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

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.

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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

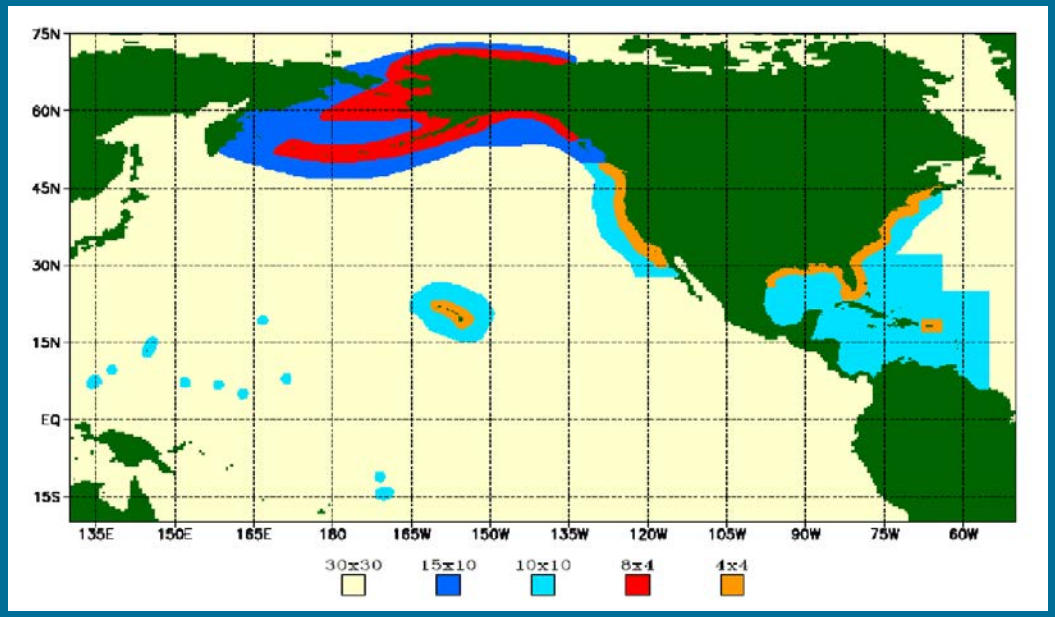
Associated Costs:

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.

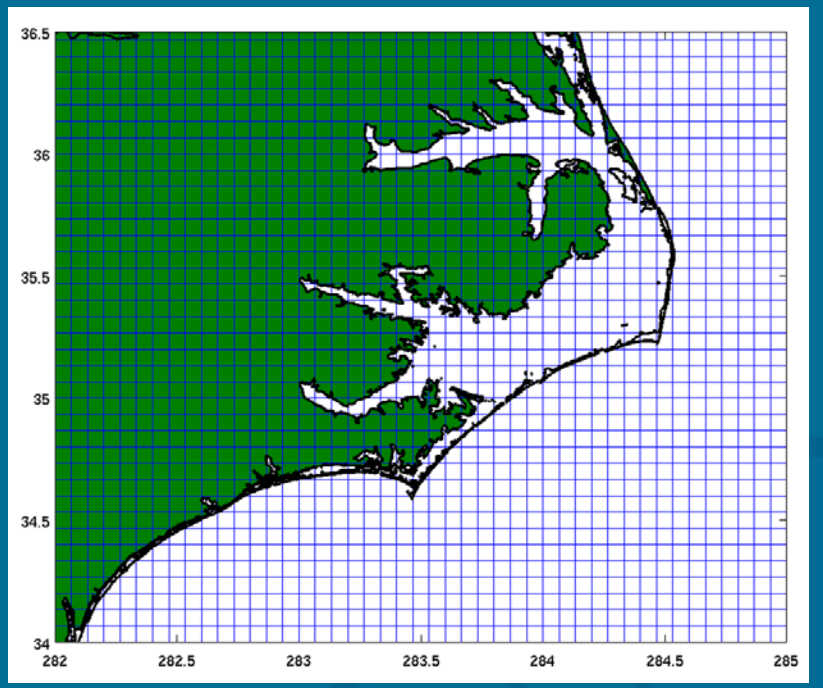
NCEP Wave guidance products

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.

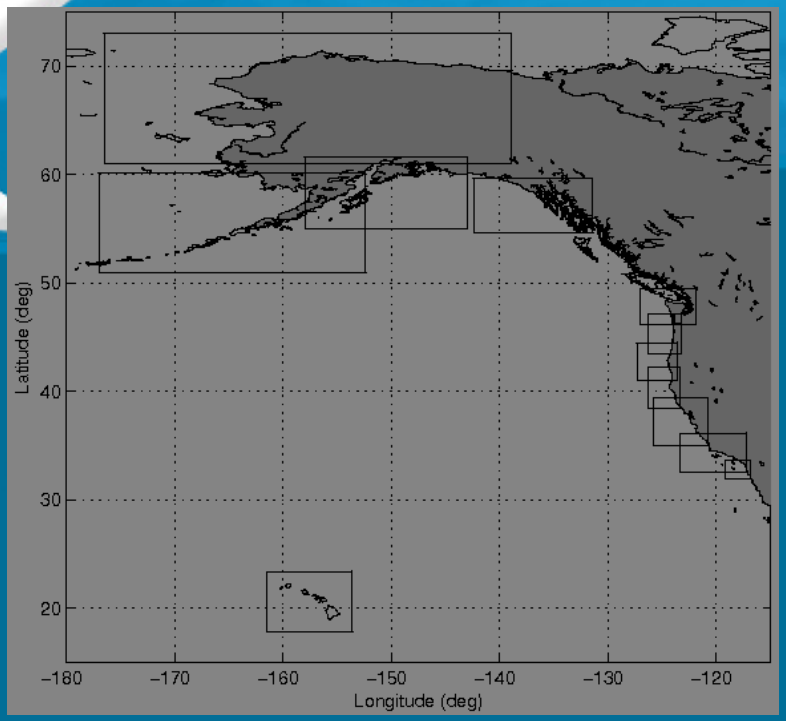
* WFO-based pilot project (WFO Eureka) transitioned to NCEP

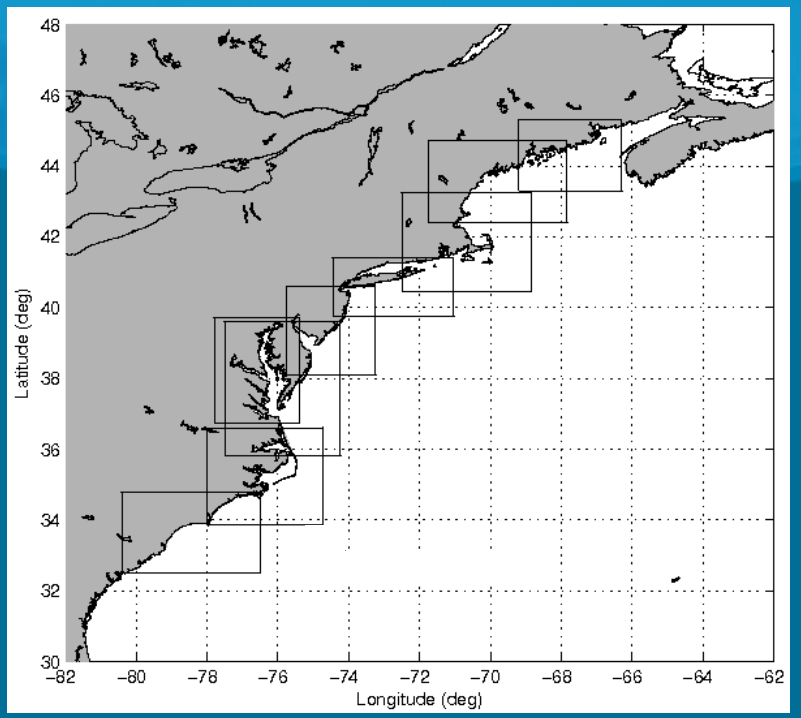
* Sandy Supplemental Milestone FY15Q4

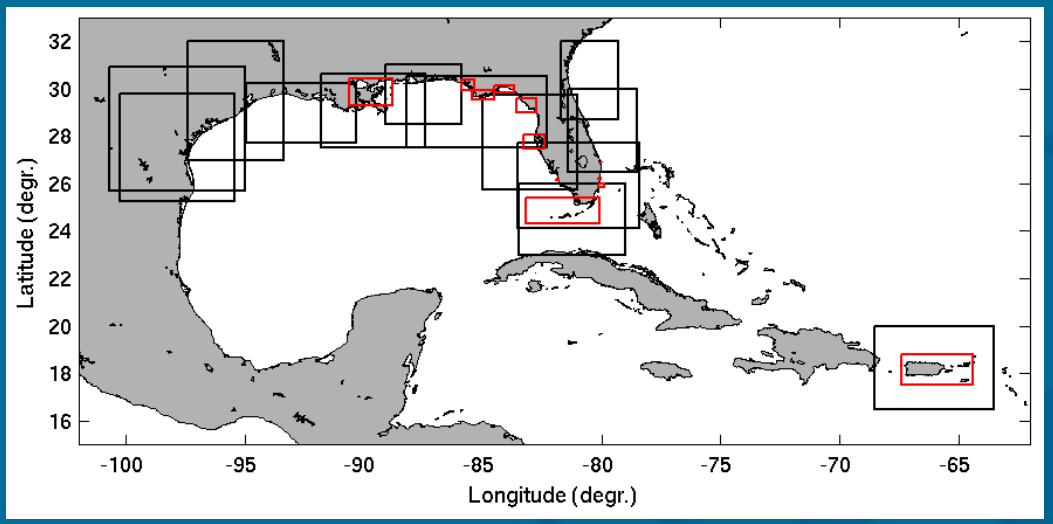
Model configuration

- 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).

