Wave Upgrades for multi-1 & multi-2 systems

EMC CCB - 08/06/2014

Multi-1 System

(Global wave model forced by GFS)

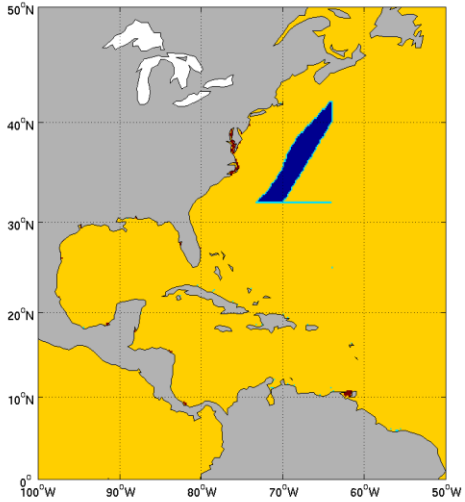
Planned Upgrades

- Update the system to use wave-code v4.15.0
  - This will make the global model in compliant with other wave systems
  - The upgraded code uses a hybrid MPI/OPENMP approach which does a much better utilization of available computational resources
- Updated the system to use RTGSST product so as to remove dependence on the 1 degree sstgrib file being generated by GFS (these products not being used at the moment so no impact on results)
- Generating a back ground wave field for the RTMA grid (only first six cycles)
- All grids are being updated to be based on ETOPO-1 bathymetry (previous ETOPO-2)
- Update masks of regional (10 arc-minute) grids
  - Extends the domain of the regional grids along the US coasts (OPC request)
  - Expand coverage for some of the islands in the Pacific (Guam WFO request)
- Replacing the Arctic rectilinear grid with a curvilinear grid for extending the domain closer to the North Pole

  Technical issues were slowing down the model so it was pulled till next upgrade

Impact

- No physics changes so impact in results is minimal
- Underlying grids change because of expanded mask and new bathymetry
- Due to the changed bathymetry and expanded domain the file sizes change
  - (COM space for multi-1 increases from 12.4 GB to 12.7 GB / cycle)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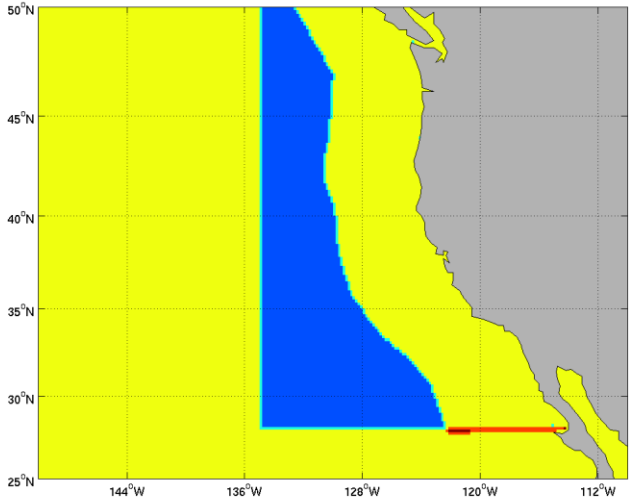
30°N
20°N
10°N
0°
100°W
90°W
80°W
70°W
60°W
50°W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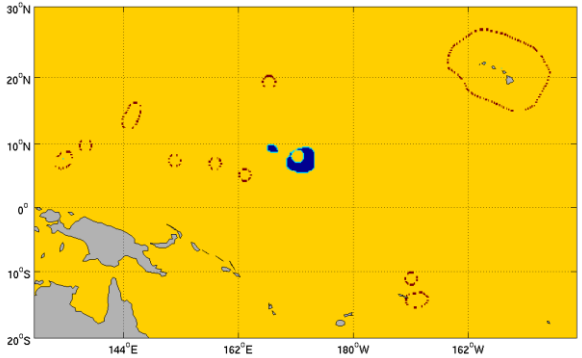
45°N
40°N
35°N
30°N
25°N
144°W
136°W
128°W
120°W
112°W


30°N
20°N
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10°S
20°S
144°E
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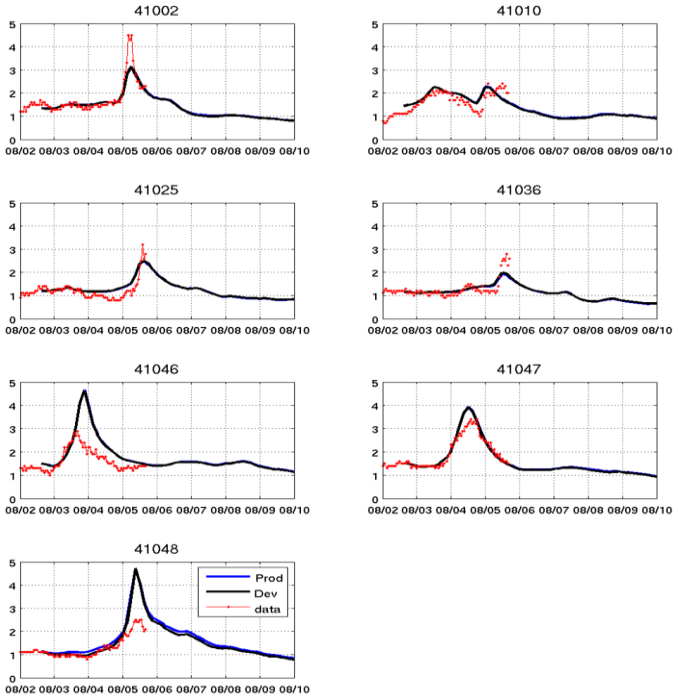
180°W
162°W

Comparison during Bertha



Multi-2 System

(Hurricane wave model forced by blended GFS + Hurricane winds)

