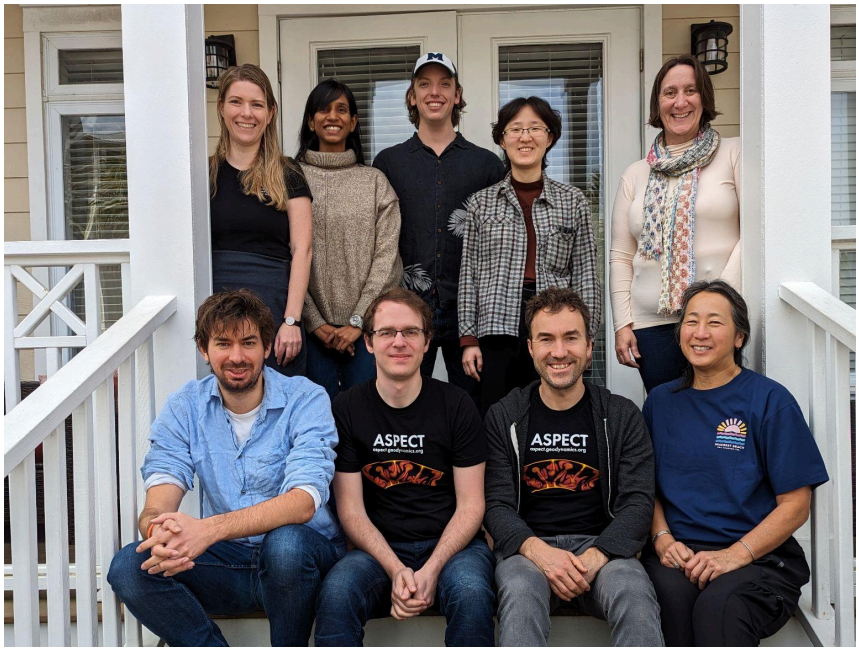

# Geodynamic World Builder Hackathon 2024



# Meeting places

This is an in person workshop. Virtual participants will meet in the following places online:

- **Zoom Meeting room** - daily rounds @9A
  https://ucdavis.zoom.us/j/92250758840?pwd=VThXdHRnLy9haE9xM29FU3V4dTdpUT09
- **Matrix Workspace for asynchronous communication (cig-aspect.slack.com):**
- https://matrix.to/#/!vhukRUGUINnZOlutoQ:matrix.org?via=matrix.org
  Join channel: Hackathon 2024 (You need to join the rooms manually)
- **Hackathon log (this document):**
  https://docs.google.com/document/d/1q-rinuSj4ctmvsOfXcG6jSH-0ojbNKRNcBcZ6k1udOs/edit?usp=sharing
- **Logistics document:**
  https://docs.google.com/spreadsheets/d/11EMuTC6VvUo6Z2qvGhcupS80dRUhAGvF9TgLVM_eABk/edit?usp=sharing
- **Google drive for photos**
  https://drive.google.com/drive/folders/1YX6xQ9DU7rZzsUVm2PkBiDXq6Z70zzWa?usp=sharing
- **Shared folder for presentations etc.**
  https://drive.google.com/drive/folders/1PLU7to2fasw8COlw7xBpXJfhw1MJbzM2?usp=sharing

# Things to do before the start of the hackathon

- Create an account on https://github.com if you don't have one yet.
- Put your name into the table "Participants and areas of interest" below and fill in your goals and interests for the hackathon.
- Join the GWB Matrix space.
- Install the latest developer version of the GWB
- Read the house rules: https://docs.google.com/document/d/1vP5Gz8okWwaReDM4zr0REau6QgsQDYwdd6MQCgXwIW8/edit#heading=h.7kaa4dayeiuv

# Land acknowledgement

We acknowledge that this location is located on the ancestral and traditional homelands of the Miccosukee and Chatot Tribe of Indians of Florida. We pay respect to the resiliency of their tribal members, past and present, and to all Indigenous peoples.

See: https://native-land.ca/

# Introduction

To further develop the geodynamic code The Geodynamic World Builder (GWB) and to grow and foster its user community, 9 users and developers of GWB worked in-person over five in February 2024.

Below is the timeline and a description of the individual contributions.

# Timeline

| **Day** | **Scheduled items**<br>**(in US Central time; (Pacific time: -2h; Central Europe: +7h)** |
|---|---|
| Monday, 02/12 | Evening: Arrival and dinner |
| Tuesday, 02/13 | 9 am:  Project discussion, Planning meeting |
| Wednesday, 02/14 | 9 am: Daily rounds<br>10 am: Model Repository for GWB |
| Thursday, 02/15 | 9 am: Daily rounds<br>Friendship bracelet tutorial<br>After lunch: afternoon and evening off |
| Friday, 02/16 | 9 am: Daily rounds |
| Saturday, 02/17 | 10 am: Departure for all |

# Participants and areas of interest

| **Name, affiliation, email** | **Goals and interests for this hackathon** |
|---|---|
| Menno Fraters<br>University of Florida<br>menno.fraters@tutanota.com | 1. Help others<br>2. Review pull requests<br>3. Finish developer documentation<br>4. Finish slab2 integration<br>5. Implement spreading ridge velocity |
| Rene Gassmoeller,<br>University of Florida,<br>rene.gassmoeller@mailbox.org | 1. Investigate Doxygen+Breathe documentation<br>2. Make sure Global Earthquake Database works with Worldbuilder main branch<br>3. PR reviews<br>4. Investigate a geodynamics.org WB tool |

| | |
|---|---|
| Lorraine Hwang<br>UC Davis<br>ljhwang@ucdavis.edu | 1. Review documentation. Proposal for naming convention:<br>● GWB<br>● the World Builder<br>2. Make brownies. |
| Juliane Dannberg<br>University of Florida<br>judannberg@gmail.com | 1. Plume feature<br>2. Set up a model with a transform fault and write a cookbook about it<br>3. Add new feature to oceanic plate temperature model top temperature so that is uses the surface temperature when it's set to -1<br>4. Small hackathon projects/issues |
| Timo Heister<br>heister@clemson.edu | 1. Help Others<br>2. Visualization<br>3. Performance/multi threading |
| Arushi Saxena<br>Clemson University<br>arushi@clemson.edu | 1. Profiling and fixing of WB main for our global earthquake database<br>2. Small hackathon projects/issues |
| Daniel Douglas<br>New Mexico Tech<br>daniel.douglas@student.nmt.edu | 1. Add spatially variable spreading rate to the half-space cooling and plate cooling oceanic temperature models<br>2. Help with slab2 integration |
| Yijun Wang<br>University of Oslo<br>yijun.wang@geo.uio.no | 1. Initial texture as random uniform distribution with deflection<br>2. Initial texture with input file |
| Magali Billen<br>UC Davis<br>mibillen@ucdavis.edu | 1. Create a cookbook for 2D cartesian subduction model<br>2. Create a cookbook for 2D spherical subduction model<br>3. Learn more about how code is set-up |

See also github issues: https://github.com/GeodynamicWorldBuilder/WorldBuilder/issues

# Resources

## Visual Studio Code Tutorial

- VS Code is an Integrated Development Environment (IDE) that simplifies programming
- It is free, powerful, and used by the majority of open-source software developers
- If you are already comfortable with a different IDE stick to it, if you do not use an IDE so far, please install VS code
- It is simpler for us to explain and help you if most of us use the same IDE
- How to get: https://code.visualstudio.com/
- Documentation: https://code.visualstudio.com/docs
- Necessary/Useful extensions for this hackathon:
    - https://marketplace.visualstudio.com/items?itemName=ms-vscode.cpptools
    - https://marketplace.visualstudio.com/items?itemName=eamodio.gitlens
    - https://marketplace.visualstudio.com/items?itemName=davydden.dealii-prm
    - https://marketplace.visualstudio.com/items?itemName=MS-vsliveshare.vsliveshare

