Case study validation of HWRF-HYCOM and HWRF-POM for Hurricane Isaac (2012)

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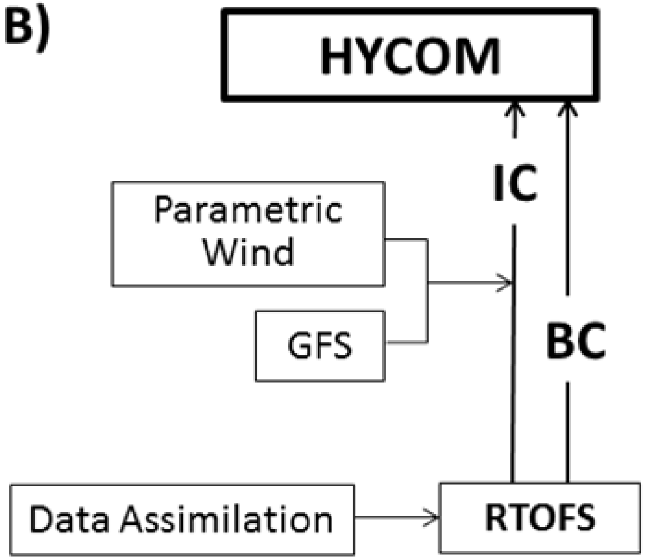
- Review of 2014 version of HWRF-HYCOM and HWRF-POM
- Time series comparisons of both models versus surface ocean observations
- Scatterplots of water temperature profiles
- Conclusions

HWRF-HYCOM documented in:

Kim, H.-S., , C. Lozano, V. Tallapragada, D. Iredell, D. Sheinin, H. L. Tolman, V. M. Gerald, and J. Sims, 2014: Performance of ocean simulations in the coupled HWRF–HYCOM model. *J. Atmos. Oceanic Technol.*, **31**, 545–559.

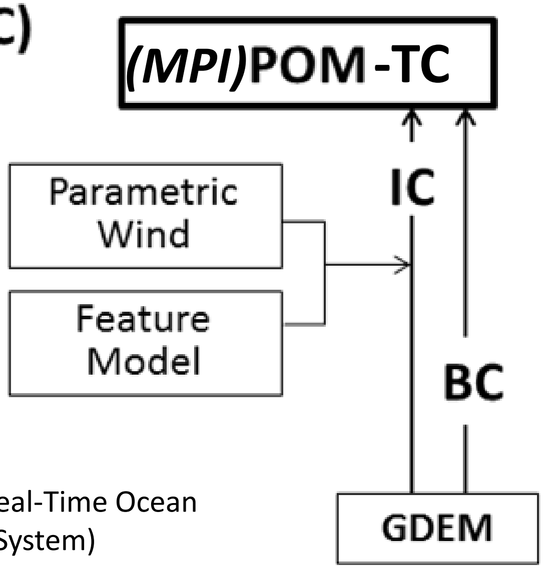
3D ocean:

(B)



(Global Real-Time Ocean Forecast System)

(C)



(Generalized Digital Environmental Model)

HYCOM:

a. dx/dy=9km on Mercator
b. 32 hybrid layers
c. Relatively finer resolution of MLD - 1 m (top), 4 m (2nd), …
d. KPP mixing

POM:

a. dx/dy=9km
b. 24 levels
c. Coarse resolution of MLD - 10 m (top), 20 m (2nd), …
d. M-Y mixing

eddy-resolving vs. eddy-permitting

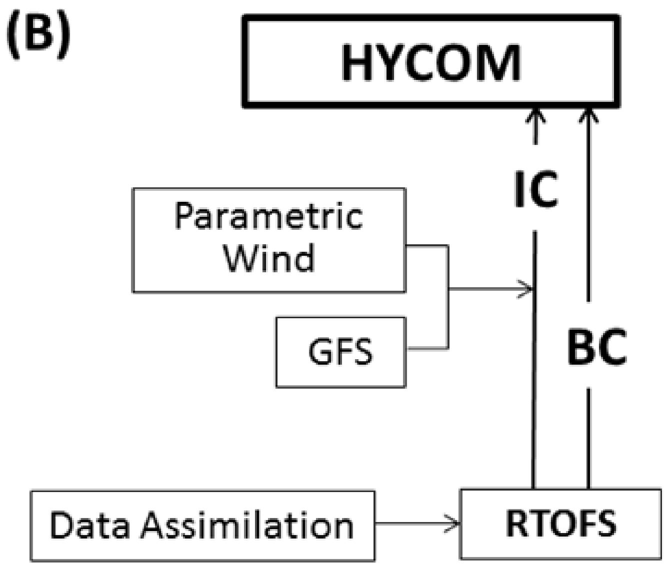
3D ocean:

GDEM monthly climatology
Sharpen eddies & currents
Use daily NCEP SST

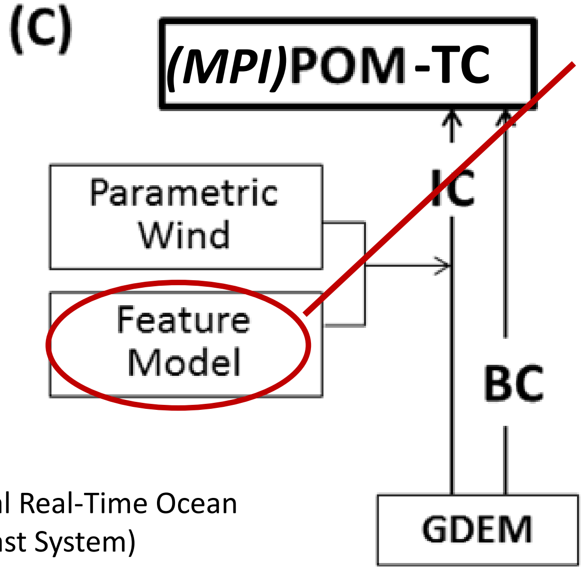
SST held constant, 48-h geostrophic adjustment

Cold wake generated by parametric winds using NHC message file

Model coupling performed



(Global Real-Time Ocean Forecast System)



