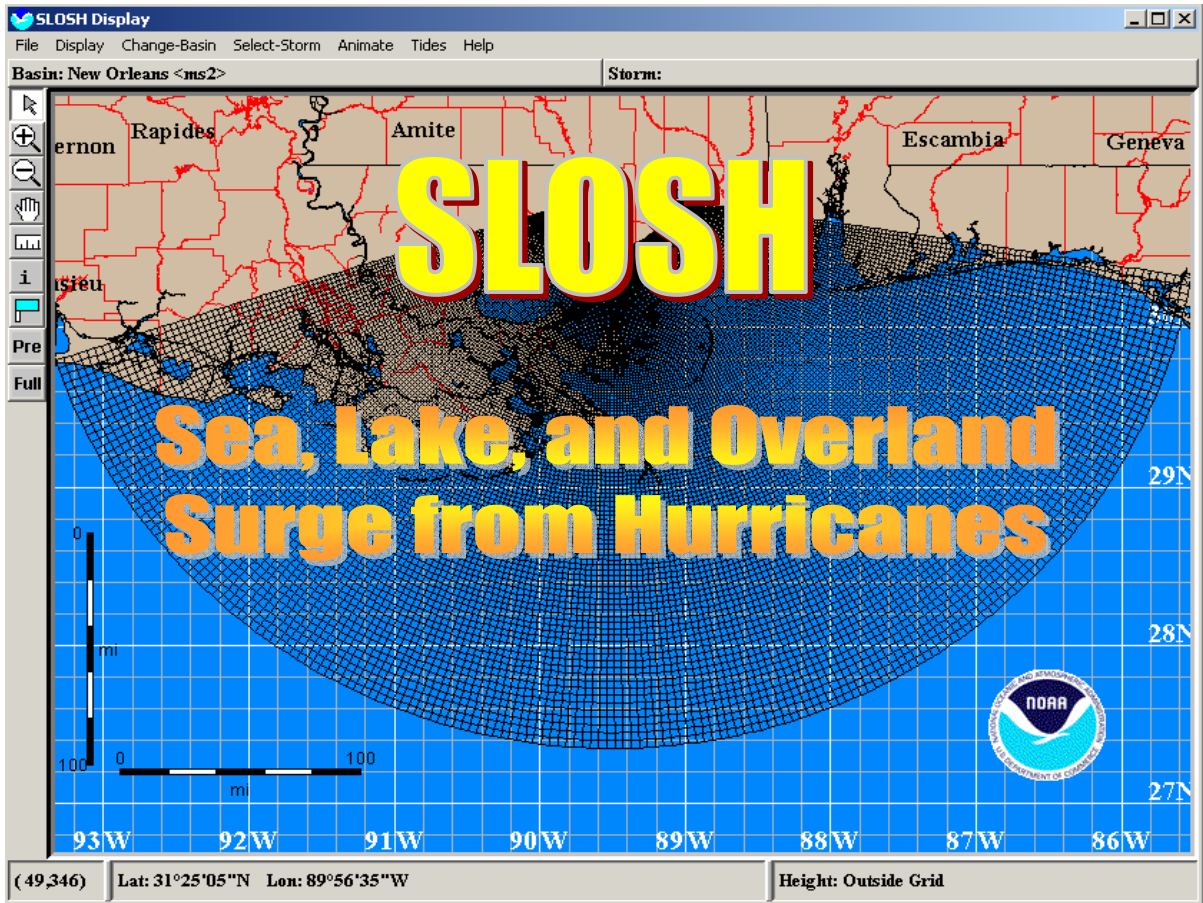


SLOSH Display Training



September 2003



FEMA

URS

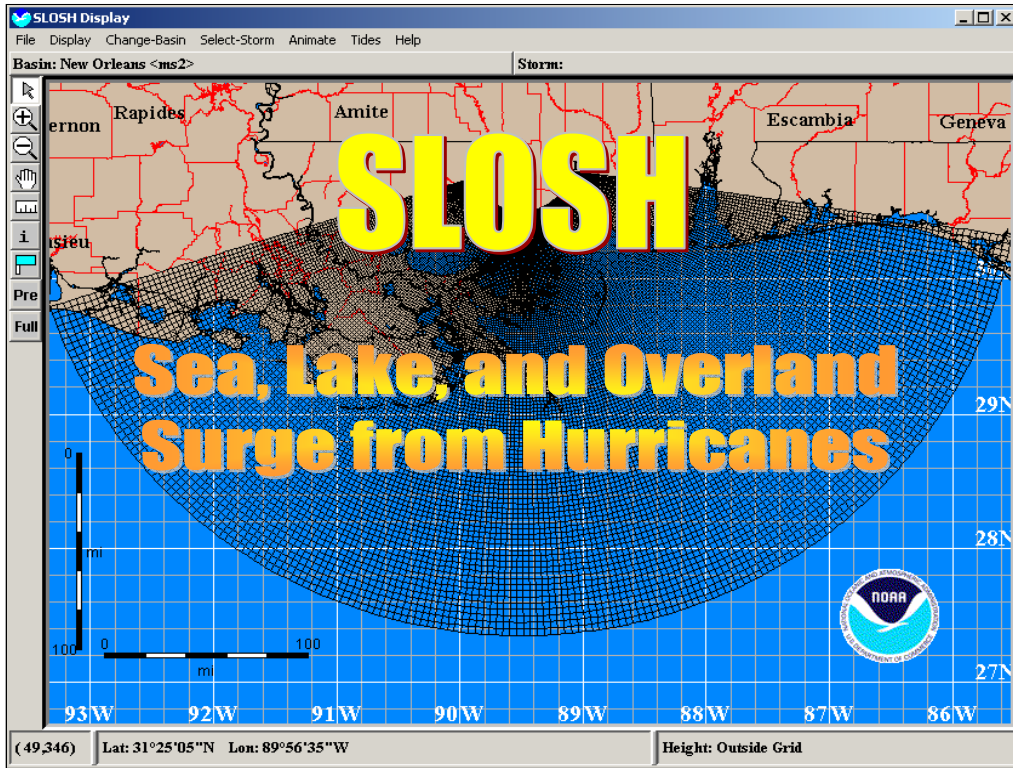


US Army Corps
of Engineers

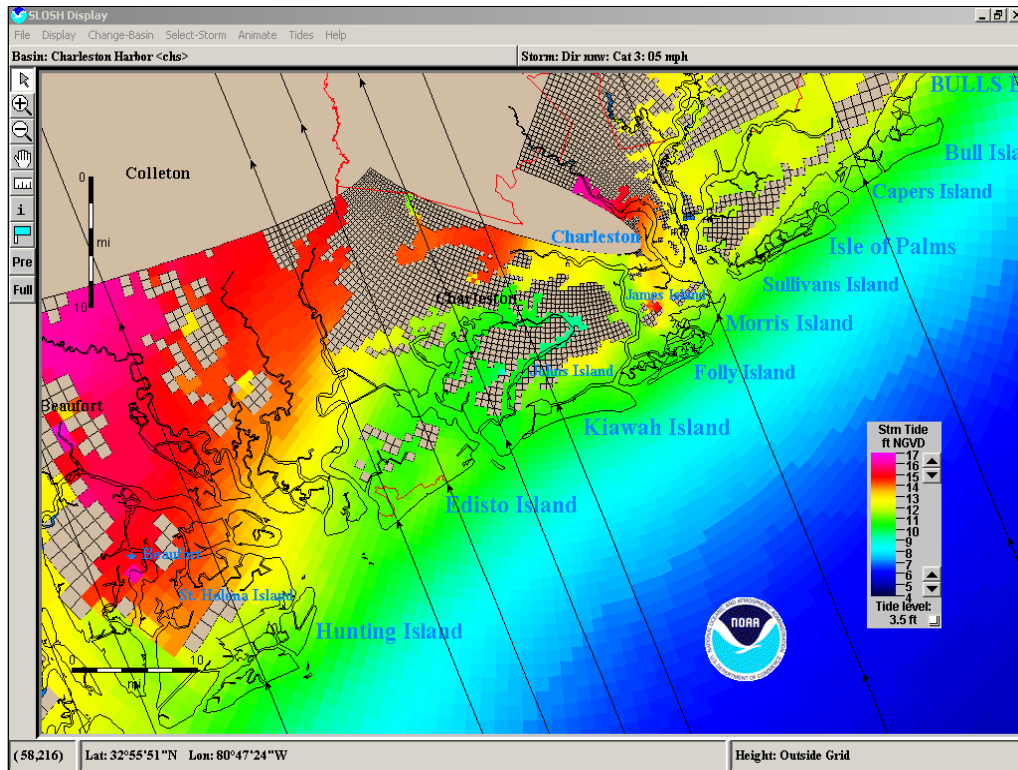
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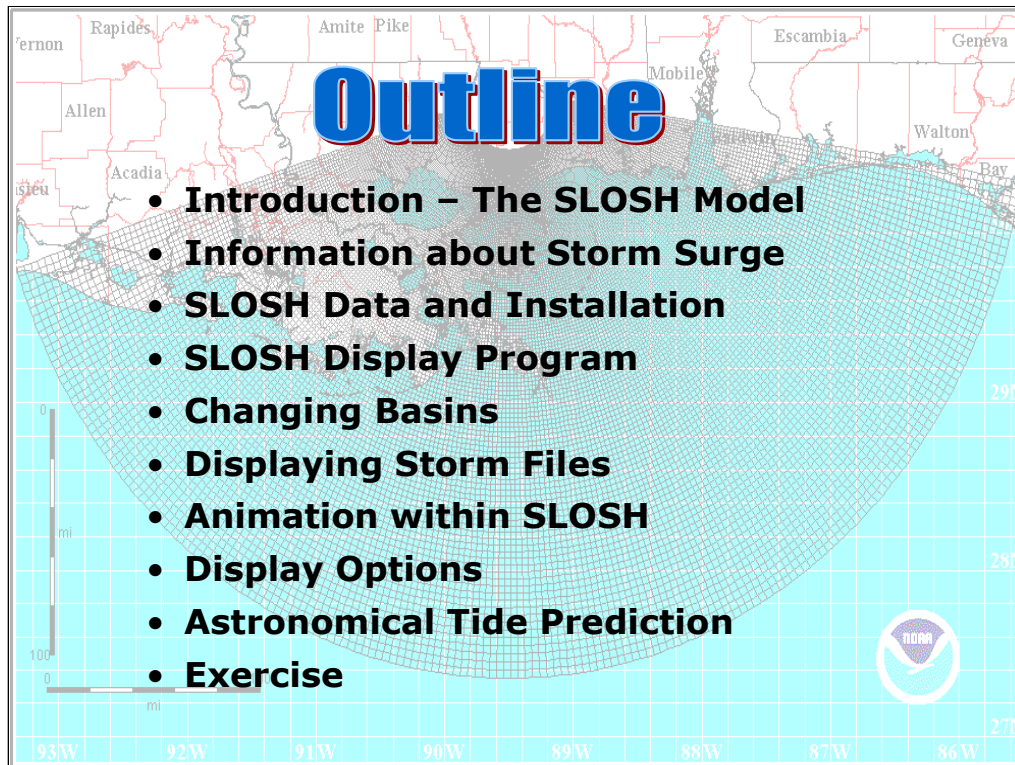
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SLOSH Display Training

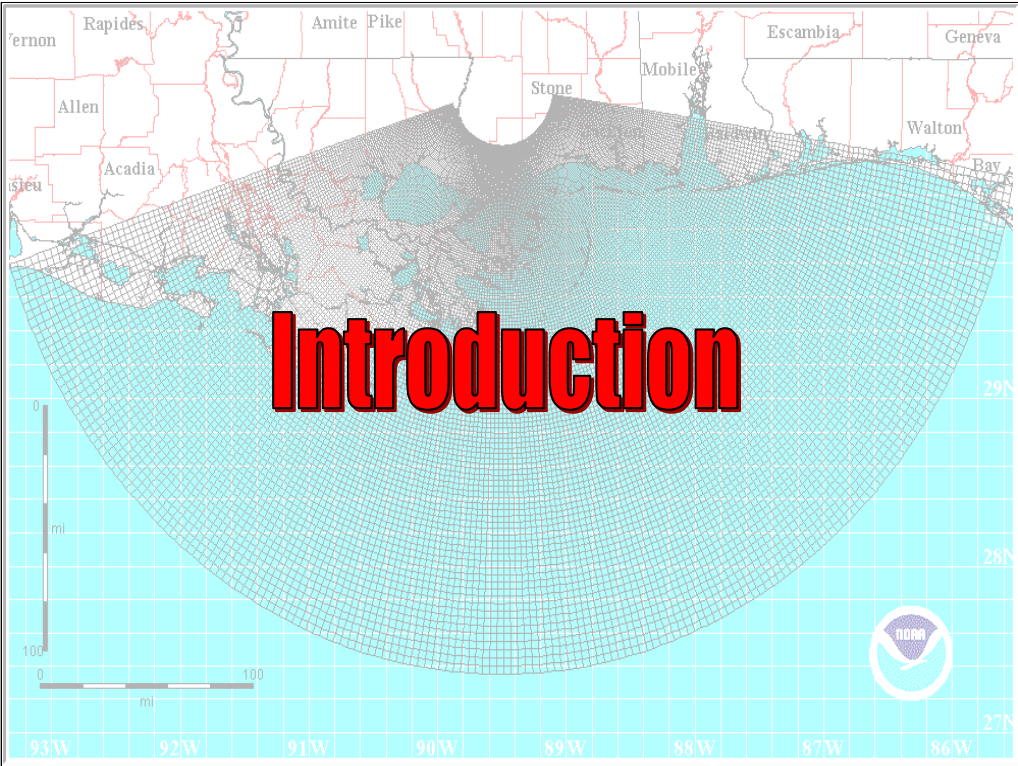


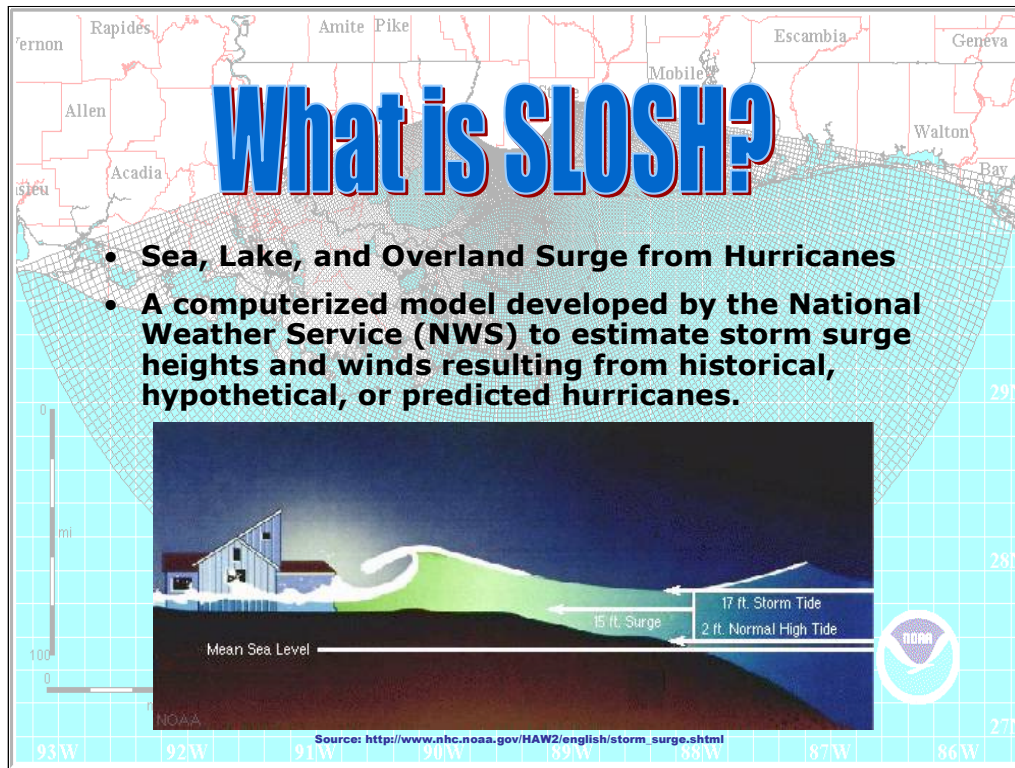
- This is the SLOSH display for a Category 3 hurricane approaching Charleston, South Carolina from the south-southeast.
- This training manual reviews the features of the SLOSH display program and the hurricane parameters that can be viewed and varied using this program.



Points to be covered in the training include:

- Introduction to the SLOSH model, information about storm surge development, and discussion about the program and data installation.
- Components of the SLOSH display, how to change between basins, how to display storm files to view storm surges, and how to animate a storm to view the change in storm surge height as storm parameters vary.
- SLOSH display options and the Astronomical Tide Prediction program, which is linked to the SLOSH display.
- Exercises





- SLOSH stands for Sea, Lake, and Overland Surge from Hurricanes. It is a computerized model developed by the National Weather Service (NWS) to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes.
- SLOSH is used by the National Hurricane Center (NHC) for the exclusive benefit of NWS, US Army Corps of Engineers (USACE), and Emergency Management personnel.
- There are several other storm surge models in use, including ADCIRC, however, SLOSH is the primary model used by the Federal Emergency Management Agency (FEMA), the National Oceanographic and Atmospheric Administration (NOAA), and USACE. It is also the basis for Hurricane Evacuation Studies (HES).



Definitions:

ADCIRC - Advanced Circulation model for oceanic, coastal, and estuarine waters

FEMA - Federal Emergency Management Agency

HES - Hurricane Evacuation Study

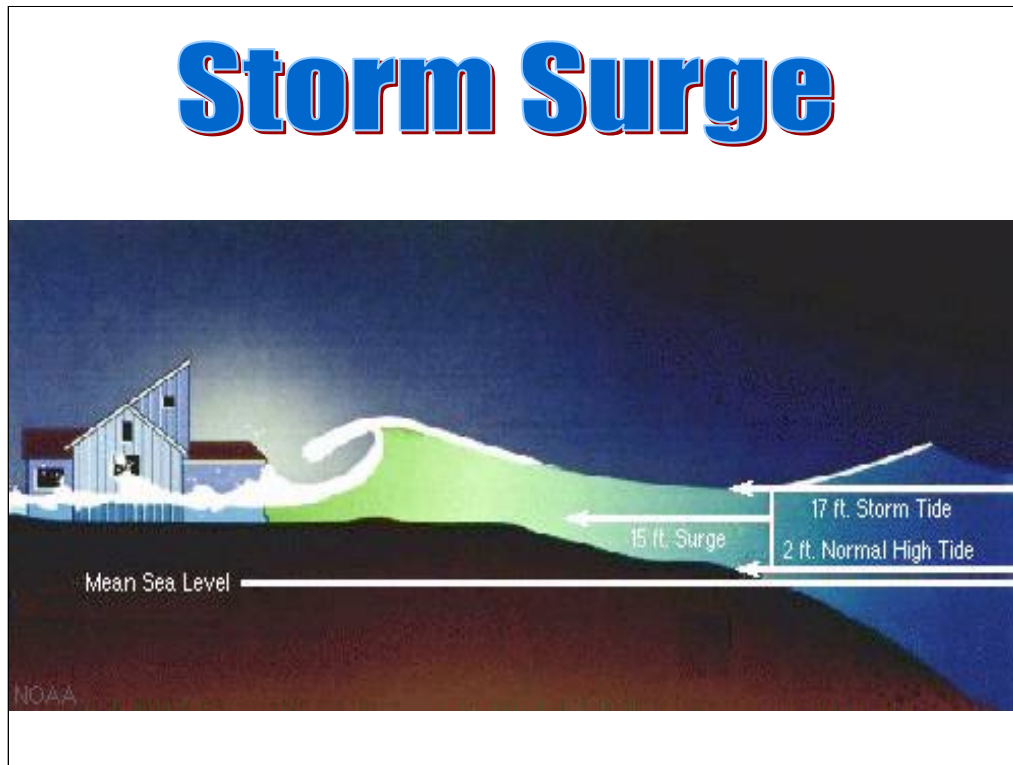
NHC - National Hurricane Center

NOAA - National Oceanographic and Atmospheric Administration

NWS - National Weather Service

SLOSH - Sea, Lake and Overland Surge from Hurricanes

USACE - United States Army Corps of Engineers

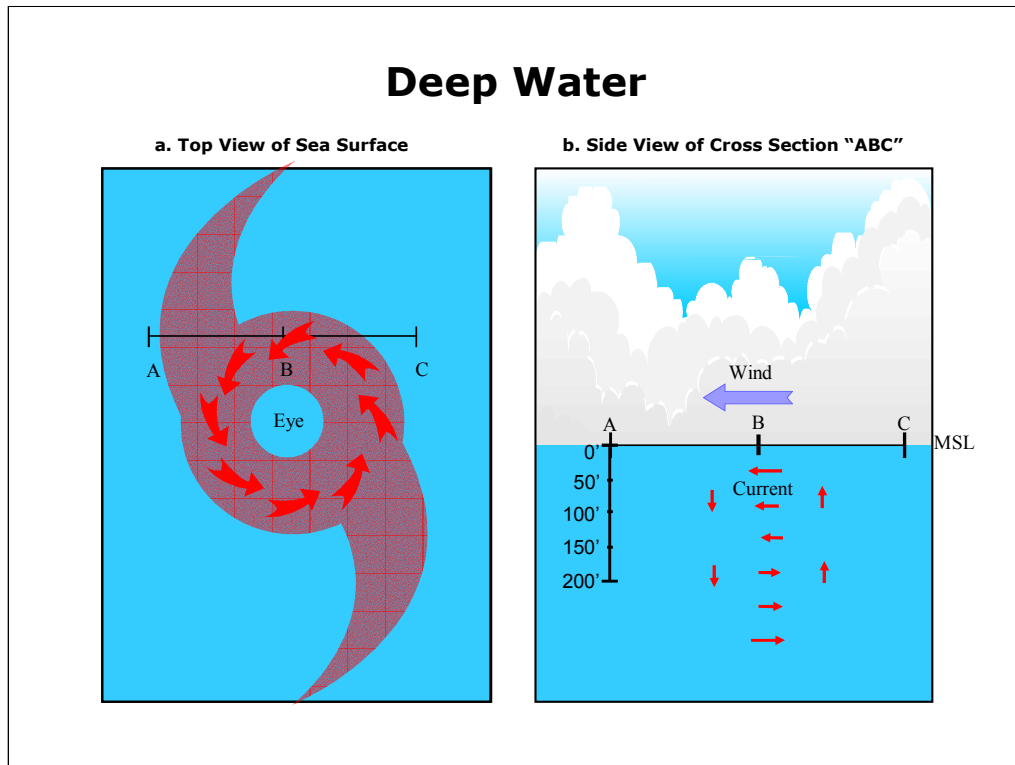


- This picture visually depicts the definition of a storm surge.
- Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm.
- This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level by 15 feet or more.

**Definitions:**

Storm Surge – water that is pushed toward the shore by the force of winds swirling around a storm.

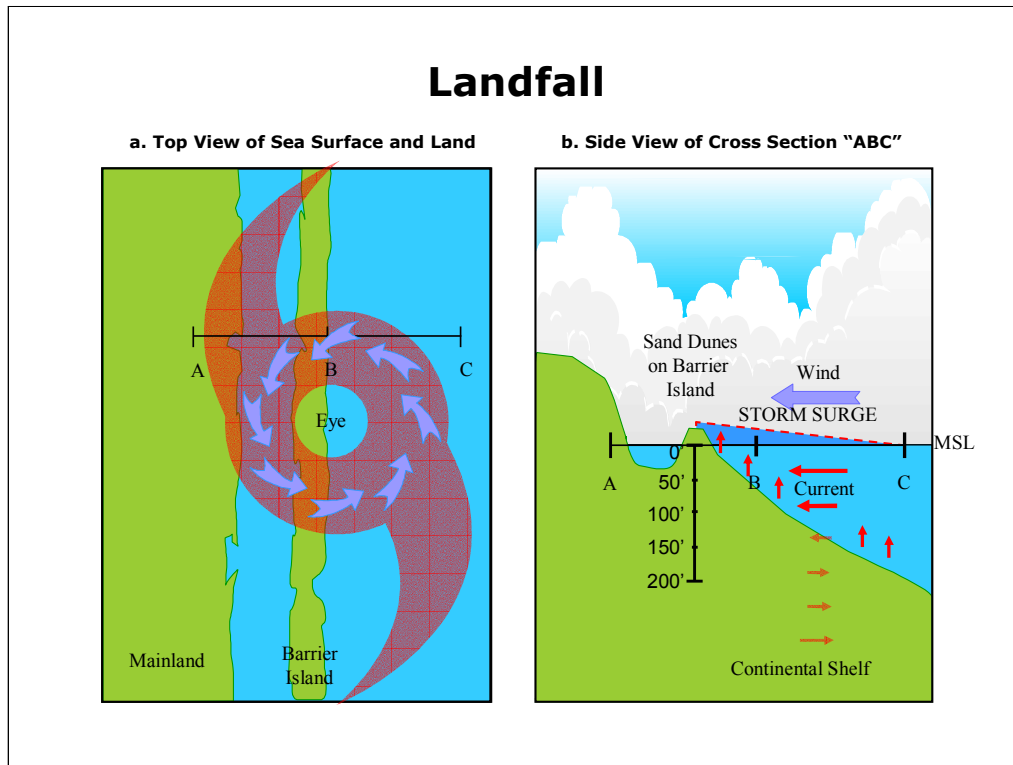
Storm Tide – the combination of the normal tide and the storm surge to create the total increase in water level due to the storm.



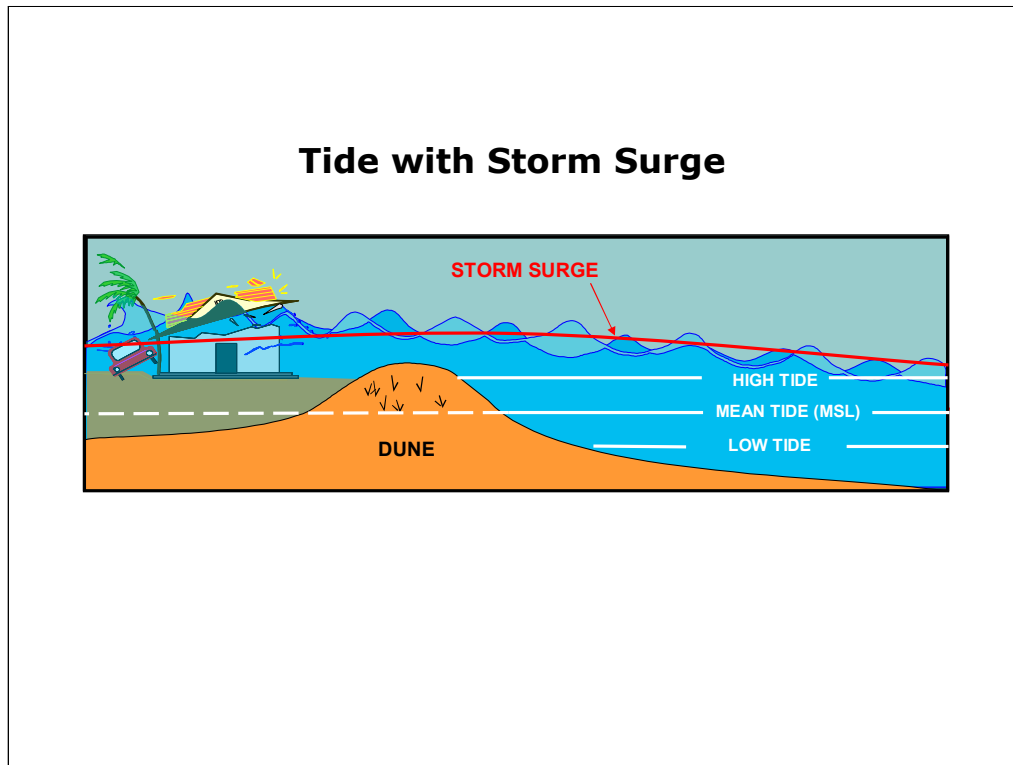
- This illustration shows how in deep water, the wind and current create a cycle of water which alleviates the build up of storm surge.
- Storm surge begins to build while the hurricane is still far out at sea over deep water. The low pressure near the center of the storm causes the water to rise. In deep water, a counter current develops well below the surface which counters an attempt by the wind to build up surges.

Note:

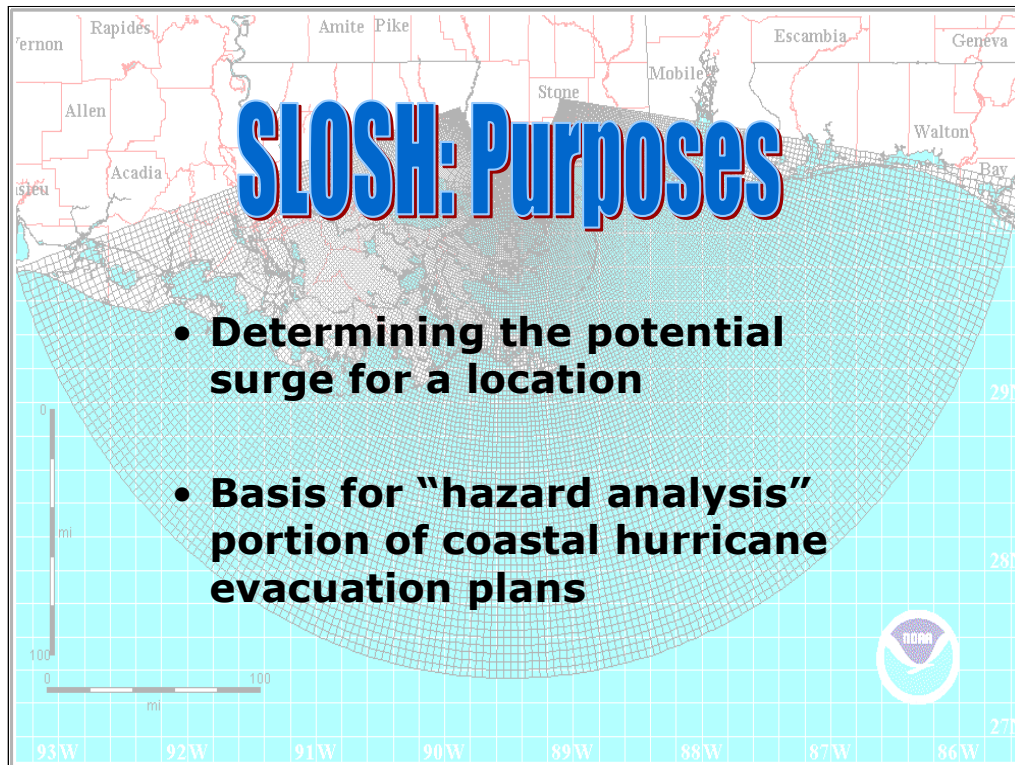
- There is some sea level rise due to the pressure change, but that is small compared to wind driven surge on a "shallow" continental shelf.



