

SEACOOS NFS BAROTROPIC SKILL ASSESSMENT

The current implementation of the SEACOOS NFS modeling system is barotropic, with the model forcings limited to atmospheric wind stress applied to the model surfaces and tidal elevations applied to the model open boundaries. We have thus focused to date on tidal and sub-tidal coastal water level skill. The skill assessment is performed over the operational model results that start on 1 April, 2004. This is the date that the Common Data Language, which formalized the numerical model output file structures, was adopted by the SEACOOS modeling group.

Tidal Skill: Since tides account for a substantial portion of the total water level variability in many coastal regions, representation of the tides is critical for storm surge predictions, navigation, etc. Table 1 gives the primary semi-diurnal and diurnal tide (M_2 and K_1) for the coastal stations shown in Figure 1, computed over the length of the operational hindcast sequence, for both the computed and observed (NOS) time series. The amplitudes are represented relatively well by the modeling system. In some cases, however, the modeled tidal phases are earlier than observed (e.g., Fernandina). In the SAB, for example, the model domain does not include the estuary region, which can significantly affect the tidal characteristics near shore.

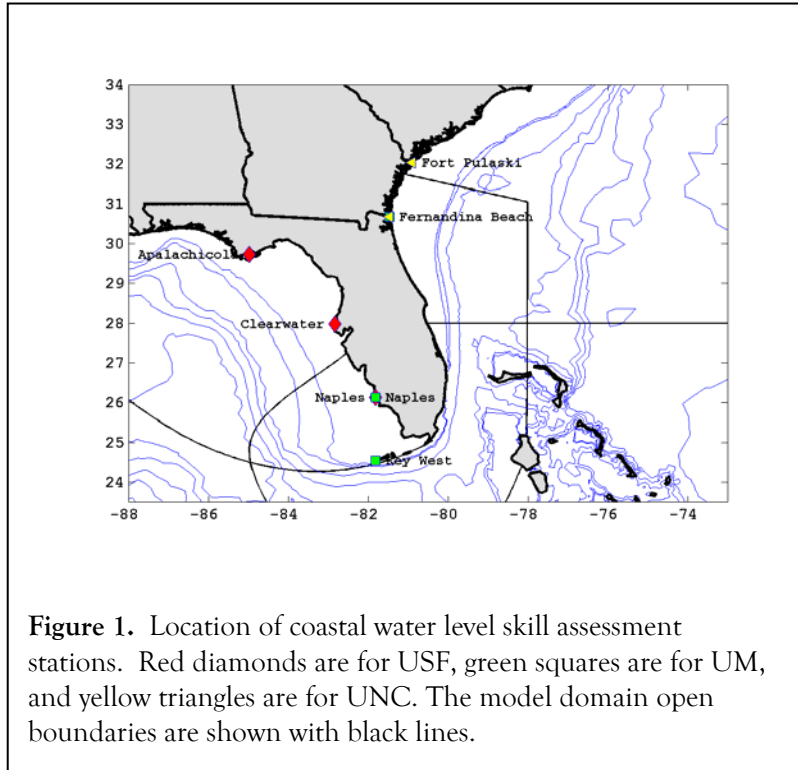


Figure 1. Location of coastal water level skill assessment stations. Red diamonds are for USF, green squares are for UM, and yellow triangles are for UNC. The model domain open boundaries are shown with black lines.

Table 1: Modeled and observed (NOS) water level tidal amplitude and phase at selected coastal stations in the SEACOOS region. The values are reported as Model/Observed, with the amplitude in cm, and the phase in degrees GMT.

	M_2		K_1	
	Amp	Phase	Amp	Phase
USF - Apalachicola	14 /12	230/257	15/14	33/57
USF - Clearwater	21/24	136/123	13/15	9/16
USF - Naples	27/29	145/144	13/16	352/10
UM - Naples	34/29	141/144	13/16	350/10
UM - Key West	16/19	59/67	06/09	336/356
UM - Fernandina	97/90	08/33	09/11	166/208
UNC - Fernandina	91/90	07/33	15/11	160/208
UNC - Ft. Pulaski	94/100	356/18	13/11	152/201

