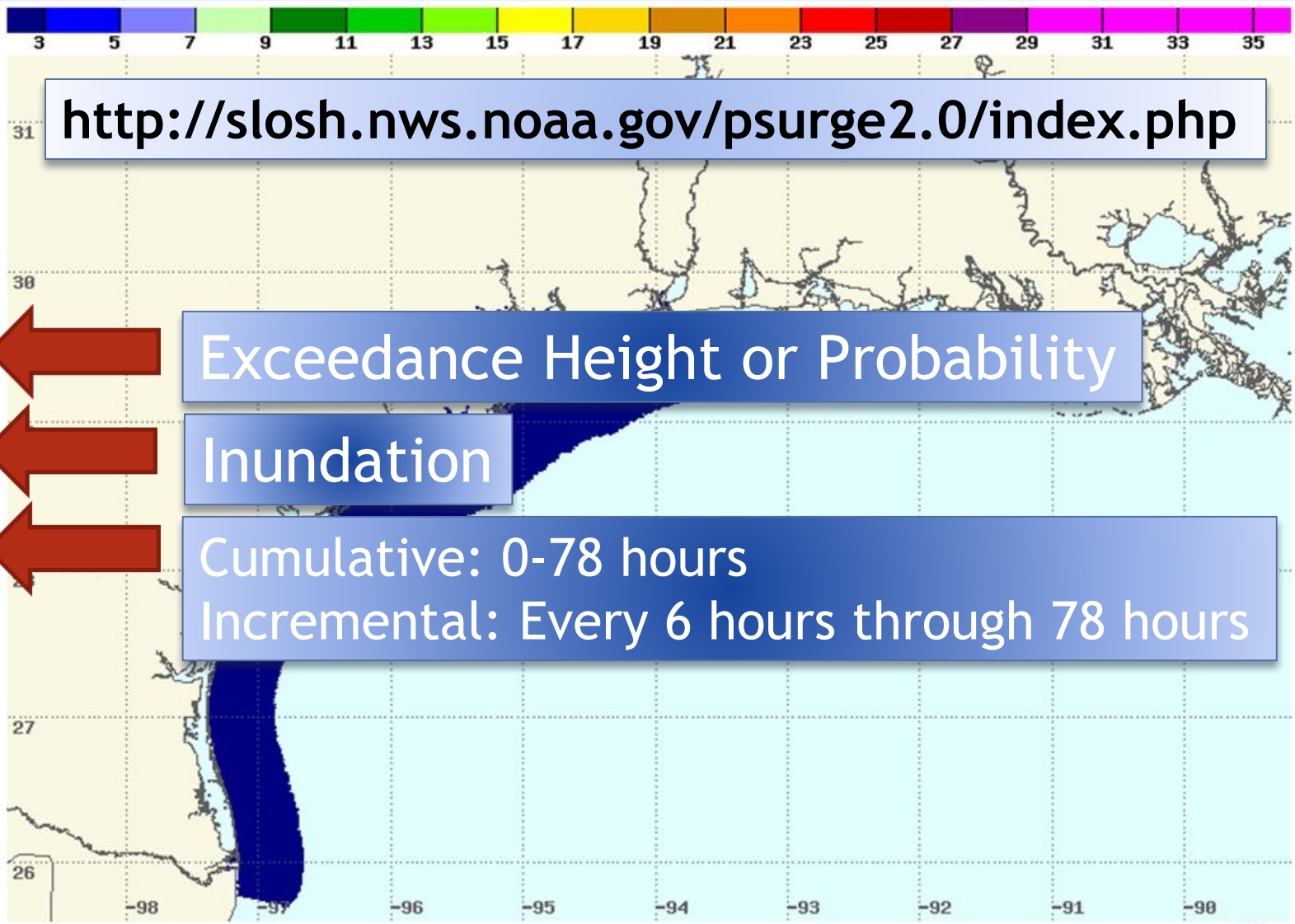
Time Grouping
Cumulative

Start | Stop
Frame: 13

Download Data
SHP GRIB II KMZ

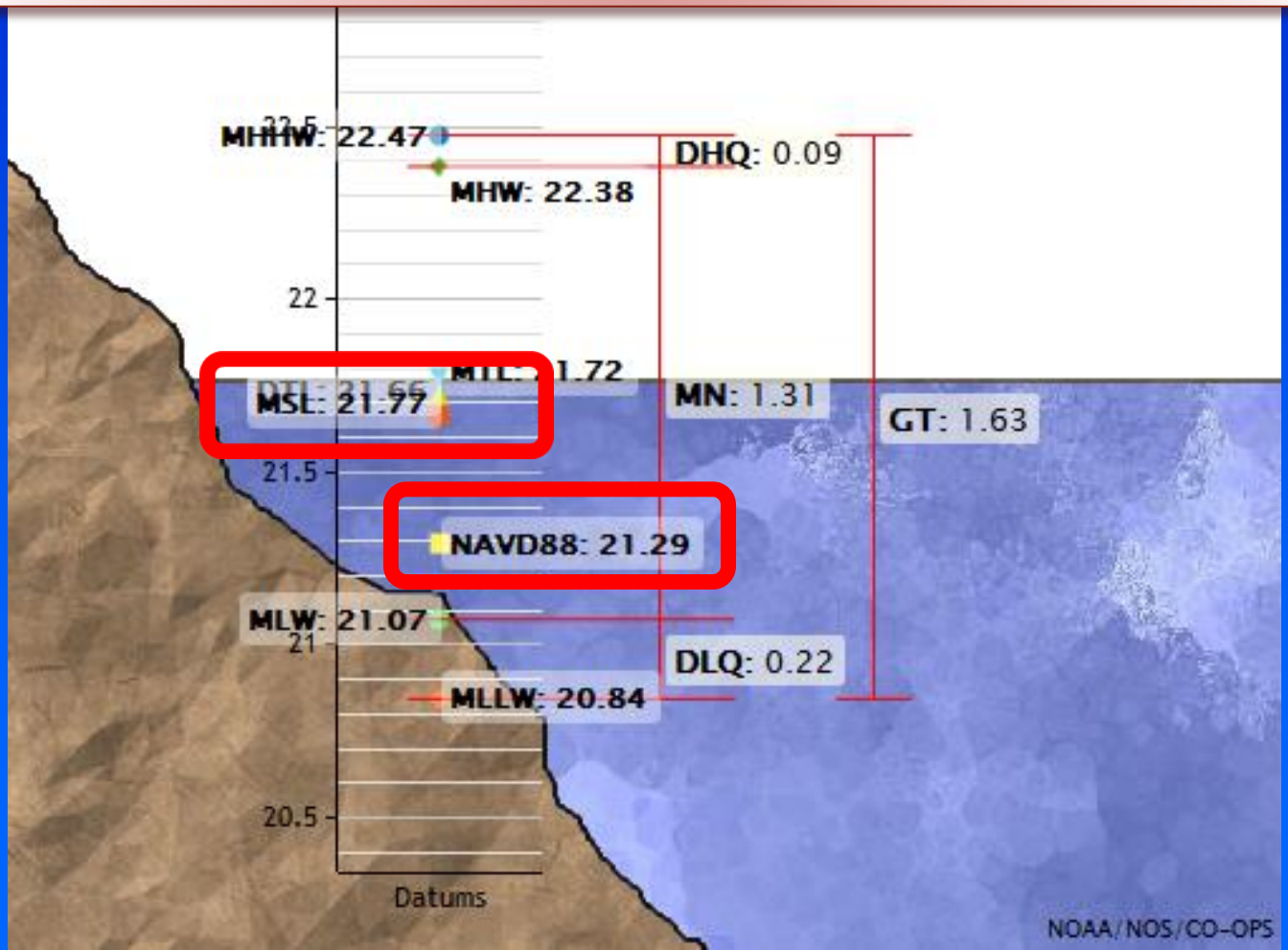
View Google Map

P-Surge 1.0



Vertical Datums for Bob Hall Pier

Difference between NAVD88 and MSL Across W Gulf is ~ 0.50 foot

