lake_quinault_landslide_tsunami, version 1.0.0

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Summary

This data release[1] contains the model setup files needed to produce simulations of a hypothetical sublacustrine landslide and resulting tsunamis in Lake Quinault.

One set of landslide and tsunami simulations is provided as an example, representing a hypothetical slope failure at the modern delta of McCormick Creek. Bathymetry collected in 2023[2] was merged with several LiDAR datasets[3,4,5,6] and resampled into a 2.74 m resolution topobathymetric Digital Terrain Model (DTM)

projected in NAD83/UTM zone 10N (EPSG:26910), with NAVD88 as the vertical datum.

Sublacustrine landslides are simulated using the numerical landslide model BingClaw[7]. The evolving thickness output from the modeled landslide in BingClaw is used to generate initial water surface conditions for the tsunami model, GeoClaw[8]. Tsunami propagation and inundation is modeled in GeoClaw using the nonlinear shallow water equations (swe) and with dispersive Boussinesq equations[8] (bouss).

Running both models requires familiarity with BingClaw and GeoClaw and this readme file does not contain instructions on how to install and compile the

necessary code. Please refer to the documentation for BingClaw9 and ClawPack10 for prerequisites and installation instructions.

File structure

The data release consists of two compressed archive files, `quinault_landslide_model_bingclaw.zip` and `quinault_tsunami_model_geoclaw.zip`. These correspond, respectively, to the BingClaw model simulating a sublacustrine landslide and the GeoClaw models simulating the resulting tsunami. Within both archive files is a top level folder, `mccormick_slide`.

BingClaw

The `mccormick_slide` folder of the BingClaw archive contains three ASCII format raster files and one example model run folder (`run01_i5000_r500_g005`). `mccormick_slide_dem_navd88.asc` is a subset of the modern topobathymetric DTM that encompasses the source region and runout area of the McCormick Creek slide in BingClaw. The geomorphic expression of slide runout from a previous sublacustrine landslide is used to compare to modeled runout in BingClaw. `mccormick_slide_dem_navd88_preslide.asc` represents a possible pre-slide topobathymetric condition, which is used as an input file in the BingClaw model. `mccormick_slide_thickness_5m.asc` is a map of initial slide thickness used as initial conditions in the BingClaw model. Generation of these three raster files is described in metadata accompanying this data

release[1].

The example BingClaw model run folder `run01_i5000_r500_g005` contains files needed to run the model and a set of outputs:

> `Makefile` is used to configure compilation of BingClaw, please refer to the BingClaw documentation[9]. Modifications to `Makefile` may be necessary depending on the system.
> `setrun.py` specifies model parameters and points to the necessary ASCII files in the `mccormick_slide` directory.
> `setplot.py` specifies model plotting routines (output plots are not included in this data release) and is provided as an example.

BingClaw model outputs are provided in the `_output` subdirectory. Please refer to the BingClaw[9] and ClawPack[10] documentation for details on output formats.

Initial water surface conditions for GeoClaw are generated from the BingClaw outputs by running the included python script `make_geoclaw_dtopo.py`. This generates the ASCII file of time-varying water surface that is provided at `make_geoclaw_dtopo_output/dtopo_mccormick_slide_run01.tt3`. This file is in the "topotype 3" format readable by GeoClaw.

GeoClaw

The `mccormick_slide` folder of the GeoClaw archive contains one ASCII format raster file and two example model run folders. `lake_quinault_topobathy_dtm.asc` is the topobathymetric input file for both example model runs. The `swe` and `bouss` folders contain example GeoClaw runs using the nonlinear shallow water equations (swe) and dispersive Boussinesq equations (bouss). Each contains a subfolder, `run01_i5000_r500_g005`, referring to the example BingClaw model run used to generate initial conditions.

swe

The `swe/run01_i5000_r500_g005` example contains files needed to run the model and a set of outputs:

> `Makefile` is used to configure compilation of GeoClaw, please refer to the ClawPack documentation[10]. Modifications to `Makefile` may be necessary depending on the system.
> `setrun.py` specifies model parameters and points to the necessary ASCII files in the `mccormick_slide` directory and the initial conditions file `dtopo_mccormick_slide_run01.tt3` in the same directory.

GeoClaw model outputs are provided in the `_output` subdirectory. Please refer to the ClawPack[10] documentation for details on output formats. A ipython Jupyter notebook, `tsunami_plots.ipynb` is provided as an example for generating custom plots of tsunami propagation and inundation. This notebook uses python libraries that are prerequisites for ClawPack installation, or included with ClawPack.

bouss

The `bouss/run01_i5000_r500_g005` example contains files needed to run the model and a set of outputs. The file structure is essentially the same as the `swe` example, however there are differences in `Makefile` and `setrun.py` that allow GeoClaw to solve the dispersive Boussinesq-type equations instead of the shallow water equations. The Boussinesq code has additional prerequisites, detailed in the ClawPack documentation[10] here: https://www.clawpack.org/bouss2d.html

Run Instructions

Once BingClaw and appropriate versions of GeoClaw are properly compiled, simulations can be run from within each `run01_i5000_r500_g005` subfolder with:

```
make new # compile the executable xgeoclaw
make data # set up the input files
make output #run model, generate output in _output
```

In the BingClaw example, `make plots` will generate a folder containing figures of modeled thickness. In the GeoClaw examples the provided Jupyter notebook `tsunami_plots.ipynb` requires installation of Jupyter, see https://docs.jupyter.org/en/latest/install.html.

References

[1]La Selle, S.M., Løvholt, F., Gibbons, S. J., Derosier, B.J., Brothers, D.S., 2025. Submarine landslide and tsunami models from Lake Quinault, Washington: U.S. Geological Survey data release, https://doi.org/10.5066/P14CB2SN.

[2]NOAA National Centers for Environmental Information (NCEI). 2023. Descriptive Report for D00278. Accessed August, 2025. https://www.ngdc.noaa.gov/nos/D00001-D02000/D00278.html

[3]Washington Geological Survey, 2012, Quinault River Basin 2011 project [lidar data]: originally contracted by the Quinault Indian Nation and Puget Sound LiDAR Consortium. [accessed July 30, 2025, at https://lidarportal.dnr.wa.gov]

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[6]Washington Geological Survey, 2019, Olympic Peninsula, Washington 3DEP 2019 project [lidar data]: originally contracted by the U.S. Geological Survey. [accessed July 30, 2025, at https://lidarportal.dnr.wa.gov]

[7]Kim, J., Løvholt, F., Issler, D., & Forsberg, C. F. (2019). Landslide material control on tsunami genesis - The Storegga Slide and tsunami (8,100 years BP). Journal of Geophysical Research: Oceans, 124(6), 3607–3627. https://doi.org/10.1029/2018JC014893

[8]Berger, M. J., & LeVeque, R. J. (2023). Implicit adaptive mesh refinement for dispersive tsunami propagation. SIAM Journal on Scientific Computing, 46(2), B554–B578. https://doi.org/10.1137/22M1520212

[9]Bingclaw Development Team (2025), BingClaw Version 5.6.1, https://github.com/norwegian-geotechnicalinstitute/BingCLAW_5.6.1, doi: 10.5281/zenodo.8354763

[10]Clawpack Development Team (2024), Clawpack Version 5.11.0,http://www.clawpack.org, doi: 10.5281/zenodo.13376470