UT GEOL 371T/391: Geodynamics: Introduction to Global Mantle Convection – Fall 2017

Thorsten W. Becker
Institute for Geophysics and Department of Geological Sciences
Jackson School of Geoscience, The University of Texas at Austin

Overview

This class is geared toward all interested undergraduate and graduate students from the Earth sciences and related fields in the natural sciences.

The goals are to, first, work through some of the key continuum dynamics problems that can serve to form a fundamental, physical intuition for the tectonic and convective processes that shape our planet. These simple solutions to classical fluid dynamics problems such as the Stokes sphere and half-space cooling form the foundation of any understanding of the solid Earth dynamics component of plate tectonics.

Second, we will cover a range of theoretical and numerical approaches to analytically approximate and model global mantle convection in two and three dimensions. We will cover simplified cases which can be used to extract information about typical planetary heat transport processes, as well as full, spherical convection models which speak to the convective state of the mantle and what determines the style of surface tectonics, including Earth's plates.

Third, we will explore applied geodynamics models that can capture a range of constraints from geology, seismology, potential fields, and geodesy and use the current and past plate configurations from the Cenozoic to understand plate driving forces and rheology of plates and mantle.

The class will consist of a mix of lectures, homework assignments, discussions of reading with student presentations, and a few, simple numerical exercises using Matlab or similar software.

Prerequisites: A basic, kinematic understanding of plate tectonics. Some exposure to Earth science, physics and math a plus, but no classes required.

Logistics

Instructor: Thorsten Becker, twb@ig.utexas.edu, JGB 4.220AA
with guest lecturers
Office hours: Mondays 10-11am, walk in (DGS ~Mon/Thu, UTIG else), and always by request

Meeting time: Mondays, 11-2pm
Class meetings start in week of Sep 18, 2017

Location: EPS 4.104

Grading: class participation (presentations), homework, and term paper (~15 page) literature review or, preferably, an independent research project
Homework is due the evening of the day of class the week after
Deadline for submitting the report is Dec 4

Textbook:

- None required. Draft lecture notes (will be modified throughout class) at: https://www.dropbox.com/s/z729fhqxijuemnv/tectonic_geodynamics.pdf?dl=0

- Suggested textbooks:
  - Dynamic Earth: Plates, plumes, and paradigms, G. Davies. Cambridge University Press, 1999.
  - Rheology of the Earth, Ranalli, G., 2nd edition, Chapman and Hall. (Out of press, local copies might be available)
  - Geodynamics. Turcotte and Schubert, Cambridge University Press (any edition)

Syllabus

unit	date	topic	reading/assignments from lecture notes
1	Sep 18	Continuum mechanics review	Sec. 3.1
2	Sep 25	Rheology	Sec. 3.2 Practical exercise 3
3	Oct 2	Fluid dynamics	Sec. 3.4 Practical exercise 1
4	Oct 9	Heat transport and half space cooling	Sec. 3.7 Practical exercise 4
5	Oct 16	Mantle convection	Secs. 3.8.1, 3.8.3, 3.8.4, and 3.9; lecture slides on Canvas Practical exercise 5
6	Oct 23	Global constraints on mantle dynamics	Lecture slides on Canvas SEATREE exercise Forte (*Treatise*, 2015)
7	Oct 30	Global plate generating models	Lecture slides on Canvas Bercovici et al. (*Treatise*, 2015)
8	Nov 6	Subduction and orogeny	Student presentations on: Billen (2008) Becker and Faccenna (2009) Goes et al. (2017)
9	Nov 13	Deep mantle dynamics and thermal evolution	Student presentations on: Korenaga (2006) Olson (2016) Foley and Driscoll (2015)
10	Nov 20	Work on term paper	
11	Nov 27	Work on term paper	
	Dec 4	**Term paper deadline**	

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