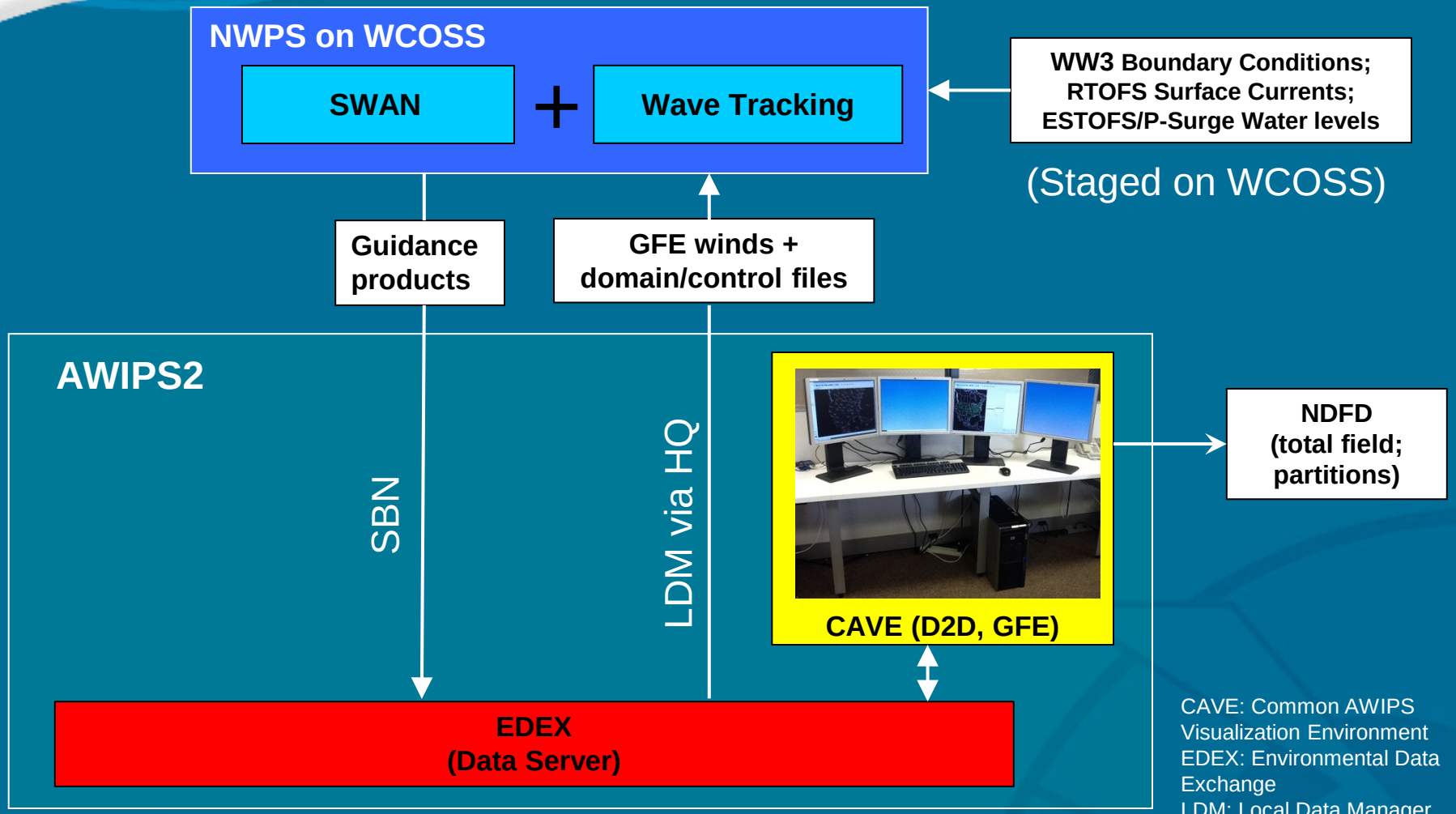
NWPS grids for coastal WFOs





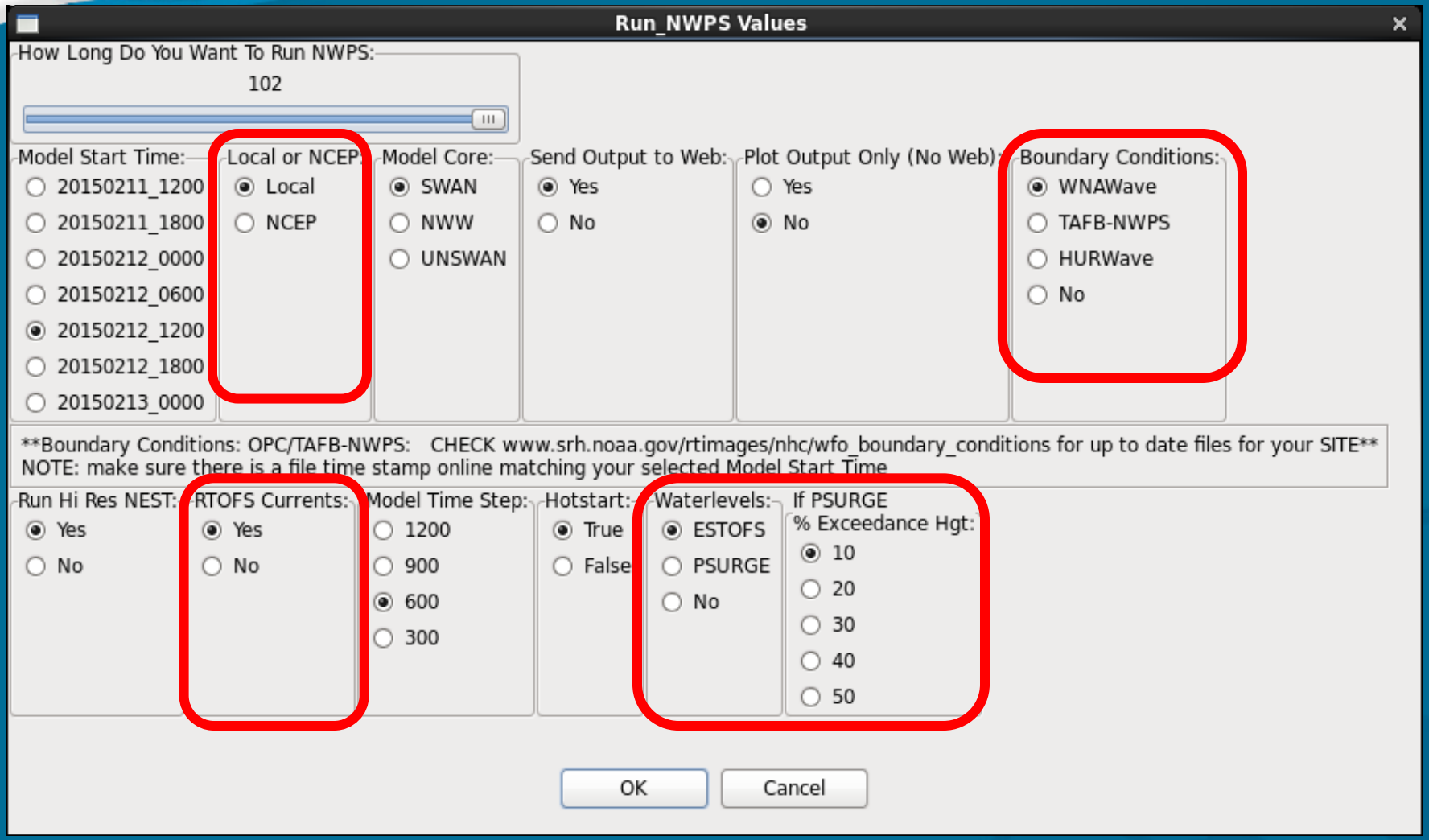


NWPS Architecture (WFO view)



