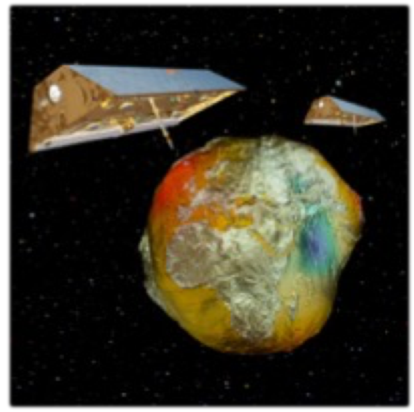
Satellite Gravimetry and Applications

SES 494/598 #87013/#87012
GPH 494/598 #87025/#87026



Syllabus, Fall 2017

Course dates:	T/Th 10:30-11:45 am
Final Exam:	23/11/2017, 10:30-11:45 am
Location:	Stauffer A 241
Professor:	Susanna Werth
Office:	Coor Hall, Room #5647
Office Hours:	on demand, after classes or by appointment
E-mail:	swerth@asu.edu
Web:	http://hydrogeodesylab.asu.edu/teaching_SG.html

Courses Description

Observations of the planetary gravity field enable the investigation of its interior and surface density distribution. Repeated gravity observations from orbit allows measuring redistributions of the planetary density over time, namely mass fluxes on the surface and subsurface. For the Earth, satellite gravimetric missions enable a continuous monitoring of mass transports in subsystems such as Hydrosphere, Oceans, Cryosphere, Solid Earth, and their feedback with global climate.
This course will concentrate on gravimetric satellite missions that map the gravity field associated with Earth and Moon. We will develop an understanding of scientific background, mission configuration, post-processing of global gravity fields and Earth science applications using the examples from recent and ongoing satellite missions. We will study on a variety of applications of satellite gravitmetry in Hydrology, Oceanography, Cryospheric and Solid Earth sciences. A focus will lie on the applications in Hydrology, hence, monitoring of changes in water resources from space. Of particular importance is the sensitivity of the mission to changes in groundwater.
Topics of the class will be: gravitational physics, satellite geodesy, Earth's subsystems and their mass fluxes, climate change impacts, water resources and drought monitoring, sea level change, melting of ice caps. The class will be presented as a combination of lectures and seminars as well as two computer based exercises handling gravimetric satellite datasets.

Courses Goal

By the end of this course, students will understand up-to-date techniques to measure gravity from orbit. The students will get to know different types of datasets of global gravity fields and how to handle them. Students will gain knowledge about the estimation of derivatives from time-variable satellite gravity fields, like gravity accelerations or mass variations. They will learn how to use tools for post-processing and analysis of global gravity fields in the form of spherical harmonics. Finally, they will get the knowledge at hand that is needed to apply these products to a diverse set of Earth science applications.

Courses Requirements

Students are expected to have a basic knowledge of Mathematics, Physics, Earth Science and reasonable computer literacy. Knowledge of programming and Matlab is very advantageous but can be established during classes.

Course Format

This course meets twice weekly for 75 minutes on Tuesdays and Thursday. During most weeks, classes will consist of a combination of lectures, discussion of science in the media or in-class problem solving. At the beginning of each lecture, we will review a couple of questions on the previous class. During the semester, there will be two weeks (four classes) with two computer-based exercises on data analysis. Three weeks will be covered by student presentations of specific case studies (presentation of a scientific paper) and related discussions. For that, articles will be assigned at the beginning of the semester. Students are expected to come to class having done the readings and prepared to participate in discussions and in-class exercises. I strongly encourage people to work together on problems and projects but each student is ultimately responsible for their own work and their own grade.

