Civil Engineering x Hazard Modeling

Tephra2 on VICTOR

Objectives:

1. **Interact** with an advanced hazard forecast model & i**dentify** which inputs are necessary to generate meaningful outputs of such models.

2. **Identify** how parameter inversions for magma chamber models can be used to calibrate eruption models and evaluate possible eruption Scale and societal impact.

3. **Practice** and **apply** how engineers can use earth process models to inform infrastructure development.

Introduction and Background:

In this lab, you will use a numerical model called 'Tephra2", which simulates the dispersion of volcanic ash from an eruption, to assess how eruption conditions impact the built infrastructure in surrounding communities. The lab uses a hypothetical eruption at South Sister volcano as the test case.

source: USGS

Preparation and Materails:

you will need...

- Access to the Internet.
- To be registered on VICTOR.
    - If you have not completed this step yet, navigate to ‘victor.ldeo.columbia.edu’ and fill out the form under ‘sign up’ in the menu.
    - * The VICTOR team needs to manually confirm all registrations, so this may take up to 24 hours.
- To be signed up for the VICTOR forum.
    - forum.victorproject.org/signup
    - Use this as a resource to ask for help or search for previously asked questions from other users.
- Optional tasks:
    - Read or review the Tephra2 Manual: **tinyurl.com/y49a83cy**
    - Watch the “Tephra2 on VICTOR’ tutorial on Youtube.
        - **tinyurl.com/2zx8psdv**

