Dataset for

2D versus 3D Numerical Simulations of Mantle Plume and Lithosphere Interaction: Quantitative Comparison and Scaling Analysis

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1. Introduction

This dataset corresponds to the study "2D versus 3D Numerical Simulations of Mantle Plume and Lithosphere Interaction: Quantitative Comparison and Scaling Analysis". It contains codes for data processing, numerical analysis, symbolic computation, and image generation (see 2). Also included are 2D and 3D numerical model data for three scenarios: (a) models without a mantle plume (3 - 4), (b) models with only a plume head (5 - 6), and (c) models with a plume tail (7 - 8). We are confident that anyone acquiring this dataset can fully replicate and validate our work, reaching the similar conclusions.

2. Codes.zip

2.1. Comparison_2D_3D

This Python script implements the 2D versus 3D models comparison algorithm described by Equation 3 in Section 2.3 of the article. The comparison results can be achieved by specifying the paths of the 3D model to be compared and the 2D model set in the script.

2.2. Cal_flux

A set of Python scripts (for 2D and 3D models respectively) used to calculate the material flux ($Q_{2D}(t)$ and $Q_{3D}(t)$) at a specific depth as described in Section 4.1.2 of the article.

2.3. Draw_figures

Most figures in the article were drawn with Python scripts, which involve data processing and visualization:

a) Numpy for array calculation and storage.

b) Scipy for data fitting, optimization, and special - function calculation.

c) Matplotlib and ParaView for visualizing model fields (e.g., temperature, viscosity) and phase diagrams.

d) Cmcrameri for a color - blind - friendly scientific colorbar.

Therefore, the above Python environment need to be installed before running these scripts. In addition, Figure 14 was drawn using GMT6.0.

2.4. Solve_eq

A notebook is presented that showcases the symbolic solution of the Equation 15 in Section 4.2.1 of the article, making use of Wolfram Mathematica.

2.5. Code_S1_in_SI

This Python program, included in the article's supplementary materials, is designed to construct 2D and 3D equivalent models of the mantle plume with a tail. It allows readers to easily grasp the equivalent relationship between 2D and 3D mantle plumes, bypassing the need to handle complex formulas.

3. No_Plume_2D.zip

The 2D static evolution model without mantle plume generation, presented in Section 2.1 of the article and Figure 1, was generated by the I2VIS program. It includes the model's material, viscosity, velocity, and temperature fields within 30 Myr.

4. No_Plume_3D.zip

The 3D static evolution model without mantle plume generation, presented in Section 2.1 of the article and Figure 1, was generated by the I3VIS program. It includes the model's material, viscosity, velocity, and temperature fields within 30 Myr.

5. Head_Only_2D.zip

The 2D mantle plume models with only a plume head (Head - Only Scenario), described in Section 2.2 of the article and the upper part of Figure 2, were generated by I2VIS. There are **1,116** models of mantle plume heads with varying temperatures and diameters, covering temperature and viscosity fields within 10 Myr.

6. Head_Only_3D.zip

The 3D mantle plume models with only a plume head (Head - Only Scenario), described in Section 2.2 of the article and the upper part of Figure 2, were generated by I3VIS. There are 9 models of mantle plume heads with varying temperatures and diameters, covering temperature and viscosity fields within 10 Myr.

7. Tail_2D.zip

The 2D mantle plume models with a plume tail (Tail Scenario), described in Section 2.2 of the article and the lower part of Figure 2, were generated by I2VIS. There are **1,240** models of mantle plumes with varying temperatures and diameters, covering temperature, velocity and viscosity fields within 10 Myr.

8. Tail_3D.zip

The 3D mantle plume models with a plume tail (Tail Scenario), described in Section 2.2 of the article and the lower part of Figure 2, were generated by I3VIS. There are 9 models of mantle plumes with varying temperatures and diameters, covering temperature, velocity and viscosity fields within 10 Myr.