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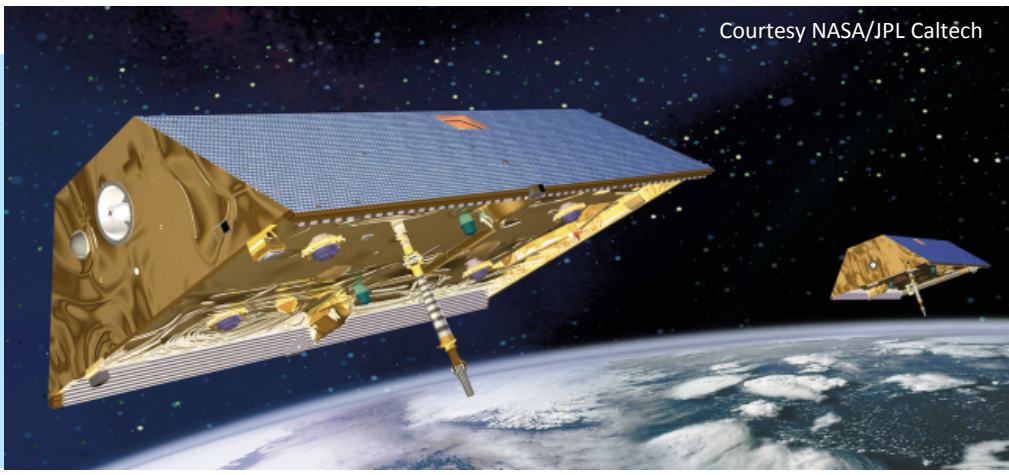
Newsletter

EGSIEM

European Gravity Service for Improved Emergency Management

Inside this issue:


Courtesy NASA/JPL Caltech

WELCOME TO EGSIEM

The **European Gravity Service for Improved Emergency Management (EGSIEM)** project, which is funded by the Horizon2020 Framework Program for Research and Innovation of the European Union, aims at using gravity field analysis for forecasting and mapping of hydrological extremes like large-scale droughts and flood events. The project is funded for three years, from 2015 to 2017. The leader of the project is the Astronomical Institute of the University of Bern.

EGSIEM CONSORTIUM

- **Universität Bern**, Switzerland
- **Université du Luxembourg**, Luxembourg
- **Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum**, Germany
- **Technische Universität Graz**, Austria
- **Leibniz Universität Hannover**, Germany
- **Centre National d'Études Spatiales**, France
- **Deutsches Zentrum für Luft- und Raumfahrt e.V.**, Germany
- **Géode & Cie**, France


Photo: M.Tognola
EGSIEM kick-off meeting, 13.-14.January 2015, Bern

Goals and Ambitions

At the heart of the EGSIEM project is the idea that *better knowledge yields better decision-making.* Towards this idea the 8 consortium members of EGSIEM aim to derive improved products from the **Gravity Recovery and Climate Experiment** (GRACE) satellite mission. The current latency and complex nature of the data derived from the GRACE mission (a dual satellite mission of NASA and the German Aerospace Center, which has been making detailed measurements of Earth's gravity field variations since March 2002) makes the data of limited value for monitoring and forecasting applications. Currently Geodesists need to wait approximately 2 months from observation by GRACE until the data is processed for access and examination. EGSIEM will improve the data latency, will perform the complex processing, and will provide a simple to use web interface (based on the *EGSIEM plotter* provided by Géode & Cie). The data will be freely available for users.

The impact of EGSIEM

The main goal of the project is to improve the availability of data for users, especially in terms of better drought and flood forecasting. EGSIEM will reduce the timeframe to 5 days. As the data is going to be made freely available (via our project website egsiem.eu), the users may use them also for other applications as well. EGSIEM aims to improve existing monitoring products. The improvement in flood and drought monitoring will benefit Europe and also other countries. For example the impact of the 2009 flood in Namibia which claimed 131 lives and displaced 445,000 people could have been better anticipated by the existence of concise warning products.

