Geodynamics Homework #2

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Chapter 1: Stress and Strain

Note:

The code was attached with this file, the python file (*.py) is used to calculate the results and the shell file (*.sh) is used to plot figures.

Exercise 1

Download the CRUST 1.0 crust thickness data. According to isostasy, compute the global isostatic topography.

Solution:

First, we downloaded the CRUST 1.0 crust thickness data from website: https://igppweb.ucsd.edu/ gabi/crust1.html. Then, we extracted the file: **crust1.0.tar.gz**, compiled the fortran file: **getCN1xyz.f** using gfortran: **gfortran getCN1xyz.f -o getCN1xyz**.

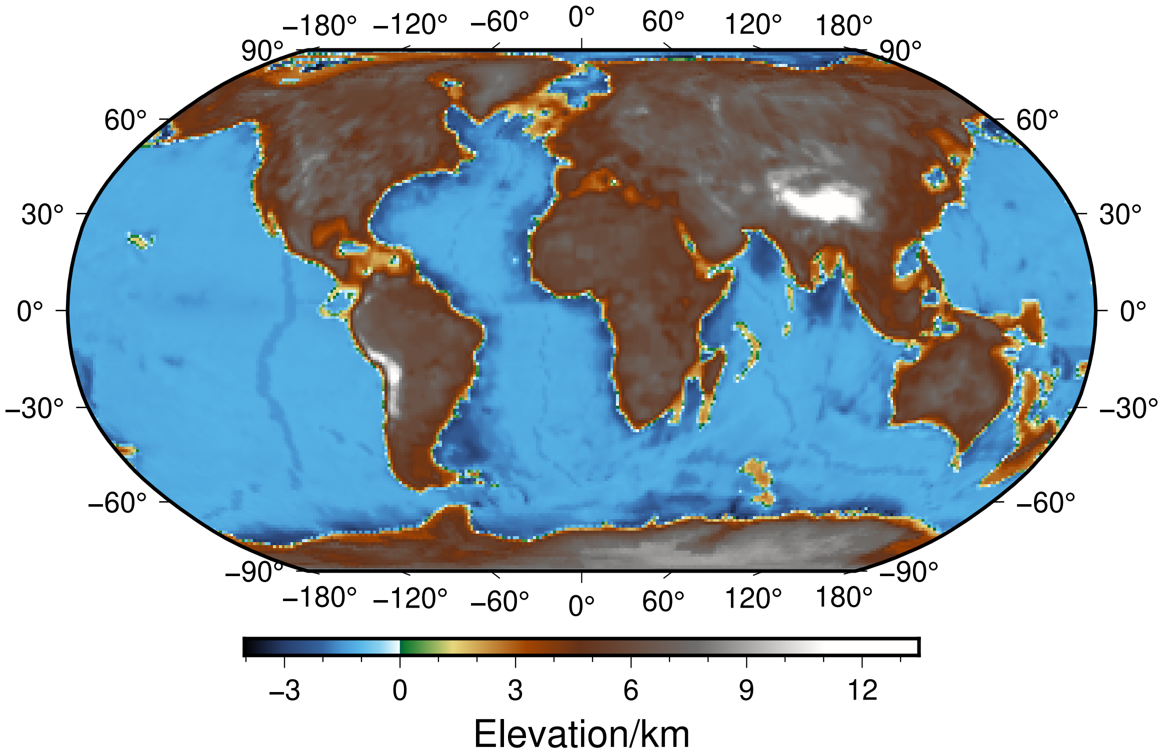
After running getCN1xyz program, we obtained the boundary depth, density, thickness, p-wave and s-wave velocity of each layer, crust thickness (2 8 layers) and sedimentary thickness (3 5 layers). We divided the global crust to two type: continent and ocean by a threshold thickness (12 km) and then calculated the evelation by the following equtions:

$$E_{continent} = h_{continental\_crust} - \frac{\rho_c}{\rho_m} h_{continental\_crust} = h_{continental\_crust}\left(1 - \frac{\rho_{continental\_crust}}{\rho_{mantle}}\right) \tag{1}$$

$$E_{ocean} = \frac{(\rho_{mantle} - \rho_{continental\_crust})}{(\rho_{mantle} - \rho_{water})} h_{continental\_crust} - \frac{(\rho_{mantle} - \rho_{ocean_curst})}{(\rho_{mantle} - \rho_{water})} h_{ocean\_curst} \tag{2}$$

The total thickness of 1-8 layers is represented continental crust thickness. And it is already stored in file **crsthk.xyz**. For ocean, the continental crust thickness and it's density is necessary, and we simply set them as the average value: $35km$, $2800kg/m^3$. Finally, we plotted the global isostatic topography by GMT.