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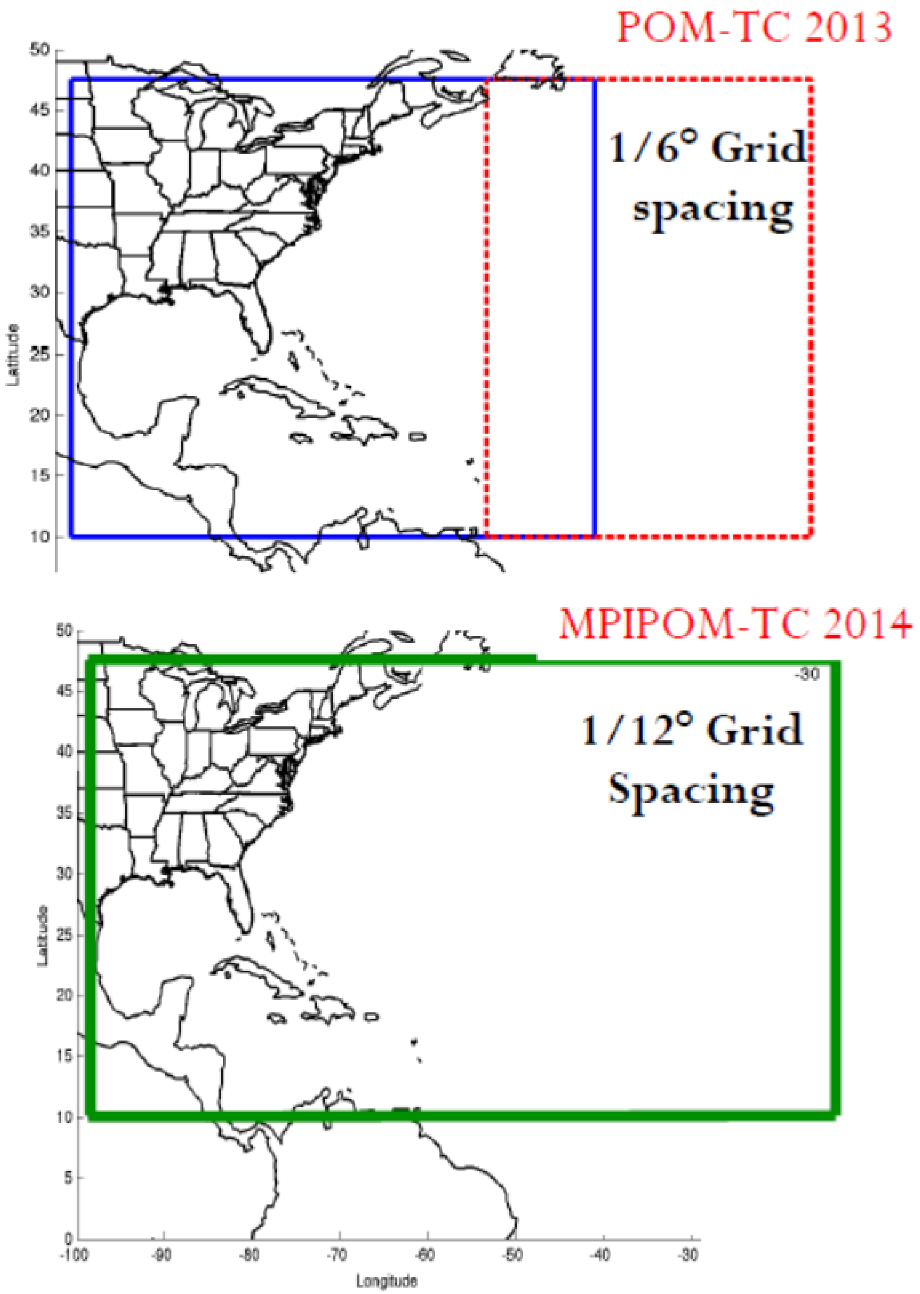
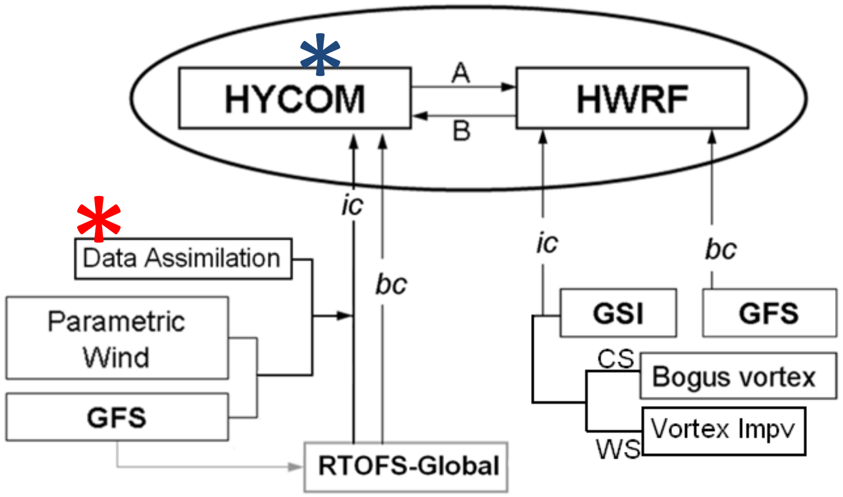
eddy-resolving vs. eddy-permitting

POM Ocean Upgrades for 2014

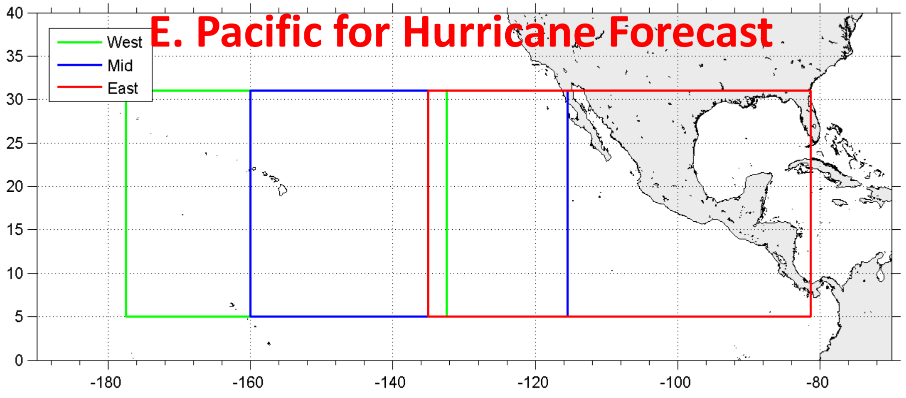
- Parallel implementation using MPI allows for larger domain and higher resolution
- Updated ocean physics
- 3D ocean in East Pacific
- Coupler upgraded for multi-processor capability and advanced extrapolation/ interpolation techniques
- NetCDF I/O



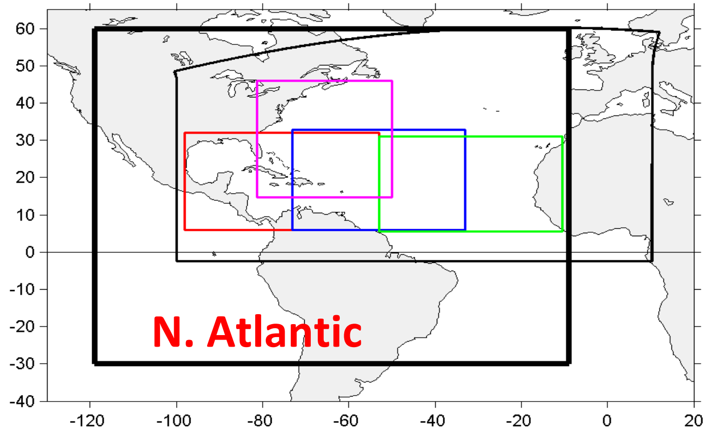
Version 2014 HWRF-HYCOM

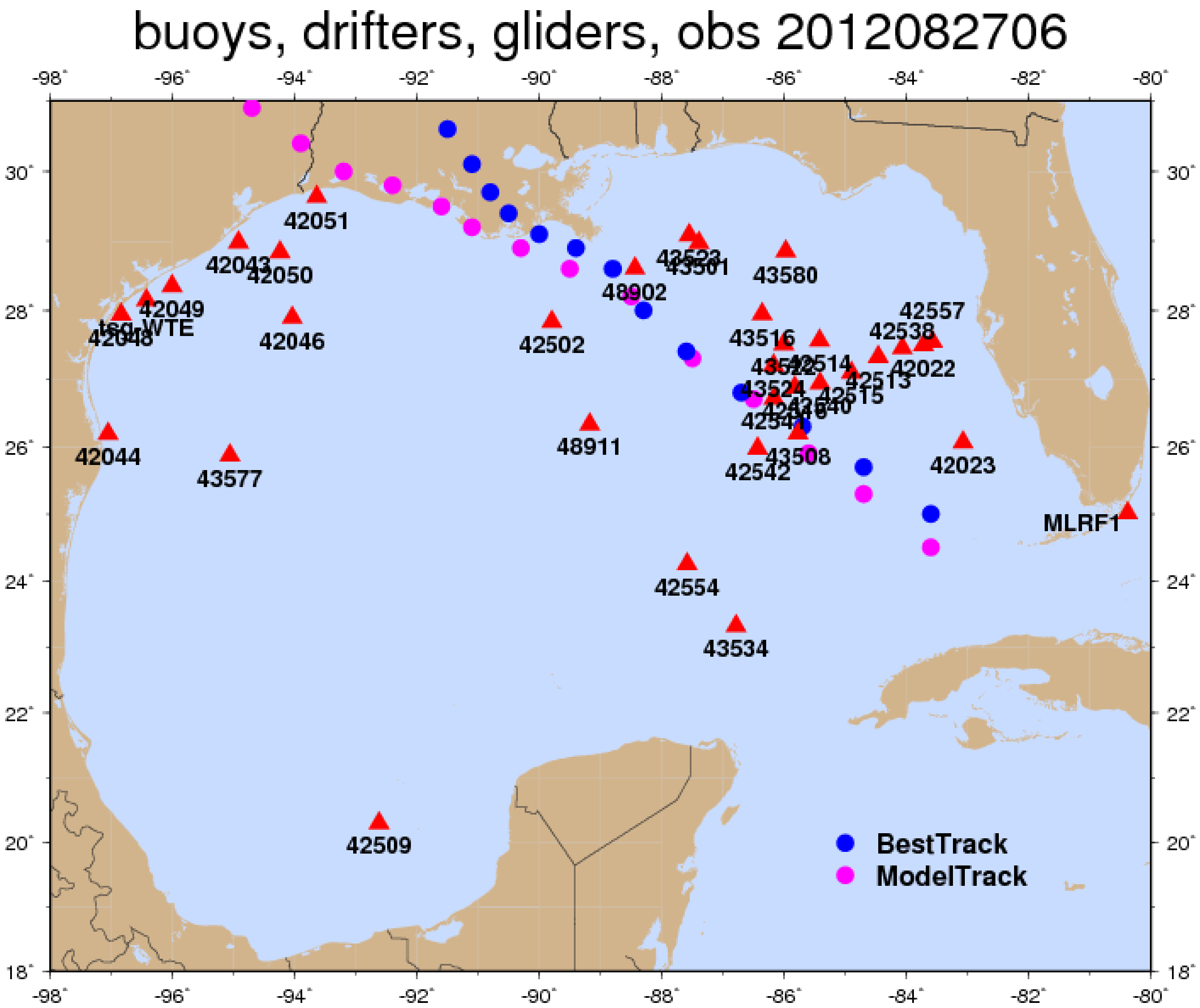


* Same config. as the Global



1. Eddy-resolving, 1/12-degree and 32-layers (better res. in the mixed layer) HYCOM
2. IC/BC from RTOFS Global
3. Provide uniform ocean to E. Pac, W.Pac and Atlantic – easier to configure
4. Data Assimilation – Global
5. * Data Assimilation – Regional (in progress)
6. Re-locatable, practically anywhere in the world
7. ESMF compliant – advantage for 3-way coupling





