No. 3
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Newsletter

EGSIEM

European Gravity Service for Improved Emergency Management

Inside this issue:

EGSIEM SCIENTIFIC SERVICES II

The general concept of EGSIEM is based on using satellite data from Gravity, Altimetry, GNSS, SLR and Copernicus missions to create three scientific services, all tailored to the needs of governments, scientists, decision makers, stakeholders and engineers. These services are:

- **scientific combination service**
- **near real-time/ regional service**
- **hydrological/early warning service**

The scientific combination service was already introduced in EGSIEM Newsletter no. 2. In this issue we introduce the second service, the near real-time/regional service. The hydrological/ early warning service is a subject for the Newsletter no. 4.

Near real-time (NRT) / regional service

Until now, monthly GRACE gravity field models have been available with a time delay of about two months, which only allows for the 'confirmation after occurrence' and to assess the severity of a hydrological extreme event. The main goal of the EGSIEM NRT service is to *reduce this latency significantly to a maximum of five days* and to *provide daily gravity field models* on a regional to global scale. These rapid gravity time series will enable us to monitor the global water storage in NRT and to observe floods and droughts as they occur. This information will help rapid mapping providers such as EGSIEM partner DLR and early warning systems to react earlier to such hydrological extreme events resulting in improved emergency and assistance efforts.

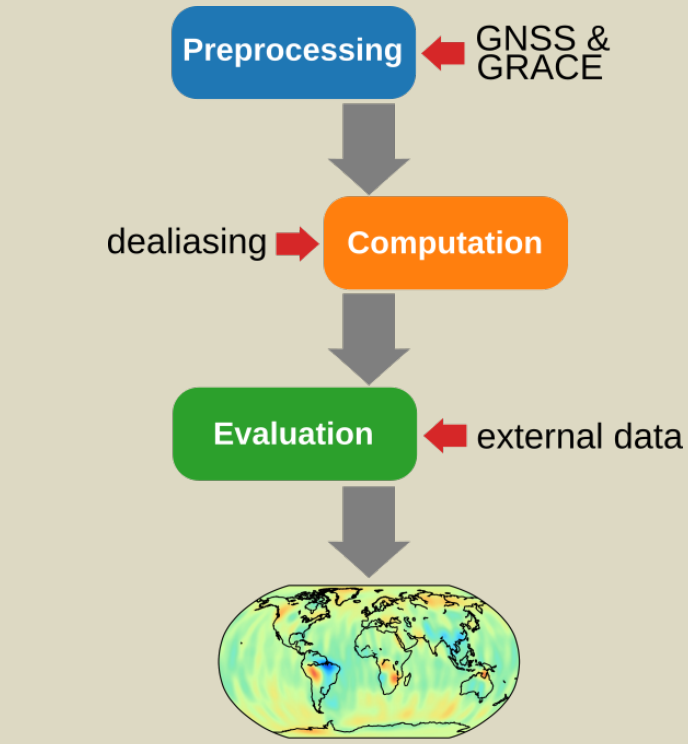
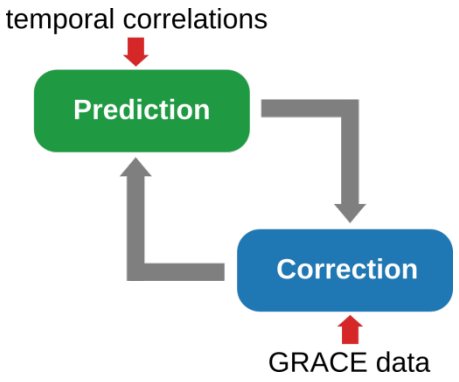


Figure 1: Schematic work flow of the NRT service for a single day. The flow chart shows the individual process steps starting with raw data preprocessing, followed by the computation of the gravity field, until, after external evaluation, the final gravity map is released.

