IMPLEMENTATION OF THE GULF OF MAINE OPERATIONAL FORECAST SYSTEM (GOMOFS) AND THE SEMI-OPERATIONAL NOWCAST/FORECAST SKILL ASSESSMENT

Spring, Maryland
July, 2018

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EXECUTIVE SUMMARY

For decades, mariners in the United States have depended on the National Oceanic and Atmospheric Administration's (NOAA's) Tide Tables for the best estimate of expected water levels. These tables provide accurate predictions of the astronomical tide; however, they cannot predict water-level changes due to wind, atmospheric pressure, and river flow, which are often significant. Furthermore, accurate estimates of water velocity, temperature, salinity, and other variables are important parameters for mariners, beachgoers, and others.

The Gulf of Maine Operational Forecast System (GoMOFS) has been implemented to provide users with nowcasts (analyses of near present) and forecast guidance of the three-dimensional (3-D) physical conditions of the Gulf of Maine, including surface water levels and 3-D water currents, water temperature, and salinity out to 72 hours. GoMOFS uses the Regional Ocean Modeling System (ROMS), developed and supported by researchers at Rutgers University, as its core ocean prediction model. ROMS is a free-surface, terrain-following, primitive equations ocean model widely used by the scientific and operational community for a diverse range of applications.

To the date of publication of this report, GoMOFS has been running reliably without any instability issues since August 2016 when the nowcast/forecast evaluation started. Standard model skill assessment based on a half-year of quasi-operational model output indicates that all targeted variables meet the National Ocean Service (NOS) model skill criteria. The successful implementation of this model therefore provides reliable guidance on water levels, currents, water temperatures and salinity to support NOS' navigation customers and could serve as the hydrodynamic basis for ecological modeling, such as harmful algal bloom (HAB) forecasting, for this nutrient rich region.

This technical report documents how CO-OPS builds the control and static files for the High Performance Computing- Coastal Ocean Modeling Framework (HPC-COMF) and then generates the required model forcing files that drive GoMOFS. Nowcast and forecast model skill assessment (January 1–June 30, 2017) is then presented.

1.0 INTRODUCTION

For decades, mariners in the United States have depended on the National Oceanic and Atmospheric Administration's (NOAA's) Tide Tables for the best estimate of expected water levels. These tables provide accurate predictions of the astronomical tide; however, they cannot predict water-level changes due to wind, atmospheric pressure, and river flow, which are often significant. Furthermore, accurate estimates of water velocity, temperature, salinity, and other variables are important parameters for mariners, beach goers and others. The Gulf of Maine Operational Forecast System (GoMOFS) provides the maritime navigation community with operational guidance of water levels, currents (speed and direction), water temperature, and salinity. The successful implementation of this project greatly promotes safe navigation in this region. GoMOFS also provides fundamental guidance for other applications such as harmful algal blooms (HAB) modeling, coastal emergency response, and ecological forecasting.

The Gulf of Maine (Figure 1) has complex bathymetry ranging from near 0 meter (m) at the coast to 4500 m along its southern open boundary. A strong tidal regime dominates most of the region. The Bay of Fundy is located at the northeastern part of the model domain. The extreme high energy of the region makes the stability of the model vulnerable.

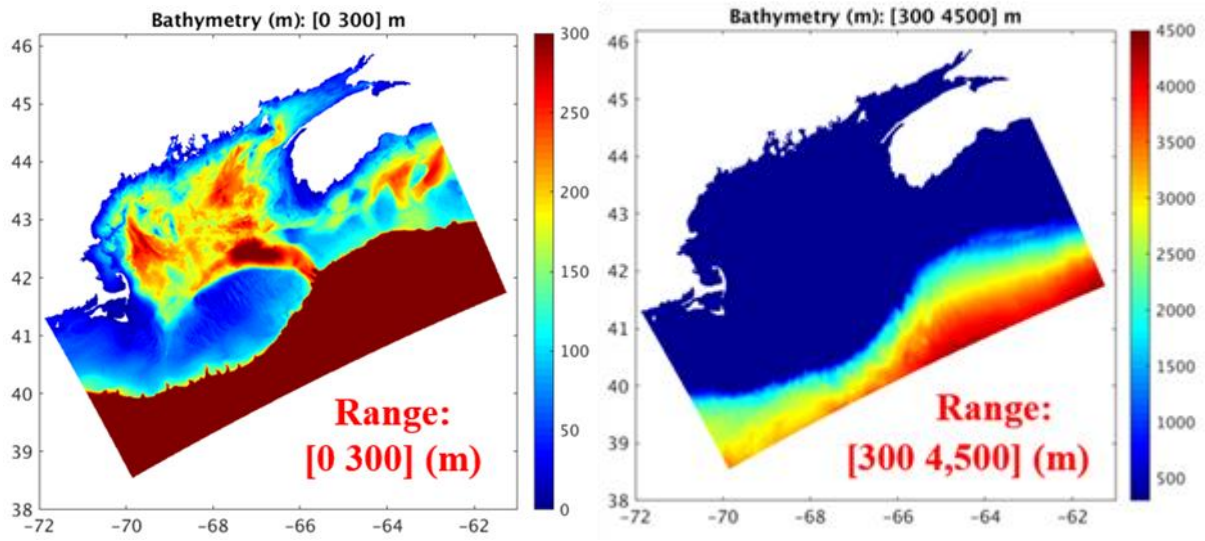

Figure 1. Gulf of Maine Operational Forecast System domain and bathymetry.

To address this challenge, an orthogonal grid is employed with 1132 × 777 points (horizontal resolution is roughly 700 m). The vertical grid follows the terrain and consists of 30 model levels. GoMOFS uses the Regional Ocean Modeling System (ROMS), developed and supported by researchers at Rutgers University, as its core ocean prediction model. ROMS is a free-surface, terrain-following, primitive-equation ocean model widely used by the scientific and operational community for a diverse range of applications (Wikipedia, 2018).

The meteorological forcing used to run GoMOFS is based on the National Weather Service (NWS) North American Mesoscale (NAM) weather prediction model winds (for both nowcast and forecast). The National Centers for Environmental Prediction (NCEP) operational meteorological forecast products of the Global Forecast System (GFS) are used as a backup if NAM is not available.

GoMOFS relies on the Global Real-Time Ocean Forecast System (G-RTOFS) to provide lateral open boundary conditions consisting of temperature, salinity, and sub-tidal water level (NCEP, 2018). The ADCIRC 2001 Tidal Database (ADCIRC, 2018) is used to generate GoMOFS tidal open boundary conditions. Additionally, U.S. Geological Survey (USGS) real-time river discharge observations of nine USGS gauges provide river forcing conditions.

The Office of Coast Survey (OCS) GoMOFS hindcast model package was delivered to the Center for Operational Oceanographic Products and Services (CO-OPS) in November 2015 (Yang et al., 2016). GoMOFS runs on NOAA's High Performance Computers (HPC) in the Coastal Ocean Modeling Framework (COMF) developed by CO-OPS (Zhang and Yang, 2014). As a result, the model system can directly access NWS operational meteorological products, global ocean forecast products, and NOAA's and USGS' observed data. This operational forecast system generates water level, current, temperature, and salinity nowcast and forecast guidance four times a day. Animations of the entire bay, as well as time series at points of interest, are publicly available.

To the date of publication of this report, GoMOFS has been running reliably without any instability issues since August 2016, when the nowcast/forecast evaluation started. Standard model skill assessment based on a half-year of quasi-operational model output indicates that all targeted variables meet the NOS model skill criteria. The successful implementation of this model therefore provides reliable guidance on water level, current, temperature, and salinity to support NOS' navigation customers and could serve as the hydrodynamic basis for ecological modeling, such as HAB forecasting, for this nutrient rich region.

This report documents how to build the control and static files for HPC-COMF and then to generate the required model forcing files that drive GoMOFS. Nowcast/forecast (N/F) model skill assessment (January 1–June 30, 2017) results are presented in the report. Note: It is assumed that readers understand the basic structures and functions of HPC-COMF. For those who want more information, please see Zhang and Yang, 2014.

2.0 MODEL NOWCAST/ FORECAST CONFIGURATION

This section describes approaches to generate 1) the meteorological surface forcing conditions, 2) the river forcing conditions, 3) the lateral open ocean boundary conditions, and 4) the initial conditions for GoMOFS nowcast/forecast simulations. All of these forcing condition files are automatically generated by the HPC-COMF.

2.1 Meteorological Forcing Conditions

Meteorological forcing conditions for GoMOFS are generated by the HPC-COMF similar to other existing NOS operational forecast systems (OFS). The **nos.gomofs.ctl** file in /**nosofs.vx.x.x/fix/gomofs/** controls which meteorological model products are used. In the GoMOFS case, the NAM is used by specifying the following two parameters in the **nos.gomofs.ctl** control file:

export DBASE_MET_NOW=NAM
export DBASE_MET_FOR=NAM

They indicate that NAM is used for both nowcast and forecast simulations to generate meteorological forcing conditions. The shell script **nos_ofs_create_forcing_met.sh** within **/nosofs.vx.x.x/ush/** can be launched to generate **nos.gomofs.met.nowcast.yyyymmdd.tccz.nc**, and **nos.gomofs.met.forecast.yyyymmdd.tccz.nc** where yyyy, mm, dd, cc indicate respectively the year, month, day and cycle of the nowcast/forecast. The required NAM model output files exist in the Weather and Climate Operational Supercomputing System (WCOSS) data tank. Products of NWS' GFS serve as the backup when NAM products are not available.

2.2 River Forcing Conditions

GoMOFS has freshwater inputs at nine USGS river gauges: St. John River, St. Croix River, Machias River, Penobscot River, Kennebec River, Androscoggin River, Saco River, Merrimack River, and Neponset River. Forcings for these rivers are reflected by their discharge rates. The discharge rate of each river for the most recent day can be retrieved directly from the NCEP data tank. The following table (Table 1) is an example from **nos.gomofs.river.ctl** showing the locations of the nine rivers and the discharge scales of these rivers at given grid points.

Table 1. Example of nos.gomofs.river.ctl.

RiverID	USGS_ID	NWS_ID	Q_min	Q_max	Q_mean	T_min	T_max	T_mean	Q_Flag	TS_Flag	River_Station_Name
1	01014000	XXXXX	USGS	28.6	2520.2	258.93	2	14.3	8.78	1	1	St John River MA
2	01021000	XXXXX	USGS	25.66	353.96	78.22	2	14.3	8.78	1	1	St.Croix MA
3	01021500	XXXXX	USGS	6.91	75.61	26.87	2	16.8	8.89	1	1	Machias MA
4	01034500	XXXXX	USGS	96.28	1667.86	366.44	2	17.6	9.29	1	1	Penobscot MA
5	01049265	XXXXX	USGS	50.12	1823.6	278.8	3.6	19.6	11.82	1	1	Kennebec MA
6	01059000	XXXXX	USGS	58.33	1653.7	184.69	3.6	19.6	11.82	1	1	Androscoggin MA
7	01066000	XXXXX	USGS	17.44	419.09	82.85	3.6	19.6	11.82	1	1	Saco MA
8	01100000	XXXXX	USGS	33.98	758.89	190.32	3	21.2	11.58	1	1	Merrimack MA
9	011055566	XXXXX	USGS	0.76	17.33	4.48	3	21.2	11.58	1	1	Neponset MA

Section 2: information of ROMS grids to specify river discharges

GRID_ID	I/Xpos	J/Ypos	DIR	FLAG	RiverID_Q	Q_Scale	RiverID_TS	TS_Scale	River_Basin_Name
1	890	747	1	3	1	-0.333	1	1	St. John River MA
2	891	747	1	3	1	-0.333	1	1	St. John River MA
3	892	747	1	3	1	-0.333	1	1	St. John River MA
4	788	760	1	3	2	-0.250	2	1	V - St. Croix MA
5	789	760	1	3	2	-0.250	2	1	V - St. Croix MA
6	790	760	1	3	2	-0.250	2	1	V - St. Croix MA
7	791	760	1	3	2	-0.250	2	1	V - St. Croix MA
8	777	742	0	3	3	0.200	3	1	U - St. Croix MA
9	777	743	0	3	3	0.200	3	1	U - St. Croix MA
10	777	744	0	3	3	0.200	3	1	U - St. Croix MA
11	777	745	0	3	3	0.200	3	1	U - St. Croix MA
12	777	746	0	3	3	0.200	3	1	U - St. Croix MA
13	715	733	1	3	4	-0.333	4	1	Machias MA
14	716	733	1	3	4	-0.333	4	1	Machias MA
15	717	733	1	3	4	-0.333	4	1	Machias MA
16	557	768	0	3	5	-0.250	5	1	Penobscot MA
17	557	769	0	3	5	-0.250	5	1	Penobscot MA
18	557	770	0	3	5	-0.250	5	1	Penobscot MA
19	557	771	0	3	5	-0.250	5	1	Penobscot MA
20	404	732	1	3	6	-0.250	6	1	Kennebec MA & Androscoggin MA
21	405	732	1	3	6	-0.250	6	1	Kennebec MA & Androscoggin MA
22	406	732	1	3	6	-0.250	6	1	Kennebec MA & Androscoggin MA
23	407	732	1	3	6	-0.250	6	1	Kennebec MA & Androscoggin MA
24	320	715	0	3	7	0.333	7	1	Saco MA
25	320	716	0	3	7	0.333	7	1	Saco MA
26	320	717	0	3	7	0.333	7	1	Saco MA
27	226	650	0	3	8	0.333	8	1	Merrimack MA
28	226	651	0	3	8	0.333	8	1	Merrimack MA
29	226	652	0	3	8	0.333	8	1	Merrimack MA
30	163	591	0	3	9	0.200	9	1	Neponset MA
31	163	592	0	3	9	0.200	9	1	Neponset MA
32	163	593	0	3	9	0.200	9	1	Neponset MA
33	163	594	0	3	9	0.200	9	1	Neponset MA
34	163	595	0	3	9	0.200	9	1	Neponset MA

The sign of Q_Scale is determined by both river direction and the orientation of the grids. Details can be found on the ROMS webpage (Wiki ROMS, 2018).

It should be noted that the river data from the USGS real-time observations are available for a time frame prior to the current time. Therefore, river discharge covers only the nowcast period. For the forecast period, the river discharge persists with the value from the most recent observation. The river climatological data (multiple-year daily mean from USGS) are used when either real-time observations are not available in the given time period or the River flag (Q_Flag) in the river control file is zero. The river climatological data for each river can be found in **nos.ofs.river.clim.usgs.nc**, which is in /**nosofs.vx.x.x/fix/share**.

2.3 Open Boundary Conditions (OBC) and the Nudging Climatological File

The purpose of **nos_ofs_create_forcing_obc.f** of COMF is to generate lateral open boundary forcing files for ROMS-based OFS, such as GoMOFS. Tides, generated from the ADCIRC EC2001 database, are provided by OCS' Coast Survey Development Laboratory (CSDL). Nontidal water level OBCs can be derived from either the U.S. Navy's Hybrid Coordinate Ocean Model (HYCOM), Extra-tropical Storm Surge (ETSS) operational forecast products, or G-RTOFS depending on the parameter of "DBASE_WL" in an OFS' main control file **nos.gomofs.ctl**. For GoMOFS, "DBASE_WL_NOW" and "DBASE_WL_FOR" are both set to "RTOFS", which means RTOFS model output is used to generate non-tidal water level OBCs for both the nowcast and forecast. Open boundary conditions of water temperature, salinity, and baroclinic velocity are also derived from RTOFS. The code's output is **nos.gomofs.obc.yyyymmdd.tccz.nc**.

As a new practice, temperature (T) and salinity (S) climatological files are required if the switch of "nudge to desired climatology fields" is turned on in the model's standard input file. This switch, **LnudgeTCLM**, can be found in the **.in** file. If this switch is turned on, as in the case of GoMOFS, **nos_ofs_create_forcing_nudg.f** is called to calculate the 3-D averaged T,S fields within the past few days. As a result, the nudging climatology file **nos.gomofs.clim.yyyymmdd.tccz.nc** is generated.

Long-term N/F experiments indicate that this climatological switch has to be turned on in the model standard input file to adequately capture the temperature and salinity structure near the open boundary for GoMOFS. Artificial small-scale turbulence, otherwise, might exist near the open boundaries. The tests also indicate that the past 7 days of averaged 3-D T,S can be used as good climatological fields.

2.4 Initial Conditions

In COMF, **nos_ofs_read_restart.f** is used to read the ROMS-based OFS model initial/restart file. If values and attributes of the variable "time" are correct, then the initial file is not changed. Otherwise, the following actions may be conducted if needed:

(1) Change the reference time (the attribute of "units") of variables "time" and "Itime" in the initial file if the reference time is different from ${BASE_DATE} specified in the control file such as "**nos.gomofs.ctl**", etc.

(2) Recompute the values of variables "time" and "Itime" using ${BASE_DATE} as the reference time in the initial file if (1) is conducted.

(3) If the "time" is 48 hours less than ${time_nowcastend}, then the nowcast simulation is terminated. An initial condition file has to be manually constructed with zero surface elevation, zero velocity, and reasonable water temperature and salinity.

Please read the HPC-COMF technical report (Zhang and Yang, 2014) for additional information.

In the case of GoMOFS, the output restart file from the nowcast of the last cycle is used to generate the initial condition for the nowcast of the current cycle. For example, **nos.gomofs.rst.nowcast.YYYYMMDD.t00z.nc** from the nowcast at 00z will be renamed (after minor "time" and "Itime" related revision) to **nos.gomofs.init.nowcastYYYYMMDD.t06z.nc** for the nowcast at 06z. The restart file from the 06z cycle nowcast **nos.gomofs.rst.nowcast.YYYYMMDD.t06z.nc**, on the other hand, will be used for the 06z forecast.

3.0 NOWCAST/ FORECAST MODEL SKILL

GoMOFS performed robustly, producing reasonable output in nowcast and forecast mode for water level, currents, temperature, and salinity over the model's skill assessment period of January 1-June 30, 2017. This can be visually validated by the cycle-by-cycle nowcast and forecast results as shown in Figures 2–5. However, to provide more scientific and objective analysis of the model performance, documented skill assessment metrics (Zhang et al., 2009) were used. Section 3.2 will briefly review the basics of skill assessment statistics, followed by the results of GoMOFS' nowcast and forecast skill assessment in section 3.3.

3.1 Nowcast and Forecast Results

The latest cycle's nowcast/forecast results are displayed on the GoMOFS operational website (Tides and Currents, 2018). Generally, these cycle-by-cycle results (Figures 2–5) indicate that the model has reasonable water level, surface currents, temperature, and salinity predictions in its nowcast and forecast time windows at all stations where measurements are available. The standard NOS model skill assessment for all nowcast and forecast variables can be found in section 3.3.

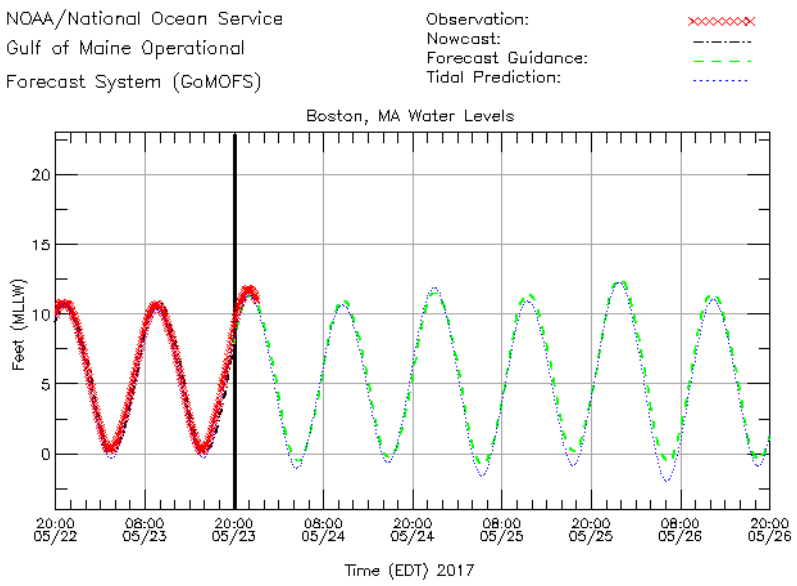

Figure 2. Example of water level nowcast and forecast output at Boston.

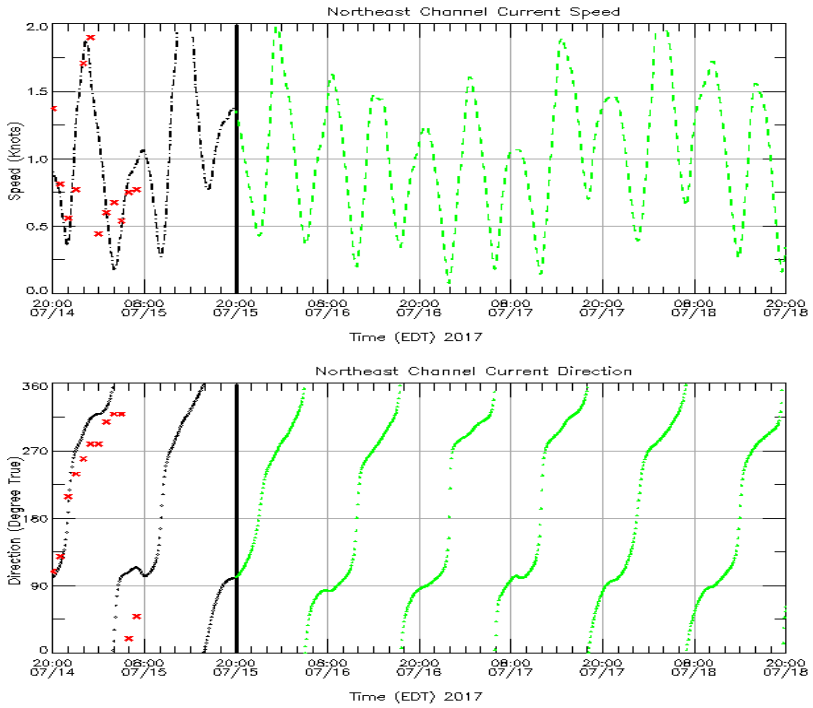

Figure 3. Example of surface currents nowcast and forecast output at Northeast Channel (N01).

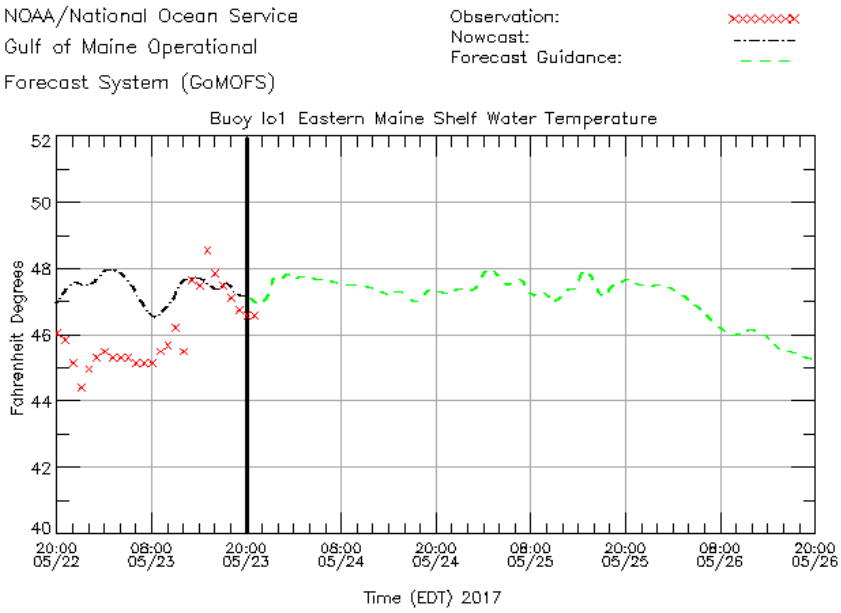

Figure 4. Example of water surface temperature nowcast and forecast output at Eastern Maine Shelf (Buoy I01).

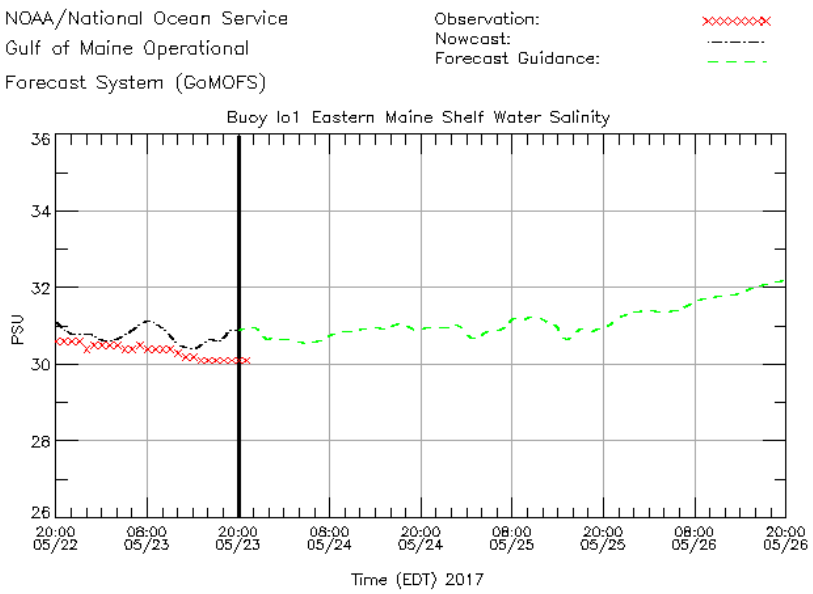

Figure 5. Example of water surface salinity nowcast and forecast output at Eastern Maine Shelf (Buoy I01).

3.2 Skill Assessment Software System and Data Source

In this section, an overview of NOS' model skill assessment statistics and software is provided, and the data sources used for the N/F model skill assessment are discussed.

Skill Assessment Statistics

Skill assessment is an objective measurement of the performance of a model when systematically compared with observations. NOS skill assessment criteria were created for evaluating the performance of circulation models (Hess et al., 2003), and a software package was subsequently developed to compute these criteria using standard file format output from the models (Zhang et al., 2009). The software computes the skill assessment scores automatically using files containing observations, predictions, and nowcast/forecast model results. A standard suite of skill assessment statistics is defined in Table 2 (Hess et al., 2003). The target frequencies of the associated statistics based on navigation requirements are:

$$CF(X) \geq 90\%, \quad POF(2X) \leq 1\%, \quad NOF(2X) \leq 1\%, \quad WOF(2X) \leq 0.5\%$$

$$MDPO(2X) \leq L, \quad MDNO(2X) \leq L$$

Table 2. Skill Assessment Statistics (Hess et al., 2003).