## Git Tutorial

- Git commands cheat sheet: https://education.github.com/git-cheat-sheet-education.pdf
- Github workflow: https://guides.github.com/introduction/flow/
- Git tutorial: https://swcarpentry.github.io/git-novice/

1. Explain and set up Git:
    a. Git install: https://carpentries.github.io/workshop-template/#git
    b. https://swcarpentry.github.io/git-novice/01-basics.html
    c. https://swcarpentry.github.io/git-novice/02-setup.html
    d. Config git name: `git config --global user.name "Vlad Dracula"`
    e. Config git email: `git config --global user.email "vlad@tran.sylvan.ia"`
2. Explain Github Workflow:
    a. https://guides.github.com/introduction/flow/
    b. Ensure you have forked ASPECT's repository (you should own your_username/aspect on github)
    c. Ensure proper remotes are set up (remote ‘upstream’ pointing to geodynamics/aspect, remove ‘origin’ pointing to your_username/aspect)
3. Setup ASPECT in VS Code
4. Walkthrough (these are terminal commands, I will walk you through the IDE instead)
    a. Create Branch
        i. ‘git checkout main'
        ii. ‘git pull upstream main'

iii. ‘git checkout -b remove_unused_option’

b. Make changes to files that contain a clause DEAL_II_VERSION_GTE. This preprocessor directive is used to determine which deal.II version is used. ASPECT now requires 9.4.0 so every check for 9.4.0 or 9.3.2 is superfluous (10.0.0 was renamed to 9.5.0 so that is superfluous as well). These files are:
   i. include/aspect/compat.h (Moh)
   ii. source/particle/generator/interface.cc (Yijun)
   iii. source/particle/property/grain_size.cc (Ranpeng)
   iv. source/particle/property/elastic_stress.cc (Poulami)
   v. source/particle/world.cc (Chameera)
   vi. source/postprocess/particles.cc (Srivatsan)
   vii. source/postprocess/visualization.cc (Maaike)
   viii. source/material_model/melt_global.cc (Michael from Poulami account)
   ix. source/simulator/core.cc (Maaike)
   x. source/simulator/assemblers/interface.cc (Yijun)
   xi. source/simulator/stokes_matrix_free.cc (Moh)
c. After making the practice change: Create commit:
   i. ‘git add FILE’
   ii. ‘git commit -m ‘Removed a deprecated option’
d. Push and open PR
   i. ‘git push origin remove_unused_option’
   ii. Open PR on github (CTRL-Click on shown link)
e. Wait for review
f. Address review (repeat steps b,c,d)
g. Now show how to change documentation via the web interface.
h. Success!

5. Now repeat the steps in 4. on your own. Pick a section of the manual in doc/sphinx/user that interests you. Find a sentence or description or formula to improve. Then repeat 4 for as often as you want or can!

# Debugging tutorial

Content of .vscode/launch.json:

```
{
	// Use IntelliSense to learn about possible attributes.
	// Hover to view descriptions of existing attributes.
	// For more information, visit: https://go.microsoft.com/fwlink/?linkid=830387
	"version": "0.2.0",
	"configurations": [
	{
	"name": "C++ Launch",
	"type": "cppdbg",
	"request": "launch",
	"program": "${workspaceFolder}/build/aspect",
	"args": ["cookbooks/convection-box/convection-box.prm"],
```

```
            "environment": [{ "name": "config", "value": "Debug" }],
            "cwd": "${workspaceFolder}"
            }
            ]
}
```

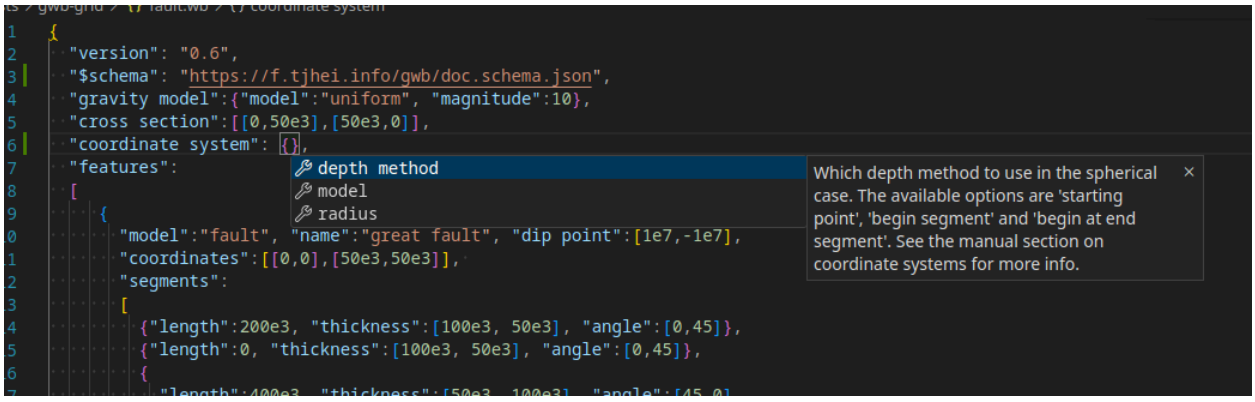
# Report on projects the participants worked on

## Write developer documentation

(All Participants)
Although the GWB already had a brand new and comprehensive user documentation, the developer documentation still had to be written. The structure was there containing what content has to be written on every page, but the actual content has now been added, leading to a comprehensive developer documentation.

## World builder file autocompletion with documentation

(Timo Heister)
VSCode can now do autocompletion and show documentation when editing .wb files:




## Filtering of data inside gwb-grid

(Timo Heister)
Gwb-grid has received many new features including:

- A better –help screen and error messages
- Parallel computation by default
- –filtered option to remove background/mantle layer from the vtu
- –by-tag generate separate output files by feature tag

## Online visualization with ParaView Glance

(Timo Heister)
See https://f.tjhei.info/gwb/index.html

## Add a Code of Conduct and a CONTRIBUTING.md

(Rene Gassmoeller, Lorraine Hwang)
Added a GWB Code of conduct and a CONTRIBUTING.md file. Both are common standards to provide important information to the community of a project.

## It's World Builder …

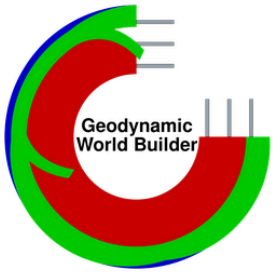
(Lorraine Hwang)
It's a World Builder world not "world builder". Manual editing to ensure we use it as a proper noun and other clean-ups. Only made it to Oceanic plate temperature in the Basic Starter Tutorial. So Long, and Thanks for All the Fish.

## Fix sphinx documentation

(Rene Gassmoeller)
Various infrastructure fixes to the World Builder online documentation system.

## Include World Builder cookbooks in online documentation

(Rene Gassmoeller)
Make sure World Builder cookbooks appear in the online documentation and create a cookbook description:




Search Ctrl + K

**Introduction**

- What is the GWB?
- GWB philosophy
- How to use this manual
- Bibliography

**User manual**

- Introduction
- Installation
- How to use the applications
- Important GWB Concepts
- Basic Starter Tutorial
- Cookbooks
  - 3D Cartesian Rift

**API manual**

- API design
- Available APIs
- API in different languages (FFI)

light/dark

# 3D Cartesian Rift

A simple setup of a rift in a Cartesian box, in which two plates are spreading at a constant spreading rate. The files can be found here.

