NOAA Technical Report NOS CS 33

THE NORTHERN GULF OF MEXICO OPERATIONAL FORECAST SYSTEM (NGOFS): MODEL DEVELOPMENT AND SKILL ASSESSMENT

Silver Spring, Maryland
March 2014

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Coast Survey Development Laboratory

Office of Coast Survey
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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EXECUTIVE SUMMARY

The National Ocean Service (NOS) Northern Gulf of Mexico Operational Forecast System (NGOFS) has been developed based on a three-dimensional hydrodynamic modeling system, the Finite Volume Coastal Ocean Model (FVCOM) (Chen et al., 2007). The unstructured model grid was constructed and populated with bathymetry obtained from NOS hydrographic survey soundings and U.S. Army Corps of Engineers survey data. FVCOM for NGOFS was calibrated and evaluated with observed data obtained from various government agencies and private companies.

The model tidal and hindcast simulations were conducted to obtain optimal model results. The tidal simulation was carried out with NOS astronomical tidal predictions imposed on the model grid's lateral open boundary. Two hindcast simulations were conducted for the periods of 1) September 2008 to August 2009 and 2) September 2010 to April 2011. The hindcast simulations are forced with simulated water levels, salinity and temperature at the lateral open boundary from the experimental NOS Gulf of Mexico Model (NGOM) and the U.S. Navy Coastal Ocean Model (NCOM); atmospheric wind and heat flux analyses at the air-sea interface from the NWS/North American Regional Reanalysis (NARR) and the North America Mesoscale Model (NAM); and the river discharge and temperature data are from USGS observations.

The tidal and hindcast simulation skills were evaluated using NOS skill assessment software (Zhang et al., 2006). By comparing with observations, a set of performance statistics for variables of water level, current, temperature and salinity was obtained. Statistical parameters included in the NOS skill assessment procedures for operational forecast systems (Hess et al., 2003; Zhang et al., 2006; and Zhang et al., 2010) are Root Mean Square Error (RMSE) and Central Frequency (CF) for hourly records, high and low water levels, and time of high and low water levels. The real-time nowcast/forecast system was then set-up based on the evaluated model and the nowcast/forecast skills were also examined before NGOFS was transitioned to operations.

The hindcast skills are summarized in two statistical variables, CF and RMSE, for four parameters: water level, current velocity, temperature and salinity. The skills obtained at stations spatially distributed over the NGOFS model domain are presented in the following figure (see details in Chapter 4).

Most of the skill assessment results show satisfactory or excellent skill and exceed the NOS criteria with the exception of a few water level CF at several stations. These locations are either located outside the model grid coverage or in small embayments not covered or well represented by the NGOFS.

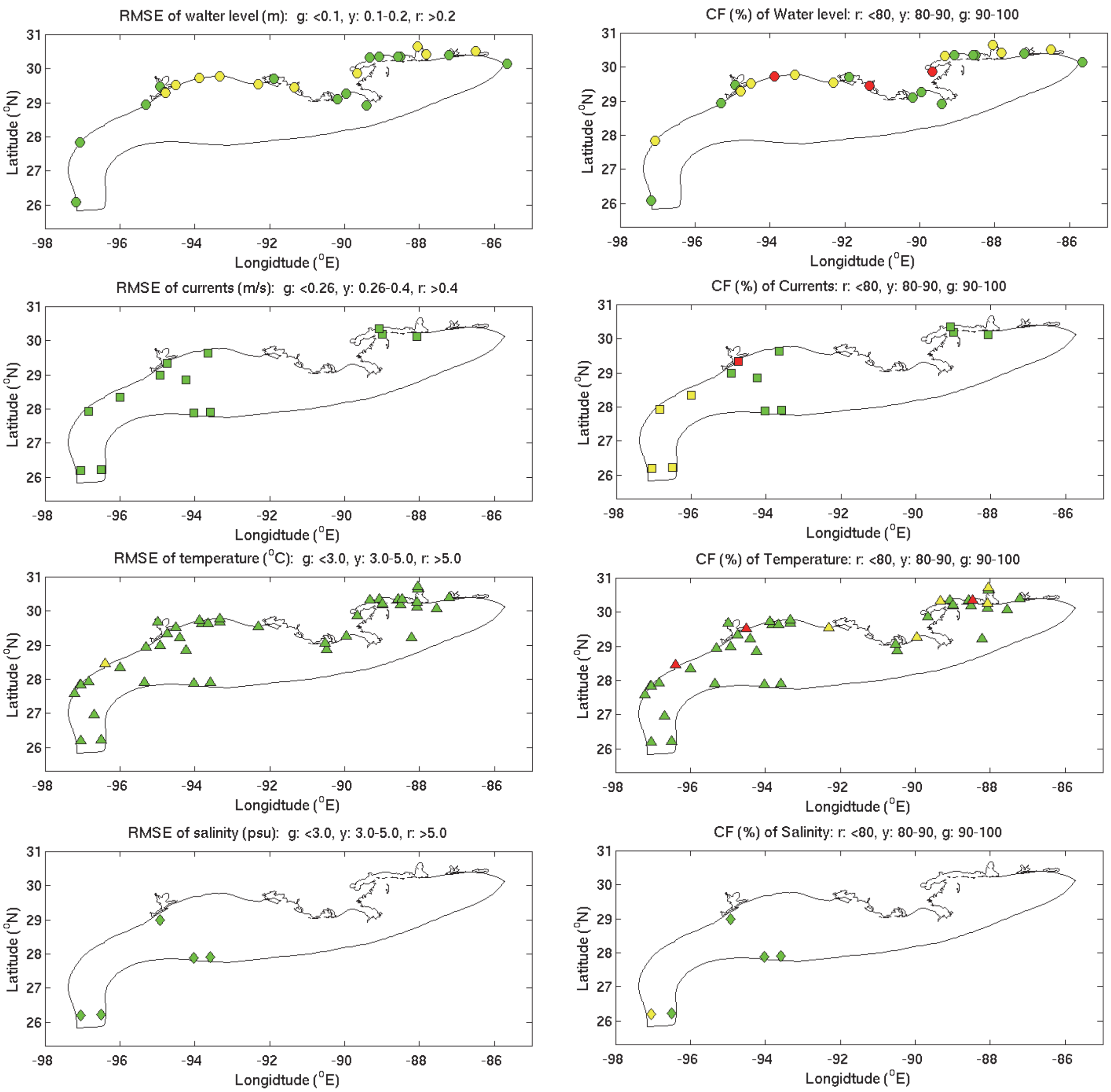


Figure 0.1. RMSE and CF for four parameters (water level, current velocity, temperature and salinity) at stations spatially distributed over the NGOFS model domain. The variable shapes are circles (water level), squares (current velocity), triangles (temperature), and diamonds (salinity) and the skill range color in the plots are defined as:

CF: Green > 90%; 90% $\geq$ Yellow $\geq$ 80%; Red <80%

RMSE for water levels (m): 0< Green $\leq$ 0.1; 0.1 $\leq$ Yellow $\leq$ 0.2; 0.2 < Red

RMSE for currents (m/s): 0 <Green $\leq$ 0.26; 0.26 $\leq$ Yellow $\leq$ 0.4; 0.4 < Red

RMSE for temperature/salinity (^{0}C, PSU): 0 < Green $\leq$ 3; 3 $\leq$ Yellow $\leq$ 5; 5 < Red

1. INTRODUCTION

National Ocean Service's (NOS) Physical Oceanographic Real-Time Systems (PORTS) along the northern coast of the Gulf of Mexico (GOM) provide real-time oceanographic data to promote safe and efficient navigation. These PORTS in this region currently include Mobile Bay, Pascagoula, Gulfport, Lake Charles, Sabine Neches, and Houston/Galveston Bay (Figure 1). In conjunction with these PORTS, NOS has been tasked to develop model-based nowcast/forecast oceanographic modeling systems to accurately provide nowcast and forecast guidance of water levels, currents, salinity, and temperature primarily for promoting maritime navigation safety. The Northern Gulf of Mexico Operational Forecast System (NGOFS), based on the unstructured three-dimensional primitive equation Finite Volume Coastal Ocean Model (FVCOM) (Chen et al., 2007), was then developed and implemented operationally by NOS in 2012 to provide nowcast and short-term (2 day) forecast guidance of water level, current, salinity and temperature in the northern Gulf of Mexico shelf region. With the shelf circulation properly modeled by NGOFS, the results can also be used not only for emergency responses but also for environmental predictions such as water quality, biological and ecological applications.

The northern Gulf of Mexico coastal circulation results from a combination of astronomical tides, GOM deep water eddies impinging against the shelf, the local atmospheric wind stress and heat flux, and riverine discharges through a vast stretch of wetlands and marshes into the coastal waters. Numerous studies including observations, analytical basic research, reanalysis, and numerical simulations have been done for either the entire, or part of the GOM at basin, regional, and local scales. A recent published book, edited by Sturges and Lugo-Fernandez (2005), collected a series of GOM circulation studies. Papers addressing the northern GOM coastal circulation in this book are the analysis of long term mooring data on Louisiana and Texas continental shelf (LATEX) by Nowlin et. al (2005) and a numerical model study by Niret et. al (2005) of the northern and western GOM. With the advancement of oceanographic knowledge through start-of-the-art observational systems of the atmosphere, surface water, and deep water, each study represents successive steps in an understanding of the GOM. The coastal shelf circulation in the northern GOM has large degree of variance in both space and time.

The FVCOM model numerically solves momentum, continuity, temperature, salinity, and density equations and is available with different turbulent closure sub-models. The irregular bottom slope is represented using a generalized vertical coordinate transformation, and the horizontal grid comprises unstructured triangular cells. The FVCOM has been successfully applied in several coastal ocean regions to simulate the hydrodynamics using an unstructured grid.

This report documents the development of the NGOFS as well as the model skill assessment. The NGOFS model system and set-up are discussed in Chapter 2 including the model grid coverage and FVCOM application general requirements such as the set-up of the initial conditions, surface and boundary forcing, and river forcing. The model calibration using the tidal simulations and the model evaluation using two hindcast simulations are described in Chapter 3. Model simulation skill assessment results from the model hindcast and the nowcast/forecast are described in Chapter 4. The salinity and temperature vertical profiles from the NOS Mobile Bay Collaborative Survey (MBCS) project (Patchen et al., 2012) are compared with the model hindcast and described in Chapter 5. Finally, conclusions are summarized in Chapter 6.

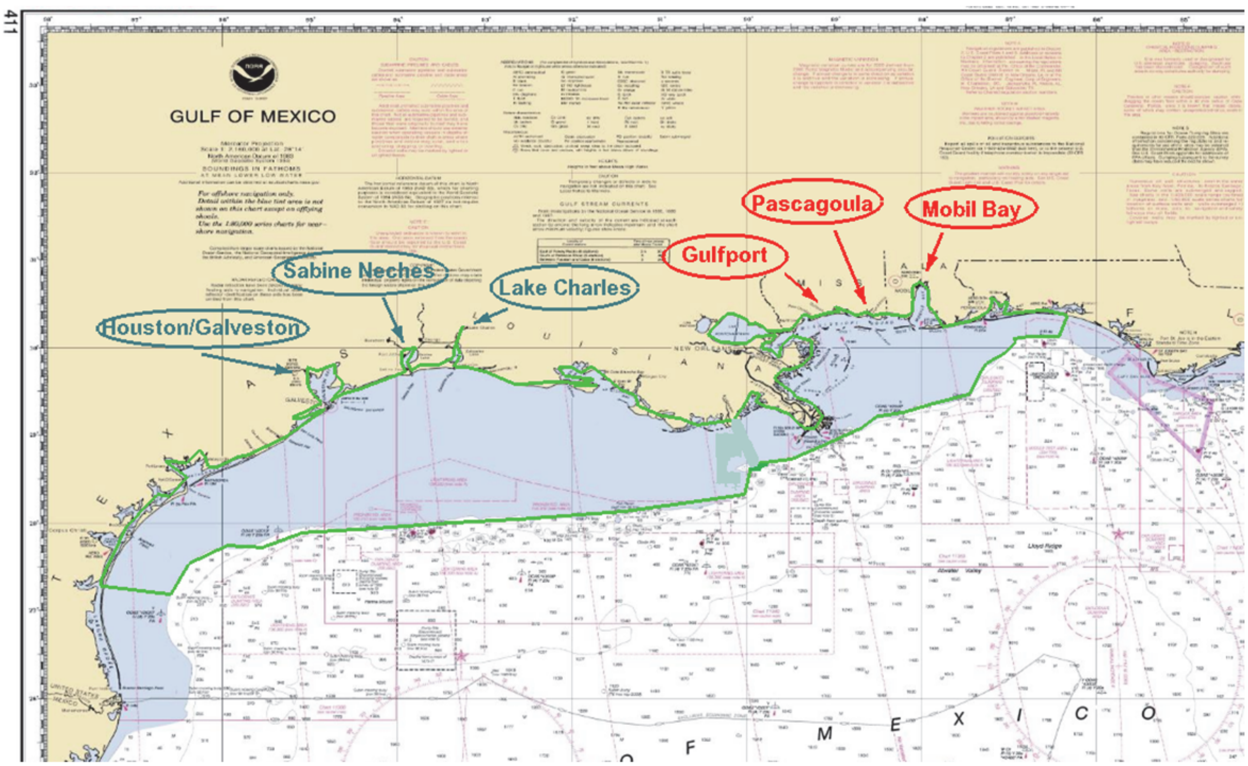


Figure 1.1. NOS PORTS locations in the northern Gulf of Mexico along with outline of NGOFS grid domain (green line). The map background is provided by a NOS nautical chart.

2. MODEL SYSTEM AND SET-UP

The FVCOM has been successfully applied in several coastal ocean regions to simulate the hydrodynamics using an unstructured grid. The governing equations and detail formulation has been documented in Chen et al. (2007) and on the web page: http://fvcom.smast.umassd.edu/index.html. Publications based on FVCOM applications can be found from this web page: http://fvcom.smast.umassd.edu/Extra/publication.html. In particular, the Northeast Coastal Ocean Forecast System (NECOFS) has been implemented by the University of Massachusetts at Dartmouth (UMASSD) in a real-time mode since 2007 (http://fvcom.smast.umassd.edu/research_projects/NECOFS/index.html) with high resolution grid nesting functionality. The FVCOM has been applied in this NGOFS regional shelf modeling system to simulate features such as the meso-scale eddies, the wind-driven coastal circulation, and the smaller scale coastal and estuarine circulation associated with complex shorelines, topography, tidal dynamics, and fresh water inputs.

Note that the FVCOM model requires an input model grid information file in ASCII format for a cold start run and NetCDF format in subsequent runs. For surface forcing, open boundary forcing (if the nesting approach is selected), and the river forcing, the FVCOM requires the input files in NetCDF format.

2.1. Model Grid

The NGOFS covers a model domain along the northern Gulf of Mexico coastal shelf from South Padre Island, Texas to the west to Panama City, Florida to the east. It is bounded roughly by the 200-m isobath along the shelf break (south) except offshore of the Mississippi River Delta where the model open ocean boundary is about 1800 m. The grid generation module within the Surface-Water Modeling System (SMS. see http://www.aquaveo.com/sms) software has been used to generate the unstructured NGOFS model grid. The grid size distribution is configured as dependent on the most recent NOAA hydrographic survey bathymetry. High resolution NOAA coastline data has been applied to delineate the land boundary. The river fresh water discharge has direct impact to the circulation in the coastal estuaries and bays and the detailed river geometry has to be included in determining the model grid coverage. The NGOFS model grid is composed of 90,267 nodes and 174,474 triangular elements (Figure 2.1). The resolution varies from approximately 150 m near the coast to 11 km close to the continental shelf break.

The model grid covers six NOS PORTS along the northern Gulf of Mexico coast. They are, from the west to the east, Houston/Galveston Bay, Sabine Neches, Lake Charles, Gulfport, Pascagoula, and Mobil Bay. The NGOFS is focused on shelf dynamics over a wide spatial domain over the northern Gulf of Mexico. Considering the operational nowcast/forecast run time efficiency, a larger time step is necessary in the model system configuration. Therefore, two PORTS with narrow navigational channels, i.e., Sabine Neches and Lake Charles, are not included in the NGOFS model domain. Two nested operational systems, namely the Northwest and Northeast Gulf of Mexico Operational Forecast Systems (NWGOFS and NEGOFS), are planned to be developed in the future with the FVCOM nesting.

The model bathymetry is obtained by interpolating the most recent NOAA hydrographic survey data onto each unstructured NGOFS model grid node. The minimum depth of the grid is defined as 2 m below mean sea level and land topography is not considered. A model bathymetry contour plot is shown in Figure 2.2. Bathymetry less than 200 m, representing the general shelf area, is shown in Figure 2.3.

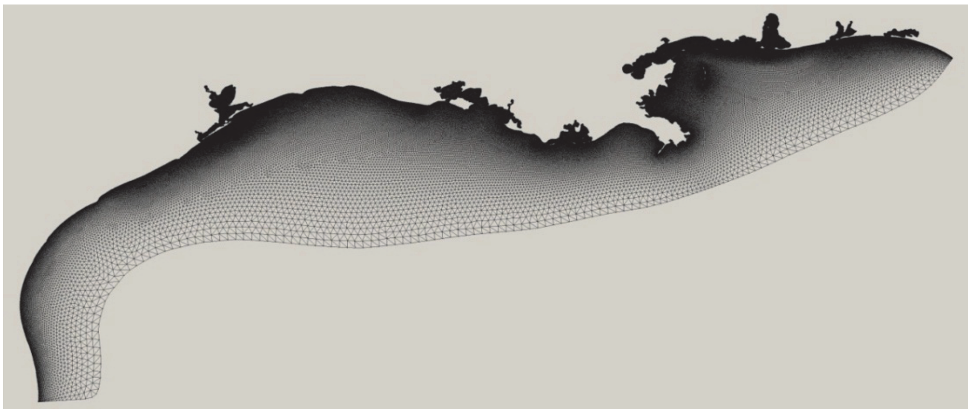


Figure 2.1. NGOFS model grid.

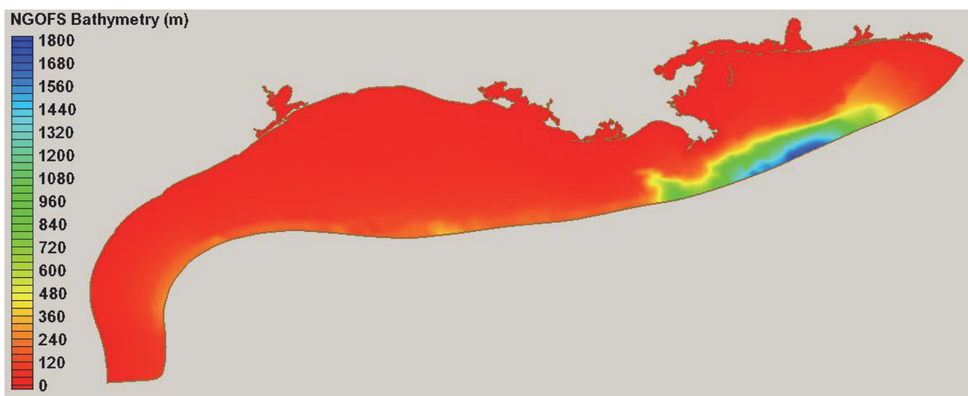


Figure 2.2. NGOFS model bathymetry.

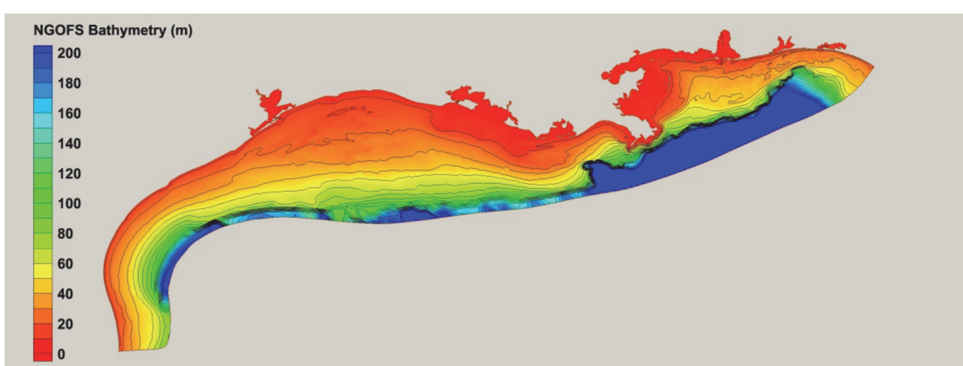


Figure 2.3. NGOFS model bathymetry showing depths less than 200 m.

2.2. Surface Boundary Forcing

The air-water surface boundary forcing for NGOFS comes from several components of the numerical weather prediction model outputs: the wind stress (calculated from the wind velocity), the atmospheric pressure, and the heat flux through the water-air interface. Although the FVCOM accepts uniform forcing (from observations) over the model domain, we use the forcing from the NOAA/NWS North America Regional Re-analysis (NARR) (Mesinger et al., 2006) and NAM (North America Mesoscale) Model (DiMego, 2012) for two NGOFS hindcasts.

The heat flux calculation requires the input from the NARR, including surface wind velocity, surface air pressure, upward and downward short wave radiation, upward and downward short long wave radiation, surface air temperature, and surface relative humidity. The bulk parameterization scheme computes the sensible heat, the latent heat, and the net heat flux on the ocean surface for the temperature equation. Net short wave radiation is also required for the heat penetration into the water column and was computed by taking an algebra sum between the upward and downward short wave radiation.

2.3. Open Ocean Boundary Condition

In the tidal simulation, the FVCOM requires specifying the tidal water levels at the open ocean boundary. The offshore tidal open boundary conditions for NGOFS are based on harmonic tidal constants obtained from the ADCIRC East Coast 2001 (Mukai et al., 2002) with adjustment using the verified harmonic constants at NOS tide stations at 8775870, South Padre Island, Texas, and 8729180, Panama City, Florida.

For the synoptic hindcast simulation, the FVCOM requires the specification of the current velocity, salinity and temperature along the open ocean boundary nodes and elements at each layer in the vertical. The boundary condition for salinity and temperature can be extracted from a global or basin scale climatologic data base. Depending on the application, the zero current velocity (or momentum transport) can be specified along the open ocean boundary. However, the time-dependent momentum transport should be specified at the open ocean boundary for better circulation results. The momentum transport can be obtained by interpolating the results from a basin or global scale model system such as the U.S. Navy's Coastal Ocean Model (NCOM) or NOAA/NWS' Real-time Ocean Forecast System (RTOFS).

2.4. River Forcing

Morphologically, a river enters the open ocean in coastal areas usually via an estuary or bay. The large seasonal temperature variation of fresh river flow as compared to the ambient coastal waters can create a density current inside the bay, in the river plume and ultimately in the open ocean bay/estuary entrance. However, the Mississippi River in the northern Gulf of Mexico is different. The river creates a huge delta from the sedimentation and bifurcation processes over a long period of time. The freshwater is therefore entering the open ocean via the delta, creating river plumes and salinity and temperature gradients in the river mouth neighborhood. The river fresh water flow is therefore contributing significantly to the shelf circulation in coastal waters.

For the NGOFS domain, major rivers such as the Mississippi and Atchafalaya Rivers play an important role in the entire NGOFS near-shore circulation from Texas to Florida.

The FVCOM accepts the river discharge and the tracer concentration (temperature and salinity in the NGOFS application) input to the model grid domain at the shoreline location. The model calculates the equivalent surface elevation changes based on the input discharge. A method for the tracer concentration boundary condition has been used for the NGOFS application to prevent unrealistic buoyance gradient near the discharge source (Chen et al., in preparation).

3. MODEL TIDAL SIMULATION AND HINDCASTS

The FVCOM model of NGOFS has been calibrated through performing the tidal and hindcast simulations. Bottom friction coefficients and other parameters for heat flux transport are determined through the calibration runs.

Section 3.1 describes the tidal simulation set-up and results. The hindcast set-up is described in Section 3.2 and the results are shown in Section 3.3 and 3.4 for hindcasts 1 and 2, respectively.

3.1. Tidal Simulation

A tidal simulation has been conducted for the year of 2008 using the NGOFS model grid forced with tidal water level boundary conditions and constant salinity and temperature. Tidal boundary conditions are generated from harmonic constant data from the ADCIRC EC2001 tidal model as described in Section 2.3. No river and atmospheric forcing are specified. The model tidal water level and current time series at tide station locations were compared against tidal water level and tidal current predictions, based on the NOS published harmonic constants using the NOS skill assessment software (Zhang et al., 2010). The skill bar-charts are presented and discussed in Section 4.1.

3.2. Hindcast Set-Up

For model validation purposes, two hindcast simulations have been conducted using the NGOFS model based on the description in Chapter 2. This section describes the details of the simulation set-up for each hindcast, including initial condition, boundary conditions, and river forcing. Observations of water levels, currents, salinity and temperature are collected and used for model-data comparison.

<u>Hindcast Periods</u>

The hindcast 1 simulation covers the period from July 1, 2008, to September 30, 2009. During this period, several extra-tropical and tropical cyclones passed through the NGOFS domain and produced high water level and current events.

The hindcast 2 simulation covers the period from September 14, 2010, to March 31, 2011. During this period three offices in NOS, including OCS, National Geodetic Survey (NGS), and Center for Operational Oceanographic Products and Services (CO-OPS), conducted Mobile Bay Collaborative Survey (MBCS) (Patchen et al., 2012). The project collected water levels, currents, salinity and temperature data. The survey data, along with other long-term observations, are then used for model verification.

<u>Initial Conditions</u>

The NGOFS requires an initial field set-up including the surface elevation, three-dimensional velocity, salinity and temperature fields, at the beginning of a simulation. The proper initial field specification is important to a simulation. For a three-dimensional baroclinic model simulation, the model initial surface elevations and three-dimensional currents are set as zero for both hindcasts. The initial salinity and temperature are interpreted from NOS's experimental Gulf of Mexico Model (NGOM) forecasts for Hindcast 1 at hour 0 of July 1, 2008, and from the U.S. Navy's global NCOM (Navy Coastal Ocean Model) forecasts for Hindcast 2 at hour 0 of September 14, 2010.

Open Ocean Boundary Conditions

The forcing at the NGOFS open boundary consists of:

1) water levels and currents: sub-tidal water levels and currents interpolated from NGOM (for hindcast 1) and NCOM (for hindcast 2) forecasts throughout the simulation period and are added to the tide (at the node) and tidal current (at the element all vertical levels) predictions based on the model tidal simulation results described in Section 3.1,
2) salinity and temperature: 3-D NGOM (for hindcast 1) and NCOM (for hindcast 2) salinity and temperature forecasts, throughout the simulation period, interpolated to the boundary nodes (at all vertical levels).

Atmospheric Surface Forcing

The surface forcing data required for the NGOFS hindcast simulation consists of meteorological parameters from NOAA's NARR (for hindcast 1) and NAM model (for hindcast 2). Data from NARR or NAM include surface wind velocity at 10 m above ground level (AGL), air pressure, surface air temperature (2m AGL), surface relative humidity (2m AGL), short- and long-wave radiation and are interpolated onto the NGOFS model domain at each node. The sensible heat, latent heat, and the net heat flux at each node are then calculated based on the bulk flux parameterization empirical formula.

River Forcing

River discharge and temperature taken from the United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), and NOAA's CO-OPS are collected and processed for creating river forcing for the NGOFS hindcasts.

Table 3.1 lists the river's name, the river entry location corresponding to the NGOFS model grid node, the USGS station ID and name, the discharge or temperature data source (USGS, USACE, or CO-OPS). Distributed river flows may be combined and enter the model grid at one location, such as #6, Houston_TX. The Atchafalaya River flow at Simmesport is equally split and enters the model grid at 3 nodes. The Mississippi River flow record at Baton Rouge, Louisiana, is split into 8 branch entry locations at the Mississippi River Delta, with the flow ratio based on a historic analysis. At each entry location (Table 3.2), the flow is further equally split onto the grid nodes that cross the river.

Table 3.1. River information for NGOFS hindcasts

#	River Input Name	Node #	USGS ID	Station Name	Discharge (hindcast)	Water Temperature(hindcast)
1	Nueces_TX	24153	08211200	Nueces Rv at Bluntzer, TX	USGS_08211200	USGS_08211503

2	SanAntonio_TX	23097	08188500	San Antonio Rv at Goliad, TX	USGS_08188500	COOPS_8773037
3	Guadalupe_TX	23098	08176500	Guadalupe Rv at Victoria, TX	USGS_08176500	COOPS_8773037
4	Colorado_TX	32482	08162500	Colorado Rv nr Bay City, TX	USGS_08162500	COOPS_8773259
5	Brazos_TX	38798	08116650	Brazos Rv nr Rosharon, TX	USGS_08116650	COOPS_8772447
6	Houston_TX	89538	08073700	Buffalo Bayou at Piney Point, TX	+ USGS_08073700 +	USGS_08068000
			08075400	Sims Bayou at Hiram Clarke St, Houston, TX	+ USGS_08075400 +	
			08075000	Brays Bayou at Houston, TX	+ USGS_08075000 +	
			08074500	Whiteoak Bayou at Houston, TX	+ USGS_08074500 +	
7	Jacinto_TX	89664	08068000	W Fk San Jacinto Rv nr Conroe, TX	+ USGS_08068000 +	USGS_08068000
			08068500	Spring Ck nr Spring, TX	+ USGS_08068500 +	
			08069000	Cypress Ck nr Westfield, TX	+ USGS_08069000 +	
			08070200	E Fk San Jacinto Rv nr New Caney, TX	+ USGS_08070200 +	
8	Trinity_TX	88931	08066500	Trinity Rv at Romayor, TX	USGS_08066500	USGS_08067100
9	Villagea_Neches_Sabine_TX	61006	08041500	Village Ck nr Kountze, TX	+ USGS_08041500 +	COOPS_8770570
			08041000	Neches Rv at Evadale, TX	+ USGS_08041000 +	
			08030500	Sabine Rv nr Ruliff, TX	+ USGS_08030500 +	
10	Calcasieu_LA	64011	08015500	Calcasieu River near Kinder, LA	USGS_08015500	USGS_08017044
11	Nezpique_LA	64019	08012000	Nezpique near Basile, LA	USGS_08012000	USGS_08017044
12	Teche_LA	67480	07385765	Bayou Teche at Adeline Bridge near Jeanerette, LA	USGS_07385765	USGS_073814675
13	Atchafalaya_1_LA	79585	07381490	(COE) Atchafalaya River at Simmesport, LA	USGS/COE_07381490	USGS_07374000
14	Atchafalaya_2_LA	79586	07381490	(COE) Atchafalaya River at Simmesport, LA	USGS/COE_07381490	USGS_07374000
15	Atchafalaya_3_LA	79587	07381490	(COE) Atchafalaya River at Simmesport, LA	USGS/COE_07381490	USGS_07374000
16	Mississippi_Baptiste_LA	62740	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
17	Mississippi_Main_Cubits_1_LA	53084	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
18	Mississippi_Main_Cubits_2_LA	52236	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
19	Mississippi_Main_Cubits_3_LA	52235	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
20	Mississippi_Loutre_1_LA	27893	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
21	Mississippi_Loutre_2_LA	27892	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
22	Mississippi_Loutre_3_LA	26886	07374000	Mississippi River at Baton	USGS_07374000	USGS_07374000

				Rouge, LA		
23	Mississippi_N_Southeast_LA	23744	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
24	Mississippi_S_Southeast_LA	22631	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
25	Mississippi_South_1_LA	20378	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
26	Mississippi_South_2_LA	21497	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
27	Mississippi_South_3_LA	20383	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
28	Mississippi_Southwest_1_LA	14115	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
29	Mississippi_Southwest_2_LA	14116	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
30	Mississippi_Southwest_3_LA	14117	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
31	Mississippi_Southwest_4_LA	14118	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
32	Mississippi_Tiger_Bois_1_LA	32096	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
33	Mississippi_Tiger_Bois_2_LA	32097	07374000	Mississippi River at Baton Rouge, LA	USGS_07374000	USGS_07374000
34	Tangipahoa_LA	88869	07375500	Tangipahoa River at Robert, LA	USGS_07375500	USGS_301001089442600
35	Chitto_LA	88169	02492000	Bogue Chitto River near Bush, LA	USGS_02492000	USGS_301141089320300
36	Pearl_LA	88090	02489500	Pearl River near Bogalusa, LA	USGS_02489500	USGS_301141089320300
37	Wolf_MS	85595	02481510	WOLF RIVER NR LANDON, MS	USGS_02481510	USGS_02481660
38	Blackc_Red_Pascag_MS	70887	02479160	BLACK CREEK NR WIGGINS, MS	USGS_02479160	USGS_02480285
			02479300	RED CREEK AT VESTRY, MS	USGS_02479300	
			02479000	PASCAGOULA RIVER AT MERRILL, MS	USGS_02479000	
39	Mobile_AL	86790	02470629	MOBILE RIVER AT RIVER MILE 31.0 AT BUCKS, AL	USGS_02470629	COOPS_8737048
40	Tensaw_AL	87516	02471019	TENSAW RIVER NR MOUNT VERNON, AL.	USGS_02471019	COOPS_8737048
41	Perdido_FL	40692	02376500	PERDIDO RIVER AT BARRINEAU PARK, FL	USGS_02376500	COOPS_8729840
42	Escambia_FL	76267	02375500	ESCAMBIA RIVER NEAR CENTURY, FL	USGS_02375500	COOPS_8729840
43	Yellow_Shoal_FL	50759	02368000	YELLOW RIVER AT MILLIGAN, FL	USGS_02368000	COOPS_8729840
			02369000	SHOAL RIVER NR CRESTVIEW, FL	USGS_02369000	
44	Choctawhatchee_FL	75834	02365500	CHOCTAWHATCHEE RIVER AT CARYVILLE, FL	USGS_02365500	COOPS_8729840

Table 3.2. Mississippi River flow split ratio and grid node ID

No.	Name of the downstream river Passes	(longitude, latitude) (^oE, ^oN)	Ratios (%)	Node IDs
1	Baptiste Collette	(-89.29858 29.36128)	4.0	62740
2*a	Main Pass & Cubits Pass	(-89.18836 29.33425)	10.3	53084,52236,52235
3	Pass A Loutre	(-89.0151 29.1934)	29.7	27893, 27892,26886
4	North Branch of Southeast Pass	(-89.02707 29.1355)	1.0	23744
5	South Branch of Southeast Pass	(-89.06018 29.07915)	1.0	22631
6	South Pass	(-89.1691 29.0176)	14.8	20378,21497,20383
7	Southwest Pass	(-89.4148 28.9237)	29.7	14115,14116,14117,14118
8*b	Tiger Pass &Pass du Bois	(-89.4105 29.109)	9.5	32096, 32097
Total			100	

Notes: *a: Combined discharge between Main Pass & Cubits Pass
*b: Combined discharge between Tiger Pass & Pass du Bois

Time Step and Mode Split

Based on the Courant condition, the external time step of the NGOFS simulation was set as 12 seconds and the internal/external mode split was set to 3. Both tidal and hindcast simulations were stable with this time step set-up even during storm events.

In summary, the set-up information and the data sources for two NGOFS hindcasts are listed in Table 3.3.

Table 3.3. Summary of NGOFS hindcast set-up. Note: Q is river flowrate and T is river temperature.

Hindcast	Simulation Period	Surface Forcing	Ocean Boundary Condition*	River Forcing
Hindcast 1	July 1, 2008 – September 30, 2009	NARR	NOS NGOM ADCIRC TIDE	USGS (Q,T) CO-OPS (T)
Hindcast 2	September 14, 2010 – April 1, 2011	NAM12	Navy NCOM	USGS (Q,T) CO-OPS (T)

*Note: sub-tidal water levels and currents from NGOM or NCOM are added to ADCIRC tidal water levels and tidal currents as water level and current velocity boundary forcing.

Run-time Namelist

The FVCOM uses an ASCII-format namelist file to specify model run parameters. An example of the NGOFS hindcast run-time namelist is shown in Appendix A. Detailed definition of the parameters in the namelist is described the FVCOM manual (Chen et al., in preparation).

Vertical Coordinate Configuration

FVCOM allows users to configure the vertical coordinate distribution. In NGOFS, the vertical coordinate is chosen as 21 sigma levels with higher resolution near the surface and the bottom to resolve the momentum and heat transfer and bottom friction in the boundary layers. The vertical sigma levels are specified based on the bathymetry (h) so that the layer thickness is: for h >= 200 m: 5 meters at 5 layers near the surface and the bottom, and uniformly distributed for the remaining 11 layers; for h < 200 m: uniformly distributed.

3.3. Hindcast 1 Model-Data Comparison

The NGOFS model hindcast 1 simulations were carried out by forcing the model with NOS's NGOM forecasts at the open boundary. The forcing at the open boundary consists of the sub-tidal water levels and currents from NGOM added to tide and tidal predictions based on the model tidal simulation (Section 3.2), and the salinity and temperature through the boundary water column. The surface forcing for hindcast 1 is forced with wind velocity, air pressure, and heat flux from NWS NARR model. The spatial resolution of the NARR gridded output is 40 km and has a temporal resolution of 3 hours. River discharge and temperature observations taken from the USGS stations and water temperature data from CO-OPS stations enter the model grid at the river mouth to the ocean or bay/estuary.

NGOFS hindcast 1 covers the period from July 1, 2008, to September 30, 2009. Model simulated time series of water levels, currents, salinity and temperature are plotted against observations for comparison. NOS standard skill assessment software is then used to evaluation the performance of the model by calculating the statistics between model simulations and observations.

Observations of water levels, currents, salinity and temperature within the NGOFS model domain during the period of hindcast 1 were collected and processed for model-data comparison. Data sources include government agencies such as NOS, National Data and Buoy Center (NDBC), Integrated Ocean Observing System (IOOS), and United States Geological Survey (USGS) and academic research institutions such as Texas Automated Buoy System (TABS), Dauphin Island Sea Laboratory (DISL), Louisiana Universities Marine Consortium (LUMCUM), and Louisiana State University (LSU). Table 3.4 lists 72 stationary output stations with longitude, latitude, model grid node number where the station corresponds, and the brief station description including the station ID if available. Model simulation outputs include water level and vertical profiles of current, salinity and temperature at each station at a specified time interval.

Water Levels

Most of the observed water levels are available from the NOS NWLON (National Water Level Observation Network) database. The procedure STEP1 of the NOS skill assessment software downloads historic water levels from NOS's CO-OPS website. These stations are listed as station #1 to #34 in the NGOFS station list (Table 3.4). The list starts from station 8729108 at Panama City, Florida, on the east end of the model grid to station 8775870 at South Padre Island, Texas, on the west end.

Time series of simulated water levels at 12 representative stations (see location map Figure 3.3.1) over most of this hindcast period are plotted against the observations and shown in Figures 3.3.2, 3.3.4, and 3.3.6. These time series plots reveal the overall envelope of the simulated tidal ranges against observations. In order to further examine detail comparisons between simulated and observed water levels, the time scale is reduced to 60 days for a plot as shown in Figures

3.3.3, 3.3.5, and 3.3.7. High surges from storm events are apparent in the detail plots; September 2-4, 2008 (days 245) due to Hurricane Ike (Figure 3.3.8) and September 12 – 15, 2008 (day 255) due to Hurricane Gustav (Figure 3.3.8). The simulated water levels follow the surge trend and maximum surge height well at some stations (8771450, Galveston Pier 21 - Figure 3.3.3 and 8741533, Pascagoula NOAA Lab – Figure 3.3.5). However, the model missed predicting maximum surge height by as much as 0.4 m at most stations probably due to the fact that the 40 km resolution NARR wind field is not accurately representing details of the hurricane wind distribution well.

Currents

(A) TABS

Near surface currents at TABS (Texas Automated Buoy System) stations (#35 to #44, Table 3.2) were also collected for hindcast 1. The current meters are attached to TABS data buoy at a depth of 2 meters below the water surface (Bender et al., 2007). The locations of these data buoys are shown as Figure 3.3.9 (http://tabs.gerg.tamu.edu/).

Model simulated current speeds and direction at the corresponding TABS depth for NGOFS hindcast 1 are plotted against the observations as shown in Figures 3.3.10 to 3.3.12 for two 60-day periods. Buoys B, W, D, and J (Figure 3.3.9) are deployed at near-shore shallow water locations along the coastline from the northeast to the southwest. For TABS buoy B, the model current speed and direction for the time series period between December 3, 2008 and February 3, 2009 (Figure 3.3.10, right) match with observations more accurately than the first time series period, October 6 to December 6, 2008 (Figure 3.3.10, left). Although model simulated current speeds follow the observation trends, the amplitudes are in general smaller than the observations. Model simulated and observed current speed and directions for buoys F and K are shown in Figure 3.3.11 and N and V in Figure 3.3.12. For TABS F, the simulated currents are circular as for TABS B, W, D, and W. However, TABS K, along with N, and V, are located near the NGOFS open boundary where the model receives the forcing, including sub-tidal water levels and tidal currents, salinity, and temperature from NGOM. The current directions at these three locations are 90 degrees out of phase with the observations.

This discrepancy is further verified with the current scatter plots at all TABS buoys. Model simulated velocity in the U- and V- directions are compared with TABS buoy observations in velocity scatter plots. Figures 3.3.14(a) shows the UV scatter plots for TABS B, W, D, and J. A relatively defined current axis for both model and observation is apparent along the coastline. The model seems to follow the topographic long-shore currents in the observations. Figure 3.3.14(b) shows the scatter plots for more offshore stations R, F, K, N and V. Except for TABS K, where the observed current roughly follows the isobaths, observed currents at TABS R, F, N and V are all circular. However, it is clear that the model currents at the TABS K location are 90 degrees out of phase with the observations and more rectilinear at TABS N and V locations.

Since tidal currents at such deep open boundary locations are expected to be small compared with sub-tidal currents, the NGOM (note: no tide in NGOM) sub-tidal currents at TABS K, N, and V locations are shown in Figure 3.3.15. It is apparent that the NGOM sub-tidal current velocity is the major reason for 90-degree out of phase currents at the open boundary.

(B) NOS NCOP

For inland bays and estuaries, NOS maintains several types of current meters at stations within the PORTS under the National Current Observation Program (NCOP). The current meter locations are show as Figure 3.3.16. Three types of Acoustic Doppler Current Profiles (ADCP) are used: bottom mounted upward-looking (U-ADCP), vertical wall mounted side-looking (H-ADCP), and buoy (or tower) mounted downward looking (D-ADCP). Observed data from these stations extracted at navigationally important depths (either 5 meters below the mean low water surface or half of the depth) are processed to evaluate model performance at corresponding vertical locations.

Model simulated current speed time series from hindcast 1 are plotted with observations at NCOP stations as shown in Figures 3.3.17 and 3.3.18. Simulated currents at station g06010 (Figure 3.3.17 top plot) match the observations in both amplitude and phase. However, NGOFS simulated current speeds are less than the observations.

Many NCOP current meter stations in the PORTS system located inside the bay are not covered by NGOFS (Lake Charles and Lake Calcasieu – Lake Charles PORTS, and Lake Sabine and Neches - Sabine Neches PORTS). Although Galveston and Mobile Bays are included in the present NGOFS model grid configuration, some inland stations inside Galveston Bay and Mobile Bay are not resolved by NGOFS. The follow-up NOS OFS development plan will include the nested sub-domains NWGOFS and NEGOFS (Northwest and Northeast Gulf of Mexico Operational Forecast Systems) having higher grid resolution. The nested sub-domain models should improve the circulation dynamics in these bays.

Temperature

Temperature observations are also collected for hindcast 1 verification. They are:

(1) TABS temperature at 2 meters below the surface
(2) NOS temperature sensors attached to NWLON water level gages
(3) NOS ADCP current meters equipped with a temperature sensor at the instrument head

The station names for temperature and salinity are listed from #45 to #66 in Table 3.4. Salinity observations are of bad quality, therefore the model simulated salinity is not included in the skill assessment for this hindcast simulation.

(A) TABS

Figure 3.3.19 shows model simulated surface temperature time series with observations at TABS buoy locations (see Figure 3.3.9) at water depth (2 m below the water surface) from July 28, 2008, to September 21, 2009. In general the simulated near surface temperature at TABS stations follows the observational seasonal trend ranging from 30 ^{0}C in the summer of 2008 to 10 ^{0}C in the winter, then back to 30 ^{0}C again in summer of 2009. However, the model overestimates the temperature by about 2 to 3 ^{0}C in the winter of 2008-2009.

(B) NOS NWLON

Temperature data at NOS water level gage locations (Figure 3.3.20) in the NWLON program are used for NGOFS hindcast verification. Hindcast 1 simulated temperature time series with observations for these stations is shown in Figure 3.3.21.The temperature and transport of the rivers near these gages play a significant role in determining the water temperatures. With accurate river temperature specified, the model simulated temperature follows observational annual trend. The one to two week synoptic scale signal in the observation (e.g., around day 500 for stations from Florida to Louisiana) is also clearly shown in the model simulated temperature. Temperature observations show a strong diurnal tidal signal at inside bay/estuary locations. However, the amplitude of this signal is reduced significantly in the model simulated temperature time series due to the fact that detail geometric configuration is not well resolved in the NGOFS shelf model grid (e.g., stations 8747437, Bay Waveland, MS, day 330-450 and 8768094, Calcasieu Pass, LA, day 335-420). This signal should be better resolved in the next phase using the nesting grid approach.

(C) NCOP

For temperature sensors attached to NOS current meters (NCOP), model simulated temperature at the corresponding observation depth is plotted with observations as shown in Figures 3.3.22. Although only about 3 to 4 months of observed data are available at 4 stations g0601 in Galveston Bay, TX and gp0101, gp0201, gp0401 in Gulfport, MS, the hindcast temperature at these stations follows the trend of the observed signal very well.

Table 3.4. NGOFS Stationary Output List for Hindcast 1

No	Longitude	Latitude	Node	Depth (m)	Station Name
1	-85.66666	30.15167	170	27.49	'8729108 Panama City, FL '
2	-86.49333	30.50333	50759	2.29	'8729501 Valparaiso, FL '
3	-87.21167	30.40333	59185	7.66	'8729840 Pensacola, FL '
4	-87.42834	30.38667	39686	4.41	'8729941 Blue Angles PK, FL '
5	-87.68333	30.27833	40673	5.50	'8731439 Gulf Shores ICWW, AL'
6	-87.82500	30.41667	78517	2.01	'8732828 Weeks Bay, AL '
7	-88.07500	30.25000	54105	2.13	'8735180 Dauphin Is Hydro, AL'
8	-88.05833	30.64833	85134	2.01	'8736897 CG Mobile, AL '
9	-88.04333	30.70833	86510	4.39	'8737048 Mobile St Dock, AL '
10	-88.50500	30.34833	67193	2.01	'8741041 Pascagoula Dock, MS '
11	-88.56667	30.35833	68283	2.21	'8741533 Pascagoula NOAA, MS '
12	-89.08167	30.36000	81995	2.01	'8745557 Gulfport Harbor, MS '
13	-89.32500	30.32500	85270	2.01	'8747437 Bay Waveland, MS '
14	-89.67167	29.86667	90019	2.01	'8761305 Shell Beach, LA '
15	-89.40667	28.93167	14117	3.41	'8760922 Pilots Sta, SW, LA '
16	-89.95667	29.26333	40367	2.40	'8761724 Grand Isle, LA '
17	-90.19833	29.11333	34220	2.01	'8762075 Port Fourchon, LA '
18	-91.33667	29.44833	63391	2.01	'8764227 Lawma, Amerada, LA '
19	-91.88000	29.71333	77549	2.01	'8765251 Cypremort Pt, LA '
20	-92.30500	29.55500	58723	2.01	'8766072 Freshwater Canal, LA'
21	-93.34167	29.76667	63987	2.01	'8768094 Calcasieu, LA '
22	-93.87000	29.73000	61006	2.01	'8770570 Sabine Pass N. TX '
23	-94.98500	29.68167	88919	5.00	'8770613 Morgans Pt, TX '
24	-95.09000	29.75667	89621	4.12	'8770743 Battleship Park, TX '
25	-95.06667	29.56333	87625	2.01	'8770933 Clear Lake, TX '
26	-94.51334	29.51500	87263	2.01	'8770971 Rollover Pass, TX '
27	-94.91833	29.48000	84824	2.01	'8771013 Eagle Pt, TX '
28	-94.79333	29.31000	77887	10.90	'8771450 Galvest Pier 21, TX '
29	-94.78833	29.28500	61599	3.39	'8771510 Galvest Pl Pier, TX '
30	-95.30167	28.94333	38799	2.01	'8772447 USCG Freeport, TX '
31	-96.38834	28.45167	23098	2.01	'8773701 Port Oconnor, TX '
32	-97.07333	27.83833	24149	2.01	'8775237 Port Aransas, TX '
33	-97.21667	27.58000	26203	2.33	'8775870 Corpus Christi, TX '
34	-97.17667	26.07667	6581	25.51	'8779748 S. Padre Is, TX '
35	-94.91833	28.98167	25368	19.20	'TABSV_B TABS Buoy B, TX '
36	-96.84333	27.94000	12709	18.30	'TABSV_D TABS Buoy D, TX '
37	-94.24167	28.84333	8140	24.10	'TABSV_F TABS Buoy F, TX '
38	-96.54333	27.86833	3963	33.00	'TABSV_H TABS Buoy H, TX '
39	-97.05000	26.19167	3902	20.07	'TABSV_J TABS Buoy J, TX '
40	-96.50000	26.21667	196	62.95	'TABSV_K TABS Buoy K, TX '
41	-94.03667	27.89000	231	105.20	'TABSV_N TABS Buoy N, TX '
42	-93.64167	29.63500	52725	9.80	'TABSV_R TABS Buoy R, TX '
43	-93.59666	27.89667	235	89.90	'TABSV_V TABS Buoy V, TX '
44	-96.00500	28.35000	8753	21.90	'TABSV_W TABS Buoy W, TX '
45	-88.07000	30.13000	35537	16.93	'mb0101c MB Buoy M, AL '
46	-88.04333	30.72167	86508	4.39	'mb0301c MB St Pier E,AL '
47	-88.03167	30.66500	86070	4.63	'mb0401c MB Cont term,AL '
48	-88.53000	30.18833	51521	11.24	'ps0101c Pascagoa,LB8 MS '
49	-88.99333	30.21000	54071	8.27	'ps0201c Pascaga,LB17 MS '
50	-88.56333	30.36000	67733	2.21	'ps0301c Pasc NG Pier MS '
51	-88.52167	30.19500	52374	8.06	'ps0401c Pasc HA LB10 MS '
52	-88.98833	30.19500	71775	8.88	'gp0101c Gulfport,LB22 MS '
53	-88.99500	30.21667	74678	7.93	'gp0201c Gulfport,LB26 MS '

54	-89.00000	30.23943	76117	8.00	'gp0301c Day Marker 32 MS '
55	-89.08667	30.34833	81277	2.84	'gp0401c GP Harbor WP, MS '
56	-93.33167	29.69333	56108	8.63	'lc0101c Lake Calcas, LA '
57	-93.34333	29.76333	63283	2.01	'lc0201c Cameron Fis, LA '
58	-93.25000	30.22833	63295	2.01	'lc0301c L Chal CTY, LA '
59	-93.80666	29.63000	52705	8.08	'sn0101c Sabin LBB 34, LA '
60	-93.87000	29.72833	60221	2.01	'sn0201c USCG Sabin, LA '
61	-94.08667	30.08000	63930	2.01	'sn0601c Port Beaumt, LA '
62	-94.77700	29.34200	73930	4.76	'g01010c Bolivar Roads, TX '
63	-94.98167	29.68167	88923	5.76	'g02010c Morgans Pt, TX '
64	-94.78333	29.35167	74881	13.09	'g04010c Hou Ship Ent, TX '
65	-94.88500	29.29833	80615	2.62	'g05010c Galves Cause, TX '
66	-94.74333	29.34167	69009	10.82	'g06010c Galves Ent, TX '
67	-89.08667	30.34667	81277	2.84	'8745651 West Pier, MS '
68	-88.98000	30.23000	76558	6.16	'8744707 GP Outer Range, MS '
69	-88.02500	30.22833	53299	6.98	'8744673 Fort Morgan, AL '
70	-88.56667	30.35500	68283	2.21	'8741501 Dock C, MS '
71	-88.50000	30.21333	54902	5.13	'8741003 Petit Bois, MS '
72	-88.51167	30.34333	67193	2.01	'8741094 Rear Range, MS '
73	-94.72333	29.35667	67923	12.6	'8771341 GB North Jetty,TX '
74	-93.83667	29.67667	60218	2.09	'8770822 Texas Point, TX '

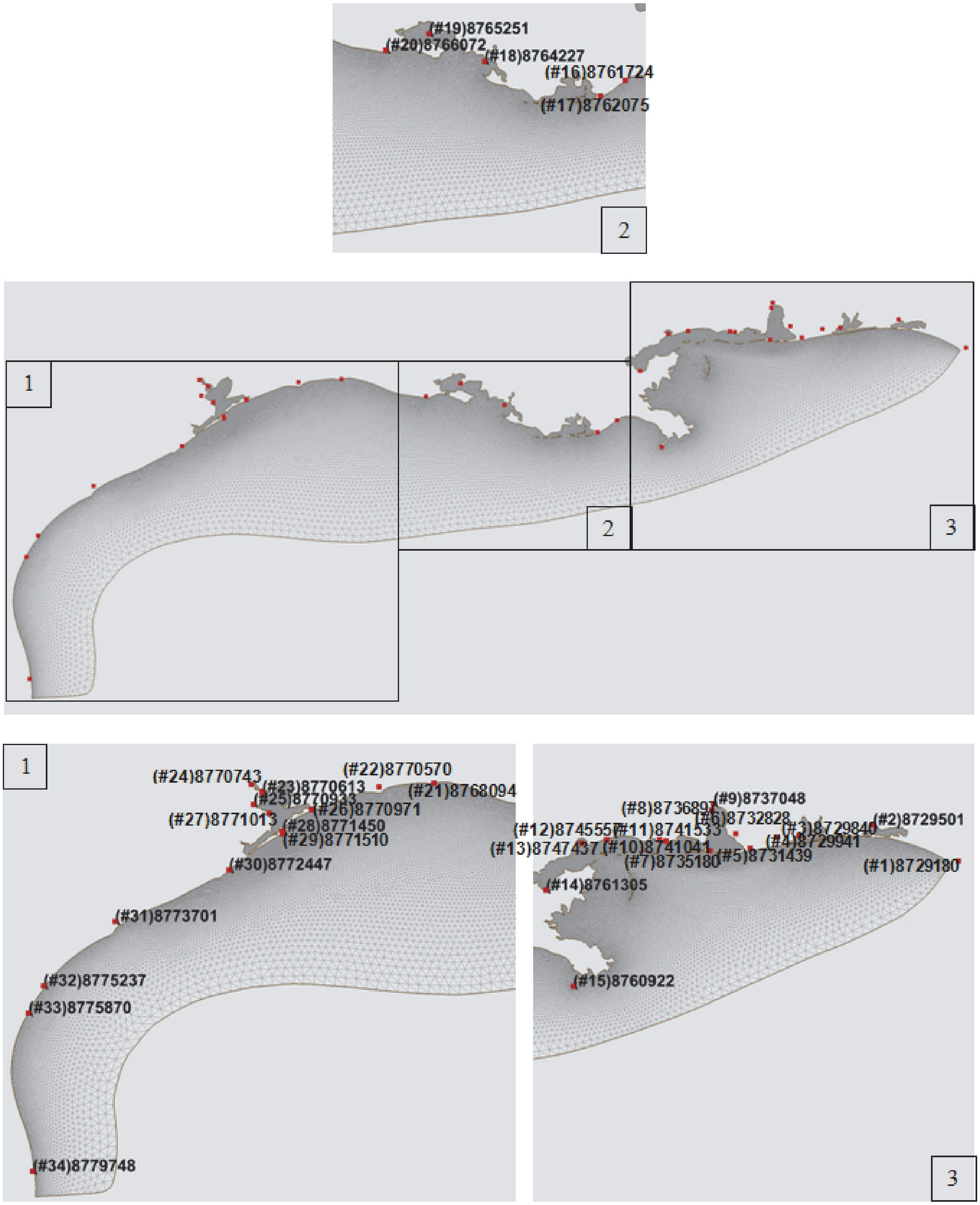


Figure 3.3.1. Maps depicting the locations of NOS NWLON water level stations (with station ID) along with portion of the NGOFS model grid.

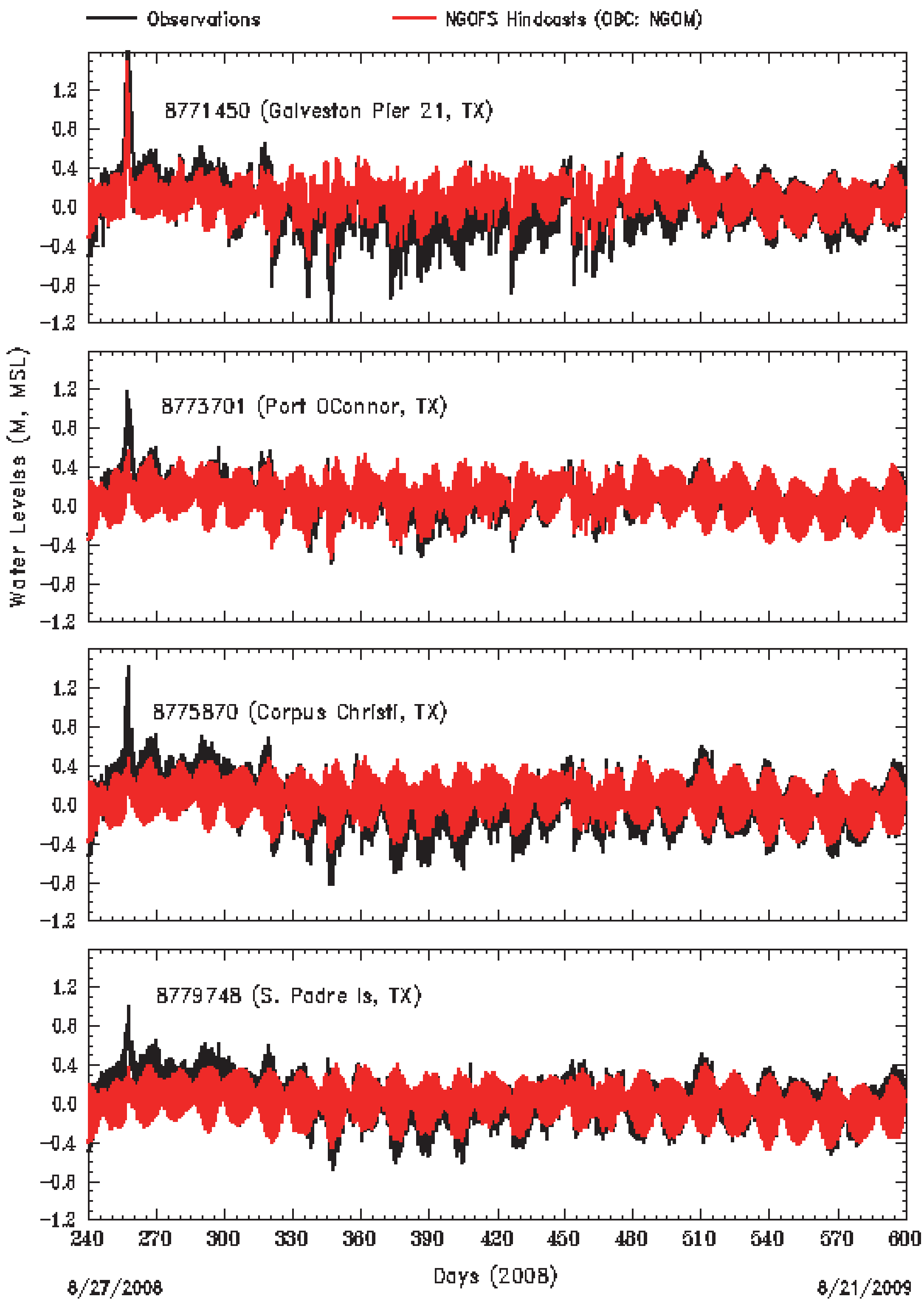


Figure 3.3.2. NGOFS hindcast 1simulated (red) and observed (black) water level time series over the entire simulation period at Texas coast NOS stations: 8779748, South Padre Island; 8775870, Corpus Christi; 8773701, Port O'Connor; and 8771450, Galveston Pier 21.

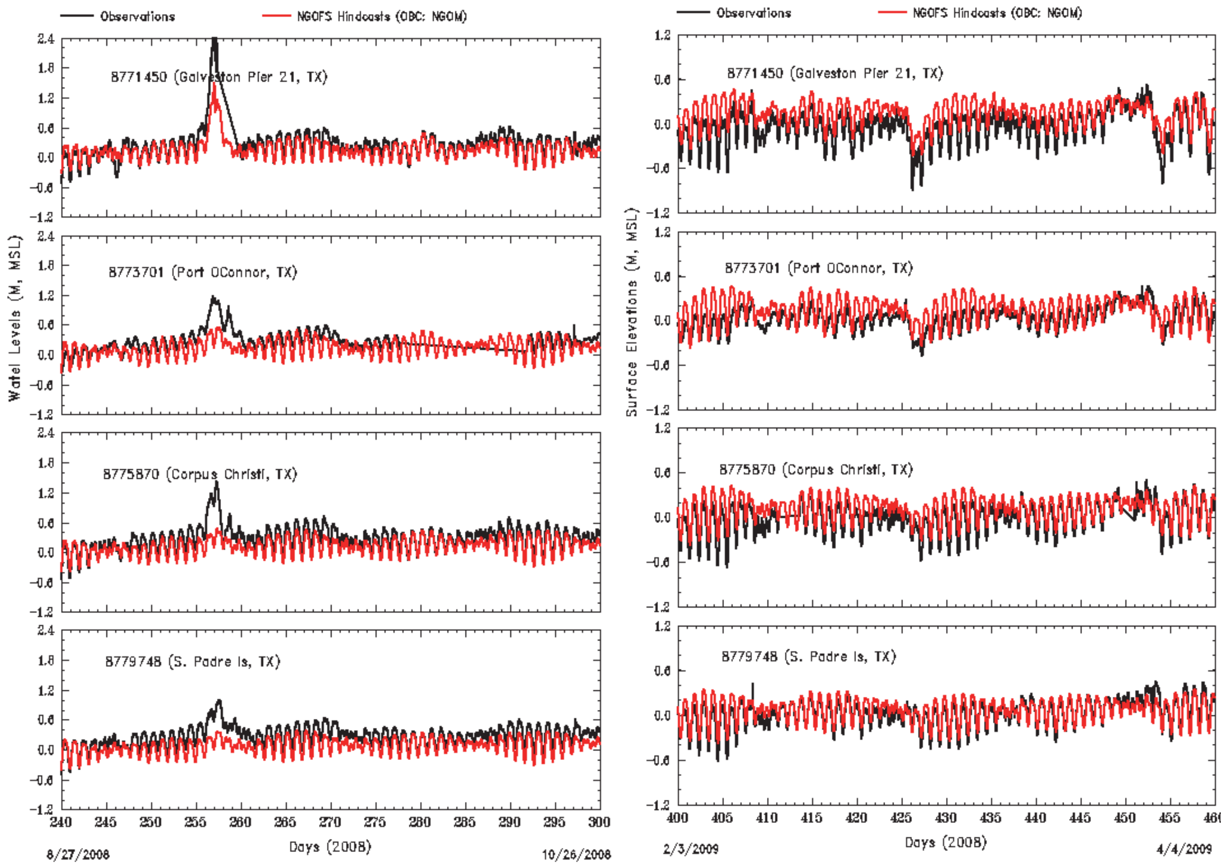


Figure 3.3.3. Detail 60-day hindcast 1 simulated (red) and observed (black) water level time series, from August 27 to October 24, 2008 (left) and from February 3 to April 4, 2009 (right) at Texas coast NOS stations: 8779748, South Padre Island; 8775870, Corpus Christi; 8773701, Port O'Connor; and 8771450, Galveston Pier 21.

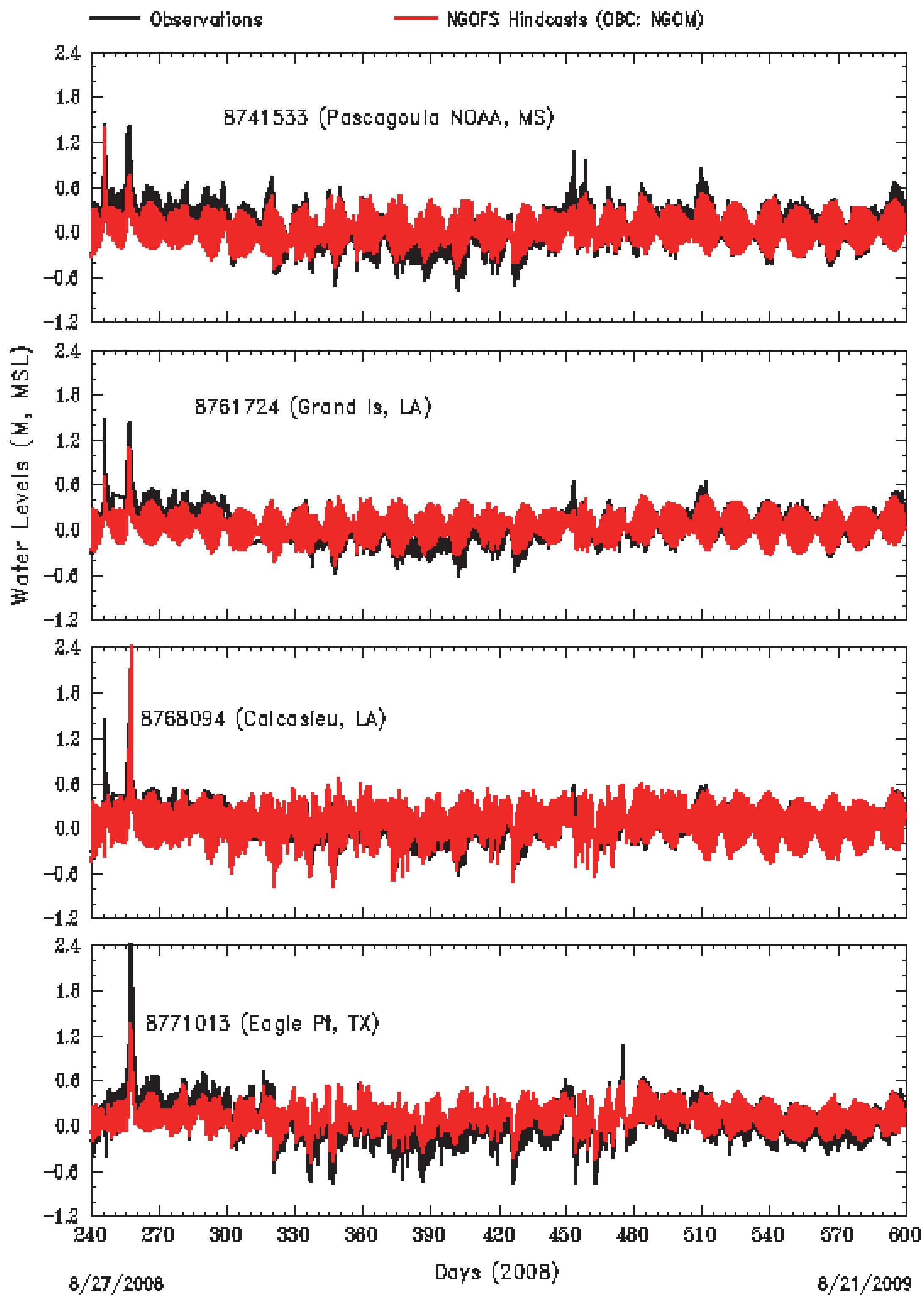


Figure 3.3.4. NGOFS hindcast 1 simulated (red) and observed (black) water level time series at NOS stations: 8771013, Eagle Point, TX; 8768094, Calcasieu, LA; 8761724, Grand Isle, LA; and 8741533, Pascagoula NOAA Lab, MS.

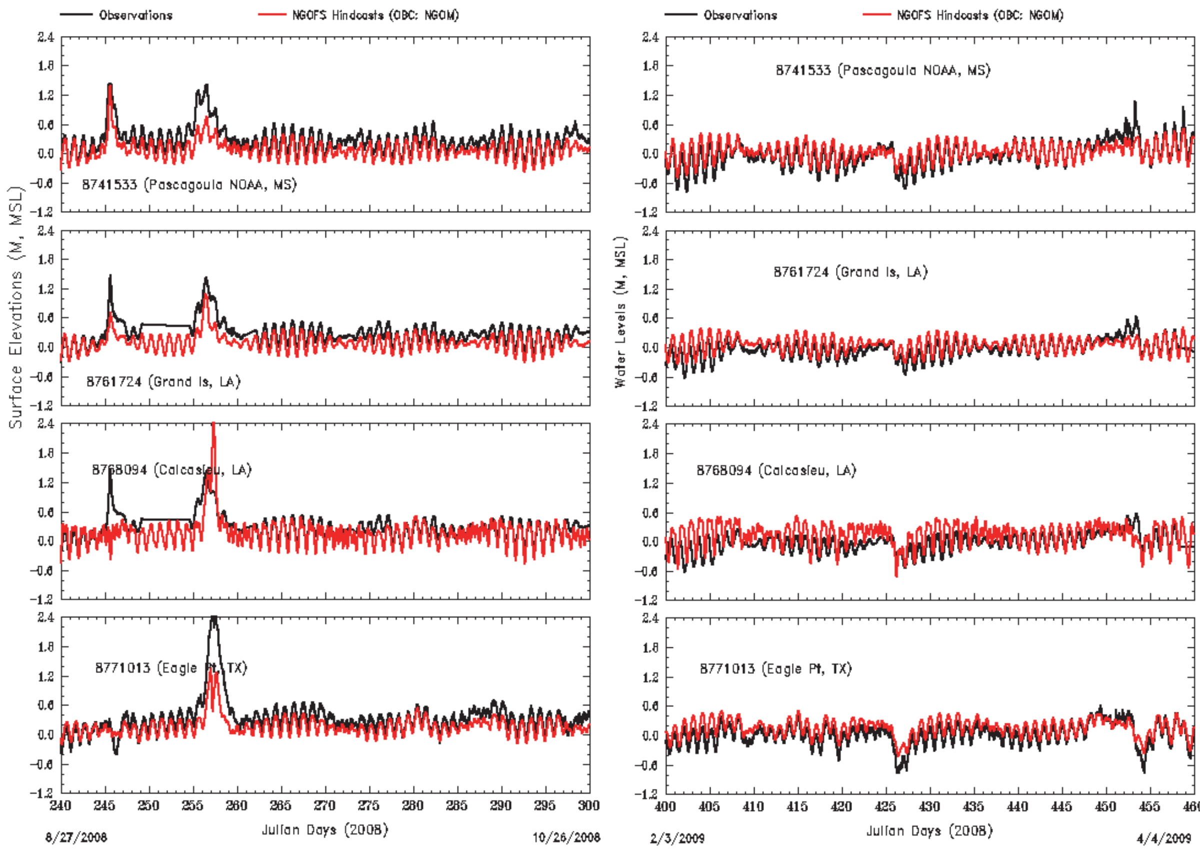


Figure 3.3.5. Detail 60-day hindcast 1 simulated (red) and observed (black) water level time series, from August 27 to October 24, 2008 (left) and from February 3 to April 4, 2009 (right) at NOS stations: 8771013, Eagle Point, TX; 8768094, Calcasieu, LA; 8761724, Grand Isle, LA; and 8741533, Pascagoula NOAA Lab, MS.

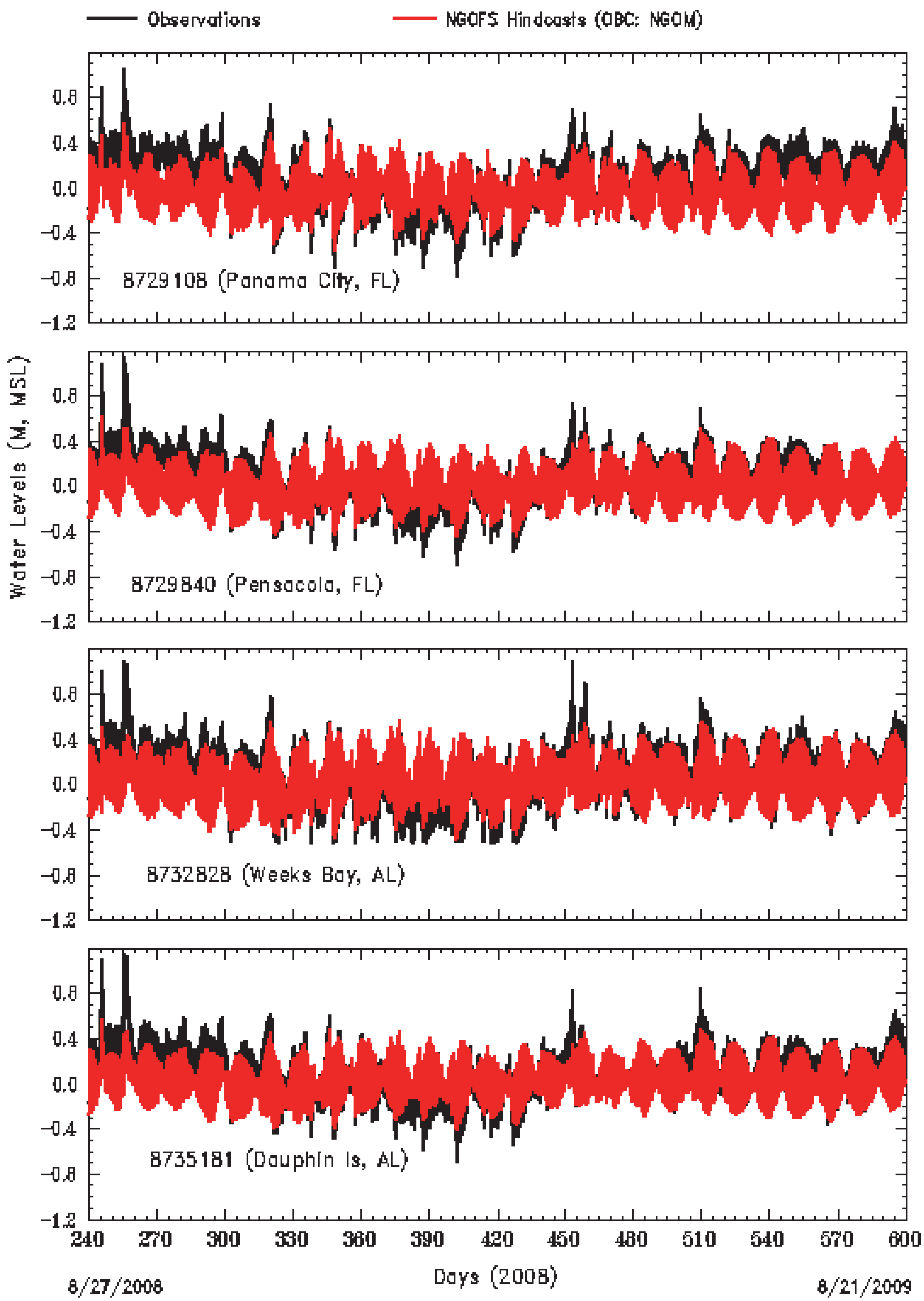


Figure 3.3.6. Hindcast 1 simulated (red) and observed (black) water level time series for NOS stations at: 8735181, Dauphin Is, AL; 8732828, Weeks Bay, AL; 8729840, Pensacola, FL; and 8729108, Panama City, FL.