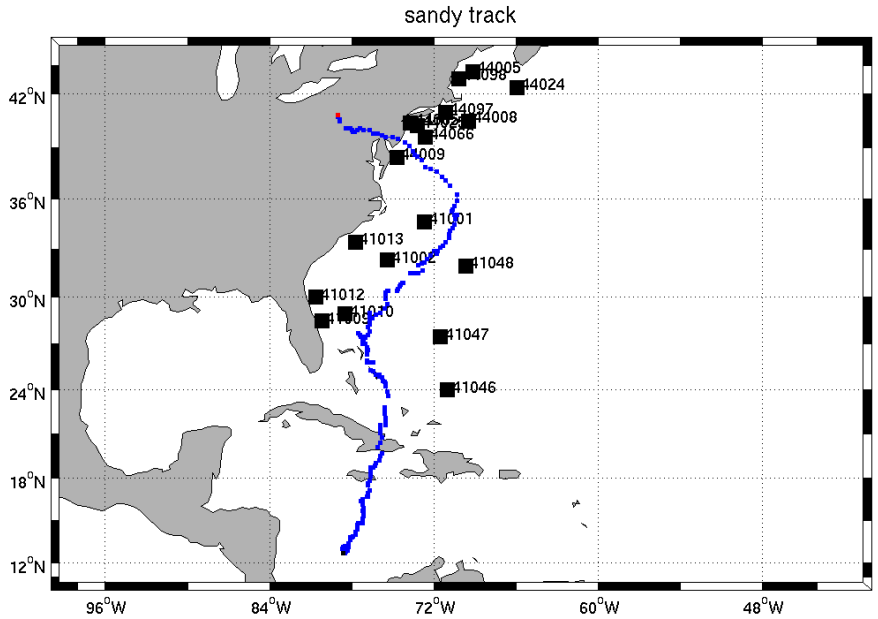
Planned Upgrades

- Upgrade to code_version 4.15.0
- Use the same grids as used in the multi_1 upgrade (with the exception of the arctic grid that is not used in the Hurricane wave models)
- Again transition to use RTGSST as opposed to SSTGRIB
- Update the system to use HWRF winds (instead of the GFDL winds)
  - Choice of hurricane wind model can now be done via a parameter in the J job
- Update the physics package to move to the standard physics package used in multi_1 model
  - Hurricane wave model was the only system using the older physics package. With this upgrade all the wave modeling systems in operations now use the same family of physics packages
  - The new physics package has shown a significant impact in the testing done for prior modeling systems - Global, Great Lakes and Ensemble systems

Impact

- A more efficient hybrid code reduces computational time
  - code is 22 % faster
- This upgrade has a significant impact since both the forcing information (winds) and physics packages are being changed
  - Some of the impact has already been in place with the upgrade of the GFDL hurricane model in June
- Impact of both wind upgrades and physics changes have been evaluated