Variable	Explanation
Error	The error is defined as the predicted value, p, minus the reference (observed or astronomical tide value, r : $e_i = p_i - r_i$.
SM	Series Mean. The mean value of a series y. Calculated as $\bar{y} = \frac{1}{N}\sum_{i=1}^{N} y_i$.
RMSE	Root Mean Square Error. Calculated as $RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N} e_i^2}$.
SD	Standard Deviation. Calculated as $SD = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N} (e_i - \bar{e})^2}$
CF(X)	Central Frequency. Fraction (percentage) of errors that lie within the limits $\pm$X.
POF(X)	Positive Outlier Frequency. Fraction (percentage) of errors that are greater than X.
NOF(X)	Negative Outlier Frequency. Fraction (percentage) of errors that are less than -X.
MDPO(X)	Maximum Duration of Positive Outliers. A positive outlier event is two or more consecutive occurrences of an error greater than X. MDPO is the length of time (based on the number of consecutive occurrences) of the longest event.
MDNO(X)	Maximum Duration of Negative Outliers. A negative outlier event is two or more consecutive occurrences of an error less than -X. MDNO is the length of time (based on the number of consecutive occurrences) of the longest event.
WOF(X)	Worst Case Outlier Frequency. Fraction (percentage) of errors that, given an error of magnitude exceeding X, either (1) the simulated value of water level is greater than the astronomical tide and the observed value is less than the astronomical tide, or (2) the simulated value of water level is less than the astronomical tide and the observed value is greater than the astronomical tide.

There are three types of data sets as shown in Table 3: Group 1, a time series of values at uniform time intervals; Group 2, a set of values representing the consecutive occurrences of an event (such as high water or slack water); and Group 3, a set of values representing a forecast valid at a given projection time. The acceptable error limits (X) and maximum duration limits (L) for the associated variables are presented in Table 4. Note that in Table 3, the upper-case letters indicate a prediction series (e.g., H), and lower-case letters (e.g., h) indicate a reference series (observation or astronomical prediction). Slack water is defined as a current speed less than 0.26 m/s (½-knot). The direction is computed only for current speeds greater than ½-knot (Hess et al., 2003).

Table 3. Data series groups and the associated variables.

Group	Variable	Symbol
Group 1	Water level	H, h
(Time Series)	Current speed	U, u
	Current direction	D,d
	Salinity	S, s
	Water temperature	T,t
Group 2	Amplitude of high water	AHW,ahw
(Values at a Tidal Stage)	Amplitude of low water	ALW,ahw
	Time of high water	THW,thw
	Time of low water	TLW,tlw
	Amplitude of maximum flood current	AFC,afc
	Amplitude of maximum ebb current	AEC,aec
	Time of maximum flood current	TFC,tfc
	Time of maximum ebb current	TEC,tec
	Direction of current at maximum flood	DFC,dfc
	Direction of current at maximum ebb	DEC,dec
	Time of start of current slack before flood	TSF,tsf
	Time of end of current slack before flood	TEF, tef
	Time of start of current slack before ebb	TSE, tse
	Time of end of current slack before ebb	TEE, tee
Group 3	Water level at forecast projection time of nn hrs	Hnn, hnn
(Values from a Forecast)	Current speed at forecast projection time of nn hrs	Unn, unn
	Current direction at forecast projection time of nn hrs	Dnn, dnn
	Salinity at forecast projection time of nn hrs	Snn, snn
	Water temperature at forecast projection time of nn hrs	Tnn, tnn

Table 4. Acceptance of error limits (X) and the maximum duration limits (L).

Variables	**X**	**L (hr)**
H, Hnn, AHW,ALW	0.15 m	24
THW, TLW	0.5 hr	25
U, Unn, AFC, AEC	0.26 m/s	24
TFC, TEC	0.5 hr	25
TSF, TEF, TSE, TEE	0.25 hr	25
D, Dnn,	22.5°	24
DFC, DEC	22.5°	25

The acceptance of error limits shown in the Table 4 is quite arbitrary and is subject to change for special model domains. For example, the tidal regime in the GoMOFS domain, especially near the Bay of Fundy (with a tide range of nearly 15 m), is the highest in the world. The acceptance of error limits of water level of 0.15 m is too stringent. The ratio of water level error to its tidal range at a station provides a more reasonable error limit for model skill assessment. An alternative limit of 10% of the tidal range is also assessed to provide a more relative and physically meaningful skill assessment. In the following sections, both the relative and absolute water level error limits are used to evaluate GoMOFS model skill.

Data Source

As shown in Table 5 and Figure 6, the observed data were collected by three entities - CO-OPS, the National Weather Service's National Data Buoy Center (NDBC) and the Northeastern

Regional Association of Coastal Ocean Observing Systems (NERACOOS). Real-time measurements of water level, current, temperature, and salinity were retrieved to compare with the model results to conduct the skill assessment. Observed data at some stations were not available for certain periods. The missing data periods, in days, are indicated in the headers of the corresponding model skill assessment tables in Appendices B, C, D, and F.

Table 5. The observation stations used for model skill assessment. In the table, WL, CU, T, and S, respectively, represent water level, current, temperature, and salinity (the * in the table indicates the stations with observation data that were not long enough for the skill assessment).

Station ID	Agency	Lat	Lon	Buoy Name	Color in Figure 6 and variables
8411060	CO-OPS	44.657	-67.210	CutlerFarrisWharf, ME	Black, T
8413320	CO-OPS	44.392	-68.205	BarHarbor, ME	Black, WL, T
8418150	CO-OPS	43.657	-70.247	Portland, ME	Black, WL, T
8419317	CO-OPS	43.32	-70.563	Wells, ME	Black, WL, T
8423898	CO-OPS	43.072	-70.712	Fort Pt., NH	Black, WL
8443970	CO-OPS	42.353	-71.053	Boston, MA	Black, WL, T
44097*	NDBC	40.981	-71.117	Block Island, RI	Blue
44020*	NDBC	41.443	-70.672	Nantucket Main Channel	Blue
44013*	NDBC	42.346	-70.651	16 NM East of Boston	Blue
44098	NDBC	42.801	-70.169	Jeffrey's Ledge, NH	Blue, T
44007	NDBC	43.531	-70.144	12 NM SE of Portland	Blue, T
44008*	NDBC	40.502	-69.247	Nantucket	Blue
44005	NDBC	43.204	-69.128	Gulf of Maine	Blue, T
44027*	NDBC	44.287	-67.307	Jonesport Maine	Blue
44011	NDBC	41.105	-66.600	Georges Bank	Blue,T
44018	NDBC	42.126	-69.630	Cape Cod, MA	Blue,T
44029	NERACOOS	42.522	-70.566	A01	Purple CU, T
44030	NERACOOS	43.181	-70.428	B01	Purple CU, T, S
44032	NERACOOS	43.715	-69.358	E01	Purple CU, S
44033*	NERACOOS	44.056	-68.997	F01	Purple
44034	NERACOOS	44.106	-68.109	I01	Purple CU, T
44037	NERACOOS	43.491	-67.880	M01	Purple, T, S
44024	NERACOOS	42.331	-65.907	N01 (Northeast Channel)	Purple CU, T, S

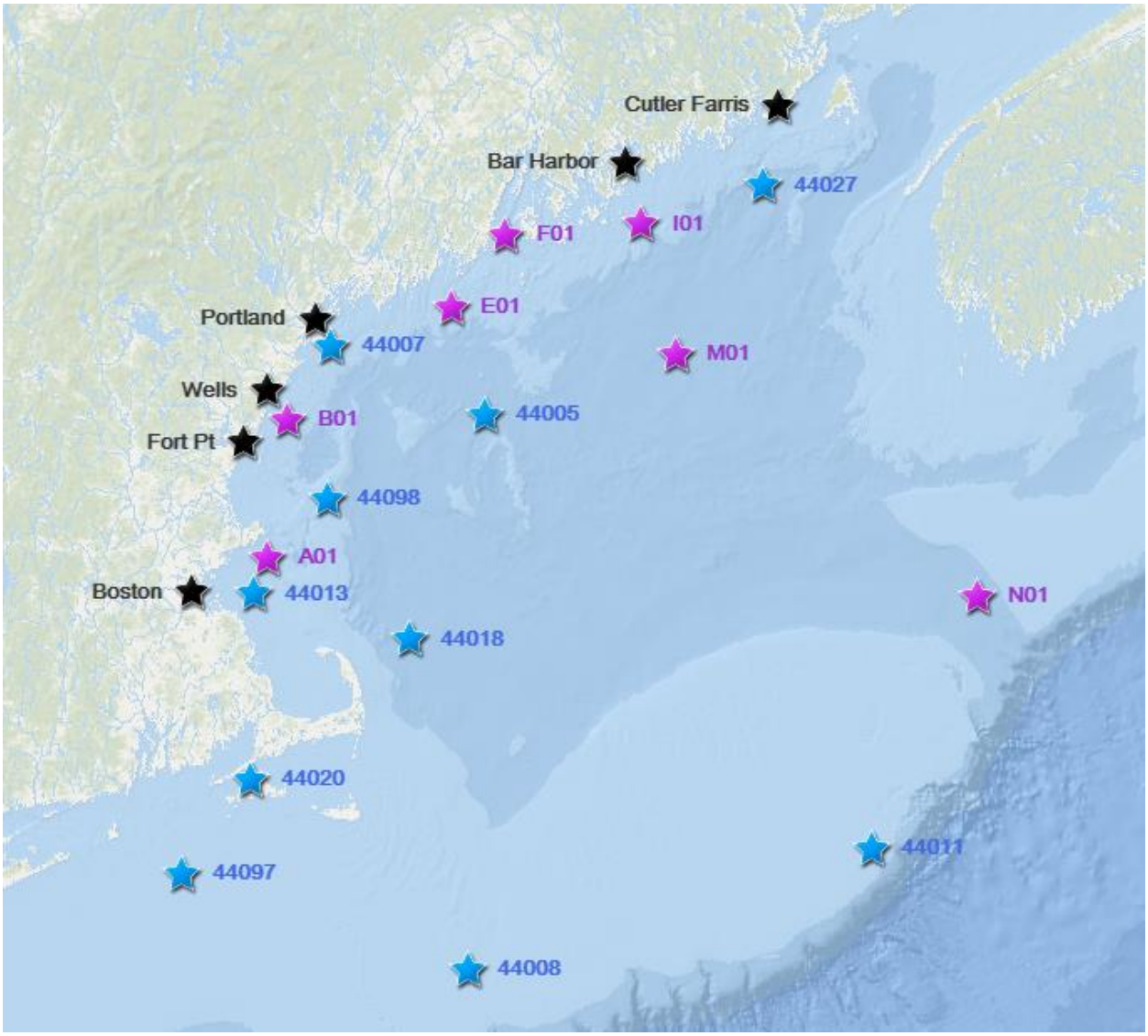

Figure 6. The locations of observation stations used for model skill assessment. CO-OPS stations are in black, NDBC in blue, and NERACOOS in purple.

3.3. Nowcast and Forecast Skill Assessment

The GoMOFS semi-operational nowcasts and forecasts model assessment period was January 1-June 30, 2017, and the results from these simulations were organized into time series for analysis using the skill assessment software. Generally, RMSE, CF, NOF, POF, MDNO, MDPO, and WOF at each station satisfy the error criteria for most variables in both the nowcast and forecast scenarios. The results of the skill assessment for water level, surface current, temperature, and salinity are discussed in the following subsections.

Results of Water Level Skill Assessment

Limited by the availability of long-term observation data, the skill assessment used only five water level stations (Table 5 and Figure 6). Modeled water levels generally agree well with observations at all analyzed stations. A typical cycle of N/F results is shown in Figure 2. Since the hydrodynamic regime in this area is dominated by tides, harmonic analysis based on model

results is necessary for every station; the analysis results can be found in Appendix A. Modeled amplitude and phase of major tidal constituents, as shown in the tables, are close to observations.

The RMSE of nowcast water elevation at all five stations are near 0.15 m, the accepted error criteria (see Table 4). The results are shown in Figure 7. Figure 8 shows forecast RMSE values at different forecast lead times from 6 hours to 48 hours. In general, forecasts out to 48 hours are within accepted error limits, with the exception of Bar Harbor, where the RMSE ranges from 0.17 to 0.18 m.

The relative RMSE (with a limit of 10% of the tidal range as mentioned previously) of the nowcast and forecast of all stations are shown in Figure 9 and Figure 10. The relative water elevation RMSE typically ranges from 3–4%.

The tables in Appendix B show details of water elevation model skill assessment results at all analyzed stations for all metrics. Generally, nowcast CF for all locations ranges from 62.1% to 73.7% (0% is the worst CF value and 100% is the best). The unsatisfying low CF is due to relatively large RMSE as previously mentioned. For the southernmost three stations, the NOF value is larger than POF, indicating negative outlier frequency is slightly higher. Both MDNO and MDPO at all stations is close to 5 hours. This indicates that during the assessment period, the model had at least once either continuously over-predicted or under-predicted water level above or below the outlier level (0.30 m) for 5 hours. These relatively high values of MDNO and MDPO are related to some extreme events, like storms, that the model did not capture well during the analysis period. The correlation coefficient of water level for all stations, however, is very high, either 0.99 or 1.00. This indicates that modeled water level over the analysis period is in-phase with observations, even though MDNO and MDPO are considerably large.

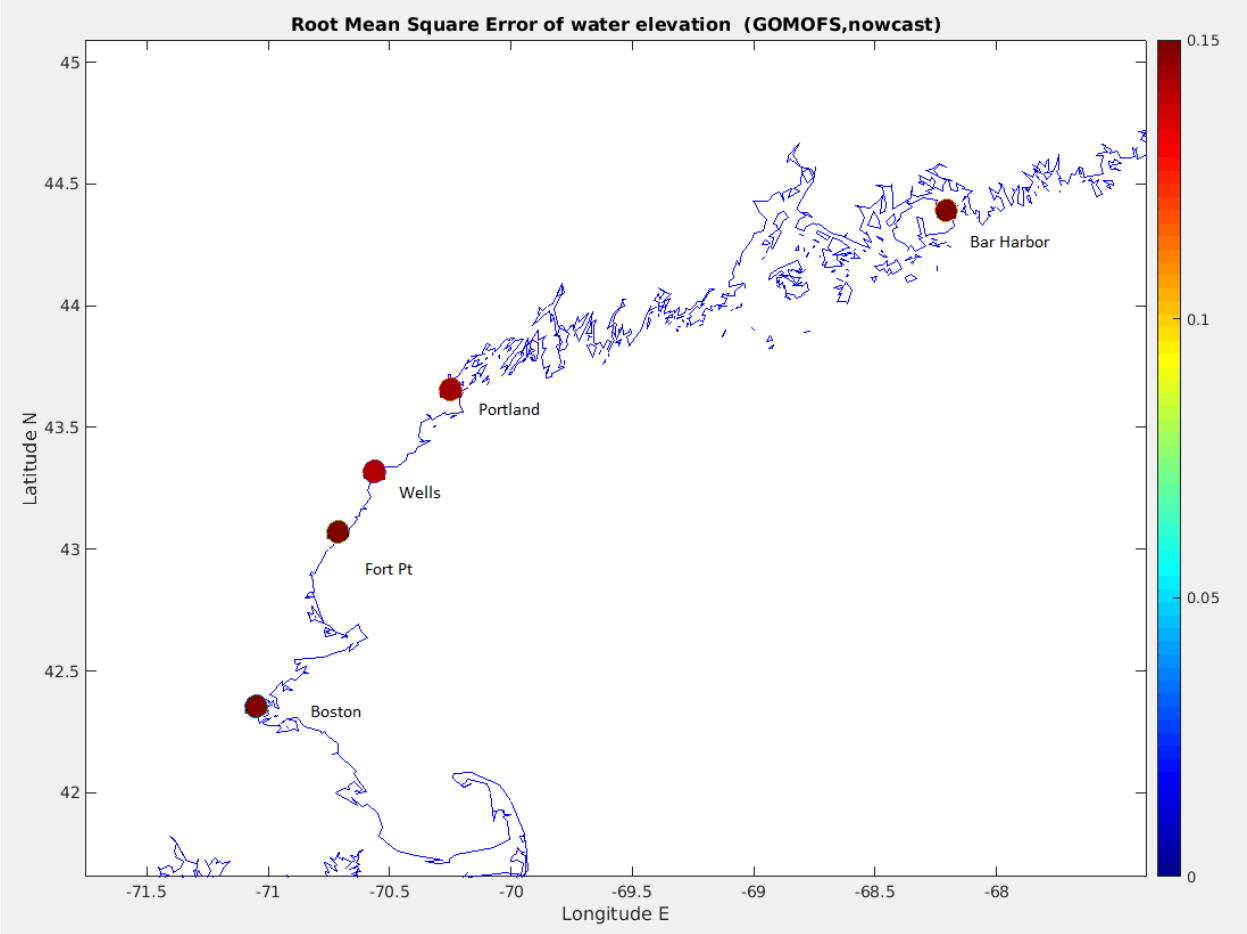

Figure 7. Nowcast RMSE of water elevation.

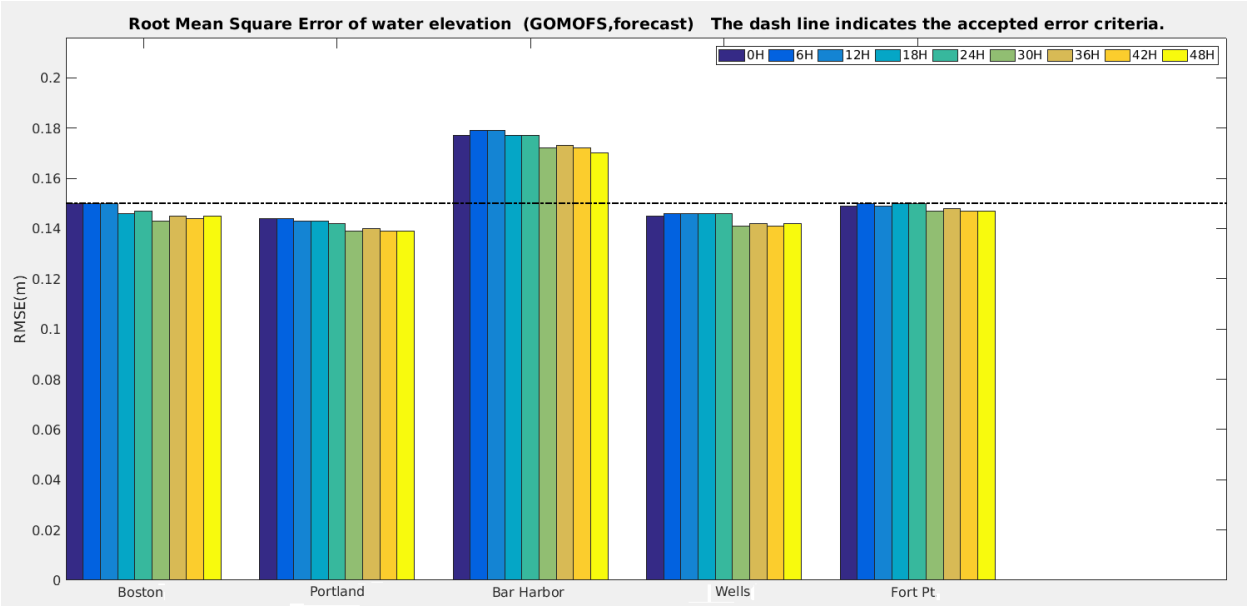

Figure 8. Forecast RMSE of water elevation.

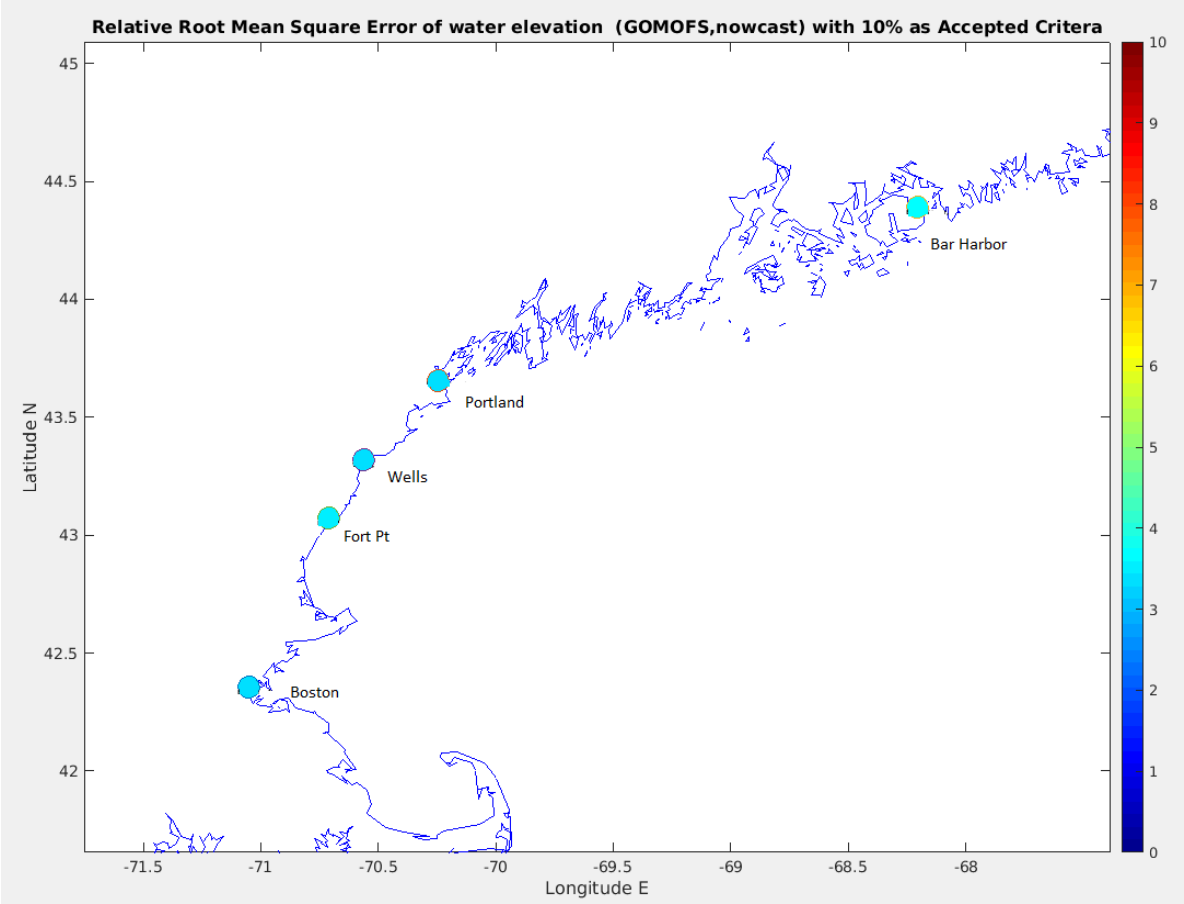

Figure 9. Nowcast relative RMSE of water elevation.

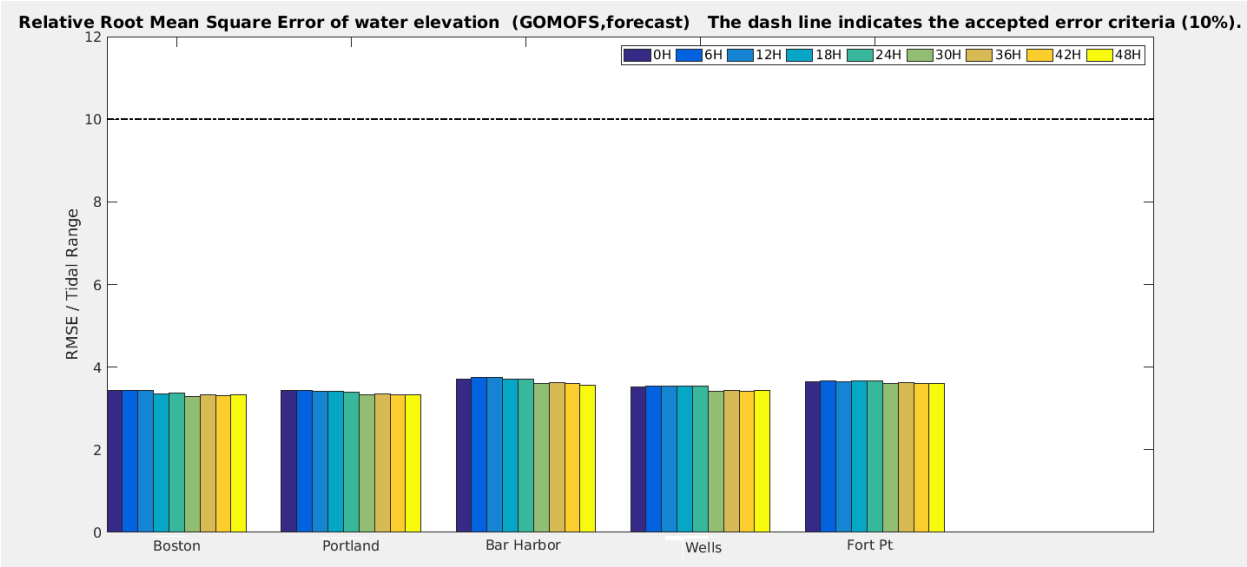

Figure 10. Forecast relative RMSE of water elevation.

Results of Surface Water Current Skill Assessment

NERACOOS stations A01, B01, E01, I01, and N01 collected sufficient surface current observations (measured at 2-m depth) during the January 1–June 30, 2017 assessment period to be used for model skill assessment (Table 5 and Figure 6). A typical cycle of N/F results is shown in Figure 3.

The RMSE of surface current speed for the nowcast and forecast results are shown in Figures 11 and 12. All stations meet NOS error criteria except for Northeast Channel, where the RMSE slightly exceeds 0.26 m/s. Similar results are found for the RMSE of surface current direction. The Northeast Channel is the only station where the RMSE of current direction exceeds 22.5°.

The details of model skill assessment results of all stations can be found in the tables in Appendix C. The correlation coefficient for surface current speed is relatively low, ranging from 0.12 to 0.71. By comparison, the correlation coefficient for current direction is relatively higher, ranging from 0.55 to 0.81. The reason for the low speed correlation coefficient stems not from inaccuracy of the current speed or AFC/AEC, but from TFC, TEC, TSF, TEF, TSE, and TEE. In other words, the errors are due to the timing of the change in current direction. For example, at station Buoy E01 where the lowest correlation coefficient is calculated, the CF of U-u can reach 97.2%, and CF of AFC-afc can be close to 100%.