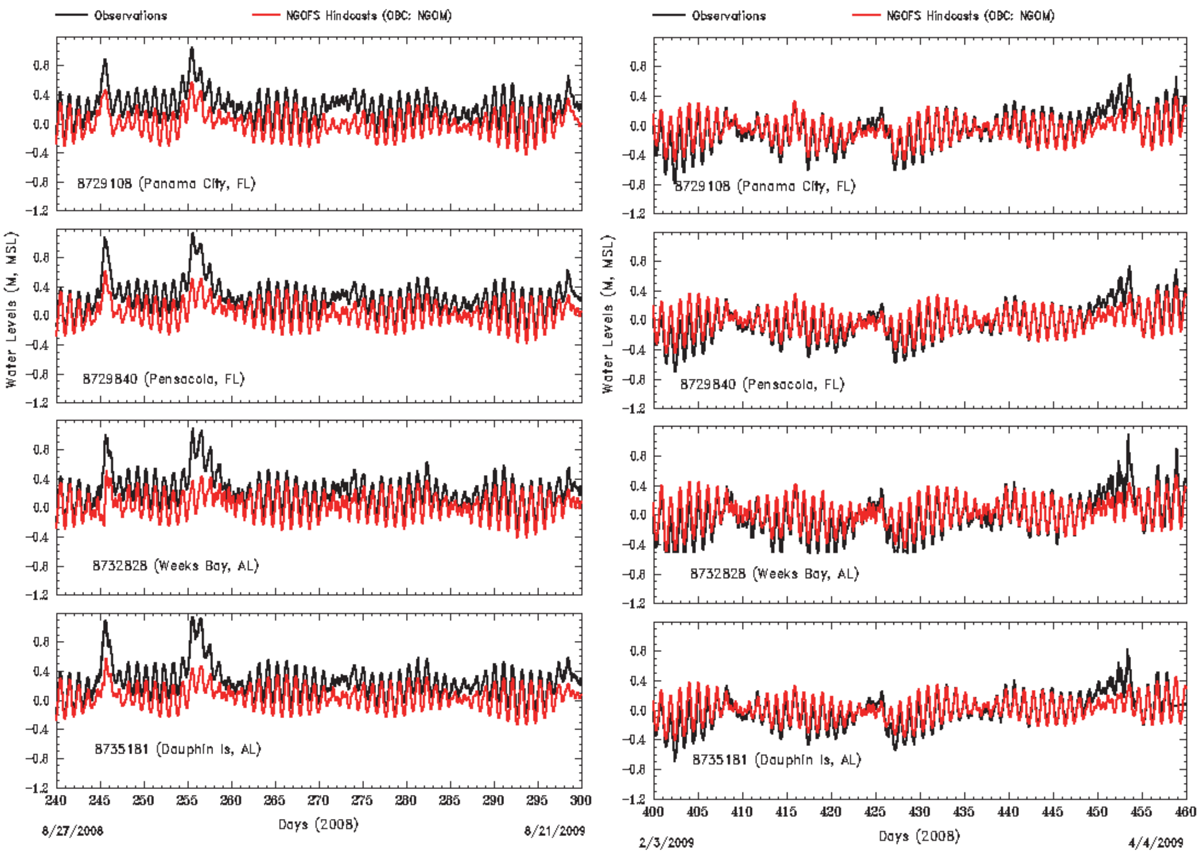


Figure 3.3.7. Detail 60-day hindcast 1 simulated (red) and observed (black) water level time series, from August 27 to October 24, 2008 (left) and from February 3 to April 4, 2009 (right) at NOS stations:: 8735181, Dauphin Is, AL; 8732828, Weeks Bay, AL; 8729840, Pensacola, FL; and 8729108, Panama City, FL.

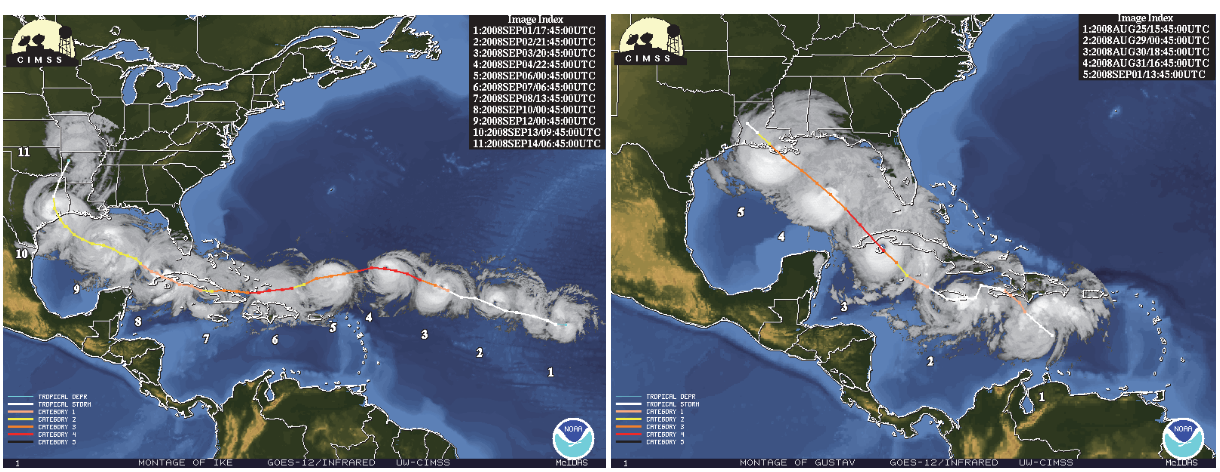


Figure 3.3.8. Tracks of Hurricanes Ike (left) and Gustav (right), September 2008 along with GOES cloud imagery. Courtesy of CIMSS.

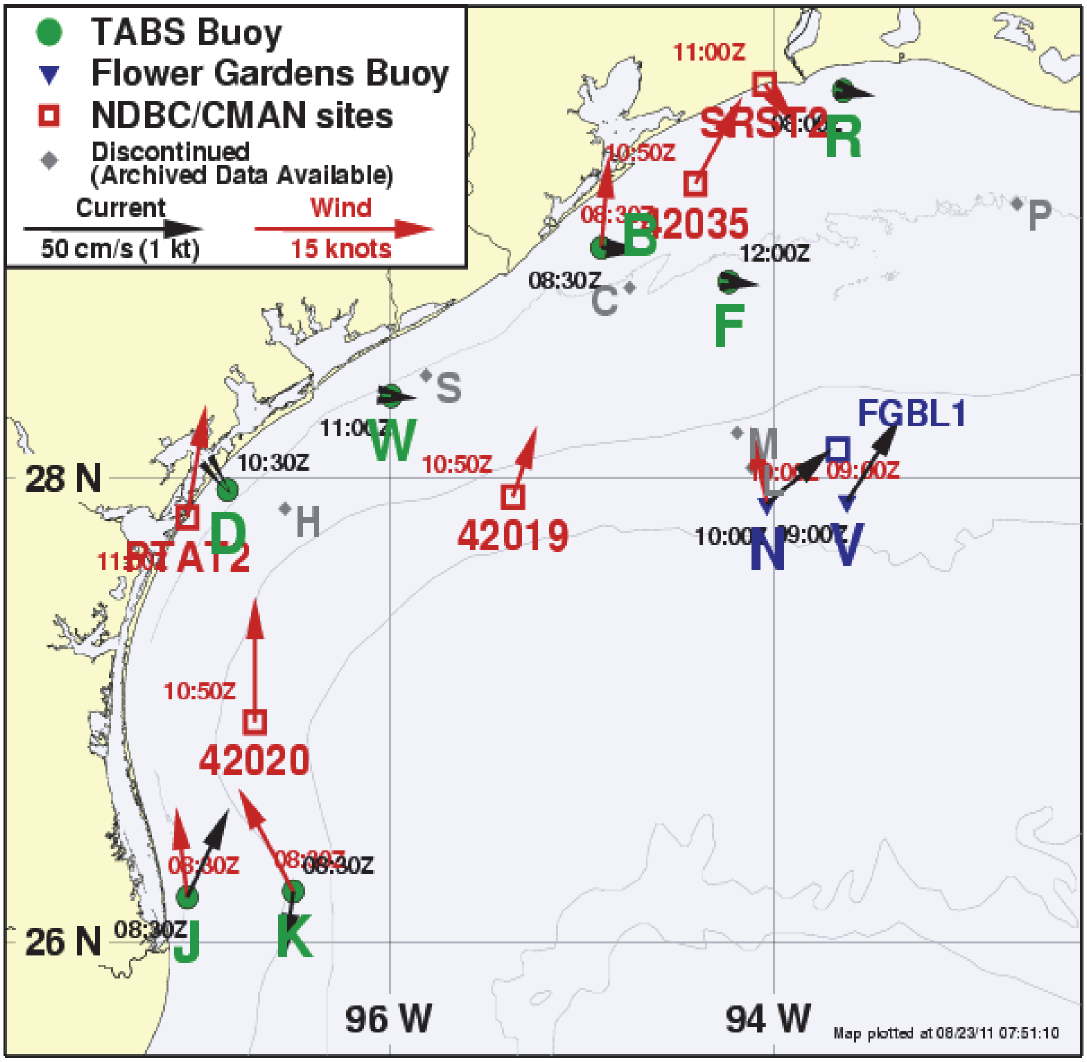


Figure 3.3.9. TABS data buoy locations (http://tabs.gerg.tamu.edu/).

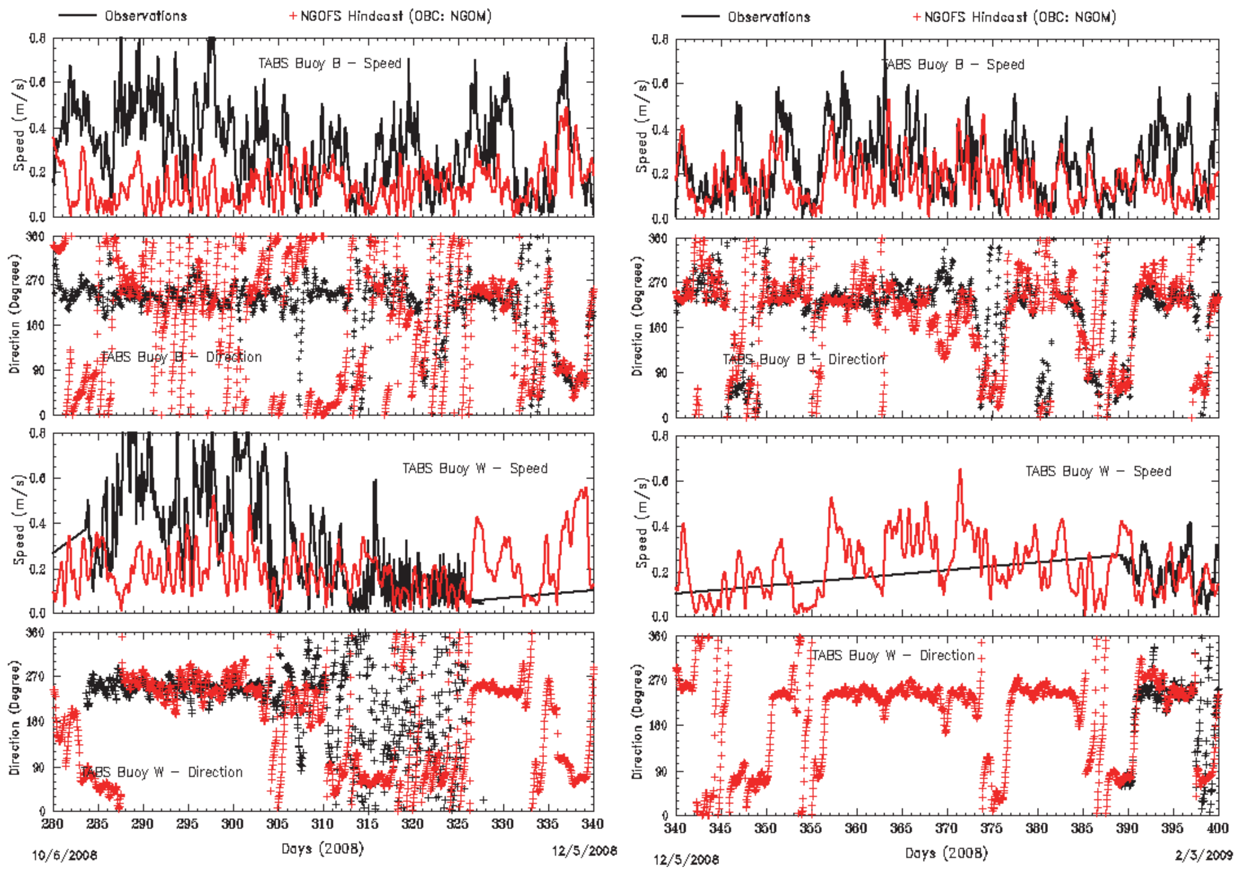


Figure 3.3.10. NGOFS hindcast 1 model simulated current speed (red solid) and direction (red crosses) at TABS Buoys B (top 2 plots) and W (bottom 2 plots) against observed speed (black solid line) and direction (black plus symbol) over two 60-day periods (October 6 2008 to February 3, 2009).

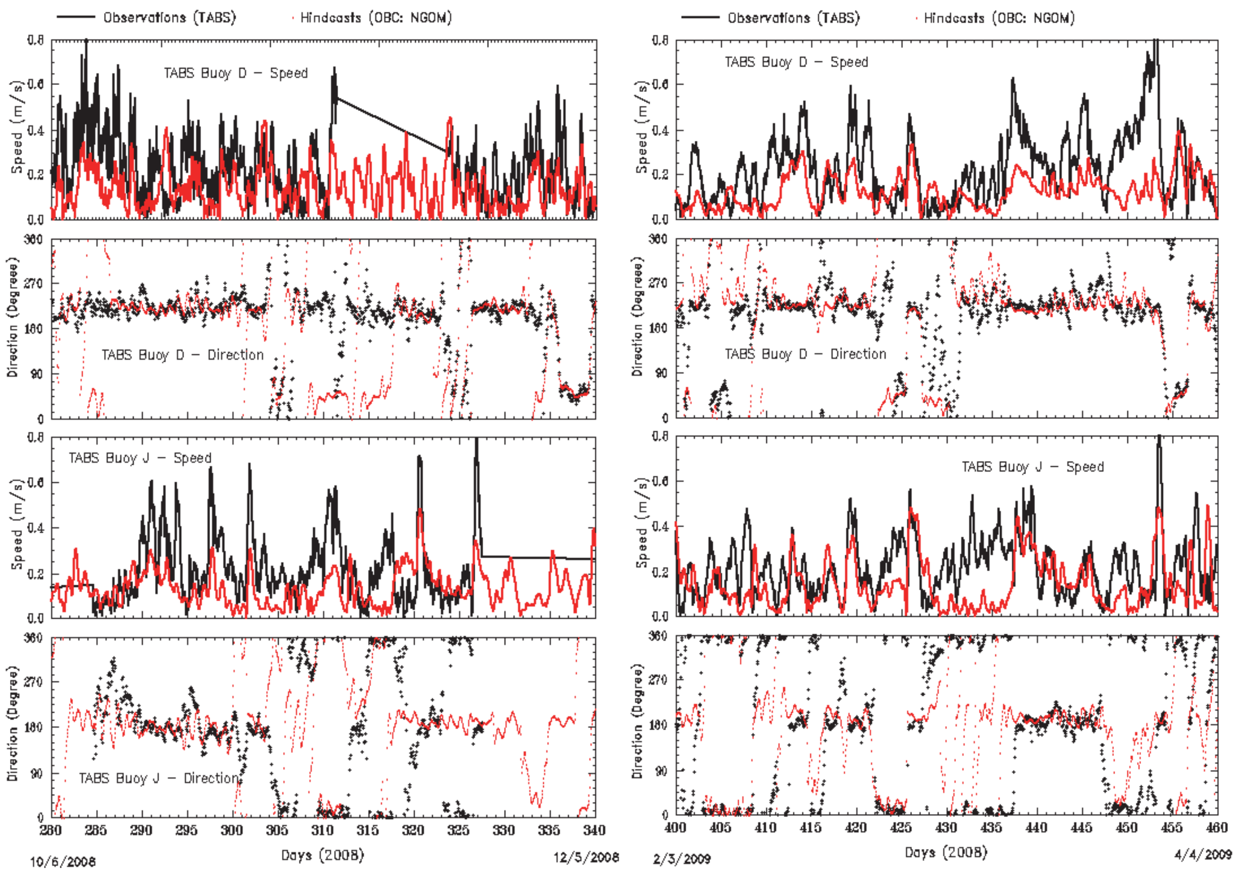


Figure 3.3.11. NGOFS hindcast 1 model simulated current speed (red solid) and direction (red crosses) at TABS Buoys D (top 2 plots) and J (bottom 2 plots) against observed speed (black solid line) and direction (black plus symbol) over two 60-day periods (October 6 to December 3, 2008 and February 3, to April 4, 2009).

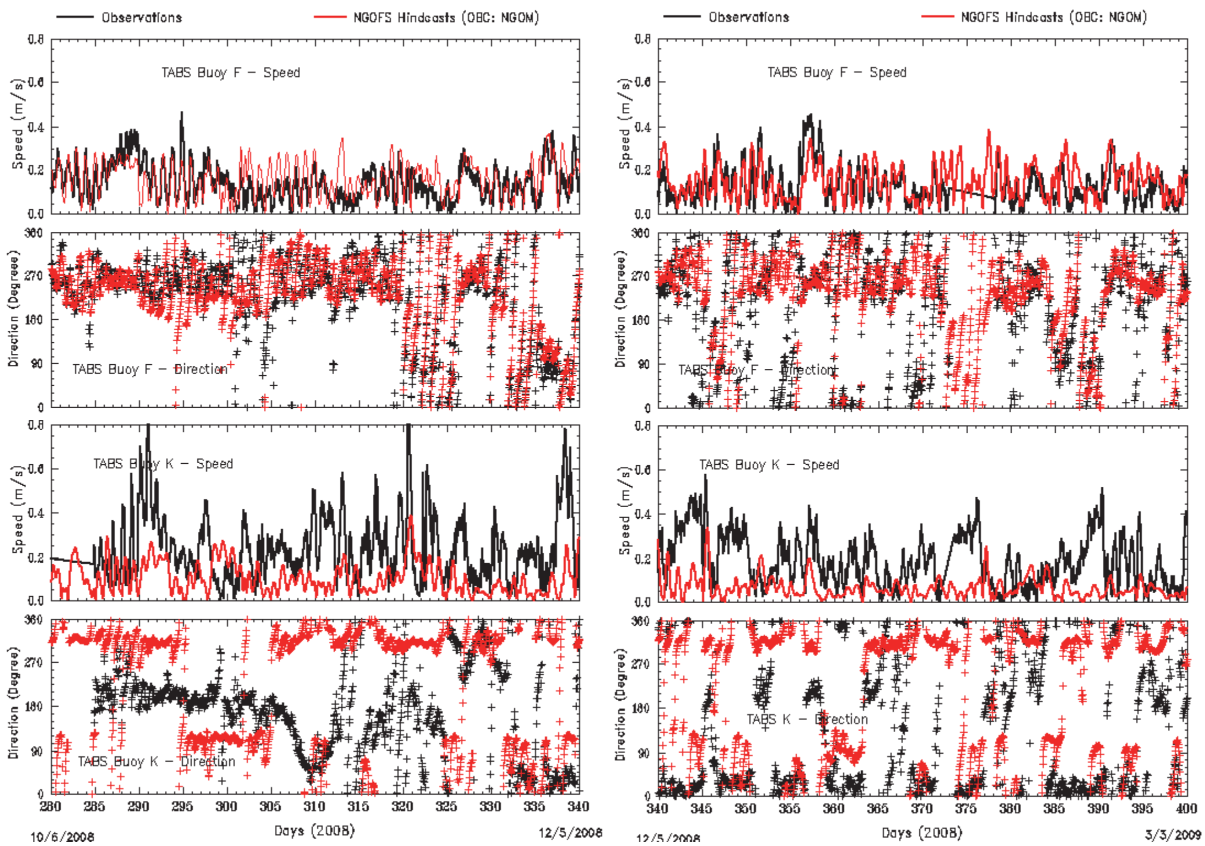


Figure 3.3.12. NGOFS hindcast 1 model simulated current speed (red solid) and direction (red crosses) at TABS Buoys F (top 2 plots) and K (bottom 2 plots) against observed speed (black solid line) and direction (black plus symbol) over two 60-day periods (October 6 to December 5, 2008 and December 5, 2008 to February 3, 2009).

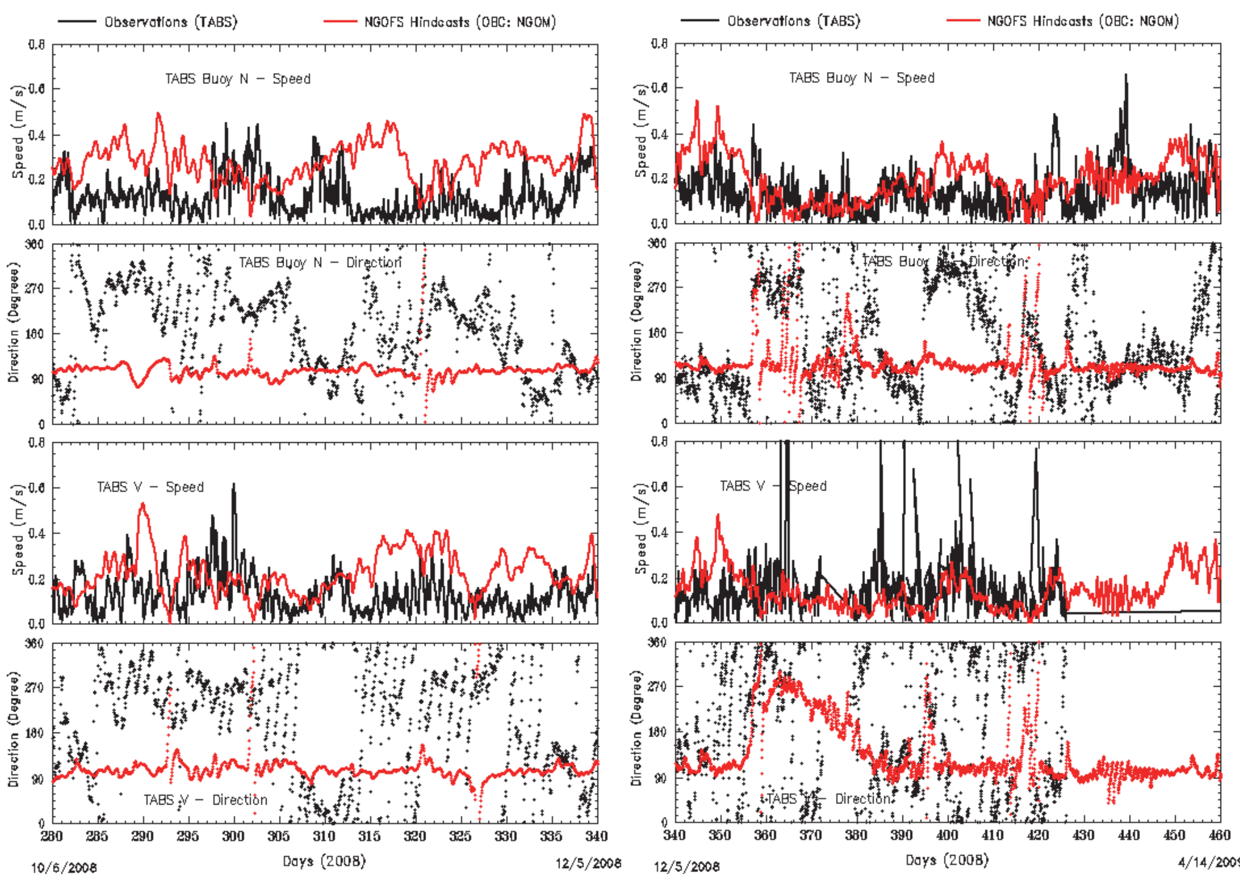


Figure 3.3.13. NGOFS hindcast 1 model simulated current speed (red solid) and direction (red circle) at TABS Buoys N (top 2 plots) and V (bottom 2 plots) against observed speed (black solid line) and direction (black plus symbol) over two 60-day periods (October 6 to December 5, 2008 and December 5, 2008 to February 3, 2009).

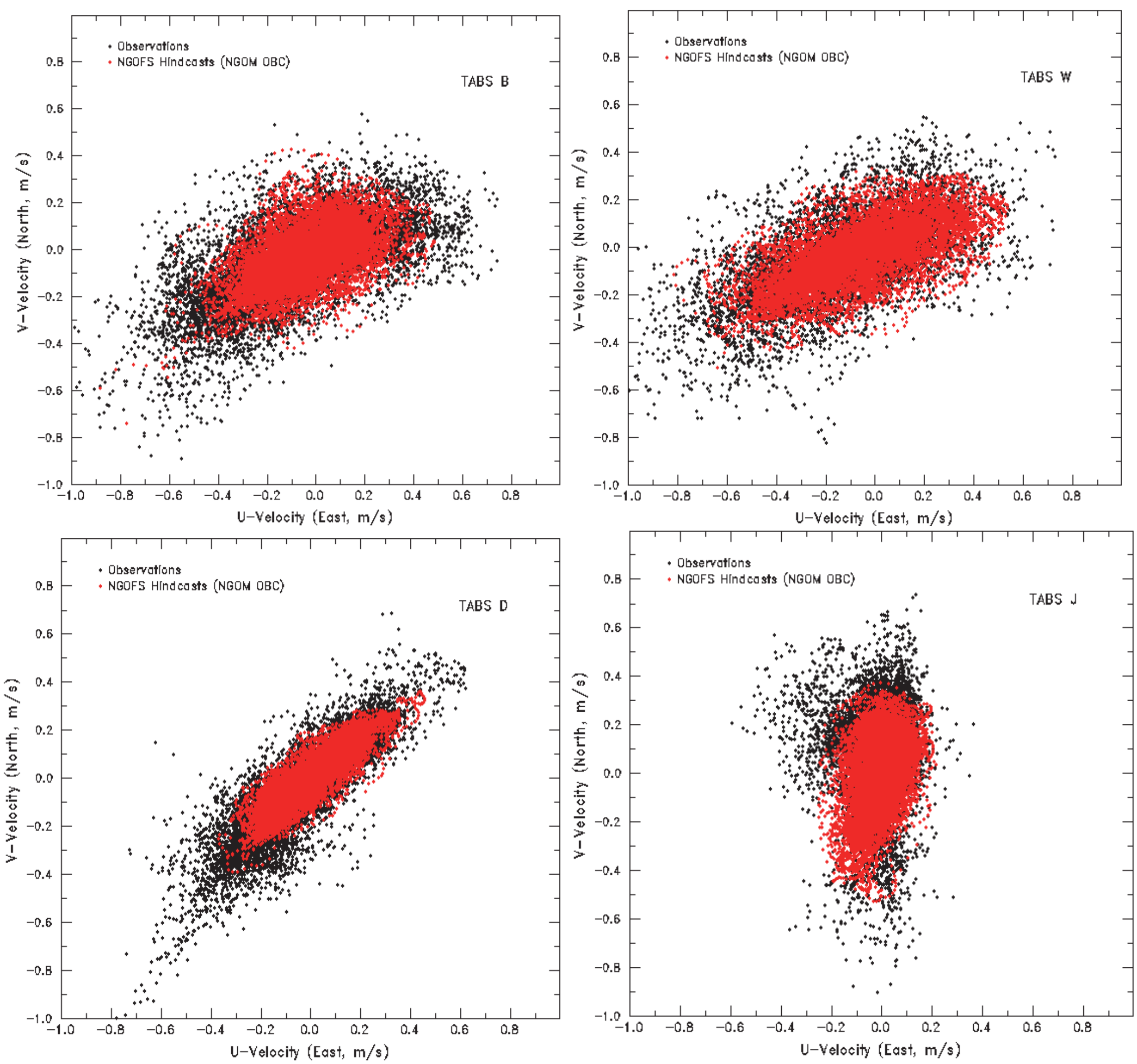


Figure 3.3.14(a). NGOFS hindcast 1 simulated and observed velocity scatter plots for TABS B, D, W, and J.

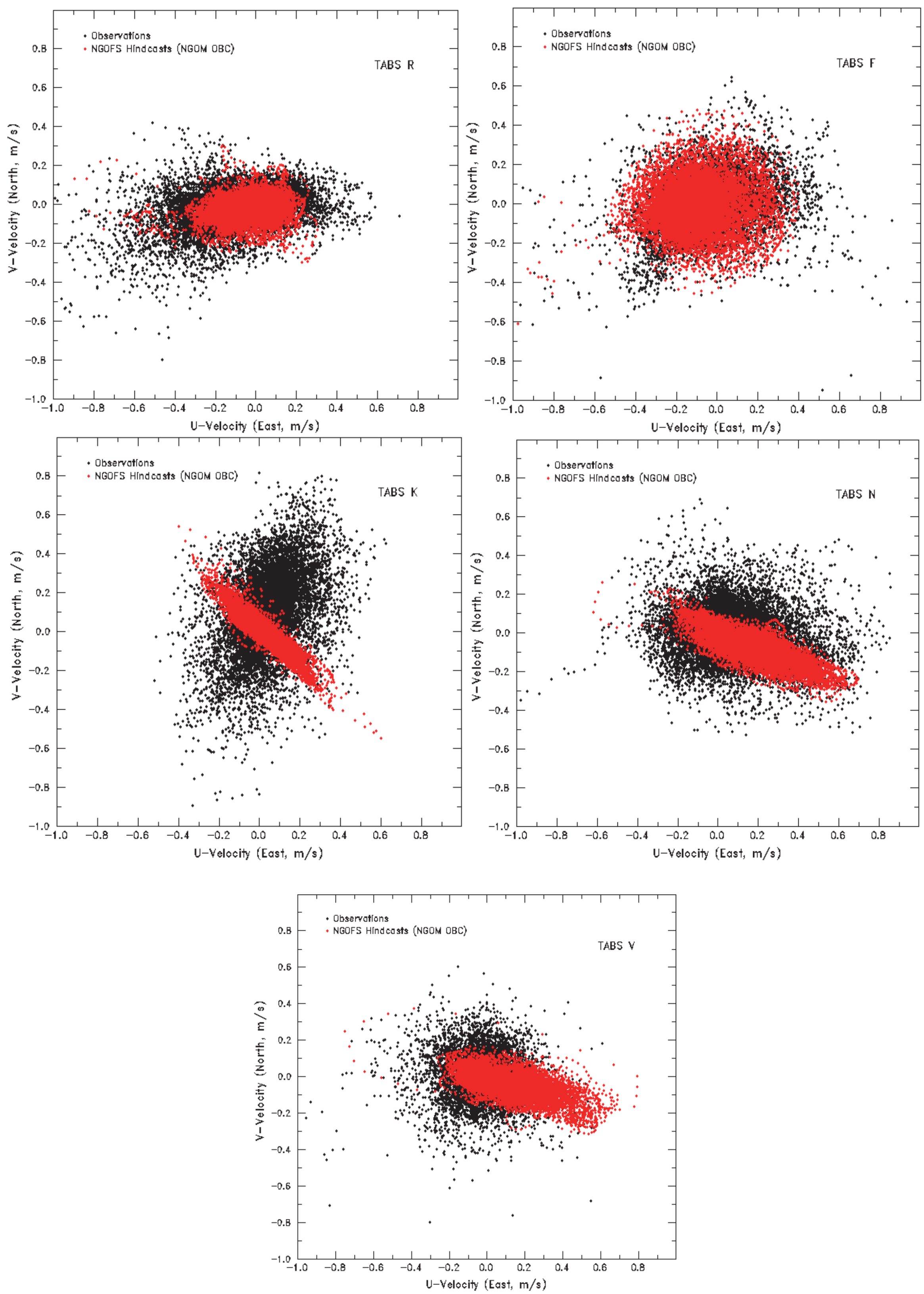
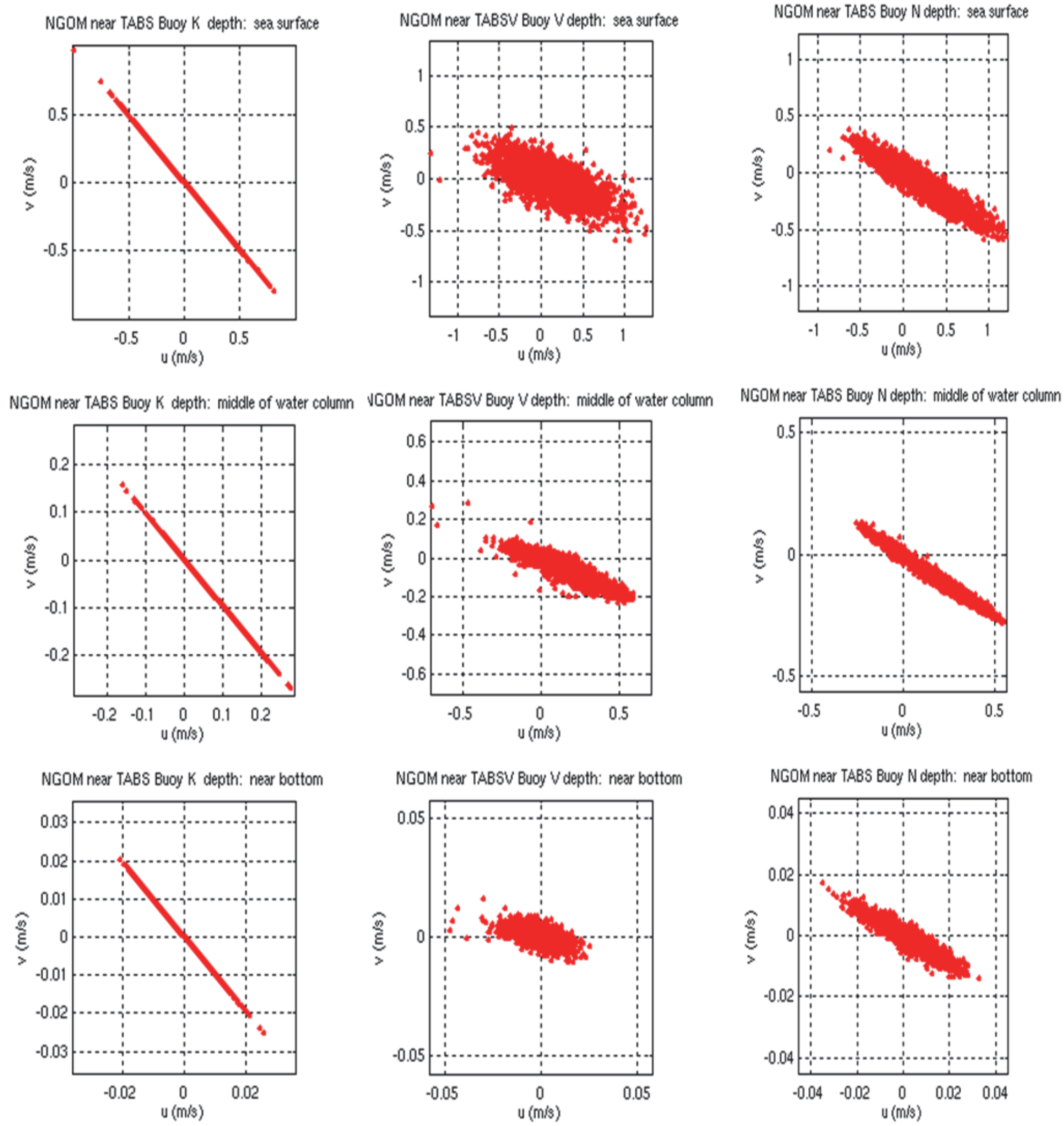


Figure 3.3.14(b). NGOFS hindcast 1simulated and observed velocity scatter plots for TABS R, F, K, N and V.



(a) (b) (c)

Figure 3.3.15. NGOM current velocity at 3 depths near TABS Buoys K (a), V (b), and K (c).

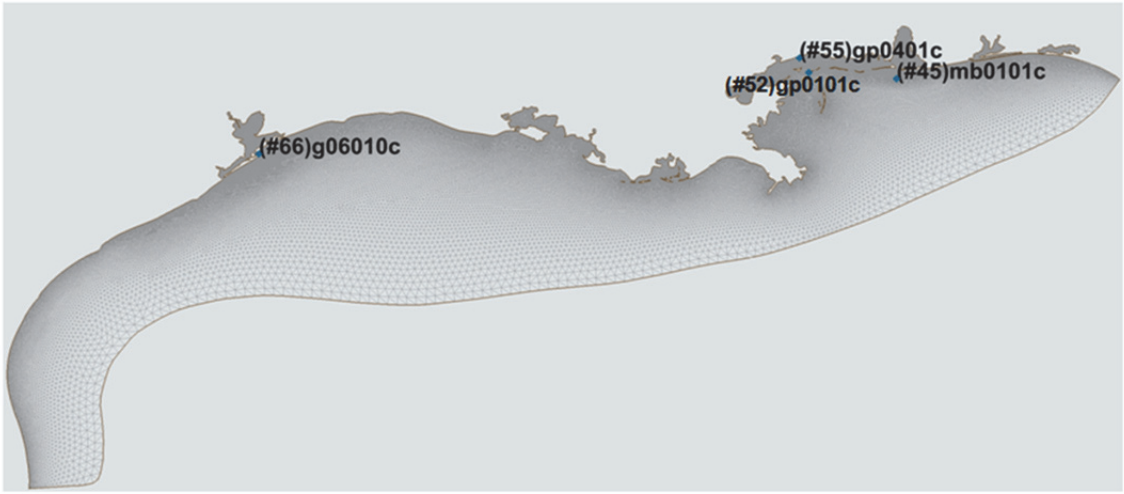


Figure 3.3.16. Maps depicting locations of NOS current meters with water temperature sensor (with station IDs) for NGOFS hindcast along with the NGOFS grid.

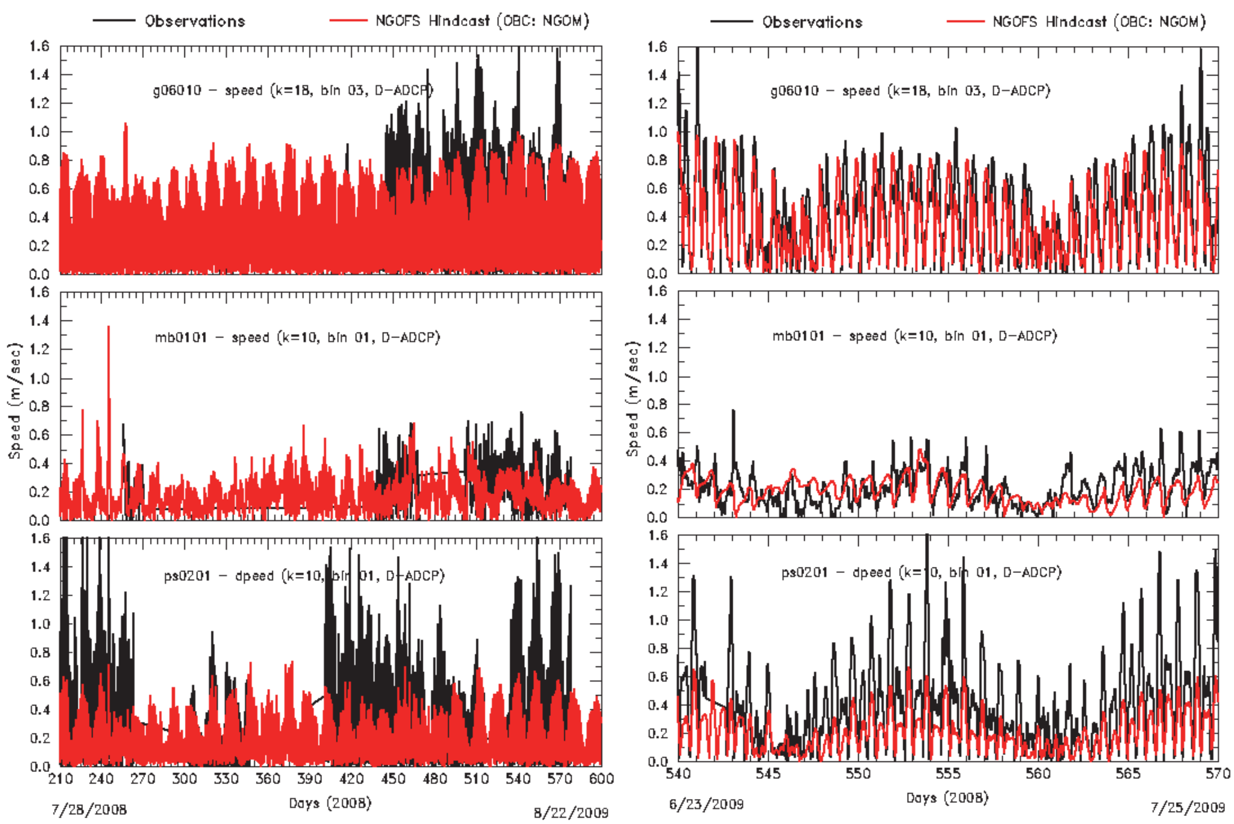


Figure 3.3.17. NGOFS simulated current speed time series from July 28, 2008 to August 22, 2009 at NOS PORTS stations at g06010 (Galveston Bay), mb0101 (Mobile Bay), and ps0201 (Pascagoula).

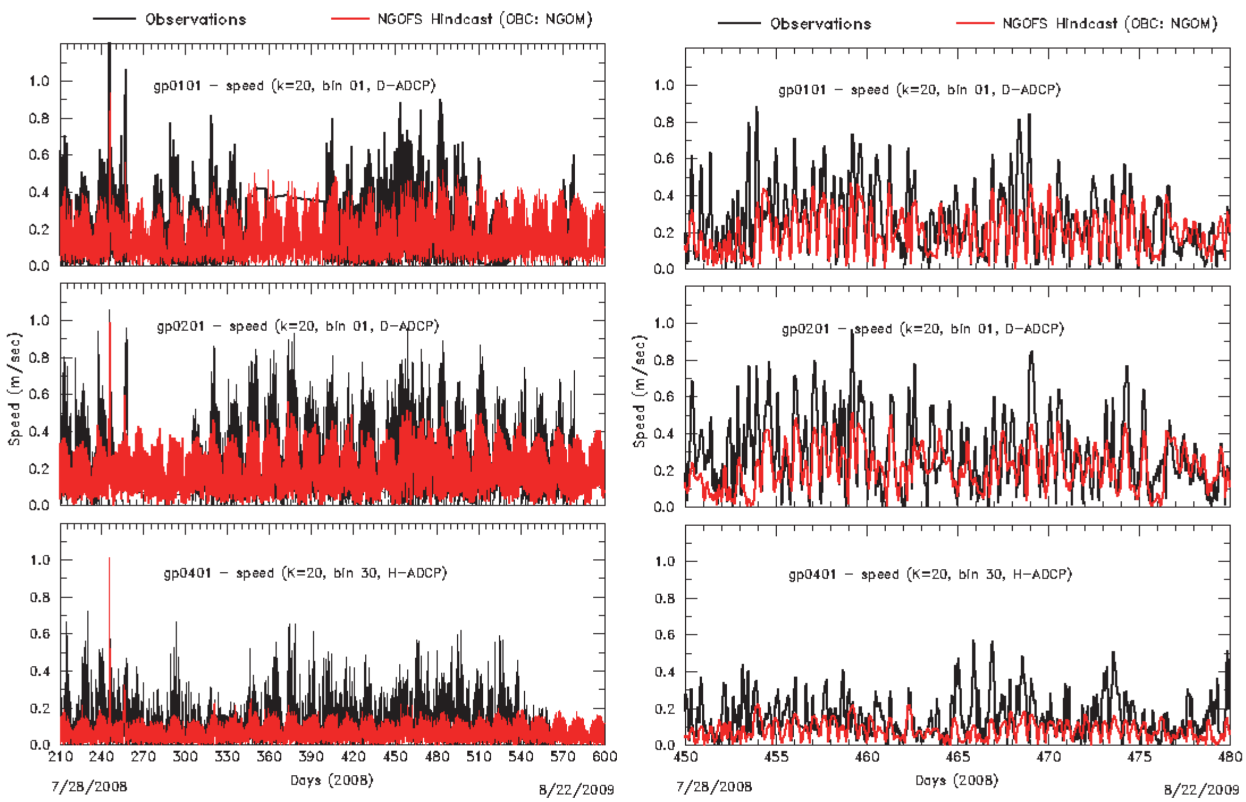


Figure 3.3.18. NGOFS simulated current speed time series from July 28, 2008 to August 22, 2009 at NOS Gulfport PORTS stations at gp0101, gp0201, and gp0401.

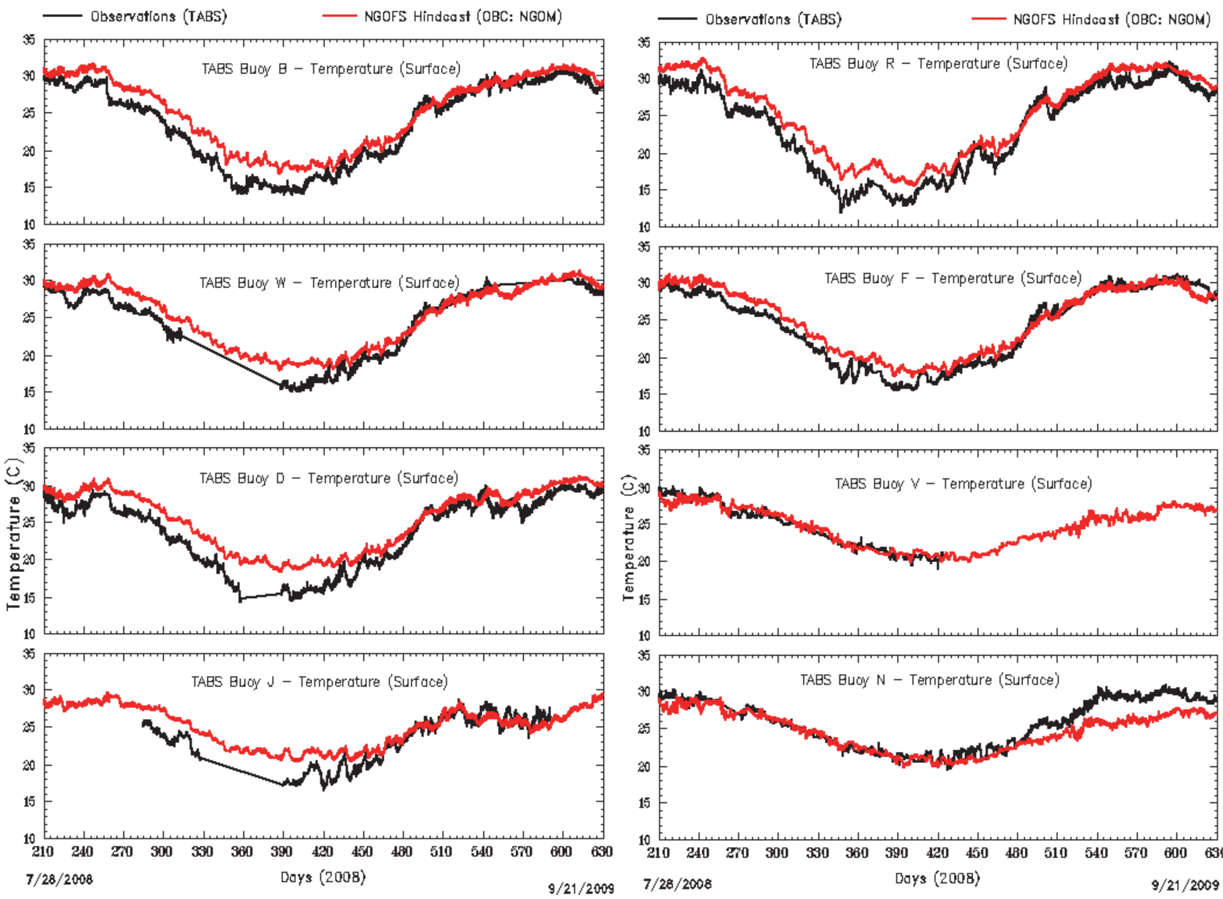


Figure 3.3.19. NGOFS model simulated surface temperature (red) at TABS buoys against observations (black) for TABS Buoys B,W,D,J (left) and R,F,V,N (right). See Figure 3.3.9 for TABS buoy locations.

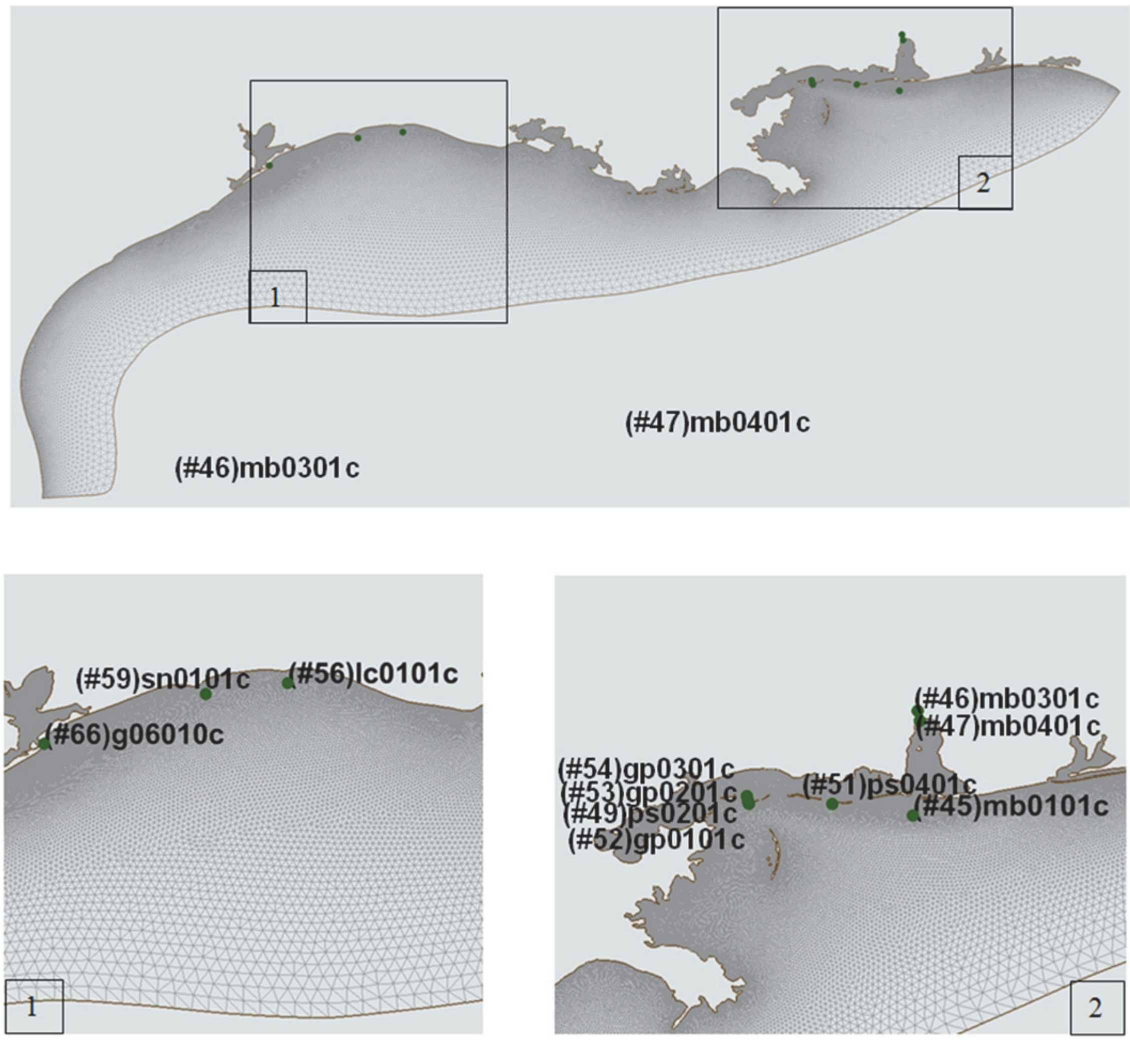


Figure 3.3.20. Maps depicting locations of NOS current meters with water temperature sensor (with station IDs) for NGOFS hindcast along with the NGOFS grid.

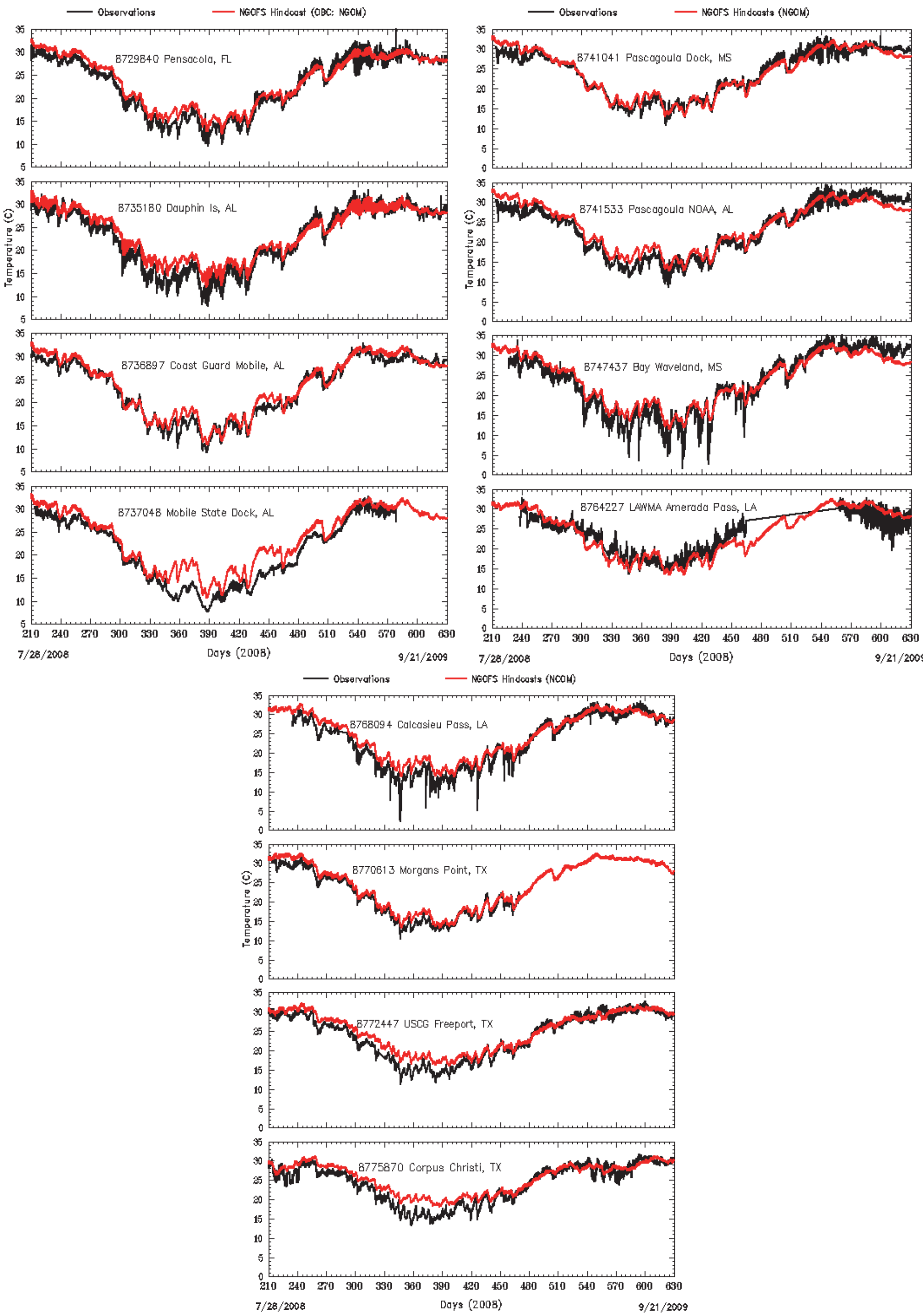


Figure 3.3.21. NGOFS hindcast 1 model simulated surface temperature (red) with observations (black) at NOS NWLON gages (see Figure 3.3.20 for locations).

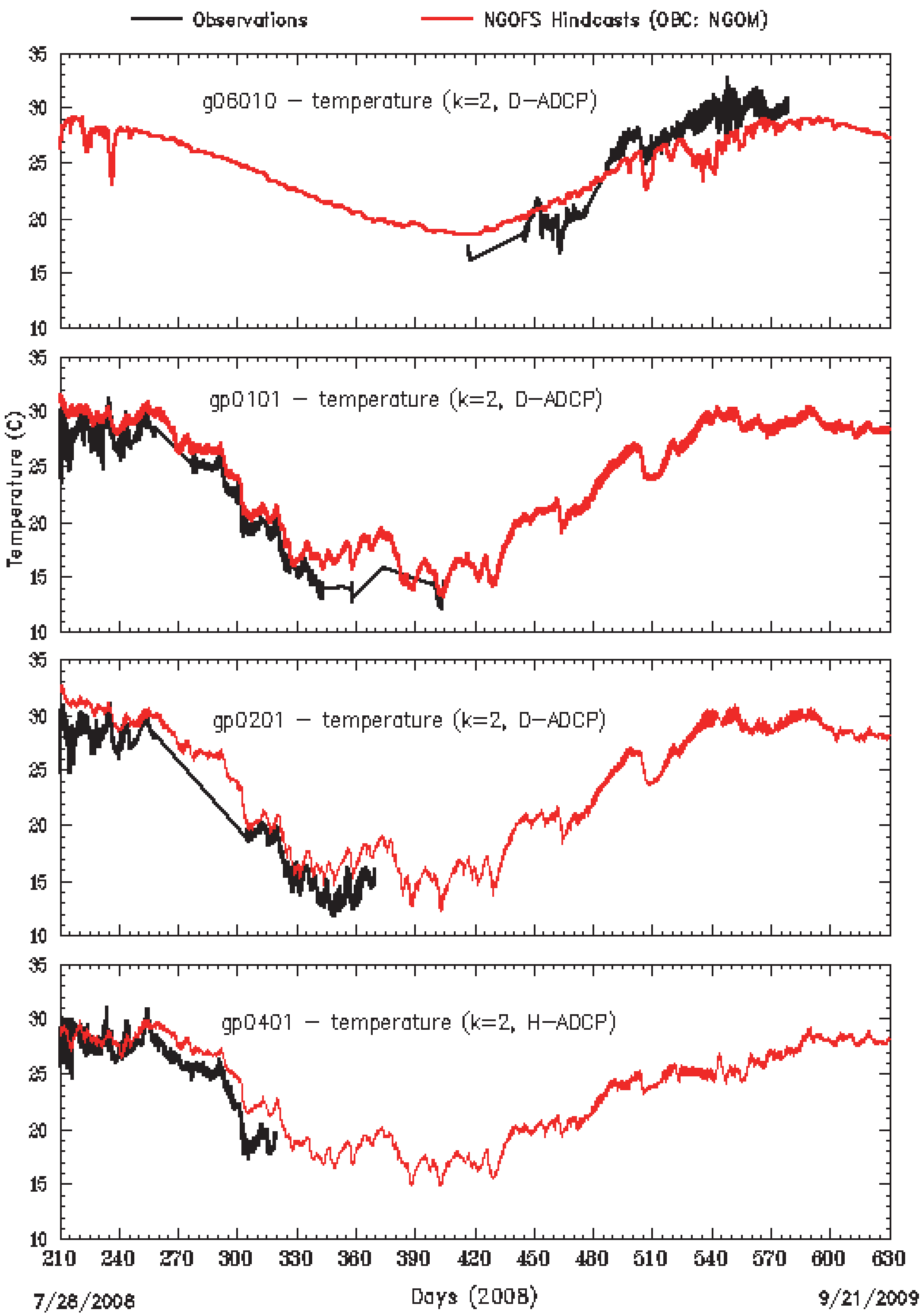


Figure 3.3.22. NGOFS hindcast 1 model simulated surface temperature (red) with observations (black) at NOS inland and bay locations in the NCOP program; g06010, gp0101, gp0201, and gp0401.

3.4. Hindcast 2 Model-Data Comparison

The NGOFS model hindcast 2 was carried out by forcing the model at the open ocean boundary with the Navy's global NCOM (Navy Coastal Ocean Model) forecasts including the sub-tidal water levels and currents (added to tide and tidal predictions based on the tidal simulation described in Section 3.1), and the salinity and temperature through the boundary water column. The model surface for this hindcast is forced with wind velocity, air pressure, and heat flux from NOAA's NAM model forecasts. River discharge and temperature taken from the USGS enter the model grid at the river mouth to the ocean or bay/estuary.

Model hindcast 2 covers the period from September 14, 2010, to March 31, 2011. Observations of water levels, currents, salinity and temperature within the NGOFS model grid during the period of hindcast 2 are collected and processed for model-data comparison. Data sources include government agencies (NOS, NBDC, USGS, and IOOS) and academic research institutions (TABS, DISL, LUMCUM, and LSU). During this period, the NOS MBCS conducted an extensive hydrographic survey in Mobile Bay AL, including measurement of water levels, currents, and CTD profiles (Patachen et al., 2012).

This section describes the model-data comparison for this hindcast period in the order of water levels, currents, temperature and salinity, followed by the model-data comparison using data from MBCS.

Water Levels

Time series of simulated water levels over part of this hindcast period are plotted against the observations at 12 representative stations (see Figure 3.3.1 location map) as shown in Figures 3.4.1, 3.4.3, and 3.4.5. To further examine comparisons in greater detail between the simulated and observed water levels, the plot time scale is reduced to 30 days for a plot as shown in Figures 3.4.2, 3.4.4, and 3.4.6.

Examining the 30-day water level detail time series plots, Figures 3.4.2, 3.4.4, and 3.4.6, the model simulates very well not only the tidal neap-spring tide modulation but also the diurnal tide amplitude and phase for all the stations. The model predicts the high surge event around Day 370 (January 5, 2011) for all the stations, however, misses the low surge events around Day 347 (December 13, 2010) and Day 362 (December 28, 2010) for the stations in the western part of the NGOFS domain from Texas to Mississippi (Figures 3.4.2 and 3.4.4) but not for the stations in the eastern part in Alabama and Florida (Figure 3.4.6).

Currents

(A) TABS

Model simulated current speeds and direction at the corresponding TABS depth for NGOFS hindcast 2 are plotted against the observations as shown as Figures 3.4.7 and 3.4.8 for the period from October 10, 2010 to February 4, 2011. Buoys B, W, D, and J (Figure 3.4.7) are deployed near-shore from the northeast to the southwest. The average depth in the area is about 20 m with current speeds in the range of 15 cm s^{-1} to 45 cm s^{-1}. Although model simulated current speeds basically follow the observation trends, the amplitudes are in general smaller than the observations. Figure 3.4.8 shows the model simulated and observed current speed and directions for buoys F, K, N, and V. Direction time series show the currents at TABS buoys are circular. Current speeds from the NCOM forecasts at TABS locations are also plotted. In general, the NGOFS model simulated currents (red) are closer to the observations than the NCOM forecasts (blue).

Model simulated velocity in U- and V- directions are further compared against TABS buoy observations in velocity scatter plots. Figure 3.4.9 shows the UV scatter plots for TABS B, W, D, and J. A relative defined current axis is apparent along the coastline. The model seems to follow the topographic long-current as observations. Figure 3.4.10 shows the scatter plots for more offshore stations R, F, K, and N. The current roughly follows the isobaths for Buoy TABS K. Unlike hindcast 1 (section 3.3 Figure 3.3.14(b)), the model simulated currents at TABS R, F, and N are all in circular shape and match the observations.

(B) NOS NCOP

Model simulated current speed time series from hindcast 2 are plotted with observations as shown in Figure 3.4.11 for station g06010 Galveston Bay, gp0101, gp0401 (Gulfport), and mb0101 (Mobile Bay) (see Figure 3.3.16 for station locations). The model simulated current speeds follow the observed signal very well in both amplitude and phase. Several inland current meters are located either beyond the current model grid domain or at locations where the model grid resolution is too coarse to accurately simulate the currents and are not shown in the report. In order to simulate the currents at such inland locations, a finer grid is needed. Future plans in the NOS operational forecast system development include nested model grids for six NOS PORTS; Mobile Bay, Pascagoula, Gulfport, Lake Charles, Sabine Neches, and Galveston Bay.

Temperature and Salinity

In addition to observations collected listed for hindcast 1 (Section 3.3), observed temperature data from the IOOS database include NDBC data buoys, LUMCOM (Louisiana Universities Marine Consortium), and the Dauphin Island Sea Lab for the second hindcast verification (http://www.ndbc.noaa.gov/maps/WestGulf.shtml). These station names are listed in Table 3.5. However, useful salinity data are only available at the five TABS stations (B, J, K, N, and V).

(A) TABS

Figure 3.2.12 shows model simulated surface temperature time series against observations at TABS Buoys B, W, D, J, R, F, V, and N. The NCOM temperature forecasts at these stations are also plotted. The NCOM temperature forecasts follow the observations better than the NGOFS in October and November 2010, but in December NGOFS and NCOM agree with each other. The temperature forecasts from both models are higher relative to the observations. The temperature time series are very similar for both NCOM and NGOFS.

Figure 3.4.13 shows model simulated surface salinity time series against observations at TABS Buoys B, K, V, and N. Note locations of Buoys K, V, and N are at boundary forcing nodes. Some observed data with rapid changes are questionable.

(B) NWLON

NGOFS hindcast 2 simulated temperature at coast and bay NOS NWLON stations are plotted against the observations and shown in Figures 3.4.14 to 3.4.16. The model simulated temperature matches very well until mid-February 2011 despite the model coarse grid. One exception is at the Mississippi River southwest pass where the model temperature is considerably higher than the observations (8760922, Pilot Station E, LA).

(C) NOS NCOP

For temperature sensors attached to NOS ADCP current meters (NCOP), the observation depths at the measure gage location (Figure 3.3.16) is used to identify the corresponding model vertical layer. Figures 3.3.17 and 3.3.18 show the simulated temperature comparisons with NOS ADCP measurements. Although Sabine Lake is not included in the NGOFS model grid, the model simulated temperature still matches well with observations at the entrance to the navigation channel (sn0101, Figure 3.4.18), indicating the NGOFS model simulates the temperature field well on the shelf.

(D) IOOS

The IOOS data base contains many temperature and salinity measurements in the northern Gulf of Mexico area from government agencies (NOAA/NDBC) and the academic research institution (Texas A&M –TABS, LUMCOM, and DIIL). The locations are shown as Figure 3.4.19. Surface temperature measurements during the NGOFS hindcast 2 are plotted with simulated surface temperature shown in Figure 3.4.30. The trend of the observed temperature time series for winter of 2010-2011 is followed well by the model. The model is able to capture most of temperature events.