Tephra2 Users Manual

Tephra2 on VICTOR

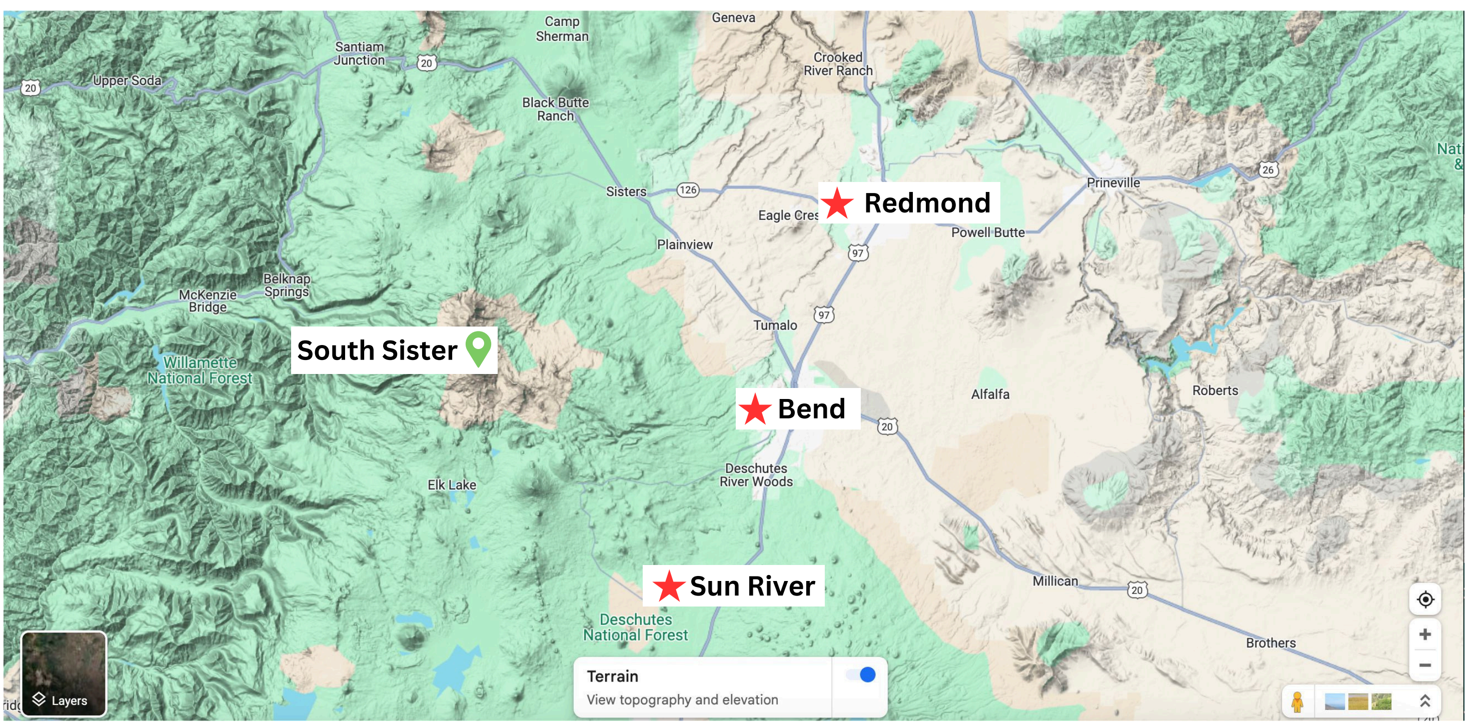
Tasks and Procedures

Part One:

Picking location points:

Site Name	Town	Description	Lat.	Long.	Roof Area	Roof type
Site #1	Bend					
Site #2	Redmond					
Site #3	Sun River					

- Use the table above to record target locations.
- Using Google Maps, identify one structure in each town (**Bend, Redmond, Sun River**).
- Record the **coordinates** the table (right-click on the structure, lat and long are shown at the top of the drop-down menu).
- Describe the building's use under **description**: for example school, government building, airport etc.
- In google maps, right click on the structure. Use measure distances to find the roof area by outlining the perimiter of the building’s roof. The **area** will be shown in a small widow at the bottom of your Google Maps screen.
- On the final page of the lab (page 7), a table is provided with roof collapse thresholds. Use the information of roof types included in the table, as well as your own investigation (for example, using Google Street View to observe building materials) to determine a **roof type.**



Tasks and Procedures

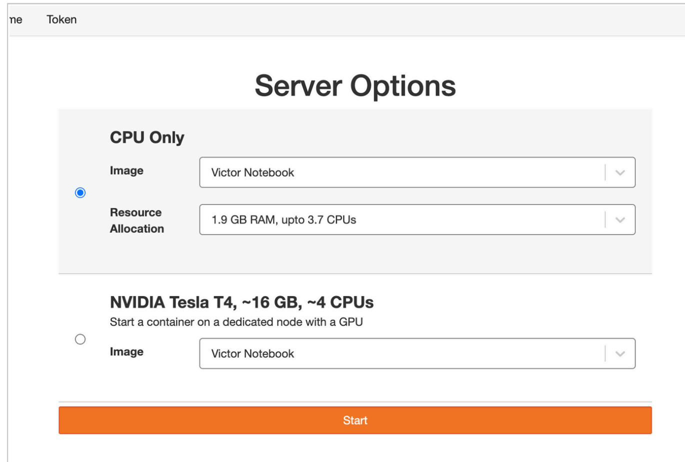
Part Two:

Getting Started on VICTOR:

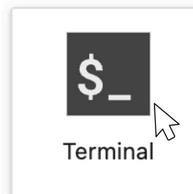
1. Log in to VICTOR at hub.victorproject.org
2. **"Server Options"**
    - Ensure Victor Notebook is selected
    - Under resource allocation, select

7.4 GB RAM, upto 3.7 CPUs

    - Clicking Start will bring you to The Launcher.