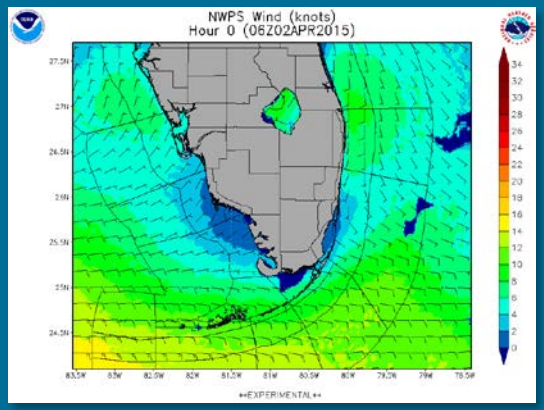
CAVE: Common AWIPS Visualization Environment
EDEX: Environmental Data Exchange
LDM: Local Data Manager

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



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 WW3
#
# ------------------------------------------------------------------
#==================================================================
#                                  MFL                             =
#  GEOGRAPHICAL DOMAIN, GEOGRAFICAL RESOLUTION AND OUTPUT TIME STEP  =
#==================================================================
export SITEID="MFL"
export REGIONID="SR"
export NELAT="27.70"
export NELON="-78.41"
export SWLAT="24.10"
export SWLON="-83.54"
#export RES="1.8"
export RES="6"
export TSTEP="3"
```

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