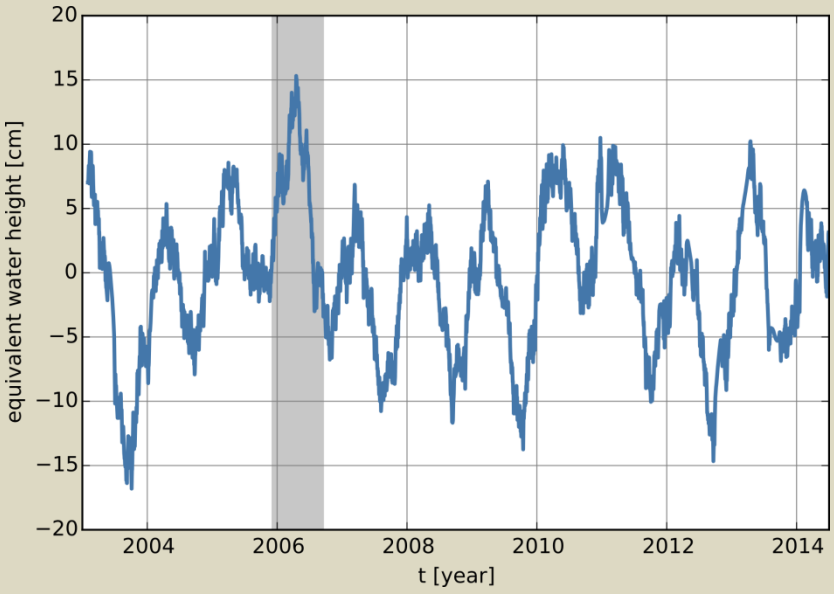
NEAR REAL-TIME/REGIONAL SERVICE

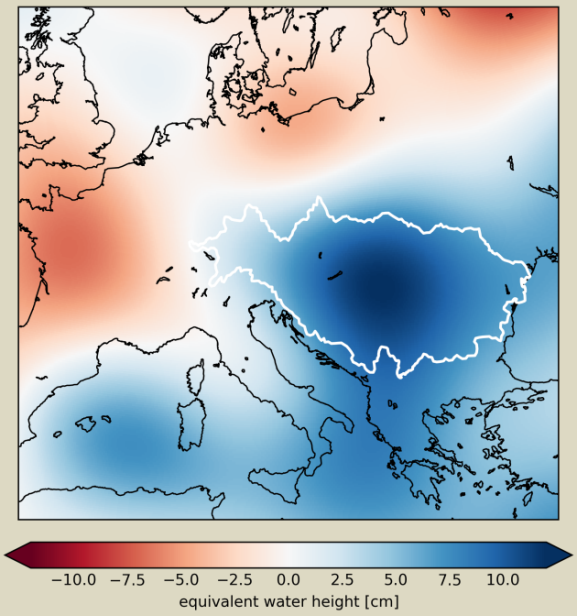
The **EGSIEM NRT service** will be implemented and operated by the German Research Center for Geosciences (GFZ) and Graz University of Technology (TU Graz), plausibility tests for the daily solutions will be performed at the University of Luxembourg (in NRT) and at GFZ (for historical flood events). To provide the best possible gravity field estimates, two strategies are pursued: TU Graz focuses on improving global gravity field solutions, whereas GFZ will implement tailored regional representations of the gravity field. Both approaches complement each other, providing global coverage, with increased spatial resolution for regional areas of interest.

The **target latency of the EGSIEM NRT solutions is five days**, which is primarily dictated by the availability of the required input products. The preprocessing of GNSS (Global Navigation Satellite System) and GRACE data will be performed on the first day. Then, when dealiasing products for correction of atmospheric and oceanic short-term mass variations become available on approximately day three, the normal equations of the daily solution can be computed. Because the data coverage within one day does not allow for a solution based on GRACE data alone, the gravity maps of the NRT service will employ a prediction – correction principle. We will use information on the temporal behavior of the gravity field to predict the following day, and then improve this prediction with the available GRACE observations. After the correction step, the solution is checked for plausibility with external data, such as GNSS loading, to ensure a reliable estimate. The final, evaluated solution is then forwarded to the hydrological service (implemented at GFZ), which derives flood and drought indicators, which will then be used for example by EGSIEM project partner DLR's Center for Satellite Based Crisis Information.



Currently we are in the process of improving and adapting our processing strategies which is the first step towards the operational phase during the last year of the project. To give you an idea of what the NRT gravity products will look like, Figures 2 and 3 show a **snapshot of the gravity field during the Danube floods in 2006**.





Figures 2+3: Daily variations of the gravity field in the Danube basin in equivalent water height. The extreme flood event in 2006 is highlighted by the gray rectangle. Similar time series will be used to derive gravity based flood and drought indicators.

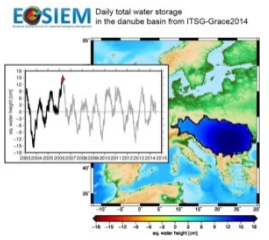
Daily Gravity Field Solution Teaser

For those of you who can't wait to get your hands on the near real-time daily gravity field solutions: TU Graz provides a continuous time series of gravity field snapshots from February 2003 to June 2014.

