Data Sources for Coastal CHPS/HECRAS

This documentation was created in association with the development of the MARFC Lower Potomac River HECRAS model configuration in CHPS.

The motivation for performing dynamic hydraulic modeling in any tidally influenced river is based on the possibility of interaction between land-based runoff events and ocean-based tide or storm surge events. OHD has performed several studies regarding the development of a HECRAS model for the Potomac River[1]. The Potomac model is now incorporated into the operational CHPS configuration for the Mid-Atlantic River Forecast Center.

This document primarily describes the operational data sources for the tidally-influenced Lower Potomac River CHPS/HECRAS implementation.

Template Configuration and Dataset

The Potomac River configuration is made available as a template for other RFCs who may wish to implement similar models. Accompanying the template configuration is a test dataset provided by MDL based on the 2003 Hurricane Isabel event. The data provided for the test is similar to data which would normally be available in an operational forecast situation. This configuration and the test dataset may be used to observe the basic function of the different configuration elements.

The configuration is posted on the Deltares ftp site

ftp://fewsnws@ftp.wldelft.nl/marfc/20110922/Config.20110921_IsabelTemplate.OHD.zip

The MDL has provided a set of test data based on the Isabel event in 2003 here:

ftp://fewsnws@ftp.wldelft.nl/marfc/20110922/test_data.20110912.zip

The Potomac River model includes the most common HECRAS boundary conditions: Upstream flow boundaries are modeled at Little Falls on the Potomac and at the Anacostia Aquatic Garden; a downstream stage boundary is modeled at Lewisetta, VA at the mouth of the Potomac into the Chesapeake bay. The model also includes a lateral inflow at Rock Creek. The test datasets for the upstream boundary are average daily flows downloaded from the USGS and converted to PiXML format for ingest into CHPS. Test datasets for the downstream boundary are comma delimited time series files with the various pieces of information necessary for creating total water level forecast as described in detail in the later sections of this document.

In the template configuration, the forecast and observed datasets are merged into continuous Upstream and Downstream time series to allow the HECRAS model to be started anywhere within the observed or forecast period.

Currently, the template functions exclusively with point surge data delivered through the AWIPS text database and has only been thoroughly tested with this data source. Configuration elements are in place to use both gridded storm surge and other gridded total water level products but the configurations for these datasets have not been rigorously tested.

A key element of the template configuration is that it reproduces the 'Anomaly' calculation as used by the MDL on their official ET Surge web page. The 5-day running average error between the observed and historic forecast

[1] One recent paper may be viewed here:
http://amazon.nws.noaa.gov/articles/HRL_Pubs_PDF_May12_2009/New_Scans_December_2010/11F_Mashriqui_12_31_09.pdf

water levels is used to adjust the future forecast. Appendix E lists the function of various configuration files in the computation of this anomaly term.

To implement the stand-alone template CHPS configuration and to run a test of the model, complete the following:

(1) Unzip the CHPS configuration and data.

(2) Copy the different data files to the appropriate data folders and ingest all of the data using the “HECRAS Preprocessing (Import TS)” workflow

(3) [optional] Activate the Select Tide mod to select ET Surge data as the downstream boundary (pure astronomical tide is the default boundary condition).

(4) Execute the “HECRAS Forecast” workflow with a cold state start 2 days before T0. The workflow will compute the latest forecast anomaly, compute the forecast total water level surge, merge the upstream and downstream boundary forecasts with the observed data, and run the HECRAS model. The Anacostia river inflows are not currently forecast by MARFC so the configuration persists the most current value forward.

Upstream Boundary

The upstream boundaries of the model at Little Falls and Rock Creek are positioned at existing MARFC forecast points: BRKM2 and RCKD2 -- the Little Falls forecast is the primary upstream input to the model. Forecast flows at Rock Creek are a lateral inflow to the model.

The Anacostia upstream boundary flow is not currently forecast; the CHPS configuration persists the existing observation as a surrogate forecast. The effect of potential error from this persistence on water levels in the Potomac is negligible. Observed flows from USGS gages on the Anacostia Northwest and Northeast branches are added together to estimate the total observed inflow at the model boundary which is placed approximately at the Anacostia River Aquatic gardens.

Internal Flow Forecasts

The CHPS derived forecast at BRKM2 from the API continuous model will provide the forecast upstream inflow boundary condition for HECRAS.

USGS or Army Corps gage data

Observed USGS gage data is assumed to be available to provide historical flows and stages for the upstream boundary of the HECRAS model. For the Hurricane Isabel test example, the observed gage data were downloaded directly from the USGS and formatted as PIXML for ingest into CHPS. For operational use, we assume that the RFC will use the USGS data in the AWIPS hydro database. The HADS website provides information for obtaining these SHEF encoded products: http://www.nws.noaa.gov/oh/hads/internal/manual/new_sec4.pdf (the end of that document specifies the WMO headers and ASOS PILs for the RFCs).

Table 1: AWIPS / HADS USER IDS, WMO Headers and their associated Product Identifiers

HADS User ID	RFC	WMO Header	ASOS PIL
TUA (ABRFC)	Arkansas-Red Basin	SRUS26 KWOH	RRSTUA
ACR (APRFC)	Alaska Pacific	SRUS32 KWOH	RRSACR
STR (CBRFC)	Colorado Basin	SRUS29 KWOH	RRSSTR
RSA (CNRFC)	California-Nevada	SRUS30 KWOH	RRSRSA
ORN (LMRFC)	Lower Mississippi	SRUS24 KWOH	RRSORN
RHA (MARFC)	Middle Atlantic	SRUS21 KWOH	RRSRHA
KRF (MBRFC)	Missouri Basin	SRUS27 KWOH	RRSKRF
MSR (NCRFC)	North Central	SRUS28 KWOH	RRSMSR
TAR (NERFC)	North East	SRUS20 KWOH	RRSTAR
PTR (NWRFC)	North West	SRUS31 KWOH	RRSPTR
TIR (OHRFC)	Ohio	SRUS22 KWOH	RRSTIR
ALR (SERFC)	South East	SRUS23 KWOH	RRSALR
FWR (WGRFC)	West Gulf	SRUS25 KWOH	RRSFWR

Downstream Boundary Observations and Astronomical Tide

The downstream water level is particularly critical – the backwater effect caused by tide and surge can alter by several feet the peak elevation for a freshwater induced flood. The primary source for observed downstream water levels are the IOOS/CO-Ops/NOS water level gaging locations. NOS is also the primary source for astronomical tide.

With all of these data, it is important to ensure that vertical datum and timezone information are consistent with the models where the data are used. The Potomac HECRAS model used in the provided template uses NAVD88 datum as the model datum and all test input datasets are provided in GMT.

IOOS/CO-Ops/NOS Observed Water Levels

In the template configuration, observed water levels are compared to the historic forecast to create a forecast anomaly which is projected forward and added to the forecast surge and tide to create the total forecast water level.

NOS water level observations may be ingested into CHPS from the AWIPS hydro-database using information from Table 2. The example CHPS configuration uses data obtained directly from the NOS tides and currents site and is formatted as csv. Appendix C details the script used to download the observed data along with the astronomical tide. SHEF encoded products from the hydro database will function equally well with the appropriate module changes in the CHPS configuration.

(Please see the NOS Tides and Currents website for more details: http://tidesandcurrents.noaa.gov).

Table 2: SHEF Encoded Water Level Products created by NOS

WMO Header	ASOS PIL	Region
SOUS41 KWBC	NOSTIDNT	North Atlantic
SOUS42 KWBC	NOSTIDGX	Gulf of Mexico
SOUS43 KWBC	NOSTIDPZ	Pacific
SOUS44 KWBC	NOSTIDGT	Great Lakes
SOAK45 KWBC	NOSTIDAK	Alaska
SOPA46 KWBC	NOSTIDHW	Hawaii

In addition to water level products, other meteorological data collected at the NOS stations is also available through AWIPS using the information in **Error! Reference source not found.**.

Table 3: SHEF Encoded Met. products created by NOS

WMO Header	ASOS PIL	Region
SXUS51 KWBC	NOSOSONT	North Atlantic
SXUS52 KWBC	NOSOSOGX	Gulf of Mexico
SXUS53 KWBC	NOSOSOPZ	Pacific
SXUS54 KWBC	NOSOSOGT	Great Lakes
SXAK55 KWBC	NOSOSOAK	Alaska
SXPA56 KWBC	NOSOSOHW	Hawaii

Astronomical Tide

The most reliable source for astronomical tide is the NOS Tides and Currents website. This site may be queried via a simple bash script (See Appendix C) to obtain the best astronomical tide prediction for any NOS water level location.

For locations where no NOS station is present, the NOS may be able to provide an estimated tidal signature.