Table 3.5. IOOS station name list for NGOFS hindcast 2

No	Longitude	Latitude	Node	Depth (m)	Station Name
75	-95.35333	27.91333	391	78.90	'42019_B LLNR 1205, TX '
76	-96.69500	26.96667	1048	88.10	'42020_B LLNR 1330, TX '
77	-97.05000	27.82833	24150	0.00	'PTAT2_C Port Aransas, TX '
78	-94.41333	29.23167	31607	0.00	'42035_B LLNR 1145, TX '
79	-92.06100	29.44000	47657	0.00	'MRSL1_T Marsh Is, LA '
80	-90.53333	29.05333	31944	0.00	'ILDL1_T Is Dernier, LA '
81	-90.48333	28.86667	12200	0.00	'SPLL1_T S. Timbalier,LA '
82	-90.66333	29.25333	52164	0.00	'LUML1_T Marine Cent, LA '
83	-90.58334	29.16667	46035	0.00	'TRBL1_T Terrebonn B, LA '
84	-89.42834	28.90500	9816	0.00	'BURL1_C SW Pass, LA '
85	-88.64833	30.04333	47103	0.00	'42067_B USM3M02, MS '
86	-88.20834	29.21333	2513	164.60	'42040_B Lake Offsh, AL '
87	-88.01167	30.43667	80307	0.00	'MBLA1_C Mid-Mob Bay, AL '
88	-88.01167	30.66667	86509	0.00	'MHPA1_C Meaher Park, AL '