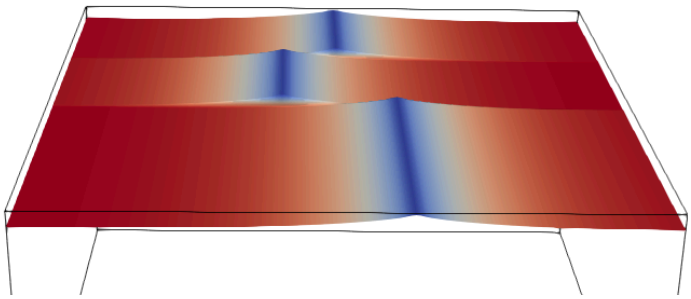
The relevant part of the world builder file looks like this:

```
{
  "version": "0.6",
  "features":
  [
    {"model":"oceanic plate", "name":"oceanic plate A", "coordinates":[[-1e3,-1e3],[2001e
     "temperature models":[{"model":"plate model", "max depth":95e3, "spreading velocity"
     "composition models":[{"model":"uniform", "compositions":[0], "max depth":10e3},
                           {"model":"uniform", "compositions":[1], "min depth":10e3, "max

    {"model":"oceanic plate", "name":"oceanic plate B", "coordinates":[[-1e3,1000e3],[200
     "temperature models":[{"model":"plate model", "max depth":95e3, "spreading velocity"
     "composition models":[{"model":"uniform", "compositions":[0], "max depth":10e3},
                           {"model":"uniform", "compositions":[1], "min depth":10e3, "max

  ]
}
```

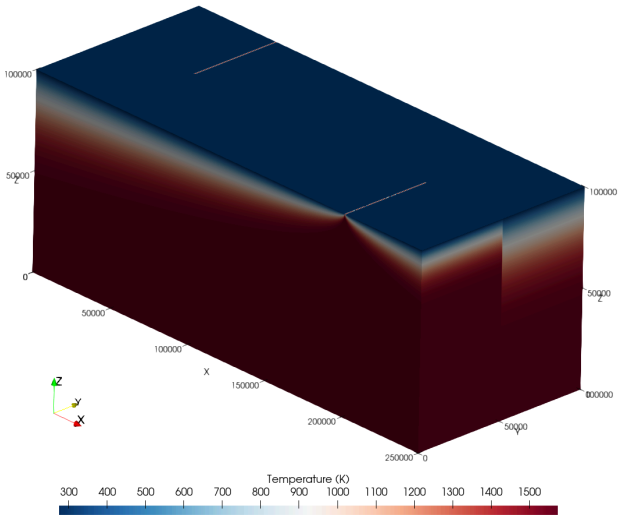
And the generated output model looks like this:

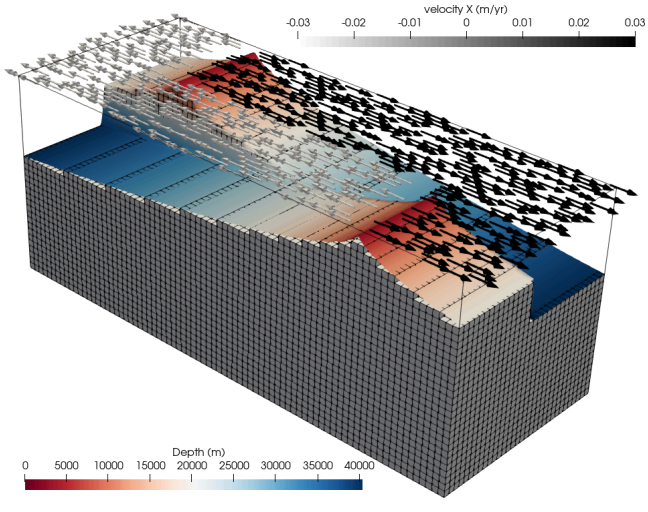


# Transform fault cookbook/coupling GWB with ASPECT

(Juliane Dannberg)

A new cookbook on how to set up a model of a mid-ocean ridge with a transform fault in the GWB (following the setup of Behn et al., 2007) and how to use it as an initial condition in ASPECT. This includes two cookbooks: One for the World Builder, one for ASPECT.