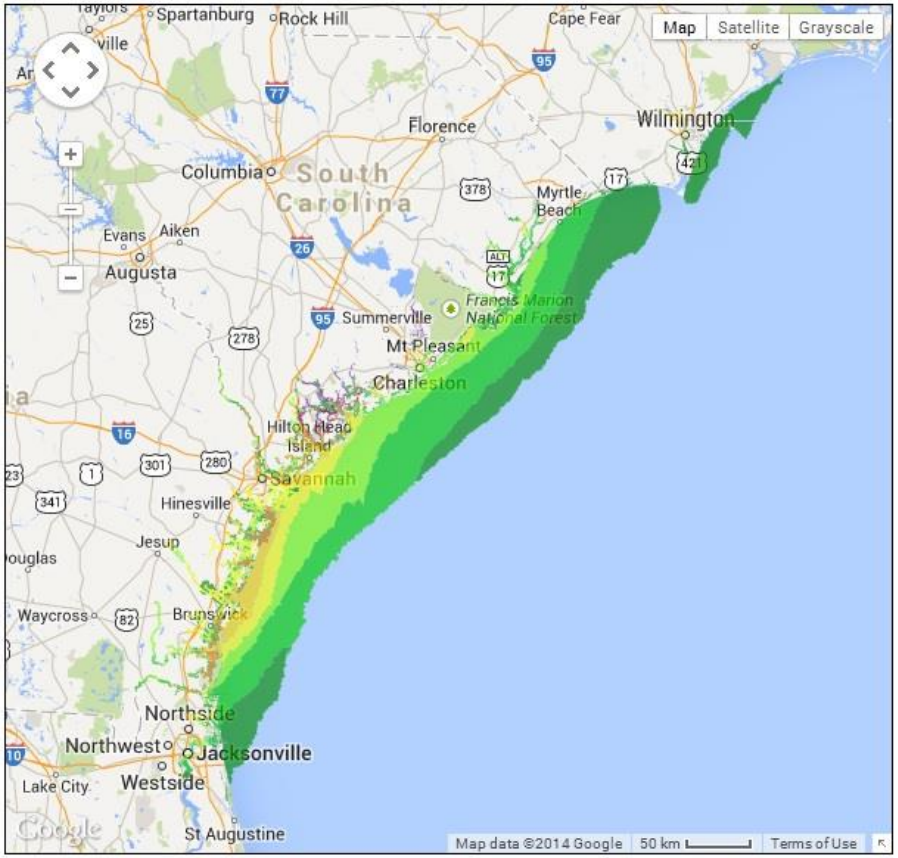


Tropical Cyclone Storm Surge Probabilities
Chance of Storm Surge >= 2 feet

Hurricane Al84psurge Test (2014) Advisory 1
For the 77 hours from 11 AM EDT Wed May 07 to 04 PM EDT Sat May 10

Select Level: Probability of Surge > 2 feet

View in Google Earth (Active KML)