GRACE DATA PROCESSING CHALLENGE

Flood event at Mekong
photo H. Thoss, GFZ

Flood and drought monitoring in Near-Real-Time will be essentially based on GRACE mission data. The GRACE satellite mission has successfully provided information about the Earth´s gravity field since 2002 and celebrated its 13th birthday on March 17, 2015. The overall satellite and instrument status of GRACE is still nominal. Unfortunately, two out of 20 cells of each battery have been lost on both satellites which makes regular switch-offs of the accelerometer Instrument Control Unit (ICU) and/or Microwave Assembly (MWA) at low Sun beta prime angles every 161 days necessary. The current orbital altitude is 395 km with a decay of about 86 m/day. Cold gas consumption and solar activity are still moderate so that a mission lifetime till beginning of 2018 is feasible. This would enable cross-validation with GRACE Follow-on. GRACE-FO has passed the Critical Design Review in February 2015 and is due for launch in August 2017.

Deriving gravity field solutions from GRACE observations requires a complex chain of data processing and analysis. The pre-processed GRACE Level-1B data products provided by the GRACE Science Data System (SDS) along with corrections and ancillary data as well as harmonized processing standards serve as input for gravity field recovery within EGSIEM. The unification of the knowledge of the entire European GRACE community will pave the way for a long awaited standardization of gravity-derived products. Combining the results obtained from different Analysis Centers of the EGSIEM consortium, each of which will perform independent analysis methods but will employ consistent processing standards, will significantly improve the quality, robustness and reliability of these data.

As **water storage anomalies from GRACE** have shown to be a **unique descriptor of large-scale hydrological extreme events,** the comprehensive long-term memory information in GRACE estimates of total water storage variations can be evaluated for flood or drought forecasting. So far, with a nominal time delay of GRACE instrument data of 11 days and of derived gravity field products of 60 days, flood and drought prediction of hydrological extremes can only confirm the occurrence of an event and estimate the severity of the event. In order to improve e.g. for SAR acquisition planning, the latency of GRACE products is therefore planned to be drastically reduced. For this a Near-Real-Time Regional Service will be established that aims to reduce the time delay of necessary input data to less than 5 days, to increase the temporal resolution to one day and to attempt to improve the quality by transferring the accuracy level of the monthly solutions to the daily solutions.

Catchment wetness serves as an initial condition for flood generation and is nowadays approximated by near-surface soil moisture, either simulated or observed, antecedent precipitation, or river discharge. The daily and regional products from the EGSIEM project will provide an opportunity to go beyond the state-of-the-art of flood and drought monitoring and forecasting by adding a long-term water storage memory component to the system, potentially improving forecasting persistence and hence extending forecast lead time.

The United Nations World Water Development Report 2015, Water for a Sustainable World published on March 20th, 2015, demonstrates the absolutely key impact of water resources on humanity. The UN clearly points out the need of early warning systems for water-related disasters: "**Water-related disasters are the most economically and socially destructive of all natural hazards**. Economic losses due to natural and human-induced water-related hazards have increased greatly in the last decade, well beyond reported immediate losses. Single water-related disasters can even have repercussions on development on a multiannual to decadal scale. This situation is likely to become exacerbated by climate change, which is anticipated to increase the frequency of heavy precipitation over many areas of the world, and to intensify droughts in some areas over certain seasons. **Planning, preparedness and coordinated responses – including floodplain management, early warning systems and increased public awareness of risk** – have been shown to greatly improve the resilience of communities to natural hazards. Blending structural and non-structural flood management approaches is particularly cost-effective. "

