COURSE SYLLABUS

GEO 6590/7590 Geodesy & Crustal Deformation

Fall 2017 Lecture: MWF 8:30—9:20 GEOL 302

Professor: Tony Lowry (Department of Geology)
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COURSE DESCRIPTION

Geodesy is the study of the Earth's shape and gravity field. Crustal deformation studies focus on changes in shape of the Earth's surface and geoid, thus emphasizing active processes of strain, mass transfer, and mass loading.

Many high-profile, "gee-whiz" topics in the solid Earth Sciences that garner media attention and fire the public imagination incorporate significant contributions from geodesy. Many of the "gee-whiz" topics in climate change and global change of the Earth's fluid envelopes now rely heavily on geodesy as well. Geodynamics, plate tectonics, earthquakes & fault slip, magmatism & volcanism, and global change studies all trace some of their most important advances to mundane (or even arcane) geodetic observations. Hence, anyone studying active Earth (& planetary) processes will benefit from an understanding of both the nuts-and-bolts of geodetic measurement and the geodetic signatures of these many different processes.

Geodesy is a highly quantitative observational metric. Not surprisingly, many of the tools we will discuss in this course are mathematical. Don't worry though: we'll be sticking to basic concepts of calculus, linear algebra and probability & statistics that should be familiar by now (and when they're not, we'll take it slow). Ultimately, this course is meant to provide you (the student) with an understanding of geodesy and crustal strain and mass transfer processes that will be helpful in both your current thesis research and your later career.

About the professor:
I am a geophysicist ("Physics of the Earth") who focuses on measuring and understanding how and why planets deform. On Earth, this relates directly to processes of fault slip, earthquakes and volcanoes, but also has implications for mass transfer in the atmosphere, hydrosphere and cryosphere.

Course Text
(Required): **Geodesy and Gravity Course Notes**, John Wahr. The text can be downloaded freely from http://samizdat.mines.edu/geodesy/ . I have also placed a pdf copy on the course website at http://aconcagua.geol.usu.edu/%7Earlowry/Geod_CD/index.html.

TOPICS

This course will be somewhat schizophrenic in that I hope to cover two rather disparate topics:

- **Physical Geodesy**, including the observational tools (both satellite and ground-based measurements), gravity and potential theory, and some of the "non-solid Earth" applications (e.g., atmospheric remote sensing, time transfer, surface height and mass changes in the oceans, ice sheets and groundwater)
- **Crustal Deformation**, in which we will examine several of the physical processes that can be studied with geodesy. Emphasis here will be on solid Earth processes and particularly those that relate to thesis topics of the students in the class (i.e., various processes and timescales of fault slip, magma flux/intrusion processes, viscoelastic rebound, and flexural isostasy). This portion of the course content will be addressed partly via a reading seminar format, in which I will assign papers to be read by all and one class member will "volunteer" to present each paper to the rest of the class.

Reading Schedule: (Subject to change based on events & student interests!)

15 Sep:	Luttrell et al. (2013) GRL **40**(3) 501-506
22 Sep:	Altamimi et al. (2012) JGR **117**(B7)
29 Sep:	Jacob et al. (2012) Nature **482**(7386) 514-518
09 Oct:	Ghosh & Holt (2012) Science **335**(6070) 838-843
19 Oct:	Chery et al. (2011) GJI **187**(2), 783-796
26 Oct:	Chang et al. (2007) Science **318**(5852), 952-956
02 Nov:	Fialko & Pearse (2012) Science **338**(6104) 250-252
09 Nov:	McCaffrey et al. (2008) Nat. Geosci. **1**(5), 316-320
16 Nov:	Borsa et al. (2014) Science **345**(6204), 1587-1590
04 Dec:	Ito & Simons (2011) Science, **332**(6032), 947-951

(Approximate) Lecture Schedule:

28 Aug: Introduction: Examples of geodesy applications
30 Aug: Context: Terrestrial Geodetic Measurement
01 Sep: Space-based geodesy: Intro to GPS measurement
(Note: No lecture during week of Sep 4–8)
11 Sep: GPS measurement Cont'd: Signal Structure and Error Sources
13 Sep: GPS Measurement Cont'd; Plate motions
15 Sep: Luttrell et al. (2013)
18 Sep: Plate motions from GPS velocities cont'd
20 Sep: Modeling horizontal velocities as flow strain
22 Sep: Altamimi et al. (2012)
25 Sep: Gravity: Measurement
27 Sep: Gravity
29 Sep: Jacob et al. (2012)
02 Oct: Modeling of GPS velocities
(No lecture Oct 4)
06 Oct: More on modeling velocities: Blocks with back-slip
09 Oct: Modeling stress equilibrium from velocities: Ghosh & Holt (2012)

11 Oct:	Velocity modeling continued
16 Oct:	Deformation measurement: InSAR (the synoptic viewpoint)
18 Oct:	Chery et al. (2011): Velocity modeling an “elastic plate”
19 Oct:	Modeling dislocation Green's functions: Mogi sources
(No lecture Oct 23–25)	
27 Oct:	Modeling dislocation Green's functions: Okada-type fault planes
30 Oct:	Chang et al. (2007): Transient deformation & magmatic intrusion
01 Nov:	Modeling dislocations: Sumatra-Andaman co- and postseismic
03 Nov:	Promise/limitations of slip inversion for modeling slow fault slip
06 Nov:	Fialko & Pearse: Transient deformation sans GPS
08 Nov:	Slow slip: More observations
10 Nov:	Slow slip: Obs and models
13 Nov:	McCaffrey et al. (slow slip in New Zealand)
15 Nov:	Earth's elastic load response
17 Nov:	Elastic load response (cont'd)
20 Nov:	Borsa et al. (2014)
18 Nov:	Earth tides; Viscoelastic (post-glacial or other) rebound
20 Nov:	Glacial isostatic adjustment
(Thanksgiving break!)	
27 Nov:	Glacial isostatic adjustment
29 Nov:	Glacial isostatic adjustment
01 Dec:	Modeling isostatic adjustment on a sphere
04 Dec:	Ito & Simons
06 Dec on:	TBA

Each of you is expected to come up with a course project, which you will present on the date of the final exam. Ideally this project will use geodesy to examine active processes that are related to your thesis or dissertation topic, and will use actual data to address a problem. A write-up of the project will be turned in along with the ppt of the final presentation. **Course Project Presentations** 11 Dec (8:30-9:20)

Course materials (incl. ppt’s) and announcements will be available on the web at
http://aconcagua.geol.usu.edu/%7Earlowry/Geod_CD/index.html

Grading:

Reading Presentations & Exercises	30 pts
Semester Project	70 pts
Total	100 pts

Late Assignment Policy:
All assignments are due at the date & time specified; no late assignments will be accepted. If you are not finished, just hand in what you have. Note that, because all assignments are to be submitted to me by email, I will not accept illness as an excuse for late assignments (unless the illness induces a coma).

Differences between the 6000 and 7000 level course:
Requirements for 7690 differ from those of 6690 in that a higher level of mathematical (i.e., theory) development will be expected of projects from 7000 level students. We will discuss specifically what that means as the project develops.

Key university policies that govern classroom behaviors, risk, etc., are found at http://catalog.usu.edu/portfolio_nopop.php?catoid=2&add=1&navoid=96#nav_links and http://catalog.usu.edu/content.php?catoid=4&navoid=546.

USU Academic Policies

Academic Honesty
Assumption of Risk
E-mail Communication Policy
Equal Opportunity Affirmative Action
Notification of Rights Under Family Educational Rights and Privacy Act FERPA
Student Right-to-Know and Campus Security Act
Additional Policies