



# *Nearshore Wave Prediction System*

## *v1.0.0*

### *CCB Meeting*

André van der Westhuysen, Roberto Padilla, Hendrik Tolman (NCEP)

Nicole Kurkowski (OST); John Kuhn (OCWWS);

Pablo Santos, Alex Gibbs, Joe Maloney (WFO-MFL), Doug Gaer, Jack Settelmaier (SRH); Troy Nicolini, Sten Tjaden, Brian Garcia (WFO-EKA); Ray Ball (WFO-MOB); Donnie King, Scott Kennedy (WFO-MHX), Carlos Anselmi (WFO-SJU), Eric Lau (PRH), Carl Dierking (WFO-JUN), Jim Nelson (WFO-ARH)

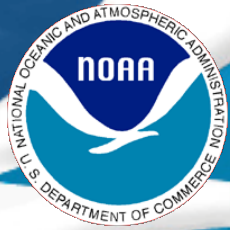
Jeffrey Hansson (USACE/CHL), Eve-Marie Devaliere (NESDIS/STAR),  
Joe Long and Hilary Stockdon (USGS)

Internal presentation to EMC, June 9, 2015



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# Outline

1. Quad chart
2. Need for nearshore wave guidance
3. NWPS system design
4. Input, output and data flow
5. System loading and Validation
6. Implementation schedule



# Nearshore Wave Prediction System (NWPS) V1.0.0

Project Status as of 05/29/2015



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## Project Information and Highlights

**Lead:** Hendrik Tolman, EMC and Becky Cosgrove, NCO

**Scope:**

1. Centralized implementation of NWPS that is currently run locally at a number of coastal WFOs.
2. Involves separate implementations for approx. 20 WFOs, using shared basic scripting.
3. Novel on-demand run triggering.

**Expected Benefits:**

1. Resolution of coastal wave model guidance improved from 4 arc-min (with ww3 multi\_1) to at least 1 arc-min.
2. Wave guidance consistent with forecaster-developed wind fields.
3. Improved economy of scale of centralized computing compared to distributed computing.

**Y**

## Scheduling

Milestone (NCEP)	Date	Status
Initial coordination with SPA team	01/31/2015	In progress
EMC testing complete/ EMC CCB approval	02/28/2015 → 06/09	
Code delivered to NCO	02/28/2015 → 06/09	
Technical Information Notice Issued	03/31/2015 → 07/01	
SPA begins prep work for 30 day test	03/02/2015 → 06/02	
30-day evaluation begins	03/09/2015 → 07/01	
30-day evaluation ends	04/07/2015 → 08/01	
IT testing ends	03/27/2015 → 07/31	
Management Briefing	04/24/2015 → 08/15	
Implementation (2 pilot offices, MFL & BOX)	04/28/2015 → 09/01	
Implementation (remaining 20 offices in SR&ER)	09/30/15	

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## Issues/Risks

**Issues:**

**Risks:**

**Mitigation:**

*Implementation shifted by 2 quarters to allow additional development and testing. Sandy implementation milestone (FY15Q4) unaffected.*

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## Finances

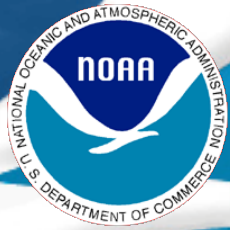
**Associated Costs:**

- 1) \$250,000 - Applied to IBM Task Order 4 to augment WCOSS by 4 nodes (approx 1%). A **continuous (24 h) reservation of these 4 nodes is required for this on-demand system.**
- 2) \$147,180 - To hire dedicated SPA for extended testing and implementation period (Sept-Nov 2014, Mar-Jul 2015)

**Funding Sources:** Sandy Supplemental; OST development funding.

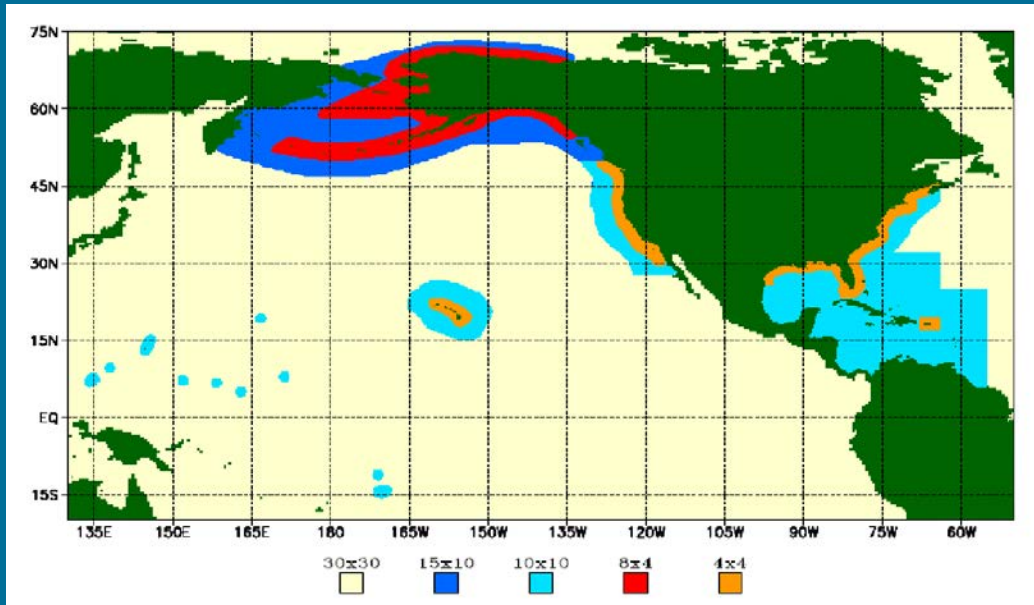
**AWIPS changes:** An NWPS run configuration GUI and additional nearshore wave products have been added to builds 14.4.1 and 15.1.1.

<b>R</b> Management Attention Required	<b>Y</b> Potential Management Attention Needed	<b>G</b> On Track
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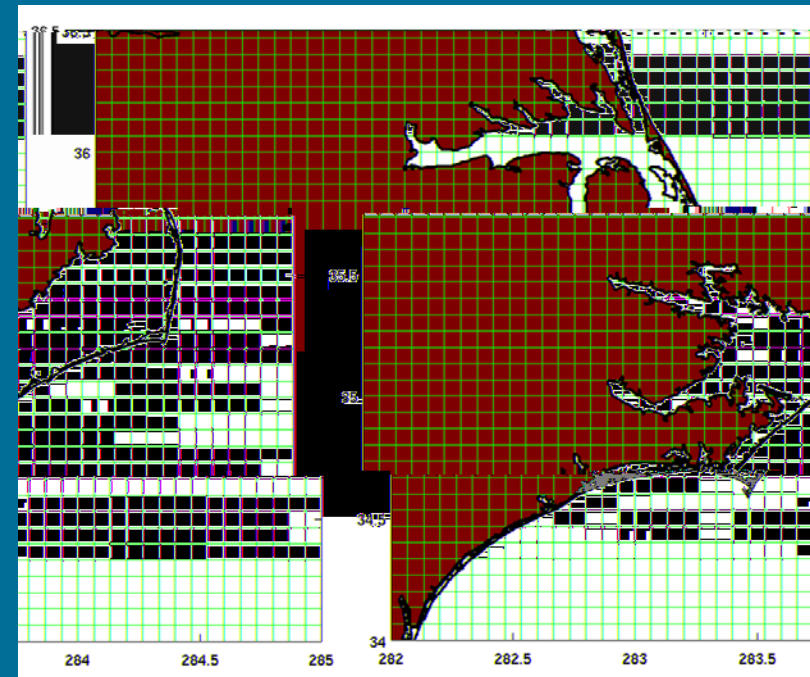
# NCEP Wave guidance products

## WAVEWATCH 3 Multi\_1 global grid mosaic

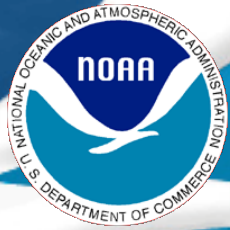


- Max. coastal resolution = 4 arc-min (7.5 km)
- Forced by GFS

## Nearshore downscaling



- Req. resolution = 500 m - 1.85 km
- Forecaster wind fields (GFE)