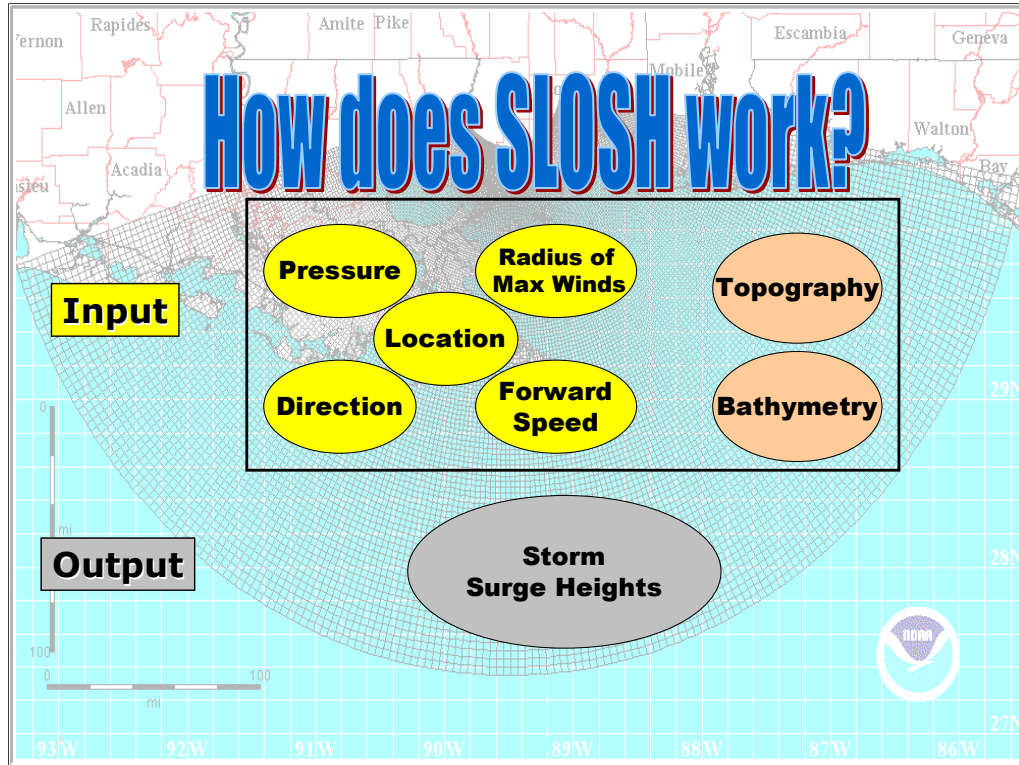
- As the water depth decreases closer to the shore, the excess water that is built up by the central pressure of the storm is not able to dissipate. The increased water has no place to go except up onto the shore. The force of winds swirling around the storm pushes the water toward the shore and creates storm surge.
- The level of storm surge in a particular area is also determined by the slope of the continental shelf. A shallow slope of the coast will allow a greater surge to inundate coastal communities. Areas with a steeper continental shelf will not see as much surge inundation, although large breaking waves can still present major problems.



- The tide level when a hurricane makes landfall can have a major impact on the total water surface elevation caused by the storm (storm tide). If a storm makes landfall at high tide, the storm tide may be several feet higher than if a storm makes landfall at mean or low tide.
- This rise in water level can cause severe flooding in coastal areas.



- SLOSH is best used for defining the potential flooding from storm surge for a location from a threatening hurricane, rather than as a predictor of the specific areas that will be inundated during a particular event.
- SLOSH output is used as the hazard analysis for hurricane evacuation plans. SLOSH model results are combined with traffic flow information for creating a HES and combined with rainfall amounts, river flow, or wind-driven waves to determine a final analysis of at-risk areas.



- Given a SLOSH Basin, which is a geographical region with known values of topography and bathymetry, and a hurricane track (identified by its pressure, radius of maximum winds, location, direction, and speed), the SLOSH model solves a complex set of equations and outputs data which are shown as color-coded storm surge in the SLOSH display.

Important Note:

- The point of a hurricane's landfall is crucial to determining which areas will be inundated by the storm surge. If the forecast hurricane track is not correct, the SLOSH model will be inaccurate.

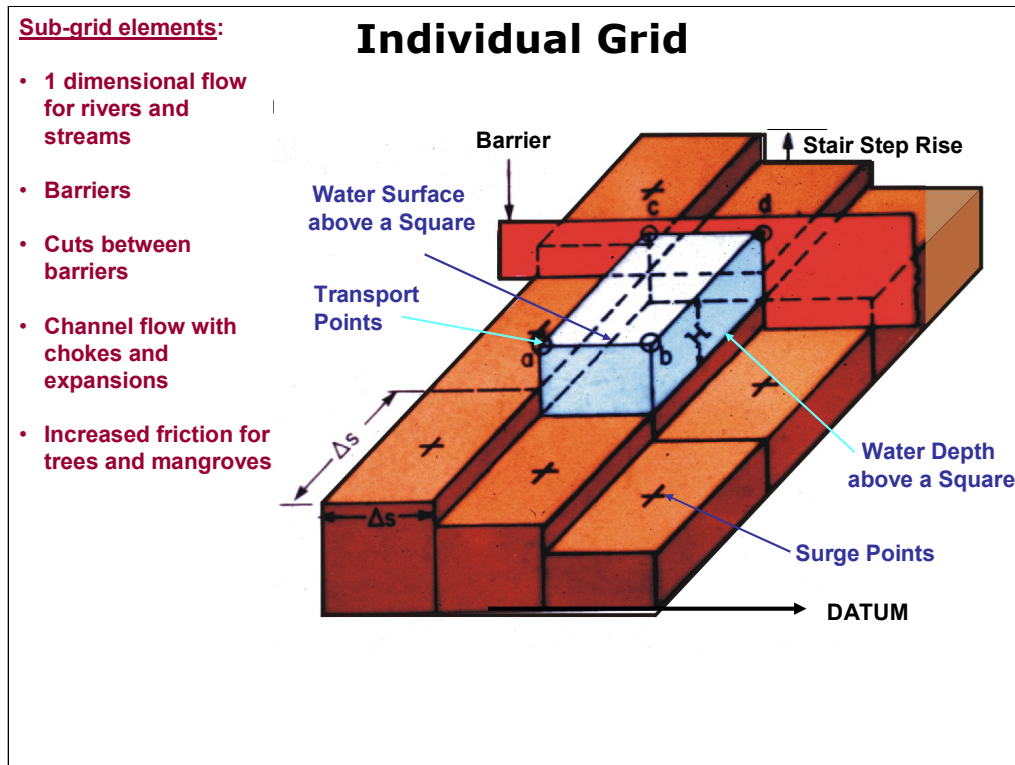


Definitions:

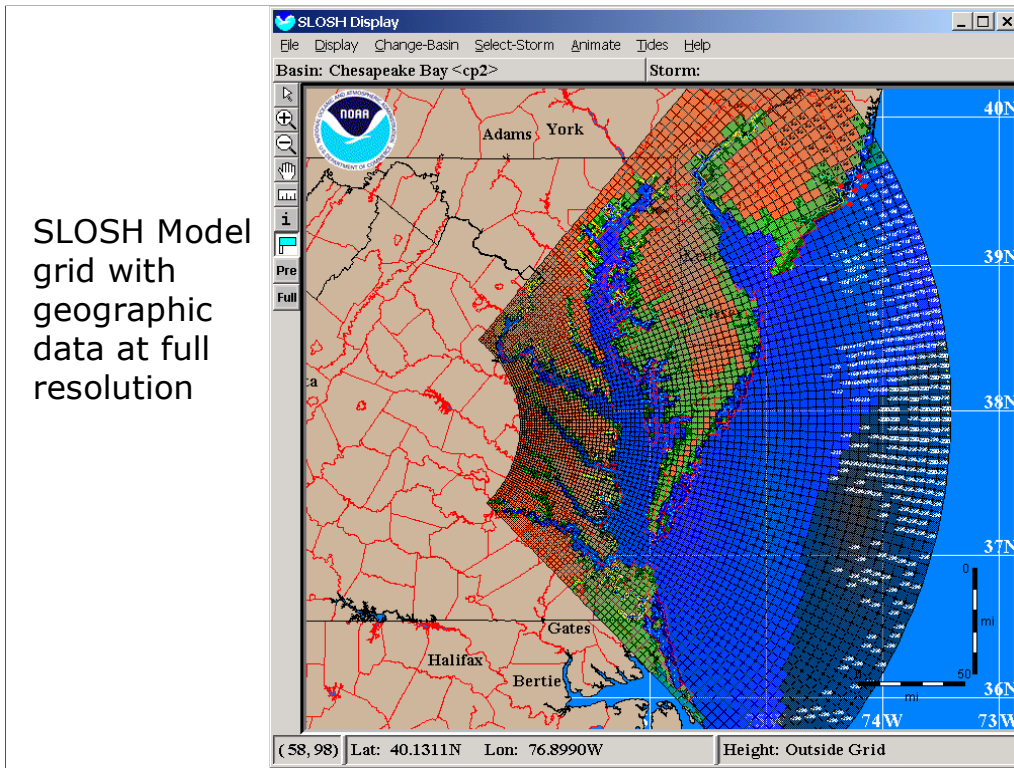
Bathymetry – the water depth relative to mean sea level. It may be expressed as positive or negative, but should be understood to be negative.

SLOSH Basin – a geographical region with known values for topography and bathymetry.

Topography – the configuration of a surface, including the elevation and position of its natural and man-made features.



- The individual elements of the SLOSH grid are the basis for calculating water surface elevations caused by storm surge in a specific SLOSH basin.
- The grid allows for barriers to flow, cuts in barriers, one dimensional flow in rivers and streams, and increased friction for trees and mangroves in certain grid blocks to be taken into consideration in the calculations.
- Δs refers to the distance or length of each side of the grid element.
- The transport points are the points at which flow enters and exits the cell.
- The water depth is calculated based on the elevation of the grid cell and the amount of water that is able to flow into that cell. The water surface is found at the elevation of the water depth combined with the average ground elevation of the grid cell.



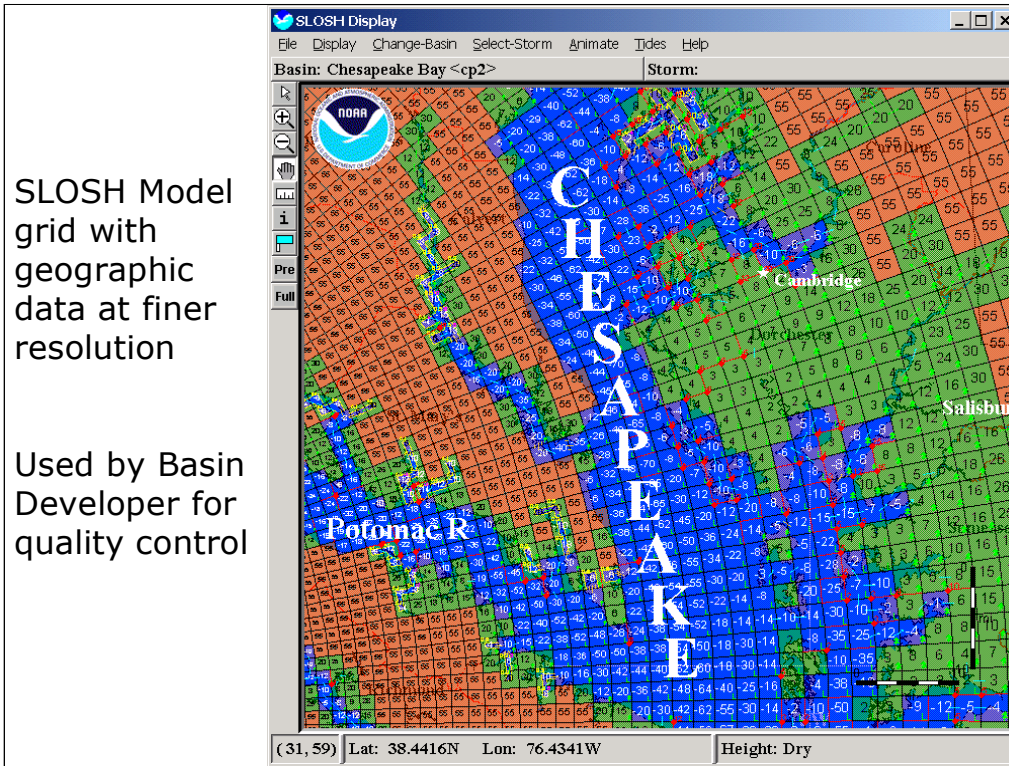
- The SLOSH model contains topographic information for each grid cell. This data is combined with the storm surge calculations based on the storm characteristics to determine the water surface elevations caused by storm surge.
- The majority of the topographic data is obtained from the U.S. Geological Survey (USGS). However, other data sources are utilized in small areas where available and necessary.
- Currently when SLOSH basins are updated, bathymetry is obtained from the National Geophysical Data Center (NGDC). Many basins have already been updated.



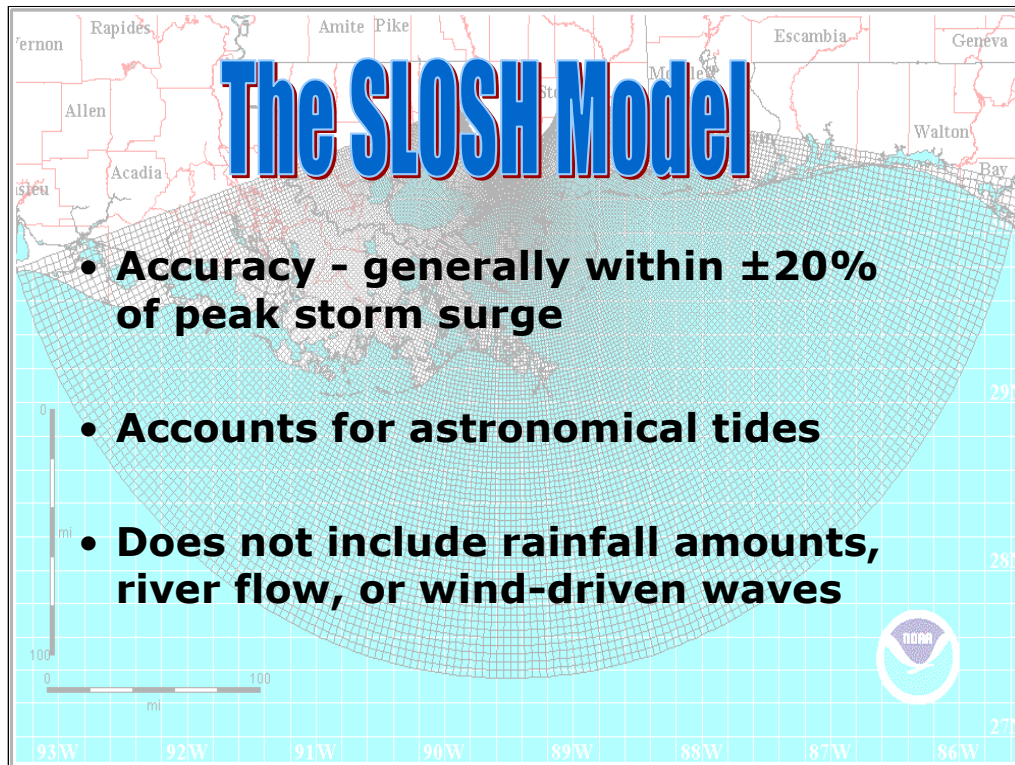
Definitions:

NGDC – National Geophysical Data Center.

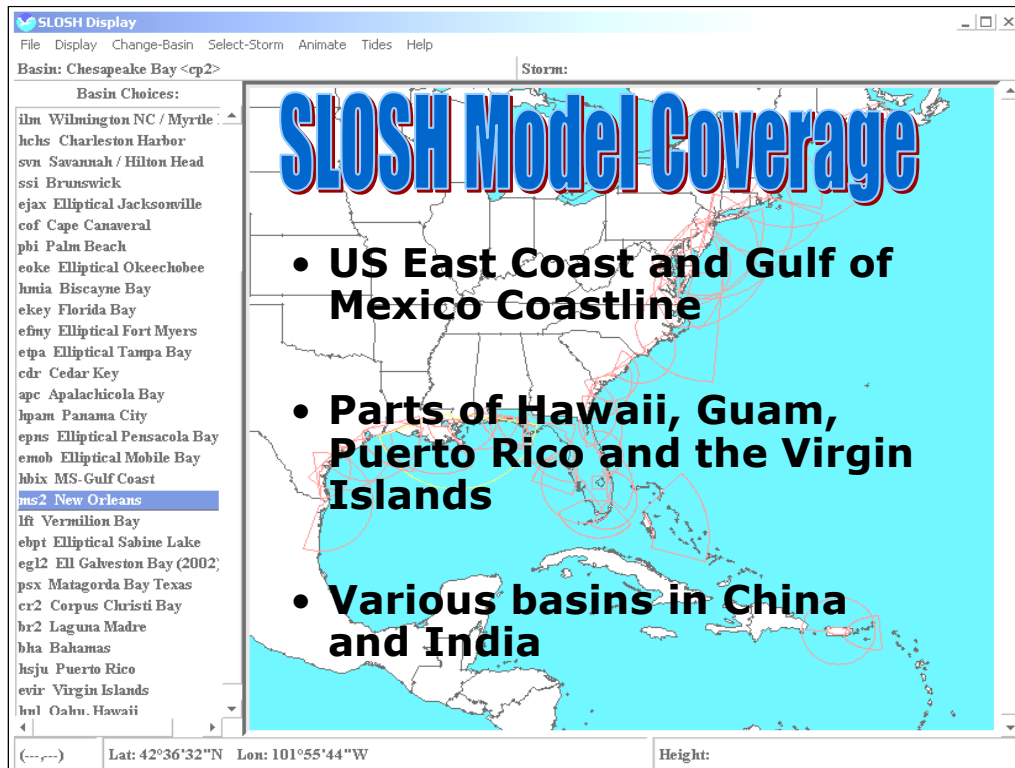
USGS – U.S. Geological Survey



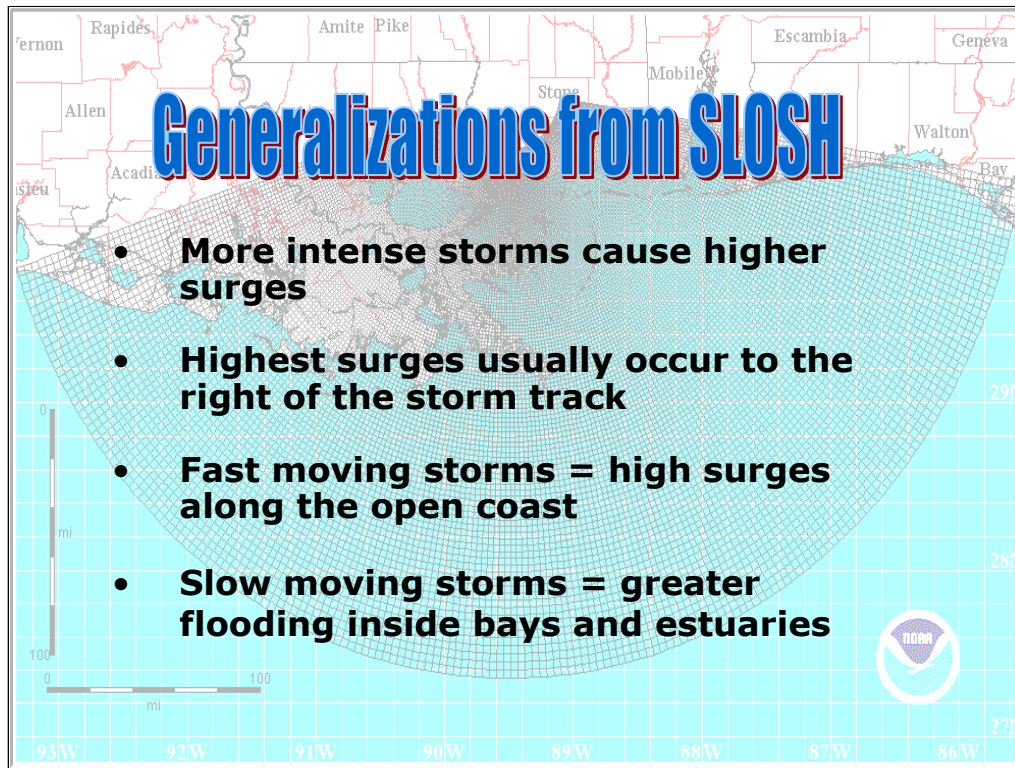
- The elevation for each grid cell is the average of the ground surface elevations found in that grid cell. The number shown in each cell is that average elevation. The water surface elevations are determined the same way. For each cell an average water surface elevation is found and assigned to that cell.
- The user of the SLOSH Display program does not have access to this detailed topography. This illustration shows an enhanced version of the SLOSH grid.



- Accuracy for the SLOSH model is generally within plus or minus 20% of the peak storm surge. If the model calculates a peak storm surge of 10 feet for the event, you can expect the observed peak to range from 8 to 12 feet.
- Post storm analyses are conducted to show how SLOSH model data compare to actual historical storm data.
- The accuracy of plus or minus 20% for the SLOSH model is for a KNOWN hurricane track, intensity, and size, based on looking at surge measurements (primarily high water marks) from past hurricanes.
- Astronomical tides can add significantly to the water height. The model accounts for tides by specifying the initial tide level.
- The SLOSH model does not include rainfall amounts, river flow, or wind-driven waves. These are combined with the model results in the final analysis of at-risk areas.

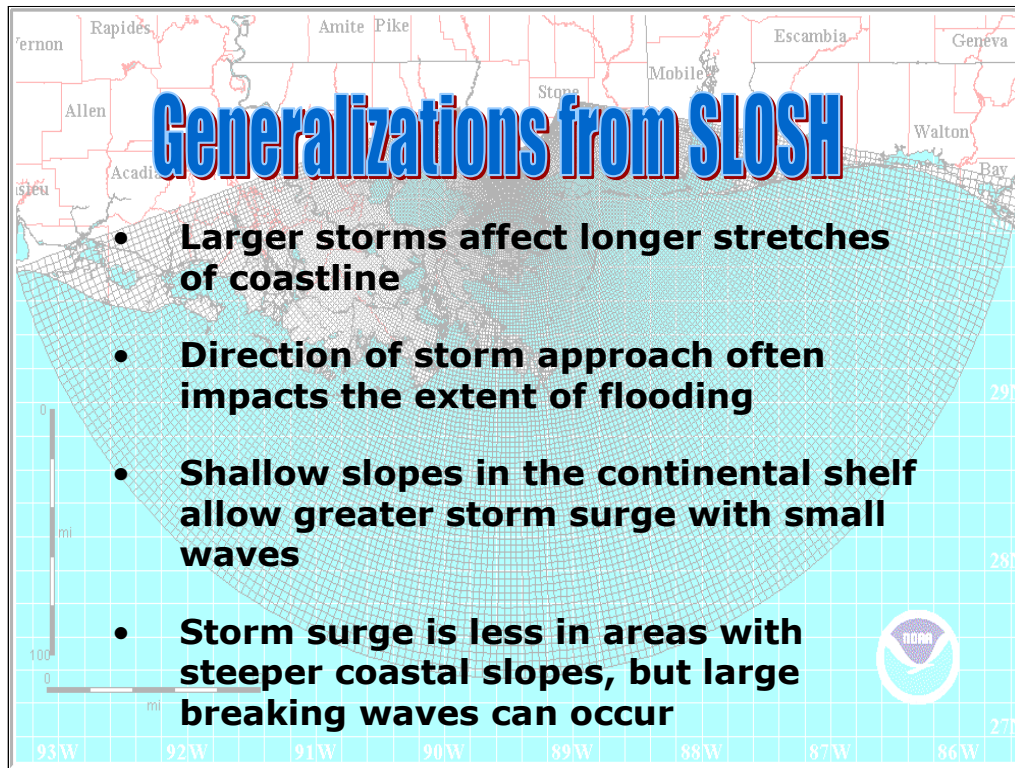


- The SLOSH model covers the U.S East Coast and the Gulf of Mexico coastline.
- Parts of Hawaii, Guam, Puerto Rico, and the Virgin Islands are included.
- Various basins in China and India are also available.
- Simulation studies have been conducted and data generated for the display program for all of the US East and Gulf coast basins. Even though basins are included for other areas, simulation studies may not have been conducted. For example, there are 5 basins in India and China but simulation studies were never performed for these areas.

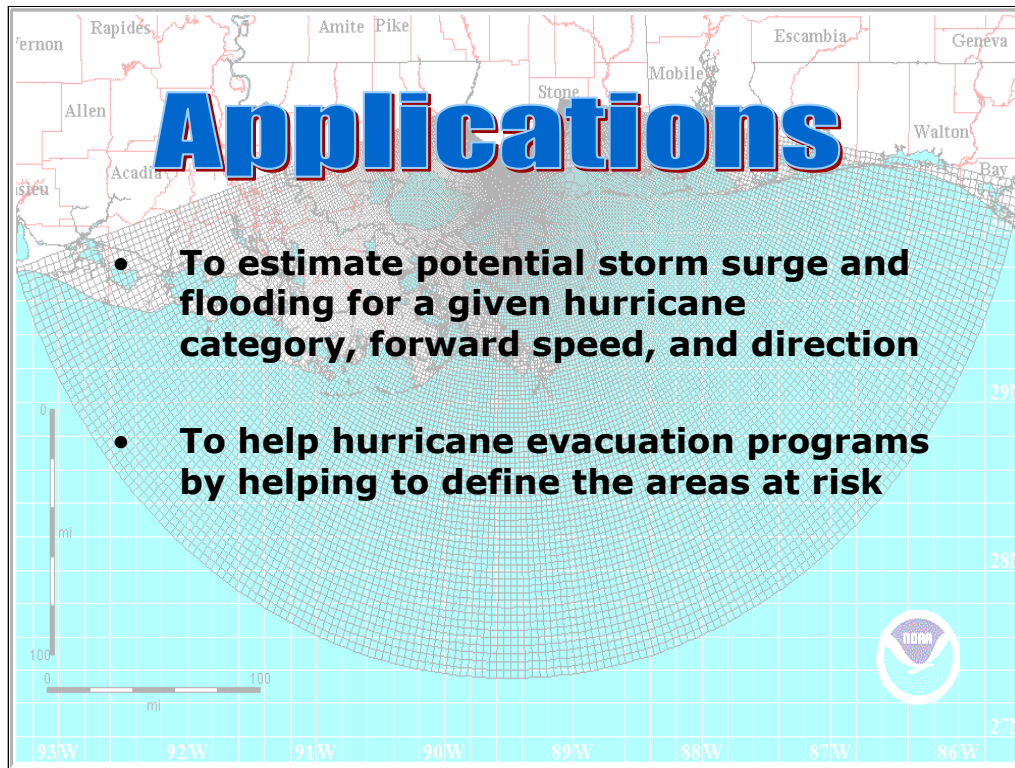


Several generalizations can be drawn from SLOSH models.

- More intense storms cause higher surges.
- The highest surges usually occur to the right of the storm track (traveling with the storm) at approximately the radius of maximum wind.
- Fast moving storms cause high surges along open coast and lower surges in sheltered bays and estuaries.
- Slow moving storms usually result in greater flooding inside bays and estuaries, with smaller values along the open coast.

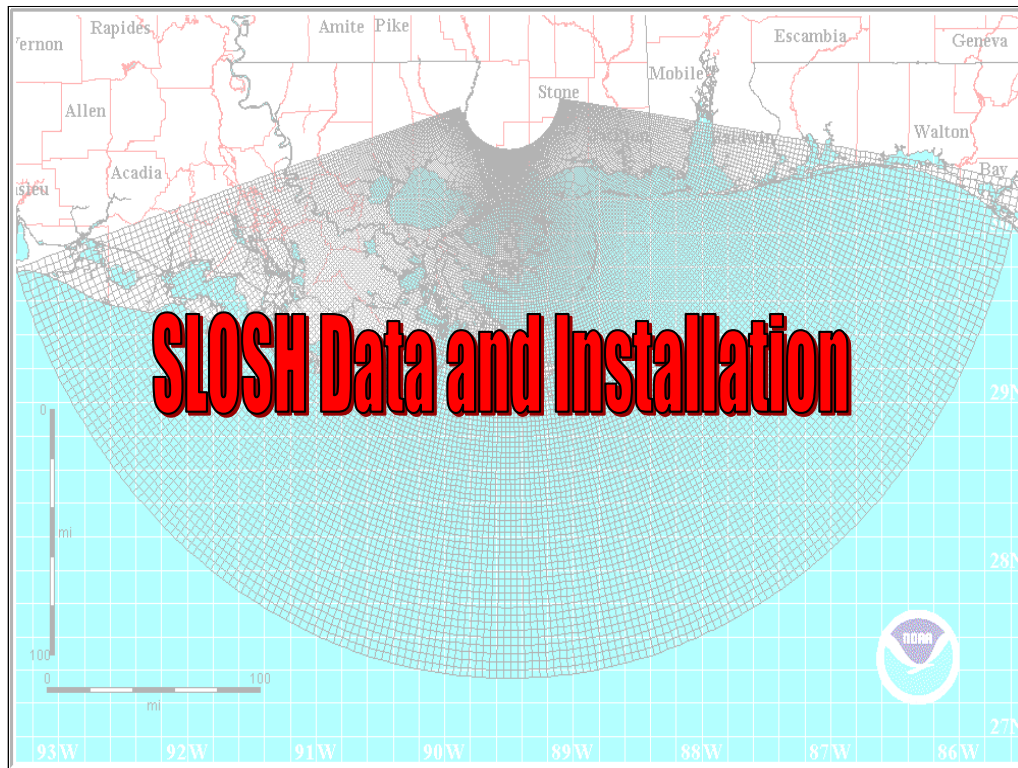


- Larger storms affect longer stretches of the coastline. A larger storm is defined as a storm having a greater radius of maximum wind.
- The direction of storm approach often impacts the extent of flooding. Depending on location, storms from one direction may cause inundation, while a storm of the same magnitude from a different direction may cause little flooding.
- The slope of the continental shelf will affect the level of surge in a particular area. Areas with shallow slopes of the continental shelf will allow a greater storm surge, but waves are small.
- Areas with deep water just offshore experience large waves, but little storm surge.