Weekly Topics (subject to change)

Week	Date	Topic
1	8/17	Introduction, Classes Organization
2	8/22 8/24	Basic concepts, static gravity field Dynamic gravity field of the Earth: The climate experiment
3	8/29 8/31	Fundamental of potential theory Spectral decomposition of the global gravity field: spherical harmonics
4	9/5 & 7	Exercises: spherical harmonics & global gravity models
5	9/12 9/14	Alternative representation of the gravity field: Mascons Methods of gravity field determination: Space Methods
6	9/19,21	Satellite missions, mission details and accuracies
7	9/26,28	Methods of processing and post-processing global gravity fields
8	10/3 10/5	**Midterm Exam:** 10:30-11:45 am, STAUFF A241 Post-processing continued
9	10/12	Applications in Hydrology: Water Balance, Groundwater
10	10/17,19	Applications in Geophysics, Oceanography and Cryospheric studies
11-13	10/26, 31 11/2,7,9	Student presentations: Application case studies
14	11/14,16	Exercises: Post-processing and analysis of GRACE gravity fields
15	11/21 11/23	Exercise evaluation and course reviews **Final Exam:** 10:30-11:45 am, STAUFF A241

Major References (not required to buy, available in library or online)

Committee on Earth Gravity from Space (1997). *Satellite Gravity and the Geosphere: Contributions to the Study of the Solid Earth and Its Fluid Envelopes*, National Academies Press, Washington, online available at: http://www.nap.edu/catalog/5767/satellite-gravity-and-the-geosphere-contributions-to-the-study-of.

Herring, T. (Ed.) (2015). *Treatise on Geophysics: Volume 3 (Geodesy),* 2nd ed., Elsevier, Amsterdam.

Hofmann-Wellenhof, B., and H. Moritz (2006). *Physical Geodesy*, 2nd ed., Springer, Wien.

Ilk, K. H. et al. (2005). *Mass Transport and Mass Distribution in the Earth System*, GeoForschungsZentrum Potsdam, online available at: http://www.iapg.bgu.tum.de/mediadb/21768/21769/programmschrift-Ed2.pdf.

Seeber, G. (2003), *Satellite Geodesy*, 2nd ed., de Gruyter, Berlin.

Torge, W. (1989), *Gravimetry*, W. de Gruyter, Berlin.

Torge, W., and J. Müller (2012). *Geodesy*, 4th ed., de Gruyter, Berlin/Boston.

Vaníček, P., and E. J. Krakiwsky (1986). *Geodesy, the concepts*, North Holland, Amsterdam.

Gravity Field Tutorial, ICGEM webpage: http://icgem.gfz-potsdam.de/ICGEM/potato/gravity-field-tutorial.pdf

Grading

To distinguish between graduate and undergraduate students, the latter will receive smaller assignments for both computer exercises as well as the presentation exercise. In compensation, there will be more weight on the evaluation of attendance and engagement in classes for undergraduates. Please note absence policy's impact on grading, below.

- Grades for undergraduate students will base upon: attendance and engagement (30%), performance during exercises (15%), presentation exercise 15%, midterm exam (20%) and final exam (20%).
- Grades for graduate students will base upon: attendance and engagement (20%), performance during exercises (20%), presentation exercise 20%, midterm exam (20%) and final exam (20%).

Absence Policy

Attendance and participation are a critical component of this course. If you must miss a class, please let the instructor know in advance. Discussions cannot be made up and it is the students' responsibility to be familiar with the material they miss. Absences due to religious practice or university-sanctioned activities should be discussed with the instructor in advance. More than three misses in total or any unannounced miss will result in a reduction of points for attendance (five percentage points per miss). In this regard, please also note the disability accommodations.

Academic Integrity Policy

Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see http://provost.asu.edu/academicintegrity.

Cellular phones and pagers should be turned silent during the class.

Disability Accommodations

Qualified students with disabilities who will require disability accommodations in this class are encouraged to make their requests to me at the beginning of the semester either during office hours or by appointment. Note: Prior to receiving disability accommodations, verification of eligibility from the Disability Resource Center (DRC) is required. Disability information is confidential.

The information in this syllabus, other than grade and absence policies, may be subject to change with reasonable advance notice.