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89   -88.14000    30.30833   66713   0.00  'CRTA1_C Ceder Pt,    AL     '
90   -88.21333    30.25833   66159   0.00  'KATA1_C Katrina Cut, AL     '
91   -88.07833    30.25167   54942   0.00  'DPHA1_C Dauphin Is,  AL     '
92   -87.82833    30.32833   77435   0.00  'BSCA1_W Bon Secour,  AL     '
93   -87.55500    30.06500   18321  25.90  '42012_B Orange Beach,AL     '
```

Mobile Bay Survey Project

Three offices in NOS, including the Office of Coast Survey (OCS), the Center for Operational Oceanographic Products and Services (CO-OPS), and the National Geodetic Survey (NGS), conducted the Mobile Bay Collaborative Survey from November 2010 to February 2011 (Patchen, et al, 2012). The Mobile Bay hydrographic project includes: a bathymetric survey of Weeks Bay, two temporal water level gage installations, four ADCP current meter deployments, and AUV (Autonomous Underwater Vehicle) deployment for salinity and temperature, and CTD profile measurements along the main navigation channel. The station locations are added to the model station output list as shown as Table 3.6 and Figure 3.4.21.

Simulated water levels and currents at the Mobile Bay project locations are compared with data collected during the survey period in Figures 3.4.22 (for water levels) and 3.4.23 (for currents at mid-depth acoustic bin).

The model hindcast water level performance at stations from the Mobile Bay Survey project are similar to other NOS NWLON stations in Mobile Bay. The model missed low surge events at Weeks Bay (8732828) as shown in Figure 3.4.6 (3rd panel from the top). The model accurately simulated currents amplitude and phase for stations MOB1101 and MOB1104 (Figure 3.4.23). However, the simulated speeds are weaker than the observations at stations MOB1105 and MOB1106 probably due to inaccurate model depth with coarse grid resolution.

The ADCPs deployed during the Mobile Bay project were also mounted with temperature sensors at the instrument head. Temperature observations during the ADCP deployment are plotted against model simulated temperature at the corresponding water depth shown in Figure 3.4.24. For temperature at the Bay entrance MOB1101, the high frequency signals are not reproduced by the model. MOB1101 is a downward looking ADCP mounted on a buoy. The temperature sensor is about 0.9 m below the water surface. The model not only misses the high frequency signals but it also over-predicts temperature. Examining the current and temperature time series at this station (Figure 3.4.25), the model temperature discrepancy seems due to the coarse grid resolution in the Mobile Bay and the river forcing specification. The nested sub-domain models may improve the model temperatures in this area.

Table 3.6. Mobile Bay Survey station name list for NGOFS hindcast 2

No	Longitude	Latitude	Node	Depth (m)	Station Name
94	-87.93333	30.48667	82259	2.00	'8733821 Pt Clear, MB,AL '
95	-87.93500	30.66667	87179	2.00	'8733839 Meaher, MB, AL '
96	-88.03500	30.22667	54120	13.70	'mob1101 MB Point, MB,AL '
97	-88.37000	30.22167	48930	4.30	'mob1104 En MS Snd, W,AL '
98	-88.54000	30.22500	56579	4.10	'mob1105 En MS Snd, E,AL '
99	-88.09834	30.29500	62261	3.70	'mob1106 Dauphin Cusw,AL '
100	-93.66833	28.11833	854	101.31	'FGBL1_T High Is 334, TX '
101	-88.46333	30.35667	65555	2.00	'GDQM6_T Grand Bay, MS '
102	-88.11333	30.44167	76189	2.00	'8735523 E Foul R Br, AL '
103	-88.08500	30.52667	81295	3.51	'8736163 Middle Bay, AL '
104	-88.08667	30.56500	82603	2.00	'8735391 Dog Rv Br, AL '

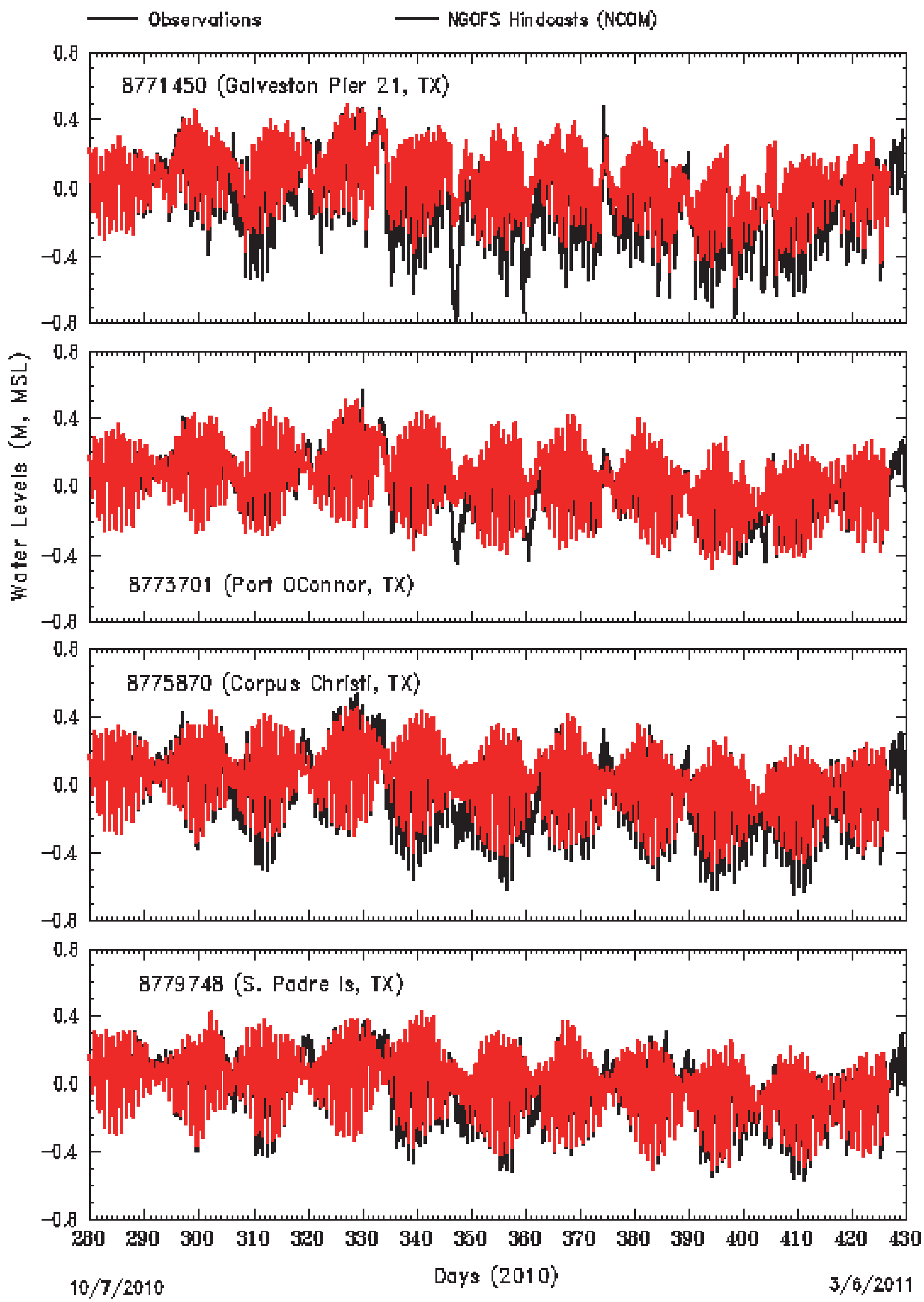


Figure 3.4.1. Simulated (red) and observed (black) water level time series for NOS stations along the Texas coast: 9779748, South. Padre Island; 8775870, Corpus Christi; 8773701, Port O'Connor; and 8771450, Galveston Pier 21.

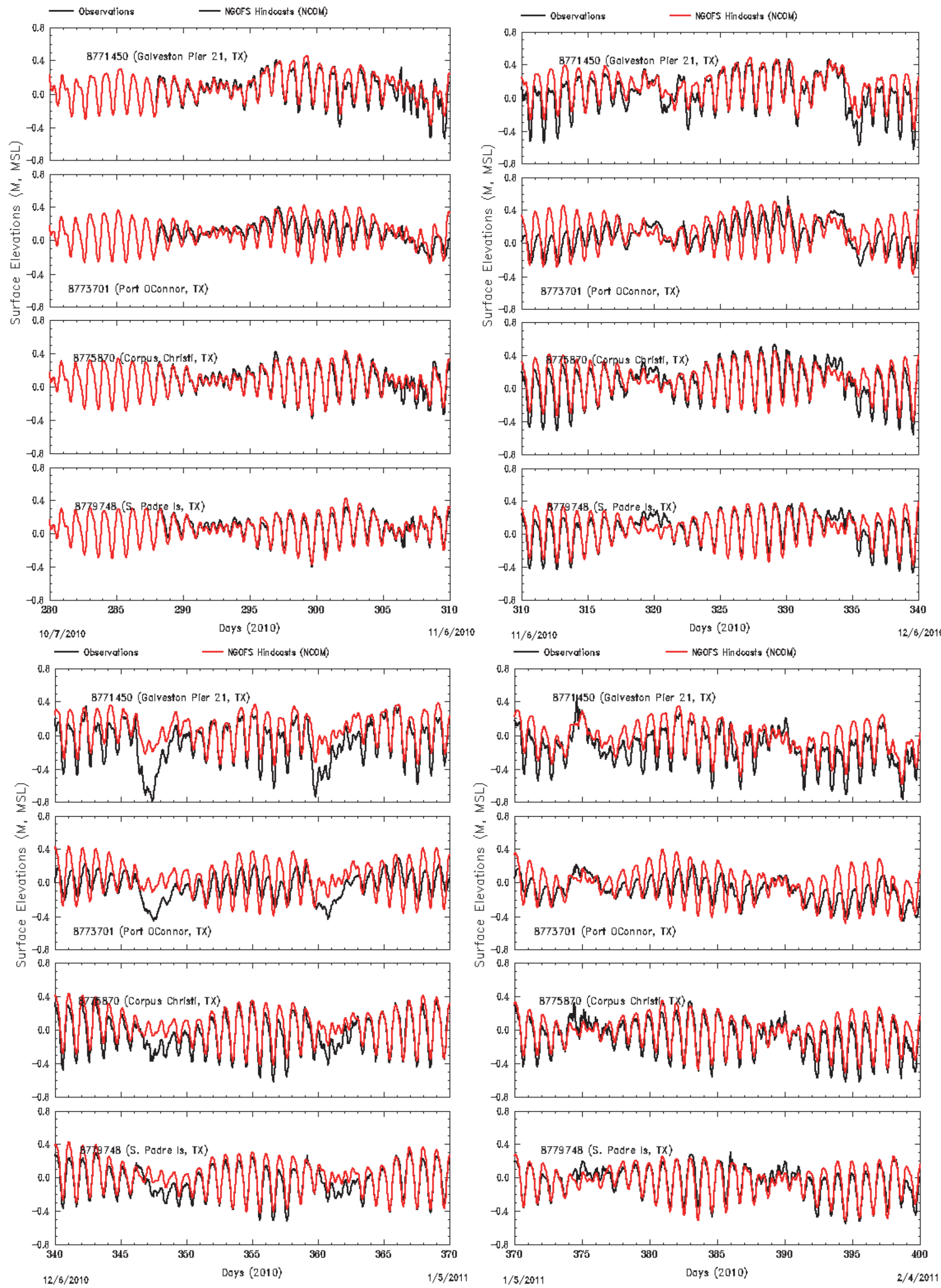


Figure 3.4.2. Detail 30-day water level time series, from October 7, 2010 to February 4, 2011, for simulated (red) and observed (black) water level time series for NOS stations along the Texas coast: 9779748 South. Padre Island; 8775870, Corpus Christi; 8773701, Port O'Connor; and 8771450, Galveston Pier 21.

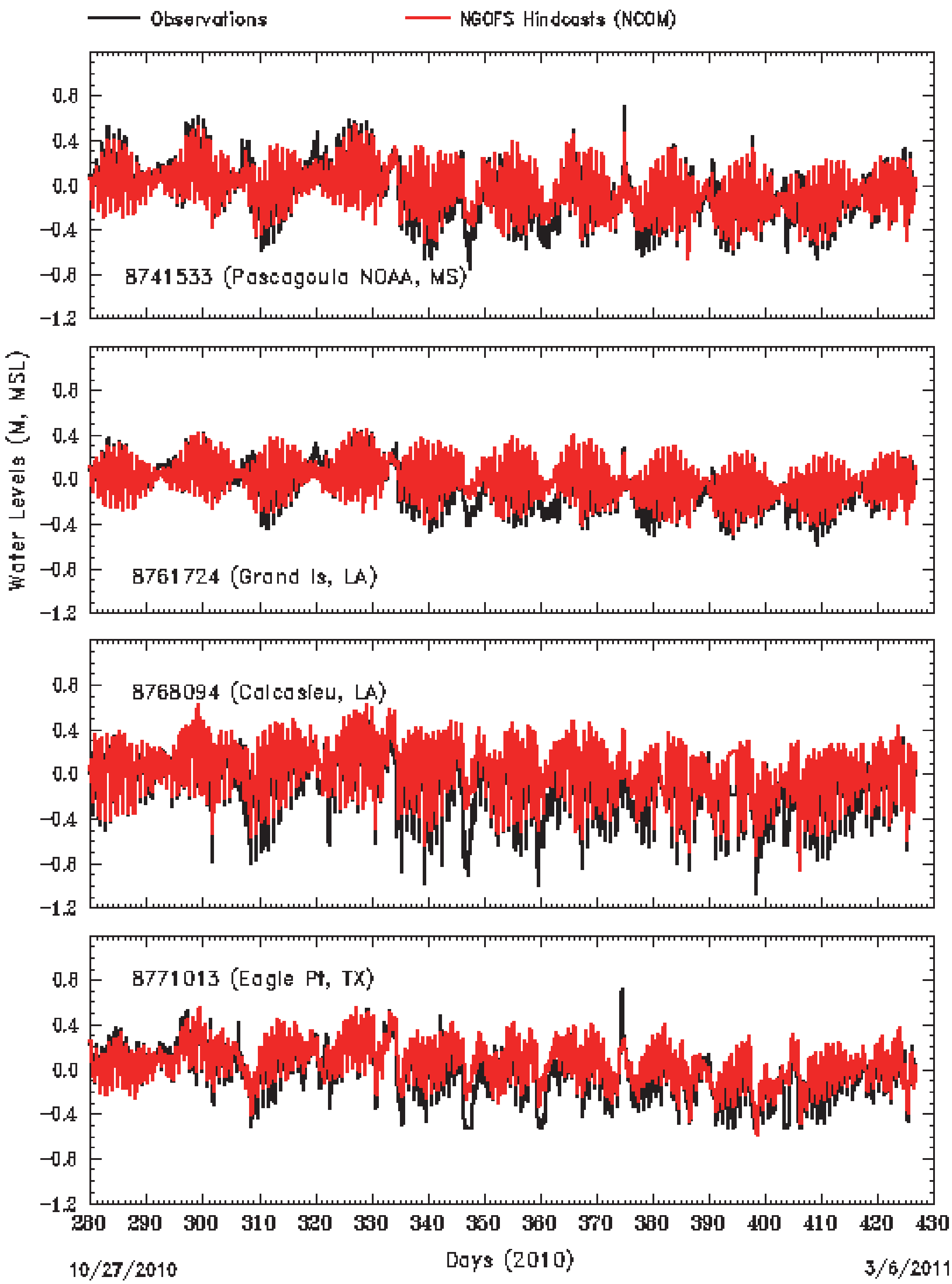


Figure 3.4.3. Simulated (red) and observed (black) water level time series for NOS stations at: 8771013, Eagle Point, TX; 8768094, Calcasieu, LA; 8761724, Grand Isle, LA; and 8741533, Pascagoula NOAA Lab, MS.

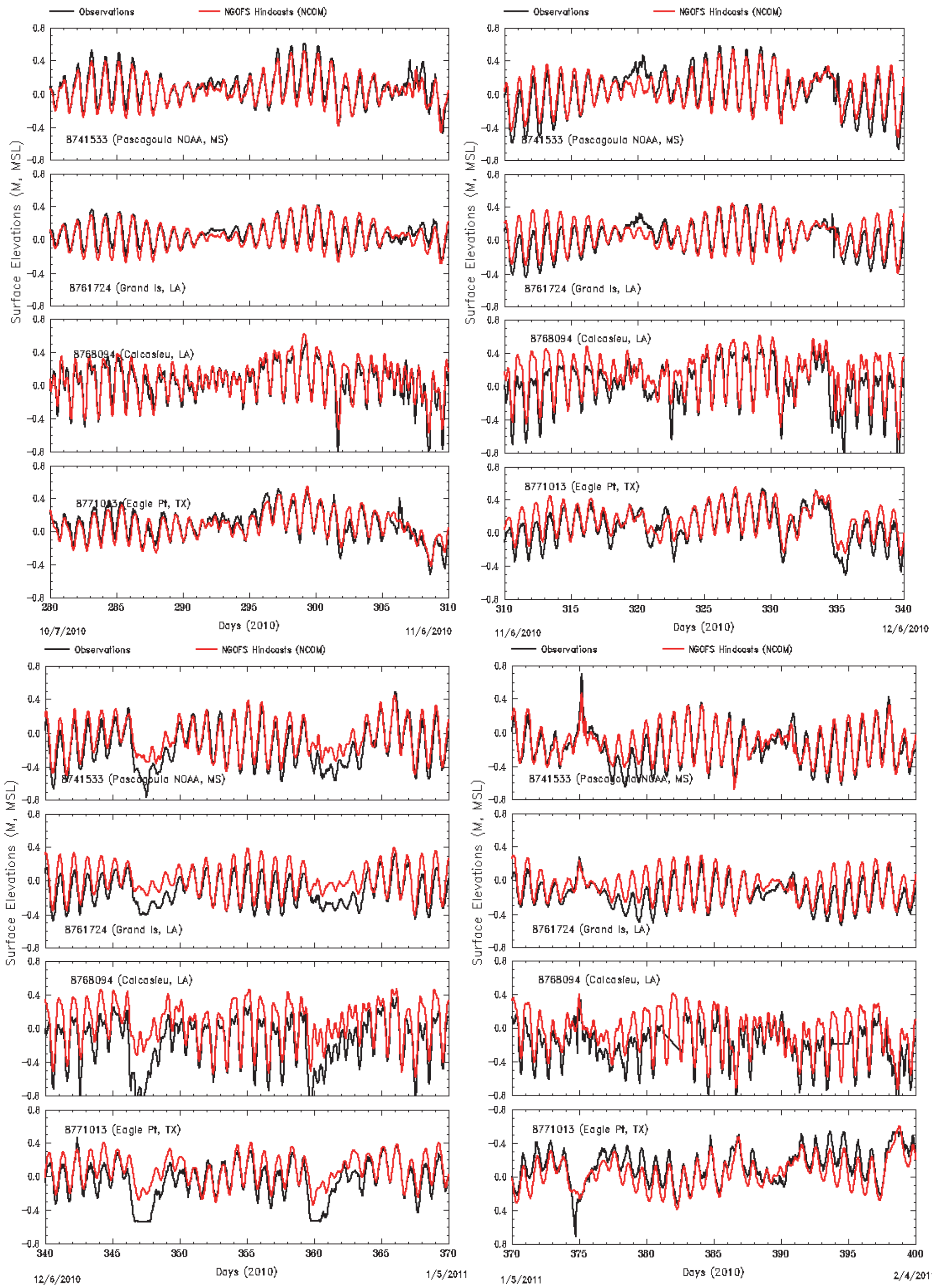


Figure 3.4.4. Detail 30-day water level time series, from October 7, 2010 to February 4, 2011, for simulated (red) and observed (black) water level time series for NOS stations at: 8771013, Eagle Point, TX; 8768094, Calcasieu, LA; 8761724, Grand Isle, LA; and 8741533, Pascagoula NOAA Lab, MS.

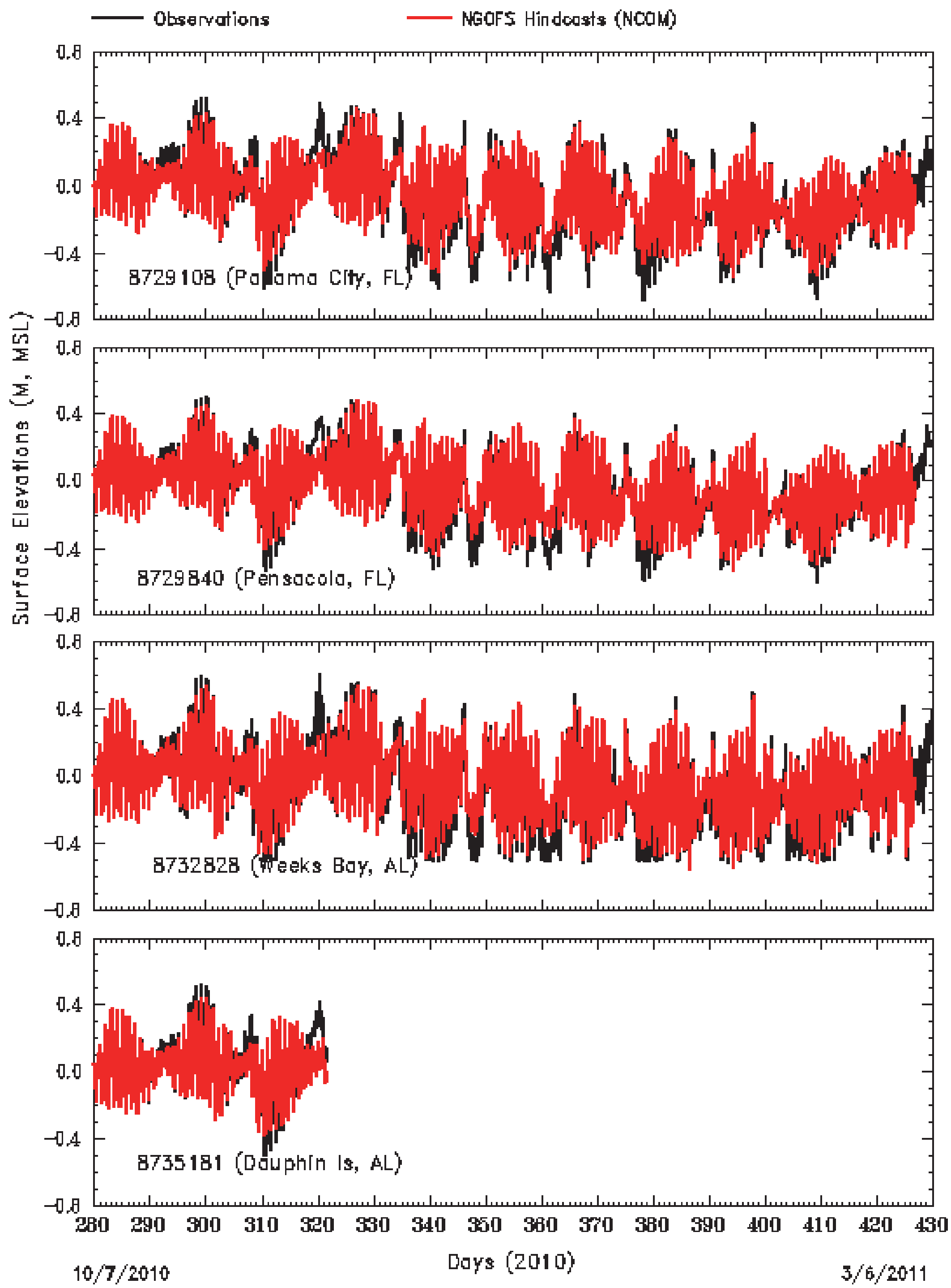


Figure 3.4.5. Simulated (red) and observed (black) water level time series for NOS stations at: 873518,1 Dauphin Is, AL; 8732828, Weeks Bay, AL;, 8729840, Pensacola, FL; and 8729108, Panama City, FL.

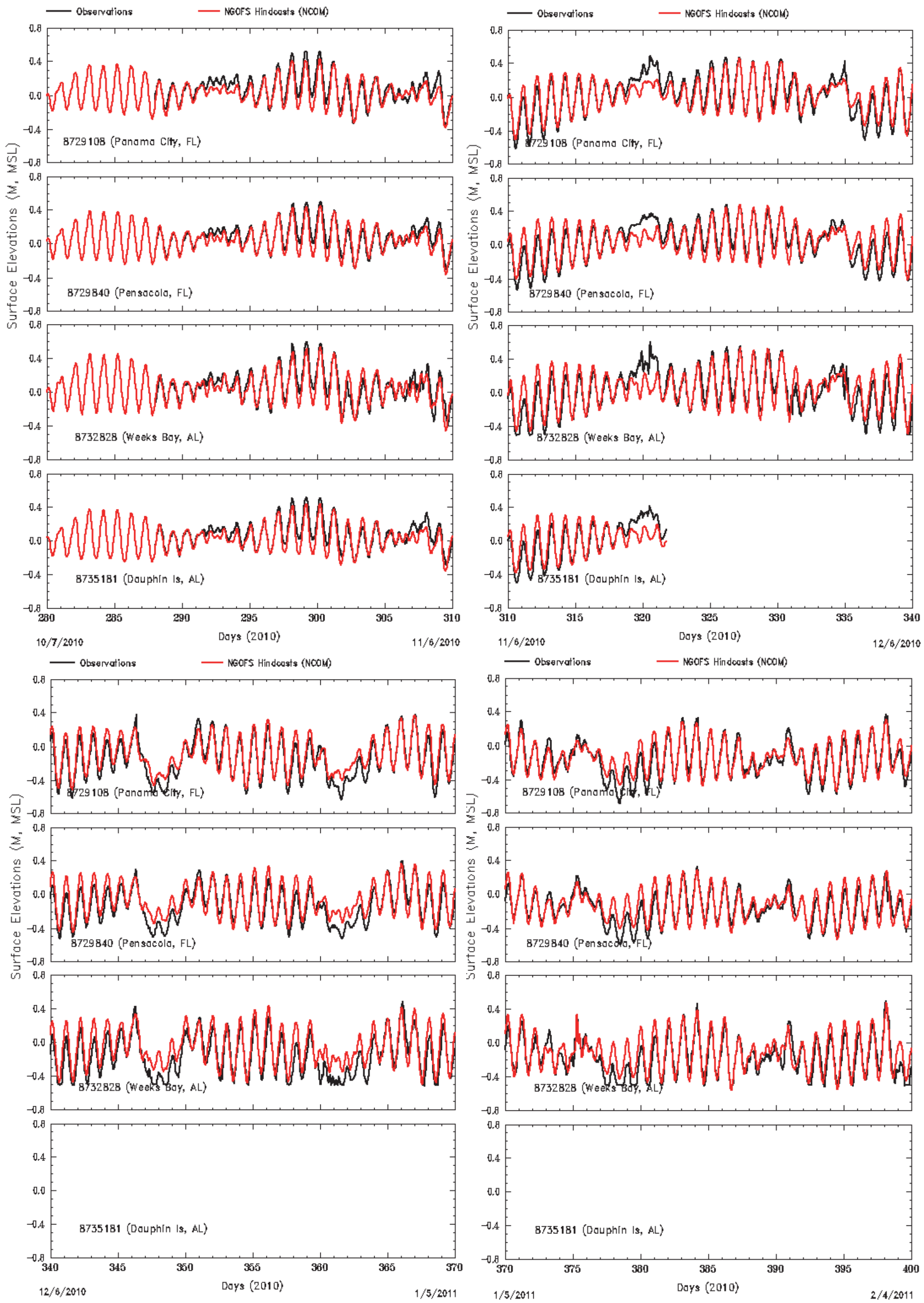


Figure 3.4.6. Detail 30-day water level time series, from October 7, 2010 to February 4, 2011, for simulated (red) and observed (black) water level time series for NOS stations at: 8735181, Dauphin Is, AL; 8732828, Weeks Bay, AL;, 8729840, Pensacola, FL; and 8729108, Panama City, FL.

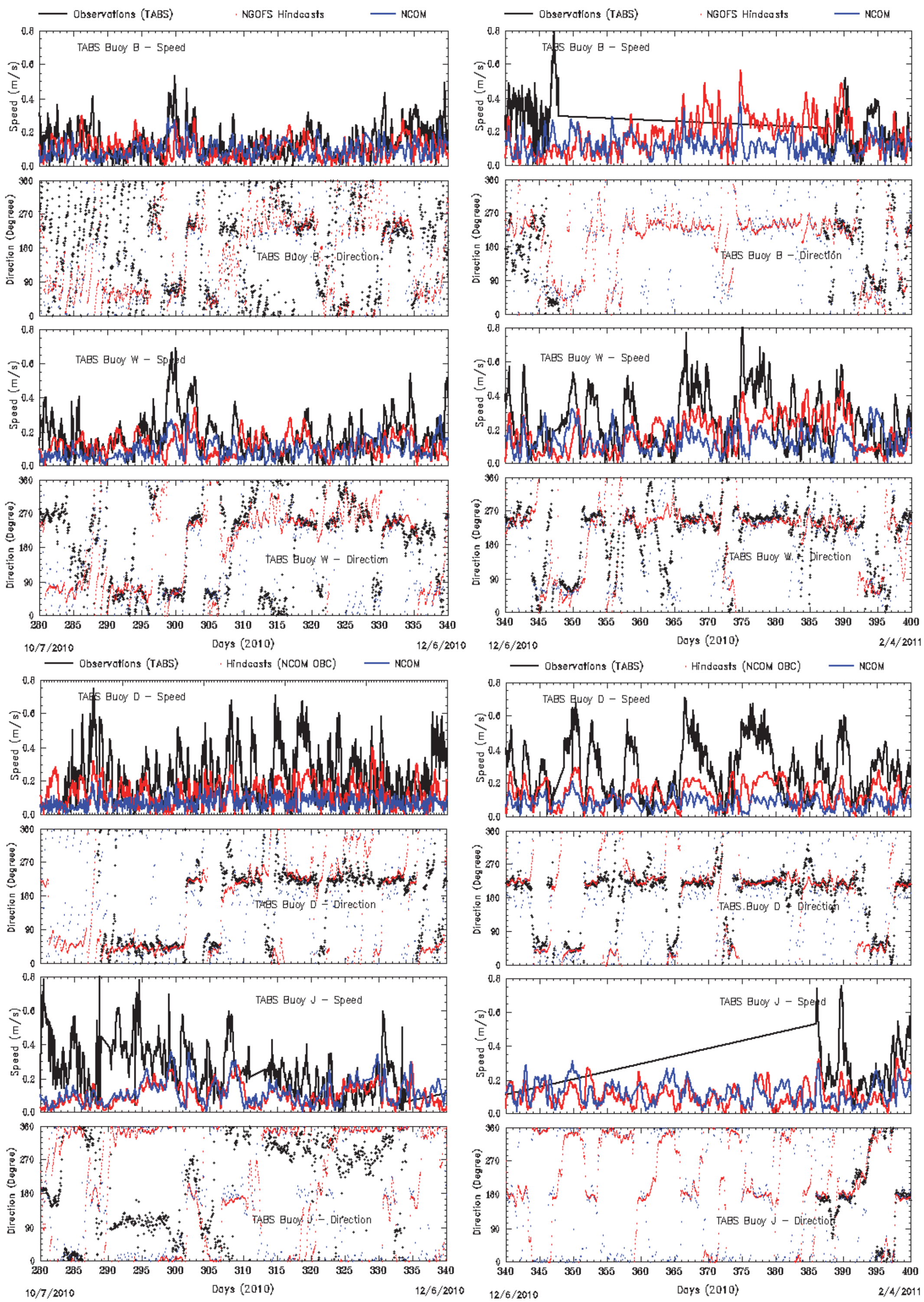


Figure 3.4.7. NGOFS model simulated current speed (red solid) and direction (red circle) at TABS Buoys B and D (upper plots) and Buoys W and J (lower plots) against observed speed (black solid line) and direction (black plus symbol) with NCOM forecasts as blue color. (see Figure 3.3.9 for TABS buoy locations).

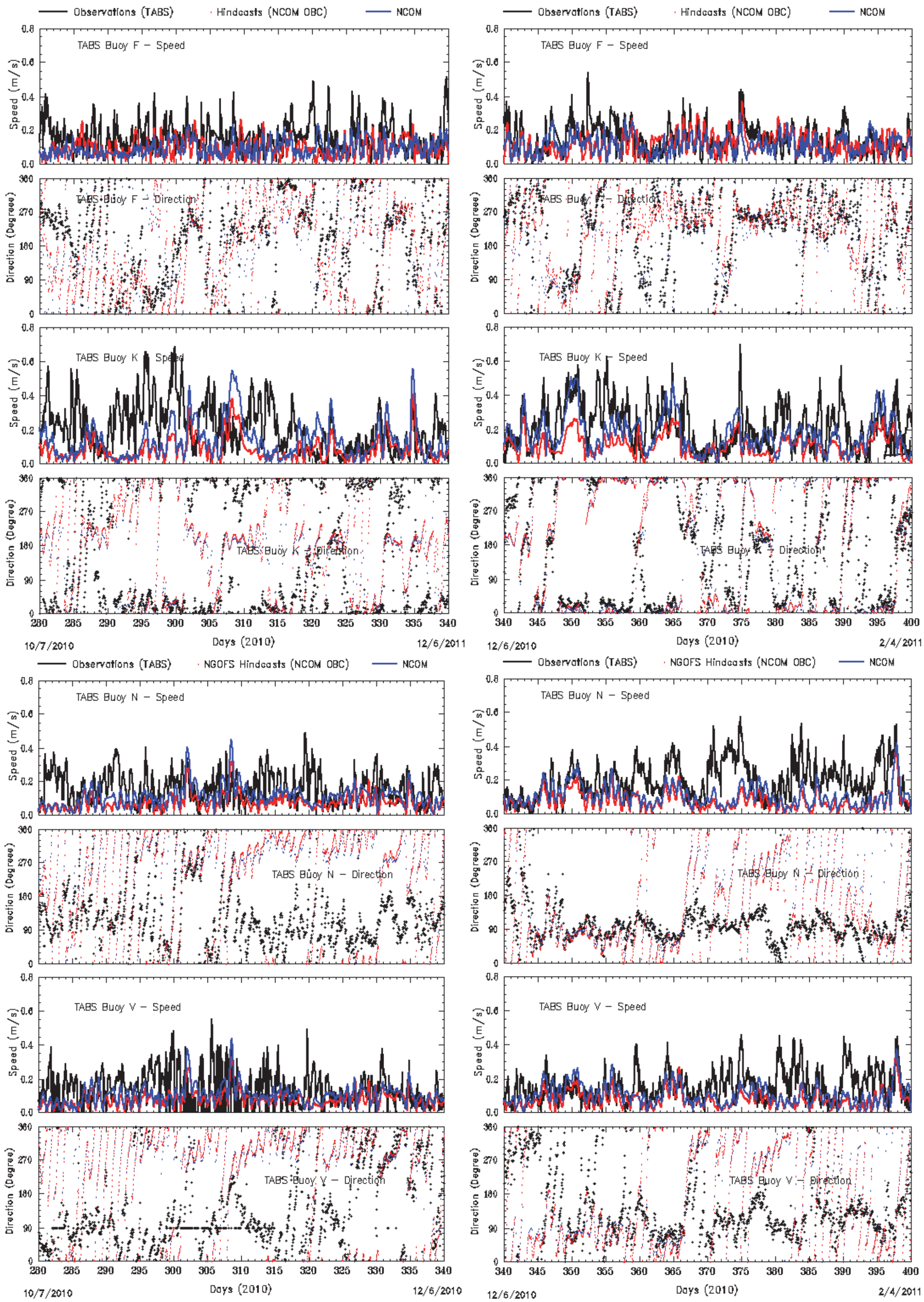


Figure 3.4.8. NGOFS model simulated current speed (red solid) and direction (red circle) at TABS Buoys F and K (upper plots) and Buoys V and N (lower plots) against observed speed (black solid line) and direction (black plus symbol). NCOM forecasts are in blue color. (see Figure 3.3.9 for TABS buoy locations).

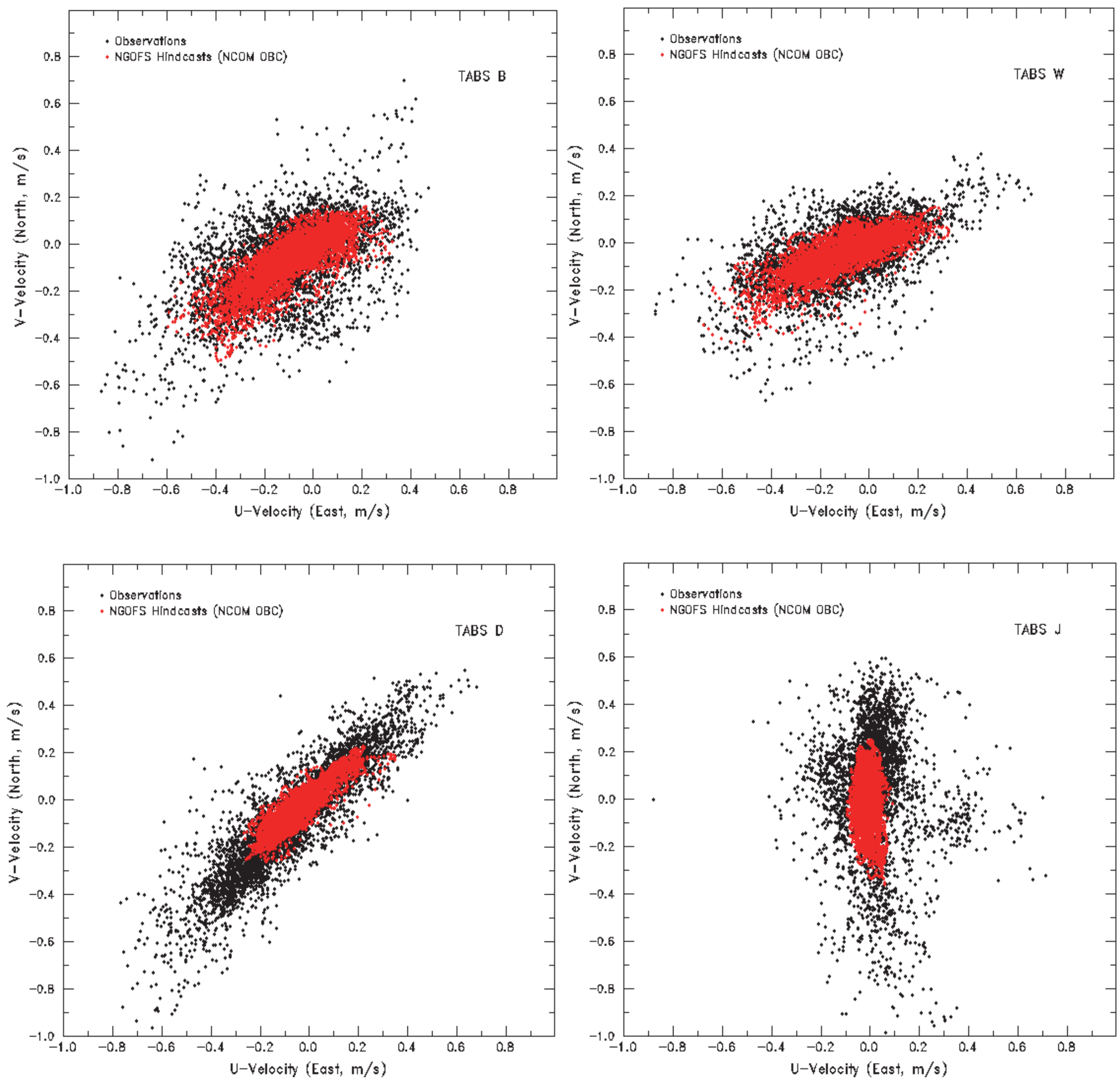


Figure 3.4.9. NGOFS simulated and observed velocity scatter plots for TABS Buoys B, D, W, and J.

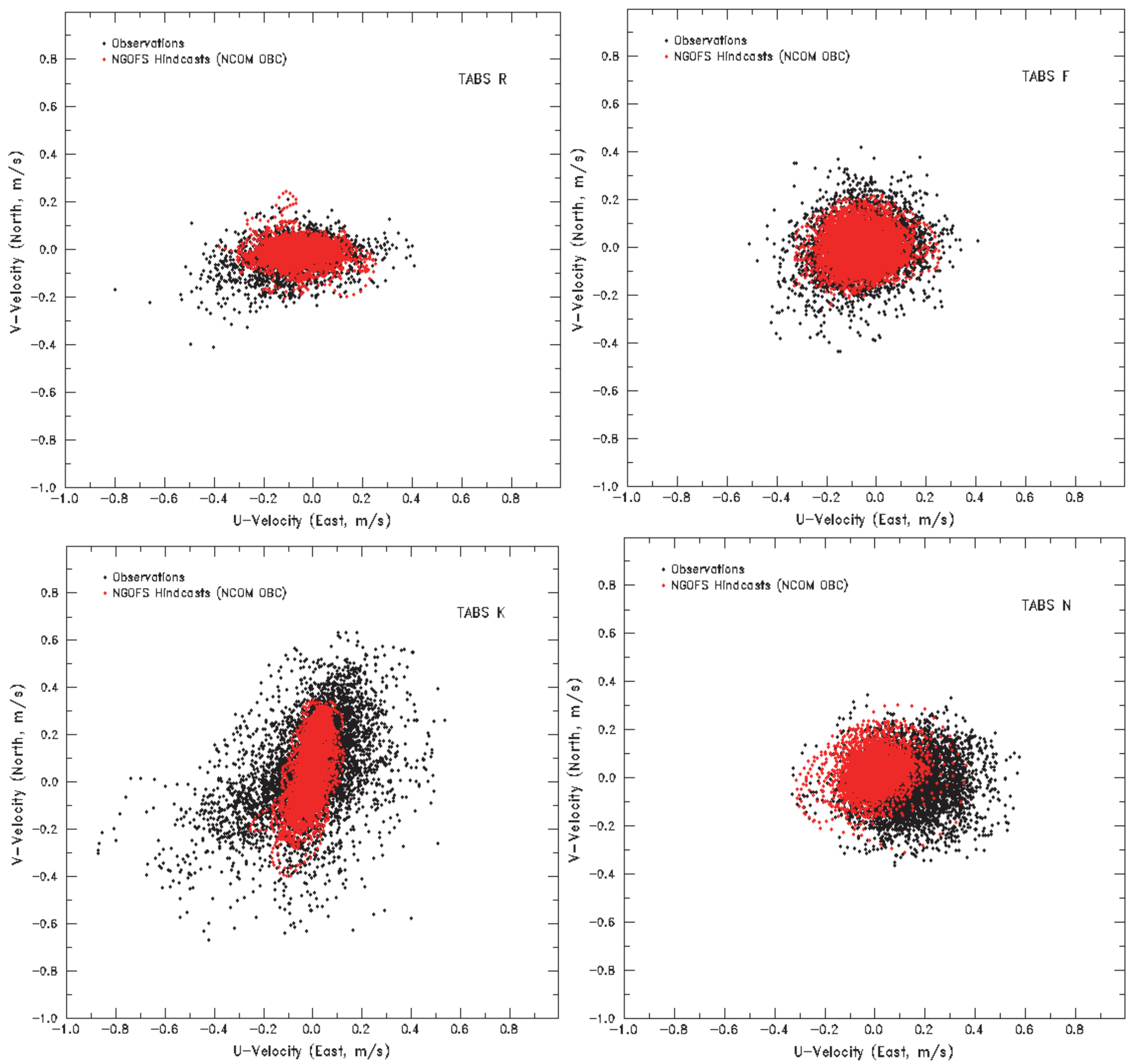


Figure 3.4.10. NGOFS simulated and observed velocity scatter plots for TABS Buoys R, F, K, and N.

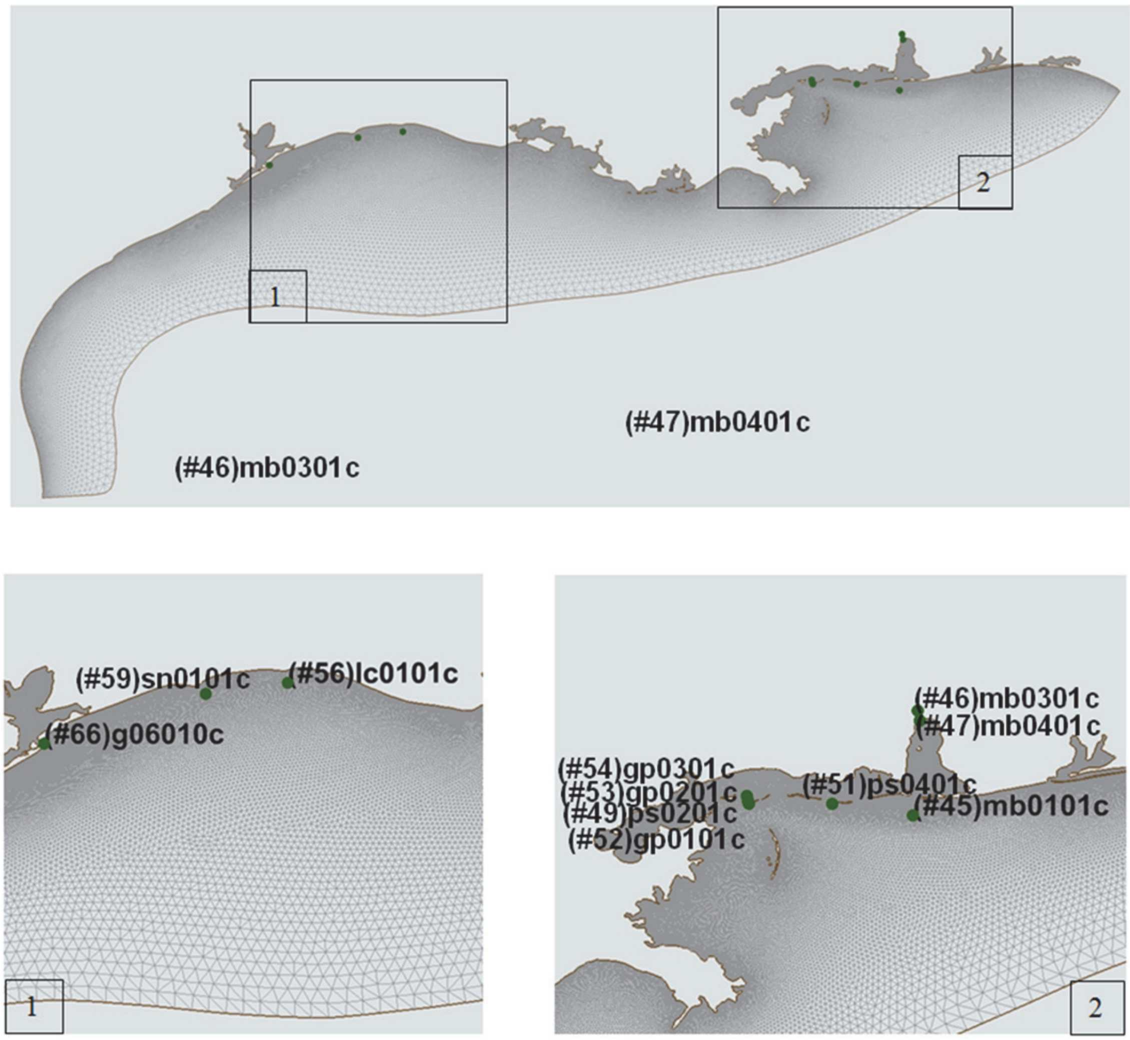


Figure 3.4.11. Maps depicting the locations of NOS current meters with water temperature sensors (with station IDs) along with the NGOFS grid.

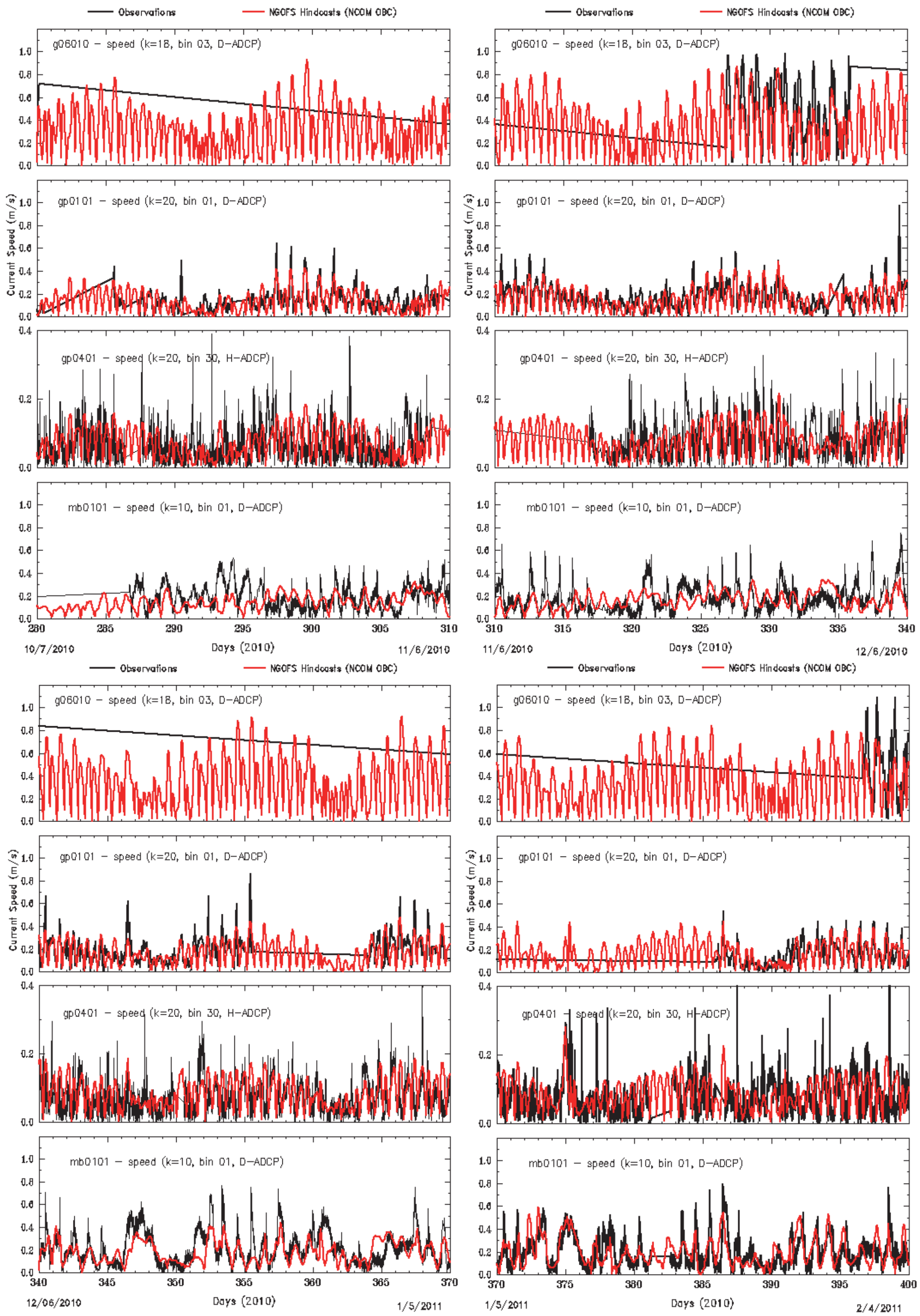


Figure 3.4.12. NGOFS simulated current speed time series from October 7, 2010 to February 4, 2011 at NOS PORTS stations at g06010 (Galveston Bay), gp0101, gp0401 (Gulfport), and mb0101 (Mobile Bay).

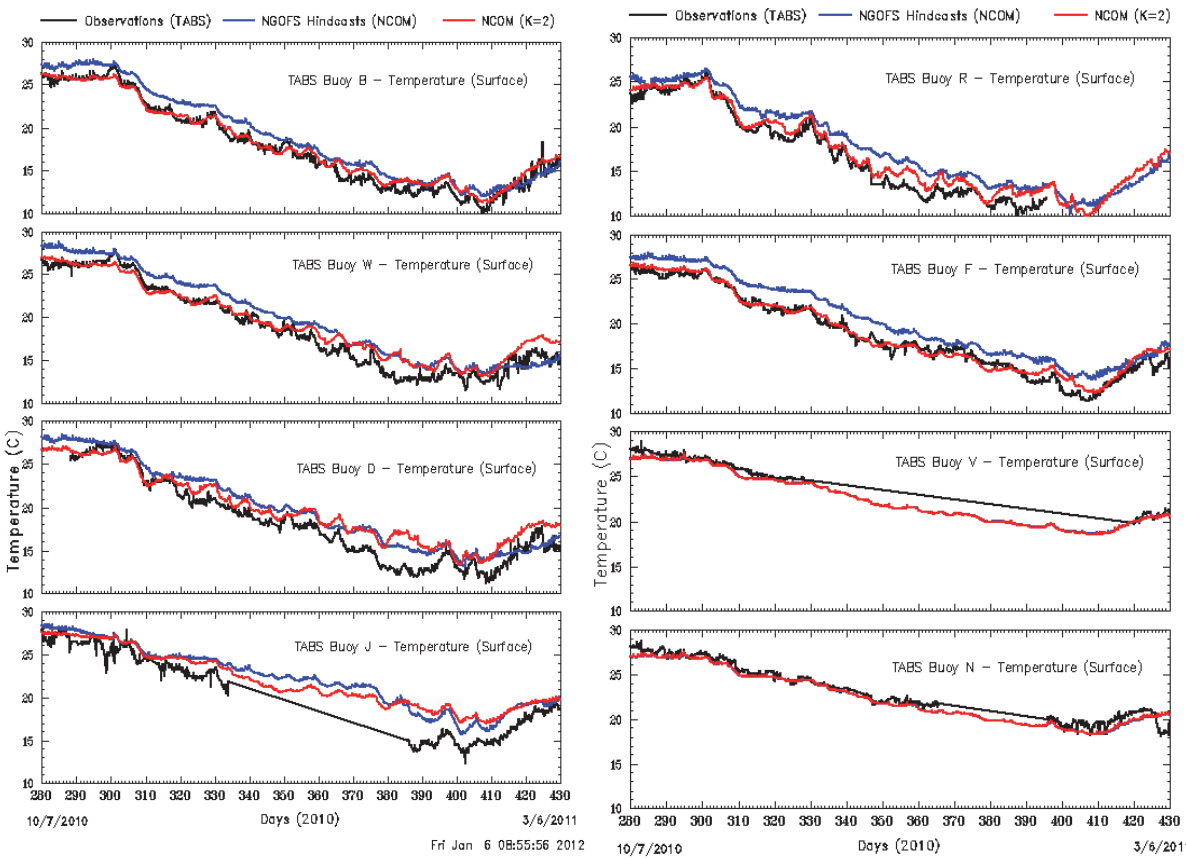


Figure 3.4.13. NGOFS model simulated surface temperature (red) at TABS buoys against observations (black) for TABS Buoys B,W,D,J (left) and R,F,V,N (right). Buoy locations are show in Figure 3.3.9. Temperature from NCOM forecasts are also plotted (blue). Note that NGOFS and NCOM temperature are identical indicating NCOM temperature are correctly applied as NGOFS boundary forcing using the nesting technique.

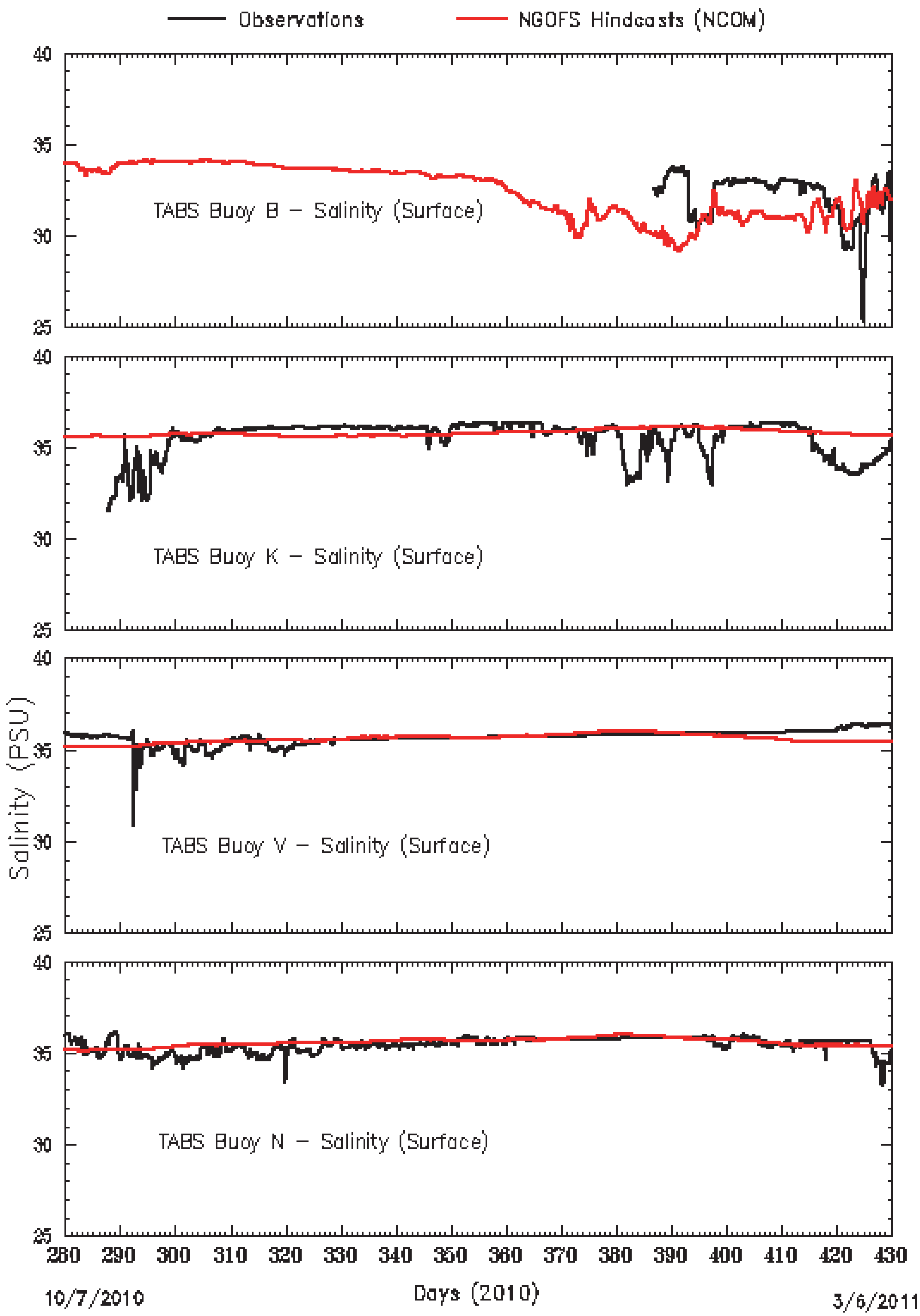


Figure 3.4.14. NGOFS hindcast 2 model simulated surface salinity (red) at TABS Buoys B, K, V, and N (black)). Buoy locations are show in Figure 3.3.9.

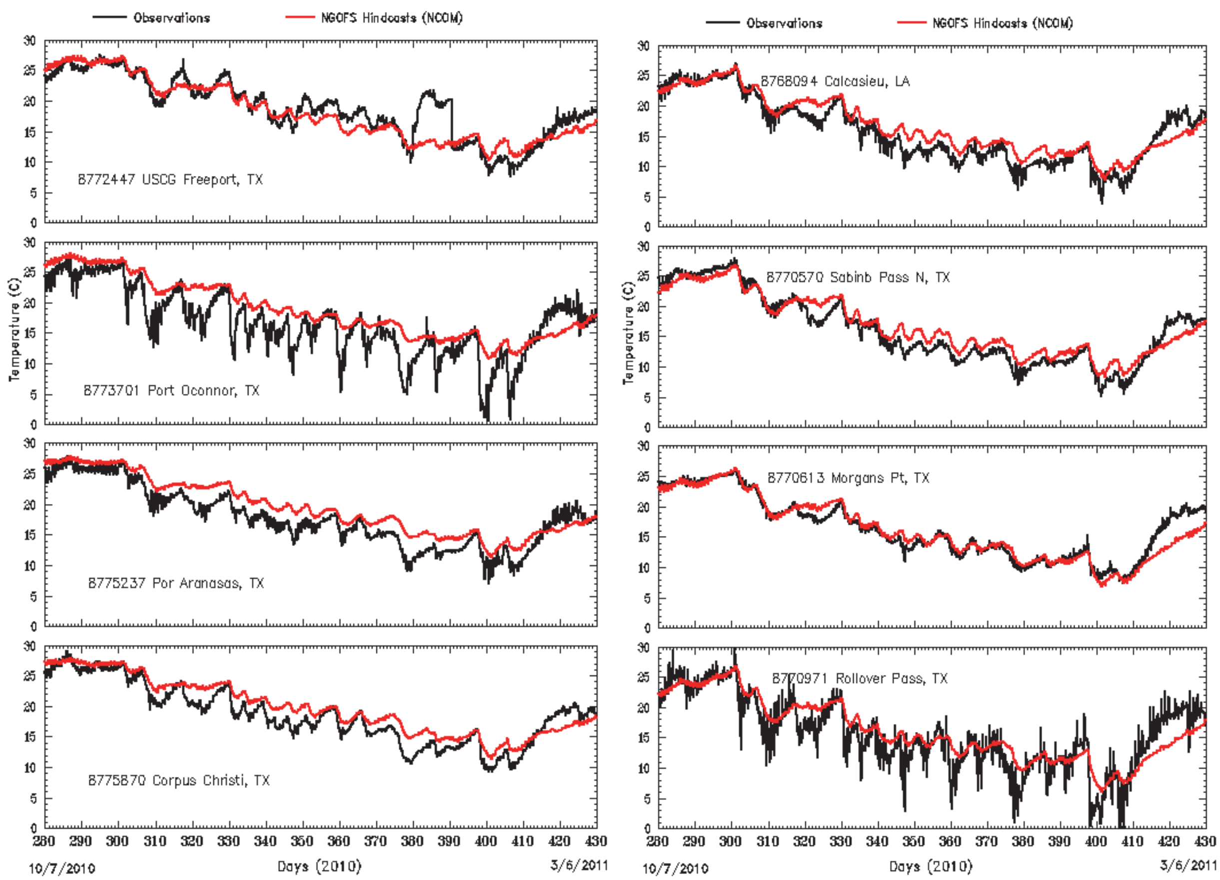


Figure 3.4.15. NGOFS hindcast 2 model simulated surface temperature (red) with observations (black) at NOS NWLON gage inland and bay locations Louisiana to Texas (see Figure 3.3.1 for locations).

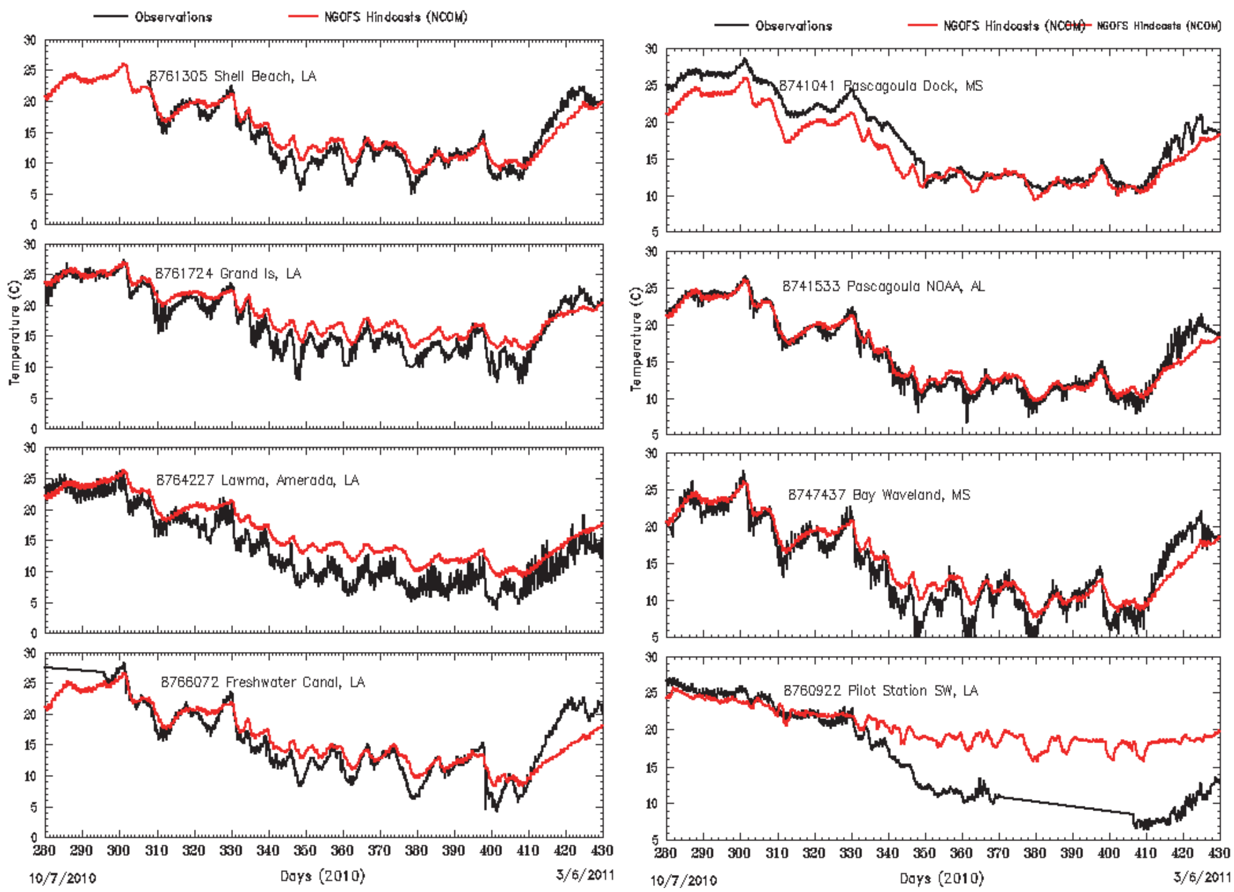


Figure 3.4.16. NGOFS model simulated surface temperature (red) with observations (black) at NOS NWLON gage inland and bay locations from Louisiana to Alabama (see Figure 3.3.1 for locations).

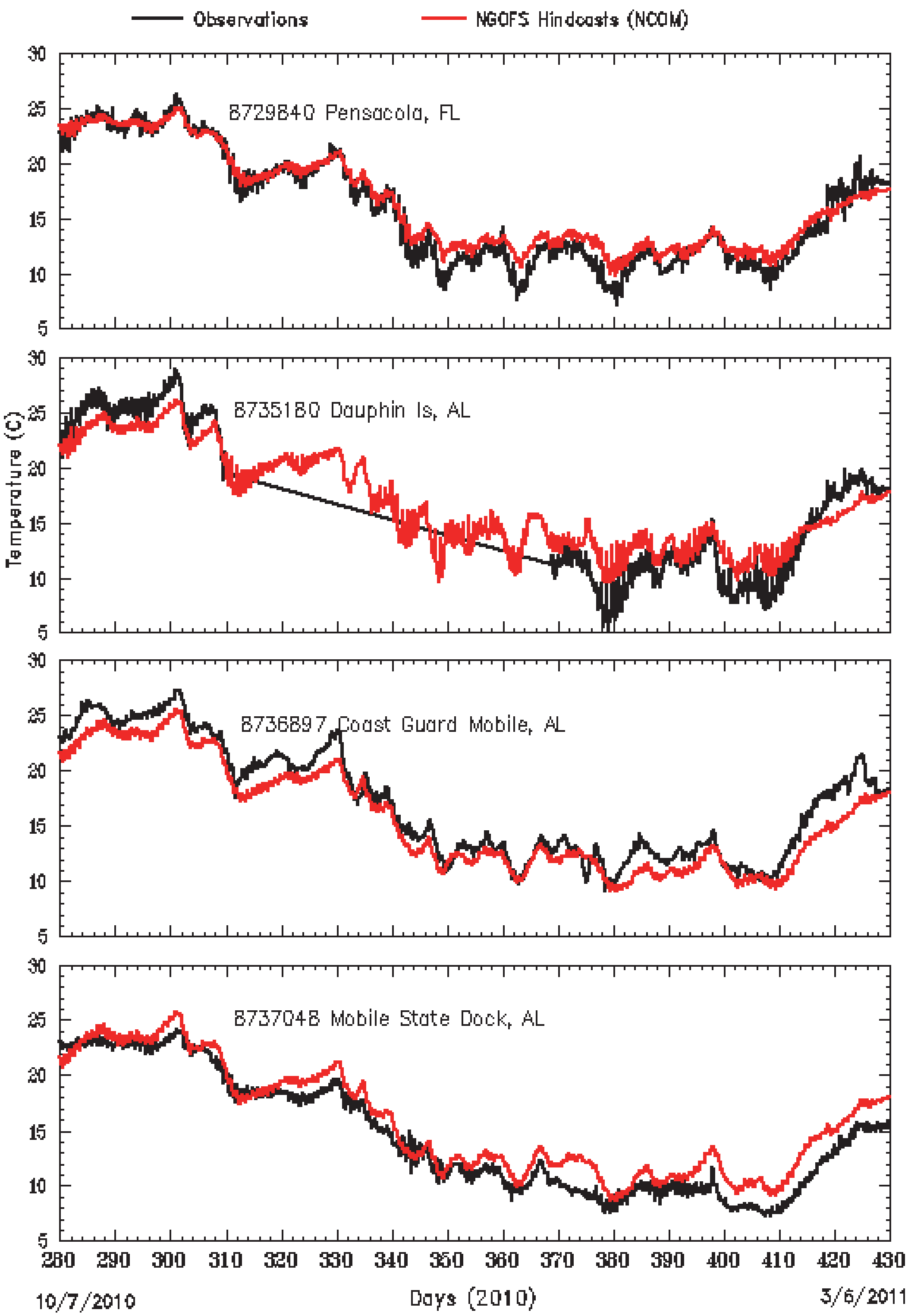


Figure 3.4.17. NGOFS model simulated surface temperature (red) with observations (black) at NOS NWLON gage inland and bay locations from Alabama to Florida (see Figure 3.3.1 for locations).

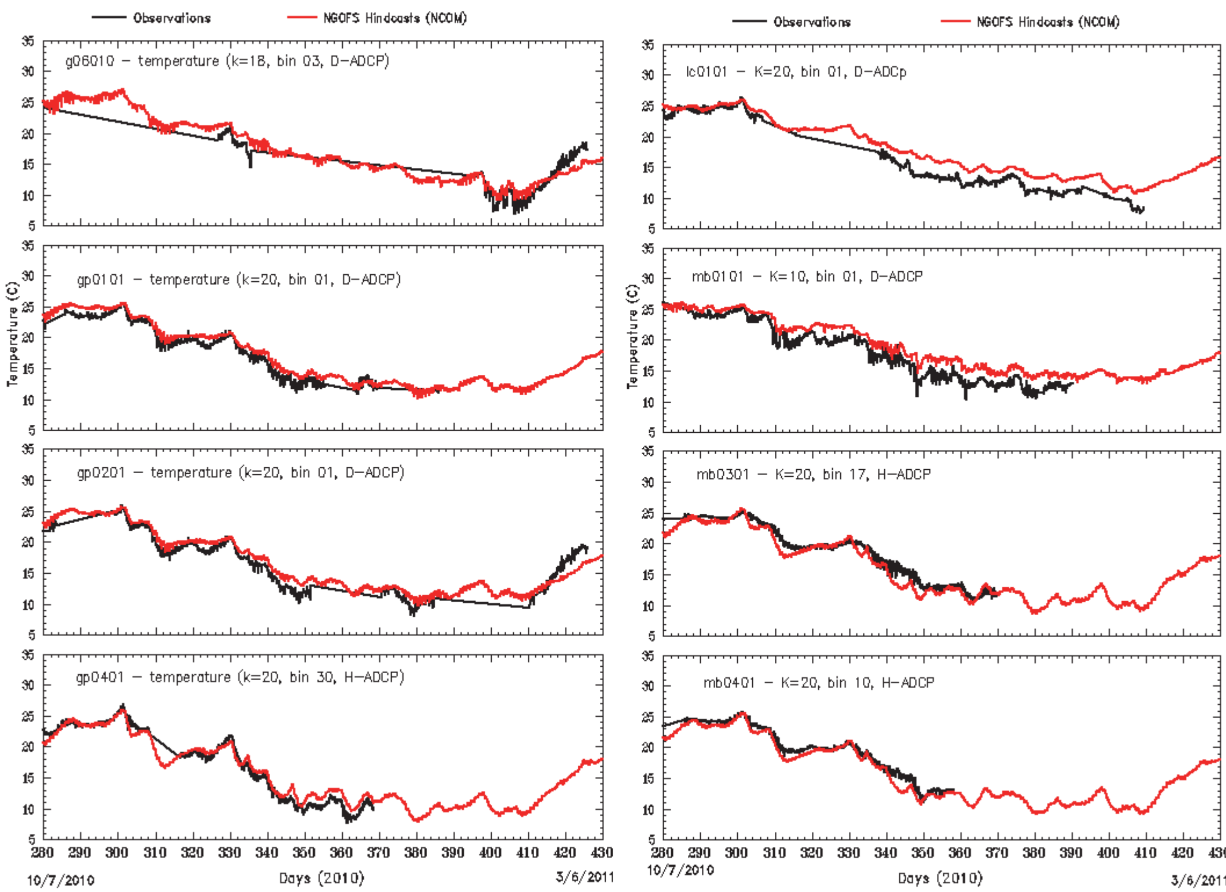


Figure 3.4.18. NGOFS hindcast 2 model simulated surface temperature (red) with observations (black) at inland and bay locations in the NOS NCOP program; g06010, gp0101, gp0201, and gp0401.

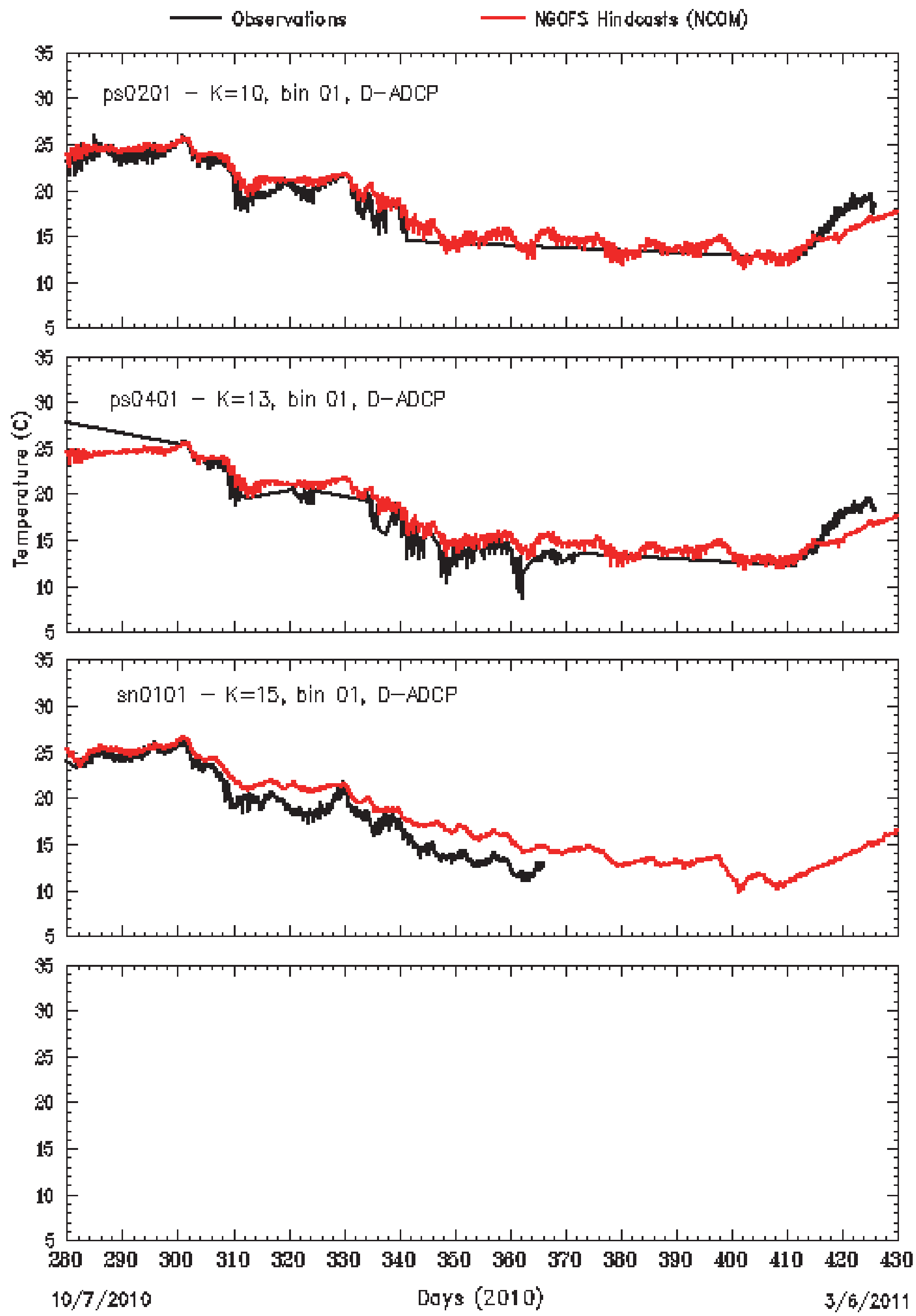


Figure 3.4.19. NGOFS hindcast 2 model simulated surface temperature (red) with observations (black) at inland and bay locations in the NOS NCOP program; ps0201, ps0401, and sn0101.

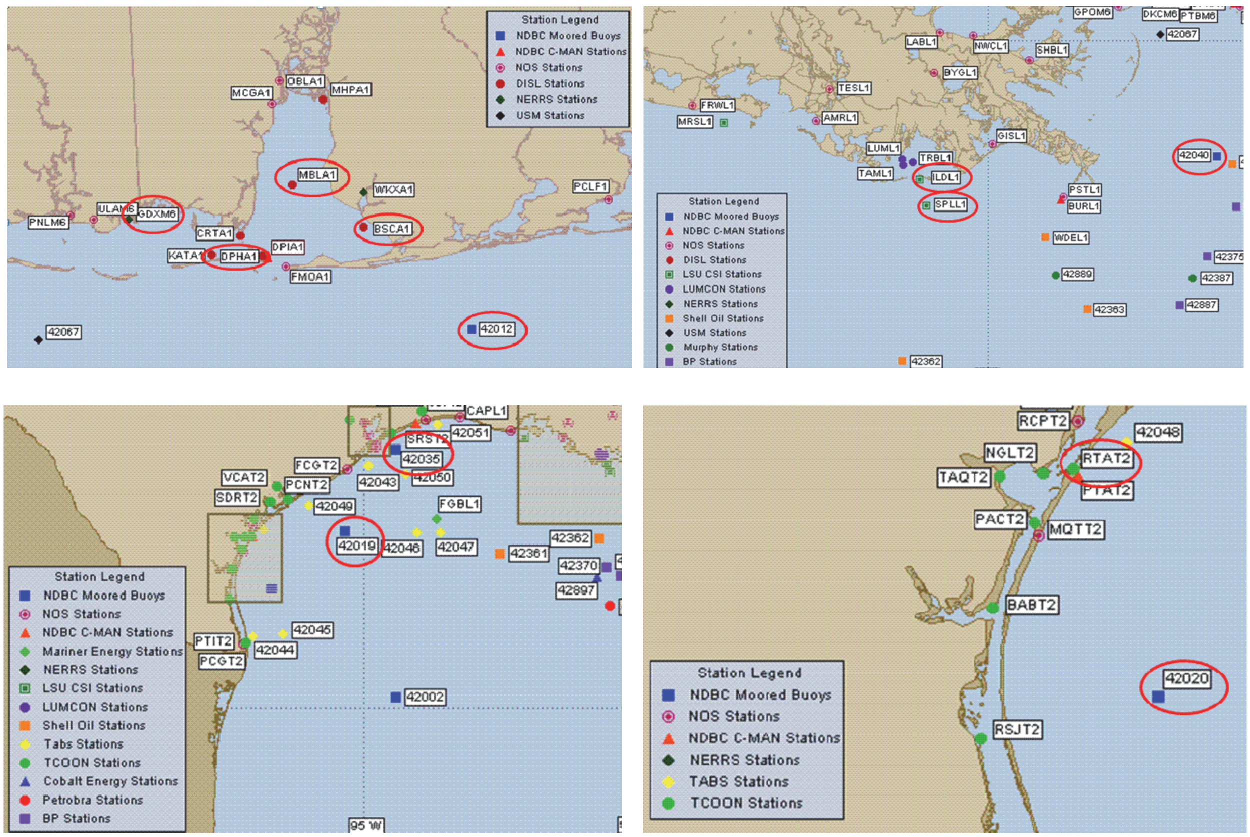


Figure 3.4.20. NDBC/IOOS surface temperature measurement locations.

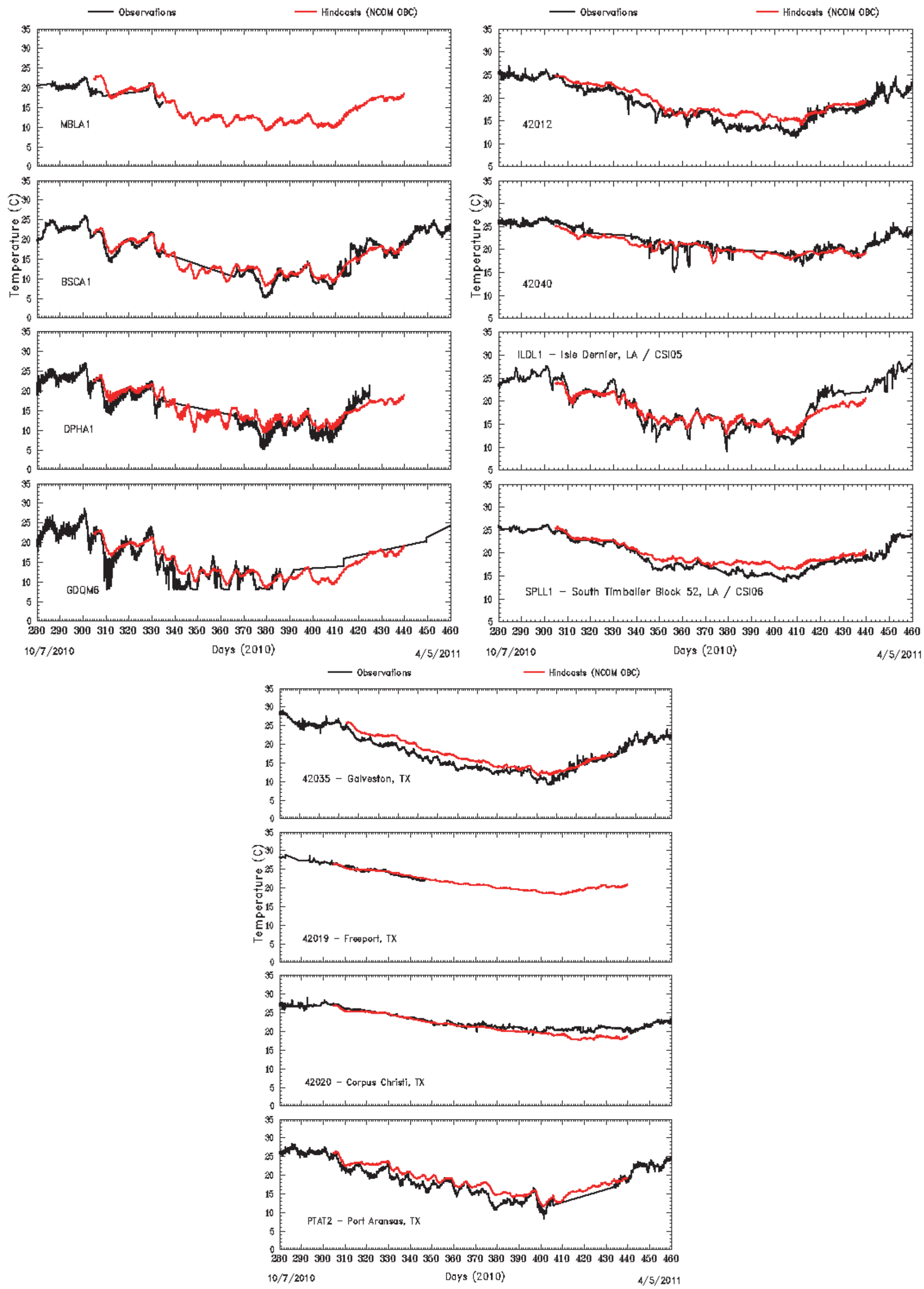


Figure 3.4.21. NGOFS simulated surface temperature time series with observations at NDBC/IOOS stations.

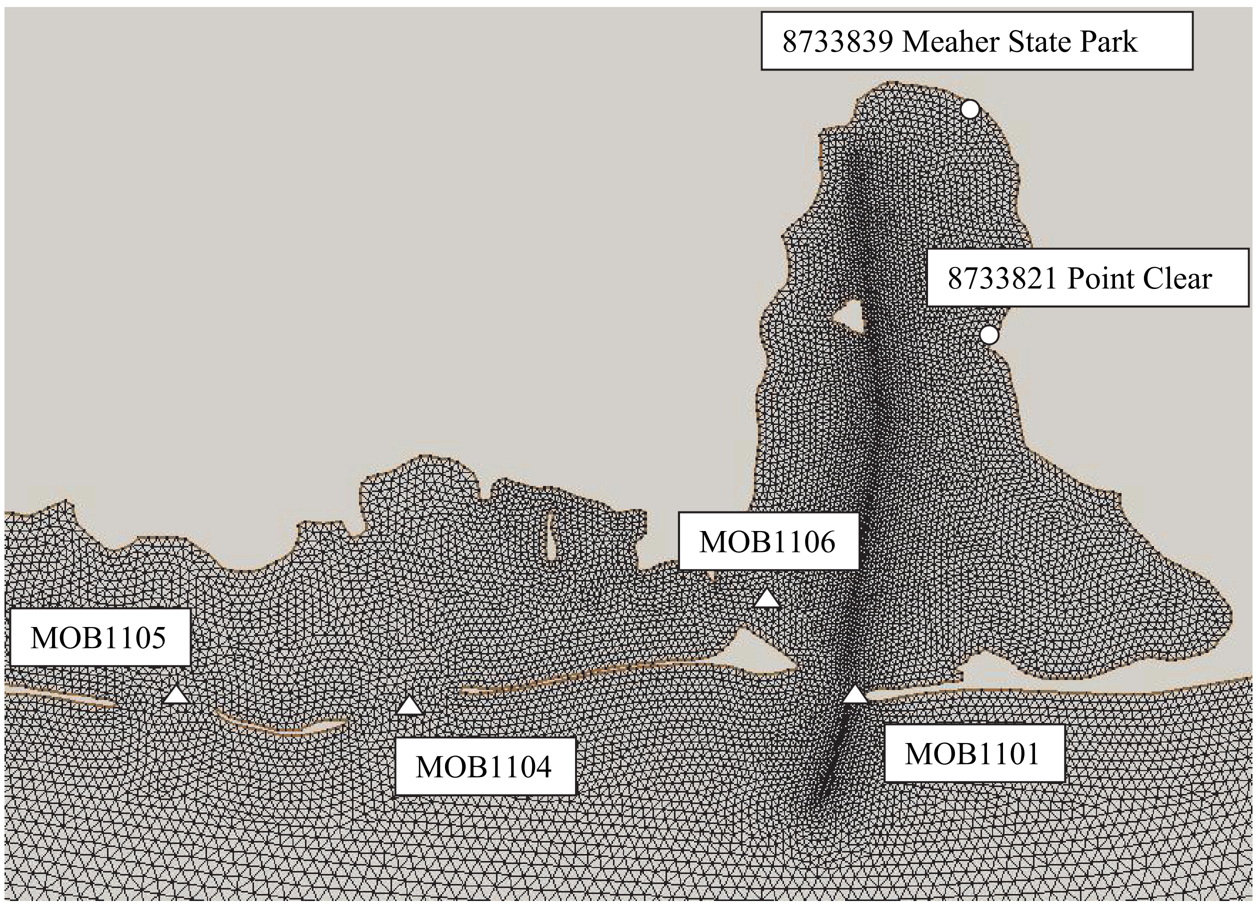


Figure 3.4.22. Mobile Bay project observation locations; water level gages (Circles - 8733839 Meaher State Park and 8733821) and ADCP current meters (Triangles - MOB1101, 1104, 1105, and 1106).

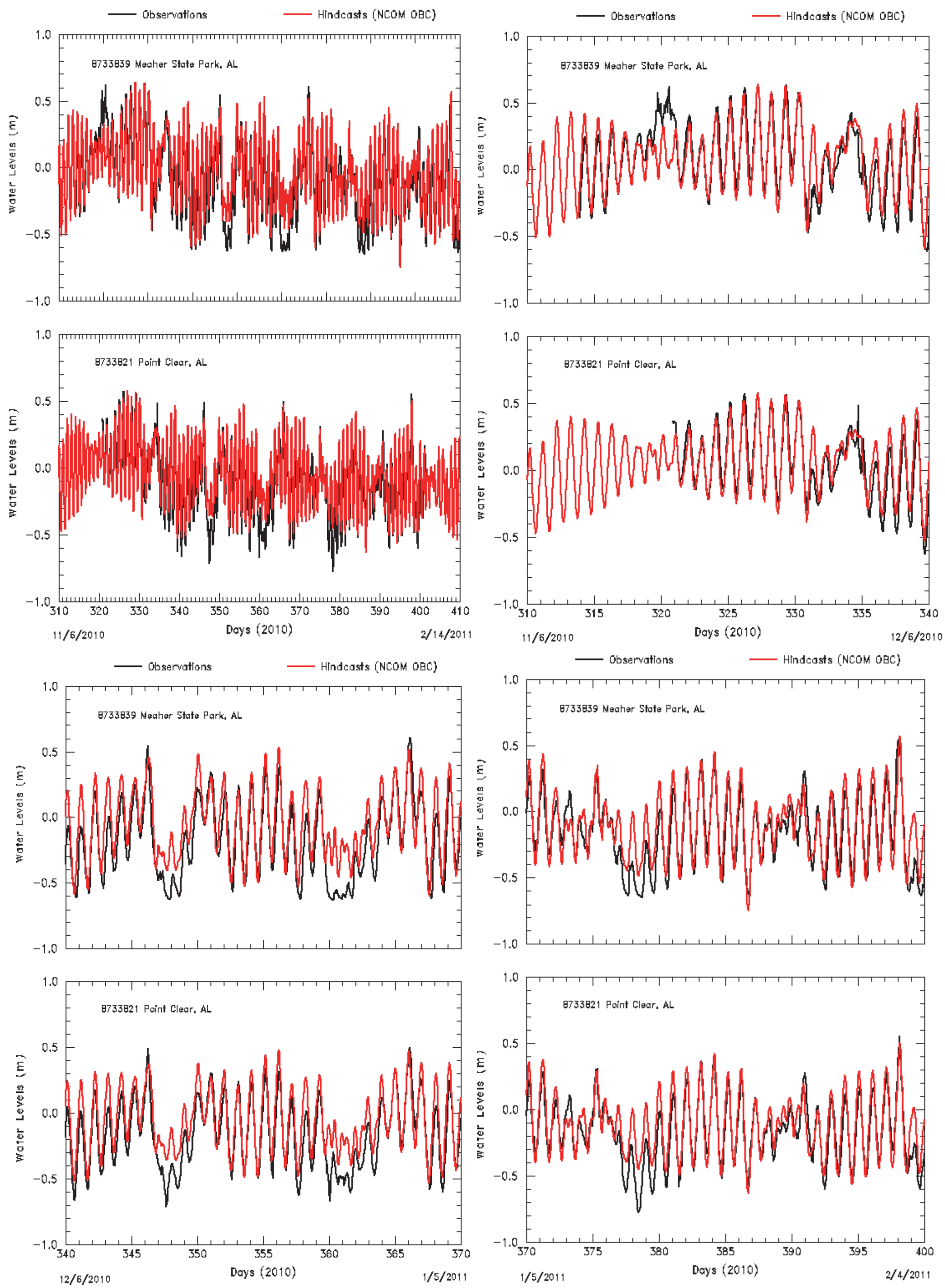


Figure 3.4.23. NGOFS simulated water levels (red) with observations (black) at Meaher State Park (8733839) and Point Clear (8733821) during the Mobile Bay Project period (see Figure 3.2.19 for gage locations).

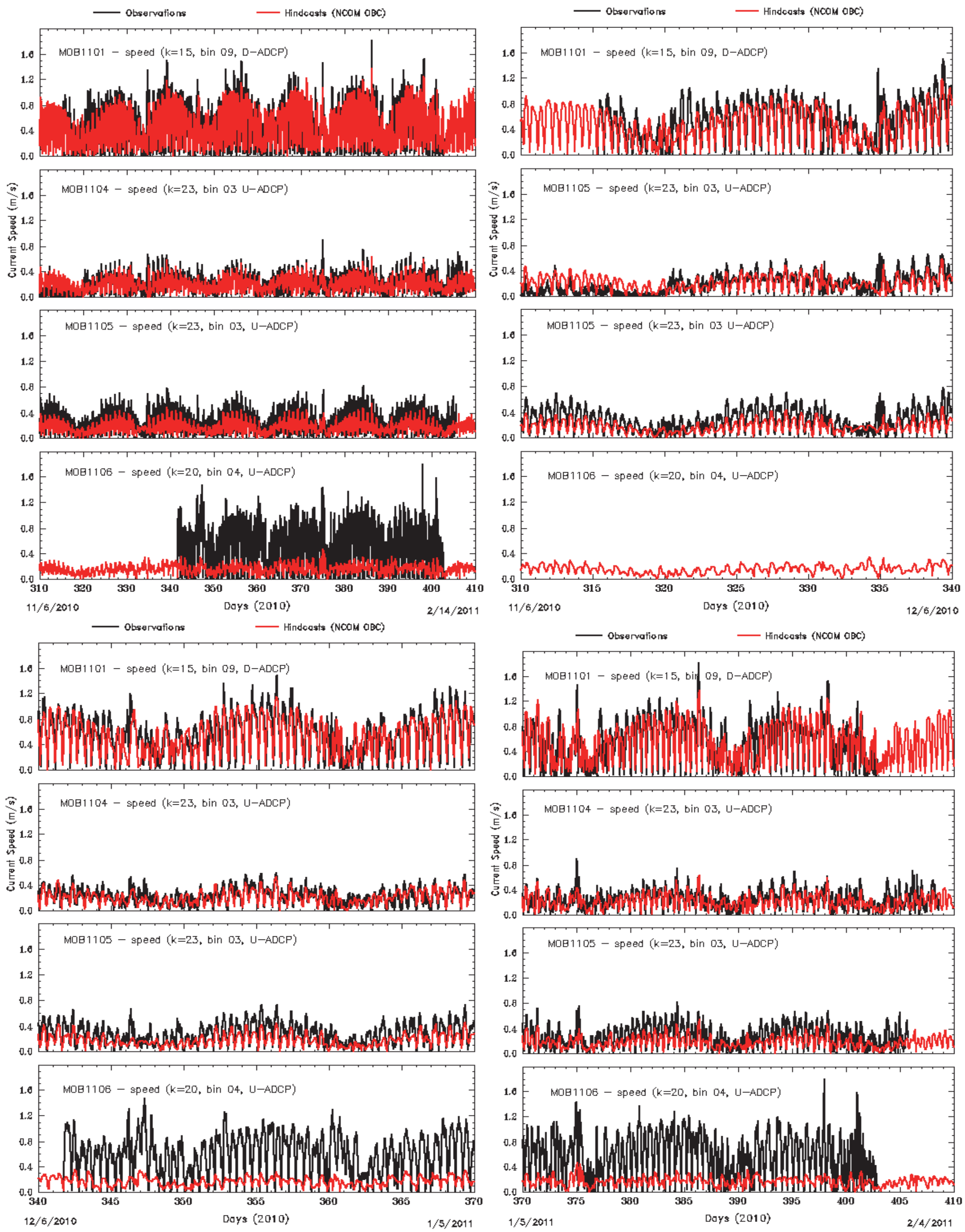


Figure 3.4.24. NGOFS simulated current speeds (red) with observations (black) at stations MOB1101, MOB1104, MOB1105, and MOB1106 during the Mobile Bay Project period (see Figure 3.4.21 for ADCP locations).

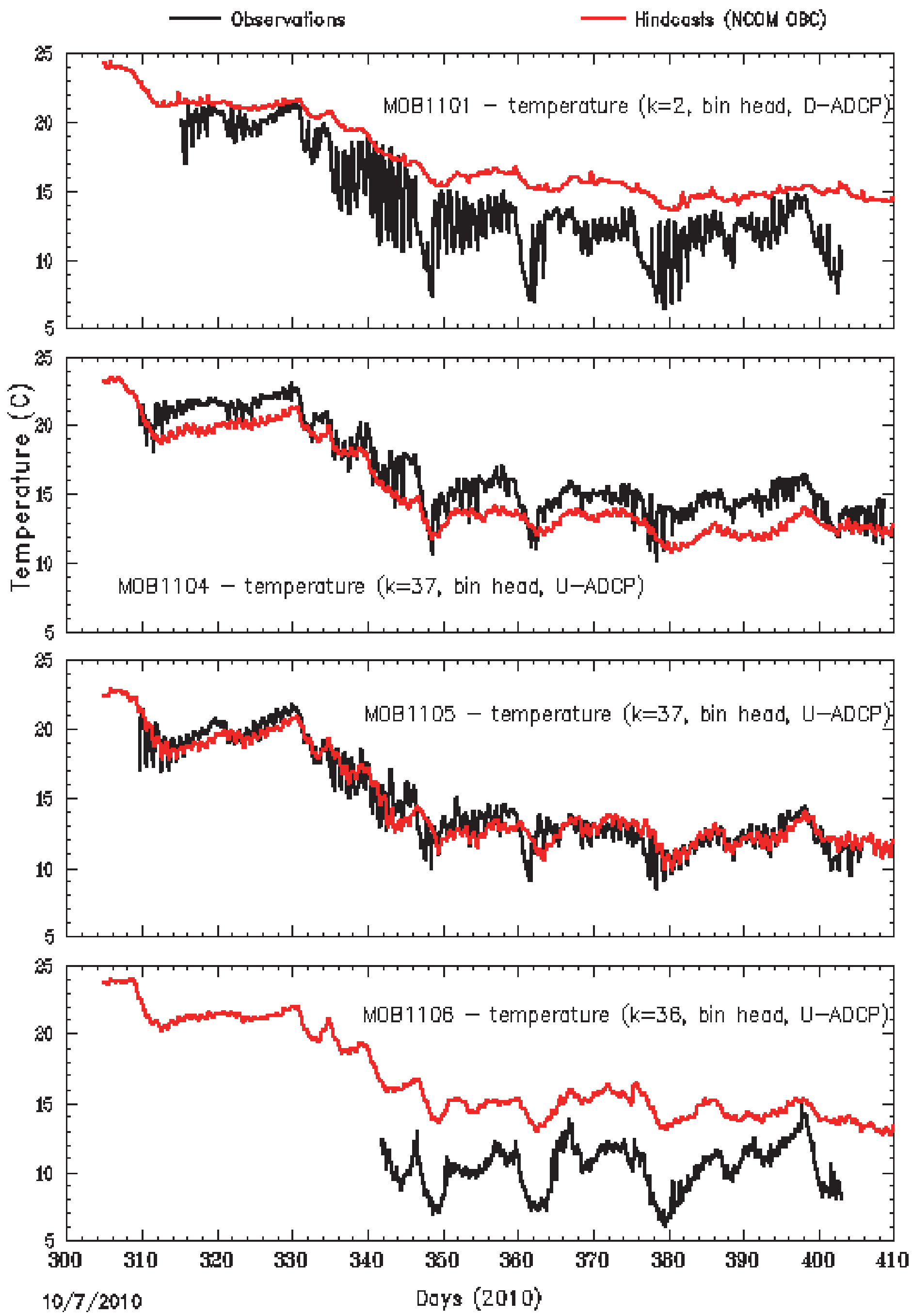


Figure 3.4.25. NGOFS simulated temperature (red) compared with observations (black) at corresponding ADCP instrument head depth for stations MOB1101, MOB1104, MOB1105, and MOB1106 (see Figure 3.4.21 for ADCP locations).

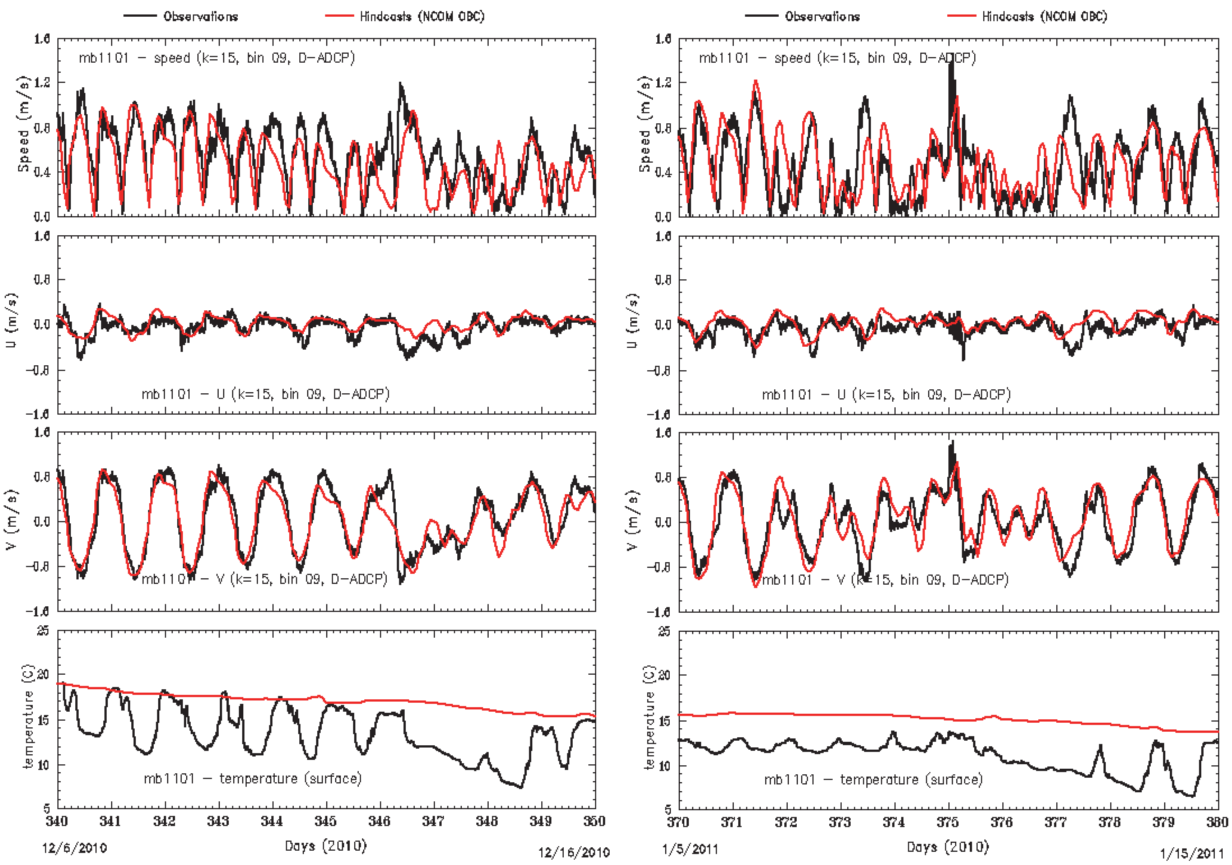


Figure 3.4.26. Current speed, U- and V- velocity, and temperature at ADCP station MOB1101.

4. MODEL SKILL ASSESSMENT

Model simulated results for water levels, currents, salinity and temperature from hindcasts 1 and 2 are compared with observations using NOS standard skill assessment software (Zhang et al., 2006; Zhang et al., 2010) to further quantify the model performance. Some of the statistic parameters in the NOS skill assessment procedures for operational forecast systems (Hess et al, 2003; Zhang et. al., 2006, Zhang et al., 2010) include the Root Mean Squared Error (RMSE), Central Frequency (CF), and Positive Outlier Frequency (POF) and Negative Outlier Frequency (NOF) for hourly records. The NOS standard criteria are greater than 90% for CF and less than 1% for NOF and POF. More detailed definitions of the above parameters can be found in Hess et al., 2003.

Statistical results from the skill assessment for tidal, hindcast, and nowcast/forecast simulations are listed in detail as Appendices B to L. The CF and RMSE are plotted as bar charts and presented in this Section.

4.1. Tidal Simulation

The simulated tidal water levels (at 28 NWLON stations) and tidal currents (at 6 NOS NCOP stations) from the tidal simulation described in Section 3.2 have been evaluated by NOS skill assessment software against the tidal water level and tidal current harmonic predictions. Detailed skill output including all parameters are listed in Appendix B. The key skill variables, RMSE and CF are plotted as bar-charts shown in Figures 4.1.1 and 4.1.2 for tidal water level and tidal current, respectively. Ninety percent of station RMSEs and CFs for tidal amplitude skill meet the NOS criteria. All the tidal current amplitude CFs at NOS NCOP stations meet the NOS criteria but not the time of maximum flood and ebb (Figure 4.1.2).

4.2. Hindcast Water Levels

Model simulated and observed water level time series at 28 NOS coastal stations within the model grid domain are processed and compared with the NOS standard skill assessment software. Detailed skill assessment output, including all parameters, are listed in Appendix C. RMSE and CF are plotted as bar-charts in Figures 4.2.1 (hindcast 1) and 4.2.2 (hindcast 2).

Hindcast 2 water levels are better than hindcast 1. The CF of most stations for both hindcasts is about or above 80%. The reasons for stations with poor CFs and high RMSEs include: (1) stations located inland where the coarse model grid resolution reduced the accuracy (such as stations inside Galveston and Mobile Bays); (2) observed stations located at the entrance of a small bay (such as Calcasieu and Sabine Lakes) not represented in the NGOFS shelf grid; (3) observed stations located at the shoreline where the small scale coastal structures are not represented in the model grid (8731439, Gulfshore, AL and 8729941, Blue Angle, FL); and (4) phase error. The RMSEs for the time of extreme water levels are more than 40 minutes at most of the stations indicating that it is always very difficult for a model to accurately predict the time of extreme water levels.

4.3. Hindcast Currents

Skills for model simulated current speed are computed at stations from the TABS data buoys and NOS CMIST stations. Detail skill assessment output tables are listed in Appendix D. RMSE and CF, are plotted as bart-charts. Figures 4.3.1shows the model current skill bar-chart for 9 TABS data buoy stations for hindcast 1 and Figure 4.3.2 for hindcast 2. Speed RMSEs are on the order of 15 m s^{-1} and CFs either exceed or are close to 90%. Note that the model under-estimated the currents (see current speed time series in Figures 3.3.10 to 3.3.13 for hindcast 1; and Figures 3.4.7 and 3.4.8 for hindcast 2).

Figures 4.3.3 and 4.3.4 show the model skill bar-charts at 6 NOS NCOP current meter stations for hindcast 1 and 4 NOS NCOP current stations for hindcast 2, respectively. The NGOFS model grid covers these station areas with reasonable resolution. In general, hindcast 2 shows better skill assessment results than hindcast 1. For example, the RMSEs of current speed for hindcast 2 are less than 10 cm s^{-1} at Gulfport, MS stations gp0101 and gp0401. Larger RMSEs at the bay entrances, i.e., g06010 at Galveston Bay and mb0101 at Mobile Bay, are due to stronger tidal currents (Figure 3.3.17) between the Bay and the Gulf of Mexico.

Skills for model simulated current directions are computed at the TABS buoys and NOS CMIST stations. Tables in Appendix E list model skills at each station. In general, hindcasted current directions significantly deviated from those of the in-situ observations, with RMSEs typically ranging between 35 and 65 degrees. Note that the area had extremely week tidal currents and hence in reality the principal elliptical tidal current directions as well as the max flood and ebb directions tend to be poorly defined. It does not make much statistical sense to evaluate model results against poorly defined hydrodynamic parameters. Therefore, we judge that the seemingly large model-data discrepancy may not subjectively reflect the model skill and recommend discarding the skill assessment results of the current directions.

4.4. Hindcast Temperature and Salinity

Temperature and salinity skills are computed for TABS, NOS NWLON, NOS NCOP, and IOOS stations. Table 4.1 lists hindcast 1 near surface temperature skill assessment results at 9 TABS stations. Table 4.2 lists hindcast 2 skill assessment results at 9 temperature and 5 salinity TABS sensors. Hindcast 2 temperature RMSEs are about 1.7 ^{0}C, lower than hindcast 1. CFs are about 90% for hindcast 2 while near to or higher than 90% for hindcast 1. Observed salinity data are found in good quality at 5 stations during hindcast 2. Tables 4.1 and 4.2 show that the skill of NGOFS temperature and salinity in the Texas offshore areas meet NOS criteria.

Tables 4.3 and 4.4 list the temperature skill for sensors at NOS NWLON stations. For both hindcast periods, the RMSEs are on the order of 1.5 to 2 C and the statistics of NOF, CF, and POF meet NOS criteria at most stations (e.g., except at station 8770971 Rollover Pass, TX, for hindcast 2, located at the inlet connecting the eastern narrow water body not represented in the model grid (so the model simulated temperature does not have the high frequency tidal signals in the observations) and 8737048, Mobile State Dock, AL, for hindcast 1, located in the north end of Mobile Bay with low grid resolution). The planned nested grid system is expected to improve the model simulated temperature at these locations.

A temperature sensor was attached to most of the ADCP current meters deployed at NOS PORTS locations in the NCOP program. Tables 4.5 and 4.6 list the skills for hindcasts 1 and 2 at NOS NCOP ADCP stations. Since the model simulated temperature at these stations follow very well with observations (shown in Figures 3.3.21 and 3.3.22; and 3.4.17 and 3.4.18), the skills are expected to meet the NOS standard.

In addition to the TABS stations, surface temperature time series at offshore stations within the NGOFS domain are available from IOOS during the hindcast 2 simulation period. Table 4.7 lists the surface temperature skills at these stations. Skills at most of stations satisfy the NOS standards except at station GDQM6 located near an inland marsh not covered by the model grid.

4.5. Mobile Bay Survey Project

The model simulated water level skills at two locations (8733839, Point Clear and 8733821 Meaher State Park) during the MBCS (Patchen et al., 2012) are listed in Table 4.8. The skills are on the same order with other water level gages inside the bay (8737048, Mobile St. Dock – St_Dcks and 8736897, Coast Guard – CG_Mobile, see Figure 3.4.21 for locations) with approximately 0.15 m RMSE and about 70% CF.

The current velocity RMSE and CF skill bar charts at 4 ADCP locations are shown in Figure 4.5.1. The skills are fairly good at all stations except station MOB1106. The model seems simulate the flow correctly from the Gulf of Mexico to the eastern Mississippi Sound through the offshore islands. The reason for model current errors at station MOB1106 needs to be investigated.

The temperature model skills from the 4 ADCP current meters are listed in Table 4.9. Stations MOB1104 and MOB1105 show excellent skills. Poor skills at MOB1101 mainly due to the high frequency tidal signals in the observations that are not accounted for by the model (see Figure 3.4.24). Similar to the current velocity skill at station MOB1106, temperature skill at this station is also poor.

4.6. Operational Nowcast/Forecast

Skill assessment for the NGOFS operational nowcast/forecast from March 2 to May 1, 2012, has been performed and plotted as the bar-charts shown in Figures 4.10 (RMSE) and 4.11 (CF) for water level and Figure 4.12 for surface temperature. There are 10 columns for each station and each represents the skill for, in the column order: nowcast, forecast at hour 1, 6, 12, 18, 24, 36, 42, and 48.

In general, the skill for the nowcast is better than the forecast as expected. For each station, the forecast skill slightly degrades with the time, i.e., increasing RMSE and decreasing CF. Two stations post the worst water level skills; Mississippi River SW Point, LA (probably due to large bathymetry gradient) and Port O'Connor, TX (due to station location inside Matagorda Bay not covered in the NGOFS model grid).

Table 4.1. NGOFS hindcast 1 skill assessment: temperature (T,t) at TABS stations. T: model; t: observation

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
TABSV_B	T-t	9418	1.661	2.057	1.213	0.0	85.0	0.0	0.0	0.0
TABSV_D	T-t	8739	1.907	2.240	1.175	0.0	81.5	0.0	0.0	0.0
TABSV_F	T-t	8728	0.794	1.433	1.192	0.0	98.7	0.0	0.0	0.0
TABSV_J	T-t	5795	1.167	1.982	1.603	0.0	81.3	0.0	0.0	0.0
TABSV_K	T-t	8476	-0.741	2.084	1.948	0.0	85.0	0.0	0.0	0.0
TABSV_N	T-t	9103	-1.122	1.774	1.374	0.0	87.5	0.0	0.0	0.0
TABSV_R	T-t	9260	1.791	2.096	1.090	0.0	86.6	0.0	0.0	0.0
TABSV_V	T-t	3875	0.298	0.653	0.581	0.0	100.0	0.0	0.0	0.0
TABSV_W	T-t	6134	1.243	1.708	1.171	0.0	93.0	0.0	0.0	0.0

Table 4.2. NGOFS hindcast 2 skill assessment: temperature (T,t) and salinity (S,s) at TABS stations. T,S:model; t,s: observation

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
TABS_B	T-t	4369	0.955	1.364	0.975	0.0	99.9	0.0	0.0	0.0
TABS_D	T-t	3919	1.127	1.683	1.250	0.0	97.7	0.0	0.0	0.0
TABS_F	T-t	4240	1.691	1.796	0.606	0.0	99.6	0.0	0.0	0.0
TABS_J	T-t	2974	1.485	1.788	0.996	0.0	95.5	0.2	0.0	3.0
TABS_K	T-t	4040	0.288	0.893	0.846	0.0	97.8	0.0	0.0	0.0
TABS_N	T-t	3648	-0.222	1.511	1.494	0.0	99.6	0.4	0.0	12.0
TABS_R	T-t	2580	1.898	2.023	0.700	0.0	93.7	0.0	0.0	0.0
TABS_V	T-t	1625	-0.407	0.530	0.340	0.0	100.0	0.0	0.0	0.0
TABS_W	T-t	4312	1.066	1.563	1.144	0.0	99.4	0.0	0.0	0.0
TABS_B	S-s	1437	-0.433	2.023	1.976	0.0	90.1	0.0	0.0	0.0
TABS_J	S-s	985	2.322	2.506	0.941	0.0	87.7	0.0	0.0	0.0
TABS_K	S-s	4040	0.483	1.166	1.062	0.0	99.7	0.0	0.0	0.0
TABS_N	S-s	3648	0.224	2.127	2.116	0.0	99.6	0.4	0.0	12.0
TABS_V	S-s	1551	-0.118	0.565	0.552	0.0	99.8	0.0	0.0	0.0

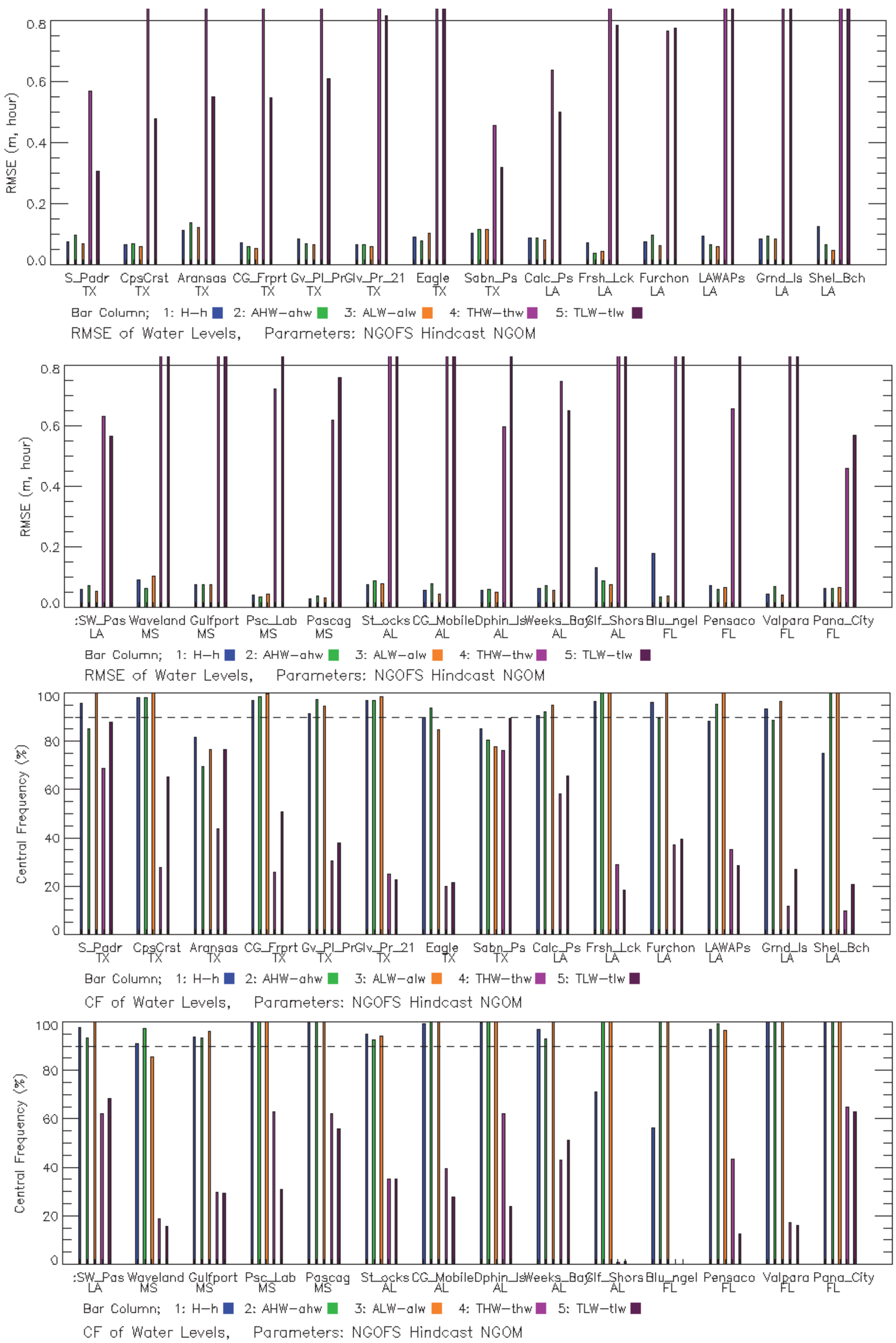
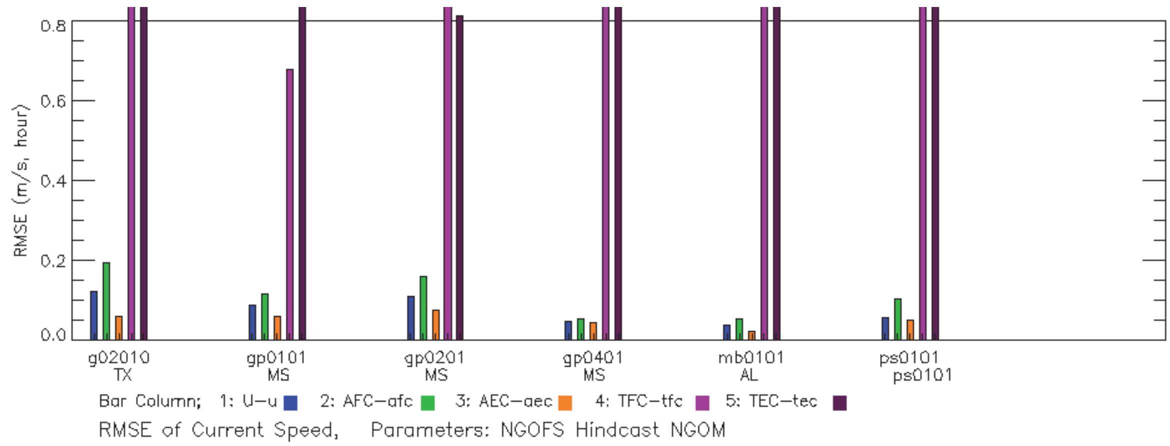


Figure 4.1.1. NGOFS tidal water level skill assessment: RMSE and CF at NOS NWLON stations.



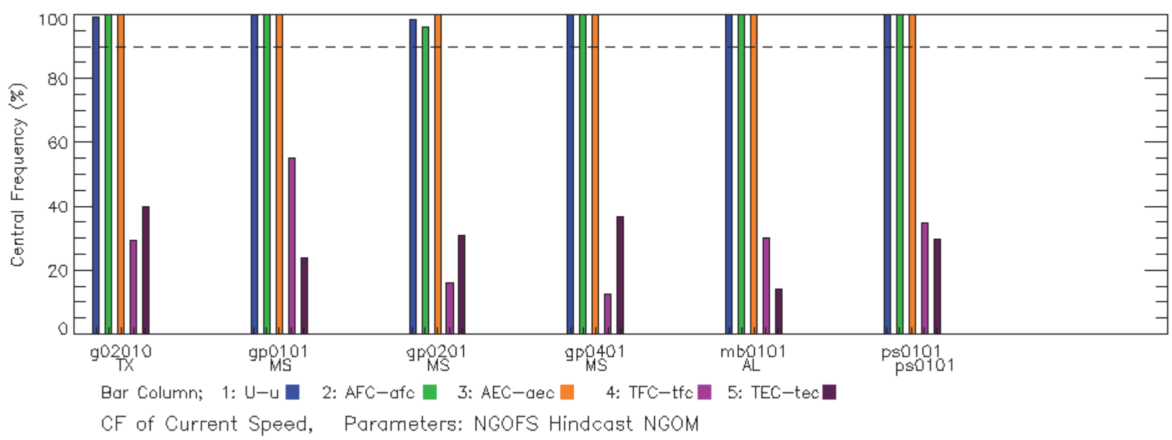


Figure 4.1.2. NGOFS tidal current speed skill assessment: tide current speed RMSE and CF at NOS NCOP stations.

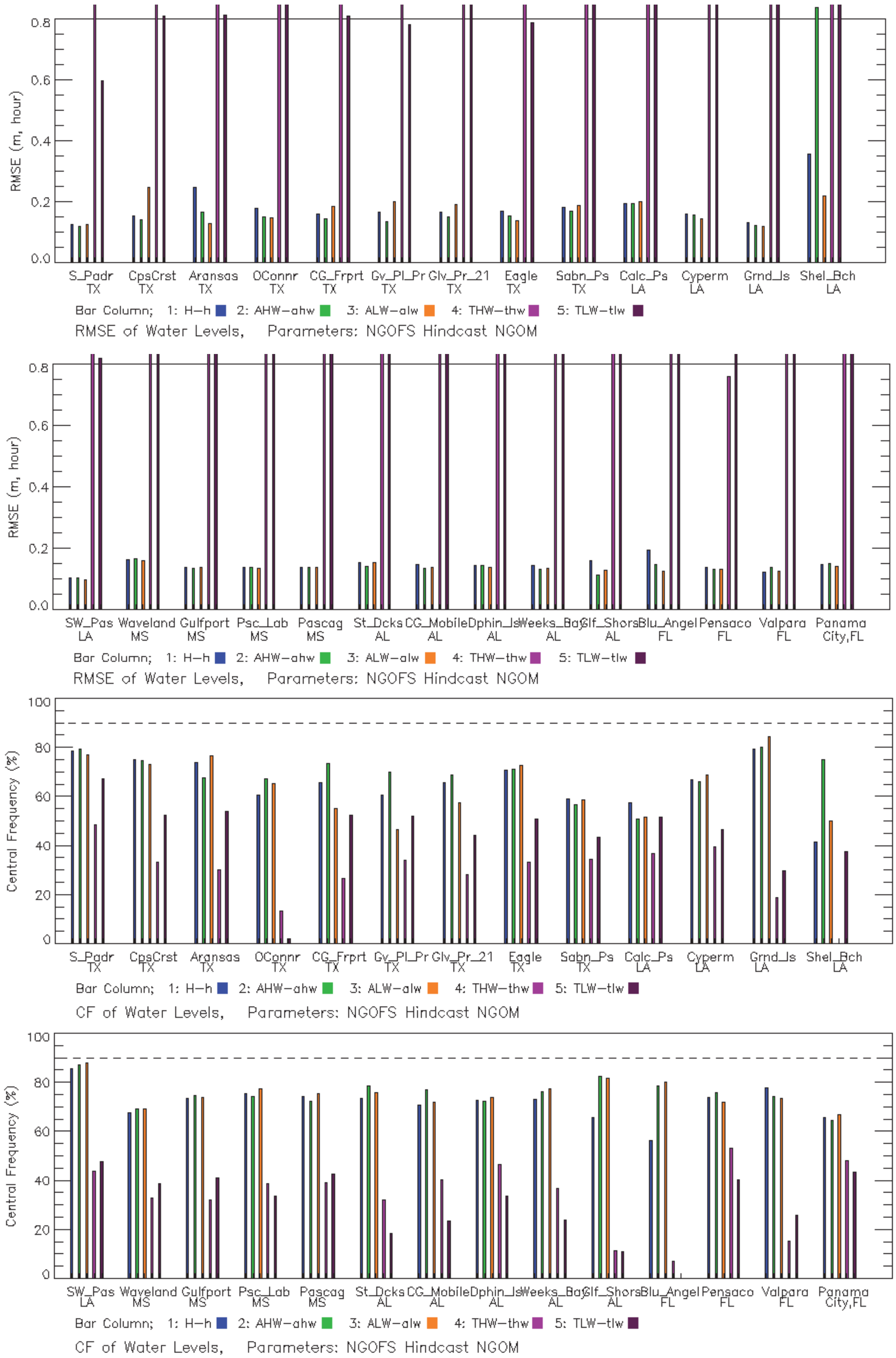


Figure 4.2.1. NGOFS hindcast 1 skill assessment: water level RMSE and CF at NOS NWLON stations.

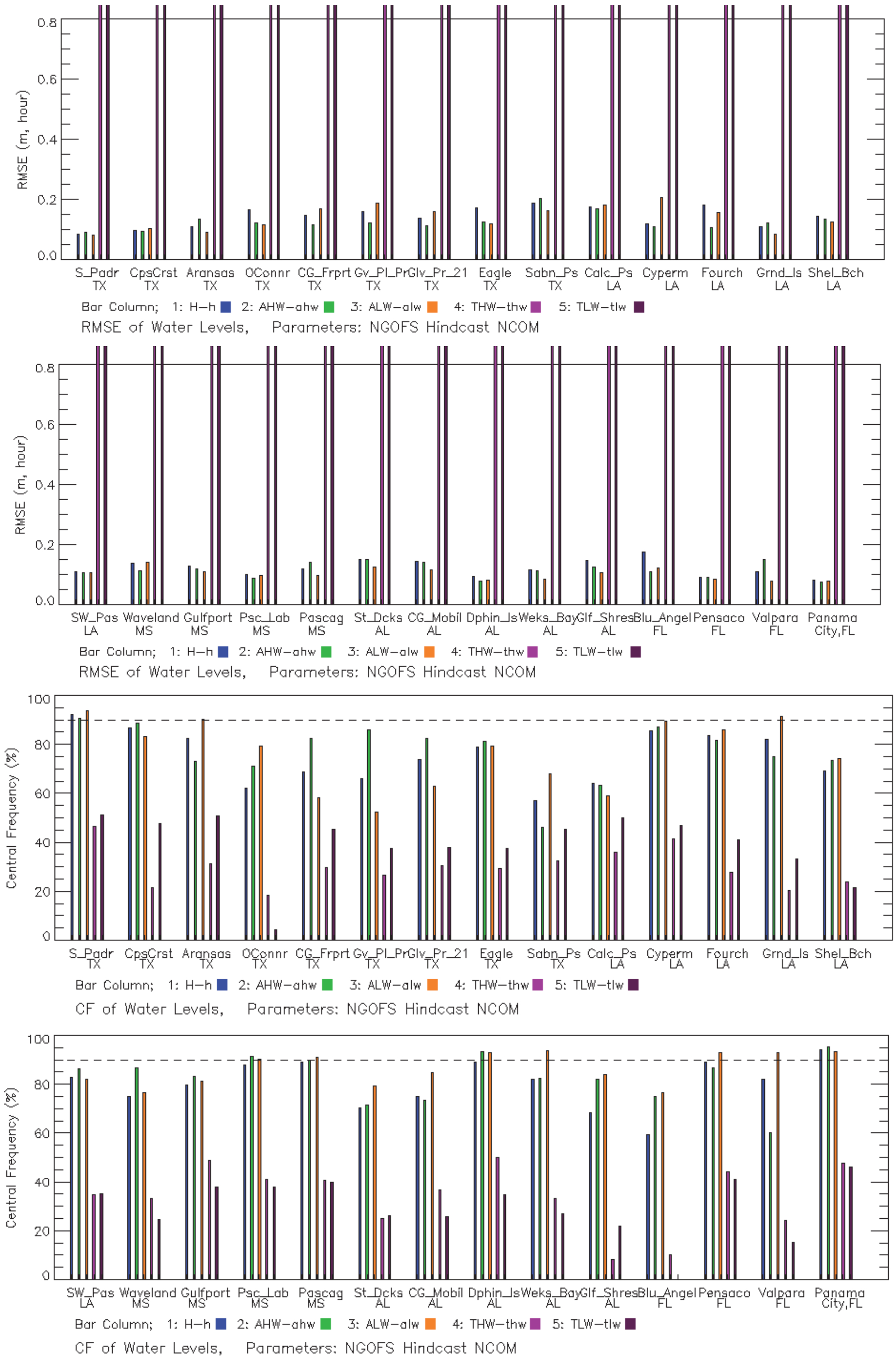


Figure 4.2.2. NGOFS hindcast 2 skill assessment: water level RMSE and CF at NOS NWLON stations.

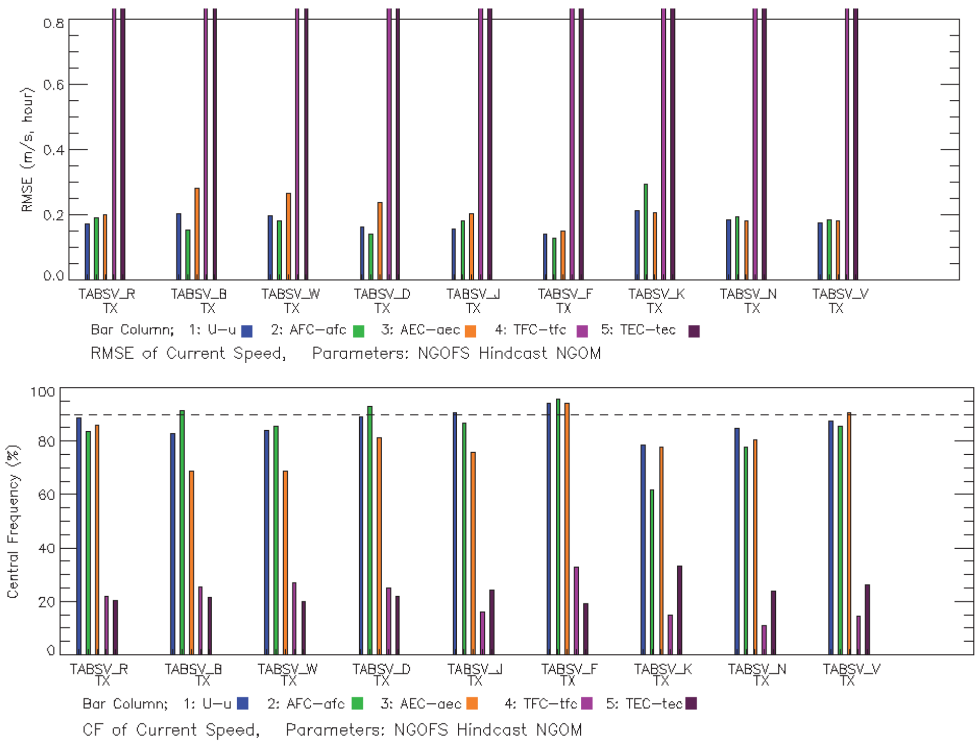


Figure 4.3. 1. NGOFS hindcast 1 skill assessment: current speed RMSE and CF at TABS stations.

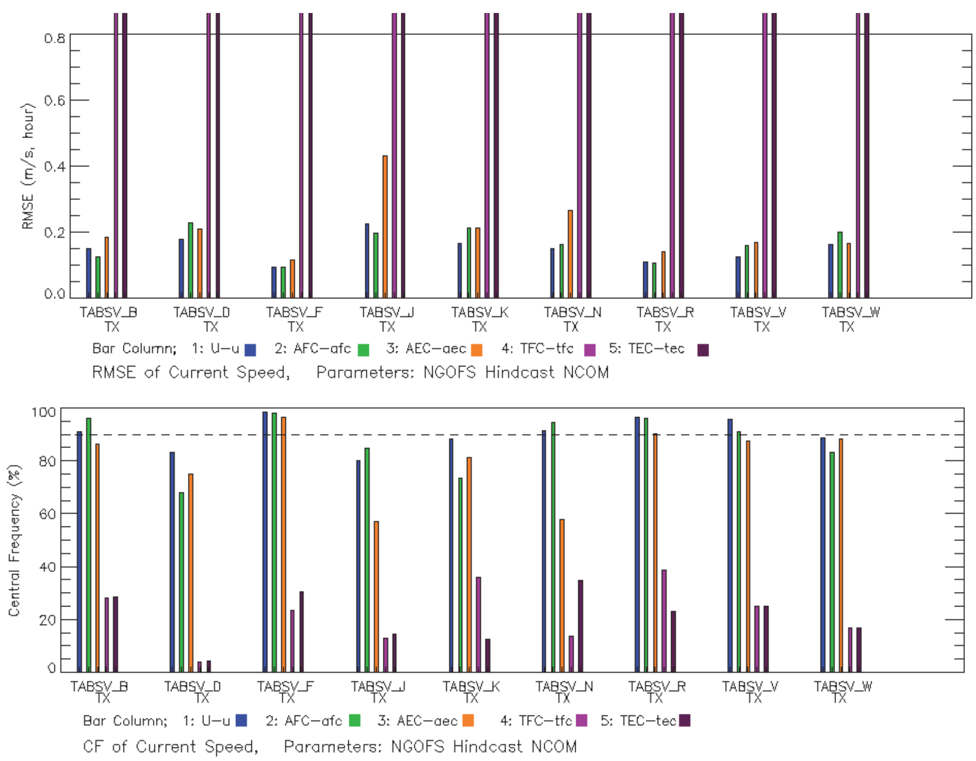


Figure 4.3.2. NGOFS hindcast 2 skill assessment: current speed RMSE and CF at TABS stations.

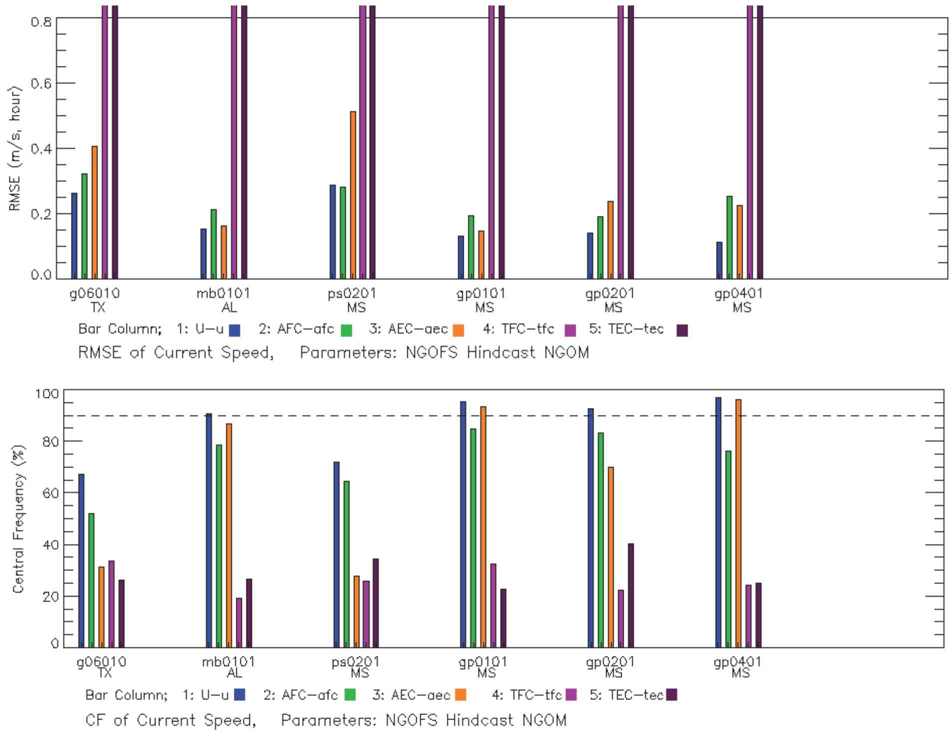


Figure 4.3.3. NGOFS hindcast 1 skill assessment: current speed RMSE and CF at NOS NCOP stations.

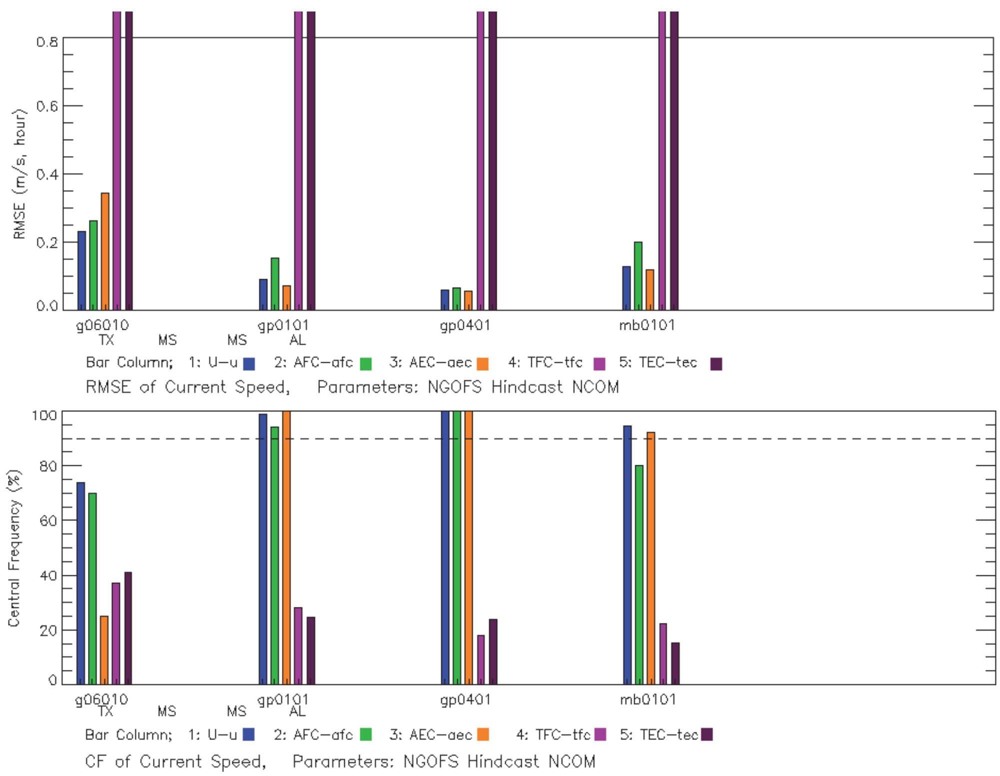


Figure 4.3.4. NGOFS hindcast 2 skill assessment: current speed RMSE and CF at NOS NCOP stations.

Table 4.3. NGOFS hindcast 1 skill assessment: temperature (T,t) at NOS NWLON stations. T: model; t: observation

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
8729840	T-t	9644	0.887	1.493	1.202	0.0	97.2	0.0	0.0	0.0
8735181	T-t	10225	1.220	1.952	1.524	0.0	87.2	0.1	0.0	3.0
8736897	T-t	10206	0.686	1.307	1.113	0.0	98.0	0.0	0.0	0.0
8737048	T-t	8740	2.244	2.792	1.661	0.0	72.9	1.6	0.0	108.0
8741041	T-t	10206	0.078	1.491	1.489	0.0	95.1	0.0	0.0	0.0
8741533	T-t	10171	0.774	1.905	1.740	0.0	90.2	0.0	0.0	0.0
8747437	T-t	9867	0.545	2.362	2.298	0.0	82.9	1.4	0.0	35.0
8764227	T-t	7311	-0.018	2.426	2.426	0.5	80.7	0.9	11.0	16.0
8768094	T-t	9327	1.307	1.922	1.408	0.0	89.9	0.5	0.0	7.0
8770613	T-t	6056	1.101	1.385	0.840	0.0	98.4	0.0	0.0	0.0
8772447	T-t	10076	1.245	1.852	1.371	0.0	89.2	0.0	0.0	0.0
8775870	T-t	10169	1.352	2.123	1.637	0.0	82.1	0.0	0.0	0.0
8779748	T-t	5271	1.977	2.804	1.989	0.0	70.9	2.7	0.0	14.0

Table 4.4. NGOFS hindcast2 skill assessment: temperature (T,t) at NOS NWLON stations. T: model; t: observation

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
8729804	T-t	4369	0.496	1.130	1.015	0.0	98.8	0.0	0.0	0.0
8735180	T-t	2956	0.289	1.817	1.794	0.0	91.4	0.0	0.0	0.0
8736897	T-t	4369	-1.104	1.563	1.106	0.0	95.9	0.0	0.0	0.0
8737048	T-t	4369	1.516	2.004	1.311	0.0	85.0	0.0	0.0	0.0
8741041	T-t	4369	-1.584	2.193	1.517	0.0	79.5	0.0	0.0	0.0
8741533	T-t	4369	0.069	1.092	1.090	0.0	97.2	0.0	0.0	0.0
8747437	T-t	4255	0.613	1.982	1.885	0.0	87.1	0.4	0.0	8.0
8761305	T-t	3558	0.369	1.685	1.645	0.0	91.7	0.0	0.0	0.0
8761724	T-t	4263	1.184	2.059	1.685	0.0	86.0	0.7	0.0	18.0
8768094	T-t	4242	0.695	1.830	1.693	0.0	90.0	0.1	0.0	4.0
8770570	T-t	4369	0.399	1.658	1.609	0.0	94.9	0.0	0.0	0.0
8770613	T-t	4369	-0.454	1.561	1.493	0.1	90.2	0.0	2.0	0.0
8770971	T-t	4369	0.493	2.813	2.770	0.6	73.9	3.6	5.0	17.0
8775237	T-t	4369	1.398	2.218	1.722	0.0	83.5	0.0	0.0	0.0
8775870	T-t	4369	0.935	1.935	1.694	0.0	90.4	0.0	0.0	0.0

Table 4.5. NGOFS hindcast 1skill assessment: temperature at NOS NCOP stations

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
gp0101	T-t	2689	1.463	1.643	0.748	0.0	96.9	0.0	0.0	0.0
gp0201	T-t	2489	2.052	2.272	0.976	0.0	84.7	0.2	0.0	2.0
gp0401	T-t	2481	2.505	2.771	1.185	0.0	68.8	0.0	0.0	0.0
mb0101	T-t	2924	1.253	2.122	1.712	0.0	84.6	0.4	0.0	3.0
mb0301	T-t	2602	0.719	1.505	1.323	0.0	93.2	0.0	0.0	0.0
ps0201	T-t	2563	1.457	2.052	1.446	0.0	86.1	1.2	0.0	12.0
ps0301	T-t	2454	1.732	2.030	1.059	0.0	86.2	0.0	0.0	0.0

Table 4.6. NGOFS hindcast 2 skill assessment: temperature at NOS NCOP stations

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station	VAR	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
g06010	T-t	1047	0.404	1.546	1.493	0.0	97.4	0.0	0.0	0.0
gp0101	T-t	1857	0.868	1.053	0.597	0.0	99.9	0.0	0.0	0.0
gp0201	T-t	1554	0.470	1.407	1.327	0.0	96.8	0.0	0.0	0.0
gp0401	T-t	2014	1.216	1.709	1.201	0.0	97.5	0.0	0.0	0.0
lc0101	T-t	2085	1.655	1.940	1.012	0.0	92.5	0.1	0.0	2.0
mb0101	T-t	2428	1.795	1.993	0.867	0.0	92.0	0.0	0.0	0.0
mb0301	T-t	2157	-0.826	1.319	1.029	0.0	96.6	0.0	0.0	0.0
mb0401	T-t	1886	-0.774	1.036	0.689	0.0	99.5	0.0	0.0	0.0
ps0201	T-t	1752	0.369	1.304	1.251	0.0	98.1	0.1	0.0	1.0
ps0401	T-t	1243	0.694	1.723	1.577	0.0	96.2	0.2	0.0	1.0
sn0101	T-t	2024	1.716	1.996	1.020	0.0	90.6	0.0	0.0	0.0

Table 4.7. NGOFS hindcast 2 skill assessment: temperature at IOOS stations

CRITERION	-	-	-	-		<1%	>90%	<1%	<N	<N
Station		IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO
PTAT2	Aransas, TX	2576	1.670	1.926	0.961	0.0	91.7	0.0	0.0	0.0
42020	LLNR 1330, TX	3216	-0.870	1.267	0.920	0.0	98.8	0.0	0.0	0.0
42019	LLNR 1205, TX	1015	-0.189	0.533	0.498	0.0	100.0	0.0	0.0	0.0
42035	LLNR 1145, TX	3205	1.605	1.884	0.986	0.0	97.5	0.0	0.0	0.0
SPLL1	S. Timbalier, LA	2960	1.226	1.461	0.796	0.0	99.1	0.0	0.0	0.0
ILDL1	Is Dernier, LA	1575	0.104	1.628	1.625	0.0	93.5	0.0	0.0	0.0
42040	Lake Offsh, AL	2418	-0.275	1.346	1.318	0.0	96.8	0.0	0.0	0.0
42012	Orange Beach, AL	3216	1.502	1.846	1.073	0.0	90.0	0.0	0.0	0.0
GDQM6	Grand Bay, MS	133	1.666	2.941	2.424	0.0	76.1	3.7	0.0	7.0
DPHA1	Dauphin Is, AL	2122	1.234	2.849	2.569	0.0	84.4	0.0	0.0	0.0
BSCA1	Bon Secour, AL	2483	0.137	6.733	6.733	0.5	94.3	0.0	11.0	0.0

Table 4.8. NGOFS hindcast 2 skill assessment: water level stations from the MBCS project. Model (H,AHW,ALW,THW,TLW), Observations (h,ahw,alw,thw,tlw)

CRITERION Station	- VAR	- IMAX	- SM	- RMSE	SD	<1% NOF	>90% CF	<1% POF	<N MDNO	<N MDPO
8733839 Point Clear, Al										
H-h		1941	0.069	0.134	0.115	0.0	72.5	2.3	0.0	6.0
AHW-ahw		73	0.090	0.138	0.105	0.0	71.2	0.0	0.0	0.0
ALW-alw		72	0.040	0.112	0.105	0.0	90.3	4.2	0.0	0.0
THW-thw		73	-0.137	1.098	1.097	21.9	32.9	13.7	0.0	0.0
TLW-tlw		72	-0.430	1.124	1.046	27.8	23.6	9.0	0.0	0.0
8733821 Meaher State Park, AL										
H-h		1945	0.072	0.157	0.139	0.1	69.7	6.9	0.0	13.0
AHW-ahw		74	0.097	0.161	0.129	0.0	71.6	8.1	0.0	0.0
ALW-alw		54	0.013	0.096	0.096	0.0	88.9	1.9	0.0	0.0
THW-thw		74	-0.338	1.180	1.138	24.3	29.7	9.5	0.0	0.0
TLW-tlw		54	-1.167	1.484	0.927	55.6	13.0	1.9	0.0	0.0

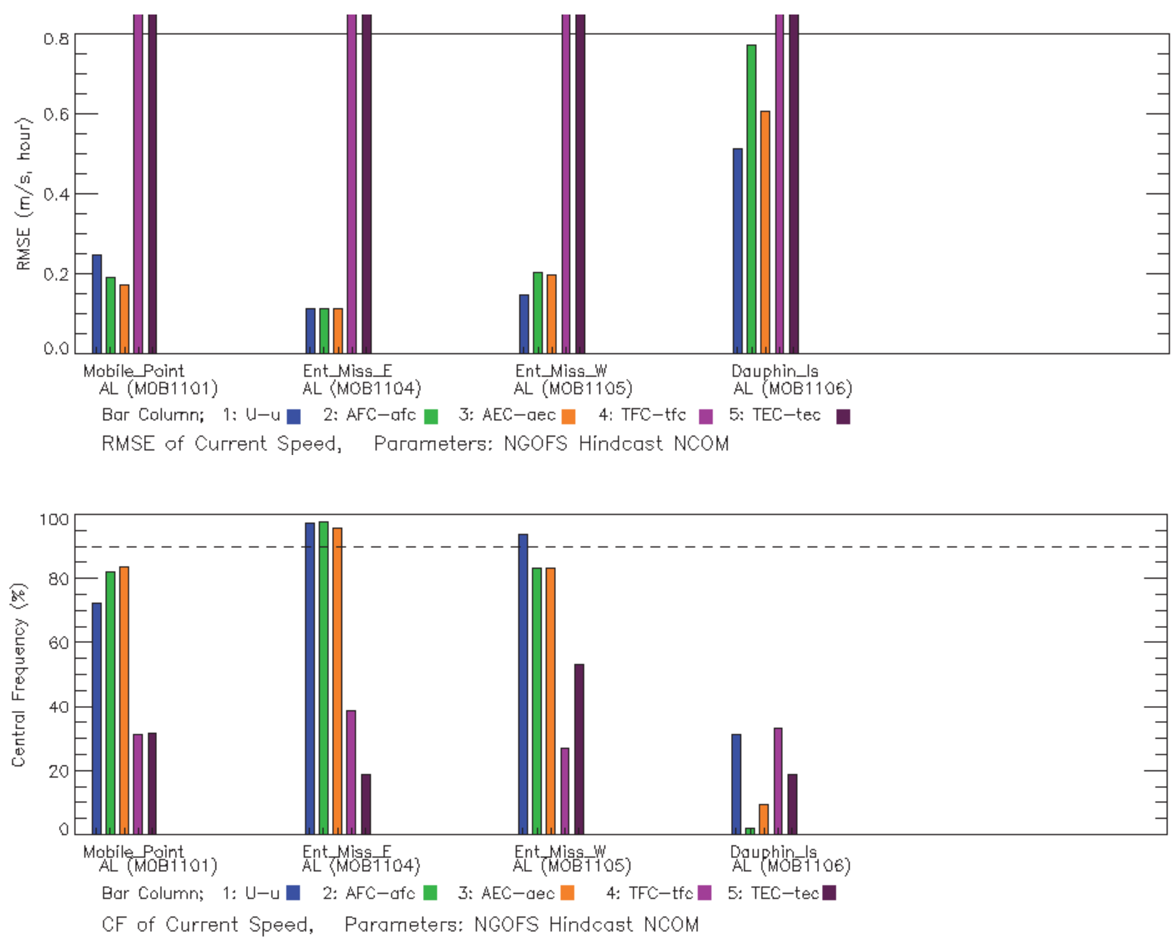


Figure 4.5.1. NGOFS skill assessment: current speed RMSE and CF at stations for the Mobile Bay Collaborative Survey project.

Table 4.9. NGOFS skill assessment: temperature (T,t) at stations for MBCS project. T: model; t: observations

CRITERION Station	VAR	- IMAX	- SM	- RMSE	- SD	<1% NOF	>90% CF	<1% POF	<N MDNO	<N MDPO
MOB1101	T-t	1920	2.832	3.351	1.791	0.0	60.0	5.8	0.0	32.0
MOB1104	T-t	1920	-1.604	1.852	0.927	0.0	96.1	0.0	0.0	0.0
MOB1105	T-t	1921	-0.089	0.988	0.984	0.0	99.1	0.0	0.0	0.0
MOB1106	T-t	1374	4.451	4.651	1.348	0.0	17.4	16.5	0.0	66.0

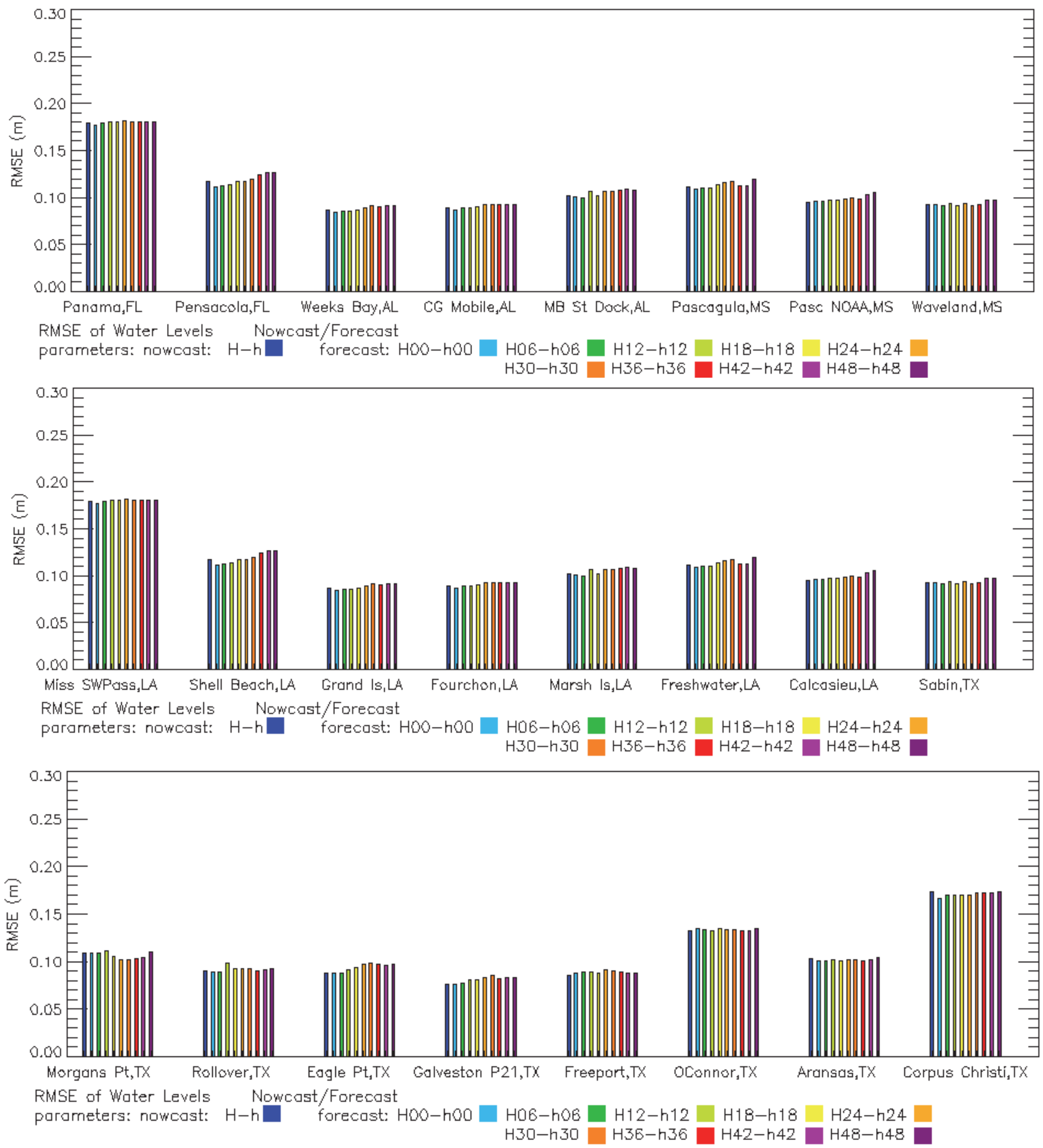


Figure 4.6.1. NGOFS operational nowcast/forecast skill assessment: water level RMSE at NOS NWLON stations.

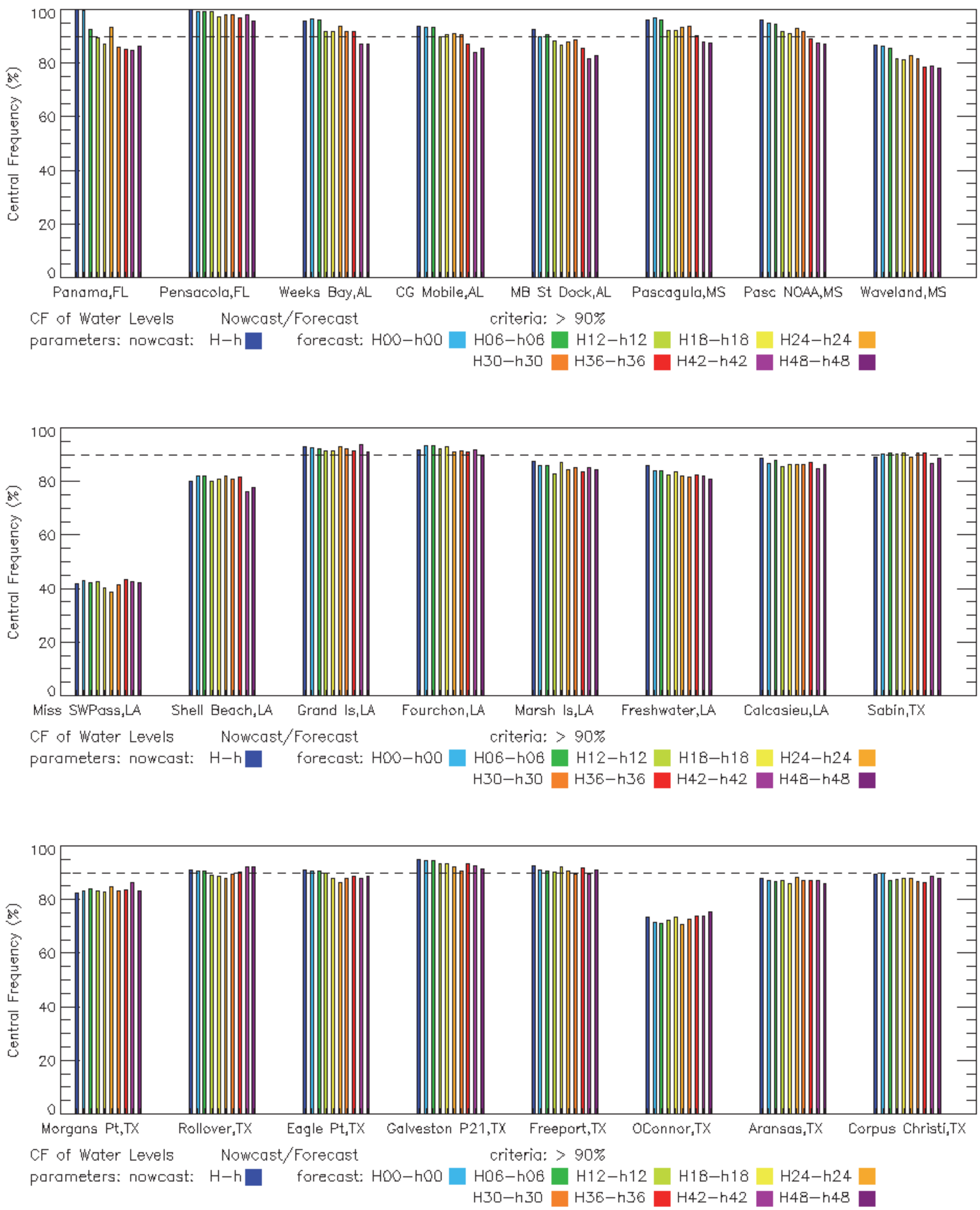


Figure 4.6.2. NGOFS operational nowcast/forecast skill assessment: water level CF at NOS NWLON stations.

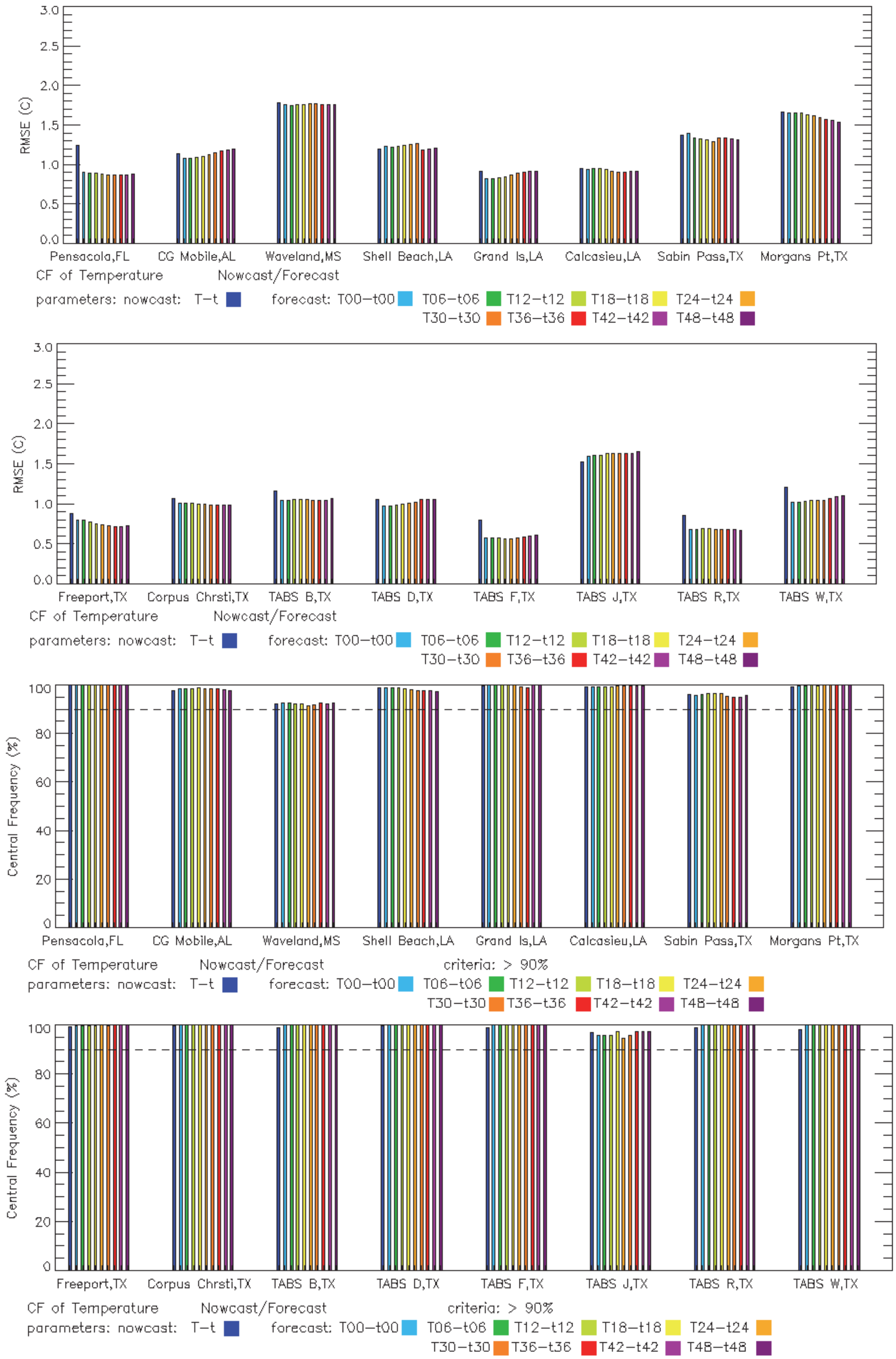


Figure 4.6.3. NGOFS operational run skill assessment: temperature RMSE and CF at NOS NWLON stations.

5. MOBILE BAY CTD MEASUREMENTS SKILL ASSESSMENT

This chapter discusses results of the NGOFS skill assessment using the CTD data collected during the Mobile Bay Collaborative Survey (Patchen et al., 2012). The CTD measurements were carried out either through CTD hand casts at discrete stations or through transect surveys with the CTD onboard an autonomous underwater vehicle (AUV). The casts were deployed separately by the OCS/CSDL's Hydrographic Systems and Technology Programs (HSTP) Branch, OCS's Navigation Services Division (NSD), and CO-OPS. They returned profiling data of temperature, salinity, and density. The AUV-CTD surveys were conducted by CSDL's HSTP.

NGOFS outputs were recorded at six-minute intervals for skill assessment. These include station time series collocated with the CTD casts and three-dimensional whole domain T/S fields outputs. To foster model-data comparison, the station data were interpolated onto the time instances and depths coincident with the CTD cast measurements; the field outputs were interpolated in both time and spatial domains to be coincident with times and locations of the AUV-CTD measurements.

To conduct model skill assessment, we compared model results with observations through both visual and quantitative analysis. Plots of T/S and density profiles from both NGOFS and CTD measurements were contrasted to provide visual evaluation on the model performance. We estimated the model error statistics in terms of mean, minimum, maximum, root-mean-squares (rms), and histograms. We also investigated the geographical distribution of model skill by hindcast water column stratification.

In the following, we describe the skill assessment results separately for the aforementioned four datasets from different sections. Sections 5.1-3 discuss results from using profiling data collected by HSTP, NSD, and CO-OPS, respectively. Section 5.4 discusses results from using the HSTP's AUV-CTD transect data. Section 5.5 summarizes the skill assessment results.

