

Pacific NW National Laboratories (PNNL) in collaboration with the Salish Sea Modeling Center (SSMC) and in consultation with the Education Coordinator for the SeaDoc Society, created this package for teaching demonstrations, and use by middle and high school teachers and their students. The model solution is provided solely for educational and research purposes; any use of the model solution beyond the intended scope must be approved by PNNL. No rights in the underlying intellectual property, beyond the grant of this permissive research license, is provided herein. The user assumes responsibility for the model use, misuse, or inability to use the model solution and in no event shall PNNL or SSMC have any liability for damages, including but not limited to any indirect, incidental, or consequential damages, arising from or in connection with the use of the model solution. Contact: Tarang Khangaonkar, Director, Salish Sea Modeling Center, for more information.

The Salish Sea Model<sup>1</sup> is based on actual ocean tides, currents, their velocities, water densities, and more oceanographic factors, based on years of scientific data collection. Data was gathered using many types of sensors to develop the mathematical formulas that make up the program to run these simulations. This model is tailored for use by students, but is the same model used by government agencies and shipping companies to analyze circulation and potential spread or past spread of oil in the Salish Sea. SeaDoc Society thanks Dr. Khangaonkar and his teams at PNNL and SSMC for their generous work and permission to utilize this brilliant technology for student research in the Explore the Salish Sea curriculum.

- Download the program <u>GNOME from the NOAA website</u> and install on a computer or computers you will use with your students to model an oil spill. It can be saved to the desktop for easy access. [Note: GNOME is compatible with Windows 7, 8, and 10. Similarly, GNOME is compatible with mac OS 10.6 or higher but not mac OS Catalina]. GNOME user manual may also be downloaded from the same site. Select the option to install the GNOME icon on your desktop.
- 2. Download the Salish Sea Model files from PNNL Salish Sea Mode Data Portal: The link to the zip file may be found on the Salish Sea Model Data Portal page

<sup>&</sup>lt;sup>1</sup> Khangaonkar T, A Nugraha, W Xu, W Long, L Bianucci, A Ahmed, T Mohamedali, and G Pelletier. 2018. Analysis of Hypoxia and Sensitivity to Nutrient Pollution in Salish Sea. *Journal of Geophysical Research – Oceans*, 123(7): 4735-4761. doi: 10.1029/2017JC013650

https://www.pnnl.gov/projects/salish-sea-model/data-portal under SSM-GNOME oil spill modeling teaching demonstration package

Move the zip file to a suitable folder (or desktop) and double click (on Mac) or right click on Windows and select "extract all". This will extract the files to the folder \SSM-GNOME\_July\_2014<sup>2</sup> by default. All required files are in a subfolder with the same name \SSM-GNOME\_July\_2014 (\SSM-GNOME\_July\_2014\SSM-GNOME\_July\_2014)

- Next follow steps for the One-time setup of the GNOME program environment to operate in "Diagnostic Mode" instead of "standard mode". This will allow GNOME to detect and open the "SSM\_July\_2014.SSMC.SAV file in the \SSM-GNOME\_July\_2014 folder to operate the GNOME program.
  - a. Start GNOME from your desktop (double click GNOME icon). (Default GNOME setting is the "standard mode")
  - b. Click (a) OK at the welcome screen, (b) Agree, (c) Select File, and (d)
     Cancel. (This will get you to stage where you can change preferences)
  - c. Under File > Preferences, click Mode tab. Select "diagnostic" option for Model as well as Startup and click OK. (Now you are ready to load 10 days of July 2014 Salish Sea Model hydrodynamic solution into GNOME.)
- 4. Click File then Open at the top left of the screen. A pop-up box will open. Locate the save file (\*.sav extension). Select the "(\..\SSM-GNOME\_July\_2014\SSM\_July\_2014.SSMC.SAV") file in the pop-up box. Click open. This will open a map of the Salish Sea model area in the GNOME map screen.
- 5. Use the zoom magnifying glass icon "+" on the top panel. Position on screen or create a window to zoom in on a selected region. Here velocities from the first-time step will be visible.
  - a. Toggle Show Velocities "On" and "Off" (black box next to "show velocities" in the left column under Maps > Movers > Currents > Show Velocities)

<sup>&</sup>lt;sup>2</sup> If using Windows, ignore or delete the \_MACOSX folder. The zip file was created on a Mac and unzipping on windows creates this additional folder.

- b. Change the scale of the arrows by double clicking "Show Velocities" to open a pop-up window (e.g. change @ 1inch = 10 m/s to 5 m/s to increase the arrow size)
- 6. Under Maps in the menu on the left, find "Show Grid"

   (a) Toggle show Grid On and Off observe what this does to the map (the grid will not be needed for most applications)

## MODEL A SPILL

- 7. Single click the spill icon on the top row then click on the map where you want the spill to start. This will open a pop-up box.
- 8. Fill in desired spill details (name the spill, type of material, Amount Released, date, start time). Try starting 18 hours from the start of the simulation. Leave other fields in default modes. Click OK.
- 9. Click play button at the right of the menu bar at the top to start the animation. Pause to change the zoom level or select different options under Maps.
- 10. Observe the spill being transported by currents from tides, winds, and estuarine circulation and make notes, take screen shots for use in student research.

There may be a web application someday, but for now you will need the program on your computer, which will need permissions from your technology administrator.

\*For more detailed instructions to load SSM currents solutions into GNOME from scratch, see below.

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More detailed instructions to load SSM currents solutions into GNOME from scratch

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- a. How to add Salish Sea NetCDF files into GNOME:
- b. 1. Make sure the converted PNNL NetCDF files that you wish to load are listed in the file "Model-Batching.txt" with the following format:
- c. NetCDF Files
- d. [FILE] GNOME\_ssm\_00182.nc
- e. [FILE] GNOME\_ssm\_00183.nc
- f. 2. Open GNOME

- g. 3. Click "File->Preferences..." and make sure you are in diagnostic mode
- h. 4. Double click "Universal Movers"
- i. 5. Load Currents
- j. 6. Select "Model-Batching.txt"
- k. 7. Do you want to reset the model start time to the first time in the file? Yes
- I. 8. Do you have an extended topology file to load? No
- m. 9. Set the uncertainty (only affects the minimum regret solution red dots)
- n. 10. Currents have now been successfully loaded; you are now free to create a spill scenario