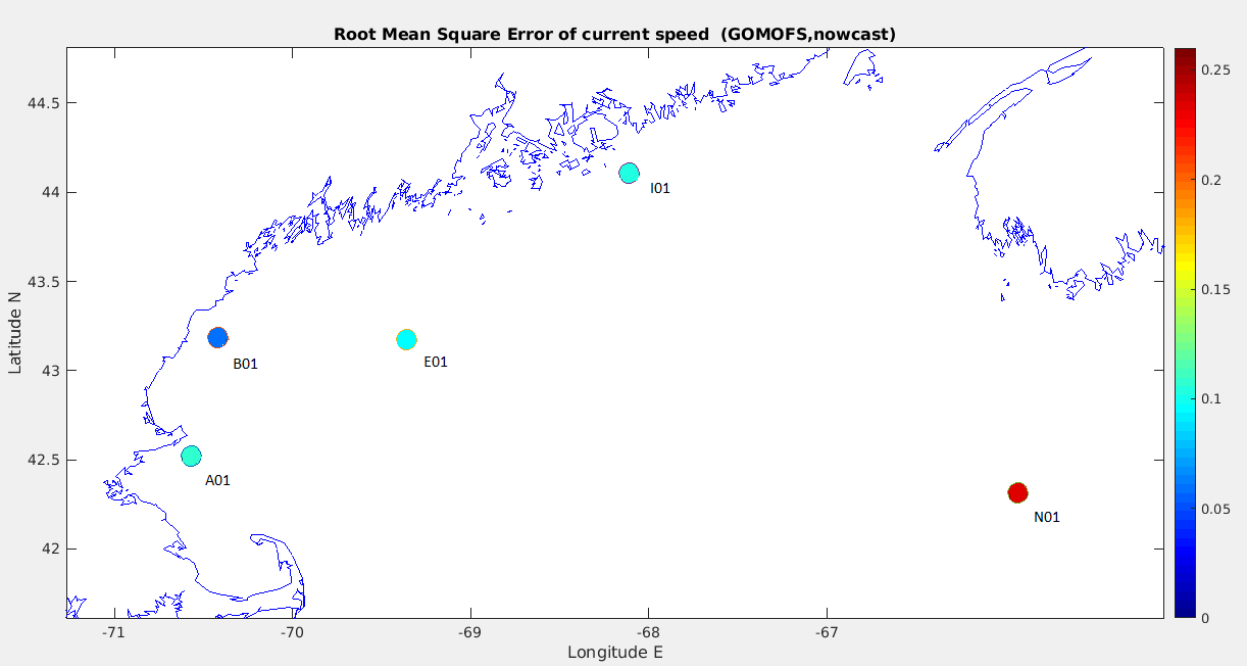

Figure 11. Nowcast RMSE of surface water current speed.

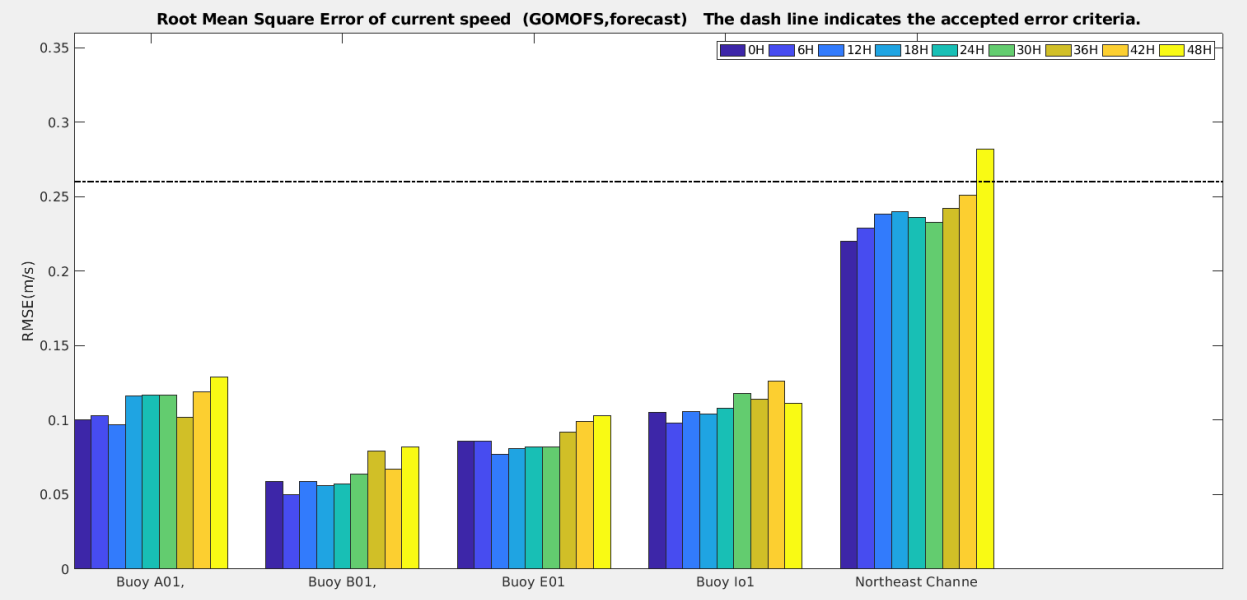

Figure 12. Forecast RMSE of surface water current speed.

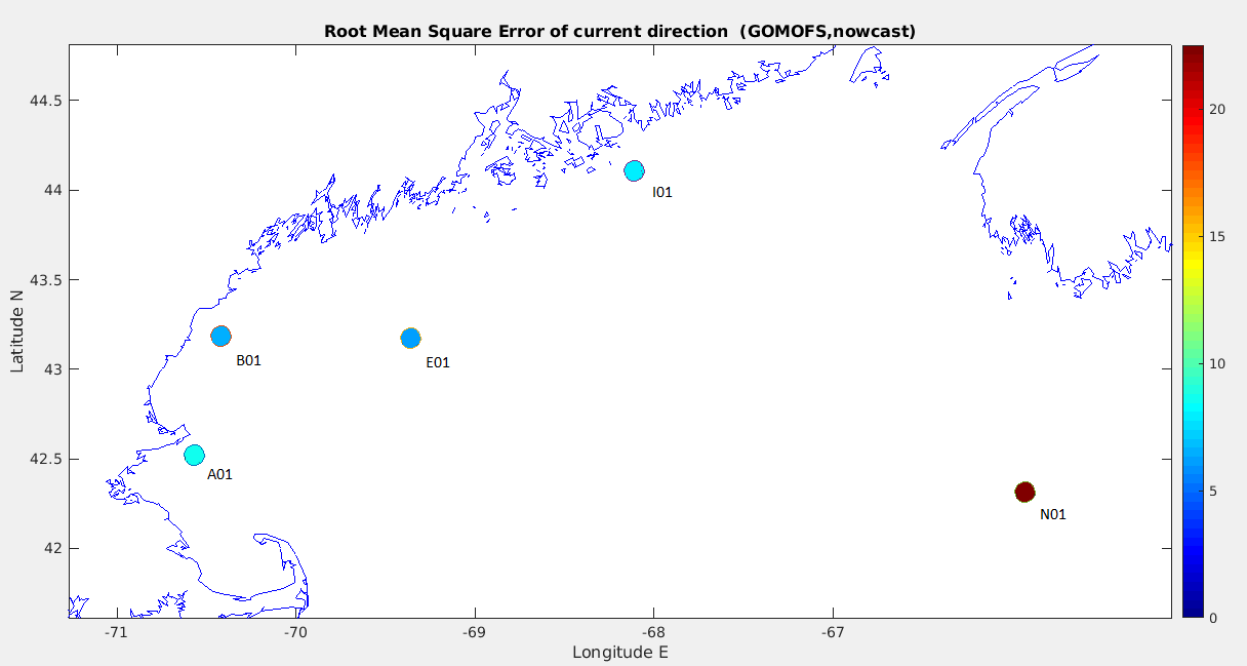

Figure 13. Nowcast RMSE of surface water current direction.

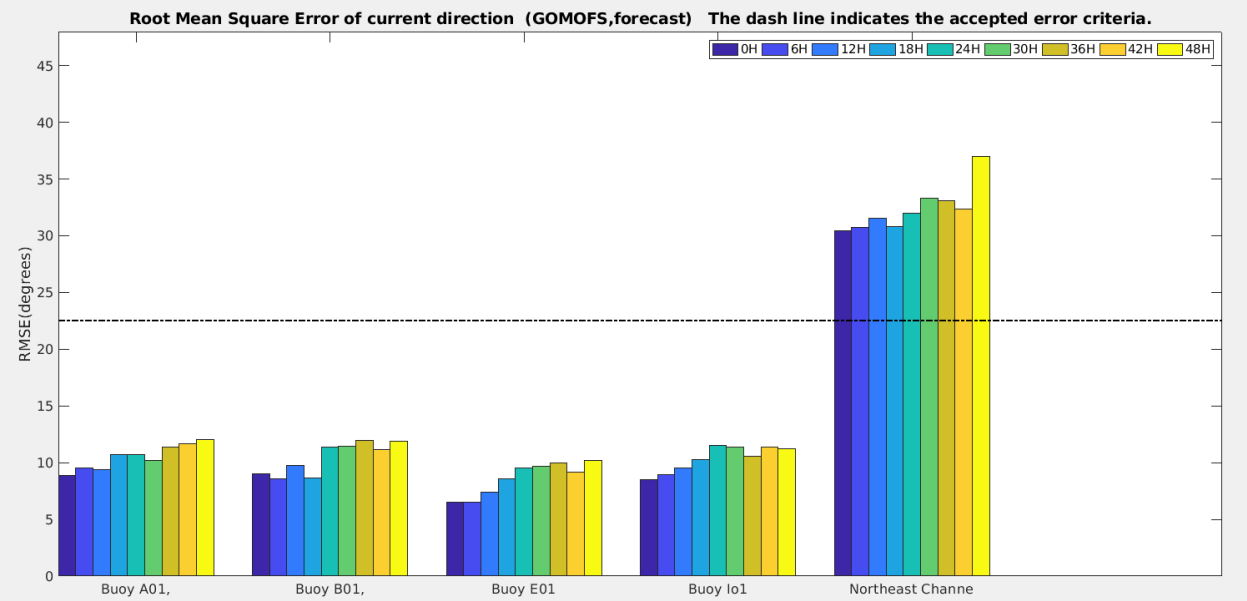

Figure 14. Forecast RMSE of surface water current direction.

Results of Surface Water Temperature Skill Assessment

Compared to water elevation and water current, more stations with long-term observations of water temperature are available for model skill assessment. The 15 water temperature stations are: Buoys A01, B01, M01, I01, Cutler Farris, Bar Harbor, Portland, 12 NM Southeast of Portland, Wells, Boston, Northeast Channel, Jeffery's Ledge, Gulf of Maine, Georges Bank, and Cape Cod (Table 5 and Figure 4). Figure 4 shows a typical cycle of N/F results.

Nowcast and forecast RMSEs of surface water temperature are illustrated, respectively, in Figure 15 and Figure 16. The error at each station is less than 3.0 °C, the NOS' water temperature accepted error criterion. The RMSE is lower than 2.0 °C in almost all stations except for Portland and Northeast Channel, where the value is around 2.3 °C.

The details of model skill assessment results of all stations can be found in the tables in Appendix D. As shown in the tables, the correlation coefficient ranges from 0.80 to 0.99 for all stations, indicating that the model captures the trend of the temperature variation. The skill assessment results for Cape Cod are not listed in the table because the observations were not available for a sufficient period of time. CF is close to 100% at almost all stations. NOF, POF, MDNO, and MDPO are almost all 0.0%, indicating high model skill performance.

Comparisons of modeled and observed sea surface temperature at all stations are shown in Appendix E. Modeled results generally agree with the observations for every station. During the assessment period, the availability of observations at M01 and Cape Cod are much shorter than those of other stations. For consistency, the time series at these two stations are retained in the report. Skill assessment results at the two stations are still valid for the period when observations are available. However, the model skill is unknown for most of the time period.

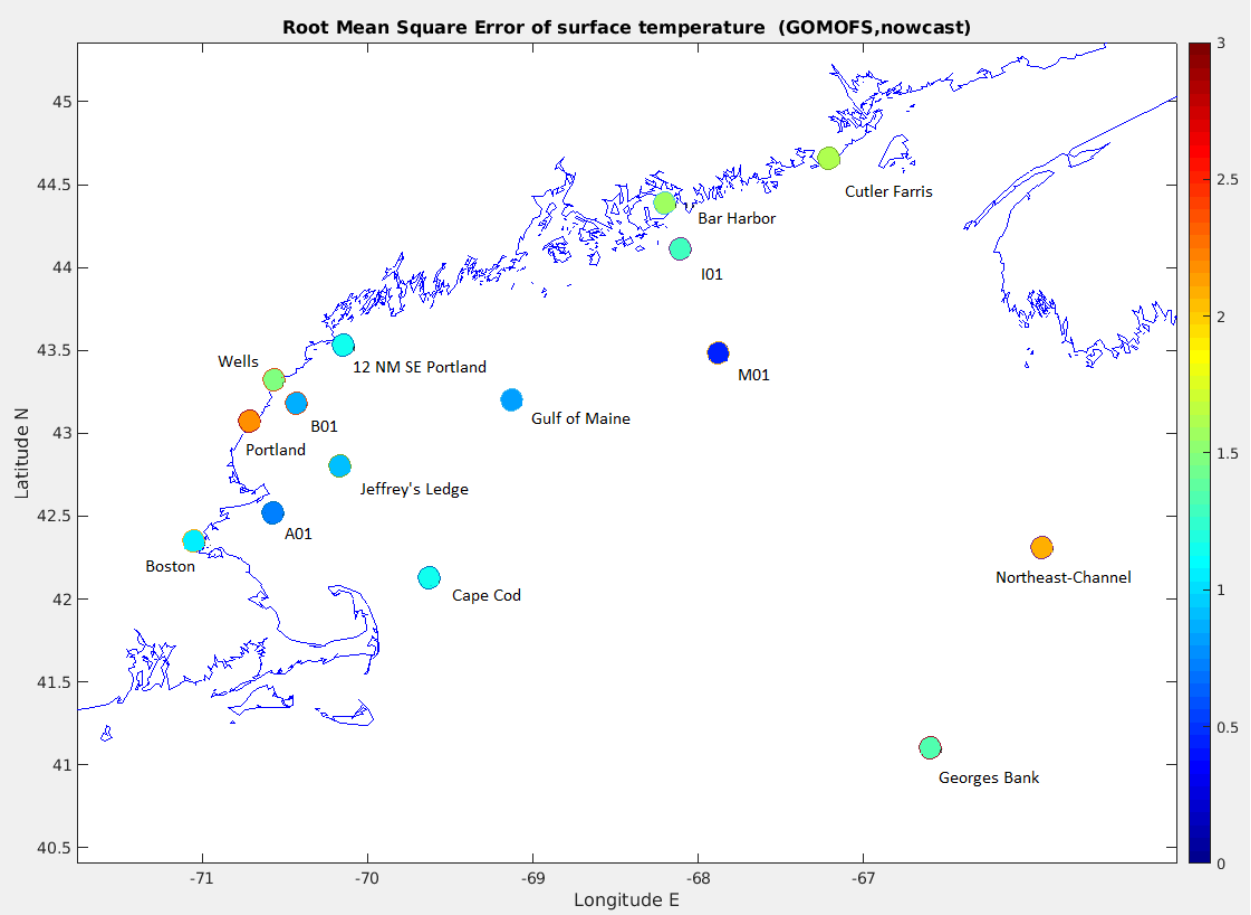

Figure 15. Nowcast RMSE of surface water temperature.

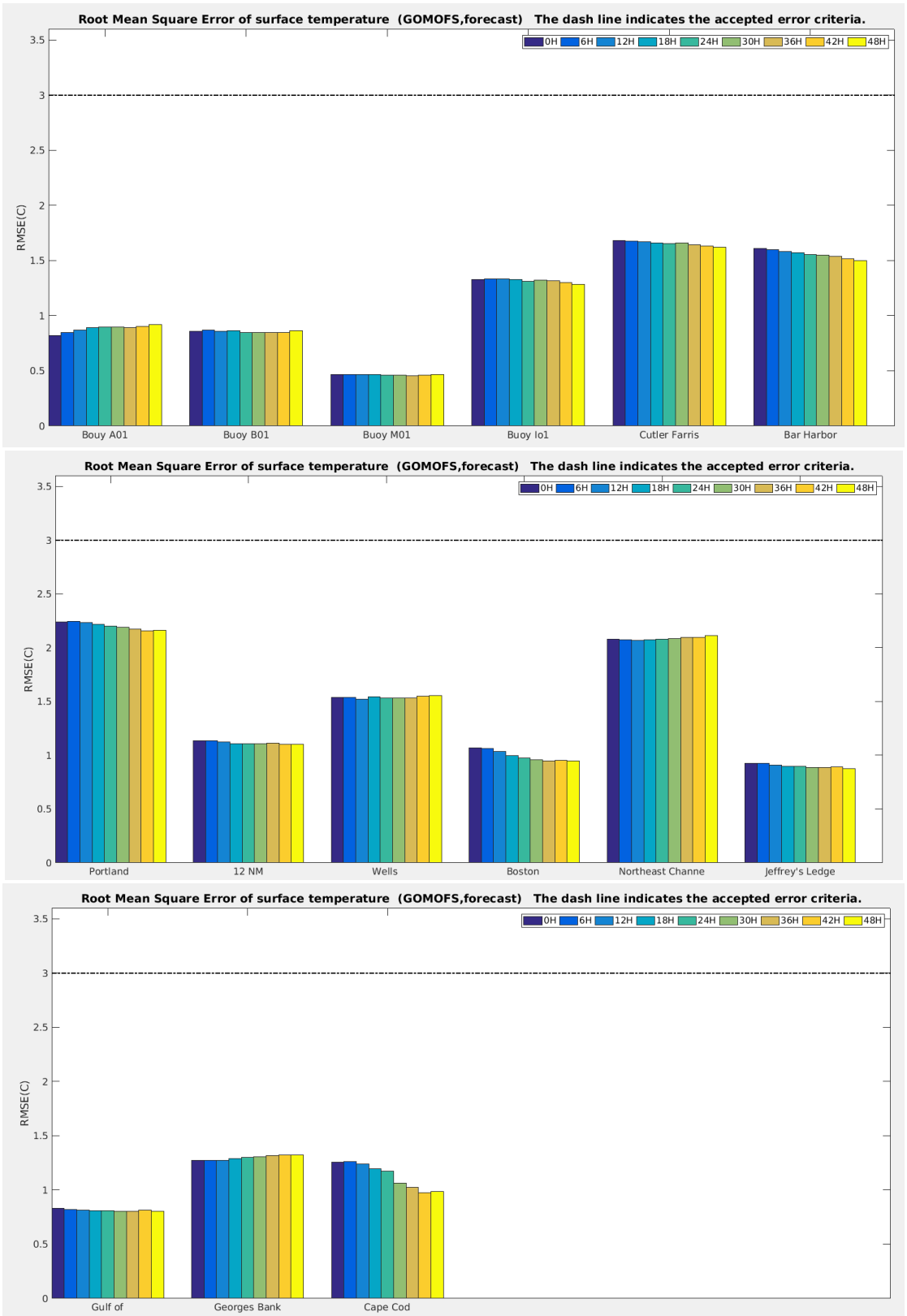

Figure 16. Forecast RMSE of surface water temperature.

Results for Surface Water Salinity Skill Assessment

There are five buoy stations with long-term observed surface salinity data available for model skill assessment. The stations are: Buoys B01, E01, M01, I01, and N01 (Table 5 and Figure 6). These buoy data are managed by NERACOOS.

Nowcast and forecast RMSEs of surface water salinity are shown respectively in Figures 17 and 18. The error at each station is under 2.0 PSU, which is below NOS-accepted error criteria of 3.5 PSU (see Table 4). RMSE at M01 is as low as 0.3 PSU. It should be noted that NOS-accepted error criteria are based on navigation (not ecological) requirements. An estuary experiences higher changes in salinity compared to an open ocean region like the Gulf of Maine. Acceptable error criteria should be based on the physical environment (estuary or open ocean domain) and requirements of the targeted user community to ensure optimal model performance.

The details of model skill assessment results of all stations can be found in the tables in Appendix F. CF is close to 100% at all stations. NOF, POF, MDNO, and MDPO are almost all 0.0%, indicating high model skill performance.

Comparisons of the modeled and observed sea surface salinity at all stations are shown in Appendix G. Modeled results generally agree with observations for every station. During the assessment period, the availability of observations at M01 are much shorter than those of other stations. For consistency, the time series at this station are retained in the report. Skill assessment results at this station are still valid for the period when observations are available.

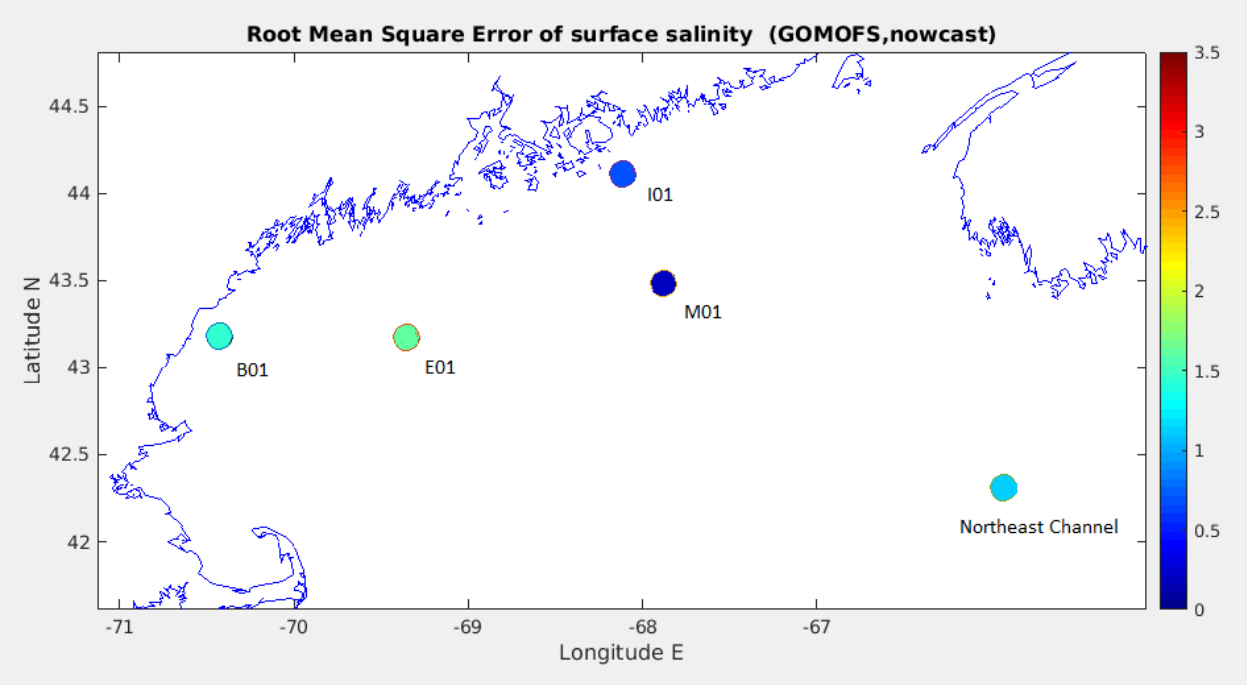

Figure 17. Nowcast RMSE of surface water salinity.

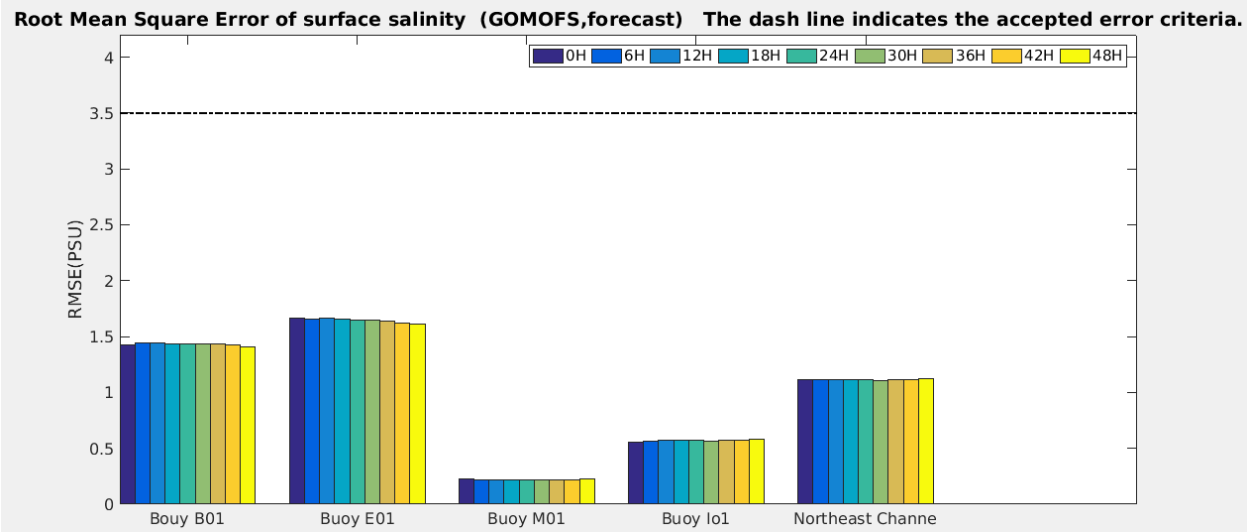

Figure 18. Forecast RMSE of surface water salinity.

4.0 CONCLUSIONS

NOS/OCS developed and tested the performance of the GoMOFS hindcast (Yang et al., 2016). CO-OPS successfully implemented this OFS using the HPC-COMF on the WCOSS platform. COMF automatically generates all necessary forcing condition files for nowcast and forecast simulations in real-time mode. GoMOFS has been stably running since September 1, 2016, the first day GoMOFS nowcast/forecast runs started. GoMOFS outputs during January 1–June 30, 2017 are used for the GoMOFS N/F skill assessment.

The results indicate that most statistical parameters of water levels pass the documented NOS skill assessment criteria, and amplitudes and epochs of the dominant M_2 constituent from modeled results are very close to the observed values at all stations. RMSEs of nowcast water elevation at all stations are close to or slightly above 0.15 m, the accepted error threshold for navigation purposes. Given the high dynamic energy of the region, a more reasonable error criterion, relative RMSE, is considered in the skill assessment. The relative error at each station is the ratio of RMSE to the tidal range of that station. The relative water elevation RMSE typically ranges from 3–4% at all stations.

The correlation coefficients for surface current speed are relatively low. The reason stems not from inaccuracy of the current speed (AFC/AEC), but from timing: TFC, TEC, TSF, TEF, TSE, and TEE.