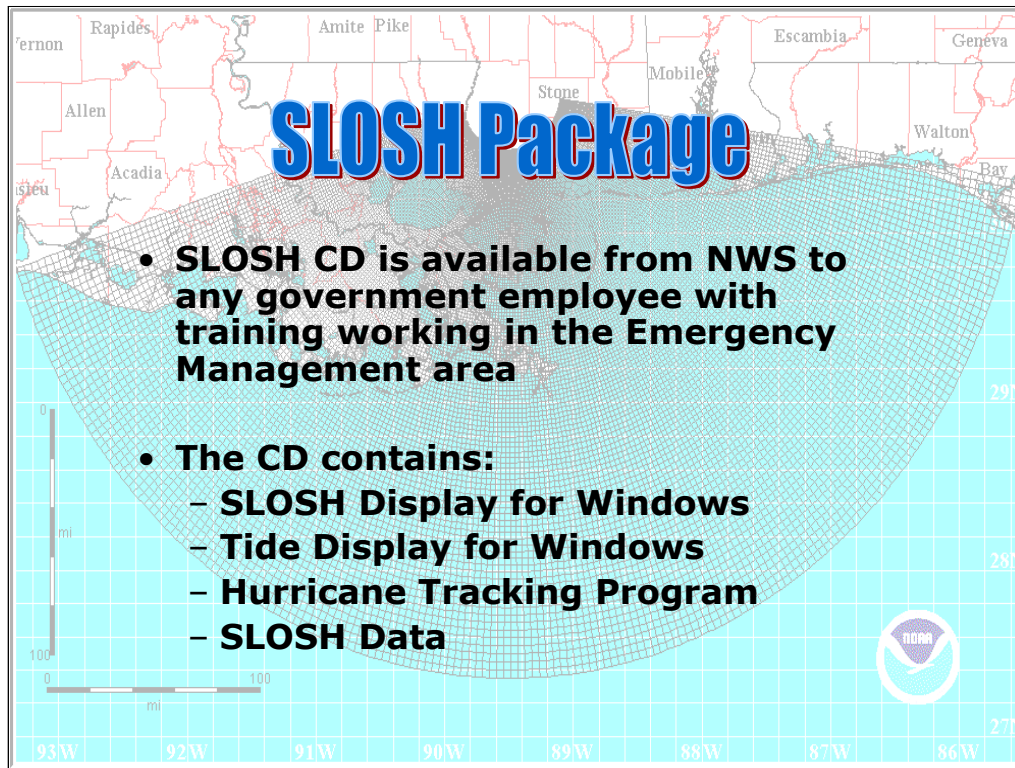


SLOSH output can be applied:

- To estimate potential storm surge and flooding for a given hurricane category, forward speed, and direction.
- To help hurricane evacuation programs by defining the areas at risk. From there, the threatened population, evacuation zones, and evacuation routes are determined, and the percentage of people evacuating and evacuation times are estimated.



- Installation of the SLOSH Display program and data.



- The SLOSH CD can be obtained from NWS, Meteorological Development Lab (MDL), Evaluation Branch.
- The CD contains: SLOSH Display for Windows, Tide Display for Windows, Hurricane Tracking Program, and SLOSH Data.

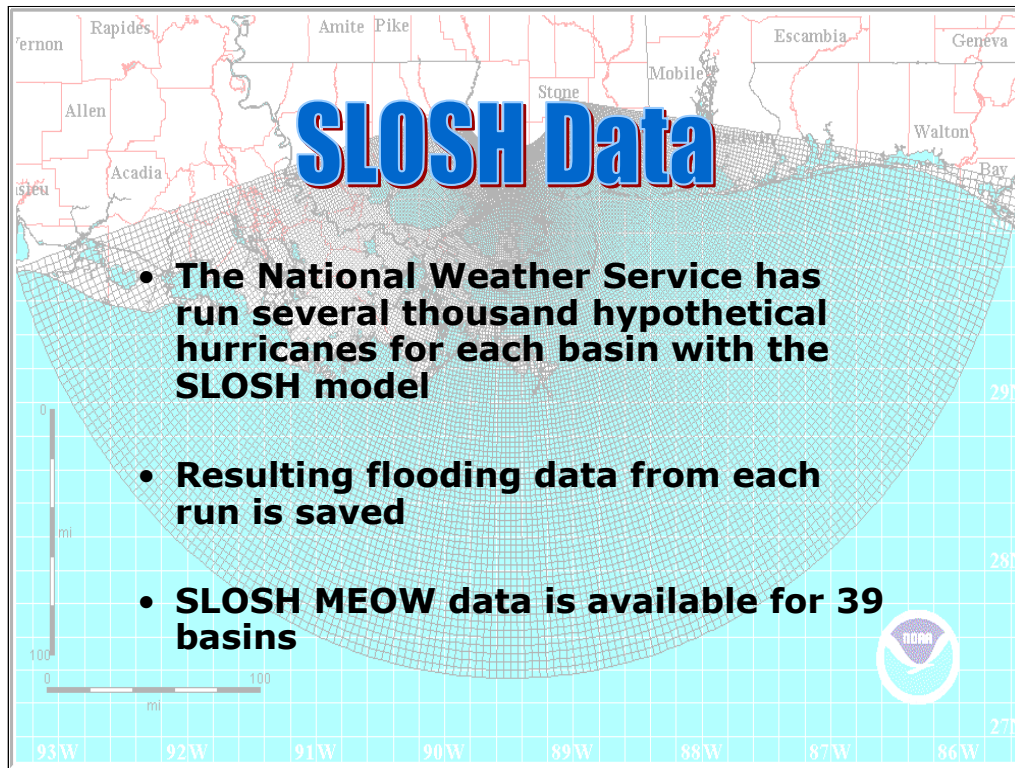
Notes:

- This program is available exclusively to emergency management personnel who have received training on the use of this program.
- Surge maps that are derived from SLOSH are available to the public.



Definition:

MDL – Meteorological Development Lab



- The National Weather Service has run several thousand hypothetical hurricanes for each basin with the SLOSH model.
- The resulting flooding data from each run are saved.
- In the New Orleans basin alone, the National Weather Service ran 1,640 individual hypothetical hurricanes. One way to reduce this large volume of data is by creating composites from many individual runs. Composites called MEOWs (Maximum Envelopes of Water) or MOMs (Maximum(s) of the MEOWs) will be defined and discussed later.
- SLOSH Maximum Envelope of Water (MEOW) data is available for 39 basins.



Definitions:

MEOW – Maximum Envelope of Water

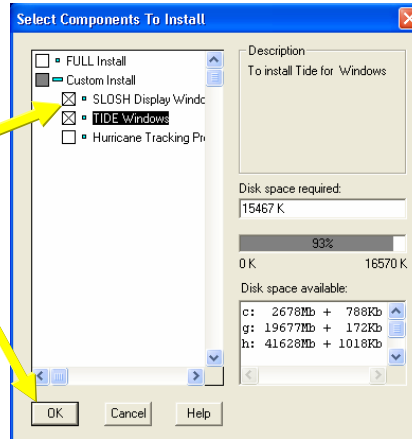
MOM – Maximum of the MEOWs



1. Insert the SLOSH Display CD and run the "Install.exe" file.
2. The "SLOSH Package For Windows" installation screen will appear. Select "Install" to begin.

3. Select Components to Install

Select "SLOSH Display Window" and "Tide Window" and hit "OK"



- Next, select the components to install. Choose either "Full" or "Custom" installation. "Full" will install all three programs in the SLOSH Package. "Custom" will install only the programs selected.
- 3. Select "SLOSH Display Window" and "Tide Window" under "Custom Install" and click "OK."

4. Set Target Directories

4a. Main Directory



C:\slosh.pkg

4b. Data Directory



C:\slosh.pkg\data

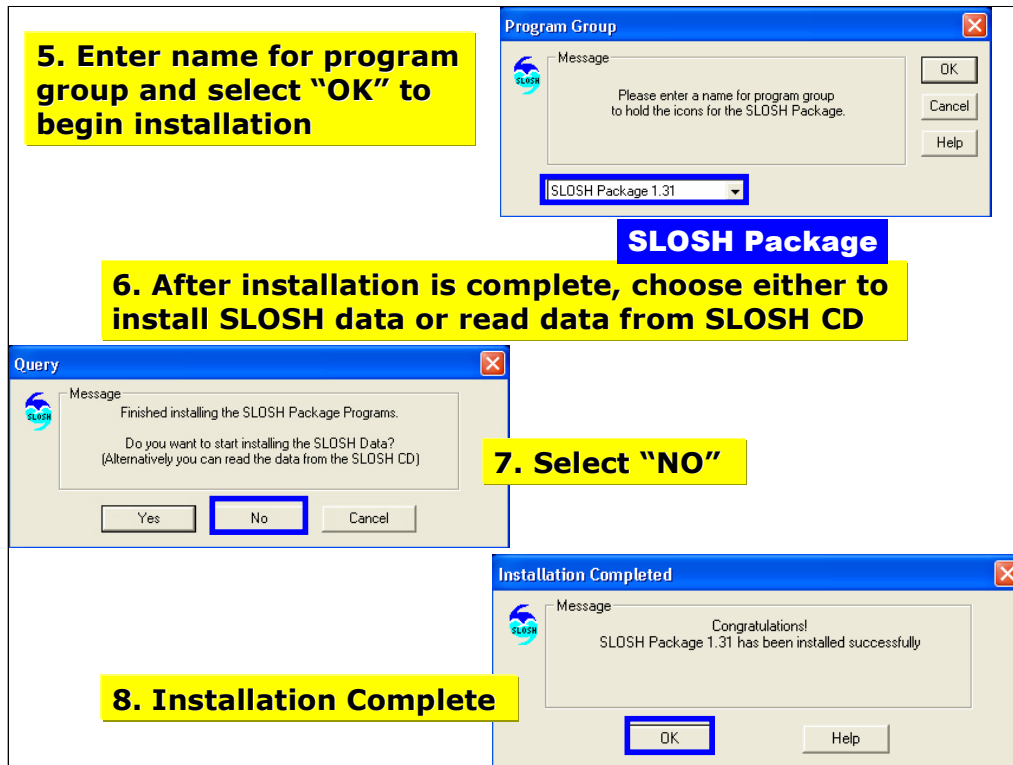
Hit "Enter" to Accept Default

4c. Output Directory



C:\slosh.pkg\output

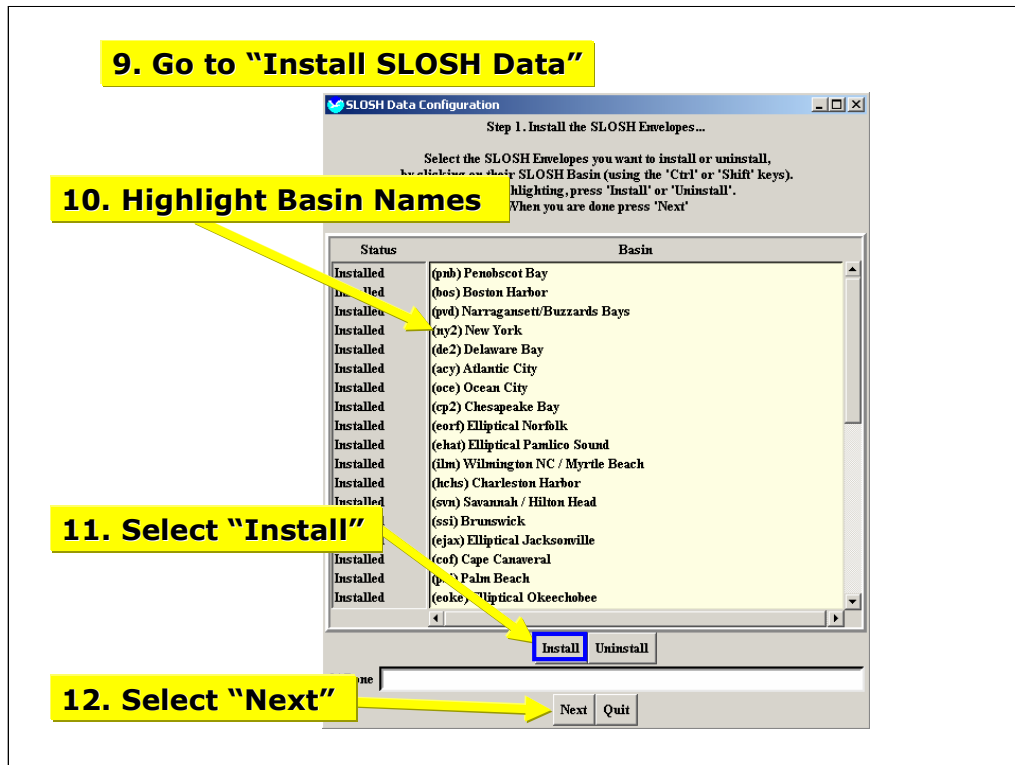
- The next three screens (4a, 4b, and 4c) deal with setting the target directories.
 - The main directory is where the SLOSH package will be installed, the data directory is where DATA files will be installed, and the OUTPUT files will be saved in the output directory.
4. Hit "Enter" or select "OK" to accept the default values or specify the location where data should be installed.



5. Next, enter a name for the program group. The default program group, where icons for the SLOSH package will be held, is SLOSH Package. Select the default name and click “OK” to begin installation.
6. Installation will take several minutes. Once installation is complete, the user has the option to install SLOSH data.
 - Selecting YES, will cause the Data Configuration Screen to appear and prompt the user to select SLOSH envelopes to install. Selecting NO, completes the installation.
7. Select “NO” at this time. SLOSH data may be installed at any time after program installation is complete.
8. Select “OK” when the “Installation Completed” screen appears.

Note:

- The SLOSH Display program can use data directly from the CD if desired.

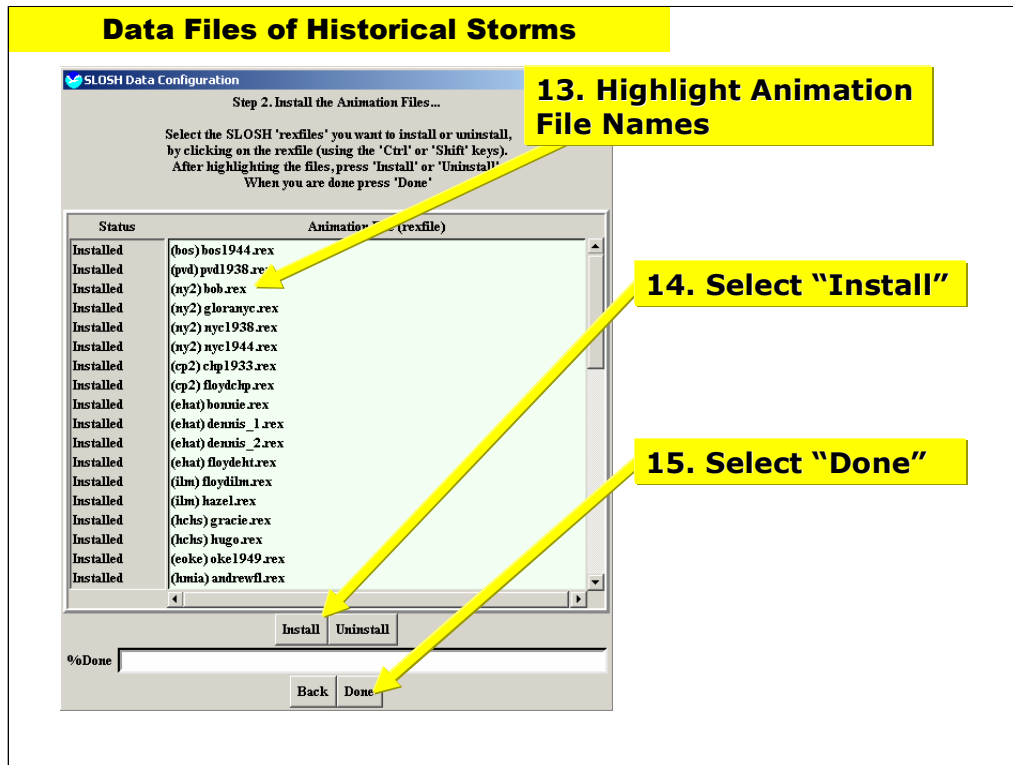


9. Go to “Start | Programs | SLOSH Package | Install SLOSH Data.”
 - SLOSH data is installed by double clicking on the “Install SLOSH Data” icon in the SLOSH Package program set.
10. Install the following SLOSH envelopes: Apalachicola Bay (apc), New Orleans (ms2), and New York (ny2).
 - Select the SLOSH envelopes to install by clicking on their SLOSH Basin name. Use the “control” key to select more than one.
11. After highlighting the SLOSH envelopes to install, press “Install.”
12. Once installation is complete, press “Next.”

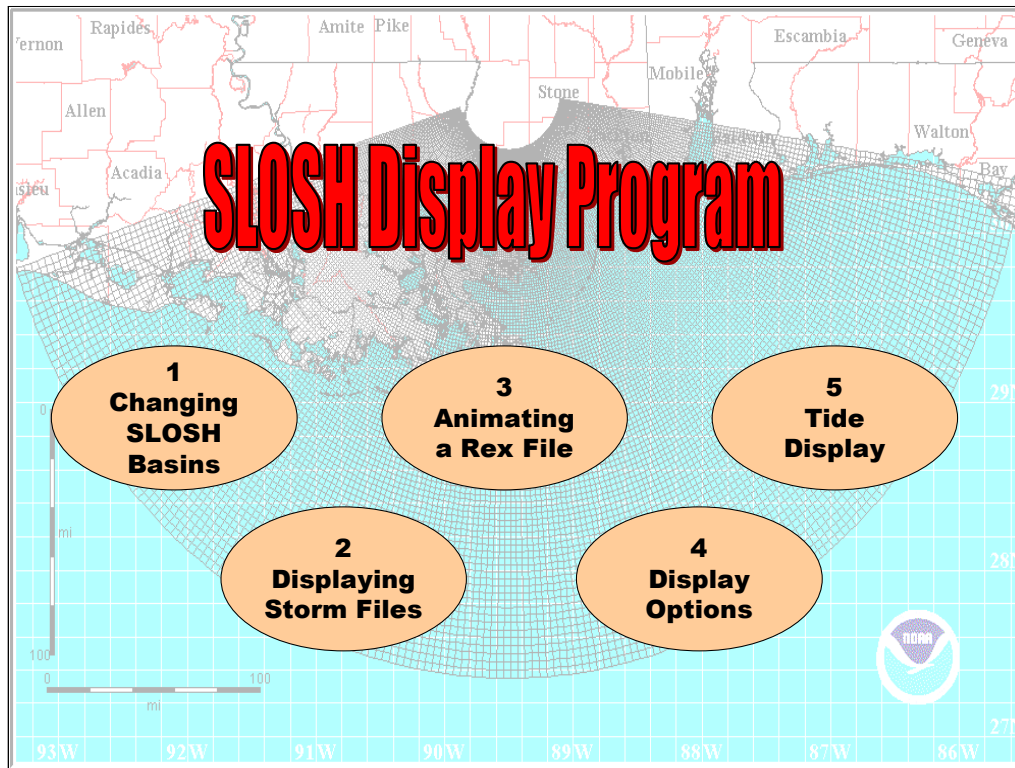


Hints:

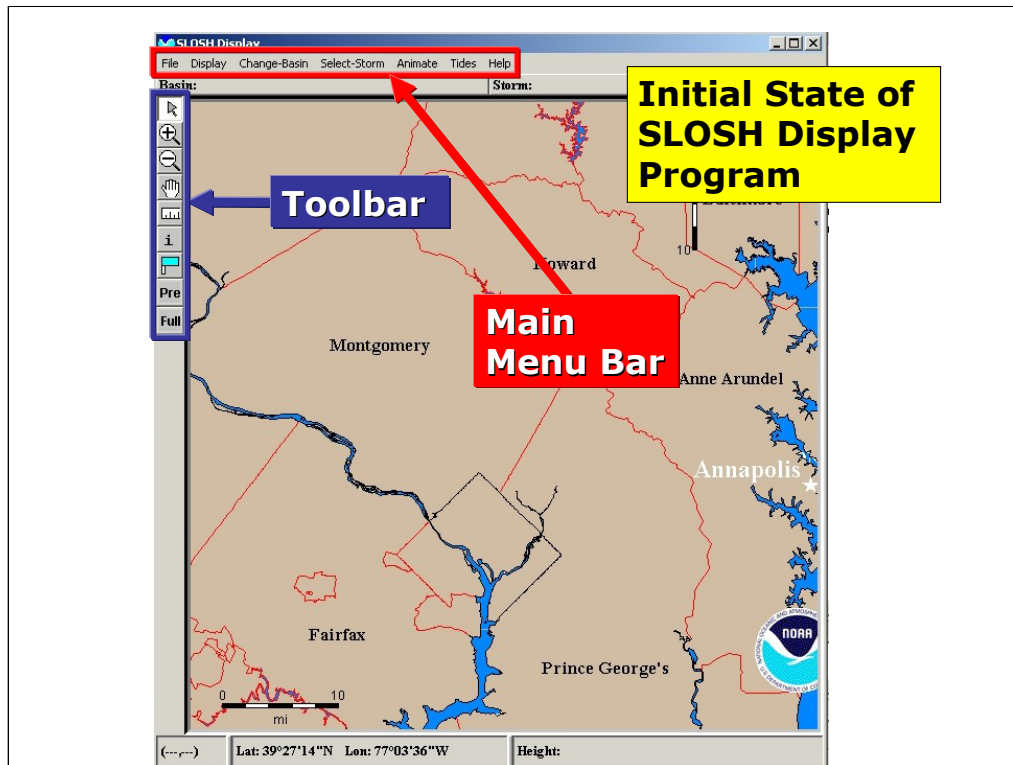
- To select multiple basins, hold down the “control” key while clicking on additional basins.
- You can install more basins at any time by repeating this process.



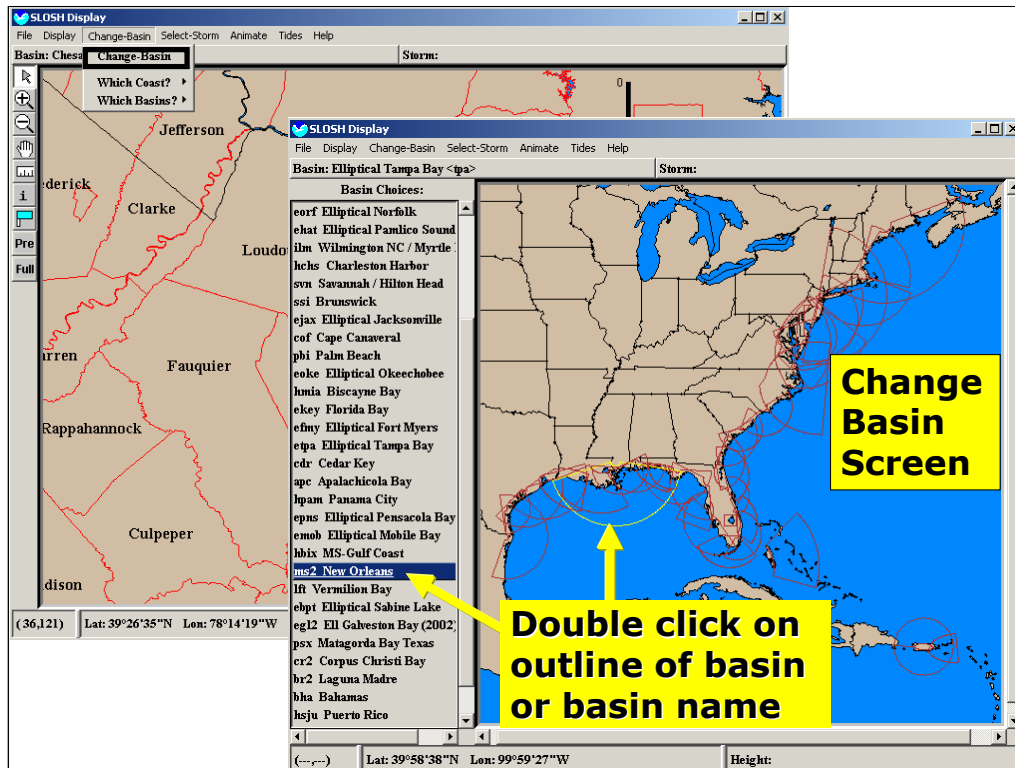
- The next step in the data configuration is installation of the animation files.
 - Select the SLOSH “Rex files” to install by clicking on the filename, using the “control” key to select more than one file. Rex files are discussed later in the training.
 - Animation files take time to install.
13. Highlight the “agnes.rex (apc)” animation file.
 14. Install the “agnes.rex (apc)” animation file.
 15. Select “Done” when the files are installed.



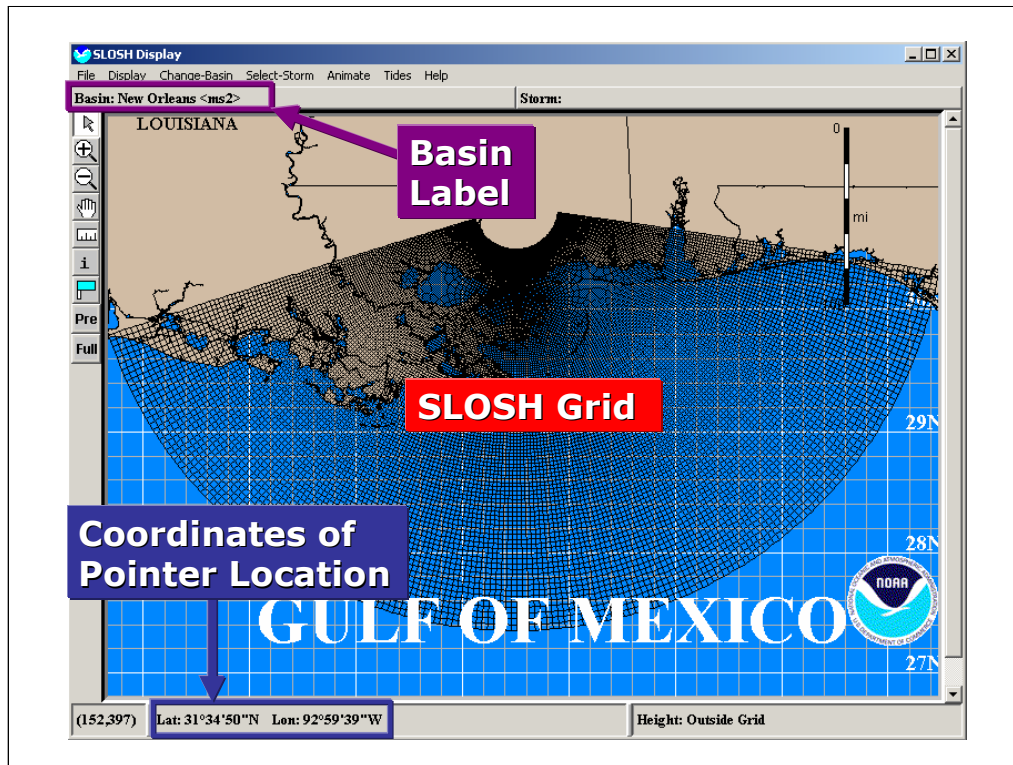
- The SLOSH Display program was developed to give National Weather Service forecasters and emergency managers a quick, easy to understand display of output from the SLOSH model.
- This section discusses how to use the features in the SLOSH Display program.
- The five main sections in the SLOSH Display program are: Changing the SLOSH Basin, Displaying Storm Files, Animating a Rex File, Display Options, and using the Tide Display.



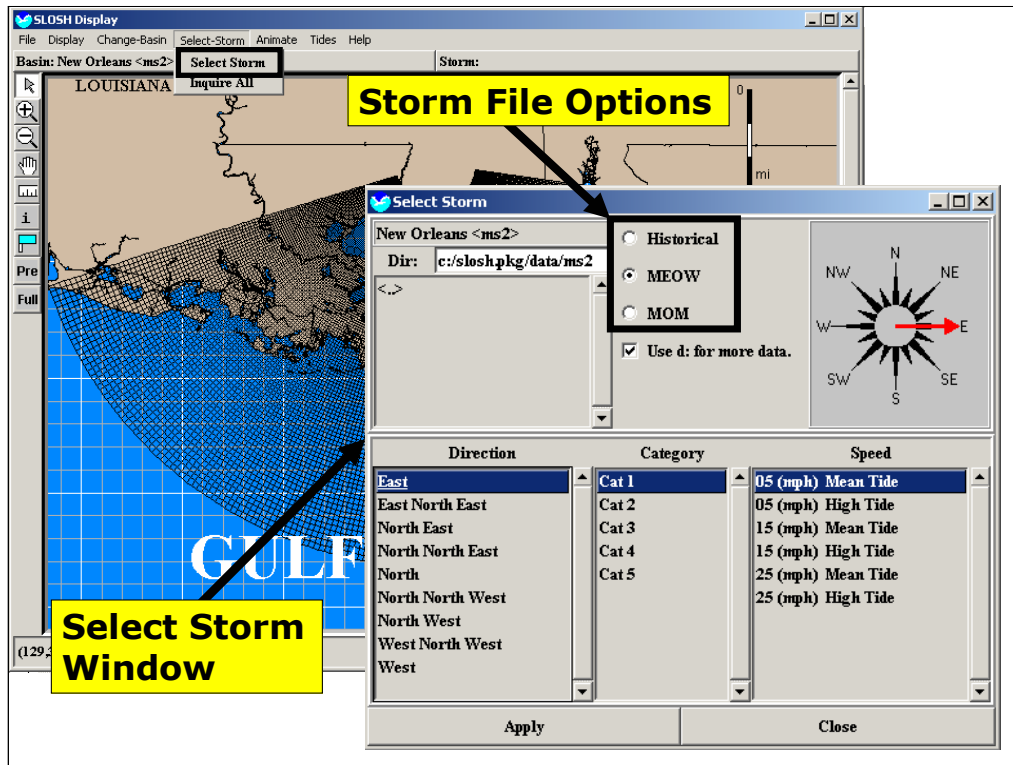
- ❑ Open the SLOSH Display program. Go to “Start | Programs | SLOSH Package | SLOSH Display.”
- The initial state of the SLOSH Display program will be either the most recently selected SLOSH Basin or a map of the Washington D.C. region.
- There is a Main Menu Bar at the top of the screen and a Toolbar on the left side.



- First, select a SLOSH basin.
- Choose to view either the installed basins only or all of the available basins by clicking on the “Change-Basin | Which Basins?” button. Also choose which coast to view by clicking on the “Change-Basin | Which Coast?” button.
- Select “Atlantic Coast” under “Which Coast?” and “Installed Basins” under “Which Basins?”
- On the Main Menu Bar, go to “Change-Basin | Change-Basin.” This will bring up the list of basin choices. Basins are listed in geographical order. To select the desired basin, double click on the outline of the basin on the map or the basin name in the “Basin Choices” list box. Basins may also be selected by highlighting the basin and then choosing “Change Basin | Change Basin” again.
- Select the New Orleans basin (ms2).



- The basin should now be selected, and the Basin label at the upper left portion of the screen should be identified as “New Orleans <ms2>.”
- The SLOSH model uses a polar, elliptical, or hyperbolic grid for its computations.
- Note that the latitude and longitude coordinates of the mouse pointer’s tip are shown in the lower left of the screen. Try moving the mouse pointer around the SLOSH grid and notice how the coordinates change.
- Now that a basin is selected, storm files for that basin may be displayed.