For water temperature

- Data from buoys, drifters, and gliders. Isaac well-sampled from a combination of different field programs

- Some data is just 0m, or 1m. But have ten profile datasets down to 50-1000 m

- model values are interpolated to the exact depth where applicable. Otherwise, model's 1st layer value is used or last layer value may be used

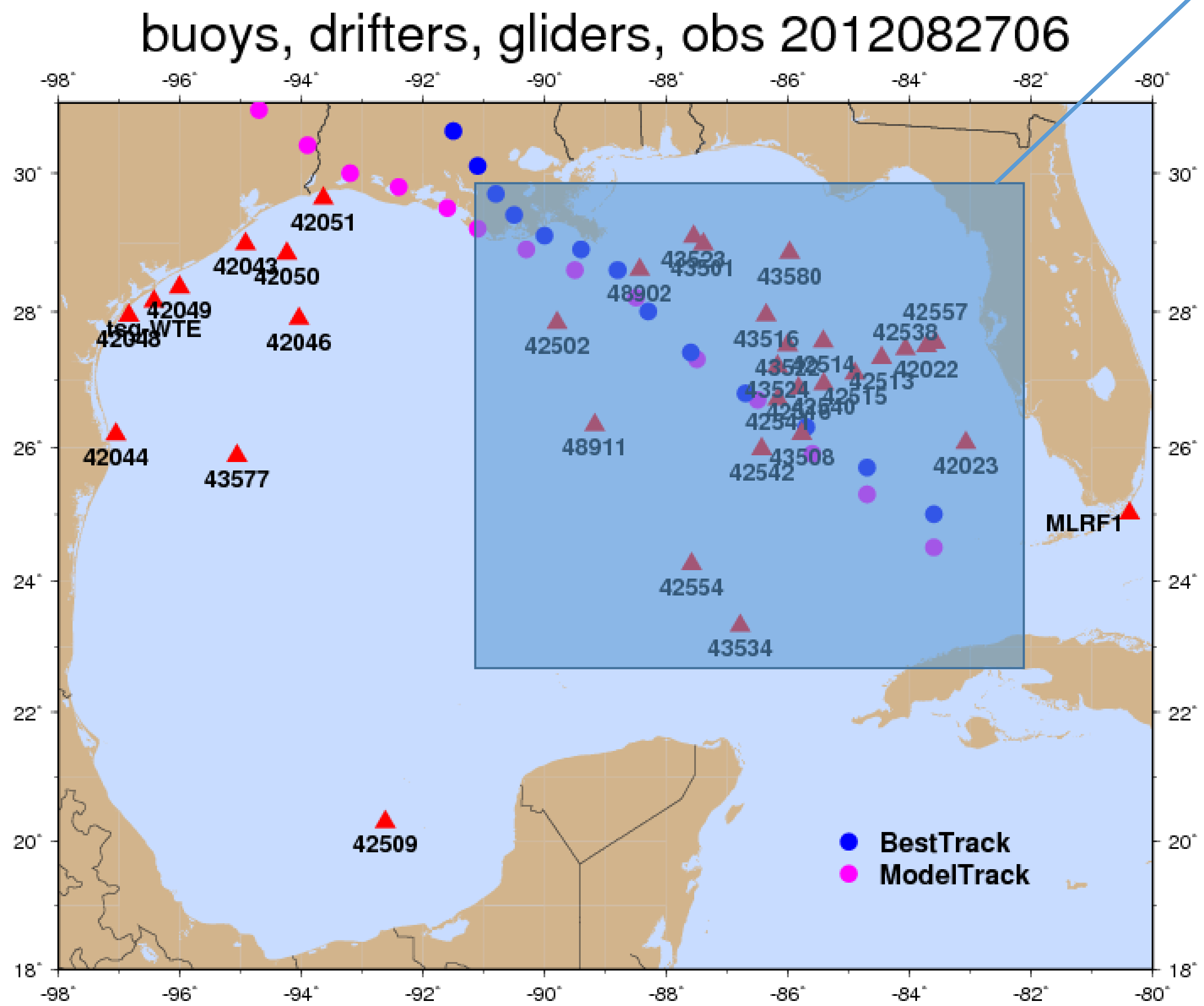
For surface wind speed

- bilinear interpolation is used for both HWIND and model wind data at the observed locations

- Model wind data are 10-m winds from nested grid

Model runs

- Study done for 2014-version HWRF for Aug 27 00, 06, 12, 18Z runs, and Aug 28 00Z run. 06Z shown in next slides. Results are typical for all runs