3. The Launcher and VICTOR Setup command
- From the Launcher, open a new terminal by clicking the **terminal icon** at the bottom left of your launcher.
- In the new terminal, type. `victor setup` and press enter.
- Identify TEPHRA2 in the list that appears
- Type its corresponding number and press enter.




```
Terminal 2
(notebook) jovyan@jupyter-ameliamullins:~$ victor setup
Hello, and welcome to the VICTOR platform.
We have a huge variety of models and tools for use.
This program is meant to make it simple to set up workflows and associated files.
To set up, please choose the number next to the model listed below.
1: alphaMELTS
2: CONFLOW
3: DISGAS
4: HAZMAP
5: HYSPLIT
6: IMEX (Lava)
7: IMEX_SfloW2D_V2
8: LaharZ
9: LAVA2D
10: MR LAVA LOBA
11: MOLASSES
12: PYFLOWGO/DOWNFLOWGO
13: Scoops3D
14: SULFUR_X
15: TEPHRA2
16: TITAN2D
17: TWODEE
Model:
```

- On the left of your screen, a folder called tephra2 will appear.
- Open the folder by clicking it and find the Jupyter Notebook for tephra2.ipynb
- Before continuing, read the information at the top of the notebook.

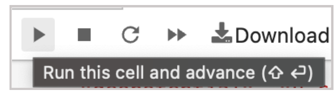
Tasks and Procedures

Part Three:

Setting Up and Running the Model

First: Change the vent location to South Sister: = 44.1,-121.77

Next: For your data, we will explore eruption volumes in the range of **1 km^3, 3km^3 and 5km^3**, however, Tephra2 takes eruption mass as input. Convert these values and record them in the table provided (Results and Questions: Page 5).



Run each cell by clicking the play button at the top of the notebook or press Shift + Enter

---

Follow these steps to run the model with each value of erupted mass.

a. Set the mass eruption value to the target variable, and run the configuration file code cells.

b. Obtain a wind file by setting the date to 10/23/2024 using the relevant variables, and run the wind data code calls.

```
[2]: #INPUT DATE AND COORDINATE VALUES HERE

#Coordinate location
vent_latitude, vent_longitude = 44.1,-121.77

#Specify month(s) (in numerical string format, e.g. "01", "11")
months = ["10"]

#Specify year(s) (in numerical string format, e.g. "1999")
years = ["2024"]

#Specify day(s) (in numerical string format, e.g. "01", "11")
days = ["23"]

#Specify hour(s) in 24 hour string format (00:00 - 23:00)
hours = ['10:00']

#Specify pressure values to generate wind field around volcano

#valid values are
# ['1', '2', '3', '5', '7', '10', '20', '30', '50','70', '100', '125','150', '175', '200','225', '250', '300', '350', '4
# '450','500', '550', '600','650', '700', '750','775', '800', '825','850', '875', '900','925', '950', '975','1000']
pressures = ['1','10','100','1000']

#Specify name of output file, in netCDF format (optional, default is download.nc)
file_name = []
```

c. Set up target of interest. Enter the coordinates of your three sites from the table in part 1. (The image below uses example coordinates)

```
[9]: locations = [[44.05812334099115,-121.3180703622792],[44.27043708913616,-121.17467125646367],[43.86843088378271,-121

elevation = 1000

locations = np.array(locations)
loced = utm.from_latlon(locations[:,0],locations[:,1])
```

d. Run Tephra2. (<one minute).
(if the cell number appears as an asterisk, the cell is still running)
e. Use the table on page 5 to record the output valves for each site.

```
[*]:
```

Data and Questions

Use this table to record the data collected in part three, and your calcualtions from page 6.

Site Name	Erupted Volume	Erupted Mass	Deposit Mass/area (kg/m2)	Deposit load (kPa)	Total mass on the roof (kg)
Site 1	$1km^3$				
	$3km^3$				
	$5km^3$				
Site 2	$1km^3$				
	$3km^3$				
	$5km^3$				
Site 3	$1km^3$				
	$3km^3$				
	$5km^3$				

Useful Information:

Gravitational Acceleration:

$9.8\ m/s^2$

Density of Tephra:

$1200\ kg/m^3$

Erupted mass:

(density of tephra) x (erupted volume)

Deposit load:

Deposit mass x gravity

Data and Questions

Answer The Following:

Using the iso mass map from the parsed tephra2 output, answer the following questions:

1. Assess: Which direction did most of the output travel from for each location? (Your answer will be a cardinal direction.)