The figures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−3
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3
6
9
12
Elevation/km

Exercise 2

Compute and plot the difference between the isostatic topography and the actual topography (ETOPO1). Discuss your results.

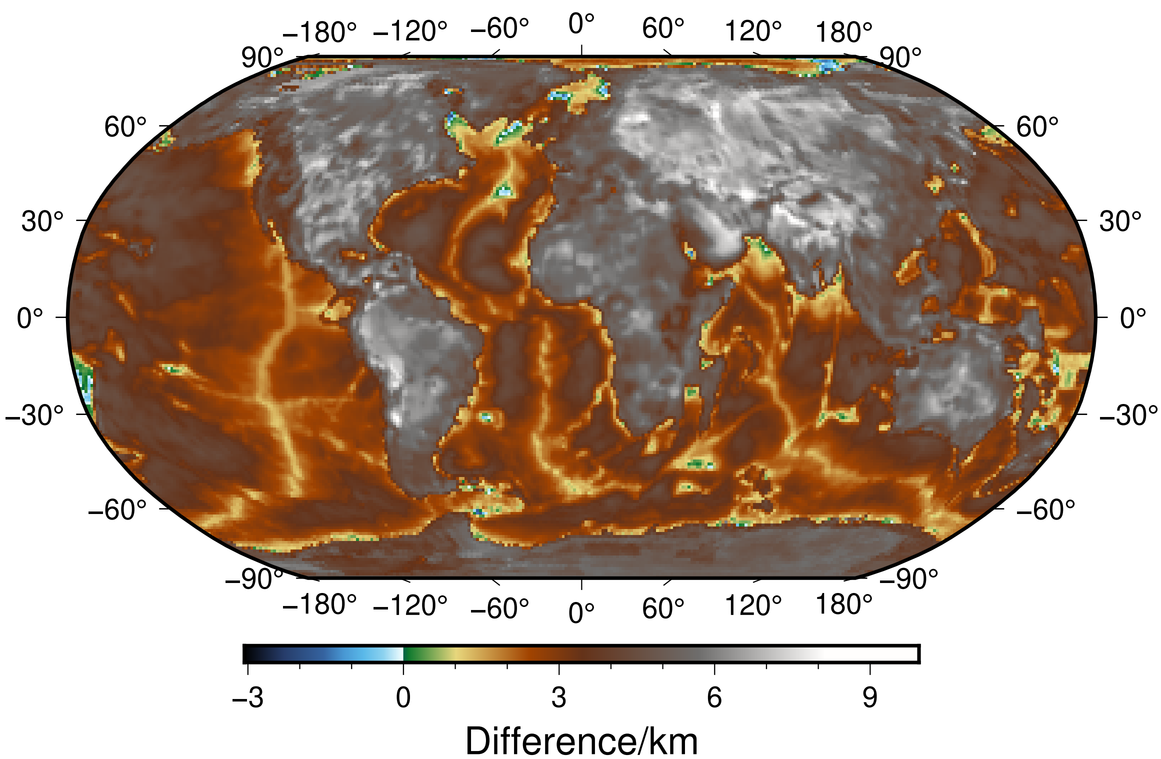
Solution:

We need not to download ETOPO1 topography data, beacause from the handbook of crust1.0, *Bathymetry and topography is that of ETOPO1* and *From the ETOPO1 files, we derived topography, bathymetry and ice thickness in our new model by binning and averaging the ETOPO1 data in 1-degree cells.* So, we leverage the lower boundary of water to represent the ETOPO1 topography. Finally, we plotted the difference by GMT.