Downstream Boundary Forecasts

Currently, NWS has four operational products providing forecast coastal boundary water levels:

(1) Extratropical Storm Surge point product (Select points for CONUS, AK, HI, PR)

(2) Extratropical Storm Surge gridded product. (Complete coverage of CONUS, AK, HI, PR)

(3) ESTOFS total water level forecasts. (Complete coverage of East and Gulf Coasts)

(4) NOCMPS total water level forecasts. (Selected estuaries and bays. See Figure 4)

Extra tropical storm surge – point products

The MDL forecast fundamentally consists of a SLOSH based water level forecast similar to the MDL hurricane/tropical storm forecasts only the ETSurge forecasts are forced with the more coarse-scale GFS winds and are computed on geographically larger grids than the hurricane simulations. In order to compute a total water level, MDL adds the surge forecast to the astronomical tide. An anomaly term is also added, equal to the 5 day running average error between the forecast surge + tide and the observation. The current extra-tropical storm surge (ETSS or ETSurge) point forecast may be viewed at: http://www.nws.noaa.gov/mdl/etsurge/

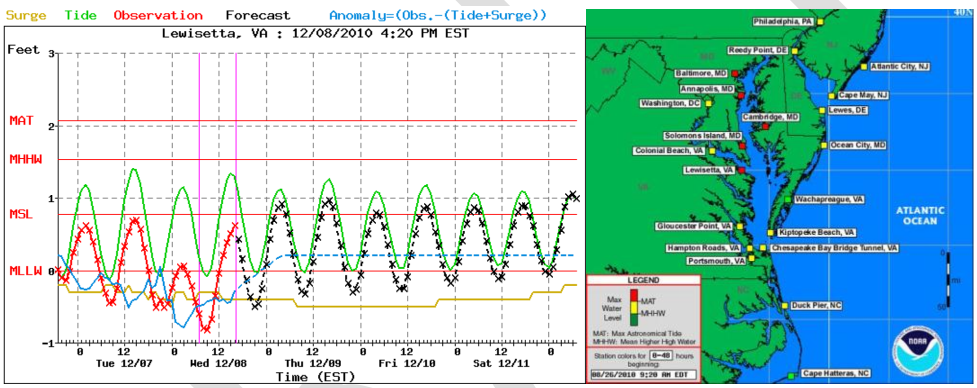

Figure 1: The MDL ET Surge website provides graphical and text forecasts of surge and total water level for more than 100 U.S. tide stations. The AWIPS text database receiveds these "official" SLOSH-based surge levels.

The MDL webserver distributes the current forecast text and an illustrative plot listed according to the MDL station abbreviation code shown in Appendix A. The text data on the website includes observations provided prior to the current time and forecasts (tide+surge+anomaly) after the current time. The data may be downloaded via 'screen-scraping' for the Lewisetta gage as follows:

```
wget -O - http://slosh.nws.noaa.gov/etsurge/data/valews.txt |  awk -F, 'BEGIN{print ("Date
Time","Surge","Tide","Obs_Fcst","Anomaly","type");} !/^#/{if ($4!=99.90){print ($1,$2,$3,$4,$6,"0");} else
{print ($1,$2,$3,$5,$6,"1");}}' > valews_fcstCombined.txt
```

A more robust approach is to extract the surge values from the raw AWIPS text product, using a python script provided by David Welch and modified to produce a .csv file which may be ingested in to CHPS. The python script which pulls the data from the text database has two crucial definitions: (1) a variable defining which of the six text products to use from the text database; and (2) a dictionary list of the gage or gages to pull out of the text product. See Appendix B for more information on how to obtain/use the python script.

The official surge dataset from MDL is published in the AWIPS text database as MRPXXX, where XXX is a code for the surge forecast grid as given in table 2. The text products may be viewed using the southern region database catalog website by using the text database product name. For example, the Pacific Coast forecast is shown here: http://www.srh.noaa.gov/productview.php?pil=WSHMRPSSP.

Table 4: Marine Product Storm Surge (ET Surge) from the Text Database.

Surge forecast location	Text database product name
Atlantic Coast	MRPSSE
Gulf Coast	MRPSSG
Pacific Coast (CONUS)	MRPSSP
Alaska, Gulf of Alaska (and Aleutian Is.)	MRPSSC
Alaska, Norton Sound, Bering Sea	MRPSSB
Alaska, Artic Coast	MRPSSA

The template CHPS configuration requires an astronomical tide forecast as well as observed water levels to create a total water level with a forecast anomaly. Most of the 120 forecast points published on the MDL website are for NOS tide gage locations where both astronomical tide and observations are available. There are a number of additional stations made available through the AWIPS text database, some of which are NOS secondary tide stations with only high/low tide forecasts. A simple screen scraping method for downloading the NOS tide at primary stations is on the deltares website: ftp://fewsnws@ftp.wldelft.nl/marfc/20110922/COOPS_tide.tar.bz2

Extra-tropical storm surge – gridded

In addition to the point forecast, the MDL produces a 97 hour (Now + 96 hours) gridded forecast of the wind-induced Extratropical Storm Surge.

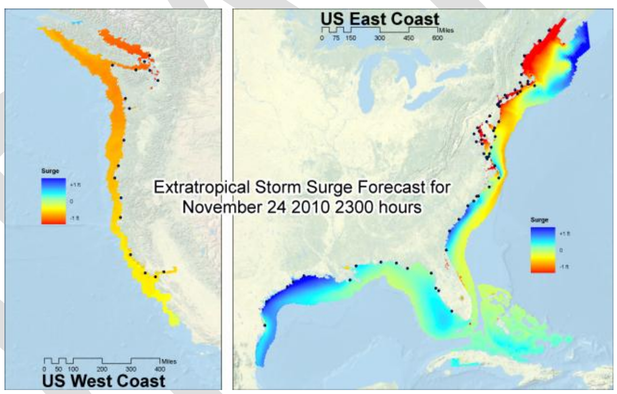

Figure 2: The MDL distributes the forecast surge value on an NDFD Grib2 grid covering all of CONUS and Alaska (AK not shown).

The forecast is re-issued every 6 hours and each new forecast overwrites the forecast from 24 hours prior. The datasets may be downloaded from the following site:

http://weather.noaa.gov/pub/SL.us008001/ST.expr/DF.gr2/DC.ndgd/GT.slosh/AR.conus/

A simple bash script such as the following can retrieve the data:

```
#!/bin/bash +x
folder=`date -u +%Y%m%dZ%H%M%S`_mdlsurge
currdir=$PWD
mkdir $folder
cd $folder
wget http://weather.noaa.gov/pub/SL.us008001/ST.expr/DF.gr2/DC.ndgd/GT.slosh/AR.conus/grib2.mdlsurgegrid.00con
wget http://weather.noaa.gov/pub/SL.us008001/ST.expr/DF.gr2/DC.ndgd/GT.slosh/AR.conus/grib2.mdlsurgegrid.06con
wget http://weather.noaa.gov/pub/SL.us008001/ST.expr/DF.gr2/DC.ndgd/GT.slosh/AR.conus/grib2.mdlsurgegrid.12con
wget http://weather.noaa.gov/pub/SL.us008001/ST.expr/DF.gr2/DC.ndgd/GT.slosh/AR.conus/grib2.mdlsurgegrid.18con
cd $currdir
```

The datasets are each interpolated onto a National Digital Forecast Database (NDFD) grid and stored in WMO standard grib2 format which may be directly ingested into CHPS with the template configuration provided. Detailed information about the grib2 format may be found here:

http://www.nco.ncep.noaa.gov/pmb/docs/grib2/grib2_doc.shtml

Although CHPS will natively read the grib2 format, it may be desireable to examine the grib2 files outside of CHPS. MDL provides the degrib utility to manipulate and export the data from the grib2 format. The degrib tool is documented and may be downloaded from this website:

http://www.weather.gov/mdl/degrib/

The utility is invoked at the command line with a command such as:

```
~/degrib/bin/degrib -in 20101208Z154843_mdlsurge/grib2.mdlsurgegrid.06con -P -pnt 38.48,-74.11 > test_ETSS)
```

ESTOFS East Coast Extra-Tropical Surge Tide Operational Forecast System

The NOS recently began producing operation total water level forecasts with the ESTOFS model. The domain of the ESTOFS model includes the entire US East and Gulf Coasts. Currently, the recommended method to ingest this product into CHPS for use as a boundary condition is to download the NDFD grib2 grids available here:

http://nomad1.ncep.noaa.gov/pub/raid2/estofs/

The total water level file for each 6 hour forecast will be available in a folder named according to the date of forecast issuance, e.g.
http://nomad1.ncep.noaa.gov/pub/raid2/estofs/estofs.20111013/estofs.t00z.conus.combined_water_level.grb2

These grib2 grids are identical to the ET Surge grids and may be imported into CHPS using a similar import module configuration.