# The Nearshore Wave Prediction System (NWPS)

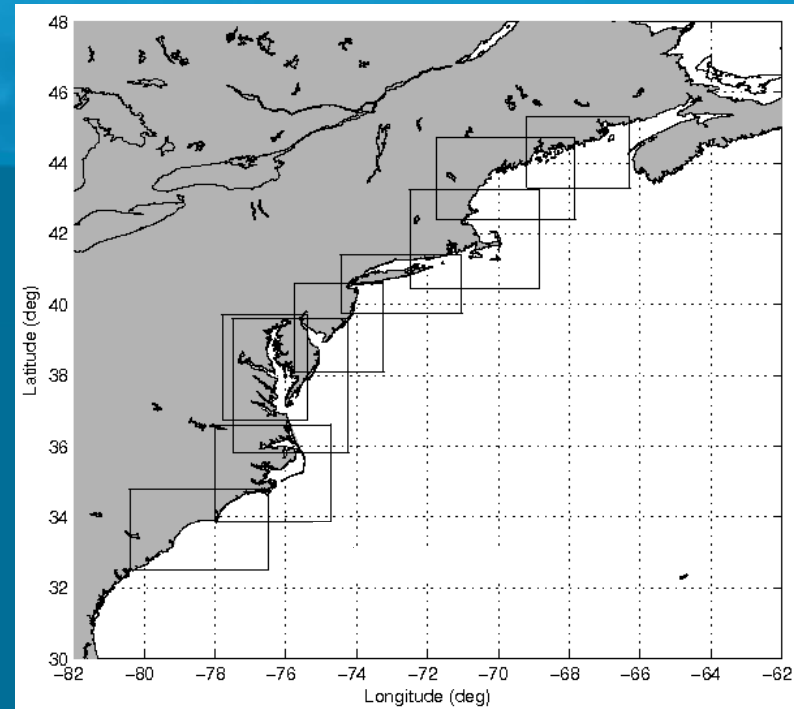
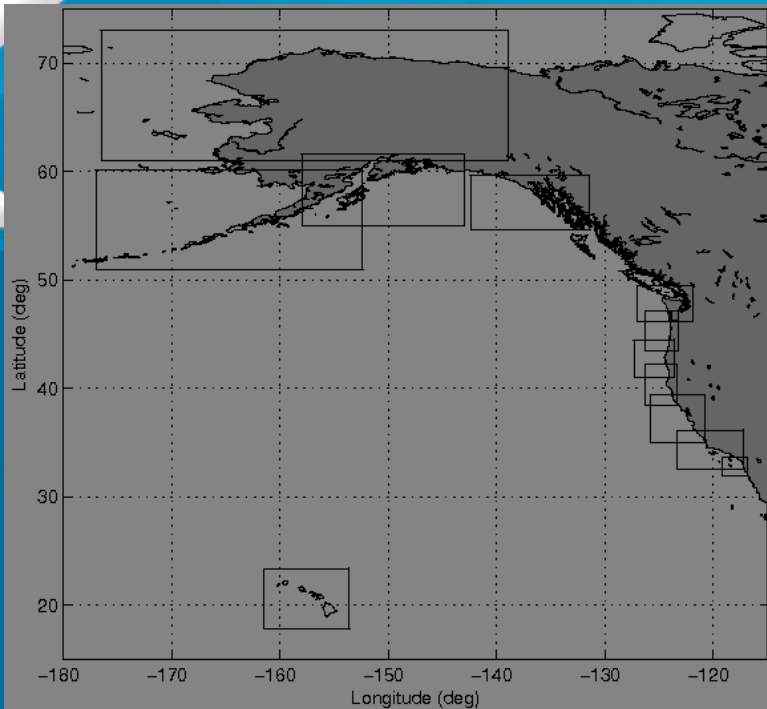
- Run on-demand, using open-source wave model SWAN.
  - Driven by forecaster-developed winds from GFE (AWIPS2), and other NCEP forcings (e.g. WW3 BCs, RTOFS/ESTOFS).
  - Included in the AWIPS2 baseline for sustainability.
  - Addresses region-specific physical processes in the nearshore (wave-current interaction, ice interaction, vegetation, etc.).
  - Includes wave partitioning (separates wave field into component systems). In future: rip current and wave run-up guidance.
- \* WFO-based pilot project (WFO Eureka) transitioned to NCEP
- \* Sandy Supplemental Milestone FY15Q4



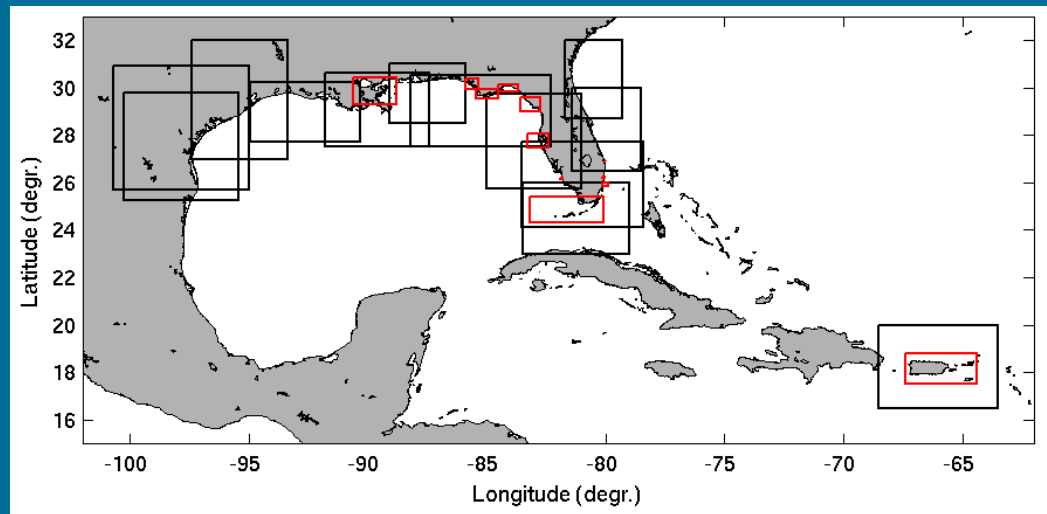
# Model configuration

- Spectral wave model SWAN v40.81, enhanced with wave partitioning (similar to WW3 v4.18).
- Wave system tracking from WW3 v4.18 (IBM optimized).
- Experimental rip current guidance (Dusek and Seim, 2013).
- Source terms, deep water (SWAN default): Komen et al. (1984), as recalibrated by Rogers et al. (2003).
- Source terms, shallow water (SWAN default): JONSWAP bed friction, Battjes and Janssen (1978) depth-induced breaking, LTA triads.
- Run length = 102 h, 2 cycles/day. Initiated on-demand by WFOs.
- Grid resolution: 1.8 km resolution outer grid (CG1), with optional nests typically at 500 m resolution (CG2-5).