Discuss:

The result shows that there is a larger difference in continent than in ocean. Beacause the formula used to calculate ocean topography is more **realistic** than the first which is used in continent (according to the slids provided by Professor Len). And the effect of water and ocean crust is ignored in the formula used in continent and it assumes that continent is just floating on the mantle. So the difference of continent is larger than ocean's.

The figure



Exercise 3

Choose a specific region, and do the same thing in 1. and 2. for this region. Discuss your results.

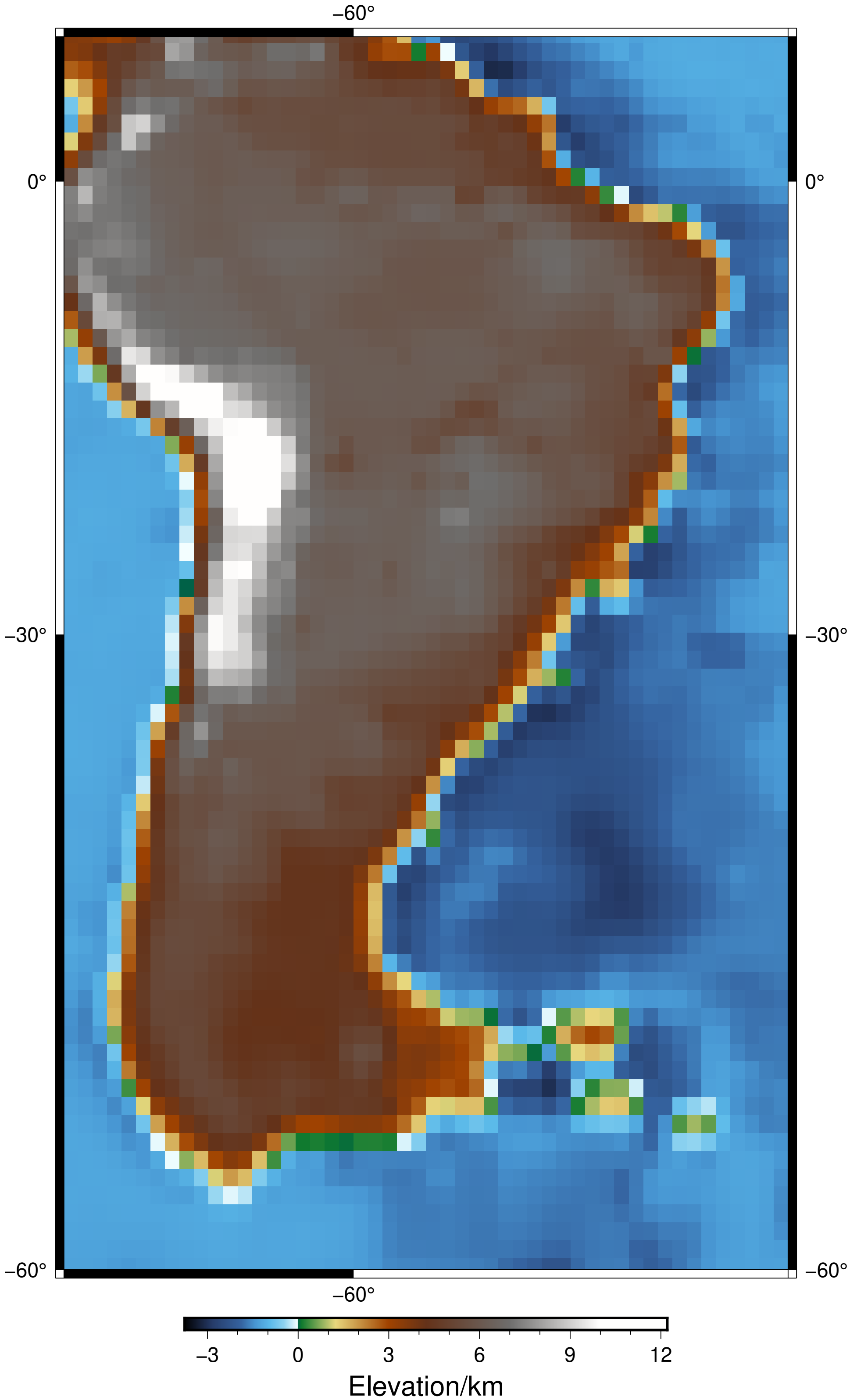
Solution:

Beacause to calculate results of a specific region, we use the same data and formula. So, we don't calculate again but just change the parameter -R when plotting by GMT. We choose the South America as an example.