The modeled surface water temperature agrees well with observations. For the skill assessment period, the surface temperature RMSE is below its criteria threshold (3.0 ^{o}C). Almost all CF, NOF, POF, MDNO, and MDPO pass the accepted threshold. The correlation coefficient at all stations is above or close to 0.90.

For surface salinity, the correlation coefficient is not as high as temperature and water level. The RMSE at each station, however, is under 2.0 PSU, which is below the NOS-accepted error threshold of 3.5 PSU. In addition, most of CF, NOF, POF, MDNO, and MDPO also pass or are close to NOS' accepted model skill assessment threshold for navigation purposes.

GoMOFS was implemented in January 2018. Similar to the skill assessment results described in this technical report, the model continues to demonstrate high model stability and sound results. The successful implementation of this model provides reliable guidance on water level, current, temperature and salinity to support NOS' navigation customers and could potentially serve as the hydrodynamic basis for future ecological modeling efforts, such as HAB forecasting, for this nutrient-rich region.

It should be noted that NOS-accepted error criteria are based on navigation (not ecological) requirements. Also, an estuary experiences higher changes in salinity compared to an open ocean region like the Gulf of Maine. Acceptable error criteria should be based on the physical environment (estuary or open ocean domain) and requirements of the targeted user community to ensure optimal model performance.

ACKNOWLEDGEMENTS

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LIST OF APPENDICES

APPENDIX A. COMPARISONS OF MODELED HARMONIC CONSTANTS WITH OBSERVATIONS

Table A-1. Modeled tidal harmonic constants compared with observations at Boston.

Station: "Boston, MA"
Observation:CO-OPS Accepted Harmonic Constants
Model: Least Squares H.A. Beginning 3- 8-2017 at Hour 12.10
amplitudes are in meters, and Phase is in degrees (GMT)

		Observed		Modeled		Difference	
N	Constituent	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
1	M(2)	1.398	109.4	1.395	111.3	-0.003	1.9
2	S(2)	0.213	146.2	0.244	151.0	0.031	4.8
3	N(2)	0.309	78.9	0.289	84.3	-0.020	5.4
4	K(1)	0.143	205.2	0.105	221.5	-0.038	16.3
5	M(4)	0.023	25.9	0.018	94.2	-0.005	68.3
6	O(1)	0.119	186.7	0.128	189.7	0.009	3.0
7	M(6)	0.034	282.1	0.026	244.4	-0.008	-37.7
8	MK(3)	0.005	232.5	0.002	185.7	-0.003	-46.8
9	S(4)	0.000	0.0	0.002	154.0	0.000	0.0
10	MN(4)	0.011	14.6	0.007	79.8	-0.004	65.2
11	NU(2)	0.067	85.5	0.000	0.0	-0.067	-85.5
12	S(6)	0.000	0.0	0.002	192.3	0.000	0.0
13	MU(2)	0.010	69.0	0.000	0.0	-0.010	-69.0
14	2N(2)	0.039	55.0	0.034	9.2	-0.005	-45.8
15	OO(1)	0.005	227.0	0.034	62.7	0.029	-164.3
16	LAMBDA(2)	0.022	143.2	0.000	0.0	-0.022	-143.2
17	S(1)	0.004	122.8	0.000	0.0	-0.004	-122.8
18	M(1)	0.007	214.4	0.014	277.5	0.007	63.1
19	J(1)	0.010	213.5	0.017	156.7	0.007	-56.8
20	MM	0.000	0.0	0.000	0.0	0.000	0.0
21	SSA	0.018	89.8	0.000	0.0	-0.018	-89.8
22	SA	0.032	126.3	0.000	0.0	-0.032	-126.3
23	MSF	0.000	0.0	0.000	0.0	0.000	0.0
24	MF	0.000	0.0	0.000	0.0	0.000	0.0
25	RHO(1)	0.003	152.8	0.000	0.0	-0.003	-152.8
26	Q(1)	0.021	171.1	0.007	183.0	-0.014	11.9
27	T(2)	0.019	123.9	0.000	0.0	-0.019	-123.9
28	R(2)	0.005	8.2	0.000	0.0	-0.005	-8.2
29	2Q(1)	0.003	168.3	0.016	280.5	0.013	112.2
30	P(1)	0.047	202.1	0.000	0.0	-0.047	157.9
31	2SM(2)	0.000	0.0	0.005	321.0	0.000	0.0
32	M(3)	0.000	0.0	0.000	0.0	0.000	0.0
33	L(2)	0.055	156.2	0.033	148.1	-0.022	-8.1
34	2MK(3)	0.007	207.9	0.008	217.0	0.001	9.1
35	K(2)	0.059	144.5	0.000	0.0	-0.059	-144.5
36	M(8)	0.006	237.1	0.003	101.9	-0.003	-135.2
37	MS(4)	0.009	68.7	0.007	112.1	-0.002	43.4

Table A-2. Modeled tidal harmonic constants compared with observations at Portland.

Station: "Portland, ME"
Observation:CO-OPS Accepted Harmonic Constants
Model: Least Squares H.A. Beginning 3- 8-2017 at Hour 12.10
amplitudes are in meters, and Phase is in degrees (GMT)

		Observed		Modeled		Difference	
N	Constituent	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
1	M(2)	1.365	102.5	1.380	105.0	0.015	2.5
2	S(2)	0.206	138.5	0.242	144.0	0.036	5.5
3	N(2)	0.306	72.0	0.284	78.5	-0.022	6.5
4	K(1)	0.141	202.2	0.108	213.6	-0.033	11.4
5	M(4)	0.011	359.1	0.012	88.4	0.001	89.3
6	O(1)	0.112	182.4	0.127	188.4	0.015	6.0
7	M(6)	0.014	130.4	0.008	99.0	-0.006	-31.4
8	MK(3)	0.004	236.5	0.000	0.0	-0.004	123.5
9	S(4)	0.000	0.0	0.002	171.8	0.000	0.0
10	MN(4)	0.006	343.1	0.004	71.6	-0.002	88.5
11	NU(2)	0.065	79.5	0.000	0.0	-0.065	-79.5
12	S(6)	0.000	0.0	0.002	62.8	0.000	0.0
13	MU(2)	0.010	43.6	0.000	0.0	-0.010	-43.6
14	2N(2)	0.040	49.6	0.036	6.4	-0.004	-43.2
15	OO(1)	0.005	244.7	0.029	82.1	0.024	-162.6
16	LAMBDA(2)	0.022	139.4	0.000	0.0	-0.022	-139.4
17	S(1)	0.008	216.8	0.000	0.0	-0.008	143.2
18	M(1)	0.006	219.2	0.009	298.6	0.003	79.4
19	J(1)	0.009	210.7	0.010	179.3	0.001	-31.4
20	MM	0.000	0.0	0.000	0.0	0.000	0.0
21	SSA	0.020	105.8	0.000	0.0	-0.020	-105.8
22	SA	0.032	128.3	0.000	0.0	-0.032	-128.3
23	MSF	0.000	0.0	0.000	0.0	0.000	0.0
24	MF	0.000	0.0	0.000	0.0	0.000	0.0
25	RHO(1)	0.003	158.3	0.000	0.0	-0.003	-158.3
26	Q(1)	0.019	164.2	0.011	170.5	-0.008	6.3
27	T(2)	0.019	110.7	0.000	0.0	-0.019	-110.7
28	R(2)	0.005	333.5	0.000	0.0	-0.005	26.5
29	2Q(1)	0.003	162.8	0.011	317.3	0.008	154.5
30	P(1)	0.048	201.3	0.000	0.0	-0.048	158.7
31	2SM(2)	0.004	96.9	0.005	336.1	0.001	120.8
32	M(3)	0.000	0.0	0.000	0.0	0.000	0.0
33	L(2)	0.059	147.1	0.032	140.7	-0.027	-6.4
34	2MK(3)	0.005	221.2	0.006	216.2	0.001	-5.0
35	K(2)	0.056	137.3	0.000	0.0	-0.056	-137.3
36	M(8)	0.000	0.0	0.000	0.0	0.000	0.0
37	MS(4)	0.004	37.0	0.003	104.2	-0.001	67.2

Table A- 3. Modeled tidal harmonic constants compared with observations at Bar Harbor.

Station: "Bar Harbor, ME"
Observation:CO-OPS Accepted Harmonic Constants
Model: Least Squares H.A. Beginning 3- 8-2017 at Hour 12.10
amplitudes are in meters, and Phase is in degrees (GMT)

		Observed		Modeled		Difference	
N	Constituent	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
1	M(2)	1.580	92.9	1.570	96.6	-0.010	3.7
2	S(2)	0.243	128.8	0.281	136.8	0.038	8.0
3	N(2)	0.351	62.3	0.313	70.9	-0.038	8.6
4	K(1)	0.140	194.3	0.116	204.5	-0.024	10.2
5	M(4)	0.008	99.1	0.011	26.0	0.003	-73.1
6	O(1)	0.110	176.1	0.120	185.0	0.010	8.9
7	M(6)	0.012	47.5	0.005	355.0	-0.007	52.5
8	MK(3)	0.000	0.0	0.000	0.0	0.000	0.0
9	S(4)	0.000	0.0	0.000	0.0	0.000	0.0
10	MN(4)	0.000	0.0	0.005	6.7	0.000	0.0
11	NU(2)	0.073	67.5	0.000	0.0	-0.073	-67.5
12	S(6)	0.000	0.0	0.000	0.0	0.000	0.0
13	MU(2)	0.006	38.3	0.000	0.0	-0.006	-38.3
14	2N(2)	0.046	40.4	0.042	356.3	-0.004	44.1
15	OO(1)	0.004	238.2	0.024	114.8	0.020	-123.4
16	LAMBDA(2)	0.029	132.4	0.000	0.0	-0.029	-132.4
17	S(1)	0.006	163.0	0.000	0.0	-0.006	-163.0
18	M(1)	0.006	213.4	0.006	344.9	0.000	131.5
19	J(1)	0.008	202.0	0.004	258.8	-0.004	56.8
20	MM	0.000	0.0	0.000	0.0	0.000	0.0
21	SSA	0.000	0.0	0.000	0.0	0.000	0.0
22	SA	0.000	0.0	0.000	0.0	0.000	0.0
23	MSF	0.000	0.0	0.000	0.0	0.000	0.0
24	MF	0.000	0.0	0.000	0.0	0.000	0.0
25	RHO(1)	0.004	168.2	0.000	0.0	-0.004	-168.2
26	Q(1)	0.020	160.3	0.017	147.6	-0.003	-12.7
27	T(2)	0.022	103.5	0.000	0.0	-0.022	-103.5
28	R(2)	0.003	346.2	0.000	0.0	-0.003	13.8
29	2Q(1)	0.003	171.0	0.010	12.1	0.007	-158.9
30	P(1)	0.046	193.6	0.000	0.0	-0.046	166.4
31	2SM(2)	0.005	101.6	0.007	356.7	0.002	104.9
32	M(3)	0.000	0.0	0.002	18.1	0.000	0.0
33	L(2)	0.079	135.0	0.037	126.1	-0.042	-8.9
34	2MK(3)	0.004	259.5	0.004	245.7	0.000	-13.8
35	K(2)	0.067	127.0	0.000	0.0	-0.067	-127.0
36	M(8)	0.000	0.0	0.002	166.5	0.000	0.0
37	MS(4)	0.000	0.0	0.004	46.9	0.000	0.0

Table A-4. Modeled tidal harmonic constants compared with observations at Wells.

Station: "Wells, ME"
Observation:CO-OPS Accepted Harmonic Constants
Model: Least Squares H.A. Beginning 3- 8-2017 at Hour 12.10
amplitudes are in meters, and Phase is in degrees (GMT)

		Observed		Modeled		Difference	
N	Constituent	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
1	M(2)	1.330	105.3	1.362	106.6	0.032	1.3
2	S(2)	0.203	141.7	0.238	145.7	0.035	4.0
3	N(2)	0.294	71.4	0.281	80.0	-0.013	8.6
4	K(1)	0.137	203.7	0.105	215.5	-0.032	11.8
5	M(4)	0.023	328.9	0.012	93.4	-0.011	124.5
6	O(1)	0.111	186.5	0.127	189.0	0.016	2.5
7	M(6)	0.010	193.7	0.006	128.5	-0.004	-65.2
8	MK(3)	0.001	310.4	0.000	0.0	-0.001	49.6
9	S(4)	0.001	93.9	0.002	167.6	0.001	73.7
10	MN(4)	0.010	301.7	0.004	78.0	-0.006	136.3
11	NU(2)	0.067	82.6	0.000	0.0	-0.067	-82.6
12	S(6)	0.001	167.6	0.000	0.0	-0.001	-167.6
13	MU(2)	0.010	37.2	0.000	0.0	-0.010	-37.2
14	2N(2)	0.051	35.9	0.035	7.1	-0.016	-28.8
15	OO(1)	0.005	256.1	0.030	77.9	0.025	-178.2
16	LAMBDA(2)	0.022	145.0	0.000	0.0	-0.022	-145.0
17	S(1)	0.005	122.3	0.000	0.0	-0.005	-122.3
18	M(1)	0.003	193.9	0.010	291.5	0.007	97.6
19	J(1)	0.007	207.5	0.011	175.2	0.004	-32.3
20	MM	0.000	0.0	0.000	0.0	0.000	0.0
21	SSA	0.020	105.8	0.000	0.0	-0.020	-105.8
22	SA	0.032	128.3	0.000	0.0	-0.032	-128.3
23	MSF	0.000	0.0	0.000	0.0	0.000	0.0
24	MF	0.000	0.0	0.000	0.0	0.000	0.0
25	RHO(1)	0.005	183.6	0.000	0.0	-0.005	176.4
26	Q(1)	0.021	182.7	0.010	169.0	-0.011	-13.7
27	T(2)	0.018	114.0	0.000	0.0	-0.018	-114.0
28	R(2)	0.006	16.0	0.000	0.0	-0.006	-16.0
29	2Q(1)	0.005	117.3	0.012	304.9	0.007	172.4
30	P(1)	0.048	203.1	0.000	0.0	-0.048	156.9
31	2SM(2)	0.004	129.9	0.005	333.0	0.001	156.9
32	M(3)	0.003	100.0	0.000	0.0	-0.003	-100.0
33	L(2)	0.057	150.1	0.031	143.3	-0.026	-6.8
34	2MK(3)	0.003	209.8	0.006	216.1	0.003	6.3
35	K(2)	0.054	139.3	0.000	0.0	-0.054	-139.3
36	M(8)	0.002	43.3	0.002	87.2	0.000	43.9
37	MS(4)	0.009	9.6	0.003	110.1	-0.006	100.5

Table A-5. Modeled tidal harmonic constants compared with observations at Fort Point.

Station: "Fort Pt., NH"
Observation:CO-OPS Accepted Harmonic Constants
Model: Least Squares H.A. Beginning 3- 8-2017 at Hour 12.10
amplitudes are in meters, and Phase is in degrees (GMT)

		Observed		Modeled		Difference	
N	Constituent	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
1	M(2)	1.314	105.9	1.355	107.7	0.041	1.8
2	S(2)	0.181	136.2	0.237	146.8	0.056	10.6
3	N(2)	0.294	76.1	0.280	81.1	-0.014	5.0
4	K(1)	0.135	203.3	0.104	216.7	-0.031	13.4
5	M(4)	0.018	324.5	0.012	96.0	-0.006	131.5
6	O(1)	0.114	187.1	0.128	189.3	0.014	2.2
7	M(6)	0.009	134.7	0.005	166.6	-0.004	31.9
8	MK(3)	0.004	244.9	0.000	0.0	-0.004	115.1
9	S(4)	0.001	162.9	0.002	162.8	0.001	-0.1
10	MN(4)	0.007	317.9	0.004	81.1	-0.003	123.2
11	NU(2)	0.063	85.2	0.000	0.0	-0.063	-85.2
12	S(6)	0.000	0.0	0.000	0.0	0.000	0.0
13	MU(2)	0.009	24.0	0.000	0.0	-0.009	-24.0
14	2N(2)	0.049	49.3	0.035	7.3	-0.014	-42.0
15	OO(1)	0.004	247.6	0.031	73.9	0.027	-173.7
16	LAMBDA(2)	0.019	144.8	0.000	0.0	-0.019	-144.8
17	S(1)	0.010	168.7	0.000	0.0	-0.010	-168.7
18	M(1)	0.005	250.2	0.011	287.3	0.006	37.1
19	J(1)	0.008	214.2	0.013	169.9	0.005	-44.3
20	MM	0.000	0.0	0.000	0.0	0.000	0.0
21	SSA	0.020	105.8	0.000	0.0	-0.020	-105.8
22	SA	0.032	128.3	0.000	0.0	-0.032	-128.3
23	MSF	0.000	0.0	0.000	0.0	0.000	0.0
24	MF	0.000	0.0	0.000	0.0	0.000	0.0
25	RHO(1)	0.004	159.4	0.000	0.0	-0.004	-159.4
26	Q(1)	0.020	156.6	0.010	170.0	-0.010	13.4
27	T(2)	0.023	94.5	0.000	0.0	-0.023	-94.5
28	R(2)	0.027	130.7	0.000	0.0	-0.027	-130.7
29	2Q(1)	0.003	38.0	0.013	298.2	0.010	99.8
30	P(1)	0.041	204.1	0.000	0.0	-0.041	155.9
31	2SM(2)	0.007	156.6	0.005	333.0	-0.002	176.4
32	M(3)	0.001	156.2	0.000	0.0	-0.001	-156.2
33	L(2)	0.047	140.3	0.031	144.7	-0.016	4.4
34	2MK(3)	0.006	225.4	0.006	215.2	0.000	-10.2
35	K(2)	0.064	131.8	0.000	0.0	-0.064	-131.8
36	M(8)	0.002	293.2	0.002	92.4	0.000	159.2
37	MS(4)	0.005	23.9	0.004	114.1	-0.001	90.2

APPENDIX B. WATER LEVEL MODEL SKILL ASSESSEMENT TABLES

Table B-1. Water level skill assessment at Bar Harbor.

Station: Bar Harbor, ME Tidal range: 4.76
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
H			27788	0.093									
h			27788	0.105									
H-h	15	cm 24h	27788	-0.011	0.176	0.176	3.9	66.2	4.1	4.9	5.1	0.00	0.99
AHW-ahw	15	cm 24h	219	-0.030	0.107	0.103	0.0	83.6	0.0	0.0	0.0		
ALW-alw	15	cm 24h	220	-0.015	0.118	0.117	0.0	80.0	0.5	0.0	0.0		
THW-thw	0.50	h 25h	219	0.210	0.287	0.196	0.0	93.2	0.0	0.0	0.0		
TLW-tlw	0.50	h 25h	220	0.150	0.242	0.190	0.0	93.6	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
H00-h00	15	cm 24h	364	-0.010	0.177	0.177	4.1	63.5	5.5	0.0	0.0	0.00	
H06-h06	15	cm 24h	364	-0.009	0.179	0.179	4.1	63.2	5.8	0.0	0.0	0.00	
H12-h12	15	cm 24h	364	-0.013	0.179	0.178	4.1	62.1	5.2	0.0	0.0	0.00	
H18-h18	15	cm 24h	364	-0.015	0.177	0.176	3.8	63.5	5.2	0.0	0.0	0.00	
H24-h24	15	cm 24h	364	-0.016	0.177	0.176	3.8	62.1	5.5	0.0	0.0	0.00	
H30-h30	15	cm 24h	364	-0.016	0.172	0.172	3.3	63.7	4.9	0.0	0.0	0.00	
H36-h36	15	cm 24h	363	-0.015	0.173	0.173	3.3	64.5	5.5	0.0	0.0	0.00	
H42-h42	15	cm 24h	362	-0.015	0.172	0.172	3.6	64.6	5.5	0.0	0.0	0.00	
H48-h48	15	cm 24h	361	-0.014	0.170	0.170	3.3	66.8	4.2	0.0	0.0	0.00	
AHW-ahw	15	cm 24h	152	-0.026	0.110	0.107	0.0	82.2	0.0				
ALW-alw	15	cm 24h	152	-0.025	0.112	0.110	0.0	78.9	0.0				
THW-thw	0.50	h 25h	152	0.204	0.280	0.192	0.0	94.1	0.0				
TLW-tlw	0.50	h 25h	152	0.168	0.254	0.191	0.0	94.1	0.0				

Table B- 2. Water level skill assessment at Portland.

Station: Portland, ME Tidal range: 4.18
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
H			27788	0.083									
h			27788	0.083									
H-h		15 cm 24h	27788	0.000	0.146	0.146	1.8	73.7	1.5	4.5	4.9	0.00	1.00
AHW-ahw		15 cm 24h	219	0.002	0.101	0.101	0.0	84.0	0.0	0.0	0.0		
ALW-alw		15 cm 24h	219	0.010	0.120	0.120	0.0	78.5	0.9	0.0	0.0		
THW-thw	0.50	h 25h	219	0.083	0.222	0.207	0.0	95.4	0.0	0.0	0.0		
TLW-tlw	0.50	h 25h	219	0.206	0.295	0.212	0.0	88.1	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
H00-h00		15 cm 24h	364	0.000	0.144	0.144	2.7	72.5	1.1	0.0	0.0	0.00	
H06-h06		15 cm 24h	364	0.000	0.144	0.144	2.7	72.5	1.4	0.0	0.0	0.00	
H12-h12		15 cm 24h	364	-0.003	0.143	0.144	2.7	73.6	1.6	0.0	0.0	0.00	
H18-h18		15 cm 24h	364	-0.005	0.143	0.143	2.5	73.9	1.1	0.0	0.0	0.00	
H24-h24		15 cm 24h	364	-0.007	0.142	0.142	2.2	73.6	1.1	0.0	0.0	0.00	
H30-h30		15 cm 24h	364	-0.007	0.139	0.139	1.9	72.3	0.8	0.0	0.0	0.00	
H36-h36		15 cm 24h	363	-0.006	0.140	0.140	1.9	72.2	0.8	0.0	0.0	0.00	
H42-h42		15 cm 24h	362	-0.005	0.139	0.139	1.7	72.9	0.6	0.0	0.0	0.00	
H48-h48		15 cm 24h	361	-0.004	0.139	0.139	2.2	73.4	0.8	0.0	0.0	0.00	
AHW-ahw		15 cm 24h	153	0.004	0.108	0.108	0.0	80.4	0.0				
ALW-alw		15 cm 24h	153	0.000	0.113	0.113	0.0	78.4	0.7				
THW-thw	0.50	h 25h	153	0.085	0.219	0.202	0.0	96.7	0.0				
TLW-tlw	0.50	h 25h	153	0.222	0.309	0.215	0.0	85.0	0.0				

Table B-3. Water level skill assessment at Wells.

Station: Wells, ME Tidal range: 4.13
Observed data time period from: / 1/ 1/2017 to / 6/30/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
H			27787	0.086									
h			27787	0.105									
H-h		15 cm 24h	27787	-0.019	0.144	0.143	2.2	73.1	0.8	4.8	4.6	0.00	1.00
AHW-ahw		15 cm 24h	219	0.027	0.104	0.101	0.0	82.2	0.0	0.0	0.0		
ALW-alw		15 cm 24h	219	-0.035	0.126	0.121	0.0	78.5	0.5	0.0	0.0		
THW-thw	0.50	h 25h	219	0.015	0.179	0.179	0.0	99.1	0.0	0.0	0.0		
TLW-tlw	0.50	h 25h	219	0.211	0.314	0.233	0.0	86.8	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
H00-h00		15 cm 24h	360	-0.017	0.145	0.145	2.8	69.4	0.6	0.0	0.0	0.00	
H06-h06		15 cm 24h	359	-0.016	0.146	0.146	2.2	69.9	0.6	0.0	0.0	0.00	
H12-h12		15 cm 24h	358	-0.019	0.146	0.144	2.5	70.9	0.3	0.0	0.0	0.00	
H18-h18		15 cm 24h	357	-0.022	0.146	0.144	2.8	70.9	0.3	0.0	0.0	0.00	
H24-h24		15 cm 24h	356	-0.024	0.146	0.144	3.1	70.8	0.3	0.0	0.0	0.00	
H30-h30		15 cm 24h	355	-0.024	0.141	0.139	2.3	69.6	0.3	0.0	0.0	0.00	
H36-h36		15 cm 24h	354	-0.023	0.142	0.141	2.8	69.2	0.3	0.0	0.0	0.00	
H42-h42		15 cm 24h	353	-0.022	0.141	0.139	2.3	71.4	0.0	0.0	0.0	0.00	
H48-h48		15 cm 24h	352	-0.021	0.142	0.140	2.6	71.9	0.0	0.0	0.0	0.00	
AHW-ahw		15 cm 24h	151	0.030	0.112	0.108	0.0	79.5	0.0				
ALW-alw		15 cm 24h	151	-0.042	0.122	0.115	0.0	76.2	0.0				
THW-thw	0.50	h 25h	151	0.028	0.182	0.180	0.0	100.0	0.0				
TLW-tlw	0.50	h 25h	151	0.219	0.308	0.217	0.0	86.8	0.0				

Table B-4. Water level skill assessment at Fort Point.

Station: Fort Pt., NH Tidal range: 4.09
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
H			27788	0.086									
h			27788	0.108									
H-h	15	cm 24h	27788	-0.022	0.149	0.147	2.7	70.8	0.7	4.8	4.6	0.00	0.99
AHW-ahw	15	cm 24h	219	0.047	0.110	0.099	0.0	79.5	0.0	0.0	0.0		
ALW-alw	15	cm 24h	219	-0.067	0.137	0.120	0.9	73.1	0.5	0.0	0.0		
THW-thw	0.50	h 25h	219	0.050	0.198	0.192	0.0	98.2	0.0	0.0	0.0		
TLW-tlw	0.50	h 25h	219	0.168	0.259	0.197	0.0	93.2	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
H00-h00	15	cm 24h	364	-0.021	0.149	0.148	2.7	66.8	0.3	0.0	0.0	0.00	
H06-h06	15	cm 24h	364	-0.021	0.150	0.149	3.0	67.0	0.3	0.0	0.0	0.00	
H12-h12	15	cm 24h	364	-0.024	0.149	0.148	3.0	69.0	0.3	0.0	0.0	0.00	
H18-h18	15	cm 24h	364	-0.027	0.150	0.148	3.6	69.0	0.3	0.0	0.0	0.00	
H24-h24	15	cm 24h	364	-0.029	0.150	0.148	3.3	67.9	0.5	0.0	0.0	0.00	
H30-h30	15	cm 24h	364	-0.029	0.147	0.144	3.0	67.0	0.3	0.0	0.0	0.00	
H36-h36	15	cm 24h	363	-0.028	0.148	0.145	3.0	68.3	0.3	0.0	0.0	0.00	
H42-h42	15	cm 24h	362	-0.026	0.147	0.144	2.8	67.7	0.3	0.0	0.0	0.00	
H48-h48	15	cm 24h	361	-0.026	0.147	0.144	2.5	68.4	0.0	0.0	0.0	0.00	
AHW-ahw	15	cm 24h	153	0.049	0.117	0.106	0.0	75.2	0.0				
ALW-alw	15	cm 24h	153	-0.080	0.140	0.115	1.3	68.0	0.0				
THW-thw	0.50	h 25h	153	0.061	0.206	0.197	0.0	99.3	0.0				
TLW-tlw	0.50	h 25h	153	0.192	0.277	0.200	0.0	92.8	0.0				

~

Table B-5. Water level skill assessment at Boston.

