GFZ Helmholtz-Zentrum POTSDAM

Bundesministerium für Bildung und Forschung

International Autumn School

The EGSIEM School for Satellite Gravimetry Applications

11 – 15 September 2017

GFZ Helmholtz Centre, Potsdam, Germany

DATE	Morning			Afternoon			Evening
Monday (11. September)	*Arrivals*			Registration & Welcome Jäggi/Flechtner 14:00-15:00	GPS & GRACE Intro Adrian Jäggi - Ulrich Meyer 15:00 – 17:30		Ice Breaker All 18:00
Tuesday (12. September)	GRACE Analysis Torsten Mayer-Gürr		Lunch at GFZ Canteen	Hydrology I Andreas Güntner		Dinner break	Hydrology II Annette Eicker 19:00-20:30
	Lecture 09:30-11:00	Practical 11:30-13:30		Lecture 14:30-16:00	Practical 16:30-18:00		
Wednesday (13. September)	Ice sheet signals Martin Horwath			GIA Holger Steffen			GNSS Loading Tonie van Dam 19:00-20:30
	Lecture 09:30-11:00	Practical 11:30-13:30		Part I-Introduction 14:30-16:00	Part II-Observations 16:30-18:00		
Thursday (14. September)	Remote Sensing Hendrik Zwenzner			GRACE FO Frank Flechtner 14:00-15:00	Cruise All 16:00-19:00		
	Lecture 09:00-10:30	Practical 11:00-13:00					
Friday (15. September)	EGSIEM Tools Stéphane Bourgogne & Matthias Weigelt		*Departures*				
	Lecture 09:00-10:30	Practical 11:00-13:00					

The EGSIEM Autumn School will be held at:

Haus H, Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences
Telegrafenberg
14473 Potsdam, Germany
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EGSIEM European Gravity Service for Improved Emergency Management

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This autumn school, held in the historic surroundings of the Telegrafenberg site, will educate students and young researchers in state of the art Satellite Gravimetry Applications, and prepare them for the usage of those products being developed within the framework of the EGSIEM project. Presentations from key members of the EGSIEM consortium will be augmented by guests giving presentations on selected topics.

Organisation of the autumn school is jointly managed by the EGSIEM project and GFZ. This event has received partial support from the European Union's Horizon 2020 research & innovation programme under grant agreement No. 637010, and generous funding from the German Federal Ministry of Education and Research.

The European Gravity Service for Improved Emergency Management (EGSIEM) Project consists of the following partners:

- **Universität Bern**
- **Université du Luxembourg**
- **Helmholtz-Zentrum Potsdam GeoForschungsZentrum**
- **Technische Universität Graz**
- **Leibniz Universität Hannover**
- **Deutsches Zentrum für Luft-und Raumfahrt**
- **Centre national d'études Spatieles**
- **géode & cie**

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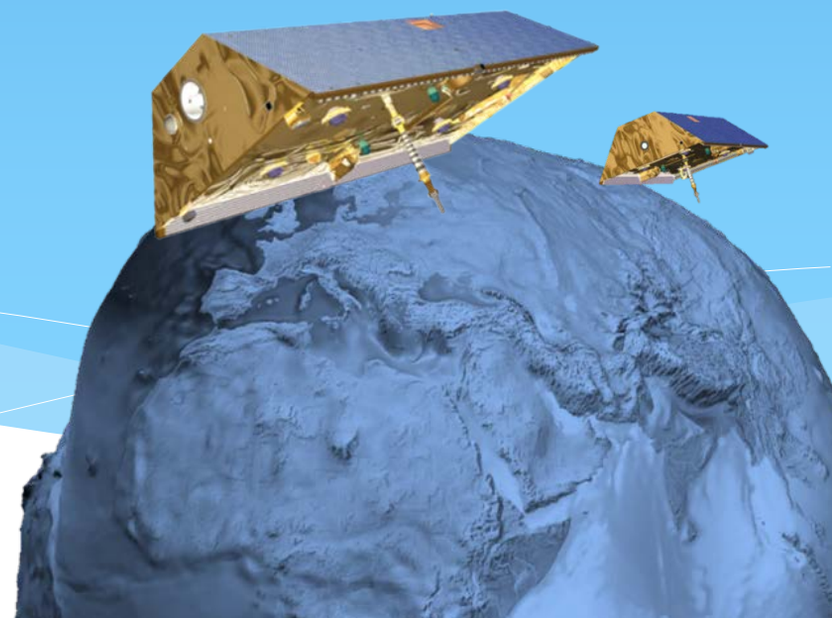

Adrian Jäggi
Universität Bern
Global Positioning Systems

Precise Orbit Determination (POD) with GPS has for 20 years been used as one of the standard techniques to derive satellite trajectories in low Earth orbit (LEO). Since the launch of dedicated gravity missions, GPS is not only used as key tracking system for LEO POD and as a necessary prerequisite to analyze dedicated measurements such as GRACE inter-satellite K-Band data, but also for extracting the long wavelength part of the Earth's gravity field. The lecture gives an introduction into the analysis of GPS data for LEO POD and presents different orbit determination strategies.