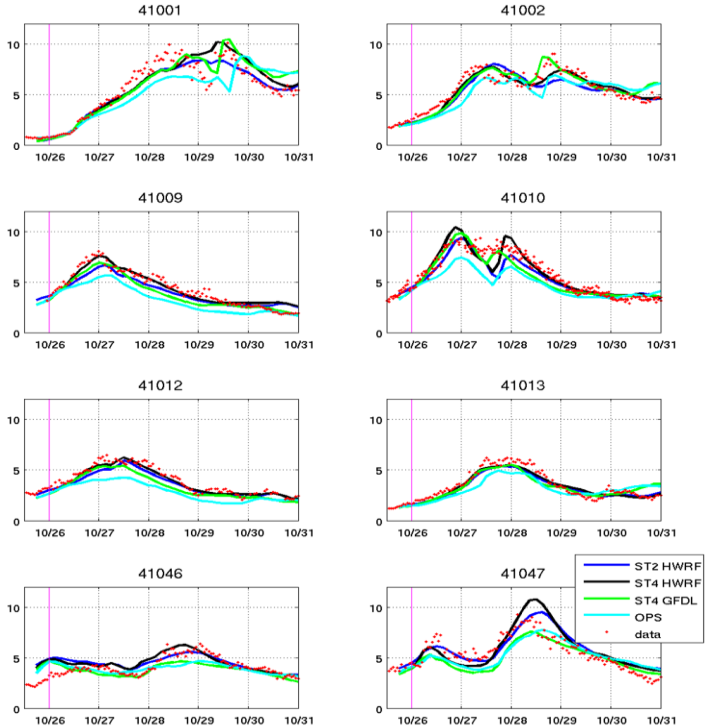
Hurricane Sandy

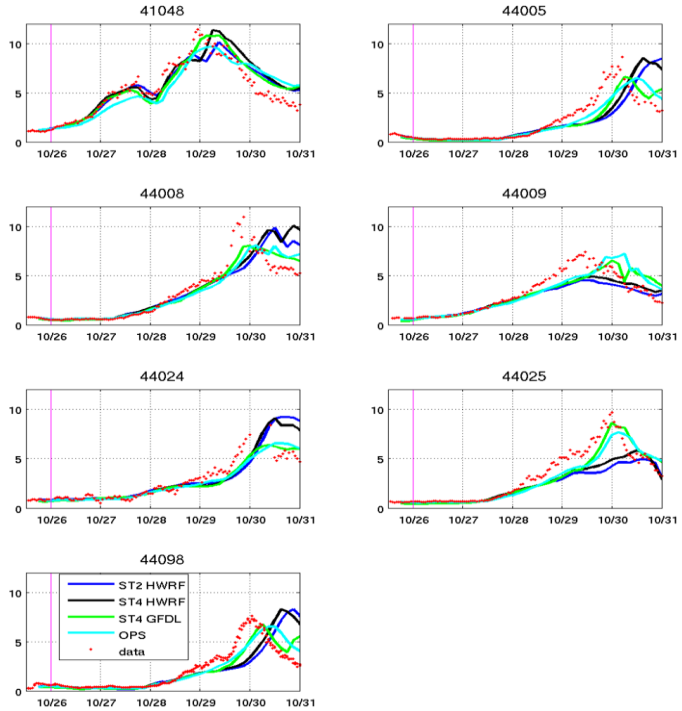


Test Bed for

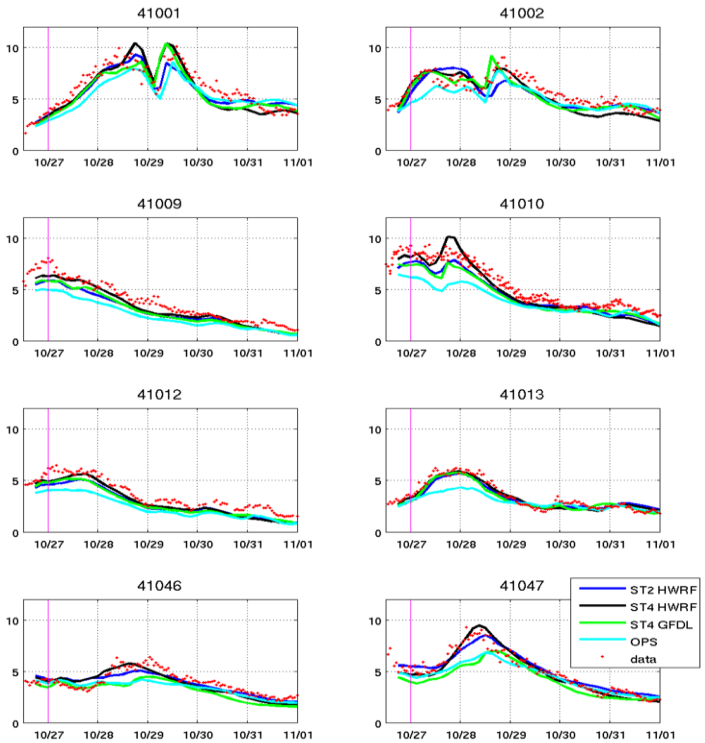
- Comparing operational suite (at that time)
- Upgraded HWRF winds (with old wave physics)
- Upgraded HWRF winds (with new wave physics)
- Upgraded GFDL winds (with new wave physics)

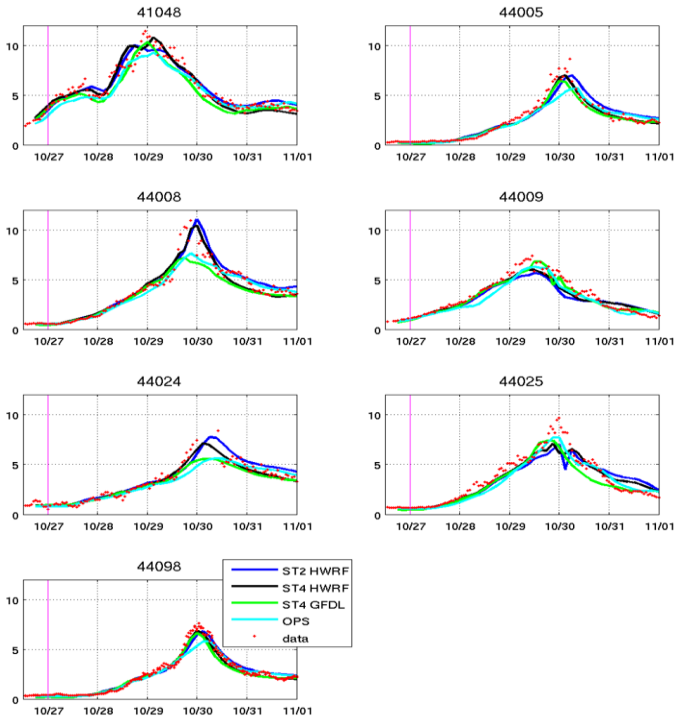
Sandy Forecast tests



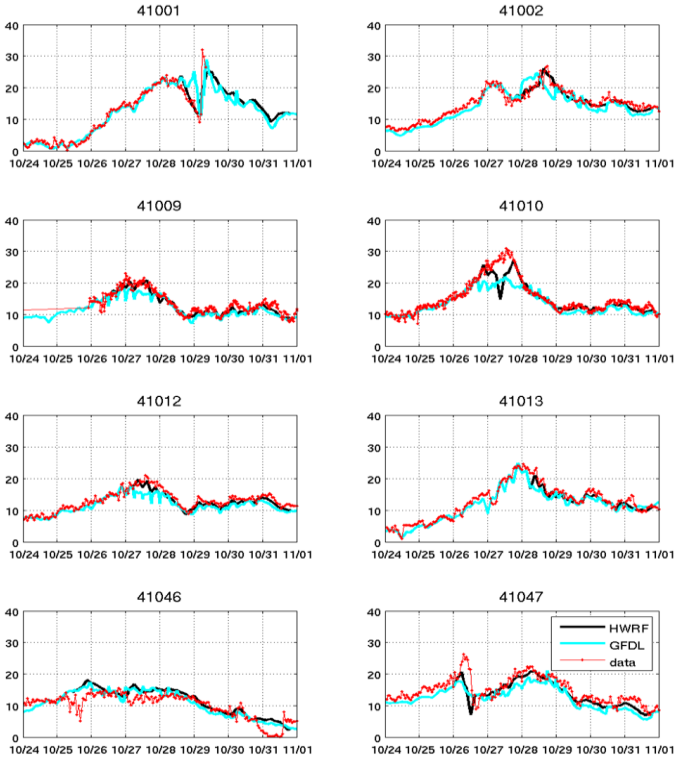


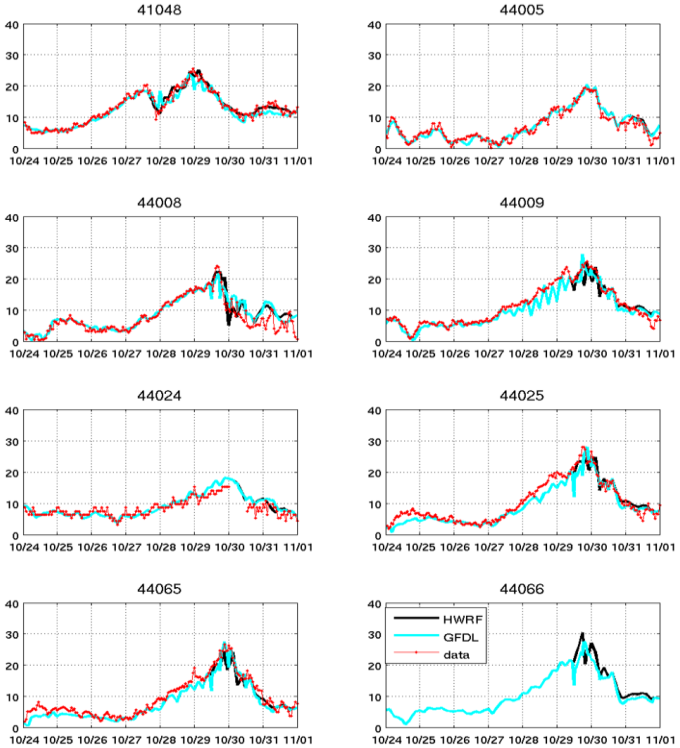
Sandy Forecast tests (contd.)