```
ssh ${SSHARGS} ldad@ls1 echo "$RUNLEN:$WNA:$NEST:$GS:$WINDS:$WEB:$PLOT:$DELTAC:$HOTSTART:$ESTOFS:$CORE >
/data/ldad/nwps/input/inp_args" 2>&1 | tee -a $logfile
```

Size = ~2 Mb zipped/WFO site

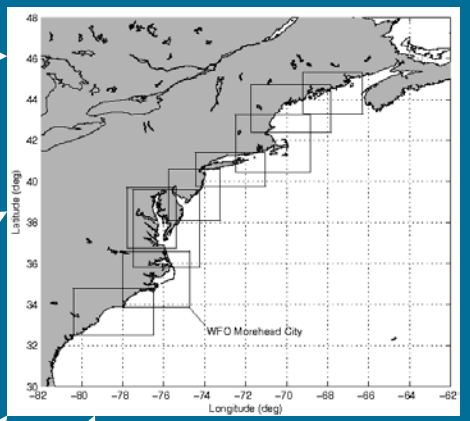
Data input (Staged on WCOSS)

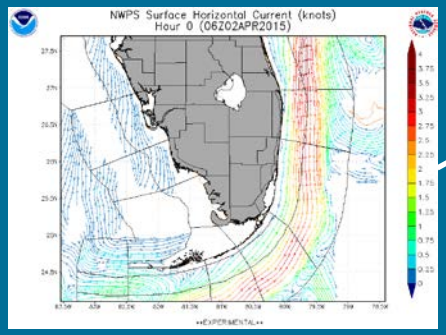
1. WAVEWATCH III boundary spectra (txt)

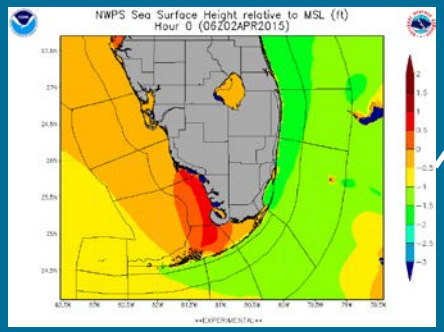
2. RTOFS surface current fields (txt)

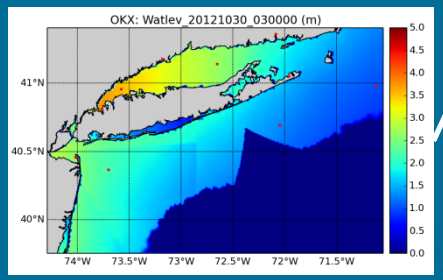
3. ESTOFS water levels (txt)
(Extra-tropical conditions)

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

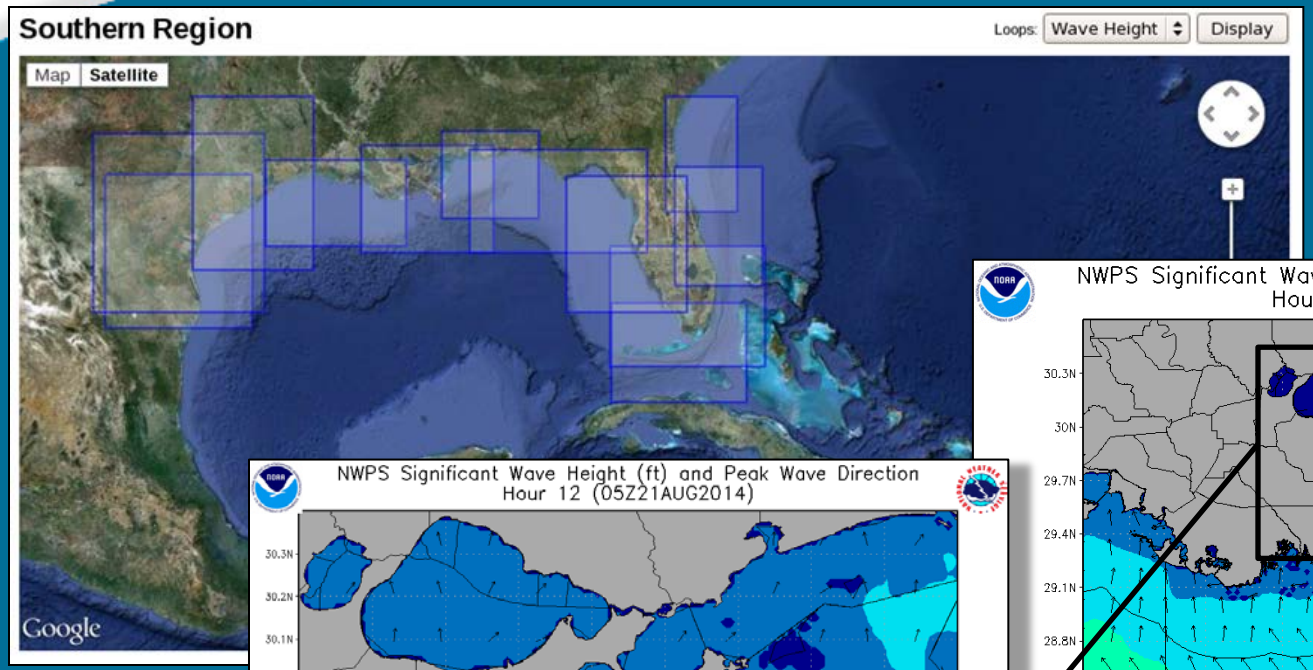




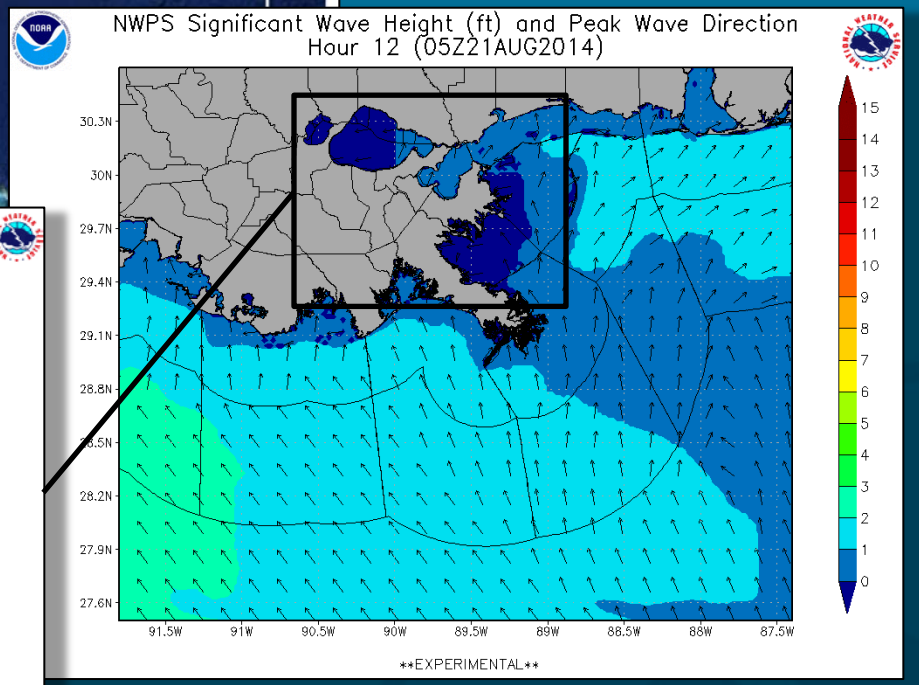