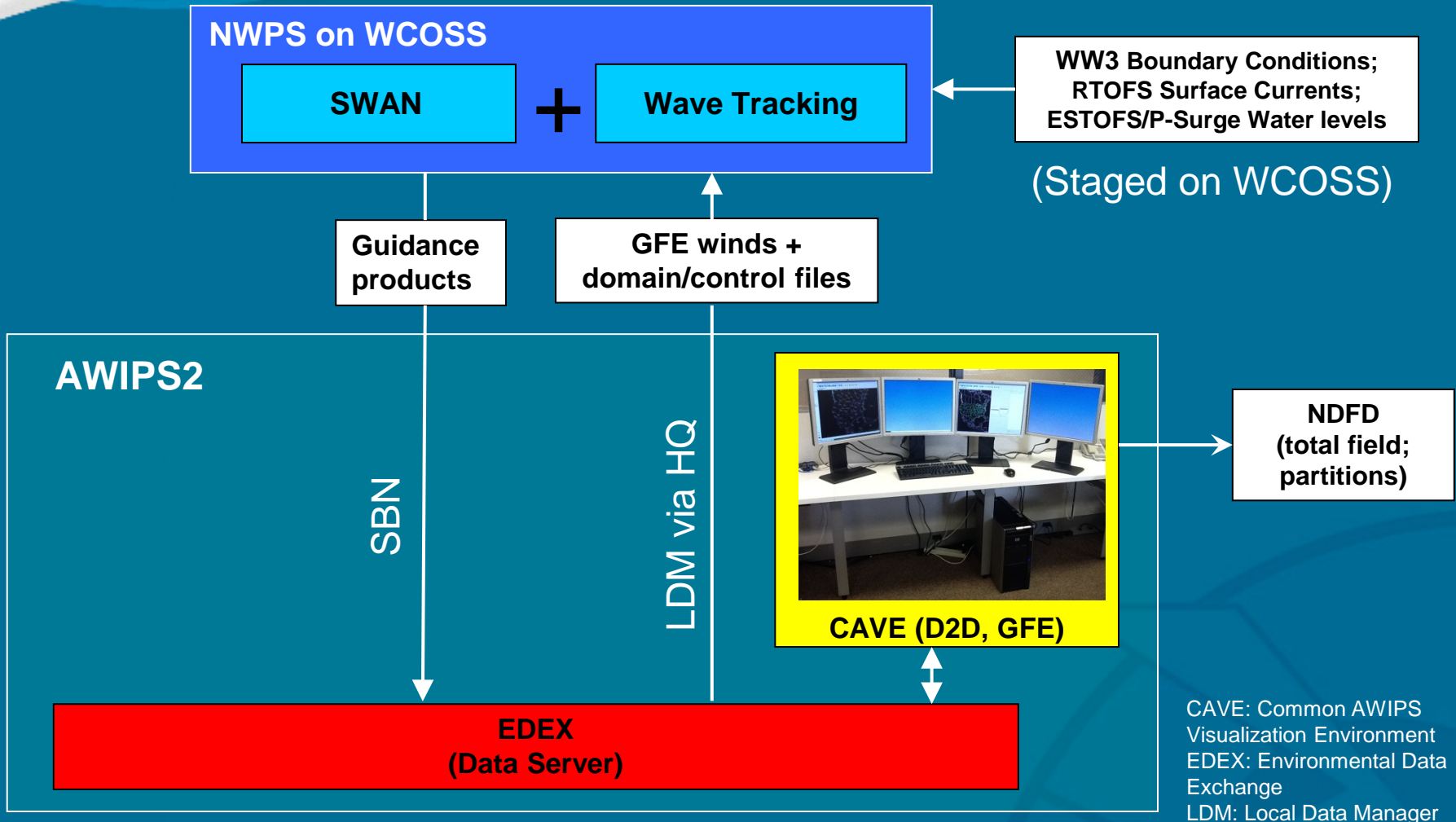


# NWPS grids for coastal WFOs

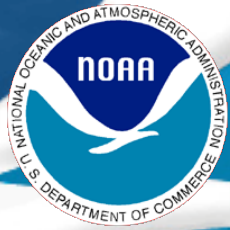




# NWPS Architecture (WFO view)







# AWIPS User Interface (v14.4.1/v15.1.1)

Run\_NWPS Values

How Long Do You Want To Run NWPS: 102

Boundary Conditions:  
 WNAWave  
 TAFB-NWPS  
 HIRWave

Model Start Time:  
 20150211\_1200  
 20150211\_1800  
 20150212\_0000  
 No

Local or NCEP:  
 Local  
 NCEP

Model Core:  
 SWAN  
 NWW  
 INSWAN

Send Output to Web:  
 Yes  
 No

Plot Output:  
 Yes  
 No

Model Start Time:  
 20150212\_0600  
 20150212\_1200  
 20150212\_1800  
 20150213\_0000

Check [www.srh.noaa.gov/rtimages/nhc/wfo\\_boundary\\_conditions](http://www.srh.noaa.gov/rtimages/nhc/wfo_boundary_conditions) for up to date files for your SITE\*\*  
Line matching your selected Model Start Time

Hotstart:  
 True  
 False

Waterlevels:  
 ESTOFS  
 PSURGE  
 No

If PSURGE % Exceedance Hgt:  
 10  
 20  
 30  
 40  
 50

Run Hi Res NEST:  
 Yes  
 No

RTOFS Currents:  
 Yes  
 No

Model Time:  
 1200  
 900  
 600  
 300

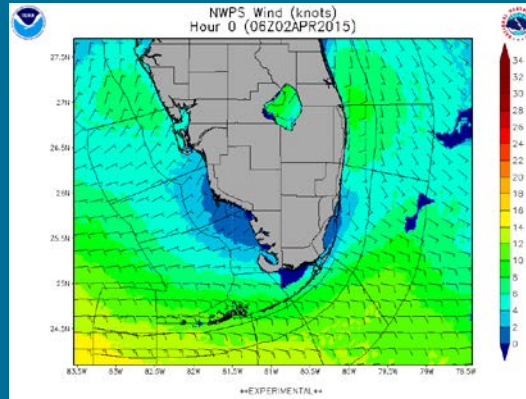
OK Cancel





# Data input (from each WFO via LDM)

1. GFE wind file (GRIB2)  
(produced in AWIPS)



2. DOMAIN file (txt)

```
-----  
# Domain File  
# Original Author(s): Roberto Padilla-Hernandez,Douglas Gaer,  
# Alex Gibbs, Pablo Santos,Tony Freeman  
# File Creation Date: 06/01/2012  
# Date Last Modified: 02/01/13  
#  
# Version control: 1.33  
#  
# Support Team:  
#  
# Contributors:  
#  
# ----- Description and Details -----  
#  
# File used to setup a geographical domain for SWAN and W3  
#  
# -----  
# MFL  
# GEOGRAPHICAL DOMAIN, GEOGRAPHICAL RESOLUTION AND OUTPUT TIME STEP =  
#-----  
export SITEID="MFL"  
export REGIONID="SR"  
export RELAT="27.70"  
export NELON="-79.41"  
export SWLAT="24.10"  
export SWLON="-83.54"  
#export RES="1.0"  
export RES="6"  
export TSTEP="3"
```

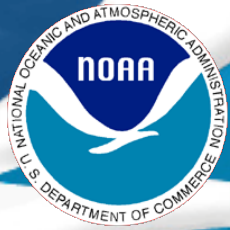
3. CONTROL file (txt)  
(produced in AWIPS)

```
ssh ${SSHARGS} ldad@lsl echo "$RUNLEN:$WNA:$NEST:$GS:$WINDS:$WEB:$PLOT:$DELTA:$SHOTSTART:$SESTOFS:$SCORE >  
/data/ldad/nwps/input/inp_args" 2>&1 | tee -a $logfile
```



Size = ~2 Mb zipped/WFO site





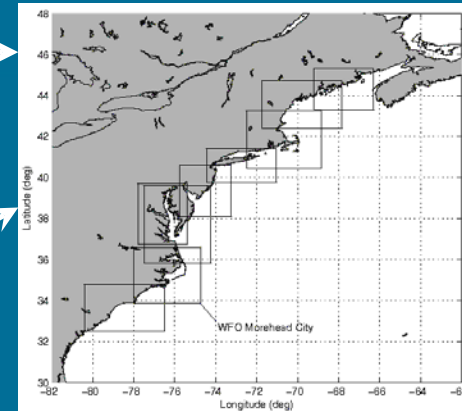
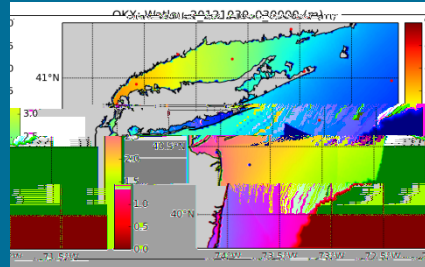
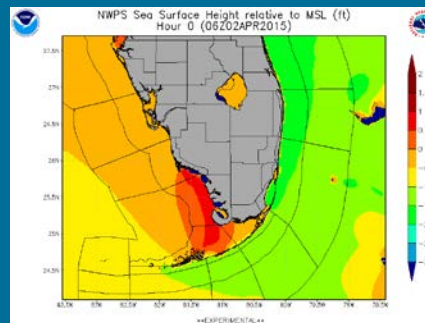
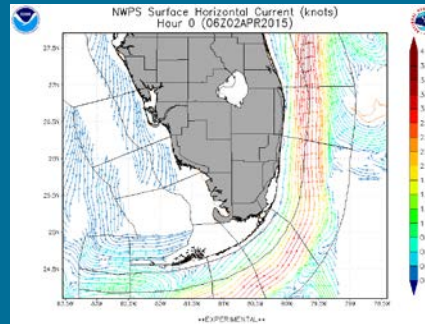
# Data input (Staged on WCOSS)

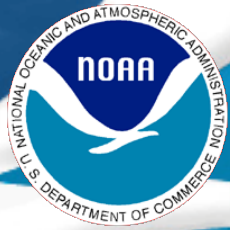
1. WAVEWATCH III boundary spectra (txt)

2. RTOFS surface current fields (txt)

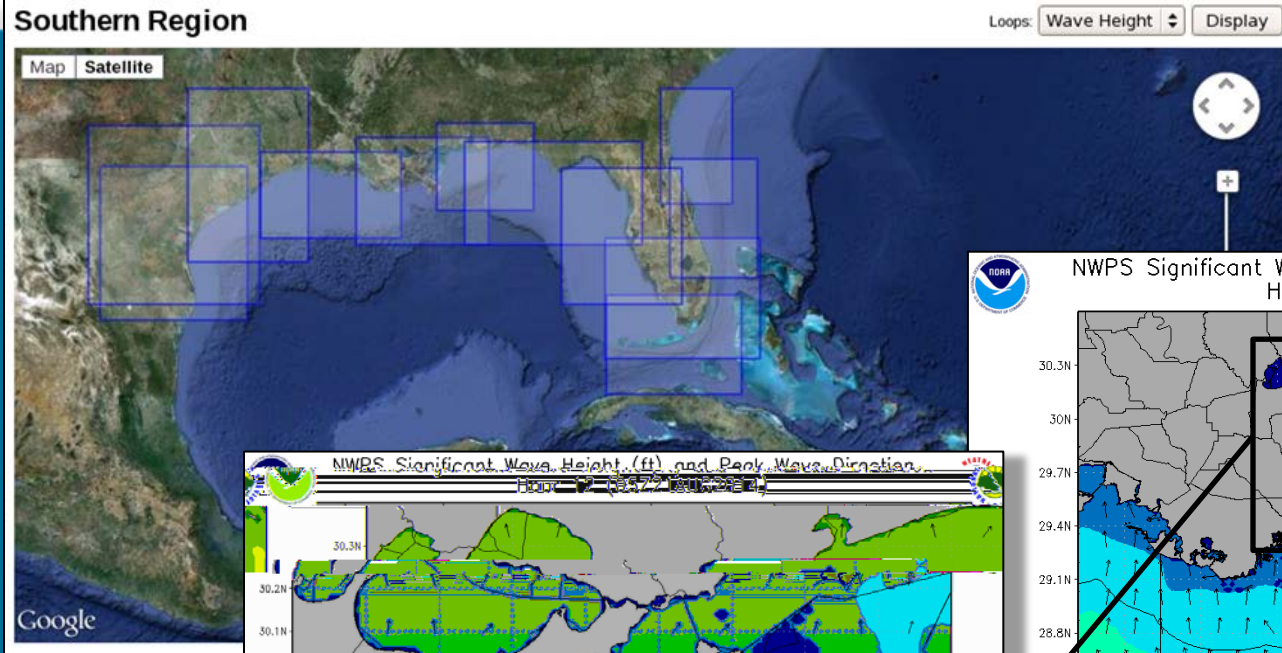
3. ESTOFS water levels (txt)  
(Extra-tropical conditions)