Discuss:

The situation is similar to the second question. So we don't repeat it again

The figure



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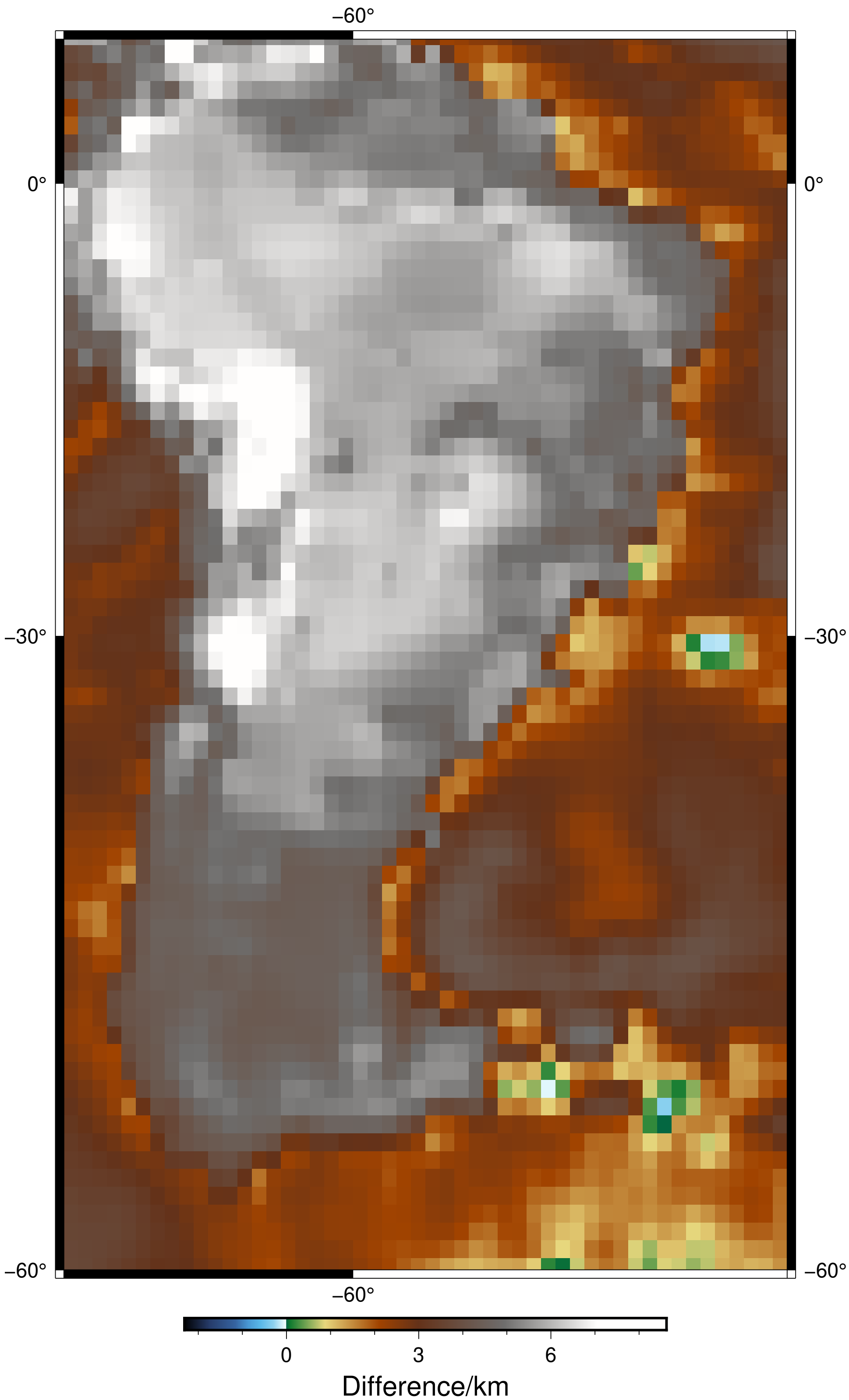
Elevation/km



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Difference/km