Coupling SWAN into WAVEWATCH III®

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SWAN and WAVEWATCH III®

- In principle SWAN and WAVEWATCH III are both third generation wind wave models sharing very similar theoretical background
- Source term packages used in SWAN and WAVEWATCH III have some differences
- Numerics used in SWAN and WAVEWATCH III are different

  SWAN uses elliptical equations to avoid the stringent limitations on time steps due to CFL criteria.
- In very fine coastal grids SWAN is computationally more efficient than WAVEWATCH III. While in regional and global domains WAVEWATCH III is computationally more efficient.
- The biggest difference between SWAN and WAVEWATCH III used to be the shallow water physics packages (WAVEWATCH III now includes some of these packages as well)

SWAN and WAVEWATCH III (contd.)

- For fine coastal wave modeling, the current State-of-the-Art is to couple coastal SWAN models with regional/global ocean models like WAM or WAVEWATCH III
- SWAN allows for direct coupling with either WAM or WAVEWATCH III
- This coupling follows the traditional nesting tradition
  - Coupling is one way
  - SWAN runs can only be done after the WAVEWATCH III (or WAM) run is completed and boundary files have been generated
- NCEP currently supports several such coastal SWAN projects where forecast results are provided for local SWAN runs

Coupling do's and don't's

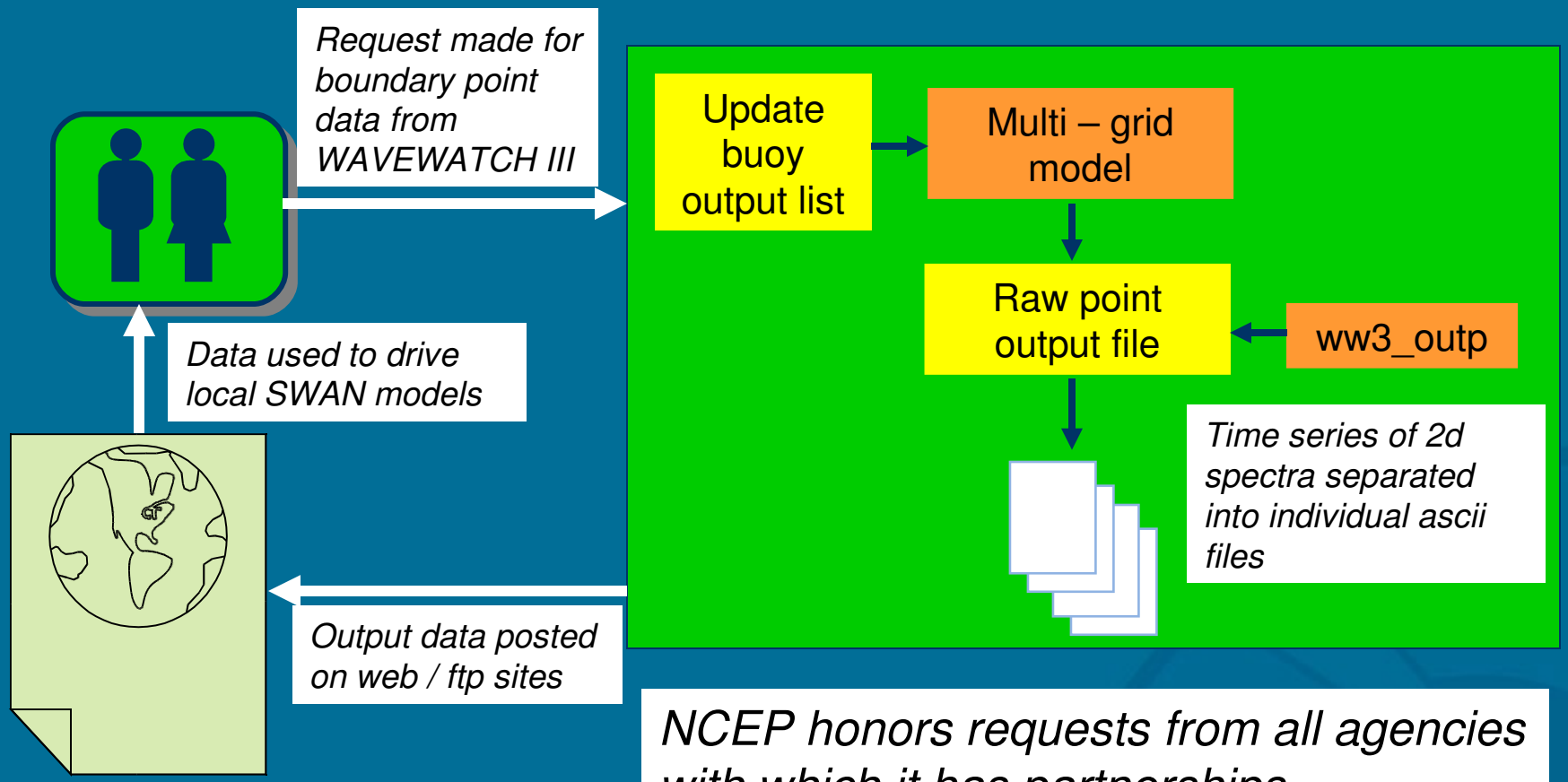
- Use spherical coordinates in the nested SWAN model since the grids in WAVEWATCH III will be in spherical coordinates (internal nested grids can be cartesian)
- The grid should lie (as close as possible) along the output WAVEWATCH III points
- The spectral grids of SWAN and WAVEWATCH III output points do not have to coincide
- WAVEWATCH III output points should be in deep water