Region of focus

For water temperature

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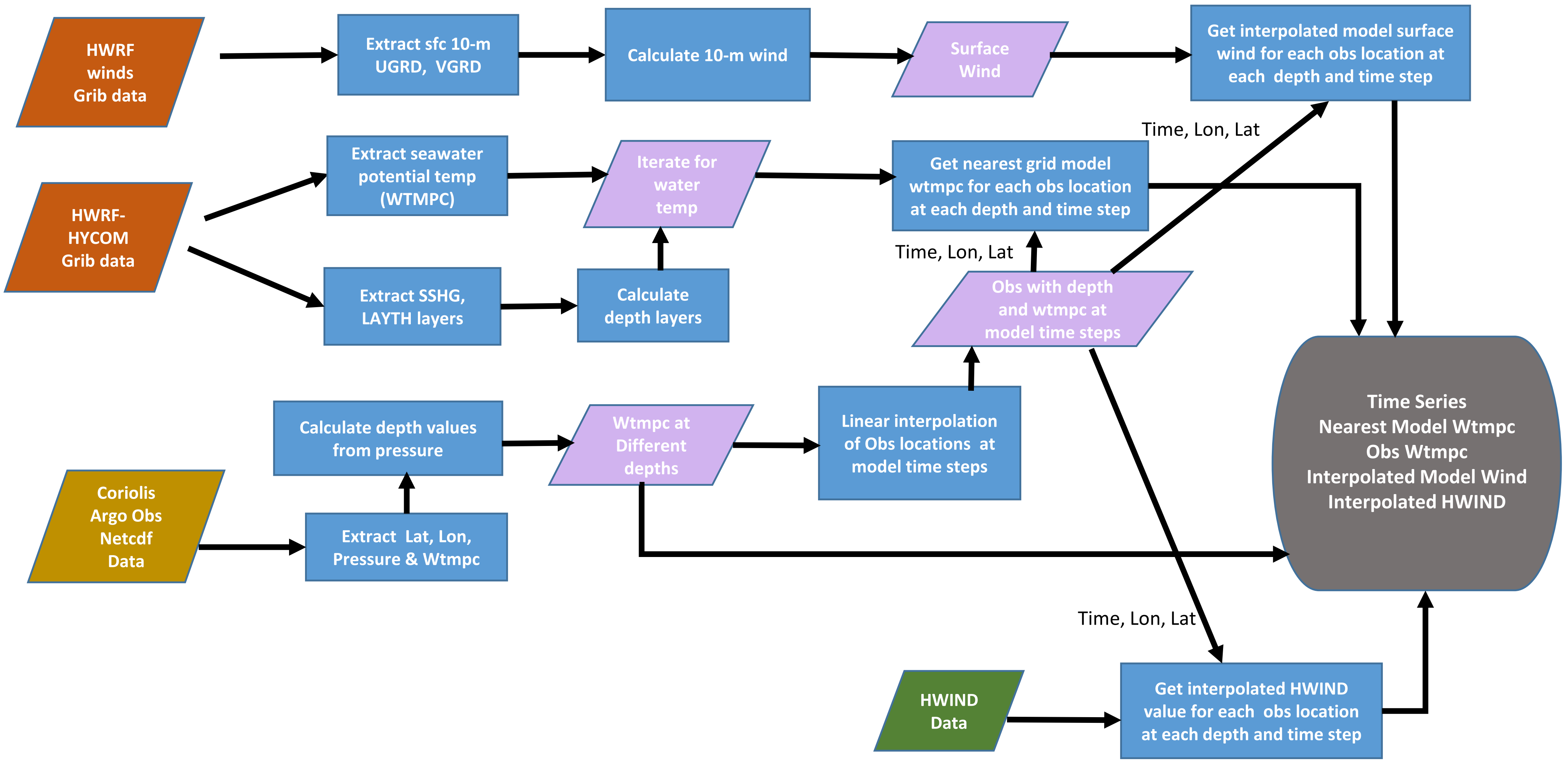
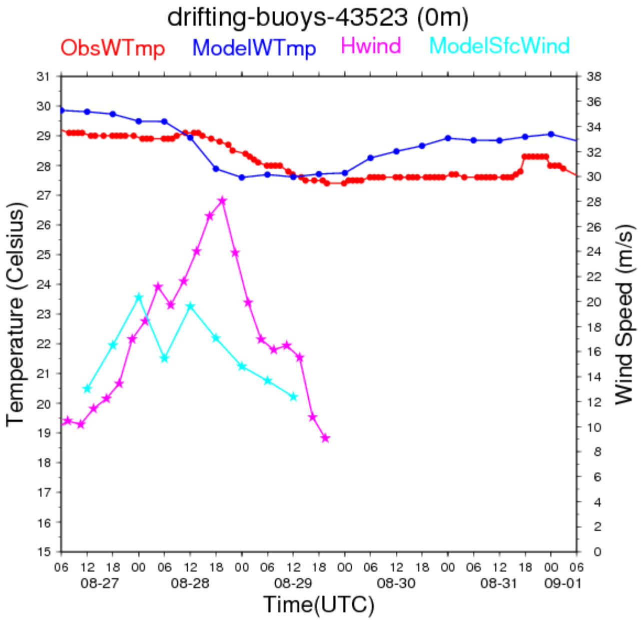
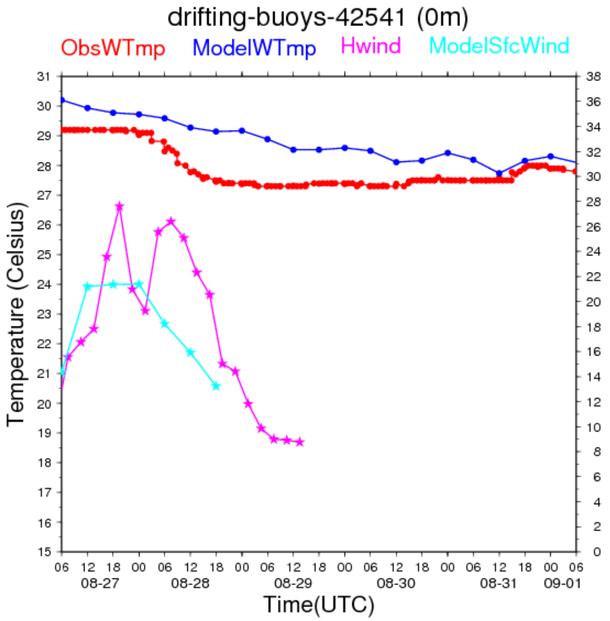
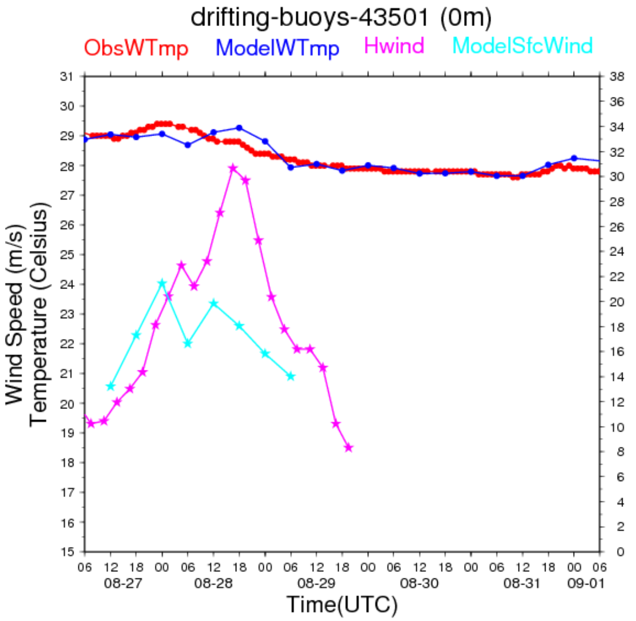

HWRF winds Grib data
Extract sfc 10-m UGRD, VGRD
Calculate 10-m wind
Surface Wind
Get interpolated model surface wind for each obs location at each depth and time step
HWRF-HYCOM Grib data
Extract seawater potential temp (WTMPC)
Iterate for water temp
Get nearest grid model wtmpc for each obs location at each depth and time step
Time, Lon, Lat
Extract SSHG, LAYTH layers
Calculate depth layers
Time, Lon, Lat
Obs with depth and wtmpc at model time steps
Calculate depth values from pressure
Wtmpc at Different depths
Linear interpolation of Obs locations at model time steps
Time Series
Nearest Model Wtmpc
Obs Wtmpc
Interpolated Model Wind
Interpolated HWIND
Coriolis Argo Obs Netcdf Data
Extract Lat, Lon, Pressure & Wtmpc
Time, Lon, Lat
HWIND Data
Get interpolated HWIND value for each obs location at each depth and time step

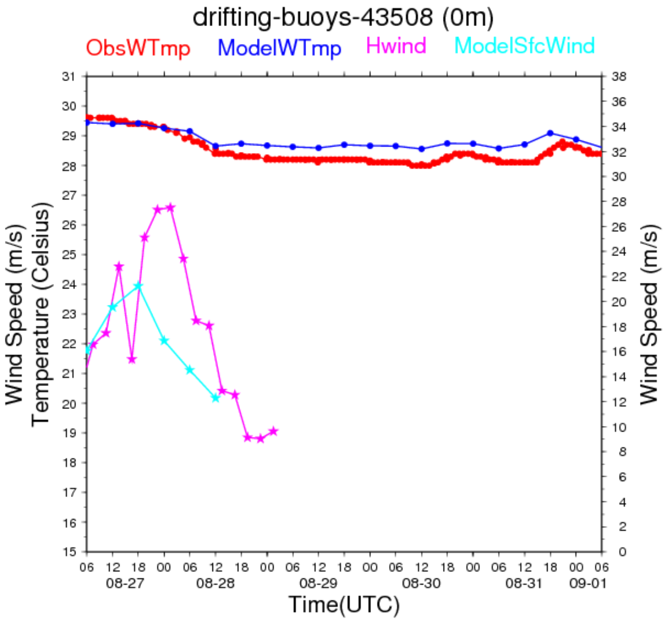
Surface water temperature comparisons

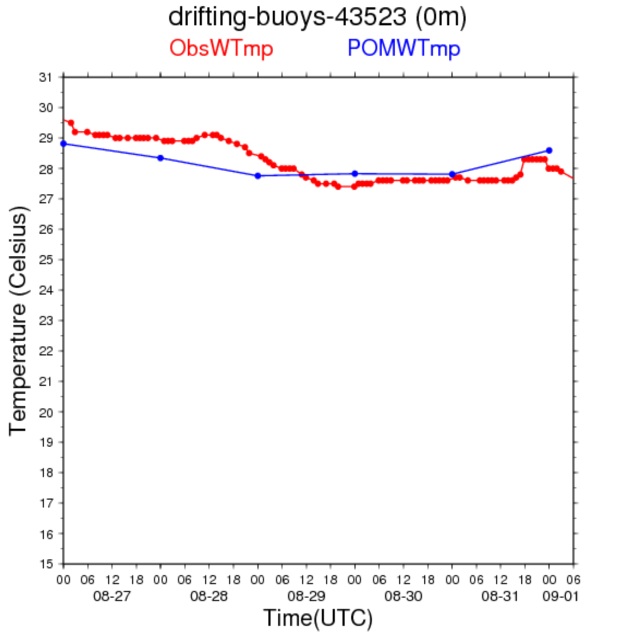
Times series comparison - east side near center; HYCOM (top) versus POM (bottom, if available)