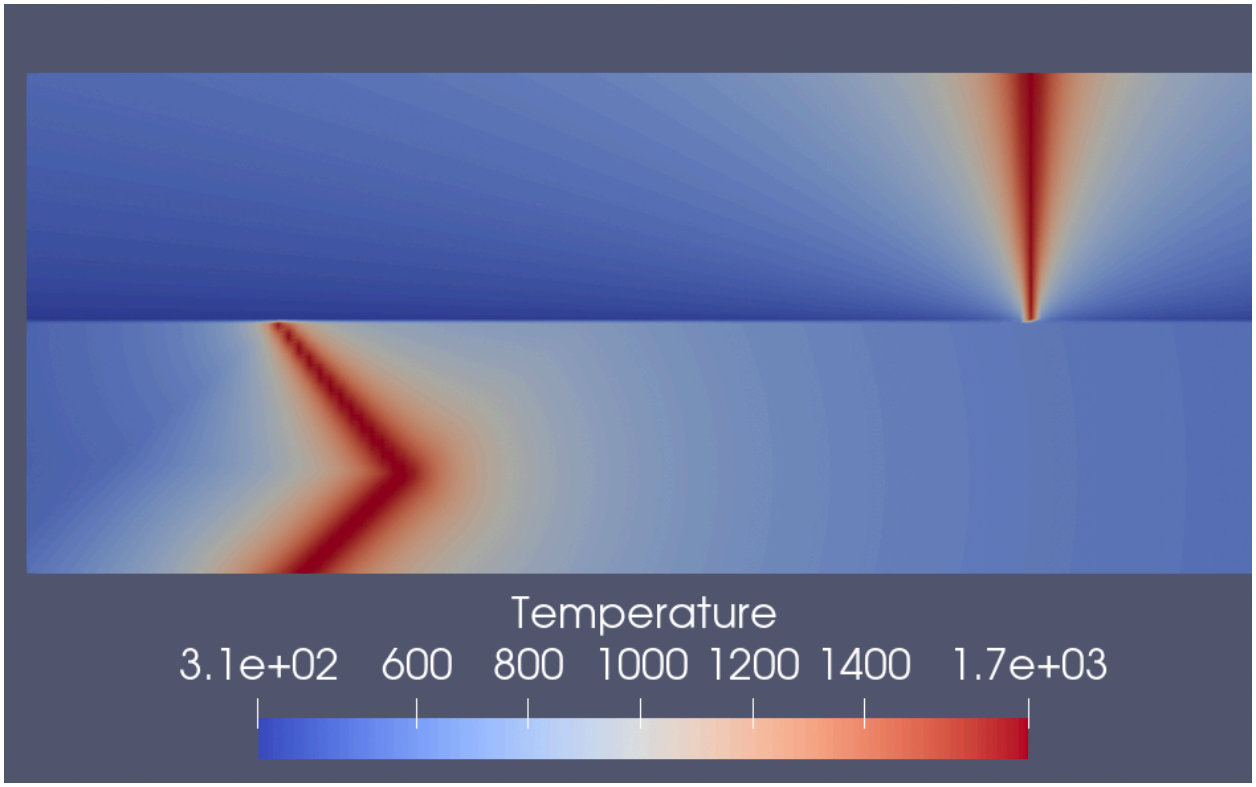



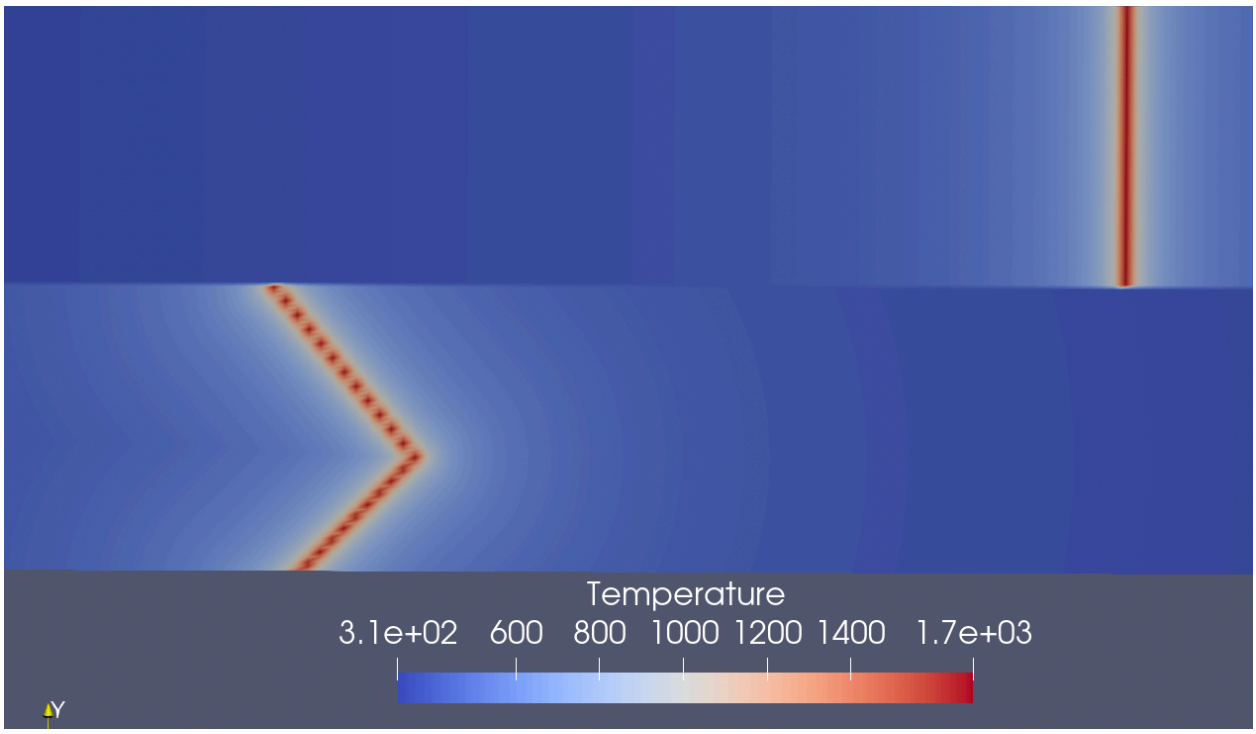
## Create function that removes duplicated code

(Daniel Douglas)
There are several temperature plugins within features that calculate the distance of a point from a spreading center. I made a function in Utilities.cc that does this calculation so that the temperature plugins just call this function.

## Add spatially variable spreading rates at ridges

(Daniel Douglas)