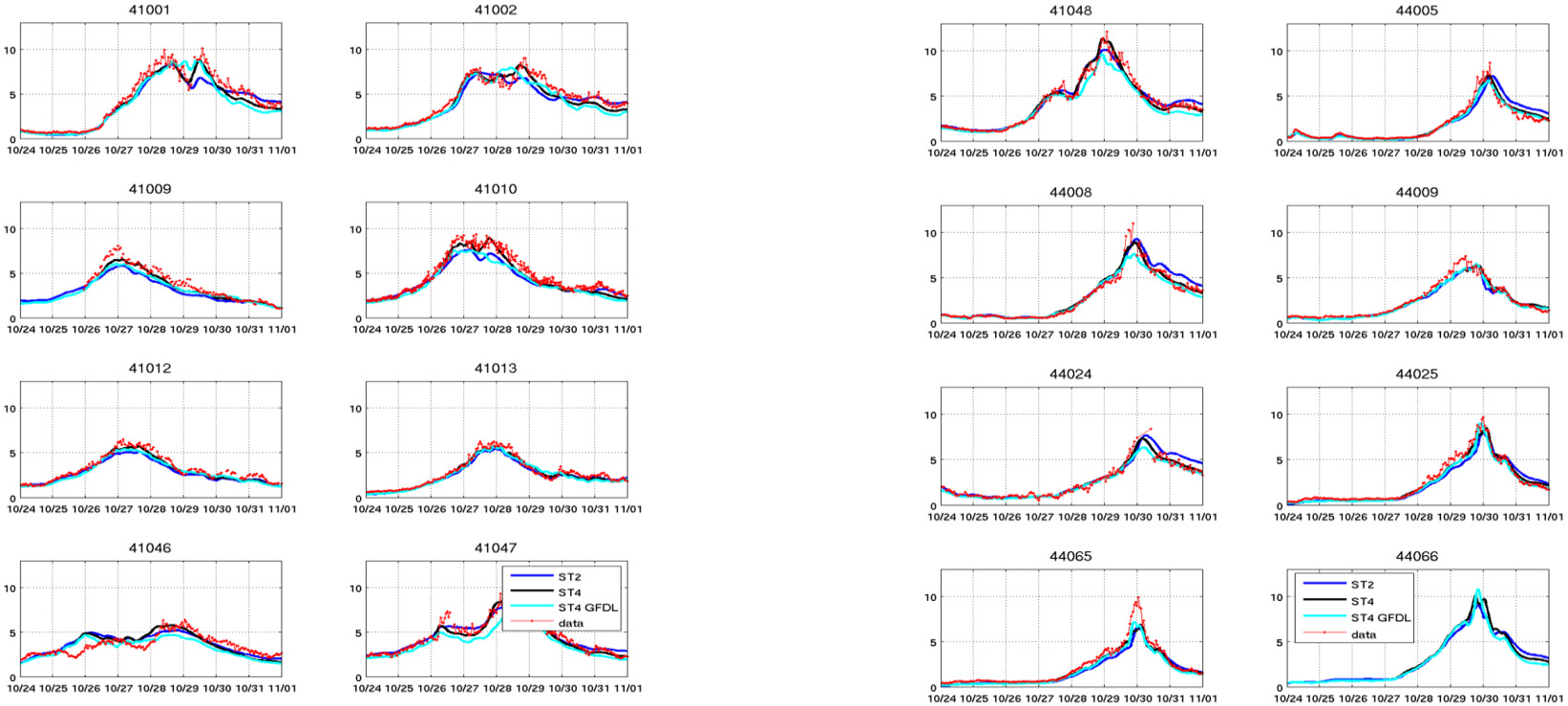
Sandy hindcast tests (wind speeds)