  This is not a stringent point anymore since WAVEWATCH III now has shallow water breaking in it.

  A big difference now are the triad interactions in SWAN (that are not included in WAVEWATCH III)

  We are currently working on developing better physics packages for shallow water dynamics

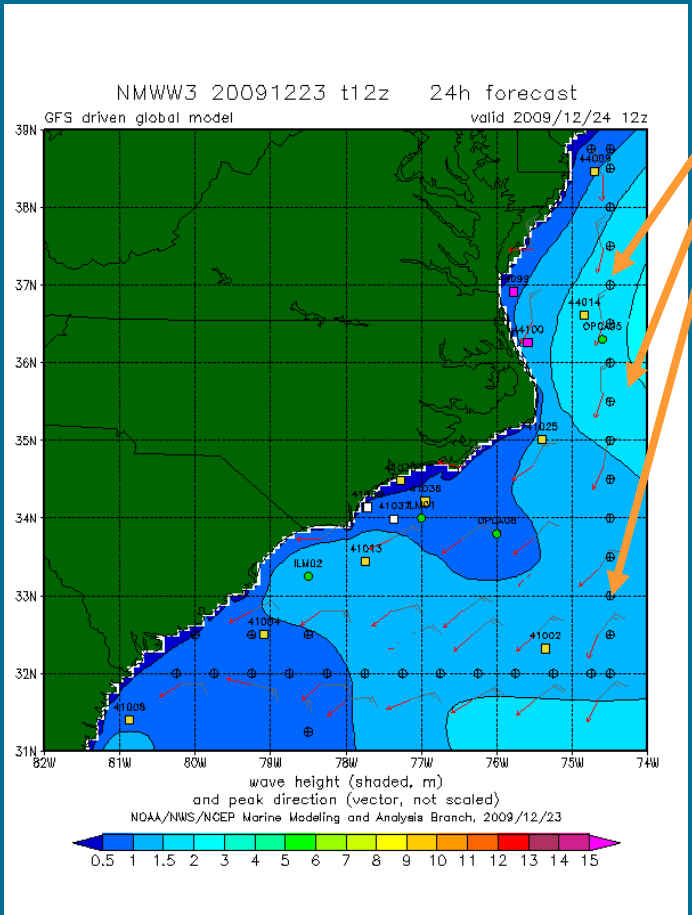
Coupling of SWAN and WAVEWATCH III at NCEP



NCEP honors requests from all agencies with which it has partnerships

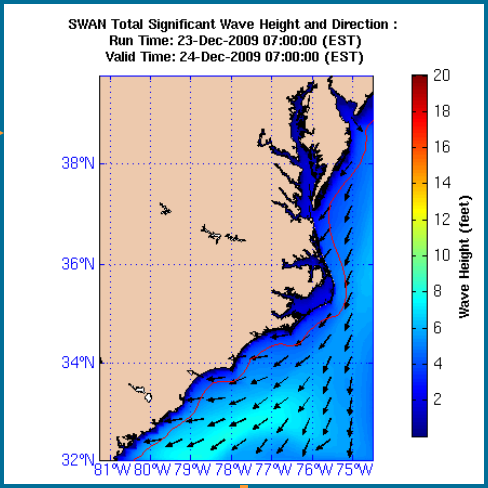
Example of WAVEWATCH III – SWAN coupling