In order to avoid overloading the local data store, we recommend working primarily with the extracted point time-series and setting a short expiry time for these 150Mb grids. We are currently exploring methods to obtain this data in a spatially subsetted form using OpenDAP protocols

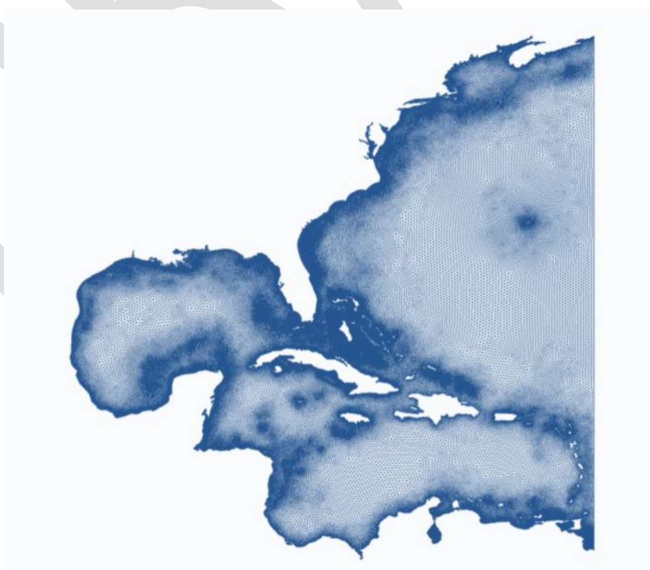

Figure 3: The NOS Extratropical Surge and Tide Operational Forecast System (ESTOFS) model extent is based on the ADCIRC East Coast 2001 (EC2001) tidal database model grid with 254,565 nodes covering the entire east coast out to 60 degrees west longitude. Coastal resolution is approximately 3 km.

NOCMPS total-ocean models

The National Operational Coastal Modeling Program (NOCMP) produces total water level forecasts for six ocean estuaries (Tampa Bay, Delaware Bay, Chesapeake Bay, Galveston Bay, the Port of New York and New Jersey, and St. John's River) and for each of the Great Lakes.

(Please see the NOCMPS website for more details: http://tidesandcurrents.noaa.gov/models.html).

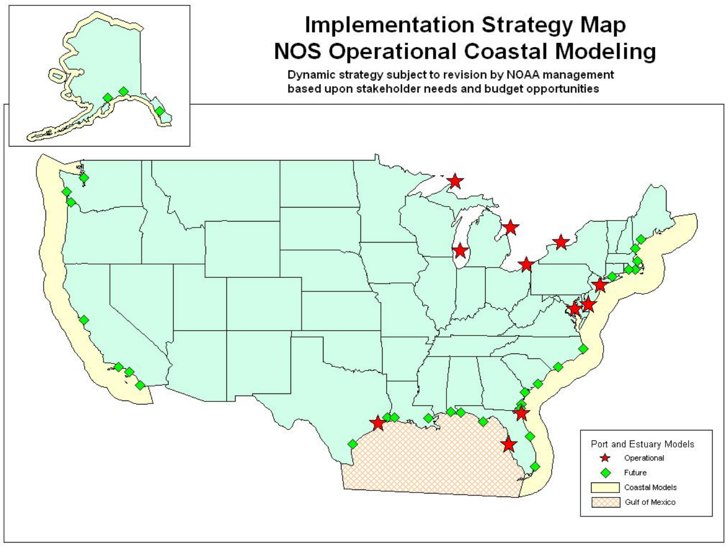

Figure 4: NOCMP Ocean Model locations: Chesapeake Bay (CBOFS), Delaware Bay (DBOFS), Port of New York and New Jersey (NYOFS), Galveston Bay (GBOFS), St. John's River (SJROFS), Tampa Bay (TBOFS), and the Great Lakes (GLOFS) consisting of Lake Erie (LEOFS), Lake Huron (LHOFS), Lake Michigan (LMOFS), Lake Ontario (LOOFS), and Lake Superior (LSOFS) Operational Forecast Systems.

The template CHPS configuration has placeholders for directly importing an archived set of CBOFS (ChesROMS) data from an experimental OpenDAP server. The OpenDAP method allows for sub-sets of the grid to be downloaded and automatically (using the IdMap) extracts only the total water level value from the full suite of output parameters. Since the subsetting and extraction is performed by the server, this method conserves download bandwidth. A similar import method can pull all recent data from the NOS operational OpenDAP server:

```
<serverUrl>http://opendap.co-ops.nos.noaa.gov:80/thredds/dodsC/NOAA/CBOFS/MODELS/catalog.xml</serverUrl>
<relativeViewPeriod unit="hour" start="-24" startOverrulable="false" end="48" endOverrulable="false"/>
```

The OpenDAP import function and the CBOFS dataset generally have received only cursory testing because the http-exposed dataset is not generally available to AWIPS computers behind the AWIPS firewall.

With many locations where these data would be beneficial, we are actively working to overcome the hurdles to ingesting this and other NOCMPS high resolution total water level forecasts. The CHOOSETS module in the template configuration was designed to allow selection between multiple potential sources of downstream total water level forecast.

For RFCs who wish to download the entire NetCDF grid and to perform local subsetting and processing, an ftp archive distributes the most recent NOCMPS grids for the TBOFS, DBOFS, CBOFS, and GLOFS forecasts:

ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nos/prod/

At present, FEWS cannot ingest a multi-parameter NetCDF grid directly and the zeta (free surface water level) parameter must be extracted prior to use in CHPS.

Appendix A: Table of Point Surge Locations

Forecast Product	Surge Forecast Location	Text product line identifier	Latitude (North)	Longitude (West)	MDL ETSurge Abbreviation	Tide3.c station number	NOS Gage Number	ASOS NWSLI
MRPSSA	Shishmaref, AK	SHISHMAREF/ AK	66.2700	166.0500				PASH
	Deering, AK	DEELING/ AK	66.0700	162.7700				PADE
	Kiwalik, AK	KIWALIK/ AK						
	Kotzebue, AK	KOTZEBUE/ AK	66.9250	162.6000	akkotz	202	9490424	PAOT
	Cape Krusenstern, AK	CAPE KRUSENSTERN/ AK						
	Point Hope, AK	POINT HOPE/ AK						
	Cape Lisburne, AK	CAPE LISBURNE/ AK	68.8833	166.1333				PALU
	Cape Beaufort, AK	CAPE BEAUFORT/ AK						
	Icy Cape, AK	ICY CAPE/ AK						
	Point Barrow, AK	POINT BARROW/ AK	71.3666	156.3666	akbar	-1		
	Smith Bay, AK	SMITH BAY/ AK						
	Harrison Bay, AK	HARRISON BAY/ AK						
	Prudhoe Bay, AK	PRUDHOE BAY/ AK	70.4000	148.5266	akprud	199	9497645	
	Camden Bay, AK	CAMDEN BAY/ AK						
MRPSSB	Port Clarence, AK	PORT CLARENCE ENT.	65.2166	166.4666	akclar	-2		
	Cape Rodney, AK	CAPE RODNEY						PACZ
	Nome, Norton Sound, AK	NOME	64.5000	165.4300	aknome	177	9468756	PAOM
	Topkok, AK	TOPKOK						
	Carolyn Is Golovnin Bay, AK	GOLOVIN	64.4500	162.8666	akcarl	-3		PAGL
	Elim, AK	ELIM						
	Koyuk, AK	KOYUK						
	Norton Bay, AK	NORTON BAY						
	Shaktoolik, AK	SHAKTOOLIK						
	Unalakleet, AK	UNALAKLEET	63.8833	160.8000				PAUN
	Healy, AK	HEALY						
	St. Michael, Norton Sound, AK	ST. MICHAEL	63.5002	162.1244	akmich	201	9668132	
	St Lawrence, Niyrakpak Lagoon Ent, AK	ST. LAWRENCE I.	63.6166	171.3833	aklwrc	-8		
	Apoon Mouth Yukon River, AK	PASTOLIK	63.0500	163.3833	akpast	-4		
	Kawanak Pass Ent, Yukon R, AK	KWIKPAK	63.0333	164.4666	akkwik	-5		
	Kwikluak Pass, Yukon River, AK	ALAKANUK	62.6166	164.8500	akalak	-6		
	Cape Romanzof, AK	SCAMMON BAY	61.8166	166.0833	akromn	-7		
	Hooper Bay, AK	HOOPER BAY	61.5300	166.1500				PAHP
	Hazen Bay, AK	HAZEN BAY						
	Mekoryuk, AK	MEKORYUK	60.3700	166.2700				PAMY
	Kipnuk, AK	KIPNUK						
	Apokak Creek Ent, AK	EEK	60.1333	162.1666	akapok	-9		
	Kuskokwak Creek Ent, AK	EEK	60.0333	162.1666	akkusk	-11		
	Popokamute, AK	EEK	60.0666	162.2500	akpopo	-10		
	Eek Channel, off Quinhagak, AK	QUINHAGAK	59.7500	162.2500	akquin	-12		
	Goodnews Bay Ent, AK	GOODNEWS BAY	59.0500	161.8166	akgood	-13		
	Togiak Bay, AK	TOGIAK BAY						PATG
	Clarks Point, Nushagak Bay, AK	NUSHAGAK BAY	58.8483	158.5516	aknush	200	9465261	
	Kvichak Bay, AK	KVICHAK BAY						
	Naknek River, Ent #13, AK	NAKNEK	58.7166	157.0500	aknakn	-14		
	Egegik River, Ent, AK	EGEGIK	58.2333	157.5000	akegeg	-15		PAII
	Pilot Point, AK	PILOT POINT						
	Port Heiden, AK	MESHIK	56.9333	158.7333	akmesh	-16		
	Saint Paul, AK	ST. PAUL I.	57.1250	170.2850	akpaul	223	9464212	