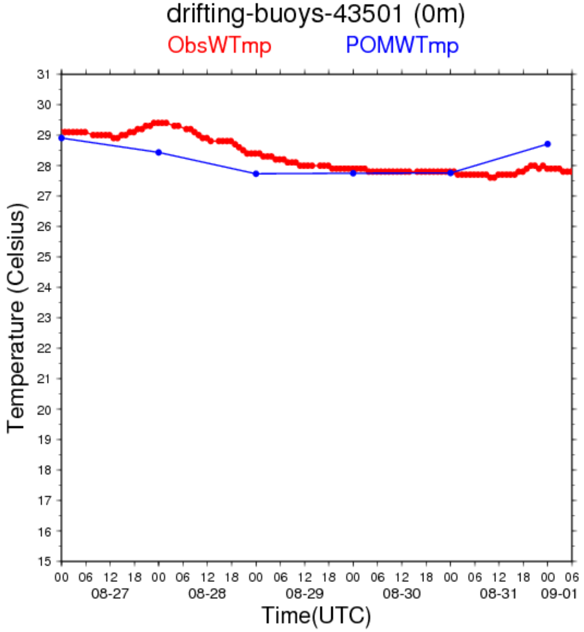




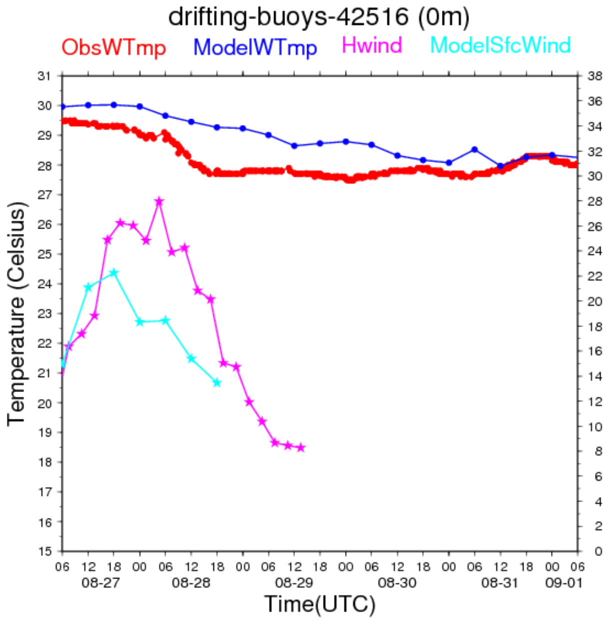


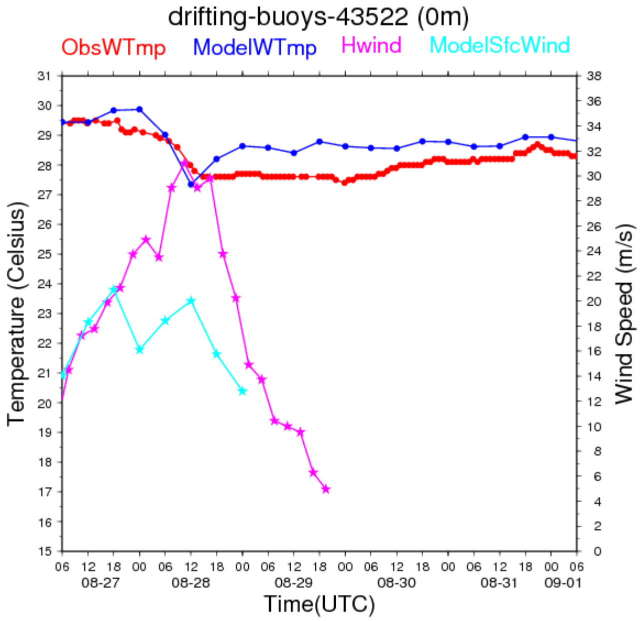


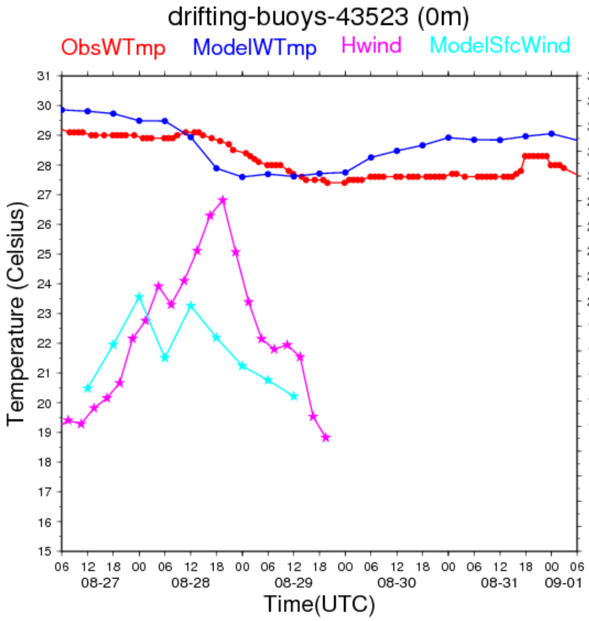


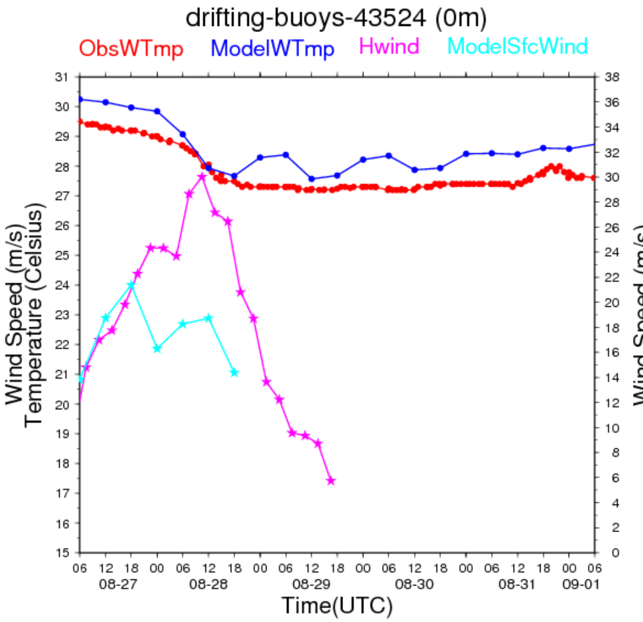


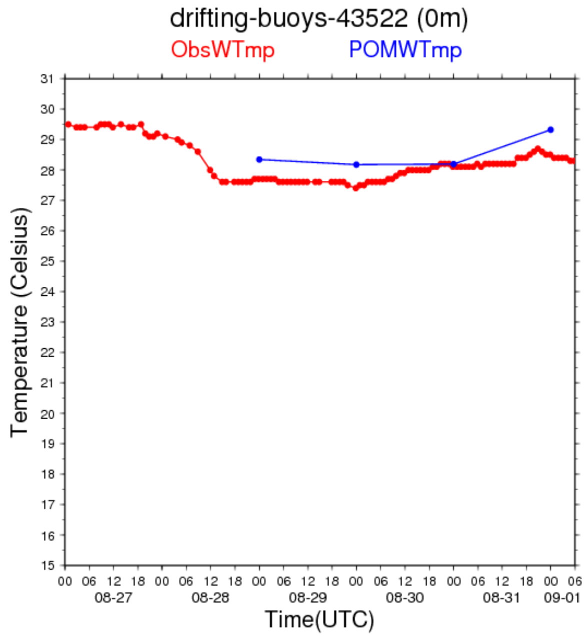
Times series comparison - east side near center; HYCOM (top) versus POM (bottom, if available)