Lat: 30.6686 Lon: -76.4539

Larger

Legend

Probability

5% - < 10%	40% - < 50%	80% - < 90%
10% - < 20%	50% - < 60%	90% - 100%
20% - < 30%	60% - < 70%	
30% - < 40%	70% - < 80%	

Disclaimer

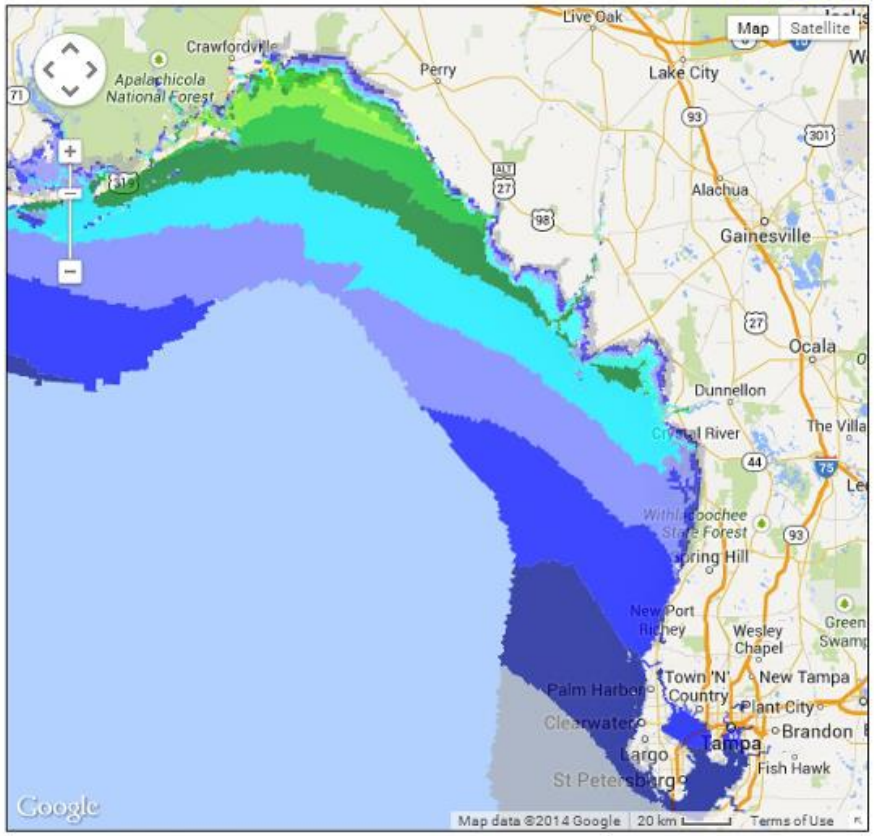
Historical Data:
NHC this storm
NHC all storms
MDL

Tropical Cyclone Storm Surge (with tide) Heights
That Have a 1 in 10 Chance of Being Exceeded

Hurricane Al84psurge Test (2014) Advisory 1
For the 77 hours from 11 AM EDT Wed May 07 to 04 PM EDT Sat May 10

Select Level: 10% Chance of Being Exceeded

View in Google Earth (Active KML)