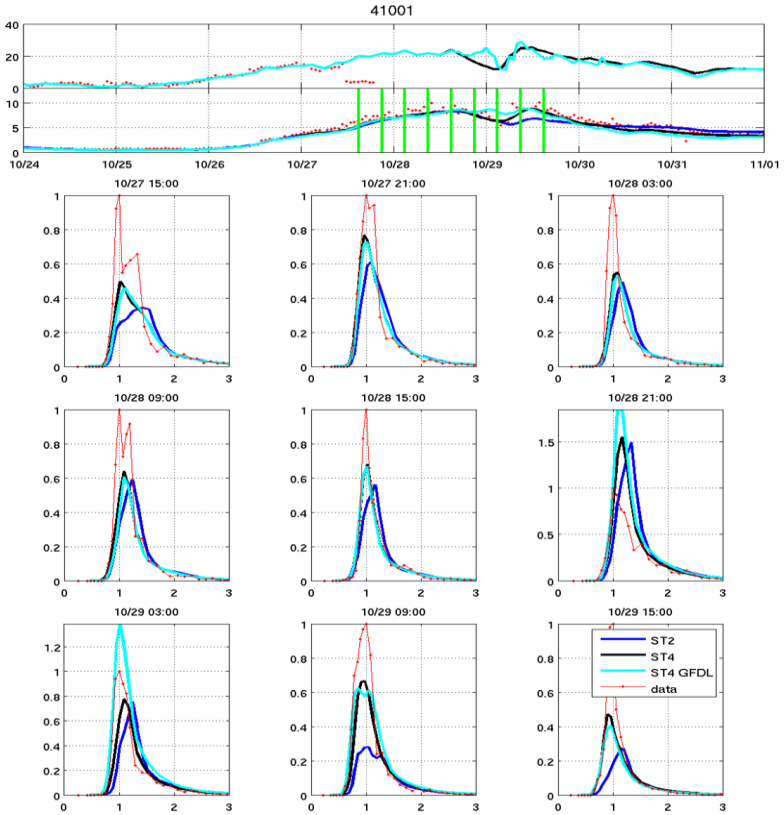


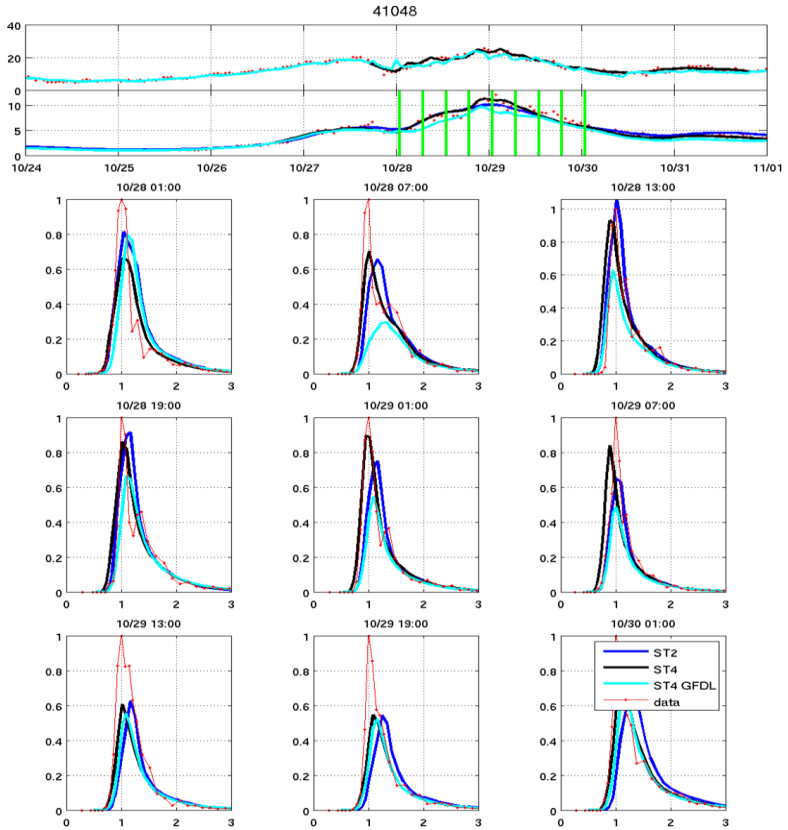
These tests have been done only with the upgraded HWRF and GFDL systems

Sandy hindcast tests (wave heights)

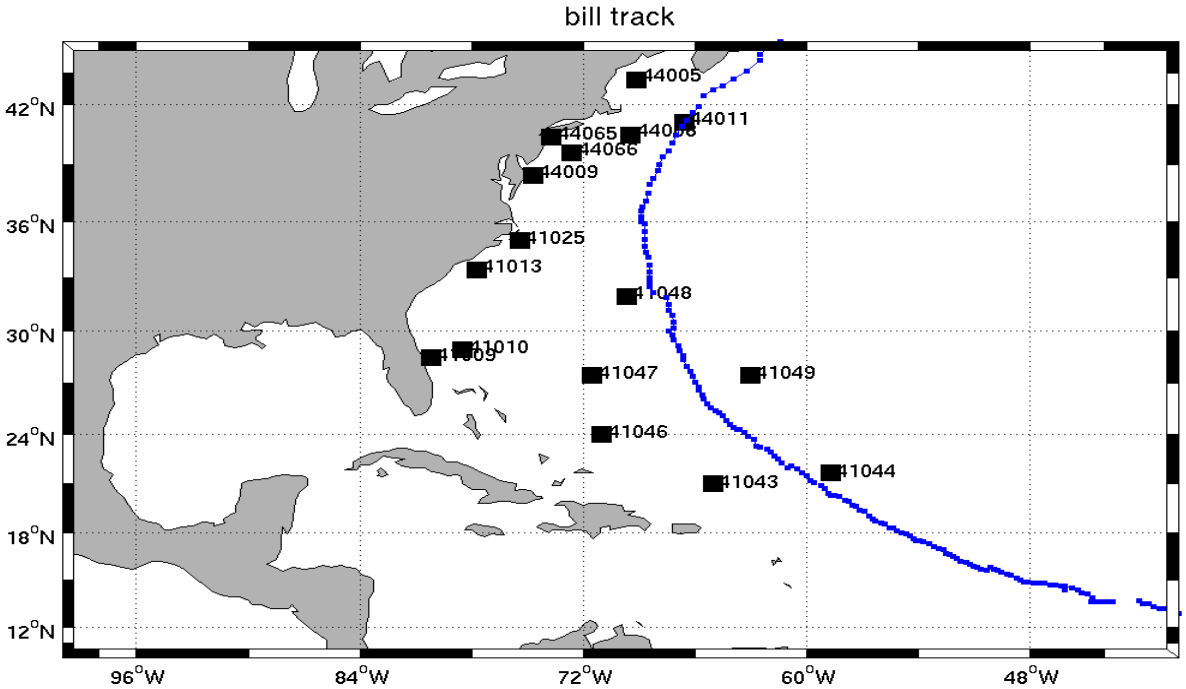


Spectral details (for Sandy)