Station: Boston, MA Tidal range: 4.36
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
H			27788	0.091									
h			27788	0.119									
H-h	15	cm 24h	27788	-0.028	0.149	0.147	3.0	72.3	0.6	4.8	4.3	0.00	1.00
AHW-ahw	15	cm 24h	219	-0.027	0.106	0.103	0.9	86.8	0.0	12.7	0.0		
ALW-alw	15	cm 24h	219	0.033	0.131	0.127	0.0	79.5	0.5	0.0	0.0		
THW-thw	0.50	h 25h	219	0.090	0.237	0.219	0.0	95.0	0.0	0.0	0.0		
TLW-tlw	0.50	h 25h	219	0.193	0.277	0.199	0.0	90.9	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
H00-h00	15	cm 24h	364	-0.025	0.150	0.148	4.1	68.1	0.3	0.0	0.0	0.00	
H06-h06	15	cm 24h	364	-0.026	0.150	0.148	4.4	69.5	0.5	0.0	0.0	0.00	
H12-h12	15	cm 24h	364	-0.030	0.150	0.147	4.4	71.4	0.8	0.0	0.0	0.00	
H18-h18	15	cm 24h	364	-0.033	0.146	0.143	3.8	71.2	0.0	0.0	0.0	0.00	
H24-h24	15	cm 24h	364	-0.035	0.147	0.143	4.4	70.3	0.0	0.0	0.0	0.00	
H30-h30	15	cm 24h	364	-0.035	0.143	0.139	3.3	71.2	0.0	0.0	0.0	0.00	
H36-h36	15	cm 24h	363	-0.034	0.145	0.141	3.3	70.5	0.3	0.0	0.0	0.00	
H42-h42	15	cm 24h	362	-0.033	0.144	0.140	3.6	71.8	0.0	0.0	0.0	0.00	
H48-h48	15	cm 24h	361	-0.033	0.145	0.141	3.6	72.6	0.0	0.0	0.0	0.00	
AHW-ahw	15	cm 24h	153	-0.028	0.115	0.112	1.3	80.4	0.0				
ALW-alw	15	cm 24h	153	0.020	0.120	0.119	0.0	78.4	1.3				
THW-thw	0.50	h 25h	153	0.111	0.235	0.208	0.0	96.7	0.0				
TLW-tlw	0.50	h 25h	153	0.206	0.278	0.187	0.0	90.2	0.0				

APPENDIX C. SURFACE CURRENT MODEL SKILL ASSESSEMENT TABLES

Table C-1. Water surface current speed skill assessment at Buoy A01.

Station: Buoy A01, MA
Observed data time period from: / 1/ 1/2017 to / 5/21/2017 with gaps of 1.16 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
U			29362	0.139									
u			29362	0.174									
U-u	26 cm/s	24h	29362	-0.035	0.361	0.359	0.6	95.5	0.0	4.7	0.0		0.20
AFC-afc	26 cm/s	24h	69	-0.070	0.123	0.102	0.0	95.7	0.0	0.0	0.0		
AEC-aec	26 cm/s	24h	77	-0.018	0.098	0.097	0.0	96.1	0.0	0.0	0.0		
TFC-tfc	0.50h	25h	69	-0.062	1.217	1.224	18.8	27.5	18.8	7.9	0.0		
TEC-tec	0.50h	25h	77	0.517	1.246	1.141	3.9	28.6	33.8	14.0	13.0		
TSF-tsf	0.25h	25h	4	-0.852	1.396	1.277	25.0	50.0	0.0	0.0	0.0		
TEF-tef	0.25h	25h	11	0.562	1.465	1.420	18.2	0.0	54.5	0.0	0.0		
TSE-tse	0.25h	25h	13	0.223	1.119	1.142	0.0	46.2	23.1	0.0	0.0		
TEE-tee	0.25h	25h	11	0.272	1.438	1.481	18.2	27.3	27.3	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
U000-u000	26 cm/s	24h	19	-0.037	0.205	0.207	5.3	89.5	0.0	0.0	0.0		
U006-u006	26 cm/s	24h	17	-0.014	0.227	0.233	5.9	94.1	0.0	0.0	0.0		
U012-u012	26 cm/s	24h	18	0.007	0.096	0.098	0.0	100.0	0.0	0.0	0.0		
U018-u018	26 cm/s	24h	18	-0.004	0.224	0.230	5.6	88.9	0.0	0.0	0.0		
U024-u024	26 cm/s	24h	16	-0.017	0.129	0.133	0.0	100.0	0.0	0.0	0.0		
U030-u030	26 cm/s	24h	19	-0.030	0.195	0.198	5.3	94.7	0.0	0.0	0.0		
U036-u036	26 cm/s	24h	16	-0.007	0.213	0.220	6.2	93.8	0.0	0.0	0.0		
U042-u042	26 cm/s	24h	16	-0.038	0.220	0.224	6.2	87.5	0.0	0.0	0.0		
U048-u048	26 cm/s	24h	18	-0.007	0.231	0.238	5.6	88.9	0.0	0.0	0.0		
U054-u054	26 cm/s	24h	16	0.000	0.122	0.126	0.0	93.8	0.0	0.0	0.0		
U060-u060	26 cm/s	24h	17	-0.040	0.241	0.245	5.9	76.5	0.0	0.0	0.0		
U066-u066	26 cm/s	24h	17	0.000	0.120	0.123	0.0	94.1	0.0	0.0	0.0		
U072-u072	26 cm/s	24h	18	-0.045	0.211	0.212	5.6	88.9	0.0	0.0	0.0		

Table C-2. Water surface current speed skill assessment at Buoy B01.

Station: Buoy B01 - Western Maine Shelf
Observed data time period from: / 1/ 1/2017 to / 6/26/2017 with gaps of 1.54 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
U			36854	0.123									
u			36854	0.137									
U-u	26	cm/s 24h	36854	-0.014	0.301	0.301	0.4	97.4	0.0	2.7	0.0		0.22
AFC-afc	26	cm/s 24h	35	-0.300	1.616	1.611	2.9	94.3	0.0	0.0	0.0		
AEC-aec	26	cm/s 24h	59	-0.048	0.106	0.095	0.0	100.0	0.0	0.0	0.0		
TFC-tfc	0.50h	25h	35	0.280	1.369	1.359	20.0	34.3	34.3	0.0	0.0		
TEC-tec	0.50h	25h	59	0.173	1.291	1.290	16.9	20.3	23.7	0.0	50.0		
TSF-tsf	0.25h	25h	15	1.505	1.866	1.141	0.0	13.3	80.0	0.0	0.0		
TEF-tef	0.25h	25h	3	0.510	1.090	1.180	0.0	0.0	66.7	0.0	0.0		
TSE-tse	0.25h	25h	20	1.332	1.766	1.190	10.0	10.0	80.0	0.0	0.0		
TEE-tee	0.25h	25h	11	0.193	1.288	1.336	18.2	36.4	27.3	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
U000-u000	26	cm/s 24h	13	-0.043	0.126	0.123	0.0	92.3	0.0	0.0	0.0		
U006-u006	26	cm/s 24h	15	-0.055	0.086	0.068	0.0	100.0	0.0	0.0	0.0		
U012-u012	26	cm/s 24h	18	-0.042	0.088	0.079	0.0	100.0	0.0	0.0	0.0		
U018-u018	26	cm/s 24h	14	-0.069	0.143	0.130	0.0	92.9	0.0	0.0	0.0		
U024-u024	26	cm/s 24h	14	-0.042	0.080	0.071	0.0	100.0	0.0	0.0	0.0		
U030-u030	26	cm/s 24h	12	-0.055	0.125	0.117	0.0	91.7	0.0	0.0	0.0		
U036-u036	26	cm/s 24h	15	-0.067	0.125	0.109	0.0	93.3	0.0	0.0	0.0		
U042-u042	26	cm/s 24h	15	-0.026	0.111	0.112	0.0	93.3	0.0	0.0	0.0		
U048-u048	26	cm/s 24h	15	-0.037	0.090	0.085	0.0	100.0	0.0	0.0	0.0		
U054-u054	26	cm/s 24h	16	-0.040	0.089	0.082	0.0	100.0	0.0	0.0	0.0		
U060-u060	26	cm/s 24h	12	-0.048	0.137	0.133	0.0	91.7	0.0	0.0	0.0		
U066-u066	26	cm/s 24h	16	-0.064	0.105	0.087	0.0	100.0	0.0	0.0	0.0		
U072-u072	26	cm/s 24h	13	-0.025	0.112	0.113	0.0	92.3	0.0	0.0	0.0		

Table C-3. Water surface current speed skill assessment at Buoy E01.

Station: Buoy E01 Central Maine Shelf
Observed data time period from: / 1/ 1/2017 to / 6/19/2017 with gaps of 1.07 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
U			35503	0.138									
u			35503	0.161									
U-u	26	cm/s 24h	35503	-0.023	0.426	0.425	0.4	97.2	0.0	2.8	0.0		0.12
AFC-afc	26	cm/s 24h	67	-0.192	1.200	1.194	3.0	95.5	0.0	0.0	0.0		
AEC-aec	26	cm/s 24h	48	0.017	0.078	0.077	0.0	100.0	0.0	0.0	0.0		
TFC-tfc	0.50h	25h	67	-0.869	1.772	1.556	47.8	20.9	14.9	23.0	0.0		
TEC-tec	0.50h	25h	48	-0.017	1.315	1.328	22.9	22.9	16.7	0.0	0.0		
TSF-tsf	0.25h	25h	23	0.035	1.386	1.416	17.4	13.0	30.4	0.0	0.0		
TEF-tef	0.25h	25h	18	-0.018	1.311	1.349	16.7	50.0	22.2	0.0	0.0		
TSE-tse	0.25h	25h	17	-0.696	0.903	0.593	11.8	47.1	0.0	0.0	0.0		
TEE-tee	0.25h	25h	11	0.001	0.701	0.735	9.1	90.9	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
U000-u000	26	cm/s 24h	7	-0.020	0.083	0.088	0.0	100.0	0.0	0.0	0.0		
U006-u006	26	cm/s 24h	10	-0.006	0.118	0.125	0.0	100.0	0.0	0.0	0.0		
U012-u012	26	cm/s 24h	7	0.021	0.118	0.125	0.0	100.0	0.0	0.0	0.0		
U018-u018	26	cm/s 24h	12	-0.014	0.107	0.111	0.0	100.0	0.0	0.0	0.0		
U024-u024	26	cm/s 24h	9	-0.029	0.158	0.164	0.0	77.8	0.0	0.0	0.0		
U030-u030	26	cm/s 24h	7	-0.022	0.082	0.085	0.0	100.0	0.0	0.0	0.0		
U036-u036	26	cm/s 24h	9	-0.005	0.140	0.148	0.0	100.0	0.0	0.0	0.0		
U042-u042	26	cm/s 24h	7	-0.038	0.075	0.070	0.0	100.0	0.0	0.0	0.0		
U048-u048	26	cm/s 24h	10	-0.001	0.114	0.120	0.0	100.0	0.0	0.0	0.0		
U054-u054	26	cm/s 24h	7	0.009	0.138	0.149	0.0	85.7	0.0	0.0	0.0		
U060-u060	26	cm/s 24h	6	-0.012	0.073	0.079	0.0	100.0	0.0	0.0	0.0		
U066-u066	26	cm/s 24h	8	-0.054	0.179	0.182	0.0	87.5	0.0	0.0	0.0		
U072-u072	26	cm/s 24h	9	-0.026	0.082	0.082	0.0	100.0	0.0	0.0	0.0		

Table C-4. Water surface current speed skill assessment at Buoy I01.

```
 Station:              Buoy Io1 Eastern Maine Shelf
 Observed data time period from: / 1/ 1/2017  to / 6/13/2017 with gaps of    3.60 days
 Data gap is filled by SVD method
 Data are not filtered
-------------------------------------------------------------------------------------------------
 VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF  SKILL
 CRITERION   -     -     -     -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------------

     SCENARIO: SEMI-OPERATIONAL NOWCAST
U                      33573   0.190
u                      33573   0.246
U-u        26 cm/s 24h 33573  -0.056  0.156  0.145   0.0  95.9   0.0    0.0  0.0         0.67
AFC-afc    26 cm/s 24h    62  -0.097  0.137  0.097   0.0  93.5   0.0    0.0  0.0
AEC-aec    26 cm/s 24h   136  -0.073  0.116  0.091   0.0  96.3   0.0    0.0  0.0
TFC-tfc    0.50h   25h    62   0.097  0.738  0.738   3.2  51.6  12.9    0.0  0.0
TEC-tec    0.50h   25h   136   0.168  0.688  0.670   5.1  48.5   8.8    0.0  0.0
TSF-tsf    0.25h   25h    45  -0.361  1.093  1.044  20.0  37.8   6.7    0.0  0.0
TEF-tef    0.25h   25h    51   0.653  1.192  1.007   5.9  25.5  41.2    0.0  0.0
TSE-tse    0.25h   25h   111  -0.669  1.134  0.920  37.8  30.6   1.8   36.5  0.0
TEE-tee    0.25h   25h   112   0.777  1.205  0.925   3.6  25.9  45.5    0.0 49.1
     SCENARIO: SEMI-OPERATIONAL FORECAST
U000-u000  26 cm/s 24h    57  -0.073  0.140  0.121   0.0  89.5   0.0    0.0  0.0
U006-u006  26 cm/s 24h    60  -0.099  0.145  0.107   0.0  93.3   0.0    0.0  0.0
U012-u012  26 cm/s 24h    57  -0.071  0.134  0.114   0.0  91.2   0.0    0.0  0.0
U018-u018  26 cm/s 24h    53  -0.093  0.146  0.113   0.0  92.5   0.0    0.0  0.0
U024-u024  26 cm/s 24h    62  -0.082  0.143  0.118   0.0  93.5   0.0    0.0  0.0
U030-u030  26 cm/s 24h    51  -0.076  0.144  0.124   0.0  92.2   0.0    0.0  0.0
U036-u036  26 cm/s 24h    55  -0.072  0.134  0.114   0.0  96.4   0.0    0.0  0.0
U042-u042  26 cm/s 24h    56  -0.086  0.148  0.121   0.0  89.3   0.0    0.0  0.0
U048-u048  26 cm/s 24h    53  -0.092  0.142  0.110   0.0  94.3   0.0    0.0  0.0
U054-u054  26 cm/s 24h    63  -0.090  0.150  0.121   0.0  88.9   0.0    0.0  0.0
U060-u060  26 cm/s 24h    52  -0.105  0.154  0.113   0.0  90.4   0.0    0.0  0.0
U066-u066  26 cm/s 24h    59  -0.076  0.140  0.118   0.0  94.9   0.0    0.0  0.0
U072-u072  26 cm/s 24h    57  -0.080  0.147  0.124   0.0  89.5   0.0    0.0  0.0
```

Table C-5. Water surface current speed skill assessment at Buoy N01.

```
 Station:                        Northeast Channel
 Observed data time period from: / 1/ 1/2017  to / 7/ 2/2017 with gaps of    5.13 days
 Data gap is filled by SVD method
 Data are not filtered
-------------------------------------------------------------------------------------------------
 VARIABLE    X     N   IMAX    SM    RMSE    SD     NOF   CF    POF   MDNO  MDPO  WOF  SKILL
 CRITERION   -     -     -     -      -      -     <1%  >90%   <1%    <N    <N  <.5%
-------------------------------------------------------------------------------------------------

     SCENARIO: SEMI-OPERATIONAL NOWCAST
U                      37344   0.435
u                      37344   0.449
U-u        26 cm/s 24h 37344  -0.014  0.236  0.235   2.0  75.8   1.4    5.2  4.9         0.71
AFC-afc    26 cm/s 24h   202  -0.034  0.316  0.315   3.0  63.9   4.5    0.0 24.1
AEC-aec    26 cm/s 24h   173   0.004  0.185  0.185   1.2  87.3   0.0    0.0  0.0
TFC-tfc    0.50h   25h   202   0.464  0.963  0.846   6.4  31.7  22.3   24.1 36.1
TEC-tec    0.50h   25h   173   0.061  0.769  0.769   8.1  43.9   8.1   12.9  0.0
TSF-tsf    0.25h   25h    83   0.284  0.891  0.850   4.8  34.9  18.1    0.0 12.9
TEF-tef    0.25h   25h    89   0.270  0.903  0.866   4.5  43.8  21.3    0.0 10.9
TSE-tse    0.25h   25h    86   0.454  0.871  0.748   2.3  43.0  20.9    0.0 12.5
TEE-tee    0.25h   25h    89   0.287  0.928  0.887   6.7  43.8  16.9    0.0  0.0
     SCENARIO: SEMI-OPERATIONAL FORECAST
U000-u000  26 cm/s 24h   231   0.001  0.230  0.230   1.7  78.8   1.7    0.0  0.0
U006-u006  26 cm/s 24h   223  -0.007  0.226  0.227   3.1  78.5   1.8    0.0  0.0
U012-u012  26 cm/s 24h   220   0.004  0.222  0.223   0.5  79.5   2.7    0.0  0.0
U018-u018  26 cm/s 24h   222  -0.007  0.221  0.221   2.3  79.3   1.8    0.0  0.0
U024-u024  26 cm/s 24h   234   0.001  0.223  0.224   1.3  76.5   1.7    0.0  0.0
U030-u030  26 cm/s 24h   226   0.007  0.216  0.216   2.2  81.0   1.8    0.0  0.0
U036-u036  26 cm/s 24h   212   0.002  0.232  0.233   1.9  77.8   2.4    0.0  0.0
U042-u042  26 cm/s 24h   224   0.010  0.213  0.213   0.9  81.2   1.8    0.0  0.0
U048-u048  26 cm/s 24h   217  -0.006  0.215  0.215   1.4  80.6   1.8    0.0  0.0
U054-u054  26 cm/s 24h   234   0.005  0.227  0.227   1.3  76.1   2.1    0.0  0.0
U060-u060  26 cm/s 24h   222  -0.002  0.225  0.225   1.8  78.8   1.8    0.0  0.0
U066-u066  26 cm/s 24h   226   0.001  0.228  0.228   1.3  75.2   1.8    0.0  0.0
U072-u072  26 cm/s 24h   232   0.005  0.227  0.228   1.3  77.2   2.2    0.0  0.0
```

Table C-6. Water surface current direction skill assessment at Buoy A01.

Station: Buoy A01, MA
Observed data time period from: / 1/ 1/2017 to / 5/21/2017with gaps of 1.16 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE / CRITERION	X	N	IMAX	SM	RMSE	SD	NOF <1%	CF >90%	POF <1%	MDNO <N	MDPO <N	WOF <.5%	SKILL
SCENARIO: SEMI-OPERATIONAL NOWCAST													
D			29362	166.609									
d			29362	174.316									
D-d	22.5	dg 24h	29362	0.505	8.899	8.884	0.2	97.7	0.9	2.7	7.3		0.71
DFC-dfc	22.5	dg 24h	69	4.438	28.403	28.260	2.9	69.6	4.3	0.0	0.0		
DEC-dec	22.5	dg 24h	77	-14.458	28.797	25.068	13.0	57.1	1.3	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
D000-d000	22.5	dg 24h	8	-7.281	15.440	14.555	0.0	87.5	0.0	0.0	0.0		
D006-d006	22.5	dg 24h	8	-7.210	15.535	14.711	0.0	87.5	0.0	0.0	0.0		
D012-d012	22.5	dg 24h	7	-5.317	15.358	15.563	0.0	85.7	0.0	0.0	0.0		
D018-d018	22.5	dg 24h	8	0.369	11.722	12.525	0.0	87.5	0.0	0.0	0.0		
D024-d024	22.5	dg 24h	8	-1.324	13.746	14.627	0.0	87.5	0.0	0.0	0.0		
D030-d030	22.5	dg 24h	9	1.261	10.208	10.744	0.0	100.0	0.0	0.0	0.0		
D036-d036	22.5	dg 24h	10	-0.977	7.387	7.718	0.0	100.0	0.0	0.0	0.0		
D042-d042	22.5	dg 24h	11	-0.582	8.691	9.095	0.0	100.0	0.0	0.0	0.0		
D048-d048	22.5	dg 24h	10	-0.193	7.064	7.443	0.0	100.0	0.0	0.0	0.0		
D054-d054	22.5	dg 24h	10	1.177	10.013	10.481	0.0	100.0	0.0	0.0	0.0		
D060-d060	22.5	dg 24h	11	2.238	11.786	12.137	0.0	90.9	0.0	0.0	0.0		
D066-d066	22.5	dg 24h	14	10.636	23.085	21.262	0.0	92.9	7.1	0.0	0.0		
D072-d072	22.5	dg 24h	11	1.771	12.063	12.515	0.0	90.9	0.0	0.0	0.0		
DFC-dfc	22.5	dg 24h	33	-2.228	23.721	23.983	6.1	63.6	0.0	0.0	0.0		
DEC-dec	22.5	dg 24h	33	-11.471	21.577	18.559	6.1	72.7	0.0	0.0	0.0		

Table C-7. Water surface current direction skill assessment at Buoy B01.

Station: Buoy B01 - Western Maine Shelf
Observed data time period from: / 1/ 1/2017 to / 6/26/2017with gaps of 1.54 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE / CRITERION	X	N	IMAX	SM	RMSE	SD	NOF <1%	CF >90%	POF <1%	MDNO <N	MDPO <N	WOF <.5%	SKILL
SCENARIO: SEMI-OPERATIONAL NOWCAST													
D			36854	182.591									
d			36854	185.696									
D-d	22.5	dg 24h	36854	-0.031	6.659	6.659	0.3	98.8	0.1	3.8	0.8		0.57
DFC-dfc	22.5	dg 24h	35	18.627	48.725	45.681	8.6	48.6	22.9	0.0	0.0		
DEC-dec	22.5	dg 24h	59	-11.391	39.263	37.897	15.3	52.5	5.1	0.0	13.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
D000-d000	22.5	dg 24h	6	3.919	9.004	8.880	0.0	100.0	0.0	0.0	0.0		
D006-d006	22.5	dg 24h	6	4.979	8.570	7.642	0.0	100.0	0.0	0.0	0.0		
D012-d012	22.5	dg 24h	6	5.168	9.765	9.077	0.0	100.0	0.0	0.0	0.0		
D018-d018	22.5	dg 24h	7	3.731	8.650	8.429	0.0	100.0	0.0	0.0	0.0		
D024-d024	22.5	dg 24h	6	7.276	11.400	9.613	0.0	100.0	0.0	0.0	0.0		
D030-d030	22.5	dg 24h	6	7.013	13.469	12.597	0.0	83.3	0.0	0.0	0.0		
D036-d036	22.5	dg 24h	7	6.514	11.951	10.822	0.0	100.0	0.0	0.0	0.0		
D042-d042	22.5	dg 24h	6	5.858	11.178	10.429	0.0	100.0	0.0	0.0	0.0		
D048-d048	22.5	dg 24h	6	6.851	11.918	10.682	0.0	100.0	0.0	0.0	0.0		
D054-d054	22.5	dg 24h	8	4.690	10.319	9.827	0.0	100.0	0.0	0.0	0.0		
D060-d060	22.5	dg 24h	6	11.147	15.083	11.130	0.0	83.3	0.0	0.0	0.0		
D066-d066	22.5	dg 24h	4	10.113	13.890	10.994	0.0	100.0	0.0	0.0	0.0		
D072-d072	22.5	dg 24h	6	4.830	13.427	13.724	0.0	83.3	0.0	0.0	0.0		
DFC-dfc	22.5	dg 24h	17	31.868	48.918	38.255	0.0	41.2	35.3	0.0	0.0		
DEC-dec	22.5	dg 24h	18	-25.237	41.776	34.257	22.2	66.7	0.0	0.0	0.0		

Table C-8. Water surface current direction skill assessment at Buoy E01.

Station: Buoy E01 Central Maine Shelf
Observed data time period from: / 1/ 1/2017 to / 6/19/2017with gaps of 1.07 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
D			35503	198.633									
d			35503	211.462									
D-d	22.5	dg 24h	35503	0.080	6.167	6.166	0.3	98.8	0.3	3.0	2.2		0.55
DFC-dfc	22.5	dg 24h	67	19.998	48.001	43.967	9.0	37.3	28.4	18.9	0.0		
DEC-dec	22.5	dg 24h	48	5.016	30.637	30.544	10.4	58.3	6.2	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
D000-d000	22.5	dg 24h	2	15.477	46.488	61.993	0.0	0.0	50.0	0.0	0.0		
D006-d006	22.5	dg 24h	2	15.475	46.485	61.990	0.0	0.0	50.0	0.0	0.0		
D012-d012	22.5	dg 24h	2	14.089	47.362	63.947	0.0	0.0	50.0	0.0	0.0		
D018-d018	22.5	dg 24h	3	24.264	45.543	47.203	0.0	0.0	33.3	0.0	0.0		
D024-d024	22.5	dg 24h	4	17.041	39.557	41.221	0.0	25.0	25.0	0.0	0.0		
D030-d030	22.5	dg 24h	3	7.579	33.716	40.237	0.0	33.3	33.3	0.0	0.0		
D036-d036	22.5	dg 24h	3	32.551	39.957	28.382	0.0	33.3	33.3	0.0	0.0		
D042-d042	22.5	dg 24h	4	22.123	36.163	33.032	0.0	50.0	50.0	0.0	0.0		
D048-d048	22.5	dg 24h	4	26.873	39.230	33.001	0.0	50.0	50.0	0.0	0.0		
D054-d054	22.5	dg 24h	2	-10.073	10.289	2.967	0.0	100.0	0.0	0.0	0.0		
D060-d060	22.5	dg 24h	2	-6.217	6.383	2.045	0.0	100.0	0.0	0.0	0.0		
D066-d066	22.5	dg 24h	3	-10.345	10.490	2.131	0.0	100.0	0.0	0.0	0.0		
D072-d072	22.5	dg 24h	3	12.746	29.995	33.254	0.0	66.7	33.3	0.0	0.0		
DFC-dfc	22.5	dg 24h	12	17.641	33.435	29.665	0.0	33.3	25.0	0.0	0.0		
DEC-dec	22.5	dg 24h	28	-1.533	25.134	25.547	7.1	60.7	0.0	0.0	0.0		

Table C-9. Water surface current direction skill assessment at Buoy I01.