4. P-Surge water levels (txt)  
(Tropical conditions)

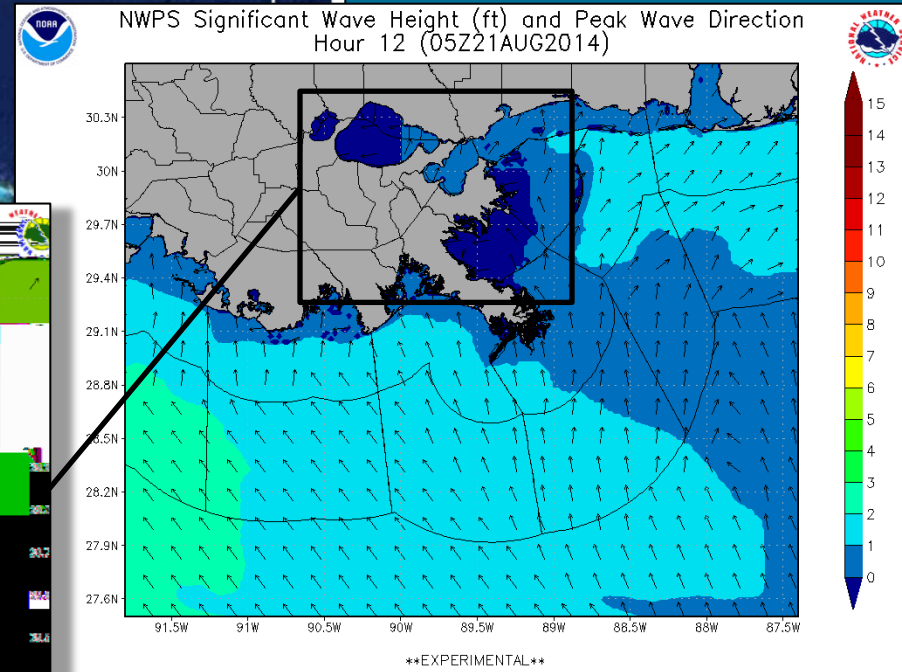
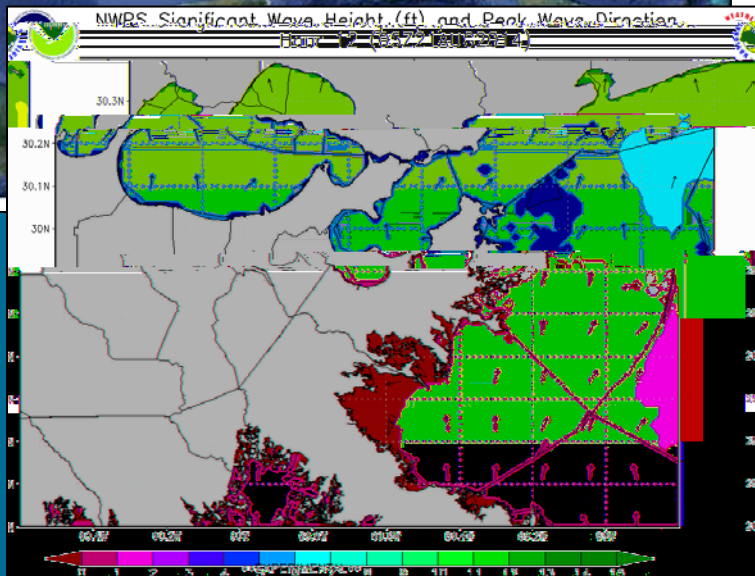




# Example output for WFO New Orleans



WFO LIX, CG1  
(1.8 km)



CG2  
(500 m)

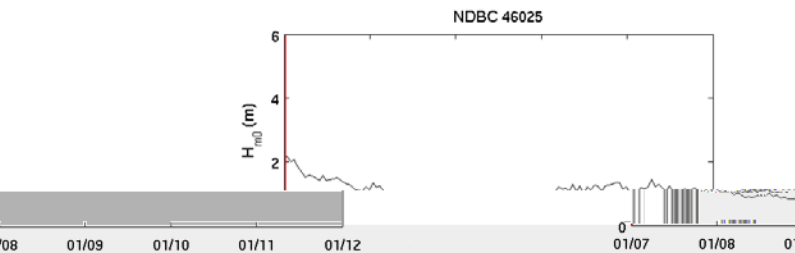
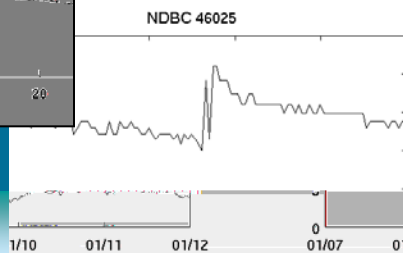
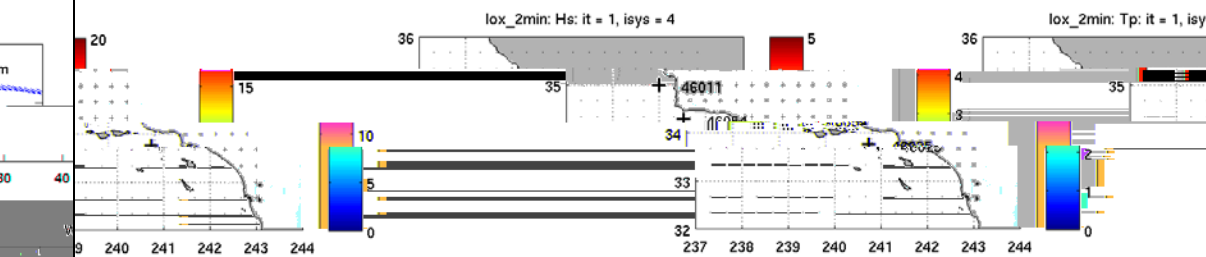
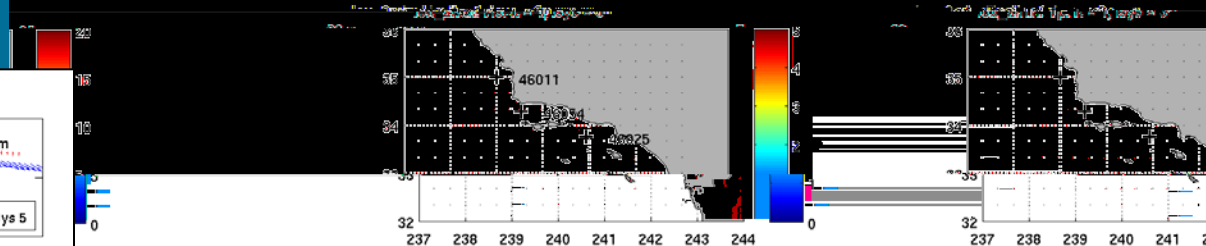
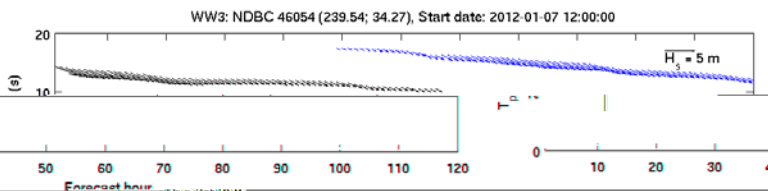
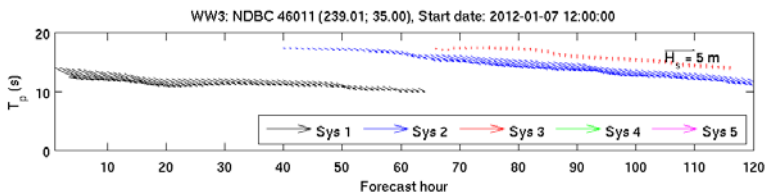
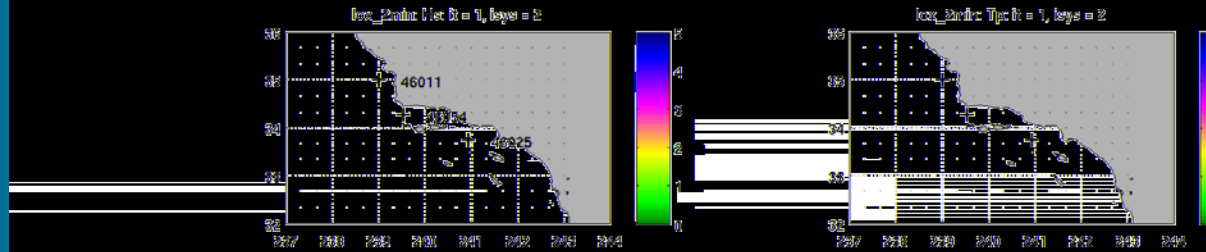
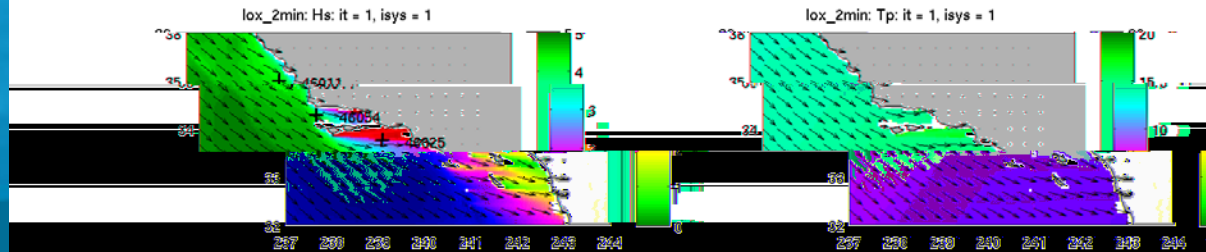