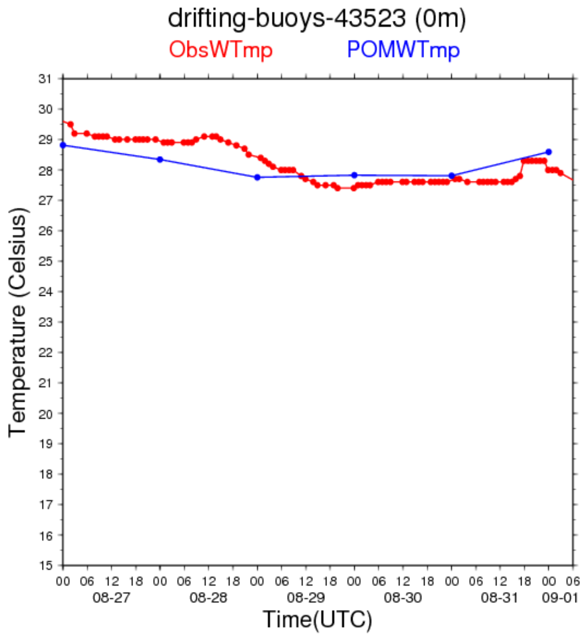




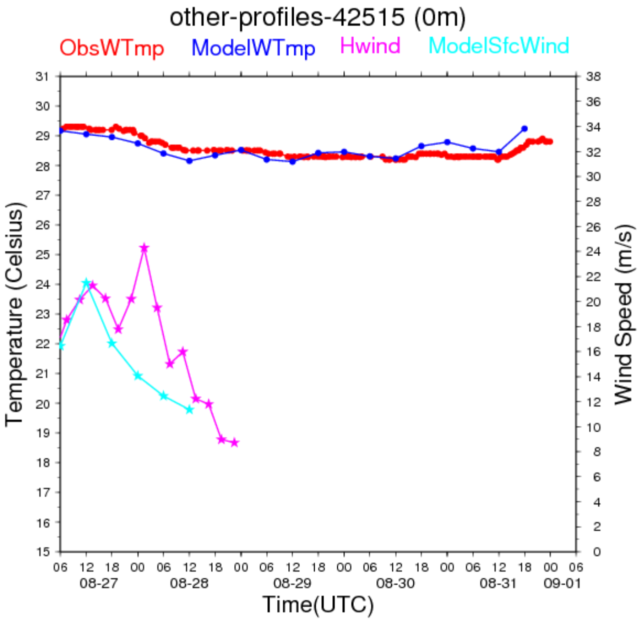


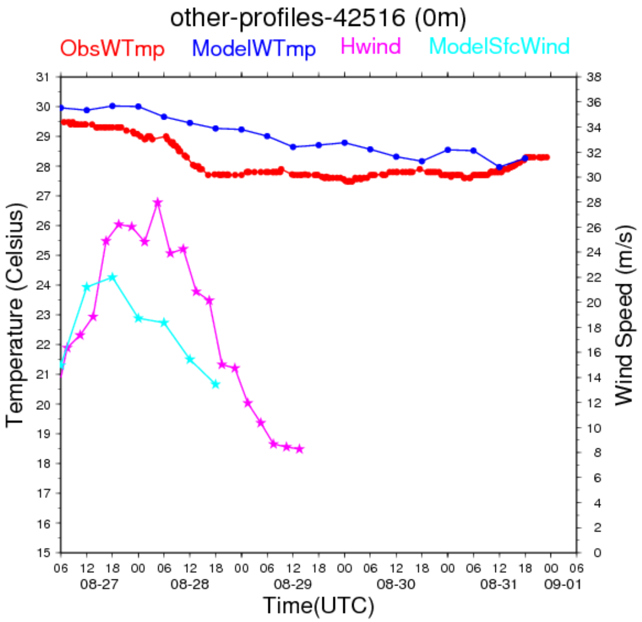


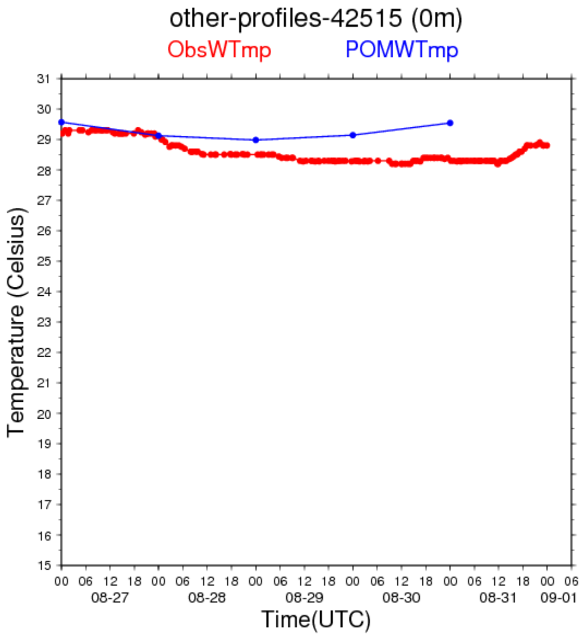




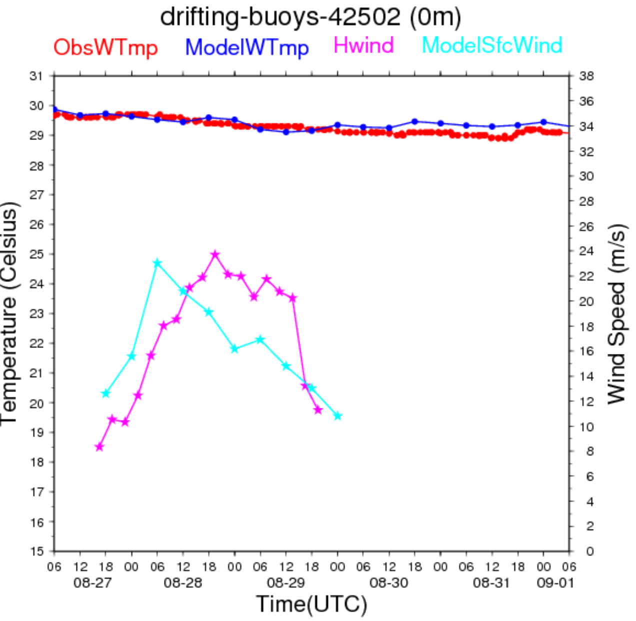
Times series comparison - east side near center; HYCOM (top) versus POM (bottom, if available)