5.1. CTD Measurements by CSDL/HSTP

This section discusses skill assessment against the temperature and salinity, and density profiling data from HSTP CTD cast measurements. Section 5.1.1 describes the meta-data information about the CTD deployment. Section 5.1.2 discusses the method and results of model-data comparisons.

5.1.1. Data Description

HSTP deployed a total of 82 CTD hand casts on 4 November and 10-14 November, 2010. The 82 casts returned 78 valid T (S, and density) profiles which were used in the present model skill assessment. Appendix F tabulates the meta-data of the casts including their IDs, locations, and dates/times. They were deployed in the mid- to lower Bay region. Figure 5.1 displays a map of deployment locations.

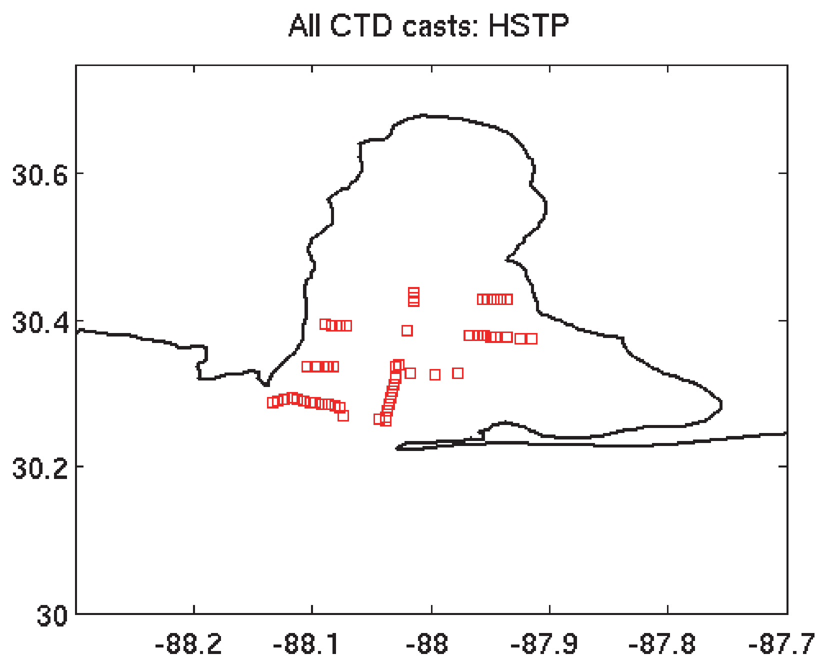


Figure 5.1. Deployment sites of 78 HSTP CTD casts.

5.1.2. Model-Data Comparison

Profiles Model time series of water level and temperature/salinity profiles at stations collocated with each of the 78 CTD stations (Figure 5.1) were recorded at a six-minute interval. Model outputs were interpolated in the time domain to be coincident with the CTD cast time. We then interpolated each T, S, or density profile from its native NGOFS' sigma coordinate onto the CTD data depths.

Figure 5.2 illustrates temperature, salinity, and density profiles from NGOFS and CTD measurements at stations 4 and 5; see Appendix F for the station information. Similar plots corresponding to the complete 78 casts are shown in Appendix G.

For each T, S, or density profile, we took the average of the model-data differences along the profile to derive an averaged model error for the profile. In the following, we refer the average T, S, or density error as to Δ_T, Δ_S, or $\Delta_{\sigma t}$, respectively. Over the 78 stations, this resulted in 78 error values for each variable. We computed their mean, minimum, maximum, root mean square (rms) and listed the results in Table 5.1.

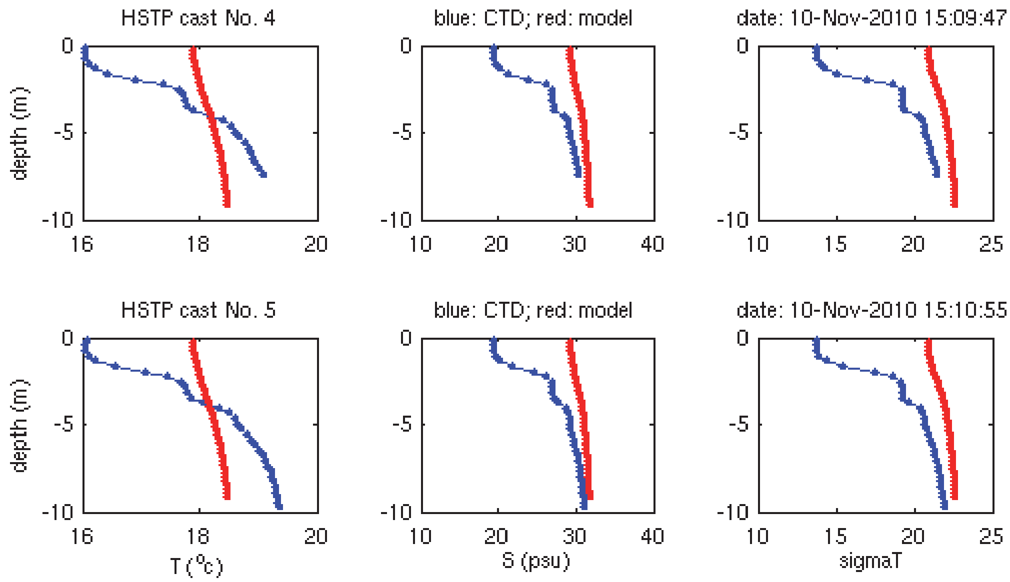


Figure 5.2. Sample plots of temperature, salinity, and density profiles from NGOFS hindcast (red lines) and HSTP CTD measurement (blue lines) at stations 4 and 5.

Table 5.1. Statistics of NGOFS errors with respect to HSTP CTD profiling data

Model errors (Δ)	Mean (Δ)	min(|Δ|)	max(|Δ|)	rms (Δ)
Δ_T (°C)	0.778	0.021	2.728	1.12
Δ_S (psu)	3.355	0.045	10.101	4.279
$\Delta_{\sigma t}$	2.368	0.015	7.016	3.042

The temperature error averages to be 0.8 °C with a maximum magnitude of 2.7 °C and an rms of 1.1 °C; The salinity error averages to be 3.4 psu with a maximum of 10.1 psu, and an rms of 4.3 psu. The density error averages to be 2.4 σ_t with a maximum of 7.0 $\Delta_{\sigma t}$ and an rms of 3.0 σ_t.

The NGOFS hindcasted a much smaller surface-to-bottom range of temperature, salinity, or density than that revealed in the CTD observations; see figures in Appendix G. This indicates that NGOFS underpredicted the water stratification. To quantify the model-data discrepancy, we computed a stratification index (SI) = $|X_b^o - X_s^o| - |X_b^m - X_s^m|$, where X represents T, S, or σ_t, superscripts *m* and *o* denote, respectively, model results and observational data, and subscripts b and s denote, respectively, bottom or surface layer values. SI depicts the model-data discrepancy of surface to bottom ranges of temperature, salinity, or density. Table 5.2 lists the mean and standard deviation of the temperature, salinity, and density index of the total 78 profiles. On average, NGOFS underpredicted the surface-to-bottom difference by 0.9 °C, 5.5 psu, and 4.0 σ_t for T, S, and density, respectively.

Table 5.2. Stratification indices (SIs) for HSTP CTD profiles

Property	mean (SI)	Std (SI)
SI_T (^oC)	0.91	0.89
SI_S (psu)	5.51	3.31
$SI_{\sigma t}$ (σ_t)	4.00	2.33

Error Maps Figures 5.3a-c display color-coded NGOFS error maps for the T, S, and density fields, respectively. The maps illustrate the geographical distribution of various error fields.

Stations along the central Bay dredged channel and in the eastern Bay demonstrate favorable model-data agreement, where the model error lay between -1.0 ^oC and 1.0 ^oC. The western Bay stations exhibit greater errors up to 3 ^oC.

The salinity error lay between -3 and 3 psu. Along the mid-Bay channel, NGOFS underpredicted salinity by 0.5-3 psu. However, it overpredicted salinity in the other regions. Some Bay mouth stations demonstrate notably larger errors of 3-10 psu. The density error field displays a similar spatial pattern to that of the salinity. NGOFS slightly underpredicted density at mid-Bay stations and overpredicted it by 4-8 σ_t at Bay entrance stations.

Histogram of Model Errors Figures 5.4a-c show model error histograms for T, S, and density, respectively. For temperature, more than 90% of the error values fell into a range between ±2.5 ^oC; more than 9% lie between ±2.5 ^oC and the remaining 1% are between 2.5-4.5 ^oC. In addition, Figure 5.4a indicates that the model error skewed toward the positive regime. This means that NGOFS tended to overpredict water temperature.

For salinity, nearly 50% of the error values fall into a range between ±2.5 psu. The remaining half lies between -16 and -2.5 psu. The histogram peaked around 2.5 psu. This indicates that NGOFS tended to overpredict the salinity field.

The histogram of density errors displays a similar pattern to that of the salinity. About 50% of error values range between ±2.5 σ_t and the remaining lies mostly between -22.5 and -2.5 σ_t.

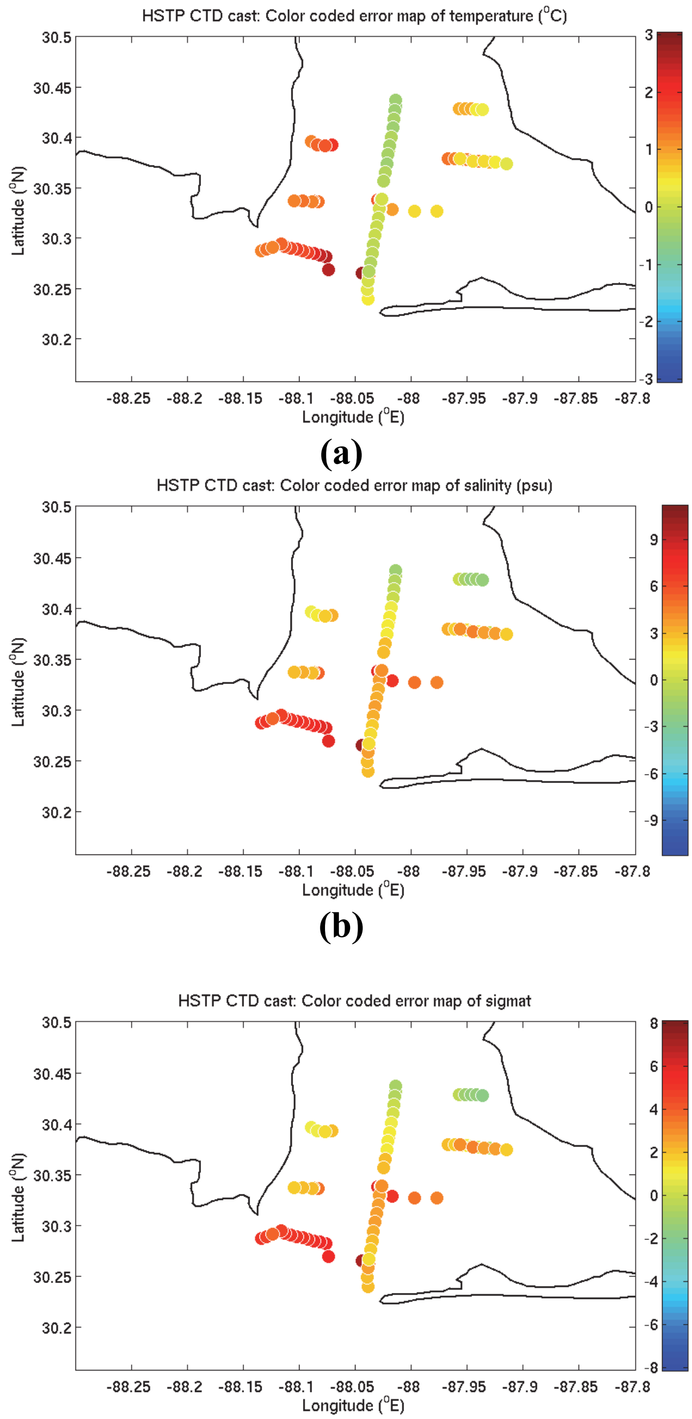


Figure 5.3. Maps of color-coded model errors for (a) temperature, (b) salinity, and (c) density at HSTP CTD stations.

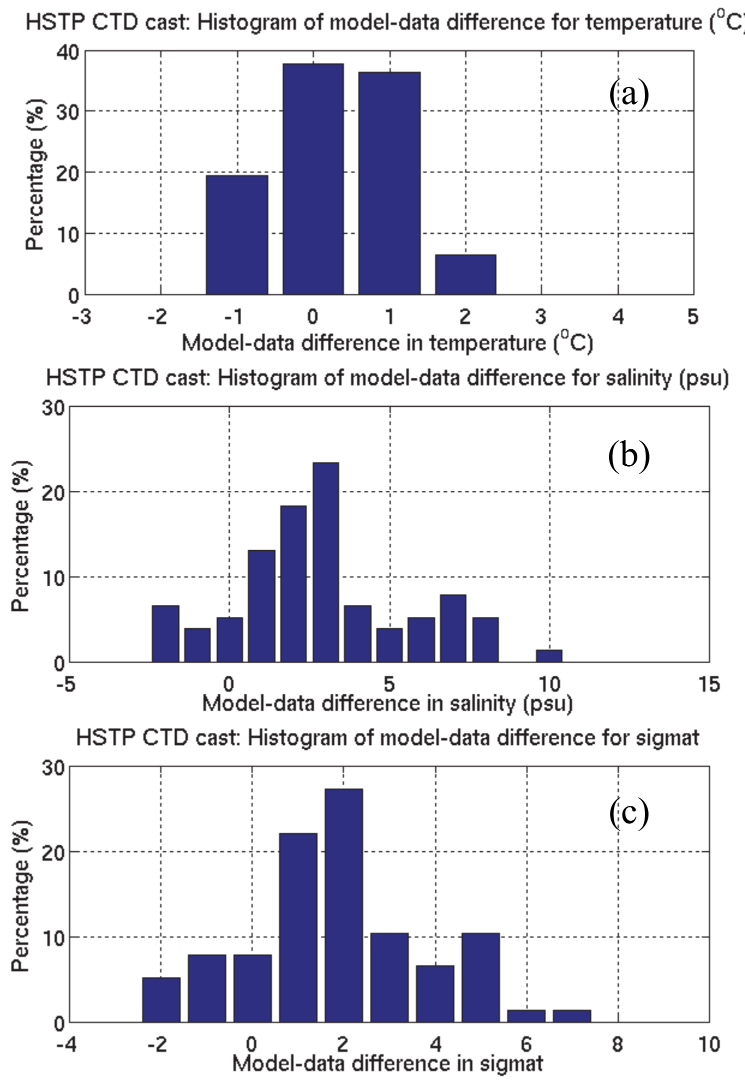


Figure 5.4. Histograms of model errors for (a) temperature, (b) salinity, and (c) density from comparing NGOFS results with the HSTP CTD cast data.

5.2. CTD Casts Measurements of OCS/NSD

This section discusses NGOFS skill assessment against the NSD CTD temperature and salinity profiling data. Section 5.2.1 describes the meta-data for each cast. Section 5.2.2 discusses the model-data comparison methods and results.

5.2.1. Data Description

NSD deployed a total of 87 CTD casts on January 16 and 18-20, 2011. Appendix H lists the cast ID, deployment position, and date/time. The casts were deployed in the mid- to lower Bay region. Figure 5.5 shows a map of the station locations.

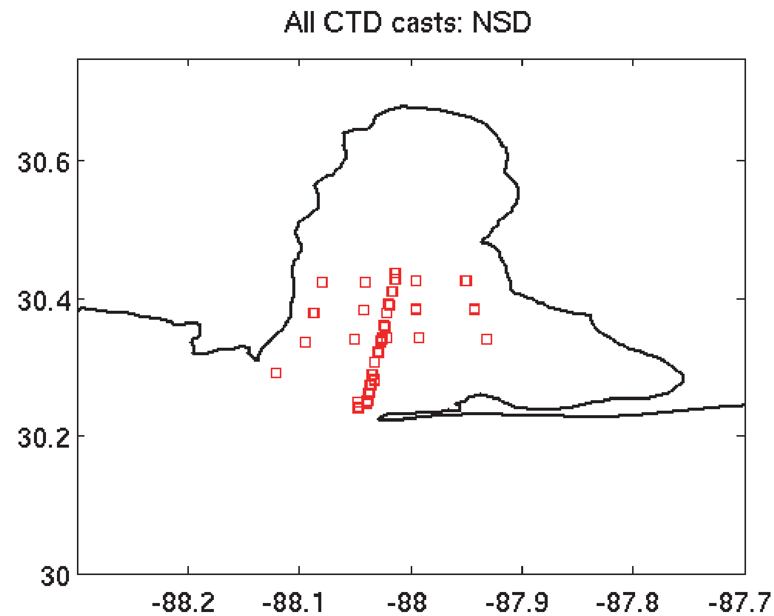


Figure 5.5. Deployment sites of 87 NSD CTD casts.

5.2.2. Model-Data Comparison

Profiles Using the same method as described in Section 5.1.2, we interpolated NGOFS station outputs of T, S, and density profiles onto time instances and depths coincident with the CTD measurements and computed averaged model errors for each profile. We then estimated the mean, minimum, maximum, and rms of the average errors of the total 87 stations and listed the results in Table 5.3.

Table 5.3. Statistics of model-data differences for NSD CTD profiles

Model–data difference (Δ)	mean (Δ)	min(|Δ|)	max(|Δ|)	rms (Δ)
Δ_T (^oC)	1.119	0.053	4.883	1.528
Δ_S (psu)	-7.137	0.113	19.635	8.878
$\Delta_{\sigma t}$ (σ_t)	-5.692	0.214	15.224	6.934

Figure 5.6 displays T, S, and density profiles of both NGOFS results and CTD measurements at stations 19 and 20 (see Appendix H for station information). Similar plots for the entire 87 casts are shown in Appendix I.

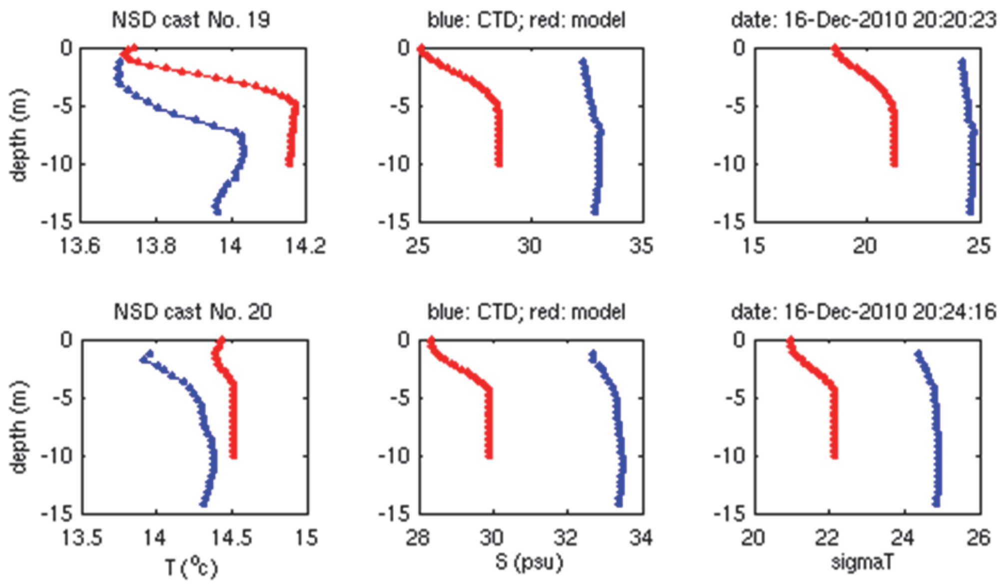


Figure 5.6. Sample plots of temperature, salinity, and σ_t profiles from NGOFS (red lines) and NSD CTD measurements (blue lines) at stations 19 and 20.

Of the 87 stations, the temperature error averages to be 1.1 ^oC with a maximum magnitude of 4.9 ^oC and an rms error of 1.5 ^oC (Table 5.3). At nearly all 87 stations, NGOFS predicted slightly higher surface temperatures than the CTD measurements; in deeper waters, the NGOFS temperature appeared to be either higher or lower than observations. In general the model-data discrepancy decreased with increasing depths.

NGOFS underpredicted salinity through the entire water column. Model errors average to be -7.1 psu with an rms equal to 8.9 psu (Table 5.3). The maximum error appears to be $|\Delta_S|$~19.6 psu. In general, model errors decrease with increasing depths. As a dependent variable of T and S, the model density error averaged to be 2.4 σ_t with a $\max(|\Delta_{\sigma t}|)$=15.2 σ_t and an rms error of 6.9 σ_t.

At nearly all 87 stations NGOFS hindcasted remarkably smaller surface-to -bottom ranges of temperature, salinity, or density than observations. Table 5.5 lists the mean and std of temperature (salinity, and density) stratification indices (Section 5.1.2) of the 87 stations. Compared with observations, NGOFS underpredicted the range by 0.9 ^oC, 5.5 psu, and 4.0 σ_t for temperature, salinity, and density, respectively.

Table 5.4. Stratification indices for NSD CTD profiles

Property	mean (SI)	Std (SI)
SI_T (°C)	1.16	1.22
SI_S (psu)	6.01	4.78
$SI_{\sigma t}$ (σ_t)	4.48	3.56

Error Maps Figures 5.7a-c display color-coded NGOFS error maps for T, S, and density, respectively. The maps reveal the geographical distribution of various error fields.

Temperature errors are less than 2.5 °C at almost all stations except a couple of stations near the southern end of the central Bay dredged channel where NGOFS exhibits errors up to 5.0 °C. In general, NGOFS demonstrated better skill in the mid-Bay region than in the lower Bay region.

NGOFS underpredicted both salinity and density. The salinity error ranges between -6 and -20 psu in mid-Bay. Its magnitude decreased to less than 3 psu in the lower Bay. The error field seemed to be irrelevant to local bottom topography. For instance, in the mid-Bay region the error range remained the same in both the deep dredged channel and shallower nearshore waters.

The density error map displays a similar pattern to the salinity. NGOFS underpredicted density by about 10 σ_t in the mid-Bay region. The error reduced to a magnitude less than 4 σ_t near the Bay entrance.

Histogram of Model Errors Figures 5.8a-c show model error histograms for T, S, and density, respectively. For temperature, over 86% of model error values lay between ±2.5 °C; nearly 12% were less than 2.5 °C; and the remaining 2% range between 2.5-4.5 °C. The histogram peak skewed toward the positive regime. This indicated that NGOFS tended to overpredict the in situ temperature.

For salinity, model errors spanned nearly evenly across a band between -12.5 psu and -2.5 psu. This is consistent with the features revealed in Figure 5.8b that NGOFS significantly underpredicted salinity. Unsurprisingly, NGOFS underpredicted water density. Figure 5.8c shows that over 90% of density errors fell between -16.5 σ_t and -1.5 σ_t.

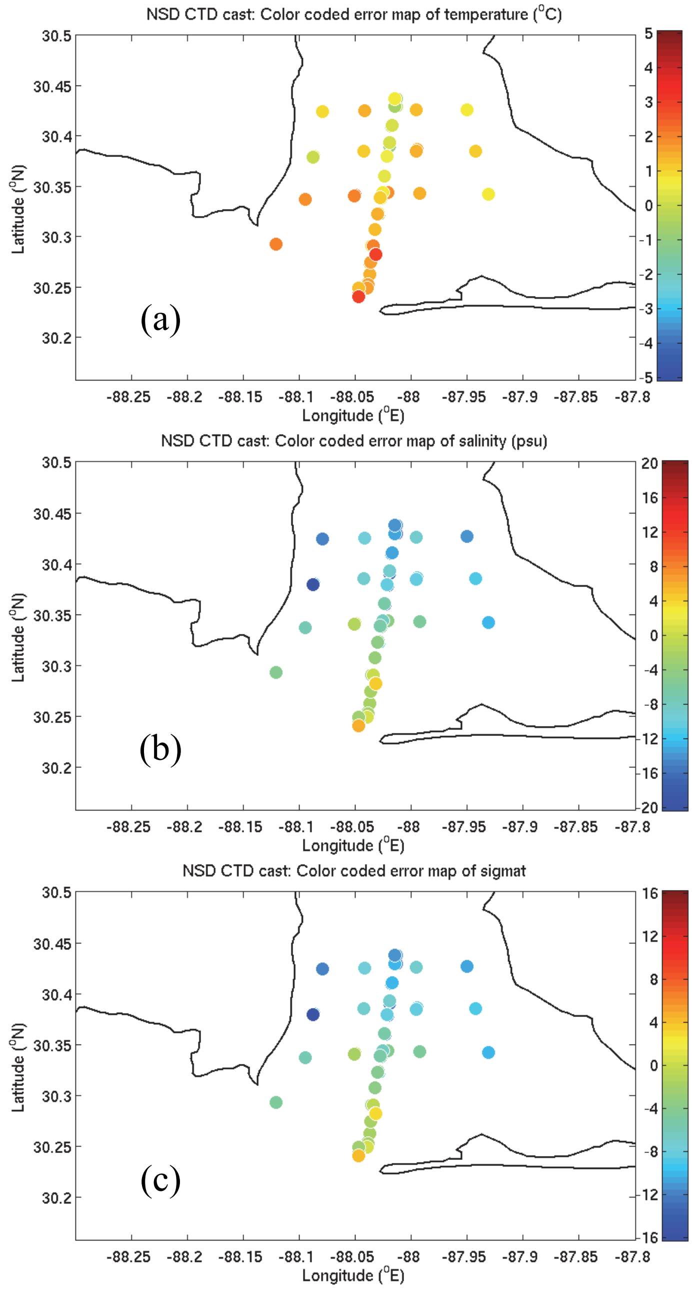


Figure 5.7. Map of color-coded model errors of (a) temperature, (b) salinity, and (c) density at NSD CTD stations.

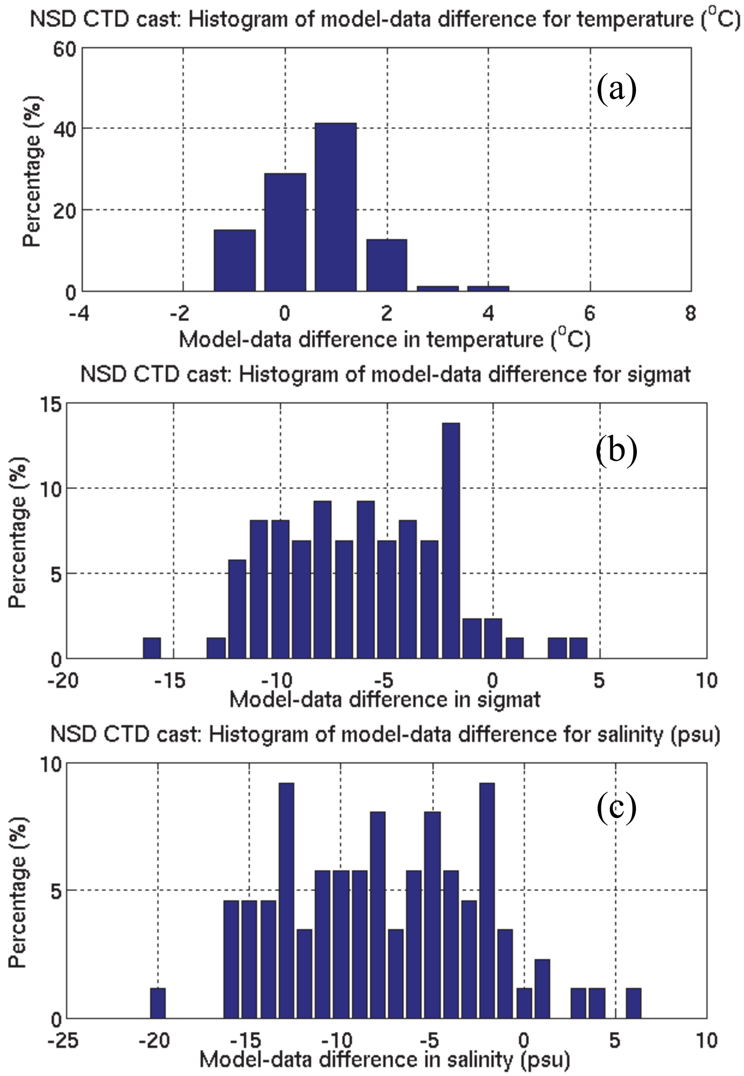


Figure 5.8. Histograms of model errors for (a) temperature, (b) salinity, and (c) density at OCS/NSD CTD stations.

5.3. CTD Cast Measurements by CO-OPS

This section discusses NGOFS skill assessment against temperature, salinity, and density profiling data from CO-OPS CTD cast measurements. Section 5.3.1 describes the meta data of the CTD casts. Section 5.3.2 discusses the model-data comparison methods and results.

5.3.1. Data Descriptions

CO-OPS deployed six CTD casts on 3 and 11 November, 2010. Table 5.5 lists the deployment location and date/time. Figure 5.9 displays a map of station locations. Of the total six casts, four (stations 1, 2, 3, and 6) were deployed along the central-Bay dredged channel and the remaining two (stations 4 and 5) were along the open coast west of the Bay.

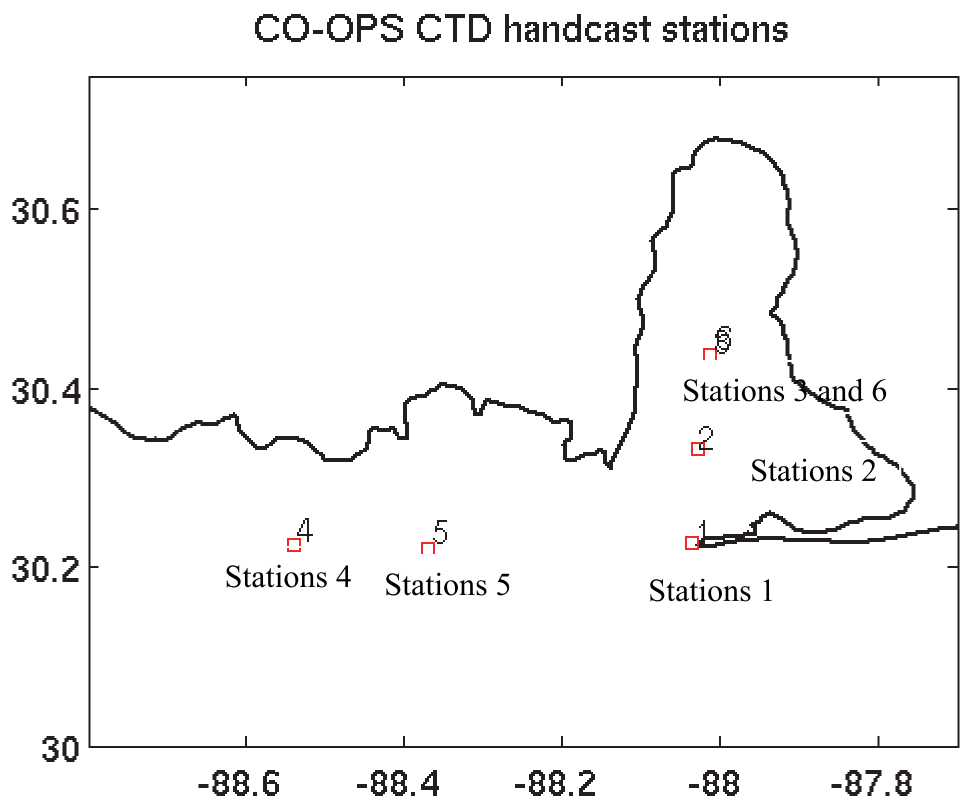


Figure 5.9. Deployment sites of CO-OPS CTD casts. Note that stations 3 and 6 were collocated.

Table 5.5. Deployment location and date/time of CO-OPS CTD casts

Cast No.	Latitude (^oN)	Longitude (^oE)	Deployment Date/time (UTC)
1	30.43730	-88.01189	2010/11/05 14:38:25
2	30.22486	-88.53919	2010/11/05 18:57:20
3	30.22142	-88.37009	2010/11/05 19:49:32
4	30.43730	-88.01189	2010/11/05 20:34:14
5	30.22703	-88.03458	2010/11/03 18:55:02
6	30.33144	-88.02900	2010/11/03 21:25:40

5.3.2. Model-Data Comparison

Profiles Using the same method as described in Section 5.1.2, we interpolated NGOFS station outputs of temperature, salinity, and density onto the time instances and depths coincident with the CTD measurements and computed average model errors for each profile. We then estimated the mean, minimum, maximum, and rms model errors of the total 6 stations and listed the results in Table 5.6.

Table 5.6. Statistics of model errors with respect to CO-OPS CTD profiling data

Model –data difference (Δ)	mean(Δ)	min($\lvert\Delta\rvert$)	max($\lvert\Delta\rvert$)	rms (Δ)
Δ_T (^oC)	1.139	0.222	2.845	1.448
Δ_S (psu)	2.237	1.117	3.677	2.413
$\Delta_{\sigma t}$ (σ_t)	1.402	0.788	2.108	1.518

Figure 5.10 displays temperature, salinity, and density profiles of both NGOFS results and CTD observations at each station. In general, NGOFS overpredicted the in-sinu temperature, salinity, and density. Of the six stations, the temperature error averaged to be 1.1 ^oC with a maximum magnitude of 2.9 ^oC and an rms error of 2.8 ^oC. The salinity error averaged to be 2.2 psu with a maximum magnitude of 3.6 psu and an rms error of 2.4 psu. The density error averaged to be 1.4 σ_t with a maximum magnitude of 2.1 σ_t and an rms error of 1.5 σ_t.

Table 5.7 lists the mean and std of T, S, and density stratification indices (Section 5.1.2) for the six stations. Compared with observations, NGOFS underpredicted the surface-to-bottom range of temperature, salinity, and density by 0.6 ^oC, 3.1 psu, and 2.2 σ_t, respectively. NGOFS underpredicted water stratifications in terms of T, S, or density as revealed in the skill assessment results from using the HSTP or NSD data (Sections 5.1 and 5.2).

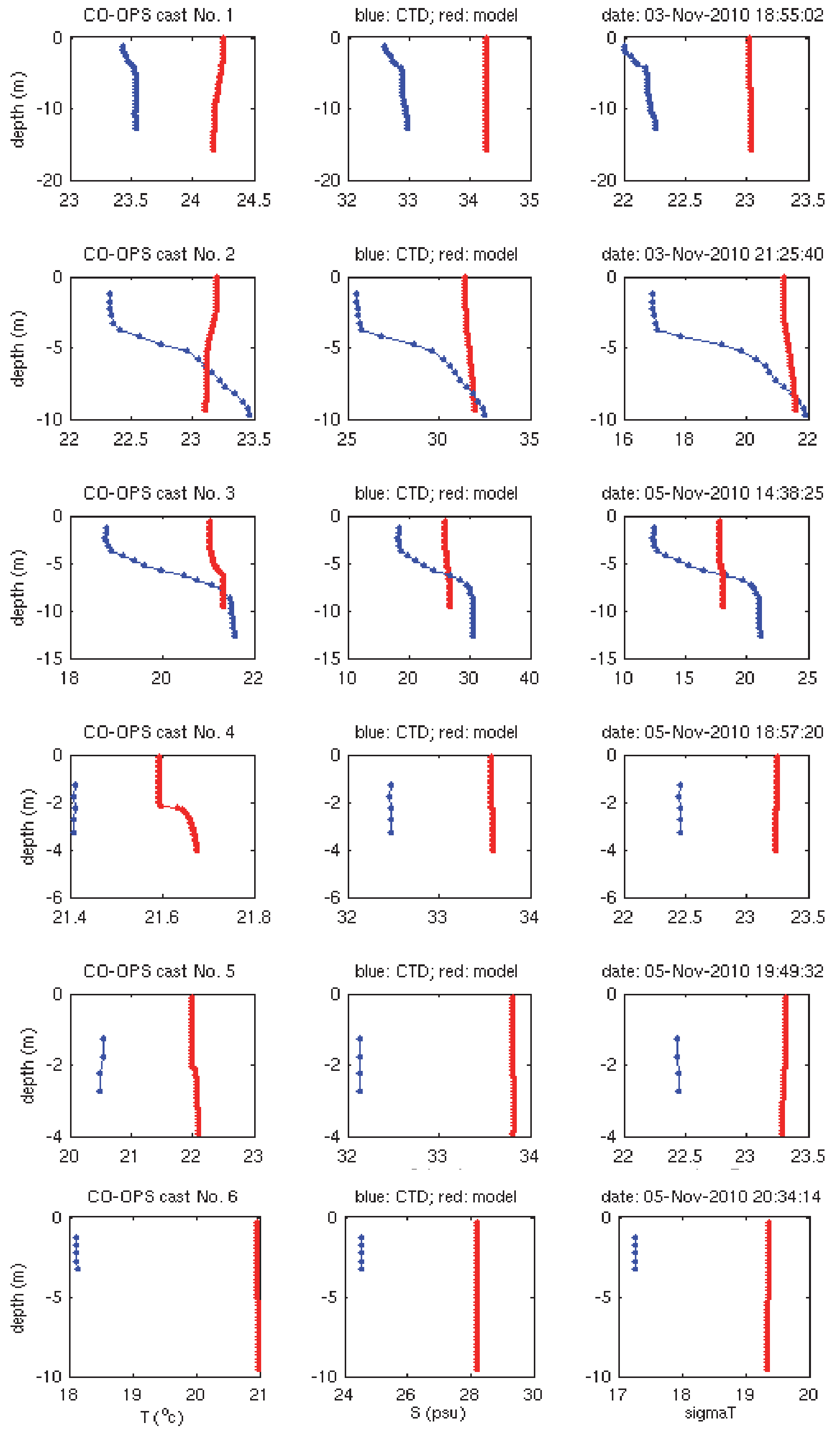


Figure 5.10. T, S, and density profiles from NGOFS results (red lines) and CO-OPS CTD measurements (blue lines).

Table 5.7. Stratification indices for CO-OPS CTD profiles

Property	mean (SI)	Std (SI)
SI_T (^oC)	0.60	0.98
SI_S (psu)	3.08	4.91
$SI_{\sigma t}$ (σ_t)	2.17	3.47

Error Maps Figures 5.11a-c display color-coded NGOFS error maps for the temperature, salinity, and density fields, respectively. The maps illustrate the geographical distribution of various error fields.

As shown in the maps, the error magnitude gradually decreased from the mid-bay region to the lower- and the outside bay region. The maximum error occurred at station 6 where $\Delta_T = 2.8$ ^oC, $\Delta_S = 3.7$ psu, and $\Delta_{\sigma t}=2.1$ σ_t. At the three outside bay stations, model errors reduced to $|\Delta_t| < 1$ ^oC, $|\Delta_s| < 1$ psu, and $|\Delta_{\sigma t}| < 1$.

Histograms of Model Errors Figures 5.12a-c show model error histograms for T, S, and density, respectively. In general, NGOFS results show favorable agreement with observations. More than 60% of the stations demonstrate $|\Delta_T| <1.5$ ^oC, $|\Delta_S| < 2.5$ psu, and $|\Delta_{\sigma t}| < 0.5$ σ_t.

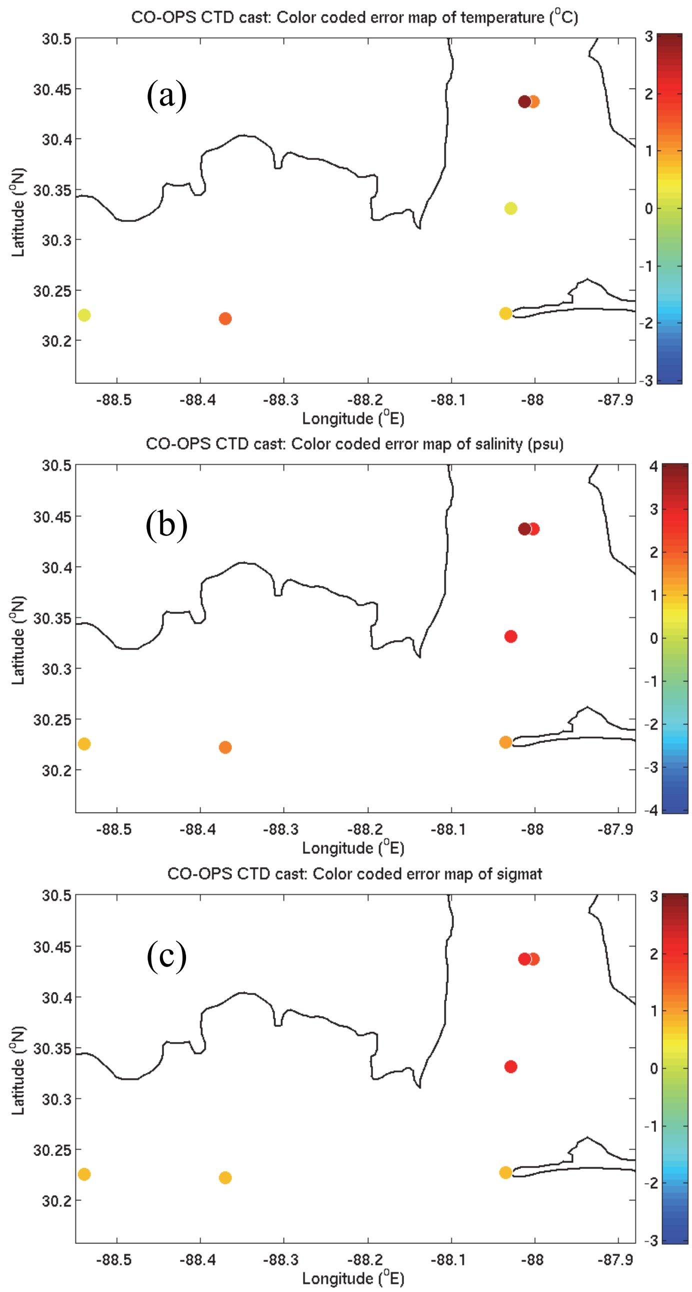


Figure 5.11. Map of color-coded model errors of (a) temperature, (b) salinity, and (c) density at CO-OPS CTD stations. Note that stations 3 and 6 were collocated. For clarity of display, the symbol for station 3 is plotted slightly to the east of its actual position.

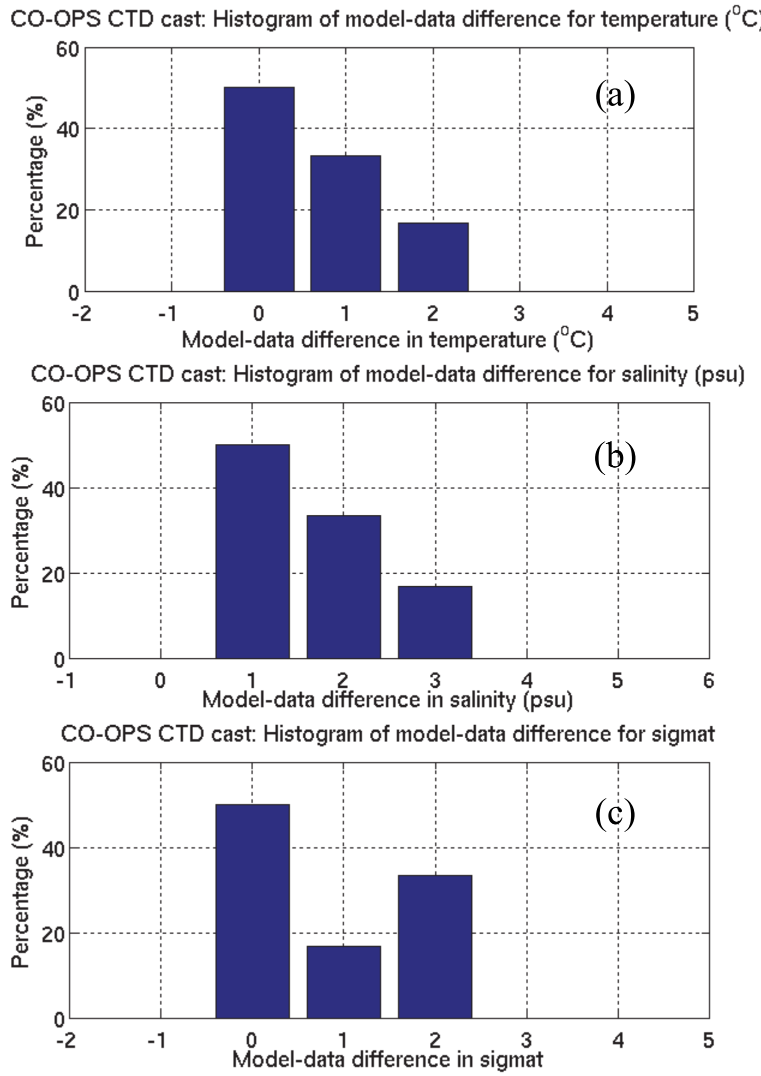


Figure 5.12. Histograms of model errors for (a) temperature, (b) salinity, and (c) density at CO-OPS CTD stations.

5.4. T/S Transect Measurements from AUV-CTD Survey

This section discusses the skill assessment against T/S transect measurements from an AUV-CTD survey (Section 5.1). Section 5.4.1 describes background information of the AUV-CTD survey. Section 5.4.2 discusses the model-data comparison methods and results.

5.4.1. Data Descriptions

The CSDL/HSTP conducted seven AUV-CTD transect surveys during the period of 10-14 November, 2010. Table 5.8 lists survey dates. Figure 5.13 displays a map of the transect routes. All seven transects were surveyed in the mid- to lower-Bay region. Each transect spanned a distance about 11-13 km. Five transects ran along straight lines in a cross-bay direction, whereas transect 5 was surveyed first along an east-to-west direction and at about the midway of the transect AUV was reoriented to a northwest direction and ended near -88.2 ^{o}E, 33.3 ^{o}N.

Table 5.8. Dates of AUV-CTD transect surveys

Transect No.	Survey Date
1	Nov. 10, 2010
2	Nov. 10, 2010
3	Nov. 11, 2010
4	Nov. 11, 2010
5	Nov. 12, 2010
6	Nov. 13, 2010
7	Nov. 14, 2010

Figure 5.14 shows a sample plot of AUV depth, water temperature, and salinity along transect 1. Figures E.1-7 in Appendix J display similar plots for all seven transects. The AUV moved up and down the water column between the surface and near the seabed. Constrained by local bathymetry, the AUV mostly moved at 4-5-m depths except during crossing the central-Bay dredged channel where it reached depths up to 18 m.

Figures E.1c-7c reveal occasional occurrences of spikes of anomalously low salinity along all seven transects. For instance, salinity anomalies as low as 1 psu appear nearly evenly along transect 1 (Figure 5.14c). These data points were attributed to sensor malfunctions due to the exposure of the CTD sensors in the air when the AUV reached the sea surface. Measurements coincident with the spikes were deemed to be spurious and hence were excluded from the skill assessment.

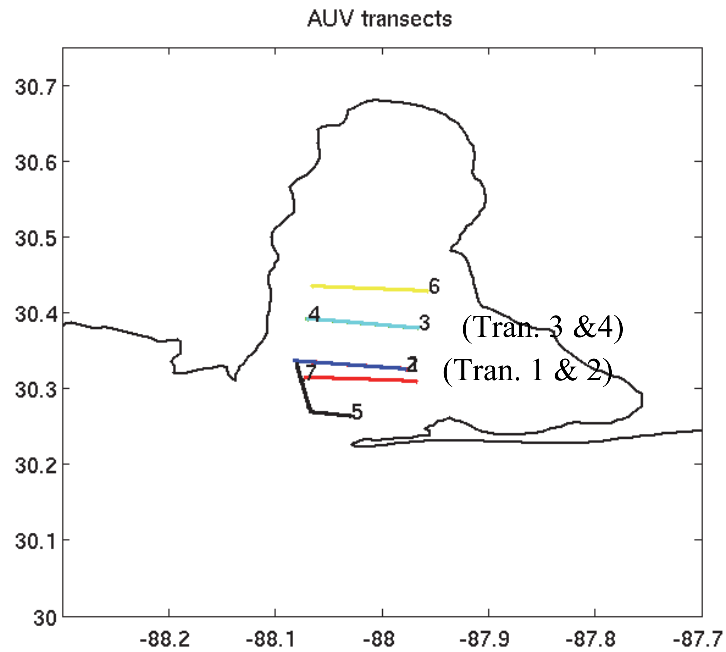


Figure 5.13. Transects of AUV-CTD measurements. Note that two pairs of AUV-CTD transects were overlapped : transects 1 and 2 and transects 3 vs. 4. A number labeled at one end of a transect line denotes the survey's ID and its launch point.

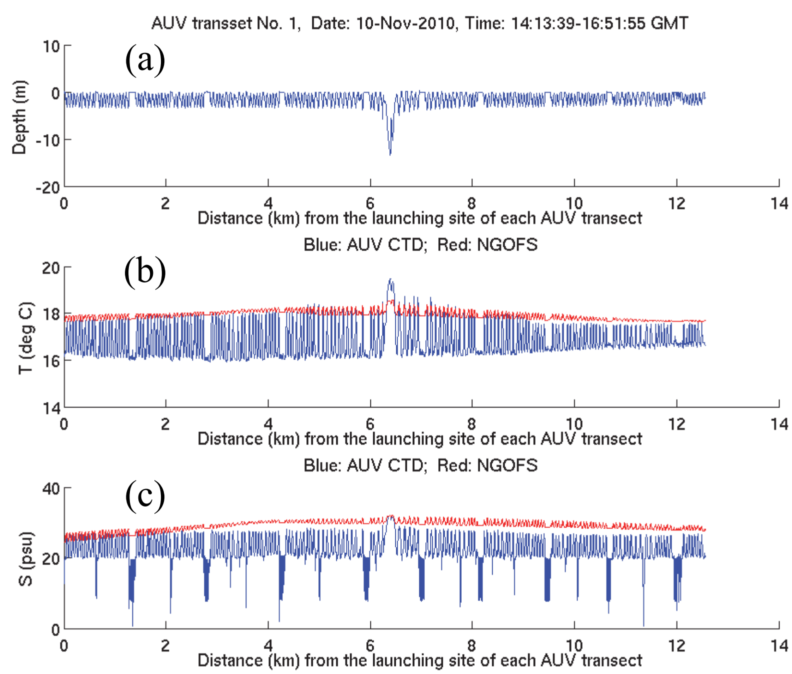


Figure 5.14. (a) depth, (b) temperature, and (c) salinity transect of NGOFS results (red lines) and AUV-CTD observations (blue lines). The date/time labeled on top of figure (a) denotes the AUV-CTD launch time.

5.4.2. Model-Data Comparison

The AUV-CTD measurements along a transect were made at varied time, geographical locations, and depths. To foster model-data comparisons, NGOFS' six-minute interval temperature/salinity fields were interpolated on to time instances and spatial locations coincident with the CTD measurements.

Along each transect, we subtracted the model temperature (salinity) from observations to form a model error series. We then computed the mean, minimum, maximum, and rms of the error series along each transect. Tables 5.6 and 5.7 listed the results for T and S, respectively.

Temperature NGOFS slightly overpredicted water temperature. For each transect, the average model error lay between 0.5-0.9 ^{o}C with a maximum between 1.2- 3.2 ^{o}C and an rms error between 0.6-2.1 ^{o}C (Table 5.6).

Figures E.1b-7b in Appendix J display the NGOFS and CTD temperature for all seven transects. NGOFS overpredicted water temperature nearly along each transect except at locations over the central-Bay dredged channel, where it underpredicted temperature by a couple of degrees Celsius.

In addition, the NGOFS temperature exhibited much smaller vertical variability than revealed by the AUV-CTD data. For instance, along transect 1 (Figure 5.14b) the CTD temperature varied over a 2 ^{o}C range (between 16-18 ^{o}C) between the sea surface and 5-m depth. However, across the same water columns the NGOFS temperature changed by only a 0.3 ^{o}C.

Figure 5.15 display model error histograms along the seven transects. Histogram peaks skewed unanimously to positive regime. In detail, the peaks were centered at 1.5 ^{o}C for transects 1-3 and 5; at 2.5 ^{o}C for transect 4; and at 0 ^{o}C for transects 5 and 6. This further substantiates the aforementioned conclusion that NGOFS overpredicted water temperature.

Salinity NGOFS overpredicted water salinity. Along each transect, average model error fell into a range between 2.2-7.1 psu, with a maximum error between 6.7-12.7 psu and an rms error between 3.5-7.7 psu (Table 5.7).

Figures E.1c-7c in APPRNDIX I illustrate the model and CTD salinity along each transect. Like the case for the water temperature, NGOFS overpredicted salinity nearly along each transect except at locations over the central-Bay dredged channel, where NGOFS underpredicted water salinity by about 4 psu.

The NGOFS salinity exhibited much small vertical variability than that revealed by the AUV-CTD data. For instance, along transect 1 (Figure 5.14c) the CTD salinity varied by 5 psu (between 20-27 psu) between the sea surface and an ~5-m depth. However, over the same depth range the NGOFS salinity altered by only a 2 psu.

In summary, NGOFS underpredicted vertical variability in both temperature and salinity. It is therefore concluded that NGOFS underpredicted the surface-to-bottom range of density and depicted smaller water stratifications than in reality.

Figures 5.15a-g display histograms of salinity errors along each transect. Histogram peaks are skewed remarkably toward the positive regime. The peaks were centered around 6-8 psu for transects 1, 2, 5 and 7; around 3-5 psu for transects 3 and 4; and around 2 psu for transect 2. Evidently NGOFS overpredicted water salinity.

Table 5.9. Statistics of model temperature errors along seven AUV-CTD transects

Transect ID	mean(Δ_T) (^oC)	min($\|\Delta_T\|$) (^oC)	max($\|\Delta_T\|$) (^oC)	rms (Δ_T) (^oC)
1	1.137	0.001	2.127	1.297
2	1.003	0.001	1.869	1.142
3	1.351	0.008	2.004	1.427
4	1.169	0.039	1.975	1.242
5	1.924	0.004	3.197	2.156
6	0.62	0.004	1.203	0.735
7	0.446	0	1.191	0.611
Average	1.09	0.013	1.94	1.23

Table 5.10. Statistics of model salinity errors along seven AUV-CTD transects

Transect ID	mean(Δ_S) (psu)	min($\|\Delta_S\|$) (psu)	max($\|\Delta_S\|$) (psu)	rms (Δ_S) (psu)
1	6.274	0.006	10.22	6.784
2	6.27	0.006	10.519	6.795
3	4.127	0.021	8.471	4.663
4	3.918	0.006	8.26	4.466
5	7.122	0.016	12.659	7.763
6	2.157	0.013	6.665	3.476
7	5.88	0.041	10.236	6.408
Average	5.10	0.016	9.58	5.77

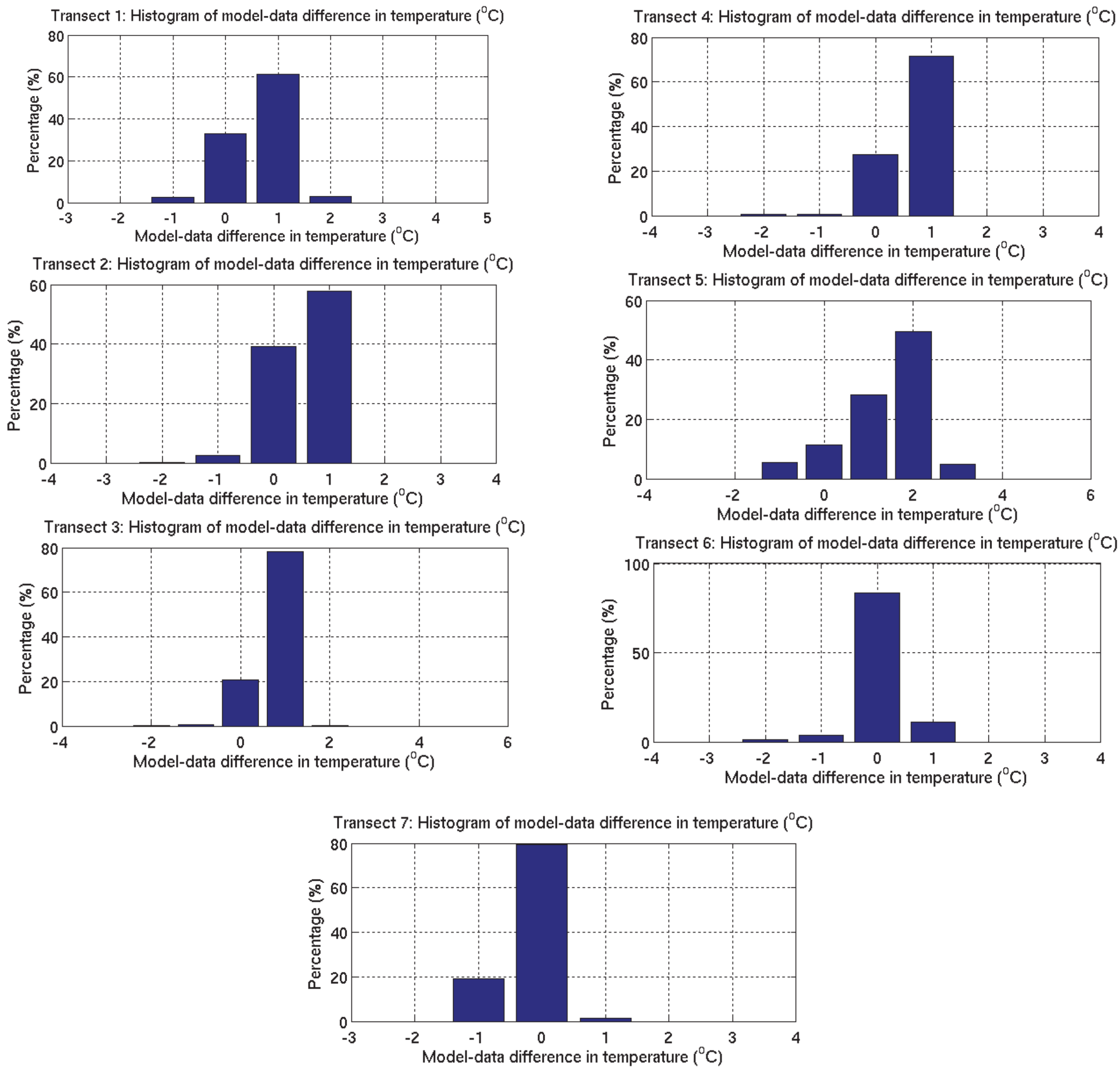


Figure 5.15. Histograms of model temperature errors along seven AUV-CTD transects.

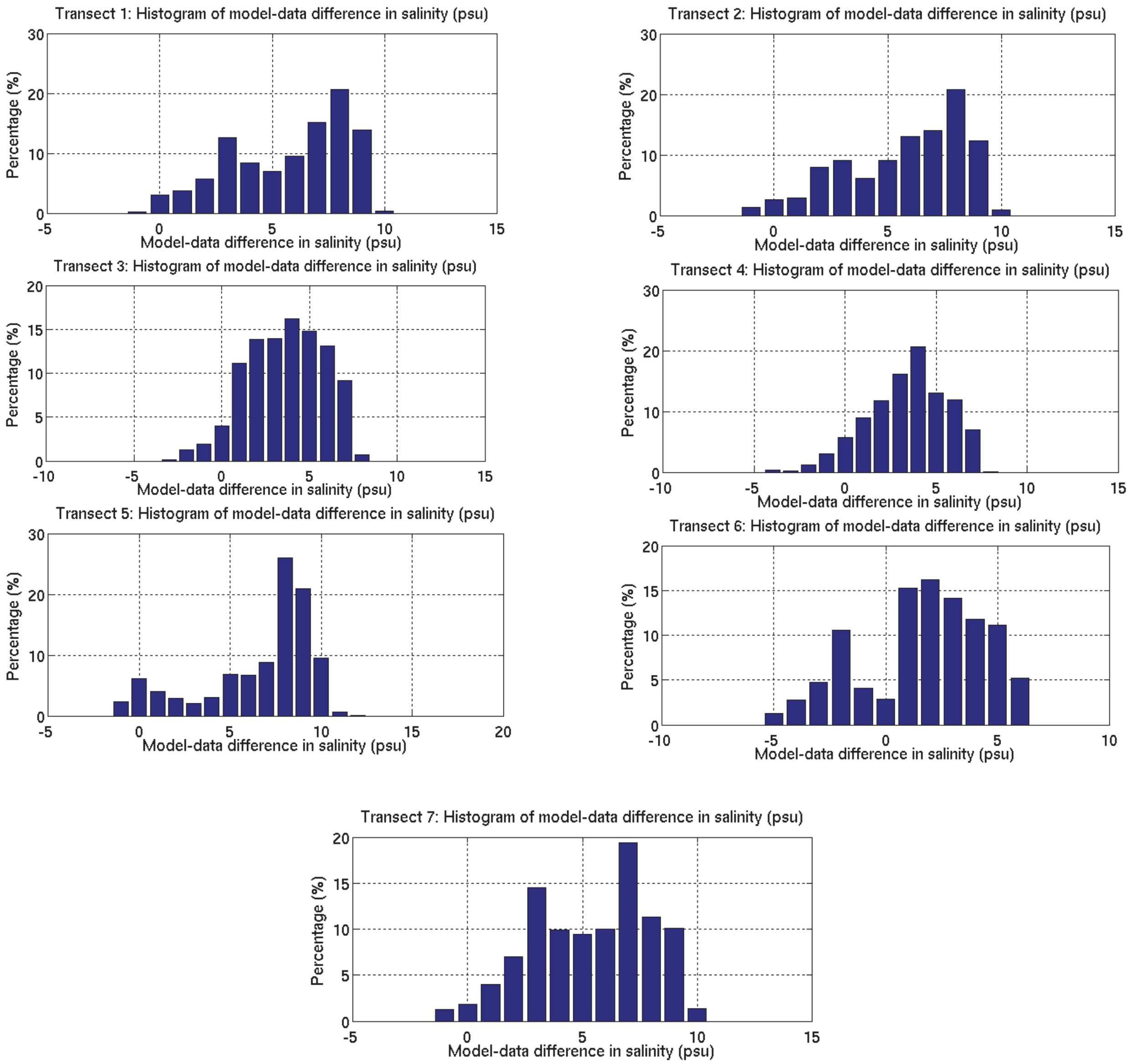


Figure 5.16. Histograms of model salinity errors along seven AUV-CTD transects.

5.5. Mobile Bay CTD Measurements Skill Assessment Summary

In this chapter, we evaluated the NGOFS model skill against T, S, and density profile data and T and S transect data collected during Mobile Bay Collaborative Survey (Patchen, 2012). The profiling data were collected through a total of 166 CTD hand cast measurements. They included 78, 82, and 6 CTD casts conducted, respectively, by CSDL/HSTP, OCS/NSD, and CO-OPS. The T and S transect data were collected in seven AUV-CTD surveys conducted by CO-OPS.

The in-situ observations were conducted in the mid- to lower Mobile Bay regions except for two CO-OPS stations along the open coast west of the Mobile Bay (Section 5.2). The surveys were conducted over two separate periods in a winter season, i.e., early November 2010 and late January 2011, respectively. Therefore the present skill assessment results represent mostly the NGOFS skills in the mid- to lower Bay regions during the winter season.

We evaluated the NGOFS skill through visual comparisons of model results and CTD observations, computing model errors, estimating error statistics and histograms, and examining the geographical distribution of error fields.

For temperature, average model errors are 0.8, 1.1, 1.1, and 1.1 ^{o}C with respect to HSTP, NSD, CO-OPS CTD cast data, and HSTP AUV-CTD transect data. The corresponding rms errors are 1.1, 1.5, 1.4, and 1.2 ^{o}C, respectively. In each case, NGOFS slightly overpredicted water temperature. For the four data sets, the average model error of 1.0 ^{o}C and the rms error of 1.3 ^{o}C.

For salinity, average model errors are, respectively, 3.4, -7.1, 2.2, 5.1 psu with respect to HSTP, NSD, CO-OPS CTD cast data, and HSTP AUV-CTD transect data. The corresponding rms errors are 4.3, 8.9, 2.4, and 5.8 psu, respectively. Taking an absolute value average of the above average or rms errors gives an overall average model error equal to 4.5 psu and an rms error of 5.4 psu.

It is noted that the above average salinity errors reveal two seemingly contradictory trends of model salinity errors as revealed by opposite signs of the error values. In detail, NGOFS underpredicted the NSD salinity and overpredicted the salinity with respect to the other three datasets (Sections 5.1-4). We tend to attribute the differed error trends to varied degrees of the uncertainty implied in the model forcing conditions. Note that the NSD survey was conducted in late January 2011, while the other three were concentrated in early November 2010. The two periods were two months apart. The accuracy of forcing conditions imposed on NGOFS runs could differ significantly between the two periods. Biases of forcing field errors might result in the seemingly opposite trends of model errors. Nevertheless, this issue is worthwhile for further investigation in future developments of the next generation Mobile Bay Ports-based OFS.

The NGOFS underpredicted the water stratifications. We computed the T and S stratification indices (Sections 5.1-3) using NGOFS and in situ profiling data. With respect to the three CTD cast datasets from HSTP to NSD to CO-OPS CTD casts, NGOFS underpredicted the surface-to-bottom range of temperature by 0.9, 1.2, and 0.6 ^{o}C, respectively. Correspondingly, it underpredicted the salinity range by 5.5, 6.0, 3.1 psu and the density range by 4.0, 4.5, and 2.2 σ_t.

On average over the three data sets, NGOFS underpredicted the surface-to-bottom range of temperature, salinity, and density by 0.9 ^{o}C, 4.9 psu, and 3.6 σt, respectively.

6. SUMMARY AND CONCLUSIONS

The NGOFS has been developed at NOS to provide 2-to-3 days short term nowcast and forecast guidance of water level, current velocity, salinity and temperature over the model grid domain. This includes the northern Gulf of Mexico continental shelf area (out to the 200 m isobath) from US-Mexico border to near Panama City, Florida. The NGOFS covers six NOS PORTS systems (Houston/Galveston, Sabine/Neches, Lake Charles, Gulfport, Pascagoula, and Mobile Bay) where NOS provides real-time information to the navigation community.

The NGOFS is a regional forecast system using the unstructured grid model FVCOM developed by UMASS Dartmouth. The model has been calibrated with the constant density astronomical tide simulation. The calibrated model is further evaluated with two synoptic hindcast simulations covering the periods of July 2008 to August 2009 and September 2010 to April 2010. The performance of the NGOFS model is evaluated through the NOS skill assessment software to compare the model simulated water level, current, temperature and salinity with the observations available from NOAA, TABS, and IOOS.

The skill assessment documented in Chapter 4 has been briefly synthesized in graphics in the executive summary. In general, the simulated water levels meet the NOS skill requirement with less accuracy during the high and low water level. Current speed skill is always less accurate than the water level. Although comparisons with the MBCS observations show areas of possible further investigation, the skill assessment of the NGOFS hindcast time series demonstrates satisfactory result and exceeds the NOS criteria.

The NGOFS skill assessment results for water level and temperature documented in Chapter 4 show acceptable results by NOS criteria except a few stations not covered by the NGOFS model grid. Future nested NGOFS system with higher grid resolution will cover these stations.

The comparison of NGOFS model simulated temperature and salinity vertical profiles with observations collected during the NOS Mobile Bay Survey Project (Patchen, et al, 2012) are presented in Chapter 5. In general the model hindcast shows less stratification than the observations. A sensitivity test for selecting a best fitted vertical mixing coefficient is recommended.

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APPENDIX A. EXAMPLE OF NGOFS HINDCAST RUN-TIME NAMELIST

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! _______  _     _  _______  _______  _______  ______     _____
 !(_______)(_)   (_)(_______)(_______)(_______)(_____ \   (_____)
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 !|_|        \___/   \______) \_____/ |_|   |_|(______/(_)\_____/
 !-- Beta Release
 !==============================================================!
 !                                                              !
 !========DOMAIN DECOMPOSITION USING: METIS 4.0.1 ===============!
 !======Copyright 1998, Regents of University of Minnesota========!
 !                                                              !
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 TIMEZONE        = 'UTC',
 DATE_FORMAT     = 'YMD',
 START_DATE      = '2011-10-02 00:00:00',
 END_DATE        = '2011-10-04 00:10:00'
 /

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 STARTUP_FILE      = 'NGOFS_init_20111002.nc'
 STARTUP_UV_TYPE   = 'set values',
 STARTUP_TURB_TYPE = 'set values',
 STARTUP_TS_TYPE   = 'set values',
 STARTUP_T_VALS    = 27.0,
 STARTUP_S_VALS    = 35.0,
 STARTUP_U_VALS    = 0.0,
 STARTUP_V_VALS    = 0.0,
 STARTUP_DMAX      = -10.0
 /

 &NML_IO
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 OUTPUT_DIR      = './OUT_ofs_1',
 IREPORT         =  1,   !25,
 VISIT_ALL_VARS  = F,
 WAIT_FOR_VISIT  = F,
 USE_MPI_IO_MODE = F
 /

 &NML_INTEGRATION
 EXTSTEP_SECONDS = 12.0,
 ISPLIT          =  3,
 IRAMP           =  4800,
 MIN_DEPTH       =  0.5,
 STATIC_SSH_ADJ  =  0.0
 /

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 RST_ON           = T,
```