Sub-tidal Skill: We have begun to address sub-tidal forecast skill by examining the low-pass (40 hr) filtered the model output, and assembling errors (observations minus model output) at each station. The sequence of hindcasts at a representative station in each model domain is shown in Figure 2. Generally, the model water levels for USF and UNC are well correlated with observations (0.83 and 0.79 respectively), and the rms size of the sub-tidal hindcast errors are 0.07 and 0.09 m, respectively for the USF and UNC stations shown in Figure 2. The situation is quite different for the Key West station, which is in the UM model domain. Although the rms error is competitive (0.06 m), the correlation coefficient is 0.12. This generally shows that in regions with relatively wide continental shelves (USF and UNC), the wind-driven sub-tidal response captures a significant amount of the sub-tidal variability. The Florida Straits region has a very narrow shelf such that the wind-driven elevations are small, and the sub-tidal wind-driven model response can be essentially uncorrelated with the observations. This is partly expected since the Florida Current in this region is very close to the coast.

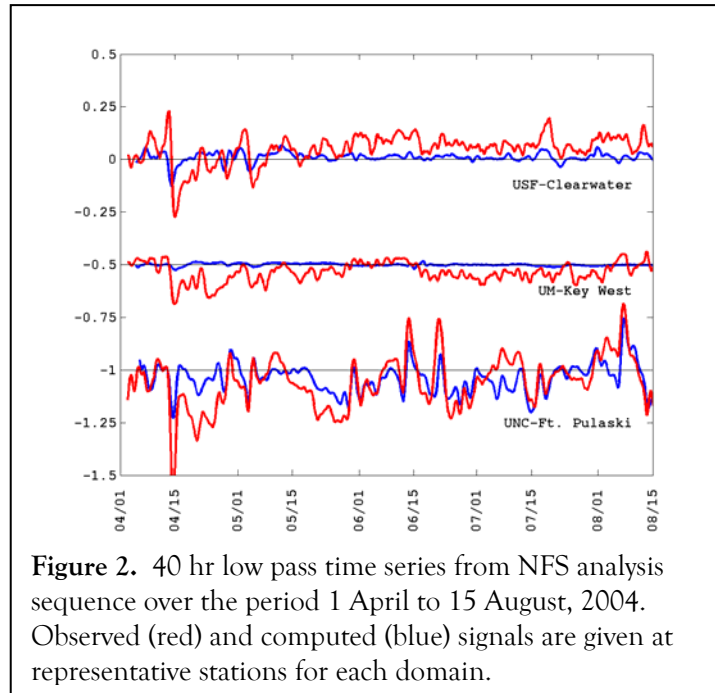


Figure 2. 40 hr low pass time series from NFS analysis sequence over the period 1 April to 15 August, 2004. Observed (red) and computed (blue) signals are given at representative stations for each domain.

Skill during the operational system forecast periods is more difficult to address, due to the short forecast length of 84 h. It is difficult to remove the tides through filtering and some tidal energy still remains. Mean correlation coefficients for computed versus observed water levels over all forecast periods are reported in Table 2. Correlation coefficients for the total water level are greater than 0.9. For the sub-tidal portion of the forecasts, the mean correlation coefficients are reduced. The rms error over all forecasts is about 0.10 m for all stations.

Table 2: Correlation coefficients for total and sub-tidal water level, and rms error of sub-tidal water level at three selected stations from the SEACOOS NFS.

	CC - Total	CC - Sub-tidal	RMS - Sub-tidal
USF - Clearwater	.94	.83	.09
UM - Key West	.96	.77	.08
UNC - Ft. Pulaski	.91	.85	.11

Examples of the NFS sub-tidal water level forecasts for 14 May and 22 August 2004 are given in Figure 3. The signature of remaining tidal energy is clearly evident, as is the generally flat computed response in the Florida Straits region (UM-Key West) region. The error in the forecast is occasionally as large as the sub-tidal signal itself, as in the UNC-Ft. Pulaski water level for the 22 August forecast. This is most likely due to misrepresented winds during the passage of atmospheric fronts.