Station: Buoy Io1 Eastern Maine Shelf
Observed data time period from: / 1/ 1/2017 to / 6/13/2017with gaps of 3.60 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
D			33573	179.077									
d			33573	180.280									
D-d	22.5	dg 24h	33573	0.292	7.989	7.984	0.0	96.9	0.4	0.2	3.9		0.75
DFC-dfc	22.5	dg 24h	62	1.147	10.723	10.749	0.0	95.2	0.0	0.0	0.0		
DEC-dec	22.5	dg 24h	136	-0.383	13.171	13.214	0.7	89.0	0.0	0.0	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
D000-d000	22.5	dg 24h	33	1.810	11.513	11.546	0.0	90.9	0.0	0.0	0.0		
D006-d006	22.5	dg 24h	30	0.922	9.935	10.062	0.0	96.7	0.0	0.0	0.0		
D012-d012	22.5	dg 24h	31	-0.560	10.531	10.690	0.0	93.5	0.0	0.0	0.0		
D018-d018	22.5	dg 24h	31	-0.161	11.244	11.428	0.0	93.5	0.0	0.0	0.0		
D024-d024	22.5	dg 24h	34	-0.048	11.525	11.698	0.0	94.1	0.0	0.0	0.0		
D030-d030	22.5	dg 24h	36	-0.843	11.390	11.520	0.0	91.7	0.0	0.0	0.0		
D036-d036	22.5	dg 24h	38	-0.036	10.556	10.697	0.0	94.7	0.0	0.0	0.0		
D042-d042	22.5	dg 24h	38	-0.795	11.348	11.472	0.0	94.7	0.0	0.0	0.0		
D048-d048	22.5	dg 24h	34	-0.366	11.238	11.401	0.0	97.1	0.0	0.0	0.0		
D054-d054	22.5	dg 24h	32	1.463	13.135	13.262	0.0	93.8	0.0	0.0	0.0		
D060-d060	22.5	dg 24h	35	0.667	12.679	12.846	0.0	97.1	0.0	0.0	0.0		
D066-d066	22.5	dg 24h	34	0.988	12.809	12.963	0.0	94.1	0.0	0.0	0.0		
D072-d072	22.5	dg 24h	29	1.122	15.546	15.780	0.0	82.8	0.0	0.0	0.0		
DFC-dfc	22.5	dg 24h	30	0.229	8.228	8.366	0.0	100.0	0.0	0.0	0.0		
DEC-dec	22.5	dg 24h	59	-1.082	12.741	12.804	0.0	88.1	0.0	0.0	0.0		

Table C-10. Water surface current direction skill assessment at Buoy N01.

Station: Northeast Channel
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017with gaps of 5.13 days
Data gap is filled by SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
D			37344	196.587									
d			37344	197.068									
D-d	22.5	dg 24h	37344	-6.513	30.588	29.885	9.5	70.9	2.9	5.8	5.6		0.81
DFC-dfc	22.5	dg 24h	202	4.282	21.833	21.463	2.0	72.8	3.5	0.0	0.0		
DEC-dec	22.5	dg 24h	173	-18.969	36.000	30.686	19.1	53.8	1.7	63.9	0.0		
SCENARIO: SEMI-OPERATIONAL FORECAST													
D000-d000	22.5	dg 24h	146	-9.375	40.411	39.443	18.5	52.7	4.1	12.0	0.0		
D006-d006	22.5	dg 24h	144	-9.826	40.727	39.662	18.8	50.7	4.9	12.0	0.0		
D012-d012	22.5	dg 24h	142	-7.513	41.554	41.014	17.6	50.0	4.9	12.0	0.0		
D018-d018	22.5	dg 24h	140	-6.967	40.791	40.336	16.4	53.6	5.0	6.0	0.0		
D024-d024	22.5	dg 24h	143	-8.146	42.009	41.356	16.8	50.3	4.9	6.0	0.0		
D030-d030	22.5	dg 24h	140	-7.583	43.313	42.797	15.0	54.3	4.3	6.0	0.0		
D036-d036	22.5	dg 24h	138	-7.180	43.056	42.608	13.8	50.7	5.8	6.0	0.0		
D042-d042	22.5	dg 24h	140	-6.702	42.348	41.964	15.0	54.3	5.0	24.0	0.0		
D048-d048	22.5	dg 24h	141	-8.749	46.983	46.325	17.7	49.6	5.7	6.0	0.0		
D054-d054	22.5	dg 24h	143	-9.290	47.646	46.896	18.2	48.3	6.3	0.0	0.0		
D060-d060	22.5	dg 24h	139	-5.435	45.684	45.524	15.1	48.9	7.2	24.0	30.0		
D066-d066	22.5	dg 24h	142	-6.473	47.481	47.204	16.9	46.5	5.6	24.0	30.0		
D072-d072	22.5	dg 24h	145	-8.158	47.602	47.060	19.3	44.1	6.9	12.0	12.0		
DFC-dfc	22.5	dg 24h	59	13.443	26.222	22.707	0.0	54.2	8.5	0.0	0.0		
DEC-dec	22.5	dg 24h	50	-16.938	36.681	32.866	18.0	56.0	0.0	13.0	0.0		

APPENDIX D. SURFACE WATER TEMPERATURE SKILL ASSESSMENT TABLES

Table D-1. Water surface temperature skill assessment at Buoy A01.

Station: Bouy A01 Tidal range:********
Observed data time period from: / 2/ 1/2017 to / 7/ 2/2017 with gaps of 1.53 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			33561	8.204									
t			33561	8.037									
T-t	3.0	c 24h	33561	0.167	0.749	0.730	0.0	99.3	0.0	0.0	0.0		0.99
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	442	0.076	0.820	0.817	0.0	98.4	0.0	0.0	0.0		
T06-t06	3.0	c 24h	443	0.059	0.847	0.845	0.0	98.2	0.0	0.0	0.0		
T12-t12	3.0	c 24h	443	0.046	0.871	0.870	0.0	98.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	444	0.026	0.890	0.891	0.0	98.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	445	0.012	0.895	0.896	0.0	98.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	444	0.008	0.900	0.901	0.0	98.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	445	-0.002	0.892	0.893	0.0	98.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	444	-0.011	0.904	0.905	0.0	97.7	0.0	0.0	0.0		
T48-t48	3.0	c 24h	443	-0.017	0.920	0.921	0.0	98.0	0.0	0.0	0.0		

Table D-2. Water surface temperature skill assessment at Buoy B01.

Station: Buoy B01 - Western Maine Shelf Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 1.18 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			41081	7.742									
t			41081	7.199									
T-t	3.0	c 24h	41081	0.543	0.888	0.702	0.0	99.8	0.0	0.0	0.0		0.98
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	559	0.519	0.857	0.683	0.0	99.8	0.0	0.0	0.0		
T06-t06	3.0	c 24h	560	0.509	0.867	0.702	0.0	99.8	0.0	0.0	0.0		
T12-t12	3.0	c 24h	561	0.499	0.861	0.703	0.0	99.8	0.0	0.0	0.0		
T18-t18	3.0	c 24h	562	0.498	0.862	0.704	0.0	100.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	563	0.492	0.849	0.693	0.0	100.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	562	0.493	0.845	0.687	0.0	100.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	561	0.494	0.848	0.690	0.0	100.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	559	0.491	0.846	0.689	0.0	100.0	0.0	0.0	0.0		
T48-t48	3.0	c 24h	557	0.497	0.863	0.706	0.0	100.0	0.0	0.0	0.0		

Table D-3. Water surface temperature skill assessment at Buoy M01.

Station: Buoy M01 Jordan Basin Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 2/15/2017 with gaps of 18.21 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			6560	6.605									
t			6560	6.862									
T-t	3.0	c 24h	6560	-0.257	0.457	0.377	0.0	100.0	0.0	0.0	0.0		0.84
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	104	-0.260	0.467	0.390	0.0	100.0	0.0	0.0	0.0		
T06-t06	3.0	c 24h	106	-0.253	0.465	0.392	0.0	100.0	0.0	0.0	0.0		
T12-t12	3.0	c 24h	102	-0.259	0.467	0.391	0.0	100.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	104	-0.249	0.464	0.393	0.0	100.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	104	-0.238	0.460	0.395	0.0	100.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	102	-0.238	0.461	0.396	0.0	100.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	103	-0.232	0.458	0.397	0.0	100.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	100	-0.238	0.463	0.399	0.0	100.0	0.0	0.0	0.0		
T48-t48	3.0	c 24h	99	-0.244	0.464	0.396	0.0	100.0	0.0	0.0	0.0		

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Table D-4. Water surface temperature skill assessment at Buoy I01.

Station: Buoy Io1 Eastern Maine Shelf Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 2.96 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			40691	6.951									
t			40691	5.991									
T-t	3.0	c 24h	40691	0.961	1.323	0.910	0.0	99.2	0.0	0.0	0.0		0.88
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	552	0.934	1.330	0.948	0.0	98.9	0.0	0.0	0.0		
T06-t06	3.0	c 24h	554	0.933	1.333	0.954	0.0	98.7	0.0	0.0	0.0		
T12-t12	3.0	c 24h	554	0.933	1.333	0.953	0.0	98.7	0.0	0.0	0.0		
T18-t18	3.0	c 24h	554	0.928	1.326	0.948	0.0	98.9	0.0	0.0	0.0		
T24-t24	3.0	c 24h	555	0.925	1.313	0.932	0.0	98.6	0.0	0.0	0.0		
T30-t30	3.0	c 24h	554	0.932	1.321	0.937	0.0	98.7	0.0	0.0	0.0		
T36-t36	3.0	c 24h	554	0.928	1.316	0.934	0.0	98.9	0.0	0.0	0.0		
T42-t42	3.0	c 24h	553	0.915	1.298	0.923	0.0	98.4	0.0	0.0	0.0		
T48-t48	3.0	c 24h	551	0.902	1.286	0.917	0.0	99.1	0.0	0.0	0.0		

Table D-5. Water surface temperature skill assessment at Cutler Farris.

Station: Cutler Farris Wharf, ME Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.72 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			41182	6.317									
t			41182	4.965									
T-t	3.0	c 24h	41182	1.351	1.649	0.944	0.0	96.0	0.3	0.5	2.0		0.80
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	560	1.364	1.682	0.985	0.0	95.7	0.2	0.0	0.0		
T06-t06	3.0	c 24h	560	1.369	1.678	0.971	0.0	95.5	0.2	0.0	0.0		
T12-t12	3.0	c 24h	560	1.355	1.669	0.976	0.0	95.5	0.2	0.0	0.0		
T18-t18	3.0	c 24h	560	1.344	1.660	0.975	0.0	95.9	0.2	0.0	0.0		
T24-t24	3.0	c 24h	560	1.332	1.651	0.976	0.0	95.9	0.2	0.0	0.0		
T30-t30	3.0	c 24h	560	1.335	1.660	0.986	0.0	95.7	0.2	0.0	0.0		
T36-t36	3.0	c 24h	559	1.328	1.641	0.965	0.0	95.9	0.2	0.0	0.0		
T42-t42	3.0	c 24h	558	1.316	1.633	0.968	0.0	96.2	0.2	0.0	0.0		
T48-t48	3.0	c 24h	557	1.296	1.623	0.977	0.0	96.2	0.2	0.0	0.0		

Table D-6. Water surface temperature skill assessment at Bar Harbor.

Station: Bar Harbor, ME Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.72 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			41351	6.199									
t			41351	4.847									
T-t	3.0	c 24h	41351	1.352	1.584	0.826	0.0	95.4	0.0	0.0	0.0		0.95
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	564	1.372	1.609	0.841	0.0	94.9	0.0	0.0	0.0		
T06-t06	3.0	c 24h	564	1.366	1.601	0.836	0.0	95.0	0.0	0.0	0.0		
T12-t12	3.0	c 24h	564	1.351	1.583	0.826	0.0	95.4	0.0	0.0	0.0		
T18-t18	3.0	c 24h	564	1.335	1.573	0.833	0.0	95.2	0.0	0.0	0.0		
T24-t24	3.0	c 24h	564	1.316	1.552	0.823	0.0	95.7	0.0	0.0	0.0		
T30-t30	3.0	c 24h	564	1.308	1.550	0.832	0.0	95.6	0.0	0.0	0.0		
T36-t36	3.0	c 24h	563	1.294	1.540	0.836	0.0	95.9	0.0	0.0	0.0		
T42-t42	3.0	c 24h	562	1.265	1.517	0.838	0.0	95.9	0.0	0.0	0.0		
T48-t48	3.0	c 24h	561	1.238	1.498	0.843	0.0	95.9	0.0	0.0	0.0		

Table D-7. Water surface temperature skill assessment at Portland.

Station: Portland, ME Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 0.72 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			41351	7.457									
t			41351	5.477									
T-t	3.0	c 24h	41351	1.980	2.194	0.944	0.0	89.2	0.0	0.0	0.6		0.90
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	563	2.026	2.240	0.955	0.0	88.3	0.0	0.0	0.0		
T06-t06	3.0	c 24h	564	2.031	2.243	0.952	0.0	89.2	0.0	0.0	0.0		
T12-t12	3.0	c 24h	564	2.024	2.233	0.945	0.0	88.5	0.0	0.0	0.0		
T18-t18	3.0	c 24h	564	2.011	2.216	0.932	0.0	88.5	0.0	0.0	0.0		
T24-t24	3.0	c 24h	564	2.002	2.202	0.918	0.0	89.7	0.0	0.0	0.0		
T30-t30	3.0	c 24h	564	1.991	2.191	0.916	0.0	89.7	0.0	0.0	0.0		
T36-t36	3.0	c 24h	563	1.972	2.175	0.919	0.0	90.1	0.0	0.0	0.0		
T42-t42	3.0	c 24h	562	1.951	2.155	0.916	0.0	90.2	0.0	0.0	0.0		
T48-t48	3.0	c 24h	561	1.947	2.161	0.939	0.0	89.3	0.0	0.0	0.0		

Table D-8. Water surface temperature skill assessment at 12 nautical miles SE of Portland.

Station: 12 NM SE of Portland Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 2.04 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			40873	7.584									
t			40873	6.711									
T-t	3.0	c 24h	40873	0.873	1.176	0.789	0.0	99.8	0.0	0.0	0.0		0.96
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	558	0.852	1.135	0.750	0.0	100.0	0.0	0.0	0.0		
T06-t06	3.0	c 24h	559	0.850	1.137	0.755	0.0	100.0	0.0	0.0	0.0		
T12-t12	3.0	c 24h	559	0.832	1.122	0.753	0.0	100.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	559	0.809	1.107	0.757	0.0	100.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	559	0.791	1.109	0.778	0.0	100.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	558	0.778	1.108	0.790	0.0	100.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	557	0.775	1.112	0.798	0.0	100.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	556	0.765	1.101	0.793	0.0	100.0	0.0	0.0	0.0		
T48-t48	3.0	c 24h	555	0.761	1.102	0.798	0.0	100.0	0.0	0.0	0.0		

Table D-9. Water surface temperature skill assessment at Wells.

Station: Wells, ME Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 3/2017 with gaps of 2.04 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			41351	7.316									
t			41351	6.448									
T-t	3.0	c 24h	41351	0.869	1.499	1.222	0.0	94.9	0.0	0.0	0.0		0.95
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	564	0.877	1.537	1.264	0.0	94.5	0.0	0.0	0.0		
T06-t06	3.0	c 24h	564	0.885	1.536	1.257	0.0	94.9	0.0	0.0	0.0		
T12-t12	3.0	c 24h	564	0.864	1.520	1.251	0.0	94.5	0.0	0.0	0.0		
T18-t18	3.0	c 24h	564	0.866	1.542	1.277	0.0	94.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	564	0.849	1.534	1.279	0.0	94.3	0.0	0.0	0.0		
T30-t30	3.0	c 24h	564	0.843	1.531	1.278	0.0	94.5	0.0	0.0	0.0		
T36-t36	3.0	c 24h	563	0.822	1.533	1.295	0.0	94.5	0.0	0.0	0.0		
T42-t42	3.0	c 24h	562	0.804	1.549	1.326	0.0	94.7	0.0	0.0	0.0		
T48-t48	3.0	c 24h	561	0.783	1.553	1.342	0.0	94.5	0.0	0.0	0.0		

Table D-10. Water surface temperature skill assessment at Boston.

Station: Boston, MA Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 6/16/2017 with gaps of 2.04 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			38127	6.756									
t			38127	6.461									
T-t	3.0	c 24h	38127	0.295	1.073	1.031	0.0	97.6	0.0	0.0	0.0		0.98
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	511	0.265	1.068	1.035	0.0	98.0	0.0	0.0	0.0		
T06-t06	3.0	c 24h	510	0.261	1.062	1.030	0.0	97.6	0.0	0.0	0.0		
T12-t12	3.0	c 24h	509	0.254	1.035	1.004	0.0	98.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	508	0.245	0.998	0.968	0.0	98.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	507	0.226	0.974	0.948	0.0	98.2	0.0	0.0	0.0		
T30-t30	3.0	c 24h	506	0.216	0.959	0.935	0.0	98.4	0.0	0.0	0.0		
T36-t36	3.0	c 24h	505	0.206	0.949	0.927	0.0	98.8	0.0	0.0	0.0		
T42-t42	3.0	c 24h	504	0.200	0.954	0.934	0.0	98.4	0.0	0.0	0.0		
T48-t48	3.0	c 24h	503	0.199	0.945	0.925	0.0	98.8	0.0	0.0	0.0		

Table D-11. Water surface temperature skill assessment at Northeast-Channel (N01).

Station: Northeast-Channel Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 3.13 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			40681	6.796									
t			40681	4.986									
T-t	3.0	c 24h	40681	1.810	2.126	1.114	0.0	85.6	0.0	0.0	0.0		0.84
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	552	1.774	2.079	1.086	0.0	85.3	0.0	0.0	0.0		
T06-t06	3.0	c 24h	553	1.760	2.072	1.094	0.0	85.2	0.0	0.0	0.0		
T12-t12	3.0	c 24h	553	1.749	2.070	1.109	0.0	85.4	0.0	0.0	0.0		
T18-t18	3.0	c 24h	553	1.746	2.075	1.121	0.0	85.7	0.0	0.0	0.0		
T24-t24	3.0	c 24h	554	1.751	2.080	1.123	0.0	85.6	0.0	0.0	0.0		
T30-t30	3.0	c 24h	554	1.753	2.087	1.134	0.0	86.5	0.0	0.0	0.0		
T36-t36	3.0	c 24h	553	1.754	2.098	1.152	0.0	85.4	0.0	0.0	0.0		
T42-t42	3.0	c 24h	552	1.742	2.097	1.169	0.0	84.8	0.0	0.0	0.0		
T48-t48	3.0	c 24h	550	1.749	2.111	1.182	0.0	84.9	0.0	0.0	0.0		

Table D-12. Water surface temperature skill assessment at Jeffrey's Ledge.

Station: Jeffrey's Ledge, NH Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 19.29 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			36740	8.363									
t			36740	7.942									
T-t	3.0	c 24h	36740	0.421	0.946	0.847	0.0	99.9	0.0	0.0	0.0		0.97
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	495	0.395	0.926	0.839	0.0	100.0	0.0	0.0	0.0		
T06-t06	3.0	c 24h	495	0.386	0.923	0.839	0.0	100.0	0.0	0.0	0.0		
T12-t12	3.0	c 24h	494	0.369	0.906	0.828	0.0	100.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	493	0.359	0.895	0.820	0.0	100.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	492	0.356	0.896	0.823	0.0	100.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	491	0.353	0.884	0.811	0.0	100.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	491	0.351	0.885	0.814	0.0	100.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	490	0.342	0.889	0.822	0.0	100.0	0.0	0.0	0.0		
T48-t48	3.0	c 24h	490	0.329	0.877	0.814	0.0	100.0	0.0	0.0	0.0		

Table D-13. Water surface temperature skill assessment at Gulf of Maine.

Station: Gulf of Maine Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 2.16 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			40843	7.775									
t			40843	7.346									
T-t	3.0	c 24h	40843	0.430	0.863	0.748	0.0	100.0	0.0	0.0	0.0		0.98
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	556	0.350	0.831	0.754	0.0	100.0	0.0	0.0	0.0		
T06-t06	3.0	c 24h	558	0.340	0.821	0.748	0.0	100.0	0.0	0.0	0.0		
T12-t12	3.0	c 24h	558	0.324	0.815	0.749	0.0	100.0	0.0	0.0	0.0		
T18-t18	3.0	c 24h	558	0.304	0.809	0.751	0.0	100.0	0.0	0.0	0.0		
T24-t24	3.0	c 24h	558	0.296	0.809	0.754	0.0	100.0	0.0	0.0	0.0		
T30-t30	3.0	c 24h	556	0.294	0.802	0.747	0.0	100.0	0.0	0.0	0.0		
T36-t36	3.0	c 24h	555	0.296	0.804	0.748	0.0	100.0	0.0	0.0	0.0		
T42-t42	3.0	c 24h	554	0.289	0.812	0.759	0.0	100.0	0.0	0.0	0.0		
T48-t48	3.0	c 24h	553	0.290	0.804	0.751	0.0	100.0	0.0	0.0	0.0		

Table D-14. Water surface temperature skill assessment at Georges Bank.

Station: Georges Bank Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 2/2017 with gaps of 1.73 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
T			40962	7.903									
t			40962	7.146									
T-t	3.0	c 24h	40962	0.756	1.339	1.105	0.0	98.7	0.0	0.0	0.0		0.88
SCENARIO: SEMI-OPERATIONAL FORECAST													
T00-t00	3.0	c 24h	558	0.711	1.274	1.058	0.0	99.5	0.0	0.0	0.0		
T06-t06	3.0	c 24h	559	0.692	1.274	1.070	0.0	99.5	0.0	0.0	0.0		
T12-t12	3.0	c 24h	559	0.665	1.274	1.087	0.0	99.8	0.0	0.0	0.0		
T18-t18	3.0	c 24h	559	0.650	1.289	1.114	0.0	99.6	0.0	0.0	0.0		
T24-t24	3.0	c 24h	559	0.648	1.298	1.126	0.0	99.6	0.0	0.0	0.0		
T30-t30	3.0	c 24h	558	0.639	1.307	1.141	0.0	99.5	0.0	0.0	0.0		
T36-t36	3.0	c 24h	557	0.630	1.317	1.157	0.0	99.1	0.0	0.0	0.0		
T42-t42	3.0	c 24h	556	0.614	1.322	1.172	0.0	99.3	0.0	0.0	0.0		
T48-t48	3.0	c 24h	555	0.598	1.322	1.181	0.0	98.9	0.0	0.0	0.0		

APPENDIX E. MODELED SURFACE WATER TEMPERATURE VERSUS OBSERVATIONS

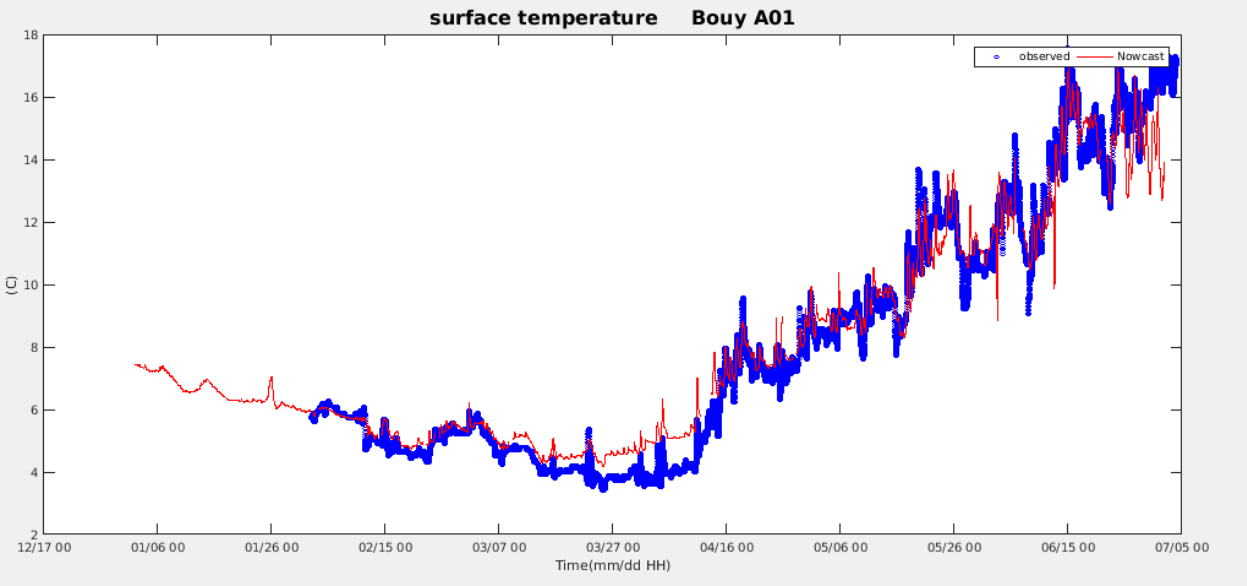

Figure E-1. Modeled versus observed surface water temperature at A01.

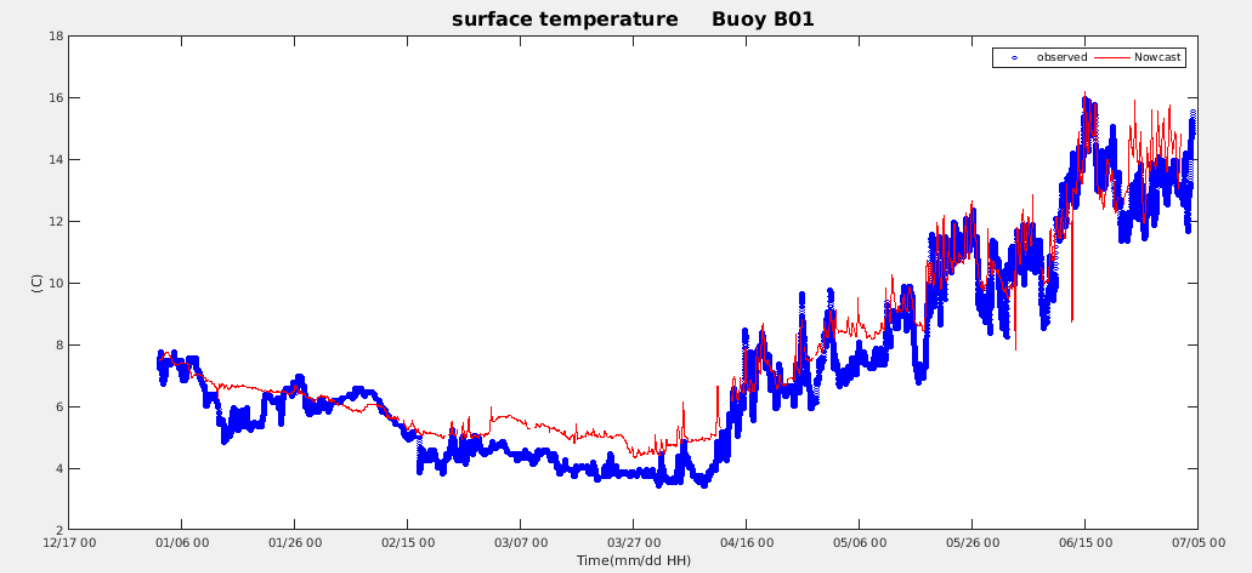

Figure E-2. Modeled versus observed surface water temperature at B01.