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RST_OUTPUT_STACK = 1
/

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NC_FIRST_OUT    = '2011-10-02 00:00:00',
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NC_SALT_TEMP    = T,
NC_TURBULENCE   = F,
NC_AVERAGE_VEL  = F,
NC_VERTICAL_VEL = F,
NC_WIND_VEL     = T,
NC_WIND_STRESS  = T,
NC_EVAP_PRECIP  = F,
NC_SURFACE_HEAT = T,
NC_GROUNDWATER  = F
/

&NML_NETCDF_AV
NCAV_ON = F,
NCAV_FIRST_OUT       = 'none',
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NCAV_SUBDOMAIN_FILES = 'none',
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NCAV_SURFACE_HEAT    = F,
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NCAV_WQM             = F,
NCAV_VORTICITY       = F
/

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WIND_Y       =  0.0200000E+00,
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HEATING_SHORTWAVE_LENGTHSCALE = 1.4000000,
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HEATING_NETFLUX    = 0.0000000E+00,

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PRECIPITATION_EVP  = 0.0000000E+00,

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AIRPRESSURE_VALUE =  0.005500000E+00
/

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ZTT                    = 2,
ZQQ                    = 2,
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RELATIVE_HUMIDITY      = 0.0,
SURFACE_PRESSURE       = 1000.0,
LONGWAVE_RADIATION     = 10.0,
SHORTWAVE_RADIATION    = 100.0
/

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HORIZONTAL_PRANDTL_NUMBER       = 1.0,
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VERTICAL_MIXING_COEFFICIENT     = 1.0000E-04,
VERTICAL_PRANDTL_NUMBER         = 1.0000,

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BOTTOM_ROUGHNESS_KIND   = 'constant',
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BOTTOM_ROUGHNESS_LENGTHSCALE    =  0.003,
BOTTOM_ROUGHNESS_MINIMUM        =  0.0025,
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BAROCLINIC_PRESSURE_GRADIENT = 'sigma levels',
SEA_WATER_DENSITY_FUNCTION   = 'dens2',
RECALCULATE_RHO_MEAN         = F,
INTERVAL_RHO_MEAN            = 'days=1.0',
TEMPERATURE_ACTIVE           = T,
SALINITY_ACTIVE              = T,
SURFACE_WAVE_MIXING          = F,
WETTING_DRYING_ON            = T,
ADCOR_ON                     = T
/

&NML_RIVER_TYPE
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RIVER_TS_SETTING        = 'calculated', !'specified',
RIVER_INFLOW_LOCATION   = 'node',
RIVER_INFO_FILE   = 'RIVERS_NAMELIST.nml',
RIVER_KIND        = 'variable'
/

&NML_OPEN_BOUNDARY_CONTROL
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OBC_TS_TYPE                = 1,
OBC_TEMP_NUDGING           = F,
OBC_TEMP_FILE              = 'NGOFS_OBC_TS_fromNCOM_200807.nc',
OBC_TEMP_NUDGING_TIMESCALE =  0.002,
OBC_SALT_NUDGING           = F,
OBC_SALT_FILE              = 'NGOFS_OBC_TS_fromNCOM_200807.nc',
OBC_SALT_NUDGING_TIMESCALE =  0.002,
OBC_MEANFLOW               = F,
OBC_MEANFLOW_FILE          = 'none',
OBC_LONGSHORE_FLOW_ON      = F,
OBC_LONGSHORE_FLOW_FILE    = 'none'
/

&NML_GRID_COORDINATES
GRID_FILE            = 'NGOFS_grd.dat',
GRID_FILE_UNITS      = 'degrees',
PROJECTION_REFERENCE = 'none',
SIGMA_LEVELS_FILE    = 'NGOFS_sigma.dat',
DEPTH_FILE      = 'NGOFS_dep.dat',
CORIOLIS_FILE   = 'NGOFS_cor.dat',
SPONGE_FILE     = 'NGOFS_spg.dat'
/

&NML_GROUNDWATER
GROUNDWATER_ON      = F,
GROUNDWATER_TEMP_ON = F,
GROUNDWATER_SALT_ON = F,
```

```
GROUNDWATER_KIND    = 'none',
GROUNDWATER_FILE    = 'none',
GROUNDWATER_FLOW    = 0.0000000E+00,
GROUNDWATER_TEMP    = 0.0000000E+00,
GROUNDWATER_SALT    = 0.0000000E+00
/

&NML_LAG
LAG_PARTICLES_ON        = F,
LAG_START_FILE  = 'none',
LAG_OUT_FILE    = 'none',
LAG_FIRST_OUT   = 'none',
LAG_RESTART_FILE        = 'none',
LAG_OUT_INTERVAL        = 'none',
LAG_SCAL_CHOICE = 'none'
/

&NML_ADDITIONAL_MODELS
DATA_ASSIMILATION       = F,
DATA_ASSIMILATION_FILE  = 'none',
BIOLOGICAL_MODEL        = F,
BIOLOGICAL_MODEL_FILE   = 'none',
SEDIMENT_MODEL          = F,
SEDIMENT_MODEL_FILE     = 'none',
ICING_MODEL             = F,
ICING_FORCING_FILE      = 'wrf_for.nc',
ICING_FORCING_KIND      = 'variable',
ICING_AIR_TEMP          =  0.0000000E+00,
ICING_WSPD              = 0.0000000E+00,
ICE_MODEL               = F,
ICE_FORCING_FILE        = 'none',
ICE_FORCING_KIND        = 'none',
ICE_SEA_LEVEL_PRESSURE  = 0.0000000E+00,
ICE_AIR_TEMP            = 0.0000000E+00,
ICE_SPEC_HUMIDITY       = 0.0000000E+00,
ICE_SHORTWAVE           = 0.0000000E+00,
ICE_CLOUD_COVER         = 0.0000000E+00
/