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# Post-processing: Wave system tracking



→ Sys 1 → Sys 2 → Sys 3 → Sys 4 → Sys 5

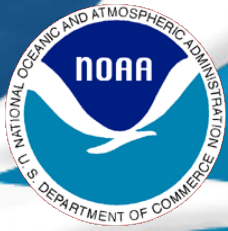
1/10 01/11 01/12 01/07 01/08 01/09 01/10 01/11 01/12 01/07 01/08 01/09 01/10 01/11 01/12



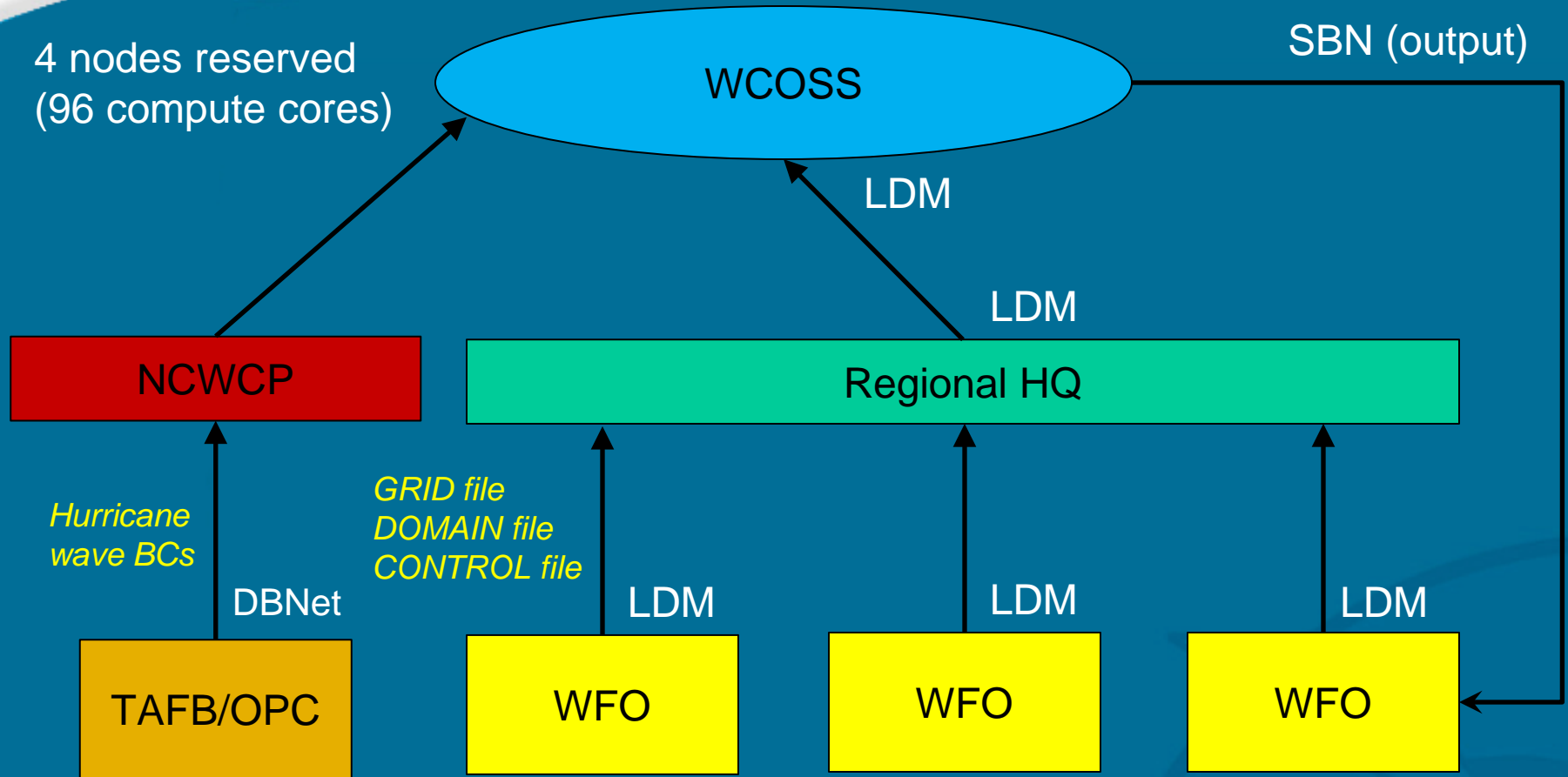
# Guidance in GFE for producing forecast

