UT GEOL 371T/391: Global Planetary Dynamics - Fall 2020

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This is an undergrad major and grad student seminar on the dynamics of terrestrial planets with a focus on the Earth as a system, including the geodynamo, mantle convection, the climate system, and the biosphere. The focus is on the interactions between the system components and how they can be parameterized to understand the dynamic controls on how terrestrial type planets evolve. We will explore a range of simplified but quantitative models, focusing on understanding the fundamental dynamics The course provides a foundation to discuss ways of resolving outstanding questions, and how to extrapolate from our to other solar systems. We will close with a discussion of attempts to model exoplanets.

Logistics

Instructor:

- Thorsten Becker twb@ig.utexas.edu, JGB 4.220AA (online)
- Office hours: Online, TBD

Lecture time:

- Mon and Wed, 9:30 - 11am

Format:

- The class consists of only a few lectures, and is subsequently driven by reading and hands-on exercises.
- Each week, two papers are assigned reading for the next week, when two students will lead the discussions on each paper. For this, short powerpoint presentations (4-5 slides, highlighting the major findings through figures) will be helpful, and some more background reading might be needed
- There are five homework problems which require running Matlab or Python code, experimenting with the models, and handing in your code electronically, along with a short (max 2000 word) report.
- There is a final project, ideally on new research ideas, or a review of a topic of interest, to be discussed with the instructor. The final project is a maximum length of 10 pages, preferably 5.
- Content counts more than formal presentation, particularly for student presentations.

Grading:

- homework problems (mix of theory and numerical exercises, 35%)
- in-class discussion of reading (30%)
- final project (35%) - due last day of exam week

Prerequisites:

- Basic geophysics and intro geology, intro geodynamics class such as *Tectonic Geodynamics*.

Textbook:

- Reading assignments.

Class schedule

Week	Class topic		Reading assignments	Exercise/homework
1 - Aug 24		Logistics		Install Matlab or Python
2 - Aug 31	Modeling Earth Systems	*Solving ODEs*	O'Neill and Lenardic (2007), Valencia et al. (2007a)	Geodynamo - Rikitake
3 - Sep 7	*Thermal evolution models for the*		Christensen (1985),	

	Earth's mantle	Korenaga (2018).	
4 - Sep 14	*Volatile transport and budgets - water and carbon*	McGovern and Schubert (1989), Sleep and Zahnle (2001)	Thermal evolution of the Mantle
5 - Sep 21	*Core evolution, magnetic field and atmospheric shielding*	Tarduno et al. (2014), Driscoll and Bercovici (2014)	
6 - Sep 28	*Weathering processes*	Kump et al. (2000), West et al. (2005)	
7 - Oct 5	*Cryosphere and hydrosphere - Snowball earth and modern glaciations and sea level*	Hoffman et al. (1997/2017); Mitrovica et al. (2020)	Fossil Fuels and the Carbon Cycle
8 - Oct 12	*True polar wander*	Evans (2003), Steinberger & Torsvik (2008)	
9 - Oct 19	*Solid Earth - atmosphere interactions: Faint Young Sun and Great oxidation event*	Feulner (2012) Lee et al. (2016)	
10 - Oct 26	*The biosystem - Gaia and Forests, biosystem stabilization of climate*	Wood et al. (2008), Runyan et al. (2012)	Volcanic Eruptions and Climate Change
11 - Nov 2	*Mass extinctions*	Sobolev et al., (2011), Rothman (2017)	
12 - Nov 9	*Thermal evolution of other kinds of terrestrial planets*	Jellinek and Jackson (2015) Lenardic and Crowley (2012)	
13 - Nov 16	*Heat loss on other planets and icy moons*	Kane et al. (2019) Greenberg et al. (2002)	Thermal evolution of Europa
	Exoplanets	Barnes et al. (2020)	

References (required reading in bold)

- Thermal evolution of the mantle
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- Plate tectonics on super earths
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- Volatiles
    - McGovern, P. J., & Schubert, G. (1989). Thermal evolution of the Earth: effects of volatile exchange between atmosphere and interior. Earth and planetary science letters, 96(1-2), 27-37.
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    - Crowley, J. W., Gérault, M., & O'Connell, R. J. (2011). On the relative influence of heat and water transport on planetary dynamics. Earth and Planetary Science Letters, 310(3-4), 380-388.
- Weathering
    - Kump, L. R., Brantley, S. L., & Arthur, M. A. (2000). Chemical weathering, atmospheric CO2, and climate. Annual Review of Earth and Planetary Sciences, 28(1), 611-667.
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    - Mitrovica, J. X., Austermann, J., Coulson, S., Creveling, J. R., Hoggard, M. J., Jarvis, G. T., & Richards, F. D. (2020). Dynamic Topography and Ice Age Paleoclimate. Annual Review of Earth and Planetary Sciences, 48, 585-621.
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