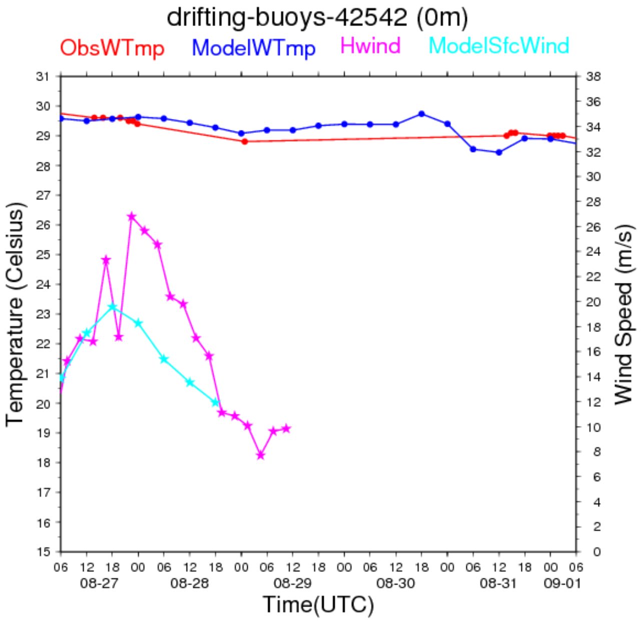


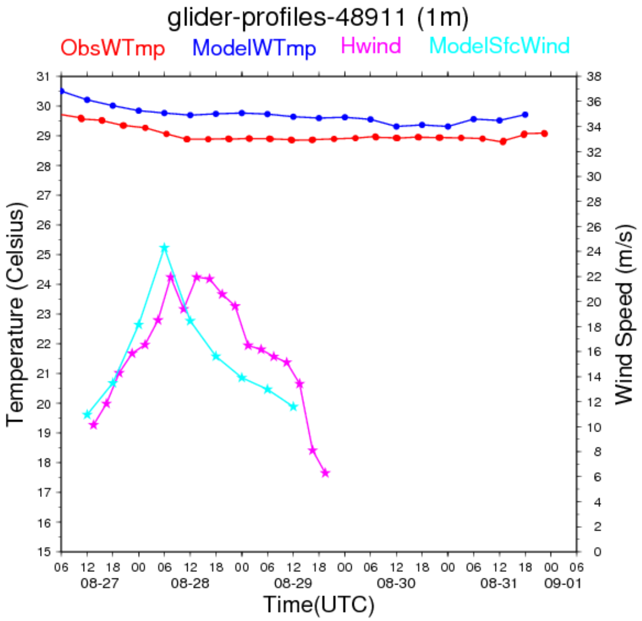


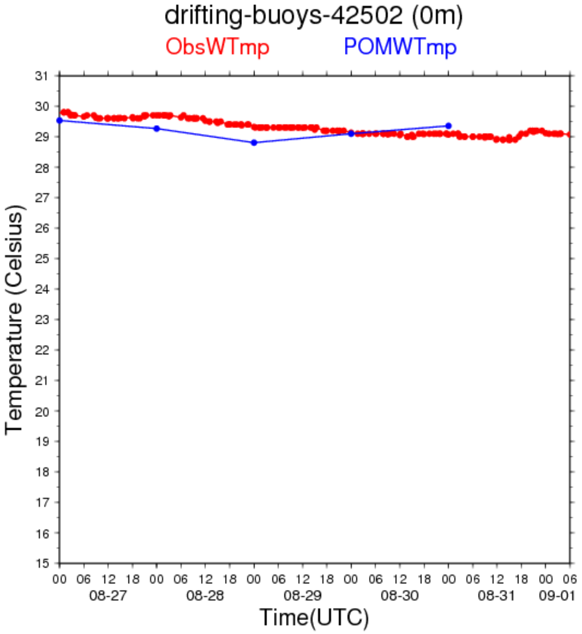


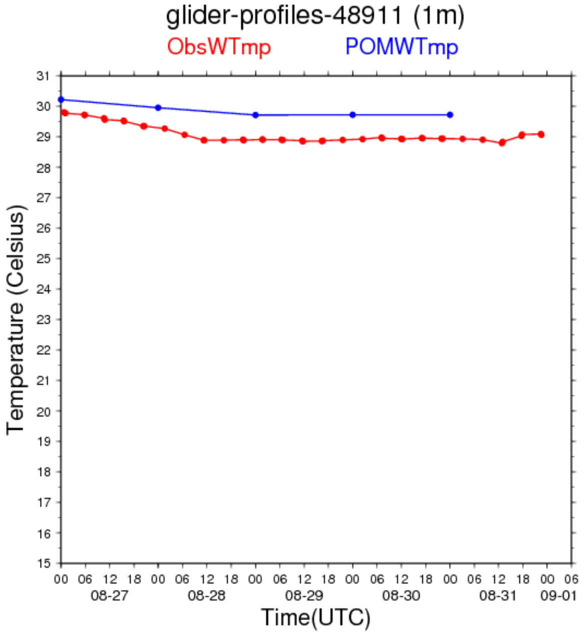
Times series comparison - west side near center; HYCOM (top) versus POM (bottom, if available)









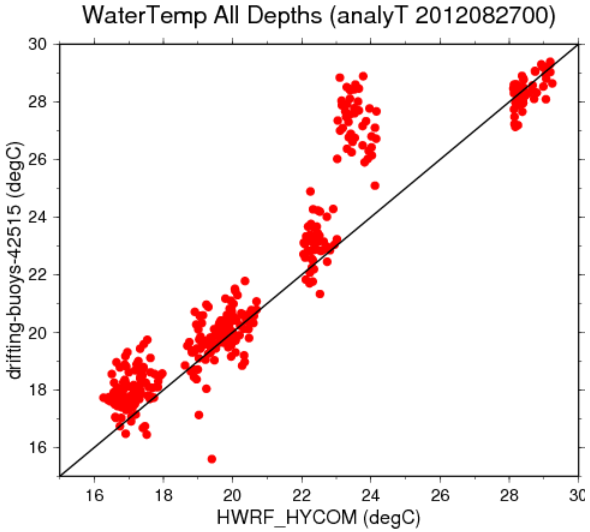


Profile temperature Comparisons

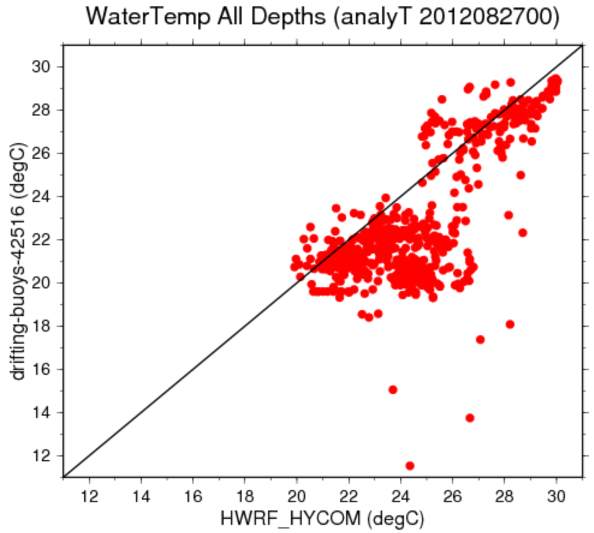
Scatterplots of 5-day forecasts

Scatterplot comparison - east side near center; HYCOM (top) versus POM (bottom)