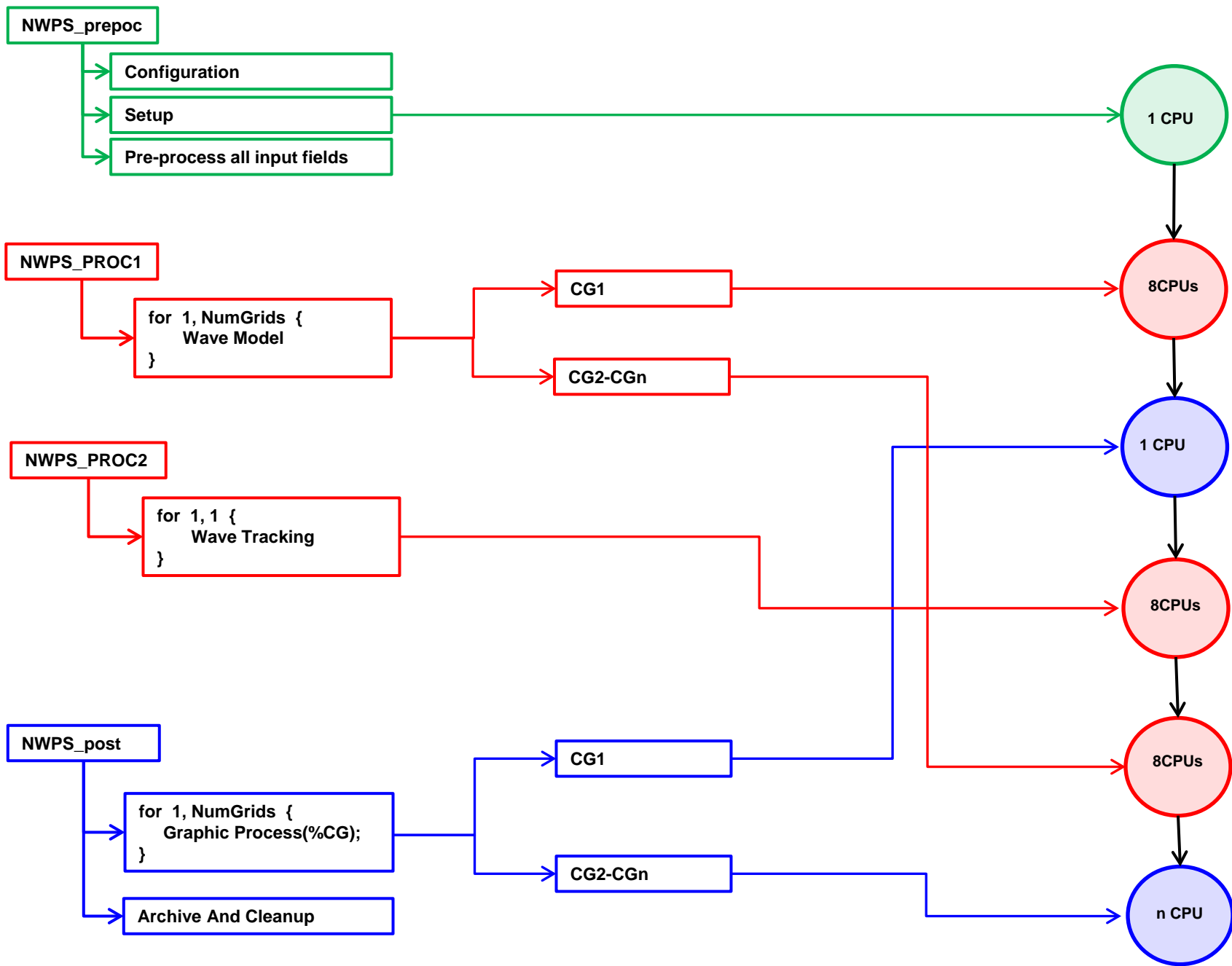






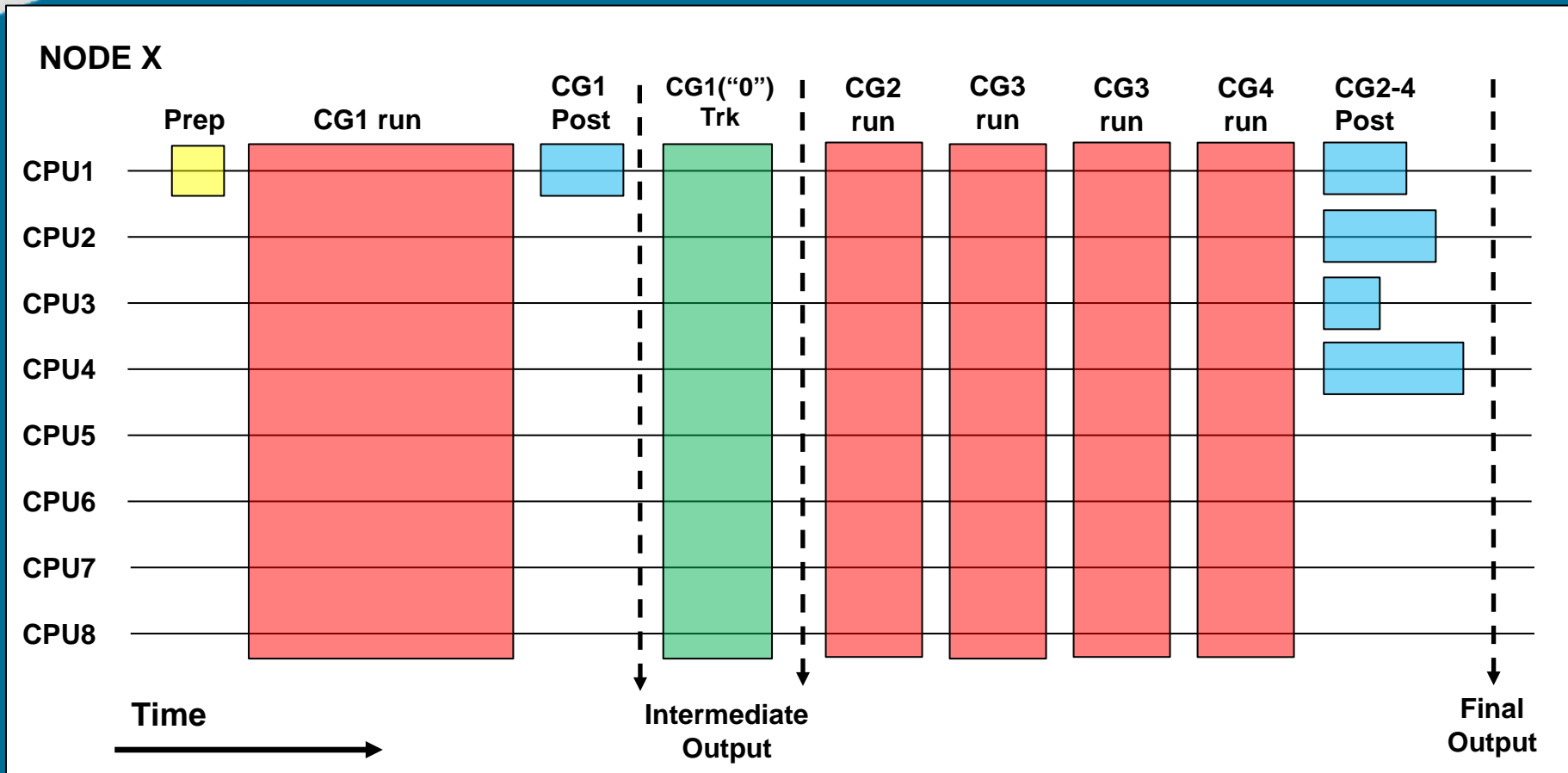
# NWPS Architecture (Regional view)







# Scheduling of jobs (single WFO)





# WCOSS resources (single WFO)

## PREP

Resource usage summary:

CPU time : 3:33 min:sec  
Max Memory : 62 MB  
Average Memory : 33.64 MB  
Num of CPUs : 1

## FORECASTCG1

Resource usage summary:

CPU time : 40:17 min:sec  
Max Memory : 511 MB  
Average Memory : 497.56 MB  
Num of CPUs : 8

## POSTCG1

Resource usage summary:

CPU time : 9:38 min:sec  
Max Memory : 1540 MB  
Average Memory : 302.05 MB  
Num of CPUs : 1

## WAVETRACKING CG1 (Incl. Post-processing)

Resource usage summary:

CPU time : 21:22 min:sec  
Max Memory : 3329 MB  
Average Memory : 162.97 MB  
Num of CPUs : 8

## FORECASTCGn

Resource usage summary:

CPU time : Variable, WFO depend.  
Max Memory : Variable  
Average Memory : Variable  
Num of CPUs : 8

## POSTCGn

Resource usage summary:

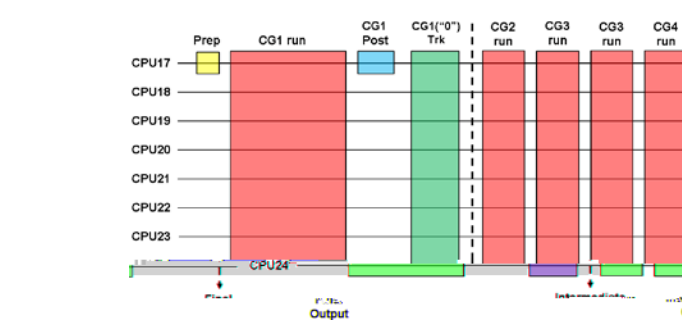
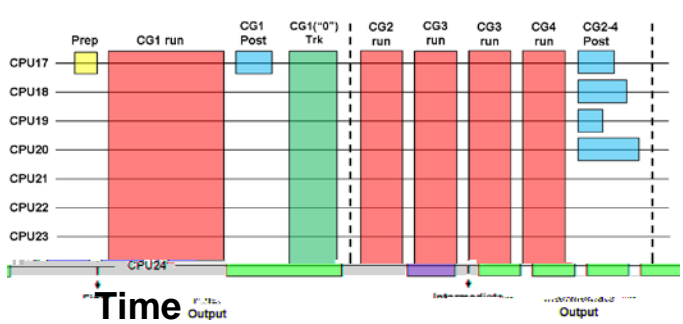
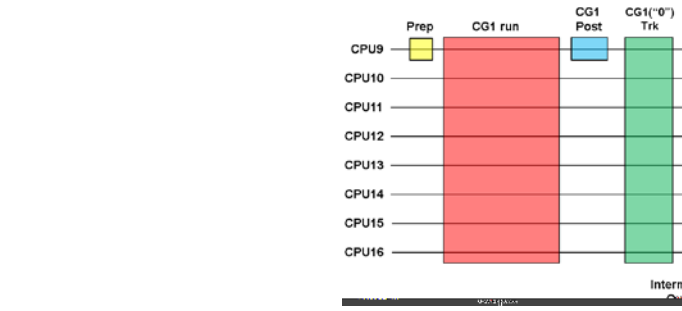
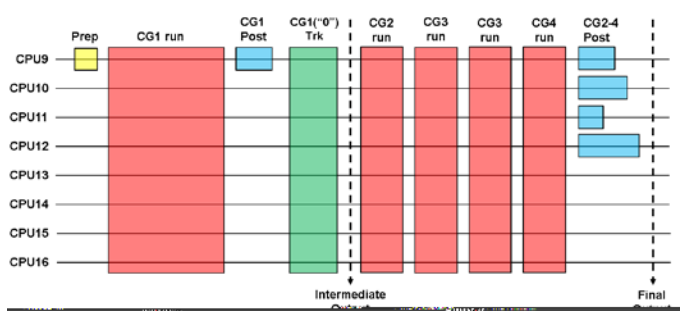
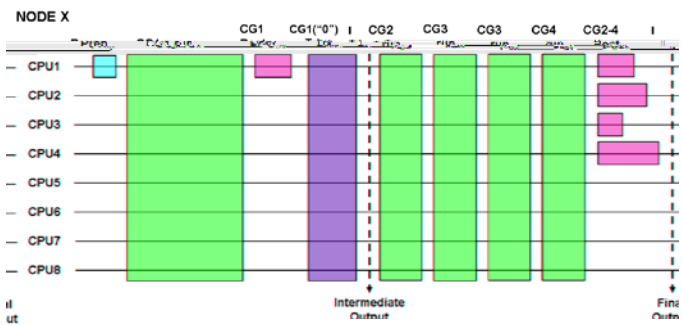
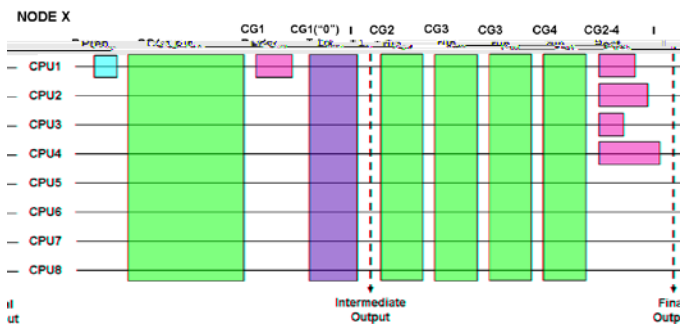
CPU time : Variable, WFO depend.  
Max Memory : Variable  
Average Memory : Variable  
Num of CPUs : Up to 4