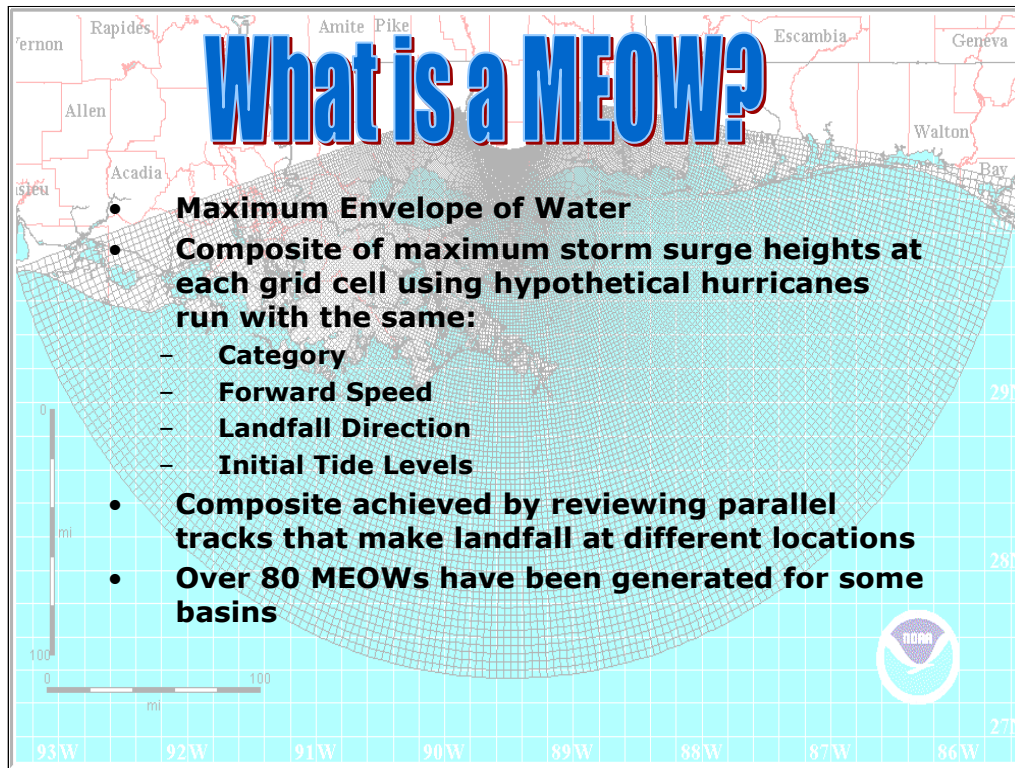


- To display a storm file, go to “Select Storm | Select Storm” on the Main Menu Bar.
- The “Select Storm” window will open. There are three types of storm files to choose from: a MEOW, an Historical Storm, and a MOM.

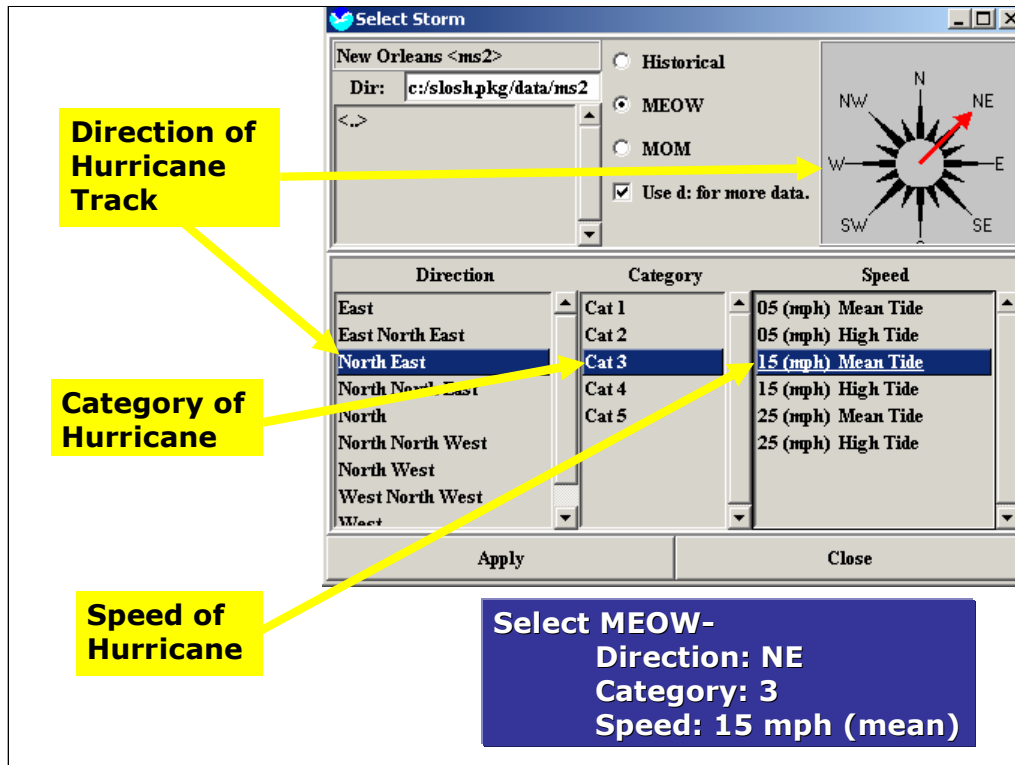


Definitions:

MEOW – Maximum Envelope of Water
 MOM – Maximum of MEOWs



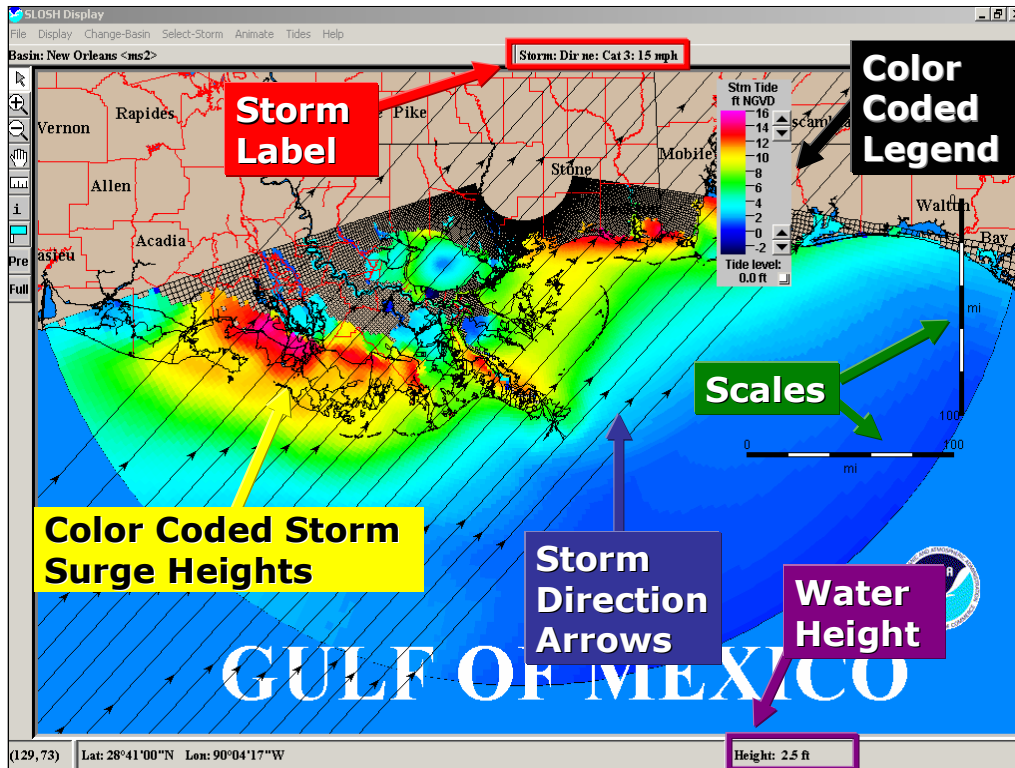
- MEOW stands for “Maximum Envelope of Water.” Envelope refers to the maximum the water reaches at any point in time at every grid cell in the SLOSH Basin, for a given hypothetical storm.
- The MEOW is formed from a composite of many individual SLOSH model runs. It is the set of the highest surge values at each grid location for a given storm category, forward speed, and direction of motion, regardless of which individual storm simulation produced the value. The NHC has generated one MEOW for each storm category, storm direction, forward speed, and tide level used in the simulation study.
- The MEOW shows the flooding possible from a threatening hurricane of a given category, size, and general track direction. NHC forecasts have error. NHC forecasters do not have the ability to determine exactly where landfall will occur, or what characteristics the hurricane will have at landfall. Accuracy increases as the forecast projection becomes shorter. A 24-hour forecast will be significantly better, in general, than a 48-hour forecast. The MEOW plans for the worst-case scenario.



- In the “Select Storm” window, click on the MEOOW radio button.
- First, highlight the desired direction of the hurricane tracks. This will change the “Category” and “Speed” list to those available for that direction. Clicking on the compass also selects the hurricane direction.
- Next, highlight the category of hurricane to display. This will change the “Speed” list to those available for that category. Then highlight the desired speed of hurricane.
- Select a MEOOW for the New Orleans basin for a Category 3 storm heading northeast at a speed of 15 mph (mean tide). Once the parameters have been selected, click on the “Apply” button in the lower left portion of the window.

Note:

- Most MEOOWs have the option of selecting High or Mean tide. Hurricane Evacuation Studies generally use the high tide option because it is a more conservative estimate.

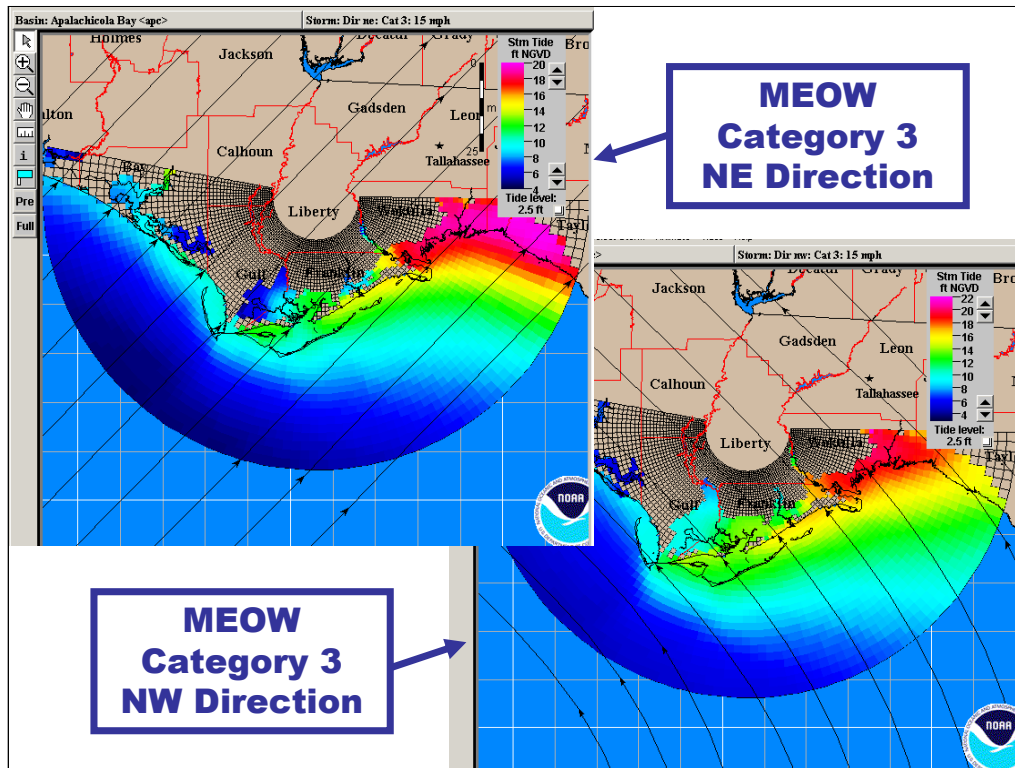


- The display screen should now show the computed MEOW color-coded storm surge heights. A color-coded depth scale is shown in the legend in the upper right portion of the screen.
- The direction, category, and speed of the storm are shown in the storm label.
- Each hypothetical hurricane's track used to generate the MEOW is displayed, along with an arrow indicating the direction of storm movement.
- The water height at the cursor's location is displayed in the lower right portion of the screen. The SLOSH grid cell location (I,J) coordinate is shown in the lower left corner of the screen.
- ❑ Place the mouse pointer over the cell or area of interest to see the storm surge at that location. The "Height" may also be labeled as "Outside Grid" if the mouse pointer is not over the current SLOSH grid displayed or "Dry" if the grid cell in question is located inside the SLOSH grid but is not inundated with water.
- The color coded legend, scales, and NOAA logo can be relocated on the screen by clicking and dragging the movable element.

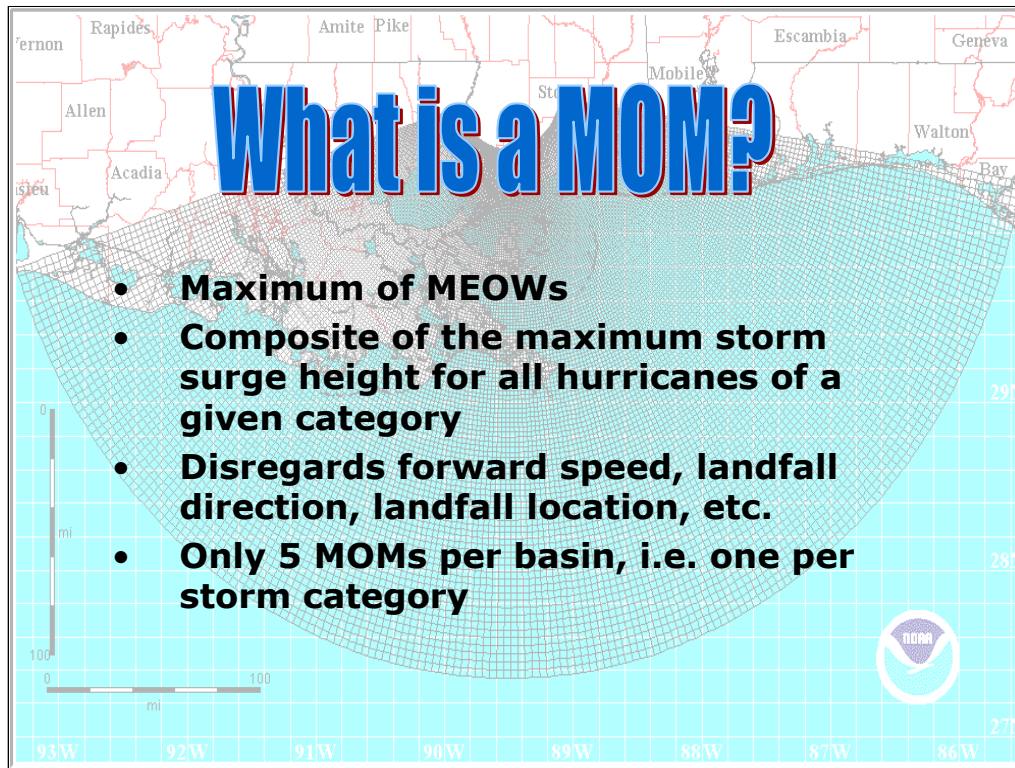


Hints:

- Use the scroll bars in the "Color Code Legend" to increase or decrease the range of the colors or press "Control + S" to select the desired range.
- The Color Code Legend can be resized by clicking and dragging the lower right box.
- "Fixed Color Scale" under the Display menu keeps the color coded scale constant and is helpful for comparing the effects of different MEOWs.



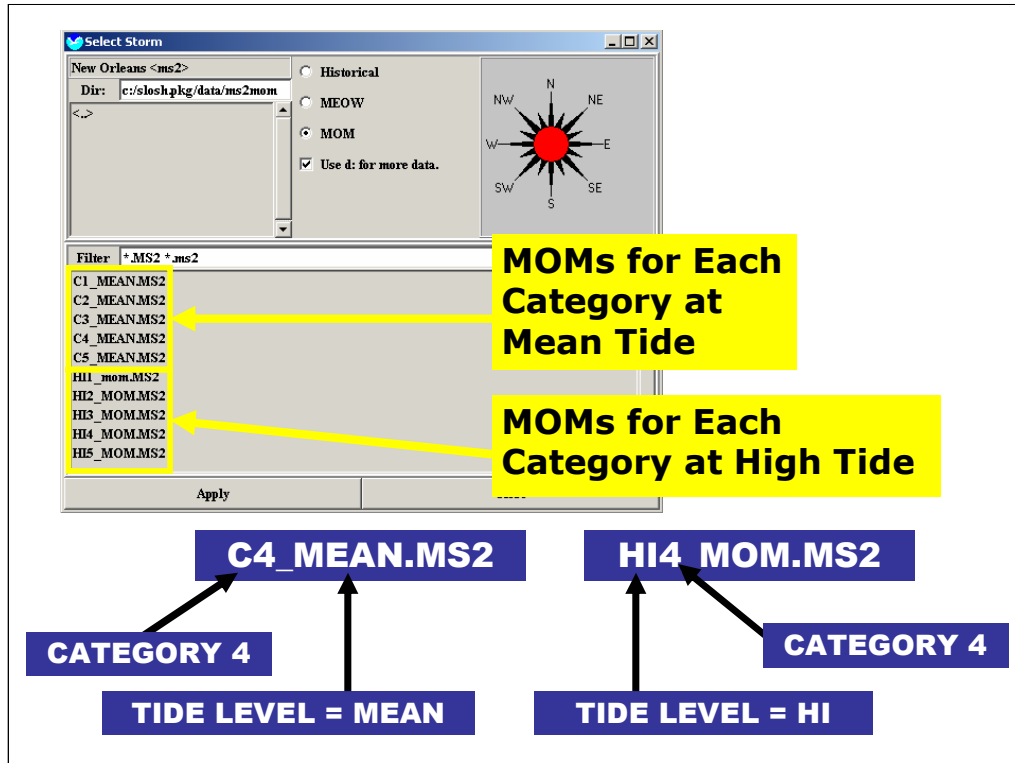
- The arrows in each MEOW show the direction the storm is traveling.
- There are multiple arrows for each MEOW which represents the fact that a MEOW is generated for a basin by storm tracks traveling in the same direction with the same Category but each track making landfall at a different location along the coast.
- The MEOW color coding shows the maximum of the water surfaces generated by the individual tracks for a particular category of storm traveling in a particular direction.
- The category and direction are constant and the MEOW is generated by taking whichever track produces a maximum storm surge for each grid cell.



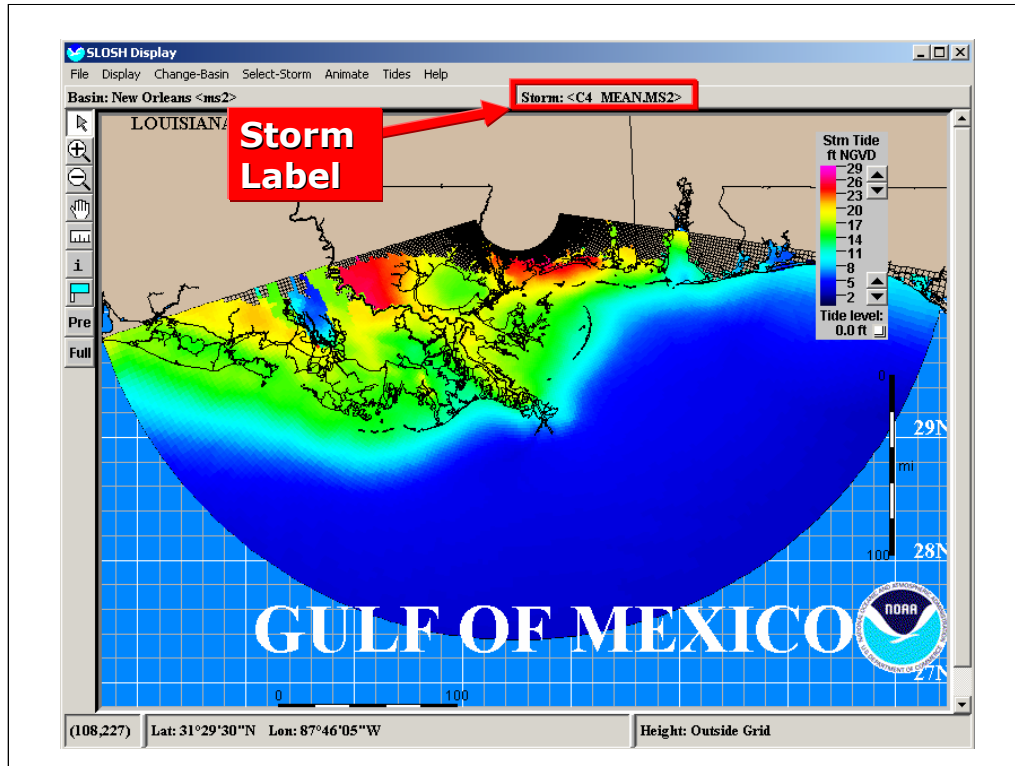
- A MOM is the Maximum of MEOWs.
- It is the composite of the maximum storm surge height for all hurricanes of a given category at every grid cell.
- There are only 5 MOMs per basin, one per storm category.

Note:

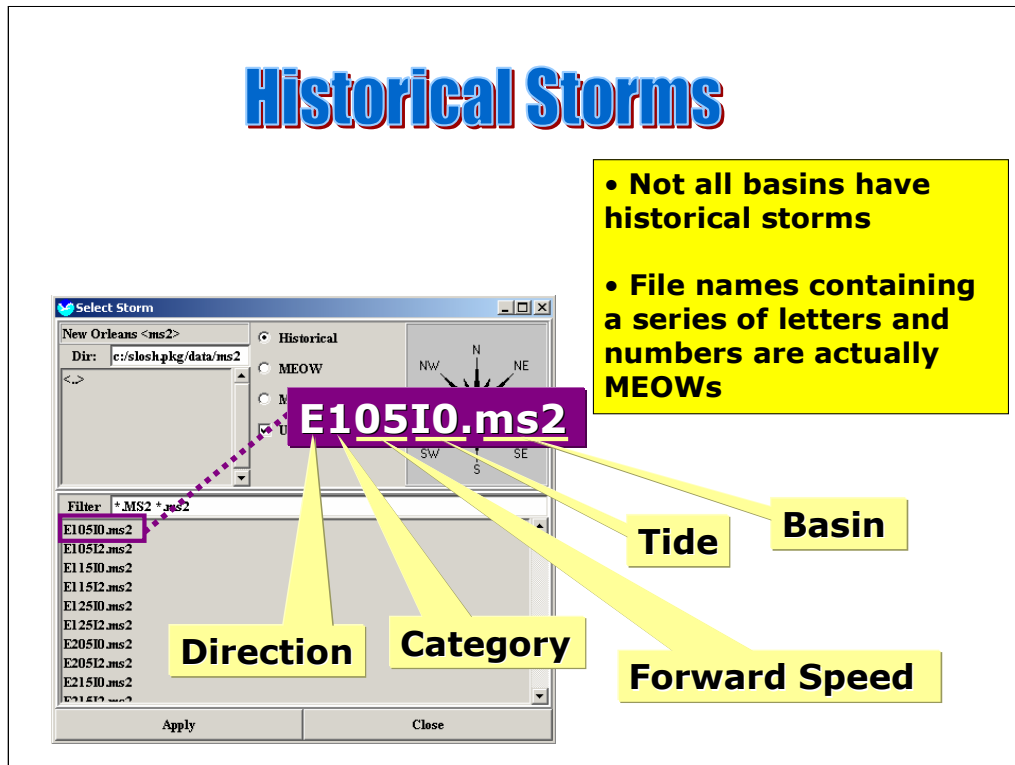
- MOM surge maps are available to the public for use in personal and corporate emergency management. Contact your local government emergency manager for more information.



- ❑ In the "Select Storm" window, click on the MOM radio button.
 - A list of available MOMs for the New Orleans <ms2> basin will be displayed. The files listed are the MOMs for category 1 through 5 storms at mean and high tide. The naming convention is slightly different for each basin. For the New Orleans basin, C1_MEAN.MS2 indicates a Category 1 MOM at mean tide, and HI1_mom.MS2 represents a Category 1 storm at high tide.
- ❑ Highlight the "C4_MEAN.MS2" storm file, click on the "Apply" button, and wait for the display to redraw.



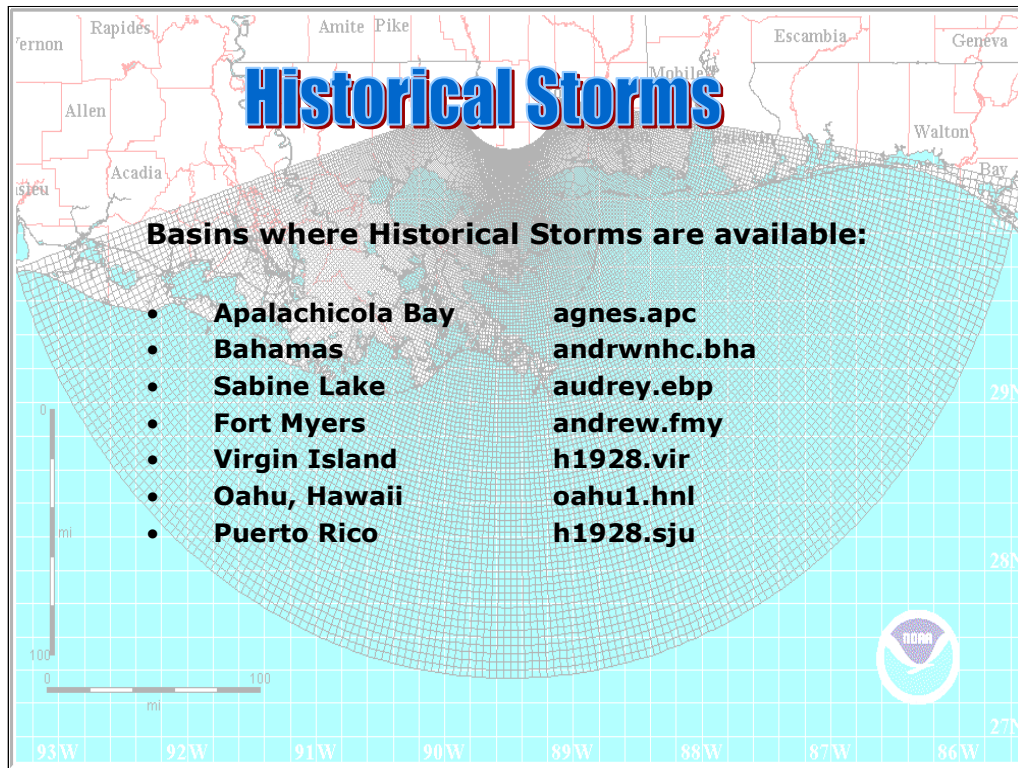
- This is the display for the MOM selected. Notice the name of the storm file in the Storm label.
- Also notice the absence of the storm direction arrows. This is because the MOM is the maximum of the MEOWs and does not have a storm direction associated with it.



- Historical storms are the third type of storm available for selection.
- ☐ In the “Select Storm” window, click on the Historical radio button.
- Historical storms are labeled by the storm name or by date. The files listed here are labeled by letters and numbers. MEOWs are also shown in the list which displays historical storms.
- Keep the following in mind when choosing a file:
 - Not all basins have a sample historical storm.
 - File names containing a series of letters and numbers are actually MEOWs.
 - The first group of letters in the MEOW file name refers to storm motion direction, the next number represents the hurricane category, the next 2 numbers represent the forward speed, 10 refers to mean tide, 12 refers to high tide, and the file extension represents the basin.
 - The files are listed alphabetically. Scroll down to find the historical storm you want.



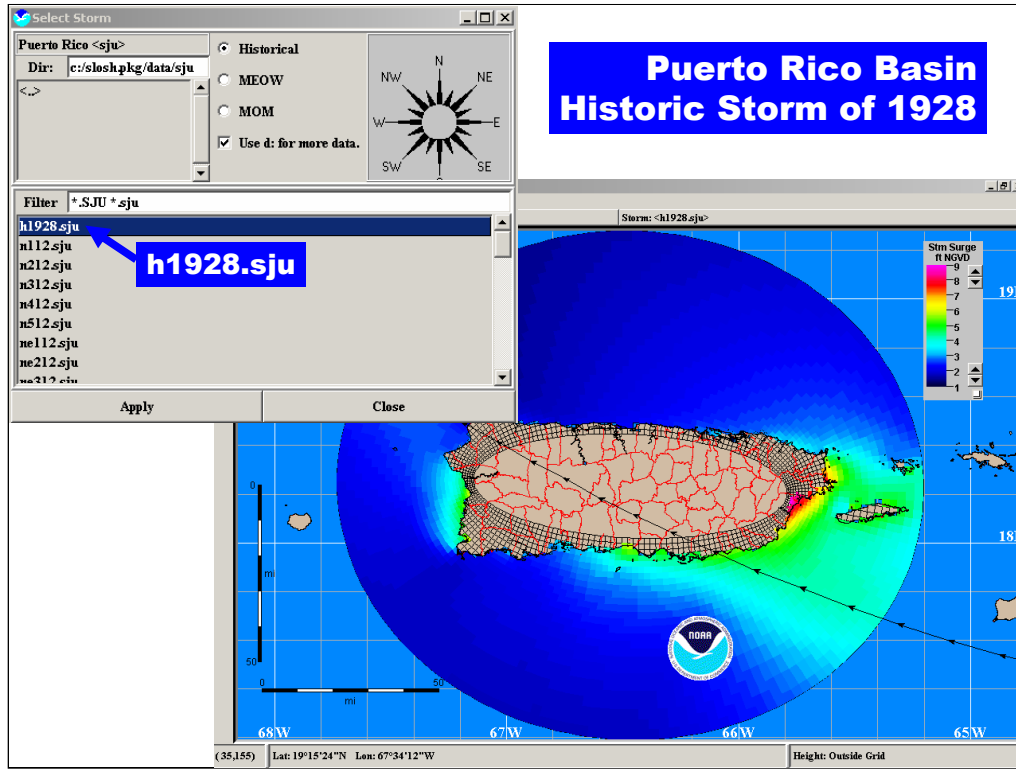
Hint: The Tide indicator in the file name “10” indicates the number of feet above or below mean sea level used to initialize the SLOSH model to account for tides.