Forecast Product	Surge Forecast Location	Text product line identifier	Latitude (North)	Longitude (West)	MDL ETSurge Abbreviation	Tide3.c station number	NOS Gage Number	ASOS NWSLI
MRPSSC	Ketchikan, AK	KETCHIKAN/ AK	55.3333	131.6250	akket	205	9450460	PAKT
	Sitka, AK	SITKA/ AK	57.0517	135.3417	aksit	206	9451600	PASI
	Juneau, AK	JUNEAU/ AK	58.2983	134.4117	akjune	207	9452210	PAJN
	Skagway, AK	SKAGWAY/ AK	59.4500	135.3267	akskag	208	9452400	PAGY
	Elfin Cove, AK	ELFIN COVE/ AK	58.1933	136.3433	akelf	209	9452634	PAEL
	Yakutat, AK	YAKUTAT/ AK	59.5483	139.7350	akyak	210	9453220	PAYA
	Cordova, AK	CORDOVA/ AK	60.5583	145.7533	akcord	211	9454050	PACV
	Valdez, AK	VALDEZ/ AK	61.1250	146.3617	akvald	212	9454240	PAVW
	Seward, AK	SEWARD/ AK	60.1200	149.4267	aksew	213	9455090	PAWD
	Seldovia, AK	SELDOVIA/ AK	59.4400	151.7200	akseld	214	9455500	PASO
	Nikiski, AK	NIKISKI/ AK	60.6833	151.3983	akniki	215	9455760	
	Anchorage, AK	ANCHORAGE/ AK	61.2383	149.8900	akanch	216	9455920	PANC
	Kodiak Island, AK	KODIAK ISLAND/ AK	57.7317	152.5117	akkod	204	9457292	PADQ
	Alitak, AK	ALITAK/ AK	56.8983	154.2467	akalit	217	9457804	
	Sand Point, AK	SAND POINT/ AK	55.3367	160.5017	aksand	218	9459450	
	King Cove, AK	KING COVE/ AK	55.0617	162.3267	akking	219	9459881	
	Adak Island, AK	ADAK ISLAND/ AK	51.8633	176.6317	akadak	220	9461380	
	Atka, AK	ATKA/ AK	52.2317	174.1733	akatka	221	9461710	PAAK
	Unalaska, AK	UNALASKA/ AK	53.8800	166.5367	akunal	222	9462620	
MRPSSE	Eastport, ME	EASTPORT/ ME	44.9033	66.9850	meeast	1	8410140	
	Bar Harbor, Frenchman Bay, ME	BAR HARBOR/ ME	44.3916	68.2050	mebar	2	8413320	
	Portland, ME	PORTLAND/ ME	43.6566	70.2466	meport	4	8418150	
	Portsmouth (Seavey Is), ME	PORTSMOUTH/ NH	43.0800	70.7416	nhport	6	8419870	
	Boston, MA	BOSTON/ MA	42.3550	71.0516	mabos	7	8443970	
	Sandwich, MA	SANDWICH/ MA						
	Buzzards Bay, MA	BUZZARDS BAY/ MA	41.7416	70.6183	mabuz	9	8447270	
	Nantucket Island, MA	NANTUCKET/ MA	41.2850	70.0966	manant	10	8449130	
	Woods Hole, MA	WOODS HOLE/ MA	41.5233	70.6716	mawood	11	8447930	
	Providence, RI	PROVIDENCE/ RI	41.8066	71.4016	riprov	12	8454000	
	New Bedford, MA	NEW BEDFORD/ MA						
	Newport, RI	NEWPORT/ RI	41.5050	71.3266	riport	14	8452660	
	Block Island, RI	BLOCK ISLAND/ RI	41.1583	71.6133	riblok	15	8459681	
	New London, CT	NEW LONDON/ CT	41.3550	72.0866	ctlond	16	8461490	
	Bridgeport, CT	BRIDGEPORT/ CT	41.1733	73.1816	ctbrid	17	8467150	
	Stamford, CT	STAMFORD/ CT						
	Montauk Point, NY	MONTAUK/ NY	41.0483	71.9600	nymont	21	8510560	
	Long Beach, NY	LONG BEACH/ NY						
	Port Jefferson, NY	PORT JEFFERSON/ NY	40.9500	73.0766	nyjeff	22	8514560	
	Kings Point, NY	WILLETS POINT/ NY	40.8100	73.7816	nyking	203	8516945	
	The Battery, NY	BATTERY/ NY	40.7000	74.0150	nybat	24	8518750	
	Bergen Point, NY	BERGEN POINT/ NY	40.6400	74.1466	nyberg	178	8519483	
	Sandy Hook, NJ	SANDY HOOK/ NJ	40.4666	74.0100	njsand	29	8531680	
	Atlantic City, NJ	ATLANTIC CITY/ NJ	39.3550	74.4183	njatl	30	8534720	
	Cape May, NJ	CAPE MAY/ NJ	38.9683	74.9600	njmay	31	8536110	
	Philadelphia, PA	PHILADELPHIA/ PA	39.9333	75.1416	paphil	35	8545240	
	Reedy Point, DE	REEDY POINT/ DE	39.5583	75.5733	dereed	36	8551910	
	Lewes, DE	LEWES/ DE	38.7816	75.1200	delews	37	8557380	
	Breakwater Hr, DE	BREAKWATER HR/ DE						
	Ocean City Inlet, MD	OCEAN CITY/ MD	38.3283	75.0917	mdoce	39	8570283	
	Baltimore, MD	BALTIMORE/ MD	39.2666	76.5783	mdbalt	40	8574680	
	Annapolis, MD	ANNAPOLIS/ MD	38.9833	76.4800	mdann	41	8575512	
	Cambridge, MD	CAMBRIDGE/ MD	38.5733	76.0683	mdcamb	42	8571892	
	Washington, DC	WASHINGTON/ DC	38.8733	77.0216	dcwash	46	8594900	GTND2
	Solomons Island, MD	SOLOMONS/ MD	38.3166	76.4516	mdsol	47	8577330	
	Wachapreague, VA	WACHAPREAGUE/ VA	37.6066	75.6866	vawach	57	8631044	
	Kiptopeke Beach, VA	KIPTOPEKE BEACH/ VA	37.1666	75.9883	vakipt	55	8632200	
	Colonial Beach, VA	COLONIAL BEACH/ VA	38.2516	76.9600	vacolo	53	8635150	
	Lewisetta, VA	LEWISETTA/ VA	37.9950	76.4650	valews	56	8635750	LWTV2
	Gloucester Point, VA	GLOUCESTER POINT/ VA	37.2466	76.5000	vaglou	54	8637624	