Lat: 30.3551 Lon: -82.0679

Larger

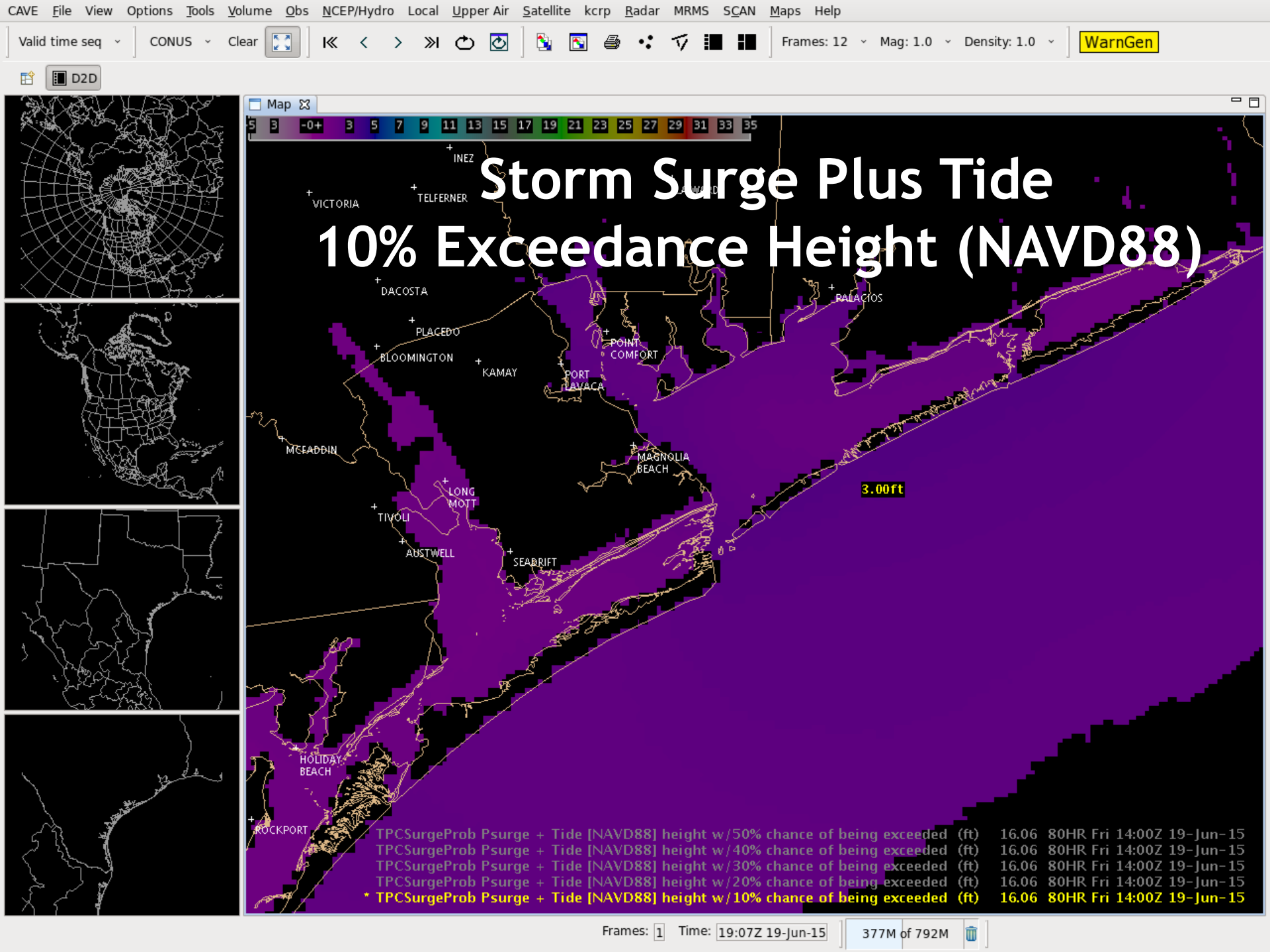
Legend

Height above ground (feet)

0 to < 2	11 to < 13	23 to < 25
2 to < 3	13 to < 15	25 to < 27
3 to < 5	15 to < 17	27 to < 29
5 to < 7	17 to < 19	29 to < 36
7 to < 9	19 to < 21	
9 to < 11	21 to < 23	

Disclaimer

Historical Data:
NHC this storm
NHC all storms
MDL


CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help
Valid time seq
CONUS
Clear
Frames: 12
Mag: 1.0
Density: 1.0
WarnGen
D2D
Map
Storm Surge Plus Tide
10% Exceedance Height (NAVD88)
INEZ
VICTORIA
TELFERNER
DACOSTA
PLACEDO
BLOOMINGTON
KAMAY
POINT COMFORT
PORT LAVACA
PALACIOS
MCFADDIN
MAGNOLIA BEACH
LONG MOTT
TIVOLI
AUSTWELL
SEABRIFT
HOLIDAY BEACH
ROCKPORT
3.00ft
TPCSurgeProb Psurge + Tide [NAVD88] height w/50% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/40% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/30% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/20% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
* TPCSurgeProb Psurge + Tide [NAVD88] height w/10% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
Frames: 1
Time: 19:07Z 19-Jun-15
377M of 792M

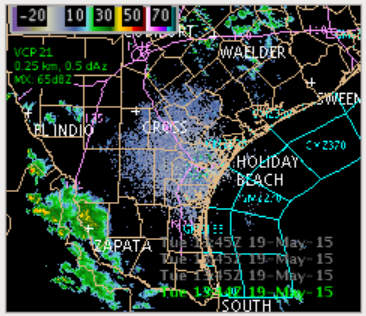
CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help

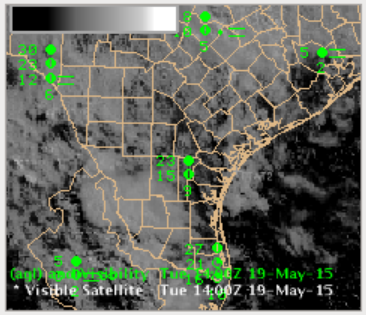
Valid time seq | CONUS | Clear | Frames: 13 | Mag: 1.0 | Density: 1.0 | WarnGen

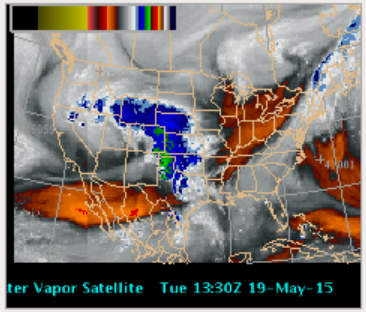
GFE | D2D

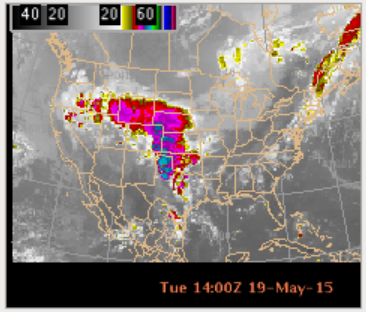
*Map

Inundation 10% Exceedance Height (AGL)