**Estimated avg total per WFO: 2h25min; 3.4GB RAM**





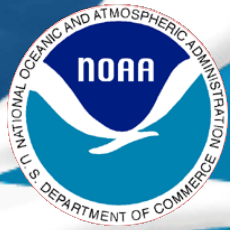
# Scheduling of all jobs (per node)



Time →

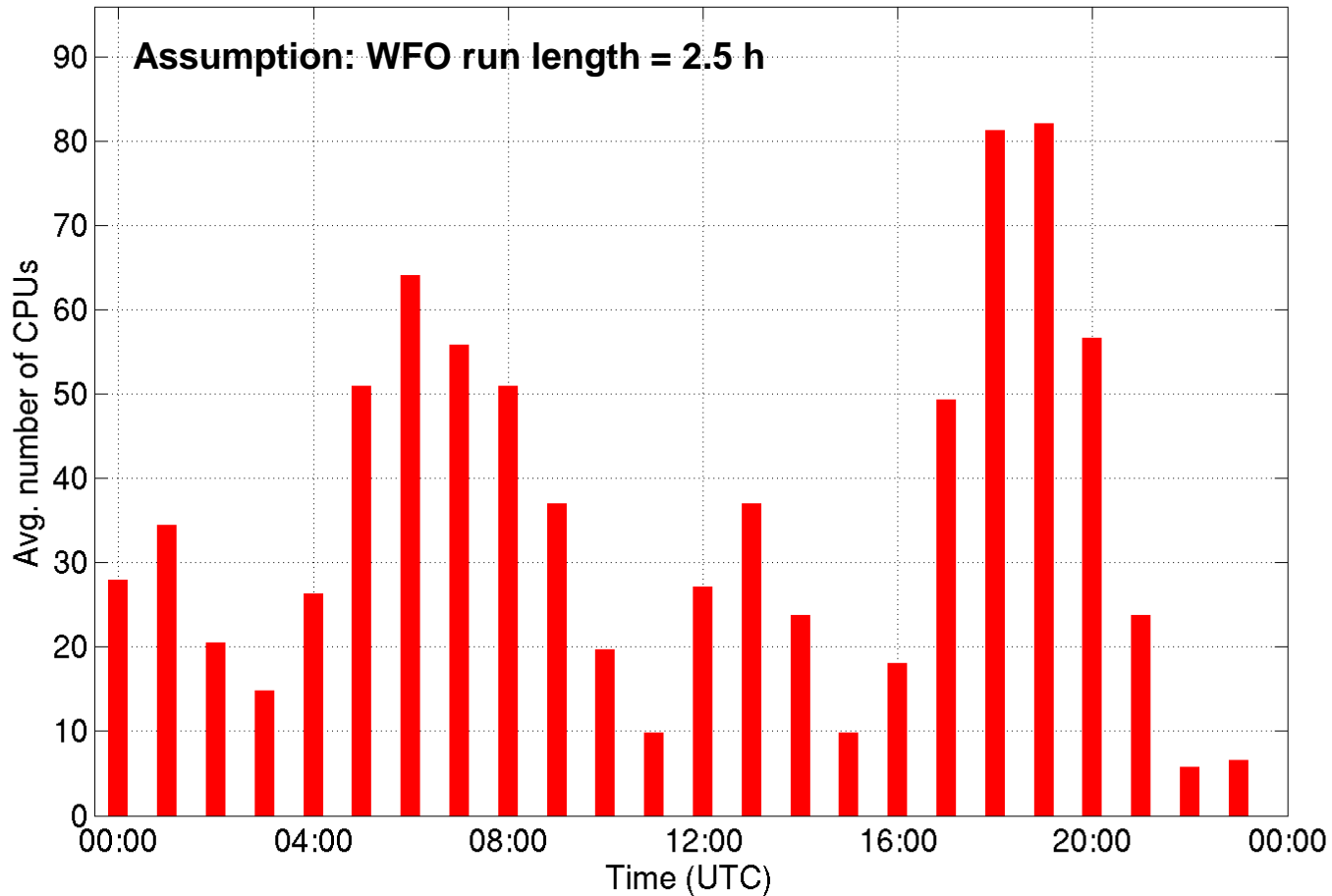
Etc.



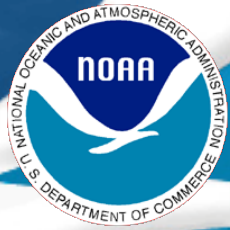


# WCROSS resources (all WFOs, estimate)

Concurrent NWPS runs during sample week of Dec 16-22, 2013 (scaled to 23 WFOs)

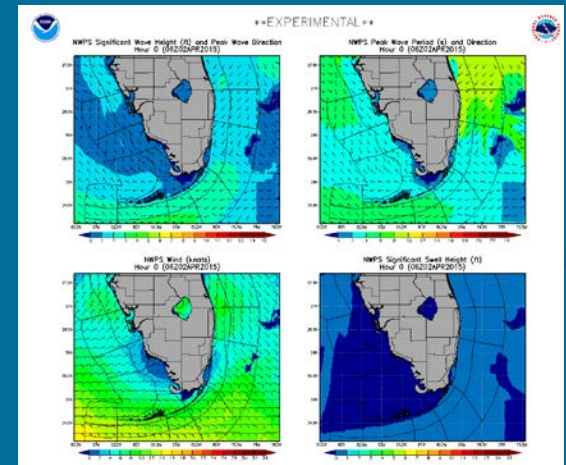
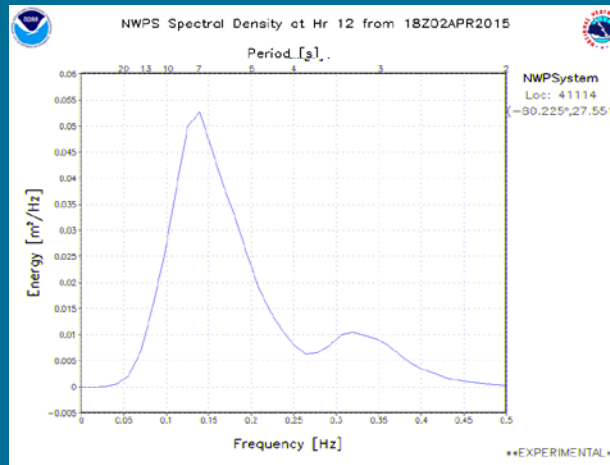
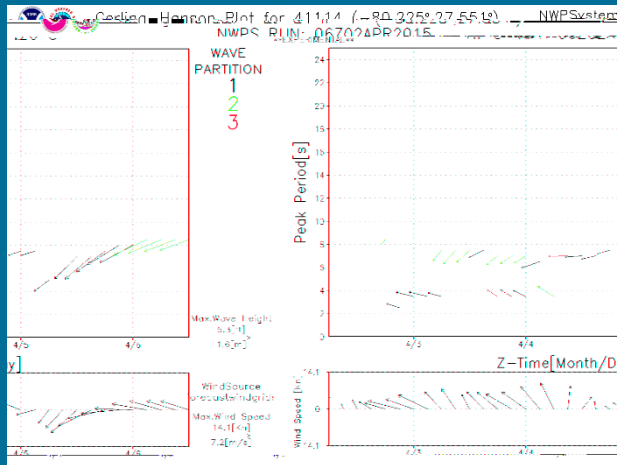