Forecast Product	Surge Forecast Location	Text product line identifier	Latitude (North)	Longitude (West)	MDL ETSurge Abbreviation	Tide3.c station number	NOS Gage Number	ASOS NWSLI
	Chesapeake Bay Br Tunnel, VA	CHESAPEAKE BBT/ VA	36.9666	76.1133	vacbbt	50	8638863	
	Old Pt. Comfort, VA	OLD PT. COMFORT/ VA						
	Hampton Roads (Sewells Pnt), VA	HAMPTON ROADS/ VA	36.9550	76.3316	vahamp	49	8638610	
	Portsmouth (Naval Shipyard), VA	PORTSMOUTH/ VA	36.8216	76.2933	vaport	51	8638660	
	Virginia Beach, VA	VIRGINIA BEACH/ VA						
	Duck Pier, NC	DUCK/ FRF PIER/ NC	36.1833	75.7466	ncduck	61	8651370	
	Cape Hatteras, NC	CAPE HATTERAS/ NC	35.2233	75.6350	nchat	63	8654400	
	Avon, NC	AVON/ NC						
	Beaufort, Duke, NC	BEAUFORT/ NC	34.7200	76.6700	ncbeau	68	8656483	
	Morehead City, NC	MOREHEAD CITY/ NC						
	Wilmington, NC	WILMINGTON/ NC	34.2266	77.9533	ncwilm	65	8658120	
	Wrightsville Beach, NC	WRIGHTSVILLE BCH/ NC	34.2100	77.7950	ncwrit	66	8658163	
	Holden Beach, NC	HOLDEN BEACH/ NC	33.9133	78.3039	nchold	67		
	Myrtle Beach, Springmaid Pier, SC	SPRINGMAID PIER/ SC	33.6550	78.9183	scsprg	70	8661070	
	Myrtle Beach, SC	MYRTLE BEACH/ SC						
	Charleston, SC	CHARLESTON/ SC	32.7816	79.9250	scchar	72	8665530	
	Savannah, GA	SAVANNAH/ GA						
	Savannah River Ent, GA	SAVANNAH RI ENT/ GA						
	Fort Pulaski, GA	FORT PULASKI/ GA	32.0333	80.9016	gapul	75	8670870	
	Fernandina, FL	FERNANDINA/ FL	30.6716	81.4650	flfern	77	8720030	
	Mayport, FL	MAYPORT/ FL						
	Cutler Naval Bas, ME	CUTLER NAVAL BAS/ ME						
	Wells, ME	WELLS/ ME						
	New Haven, CT	NEW HAVEN/ CT						
	Bishops Head, MD	BISHOPS HEAD/ MD						
	Mccreadys Creek, MD	MCCREADYS CREEK/ MD						
	Beaver Creek, MD	BEAVER CREEK/ MD						
	Piney Point, MD	PINEY POINT/ MD						
	Potomac Rv Alex, VA	POTOMAC RV ALEX/ VA						
	Sunset Beach, NC	SUNSET BEACH/ NC						
	Oyster Landing, SC	OYSTER LANDING/ SC						
	South Capers Is, SC	SOUTH CAPERS IS/ SC						
	Fripp Inlet, SC	FRIPP INLET/ SC						
	St Simons Is, GA	ST SIMONS IS/ GA						
MRPSSG	Naples, FL	NAPLES/ FL	26.1300	81.8066	flnap	87	8725110	
	Punta Rasa, FL	PUNTA RASA/ FL						
	Anna Maria, FL	ANNA MARIA/ FL						
	Saint Petersburg, FL	ST. PETERSBURG/ FL	27.7600	82.6266	flpete	90	8726520	
	Clearwater Beach, FL	CLEARWATER/ FL	27.9766	82.8316	flclr	98	8726724	
	Cedar Key, FL	CEDAR KEY/ FL	29.1350	83.0316	flcedr	92	8727520	
	St. Marks R., FL	ST. MARKS R./ FL						
	Apalachicola, FL	APALACHICOLA/ FL	29.7266	84.9816	flapal	94	8728690	
	Panama City Beach, FL	PANAMA CITY BEACH/ FL	30.2133	85.8800	flpana	110	8729210	
	Pensacola, FL	PENSACOLA/ FL	30.4033	87.2116	flpens	96	8729840	
	Waveland, MS	BAY ST. LOUIS/ MS	30.2816	89.3666	mslous	179	8747437	
	Port Eads, LA	PORT EADS/ LA						
	Grand Isle East PT, LA	BAYOU RIGAUD/ LA	29.2633	89.9566	lariga	128	8761724	
	Timbalier Is., LA	TIMBALIER IS./ LA						
	Eugene Is., LA	EUGENE IS./ LA						
	Weeks Bay, LA	WEEKS BAY/ LA						
	Calcasieu Pass, LA	CALCASIEU PASS/ LA						
	Sabine Pass, TX	SABINE PASS/ TX	29.7300	93.8700	txsabn	138	8770570	
	Galveston, Pleasure Pier, TX	GALVESTON/ PRS.	29.2850	94.7883	txgalv	141	8771510	
	Freeport, TX	FREEPORT/ TX	28.9333	95.3000	txfree	142	8772447	
	Port Aransas, TX	PORT ARANSAS/ TX	27.8266	97.0500	txaran	144	8775270	
	Padre Island, TX	PADRE ISLAND/ TX	26.0683	97.1566	txpadr	146	8779750	

Forecast Product	Surge Forecast Location	Text product line identifier	Latitude (North)	Longitude (West)	MDL ETSurge Abbreviation	Tide3.c station number	NOS Gage Number	ASOS NWSLI
MRPSSP	Cherry Point, WA	CHERRY POINT/ WA	48.8633	122.7583	wacher	180	9449424	
	Friday Harbor, WA	FRIDAY HARBOR/ WA	48.5467	123.0100	wafrid	181	9449880	
	Armitage Island, WA	ARMITAGE ISLAND/ WA						
	Lopez Islnad, WA	LOPEZ ISLNAD/ WA						
	Neah Bay, WA	NEAH BAY/ WA	48.3683	124.6167	waneah	182	9443090	
	Port Angeles, WA	PORT ANGELES/ WA	48.1250	123.4400	waangl	184	9444090	CLM
	Port Townsend, WA	PORT TOWNSEND/ WA	48.1117	122.7500	watown	183	9444900	
	Everett, WA	EVERETT/ WA						PAE
	Seattle, WA	SEATTLE/ WA	47.6050	122.3383	waseat	185	9447130	SEA
	Yoman Point, WA	YOMAN POINT/ WA						
	Toke Point, WA	TOKE POINT/ WA	46.7083	123.9650	watoke	186	9440910	
	Columbia Rv Ent, OR	COLUMBIA RV ENT/ OR						
	Astoria, OR	ASTORIA/ OR	46.2083	123.7667	orastr	187	9439040	AST
	South Beach, Yaquina R. OR	S-BCH/ YAQUINA R/ OR	44.6250	124.0433	orsout	188	9435380	
	Charleston, OR	CHARLESTON/ OR	43.3450	124.3217	orchar	189	9432780	
	Port Orford, OR	PORT ORFORD/ OR	42.7400	124.4967	orford	195	9431647	
	Crescent City, CA	CRESCENT CITY/ CA	41.7450	124.1833	cacres	190	9419750	CEC
	North Spit, CA	NORTH SPIT/ CA	40.7667	124.2167	caspit	191	9418767	
	Arena Cove, CA	ARGENA COVE/ CA	38.9133	123.7083	caarna	198	9416841	
	Rio Vista, CA	RIO VISTA/ CA						
	Mare Is.Naval, CA	MARE IS.NAVAL/ CA						
	Port Chicago, CA	PORT CHICAGO/ CA	38.0567	122.0383	cachic	192	9415144	
	Antioch, CA	ANTIOCH/ CA						
	Point Reyes, CA	POINT REYES/ CA	37.9967	122.9750	careys	193	9415020	
	San Francisco, CA	SAN FRANCISCO/ CA	37.8067	122.4650	cafran	194	9414290	
	Dumbarton Bridge, CA	DUMBARTON BRIDGE/ CA						

For current forecast in graphical format, you may browse from the MDL main page or go directly to the forecast by inserting the station abbreviation into the following address: http://www.weather.gov/mdl/etsurge/data/<station_abbr>.gif

For the text format forecast, the address is http://www.weather.gov/mdl/etsurge/data/<station_abbr>.txt

For example, the abbreviation for Lewisetta, VA is “valews” and the corresponding forecast text and graphic are found at http://www.weather.gov/mdl/etsurge/data/valews.txt and http://www.weather.gov/mdl/etsurge/data/valews.gif

Archives of the graphics only from the last 9 forecasts (54 hours) are found in on the MDL webserver as http://slosh.nws.noaa.gov/etsurge/dataA/<station_abbr>.gif

http://slosh.nws.noaa.gov/etsurge/dataB/<station_abbr>.gif

and so on, until

http://slosh.nws.noaa.gov/etsurge/dataI/<station_abbr>.gif

Appendix B: Python Script for ET Surge Ingest

MARFC used two scripts to successfully format the surge data from the WASD2 and LWTV2 NOS tidal gages for ingest in the CHPS database. The first script is a k-shell script which set appropriate environment variables followed by a second python script to access the text database and prepare the formatted data. The scripts are posted on the Deltares ftp site: ftp://ftp.wldelft.nl/marfc/20110922/extsrg2csv.tar.bz2

`Selected text from the script` is included below with additional comments inserted in normal font.

```
#!/bin/ksh

# script to call OHD python script to extract and reformat
# FQUS23 KWNO  PITMRPSSE GFS surge data.  The data is forwarded
# CHPS import directory.

hecras_chps_dir=$(gad HECRAS_CHPS_DIR)
hecras_chps_etss_dir=$hecras_chps_dir/csv_etss
transfer_dir=$(gad chps_local)/data/toCHPS/marfc/csv/etss
stormsurge_arc_dir=$hecras_chps_dir/archive
stormsurge_arc_dir2=$(gad CHPS_ARCHIVE_DIR)/hecras

cd $hecras_chps_dir
```

Call the python script (see below).

```
./extsrg2csv.py >> /dev/null
```

Move the resulting formatted files to the appropriate locations for chps ingest.

```
# copy file to chps3:/awips/chps_local/data/toCHPS/marfc/csv/etss
cd $hecras_chps_etss_dir

user="*************"
passwd="*************"

    /usr/local/bin/expect -- << eof
    log_user 0
    set prompt "(%|#|\\$) $"               ;# default prompt
    catch {set prompt $env(EXPECT_PROMPT)}

    spawn su - $user
    set timeout 10
    expect eof exit timeout {send_user "timed out\n"; exit} -re Password:
    send "$passwd\r"
    puts "entered passwd"
    expect $prompt
    send "cd $hecras_chps_etss_dir\r"
    expect $prompt
    send "scp WASD2.*.csv chps3:$transfer_dir\r"
    expect $prompt
    send "scp LWTV2.*.csv chps3:$transfer_dir\r"
    expect $prompt
    send "cp LWTV2.*.csv /home/ncp\r"
    expect $prompt
    send "scp WASD2.*.csv chps6:$transfer_dir\r"
    expect $prompt
    send "scp LWTV2.*.csv chps6:$transfer_dir\r"
    expect $prompt
    send "exit\r"
    close

eof

#archive files
cp *.csv $stormsurge_arc_dir2
mv *.csv $stormsurge_arc_dir
```