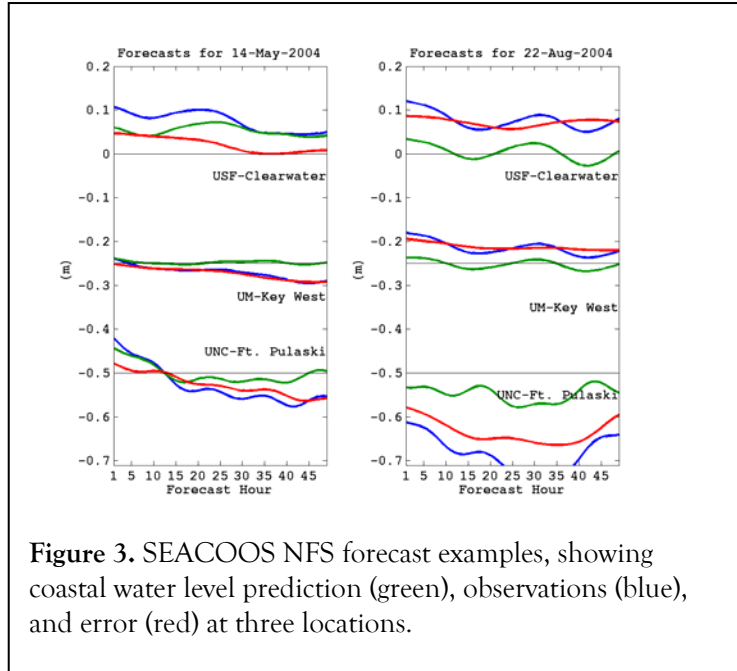


Figure 3. SEACOOS NFS forecast examples, showing coastal water level prediction (green), observations (blue), and error (red) at three locations.

EDAS/ETA Wind Fields:

We are also examining the spatial and temporal errors in the NCEP

EDAS/ETA wind fields that are used to drive the NFS model system. Figure 4 shows the large-scale error pattern in the NCEP analysis product. The wind observation locations include many over-land stations. Although the NCEP model output generally under-estimates the observed wind field by less than 3 m/s, the bias is essentially offshore. This is also true in the forecast time periods.

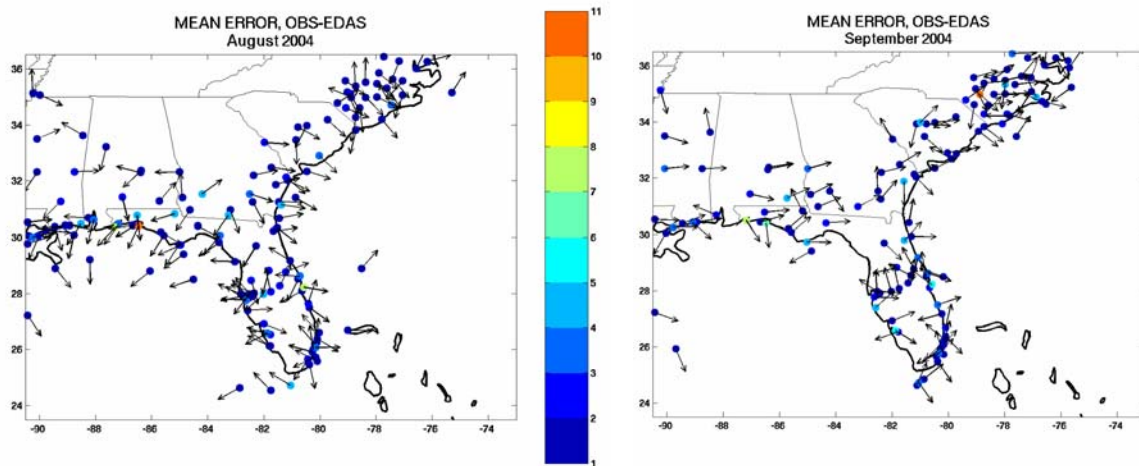


Figure 4: Magnitude (m/s) and direction of the mean difference between all available observations and the NCEP analysis model output for August and September 2004. Each spatial location has at least 10 days of hourly observations available in each month.

Conclusions:

There are several important issues that are presented by the preliminary barotropic skill assessment. Much of the total coastal water level variability is accounted for using only barotropic dynamics in regions that have relatively wide continental shelves. While this indicates that the modeled tides are reasonably accurate, sub-tidal variability may not be as well represented. This may be due to misrepresented wind forcing (a common problem), to missing baroclinic components, or a combination of both. Examination of available velocity records, although more sparse in space and time than water levels, will likely further illustrate the need for more complete dynamics (primarily mass-field effects). Velocity measurements from mid-shelf stations in the SAB and WFS routinely exhibit the signatures of Loop Current and Gulf Stream intrusions onto the continental shelves. A more detailed comparison between the forecast water level errors and the errors in the forecasted wind fields must be made. This may reveal that, at least for sub-tidal coastal water levels, the NCEP ETA model may not be ideal.