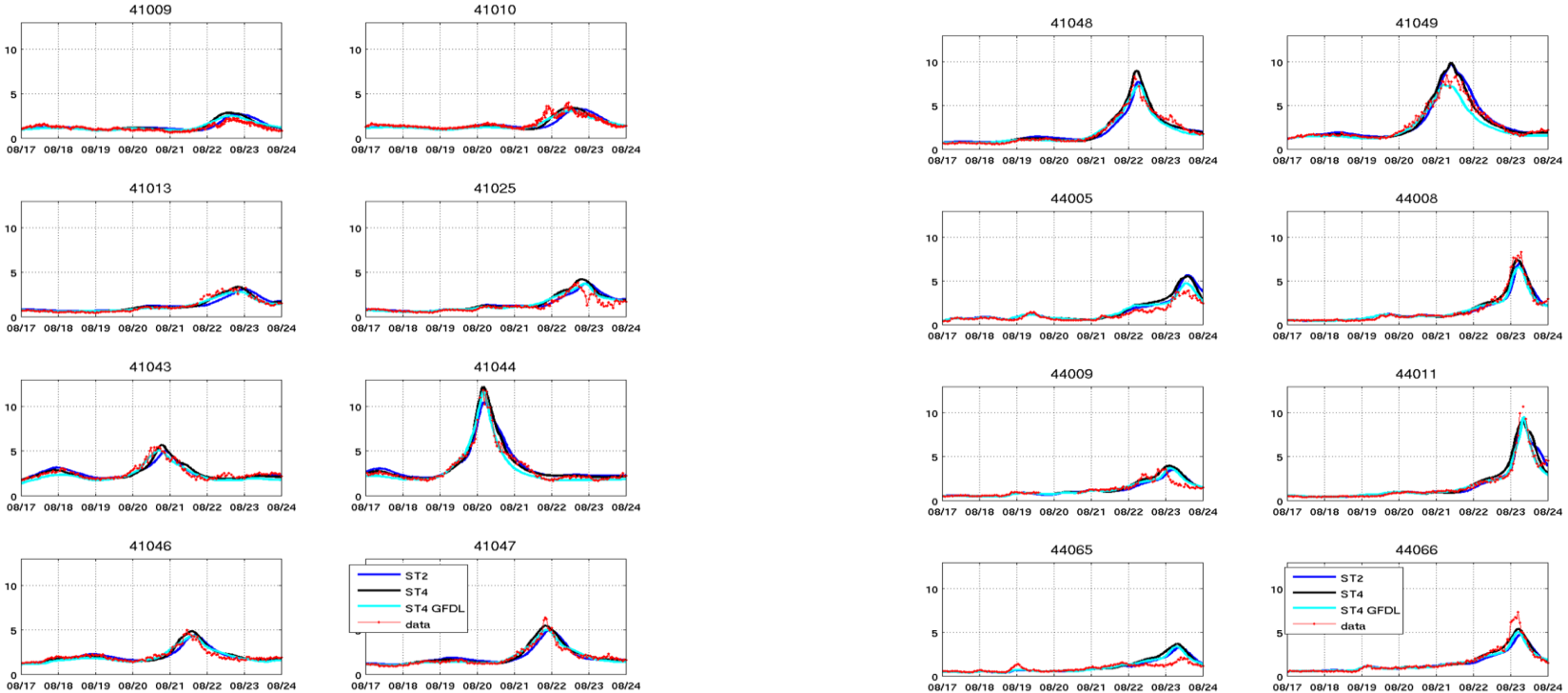




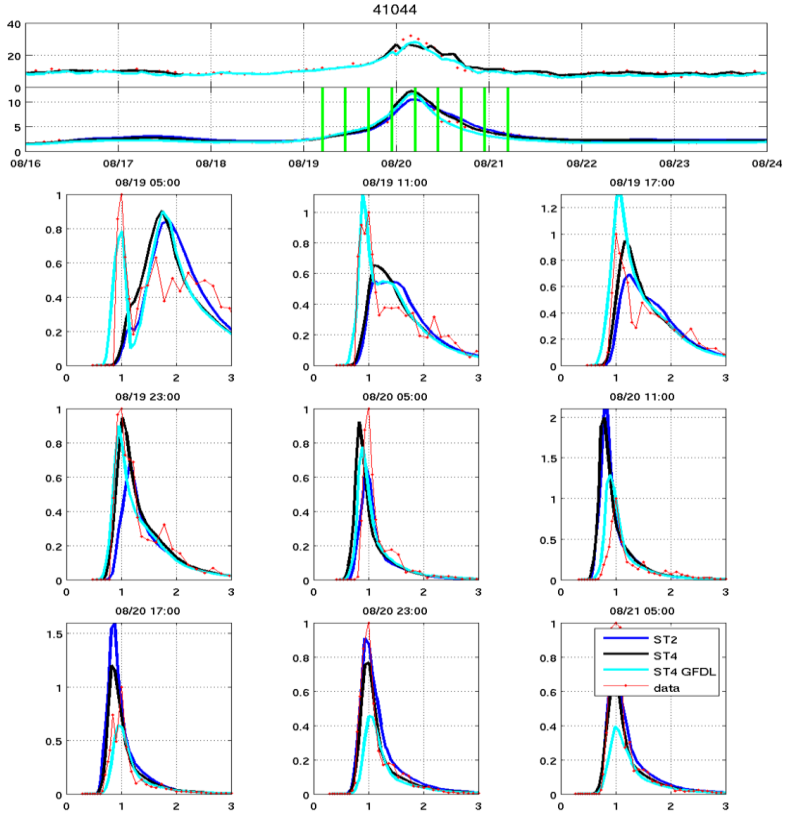
Hurricane Bill

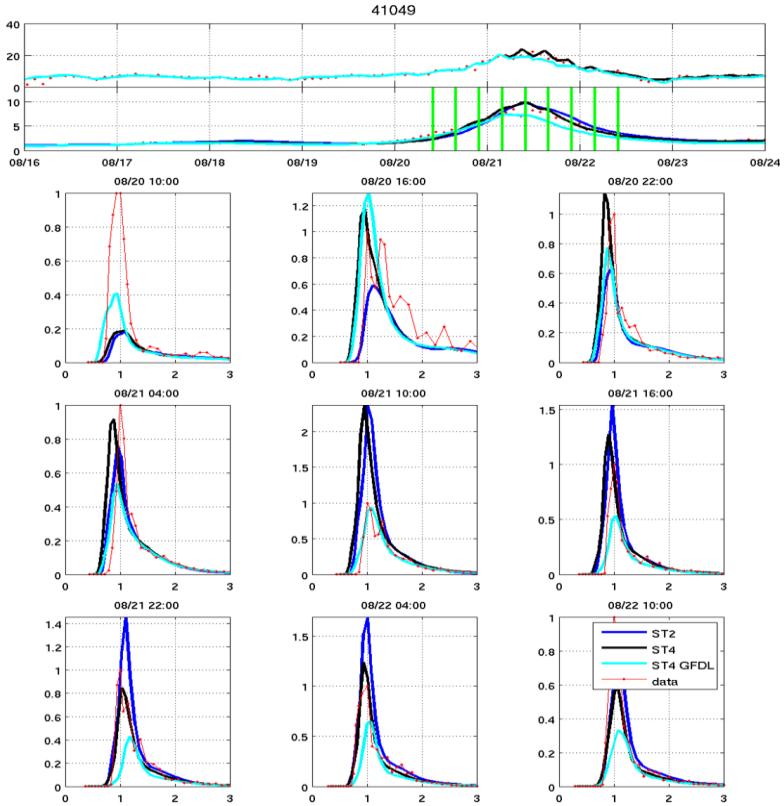


Bill hindcast tests (wave heights)