The python script begins with importing the necessary python libraries.

```
#!/usr/local/python/bin/python

import os, re, sys, string, datetime, math, shutil
from time import localtime, strftime, gmtime
```

Set environment variables to allow access to the text database and appropriate output folders.

```
#Set Environment Variables
print 'Set Environment Variables'
os.environ['FXA_HOME'] = '/awips/fxa'
```

```
os.system('export FXA_HOME')
os.system('. /awips/fxa/readenv.sh')

csvDir=os.path.join(os.getcwd(),'csv_etss/')
textdbDir=os.path.join(os.getcwd(),'textdb_etss/')
os.system('mkdir ' + csvDir + ' 2>>/dev/null')
os.system('mkdir ' + textdbDir + ' 2>>/dev/null')
print 'textdb product will be read from: ' + textdbDir
print 'comma-delimited files for CHPS input will be written to: ' + csvDir
```

Define the name of the output file (surgelist) and the name of the gage as defined in the text product (surgeDict). See Appendix A.

```
#Set locations to parse and control variables
surgeList=['LWTV2','WASD2']
surgeDict={'LWTV2':'LEWISETTA/ VA','WASD2':'WASHINGTON/ DC'}
lagTimeDict={'LWTV2':'0','WASD2':'0'}
valueOffsetDict={'LWTV2':'0','WASD2':'0'}
```

Define the name of the text product from the database.

```
textdbProduct_6 = 'MRPSSE'
#MARFC stores product as PITMRPSSE
#textdbProduct_9 = 'WSH' + textdbProduct_6
textdbProduct_9 = 'PIT' + textdbProduct_6
```

Download the text product. (If the os.system line is commented, the script will create the comma-delimited surge forecast from an existing text file in the working folder which may be useful for debugging.)

```
productPath = os.path.join (textdbDir,textdbProduct_9+'.txt')
textdbPath = os.path.join ('/awips/fxa/bin', 'textdb')

#Dump out latest textdbProduct Tide Product
print '\nDump out ' + textdbProduct_9 + ' Storm Surge Product'

print textdbPath + ' -r ' + textdbProduct_6 +  ' > '+ productPath
os.system(textdbPath + ' -r ' + textdbProduct_6 + ' > '+ productPath)

gmtYear_4=strftime('%Y', gmtime())
gmtMonth=strftime('%m', gmtime())
gmtDay=strftime('%d', gmtime())
gmtHour=strftime('%H', gmtime())
gmtMin=strftime('%M', gmtime())
initDay = open(productPath, 'r').readlines()[0].split()[2][0:2]  #Used in time calcs for day UTZ vs local
initHour = open(productPath, 'r').readlines()[3].split()[0][0:2]
print 'initDay='+initDay
print 'initHour='+initHour
print 'The current GMT hour is '+gmtHour
print 'The current GMT day is '+gmtDay
print 'The current GMT day is '+gmtMonth
print 'The hour read from the '+ textdbProduct_9 + ' is '+initHour
print 'The day read from the '+ textdbProduct_9 + ' is '+initDay
print 'The month is assumed to be the GMT month --'
print 'PLEASE verify that assumption is correct.'
```

Located the appropriate station using the surgeDict and read data from the text file.

```
try:
    initPrevHour = open(productPath + '.prev', 'r').readlines()[3].split()[0][0:2]
    print 'The initial hour on the previous file is '+initPrevHour+'\n'

except:
    print 'Create ' + productPath + '.prev'
    initPrevHour = shutil.copyfile(productPath,productPath + '.prev')
    initPrevHour = open(productPath + '.prev', 'r').readlines()[3].split()[0][0:2]

for etss in surgeList:
    #Reset Tide Lists
    etssVal=[]
    modVal=[]

    try:
        print 'Have a new ' + textdbProduct_9 + ' Product. Run Project.'

        #Apply any Lags to the initial Hour read in from the textdbProduct_9 product, used to create the TS 
begin time
        beginModHour=(int(lagTimeDict[etss])+int(initHour)) # Add lag time

        #Set date-time read in as-is from textdbProduct_9 product as datetime object, use the initDay variable 
with lagged time
        dF=datetime.datetime(int(gmtYear_4),int(gmtMonth),int(initDay),int(beginModHour),00,00)
```

```
        print 'The date-time of the ' + textdbProduct_9 + ' product (GMT) is '+dF.strftime("%m/%d/%Y %H:%M")

        print '\nBegin tide etsurge conversion on: '+etss
        print 'Find starting line of specified Tide Anomaly'
        counter=0
        for l in open(productPath, 'r'):
            srchEtss=re.compile(surgeDict[etss])
            if srchEtss.search(l):
                etssLoc=counter
            counter=counter+1

        print 'Begining at starting line of storm surge data, add next 4 days of values to list'

        #Insert the nowcast value first
        nowcast=open(productPath, 'r').readlines()[etssLoc][68:72]
        print nowcast
        etssVal.append(float(nowcast)/10)
        for l in open(productPath, 'r').readlines()[etssLoc+1:etssLoc+5]:
            print l
            val_text=l.strip()
            vals = re.sub('-',' -',val_text)
            for v in vals.split():
                etssVal.append(float(v)/10)

        print 'The tide anomaly for '+etss+' begins at line '+str(etssLoc)
        nVal = len (etssVal)
        print 'The number of Storm Surge values is '+str(nVal)

        print 'Sum together the et surge with the value shift transformation'
        for r in range(0,nVal):
            val=float(float(etssVal[r])+float(valueOffsetDict[etss]))
            modVal.append(round(val,4))
```

Write the data to a CSV file.

```
        #Write surge time series to CSV
        i=0
        csvCnt=1
        print 'Processing surge for '+etss
        datename='%s%s%s%02d00Z' % (gmtYear_4,gmtMonth,initDay,beginModHour)
        outFile=open(csvDir+etss+'.'+datename+'.csv','w')
        csvHeader1 = 'Location Names, ETSurge predicted at '+etss
        csvHeader2 = 'Location Ids, '+etss+'_ETSS_FORECAST'
        csvHeader3 = 'Time, ETSS [FT]'
        print >> outFile, csvHeader1
        print >> outFile, csvHeader2
        print >> outFile, csvHeader3
        for tHour, value in enumerate(modVal):
            tDiff=datetime.timedelta(hours=tHour -1)  #Increment printout time by one hour for each value
            #beginning with the nowcast time (forecast - 1)
            csvdF=dF+tDiff
            csvTS = csvdF.strftime("%Y-%m-%d %H:00:00")+','+str(value)
            try:
                print >> outFile, csvTS
            except:
                print csvTS

    except:
        print 'Error in loop!'
    #else:
        #print 'Not a new file, wait until next time!'
print 'Done!!!'
```

Appendix C: Shell/Awk Script for NOS Astronomical Tide and Observed Tide Download

The following bash script is an example of how to download the hourly astronomical tide from the CO-OPS tides website. The script converts the downloaded data into a .csv file suitable for ingest into CHPS.

```
#!/bin/bash -x

sta_shortname="8635750_LewisVA";
NWSSLID=LWTV2
start_year=1999;
end_year=2025;
COOPSsta_number="8635750";
COOPSsta_name="Lewisetta%2C+VA";
COOPSinterval="W2"; #Hourly astronomical and verified observations. Must be hourly for 1-year download
#COOPSinterval="W1"; #Six minute data may only be downloaded one month at-a-time.
#COOPSdatum="0"; #Station Datum
#COOPSdatum="1"; #MHHW
#COOPSdatum="2"; #MHW
#COOPSdatum="3"; #MTL
#COOPSdatum="4"; #MSL
#COOPSdatum="5"; #MLW
#COOPSdatum="6"; #MLLW
COOPSdatum="7"; #NAVD88
datumname="NAVD88";
COOPStimeshift="g" #GMT
#COOPStimeshift="d" #local time WITH daylight savings shift
#COOPStimeshift="s" #local time WITHOUT daylight savings shift
timezone="GMT";
#COOPSunit="0"; #meters
COOPSunit="1"; #feet
units="FT"
COOPSbaseURL="http://tidesandcurrents.noaa.gov/";
COOPSpageName="data_menu.shtml";
COOPSpageOptions="&wl_sensor_hist="$COOPSinterval"&relative=&datum="$COOPSdatum"&unit="$COOPSunit"&shift="$COO
PStimeshift"&stn="$COOPSsta_number"+"$COOPSsta_name"&type=Historic+Tide+Data&format=View+Data";

if [ ! -d txt ]; then mkdir txt; fi
if [ ! -d csv ]; then mkdir csv; fi
```