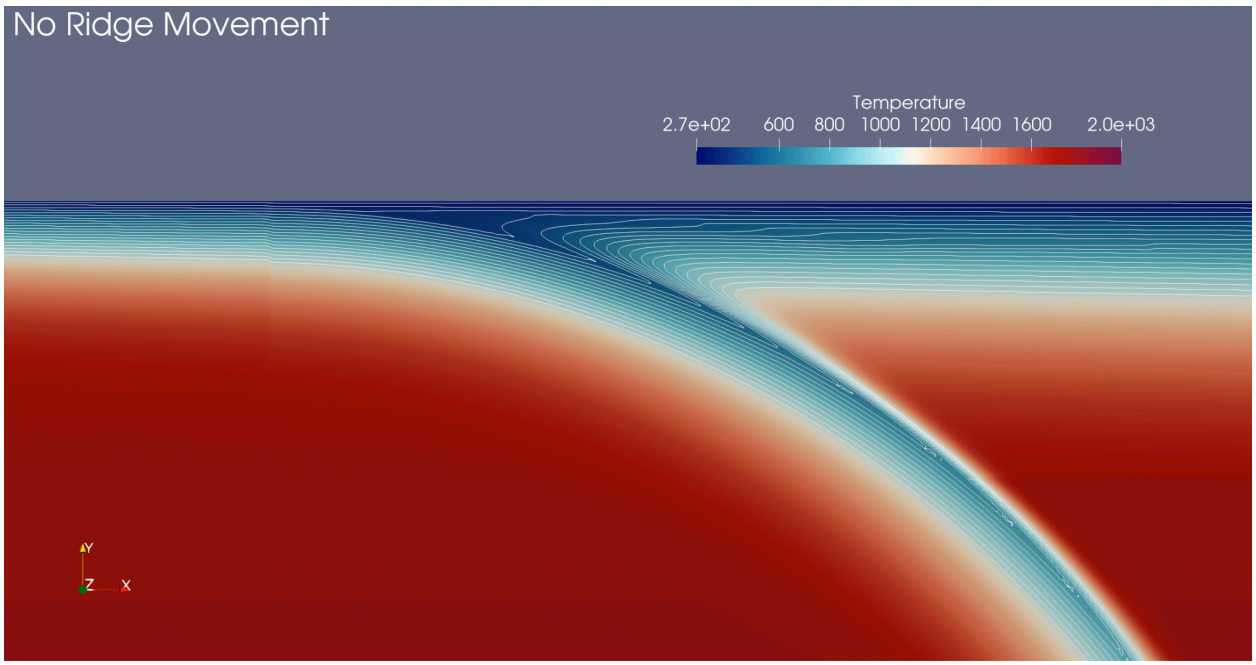


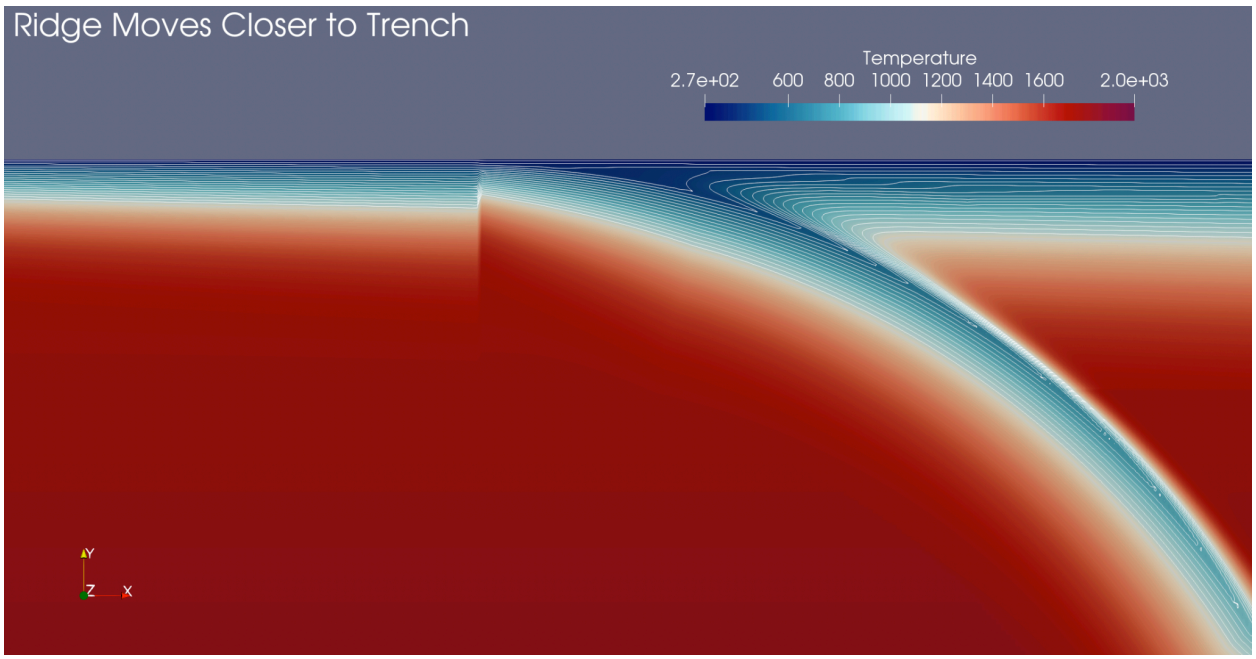


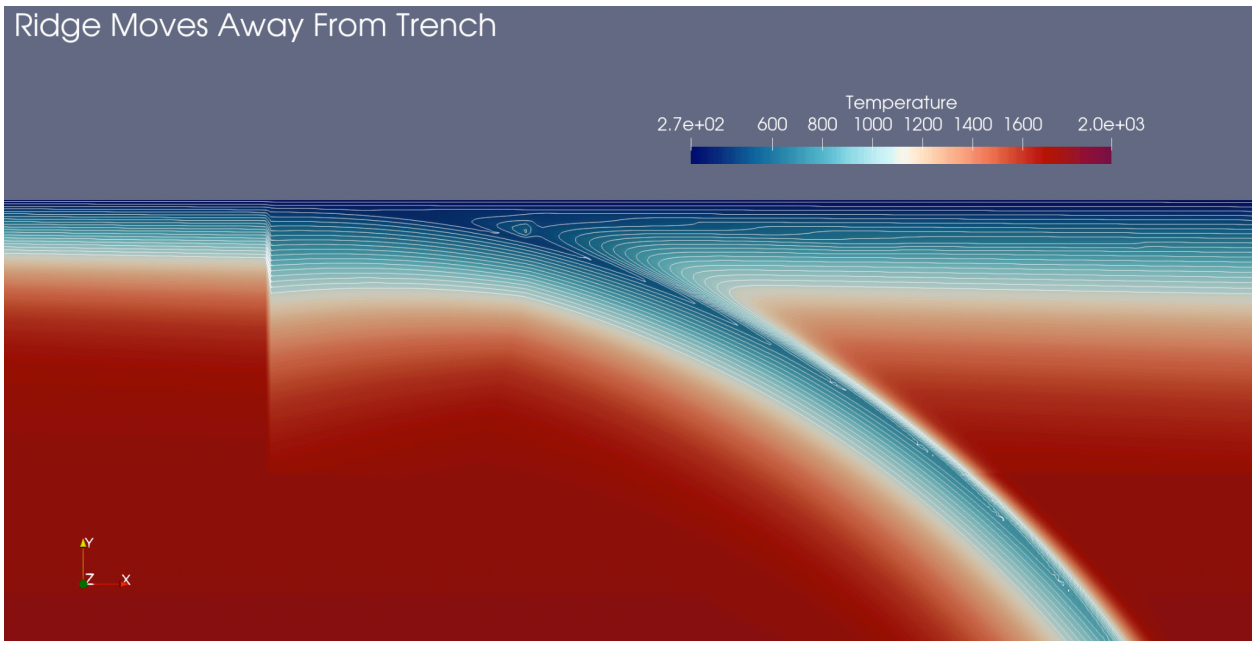

Modify the “spreading velocity” parameter to allow for spatial variation in the spreading velocity between user specified ridge points. The new setup does not break the old input for previous .wb files. If “spreading velocity” is just a single double, the spreading velocity at all ridge points is equal to that specified double. However, if the user specifies an array then the values are assumed to align with the ridge coordinates, and World Builder will linearly interpolate between the spreading rates specified at each ridge point.

## Account for past ridge movement in mass conserving model (WIP)

(Daniel Douglas)


No Ridge Movement
Temperature
2.7e+02 600 800 1000 1200 1400 1600 2.0e+03
Y
Z X


Ridge Moves Closer to Trench
Temperature
2.7e+02 600 800 1000 1200 1400 1600 2.0e+03
Y
Z X




## Create feature tag functionality

(Menno Fraters and Timo Heister)
Added a system which allows users to tag features. The tag index can then be written out through the gwb-dat program.

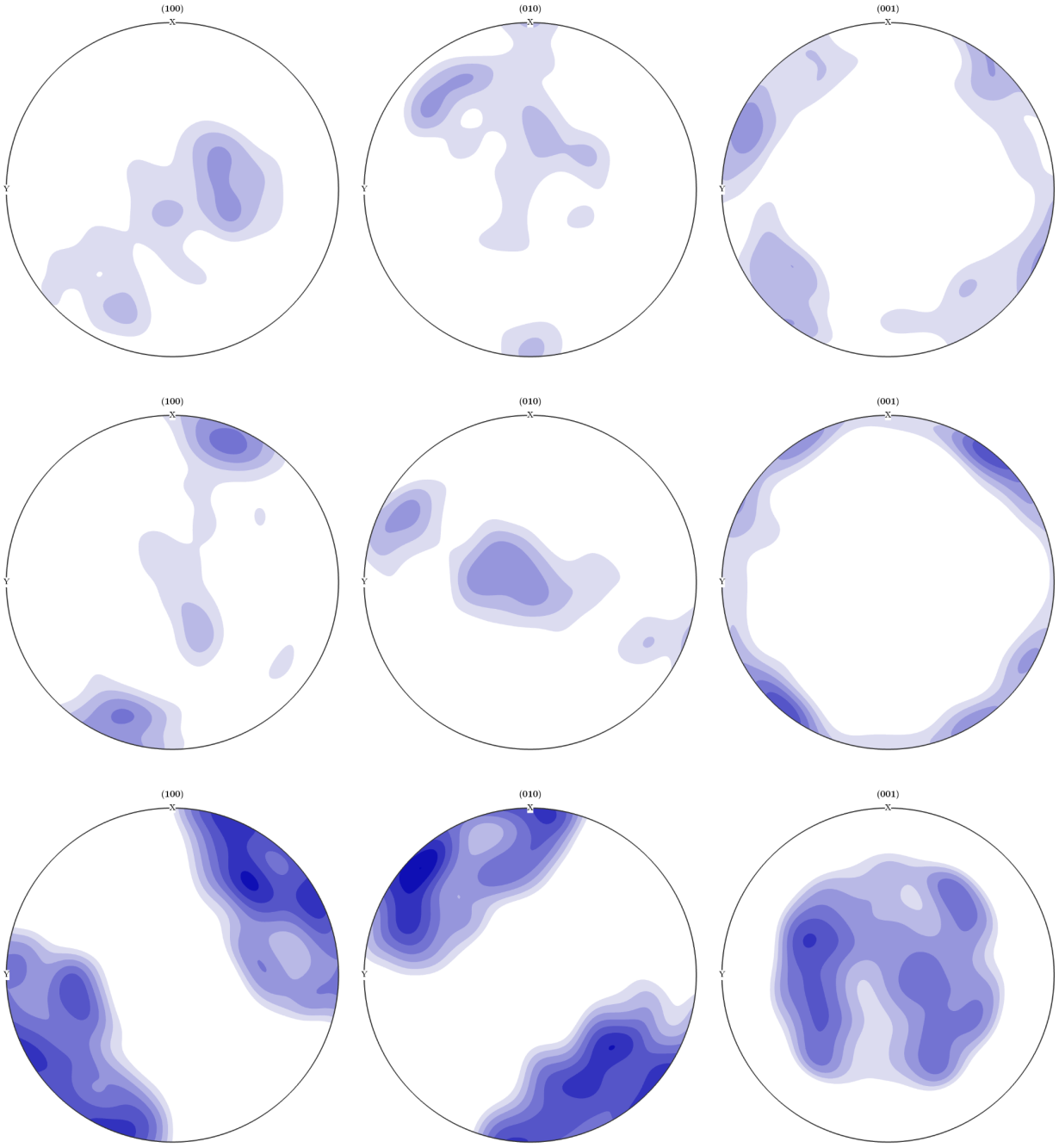
## Add limit resolution option to gwb-grid