Outer Banks – North Carolina

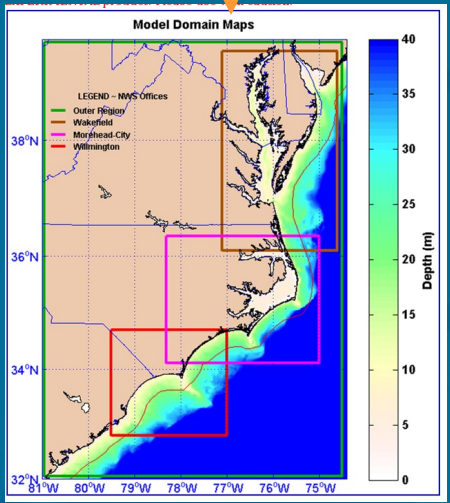


WAVEWATCH III Run

2d spectra output from boundary points used to drive outer domain SWAN run



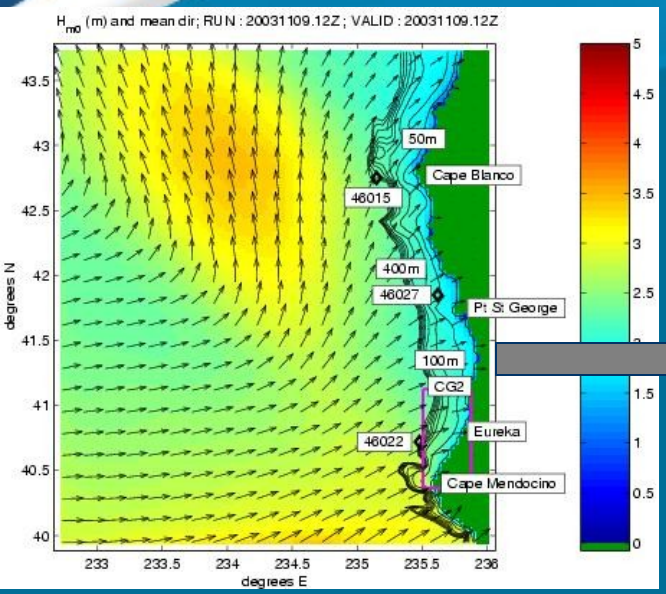
Outer domain SWAN model nested with several inner domain runs