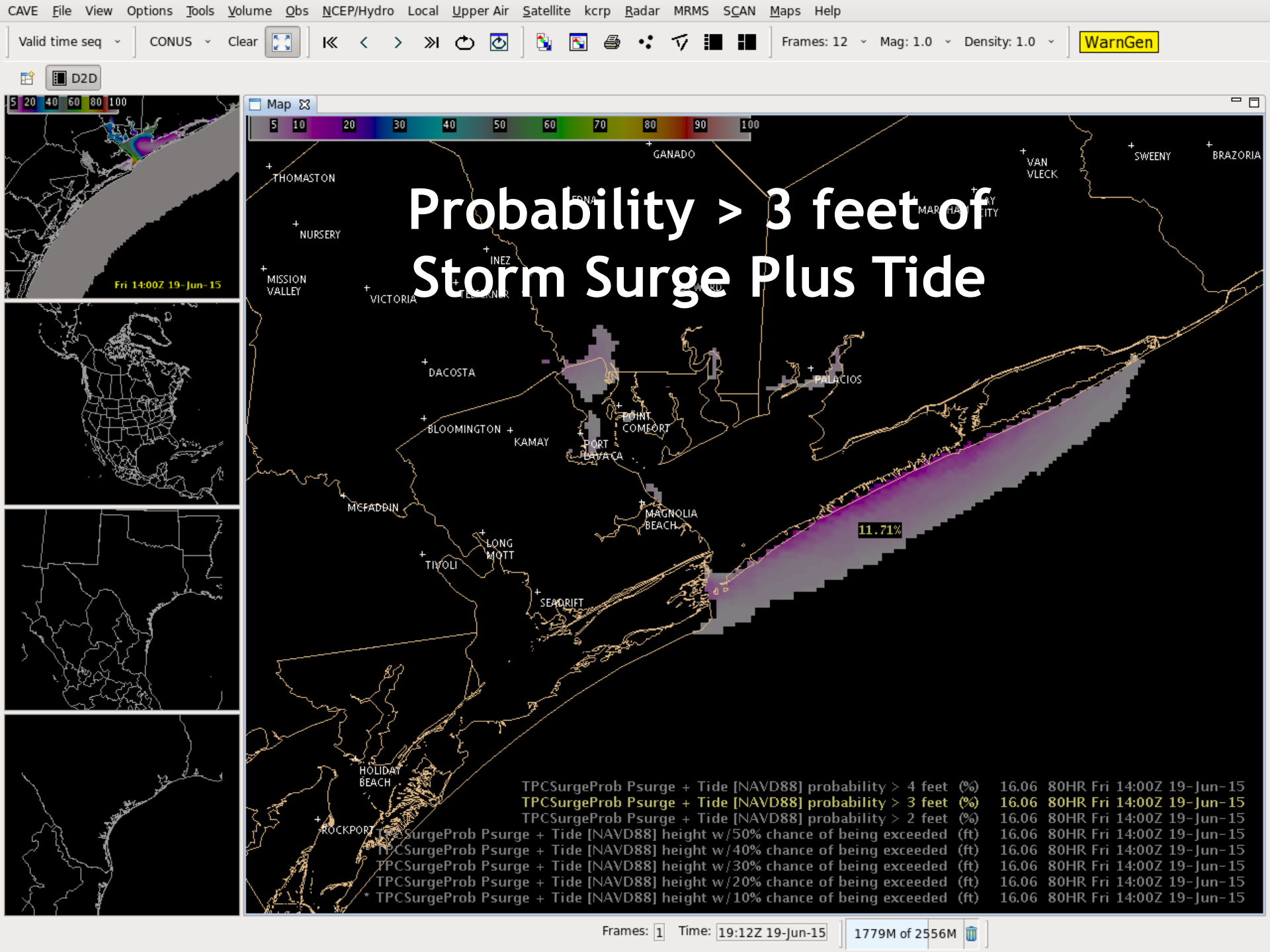




18.13ft

* TPCSurgeProb PHISH height w/10% chance of being exceeded - cumulative [agl] (ft) 11.12 78HR Sun 18:00Z 14-Sep-08

Frames: 13 Time: 14:12Z 19-May-15 780M of 1200M


CAVE File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kcrp Radar MRMS SCAN Maps Help
Valid time seq
CONUS
Clear
Frames: 12
Mag: 1.0
Density: 1.0
WarnGen
D2D
Map
Probability > 3 feet of Storm Surge Plus Tide
5 10 20 30 40 50 60 70 80 90 100
GANADO
THOMASTON
NURSERY
INEZ
MISSION VALLEY
VICTORIA
DACOSTA
BLOOMINGTON
KAMAY
POINT COMFORT
PORT LAVACA
PALACIOS
VAN VLECK
SWEENY
BRAZORIA
MCFADDIN
MAGNOLIA BEACH
11.71%
LONG MOTT
TIVOLI
SEADRIFT
HOLIDAY BEACH
ROCKPORT
TPCSurgeProb Psurge + Tide [NAVD88] probability > 4 feet (%) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] probability > 3 feet (%) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] probability > 2 feet (%) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/50% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/40% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/30% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/20% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
TPCSurgeProb Psurge + Tide [NAVD88] height w/10% chance of being exceeded (ft) 16.06 80HR Fri 14:00Z 19-Jun-15
Fri 14:00Z 19-Jun-15
Frames: 1
Time: 19:12Z 19-Jun-15
1779M of 2556M