After the initial download, the following lines may be commented as shown to re-process without re-downloading.

```
#for (( i = $start_year; i <= $end_year; i++ ));
  #do
  ##wget
"http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate="$i"0101&edate="$i"1231&wl_sensor_hist=W2&relative=&da
tum=6&unit=1&shift=g&stn=8635750+Lewisetta%2C+VA&type=Historic+Tide+Data&format=View+Data";
  ##mv
"data_menu.shtml?bdate="$i"0101&edate="$i"1231&wl_sensor_hist=W2&relative=&datum=6&unit=1&shift=g&stn=8635750+
Lewisetta,+VA&type=Historic+Tide+Data&format=View+Data" 8635750_LewisVA_$i.txt;
  #COOPSdate="?bdate="$i"0101&edate="$i"1231"
  #wget "$COOPSbaseURL$COOPSpageName$COOPSdate$COOPSpageOptions";
  ##mv "$COOPSpageName${COOPSdate//=/\\=}${COOPSpageOptions/%2C/,}" "$sta_shortname""_$i.txt";
  #mv $COOPSpageName$COOPSdate${COOPSpageOptions/\%2C/,} "./txt/$sta_shortname""_$i.txt";
  #done

for (( i = $start_year; i <= $end_year; i++ ));
  do
  csplit -ftmpfile ./txt/$sta_shortname"_"$i".txt" 104 8864;
```

The awk line below may be changed to read the second, third, and fifth fields in order to obtain observed values, if they are available.

```
  awk '{print ($2,$3,$4)}' tmpfile01 > tmpfile03;
  sed -i "s/^\(......\)/\1-/" tmpfile03;
  sed -i "s/$i/$i-/" tmpfile03;
  sed -i "s/ /:00,/2" tmpfile03; #add seconds and a comma to delimit date time, value
  mv tmpfile03 ./csv/$sta_shortname"_"$i".csv";
  \rm tmpfile*;
  done

cd ./csv;
  if [[ -f $sta_shortname.csv ]]; then \rm $sta_shortname.csv; fi
  #echo "Location Names, Lewisetta GMT Harmonic Tides NAVD88 Feet" >> $sta_shortname.csv
  echo "Location Names, ${COOPSsta_name/\%2C+/, } $timezone Harmonic Tides $datumname $units" >>
"$sta_shortname.csv"
  echo "Location Ids, $NWSSLID" >> $sta_shortname.csv
  echo "Time, STID [$units]" >> $sta_shortname.csv
  for (( i = $start_year; i <= $end_year; i++ ));
    do
    cat $sta_shortname"_"$i".csv" >> $sta_shortname.csv;
    done
cd ..;
```

Appendix D: Tide3.c Tide generation Code

We recommend leaving harmonic tide computation to the experts at NOS/Co-OPS. In addition to the regular epochal updates every 19 years, the NOS constantly reviews observed tidal ranges and makes adjustments as needed to both the harmonic constituents and to the forecast tide.

It is instructive to know, however, that it is possible to use constituents to generate a harmonic tide sequence.

Tide3.c was provided by Amy Haase, Arthur Taylor, and Wilson Shaffer in the NOAA MDL. The program computes the tide for a given tide station for any given day between Jan 1 1800 and Dec 31 2025 using a table of harmonic constituents for various NOS tidal stations. Equations in the program generally follow Schureman[2]

The MDL uses a version of this same code, compiled on the IBM AIX workstation which provides the operational gridded ETSS (extra tropical storm surge) forecast shown here:
http://www.opc.ncep.noaa.gov/et_surge/et_surge_info.shtml
http://www.opc.ncep.noaa.gov/Loops/SURGE_MID_EAST/SURGE_MID_96_HR.shtml

The source, data files, and a simple linux executable are found here:

ftp://ftp.wldelft.nl/marfc/20110922/tide3.tar.bz2

- tide3.x – linux x86 compiled executable
- tide3.c – main code
- tide3.h – header
- tide.txt – programmers notes
- ft03.dta - file containing yearly constants (nodal factor and equilibrium arguments) created by CO-OPS.
- ft07.dta - angular speed (constant) location dependent amplitude and phase/epoch created by CO-OPS

The executable may be recreated using the following command with the gcc compiler:

```
Gcc –lm –DNO_TCL tide3.c –o tide3.x
```

To invoke the tide3 program, the usage is simply:

```
tide3.x <secondary/primary> <station number> <year> <month> <day> <hr> <numHours> <f_mllw> <f_seasonal>
```

For example, the following command:

```
./tide3.x primary 56 2010 11 06 18 97 1 1
```

produces the current tide + 96 hours of forecast tide for the Lewisetta gage on November 6 2010 6:00 PM.

Other station numbers are listed in appendix A.

Notes:

The ft03.dta and ft07.dta files must be in the same directory with the executable.

The f_mllw flags is set as 1 or 0. If f_mllw = 1, then the tide levels are given relative to Mean Lower Low water. If f_mllw = 0, then the tide levels are given relative to MSL. The ET Surge website use f_mllw=1.

The f_seasonal flag is set as 1 or 0 to include or exclude, respectively, the effect of seasonal variation in temperature and prevailing wind direction on the tide levels. The ET Surge website uses f_seasonal = 1.

[2] Schureman, P. (1941). *Manual of Harmonic Analysis and Prediction of Tides*. U.S. G.P.O, Washington.

Appendix E: CHPS configuration files and test dataset

Selected listing of configuration files included in stand-alone template

ftp://fewsnws@ftp.wldelft.nl/marfc/20110922/Config.20110921_IsabelTemplate.OHD.zip

```
Config.20110921_IsabelTemplate.OHD
|-- ColdStateFiles
|    `-- hecras_potomac
|        `-- HECRAS_POTOMAC_UpdateStates Default.zip .......................restart file for cold-state runs
|-- DisplayConfigFiles
|    |-- ManualForecastDisplay.xml
|    |-- SpatialDisplay.xml
|    `-- SystemMonitorDisplay.xml
|-- IconFiles
|-- IdMapFiles
|    |-- IdImportCSV.xml .............................Id mapping for Astronomical tide, observed water level
|    |-- IdImportETSS.xml ..........................................Id mapping for gridded ETSurge ingest
|    |-- IdImportPIXML.xml ................................................Id Mapping for stream gage data
|    |-- Idhecrasexport.xml .....................Id mapping for transfer of data from CHPS into HECRAS model
|    `-- Idhecrasimport.xml .................Id mapping or transfer of data from HECRAS model back into CHPS
|-- MapLayerFiles
|-- ModuleConfigFiles
|    |-- import
|    |    |-- ImportCSV_AstronomicalTide.xml ...........................import astronomical tide time series
|    |    |-- ImportCSV_ETSS.xml .........................import ET Surge from formatted text database output
|    |    |-- ImportCSV_FCSTFlow.xml .............used with SA example to import a test forecast time series
|    |    |-- ImportCSV_OBSFlow.xml ............................used with SA example to import observed flows
|    |    |-- ImportCSV_OBSLevel.xml ...........................used with SA example to import observed flows
|    |    |-- ImportETSS.xml ..............................................import NDFD/grib2 gridded ET Surge
|    |    |-- ImportNetCDFcbofs.xml ...........import NETCDF format gridded CBOFS data using OpenDAP protocol
|    |    |-- ImportNetCDFchesroms.xml ..................................same as above, slightly different URL
|    |-- preprocessing
|    |    |-- HECRAS_POTOMAC_CBOFS_Grid2Point.xml .......................extract a time series for lewisetta
|    |    |-- HECRAS_POTOMAC_ETSS_Grid2Point.xml ...........................................................same
|    |    |-- HECRAS_POTOMAC_ROMS_Grid2Point.xml ...........................................................same
|    |    `-- RRS_PreProcessing_Inst_Ocean.xml .............................................................same
|    `-- hecras_potomac
|         |-- STAGEQ_HECRAS_POTOMAC_Forecast.xml ............................convert stage forecasts to flow
|         |-- SWITCHTS_HECRAS_POTOMAC_DS_ETSS_Forecast.xml .................select point or gridded ET Surge
|         |-- ANOMALY1_HECRAS_POTOMAC_DS_Forecast.xml  ...........compute 5-day average surge forecast error
|         |-- ANOMALY2_HECRAS_POTOMAC_DS_Forecast.xml ..................compute current surge forecast error
|         |-- ANOMALY3_HECRAS_POTOMAC_DS_Forecast.xml ...............smooth current error into 5-day average
|         |-- ANOMALY4_HECRAS_POTOMAC_DS_Forecast.xml .........add tide, smoothed error, and current forecast
|         |-- CHOOSETS_HECRAS_POTOMAC_DS_Forecast.xml .....select between various total water level forecasts
|         |                                                (ET Surge, pure Astronomical Tide, CBOFS, ...)
|         |-- MERGETS_HECRAS_POTOMAC_DS_Forecast.xml ........................merge the downstream water level
|         |                                                        forecast to the observed data up to T0
|         |-- PERSIST_HECRAS_ANACOSTIA_US_Forecast.xml ..................persist non-forecast upstream gages
|         |-- MERGETS_HECRAS_POTOMAC_US_Forecast.xml ........................merge the upstream flow forecast
|         |                                                                 to the observed data up to T0
|         |-- HECRAS_POTOMAC_Forecast.xml .........................................executes the HECRAS model
|         `-- HECRAS_POTOMAC_SHEF_Export.xml .......................MARFC added to export result time series
|            |-- ModuleDataSetFiles
|    `-- hecras_potomac
|         `-- HECRAS_POTOMAC_UpdateStates.zip ...........................................HECRAS model files
|-- ModuleParFiles
|    `-- hecras_potomac
|         |-- HECRAS_POTOMAC_Forecast.xml ................................................Time step modifier
|         `-- SWITCHTS_HECRAS_POTOMAC_DS_ETSS_Forecast.xml .......Modifier to select gridded or point ETSurge
|-- RegionConfigFiles
|    |-- ColdModuleInstanceStateGroups.xml
|    |-- Filters.xml
|    |-- Grids.xml .....................................................example grids for CBOFS and ET Surge
|    |-- LocationSets.xml
|    |-- Locations.xml
|    |-- ModifierTypes.xml
|    |-- ModuleConfigProperties.xml
|    |-- ModuleInstanceDescriptors.xml
|    |-- ModuleInstanceSets.xml
|    |-- Parameters.xml ...........................................Parameters for the CHOOSETS and ETSurge
|    |-- Topology.xml
|    `-- WorkflowDescriptors.xml
|-- RootConfigFiles
|-- SystemConfigFiles
|    |-- DisplayDescriptors.xml
|    |-- DisplayInstanceDescriptors.xml
|    |-- Explorer.xml
|    |-- ModuleDescriptors.xml
|-- UnitConversionsFiles
`-- WorkflowFiles
     |-- hecras_potomac ....................................Various workflows to execute forecast elements
     `-- system+preprocessing .........................................Workflows to import/preprocess data
```