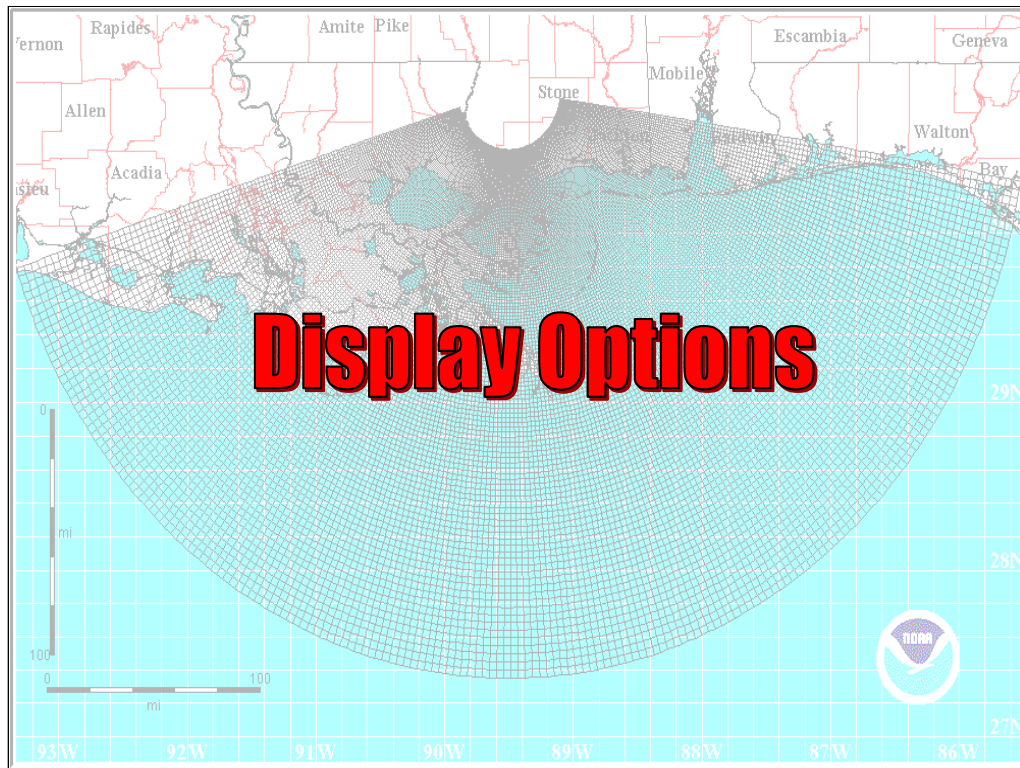
Historical storm data are available for 7 basins in the SLOSH display.

They are:

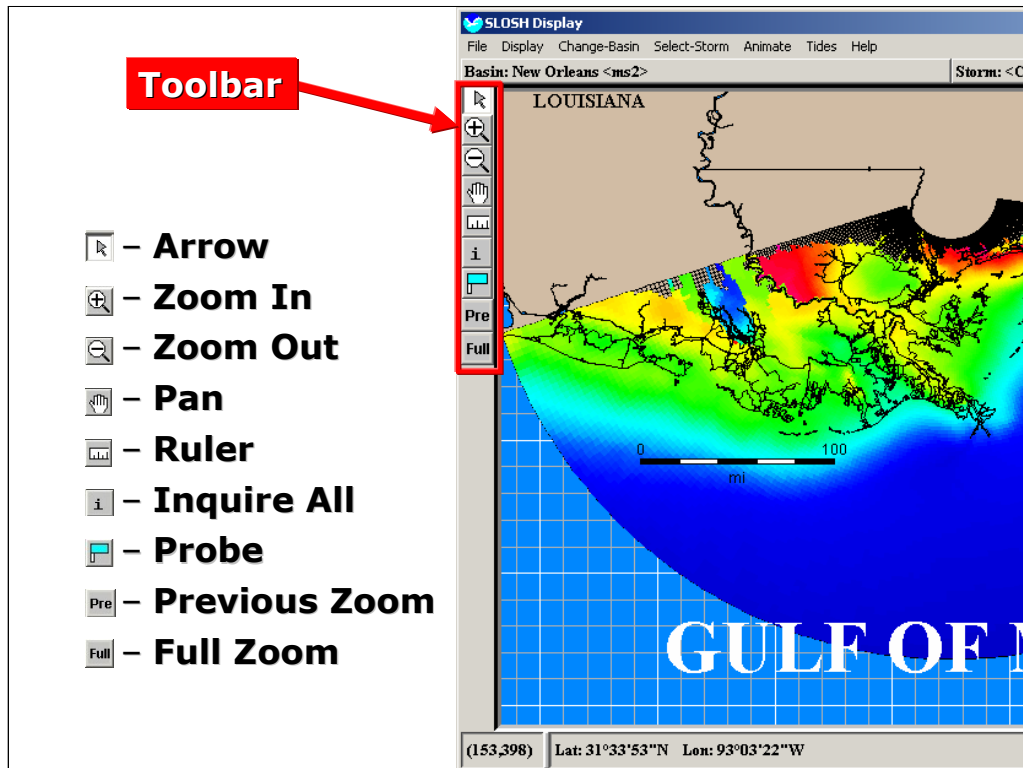
- Apalachicola Bay
- Bahamas
- Sabine Lake in Louisiana
- Fort Myers
- Virgin Island
- Oahu, Hawaii
- Puerto Rico



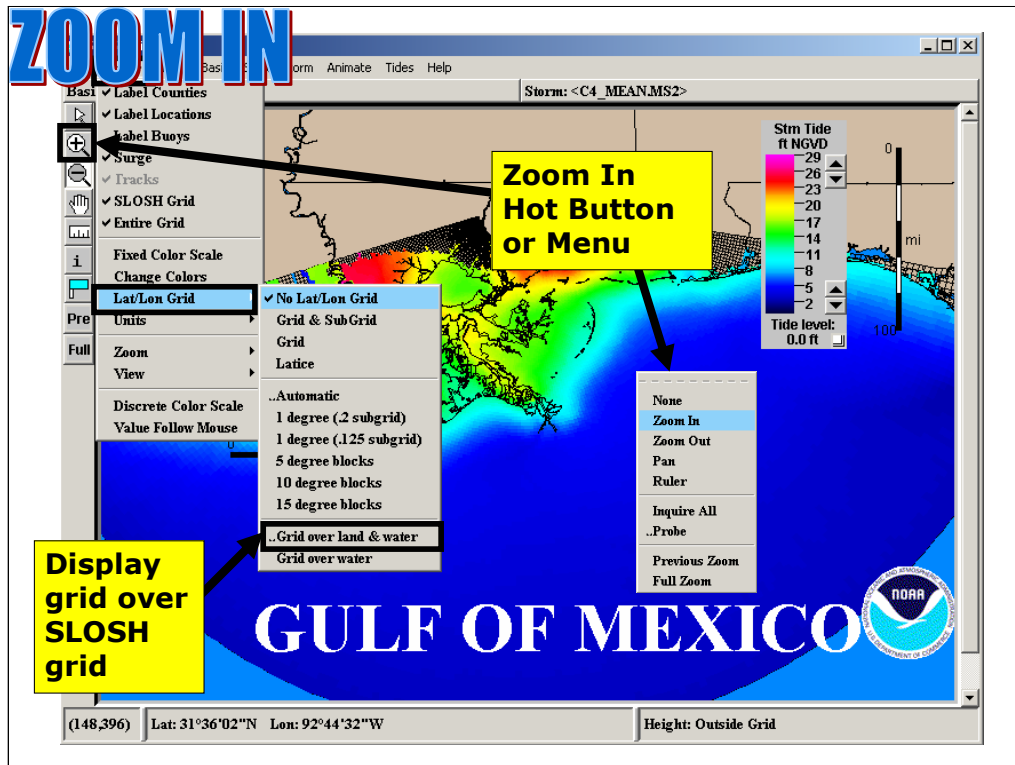
- Example historical storm



- Now that a storm is displayed, the labels, grids, and other display features may be modified.



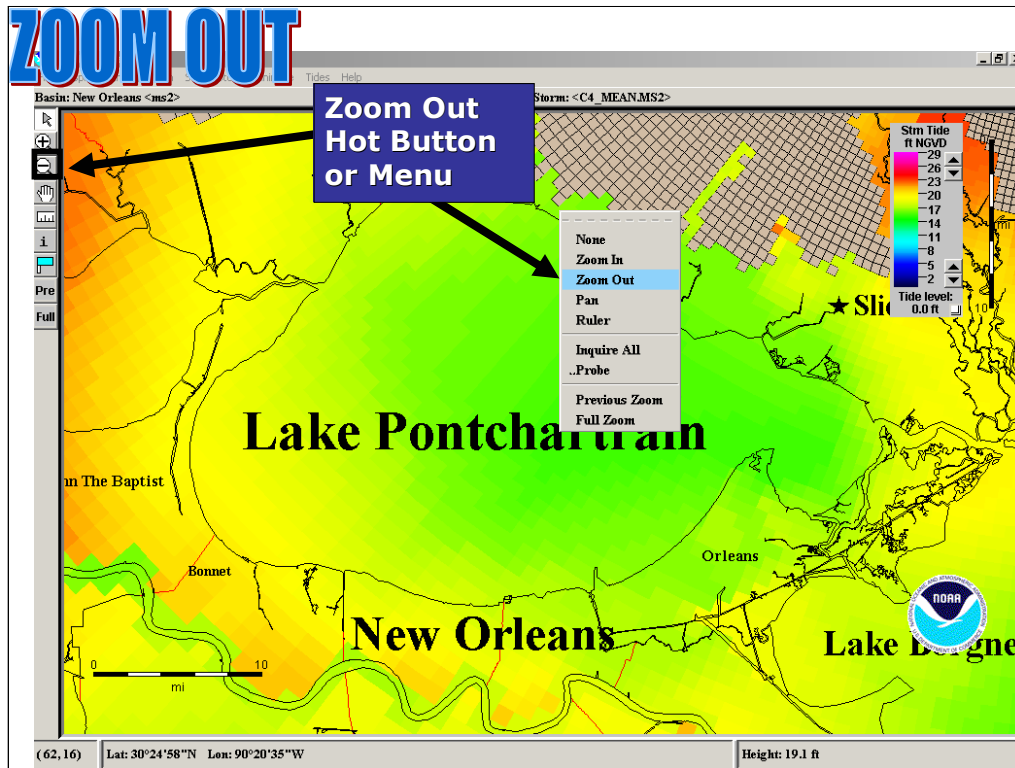
- “Hot buttons” are available on the Toolbar for quick access to routine commands.
- This section defines and shows the uses of each of these functions.



- Click on the “Display” heading in the Main Menu Bar to bring up the display options.
- As an example, zoom in to Lake Pontchartrain in Louisiana. This area is located near latitude 30 degrees, 10 minutes and longitude 90 degrees, 10 minutes.
- Go to “Display | Lat/Lon Grid” to display the grid over land and water or use the mouse to follow the latitude and longitude (displayed in the lower left of the screen) to help find this lake.
- To zoom in, either go to the “Zoom In” hot button on the left side of the screen or go to “Display | Zoom | Zoom in.”
- Click and drag the mouse to make a box around the area of interest, in this case, Lake Pontchartrain.



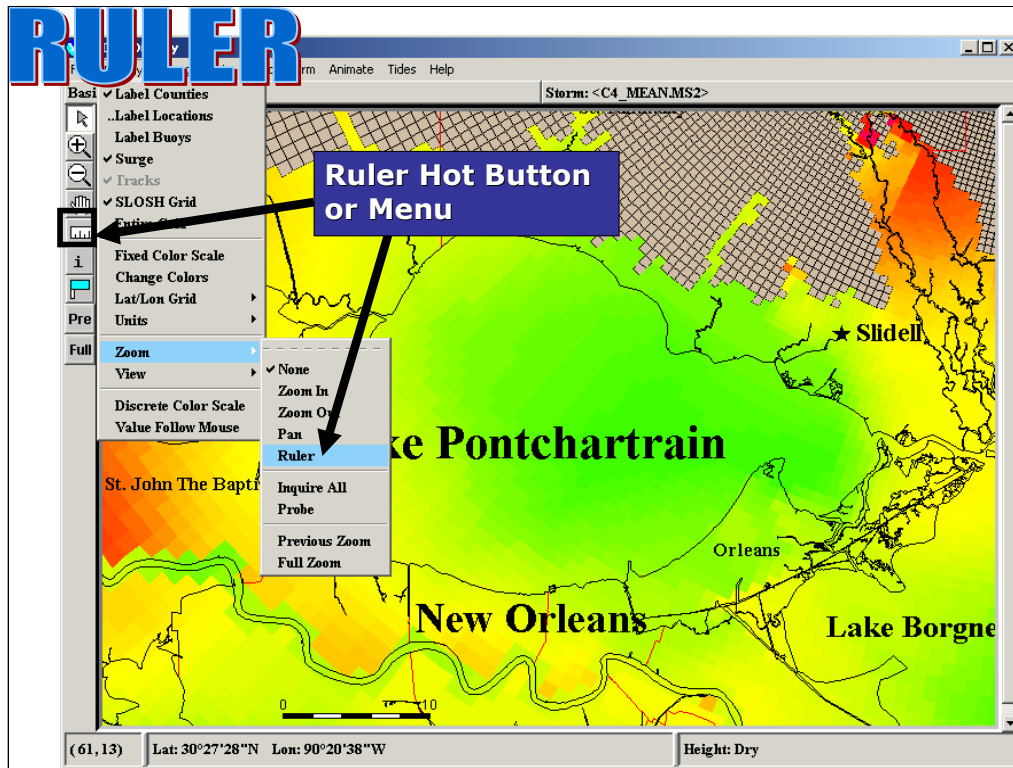
Hint: Right clicking on the map will bring up the Display menu. Under the Zoom option, left clicking on the dashed line (- - - - -) brings up a Zoom tear-off menu.



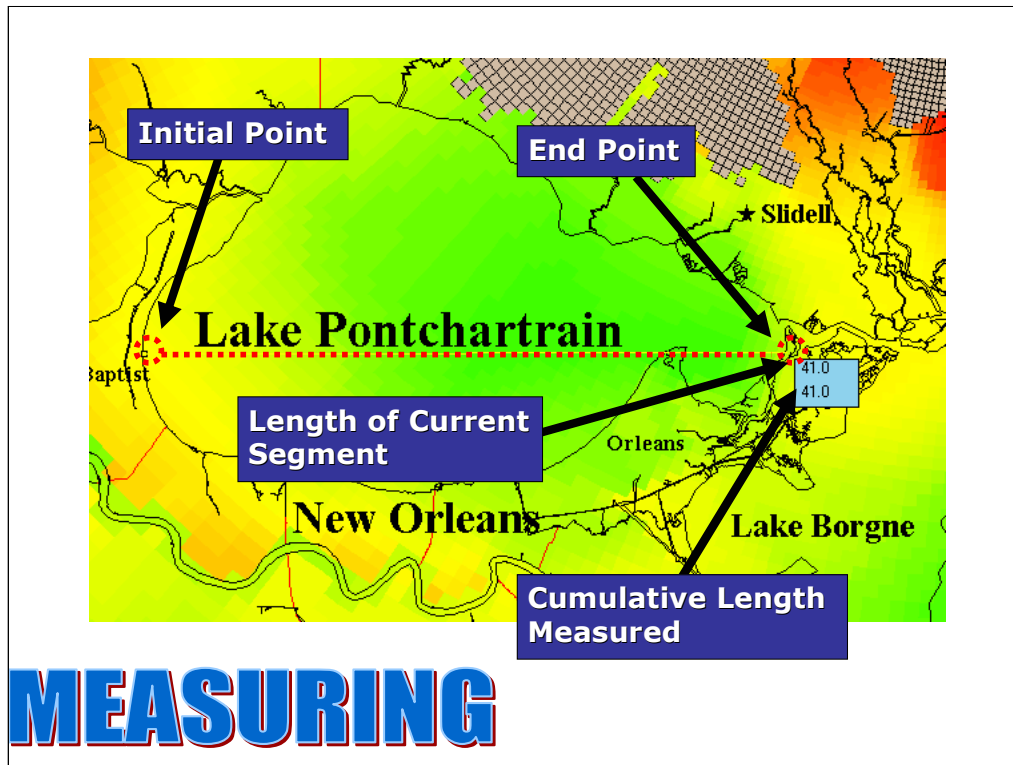
- Zooming in closer shows greater detail; parish, city, and water body names appear.
- Now that Lake Pontchartrain is located and identified, zoom out to include more of the surrounding parishes in the view.
- To zoom out, either use the “Zoom Out” hot button or “Display | Zoom | Zoom Out.” Place the cross hair in the center of Lake Pontchartrain and click.



Hint: By right clicking on the “Hot Button” for zoom in / zoom out, you can zoom in or out directly, without going into the Display menu.



- Use the ruler to determine the approximate horizontal distance across Lake Pontchartrain.
- Using either the “Ruler” hot button or “Display | Zoom | Ruler,” point the mouse at the Lake Pontchartrain shoreline and click. This sets the initial point.
- Now drag the mouse to the farthest shoreline and click again.

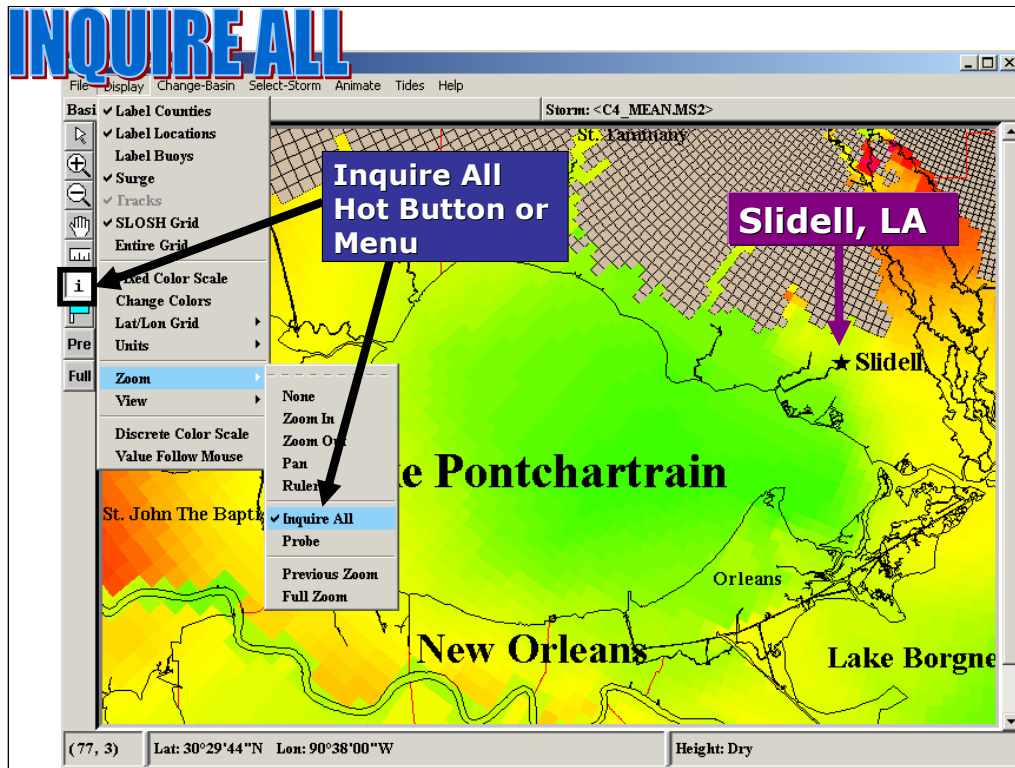


- The light blue box that appears indicates the distance between the start and end points. Lake Pontchartrain is approximately 41 miles across. The top number represents the distance between the active segments. The bottom number is the cumulative distance traveled along the path from the starting point.



Hints:

- In measure mode, the “Delete” key will remove the last selected location.
- Measured distances can be in kilometers, statute miles, or nautical miles, based on the “UNITS” as selected from the Display menu.



- Another useful feature in the SLOSH Display program is the “Inquire All” option. “Inquire All” brings up a window containing storm surges for all categories, directions, and speeds for a single point on the SLOSH grid. This allows the user to look at different scenarios for a single location.
- ❑ Investigate Slidell, LA. Click on the “Inquire All” hot button or go to “Display | Zoom | Inquire All” from the Main Menu Bar.
- ❑ A question mark icon will replace the mouse arrow. Drag this to Slidell, LA, which is near latitude 30 degrees, 16 minutes and longitude 89 degrees, 47 minutes, and click.

Inquire All Window

AVAILABLE MEOWS

Category 1	Category 2	Category 3	Category 4	Category 5	
nw 05 12	5.4	nw 05 12	10.8	nw 25 12	20.2
n 05 12	4.9	n 05 12	10.1	nw 25 12	19.7
nw 05 12	4.5	nw 25 12	14.9	wvw 15 12	18.9
nne 05 12	4.0	nw 15 12	9.8	nw 05 12	18.6
w 05 12	3.9	nw 15 12	9.6	nw 15 12	18.3
e 25 12	3.6	nw 05 10	8.5	wvw 15 12	18.0
ne 05 12	3.6	n 15 12	8.4	n 05 12	17.9
e 15 12	3.5	nne 05 12	8.4	nw 05 12	17.8
wvw 05 12	3.5	wvw 05 12	8.1	wvw 15 10	17.6
e 05 12	3.2	nw 05 10	7.6	wvw 25 12	17.5
ene 05 12	3.2	n 05 10	7.5	nw 25 10	17.4
ene 15 12	3.2	wvw 15 12	7.5	nw 15 10	17.2
w 25 12	3.2	w 05 12	7.3	nw 05 10	17.1
ne 15 12	3.2	ne 05 12	7.2	nw 05 12	17.0
		nw 15 10	12.9	nw 05 10	

Sort by height | Sort by Direct | Clockwise | Starting Directw

Double click on list item to load MEOW

SLOSH Coordinates: (40, 60) | Latitude: 30.2820 | Longitude: 89.

Save to file | Close

Save Data to File (points to Save to file)

Save As Window (points to Save As dialog)

Save As dialog:
 Dir: c:/sloshpkg/output/ms2
 Filter: *.hgt *.HGT
 File: 095017.hgt
 Done | Cancel

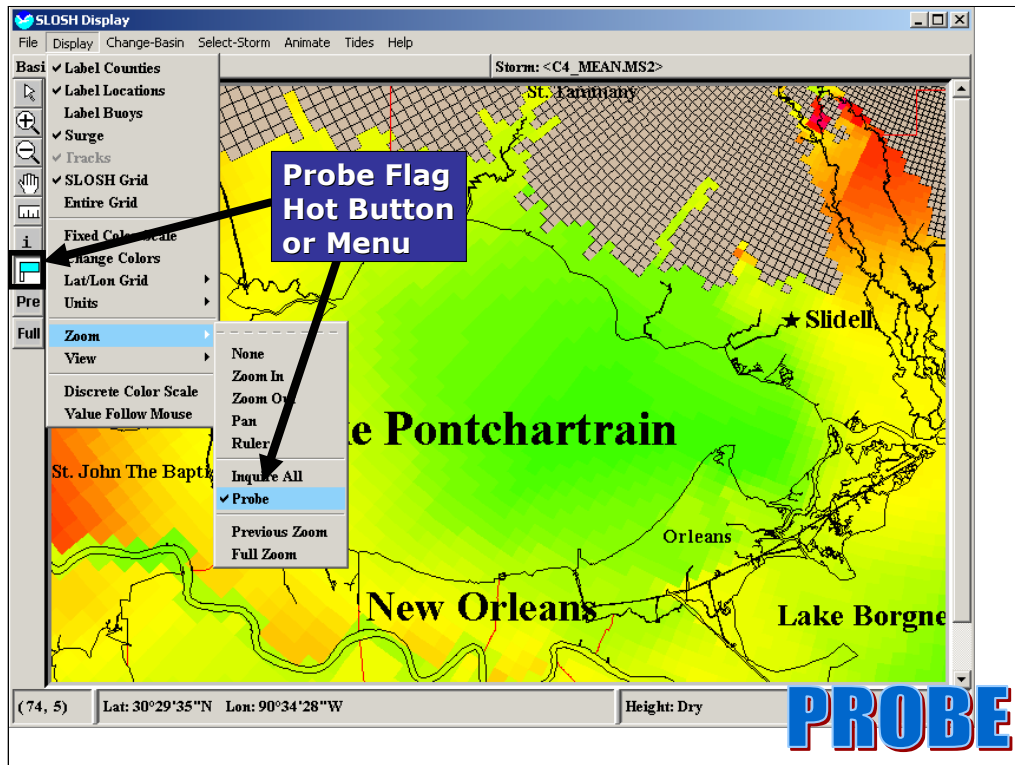
- “Inquire All” brings up a window of data showing all available MEOWs for this location. Data are specific for the grid point selected. This data can be reviewed to see how the different combinations of storm category, wind speed, and forward speed affect the maximum potential storm surge in the selected location. This data can also be saved as a text file.

Notes:

- “Save to File” allows the user to save all of the data in the Inquire All Window to a file.
- The file will be stored in the directory listed: c:/slosh.pkg/output/ms2.
- The file can then be opened using either a text editor or spreadsheet program such as Excel.
- The data may require some formatting to be usable.



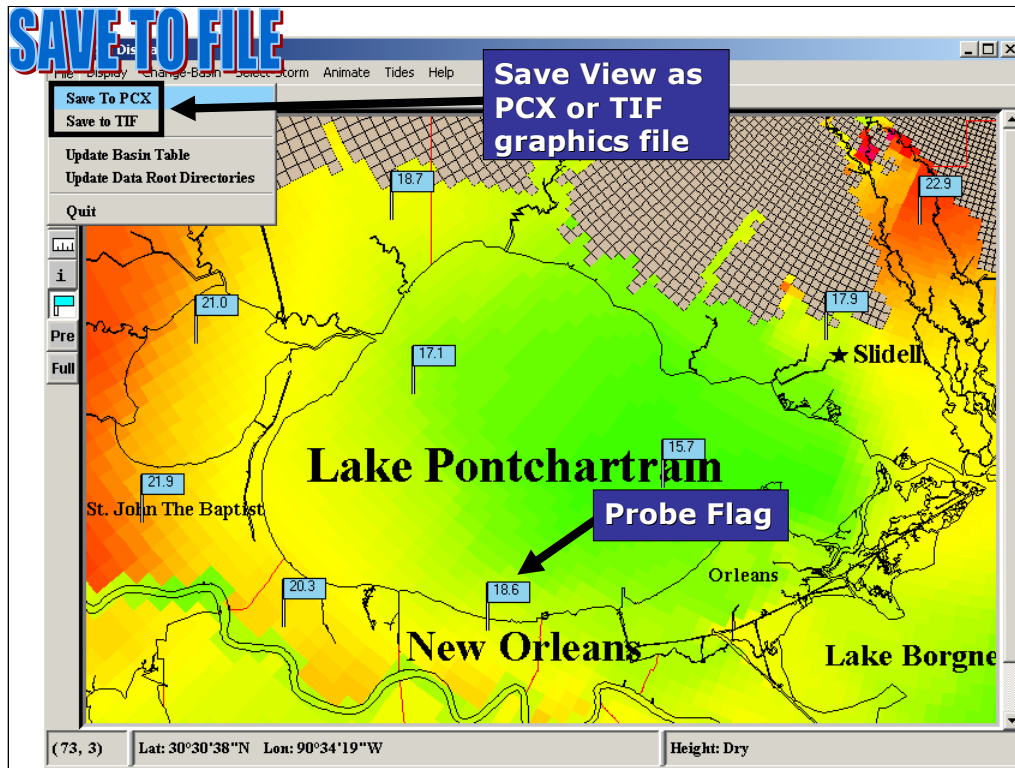
Hint: Double clicking on a storm in the list will load the MEOW into the display window.



- The “Probe Flag” option labels the storm surge for different locations.
- ❑ Click on the “Probe Flag” hot button or go to “Display | Zoom | Probe Flag” from the Main Menu Bar. Move the mouse over a location of interest and click.
- A flag appears with the storm surge height labeled. To remove this probe flag, click on the bottom of the flag pole or use the “Delete” key to remove the last flag.
- ❑ Label several places on the map and see how the storm surge varies from one place to another.



Hint: To remove the flags, click in the same grid cell or near the bottom of the flag if the grid is not visible. Also, the “Delete” key will remove the last flag.



- An image of the information shown in the current view can be saved as either a tif or pcx file. Go to “File | Save to PCX” or “File | Save to TIF.”
- Since a “Print” function is not available in the SLOSH display program, to get a hard copy, the user must save the image and then print it from an image printing program.

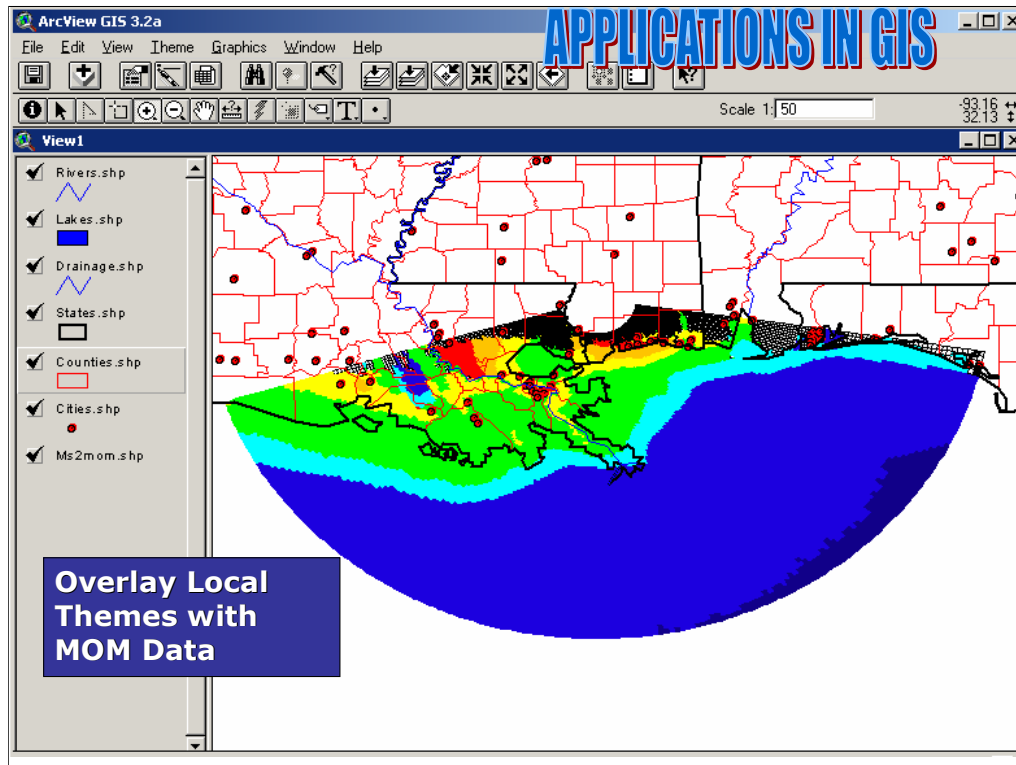
Important Note:

- The storm surge elevations shown with the “Probe” function are the total predicted storm surge elevations above mean sea level. These elevations do not include the effects of tides.



Definitions:

PCX – PC Paintbrush Bitmap Graphic
TIF – Tagged Image File Format



- The SLOSH Display CD contains an ArcView theme for each basin. The themes include the MOM data.
- Using a GIS program, the user can view local data, such as roads, streams, and topography, along with SLOSH MOMs to aid with storm surge analyses.