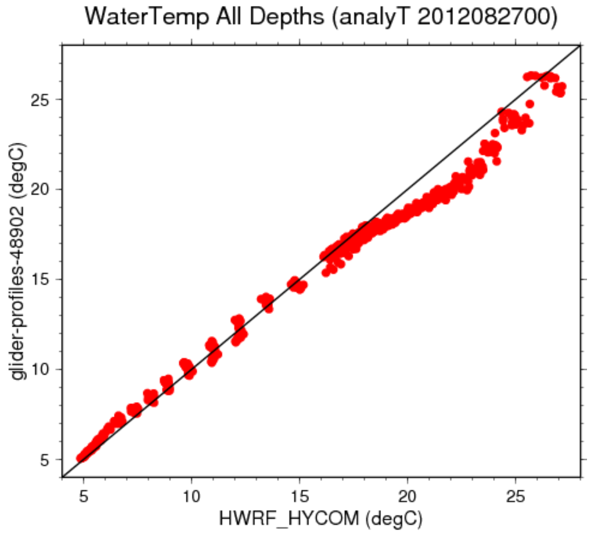
30 levels, 0 m to 160 m



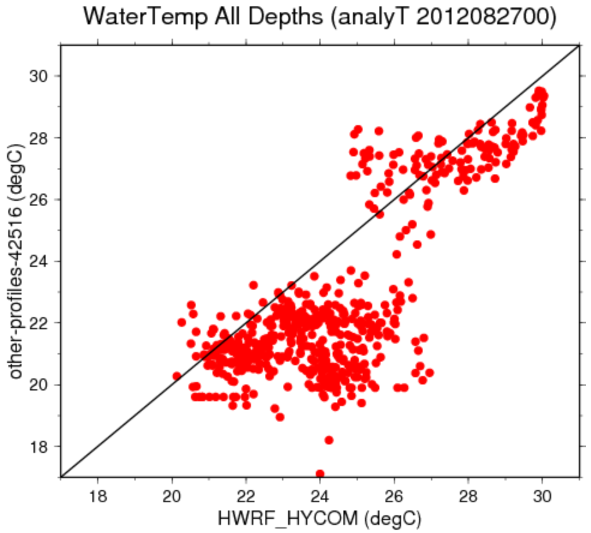
41 levels, 0 m to 102 m



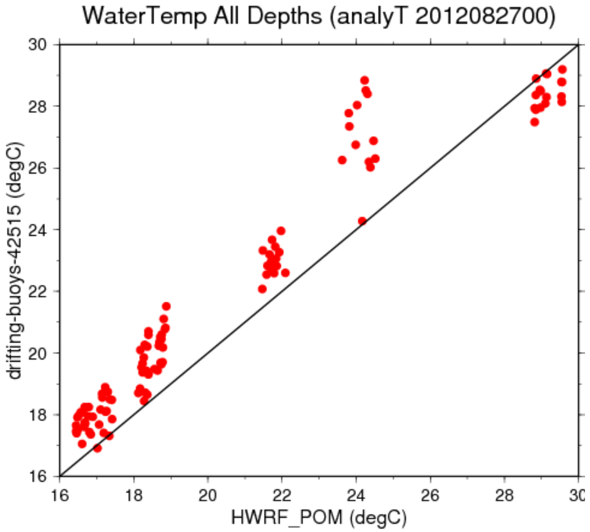
38 levels, 40 m to 993 m



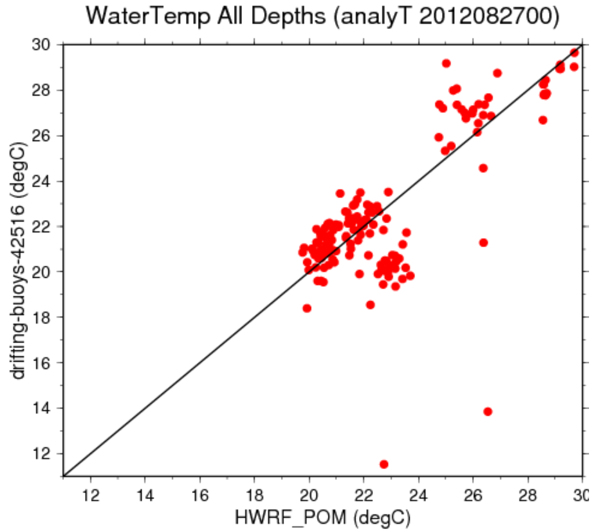
38 levels, 0 m to 102 m



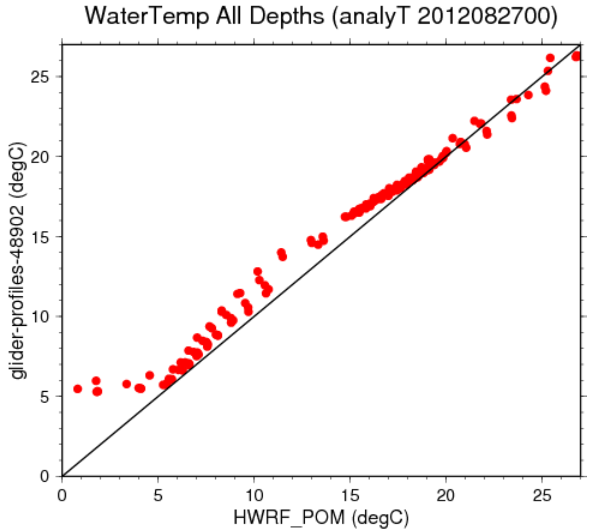
30 levels, 0 m to 160 m



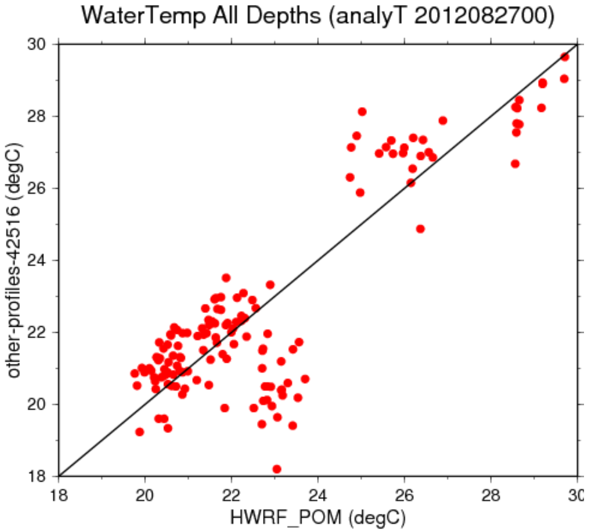
40 levels, 17 m to 102 m



37 levels, 40 m to 950 m

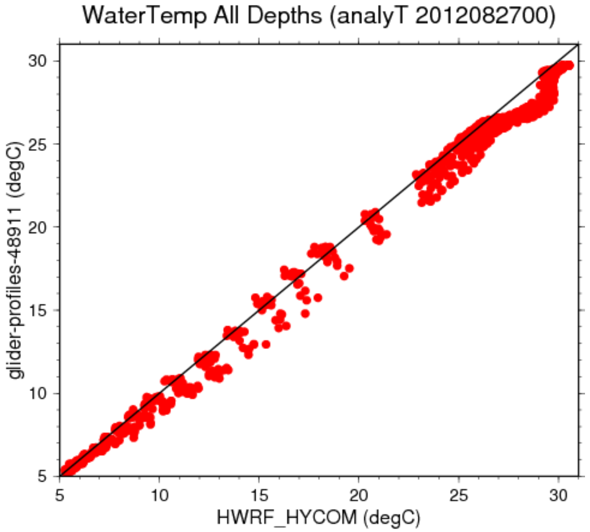


37 levels, 17 m to 102 m

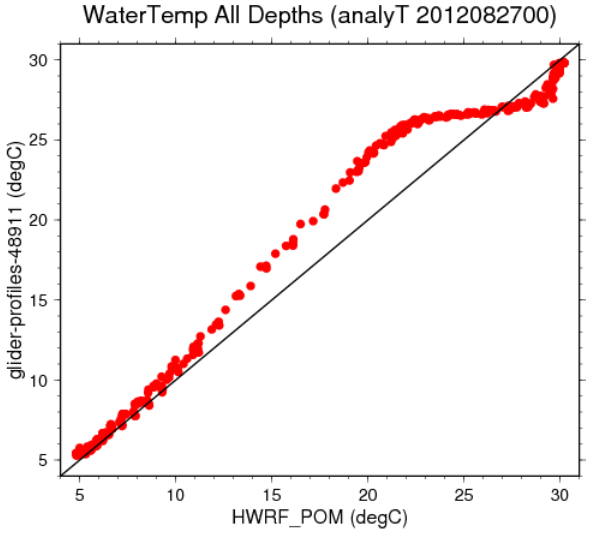


Scatterplot comparison - west side near center; HYCOM (top) versus POM (bottom)

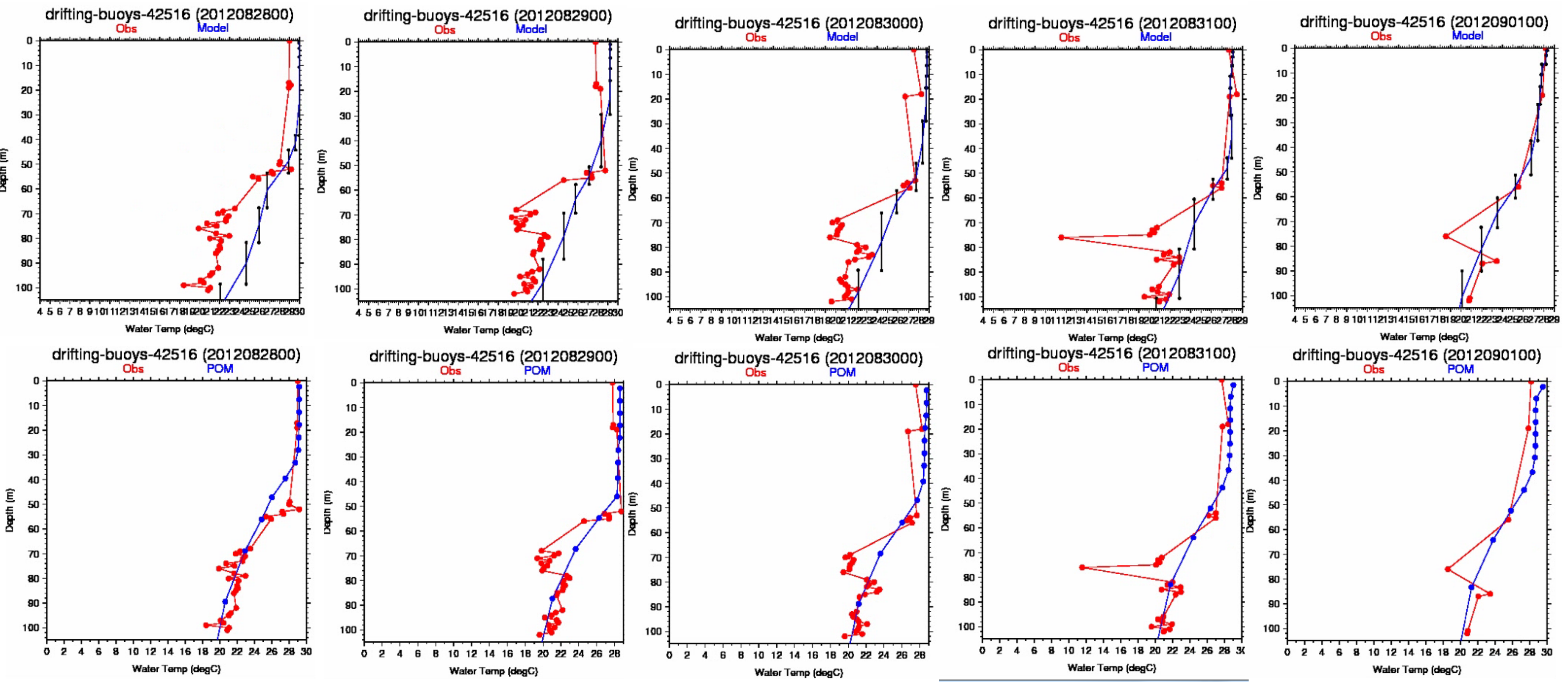
81 levels, 1 m to 996 m



81 levels, 1 m to 996 m



Profile comparison - drifting buoy 42516, east side of center, HYCOM (top) versus POM (bottom)



Preliminary conclusions

- HYCOM water temperature more responsive to TC forcing than POM, especially on eastern side "cold swath" region. This is a favorable attribute.
- POM response, in contrast, is rather stiff, perhaps by design to restrict temperature drift and for operational consistency:
  1. POM uses diffusive mixing, which means the shear-instability driven mixing is omitted.
  2. POM has weak diurnal signal; initial condition based on daily GFS SST
  3. POM mixed layer can be too thick due to coarser vertical resolution near ocean surface
- HYCOM exhibiting positive bias. There may also be a tendency to recover from mixing processes faster than observed. This could also be an artifact of seawater potential temperature computations and peak wind stress negative bias. Track errors are also a factor in isolated incidents, but not the major issue.

Future work will include validation metrics of all five runs, mixing depth examination, and PBL physics sensitivity studies