Data files included in stand-alone template

ftp://fewsnws@ftp.wldelft.nl/marfc/20110922/test_data.20110912.zip

```
test_data.20110912
`-- csv
    |-- astrotide
    |   |-- 8594900_WashDC.csv ...........................................1-hour Astronomical tide at WASD2
    |   |-- 8635750_2009-2013_NAVD88.txt .............15-minute Astronomical tide at LWTV2 for later period
    |   `-- 8635750_LewisVA.csv ..........................................1-hour Astronomical tide at LWTV2
    |-- etss ...............................Individual surge forecasts for WASD2 and LWTV2 for Isabel event
    |   |-- LWTV2.200309100700Z.csv
    |   |-- LWTV2.200309101300Z.csv
    |   |-- LWTV2.200309101900Z.csv
    |   |-- LWTV2.200309111300Z.csv
    |   |-- LWTV2.200309111900Z.csv
    |   |-- LWTV2.200309120700Z.csv
    |   |-- LWTV2.200309121300Z.csv
    |   |-- LWTV2.200309121900Z.csv
    |   |-- LWTV2.200309130700Z.csv
    |   |-- LWTV2.200309131300Z.csv
    |   |-- LWTV2.200309131900Z.csv
    |   |-- LWTV2.200309140700Z.csv
    |   |-- LWTV2.200309141300Z.csv
    |   |-- LWTV2.200309141900Z.csv
    |   |-- LWTV2.200309150700Z.csv
    |   |-- LWTV2.200309151300Z.csv
    |   |-- LWTV2.200309151900Z.csv
    |   |-- LWTV2.200309160700Z.csv
    |   |-- LWTV2.200309161300Z.csv
    |   |-- LWTV2.200309161900Z.csv
    |   |-- LWTV2.200309170700Z.csv
    |   |-- LWTV2.200309171300Z.csv
    |   |-- LWTV2.200309171900Z.csv
    |   |-- LWTV2.200309180700Z.csv
    |   |-- LWTV2.200309181300Z.csv
    |   |-- LWTV2.200309181900Z.csv
    |   |-- LWTV2.200309190700Z.csv
    |   |-- LWTV2.200309191300Z.csv
    |   |-- LWTV2.200309191900Z.csv
    |   |-- LWTV2.200309200700Z.csv
    |   |-- LWTV2.200309201300Z.csv
    |   |-- LWTV2.200309201900Z.csv
    |   |-- LWTV2.200309211300Z.csv
    |   |-- LWTV2.200309211900Z.csv
    |   |-- LWTV2.200309220700Z.csv
    |   |-- LWTV2.200309221300Z.csv
    |   |-- LWTV2.200309221900Z.csv
    |   |-- LWTV2.200309230700Z.csv
    |   |-- LWTV2.200309231300Z.csv
    |   |-- LWTV2.200309231900Z.csv
    |   |-- LWTV2.200309240700Z.csv
    |   |-- LWTV2.200309241300Z.csv
    |   |-- LWTV2.200309241900Z.csv
    |   |-- LWTV2.200309250700Z.csv
    |   |-- LWTV2.200309251300Z.csv
    |   |-- LWTV2.200309251900Z.csv
    |   |-- LWTV2.200309260700Z.csv
    |   |-- LWTV2.200309261300Z.csv
    |   |-- LWTV2.200309261900Z.csv
    |   |-- LWTV2.200309270700Z.csv
    |   |-- LWTV2.200309271300Z.csv
    |   |-- LWTV2.200309271900Z.csv
    |   |-- LWTV2.200309280700Z.csv
    |   |-- LWTV2.200309281300Z.csv
    |   |-- LWTV2.200309281900Z.csv
    |   |-- LWTV2.200309290700Z.csv
    |   |-- LWTV2.200309291300Z.csv
    |   |-- LWTV2.200309291900Z.csv
    |   |-- WASD2.200309100700Z.csv
    |   |-- WASD2.200309101300Z.csv
    |   |-- WASD2.200309101900Z.csv
    |   |-- WASD2.200309111300Z.csv
    |   |-- WASD2.200309111900Z.csv
    |   |-- WASD2.200309120700Z.csv
    |   |-- WASD2.200309121300Z.csv
    |   |-- WASD2.200309121900Z.csv
    |   |-- WASD2.200309130700Z.csv
    |   |-- WASD2.200309131300Z.csv
    |   |-- WASD2.200309131900Z.csv
    |   |-- WASD2.200309140700Z.csv
    |   |-- WASD2.200309141300Z.csv
    |   |-- WASD2.200309141900Z.csv
    |   |-- WASD2.200309150700Z.csv
    |   |-- WASD2.200309151300Z.csv
    |   |-- WASD2.200309151900Z.csv
    |   |-- WASD2.200309160700Z.csv
    |   |-- WASD2.200309161300Z.csv
    |   |-- WASD2.200309161900Z.csv
    |   |-- WASD2.200309170700Z.csv
```

```
|   |-- WASD2.200309171300Z.csv
|   |-- WASD2.200309171900Z.csv
|   |-- WASD2.200309180700Z.csv
|   |-- WASD2.200309181300Z.csv
|   |-- WASD2.200309181900Z.csv
|   |-- WASD2.200309190700Z.csv
|   |-- WASD2.200309191300Z.csv
|   |-- WASD2.200309191900Z.csv
|   |-- WASD2.200309200700Z.csv
|   |-- WASD2.200309201300Z.csv
|   |-- WASD2.200309201900Z.csv
|   |-- WASD2.200309211300Z.csv
|   |-- WASD2.200309211900Z.csv
|   |-- WASD2.200309220700Z.csv
|   |-- WASD2.200309221300Z.csv
|   |-- WASD2.200309221900Z.csv
|   |-- WASD2.200309230700Z.csv
|   |-- WASD2.200309231300Z.csv
|   |-- WASD2.200309231900Z.csv
|   |-- WASD2.200309240700Z.csv
|   |-- WASD2.200309241300Z.csv
|   |-- WASD2.200309241900Z.csv
|   |-- WASD2.200309250700Z.csv
|   |-- WASD2.200309251300Z.csv
|   |-- WASD2.200309251900Z.csv
|   |-- WASD2.200309260700Z.csv
|   |-- WASD2.200309261300Z.csv
|   |-- WASD2.200309261900Z.csv
|   |-- WASD2.200309270700Z.csv
|   |-- WASD2.200309271300Z.csv
|   |-- WASD2.200309271900Z.csv
|   |-- WASD2.200309280700Z.csv
|   |-- WASD2.200309281300Z.csv
|   |-- WASD2.200309281900Z.csv
|   |-- WASD2.200309290700Z.csv
|   |-- WASD2.200309291300Z.csv
|   `-- WASD2.200309291900Z.csv
|-- forecast_flow
|   |-- BRKM2.csv  ................................................Potomac at Little Falls -- forecast
|   `-- RCKD2.csv  ................................................................Rock Creek Forecast
|-- obs_flow
|   |-- ACOM2.csv ...................................................Anacostia NW Branch at Hyattsville
|   |-- BRKM2.csv  ............................................................Potomac at Little Falls
|   |-- RCKD2.csv  .........................................................................Rock Creek
|   `-- RVDM2.csv  ...................................................Anacostia NE Branch at Riverdale
`-- obs_level
    |-- 01647600_WisconsinAve.OBS.csv  ..................Wisconsin Avenue (GTND2) observed water levels
    |-- 0165258890_Alexandria.OBS.csv  ........................Alexandria (AXTV2) observed water levels
    |-- 8594900_WashDC.OBS.csv  ....................Washington Waterfront (WASD2) observed water levels
    `-- 8635750_LewisVA.OBS.csv  ..............................Lewisetta (LWTV2) observed water levels

6 directories, 129 files
```