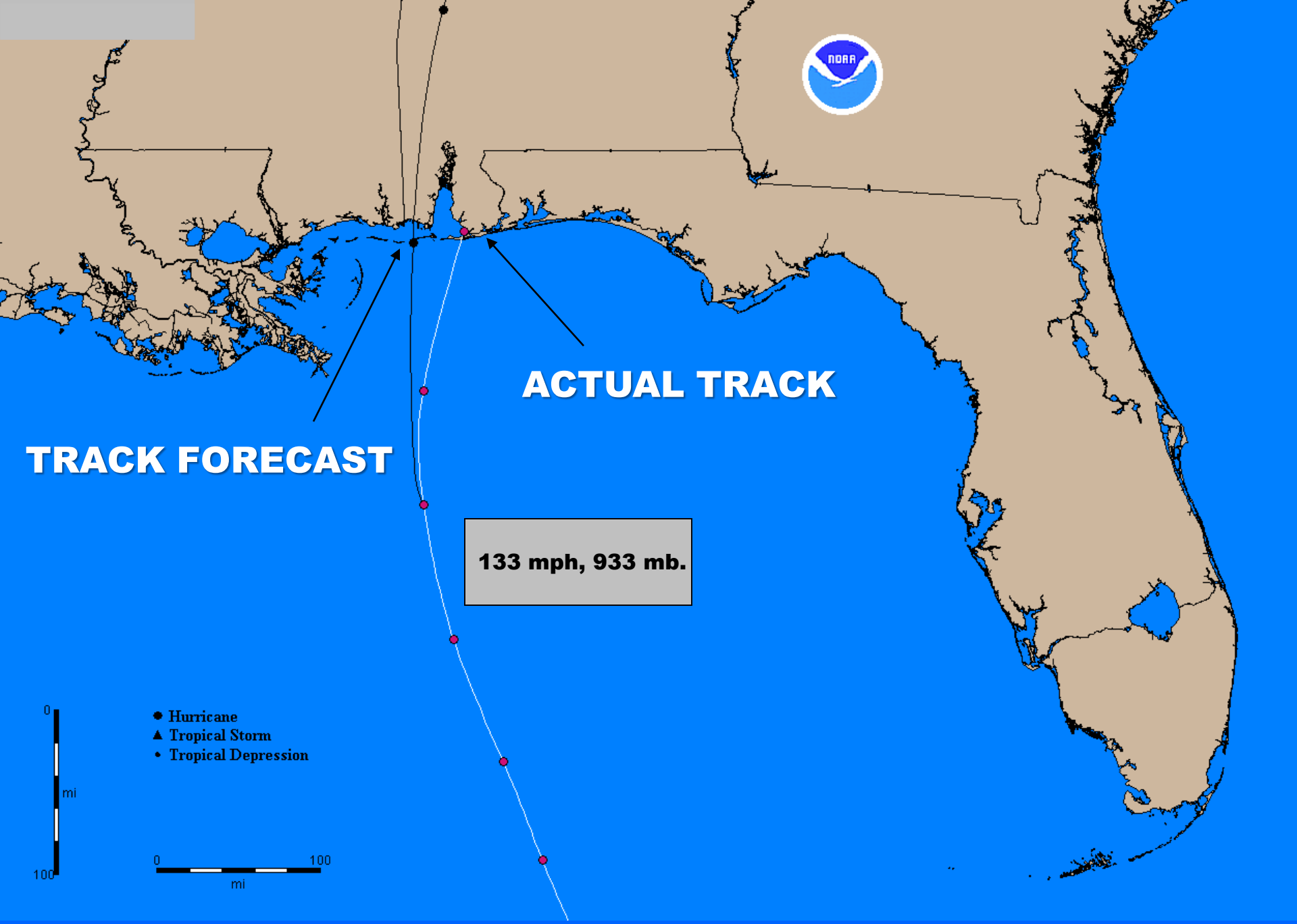
When is P-Surge Available?

- Whenever a hurricane watch/warning is in effect.
  - Some tropical storm watch/warnings, too.

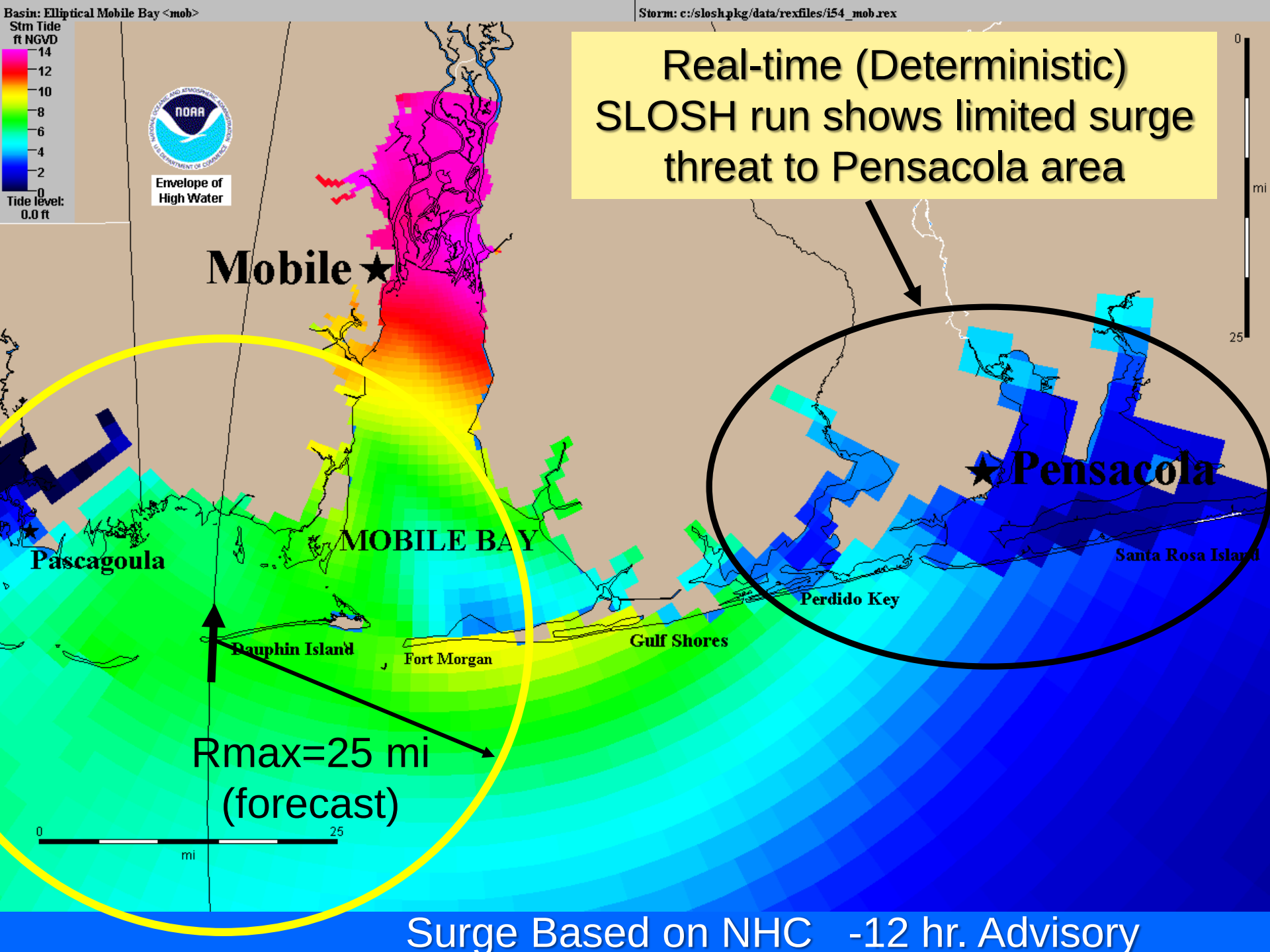
- Available 30 minutes after the NHC advisory.
  - 430 AM/PM CDT.
  - 1030 AM/PM CDT.