(Menno Fraters)
Gwb-grid can now limit the resolution it uses to create a vtu file by setting a command line option.

## Generate random uniform distributed texture with deflection

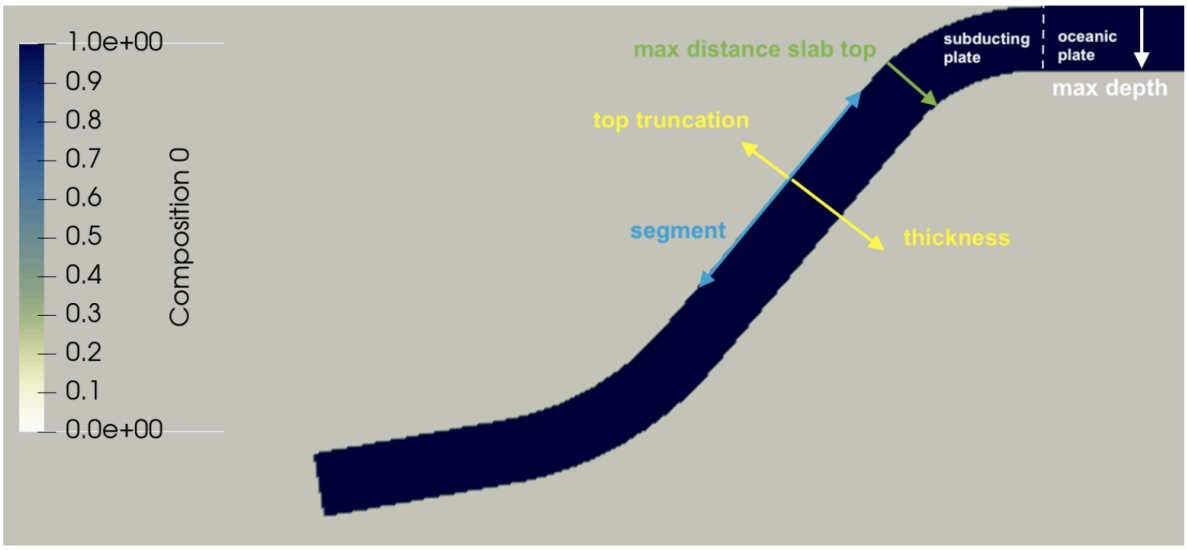
(Yijun Wang)
Added random number seed (integer) as an global input. Added the random uniform distribution with deflection to all features. Now it is able to generate random textures with different deflection away from the center (mean orientation). Textures are generated using gwb-dat as rotation matrices and visualized using MTEX in Matlab.

Sample textures (1000 grains) with different deflections (d = 0.8, 0.6, 0.3 from top to bottom):


(100)
X
Y
(010)
X
Y
(001)
X
Y
(100)
X
Y
(010)
X
Y
(001)
X
Y
(100)
X
Y
(010)
X
Y
(001)
X
Y

## Add a Simple Subduction 2D Cartesian Cookbook Tutorial

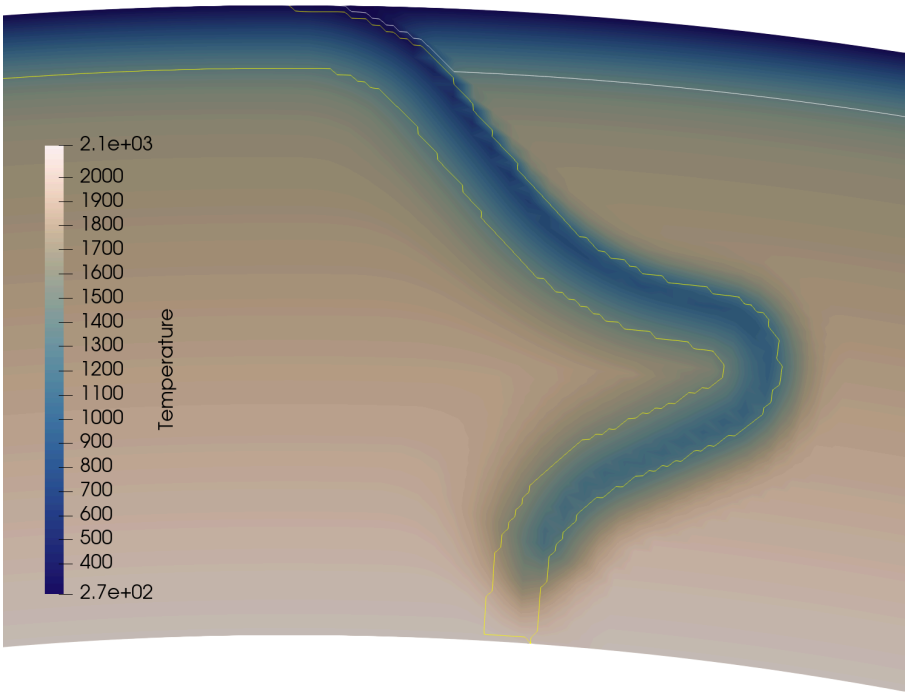
(Magali Billen)




Composition layer for the slab illustrating the slab segment geometry information. #