&NML_PROBES
PROBES_ON       = F,
PROBES_NUMBER   = 2,
PROBES_FILE     = 'PROBE_sta.nml'
/

&NML_STATION_TIMESERIES
OUT_STATION_TIMESERIES_ON = T,
STATION_FILE              = 'NGOFS_station.dat',
LOCATION_TYPE             = 'node',
OUT_ELEVATION             = T,
OUT_VELOCITY_3D           = T,
OUT_VELOCITY_2D           = F,
OUT_WIND_VELOCITY         = T,
OUT_SALT_TEMP             = T,
```

```
 OUT_INTERVAL                = 'seconds = 360.0'
 /

 &NML_NCNEST
 NCNEST_ON        = F,
 NCNEST_BLOCKSIZE = 50,
 NCNEST_NODE_FILES= 'input_nest_node_2LayerNd.dat'
 /

 &NML_NESTING
 NESTING_ON        = T,
 NESTING_BLOCKSIZE = 50,
 NESTING_FILE_NAME = 'nos.ngofs.obc.20111004.t00z_ori_new_zy.nc'
 /

 &NML_BOUNDSCHK
 BOUNDSCHK_ON    = F,
 CHK_INTERVAL    = 50,
 VELOC_MAG_MAX   = 10.0000000E+00,
 ZETA_MAG_MAX    = 10.0000000E+00,
 TEMP_MAX        = 50.0000000E+00,
 TEMP_MIN        =  0.0000000E+00,
 SALT_MAX        = 45.0000000E+00,
 SALT_MIN        =  0.0000000E+00
/
```

APPENDIX B. SKILL ASSESSMENT TABLES FOR NGOFS TIDAL SIMULATION.

Tide

```
Station:S_Padr  TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-----------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-----------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.018
H-h        15 cm 24h 51360   0.017  0.076  0.074   0.0  95.7   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   250   0.059  0.096  0.076   0.0  85.2   0.0    0.0  0.0
ALW-alw    15 cm 24h   254  -0.025  0.068  0.063   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   250  -0.061  0.569  0.567   1.2  68.8   4.8    0.0 49.8
TLW-tlw  0.50  h 25h   254  -0.188  0.305  0.241   0.4  87.8   0.0    0.0  0.0

Station:CpsCrst TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-----------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-----------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.026
H-h        15 cm 24h 51360   0.025  0.067  0.062   0.0  98.1   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   247   0.030  0.068  0.062   0.0  98.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   252   0.029  0.060  0.052   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   247   0.850  1.096  0.693   0.0  27.9  40.9    0.0197.0
TLW-tlw  0.50  h 25h   252   0.371  0.477  0.300   0.0  65.1   2.4    0.0  0.0

Station:Aransas TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-----------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-----------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.011
H-h        15 cm 24h 51360   0.010  0.111  0.110   0.0  81.6   0.1    0.0  2.2  0.00
AHW-ahw    15 cm 24h   237   0.103  0.138  0.093   0.0  69.6   1.3    0.0 24.8
ALW-alw    15 cm 24h   255  -0.085  0.122  0.088   0.0  76.5   0.0    0.0  0.0
THW-thw  0.50  h 25h   237  -0.153  1.033  1.024  17.7  43.9   9.7   74.0 73.8
TLW-tlw  0.50  h 25h   255   0.022  0.549  0.550   0.0  76.5   5.5    0.0 11.2

Station:CG_Frprt TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-----------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-----------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.021
```

```
H-h        15 cm 24h 51360   0.020  0.071  0.068   0.0  96.9   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   239   0.021  0.059  0.055   0.0  98.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   244   0.015  0.053  0.051   0.0  99.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   239   1.026  1.291  0.786   0.4  25.9  54.4    0.0146.9
TLW-tlw  0.50  h 25h   244   0.450  0.548  0.313   0.0  50.8   2.0    0.0  0.0

Station:Gv_Pl_Pr TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.002
h                    51360  -0.015
H-h        15 cm 24h 51360   0.013  0.084  0.083   0.0  91.6   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   272  -0.008  0.068  0.067   0.0  97.4   0.0    0.0  0.0
ALW-alw    15 cm 24h   279   0.031  0.067  0.059   0.0  94.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   272   0.936  1.198  0.749   0.0  30.5  47.4    0.0222.2
TLW-tlw  0.50  h 25h   279   0.510  0.609  0.334   0.4  38.0   3.6    0.0 11.3

Station:Glv_Pr_21 TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.003
h                    51360  -0.013
H-h        15 cm 24h 51360   0.015  0.067  0.065   0.0  97.0   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   265   0.017  0.067  0.065   0.0  97.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   285   0.026  0.060  0.055   0.0  98.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   265   1.093  1.427  0.919   0.8  24.9  47.5    0.0178.3
TLW-tlw  0.50  h 25h   285   0.702  0.815  0.414   0.0  22.5  10.9    0.0 24.9

Station:Eagle TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.015
h                    51360  -0.008
H-h        15 cm 24h 51360   0.023  0.092  0.089   0.0  89.7   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   187   0.003  0.078  0.078   0.0  93.6   0.0    0.0  0.0
ALW-alw    15 cm 24h   231   0.063  0.104  0.083   0.0  84.8   0.0    0.0  0.0
THW-thw  0.50  h 25h   187   1.194  1.434  0.796   0.5  19.8  56.1    0.0 99.2
TLW-tlw  0.50  h 25h   231   0.800  0.942  0.500   0.0  21.6  33.8    0.0 98.8

Station:Sabn_Ps TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
```

```
h                    51360   0.001
H-h        15 cm 24h 51360  -0.002  0.102  0.102   0.0  85.3   0.2    0.0  2.7  0.00
AHW-ahw    15 cm 24h   307   0.086  0.116  0.079   0.0  80.5   1.6    0.0 73.1
ALW-alw    15 cm 24h   310  -0.074  0.115  0.089   0.0  77.7   0.0    0.0  0.0
THW-thw  0.50  h 25h   307  -0.061  0.457  0.454   2.0  76.2   1.0    0.0  0.0
TLW-tlw  0.50  h 25h   310   0.008  0.318  0.318   0.6  89.4   1.0    0.0  0.0

Station:Calc_Ps LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.003
H-h        15 cm 24h 51360   0.002  0.087  0.087   0.0  90.7   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   312   0.063  0.087  0.060   0.0  92.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   313  -0.027  0.080  0.075   0.0  94.9   0.0    0.0  0.0
THW-thw  0.50  h 25h   312   0.339  0.638  0.541   2.6  58.3   7.7   24.3 49.7
TLW-tlw  0.50  h 25h   313   0.370  0.499  0.335   0.3  65.5   2.6    0.0  0.0

Station:Frsh_Lck LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.002
h                    51360   0.000
H-h        15 cm 24h 51360  -0.002  0.071  0.071   0.0  96.6   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   278   0.002  0.037  0.037   0.0 100.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   284  -0.015  0.044  0.041   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   278   0.873  1.134  0.724   0.0  28.8  42.8    0.0148.7
TLW-tlw  0.50  h 25h   284   0.708  0.784  0.338   0.0  18.3  11.6    0.0 73.9

Station:Furchon  LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.000
h                    51360  -0.030
H-h        15 cm 24h 51360   0.030  0.075  0.069   0.0  96.2   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   201   0.073  0.098  0.065   0.0  89.6   0.0    0.0  0.0
ALW-alw    15 cm 24h   203  -0.001  0.061  0.061   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   201  -0.519  0.767  0.566  12.9  37.3   0.5   23.7  0.0
TLW-tlw  0.50  h 25h   203  -0.534  0.774  0.561  13.3  39.4   1.0   24.4  0.0

Station:LAWAPs  LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
```

```
H                    51360   0.006
h                    51360   0.000
H-h        15 cm 24h 51360   0.005  0.094  0.094   0.1  88.3   0.0    2.0  0.0  0.00
AHW-ahw    15 cm 24h   191   0.042  0.067  0.052   0.0  95.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   273  -0.023  0.059  0.055   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   191   0.573  1.366  1.244   6.8  35.1  32.5   23.3 97.5
TLW-tlw  0.50  h 25h   273   0.710  0.919  0.583   0.7  28.6  33.7    0.0245.8

Station:Grnd_Is LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.000
h                    51360  -0.007
H-h        15 cm 24h 51360   0.007  0.084  0.083   0.0  93.3   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   203   0.069  0.094  0.064   0.0  88.7   0.0    0.0  0.0
ALW-alw    15 cm 24h   204  -0.056  0.085  0.064   0.0  96.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   203  -0.967  1.124  0.574  42.9  11.8   1.0  214.3  0.0
TLW-tlw  0.50  h 25h   204  -0.642  0.915  0.653  18.1  27.0   2.0   42.0  0.0

Station:Shel_Bch LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.028
h                    51360   0.000
H-h        15 cm 24h 51360   0.027  0.125  0.122   0.0  75.0   1.3    0.0  5.2  0.00
AHW-ahw    15 cm 24h   141   0.056  0.065  0.034   0.0 100.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   102  -0.008  0.046  0.045   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   141   1.305  1.995  1.514  11.3   9.9  61.7    0.0148.8
TLW-tlw  0.50  h 25h   102   1.371  1.874  1.284   3.9  20.6  61.8    0.0 73.6

Station:S_Padr  TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.018
H-h        15 cm 24h 51360   0.017  0.076  0.074   0.0  95.7   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   250   0.059  0.096  0.076   0.0  85.2   0.0    0.0  0.0
ALW-alw    15 cm 24h   254  -0.025  0.068  0.063   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   250  -0.061  0.569  0.567   1.2  68.8   4.8    0.0 49.8
TLW-tlw  0.50  h 25h   254  -0.188  0.305  0.241   0.4  87.8   0.0    0.0  0.0

Station:CpsCrst TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------
```

```
     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.026
H-h        15 cm 24h 51360   0.025  0.067  0.062   0.0  98.1   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   247   0.030  0.068  0.062   0.0  98.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   252   0.029  0.060  0.052   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   247   0.850  1.096  0.693   0.0  27.9  40.9    0.0197.0
TLW-tlw  0.50  h 25h   252   0.371  0.477  0.300   0.0  65.1   2.4    0.0  0.0

Station:Aransas TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.011
H-h        15 cm 24h 51360   0.010  0.111  0.110   0.0  81.6   0.1    0.0  2.2  0.00
AHW-ahw    15 cm 24h   237   0.103  0.138  0.093   0.0  69.6   1.3    0.0 24.8
ALW-alw    15 cm 24h   255  -0.085  0.122  0.088   0.0  76.5   0.0    0.0  0.0
THW-thw  0.50  h 25h   237  -0.153  1.033  1.024  17.7  43.9   9.7   74.0 73.8
TLW-tlw  0.50  h 25h   255   0.022  0.549  0.550   0.0  76.5   5.5    0.0 11.2

Station:CG_Frprt TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.021
H-h        15 cm 24h 51360   0.020  0.071  0.068   0.0  96.9   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   239   0.021  0.059  0.055   0.0  98.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   244   0.015  0.053  0.051   0.0  99.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   239   1.026  1.291  0.786   0.4  25.9  54.4    0.0146.9
TLW-tlw  0.50  h 25h   244   0.450  0.548  0.313   0.0  50.8   2.0    0.0  0.0

Station:Gv_Pl_Pr TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.002
h                    51360  -0.015
H-h        15 cm 24h 51360   0.013  0.084  0.083   0.0  91.6   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   272  -0.008  0.068  0.067   0.0  97.4   0.0    0.0  0.0
ALW-alw    15 cm 24h   279   0.031  0.067  0.059   0.0  94.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   272   0.936  1.198  0.749   0.0  30.5  47.4    0.0222.2
TLW-tlw  0.50  h 25h   279   0.510  0.609  0.334   0.4  38.0   3.6    0.0 11.3

Station:Glv_Pr_21 TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------
```

```
     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.003
h                    51360  -0.013
H-h         15 cm 24h 51360   0.015  0.067  0.065   0.0  97.0   0.0    0.0  0.0  0.00
AHW-ahw     15 cm 24h   265   0.017  0.067  0.065   0.0  97.0   0.0    0.0  0.0
ALW-alw     15 cm 24h   285   0.026  0.060  0.055   0.0  98.6   0.0    0.0  0.0
THW-thw   0.50  h 25h   265   1.093  1.427  0.919   0.8  24.9  47.5    0.0178.3
TLW-tlw   0.50  h 25h   285   0.702  0.815  0.414   0.0  22.5  10.9    0.0 24.9

Station:Eagle TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.015
h                    51360  -0.008
H-h         15 cm 24h 51360   0.023  0.092  0.089   0.0  89.7   0.0    0.0  0.0  0.00
AHW-ahw     15 cm 24h   187   0.003  0.078  0.078   0.0  93.6   0.0    0.0  0.0
ALW-alw     15 cm 24h   231   0.063  0.104  0.083   0.0  84.8   0.0    0.0  0.0
THW-thw   0.50  h 25h   187   1.194  1.434  0.796   0.5  19.8  56.1    0.0 99.2
TLW-tlw   0.50  h 25h   231   0.800  0.942  0.500   0.0  21.6  33.8    0.0 98.8

Station:Sabn_Ps TX
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360   0.001
H-h         15 cm 24h 51360  -0.002  0.102  0.102   0.0  85.3   0.2    0.0  2.7  0.00
AHW-ahw     15 cm 24h   307   0.086  0.116  0.079   0.0  80.5   1.6    0.0 73.1
ALW-alw     15 cm 24h   310  -0.074  0.115  0.089   0.0  77.7   0.0    0.0  0.0
THW-thw   0.50  h 25h   307  -0.061  0.457  0.454   2.0  76.2   1.0    0.0  0.0
TLW-tlw   0.50  h 25h   310   0.008  0.318  0.318   0.6  89.4   1.0    0.0  0.0

Station:Calc_Ps LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.001
h                    51360  -0.003
H-h         15 cm 24h 51360   0.002  0.087  0.087   0.0  90.7   0.0    0.0  0.0  0.00
AHW-ahw     15 cm 24h   312   0.063  0.087  0.060   0.0  92.3   0.0    0.0  0.0
ALW-alw     15 cm 24h   313  -0.027  0.080  0.075   0.0  94.9   0.0    0.0  0.0
THW-thw   0.50  h 25h   312   0.339  0.638  0.541   2.6  58.3   7.7   24.3 49.7
TLW-tlw   0.50  h 25h   313   0.370  0.499  0.335   0.3  65.5   2.6    0.0  0.0

Station:Frsh_Lck LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
```

```
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360  -0.002
h                    51360   0.000
H-h        15 cm 24h 51360  -0.002  0.071  0.071   0.0  96.6   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   278   0.002  0.037  0.037   0.0 100.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   284  -0.015  0.044  0.041   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   278   0.873  1.134  0.724   0.0  28.8  42.8    0.0148.7
TLW-tlw  0.50  h 25h   284   0.708  0.784  0.338   0.0  18.3  11.6    0.0 73.9

Station:Furchon  LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.000
h                    51360  -0.030
H-h        15 cm 24h 51360   0.030  0.075  0.069   0.0  96.2   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   201   0.073  0.098  0.065   0.0  89.6   0.0    0.0  0.0
ALW-alw    15 cm 24h   203  -0.001  0.061  0.061   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   201  -0.519  0.767  0.566  12.9  37.3   0.5   23.7  0.0
TLW-tlw  0.50  h 25h   203  -0.534  0.774  0.561  13.3  39.4   1.0   24.4  0.0

Station:LAWAPs  LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.006
h                    51360   0.000
H-h        15 cm 24h 51360   0.005  0.094  0.094   0.1  88.3   0.0    2.0  0.0  0.00
AHW-ahw    15 cm 24h   191   0.042  0.067  0.052   0.0  95.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   273  -0.023  0.059  0.055   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   191   0.573  1.366  1.244   6.8  35.1  32.5   23.3 97.5
TLW-tlw  0.50  h 25h   273   0.710  0.919  0.583   0.7  28.6  33.7    0.0245.8

Station:Grnd_Is LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.000
h                    51360  -0.007
H-h        15 cm 24h 51360   0.007  0.084  0.083   0.0  93.3   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   203   0.069  0.094  0.064   0.0  88.7   0.0    0.0  0.0
ALW-alw    15 cm 24h   204  -0.056  0.085  0.064   0.0  96.6   0.0    0.0  0.0
THW-thw  0.50  h 25h   203  -0.967  1.124  0.574  42.9  11.8   1.0  214.3  0.0
TLW-tlw  0.50  h 25h   204  -0.642  0.915  0.653  18.1  27.0   2.0   42.0  0.0

Station:Shel_Bch LA
Observed data time period from: / 2/ 1/2008  to / 9/ 2/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
```

```
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
H                    51360   0.028
h                    51360   0.000
H-h        15 cm 24h 51360   0.027  0.125  0.122   0.0  75.0   1.3    0.0  5.2  0.00
AHW-ahw    15 cm 24h   141   0.056  0.065  0.034   0.0 100.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   102  -0.008  0.046  0.045   0.0 100.0   0.0    0.0  0.0
THW-thw  0.50  h 25h   141   1.305  1.995  1.514  11.3   9.9  61.7    0.0148.8
TLW-tlw  0.50  h 25h   102   1.371  1.874  1.284   3.9  20.6  61.8    0.0 73.6
```

Tidal Current

```
Station:g02010 TX
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.060
u                    48960   0.152
U-u      26 cm/s 24h 48960  -0.092  0.121  0.078   0.0  99.3   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   154  -0.190  0.193  0.029   0.0 100.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h     5  -0.052  0.060  0.034   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   154   0.582  1.220  1.076   6.5  29.2  36.4    0.0121.8
TEC-tec  0.50h   25h     5  -0.960  1.242  0.882  60.0  40.0   0.0    0.0  0.0

Station:gp0101 MS
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.155
u                    48960   0.111
U-u      26 cm/s 24h 48960   0.044  0.088  0.076   0.0 100.0   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   192   0.092  0.117  0.073   0.0 100.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h   208   0.019  0.060  0.057   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   192   0.262  0.677  0.626   0.5  55.2  12.5    0.0 74.2
TEC-tec  0.50h   25h   208  -0.482  1.330  1.242  37.5  24.0  12.0  220.3 73.9
TSF-tsf  0.25h   25h    99   1.516  1.599  0.512   0.0   3.0  90.9    0.0 49.1
TEF-tef  0.25h   25h   190  -1.488  1.836  1.079  72.1   9.5   0.0  123.1  0.0
TSE-tse  0.25h   25h   232   1.880  1.994  0.665   0.0   0.0 100.0    0.0 98.7
TEE-tee  0.25h   25h   125  -0.774  1.232  0.962  46.4  17.6   0.0    0.0  0.0

Station:gp0201 MS
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.152
u                    48960   0.216
U-u      26 cm/s 24h 48960  -0.065  0.110  0.089   0.0  98.3   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   174  -0.141  0.158  0.071   0.0  96.0   0.0    0.0  0.0
```

```
AEC-aec  26 cm/s 24h   166  -0.041  0.074  0.061   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   174  -0.755  1.455  1.247  50.6  16.1  11.5  195.4 21.8
TEC-tec  0.50h   25h   166  -0.536  0.814  0.615  18.7  30.7   1.8   99.1  0.0
TSF-tsf  0.25h   25h    92  -0.807  1.243  0.951  44.6  22.8   3.3   73.9  0.0
TEF-tef  0.25h   25h    32   0.706  1.646  1.511  18.8  15.6  46.9    0.0 48.3
TSE-tse  0.25h   25h    64  -1.802  1.959  0.774  87.5   6.2   0.0   74.7  0.0
TEE-tee  0.25h   25h    93   0.161  0.802  0.790   4.3  63.4  11.8    0.0  0.0

Station:gp0401 MS
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -       -      -      -       <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.085
u                    48960   0.079
U-u      26 cm/s 24h 48960   0.006  0.048  0.047   0.0 100.0   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   207  -0.034  0.054  0.042   0.0 100.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h   150   0.023  0.043  0.037   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   207   1.083  1.293  0.708   1.9  12.6  60.9    0.0172.9
TEC-tec  0.50h   25h   150   0.442  0.909  0.797   2.0  36.7  20.0    0.0 24.8

Station:mb0101 AL
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -       -      -      -       <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.058
u                    48960   0.036
U-u      26 cm/s 24h 48960   0.022  0.039  0.032   0.0 100.0   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   160   0.041  0.052  0.031   0.0 100.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    79  -0.003  0.023  0.023   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   160   0.329  1.287  1.248  10.6  30.0  21.9   73.6 49.1
TEC-tec  0.50h   25h    79  -0.343  1.735  1.712  43.0  13.9  22.8   56.7 49.1

Station:ps0101
Observed data time period from: / 3/ 1/2008  to / 9/22/2008 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -       -      -      -       <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: TIDAL SIMULATION ONLY
U                    48960   0.104
u                    48960   0.091
U-u      26 cm/s 24h 48960   0.013  0.057  0.055   0.0 100.0   0.0    0.0  0.0
AFC-afc  26 cm/s 24h   164   0.094  0.103  0.042   0.0 100.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h   213  -0.012  0.049  0.048   0.0 100.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h   164  -0.129  1.062  1.058  20.1  34.8   9.8   48.8 49.0
TEC-tec  0.50h   25h   213   0.220  1.366  1.351  17.8  29.6  27.7   49.3 83.1
```

APPENDIX C. ASSESSMENT TABLES FOR NGOFS HINDCAST: WATER LEVEL.

Station: South Padre Is, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.003								
h			4345	-0.001								
H-h	15 cm	24h	4345	0.005	0.085	0.085	0.0	92.2	0.0	0.0	0.0	0.02
AHW-ahw	15 cm	24h	193	0.015	0.091	0.090	0.0	90.7	0.0	0.0	0.0	
ALW-alw	15 cm	24h	205	-0.006	0.081	0.081	0.0	93.7	0.0	0.0	0.0	
THW-thw	0.50	h 25h	193	-0.021	0.858	0.860	8.3	46.6	10.4	0.0	0.0	
TLW-tlw	0.50	h 25h	205	-0.010	0.850	0.852	13.2	51.2	10.2	24.0	0.0	

Station: Corpus Christi, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.031								
h			4345	-0.004								
H-h	15 cm	24h	4345	0.035	0.098	0.092	0.1	86.7	0.0	1.0	1.0	0.05
AHW-ahw	15 cm	24h	194	0.006	0.095	0.095	0.0	88.7	0.0	0.0	0.0	
ALW-alw	15 cm	24h	203	0.057	0.103	0.086	0.0	83.3	0.0	0.0	0.0	
THW-thw	0.50	h 25h	194	0.717	1.241	1.016	5.7	21.6	36.6	15.0	74.0	
TLW-tlw	0.50	h 25h	203	0.291	0.896	0.850	4.4	47.8	19.2	0.0	24.0	

Station: Port Aransas, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.034								
h			4345	0.005								
H-h	15 cm	24h	4345	0.029	0.110	0.106	0.0	82.5	0.4	0.0	2.0	0.07
AHW-ahw	15 cm	24h	164	0.078	0.134	0.110	0.0	73.2	1.8	0.0	0.0	
ALW-alw	15 cm	24h	197	-0.025	0.090	0.086	0.0	90.4	0.0	0.0	0.0	
THW-thw	0.50	h 25h	164	0.030	1.252	1.255	23.8	31.1	18.9	0.0	0.0	
TLW-tlw	0.50	h 25h	197	-0.046	0.858	0.859	12.2	50.8	11.7	40.0	0.0	

Station: Port OConnor, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.046								
h			4345	0.007								
H-h	15 cm	24h	4345	0.039	0.165	0.160	1.4	62.1	5.7	5.0	28.0	2.90

AHW-ahw	15 cm	24h	38	0.043	0.123	0.117	0.0	71.1	0.0	0.0	0.0	
ALW-alw	15 cm	24h	72	-0.063	0.115	0.097	0.0	79.2	0.0	0.0	0.0	
THW-thw	0.50 h	25h	38	-0.974	1.496	1.150	50.0	18.4	7.9	0.0	0.0	
TLW-tlw	0.50 h	25h	72	-1.639	1.756	0.635	77.8	4.2	0.0	0.0	0.0	

Station: USCG Freeport, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 1.46 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4314	0.041								
h			4314	-0.055								
H-h	15 cm	24h	4314	0.096	0.248	0.229	0.1	68.6	2.8	2.0	26.0	0.72
AHW-ahw	15 cm	24h	199	0.053	0.116	0.104	0.5	82.4	1.0	0.0	0.0	
ALW-alw	15 cm	24h	208	0.138	0.170	0.099	0.0	58.2	4.3	0.0	0.0	
THW-thw	0.50 h	25h	199	0.673	1.232	1.034	5.5	29.6	33.7	0.0	24.0	
TLW-tlw	0.50 h	25h	208	0.178	0.891	0.875	8.2	45.2	13.9	0.0	0.0	

Station: Galveston Pleasure Pier, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.038								
h			4345	0.016								
H-h	15 cm	24h	4345	0.022	0.682	0.681	1.6	65.3	4.6	12.0	35.0	0.90
AHW-ahw	15 cm	24h	210	0.032	0.132	0.129	0.5	86.7	1.9	0.0	0.0	
ALW-alw	15 cm	24h	224	0.147	0.187	0.116	0.0	53.1	5.4	0.0	23.0	
THW-thw	0.50 h	25h	210	0.724	1.242	1.012	6.2	25.7	38.6	0.0	73.0	
TLW-tlw	0.50 h	25h	224	0.330	0.945	0.887	5.4	38.8	21.0	0.0	24.0	

Station: Galveston Pleasure Pier 21, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.039								
h			4345	-0.043								
H-h	15 cm	24h	4345	0.083	0.139	0.112	0.0	73.9	3.0	0.0	34.0	0.67
AHW-ahw	15 cm	24h	171	0.049	0.113	0.102	0.6	82.5	1.8	0.0	12.0	
ALW-alw	15 cm	24h	216	0.115	0.159	0.110	0.0	63.0	3.2	0.0	13.0	
THW-thw	0.50 h	25h	171	0.351	1.233	1.186	11.1	30.4	29.8	24.0	25.0	
TLW-tlw	0.50 h	25h	216	0.495	0.969	0.835	4.2	38.0	22.7	0.0	24.0	

Station: Eagle Point, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.051								
h			4345	-0.005								

H-h	15 cm	24h	4345	0.057	0.171	0.161	0.1	78.8	2.3	2.0	24.0	0.90
AHW-ahw	15 cm	24h	144	0.047	0.124	0.115	0.7	81.2	0.7	0.0	0.0	
ALW-alw	15 cm	24h	165	0.070	0.119	0.097	0.0	79.4	1.2	0.0	0.0	
THW-thw	0.50 h	25h	144	0.042	1.190	1.194	18.8	29.2	20.1	0.0	0.0	
TLW-tlw	0.50 h	25h	165	0.352	1.003	0.942	8.5	37.6	21.2	0.0	0.0	

Station: Sabine Pass North, TX
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	0.055								
h			4345	-0.079								
H-h	15 cm	24h	4345	0.134	0.189	0.134	0.1	57.1	10.7	0.0	49.0	2.72
AHW-ahw	15 cm	24h	230	0.168	0.203	0.113	0.0	46.1	11.3	0.0	25.0	
ALW-alw	15 cm	24h	242	0.105	0.161	0.122	0.0	67.8	5.0	0.0	12.0	
THW-thw	0.50 h	25h	230	-0.061	1.099	1.100	17.4	32.6	17.0	23.0	48.0	
TLW-tlw	0.50 h	25h	242	-0.165	0.905	0.891	15.3	45.5	4.5	59.0	0.0	

Station: Calcasieu Pass, LA
Observed data time period from: / 9/30/2010 to / 3/30/2011 with gaps of 4.04 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4255	0.039								
h			4255	-0.077								
H-h	15 cm	24h	4255	0.117	0.176	0.132	0.1	64.0	7.9	0.0	49.0	2.02
AHW-ahw	15 cm	24h	228	0.123	0.170	0.117	0.0	63.2	6.6	0.0	25.0	
ALW-alw	15 cm	24h	242	0.134	0.182	0.124	0.0	59.1	7.4	0.0	23.0	
THW-thw	0.50 h	25h	228	0.018	1.128	1.130	18.4	36.0	17.1	25.0	12.0	
TLW-tlw	0.50 h	25h	242	0.157	0.900	0.888	8.3	50.0	14.0	36.0	12.0	

Station: Cypermort, LA
Observed data time period from: / 9/30/2010 to /11/10/2010 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			975	0.058								
h			975	0.016								
H-h	15 cm	24h	975	0.042	0.119	0.111	0.0	85.7	1.4	0.0	7.0	0.92
AHW-ahw	15 cm	24h	46	0.067	0.109	0.087	0.0	87.0	2.2	0.0	0.0	
ALW-alw	15 cm	24h	47	0.051	0.206	0.202	0.0	89.4	2.1	0.0	0.0	
THW-thw	0.50 h	25h	46	0.022	1.113	1.125	17.4	41.3	19.6	13.0	0.0	
TLW-tlw	0.50 h	25h	47	-0.234	0.957	0.938	17.0	46.8	8.5	13.0	0.0	

Station: Port Fourchon, LA
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 6.96 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4182	-0.004								

```
h                     4182  -0.028
H-h        15 cm 24h  4182   0.023  0.180  0.178   1.9  83.4   0.3   76.0  4.0  1.08
AHW-ahw    15 cm 24h   152   0.058  0.106  0.089   0.0  81.6   0.0    0.0  0.0
ALW-alw    15 cm 24h   149   0.040  0.155  0.150   0.7  85.9   0.7    0.0  0.0
THW-thw  0.50  h 25h   152  -0.513  1.181  1.067  27.0  27.6  11.2    0.0 24.0
TLW-tlw  0.50  h 25h   149  -0.242  1.017  0.991  18.1  40.9   8.1    0.0  0.0

Station:                           Grand Isle, LA
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF     POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     4345   0.000
h                     4345  -0.048
H-h        15 cm 24h  4345   0.047  0.110  0.099   0.0  82.0   0.3    0.0  3.0  0.12
AHW-ahw    15 cm 24h   148   0.079  0.123  0.095   0.0  75.0   0.0    0.0  0.0
ALW-alw    15 cm 24h   153   0.013  0.085  0.085   0.0  91.5   0.0    0.0  0.0
THW-thw  0.50  h 25h   148  -0.905  1.346  0.999  43.9  20.3   6.8   49.0  0.0
TLW-tlw  0.50  h 25h   153  -0.451  1.129  1.038  24.8  33.3   9.2    0.0 24.0

Station:                          Shell Beach, LA
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF     POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     4345   0.007
h                     4345  -0.013
H-h        15 cm 24h  4345   0.021  0.245  0.244   1.7  69.2   1.7    9.0 16.0  0.99
AHW-ahw    15 cm 24h   172   0.006  0.720  0.722   1.7  73.3   0.6    0.0  0.0
ALW-alw    15 cm 24h   162   0.031  0.124  0.121   0.0  74.1   1.9    0.0  0.0
THW-thw  0.50  h 25h   172   0.407  1.201  1.133  12.2  23.8  26.2   12.0 24.0
TLW-tlw  0.50  h 25h   162   0.772  1.293  1.041   3.1  21.6  44.4    0.0 96.0

Station:                   Pilots Sta SW Pass, LA
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF     POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     4345  -0.009
h                     4345   0.036
H-h        15 cm 24h  4345  -0.045  0.108  0.099   0.1  82.7   0.0    1.0  0.0  0.00
AHW-ahw    15 cm 24h   159  -0.029  0.106  0.102   0.6  86.2   0.0    0.0  0.0
ALW-alw    15 cm 24h   162  -0.048  0.106  0.095   0.0  82.1   0.0    0.0  0.0
THW-thw  0.50  h 25h   159   0.220  1.061  1.041  10.7  34.6  19.5    0.0 25.0
TLW-tlw  0.50  h 25h   162   0.315  1.080  1.037  10.5  35.2  19.8    0.0 47.0

Station:                         Bay Waveland, MS
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF     POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
```

```
H                    4345  -0.016
h                    4345  -0.049
H-h        15 cm 24h  4345   0.033  0.139  0.135   1.0  74.9   2.8    7.0 17.0  0.69
AHW-ahw    15 cm 24h   168  -0.004  0.112  0.112   0.6  86.9   1.2    0.0  0.0
ALW-alw    15 cm 24h   174   0.081  0.141  0.116   0.0  76.4   2.3    0.0  0.0
THW-thw  0.50  h 25h   168   0.452  1.144  1.054  10.7  33.3  25.6    0.0 24.0
TLW-tlw  0.50  h 25h   174   0.534  1.271  1.156  11.5  24.7  33.3   25.0 72.0

Station:                     Gulfport Harbor, MS
Observed data time period from: / 9/30/2010  to / 1/ 4/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                    2296   0.007
h                    2296  -0.034
H-h        15 cm 24h  2296   0.041  0.129  0.123   0.4  79.5   2.7    4.0 12.0  0.96
AHW-ahw    15 cm 24h    90   0.032  0.118  0.114   0.0  83.3   2.2    0.0  0.0
ALW-alw    15 cm 24h    90   0.049  0.108  0.097   0.0  81.1   0.0    0.0  0.0
THW-thw  0.50  h 25h    90   0.311  0.989  0.944   6.7  48.9  17.8    0.0  0.0
TLW-tlw  0.50  h 25h    90   0.211  1.090  1.076  12.2  37.8  20.0    0.0 24.0

Station:                 Pascagoula NOAA Lab, MS
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                    4345  -0.039
h                    4345  -0.050
H-h        15 cm 24h  4345   0.011  0.101  0.101   0.3  87.8   0.4    3.0  7.0  0.16
AHW-ahw    15 cm 24h   173   0.009  0.089  0.089   0.0  91.3   0.0    0.0  0.0
ALW-alw    15 cm 24h   177   0.014  0.096  0.096   0.0  90.4   1.1    0.0  0.0
THW-thw  0.50  h 25h   173  -0.133  1.062  1.056  17.9  41.0  13.3   46.0 24.0
TLW-tlw  0.50  h 25h   177  -0.390  1.022  0.948  27.1  37.9   6.8   48.0  0.0

Station:                  Port of Pascagoula, MS
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                    4345  -0.040
h                    4345  -0.018
H-h        15 cm 24h  4345  -0.022  0.270  0.269   2.1  87.6   0.4   11.0  7.0  1.10
AHW-ahw    15 cm 24h   167   0.006  0.095  0.095   0.0  90.4   0.0    0.0  0.0
ALW-alw    15 cm 24h   177   0.016  0.096  0.095   0.6  91.0   1.1    0.0  0.0
THW-thw  0.50  h 25h   167   0.000  1.137  1.141  17.4  40.7  16.2   37.0 25.0
TLW-tlw  0.50  h 25h   177   0.000  1.003  1.006  14.7  40.1  15.3   23.0 35.0

Station:                  Mobile State Docks, AL
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
---------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
---------------------------------------------------------------------------------------------
```

```
     SCENARIO: HINDCAST
H                     4345  -0.013
h                     4345  -0.080
H-h        15 cm 24h  4345   0.067  0.150  0.134   0.4  70.4   4.9    6.0 15.0  1.82
AHW-ahw    15 cm 24h   172   0.096  0.149  0.114   0.0  71.5   6.4    0.0 17.0
ALW-alw    15 cm 24h   160   0.038  0.124  0.119   0.6  79.4   2.5    0.0  0.0
THW-thw  0.50  h 25h   172  -0.715  1.203  0.970  37.2  25.0   5.8   24.0  0.0
TLW-tlw  0.50  h 25h   160  -0.806  1.301  1.025  42.5  26.2   5.0   50.0 23.0

Station:                   Coast Guard Mobile, AL
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     4345  -0.014
h                     4345  -0.066
H-h        15 cm 24h  4345   0.052  0.144  0.134   0.6  75.1   4.5    8.0 18.0  1.47
AHW-ahw    15 cm 24h   174   0.076  0.140  0.119   0.0  73.6   5.7    0.0 26.0
ALW-alw    15 cm 24h   175   0.021  0.116  0.115   0.6  84.6   2.9    0.0  0.0
THW-thw  0.50  h 25h   174  -0.339  1.096  1.045  25.9  36.8   9.8   10.0  0.0
TLW-tlw  0.50  h 25h   175  -0.554  1.188  1.054  29.7  25.7   8.0   33.0  0.0

Station:                 Dauphin Island Hydro, AL
Observed data time period from: / 9/30/2010  to /11/17/2010 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     1146   0.021
h                     1146   0.058
H-h        15 cm 24h  1146  -0.037  0.095  0.088   0.9  89.2   0.0    5.0  0.0  0.00
AHW-ahw    15 cm 24h    46  -0.015  0.078  0.078   0.0  93.5   0.0    0.0  0.0
ALW-alw    15 cm 24h    43  -0.043  0.082  0.070   0.0  93.0   0.0    0.0  0.0
THW-thw  0.50  h 25h    46   0.022  0.872  0.882  17.4  50.0  13.0    0.0  0.0
TLW-tlw  0.50  h 25h    43  -0.372  1.161  1.113  32.6  34.9   7.0    0.0  0.0

Station:                            Weeks Bay, AL
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                     4345  -0.029
h                     4345  -0.055
H-h        15 cm 24h  4345   0.026  0.115  0.112   0.6  81.9   0.6   11.0  4.0  0.18
AHW-ahw    15 cm 24h   184   0.041  0.113  0.105   0.0  82.6   0.5    0.0  0.0
ALW-alw    15 cm 24h   163  -0.009  0.085  0.085   0.6  93.9   0.0    0.0  0.0
THW-thw  0.50  h 25h   184  -0.294  1.128  1.092  24.5  33.2  10.3    0.0 22.0
TLW-tlw  0.50  h 25h   163  -0.294  1.188  1.154  22.7  27.0   9.2   48.0 11.0

Station:                          Gulf Shores, AL
Observed data time period from: / 9/30/2010  to / 3/16/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------
```

```
     SCENARIO: HINDCAST
H                      4000  -0.057
h                      4000  -0.053
H-h        15 cm 24h  4000  -0.004  0.147  0.147   2.3  68.2   1.0    6.0  4.0  1.23
AHW-ahw    15 cm 24h    73   0.006  0.126  0.127   2.7  82.2   0.0    0.0  0.0
ALW-alw    15 cm 24h    50   0.007  0.107  0.107   2.0  84.0   0.0    0.0  0.0
THW-thw  0.50  h 25h    73  -1.164  1.600  1.106  61.6   8.2   5.5    0.0  0.0
TLW-tlw  0.50  h 25h    50  -0.980  1.449  1.079  52.0  22.0   8.0    0.0  0.0

Station:                     Blue Angels Park, FL
Observed data time period from: / 9/30/2010  to / 3/15/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                      3979  -0.057
h                      3979  -0.064
H-h        15 cm 24h  3979   0.008  0.174  0.174   3.7  59.3   5.2    6.0  8.0  4.83
AHW-ahw    15 cm 24h    20   0.006  0.110  0.113   0.0  75.0   0.0    0.0  0.0
ALW-alw    15 cm 24h    17  -0.041  0.123  0.119   0.0  76.5   0.0    0.0  0.0
THW-thw  0.50  h 25h    20  -1.150  1.775  1.387  65.0  10.0  10.0    0.0  0.0
TLW-tlw  0.50  h 25h    17  -1.294  1.609  0.985  58.8   0.0   5.9    0.0  0.0

Station:                            Pensacola, FL
Observed data time period from: / 9/30/2010  to / 3/31/2011 with gaps of    3.71 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                      4268  -0.041
h                      4268  -0.050
H-h        15 cm 24h  4268   0.010  0.091  0.090   0.0  89.0   0.0    0.0  0.0  0.00
AHW-ahw    15 cm 24h   174   0.041  0.091  0.082   0.0  86.8   0.0    0.0  0.0
ALW-alw    15 cm 24h   168  -0.019  0.083  0.081   0.0  92.9   0.0    0.0  0.0
THW-thw  0.50  h 25h   174  -0.293  0.894  0.847  17.8  44.3   6.9    0.0  0.0
TLW-tlw  0.50  h 25h   168  -0.208  0.916  0.895  14.3  41.1   7.1    0.0  0.0

Station:                           Valparaiso, FL
Observed data time period from: / 9/30/2010  to / 3/14/2011 with gaps of   32.63 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM     RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
H                      3185  -0.031
h                      3185  -0.082
H-h        15 cm 24h  3185   0.050  0.109  0.097   0.0  82.1   0.1    0.0  3.0  0.00
AHW-ahw    15 cm 24h   103   0.126  0.151  0.084   0.0  60.2   0.0    0.0  0.0
ALW-alw    15 cm 24h    98  -0.012  0.079  0.078   0.0  92.9   0.0    0.0  0.0
THW-thw  0.50  h 25h   103  -0.563  1.182  1.045  32.0  24.3   7.8    0.0  0.0
TLW-tlw  0.50  h 25h    98  -0.704  1.351  1.160  39.8  15.3   8.2    0.0 12.0
```

Station: Panama City, FL
Observed data time period from: / 9/30/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
H			4345	-0.063								
h			4345	-0.064								
H-h	15 cm	24h	4345	0.001	0.081	0.081	0.0	94.0	0.0	0.0	0.0	0.00
AHW-ahw	15 cm	24h	179	-0.005	0.075	0.075	0.0	95.5	0.0	0.0	0.0	
ALW-alw	15 cm	24h	181	0.010	0.077	0.077	0.0	93.4	0.0	0.0	0.0	
THW-thw	0.50 h	25h	179	0.056	0.909	0.910	11.2	47.5	14.5	23.0	0.0	
TLW-tlw	0.50 h	25h	181	0.265	0.952	0.917	9.4	45.9	19.9	0.0	24.0	

APPENDIX D. SKILL ASSESSMENT TABLES FOR NGOFS HINDCAST: CURRENT SPEED

Station: g06010 Galveston Bay Entr Channel LB 11, TX
Observed data time period from: /10/ 1/2010 to / 3/ 1/2011 with gaps of 108.62 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			1047	0.335								
u			1047	0.461								
U-u	26 cm/s	24h	1047	-0.126	0.231	0.194	2.4	73.7	0.0	4.0	0.0	0.76
AFC-afc	26 cm/s	24h	43	-0.202	0.263	0.171	4.7	69.8	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	44	-0.317	0.344	0.136	6.8	25.0	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	43	-0.349	1.089	1.044	14.0	37.2	4.7	24.0	0.0	
TEC-tec	0.50h	25h	44	-0.023	0.965	0.976	9.1	40.9	2.3	0.0	0.0	

Station: gp0101 Gulfport Ship Channel LB 22, MS
Observed data time period from: /10/ 1/2010 to / 3/ 1/2011 with gaps of 37.71 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			2764	0.156								
u			2764	0.161								
U-u	26 cm/s	24h	2764	-0.005	0.091	0.091	0.0	99.0	0.0	0.0	0.0	
AFC-afc	26 cm/s	24h	85	-0.084	0.152	0.127	1.2	94.1	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	65	-0.024	0.073	0.069	0.0	100.0	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	85	-0.412	1.193	1.126	16.5	28.2	7.1	0.0	0.0	
TEC-tec	0.50h	25h	65	0.046	1.295	1.304	13.8	24.6	16.9	0.0	0.0	

Station: gp0401 Gulfport Harbor, West Pier, MS
Observed data time period from: /10/ 1/2010 to / 3/ 1/2011 with gaps of 13.96 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			3328	0.080								
u			3328	0.068								
U-u	26 cm/s	24h	3328	0.013	0.058	0.057	0.0	99.9	0.0	0.0	0.0	
AFC-afc	26 cm/s	24h	56	0.011	0.066	0.066	0.0	100.0	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	75	-0.014	0.056	0.054	0.0	100.0	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	56	0.768	1.470	1.265	7.1	17.9	37.5	0.0	0.0	
TEC-tec	0.50h	25h	75	0.320	1.296	1.264	12.0	24.0	18.7	0.0	0.0	

Station: mb0101 Mobile Bay Buoy M, AL
Observed data time period from: /10/13/2010 to / 2/14/2011 with gaps of 1.96 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			2932	0.173								
u			2932	0.201								

```
U-u      26 cm/s 24h  2932  -0.028  0.128  0.125   0.1  94.5   0.0    1.0  0.0
AFC-afc  26 cm/s 24h    45  -0.120  0.201  0.162   0.0  80.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    26  -0.008  0.119  0.121   0.0  92.3   0.0    0.0  0.0
TFC-tfc  0.50h   25h    45  -0.178  1.333  1.336  20.0  22.2  13.3    0.0  0.0
TEC-tec  0.50h   25h    26  -0.308  1.330  1.320  23.1  15.4   7.7    0.0  0.0

Station:                          TABSV_B TX
Observed data time period from: /10/ 1/2010  to / 4/ 2/2011 with gaps of   39.08 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X      N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -      -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
U                     3433   0.181
u                     3433   0.206
U-u      26 cm/s 24h  3433  -0.026  0.150  0.148   0.6  91.1   0.0    7.0  0.0
AFC-afc  26 cm/s 24h    25  -0.084  0.125  0.095   0.0  96.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    74  -0.073  0.184  0.170   1.4  86.5   0.0    0.0  0.0
TFC-tfc  0.50h   25h    25   0.160  1.095  1.106   4.0  28.0  12.0    0.0  0.0
TEC-tec  0.50h   25h    74   0.162  1.284  1.282  10.8  28.4  20.3    0.0 23.0
TSF-tsf  0.25h   25h     9  -0.853  2.260  2.220  66.7  11.1  22.2    0.0  0.0
TEF-tef  0.25h   25h    16  -2.432  2.432  0.000 100.0   0.0   0.0    0.0  0.0
TSE-tse  0.25h   25h    33   0.749  2.075  1.965  24.2  12.1  60.6    0.0  0.0
TEE-tee  0.25h   25h    22  -1.103  1.909  1.595  59.1   9.1  18.2    0.0  0.0

Station:                          TABSV_D TX
Observed data time period from: /10/15/2010  to / 4/ 2/2011 with gaps of   63.12 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X      N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -      -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
U                     2520   0.127
u                     2520   0.246
U-u      26 cm/s 24h  2520  -0.119  0.177  0.131   0.1  83.2   0.0    2.0  0.0
AFC-afc  26 cm/s 24h    25  -0.171  0.227  0.153   0.0  68.0   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    24  -0.173  0.210  0.122   0.0  75.0   0.0    0.0  0.0
TFC-tfc  0.50h   25h    25   0.280  1.661  1.671  28.0   4.0  32.0   11.0  0.0
TEC-tec  0.50h   25h    24   0.167  1.607  1.633  25.0   4.2  29.2    0.0  0.0
TSE-tse  0.25h   25h     3  -1.832  1.832  0.000 100.0   0.0   0.0    0.0  0.0
TEE-tee  0.25h   25h     2  -1.628  1.628  0.000 100.0   0.0   0.0    0.0  0.0

Station:                          TABSV_F TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011 with gaps of    6.08 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X      N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -      -     -      -      -      -      <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
U                     4240   0.116
u                     4240   0.142
U-u      26 cm/s 24h  4240  -0.026  0.094  0.091   0.0  98.3   0.0    0.0  0.0
AFC-afc  26 cm/s 24h    94  -0.033  0.093  0.087   0.0  97.9   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    85  -0.061  0.117  0.101   0.0  96.5   0.0    0.0  0.0
TFC-tfc  0.50h   25h    94  -0.043  1.313  1.319  19.1  23.4  12.8    0.0  0.0
TEC-tec  0.50h   25h    85   0.424  1.198  1.127   5.9  30.6  18.8   15.0  0.0
TSF-tsf  0.25h   25h     9  -1.561  2.075  1.451  77.8   0.0   0.0    0.0  0.0
TEF-tef  0.25h   25h     9   0.856  1.074  0.688   0.0  33.3  66.7    0.0  0.0
TSE-tse  0.25h   25h    23  -1.816  1.914  0.617  82.6   0.0   0.0    0.0  0.0
TEE-tee  0.25h   25h     5  -0.223  1.515  1.675  40.0  20.0  40.0    0.0  0.0

Station:                          TABSV_J TX
```

Observed data time period from: /10/ 1/2010 to / 4/ 2/2011 with gaps of 57.29 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			3008	0.106								
u			3008	0.256								
U-u	26 cm/s	24h	3008	-0.150	0.225	0.167	3.5	80.2	0.0	15.0	0.0	
AFC-afc	26 cm/s	24h	39	-0.155	0.198	0.125	0.0	84.6	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	14	-0.316	0.432	0.304	21.4	57.1	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	39	-0.385	1.368	1.330	28.2	12.8	5.1	0.0	0.0	
TEC-tec	0.50h	25h	14	-0.286	1.464	1.490	28.6	14.3	14.3	0.0	0.0	

Station: TABSV_K TX
Observed data time period from: /10/ 1/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			4368	0.125								
u			4368	0.200								
U-u	26 cm/s	24h	4368	-0.075	0.166	0.147	0.3	88.1	0.0	1.0	0.0	
AFC-afc	26 cm/s	24h	53	-0.143	0.212	0.158	0.0	73.6	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	16	-0.120	0.211	0.179	0.0	81.2	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	53	0.075	1.244	1.253	13.2	35.8	17.0	0.0	0.0	
TEC-tec	0.50h	25h	16	0.375	1.275	1.258	12.5	12.5	12.5	0.0	0.0	
TSF-tsf	0.25h	25h	6	-0.429	1.592	1.679	33.3	16.7	33.3	0.0	0.0	
TEF-tef	0.25h	25h	15	1.706	1.975	1.030	6.7	13.3	80.0	0.0	0.0	
TEE-tee	0.25h	25h	3	1.691	1.947	1.183	0.0	33.3	66.7	0.0	0.0	

Station: TABSV_N TX
Observed data time period from: /10/ 1/2010 to / 3/31/2011 with gaps of 0.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			4368	0.086								
u			4368	0.183								
U-u	26 cm/s	24h	4368	-0.096	0.149	0.113	0.0	91.5	0.0	0.0	0.0	
AFC-afc	26 cm/s	24h	37	-0.130	0.162	0.098	0.0	94.6	0.0	0.0	0.0	
AEC-aec	26 cm/s	24h	26	-0.225	0.265	0.143	0.0	57.7	0.0	0.0	0.0	
TFC-tfc	0.50h	25h	37	0.027	1.385	1.404	16.2	13.5	18.9	0.0	0.0	
TEC-tec	0.50h	25h	26	-0.385	1.387	1.359	26.9	34.6	15.4	0.0	0.0	
TSF-tsf	0.25h	25h	4	0.906	0.906	0.026	0.0	0.0	0.0	0.0	0.0	
TSE-tse	0.25h	25h	5	0.238	0.987	1.071	0.0	0.0	40.0	0.0	0.0	

Station: TABSV_R TX
Observed data time period from: /10/ 1/2010 to / 1/30/2011 with gaps of 16.00 days
Data gap is not filled
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%
SCENARIO: HINDCAST												
U			2580	0.087								
u			2580	0.139								
U-u	26 cm/s	24h	2580	-0.052	0.109	0.096	0.2	96.5	0.0	0.0	0.0	
AFC-afc	26 cm/s	24h	26	-0.058	0.105	0.090	0.0	96.2	0.0	0.0	0.0	

```
AEC-aec  26 cm/s 24h    52  -0.092  0.140  0.106   0.0  90.4   0.0    0.0  0.0
TFC-tfc  0.50h   25h    26  -0.308  1.240  1.225  19.2  38.5  11.5    0.0  0.0
TEC-tec  0.50h   25h    52  -0.327  1.487  1.465  30.8  23.1  17.3    0.0  0.0
TEE-tee  0.25h   25h    13  -1.290  1.290  0.000 100.0   0.0   0.0    0.0  0.0

Station:                          TABSV_V TX
Observed data time period from: /10/ 1/2010  to / 3/ 5/2011 with gaps of    0.00 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -       -     -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
U                     3738   0.082
u                     3738   0.153
U-u      26 cm/s 24h  3738  -0.071  0.125  0.104   0.0  95.8   0.0    0.0  0.0
AFC-afc  26 cm/s 24h    44  -0.126  0.160  0.100   0.0  90.9   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    16  -0.135  0.168  0.104   0.0  87.5   0.0    0.0  0.0
TFC-tfc  0.50h   25h    44   0.227  1.477  1.476  13.6  25.0  34.1    0.0  0.0
TEC-tec  0.50h   25h    16  -0.125  1.225  1.258  12.5  25.0  12.5    0.0  0.0
TSE-tse  0.25h   25h     2   0.240  0.240  0.000   0.0 100.0   0.0    0.0  0.0

Station:                          TABSV_W TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011 with gaps of    2.83 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -    -       -     -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
U                     4312   0.178
u                     4312   0.221
U-u      26 cm/s 24h  4312  -0.043  0.164  0.158   0.6  88.6   0.1    6.0  3.0
AFC-afc  26 cm/s 24h    18  -0.140  0.201  0.149   0.0  83.3   0.0    0.0  0.0
AEC-aec  26 cm/s 24h    42  -0.072  0.165  0.150   0.0  88.1   0.0    0.0  0.0
TFC-tfc  0.50h   25h    18  -0.278  1.225  1.227  16.7  16.7   5.6    0.0  0.0
TEC-tec  0.50h   25h    42   0.238  1.327  1.322  11.9  16.7  19.0    0.0  0.0
TSE-tse  0.25h   25h    13   0.054  1.984  2.064  38.5  30.8  30.8    0.0  0.0
TEE-tee  0.25h   25h     9   0.424  1.716  1.764  22.2  11.1  44.4    0.0  0.0
```

APPENDIX E. SKILL ASSESSMENT TABLES FOR NGOFS HINDCAST: CURRENT DIRECTION

```
Station: g06010 Galveston Bay Entr Channel LB 11 D-ADCP
Observed data time period from: /10/ 1/2010  to / 3/ 1/2011with gaps of  108.62 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     1047 166.811
d                     1047 166.111
D-d      22.5 dg 24h  1047   0.909 14.305 14.283   0.1  98.8   0.3    0.0  1.0
DFC-dfc  22.5 dg 24h    43  11.618 12.020  3.119   0.0 100.0   0.0    0.0  0.0
DEC-dec  22.5 dg 24h    44 -11.808 12.424  3.909   0.0 100.0   0.0    0.0  0.0
```

```
Station: gp0101 Gulfport Ship Channel LB 22 D-ADCP K20,
Observed data time period from: /10/ 1/2010  to / 3/ 1/2011with gaps of   37.71 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     2764 218.655
d                     2764 217.191
D-d      22.5 dg 24h  2764   0.497  5.820  5.800   0.2  98.9   0.0    2.0  0.0
DFC-dfc  22.5 dg 24h    85  11.370 20.794 17.514   2.4  84.7   3.5    0.0  0.0
DEC-dec  22.5 dg 24h    65  -4.844 24.936 24.652   6.2  69.2   1.5    0.0  0.0
```

```
Station: gp0201 Gulfport Ship Channel LB 26 D-ADCO K20,
Observed data time period from: /10/ 1/2010  to / 3/ 1/2011with gaps of   84.33 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     1691 160.365
d                     1691 147.631
D-d      22.5 dg 24h  1691  -2.501  7.857  7.451   0.0  95.5   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    40 -10.280 14.533 10.404   0.0  85.0   0.0    0.0  0.0
DEC-dec  22.5 dg 24h    44 -17.949 22.584 13.865   0.0  61.4   0.0    0.0  0.0
```

```
Station: gp0401 West Pier H-ADCP 4m*30 K20, MS
Observed data time period from: /10/ 1/2010  to / 3/ 1/2011with gaps of   13.96 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD      NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -       -      <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     3328 175.712
d                     3328 184.566
D-d      22.5 dg 24h  3328   0.013  0.547  0.547   0.0 100.0   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    56 -29.522 47.437 37.467  37.5  19.6   7.1    0.0  0.0
DEC-dec  22.5 dg 24h    75   7.556 31.150 30.423   5.3  68.0   9.3    0.0  0.0
```

```
Station: mb0101 Mobile Bay Buoy M D-ADCP K10, AL
Observed data time period from: /10/13/2010  to / 2/14/2011with gaps of    1.96 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     2932 215.815
d                     2932 192.984
D-d      22.5 dg 24h  2932  -0.257  8.643  8.640   0.5  97.9   0.4    9.0  3.0
DFC-dfc  22.5 dg 24h    45   2.067 41.046 41.457  11.1  51.1   8.9    0.0 24.0
DEC-dec  22.5 dg 24h    26  -1.974 43.735 44.556  15.4  65.4   3.8    0.0  0.0


Station:                  TABSV_B TABS Buoy B, TX
Observed data time period from: /10/ 1/2010  to / 4/ 2/2011with gaps of   39.08 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     3433 191.471
d                     3433 192.273
D-d      22.5 dg 24h  3433  -0.962  8.784  8.732   0.5  95.5   0.4    8.0 10.0
DFC-dfc  22.5 dg 24h    25  -1.210 36.882 37.622  12.0  52.0  12.0    0.0  0.0
DEC-dec  22.5 dg 24h    74  -5.154 35.006 34.861   9.5  66.2   5.4    0.0  0.0

Station:                  TABSV_D TABS Buoy D, TX
Observed data time period from: /10/15/2010  to / 4/ 2/2011with gaps of   63.12 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     2520 166.696
d                     2520 177.065
D-d      22.5 dg 24h  2520   0.019  0.709  0.709   0.0 100.0   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    25 -10.609 33.331 32.249   4.0  76.0   4.0    0.0  0.0
DEC-dec  22.5 dg 24h    24  11.387 17.046 12.957   0.0  83.3   0.0    0.0  0.0

Station:                  TABSV_F TABS Buoy F, TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011with gaps of    6.08 days
Data gap is not filled
Data are not filtered
-------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     4240 219.047
d                     4240 204.726
D-d      22.5 dg 24h  4240  -0.016  0.802  0.802   0.0 100.0   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    94 -15.262 48.378 46.154  25.5  35.1   6.4    0.0  0.0
DEC-dec  22.5 dg 24h    85   2.447 42.569 42.751   7.1  47.1  16.5   11.0  0.0

Station:                  TABSV_J TABS Buoy J, TX
Observed data time period from: /10/ 1/2010  to / 4/ 2/2011with gaps of   57.29 days
Data gap is not filled
Data are not filtered
```

```
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     3008 213.589
d                     3008 168.065
D-d      22.5 dg 24h  3008  -0.035  0.813  0.812   0.0 100.0   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    39   0.799 46.739 47.343  12.8  35.9  20.5    0.0  0.0
DEC-dec  22.5 dg 24h    14  18.015 51.136 49.664   7.1  42.9  28.6    0.0  0.0

Station:                  TABSV_K TABS Buoy K, TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     4368 169.360
d                     4368 143.395
D-d      22.5 dg 24h  4368  -0.577  5.877  5.850   0.5  98.9   0.0    7.0  0.0
DFC-dfc  22.5 dg 24h    53  -8.965 35.992 35.191  13.2  64.2   7.5    0.0  0.0
DEC-dec  22.5 dg 24h    16  12.032 35.756 34.775   6.2  56.2  25.0    0.0  0.0

Station:                  TABSV_N TABS Buoy N, TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     4368 182.757
d                     4368 114.783
D-d      22.5 dg 24h  4368   0.023  2.231  2.231   0.0  99.6   0.0    0.0  0.0
DFC-dfc  22.5 dg 24h    37 -41.919 61.753 45.971  43.2  37.8   0.0    0.0  0.0
DEC-dec  22.5 dg 24h    26  32.986 51.251 40.002   0.0  30.8  34.6    0.0  0.0

Station:                  TABSV_R TABS Buoy R, TX
Observed data time period from: /10/ 1/2010  to / 1/30/2011with gaps of   16.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     2580 211.501
d                     2580 215.290
D-d      22.5 dg 24h  2580  -0.088  2.544  2.543   0.1  99.8   0.0    1.0  0.0
DFC-dfc  22.5 dg 24h    26  -8.991 36.488 36.064  11.5  69.2   3.8    0.0  0.0
DEC-dec  22.5 dg 24h    52  -6.551 37.564 37.349  11.5  61.5   3.8    0.0  0.0

Station:                  TABSV_V TABS Buoy V, TX
Observed data time period from: /10/ 1/2010  to / 3/ 5/2011with gaps of    0.00 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     3738 191.025
```

```
d                     3738 132.277
D-d      22.5 dg 24h  3738  -0.041  2.702  2.702   0.1  99.6   0.0    2.0  0.0
DFC-dfc  22.5 dg 24h    44 -38.906 65.947 53.863  45.5  31.8   6.8    0.0  0.0
DEC-dec  22.5 dg 24h    16  12.840 38.732 37.740   0.0  56.2  18.8    0.0  0.0

Station:                  TABSV_W TABS Buoy W, TX
Observed data time period from: /10/ 1/2010  to / 3/31/2011with gaps of    2.83 days
Data gap is not filled
Data are not filtered
------------------------------------------------------------------------------------------
VARIABLE    X     N   IMAX    SM    RMSE     SD     NOF   CF    POF   MDNO  MDPO  WOF
CRITERION   -     -     -      -      -      -     <1%  >90%   <1%    <N    <N  <.5%
------------------------------------------------------------------------------------------