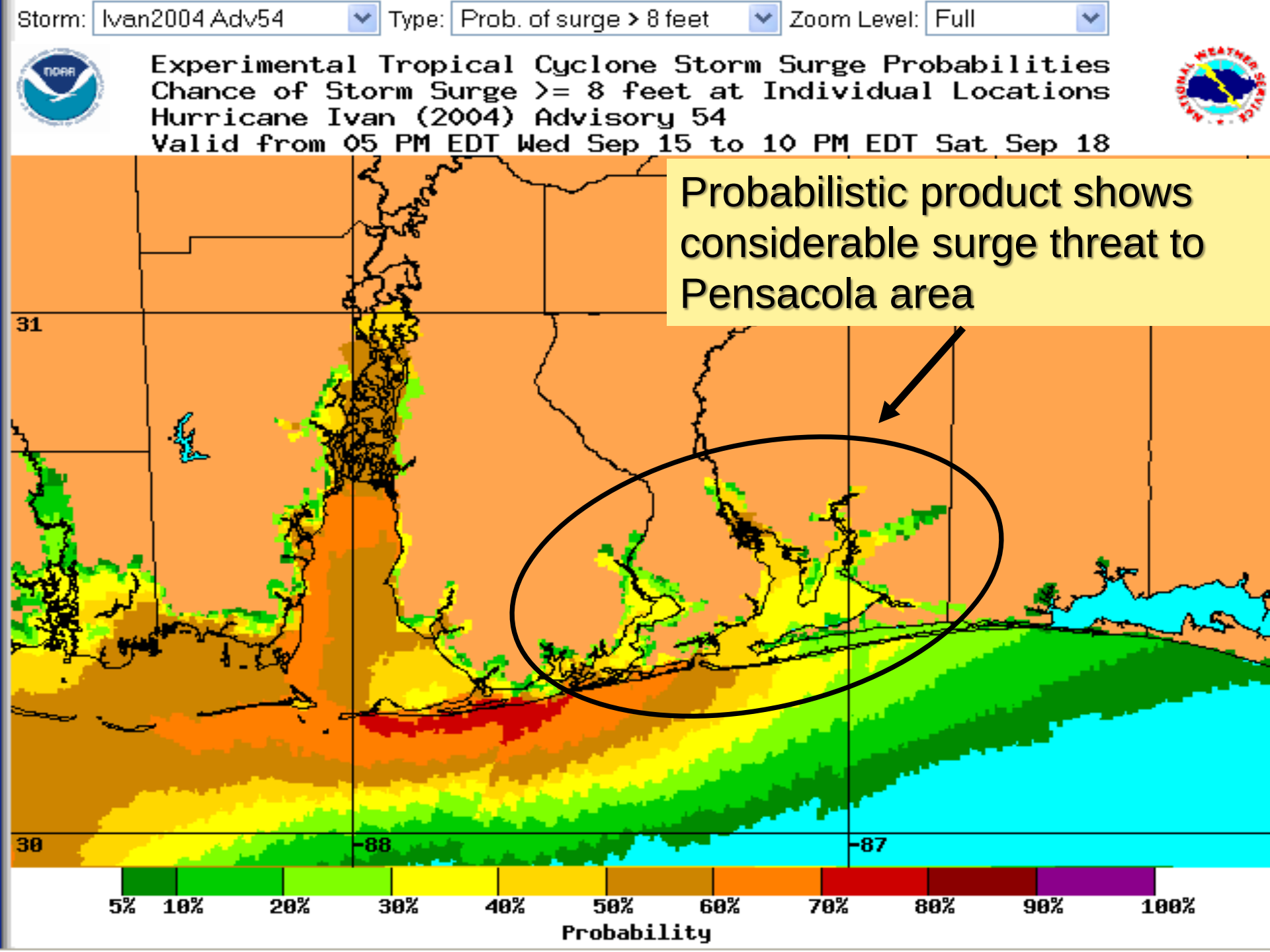
How do I interpret P-Surge?