Ulrich Meyer
Universität Bern
Introduction to GRACE

One of the main goals of the GRACE mission over the past 15 years has been to observe the medium to short wavelength part of the Earth's gravity field and its temporal variations, and additionally to measure the twin satellites' orbits (the inter-satellite range is measured with micrometer accuracy). This lecture gives an overview of the GRACE mission and data processing, and offers a first glimpse of the main products available, and their application.

Torsten Mayer-Gürr
TU Graz
GRACE Data

One of the main products of the GRACE mission are the monthly gravity field solutions in terms of spherical harmonics. These products are not easy to handle and to interpret. This lecture explains some properties of the solutions. It will also give an overview on how to process the data for mass transport interpretation. This includes filtering and gridding and the transformation in terms of total water storage or equivalent water heights. In the practical MATLAB software will be developed to compute such results.

Andreas Güntner
GFZ
Modelling the hydrological cycle

This lecture will give an overview of the components of the global water cycle and an introduction into the concepts of hydrological modelling. Focus is given to illustrating different water storage compartments and the value of time-variable gravity data to quantify their dynamics. During practicals students will use a hydrological model to experience the inter-play of water fluxes and water storage dynamics as influenced by model parameterization. The basic principles of model calibration as a strategy of tuning the model structure and model parameters in a way that simulation results correspond to observations will be conveyed within a calibration exercise.

Annette Eicker
HCU Hamburg
Assimilating GRACE data into hydrological models

Data assimilation (DA) is a tool for integrating observations into numerical models in order to provide more realistic model results. We will introduce the concept of data assimilation for integrating GRACE observations into hydrological models. The approach allows us to improve the model results, but also delineate GRACE observations into individual hydrological storage compartments and increase the spatial and temporal resolution of water storage estimates. The methodological concept of the ensemble Kalman filter method of DA will be introduced and the associated challenges discussed.

Martin Horwath
TU Dresden
Ice Sheet Signals

The lecture introduces processes related to ice sheet changes, ranging from local glaciological phenomena to global sea level fingerprints. These processes add up as prominent signals in GRACE satellite gravimetry. They also affect a wealth of complementary geodetic observations. The lecture illustrates how a combination of geodetic techniques, together with glaciological and geophysical modeling, leads to an improved understanding of ice sheet processes. Exercises will give participants access to current results and challenges.

Holger Steffen
Lantmäteriet
GIA

Glacial isostatic adjustment (GIA) describes the response of the Earth in terms of deformation as well as stress, rotation and geopotential changes due to changing ice-ocean load distributions on the Earth's surface. The lecture will give an overview of the determination, observation and modelling of GIA from the initiation of the first measurements about 300 years ago in Fennoscandia to the most recent advances thanks to satellite-geodetic techniques.

Tonie van Dam
Uni du Luxembourg
GNSS Loading

The Earth responds elastically to surface mass loading. Many publications have demonstrated that GNSS is capable of observing these displacements. GNSS combined with GRACE observations allows us to refine the mass load at a finer scale in regions where GNSS is sufficiently spatially dense, and by analysing the horizontal motions, we can determine where the load is located. In this session, we will review elastic loading theory. We will demonstrate the theory that allows us to compare GRACE and GNSS observations. We will also review the literature that compares GNSS and GRACE to outline the limitations and the benefits of these comparisons.

Hendrik Zwenzner
DLR-ZKI
Remote Sensing

This lecture and practical will present an overview of different space-based earth observation techniques and mechanisms currently in use. Special focus will be placed on the application of SAR satellite data for flood mapping. Examples from the rapid mapping service of DLR's Center for satellite-based Crisis Information (ZKI) will be presented and discussed during this session.

Frank Flechtner
GFZ
GRACE FO Mission

The GRACE Follow On (FO) mission, due for launch early 2018, will continue providing time-variable estimates of the Earth's gravity field for a period of up to five years at a precision and temporal sampling equivalent to that achieved with GRACE. The FO will provide quick look (<24h) products for enhanced operational use for water resource management and will demonstrate inter-satellite interferometry in LEO for future gravity missions. The talk will focus on the mission status and will also give an outlook on potential Next Generation Gravity Missions.

Matthias Weigelt
LU Hannover
EGSIEM Tools

Dissemination is an essential part of the EGSIEM project: therefore we developed the EGSIEM plotter which allows easy but powerful access to GRACE data. Users can be overwhelmed by the number of available solutions and preprocessing possibilities on offer. The EGSIEM plotter simplifies these variables considerably. Individual & combined solutions are available for various applications which automatically consider various preprocessing steps.

Stéphane Bourgogne
géode & Cie
The EGSIEM Plotter

The GRACE mission allows us to monitor mass transfers and water variations all over the globe. We have designed and built a tool to instantly visualize the results by simple clicks on a web page: The EGSIEM Plotter. We will explore the full possibilities of the tool together with the students, and discover how mass distribution is changing rapidly over the Earth, either in a periodic fashion (monsoons, seasonal effects over equatorial areas...), or in a secular fashion (ice melt at the poles).