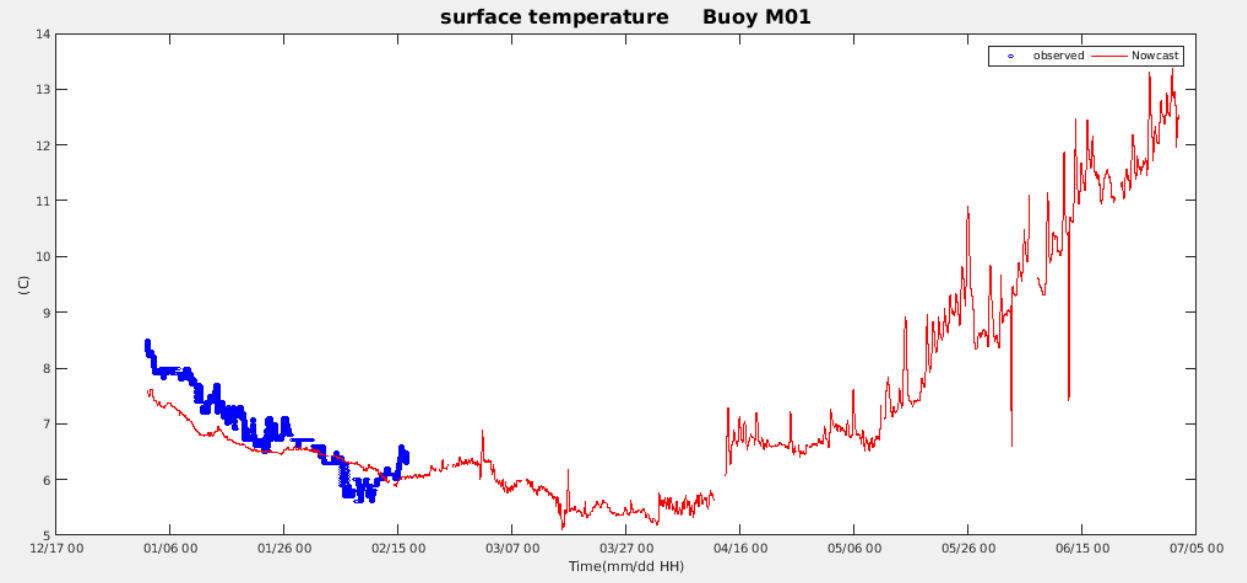

Figure E-3. Modeled versus observed surface water temperature at M01.

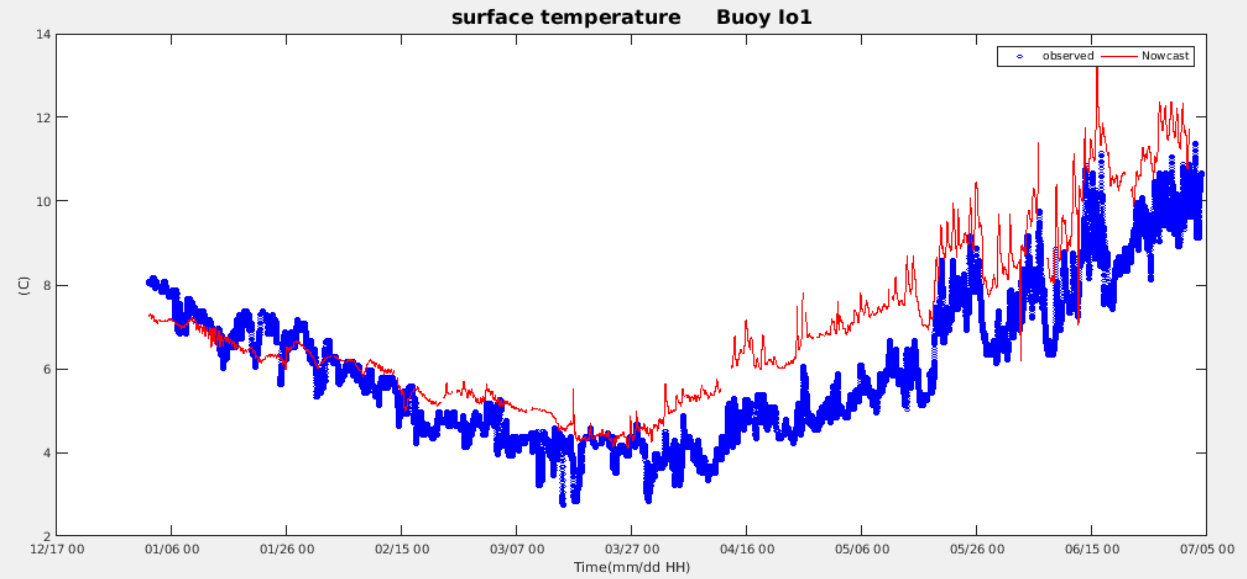

Figure E-4. Modeled versus observed surface water temperature at I01.

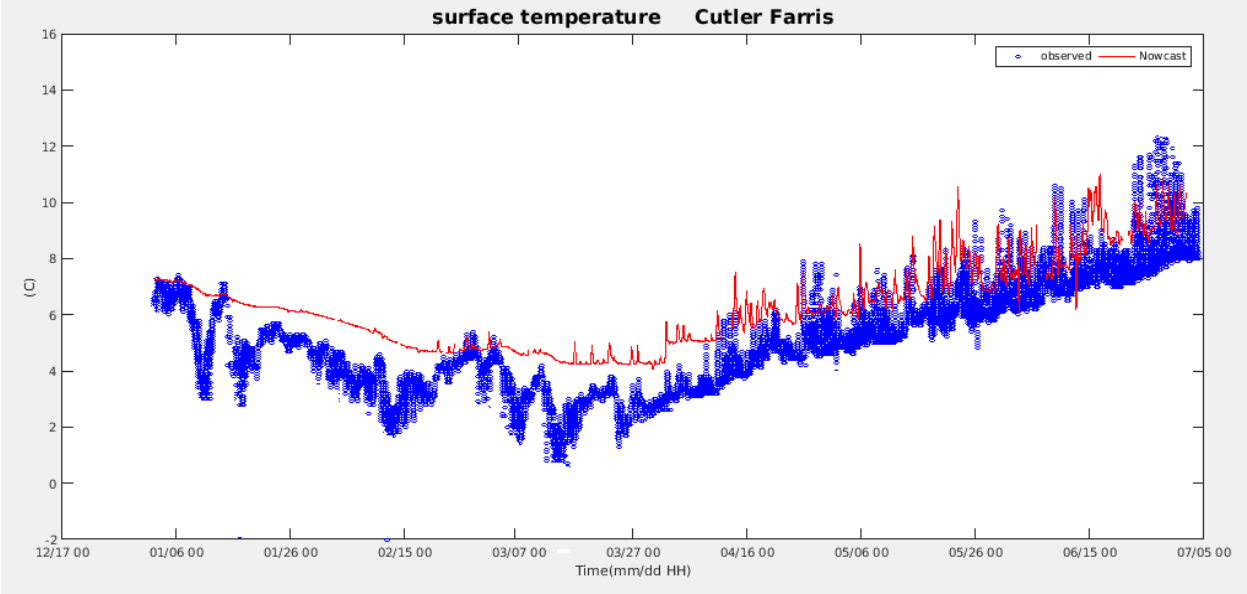

Figure E-5. Modeled versus observed surface water temperature at Curler Farris.

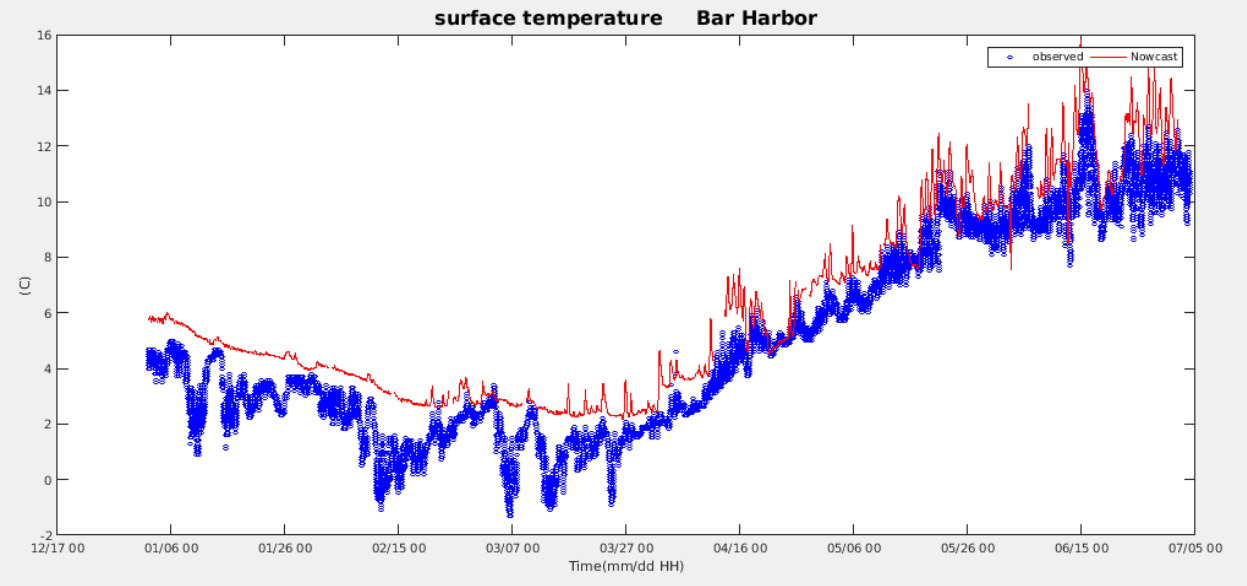

Figure E-6. Modeled versus observed surface water temperature at Bar Harbor.

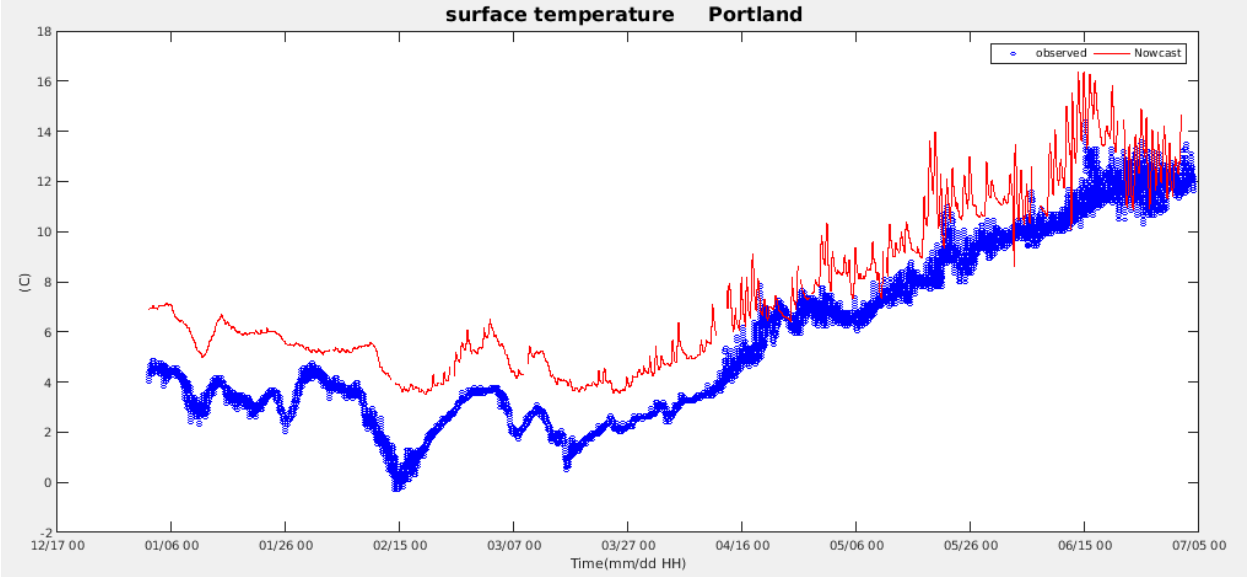

Figure E-7. Modeled versus observed surface water temperature at Portland.

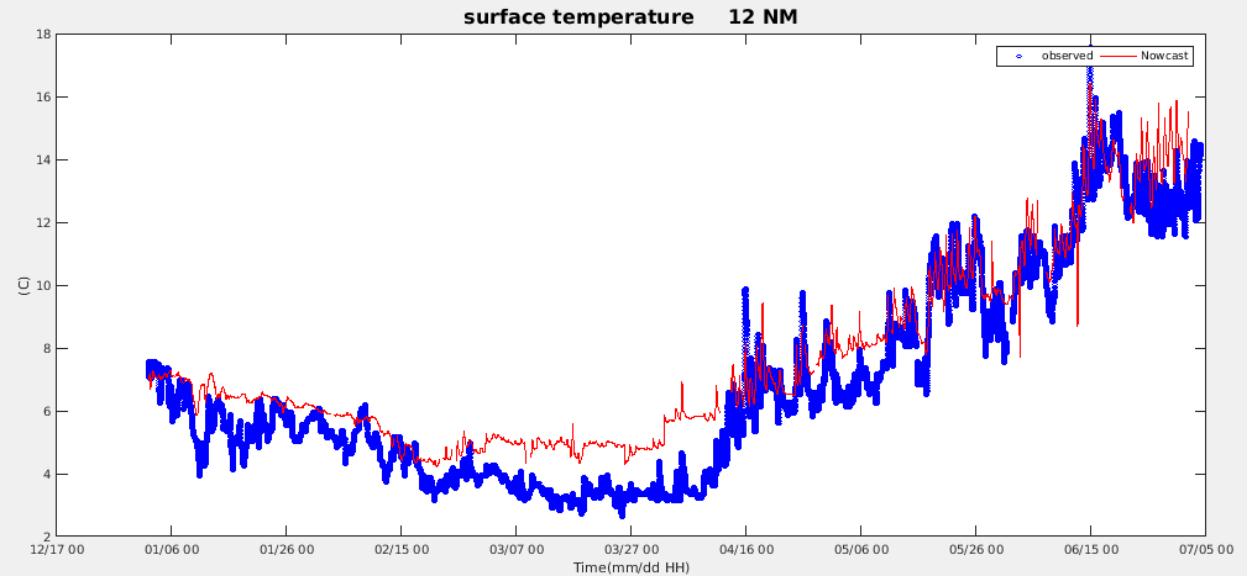

Figure E-8. Modeled versus observed surface water temperature at 12 nautical miles SE of Portland.

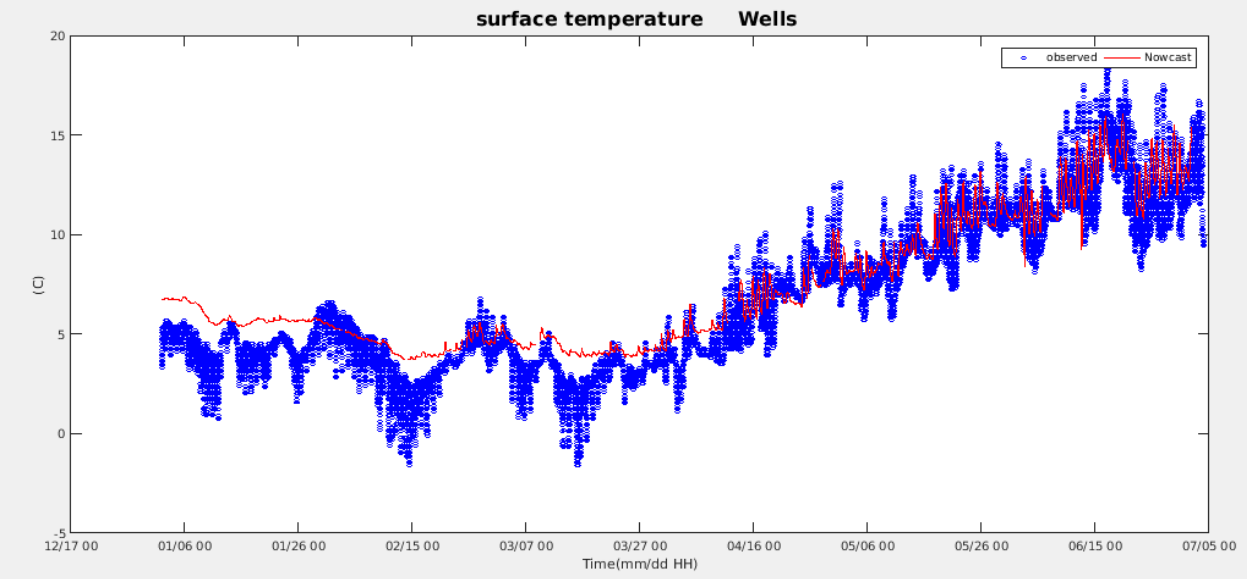

Figure E-9. Modeled versus observed surface water temperature at Wells.

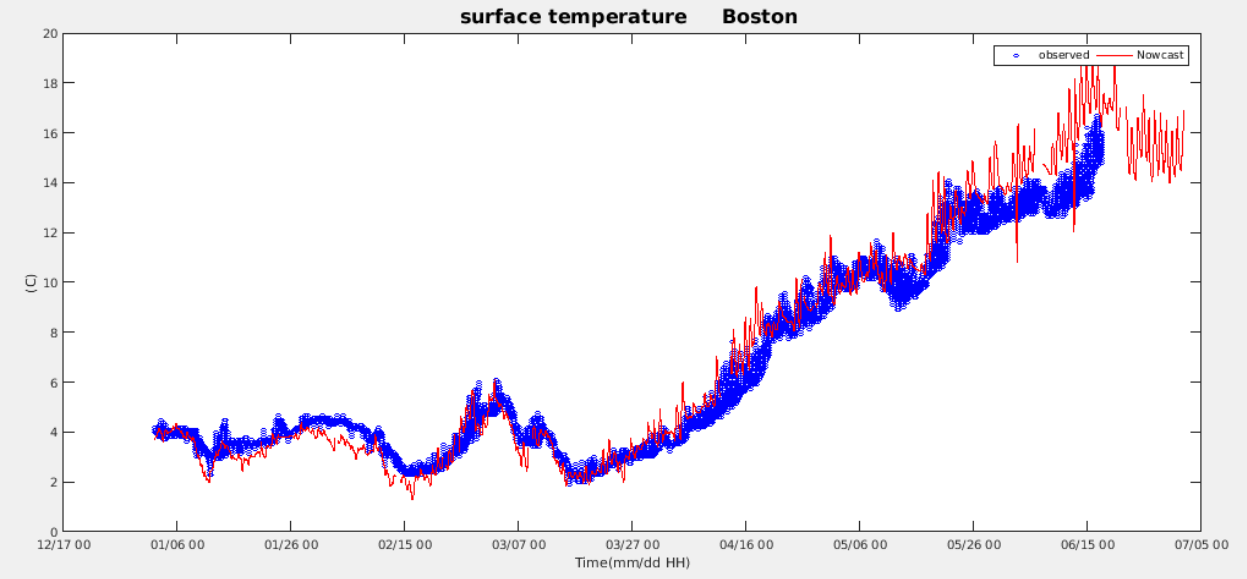

Figure E-10. Modeled versus observed surface water temperature at Boston.

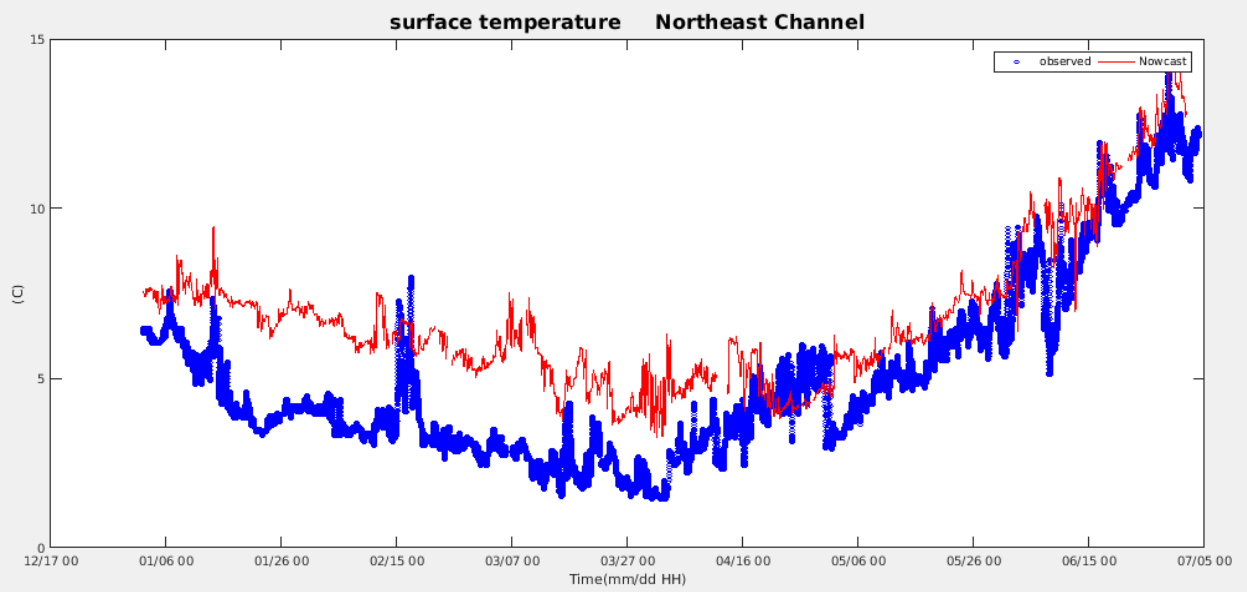

Figure E-11. Modeled versus observed surface water temperature at Northeast Channel.

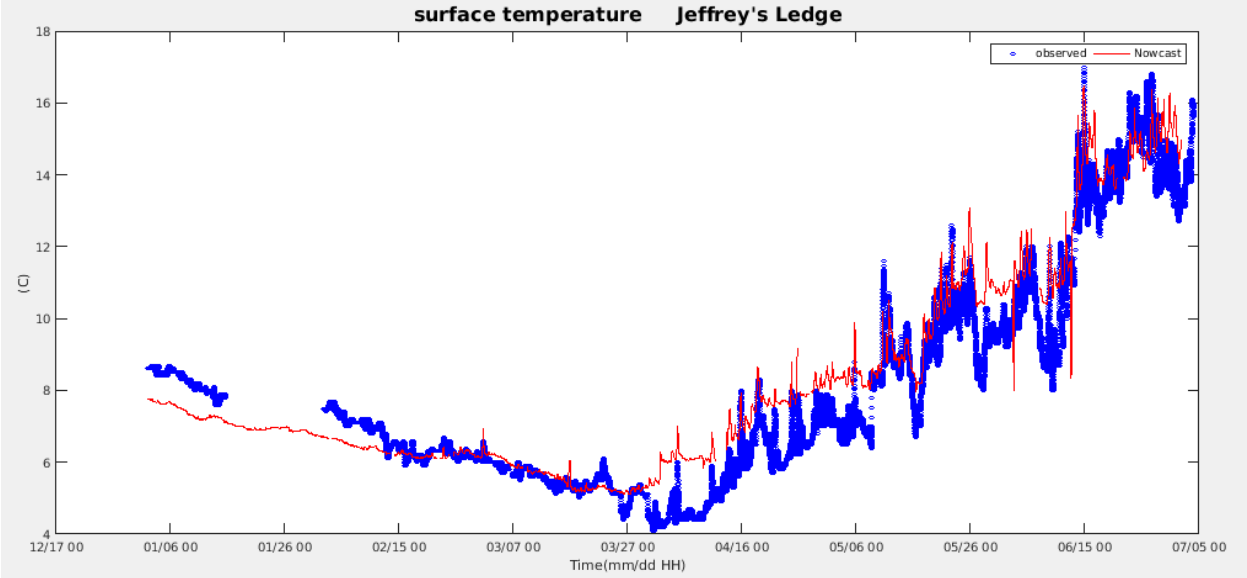

Figure E-12. Modeled versus observed surface water temperature at Jeffrey's Ledge.

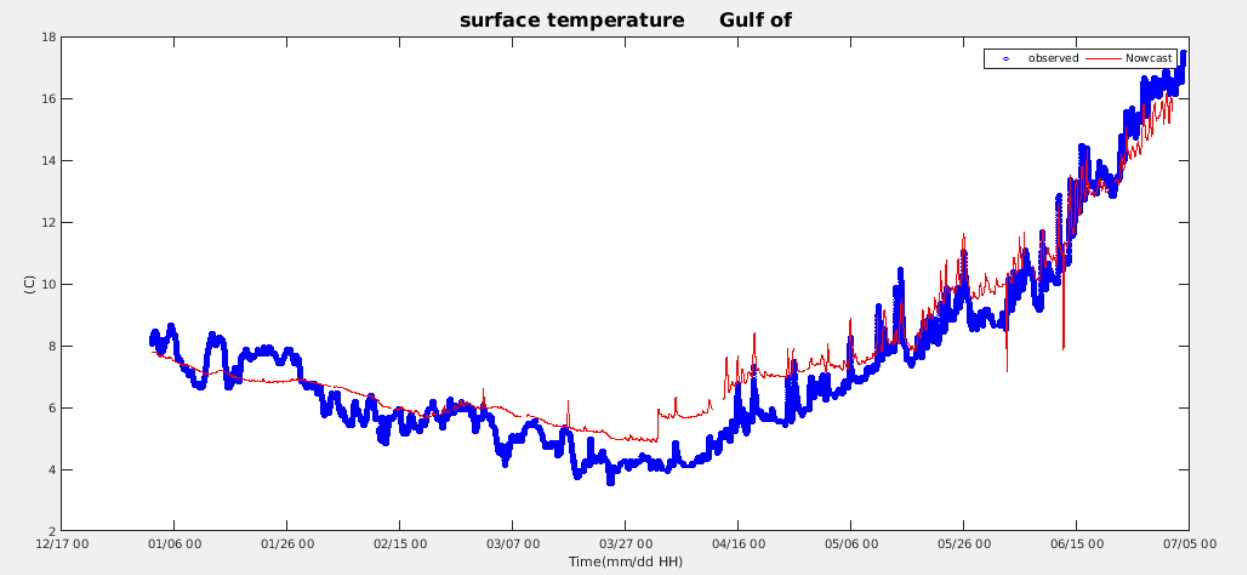

Figure E-13. Modeled versus observed surface water temperature at Gulf of Maine.