THE EGSIEM PLOTTER

Modules/Output/Advantages

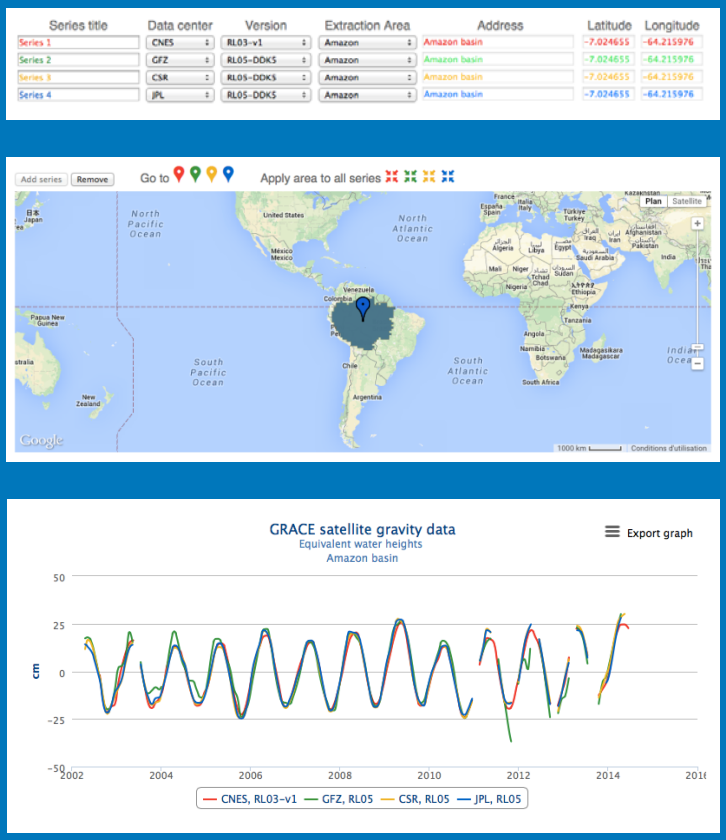
In order to **visualize and compare the gravity results from GRACE** provided by the different Analysis Centers, the EGSIEM project will develop a specific, fast, lightweight and user friendly dedicated tool. Users will be able to visualize gravity field time series over areas of the Earth, either predefined or interactively defined by the users.

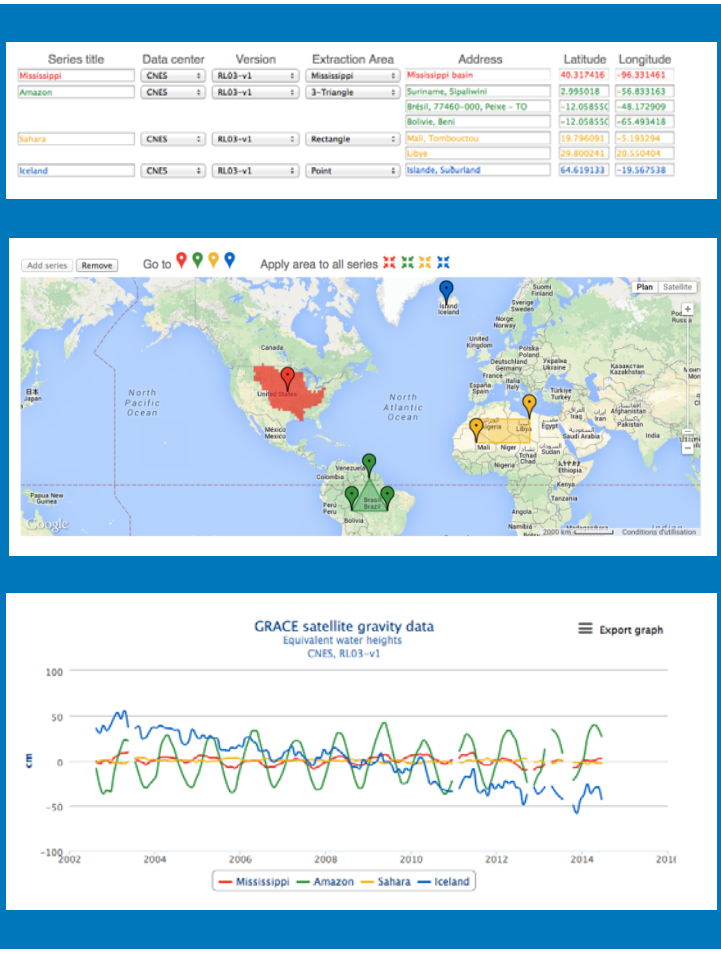
The tool contains 3 modules:

i) data selection module to select the type of data the user wants to plot, the data center, and the data version.

ii) geographic module, in which the users can choose an arbitrary place over the globe, a self-defined area or a pre-defined river basin over which they want to extract the data (as shown in the figure below). This allows the user to visualize the ice melting in the Arctic, the annual water cycle in Amazon, drought trends in deserts or mass displacements after earthquakes, and much more.

iii) plotting module, shows the time series of the gravity change in terms of equivalent water height, which is a preferable means of interpreting the gravity signal. Once the well known phenomena (ocean tides, earth tides, ...) are removed, the residual signal can be interpreted as variations of hydrological or glaciological signal. Users can compare results between selected product centers, export graphs and reuse them for scientific presentations!