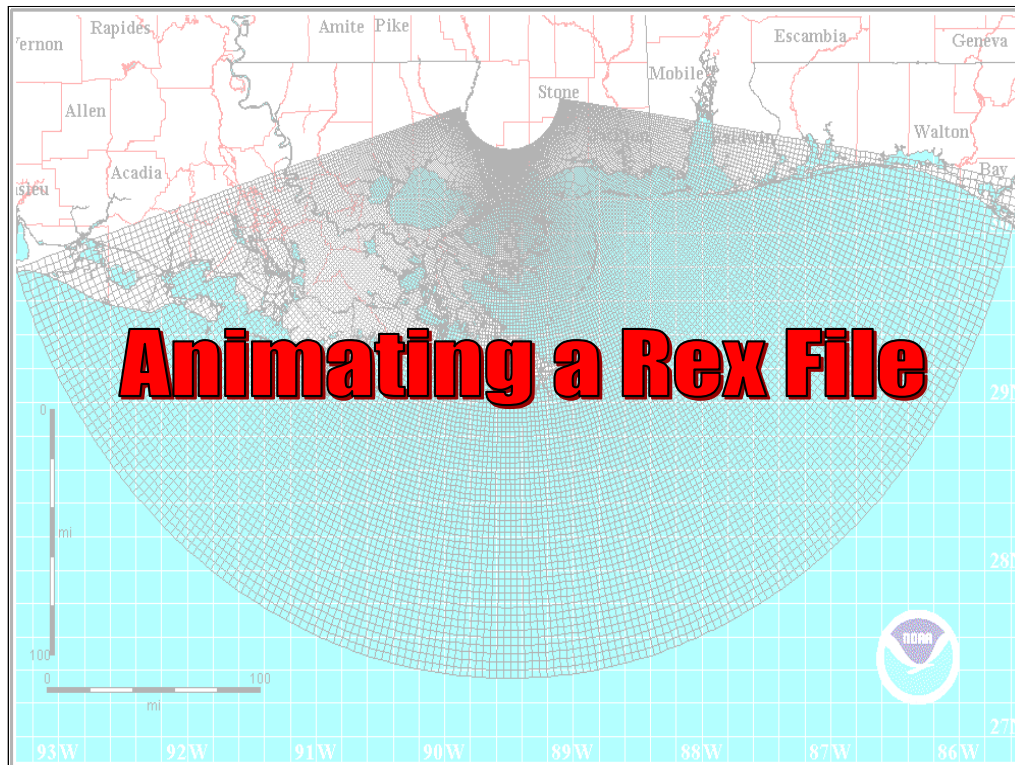


Definition:

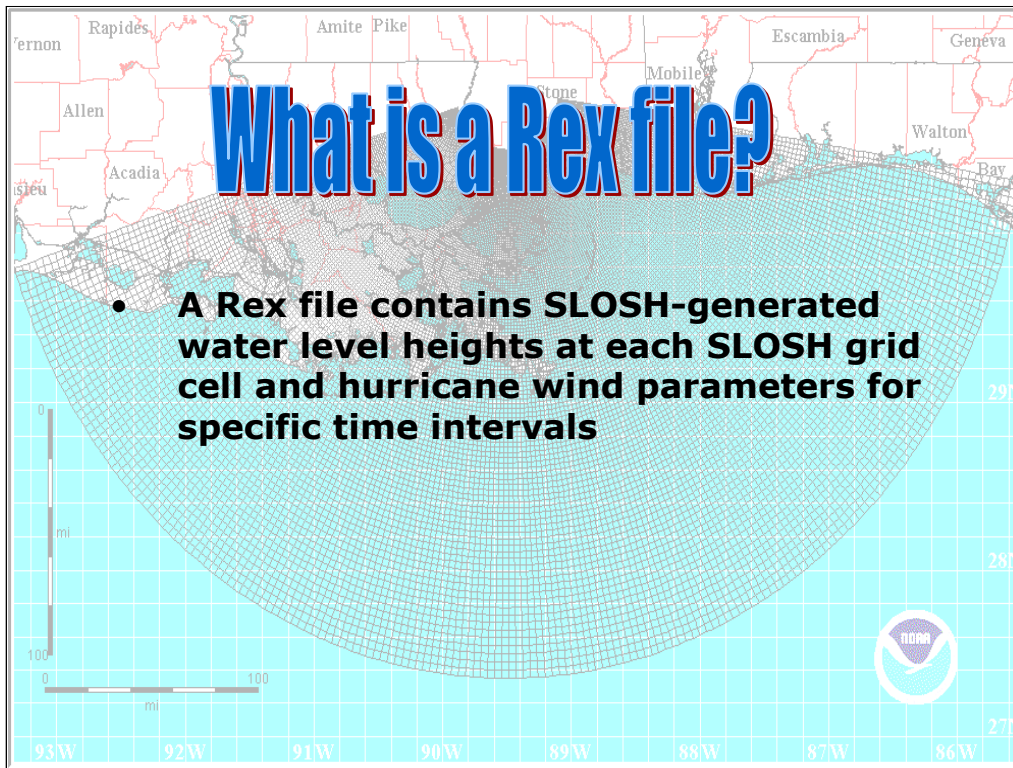
GIS – Geographic Information Systems



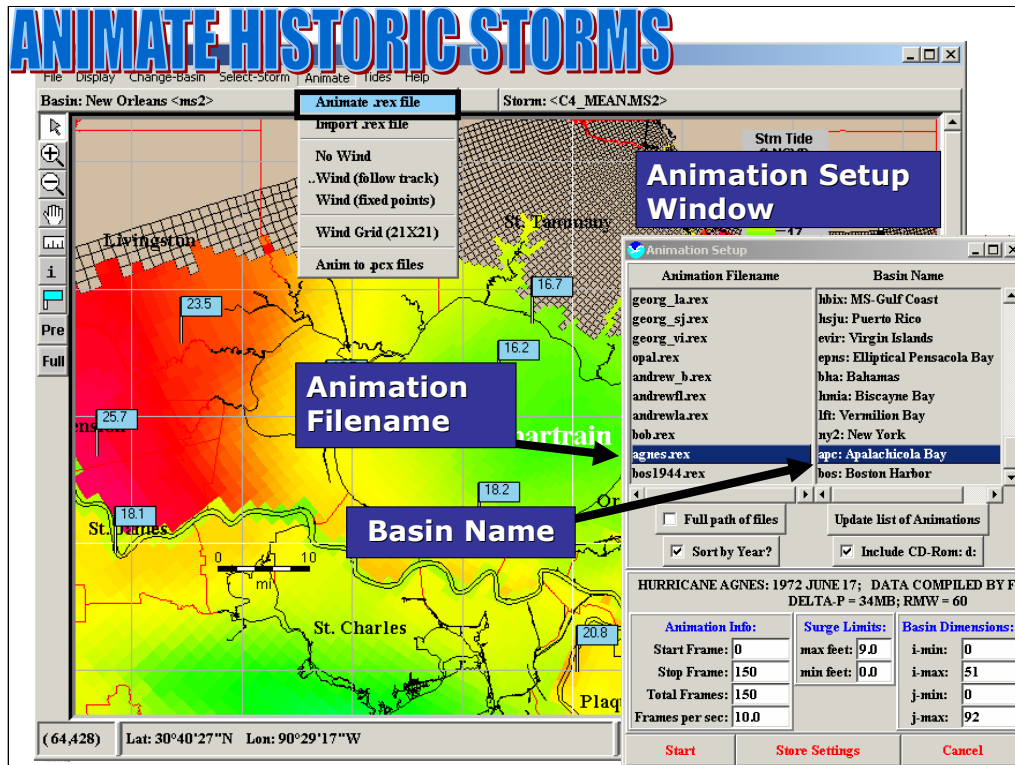
Hint: In the ArcView theme, grid cells that are labeled as “Dry” on the SLOSH Display grid will have a value of “99.9” for the storm surge height.



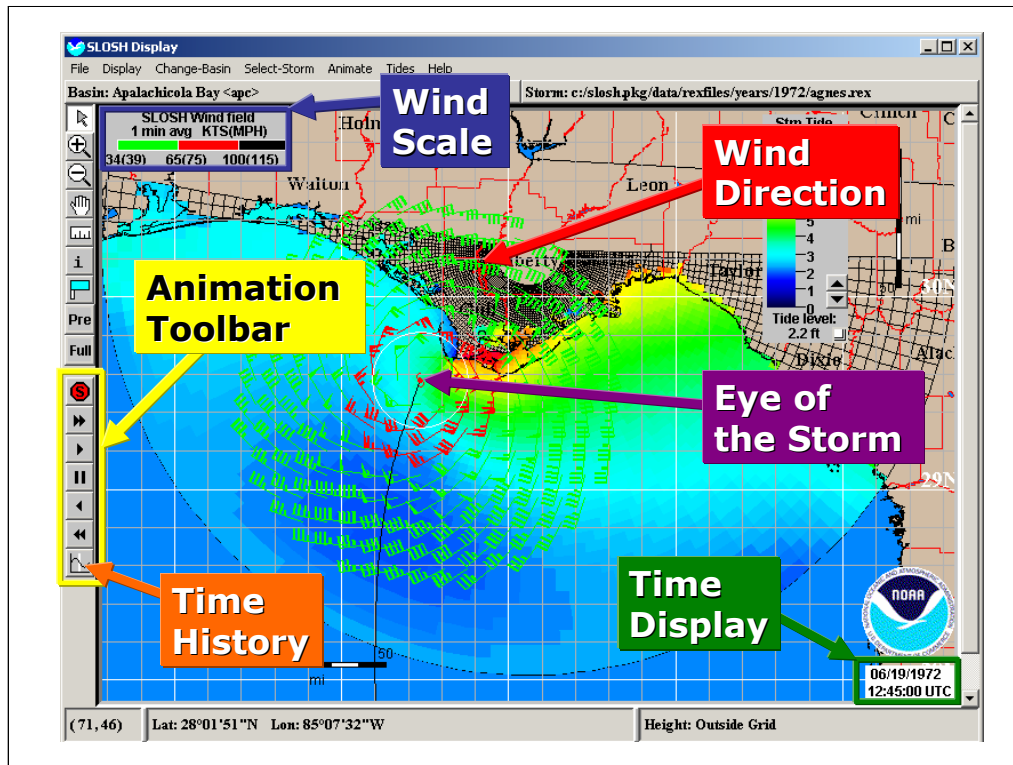
- This section covers animation within the SLOSH Display program to view the storm surge in specific time intervals. Rex files are SLOSH-specific animation files.
- The SLOSH Display has 50 Rex files in its data directory.



- A Rex file displays the height of water in every grid cell in the SLOSH Basin at specific time intervals and shows the wind field used within SLOSH at that time.
- Rex files can be animated to show progression of the storm and change in storm surge height as storm parameters vary.










- ❑ To select a Rex file to animate, go to “Animate | Animate .rex file” from the Main Menu Bar. The “Animation Setup” window will open. The Animation Filename and its basin are listed.
- ❑ Highlight “agnes.rex” in the Apalachicola Bay Basin and select “Start.”



- The animation file will begin tracking Hurricane Agnes from the Gulf of Mexico to the Florida panhandle. The view will also automatically change to the Apalachicola Bay SLOSH Basin.
- Several new items will appear on the screen. A “Wind Scale” will be in the upper left corner of the screen. This displays the color corresponding to the wind speed on the “Wind Direction” icons in the storm.
 - The wind scale uses green to display tropical storm force to hurricane force wind. Red is used for hurricane force to 100 knots (kts) (Category 3). Categories 3, 4, and 5 are shown in black.
 - Wind barbs are also shown using standard meteorological convention. A short barb is 5 kts and a full barb is 10 kts. A triangular flag is 50 kts. These are combined as needed to give the appropriate wind speed. As an example, a wind flag showing a triangle, two full barbs and one half barb would indicate a wind speed of 75 kts. Direction is indicated by the direction of the wind barb itself.
- The “Time Display” shows the current time interval of the storm.
- The “Animation Toolbar” displays several functions for use with the animated Rex file.

Animation Toolbar and Time Display

-  **Exit Animation**
-  **Forward To End**
-  **Forward 1 Frame**
-  **Pause**
-  **Rewind 1 Frame**
-  **Rewind To Beginning**
-  **Time History**

The Time Display box shows the date and time the historical storm occurred. UTC stands for “Coordinated Universal Time” which is the time standard used by the scientific and meteorological community.

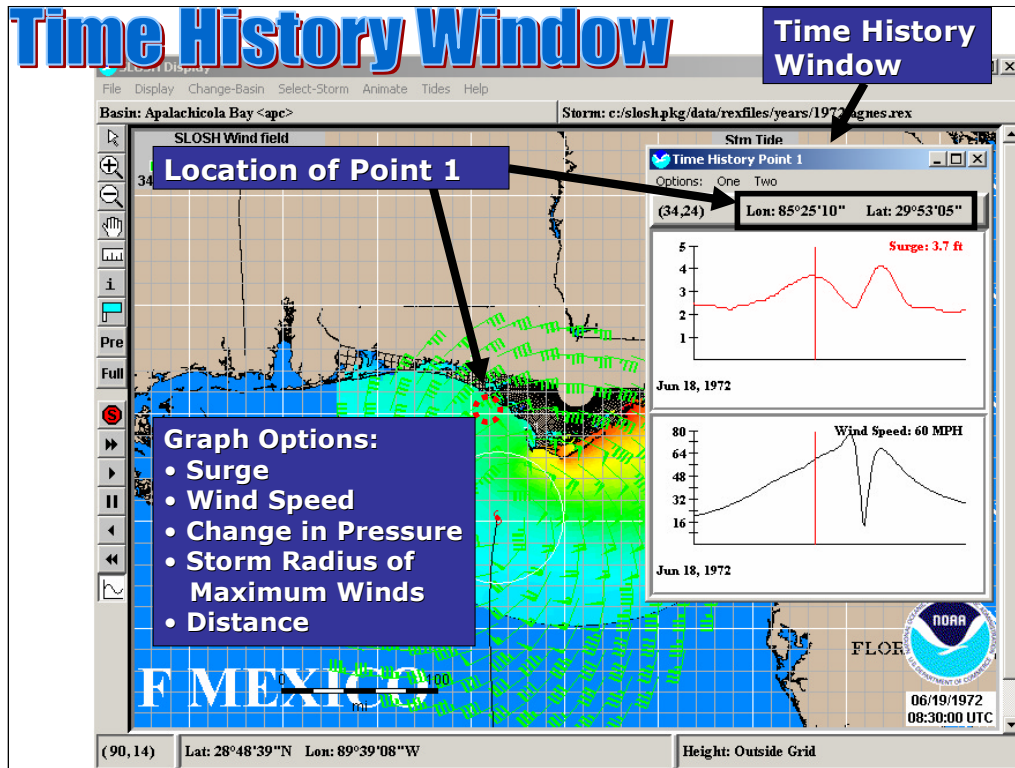
09/29/1959
10:30:00 UTC

- The “Time History” button at the bottom of the “Animation Toolbar” allows the user to generate a graph of parameters at a given grid cell over time. Clicking on the double lines will pause the animation.
- The red enclosed “S” button is used to stop animation.
- Universal Coordinated Time (UTC) is equivalent to Greenwich Mean Time (GMT), the time reference used by scientists, the military, and aviators. UTC is five hours ahead of Eastern Standard Time (four hours ahead of Eastern Daylight Savings Time)



Definition:

UTC – Coordinated Universal Time

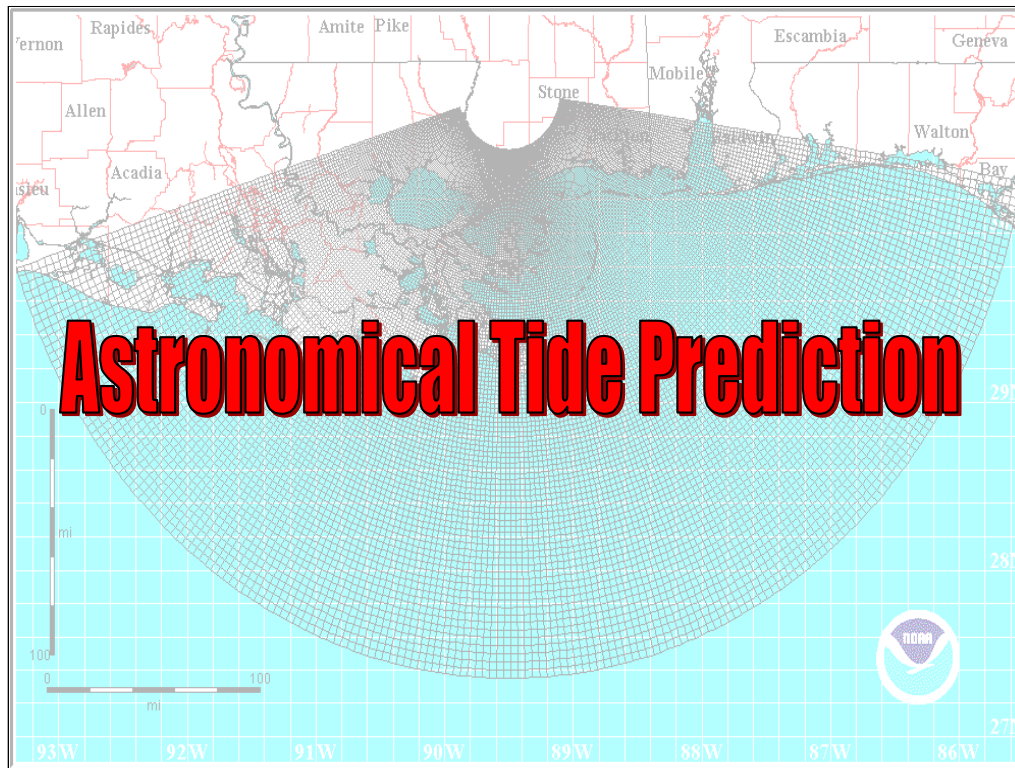


- ❑ Click on the “Time History” button.
- ❑ Click on any grid cell with the cross hair. A new window containing two graphs will appear. Each graph can display up to five parameters that can be toggled on and off.
 - These parameters include storm surge, wind speed, change in pressure, storm radius of maximum winds, and distance. Up to five graphs can be drawn in the same window by going to “Options | Number of Graphs” in the “Time History” window.
 - The vertical red line on the graph indicates the time shown in the animation. These graphs can be saved under the “Options” menu in the “Time History” window.

Time History Graph Options

- **All five options can be shown on the same graph or on 5 separate graphs.**
- **Surge** - storm surge at the chosen location
- **Speed** - wind speed
- **Storm Delta P** - change in pressure (mb)
- **Storm Rmax** - radius of max winds
- **Distance** - distance from the eye of the storm

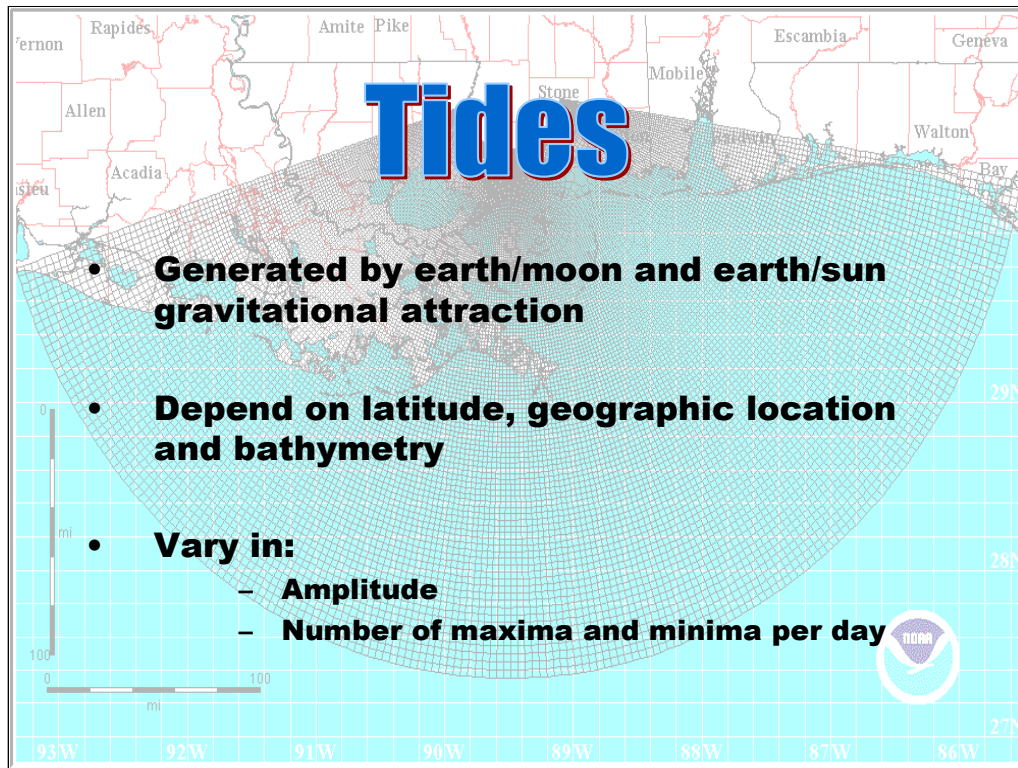
- All 5 options can be shown on the same graph or on 5 separate graphs.
- Surge is the storm surge at the chosen location.
- Speed refers to the wind speed at the chosen location.
- Storm Delta P is the pressure difference between the surface pressure outside of the storm and the storm's central (lowest) pressure at the surface.
- Storm Rmax is the distance from the storm center to the maximum surface winds.
- Distance is how far the eye of the storm is from the chosen location.
- Under the "Time History | Options" drop down menu, you can save the graphical data to a file in .txt, .ps, or .pcx format.
- The saved files will be stored in the slosh.pkg\output folder on the hard drive.



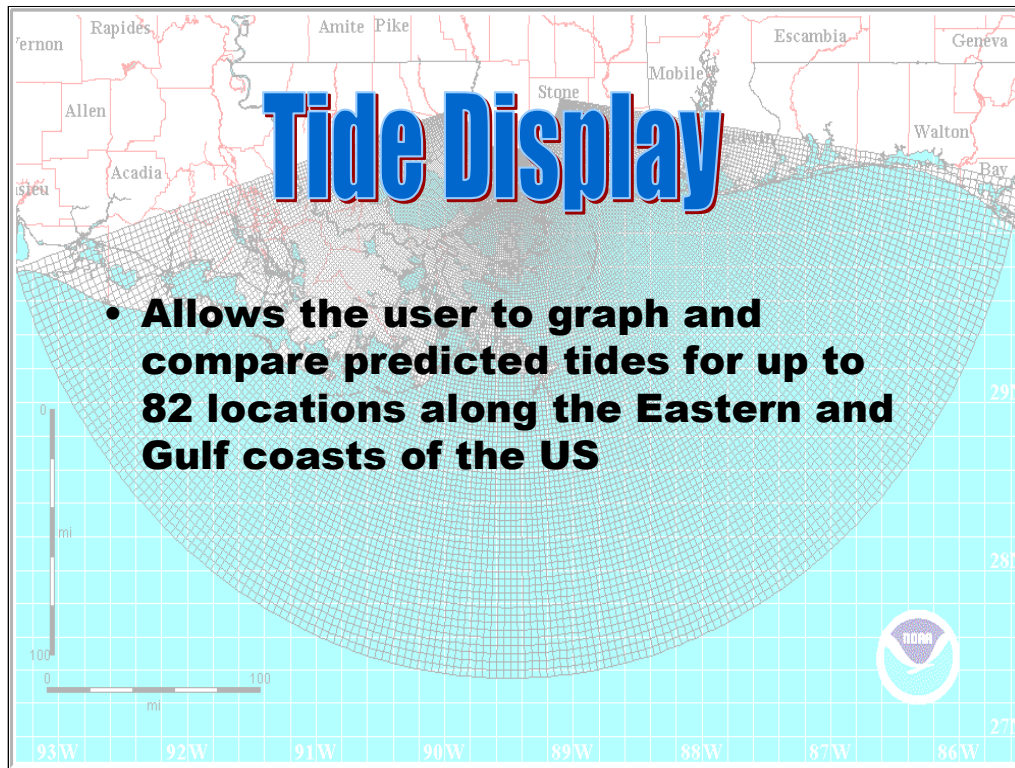
- The last main feature of the SLOSH display to review is the Astronomical Tide Prediction Program. This can be viewed by going to the “Tides | Tide Display” option under the Main Menu Bar on the SLOSH Display window.

Note:

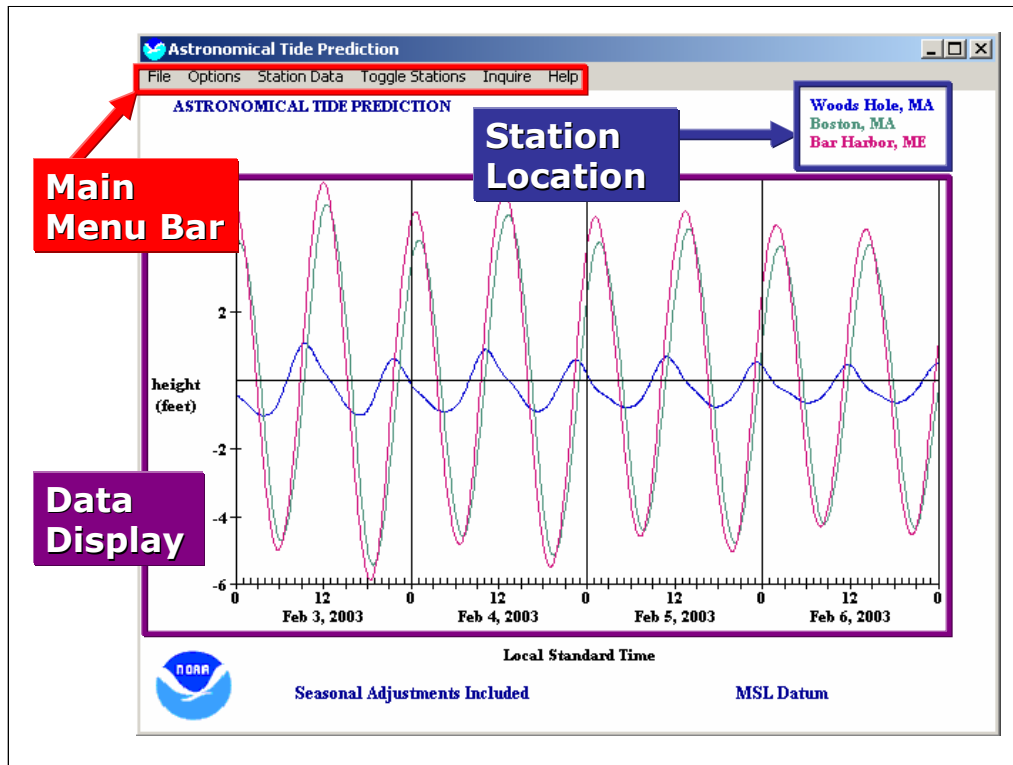
- The Extratropical Storm Surge website (<http://nws.noaa.gov/mdl/etsurge>) is an extremely useful source of information about the predicted total water level at a given station. The website contains detailed information about the data presented.



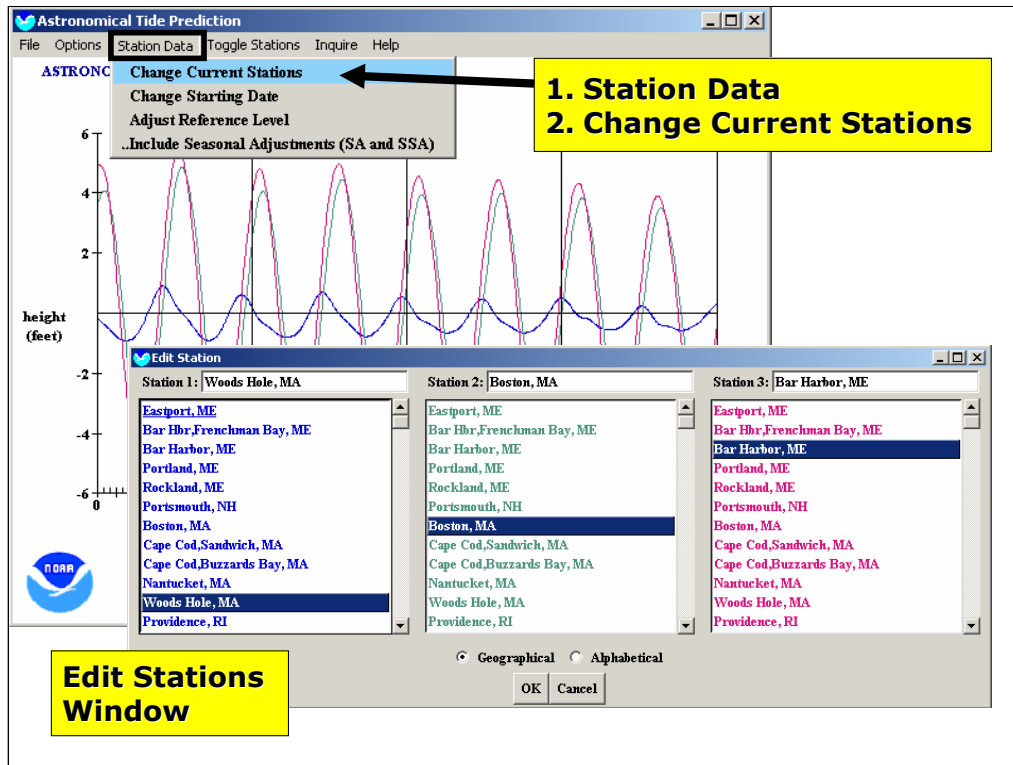
- Tides play an important role in determining the total water level experienced during a hurricane.
- Tides are generated by the gravitational attraction between both the earth and moon and the earth and sun.
- Tides depend on latitude, geographic location, and bathymetry.
- Tides vary significantly in amplitude and the number of maxima and minima per day along the U.S. coastline.



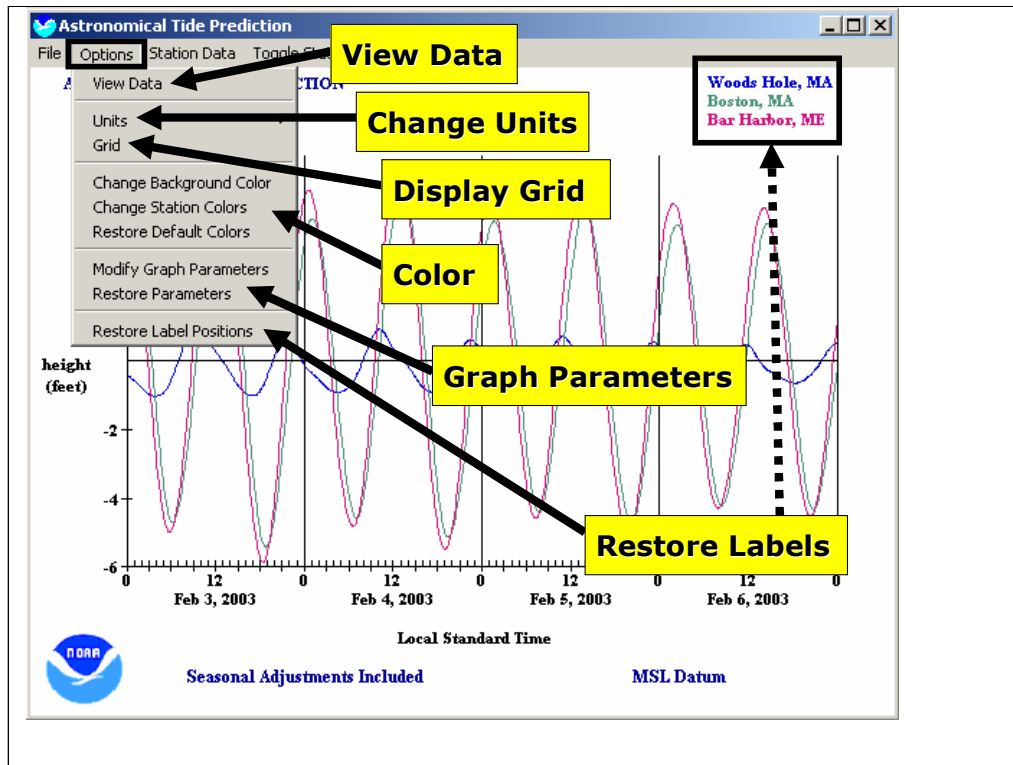
- Given a date between 1800 and 2025, the Tide Display program graphs the predicted tides for any of 82 locations along the Eastern and Gulf coasts of the United States. This program allows emergency managers and hurricane forecasters to view predicted tides along with the hurricane storm surge generated by the SLOSH model.