## Add a Simple Subduction 2D Chunk Cookbook Tutorial

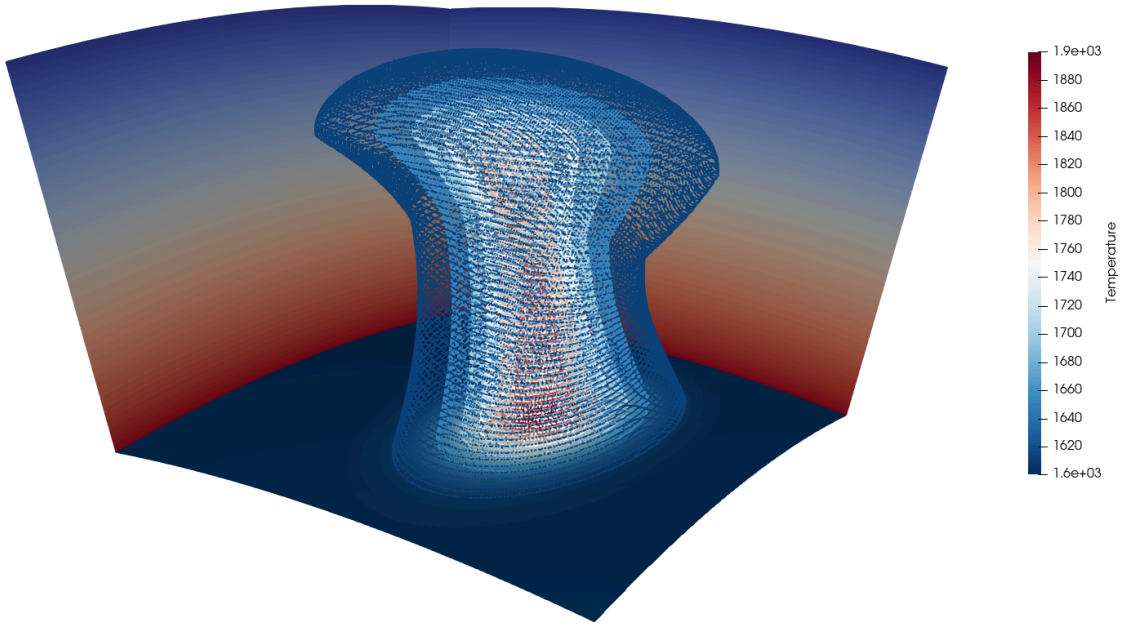
(Magali Billen)



# Make a new ‘plume’ feature

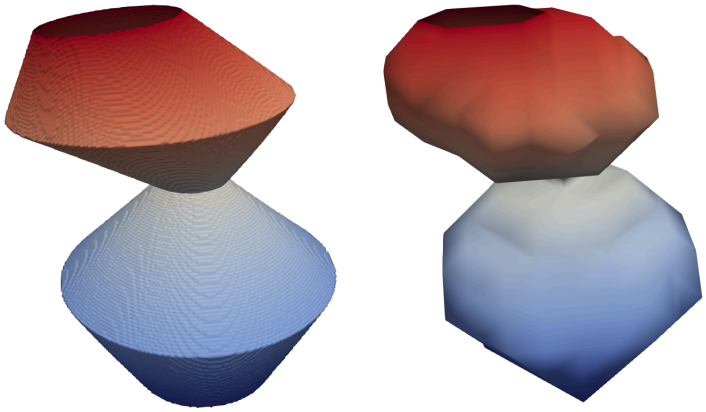
(Juliane Dannberg)

Added a new feature to create a mantle plume. The mantle plume is created from several cross sections, which are given in terms of the location and depth of the center of the plume, the length of the semi-major axis, the orientation of the semi-major axis, and the eccentricity. This allows for the flexibility to create complex features.

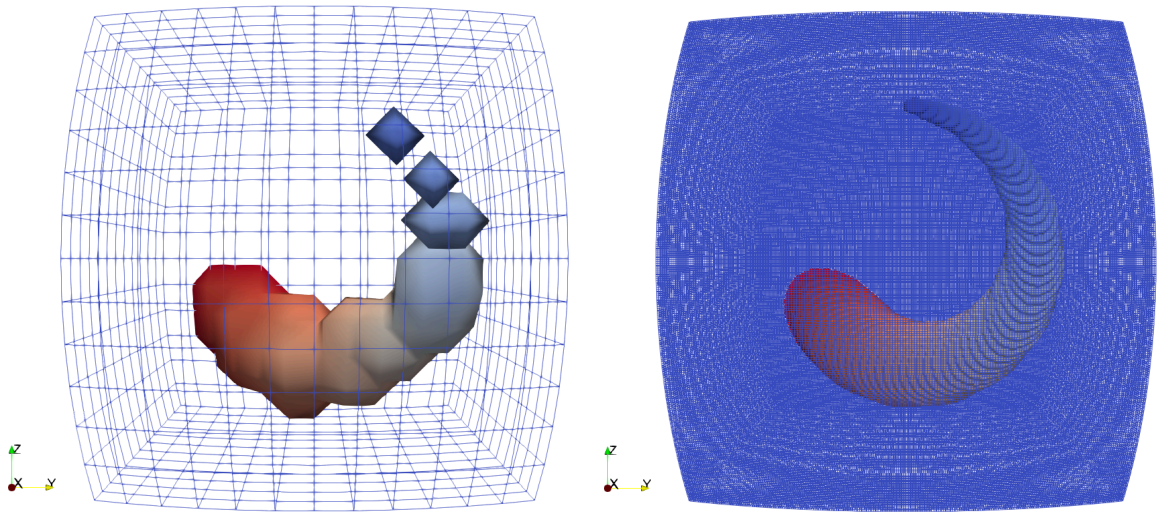


# Add tests for the ‘plume’ feature

(Juliane Dannberg)
Added tests for the plume feature, both in Cartesian and spherical geometry:



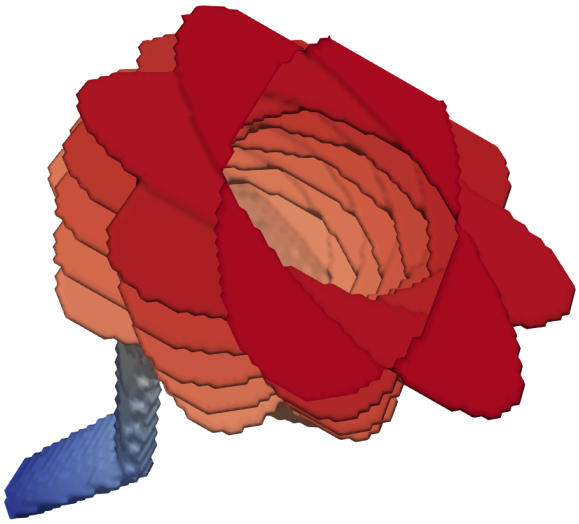
Cartesian geometry (left panel: high resolution, right panel: actual test resolution)

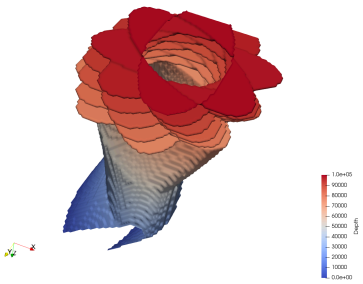


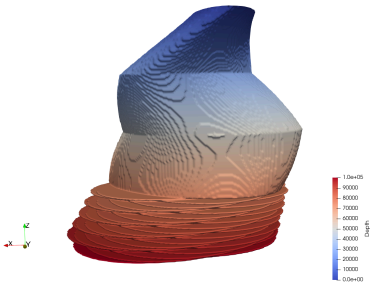
Spherical geometry (left panel: high resolution, right panel: actual test resolution)

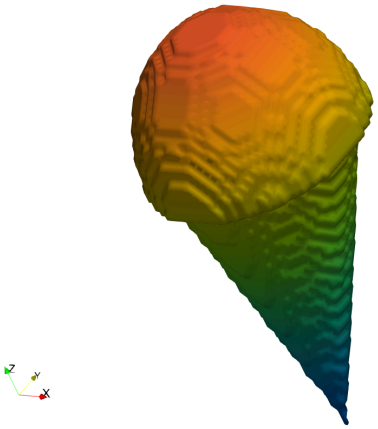
Some fun accidents that occurred while testing the plume feature

(Juliane Dannberg)









## Add a test case for spherical geometry in gwb-grid

(Arushi Saxena)
We have included a test that uses faults in a spherical grid.