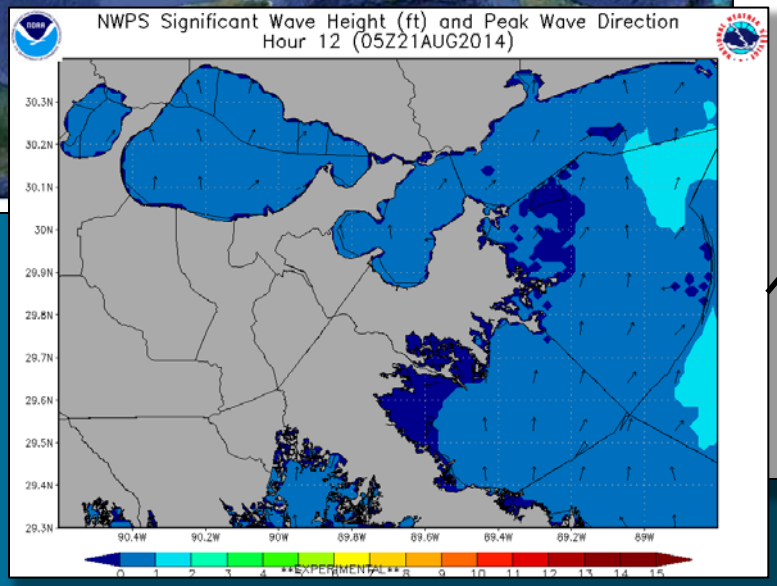


Example output for WFO New Orleans



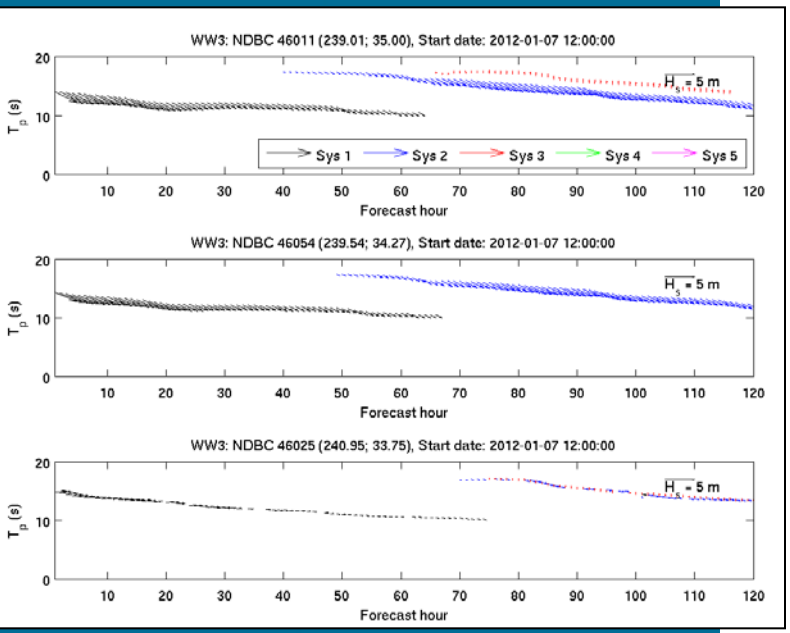
WFO LIX, CG1
(1.8 km)

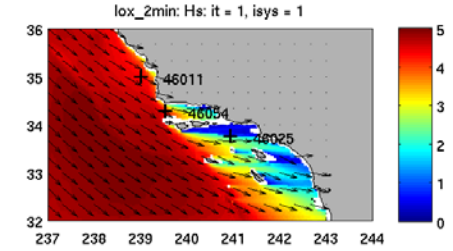


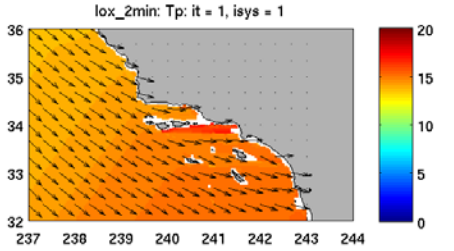


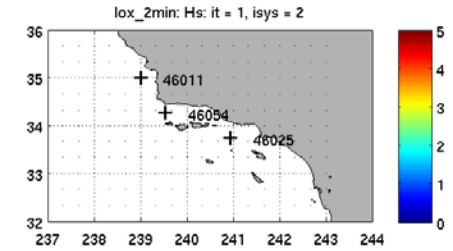
CG2
(500 m)

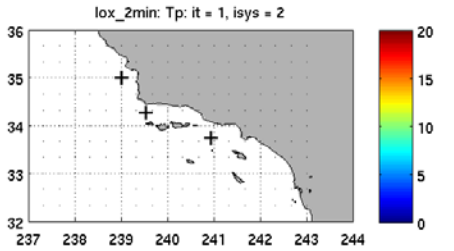
Post-processing: Wave system tracking

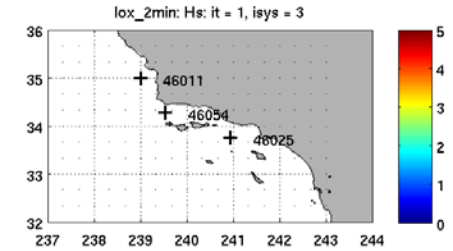


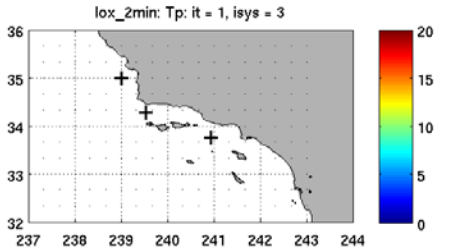


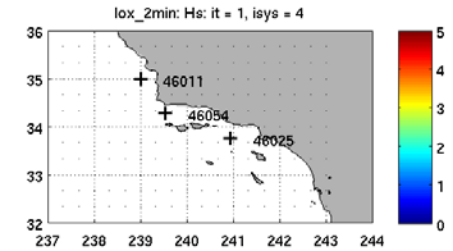


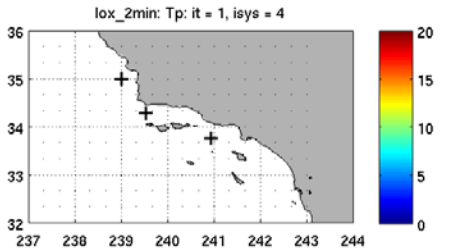


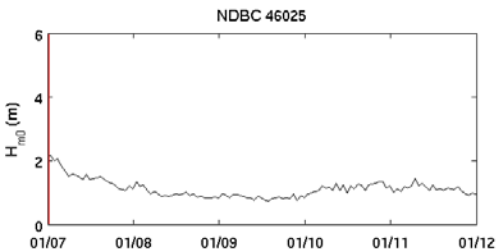


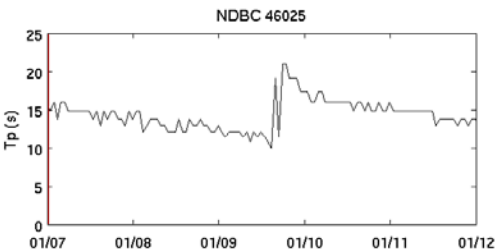


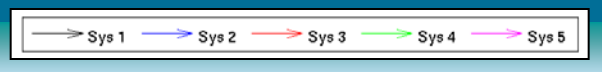




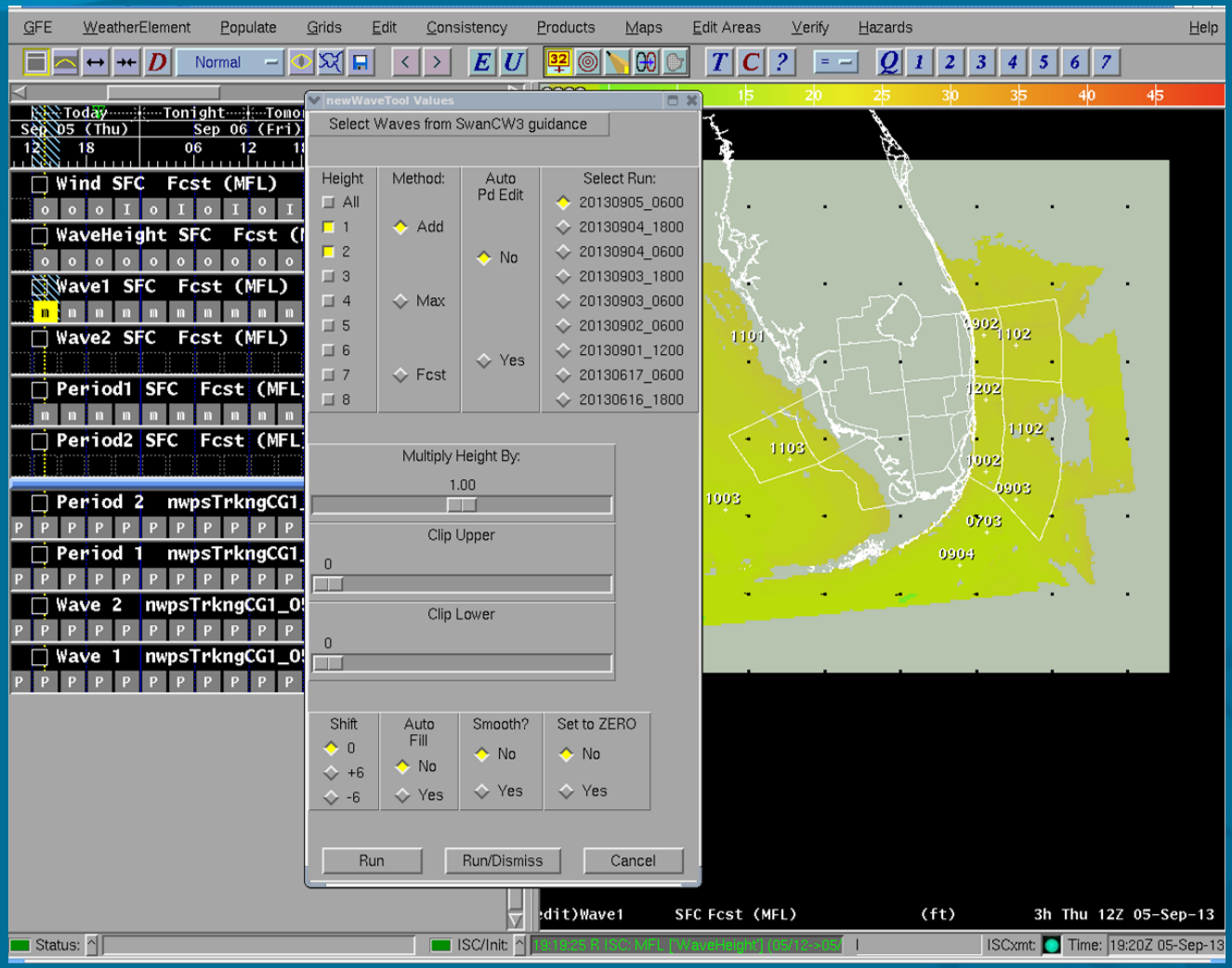