     SCENARIO: HINDCAST
D                     4312 209.487
d                     4312 203.633
D-d      22.5 dg 24h  4312  -0.207  7.468  7.466   0.3  97.8   0.4    4.0 13.0
DFC-dfc  22.5 dg 24h    18  -6.180 47.281 48.235  16.7  55.6  11.1    0.0  0.0
DEC-dec  22.5 dg 24h    42  -0.229 38.017 38.477   9.5  71.4   9.5    0.0  0.0
```

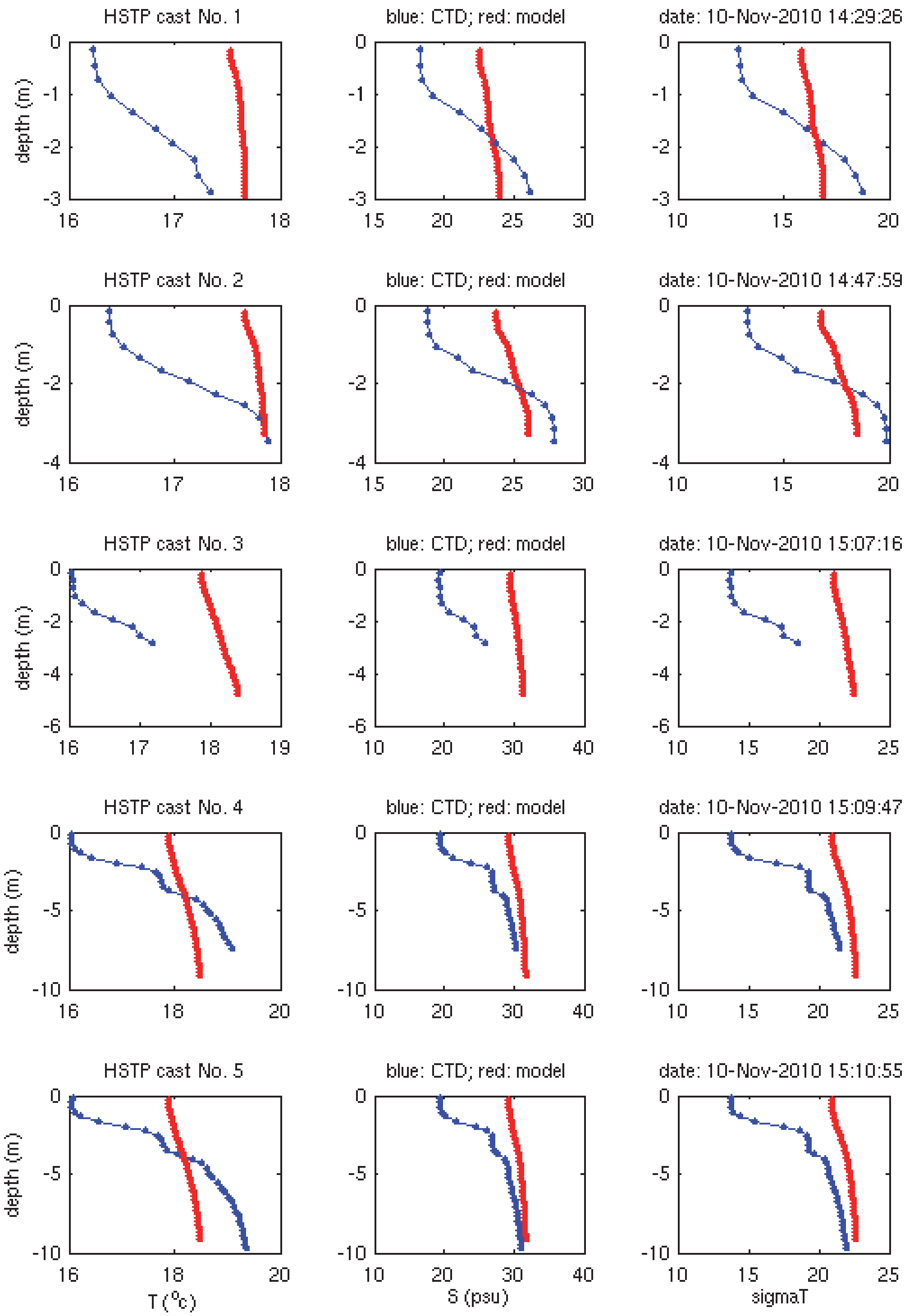
APPENDIX F. METADATA OF CTD PROFILES FROM CSDL/HSTP SURVEY: HSTP CTD CASTS ID, LOCATION, AND DATE/TIME.

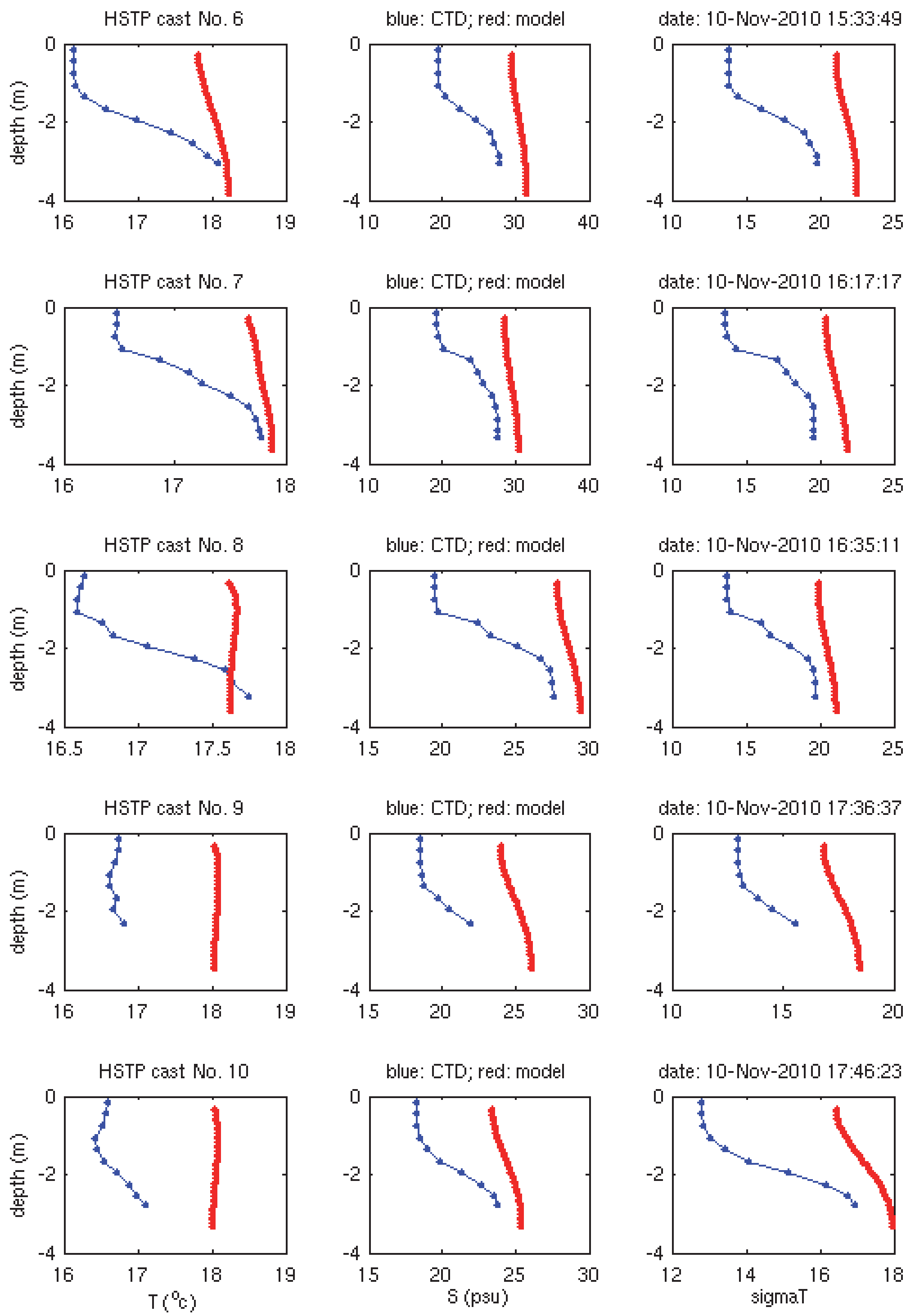
No.	Cast ID	Lon (°W)	Lat (°N)	Date/Time (GMT)
1	142926	-88.1041	30.3373	10-Nov-2010 14:29:26
2	144759	-88.0869	30.3359	10-Nov-2010 14:47:59
3	150716	-88.0297	30.338	10-Nov-2010 15:07:16
4	150947	-88.0272	30.3383	10-Nov-2010 15:09:47
5	151055	-88.0273	30.3382	10-Nov-2010 15:10:55
6	153349	-88.0173	30.3288	10-Nov-2010 15:33:49
7	161717	-87.9967	30.3264	10-Nov-2010 16:17:17
8	163511	-87.9774	30.327	10-Nov-2010 16:35:11
9	173637	-88.0828	30.336	10-Nov-2010 17:36:37
10	174623	-88.088	30.3367	10-Nov-2010 17:46:23
11	174723	-88.0882	30.3364	10-Nov-2010 17:47:23
12	175522	-88.0971	30.3374	10-Nov-2010 17:55:22
13	180253	-88.1048	30.3372	10-Nov-2010 18:02:53
14	182038	-88.0278	30.3297	10-Nov-2010 18:20:38
15	184837	-88.0282	30.3296	10-Nov-2010 18:48:37
16	145139	-88.0707	30.3928	11-Nov-2010 14:51:39
17	145801	-88.0891	30.396	11-Nov-2010 14:58:01
18	150317	-88.0839	30.393	11-Nov-2010 15:03:17
19	150802	-88.077	30.392	11-Nov-2010 15:08:02
20	152138	-88.0199	30.3856	11-Nov-2010 15:21:38
21	152425	-88.0199	30.3856	11-Nov-2010 15:24:25
22	155905	-88.0199	30.3854	11-Nov-2010 15:59:05
23	161911	-87.9669	30.3792	11-Nov-2010 16:19:11
24	162330	-87.961	30.3791	11-Nov-2010 16:23:30
25	162659	-87.9557	30.3784	11-Nov-2010 16:26:59
26	163234	-87.9502	30.3781	11-Nov-2010 16:32:34
27	163604	-87.9455	30.3774	11-Nov-2010 16:36:04
28	163917	-87.9402	30.3768	11-Nov-2010 16:39:17
29	164232	-87.9352	30.3764	11-Nov-2010 16:42:32
30	164602	-87.93	30.3758	11-Nov-2010 16:46:02
31	153557	-88.0763	30.2818	12-Nov-2010 15:35:57
32	153953	-88.0814	30.2833	12-Nov-2010 15:39:53
33	154241	-88.0868	30.2846	12-Nov-2010 15:42:41
34	154515	-88.0921	30.286	12-Nov-2010 15:45:15
35	155150	-88.0968	30.2876	12-Nov-2010 15:51:50
36	155441	-88.102	30.2888	12-Nov-2010 15:54:41
37	155807	-88.1074	30.2904	12-Nov-2010 15:58:07
38	160131	-88.1128	30.2919	12-Nov-2010 16:01:31
39	160432	-88.1164	30.2943	12-Nov-2010 16:04:32
40	161935	-88.0738	30.269	12-Nov-2010 16:19:35
41	163119	-88.0442	30.2652	12-Nov-2010 16:31:19
42	165619	-88.0379	30.2632	12-Nov-2010 16:56:19
43	142233	-88.1334	30.2873	13-Nov-2010 14:22:33
44	142449	-88.1292	30.2889	13-Nov-2010 14:24:49
45	142654	-88.1235	30.2911	13-Nov-2010 14:26:54
46	164304	-88.0139	30.4314	13-Nov-2010 16:43:04
47	170343	-87.957	30.4288	13-Nov-2010 17:03:43
48	170653	-87.9519	30.4287	13-Nov-2010 17:06:53
49	171056	-87.9465	30.4283	13-Nov-2010 17:10:56
50	171432	-87.9414	30.4281	13-Nov-2010 17:14:32
51	171812	-87.9361	30.4277	13-Nov-2010 17:18:12
52	181627	-88.0139	30.4371	13-Nov-2010 18:16:27
53	181754	-88.014	30.437	13-Nov-2010 18:17:54
54	182306	-88.0143	30.4271	13-Nov-2010 18:23:06
55	182654	-88.0157	30.4183	13-Nov-2010 18:26:54

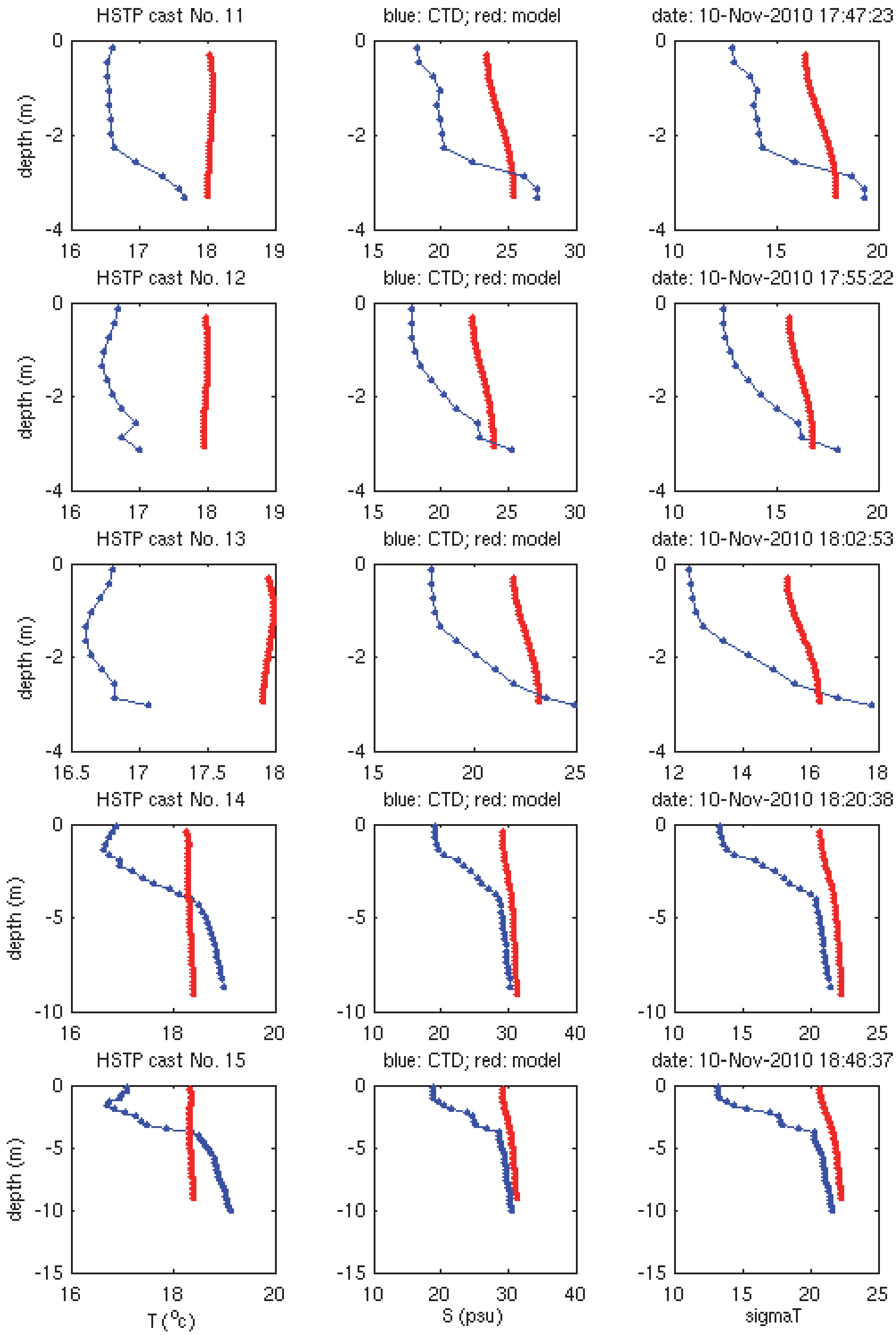
56	183037	-88.0165	30.4096	13-Nov-2010 18:30:37
57	183423	-88.0178	30.4005	13-Nov-2010 18:34:23
58	183825	-88.0194	30.3915	13-Nov-2010 18:38:25
59	184141	-88.0205	30.3831	13-Nov-2010 18:41:41
60	184516	-88.0216	30.3739	13-Nov-2010 18:45:16
61	184846	-88.0231	30.3652	13-Nov-2010 18:48:46
62	185215	-88.0243	30.3564	13-Nov-2010 18:52:15
63	185650	-88.0263	30.3385	13-Nov-2010 18:56:50
64	191429	-88.0382	30.2395	13-Nov-2010 19:14:29
65	191928	-88.0391	30.2488	13-Nov-2010 19:19:28
66	192312	-88.0384	30.2579	13-Nov-2010 19:23:12
67	155833	-87.9562	30.3792	14-Nov-2010 15:58:33
68	160219	-87.9451	30.3766	14-Nov-2010 16:02:19
69	160456	-87.9352	30.3761	14-Nov-2010 16:04:56
70	160737	-87.9248	30.3751	14-Nov-2010 16:07:37
71	161021	-87.9146	30.3742	14-Nov-2010 16:10:21
72	170340	-88.0295	30.3202	14-Nov-2010 17:03:40
73	170816	-88.0308	30.3116	14-Nov-2010 17:08:16
74	171217	-88.0324	30.3028	14-Nov-2010 17:12:17
75	171642	-88.0337	30.2934	14-Nov-2010 17:16:42
76	172102	-88.0349	30.2849	14-Nov-2010 17:21:02
77	172602	-88.0361	30.2759	14-Nov-2010 17:26:02
78	173149	-88.0374	30.2665	14-Nov-2010 17:31:49

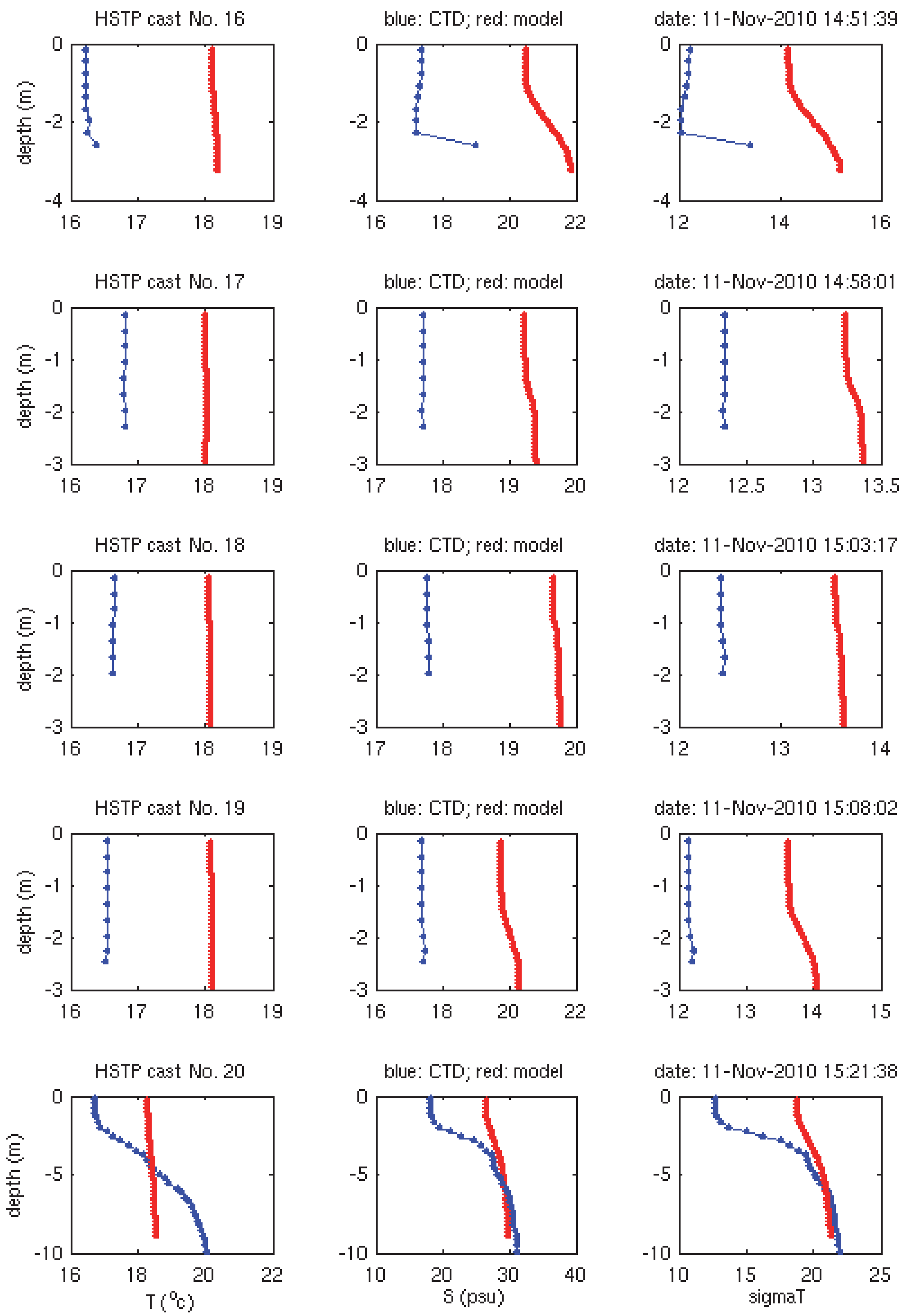
APPENDIX G. COMPARISON OF NGOFS HINDCAST SALINITY AND TEMPERATURE PROFILE WITH CSDL/HSTP CTD DATA

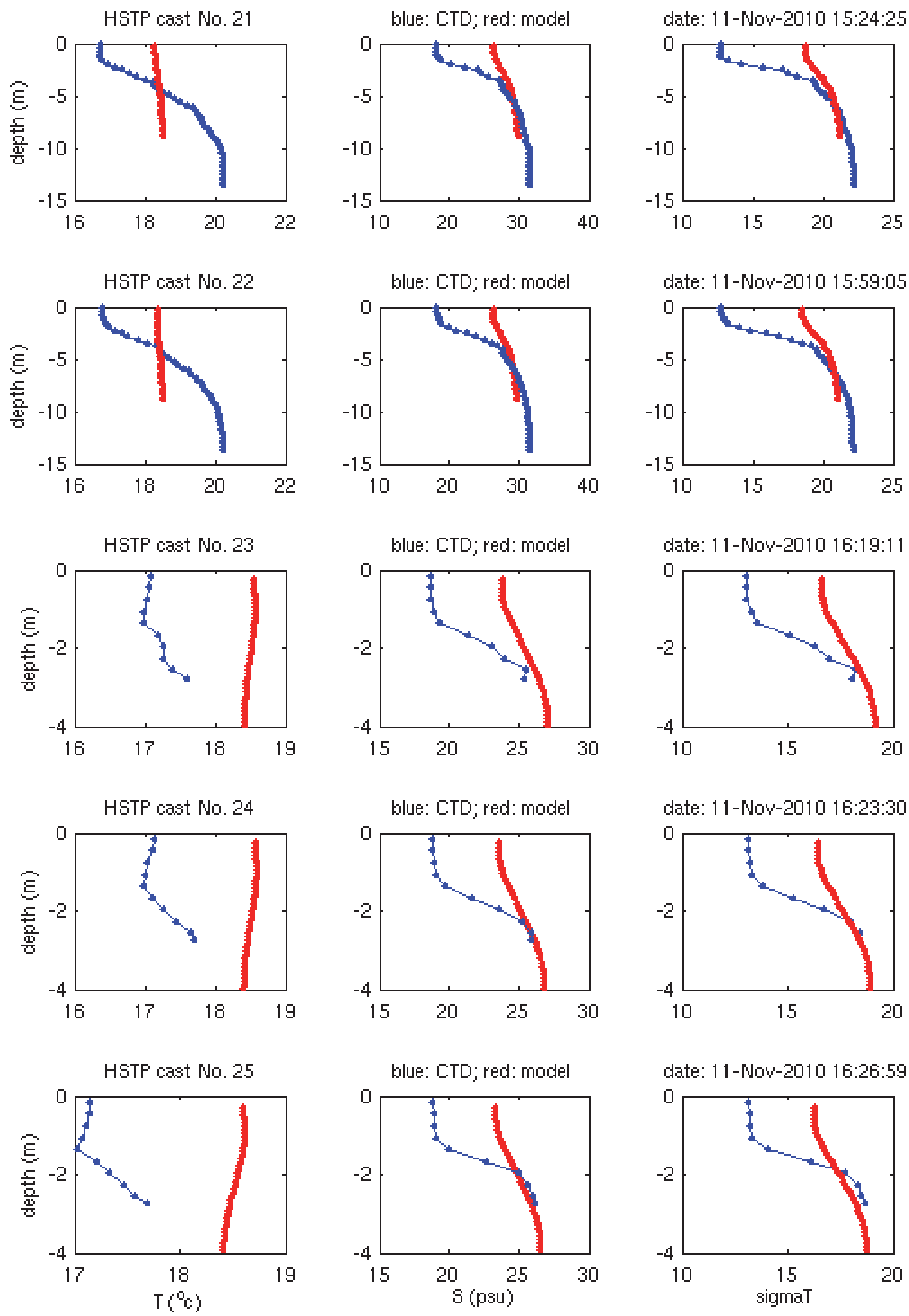
Note: Red and blue colors denote model results and observational data, respectively.



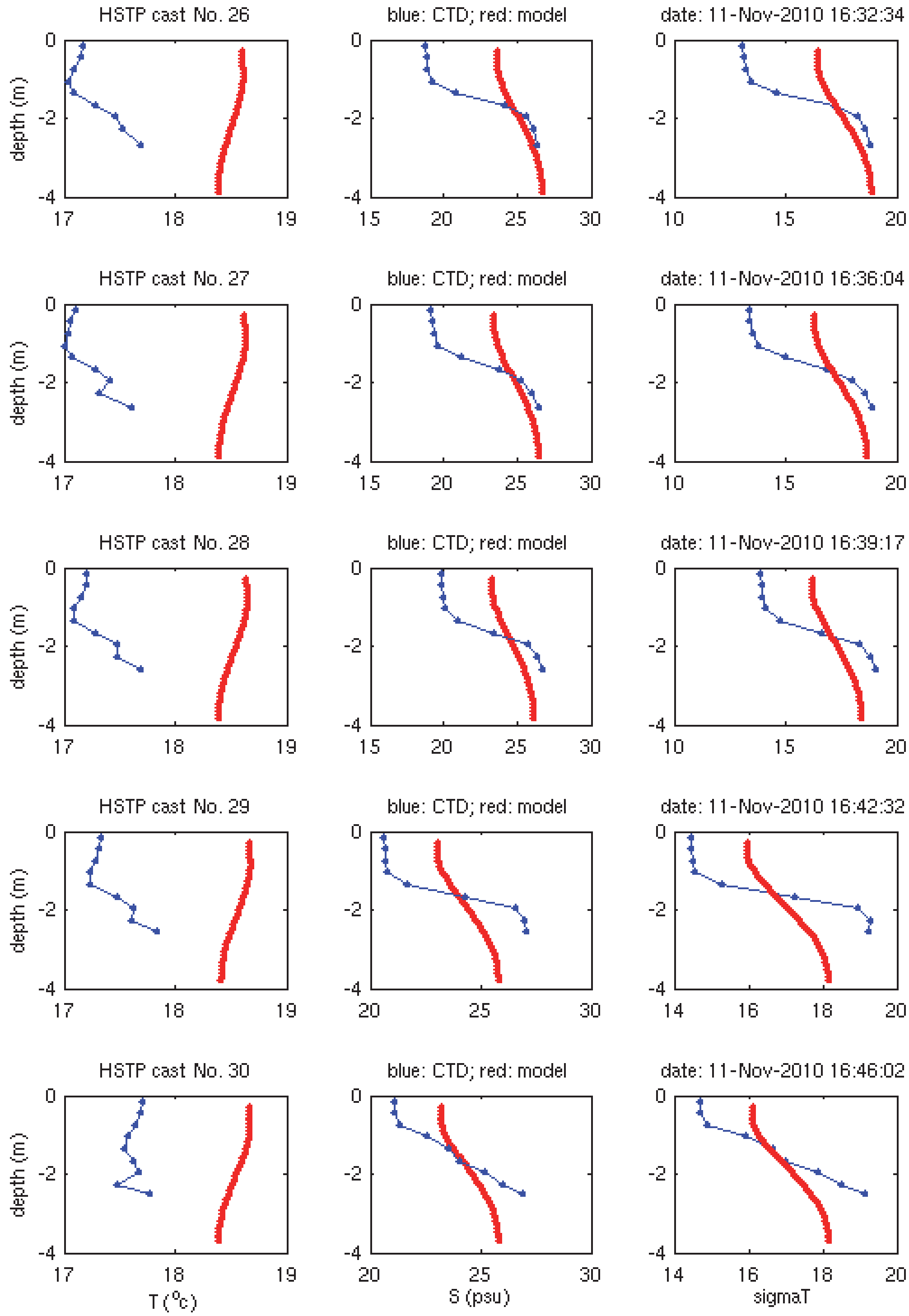

HSTP cast No. 6
blue: CTD; red: model
date: 10-Nov-2010 15:33:49
HSTP cast No. 7
blue: CTD; red: model
date: 10-Nov-2010 16:17:17
HSTP cast No. 8
blue: CTD; red: model
date: 10-Nov-2010 16:35:11
HSTP cast No. 9
blue: CTD; red: model
date: 10-Nov-2010 17:36:37
HSTP cast No. 10
blue: CTD; red: model
date: 10-Nov-2010 17:46:23
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 11
blue: CTD; red: model
date: 10-Nov-2010 17:47:23
HSTP cast No. 12
blue: CTD; red: model
date: 10-Nov-2010 17:55:22
HSTP cast No. 13
blue: CTD; red: model
date: 10-Nov-2010 18:02:53
HSTP cast No. 14
blue: CTD; red: model
date: 10-Nov-2010 18:20:38
HSTP cast No. 15
blue: CTD; red: model
date: 10-Nov-2010 18:48:37
depth (m)
T (°c)
S (psu)
sigmaT

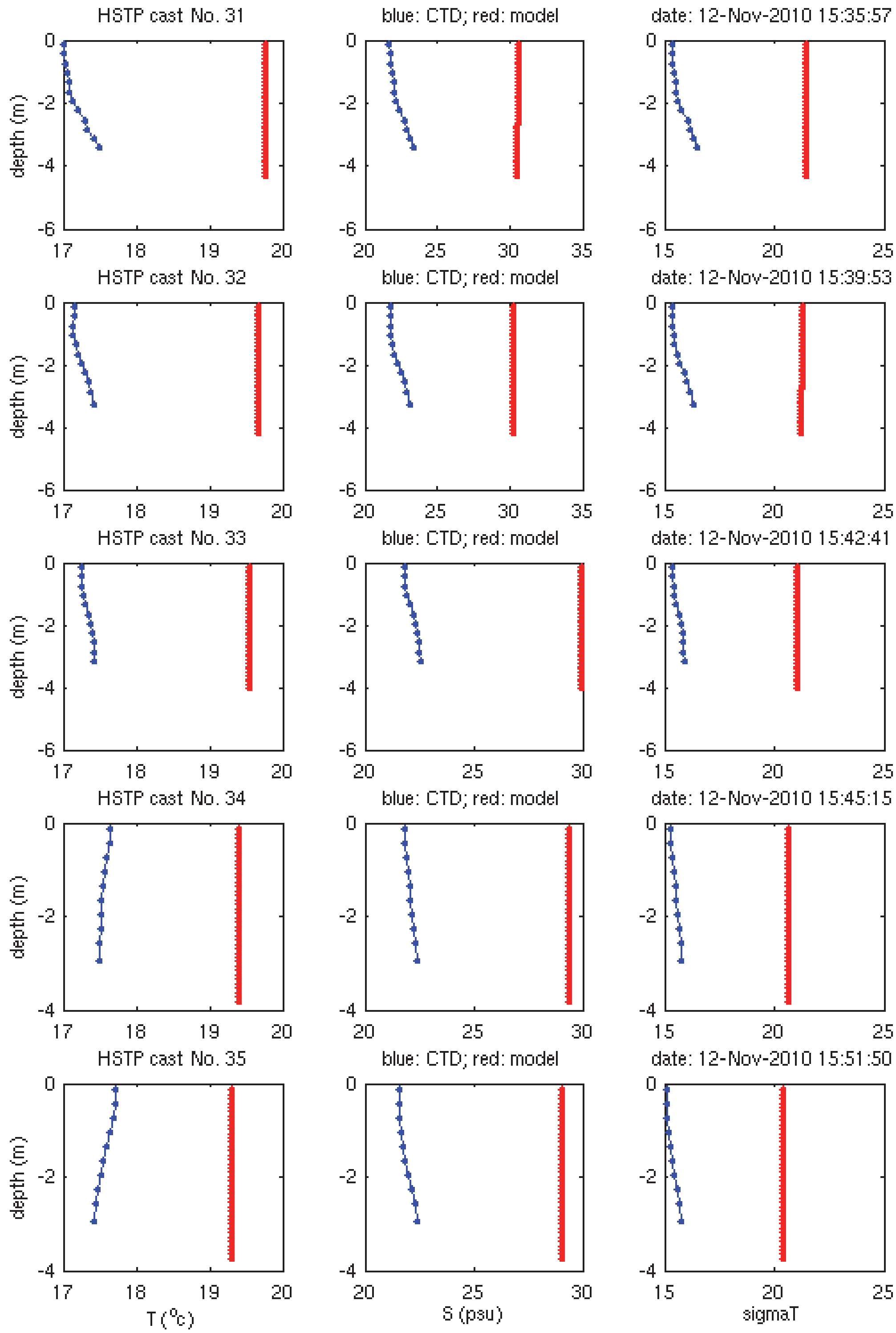

HSTP cast No. 16
blue: CTD; red: model
date: 11-Nov-2010 14:51:39
HSTP cast No. 17
blue: CTD; red: model
date: 11-Nov-2010 14:58:01
HSTP cast No. 18
blue: CTD; red: model
date: 11-Nov-2010 15:03:17
HSTP cast No. 19
blue: CTD; red: model
date: 11-Nov-2010 15:08:02
HSTP cast No. 20
blue: CTD; red: model
date: 11-Nov-2010 15:21:38
depth (m)
T (°c)
S (psu)
sigmaT

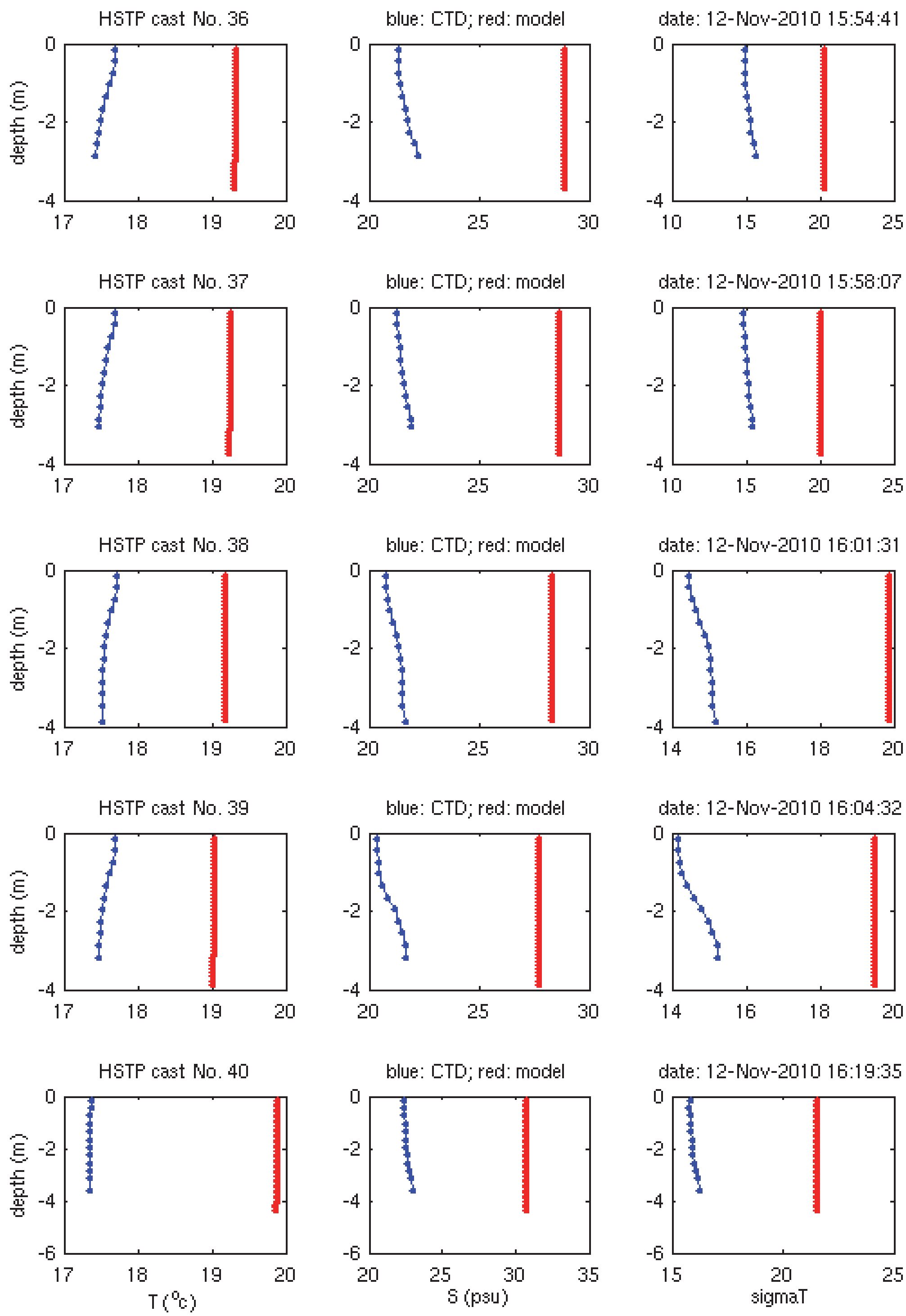


HSTP cast No. 21
blue: CTD; red: model
date: 11-Nov-2010 15:24:25
HSTP cast No. 22
blue: CTD; red: model
date: 11-Nov-2010 15:59:05
HSTP cast No. 23
blue: CTD; red: model
date: 11-Nov-2010 16:19:11
HSTP cast No. 24
blue: CTD; red: model
date: 11-Nov-2010 16:23:30
HSTP cast No. 25
blue: CTD; red: model
date: 11-Nov-2010 16:26:59
depth (m)
T (°c)
S (psu)
sigmaT

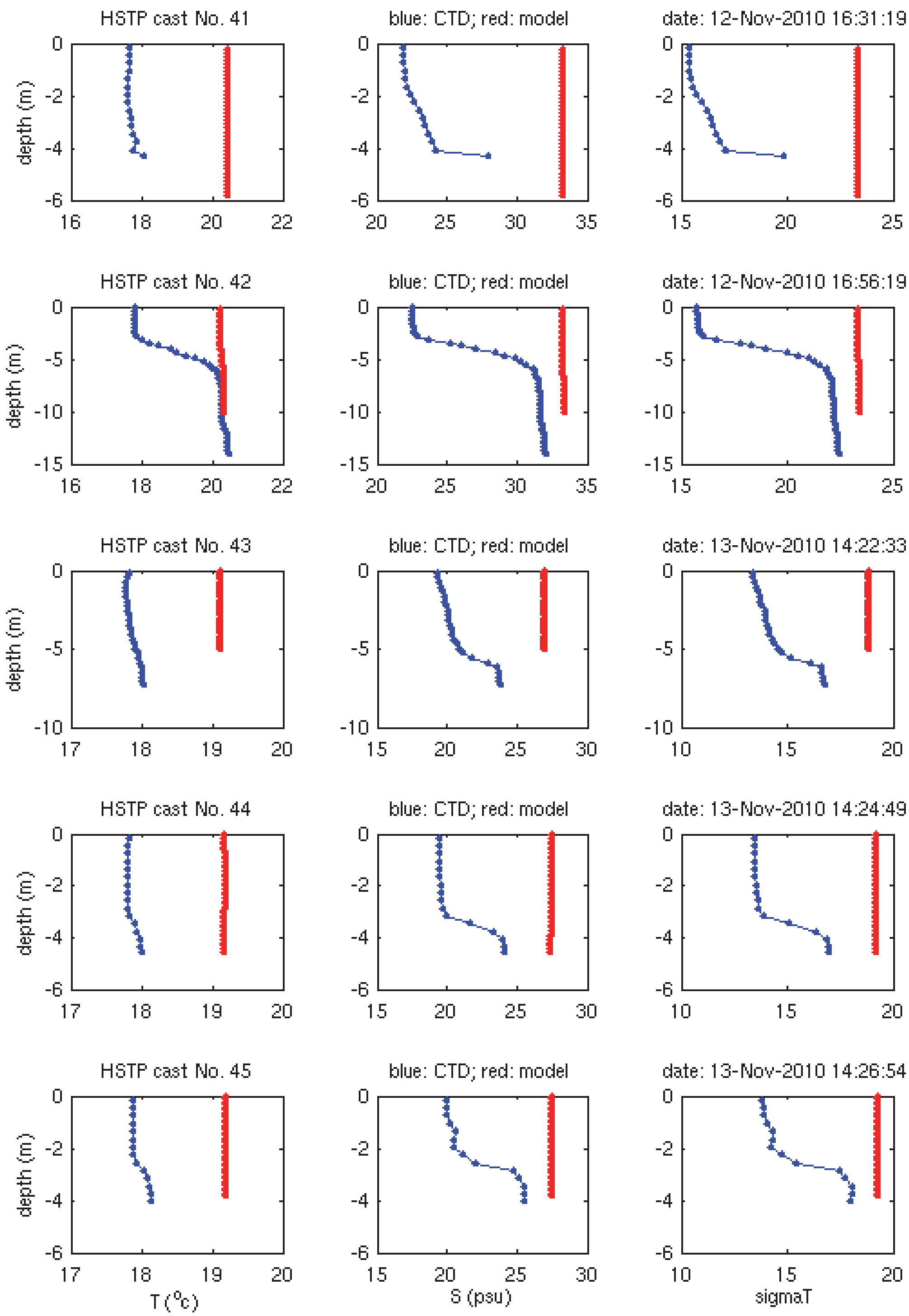


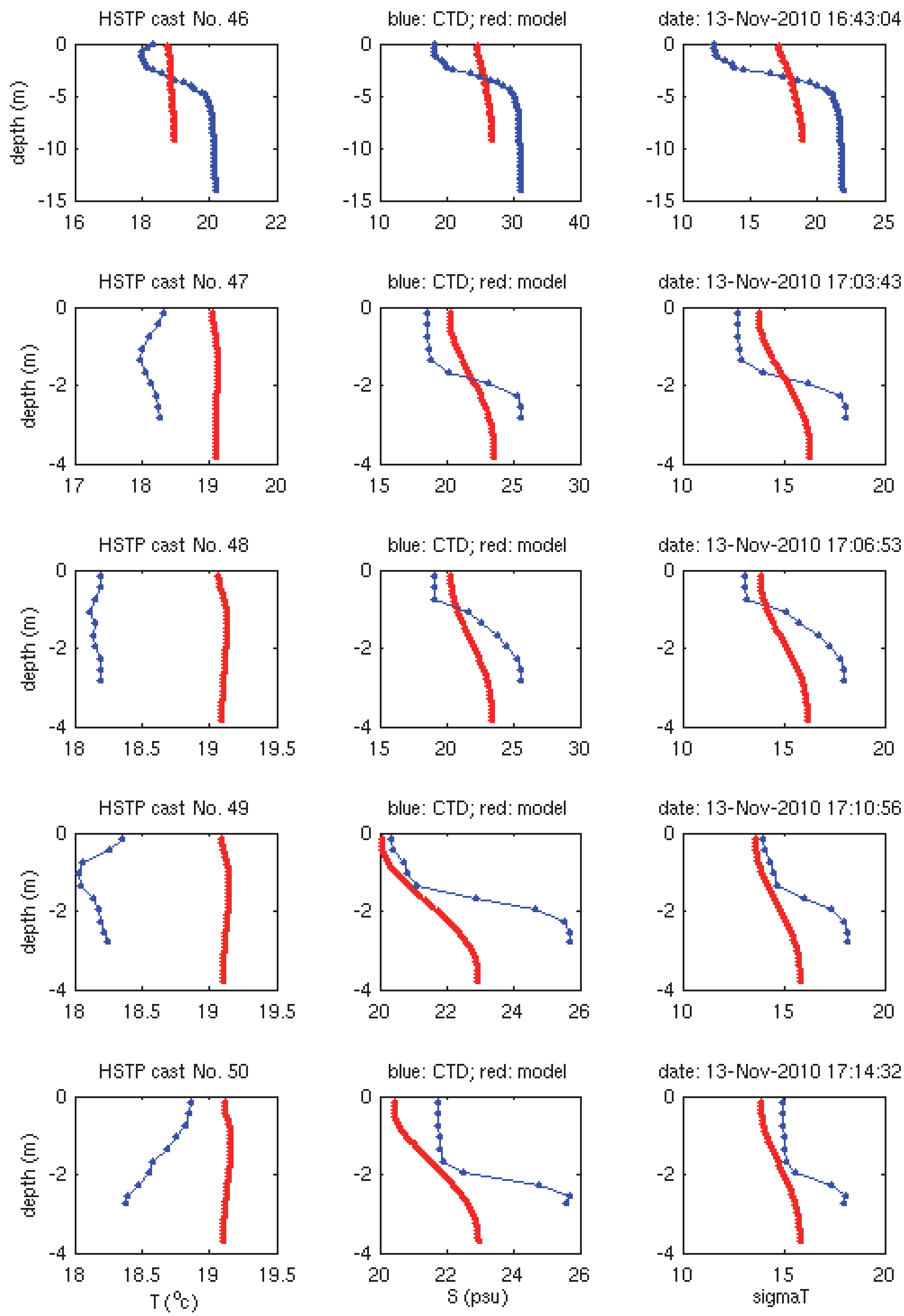
HSTP cast No. 26
blue: CTD; red: model
date: 11-Nov-2010 16:32:34
HSTP cast No. 27
blue: CTD; red: model
date: 11-Nov-2010 16:36:04
HSTP cast No. 28
blue: CTD; red: model
date: 11-Nov-2010 16:39:17
HSTP cast No. 29
blue: CTD; red: model
date: 11-Nov-2010 16:42:32
HSTP cast No. 30
blue: CTD; red: model
date: 11-Nov-2010 16:46:02
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 31
blue: CTD; red: model
date: 12-Nov-2010 15:35:57
HSTP cast No. 32
blue: CTD; red: model
date: 12-Nov-2010 15:39:53
HSTP cast No. 33
blue: CTD; red: model
date: 12-Nov-2010 15:42:41
HSTP cast No. 34
blue: CTD; red: model
date: 12-Nov-2010 15:45:15
HSTP cast No. 35
blue: CTD; red: model
date: 12-Nov-2010 15:51:50
depth (m)
T (°c)
S (psu)
sigmaT

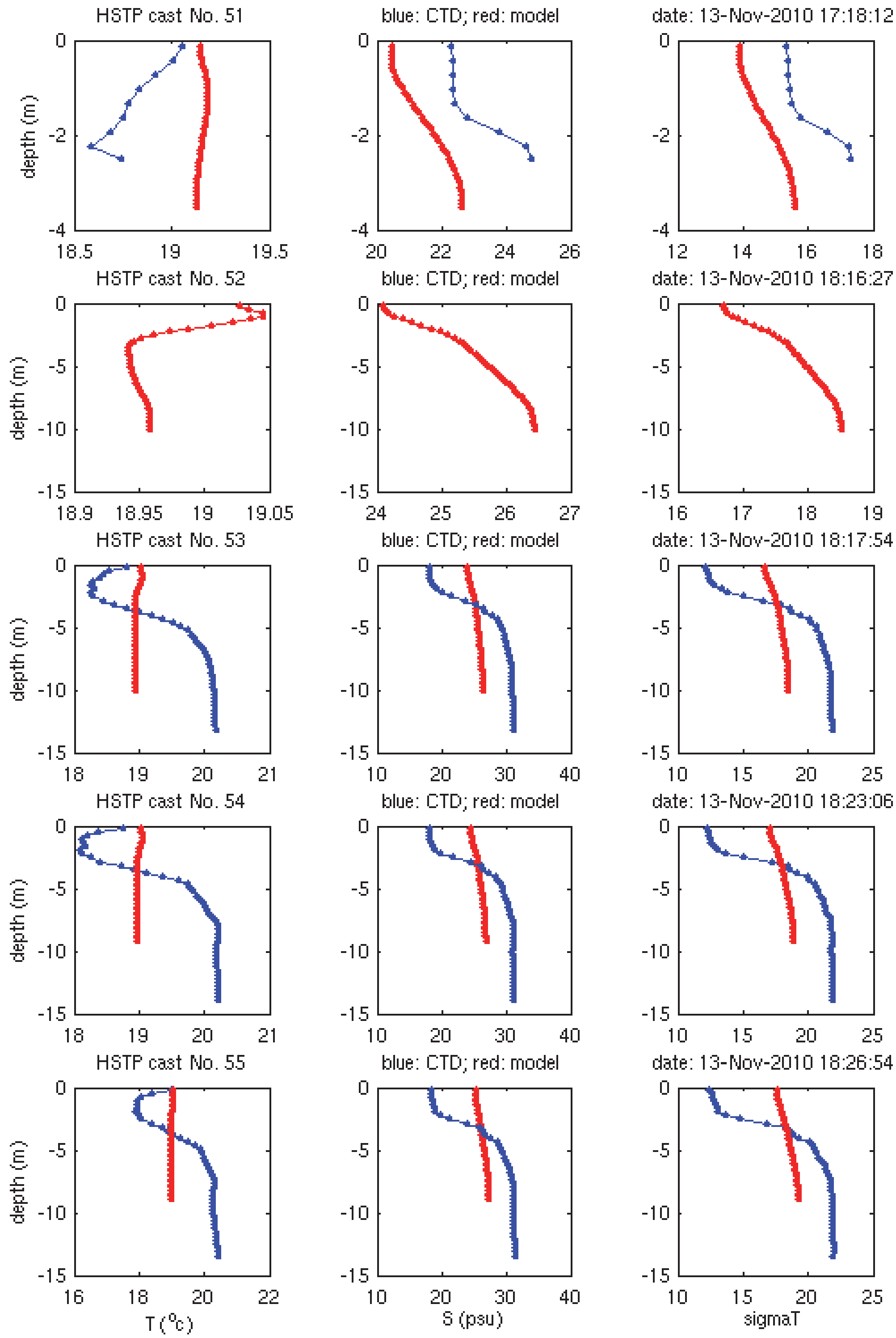


HSTP cast No. 36
blue: CTD; red: model
date: 12-Nov-2010 15:54:41
HSTP cast No. 37
blue: CTD; red: model
date: 12-Nov-2010 15:58:07
HSTP cast No. 38
blue: CTD; red: model
date: 12-Nov-2010 16:01:31
HSTP cast No. 39
blue: CTD; red: model
date: 12-Nov-2010 16:04:32
HSTP cast No. 40
blue: CTD; red: model
date: 12-Nov-2010 16:19:35
depth (m)
T (°c)
S (psu)
sigmaT

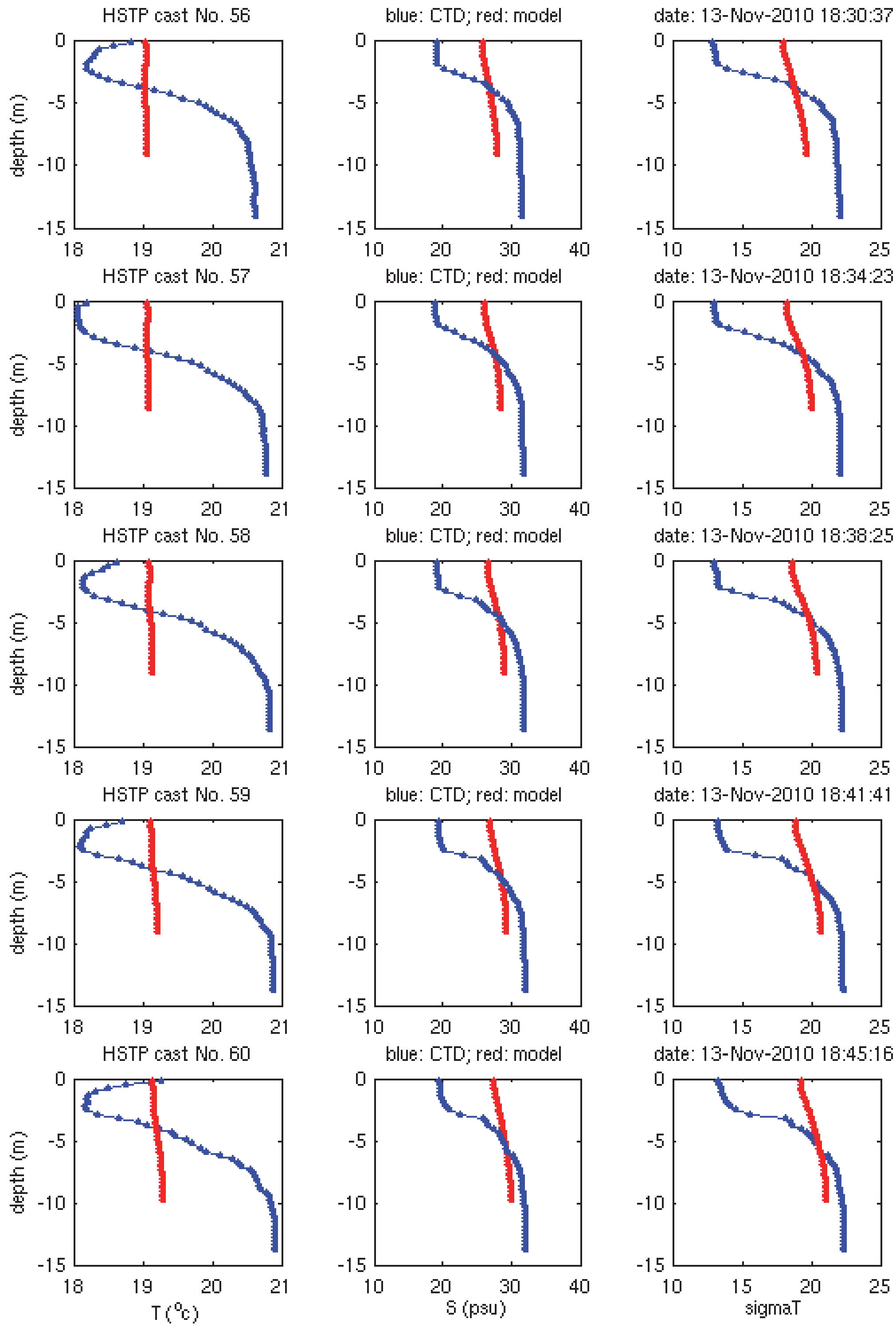

HSTP cast No. 41
blue: CTD; red: model
date: 12-Nov-2010 16:31:19
HSTP cast No. 42
blue: CTD; red: model
date: 12-Nov-2010 16:56:19
HSTP cast No. 43
blue: CTD; red: model
date: 13-Nov-2010 14:22:33
HSTP cast No. 44
blue: CTD; red: model
date: 13-Nov-2010 14:24:49
HSTP cast No. 45
blue: CTD; red: model
date: 13-Nov-2010 14:26:54
depth (m)
T (°c)
S (psu)
sigmaT

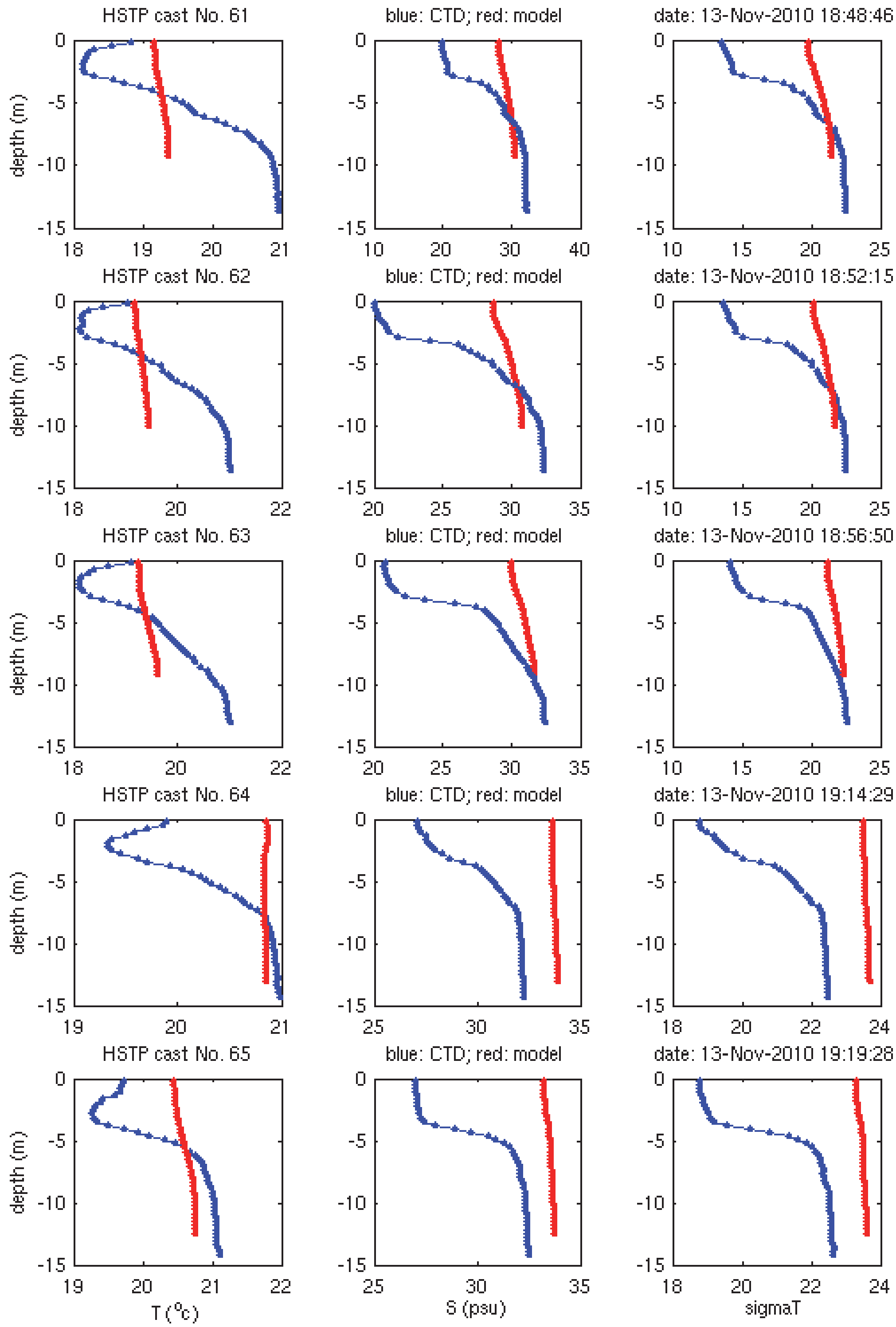


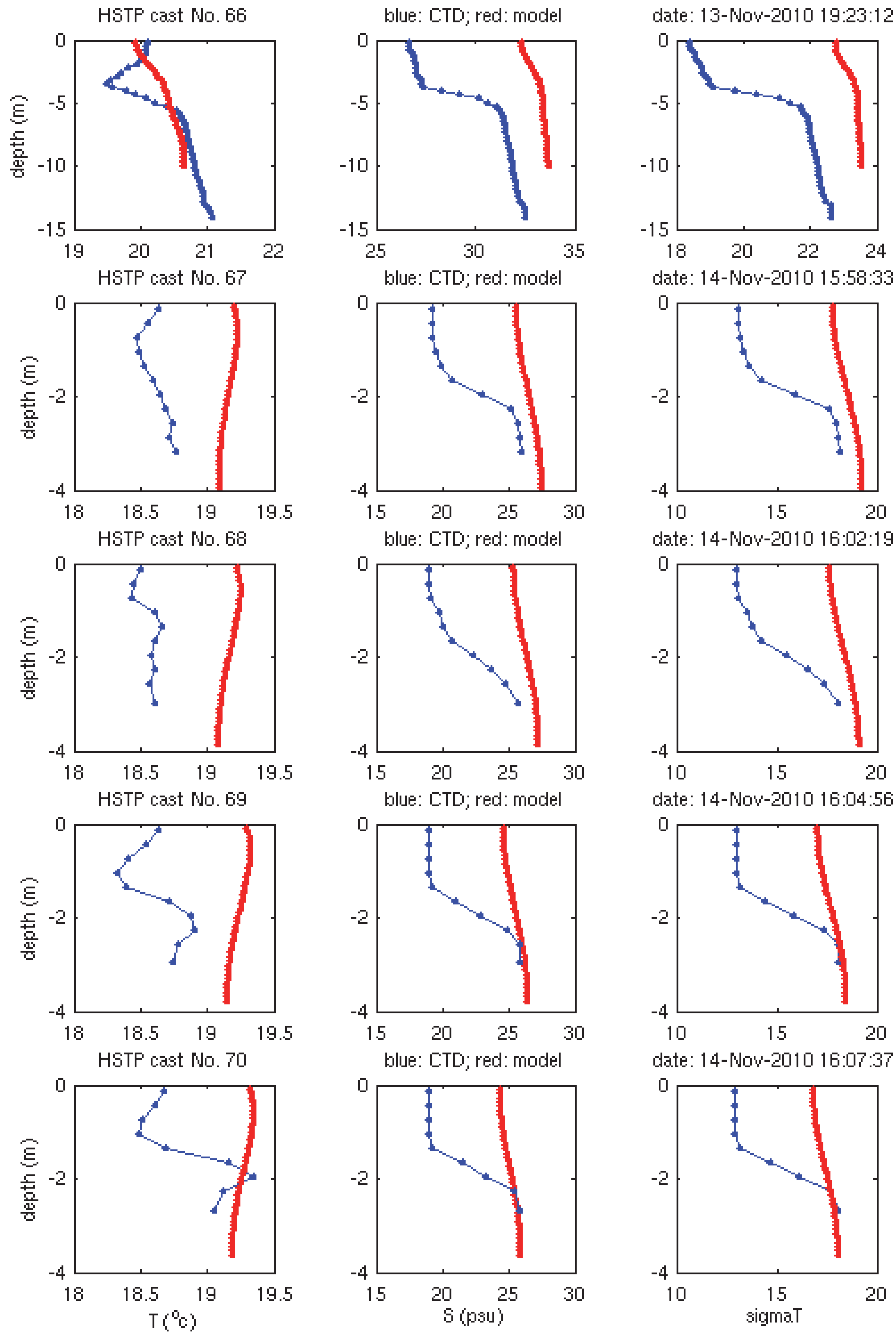
HSTP cast No. 46
blue: CTD; red: model
date: 13-Nov-2010 16:43:04
HSTP cast No. 47
blue: CTD; red: model
date: 13-Nov-2010 17:03:43
HSTP cast No. 48
blue: CTD; red: model
date: 13-Nov-2010 17:06:53
HSTP cast No. 49
blue: CTD; red: model
date: 13-Nov-2010 17:10:56
HSTP cast No. 50
blue: CTD; red: model
date: 13-Nov-2010 17:14:32
depth (m)
T (°c)
S (psu)
sigmaT

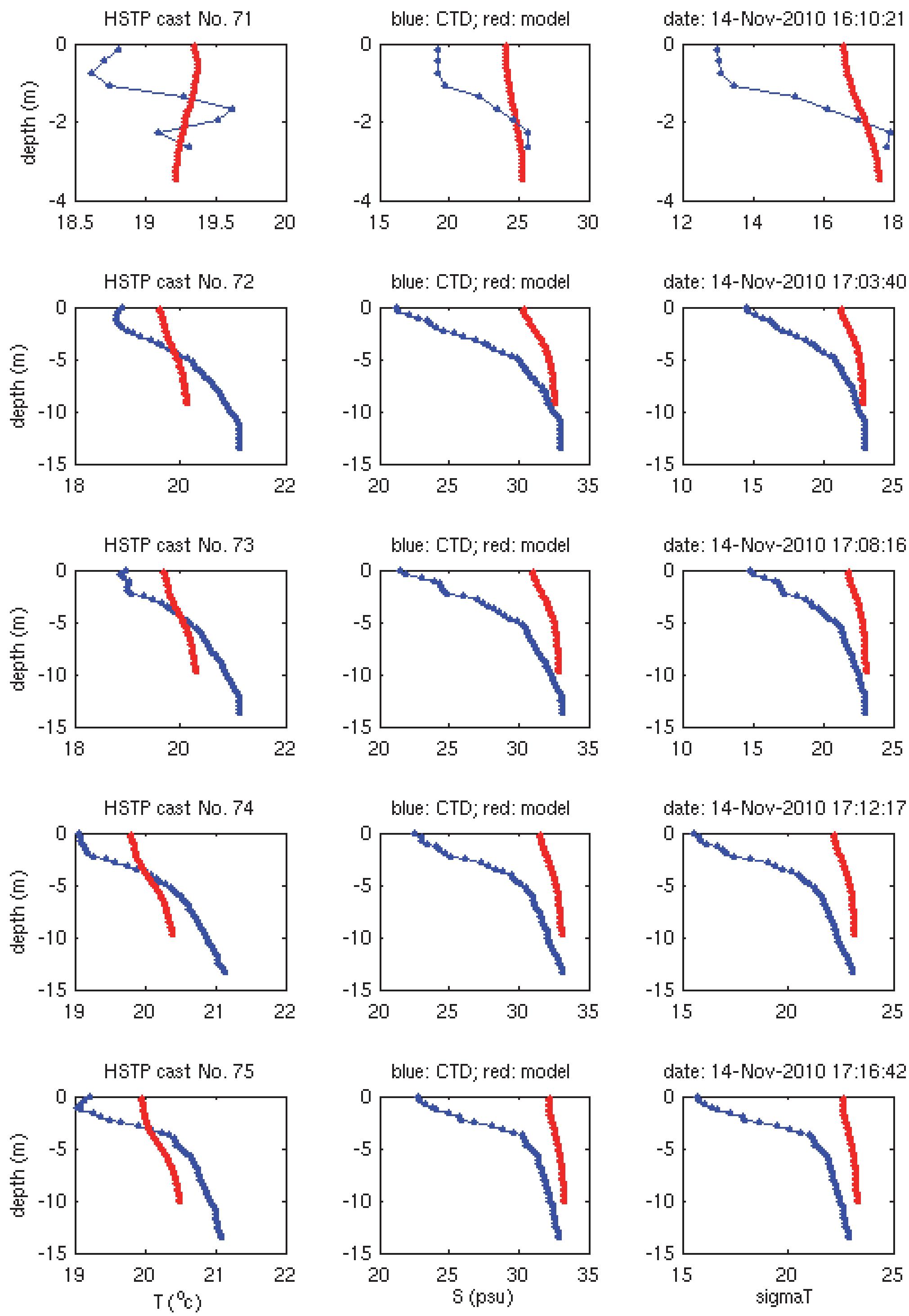


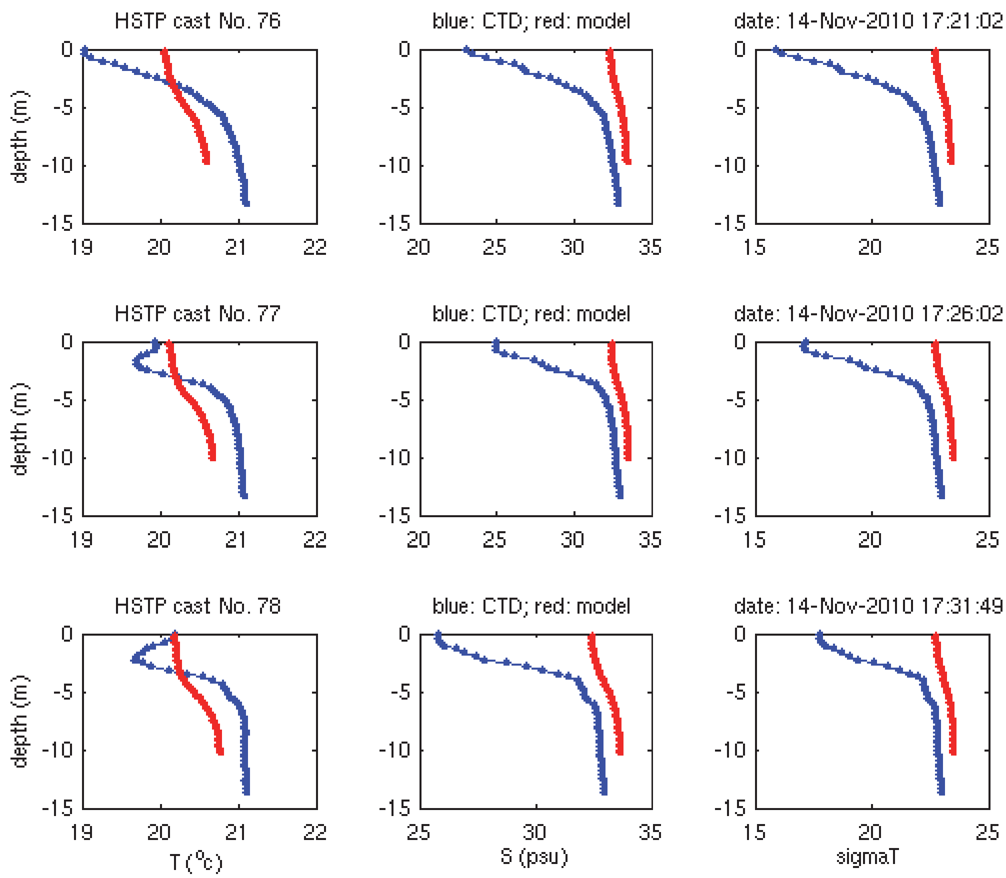
HSTP cast No. 51
blue: CTD; red: model
date: 13-Nov-2010 17:18:12
HSTP cast No. 52
blue: CTD; red: model
date: 13-Nov-2010 18:16:27
HSTP cast No. 53
blue: CTD; red: model
date: 13-Nov-2010 18:17:54
HSTP cast No. 54
blue: CTD; red: model
date: 13-Nov-2010 18:23:06
HSTP cast No. 55
blue: CTD; red: model
date: 13-Nov-2010 18:26:54
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 56
blue: CTD; red: model
date: 13-Nov-2010 18:30:37
HSTP cast No. 57
blue: CTD; red: model
date: 13-Nov-2010 18:34:23
HSTP cast No. 58
blue: CTD; red: model
date: 13-Nov-2010 18:38:25
HSTP cast No. 59
blue: CTD; red: model
date: 13-Nov-2010 18:41:41
HSTP cast No. 60
blue: CTD; red: model
date: 13-Nov-2010 18:45:16
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 61
blue: CTD; red: model
date: 13-Nov-2010 18:48:46
HSTP cast No. 62
blue: CTD; red: model
date: 13-Nov-2010 18:52:15
HSTP cast No. 63
blue: CTD; red: model
date: 13-Nov-2010 18:56:50
HSTP cast No. 64
blue: CTD; red: model
date: 13-Nov-2010 19:14:29
HSTP cast No. 65
blue: CTD; red: model
date: 13-Nov-2010 19:19:28
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 66
blue: CTD; red: model
date: 13-Nov-2010 19:23:12
HSTP cast No. 67
blue: CTD; red: model
date: 14-Nov-2010 15:58:33
HSTP cast No. 68
blue: CTD; red: model
date: 14-Nov-2010 16:02:19
HSTP cast No. 69
blue: CTD; red: model
date: 14-Nov-2010 16:04:56
HSTP cast No. 70
blue: CTD; red: model
date: 14-Nov-2010 16:07:37
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 71
blue: CTD; red: model
date: 14-Nov-2010 16:10:21
HSTP cast No. 72
blue: CTD; red: model
date: 14-Nov-2010 17:03:40
HSTP cast No. 73
blue: CTD; red: model
date: 14-Nov-2010 17:08:16
HSTP cast No. 74
blue: CTD; red: model
date: 14-Nov-2010 17:12:17
HSTP cast No. 75
blue: CTD; red: model
date: 14-Nov-2010 17:16:42
depth (m)
T (°c)
S (psu)
sigmaT


HSTP cast No. 76
blue: CTD; red: model
date: 14-Nov-2010 17:21:02
HSTP cast No. 77
blue: CTD; red: model
date: 14-Nov-2010 17:26:02
HSTP cast No. 78
blue: CTD; red: model
date: 14-Nov-2010 17:31:49
depth (m)
T (°c)
S (psu)
sigmaT

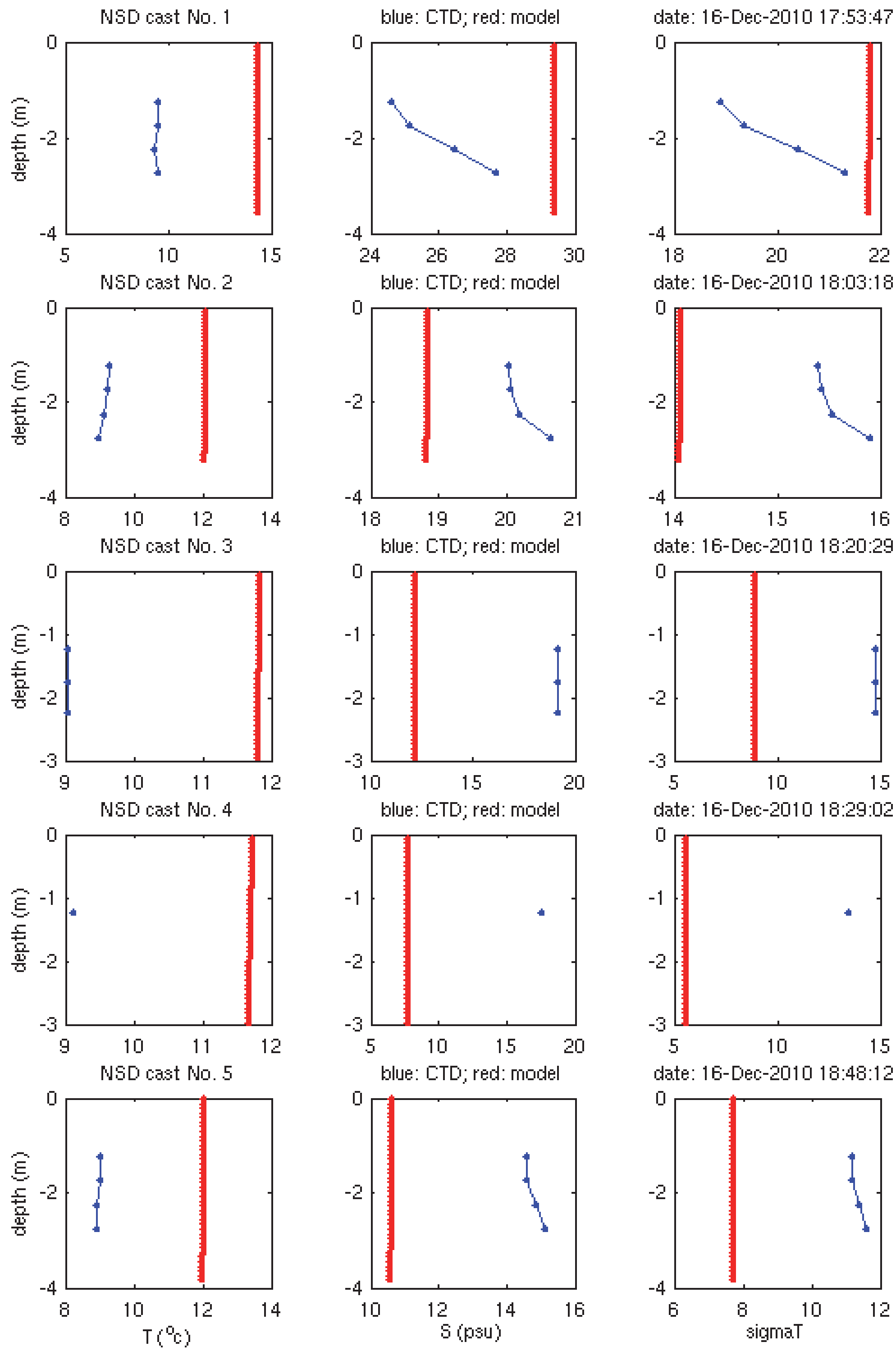
APPENDIX H. META DATA OF CTD CASTS CONDUCTED BY OCS/NSD: CAST NUNMBER, LOCATION, AND DATA/TIME OF NSD CTD CASTS

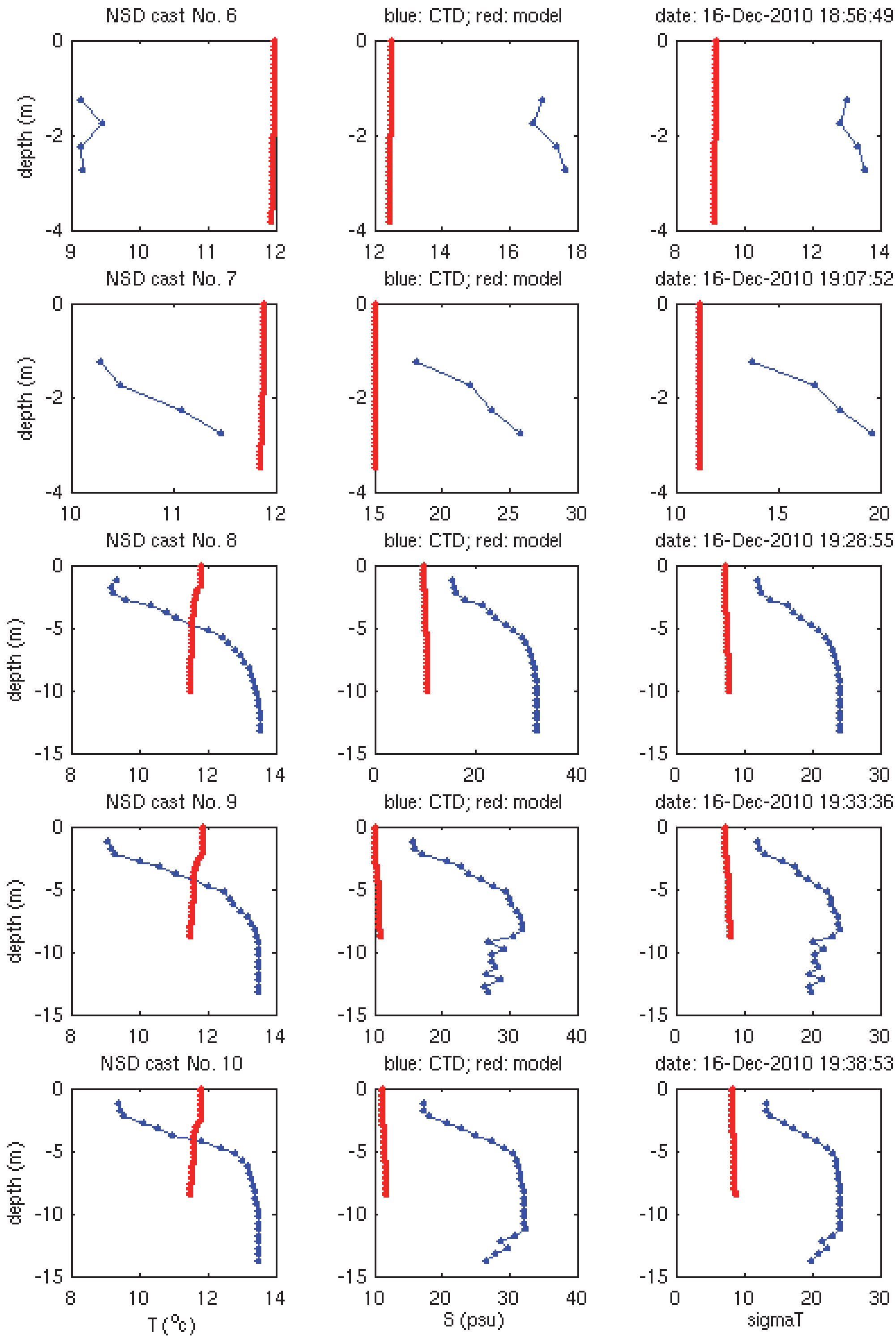
No.	Lon (°W)	Lat (°N)	Date/Time (GMT)
1	-88.0471	30.2411	16-Dec-2010 17:53:47
2	-88.0942	30.3373	16-Dec-2010 18:03:18
3	-88.087	30.3802	16-Dec-2010 18:20:29
4	-88.0794	30.4244	16-Dec-2010 18:29:02
5	-87.9499	30.4265	16-Dec-2010 18:48:12
6	-87.9426	30.3854	16-Dec-2010 18:56:49
7	-87.9312	30.342	16-Dec-2010 19:07:52
8	-88.0133	30.4375	16-Dec-2010 19:28:55
9	-88.0134	30.4294	16-Dec-2010 19:33:36
10	-88.0166	30.4099	16-Dec-2010 19:38:53
11	-88.0192	30.3901	16-Dec-2010 19:43:32
12	-88.0209	30.3788	16-Dec-2010 19:47:48
13	-88.0232	30.3601	16-Dec-2010 19:53:22
14	-88.0257	30.3427	16-Dec-2010 19:58:51
15	-88.0264	30.338	16-Dec-2010 20:02:13
16	-88.0288	30.3224	16-Dec-2010 20:06:45
17	-88.0318	30.307	16-Dec-2010 20:11:13
18	-88.0338	30.2903	16-Dec-2010 20:16:02
19	-88.0359	30.2741	16-Dec-2010 20:20:23
20	-88.0376	30.2628	16-Dec-2010 20:24:16
21	-88.039	30.2529	16-Dec-2010 20:28:00
22	-88.0396	30.2479	16-Dec-2010 20:31:13
23	-88.0469	30.2413	16-Dec-2010 20:35:50
24	-88.0322	30.2821	16-Dec-2010 20:43:16
25	-88.1207	30.2927	20-Dec-2010 08:23:12
26	-88.0942	30.3373	20-Dec-2010 08:34:12
27	-88.0872	30.3803	20-Dec-2010 08:42:32
28	-88.0794	30.4242	20-Dec-2010 08:51:13
29	-87.9501	30.4265	20-Dec-2010 09:10:12
30	-87.9425	30.3854	20-Dec-2010 09:16:47
31	-87.9315	30.342	20-Dec-2010 09:25:34
32	-88.0134	30.4374	20-Dec-2010 09:43:19
33	-88.0143	30.4293	20-Dec-2010 09:47:12
34	-88.0168	30.41	20-Dec-2010 09:51:22
35	-88.0196	30.3932	20-Dec-2010 09:56:10
36	-88.0214	30.379	20-Dec-2010 10:00:19
37	-88.0238	30.3605	20-Dec-2010 10:05:14
38	-88.0256	30.3412	20-Dec-2010 10:09:53
39	-88.0269	30.3381	20-Dec-2010 10:13:24
40	-88.0292	30.3232	20-Dec-2010 10:18:10
41	-88.0319	30.307	20-Dec-2010 10:22:42
42	-88.0351	30.2906	20-Dec-2010 10:31:52
43	-88.0366	30.2741	20-Dec-2010 10:37:40
44	-88.037	30.2627	20-Dec-2010 10:41:29
45	-88.0387	30.2523	20-Dec-2010 10:45:54
46	-88.0398	30.2481	20-Dec-2010 10:49:06
47	-88.0466	30.241	20-Dec-2010 10:53:30
48	-88.0322	30.2819	20-Dec-2010 11:01:30
49	-88.0942	30.3374	18-Jan-2011 19:30:22
50	-88.0869	30.3799	18-Jan-2011 19:40:25
51	-88.0408	30.4248	18-Jan-2011 19:56:23
52	-87.9948	30.426	18-Jan-2011 20:02:51
53	-87.95	30.4265	18-Jan-2011 20:09:54
54	-87.9426	30.3854	18-Jan-2011 20:16:56
55	-87.9947	30.3864	18-Jan-2011 20:23:53

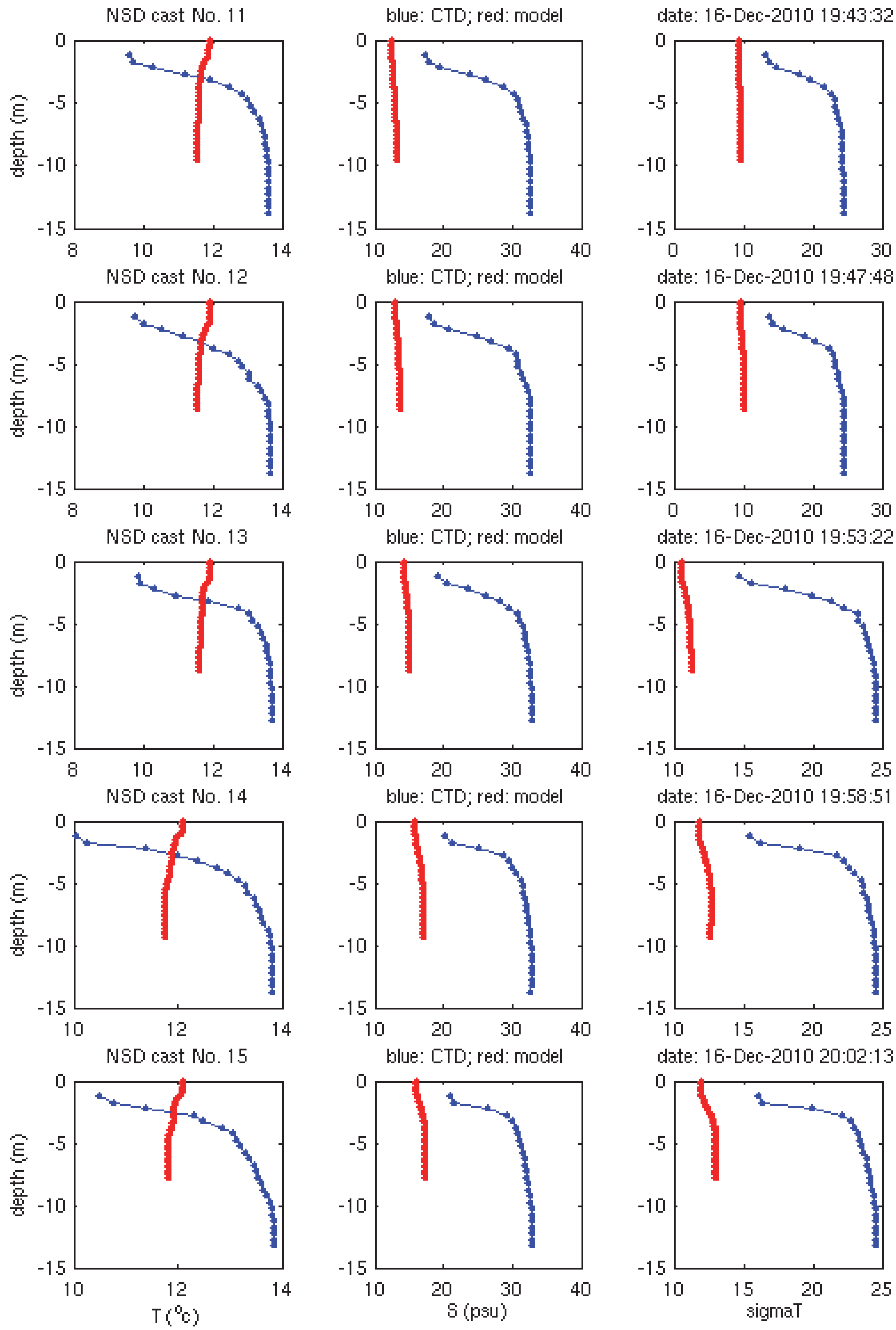
56	-88.0417	30.3849	18-Jan-2011 20:32:34
57	-88.0504	30.3416	18-Jan-2011 20:39:46
58	-87.9926	30.3428	18-Jan-2011 20:47:40
59	-87.9312	30.342	18-Jan-2011 20:57:39
60	-88.0145	30.4373	18-Jan-2011 21:06:20
61	-88.0174	30.4099	18-Jan-2011 21:24:27
62	-88.0209	30.3436	18-Jan-2011 21:30:01
63	-88.0255	30.3436	18-Jan-2011 21:35:28
64	-88.03	30.3225	18-Jan-2011 21:41:26
65	-88.0337	30.2905	18-Jan-2011 21:45:47
66	-88.0394	30.2485	18-Jan-2011 21:51:25
67	-88.047	30.2429	18-Jan-2011 21:56:47
68	-88.032	30.2822	18-Jan-2011 22:04:15
69	-88.0945	30.3369	19-Jan-2011 07:48:11
70	-88.0873	30.3793	19-Jan-2011 07:57:08
71	-88.0793	30.4241	19-Jan-2011 08:04:30
72	-88.0414	30.4249	19-Jan-2011 08:11:37
73	-87.9953	30.4258	19-Jan-2011 08:17:09
74	-87.9504	30.4263	19-Jan-2011 08:24:02
75	-87.9424	30.385	19-Jan-2011 08:30:51
76	-87.9956	30.3847	19-Jan-2011 08:37:08
77	-88.042	30.3848	19-Jan-2011 08:46:37
78	-88.0507	30.3406	19-Jan-2011 08:53:32
79	-87.9923	30.3427	19-Jan-2011 09:00:58
80	-88.0172	30.4108	19-Jan-2011 09:35:12
81	-88.0215	30.3795	19-Jan-2011 09:40:41
82	-88.0275	30.3388	19-Jan-2011 09:45:38
83	-88.0321	30.3074	19-Jan-2011 09:51:37
84	-88.0361	30.2744	19-Jan-2011 09:56:41
85	-88.0471	30.249	19-Jan-2011 10:01:29
86	-88.0471	30.2407	19-Jan-2011 10:06:11
87	-88.0319	30.282	19-Jan-2011 10:09:18

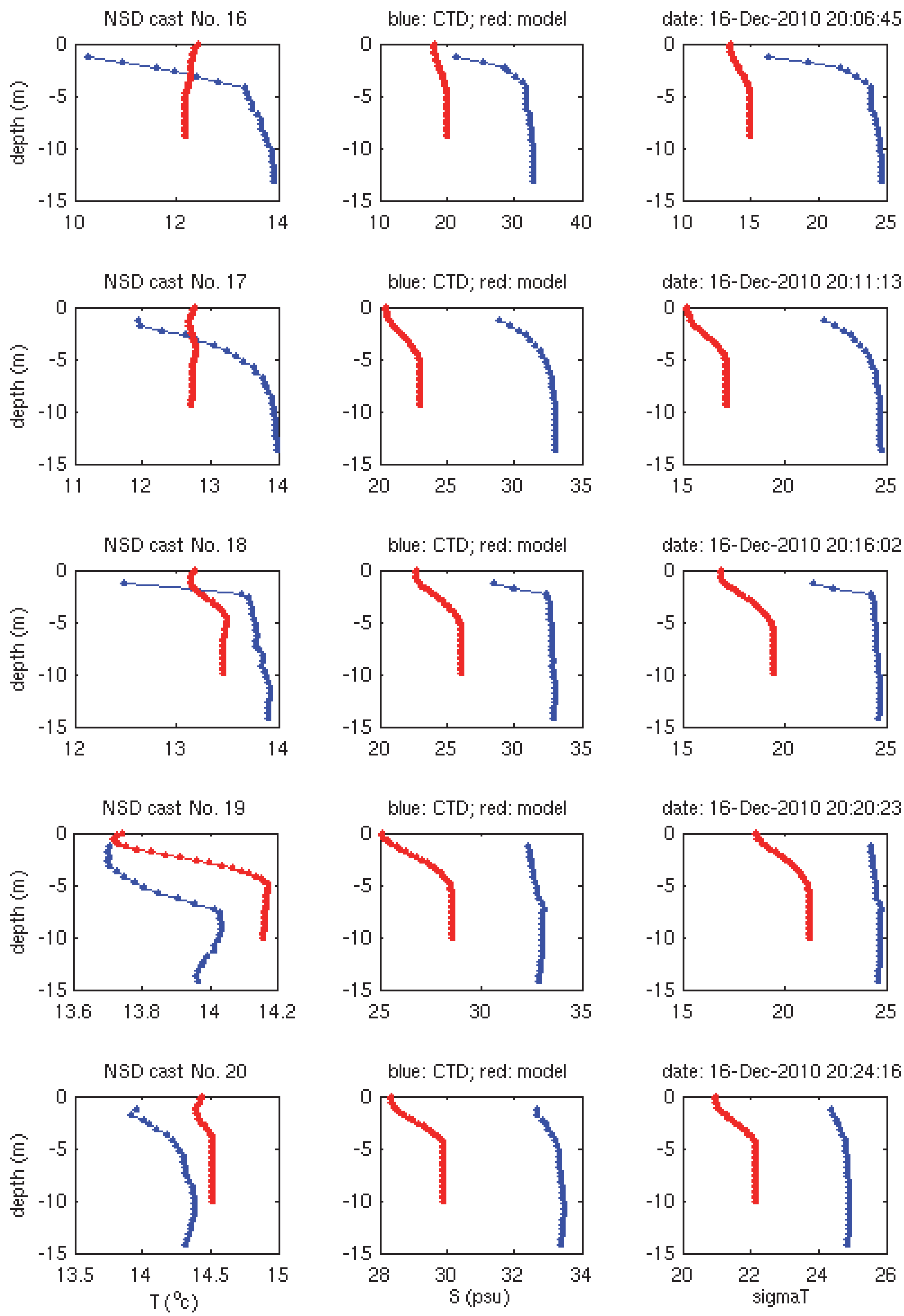
APPENDIX I. COMPARISON OF MODEL HINDCAST SALINITY AND TEMPERATURE VERTICAL PROFILE WITH OCS/NSD CTS MOBILE BAY SURVEY DATA

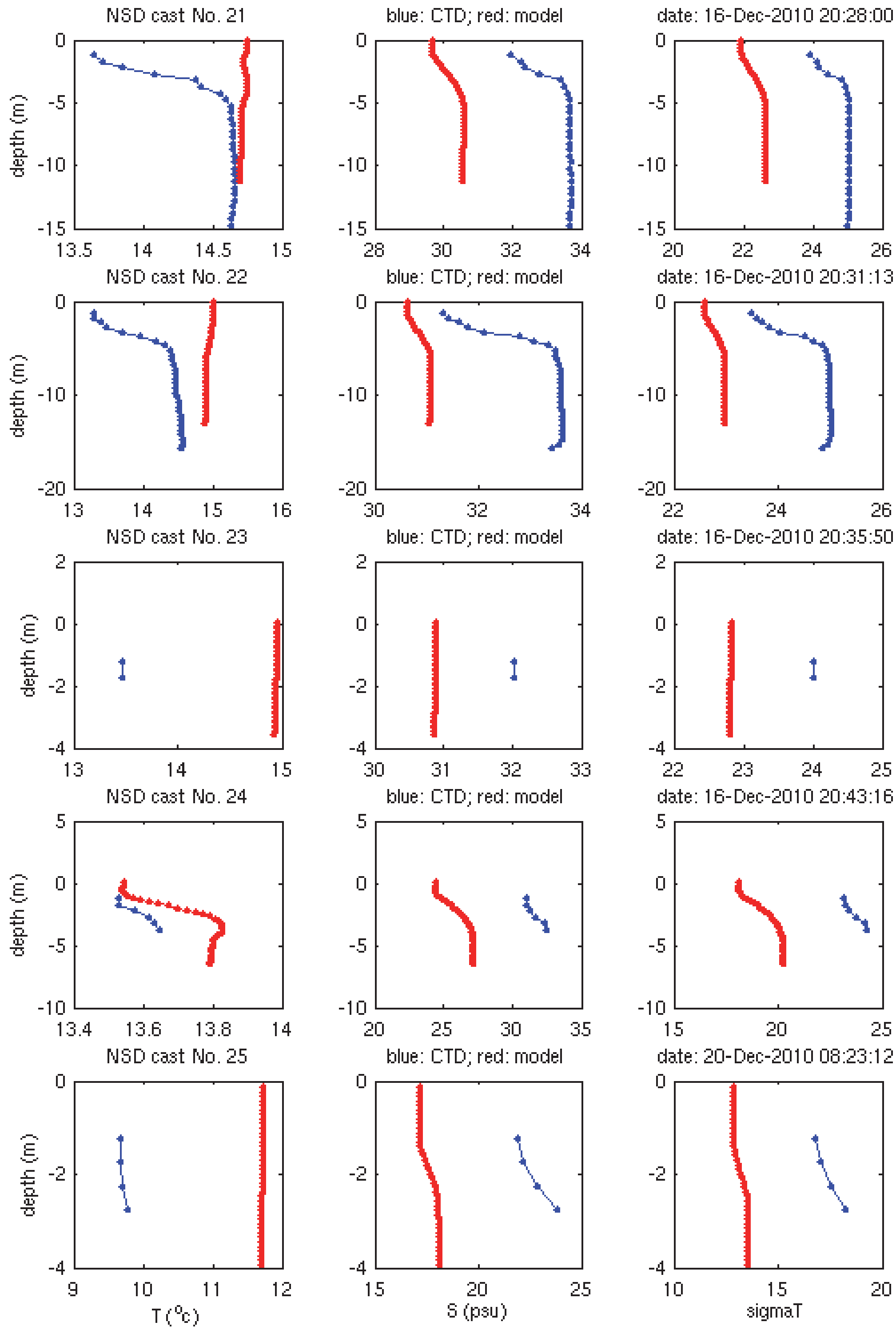
Note: In each plot, red and blue colors denote model results and observational data, respectively.

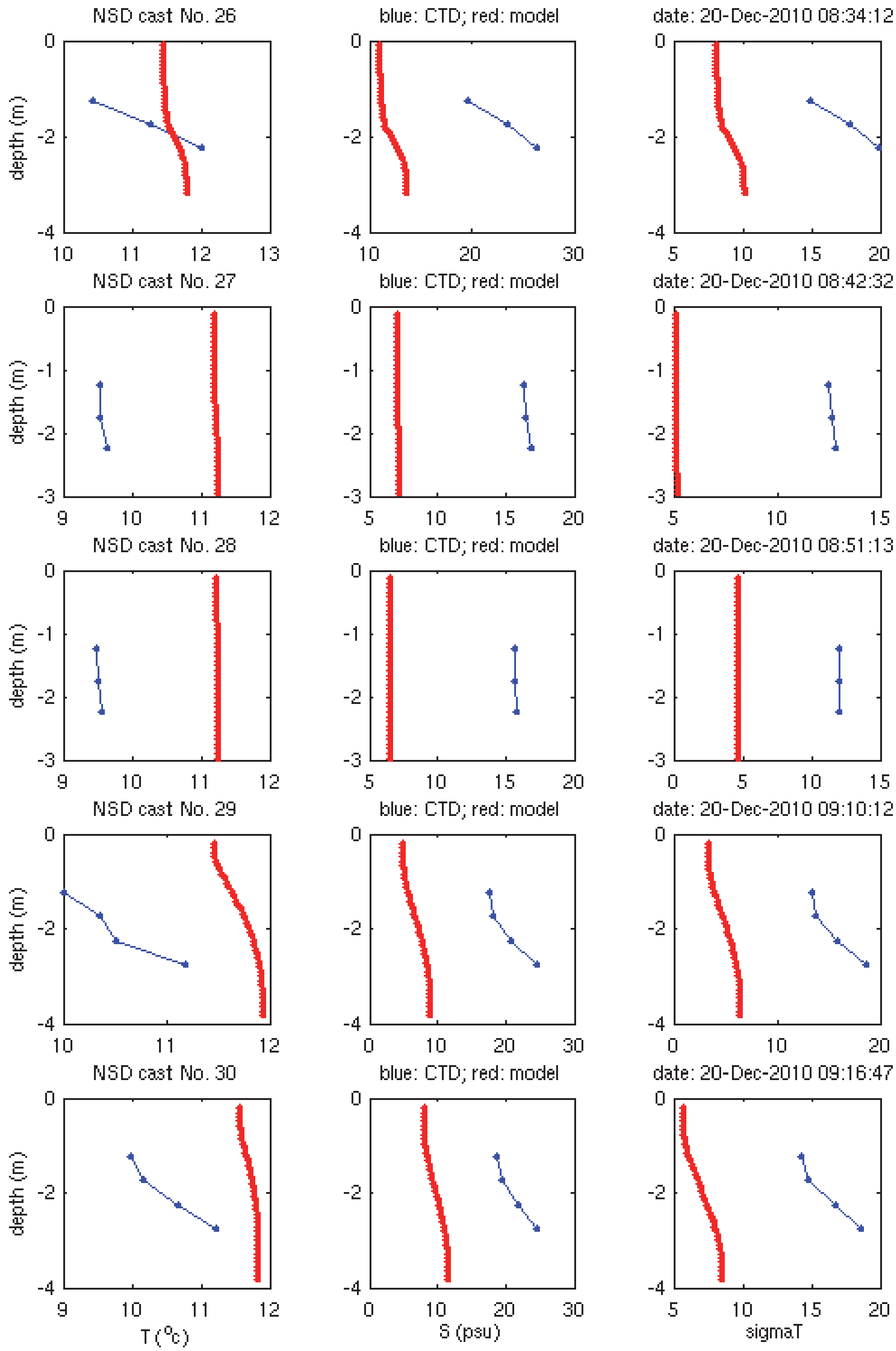


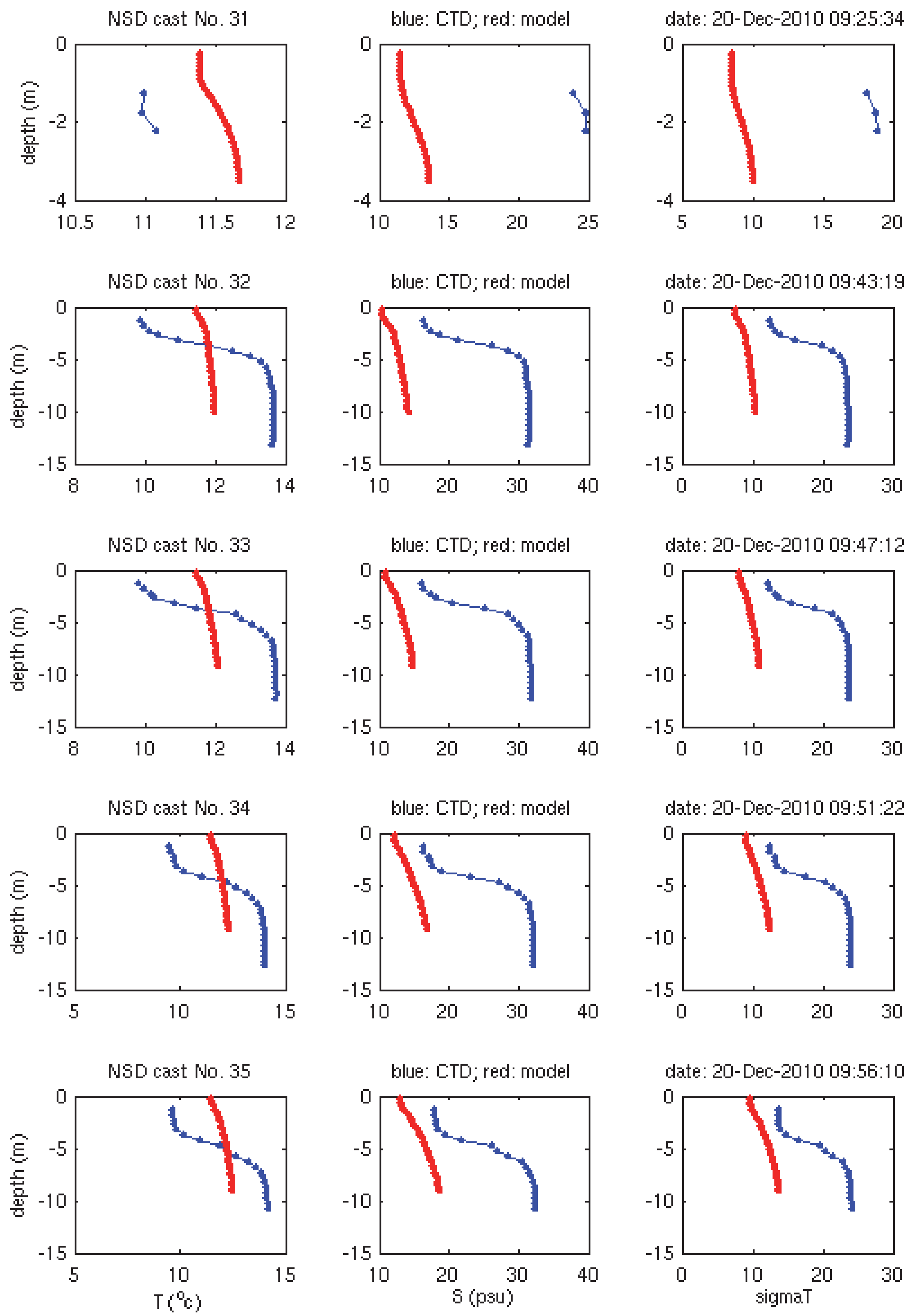

NSD cast No. 6
blue: CTD; red: model
date: 16-Dec-2010 18:56:49
NSD cast No. 7
blue: CTD; red: model
date: 16-Dec-2010 19:07:52
NSD cast No. 8
blue: CTD; red: model
date: 16-Dec-2010 19:28:55
NSD cast No. 9
blue: CTD; red: model
date: 16-Dec-2010 19:33:36
NSD cast No. 10
blue: CTD; red: model
date: 16-Dec-2010 19:38:53
depth (m)
T (°c)
S (psu)
sigmaT

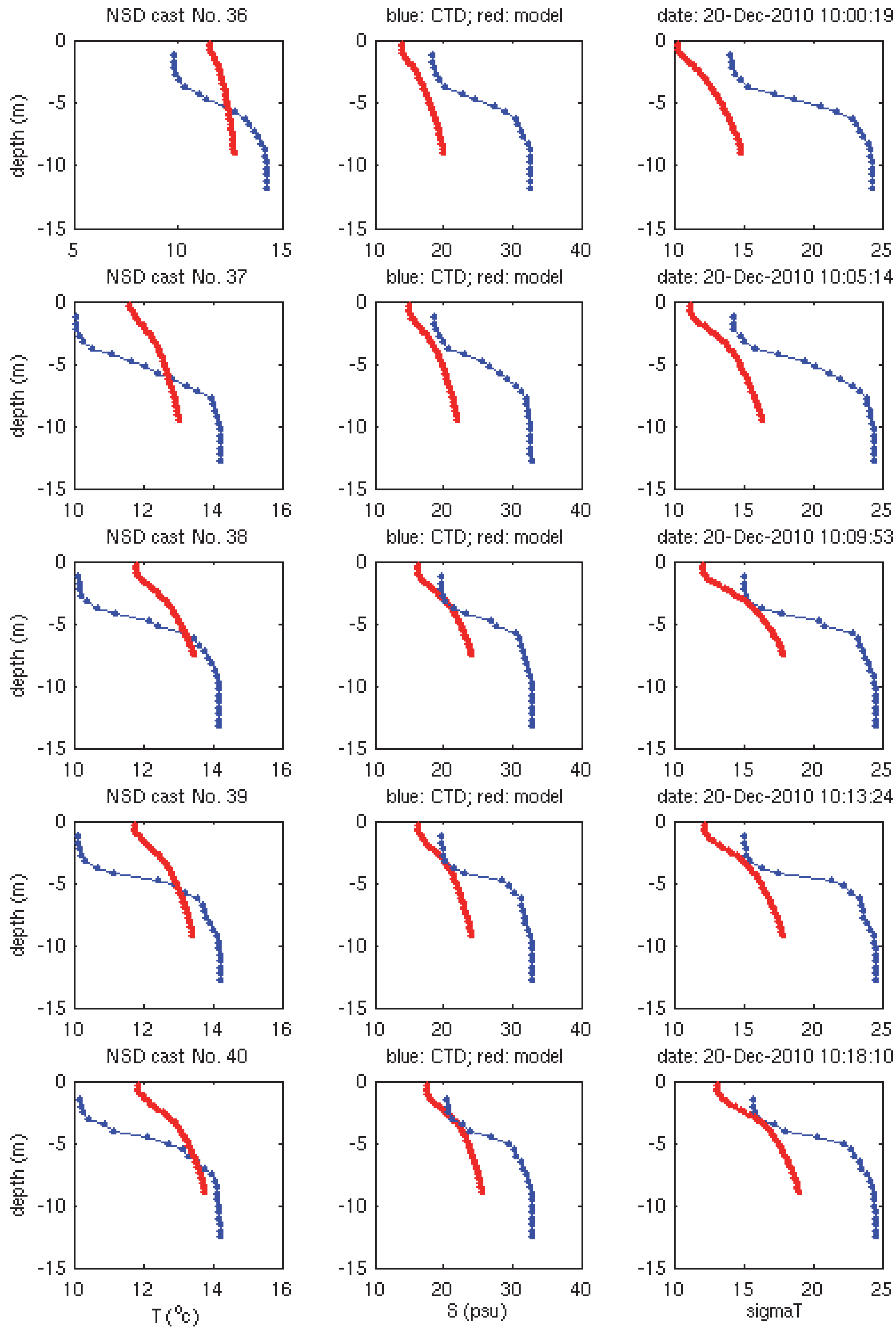

NSD cast No. 11
blue: CTD; red: model
date: 16-Dec-2010 19:43:32
NSD cast No. 12
blue: CTD; red: model
date: 16-Dec-2010 19:47:48
NSD cast No. 13
blue: CTD; red: model
date: 16-Dec-2010 19:53:22
NSD cast No. 14
blue: CTD; red: model
date: 16-Dec-2010 19:58:51
NSD cast No. 15
blue: CTD; red: model
date: 16-Dec-2010 20:02:13
depth (m)
T (°c)
S (psu)
sigmaT

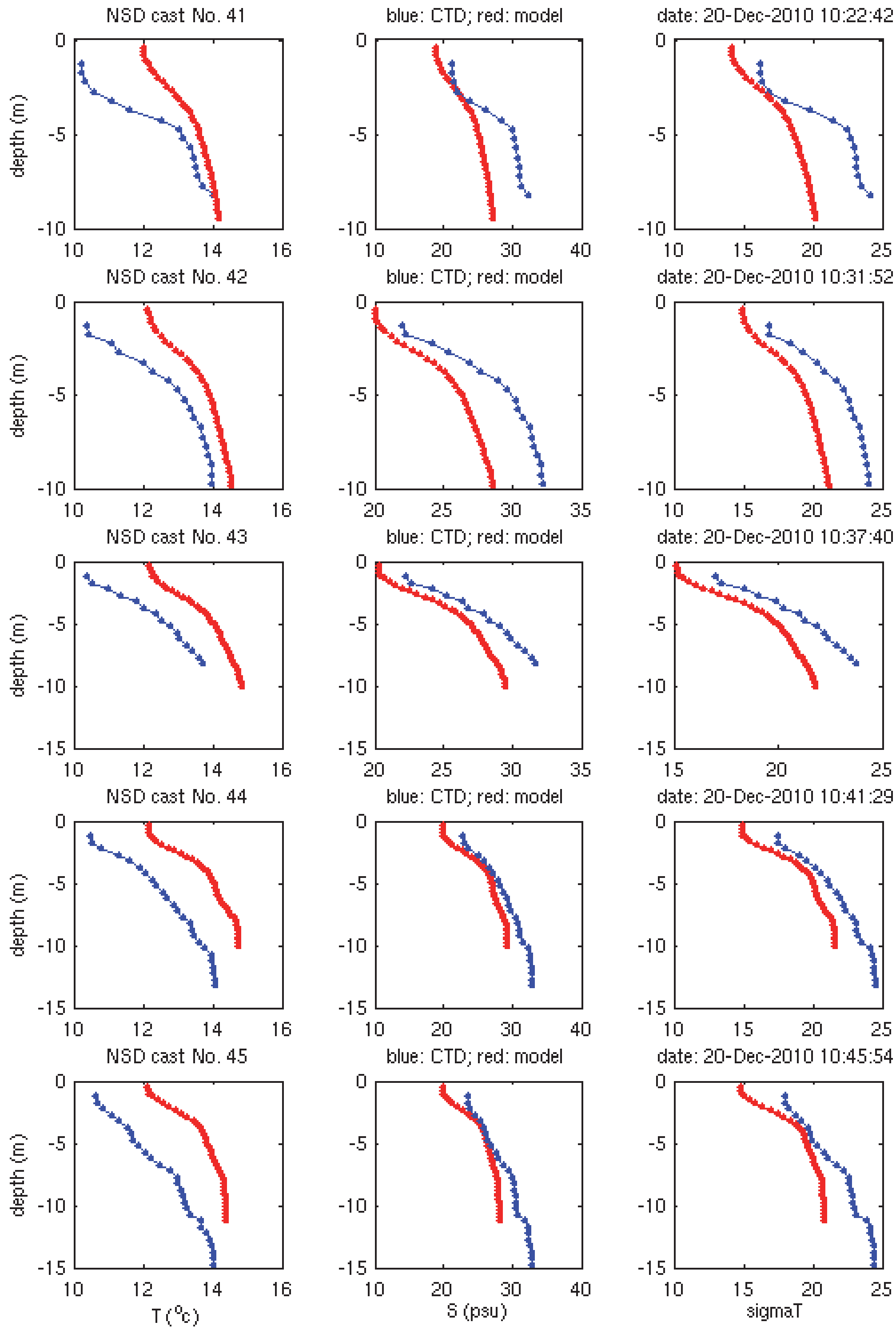

NSD cast No. 16
blue: CTD; red: model
date: 16-Dec-2010 20:06:45
NSD cast No. 17
blue: CTD; red: model
date: 16-Dec-2010 20:11:13
NSD cast No. 18
blue: CTD; red: model
date: 16-Dec-2010 20:16:02
NSD cast No. 19
blue: CTD; red: model
date: 16-Dec-2010 20:20:23
NSD cast No. 20
blue: CTD; red: model
date: 16-Dec-2010 20:24:16
depth (m)
0
-5
-10
-15
10 12 14
10 20 30 40
10 15 20 25
11 12 13 14
20 25 30 35
15 20 25
12 13 14
20 25 30 35
15 20 25
13.6 13.8 14 14.2
25 30 35
15 20 25
13.5 14 14.5 15
28 30 32 34
20 22 24 26
T (°c)
S (psu)
sigmaT


NSD cast No. 21
blue: CTD; red: model
date: 16-Dec-2010 20:28:00
NSD cast No. 22
blue: CTD; red: model
date: 16-Dec-2010 20:31:13
NSD cast No. 23
blue: CTD; red: model
date: 16-Dec-2010 20:35:50
NSD cast No. 24
blue: CTD; red: model
date: 16-Dec-2010 20:43:16
NSD cast No. 25
blue: CTD; red: model
date: 20-Dec-2010 08:23:12
depth (m)
T (^{o}c)
S (psu)
sigmaT

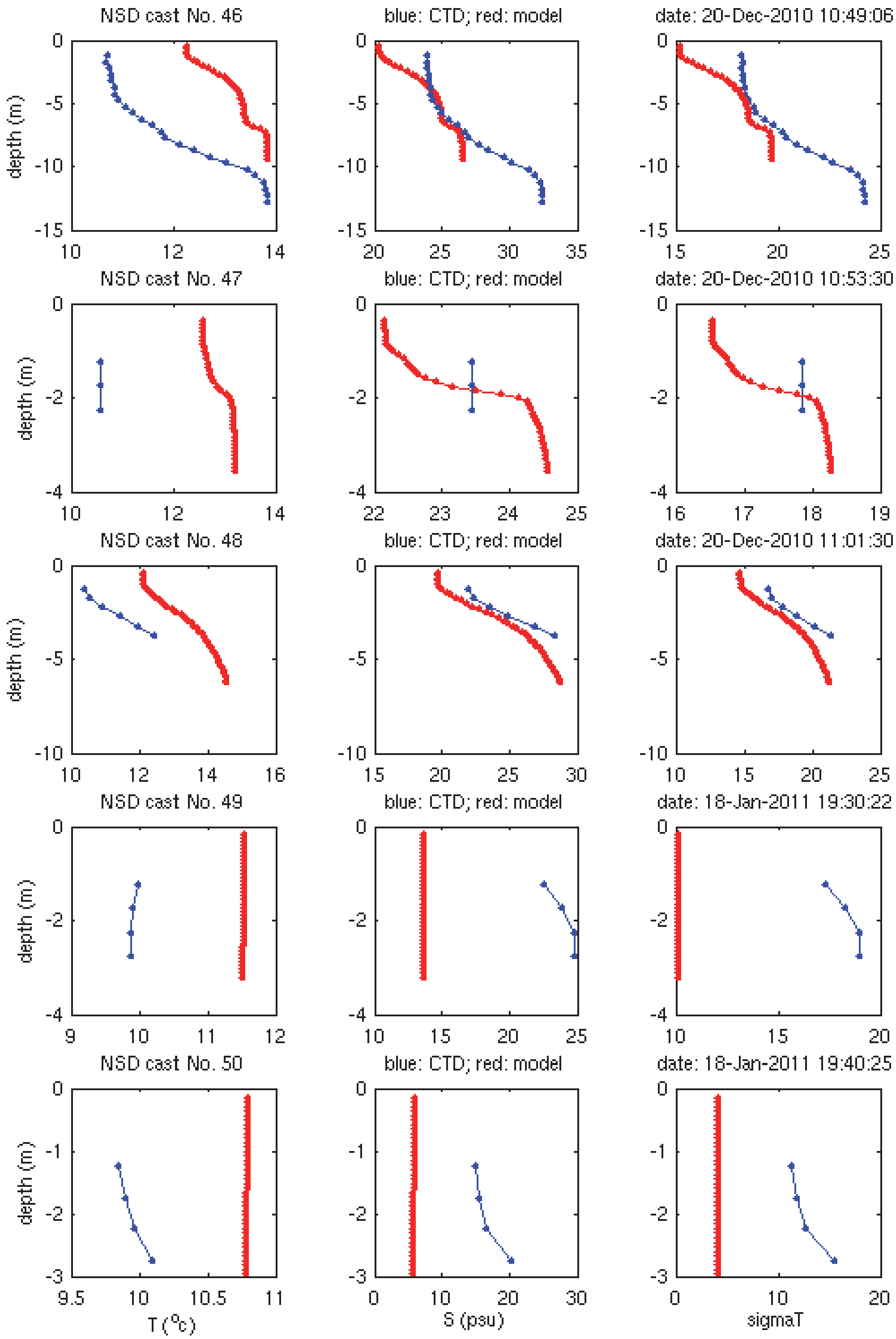

NSD cast No. 26
blue: CTD; red: model
date: 20-Dec-2010 08:34:12
NSD cast No. 27
blue: CTD; red: model
date: 20-Dec-2010 08:42:32
NSD cast No. 28
blue: CTD; red: model
date: 20-Dec-2010 08:51:13
NSD cast No. 29
blue: CTD; red: model
date: 20-Dec-2010 09:10:12
NSD cast No. 30
blue: CTD; red: model
date: 20-Dec-2010 09:16:47
depth (m)
T (°c)
S (psu)
sigmaT

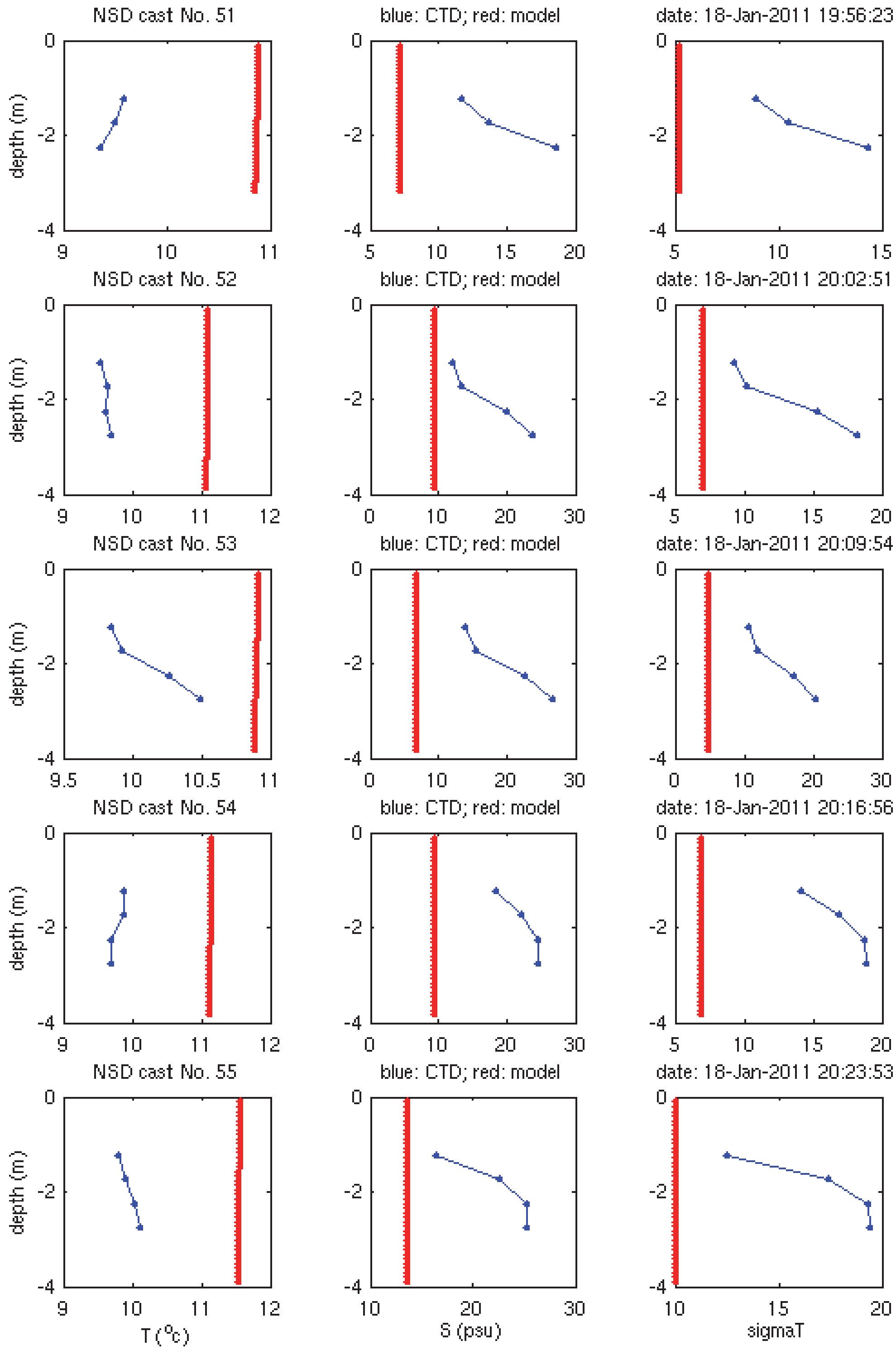

NSD cast No. 31
blue: CTD; red: model
date: 20-Dec-2010 09:25:34
NSD cast No. 32
blue: CTD; red: model
date: 20-Dec-2010 09:43:19
NSD cast No. 33
blue: CTD; red: model
date: 20-Dec-2010 09:47:12
NSD cast No. 34
blue: CTD; red: model
date: 20-Dec-2010 09:51:22
NSD cast No. 35
blue: CTD; red: model
date: 20-Dec-2010 09:56:10
depth (m)
T (°c)
S (psu)
sigmaT

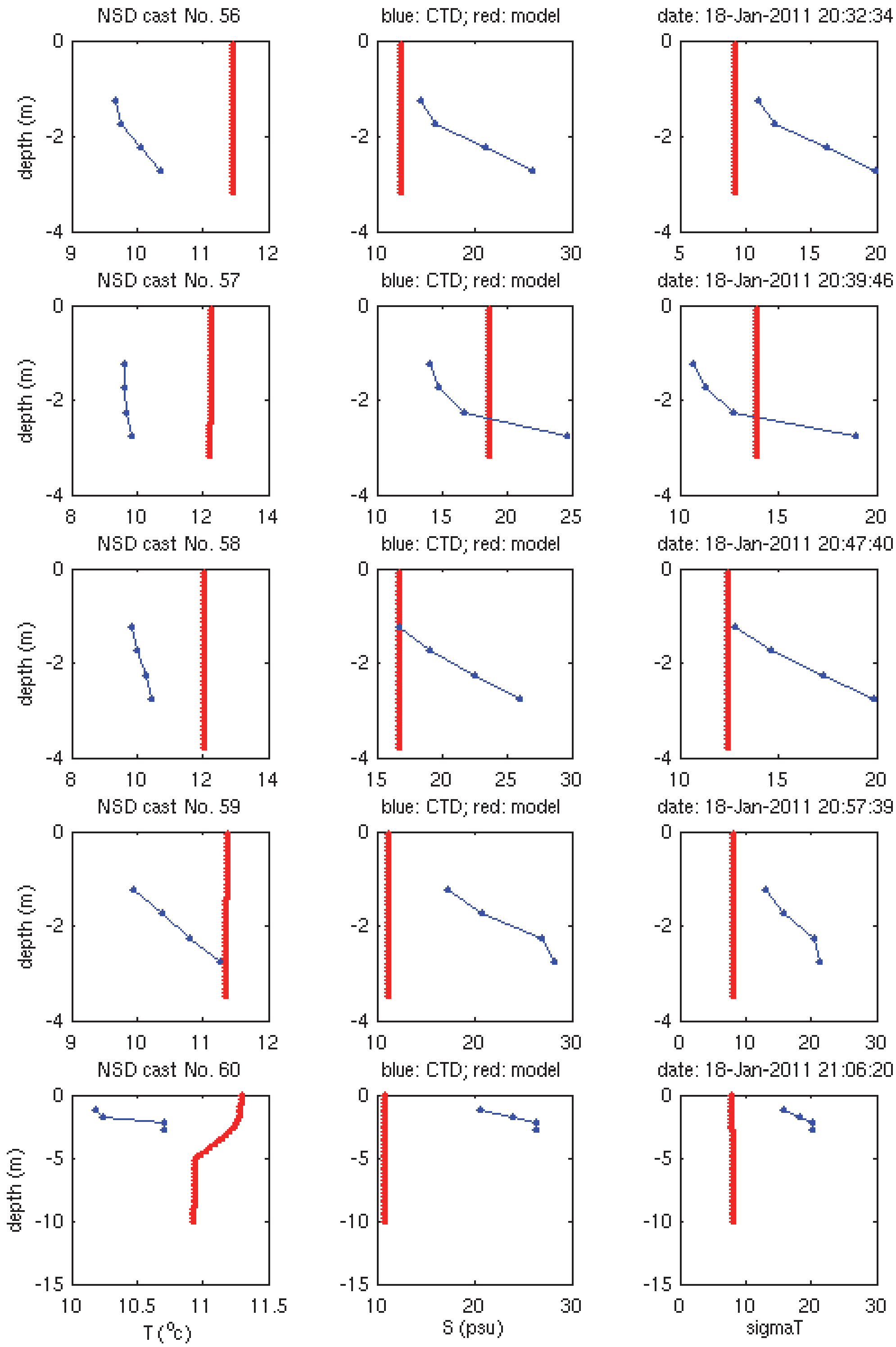

NSD cast No. 36
blue: CTD; red: model
date: 20-Dec-2010 10:00:19
NSD cast No. 37
blue: CTD; red: model
date: 20-Dec-2010 10:05:14
NSD cast No. 38
blue: CTD; red: model
date: 20-Dec-2010 10:09:53
NSD cast No. 39
blue: CTD; red: model
date: 20-Dec-2010 10:13:24
NSD cast No. 40
blue: CTD; red: model
date: 20-Dec-2010 10:18:10
depth (m)
T (°c)
S (psu)
sigmaT

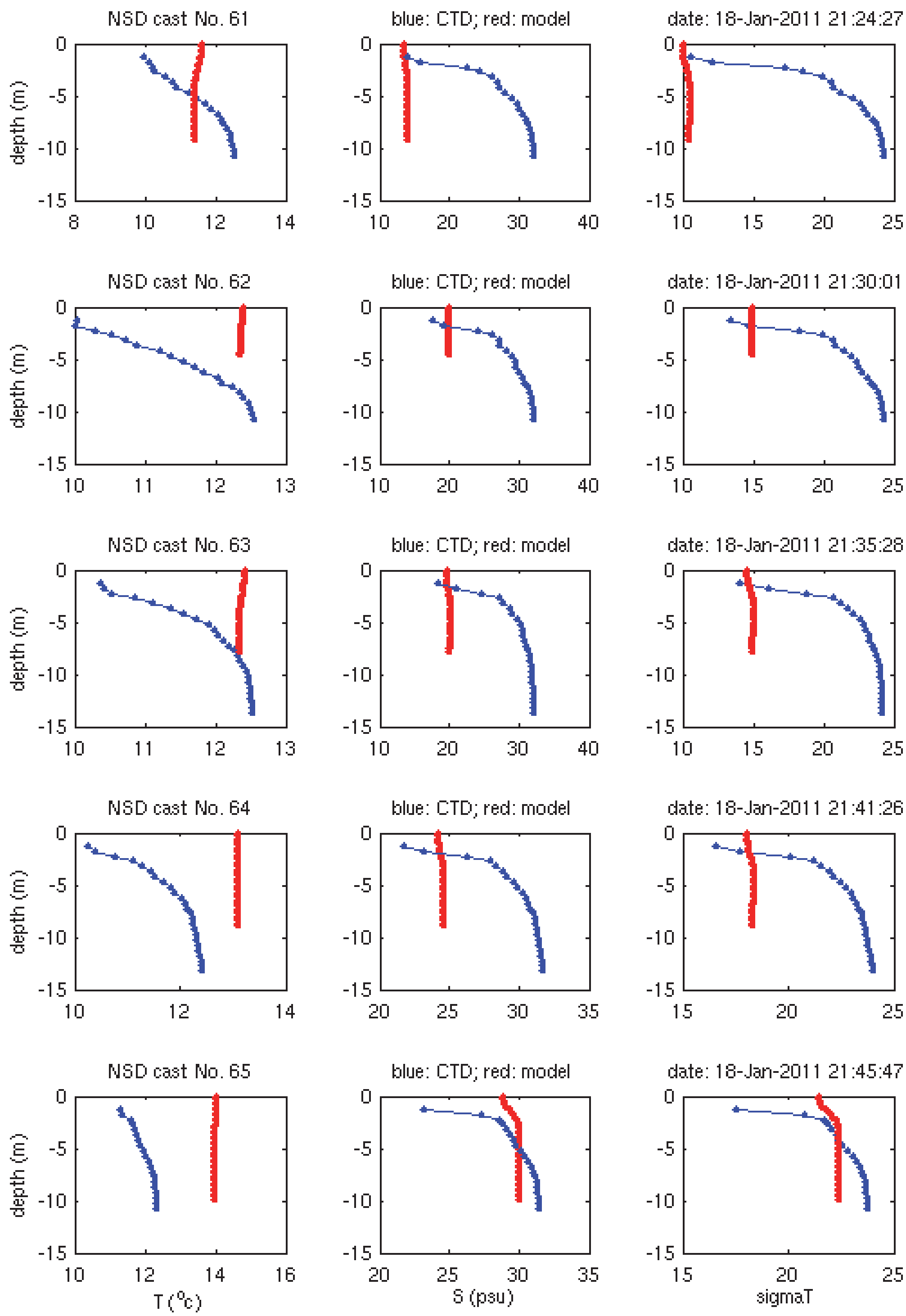


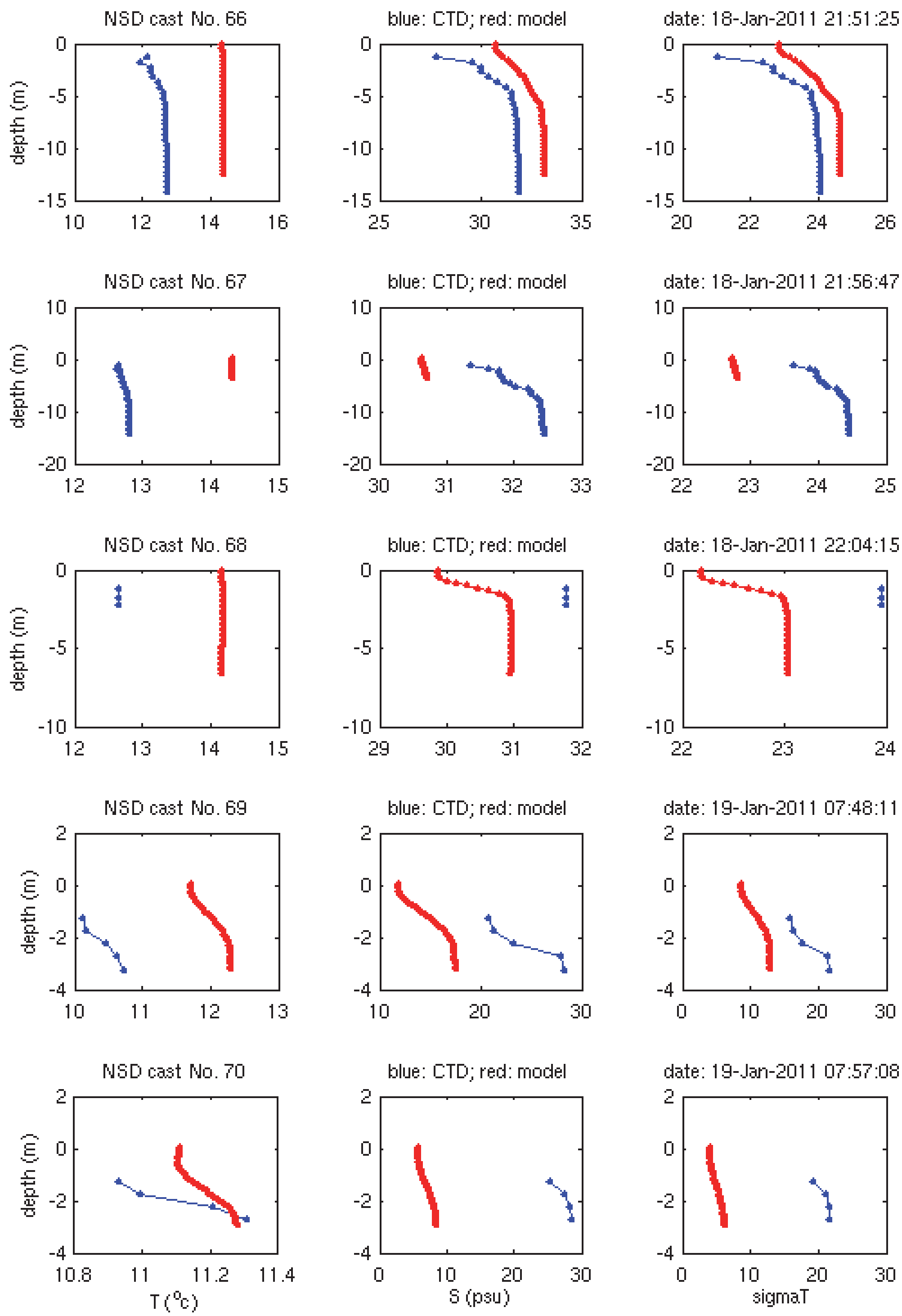
NSD cast No. 41
blue: CTD; red: model
date: 20-Dec-2010 10:22:42
NSD cast No. 42
blue: CTD; red: model
date: 20-Dec-2010 10:31:52
NSD cast No. 43
blue: CTD; red: model
date: 20-Dec-2010 10:37:40
NSD cast No. 44
blue: CTD; red: model
date: 20-Dec-2010 10:41:29
NSD cast No. 45
blue: CTD; red: model
date: 20-Dec-2010 10:45:54
depth (m)
T (°c)
S (psu)
sigmaT

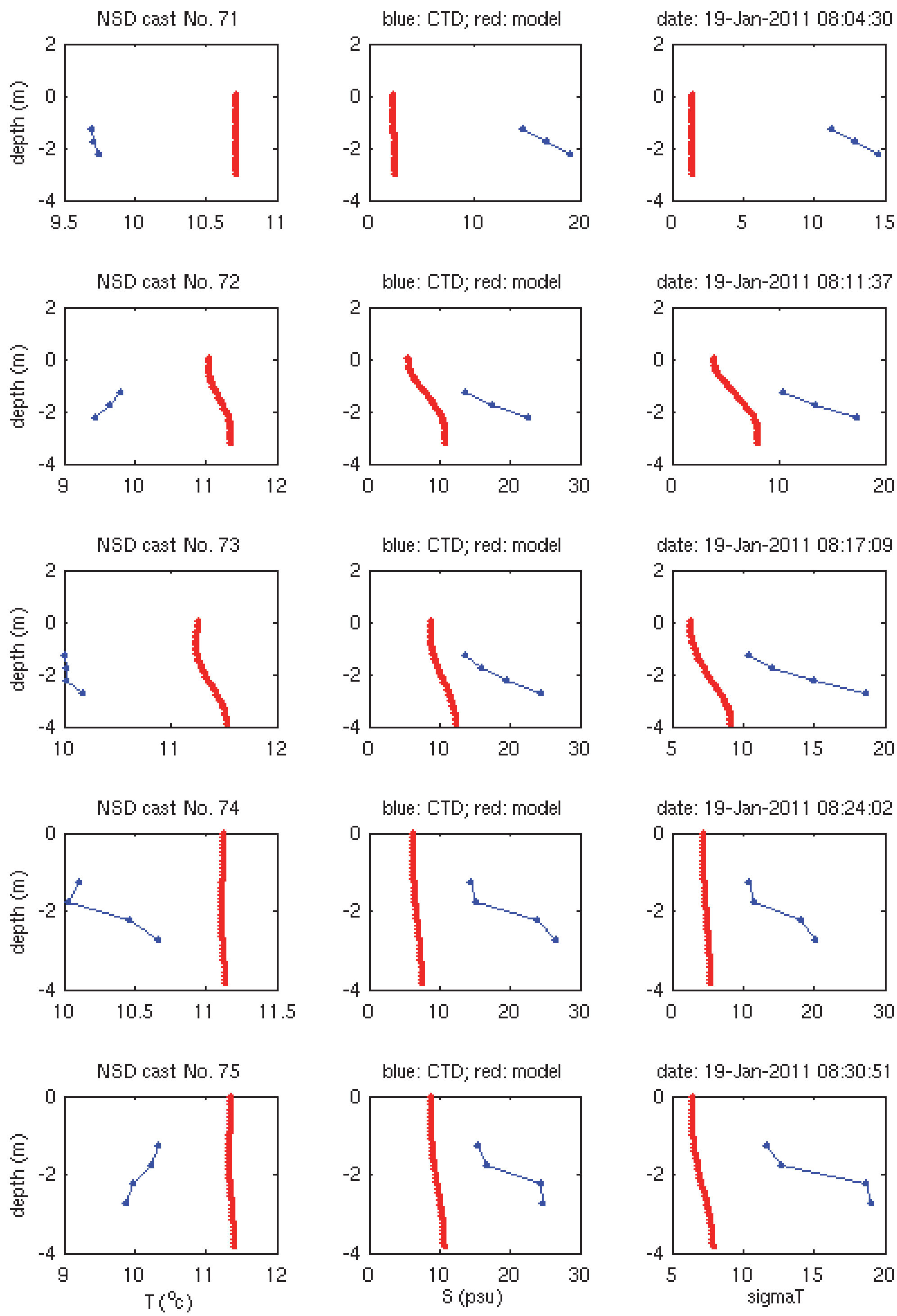

NSD cast No. 46
blue: CTD; red: model
date: 20-Dec-2010 10:49:06
NSD cast No. 47
blue: CTD; red: model
date: 20-Dec-2010 10:53:30
NSD cast No. 48
blue: CTD; red: model
date: 20-Dec-2010 11:01:30
NSD cast No. 49
blue: CTD; red: model
date: 18-Jan-2011 19:30:22
NSD cast No. 50
blue: CTD; red: model
date: 18-Jan-2011 19:40:25
depth (m)
T (°c)
S (psu)
sigmaT


NSD cast No. 51
blue: CTD; red: model
date: 18-Jan-2011 19:56:23
NSD cast No. 52
blue: CTD; red: model
date: 18-Jan-2011 20:02:51
NSD cast No. 53
blue: CTD; red: model
date: 18-Jan-2011 20:09:54
NSD cast No. 54
blue: CTD; red: model
date: 18-Jan-2011 20:16:56
NSD cast No. 55
blue: CTD; red: model
date: 18-Jan-2011 20:23:53
depth (m)
T (°c)
S (psu)
sigmaT

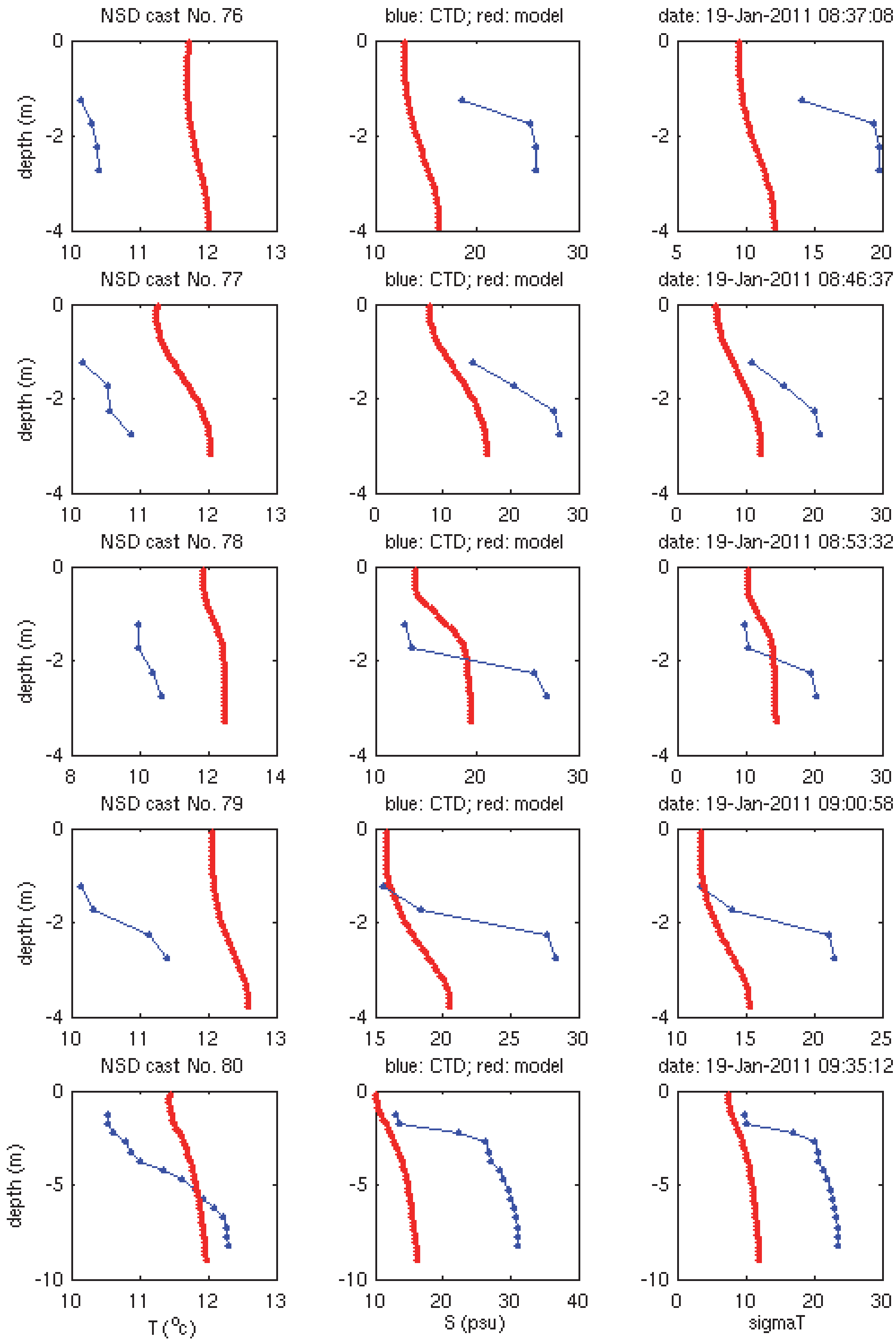

NSD cast No. 56
blue: CTD; red: model
date: 18-Jan-2011 20:32:34
NSD cast No. 57
blue: CTD; red: model
date: 18-Jan-2011 20:39:46
NSD cast No. 58
blue: CTD; red: model
date: 18-Jan-2011 20:47:40
NSD cast No. 59
blue: CTD; red: model
date: 18-Jan-2011 20:57:39
NSD cast No. 60
blue: CTD; red: model
date: 18-Jan-2011 21:06:20
depth (m)
T (°c)
S (psu)
sigmaT

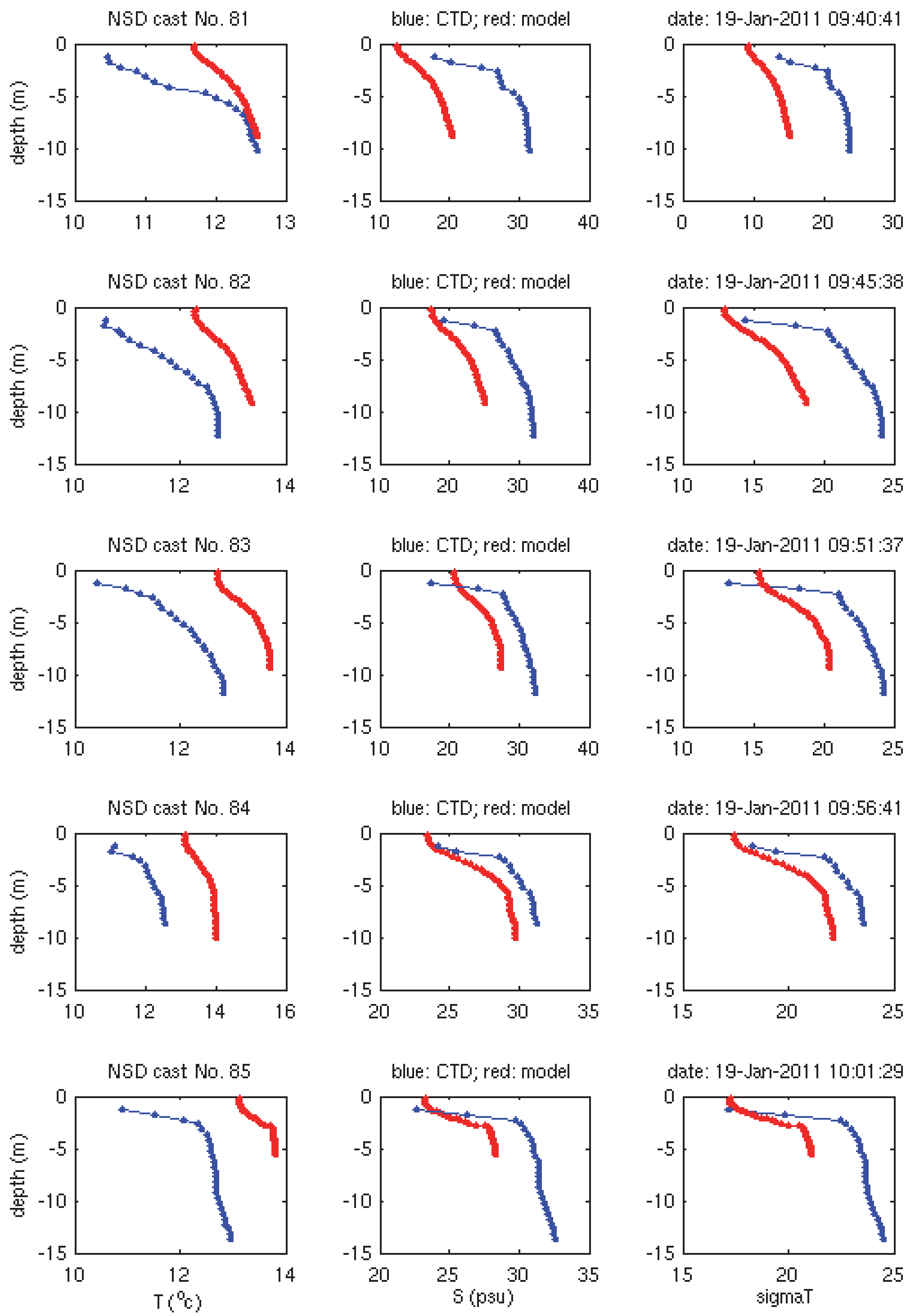

NSD cast No. 61
blue: CTD; red: model
date: 18-Jan-2011 21:24:27
NSD cast No. 62
blue: CTD; red: model
date: 18-Jan-2011 21:30:01
NSD cast No. 63
blue: CTD; red: model
date: 18-Jan-2011 21:35:28
NSD cast No. 64
blue: CTD; red: model
date: 18-Jan-2011 21:41:26
NSD cast No. 65
blue: CTD; red: model
date: 18-Jan-2011 21:45:47
depth (m)
T (°c)
S (psu)
sigmaT

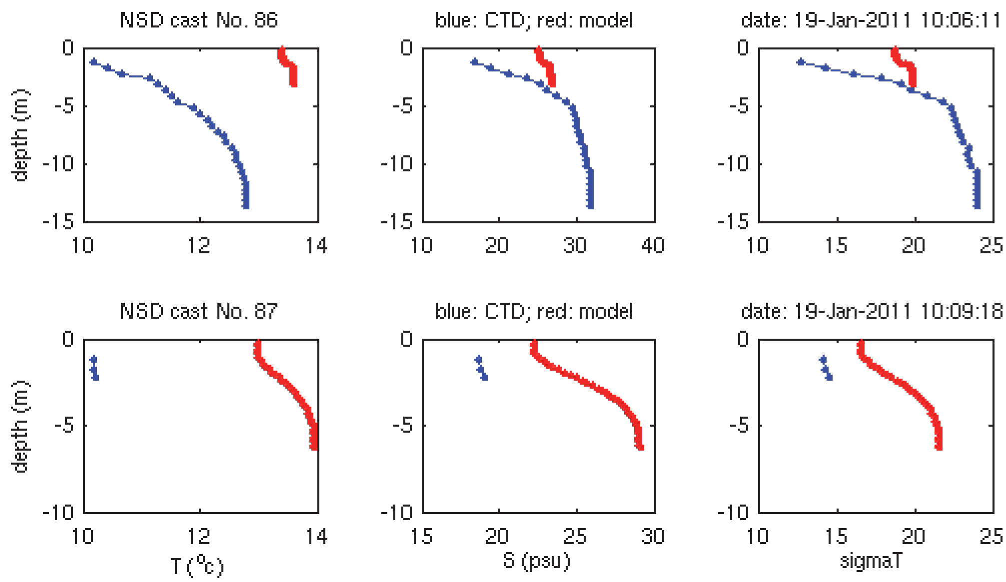

NSD cast No. 66
blue: CTD; red: model
date: 18-Jan-2011 21:51:25
NSD cast No. 67
blue: CTD; red: model
date: 18-Jan-2011 21:56:47
NSD cast No. 68
blue: CTD; red: model
date: 18-Jan-2011 22:04:15
NSD cast No. 69
blue: CTD; red: model
date: 19-Jan-2011 07:48:11
NSD cast No. 70
blue: CTD; red: model
date: 19-Jan-2011 07:57:08
depth (m)
T (°c)
S (psu)
sigmaT



NSD cast No. 71
blue: CTD; red: model
date: 19-Jan-2011 08:04:30
NSD cast No. 72
blue: CTD; red: model
date: 19-Jan-2011 08:11:37
NSD cast No. 73
blue: CTD; red: model
date: 19-Jan-2011 08:17:09
NSD cast No. 74
blue: CTD; red: model
date: 19-Jan-2011 08:24:02
NSD cast No. 75
blue: CTD; red: model
date: 19-Jan-2011 08:30:51
depth (m)
T (°c)
S (psu)
sigmaT

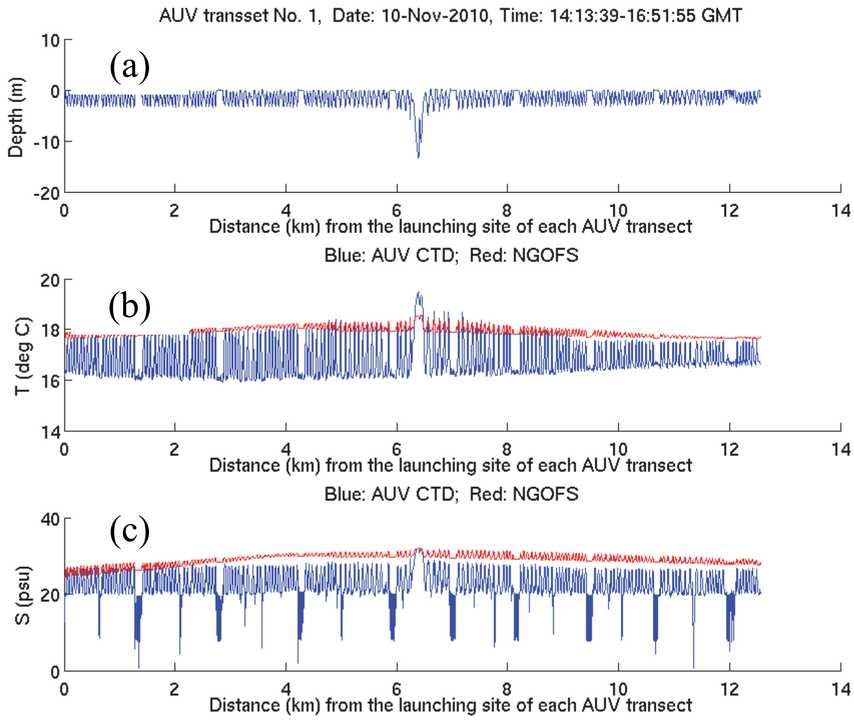

NSD cast No. 76
blue: CTD; red: model
date: 19-Jan-2011 08:37:08
NSD cast No. 77
blue: CTD; red: model
date: 19-Jan-2011 08:46:37
NSD cast No. 78
blue: CTD; red: model
date: 19-Jan-2011 08:53:32
NSD cast No. 79
blue: CTD; red: model
date: 19-Jan-2011 09:00:58
NSD cast No. 80
blue: CTD; red: model
date: 19-Jan-2011 09:35:12
depth (m)
T (°c)
S (psu)
sigmaT

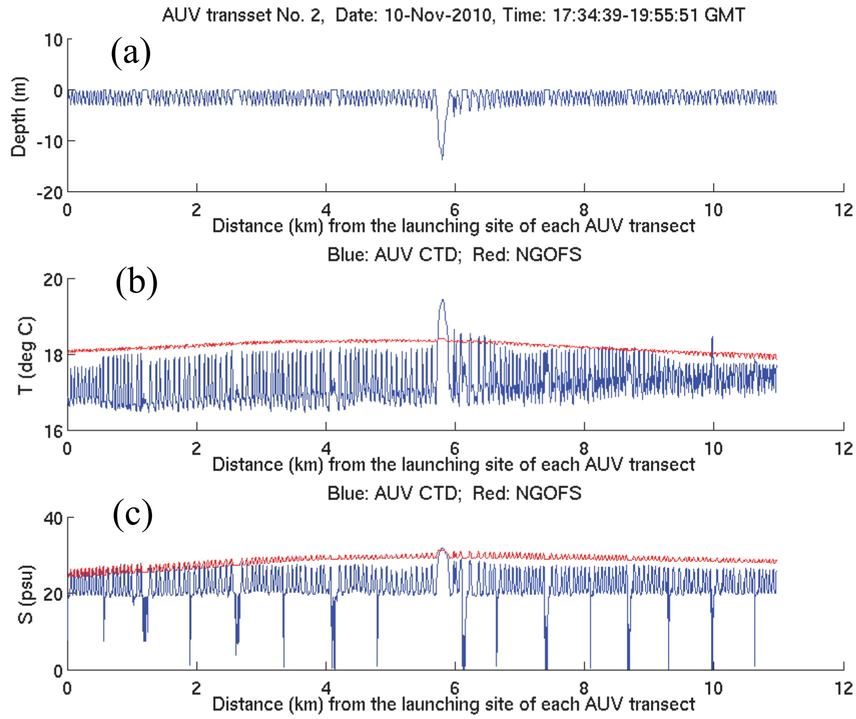

NSD cast No. 81
blue: CTD; red: model
date: 19-Jan-2011 09:40:41
NSD cast No. 82
blue: CTD; red: model
date: 19-Jan-2011 09:45:38
NSD cast No. 83
blue: CTD; red: model
date: 19-Jan-2011 09:51:37
NSD cast No. 84
blue: CTD; red: model
date: 19-Jan-2011 09:56:41
NSD cast No. 85
blue: CTD; red: model
date: 19-Jan-2011 10:01:29
depth (m)
T (°c)
S (psu)
sigmaT

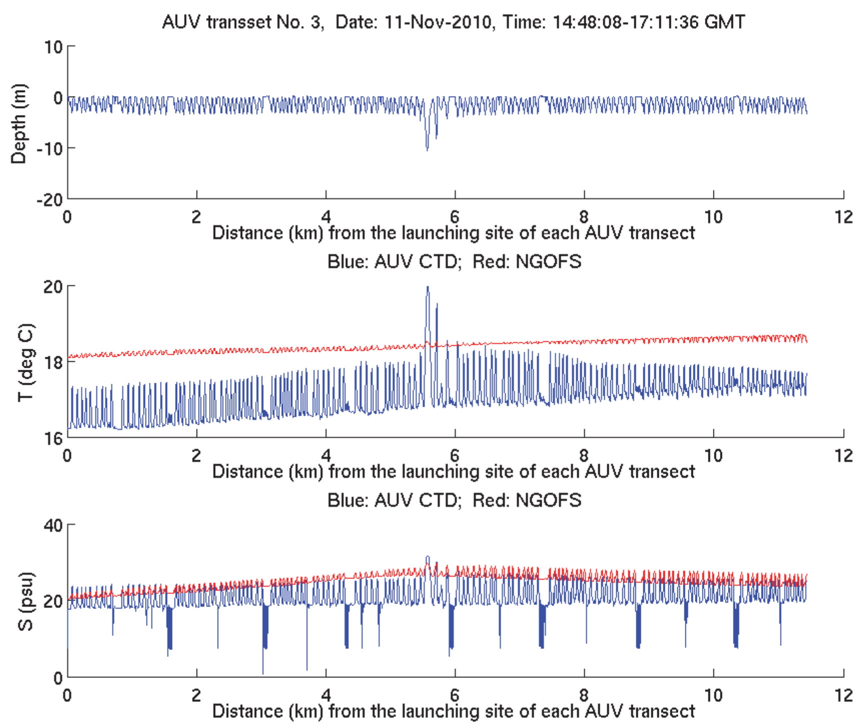

NSD cast No. 86
blue: CTD; red: model
date: 19-Jan-2011 10:06:11
depth (m)
NSD cast No. 87
blue: CTD; red: model
date: 19-Jan-2011 10:09:18
depth (m)
T (°c)
S (psu)
sigmaT

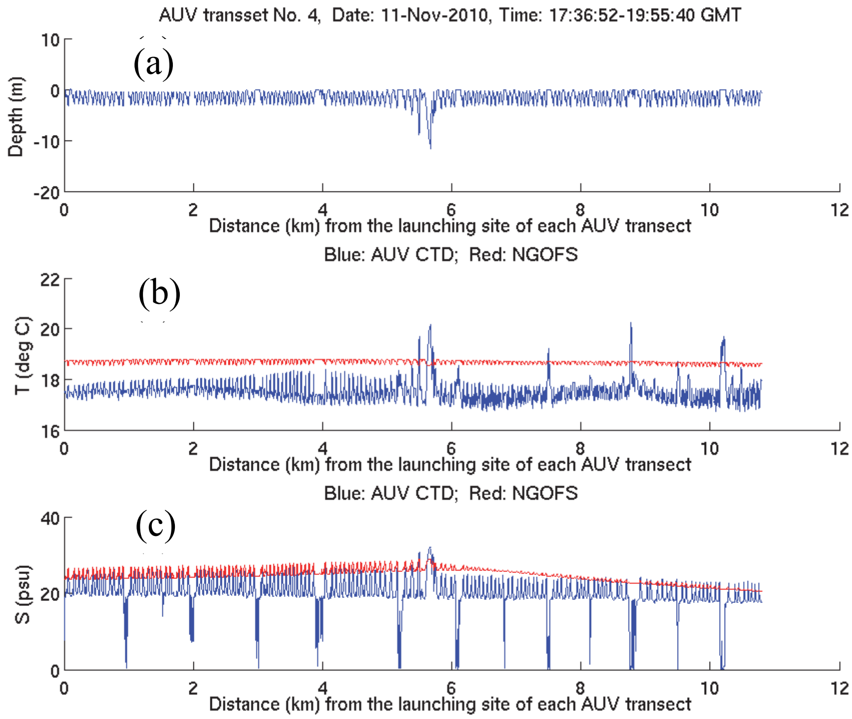
APPENDIX J. COMPARISONS OF MODEL HINDCAST SALINITY AND TEMPERATURE WITH OBSERVATIONS FROM OCS/NSD AUV SURVEY

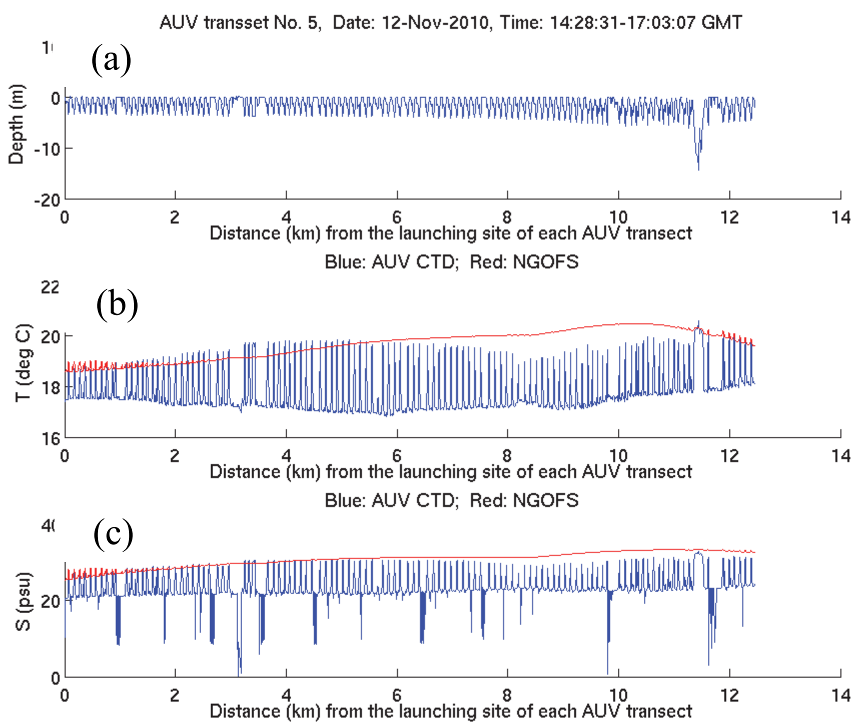
Note: Red and blue colors denote model results and observational data, respectively.

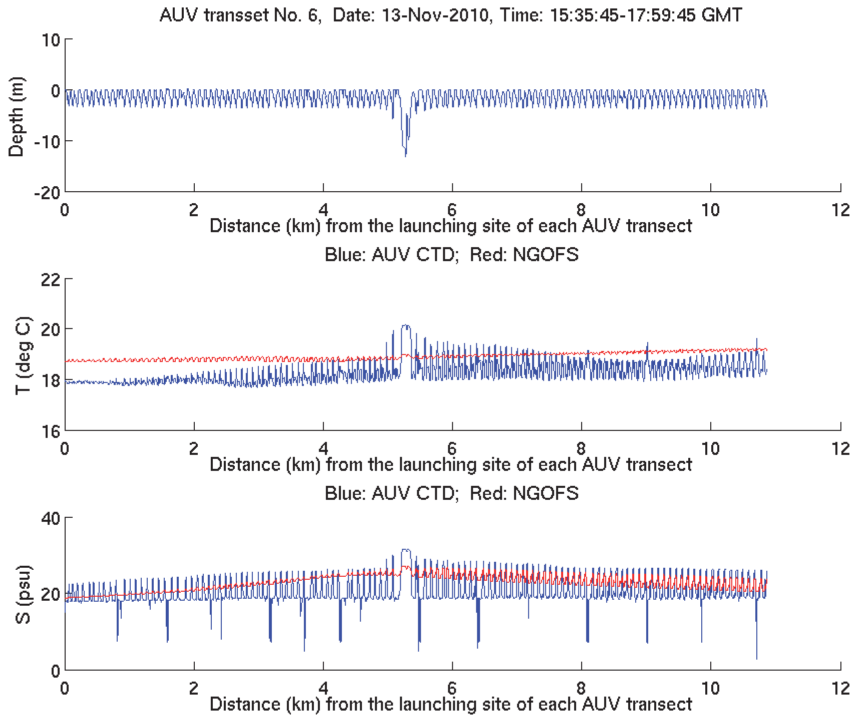


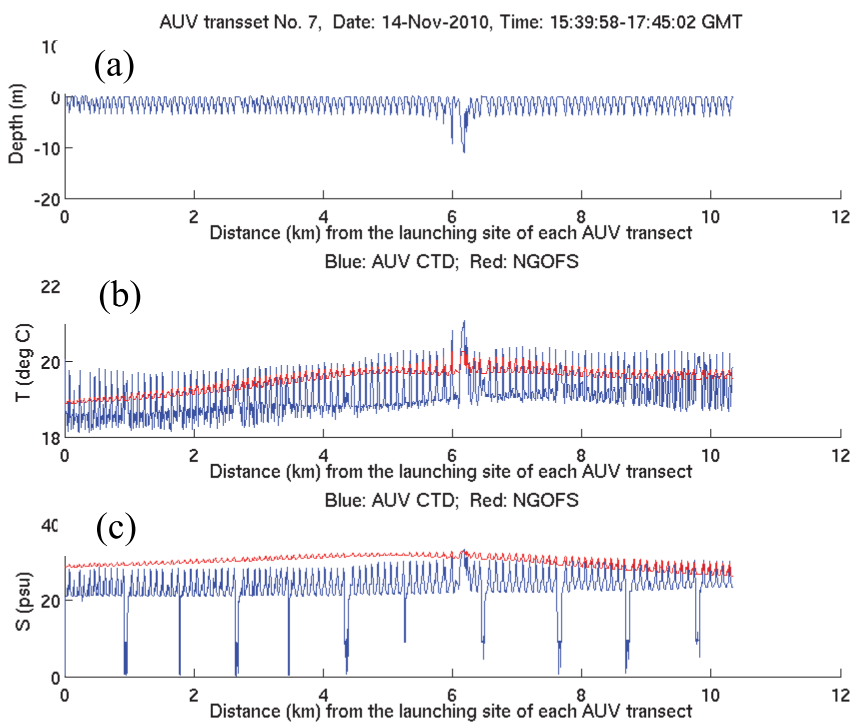

AUV transset No. 2, Date: 10-Nov-2010, Time: 17:34:39-19:55:51 GMT
(a)
Depth (m)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(b)
T (deg C)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(c)
S (psu)
Distance (km) from the launching site of each AUV transect


AUV transset No. 3, Date: 11-Nov-2010, Time: 14:48:08-17:11:36 GMT
Depth (m)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
T (deg C)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
S (psu)
Distance (km) from the launching site of each AUV transect


AUV transset No. 4, Date: 11-Nov-2010, Time: 17:36:52-19:55:40 GMT
(a)
Depth (m)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(b)
T (deg C)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(c)
S (psu)
Distance (km) from the launching site of each AUV transect


AUV transset No. 5, Date: 12-Nov-2010, Time: 14:28:31-17:03:07 GMT
(a)
Depth (m)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(b)
T (deg C)
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(c)
S (psu)
Distance (km) from the launching site of each AUV transect


AUV transset No. 6, Date: 13-Nov-2010, Time: 15:35:45-17:59:45 GMT
Depth (m)
10
0
-10
-20
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
T (deg C)
22
20
18
16
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
S (psu)
40
20
0
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect


AUV transset No. 7, Date: 14-Nov-2010, Time: 15:39:58-17:45:02 GMT
(a)
Depth (m)
0
-10
-20
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
22
(b)
T (deg C)
20
18
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect
Blue: AUV CTD; Red: NGOFS
(c)
S (psu)
20
0
0
2
4
6
8
10
12
Distance (km) from the launching site of each AUV transect