Site 1 (Bend):

Site 2 (Redmond):

Site 3 (Sun River):

2. From the information given in the map, calculate mass per unit area of deposit at each site (and record in table)
3. Calculate the load (weight per area) of the deposit on the roof by multiplying by the gravitational acceleration. (Record in table).
4. From the mass/area value and the roof dimensions you wrote down, calculate the total ash mass weighing the roof at each site (and record in table)

Connect to Civil Engineering:

On the next page (page 7) there is a table that details the load threshold for collapse of different kinds of roofs. Using the table, and your measurements of the target structure in each location and the roof load you recorded on page 1, indicate in the spaces below whether the roof will collapse at each site and eruption volume: (circle yes or no for each)

	Volume 1	Volume 2	Volume 3
Site 1	YES / NO	YES / NO	YES / NO
Site 2	YES / NO	YES / NO	YES / NO
Site 3	YES / NO	YES / NO	YES / NO

Classifying Roof Type

Roof classes	Description			Typical design load range	Mean collapse load (kPa)
	Our survey	Spence et al. (2005)	Marti et al. (2008)		
WE (weak)	- Roofs made of metallic, fiber cement, zinc, or plastic sheets, regular plan and simple design or irregular plan/composite design of all kinds of angles and masonry (i.e., S-A-F/X/0–2/R-I-B). - Tiled roofs with two or more pitches, regular plan and simple design or irregular plan/composite designand wooden masonry (i.e., A/T/0–2/W).	- Sheet roofs (i.e., X), old or in poor condition. - Tiled roof (i.e., T), old or in poor condition. - Masonry vaulted roof.	Old pitched tile or sheet metal (i.e., T or X).	Pre-design or no design code	2.0
MW (medium weak)	- Tiled roof with all kinds of angles, visibly in good condition, regular plan and simple design or irregular plan/composite design, and irregular bearing masonry (i.e., S-A-F/T/0–2/I).	- Sheet roof on timber; average quality; average or good quality tiled roof on timber rafters or trusses (i.e., S-A-F/X-T). - Steel or precast reinforced concrete joists and flat terrace roof (i.e., F/C).	Modern pitched tile or sheet metal (i.e., S-A/X-T), old flat or pitched concrete (i.e., S-A-F/C).	1.0–2.0 kPa	3.0
MS (medium strong)	- Tiled roof with two or more pitches. - Tiled single pitch roof with infill in concrete blocks visibly in good condition, regular plan and simple design or irregular plan/composite design and reinforced concrete and/or masonry structure with regular or combined bearing masonry and/or infill walls (i.e., S-A/T/0–2/R-B).	- Flat reinforced concrete roof not all above characteristics; sloping reinforced concrete roof (i.e., S-F/C). - Sheet roof on timber rafters or trusses, good quality and condition, designed for cyclone areas (i.e., X).	Recent pitched tile or sheet roofs (i.e., S-A/X-T), modern flat or pitched concrete (i.e., S-F/C).	2.0–3.0 kPa	4.5
ST (strong)	- Flat roof in concrete (either concrete slab and/or reinforced concrete), of all kinds of structure regularity/design and reinforced concrete and/or masonry structure with regular, irregular, or combined bearing masonry and/or infill walls (i.e., F/C/0-1–2/R-I-B).	- Flat reinforced concrete roof designed for access; recent, good quality construction, younger than 20 years (i.e., F/C).	Recent flat or pitched concrete (i.e., S-F/C).	>3.0 kPa	7.0

Source:

Reyes-Hardy, M. P., Biass, S., Dominguez, L., Di Maio, L. S., Frischknecht, C., Bonadonna, C., & Pérez, N. (2024). Temporal evolution of roof collapse from tephra fallout during the 2021-Tajogaite eruption (La Palma, Spain). Frontiers in Earth Science, 11, 1303330.