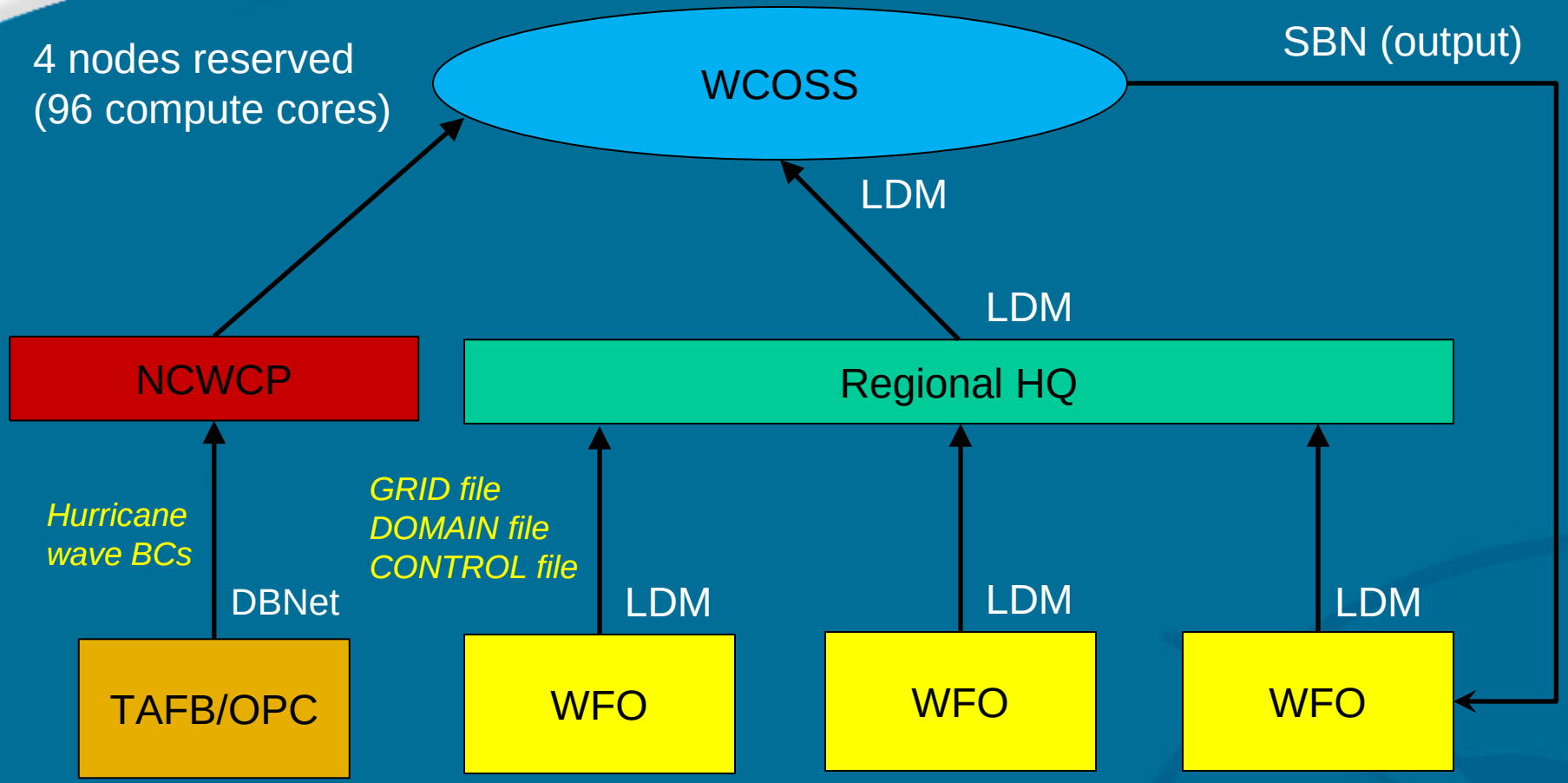


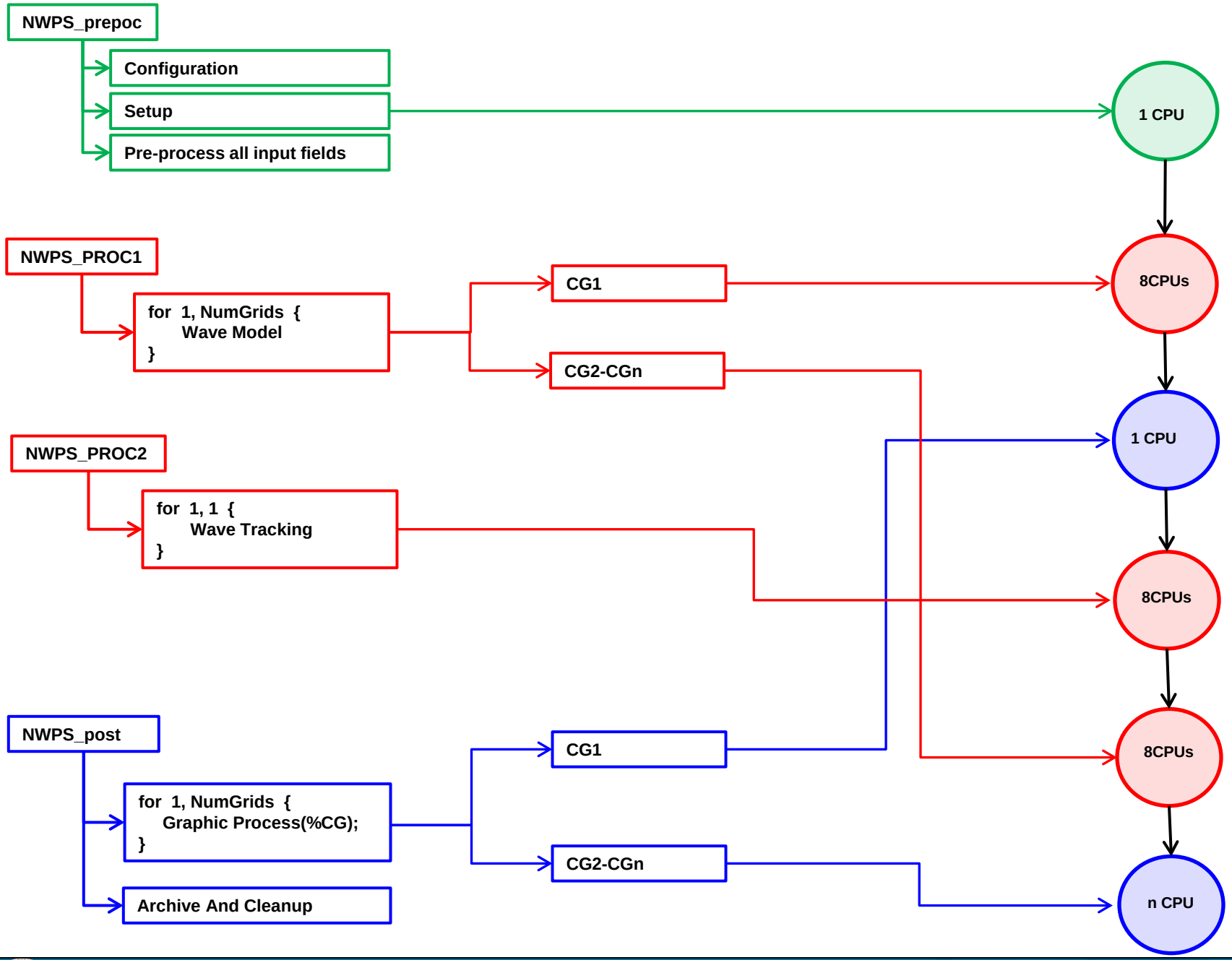


Guidance in GFE for producing forecast

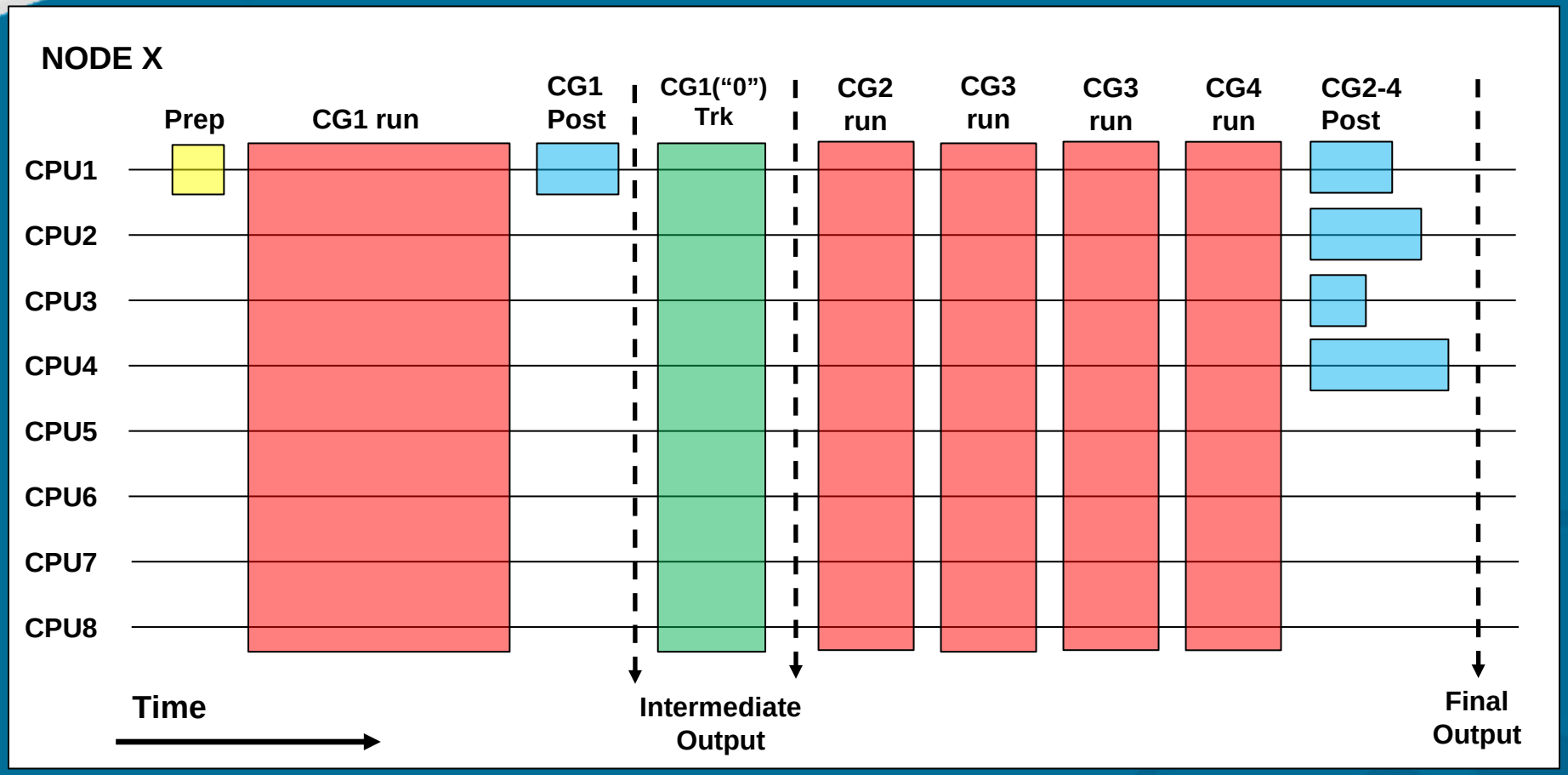


NWPS Architecture (Regional view)




NWPS_prepoc
Configuration
Setup
Pre-process all input fields
1 CPU
NWPS_PROC1
for 1, NumGrids {
Wave Model
}
CG1
CG2-CGn
8CPUs
1 CPU
NWPS_PROC2
for 1, 1 {
Wave Tracking
}
8CPUs
NWPS_post
for 1, NumGrids {
Graphic Process(%CG);
}
Archive And Cleanup
CG1
CG2-CGn
8CPUs
n CPU

Scheduling of jobs (single WFO)



WCOSS resources (single WFO)

P R E P
Resource usage summary:

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

F O R E C A S T CG1
Resource usage summary:

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

P O S T CG1
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

F O R E C A S T CGn
Resource usage summary:

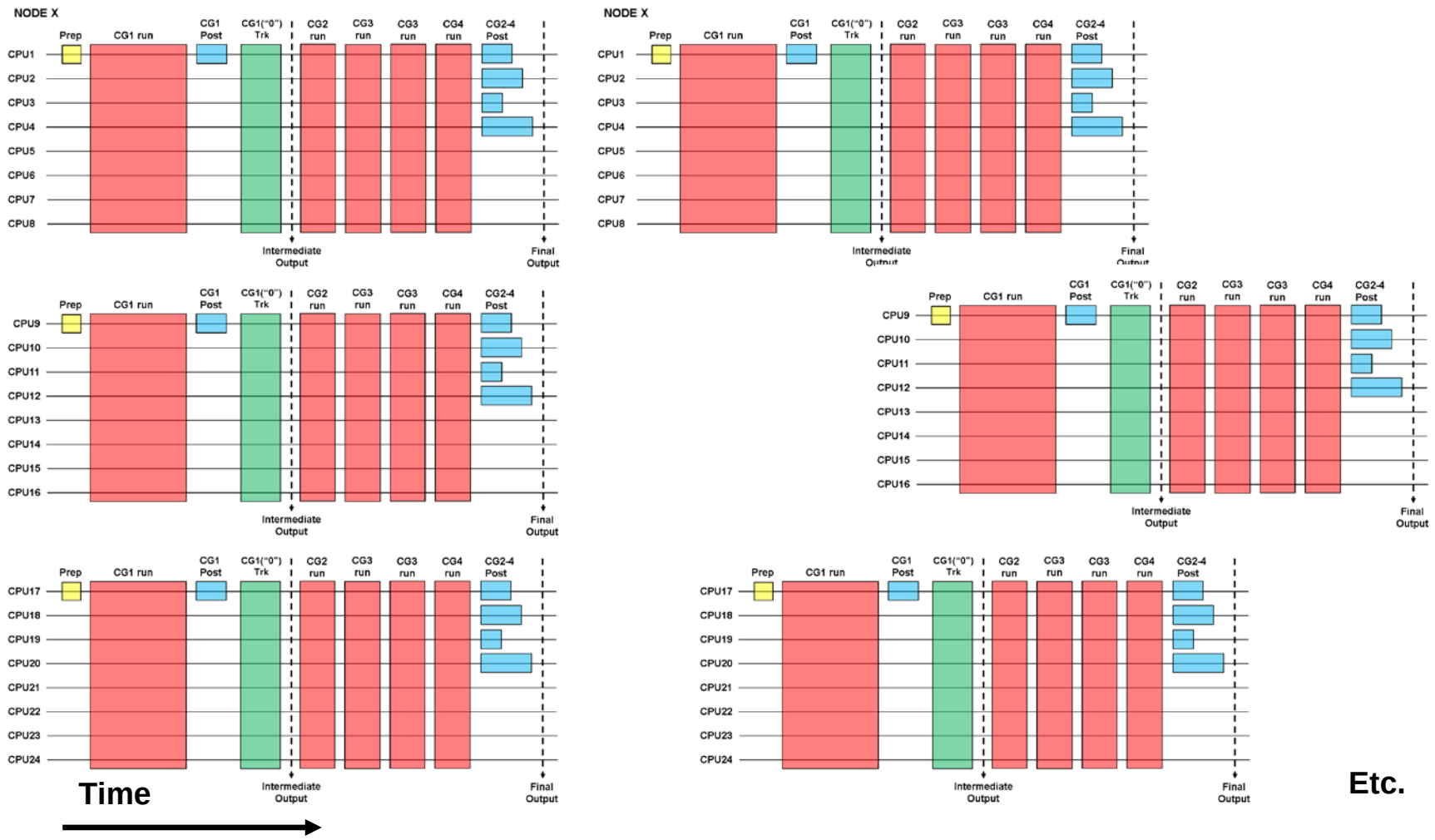
CPU time :	Variable, WFO depend.
Max Memory :	Variable
Average Memory :	Variable
Num of CPUs :	8

P O S T CGn
Resource usage summary:

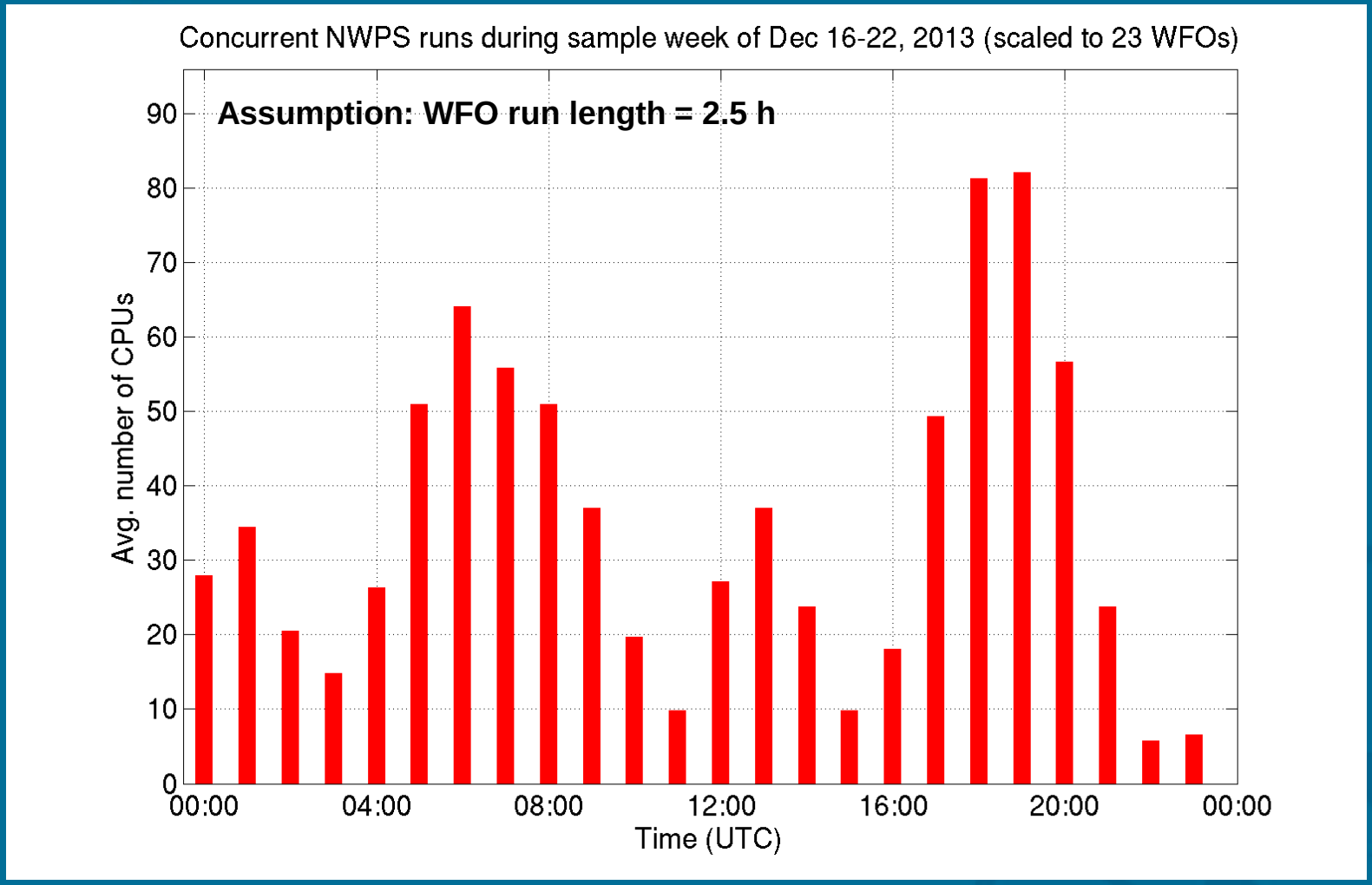
CPU time :	Variable, WFO depend.
Max Memory :	Variable
Average Memory :	Variable
Num of CPUs :	Up to 4

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

Scheduling of all jobs (per node)

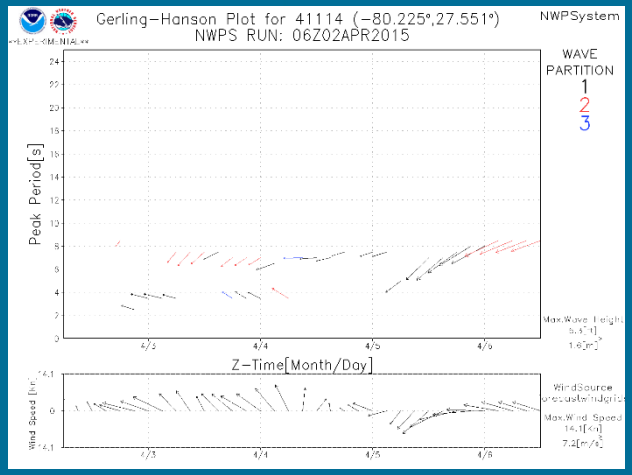


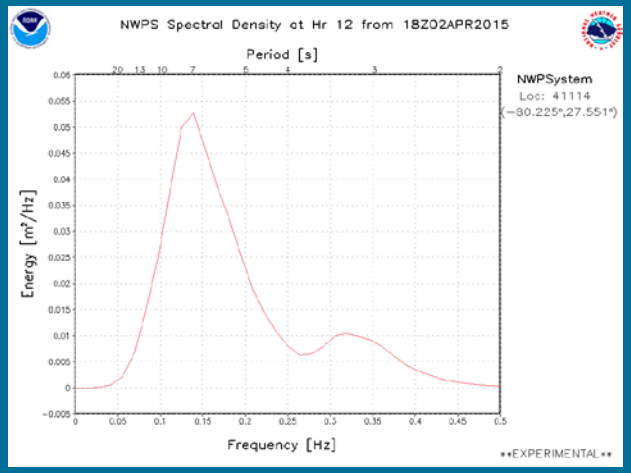
WCOSS resources (all WFOs, estimate)