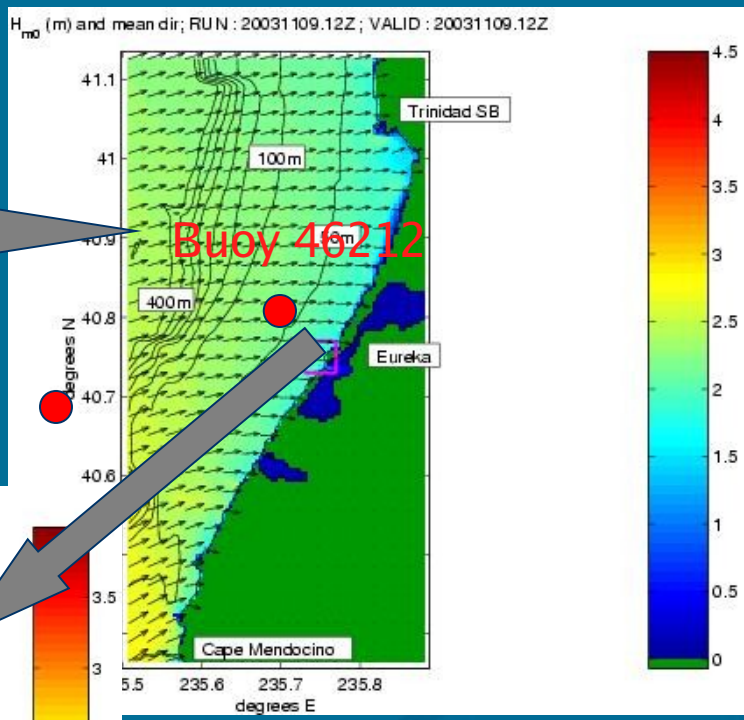


WAVEWATCH III boundary information needed only for the outer domain model

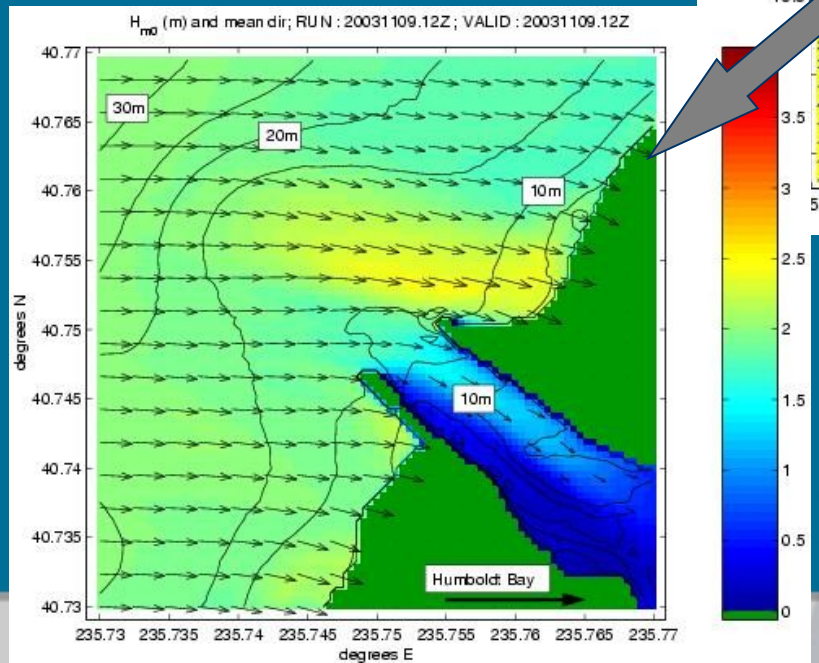
Example of WAVEWATCH III – SWAN coupling