- Look at the Astronomical Tide Prediction window.
- The Main Menu Bar is located at the top of the screen. Each of these options will be discussed in this section.
- The Data Display area shows the predicted tide for specified stations. Tide data for up to three stations may be shown at a time. The date is shown on the x-axis, and the water height is on the y-axis.
- The stations of interest are shown on the upper right of the screen. They are color-coded to match the color of the corresponding data on the graph below.



- Select the station or stations of interest.
- ❑ Go to “Station Data” on the Main Menu Bar and select “Change Current Stations.”
- The “Edit Stations” window will open. It is possible to view the stations geographically or by alphabetical order. The default stations selected are Woods Hole, MA as Station 1, Boston, MA as Station 2, and Bar Harbour, Maine as Station 3.
- ❑ Select any three stations of interest and click “OK”.
- A graphical display of the predicted tides for the upcoming days for the stations selected is shown.



- Look at the various selections available under “Options” on the Main Menu Bar.
- “View Data” brings up a window containing tide data in tabular format. The data can also be saved to a text file.
- “Units” allows the user to change the display units to either feet or meters.
- “Grid” displays a grid in the data display window.
- The “Options” menu contains three functions which modify colors on the tide display graph. The “Change Background Color” option can be used to change the background color of the main canvas. The “Change Station Colors” option allows the user to individually change the color used to plot the data for each station.
- To bring up the color chart, click on the color box next to the station name. The “Restore Default Colors” option restores all default colors to the tide graph.
- The “Modify Graph Parameters” option allows the user to specify the range and increment of the y-axis (height). “Restore Parameters” reverts the graph parameters to the default extents.
- The user can relocate the Station Names (on the top right of the window) with the mouse arrow to anywhere on the data display screen. The “Restore Label Positions” option resets the label position to its default location.

The screenshot shows the 'Astronomical Tide Prediction' software window. The 'Station Data' menu is open, highlighting 'Change Starting Date', 'Adjust Reference Level', and 'Include Seasonal Adjustments'. Three yellow callout boxes with arrows point to these menu items. To the right, three dialog boxes are shown: 'Change Starting Date' (with fields for Starting Year, Month, Day, and Number of Days Shown), 'Adjust Reference Level' (with fields for Datum for Woods Hole, MA, Boston, MA, and Bar Harbor, ME, and buttons for 'Use MLLW Datum' and 'Restore MSL Datum'), and 'Include Seasonal Adjustments' (with a checkbox for 'Seasonal Adjustments Included'). The background graph shows tide height (feet) on the y-axis (ranging from -6 to 6) and Local Standard Time on the x-axis (ranging from Feb 3, 2003 to Feb 5, 2003). The graph displays two tidal curves: a blue curve for 'MSL Datum' and a red curve for 'Seasonal Adjustments Included'. The NOAA logo is visible in the bottom left corner of the software window.

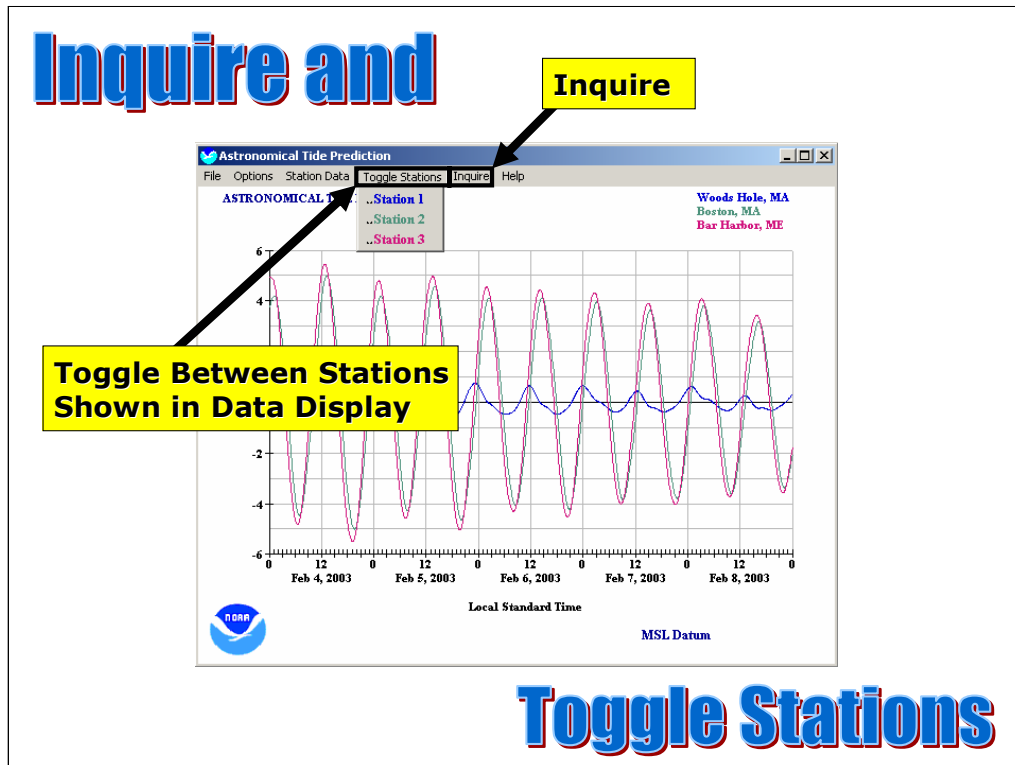
Station Data Options

- Other options under “Station Data” on the Main Menu are Change Starting Date, Adjust Reference Level, and whether to include Seasonal Adjustments.
- Selecting the “Change Starting Date” option brings up a window to adjust the starting year, month and day, and change the number of days shown for the tide levels in the data display.
- The “Adjust Reference Level” option lets the user change the starting datum for each station. It is also possible to select between using the Mean Lower Low Water (MLLW) or stay with the default Mean Sea Level (MSL) datum. MLLW is a tidal datum. It is the average of the lowest low tide from each day. The reference level used for the data displayed will be labeled at the bottom of the “Astronomical Tide Prediction” window.
- “Include Seasonal Adjustments” does just that. If this option is on, then “Seasonal Adjustments Included” will appear at the bottom of the data display.

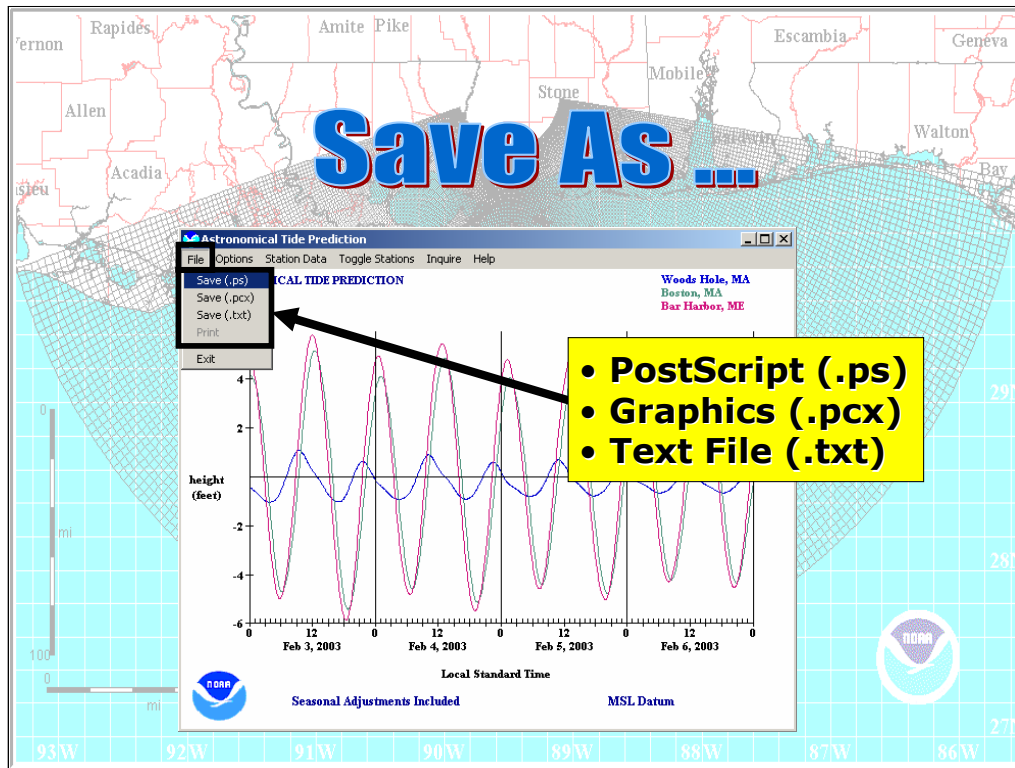


Definitions:

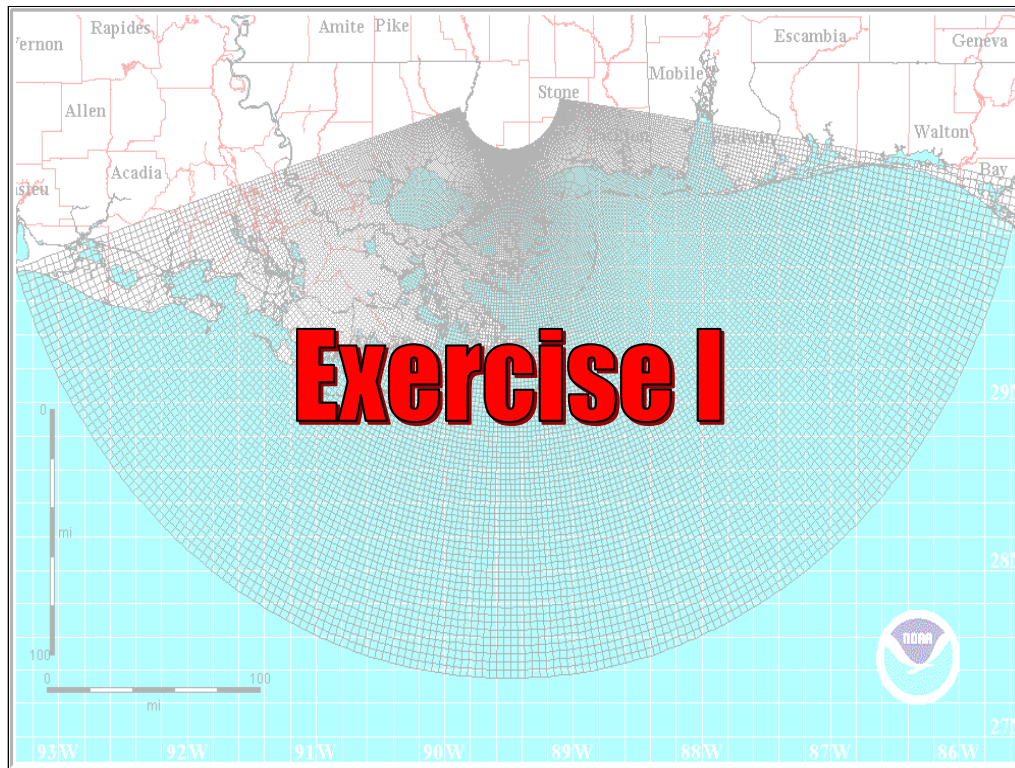
MLLW – Mean Lower Low Water
MSL – Mean Sea Level



- By default, the Tide Display Program shows three stations on the tide graph. The Toggle function allows the user to remove or replace stations on the tide graph.
- The Toggle function is executed by clicking on “Toggle Stations” on the top menu bar and then clicking on the desired (color coordinated) station to toggle off. The station may be replaced by re-clicking on the appropriate station under the “Toggle Stations” menu.
- Clicking on the “Inquire” drop-down menu produces a red vertical line in the middle of the tide graph.
- The graph can be traced using the left and right arrow keys or the mouse. Y-coordinate points are displayed next to the station name labels.
- Turn the inquire function off by re-clicking on “Inquire.”

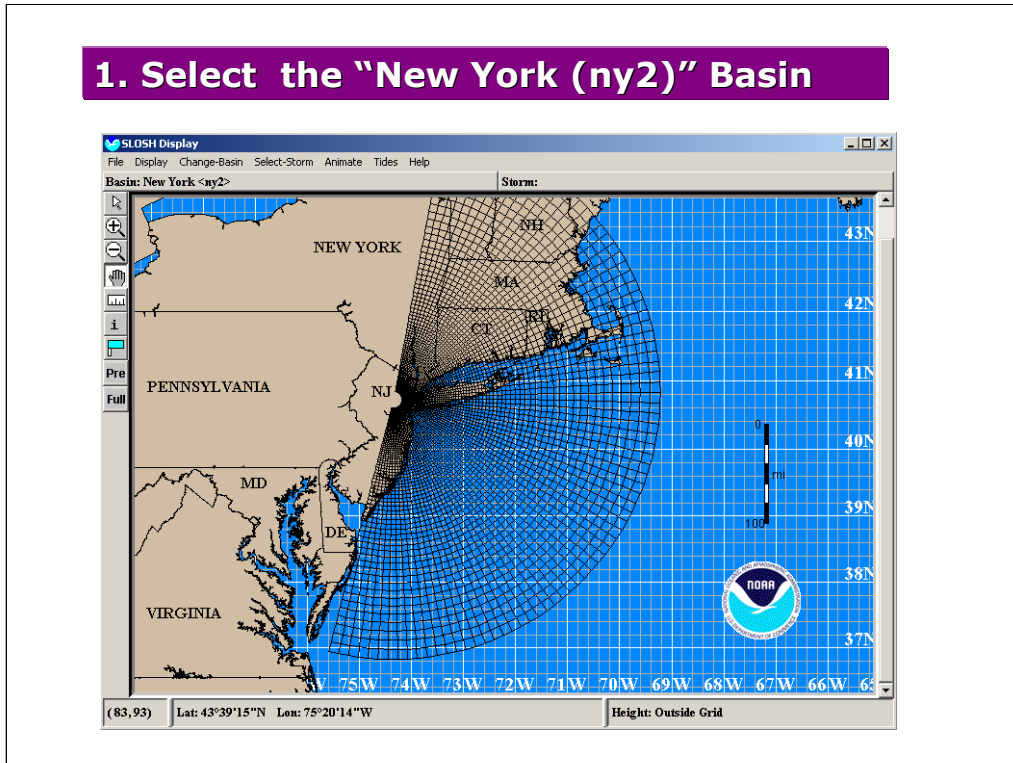


- The Tide Display Program allows three different save options under the “File” menu.
- The first option, save.ps, allows the user to save the current tide graph as a PostScript file, which can be used to create a .pdf file.
- The second option, save.pcx, allows the user to save the current tide graph as a .pcx file. This file can then be opened and printed in any graphics program capable of displaying a .pcx file.
- The third save option, save.txt, saves the raw (x,y) data used to create the tide graph to a text file. This can also be accomplished under the “Options | View Data” menu.

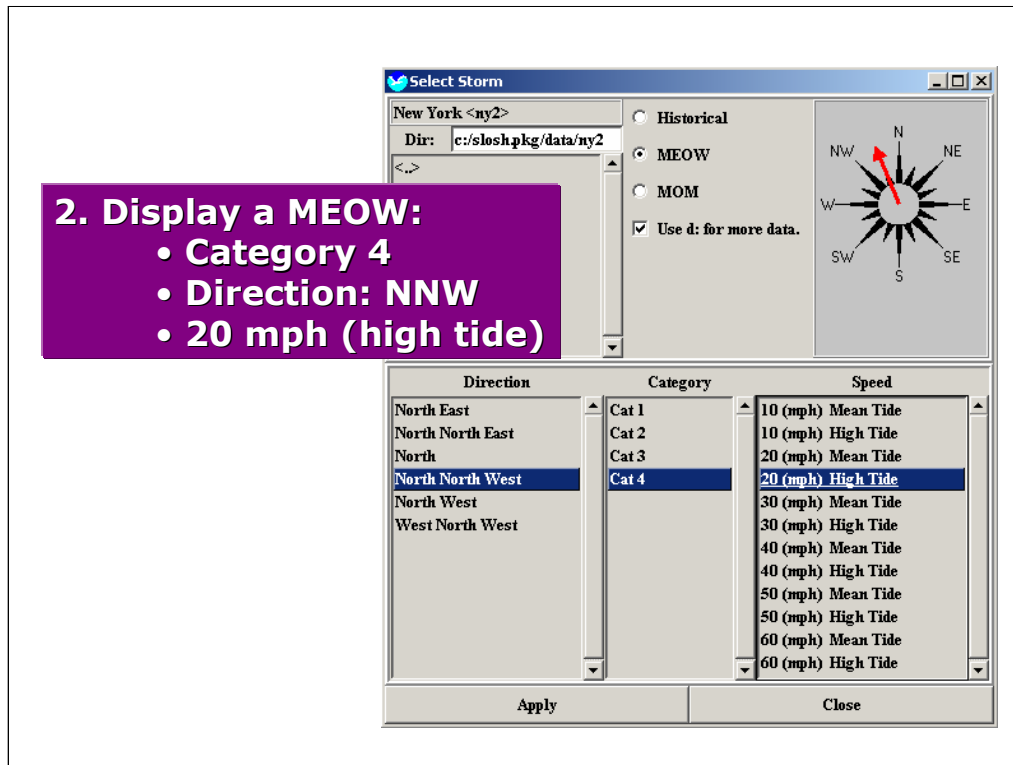


- Apply what you have learned in this training in a review exercise.

1. Select the "New York (ny2)" Basin

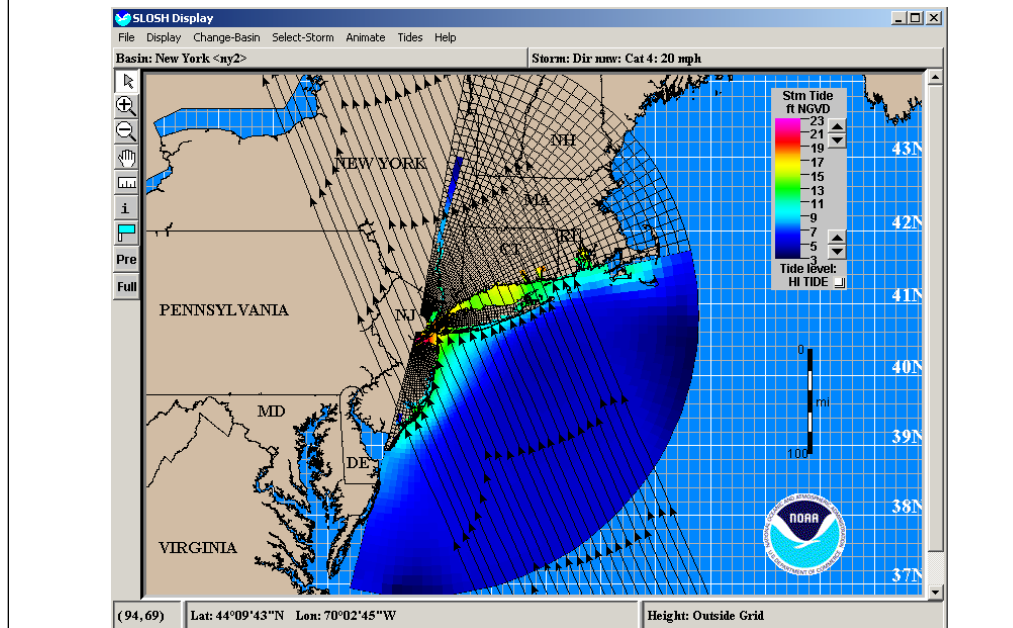


1. Select the "New York (ny2)" Basin. Remember, to select the "New York (ny2)" basin, go to "Change-Basin | Change-Basin" and double click on the basin name or basin outline in the map.



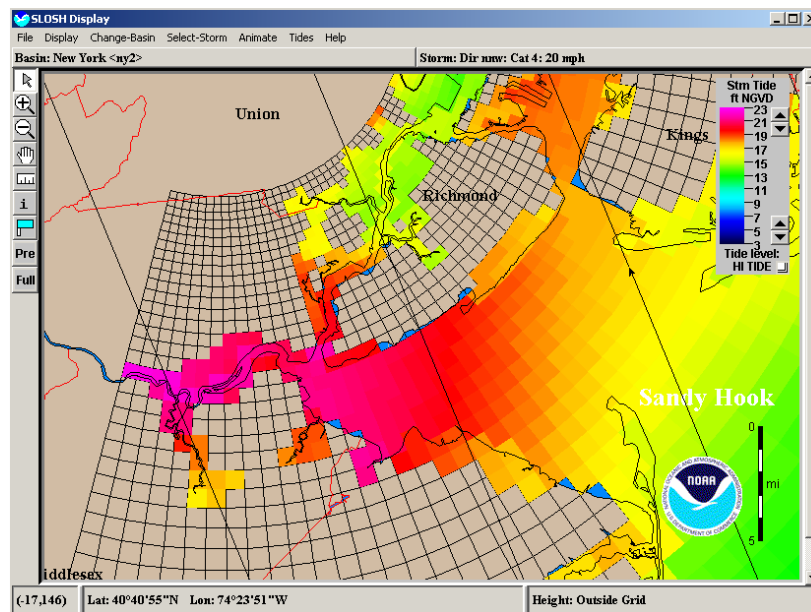
2. Display a MEOW for a Category 4 storm traveling north-northwest at a speed of 20 mph during high tide.

3. Locate the area that potentially could receive the highest storm surge

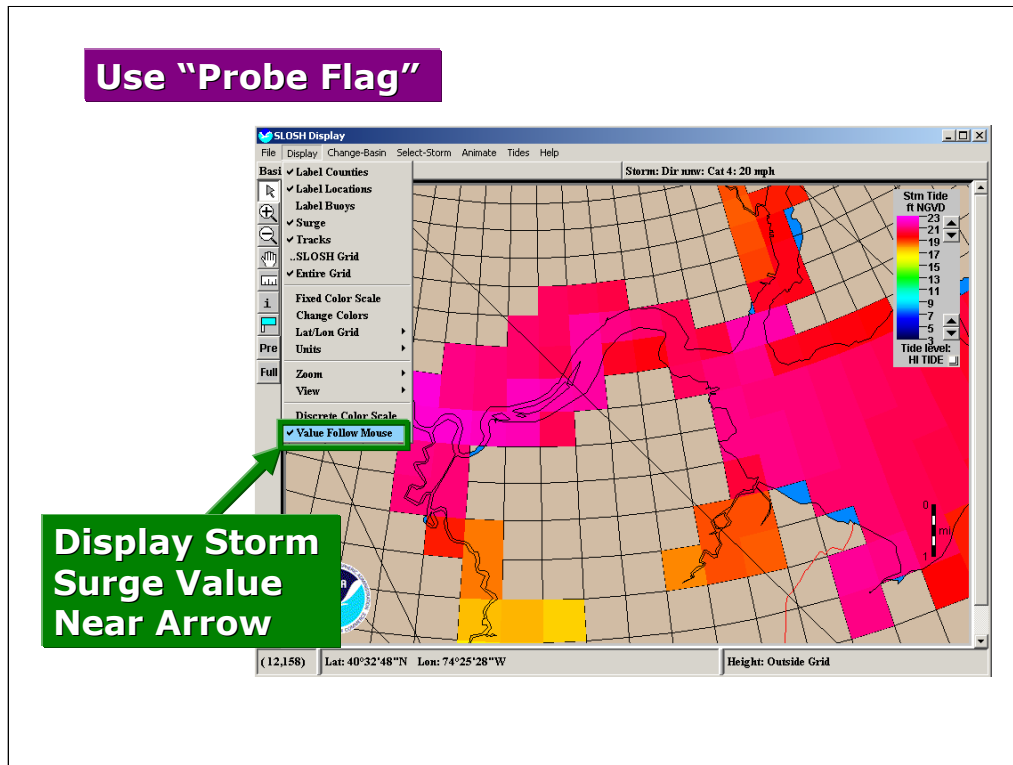


3. The MEOW selected should now be displayed. Find the area that potentially could receive the highest storm surge from a storm with these parameters.
 - Look at the “Storm Tide” scale. The highest storm surge on the scale is 23 and is a pinkish color. The pinkish color is on the New Jersey shoreline. Zoom in to this area to get a closer look.

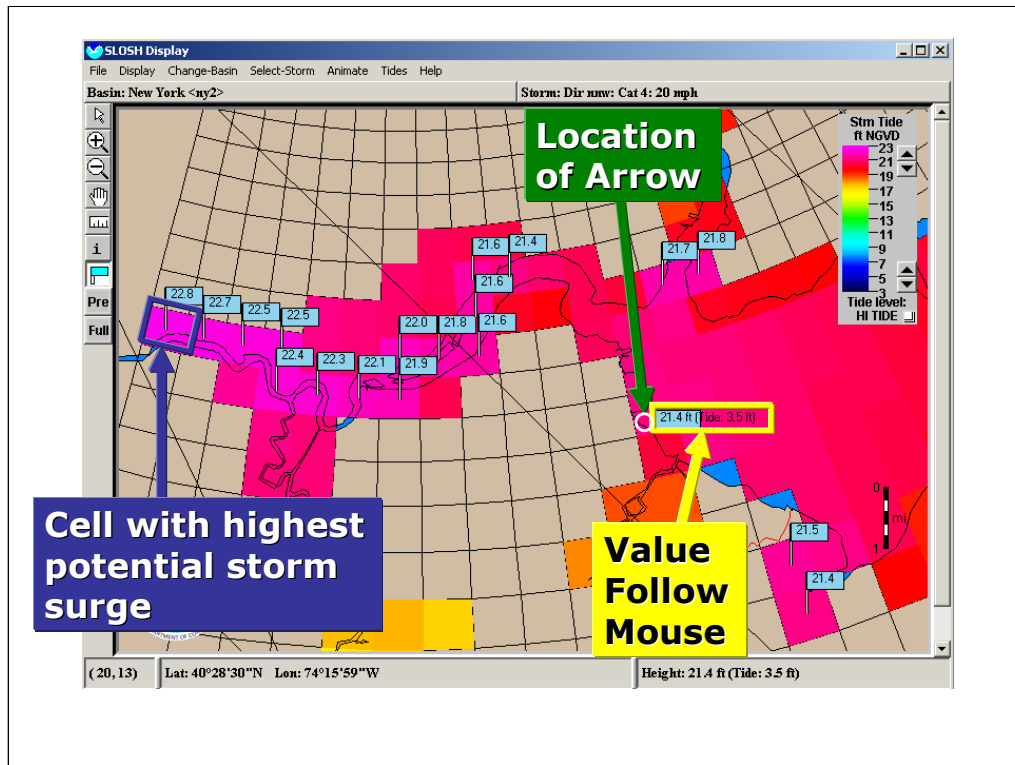
4. Where is the highest potential storm surge value?



- The area with the highest potential storm surge is near Sandy Hook, New Jersey along the New Jersey and New York border.
- Now locate the grid cell with the highest storm surge value.
- Zoom in closer on the area containing the pink grid cells.



- To locate the highest potential storm surge value from the MEOW displayed, use the "Probe Flag" feature to label the storm surge for individual grid cells.
- To display the storm surge value for the grid cell the mouse pointer is over, go to "Display | Value Follow Mouse."



- The grid cells with the color corresponding to the highest storm surge values have been labeled with the “Probe Flag.”
- The storm surge value and tide height are displayed near the mouse pointer when the “Value Follow Mouse” option is turned on.
- The grid cell with the highest potential storm surge, which is 22.8 feet, has been located.
- Now find which combinations of storm parameters could potentially produce the maximum storm surge for this grid cell.