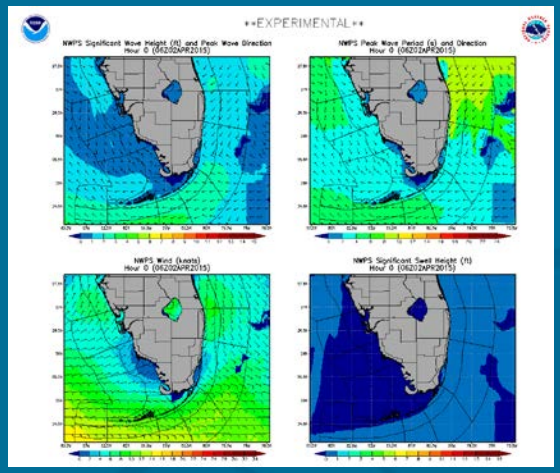


Data output

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)



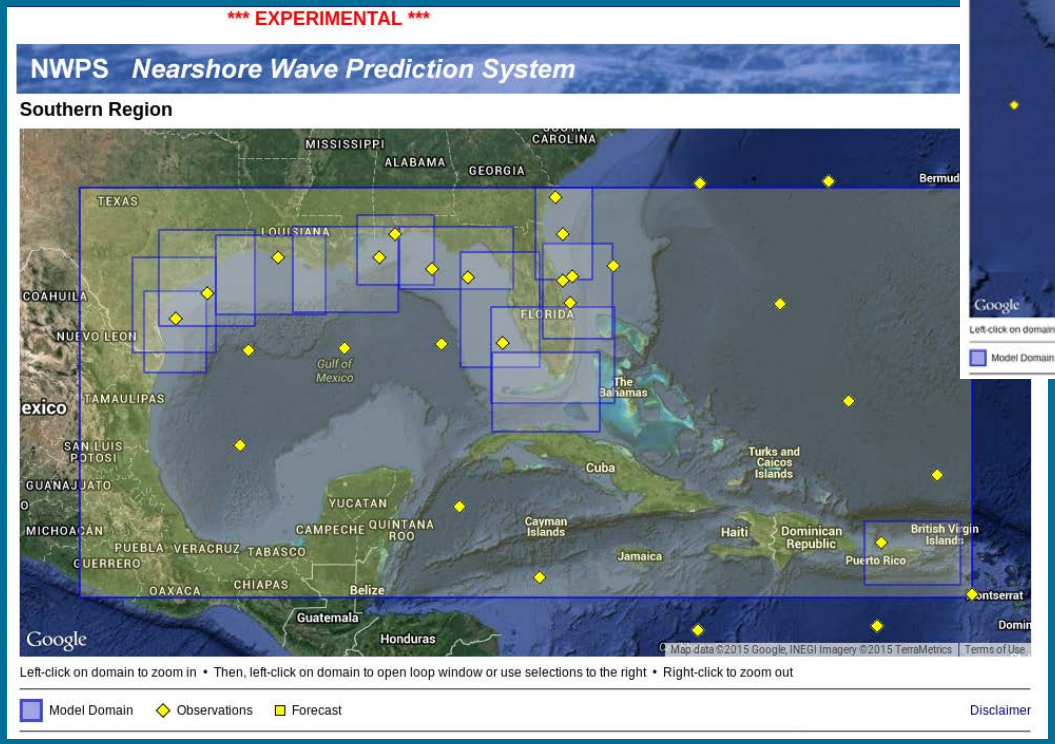


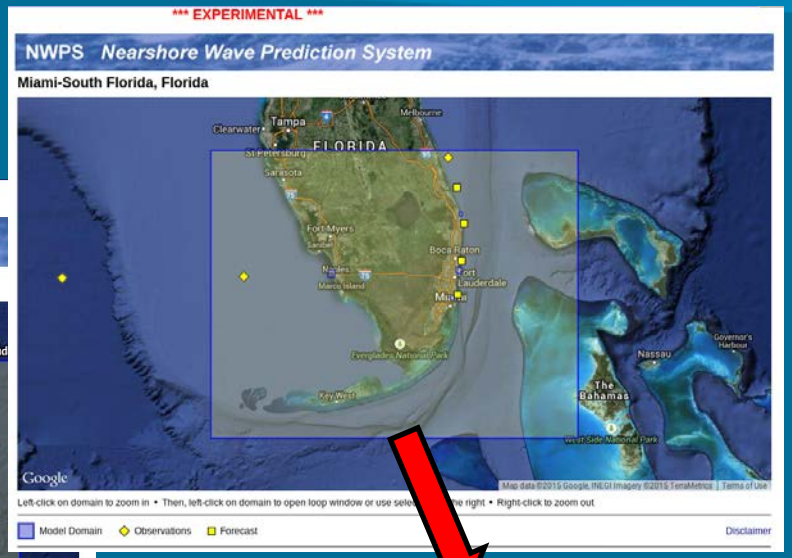


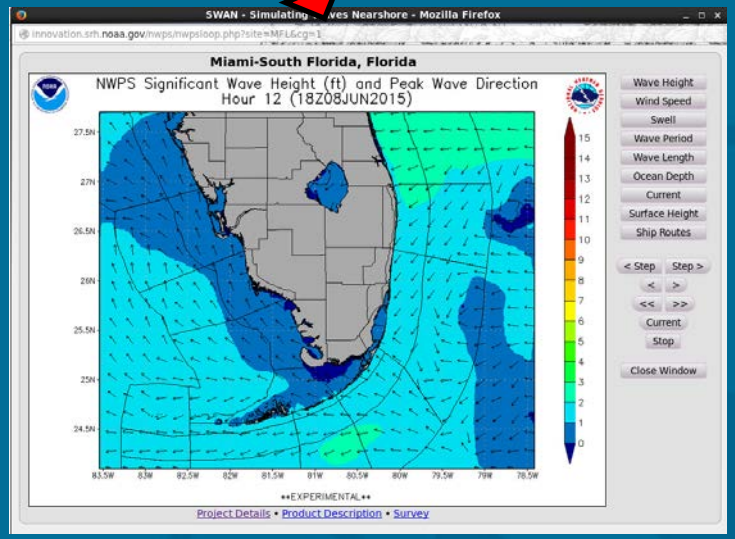
Total GRIB2 volume (23 WFOs, all domains) = 1.6 GB/cycle ~ 2x /day -> SBN

Total PNG volume = 964 MB/cycle (18,866 files) ~ 2x /day -> EMC's Polar

Web graphics on EMC's Polar



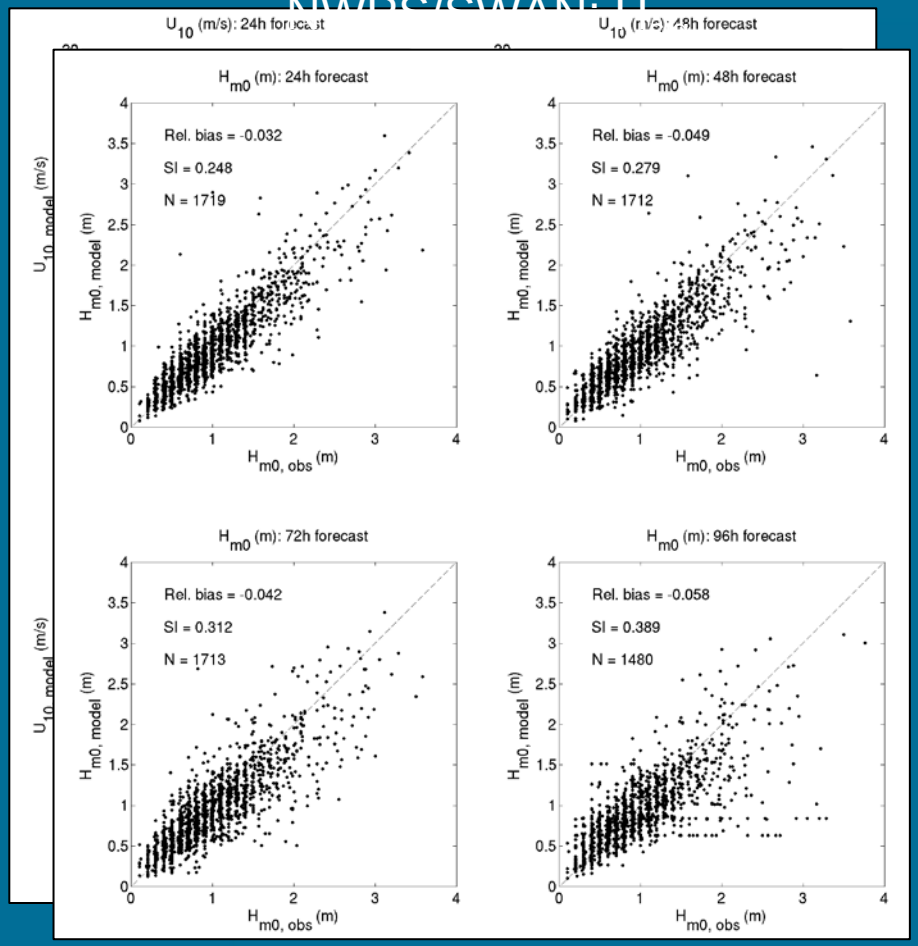


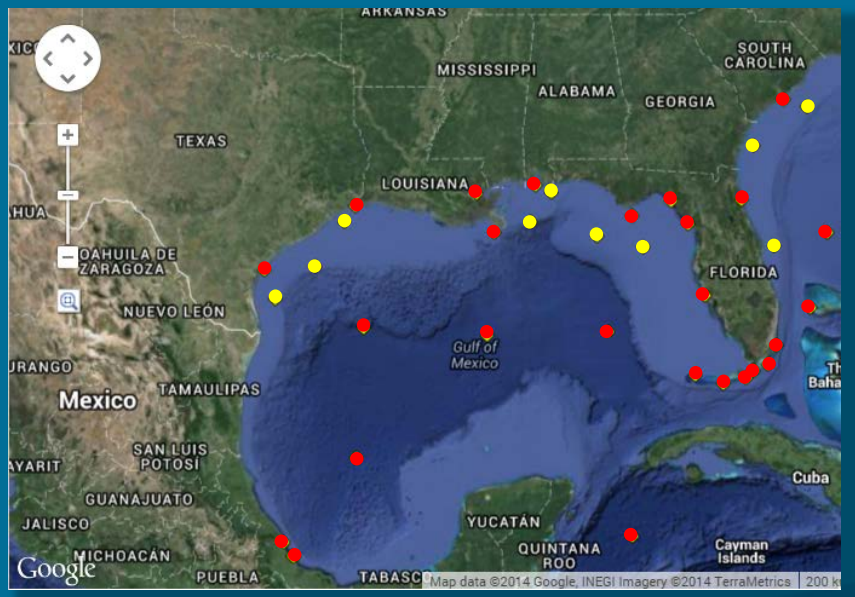


http://innovation.srh.noaa.gov/nwps/

Validation at nearshore NDBC buoys

GFE winds: U_{10}
NWPS/SWAN: U_{10}





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