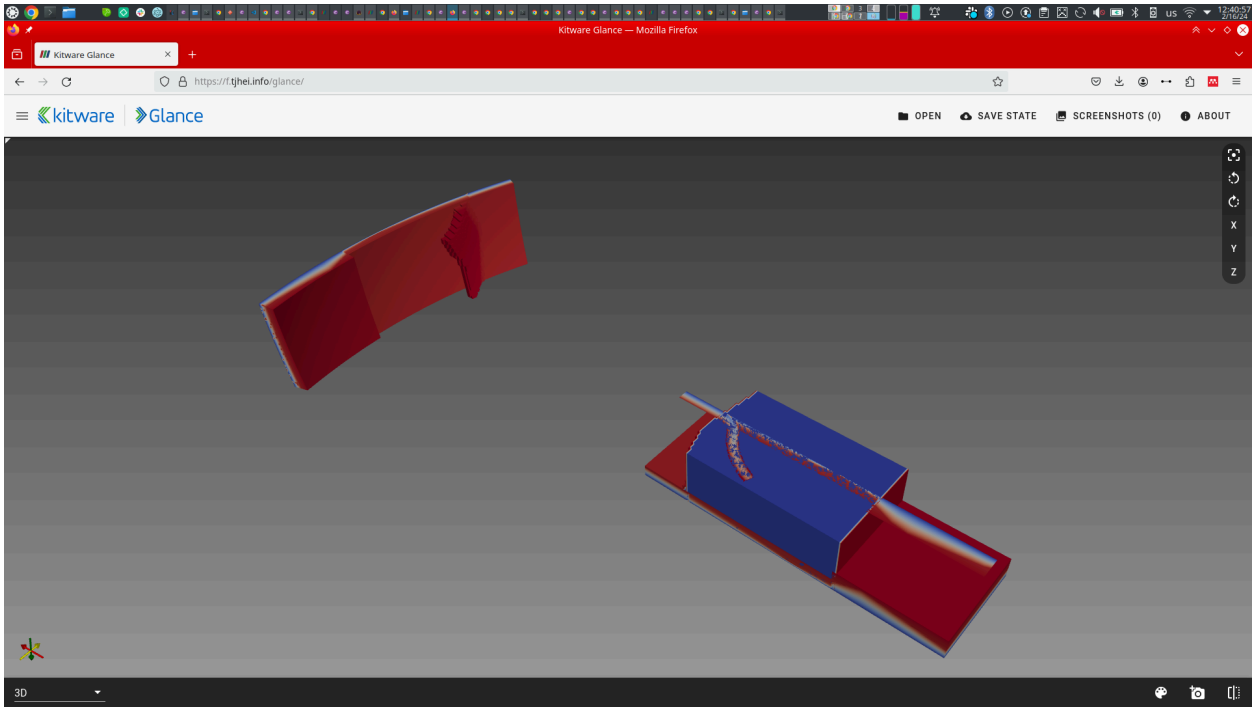
## Add randomly initialized compositional values within a user-specified bounds

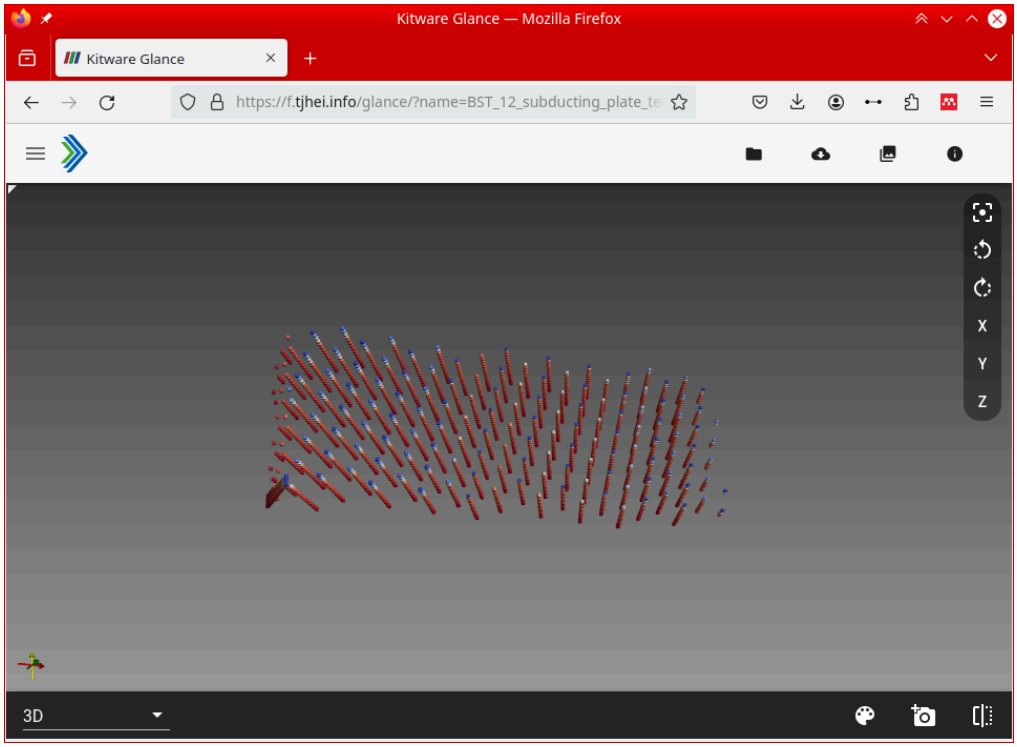
(Menno Fraters and Arushi Saxena)
We have included random compositional values that are generated within a user-specified range of values. Here is the output of using this plugin with a continental plate:

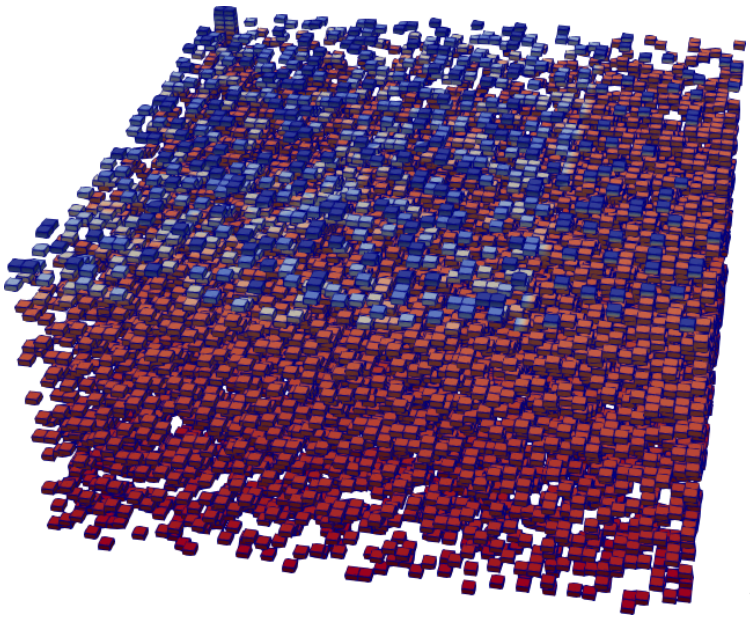

## Added the plate boundary models in WorldBuilder Collectibles

(Arushi Saxena, Lorraine Hwang, and Timo Heister)
We now have a repository for published models that use GWB for defining plate boundaries. Currently, the repository hosts the global mantle flow modes from Saxena et al., (2023) that investigate three plate boundary models–Nuvel-NNR (1991) plate boundary model with 37 segments and vertical dips, Peter Birds' (2003) model with 87 fault segments and vertical dips, and the Global Earthquake Model (2018) with over 14,000 fault segments and varying dips. We include both the .gwb file and the .grd file for each of the models.

# Funny Pictures





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