5. Which storm parameters could potentially produce the maximum storm surge for this grid cell?

Use "Inquire All"

Category 1		Category 2		Category 3		Category 4		Historical	
nw 60 I3	9.1	nw 40 I3	15.4	nw 40 I3	23.8	nw 40 I3	35.2	hi_tide	3.5
nw 40 I3	8.9	wnw 30 I3	15.4	wnw 60 I3	22.0	nw 40 I1	33.0		
wnw 30 I3	8.8	nw 30 I3	14.3	wnw 50 I3	21.6	wnw 30 I3	32.6		
wnw 50 I3	8.7	wnw 40 I3	14.0	wnw 40 I3	20.7	wnw 50 I3	30.5		
nw 30 I3	8.5	wnw 60 I3	13.9	nw 30 I3	19.9	wnw 60 I3	30.0		
wnw 40 I3	8.4	wnw 50 I3	13.8	wnw 30 I1	19.9	wnw 30 I1	29.9		
wnw 20 I3	8.4	nw 40 I1	13.7	nw 40 I1	19.5	wnw 40 I3	28.7		
nw 20 I3	8.3	wnw 20 I3	13.0	wnw 40 I3	19.4	nw 30 I3	28.4		
wnw 10 I3	8.3	wnw 10 I3	12.8	wnw 10 I3	18.3	wnw 60 I1	28.3		
wnw 30 I3	8.2	wnw 30 I1	12.8	wnw 20 I3	18.2	nw 50 I1	28.2		
n 50 I3	8.1	nw 20 I3	12.5	nw 20 I3	18.0	wnw 40 I1	26.4		
n 60 I3	8.0	wnw 30 I3	12.1	nw 10 I3	17.7	nw 30 I1	25.5		
n 40 I3	7.9	nw 10 I3	11.9	wnw 40 I1	17.5	wnw 20 I3	24.3		
wnw 20 I3	7.9	wnw 50 I1	11.5	wnw 30 I3	17.4	nw 20 I3	24.2		
nw 10 I3	7.8	wnw 60 I1	11.5	nw 30 I1	17.3	wnw 30 I3	23.6		

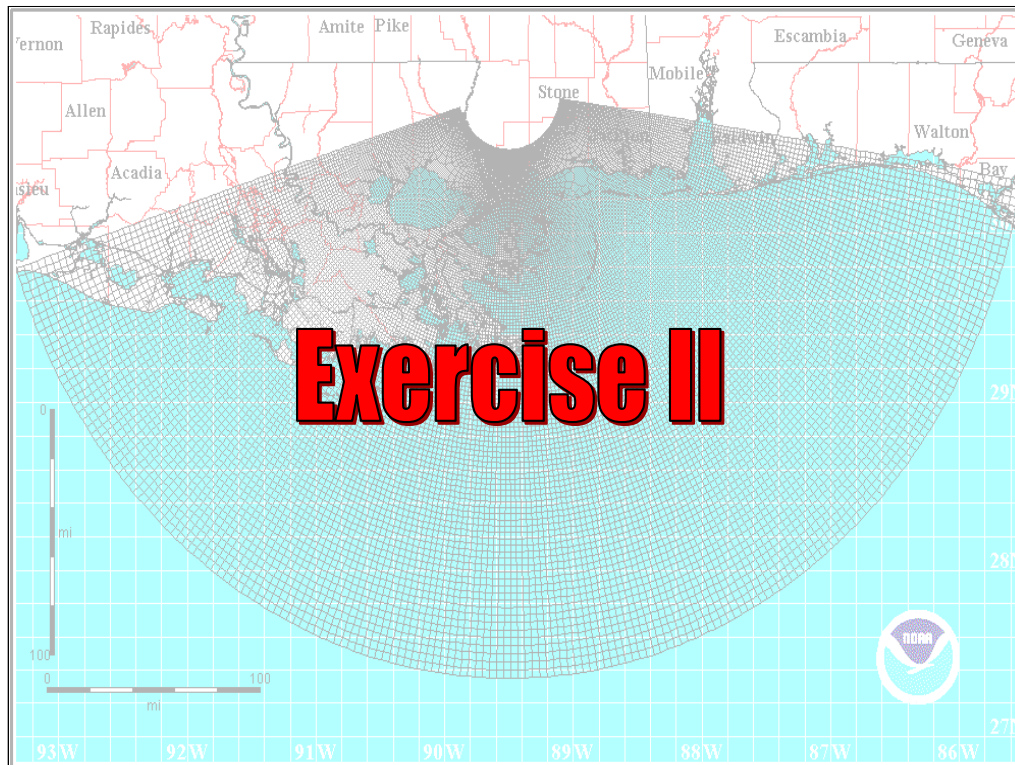
Sort by height
 Sort by Direct
 Clockwise
 Starting Directw

Double click on list item to load MEOW

SLOSH Coordinates: (18, 1) Latitude: 40.4954 Longitude: 74.4143

Save to file Close

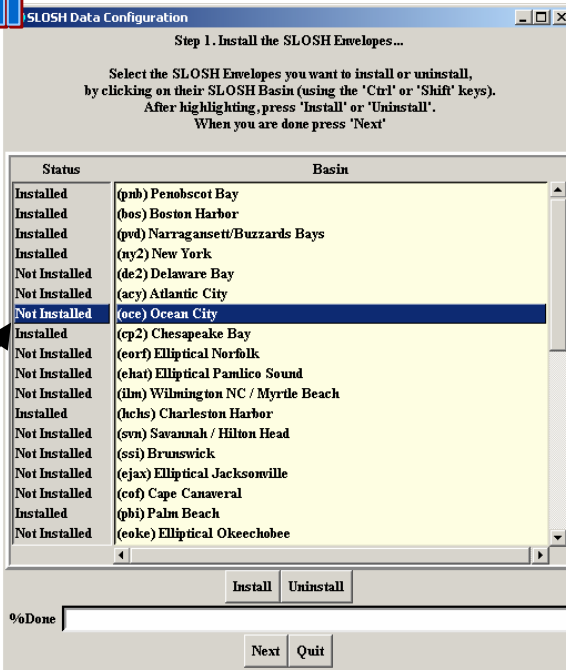
- Use the "Inquire All" button to display all available MEOWs for this grid cell.
- The highest storm surge value (35.2 feet) could potentially occur in a Category 4 storm traveling in a northwesterly direction at 40 mph and occurring during high tide.



- This exercise allows students to explore any basin of interest and to practice using the features available in the SLOSH Display program.
- This exercise will be completed independently. There is an answer key at the end of the exercise.

Install a New Basin

- **Load a basin that was not previously installed. For example, your local basin.**



Not Installed

SLOSH Data Configuration

Step 1. Install the SLOSH Envelopes...

Select the SLOSH Envelopes you want to install or uninstall, by clicking on their SLOSH Basin (using the 'Ctrl' or 'Shift' keys). After highlighting, press 'Install' or 'Uninstall'. When you are done press 'Next'

Status	Basin
Installed	(pnb) Penobscot Bay
Installed	(bos) Boston Harbor
Installed	(pvd) Narragansett/Buzzards Bays
Installed	(ny2) New York
Not Installed	(de2) Delaware Bay
Not Installed	(acy) Atlantic City
Not Installed	(oce) Ocean City
Installed	(cp2) Chesapeake Bay
Not Installed	(eorf) Elliptical Norfolk
Not Installed	(ehat) Elliptical Pamlico Sound
Not Installed	(ilm) Wilmington NC / Myrtle Beach
Installed	(hchs) Charleston Harbor
Not Installed	(svn) Savannah / Hilton Head
Not Installed	(ssi) Brunswick
Not Installed	(ejax) Elliptical Jacksonville
Not Installed	(cof) Cape Canaveral
Installed	(phi) Palm Beach
Not Installed	(eoke) Elliptical Okeechobee

Install Uninstall

%Done

Next Quit

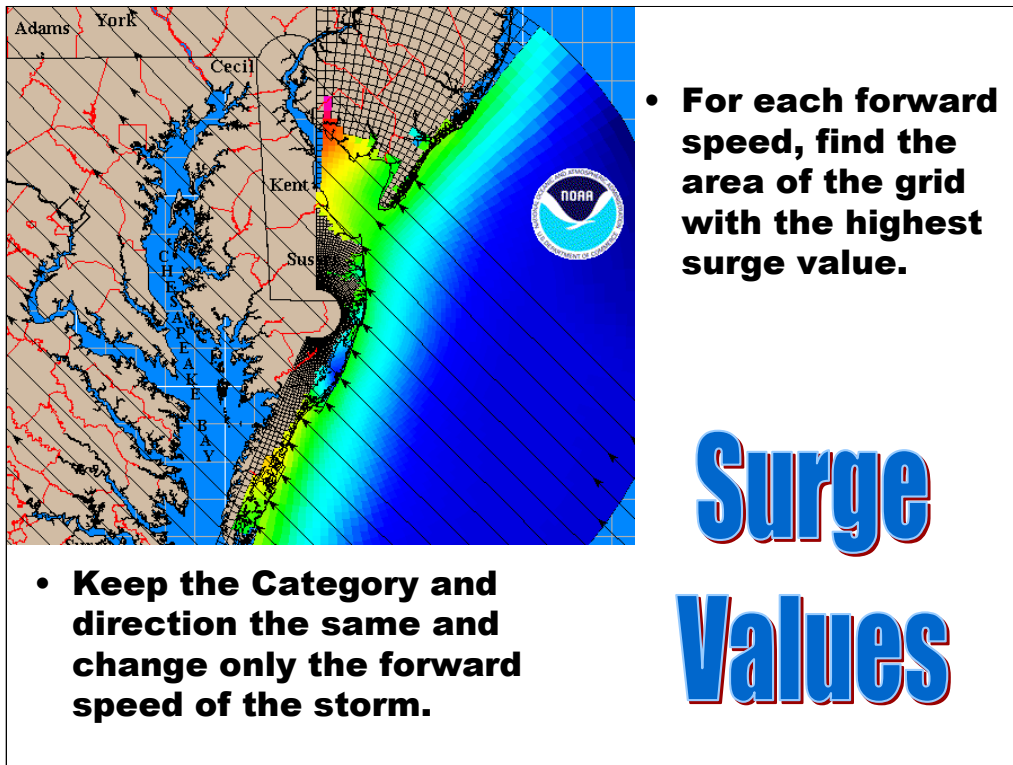
Change Basin

- **Change the basin shown in the SLOSH Display to the basin that you have just loaded.**
- **Select a Category 3 storm in a direction that is logical for the basin you have chosen.**

1. Are there any historical storms in your basin?

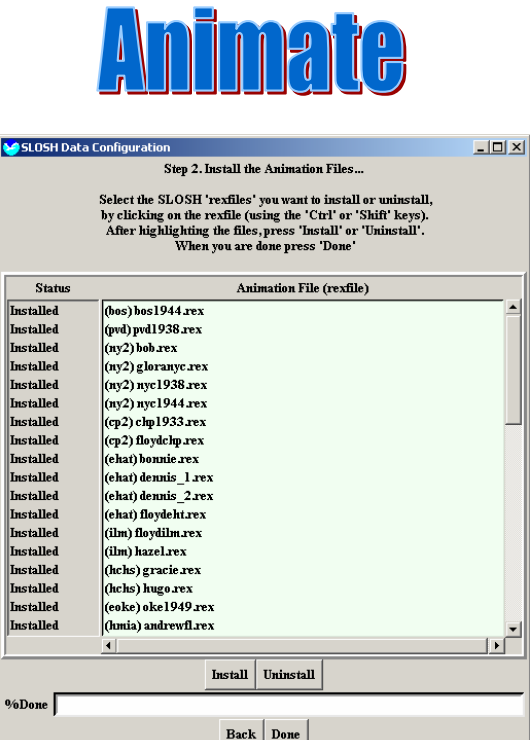


Hint: Historical storms have unique names; standard file names are MEOWs.



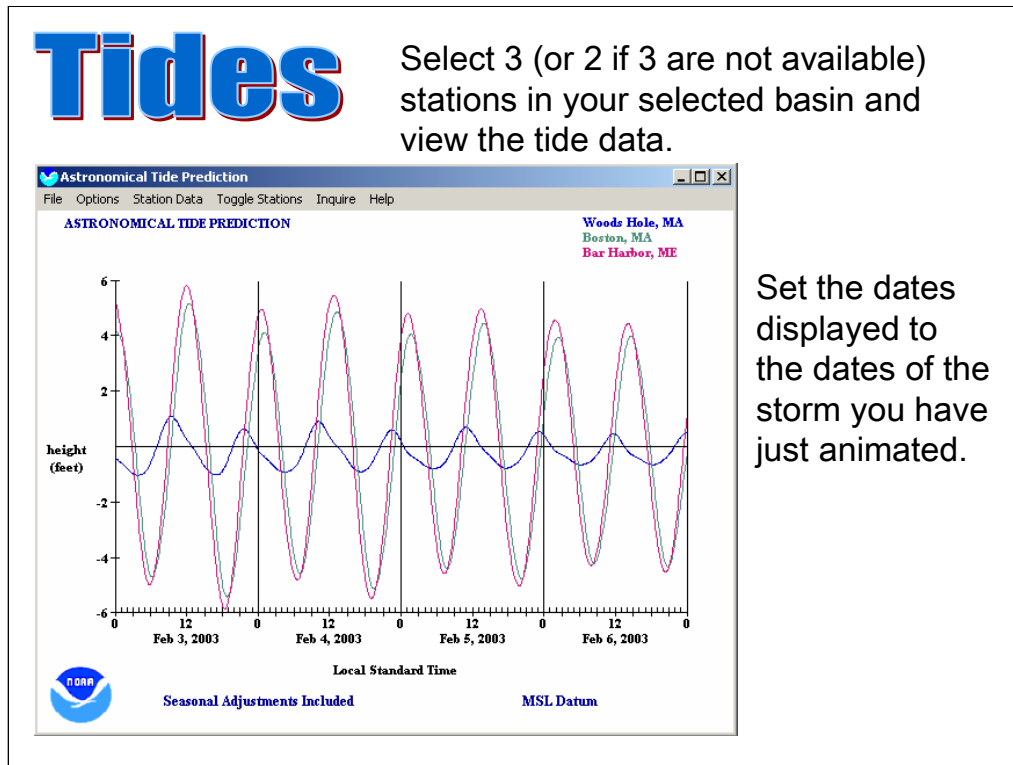
2. Which speed storm produces the greatest surge?
3. Are the greatest surge values always in the same location no matter what speed the storm is traveling?
4. With the same tide height, what is the greatest difference in surge height?
5. Do the generalizations listed on pages 17 and 18 apply?

- **Install the Rex file(s) for the basin that you have selected.**
- **If your basin doesn't have any Rex files then load the Chesapeake Bay basin and (cp2)chp1933.rex file.**
- **Animate the Rex file and view the Time History for the point of greatest surge you found earlier.**



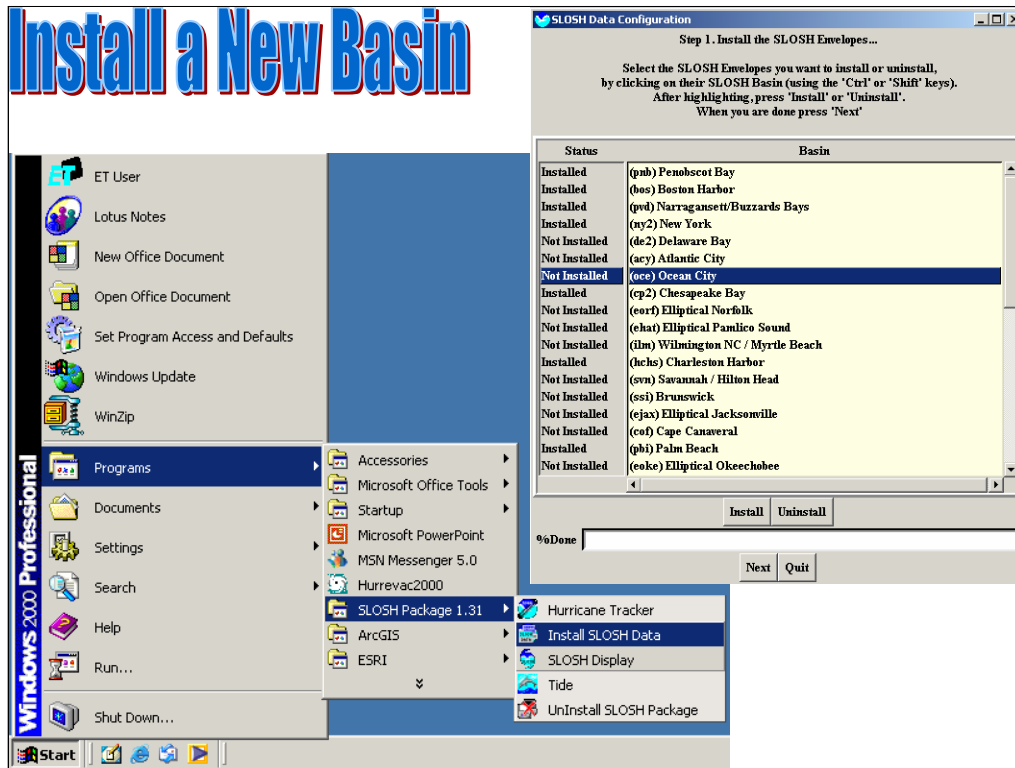
6. What was the greatest surge for that point during the animated storm?

7. What was the greatest wind speed for that location?



8. Do the tide data show that surge elevations in different areas of your basin will be greatly affected by the tide level?

Answer Key



- Insert the SLOSH CD.
- Go to the Start Menu | Programs | SLOSH Package | Install SLOSH Data.
- Select a basin that has not been installed and click “Install.”
- Click “Next” when the basin has been installed.

• **Change the basin shown in the SLOSH Display to the basin that you have just loaded.**

Change Basin

The screenshot shows the SLOSH Display application window. The main map displays the Chesapeake Bay area with various basins outlined in red. A 'Change-Basin' dialog box is open, listing various basins such as Delaware Bay, Atlantic City, Ocean City, Chesapeake Bay, and others. The 'Ocean City' basin is currently selected. The status bar at the bottom of the window shows the current location as (36.121) and (39°26'35\"

- Go to Change-Basin | Change-Basin.
- Select the basin that you just loaded.

• **Select a Category 3 storm in a direction that is logical for the basin you have chosen.**

Select Storm

Select Storm

Ocean City <oce> Historical MEOW MOM

Dir: c:/sloshpkg/data/oce

Use d: for more data.

Direction: North West

Category: Cat 3

Speed: 10 (mph) Mean Tide

Filter: *.OCE *.oce

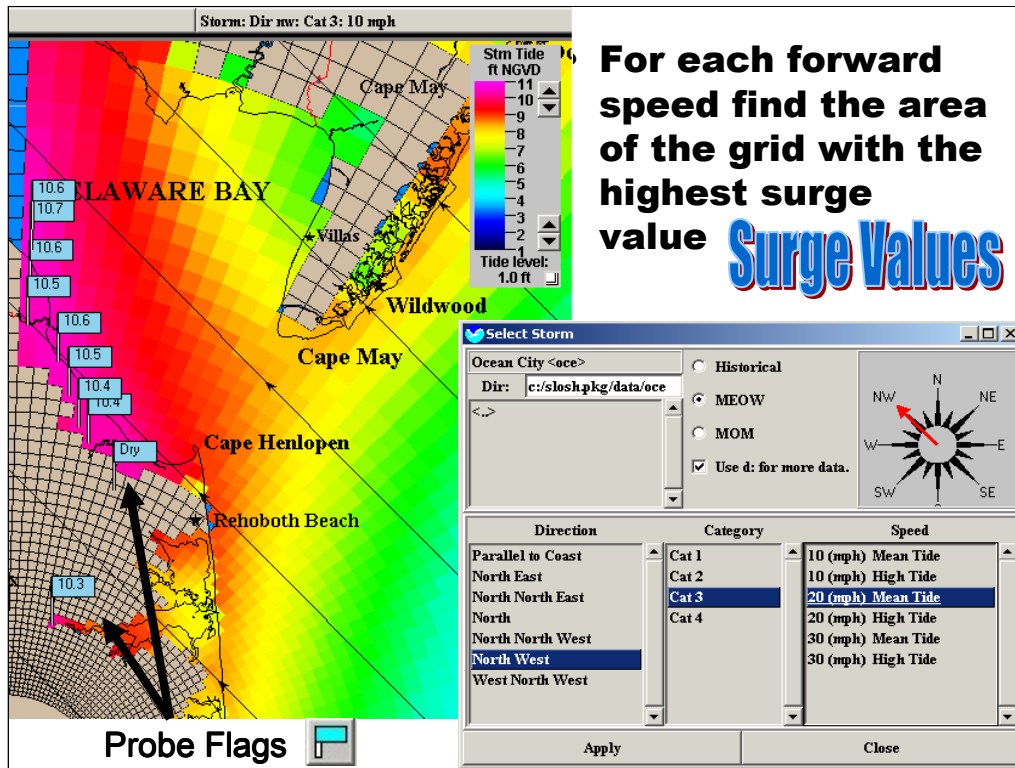
N11011.oce
N11013.oce
N12011.oce
N12013.oce
N13011.oce
N13013.oce
N14011.oce
N14013.oce
N15011.oce

No Historical Storm

Vary the Speed

Answer 1. Are there any historical storms in your basin? **It depends on the basin selected. See page 42 for a list of historical storms. Few basins have historical storm data available in SLOSH.**

- Go to Select Storm | Select Storm.
- First, click on the “Historical” button.
- If there are any historical storms for the basin, it will have a unique name.
- Next select the “MEOW” button.
- Choose a direction under “Direction” and Cat 3 under “Category.”
- Choose the first speed you would like to investigate.



Answer 2. Which speed storm produces the greatest surge? **The fastest moving storm typically produces the greatest surge values.**

- Go to Select Storm | Select Storm.
- Choose the MEOOW button, a logical direction for the storm to be traveling, and Category 3.
- View the first speed storm by clicking on the speed and tide height.
- Find the location of the greatest surge for that speed storm by placing "Probe Flags."
- Repeat this process for the other storm forward speeds available.

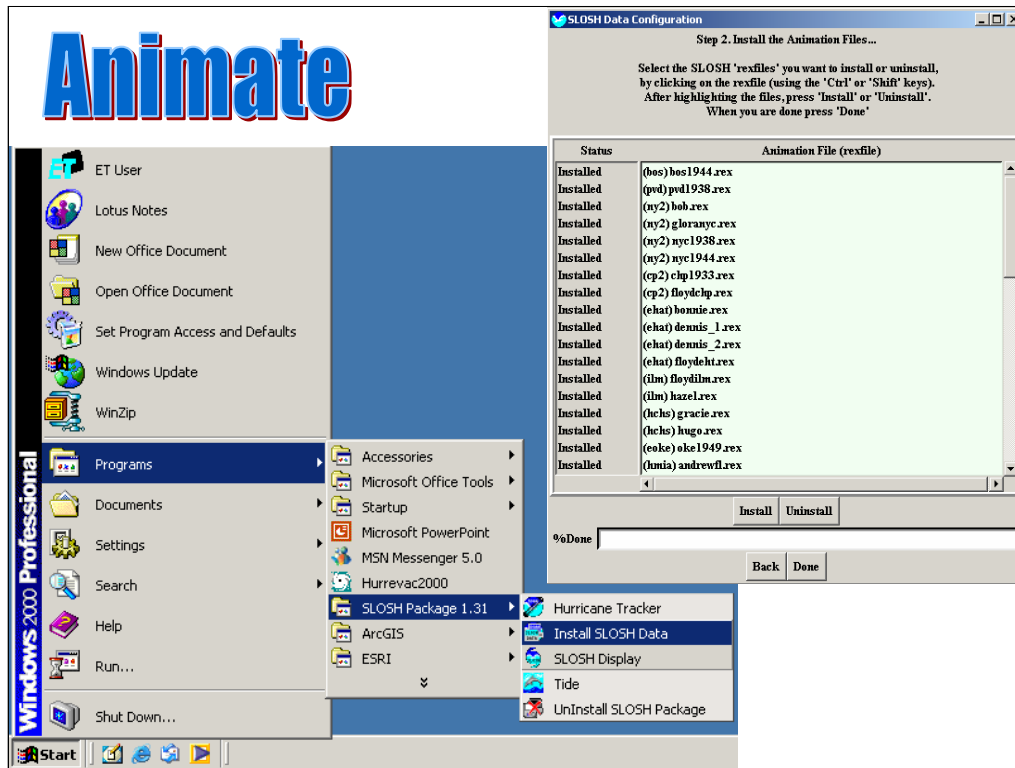
Answer 3. Are the greatest surge values always in the same location no matter what speed the storm is traveling? **No, the greatest surge value is not always in the same location. The speed of the storm has an impact on where the highest surge elevations are found.**

Keep the Category and Direction the same and change only the Forward Speed of the Hurricane

Answer 4. With the same tide height, what is the greatest difference in surge height? **This surge height will vary significantly with the basin and direction selected.**

- Leave the Select Storm window open.
- Select different speeds of the storm with the same tide (mean or high).
- Click “Apply.”
- If you have placed Probe Flags at the location of greatest surge for each storm, you can follow the change in values as you view the different speed storms.

Answer 5. Do the generalizations listed on pages 17 and 18 apply? **Yes**



To install Rex files:

- Go to Start Menu | Programs | SLOSH Package | Install SLOSH Data.
- Click "Next" in the first window to reach the animation files.
- Look for any Rex files with your selected basin's short name in parentheses, e.g., (cp2) for the Chesapeake Bay basin. If you do not know what the short name for your basin is, click "Back" and locate your basin in the list, then click "Next" again.
- If your basin does not have any Rex files available, install the Chesapeake Bay basin and the two Rex files that begin with (cp2).

The image shows two windows from the SLOSH software. The 'Animation Setup' window on the left lists various basins and their corresponding Rex files. The 'Time History Point 1' window on the right displays two graphs: 'Surge(ft)' and 'Wind Speed(MPH)'. The 'Surge(ft)' graph shows a peak of approximately 11 feet, and the 'Wind Speed(MPH)' graph shows a peak of approximately 83 MPH. The 'Time History Point 1' window also includes a menu with options like 'Surge', 'Speed', 'Storm Delta P', 'Storm Rmax', and 'Distance'.

• **Animate the Rex file and view the Time History for the point you found earlier of greatest surge**

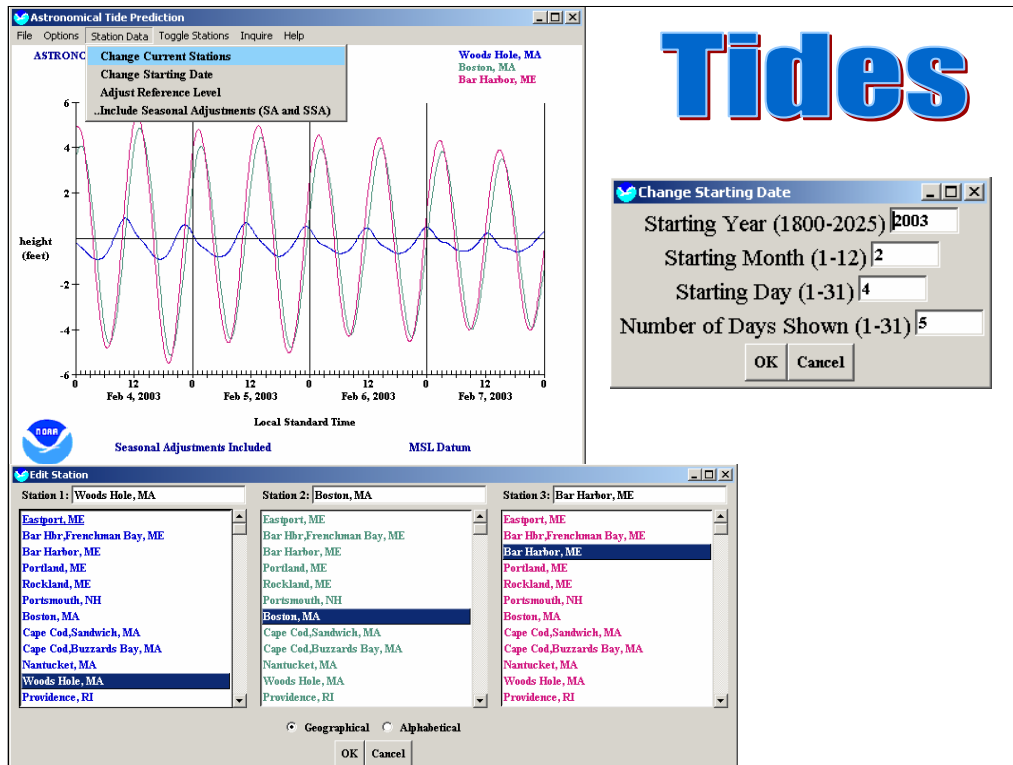
- Go to Animate | Animate .rex file.
- Select the Rex file for your selected basin.
- Click “Start.”

Answer 6. What was the greatest surge for that point during the animated storm? **The greatest surge elevation during an animated storm depends on the basin chosen.**

- During the Animation, place Probe Flags at the locations that appear to be experiencing the greatest surge.
- When the animation is finished, the SLOSH Display program shows a “snapshot” of the highest surges.
- Add additional Probe Flags if necessary to find the area of maximum surge.

Answer 7. What was the greatest wind speed for that location? **The maximum wind speed is dependent on the basin chosen.**

- Click on the “Time History” hot button.
- Click on the grid cell that you found to have the greatest storm surge in the previous question.
- Run the animation again.
- Use the Time History graphs to view the wind speed.



Answer 8. Do the tide data show that surge elevations in different areas of your basin will be greatly affected by the tide level? **Depends on basin chosen**

- Select Station Data | Change Current Stations.
- Choose stations located within the basin you have selected to work with.
- Select Station Data | Change Starting Date.
- Find the date the storm you have just animated occurred by looking at the Time/Date in the animation window.
- Enter those dates and click OK.

SLOSH Display Training

Glossary and Acronyms

ADCIRC – Advanced Circulation Model for oceanic, coastal, and estuarine waters. This is a program used to simulate storm surge. It is commercially available to the public.

Bathymetry – the water depth relative to mean sea level. It may be expressed as positive or negative but should be understood to be negative.

Category - the category of the hurricane, based on the Saffir-Simpson Scale.

Envelope - the maximum the water reaches at any point in time at every grid cell in the SLOSH basin.

FEMA – Federal Emergency Management Agency.

GIS – Geographic Information Systems.

HES - Hurricane Evacuation Study. SLOSH is used to estimate storm surge which is then used in these studies.

Hurricane Track – a- set of parameters used to approximate the hurricane. The parameters include: Pressure, Radius of Maximum Winds, Location, Forward Speed and Forward Direction.

MDL - Meteorological Development Laboratory - The part of NWS whose focus is on developing techniques (programs) to aid Forecast Offices (including the NHC) <http://www.nws.noaa.gov/mdl/>.

MEOW - Maximum Envelope of Water. The maximum at every grid cell that is reached in any of several envelopes, where the envelopes are acquired by running the model on storms with the same Category, forward speed, and direction of motion, but with tracks that are parallel to each other.

MLLW – Mean Lower Low Water.

MOM - Maximum of MEOWs. The maximum at every grid cell that is reached in any of several MEOWs, where the only constant is Category.

MSL – Mean Sea Level.

NGDC – National Geophysical Data Center.

NHC - National Hurricane Center (a.k.a. Tropical Prediction Center) - The part of NWS whose focus is on predicting Tropical Storms <http://www.nhc.noaa.gov/>.

NOAA - National Oceanic and Atmospheric Administration.

NWS - National Weather Service - The part of NOAA whose focus is on predicting the weather.

PCX – PC Paintbrush Bitmap Graphic.

REX file – displays the height of water in every grid cell in the SLOSH Basin at specific time intervals and shows the wind field used within SLOSH at that time.

Saffir-Simpson Scale - a 1-5 rating based on the hurricane's present intensity (5 being the most intense); used to estimate the potential property damage and flooding expected along the coast from a hurricane landfall.

SLOSH - Sea Lake and Overland Surge from Hurricanes.

SLOSH Basin - a geographic region as defined by the SLOSH grid with known values for topography, and bathymetry in addition to sub grid properties and barriers, on which the SLOSH model is run.

SLOSH grid - the SLOSH model uses a polar, elliptical, or hyperbolic grid for its computations. The reason for not using a Cartesian grid is to get finer resolutions near shore. This is not only the area we are most interested in, but this type of grid (having finer resolution near shore) aids in solving some of the mathematical equations.

SLOSH model - the model that generates the hurricane storm surge given a SLOSH Basin and a Hurricane Track. It generates an Envelope of high water and a Rex File.

Storm Surge - water that is pushed toward the shore by the force of winds swirling around a storm.

Storm Tide – the combination of normal tide and the storm surge to create the total increase in water level due to the storm.

TIF – Tagged Image File format.

Topography - the configuration of a surface including the elevation and position of its natural and man-made features.

USACE – U.S. Army Corps of Engineers.

USGS – U.S. Geological Survey.

UTC – Coordinated Universal Time. It is equal to Greenwich Mean Time (GMT) and five hours ahead of Eastern Standard Time (EST) and four hours ahead of Eastern Daylight Time (EDT).