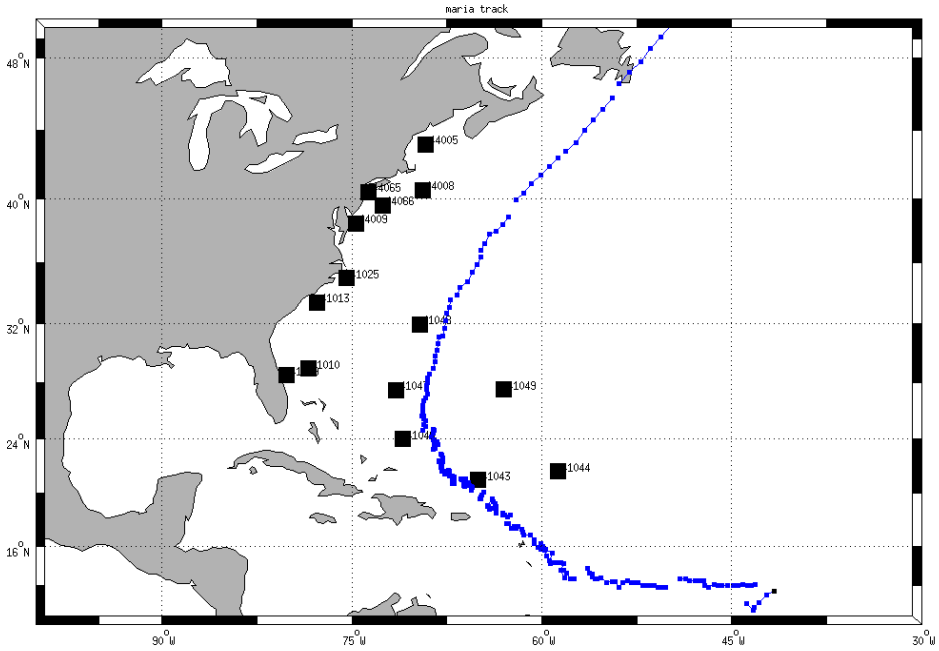


Spectral details (for Bill)