Humboldt Bay, Euraka





Buoy 46022



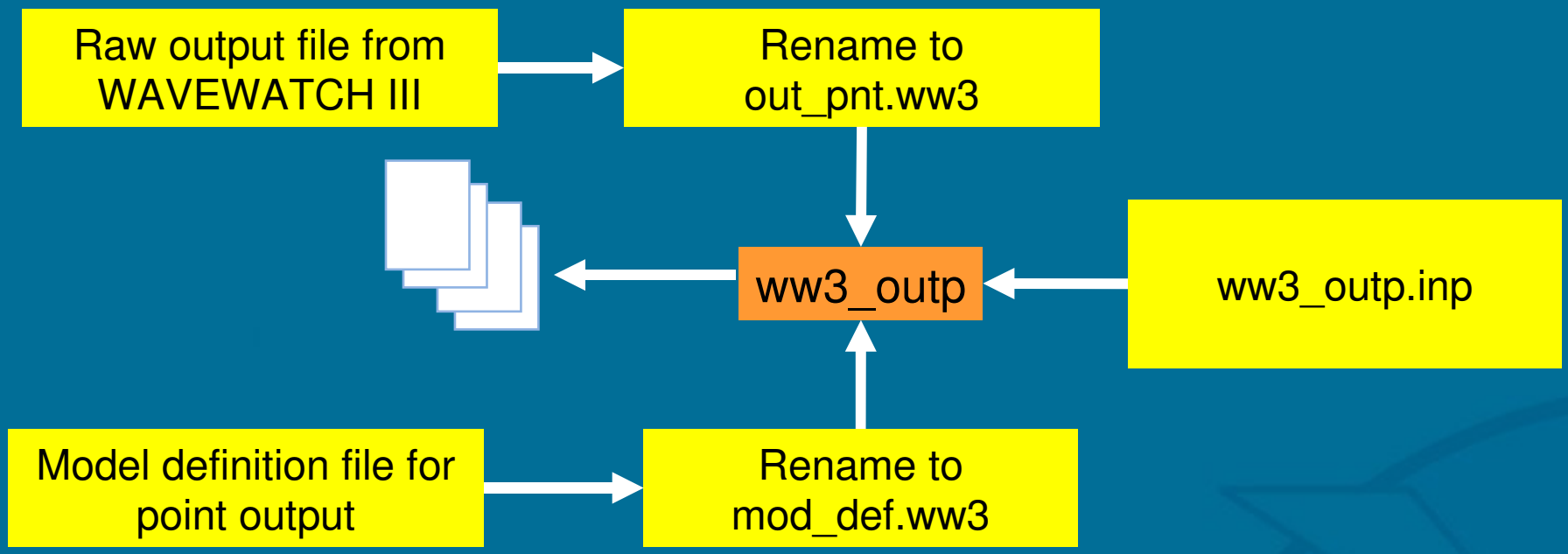
OUTPUT FROM WAVEWATCH III

- STEP 1 : Identify the outer domain of the SWAN model where boundary data from WAVEWATCH III is needed. Select boundary points along this domain (usually at a spacing of 0.2° – 0.5°) and include these points as part of WAVEWATCH III output (done in ww3_shel.inp if a single grid model or ww3_multi.inp if a multi-grid model)

```
  -80.25   32.00  'MHX51     '  999.   BPT  NCEP      45
  -79.75   32.00  'MHX52     '  999.   BPT  NCEP      45
  -79.25   32.00  'MHX53     '  999.   BPT  NCEP      45
  -78.75   32.00  'MHX54     '  999.   BPT  NCEP      45
  -78.25   32.00  'MHX55     '  999.   BPT  NCEP      45
  -77.75   32.00  'MHX56     '  999.   BPT  NCEP      45
  -77.25   32.00  'MHX57     '  999.   BPT  NCEP      45
  -76.75   32.00  'MHX58     '  999.   BPT  NCEP      45
  -76.25   32.00  'MHX59     '  999.   BPT  NCEP      45
```

Details of Coupling

- STEP2: After WAVEWATCH III model run completed extract point information from raw point output



Details of coupling

- ww3_outp.inp (a self documented detailed example file is included as part of the distributed model)

```
$Wavewatch III point output
$
TIME      DT      NT
$
$ Output points (you can
$
 1
-1
$
$ Output Type
0
$
```

Output points are identified by the sequence in which they are defined NOT by their i.d.

Mandatory value needed to indicate the end of output points

Creates a buoy log file called "buoy_log.ww3"

Details of coupling

- Buoy_log.ww3

Buoy i.d. (from ww3_multi.inp)

1	23092	72.49	17.02	w_coast
2	23093	73.75	15.40	w_coast
3	23094	74.50	12.94	w_coast
4	23096	80.39	13.19	e_coast
5	23097	69.24	15.47	ar_sea
6	23098	72.51	10.65	w_coast
7	23099	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]100	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]101	[illegible]	[illegible]	[illegible]
10	23168	87.50	15.00	bay_beng
11	23169	90.14	18.13	bay_beng
12	23170	72.66	8.33	w_coast
13	23172	72.00	12.50	w_coast
14	23173	78.57	8.21	e_coast
15	23174	81.53	11.57	e_coast

Output point needed in ww3_prep.inp

Output point coordinates

Grid in which point resides

Details of coupling

- ww3_outp.inp (to create 2d ascii spectral files for SWAN)

```
$Wavewatch III point output processing
$
TIME      DT      NT
$
$ Output points (you can have multiple points)
$
$ Output Type
1
3 0. 0. 51 F
$
```

Output type is transfer files (for SWAN model)

Scaling factors (ignored for transfer files)

Output file identifier (output will be stored in tab51.ww3)

Creates 2d s

Flag for output file type (F=ascii file, T=binary file)

INPUT TO SWAN

- Spectra input to SWAN can be done in one of two ways
  - Individual boundary points are in separate files
  - Boundary points are in one file
- WAVEWATCH III can output boundary points in both ways
- At NCEP we prefer the first approach because it greatly simplifies post processing
  - Do not have to worry about the order of points
  - Can add additional points easily (only have to modify one file)

Details of Coupling

- SWAN example file using separate files for individual boundary points

```
$
$Some SWAN commands (that I have ignored here)…
$
BOUN SEG XY 279.75 32 285.5 32 VAR FILE 0.00 'nah.MHX51.spec.swan'    1 &
                         0.50 'nah.MHX52.spec.swan'    1 &
                           1.00 'nah.MHX53.spec.swan'    1 &
                         1.50 'nah.MHX54.spec.swan'    1 &
                         2.00 'nah.MHX55.spec.swan'    1 &
                         2.50 'nah.MHX56.spec.swan'    1 &
                         3.00 'nah.MHX57.spec.swan'    1 &
                         3.50 'nah.MHX58.spec.swan'    1 &
                         4.00 'nah.MHX59.spec.swan'    1 &
                         4.50 'nah.MHX60.spec.swan'    1 &
                         5.00 'nah.MHX61.spec.swan'    1 &
                         5.50 'nah.MHX62.spec.swan'    1 &
                           5.75 'nah.MHX63.spec.swan'    1
```

The end

End of Lecture 2.2