Try it yourself!
A preliminary version is already online at
www.egsiem.eu

Outlook

This tool will be of great help for assessing the gravity results in specific areas of interest. It will encourage feedback from users, and increase the level of cooperation within the GRACE community, namely in studying the differences in the data processing and their consequences on the results.

More developments are in progress and will come soon: downloading of numerical data, linear regression or periodic model adjustment (annual and semi-annual), and more. In addition, all available results from EGSIEM will be included within the EGSIEM Plotter (http://plot.egsiem.eu/) during the 3 years of the project, including: **combined fields produced by the EGSIEM team, hydrological area mean values, flood indicators, and all EGSIEM outputs**.

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EGSIEM CONSORTIUM INTRODUCES ITSELF

Interview questions:
1 - What interests you about Geodesy?
2 - Describe your role in EGSIEM?
3 - What is the one aspect of EGSIEM you are most interested in?

Prof. Dr. Adrian Jäggi

1 - The opportunity to exploit ultra-precise sensor data from current and future satellite missions by adopting rigorous and well defined mathematical methods to monitor and understand the complex system Earth. Being an Astronomer with a background in Celestial Mechanics the subject of satellite orbit determination has interested me since my Ph.D. studies, especially the full exploitation of the inter-satellite K-Band measurements from GRACE.

2 - Being the coordinator of the EGSIEM project I am the scientific lead and am responsible for the project in general. I am the intermediary between the consortium and the European Commission and amongst other tasks, I am in charge of managing the financial contribution and of collecting, reviewing and submitting project reports. I also maintain an overview of the entire EGSIEM project and give advice on any kind of questions that may arise during project execution.

3 - To realize the unification of the knowledge of the entire European GRACE community. I am convinced that the combination of the results obtained from the different analysis centers of the EGSIEM consortium will significantly increase the quality, robustness and reliability of these data. Ultimately I hope that our initiative will be continued beyond the project duration and that the established services will be put under the umbrella of the International Association of Geodesy.

Dr. Ulrich Meyer

1 - I like to have an overview. In my spare time I am climbing mountains, in my working life I look at the Earth with the eyes of the satellites. Well, not exactly with their eyes (or cameras), but with their gravity sensors. These allow us to even take a look into the Earths hidden interior.

2 - One of the ideas behind EGSIEM is to provide a gravity service. Up to now it has been the task of the user to compare the gravity field solutions of the different analysis centers or choose the products of one center blindly. Within EGSIEM we will combine the solutions of all associated analysis centers and provide mean solutions where the errors or weaknesses inherent to the individual solutions are expected to be reduced. It will be my task to coordinate this combination.

3 - The careful comparison of the different processing strategies and the corresponding monthly gravity field solutions will stimulate the development of all kind of processing improvements. That is what we need to get the best out of the GRACE data and be ready for GRACE-FO in 2017.

Dr. Andreja Sušnik

University of Bern
Astronomical Institute (AIUB)
http://www.unibe.ch
http://www.aiub.unibe.ch

1 - As I am coming originally from the field of geology, I find it fascinating that geodesy can use a combination of ground based surveys and satellite information to study processes on the Earth, processes that are not always visible to the human eye - for example the movement of tectonic plates. For me this is both interesting and challenging.

2 - I am mainly involved in processing of combined multi-GNSS and SLR data. This allows establishment of an improved reference frame, which is a prerequisite for precise orbit and gravity field determination.

3 - My main interest is in the reduction of the latency and the improvement of the temporal resolution of the gravity field solutions. This will greatly improve flood and drought monitoring in near-real time.

M.A. Keith Cann-Guthauser

1 - Coming from a non-scientific background I guess the *exactness* is what interests me. Just how accurate does one need to be when calculating distance, or bouncing signals off satellites tens or hundreds of kilometers above, it turns out very!

2 - I look after the administration of the project, communicating various deliverable deadlines and answering queries regarding the rules of the EU. I also help out with some of the dissemination activities and the project finances.

3 - I guess it is the interplay between what I regard as the 'hard core' geodesists who are working beside other partners who specialize in crisis management and web visualization experts. It is always interesting when one is at the crossover point in research fields and EGSIEM is a wonderful example of this phenomenon.

MEET EGSIEM

European Geosciences Union, Vienna
April 12th-17th, 2015, Section G4.2

International Union of Geodesy and Geophysics, Prague
June 22nd-July 2nd, 2015, Symposium G03

KEEP IN TOUCH

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