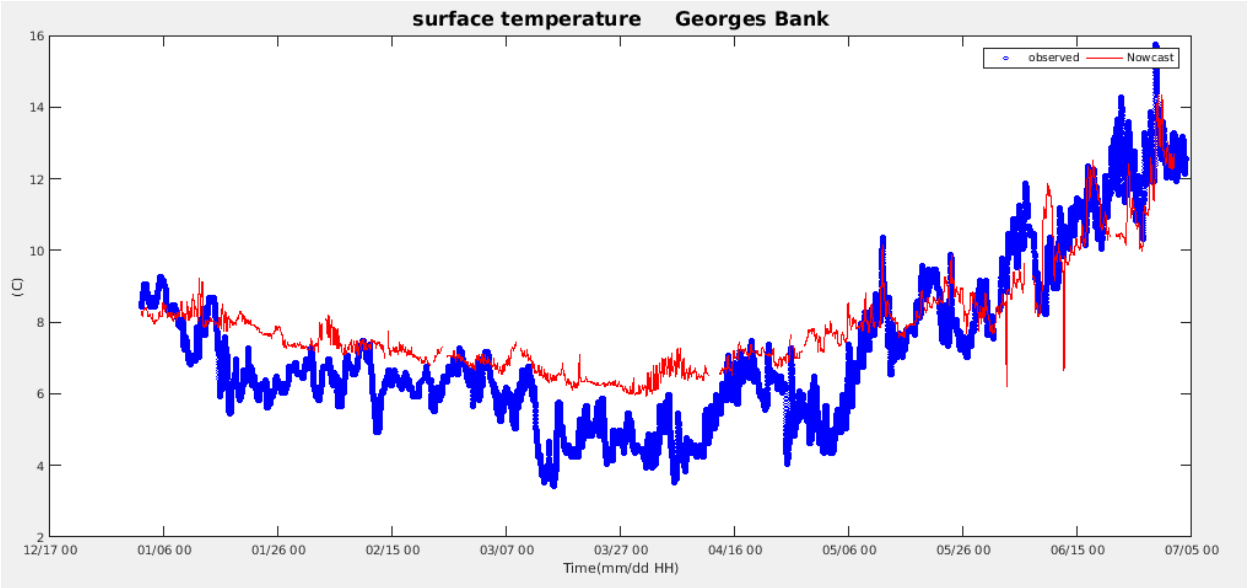

Figure E-14. Modeled versus observed surface water temperature at Georges Bank.

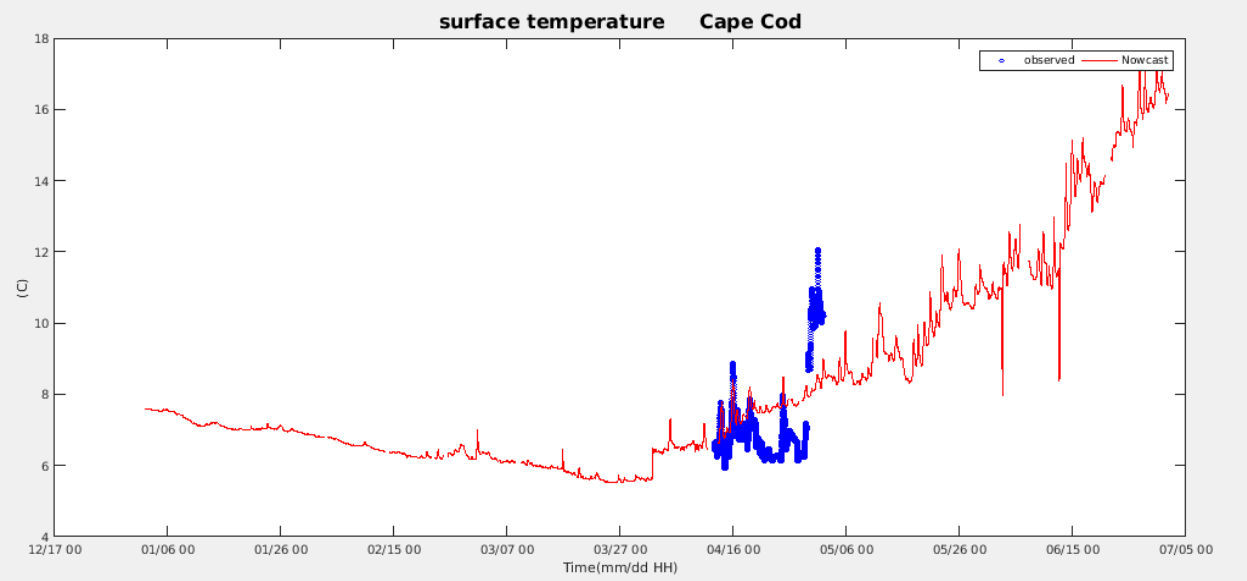

Figure E-15. Modeled versus observed surface water temperature at Cape Cod.

APPENDIX F. SURFACE WATER SALINITY SKILL ASSESSMENT TABLES

Table F-1. Water surface salinity skill assessment at Buoy B01.

Station: Bouy B01 Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 1/2017 with gaps of 0.00 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
S			41351	32.208									
s			41351	31.249									
S-s	3.5	24h	41351	0.961	1.489	1.138	0.1	96.8	0.0	1.8	0.0		0.68
SCENARIO: SEMI-OPERATIONAL FORECAST													
S00-s00	3.5	24h	561	0.936	1.422	1.071	0.0	97.3	0.0	0.0	0.0		
S06-s06	3.5	24h	560	0.951	1.446	1.091	0.0	97.1	0.0	0.0	0.0		
S12-s12	3.5	24h	559	0.953	1.444	1.085	0.0	97.1	0.0	0.0	0.0		
S18-s18	3.5	24h	558	0.953	1.435	1.073	0.0	97.8	0.0	0.0	0.0		
S24-s24	3.5	24h	557	0.956	1.438	1.075	0.0	97.3	0.0	0.0	0.0		
S30-s30	3.5	24h	556	0.956	1.435	1.071	0.0	97.1	0.0	0.0	0.0		
S36-s36	3.5	24h	555	0.954	1.432	1.069	0.0	97.5	0.0	0.0	0.0		
S42-s42	3.5	24h	554	0.948	1.428	1.069	0.0	97.1	0.0	0.0	0.0		
S48-s48	3.5	24h	553	0.936	1.411	1.057	0.0	97.5	0.0	0.0	0.0		

Table F-2. Water surface salinity skill assessment at Buoy E01.

Station: Buoy E01 Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 1/2017 with gaps of 0.13 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
S			41322	32.798									
s			41322	31.457									
S-s	3.5	24h	41322	1.342	1.651	0.961	0.1	97.5	0.0	1.5	0.0		0.44
SCENARIO: SEMI-OPERATIONAL FORECAST													
S00-s00	3.5	24h	561	1.359	1.662	0.957	0.0	97.0	0.0	0.0	0.0		
S06-s06	3.5	24h	560	1.355	1.656	0.952	0.0	97.0	0.0	0.0	0.0		
S12-s12	3.5	24h	559	1.360	1.662	0.956	0.0	97.0	0.0	0.0	0.0		
S18-s18	3.5	24h	558	1.356	1.653	0.948	0.0	97.1	0.0	0.0	0.0		
S24-s24	3.5	24h	556	1.355	1.650	0.942	0.0	97.1	0.0	0.0	0.0		
S30-s30	3.5	24h	555	1.354	1.647	0.939	0.0	97.1	0.0	0.0	0.0		
S36-s36	3.5	24h	554	1.348	1.637	0.930	0.0	97.1	0.0	0.0	0.0		
S42-s42	3.5	24h	553	1.340	1.618	0.908	0.0	97.3	0.0	0.0	0.0		
S48-s48	3.5	24h	552	1.339	1.616	0.905	0.0	97.3	0.0	0.0	0.0		

Table F-3. Water surface salinity skill assessment at Buoy M01.

Station: Buoy M01 Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 2/13/2017 with gaps of 0.13 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
S			10282	32.957									
s			10282	32.800									
S-s	3.5	24h	10282	0.158	0.226	0.162	0.0	100.0	0.0	0.0	0.0		0.39
SCENARIO: SEMI-OPERATIONAL FORECAST													
S00-s00	3.5	24h	156	0.145	0.222	0.168	0.0	100.0	0.0	0.0	0.0		
S06-s06	3.5	24h	156	0.150	0.219	0.161	0.0	100.0	0.0	0.0	0.0		
S12-s12	3.5	24h	156	0.154	0.219	0.156	0.0	100.0	0.0	0.0	0.0		
S18-s18	3.5	24h	156	0.159	0.219	0.150	0.0	100.0	0.0	0.0	0.0		
S24-s24	3.5	24h	156	0.163	0.219	0.146	0.0	100.0	0.0	0.0	0.0		
S30-s30	3.5	24h	155	0.166	0.219	0.142	0.0	100.0	0.0	0.0	0.0		
S36-s36	3.5	24h	154	0.169	0.220	0.141	0.0	100.0	0.0	0.0	0.0		
S42-s42	3.5	24h	153	0.171	0.221	0.141	0.0	100.0	0.0	0.0	0.0		
S48-s48	3.5	24h	152	0.173	0.222	0.141	0.0	100.0	0.0	0.0	0.0		

Table F-4. Water surface salinity skill assessment at Buoy I01.

Station: Buoy Io1 Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 7/ 1/2017 with gaps of 1.93 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
S			40895	32.436									
s			40895	32.029									
S-s	3.5	24h	40895	0.407	0.695	0.564	0.2	99.7	0.0	3.5	0.0		0.75
SCENARIO: SEMI-OPERATIONAL FORECAST													
S00-s00	3.5	24h	554	0.390	0.558	0.400	0.0	100.0	0.0	0.0	0.0		
S06-s06	3.5	24h	553	0.396	0.566	0.404	0.0	100.0	0.0	0.0	0.0		
S12-s12	3.5	24h	552	0.400	0.569	0.405	0.0	100.0	0.0	0.0	0.0		
S18-s18	3.5	24h	551	0.402	0.570	0.405	0.0	100.0	0.0	0.0	0.0		
S24-s24	3.5	24h	550	0.406	0.569	0.400	0.0	100.0	0.0	0.0	0.0		
S30-s30	3.5	24h	550	0.407	0.568	0.397	0.0	100.0	0.0	0.0	0.0		
S36-s36	3.5	24h	550	0.413	0.574	0.399	0.0	100.0	0.0	0.0	0.0		
S42-s42	3.5	24h	549	0.420	0.577	0.396	0.0	100.0	0.0	0.0	0.0		
S48-s48	3.5	24h	548	0.423	0.580	0.397	0.0	100.0	0.0	0.0	0.0		

Table F-5. Water surface salinity skill assessment at Buoy N01 (Northeast Channel).

Station: Northeast Channel Tidal range:********
Observed data time period from: / 1/ 1/2017 to / 4/30/2017 with gaps of 0.13 days
Data gap is filled using SVD method
Data are not filtered

VARIABLE	X	N	IMAX	SM	RMSE	SD	NOF	CF	POF	MDNO	MDPO	WOF	SKILL
CRITERION	-	-	-	-	-	-	<1%	>90%	<1%	<N	<N	<.5%	
SCENARIO: SEMI-OPERATIONAL NOWCAST													
S			27189	32.470									
s			27189	32.113									
S-s	3.5	24h	27189	0.357	1.130	1.072	0.0	100.0	0.0	0.0	0.0		0.20
SCENARIO: SEMI-OPERATIONAL FORECAST													
S00-s00	3.5	24h	360	0.440	1.110	1.020	0.0	100.0	0.0	0.0	0.0		
S06-s06	3.5	24h	359	0.442	1.111	1.020	0.0	100.0	0.0	0.0	0.0		
S12-s12	3.5	24h	358	0.449	1.114	1.021	0.0	100.0	0.0	0.0	0.0		
S18-s18	3.5	24h	357	0.459	1.111	1.014	0.0	100.0	0.0	0.0	0.0		
S24-s24	3.5	24h	356	0.465	1.111	1.010	0.0	100.0	0.0	0.0	0.0		
S30-s30	3.5	24h	355	0.469	1.106	1.003	0.0	100.0	0.0	0.0	0.0		
S36-s36	3.5	24h	355	0.467	1.113	1.012	0.0	100.0	0.0	0.0	0.0		
S42-s42	3.5	24h	355	0.459	1.115	1.017	0.0	100.0	0.0	0.0	0.0		
S48-s48	3.5	24h	355	0.464	1.120	1.021	0.0	100.0	0.0	0.0	0.0		

APPENDIX G. MODELED SURFACE WATER SALINITY VERSUS OBSERVATIONS FIGURES

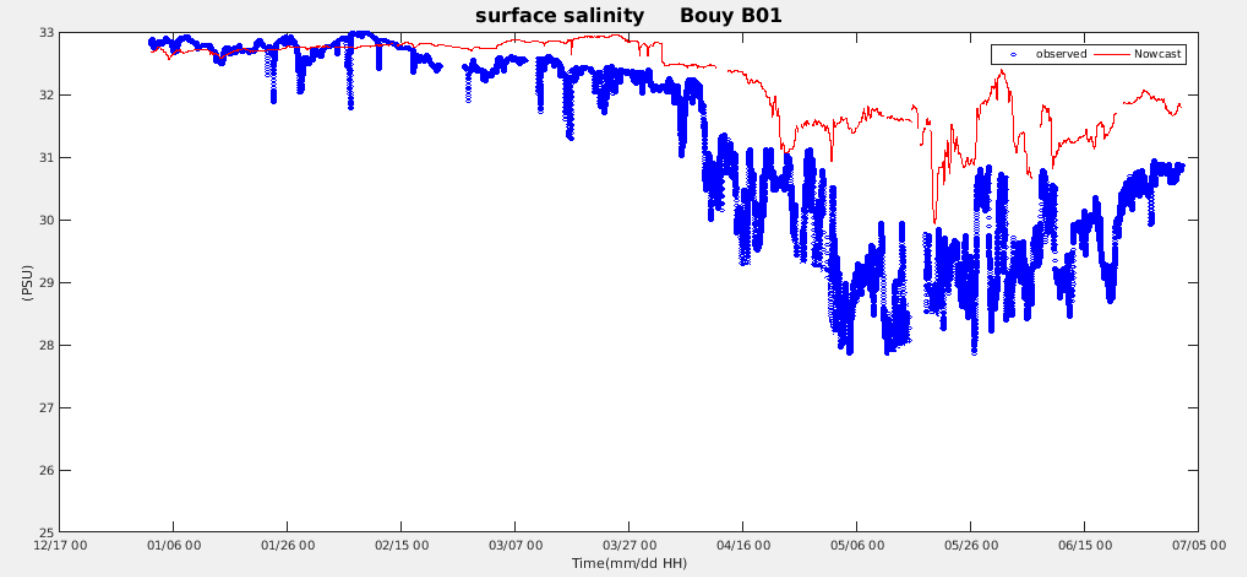

Figure G-1. Modeled versus observed surface water salinity at Buoy B01.

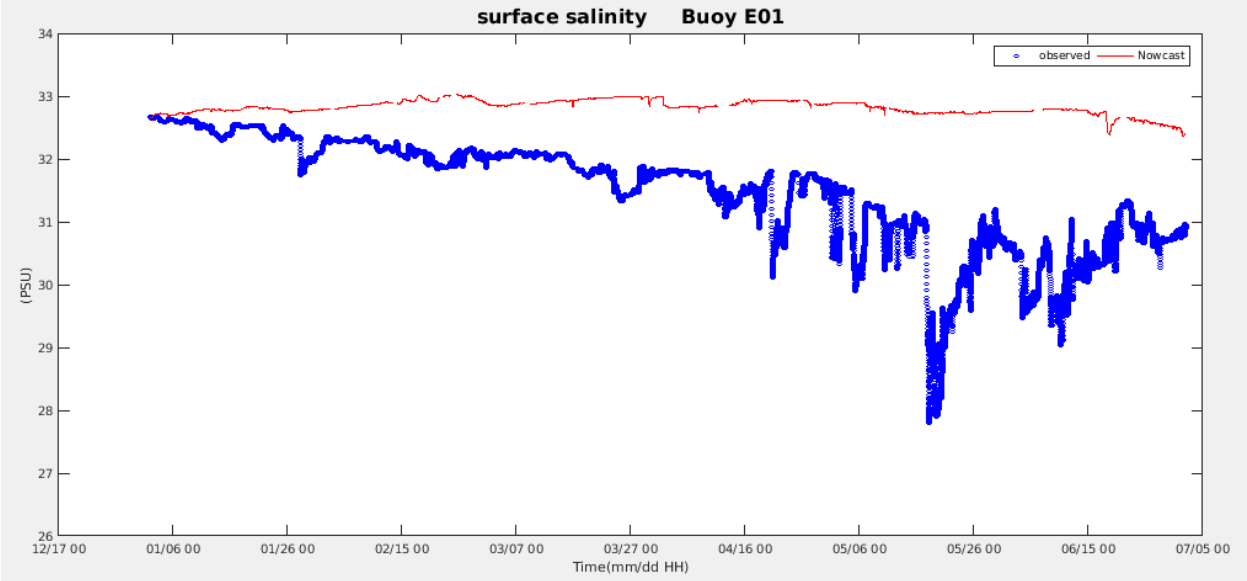

Figure G-2. Modeled versus observed surface water salinity at Buoy E01.

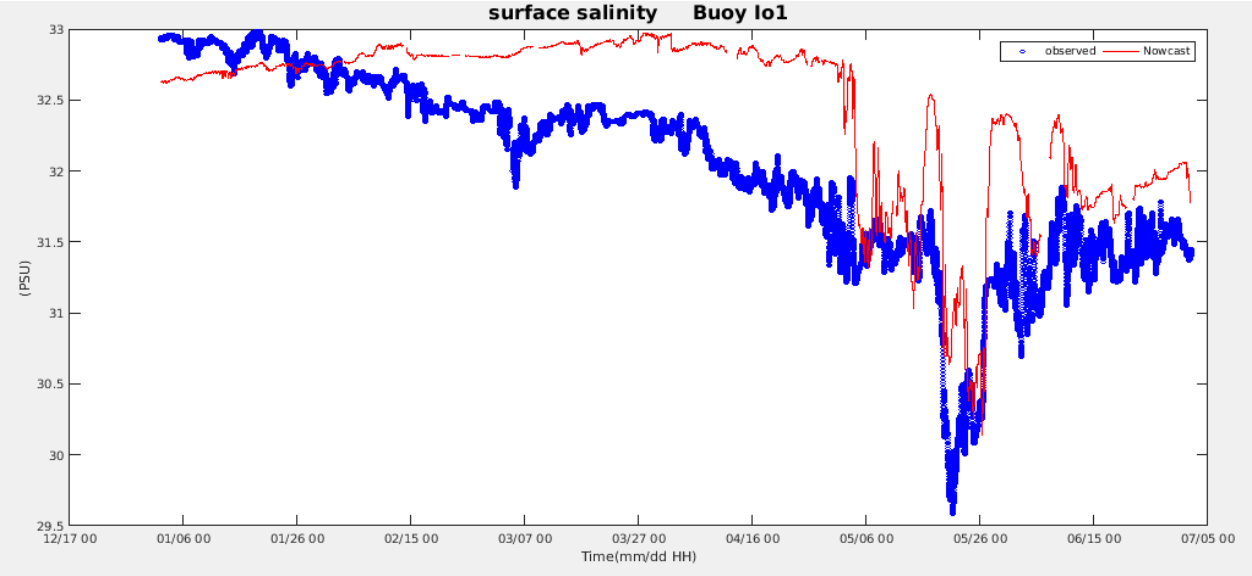

Figure G-3. Modeled versus observed surface water salinity at Buoy I01.

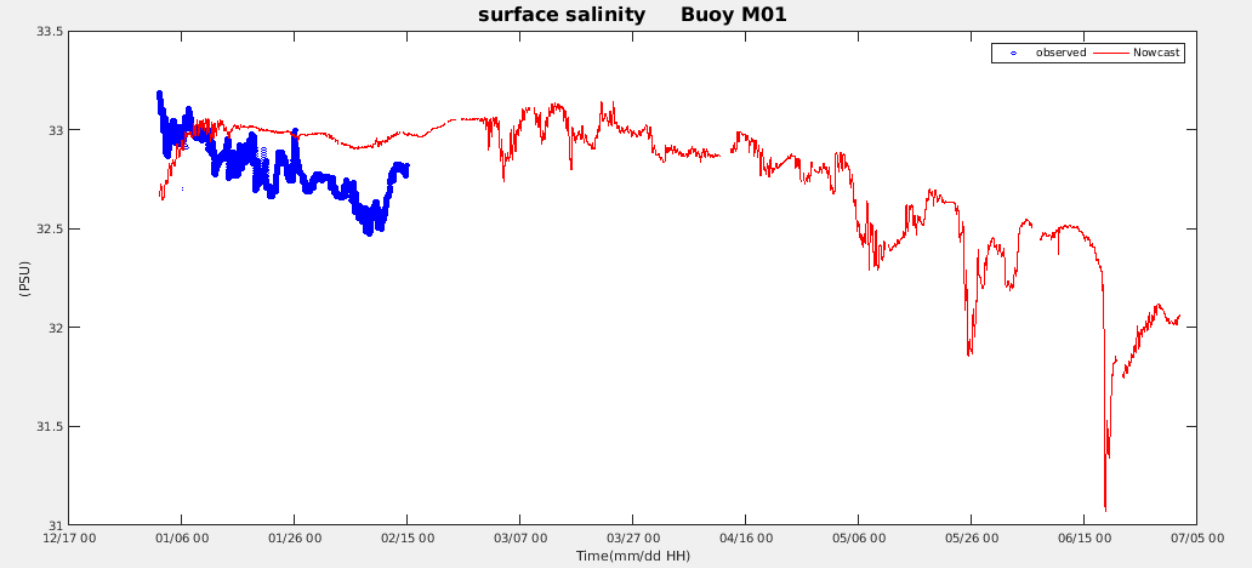

Figure G-4. Modeled versus observed surface water salinity at Buoy M01.

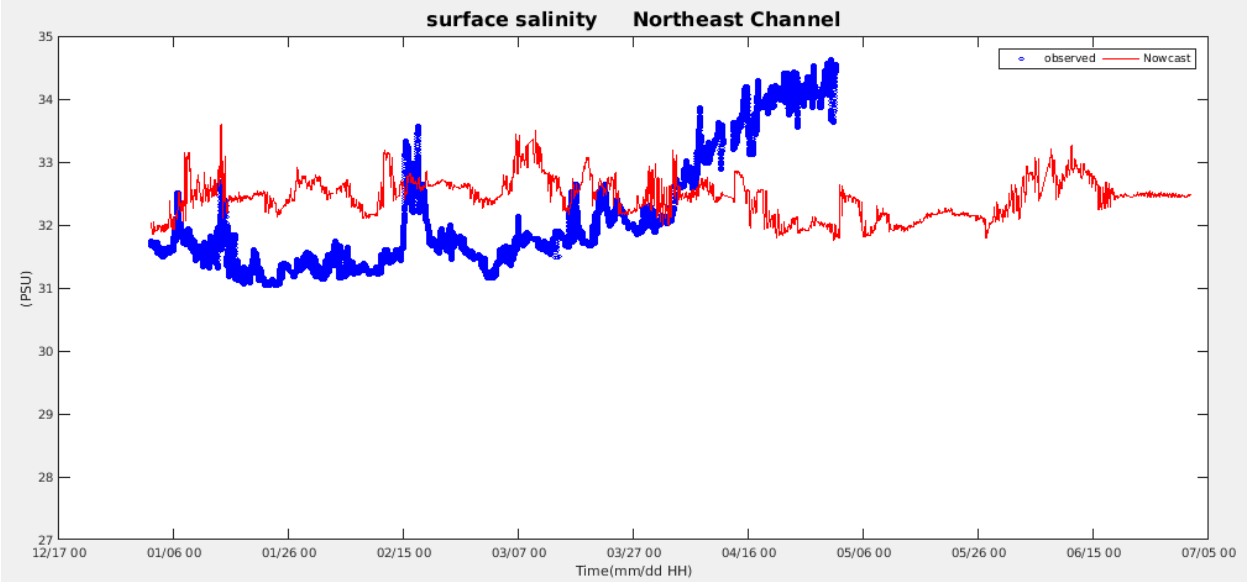

Figure G-5. Modeled versus observed surface water salinity at Northeast Channel (N01).

ACRONYMS

ADCIRC	Advanced Circulation
AEC	Amplitude of maximum ebb current
AFC	Amplitude of maximum flood current
CF	central frequency
COMF	Coastal Ocean Modeling Framework
CO-OPS	Center for Operational Oceanographic Products and Services
CSDL	Coast Survey Development Laboratory
ETSS	Extra-tropical Storm Surge
GFS	Global Forecast System
GoMOFS	Gulf of Maine Operational Forecast System
G-RTOFS	Global Operational Real-Time Ocean Forecast System
HAB	harmful algal bloom
HPC	High Performance Computing
HYCOM	Hybrid Coordinate Ocean Model
m/s	meters per second
m	meters
MDPO	maximum duration of positive outliers
MDNO	maximum duration of negative outliers
NAM	North American Mesoscale
NCEP	National Centers for Environmental Prediction
NDBC	National Data Buoy Center
NERACOOS	Northeastern Regional Association of Coastal Ocean Observing Systems
N/F	Nowcast/Forecast
NOAA	National Oceanic and Atmospheric Administration
NOF	negative outlier frequency
NOS	National Ocean Service
NWS	National Weather Service
OBC	open boundary condition
OCS	Office of Coast Survey
PSU	practical salinity unit
POF	positive outlier frequency
RMSE	root mean square error
ROMS	Regional Ocean Modeling System
SM	series mean
SD	standard deviation
TEC	Time of maximum ebb current
TEF	Time of end of current slack before flood
TEE	Time of end of current slack before ebb
TFC	Time of maximum flood current
TSE	Time of start of current slack before ebb
TSF	Time of start of current slack before flood
USGS	U.S. Geological Survey
WCOSS	Weather and Climate Operational Supercomputing System
WOF	worst case outlier frequency