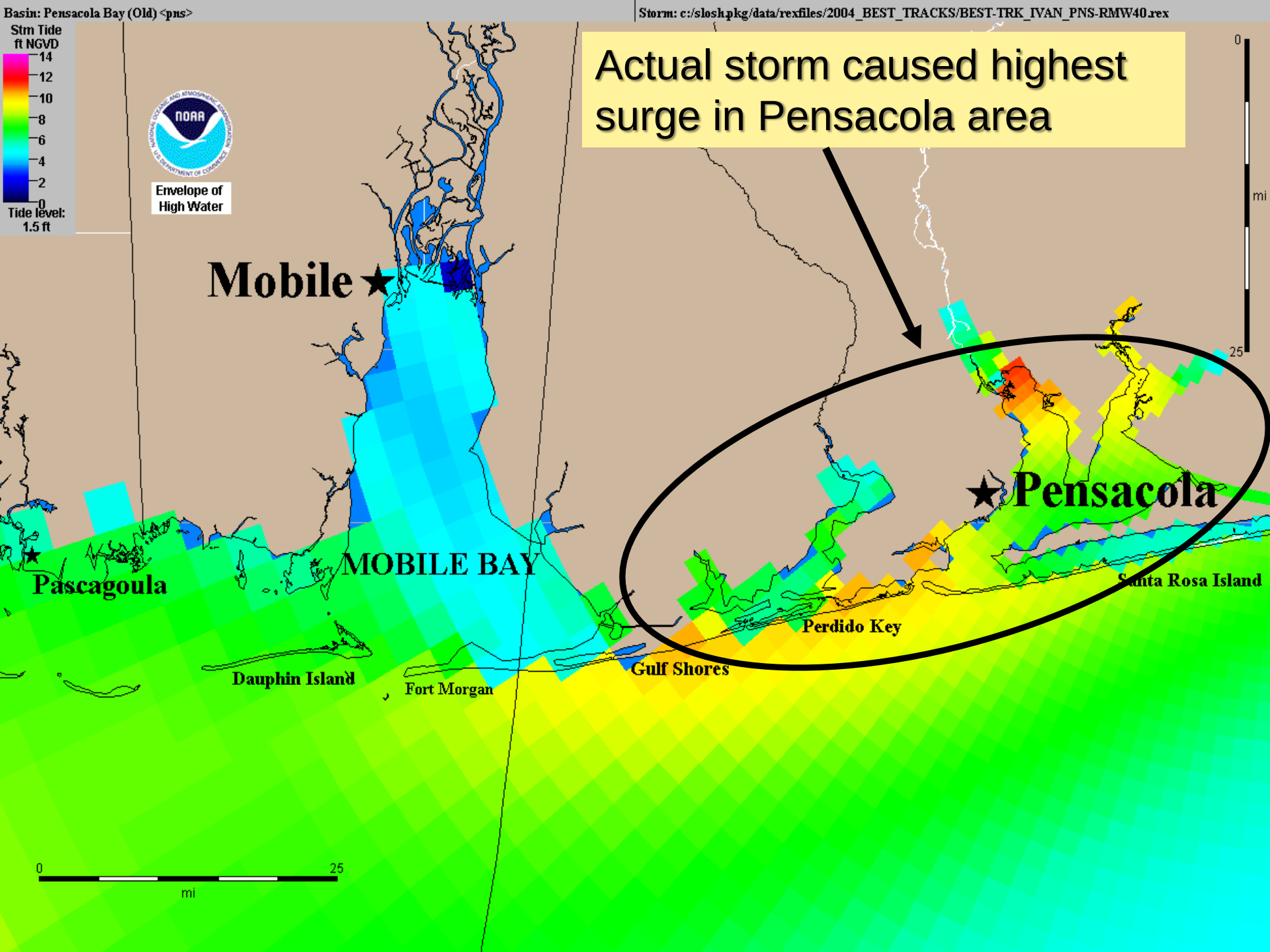
Why is P-Surge better than using a single deterministic solution?



Actual Hurricane Track 30 mi. E of -12 hr. Advisory Forecast Track


Basin: Elliptical Mobile Bay <mob>
Storm: c:/slosh.pkg/data/rexfiles/i54_mob.rex
Stm Tide
ft NGVD
14
12
10
8
6
4
2
0
Tide level:
0.0 ft
Envelope of
High Water
Real-time (Deterministic)
SLOSH run shows limited surge
threat to Pensacola area
0
25
mi
Mobile
Pensacola
Pascagoula
MOBILE BAY
Santa Rosa Island
Perdido Key
Gulf Shores
Fort Morgan
Dauphin Island
Rmax=25 mi
(forecast)
0
25
mi
Surge Based on NHC -12 hr. Advisory


Storm: Ivan2004 Adv54
Type: Prob. of surge > 8 feet
Zoom Level: Full
Experimental Tropical Cyclone Storm Surge Probabilities
Chance of Storm Surge >= 8 feet at Individual Locations
Hurricane Ivan (2004) Advisory 54
Valid from 05 PM EDT Wed Sep 15 to 10 PM EDT Sat Sep 18
Probabilistic product shows considerable surge threat to Pensacola area
31
30
88
87
5%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability


Basin: Pensacola Bay (Old) <pns>
Storm: c:/sloshpkg/data/rexfiles/2004_BEST_TRACKS/BEST-TRK_IVAN_PNS-RMW40.rex
Stm Tide
ft NGVD
14
12
10
8
6
4
2
0
Tide level:
1.5 ft
Envelope of
High Water
Actual storm caused highest surge in Pensacola area
Mobile
Pensacola
MOBILE BAY
Pascagoula
Dauphin Island
Fort Morgan
Gulf Shores
Perdido Key
Santa Rosa Island
0
25
mi
0
25
mi


Questions?