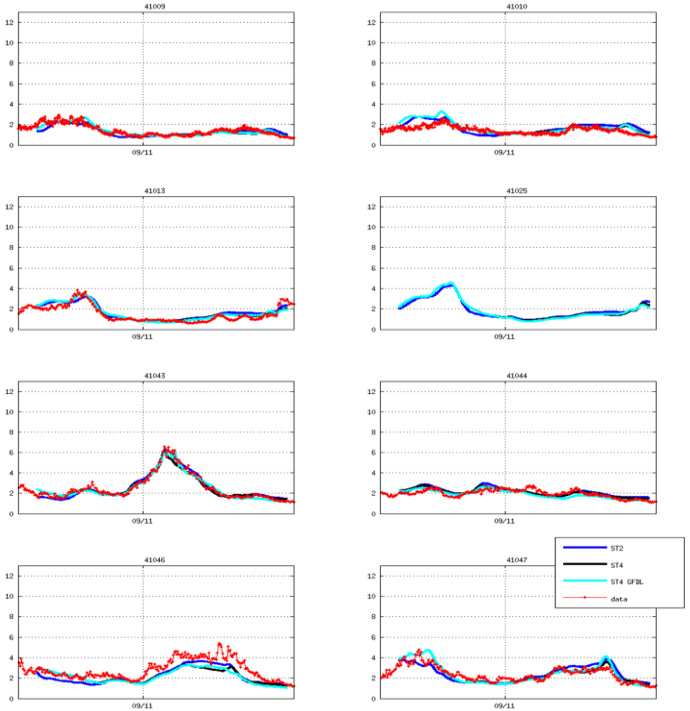


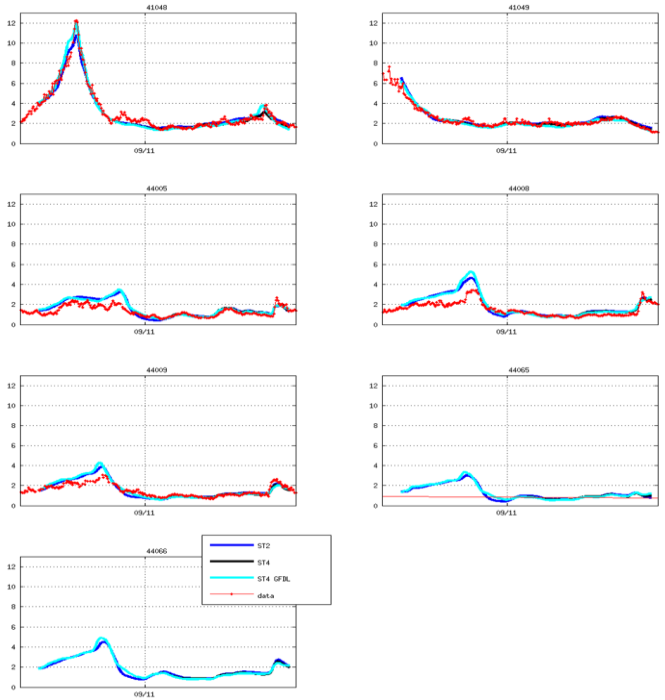


Hurricane Maria

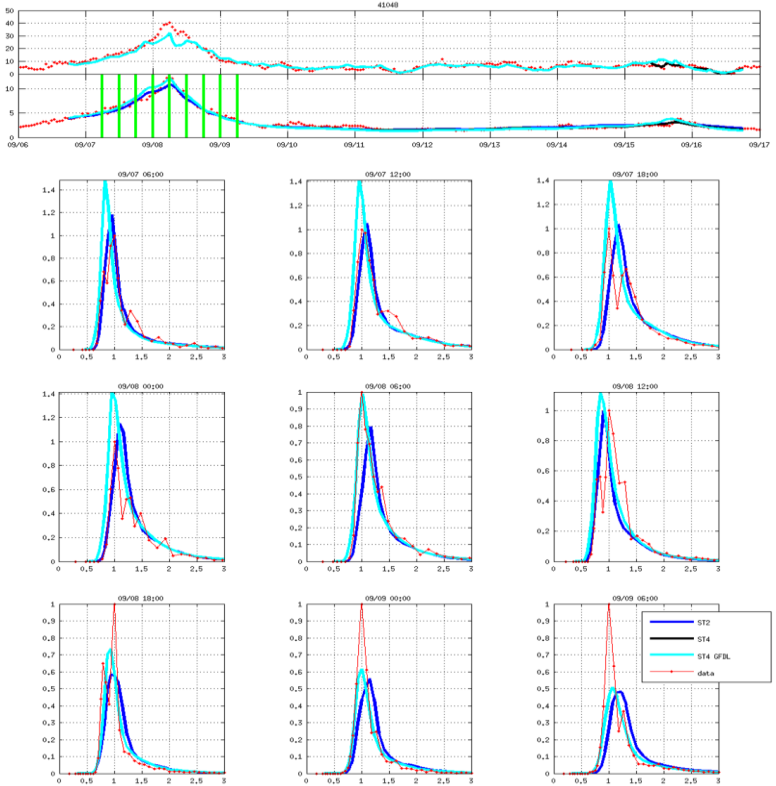


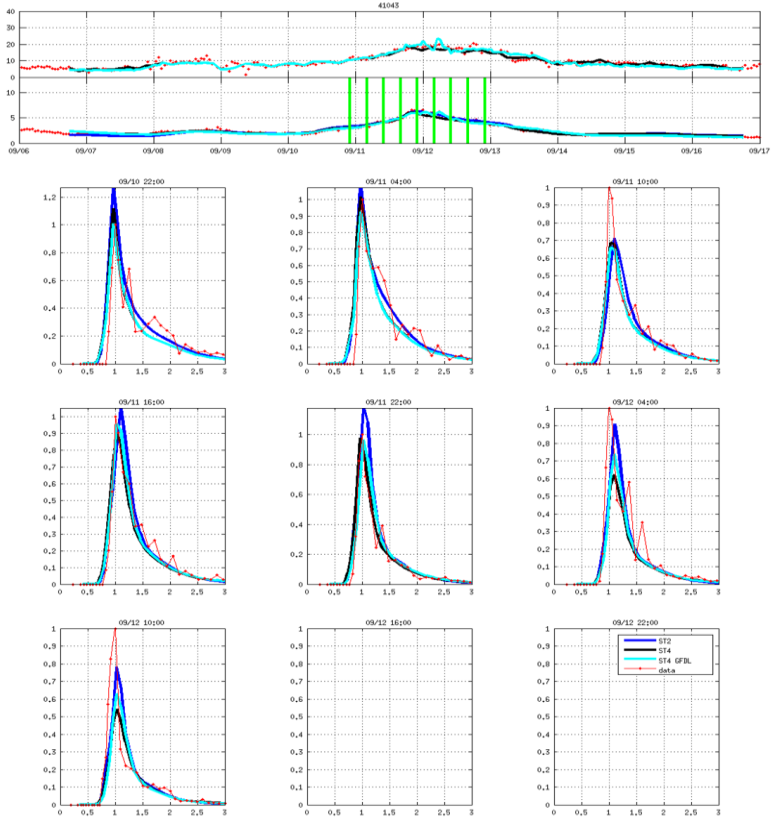
Maria hindcast tests (wave heights)



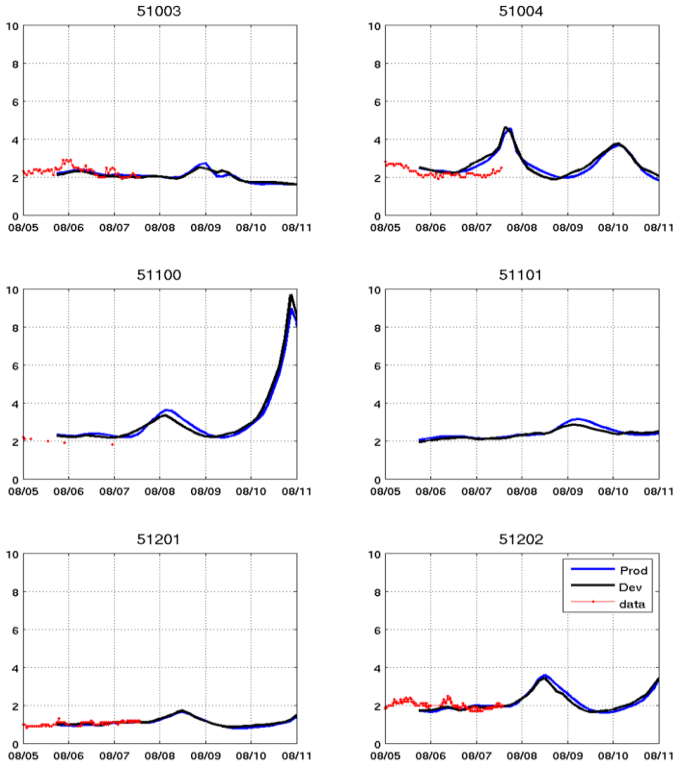


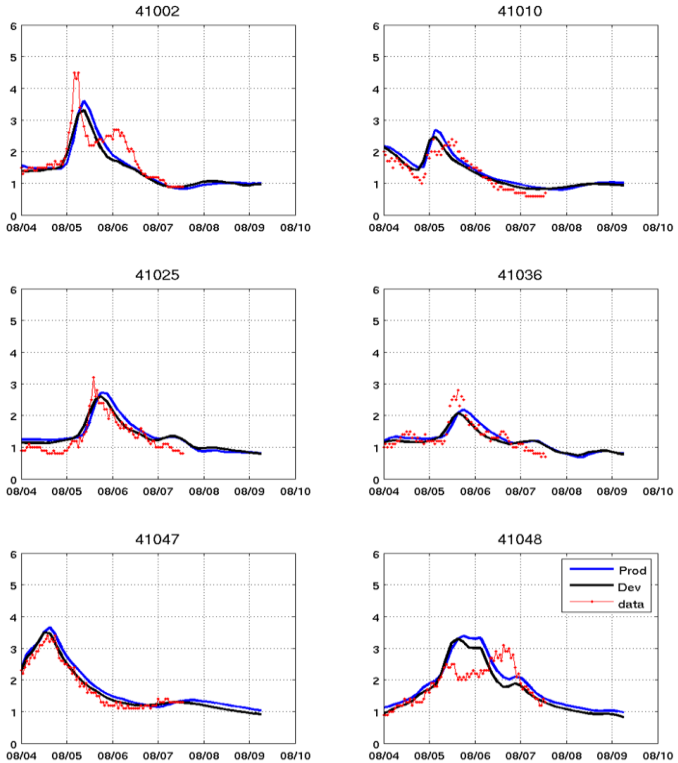
Spectral details (for Maria)





Real Time testing (Iselle/Julio & Bertha)





Final Comments on Upgrades

- By pulling out the curvilinear Arctic grid Multi-1 upgrade becomes technical with minimal science changes
  - Changes in grid domains & bathymetry and use of a more computationally efficient engine
- Multi-2 upgrade transitions to using HWRF winds and new wave physics
  - With this upgrade all wave model suites now use the same set of physics packages
  - Improvement in wave physics not as significant in Hurricane conditions as other systems in terms of bulk parameters
  - Much better representation of the spectral domain removes biases in peak periods and improves swell arrival times
  - Transition to HWRF system as the driving force will aid further development of coupled systems
  - Model run time reduced by 22% due to using a computationally more efficient engine
- NCO to see if the models can be run using reduced resources without compromising delivery times