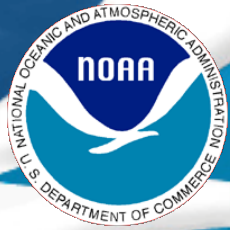
# Data output

1. **GRIB2 files** with all parameters, per WFO per grid (CG1-5), with **WMO Headers**
2. **Png files** with wave partition time series (Gerling-Hanson plots)
3. **Png files** with wave spectra
4. **Png files** with wave fields
5. **Text files** with wave, water level and rip current output (MFL, MHX, TBW)

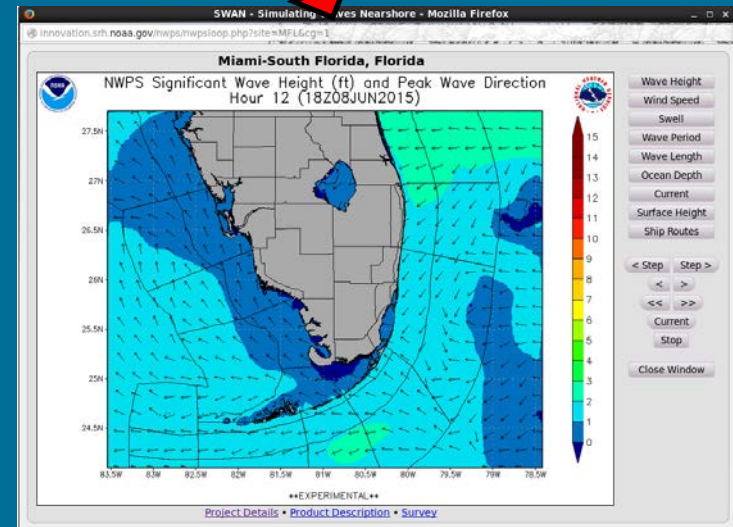
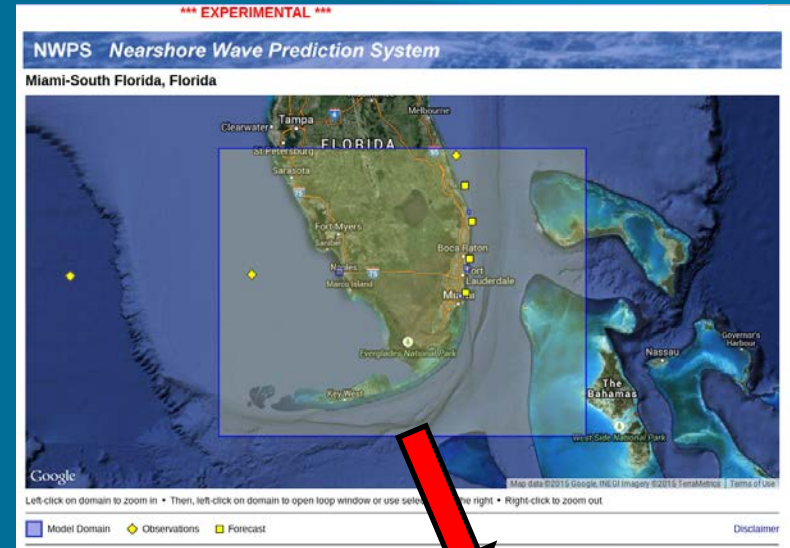


➔ Total GRIB2 volume (23 WFOs, all domains) = 1.6 GB/cycle ~ 2x /day -> SBN  
Total PNG volume = 964 MB/cycle (18,866 files) ~ 2x /day -> EMC's Polar





# Web graphics on EMC's Polar



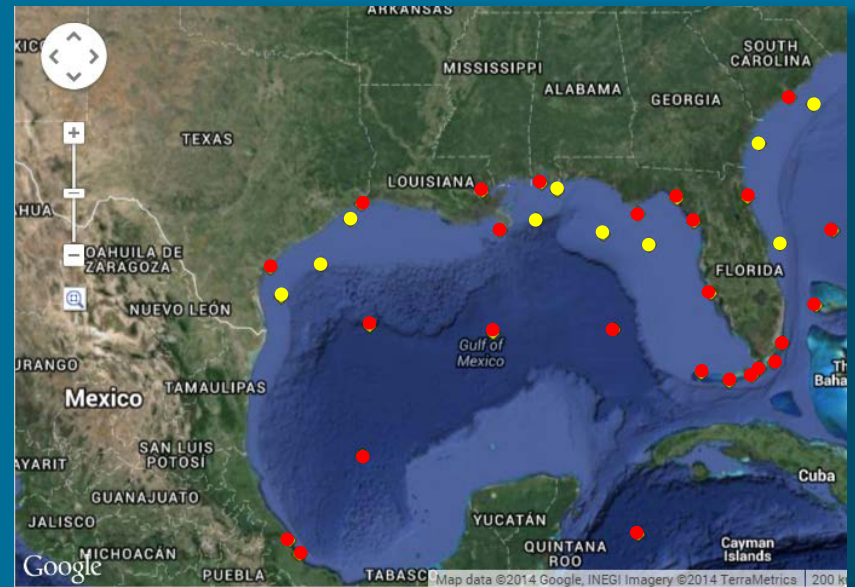
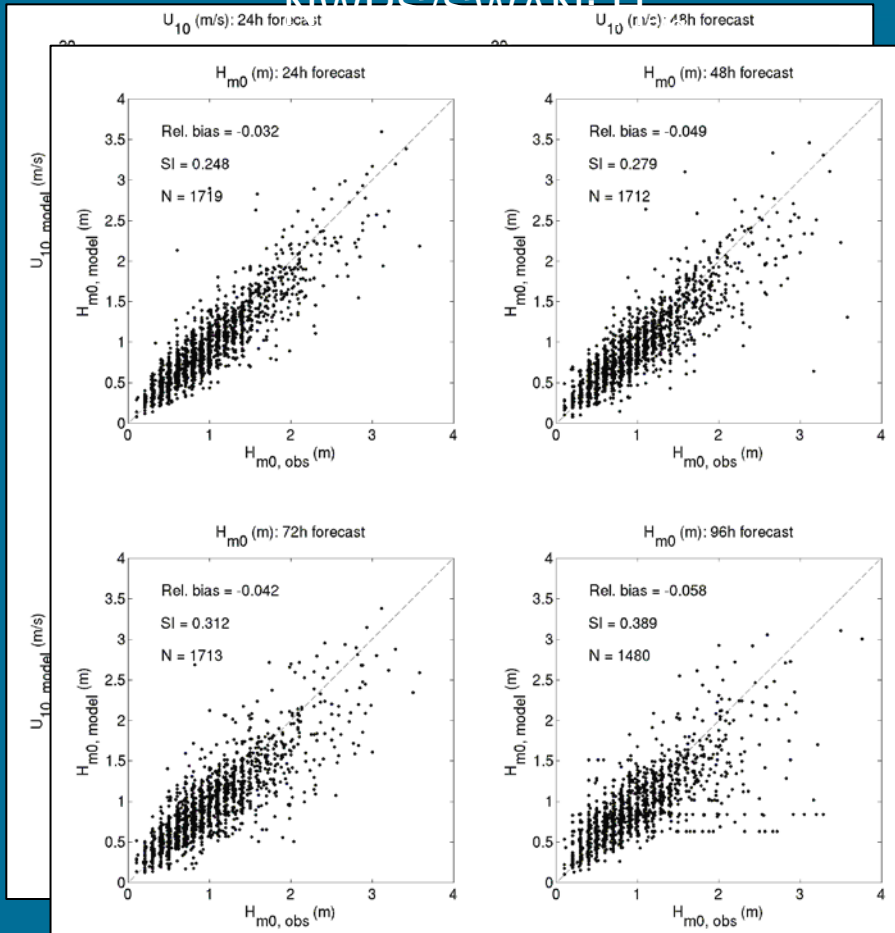
<http://innovation.srh.noaa.gov/nwps/>





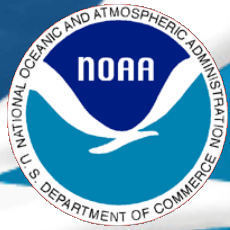
# Validation at nearshore NDBC buoys

GFE winds:  $U_{10}$   
NDBC/SWAN:  $H_{m0}$



Operational runs at SR WFOs:  
2014/10/11-2015/05/20





# Implementation schedule

- Code delivered to NCO – Jun 9, 2015
- SPA begins prep work for 30 day test – Jun 9, 2015
- TIN issued – Jul 1, 2015
- 30-day evaluation begins (MFL & BOX) – Jul 1, 2015
- IT testing ends – Jul 31, 2015
- 30-day evaluation ends (MFL & BOX) – Aug 1, 2015
- Management Briefing - Aug 15, 2015
- Implementation (MFL & BOX) – Sept 1, 2015
- Implementation (remaining 21 offices in SR & ER) – Sept 30, 2015