➡ http://itsg.tugraz.at/research/ITSG-Grace2014#daily

To get a visual overview you can check out the videos on the EGSIEM website.

➡ http://egsiem.eu/42-amazon-video.



EGSIEM Publications

The research results of the EGSIEM consortium are continuously published at international scientific conferences and intensively discussed within the scientific community. The most recent contributions are listed below. All presentations and posters are freely accessible and are available at the EGSIEM homepage!

In addition, updates on the work progress, background information related to the individual research projects, intermediate results, news and interesting facts relevant to the field of study are published on a weekly basis on our blog **https://egsiem.wordpress.com/**.

European Geosciences Union, Vienna
April 12th-17th, 2015

- **Adrian Jäggi et al.** European Gravity Service for Improved Emergency Management: a new Horizon2020 project to serve the international community and improve the accessibility to gravity field products
- **Matthias Weigelt et al:** Refinement of the acceleration approach for GRACE gravity field recovery
- **Yoomin Jean et al.:** Combination of GRACE monthly gravity field solutions from different processing centers
- **Uli Meyer et al.:** Combined GRACE/SLR monthly gravity field solutions

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

- **Uli Meyer et al.:** Improving the noise model for AIUB monthly gravity field solutions
- **Andreja Susnik et al.:** Validation of GNSS orbits using Satellite Laser Ranging data
- **Christian Gruber et al.:** European Gravity Service for Improved Emergency Management- a new Horizon2020 project to serve the international community and improve the accessibility to gravity field products
- **Beate Klinger et al.:** Improved GRACE reprocessing methodologies: impact on monthly gravity field solutions

Geodetic week, Stuttgart
September 15th-17th, 2015

- **Yoomin Jean et al.:** Combination of GRACE monthly gravity field solutions with different weighting schemes
- **Andreas Kvas et al.:** Towards near real-time daily GRACE gravity field solutions

GRACE Science Team Meeting, Austin, TX
September 21st-23rd, 2015

- **Frank Flechtner et al.:** European Gravity Service for Improved Emergency Management – EGSIEM a new Horizon2020 project to improve accessibility to gravity field products for hydrology

All publications are available for download at our homepage!
http://egsiem.eu/2015-02-25-15-55-59/publication

EGSIEM CONSORTIUM INTRODUCES ITSELF

Prof. Dr. Frank Flechtner

1 – Being a geodesist, monitoring of mass transport in system Earth from ultra-precise satellite-to-satellite tracking data has fascinated me already since about 15 years. From the very beginning I was deeply involved in the implementation and operation of GRACE. First, as the GFZ Science Data System Manager and since 2009 also as the GRACE Co-PI (Principal Investigator). The indescribable success of GRACE has motivated GFZ to realize with NASA a Follow-on mission (GRACE-FO) which is due for launch in August 2017. Here, I am responsible for the German contributed mission elements such as the launcher, mission operations, science exploitation, optical components to the innovative Laser Ranging Interferometer or a passive Laser Retro Reflector.

2 – GFZ is one of the analysis centers (AC) of EGSIEM and is providing a GRACE solution based on the dynamic approach. Additionally we provide, together with our project partner TU Graz, Near Real Time gravity field models which shall be used for early warning of floods and droughts. For this, I am the responsible Project Manager at GFZ and I am also a member of the EGSIEM Executive Board. This Coordination Team is responsible e.g. for the preparation of General Assembly meetings, decisions taken by the General Assembly, monitoring of the progress of the Consortium Plan and to propose any necessary modifications to the Consortium Plan.

3 - The main aspects of EGSIEM that interest me is the realization of a monthly combined gravity model which will likely be more precise than any other single AC solution. The second aspect is that I would like to see that satellite derived gravity information can be used for a flood and drought monitoring service. This would highly motivate for the realization of Next Generation Gravity Missions.

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?

EGSIEM CONSORTIUM INTRODUCES ITSELF

Prof. Dr. Andreas Güntner

1 – Towards improving our understanding of water cycle dynamics and of hydrological change, the integration of a diversity of geophysical and geodetic observations into hydrological analyses is as a highly promising strategy in my view. Being a hydrologist, I've always been fascinated by the unprecedented type of integrative water storage information that GRACE provides for hydrology. It is running like a common thread through my research activities trying to make geodetic techniques (gravimetry, altimetry, GNSS reflectometry) useful for hydrological applications, including the possibly unintended use of geodetic sensors for hydrology.

2 – In EGSIEM, I am head of Work Package 6, the hydrological service. I am responsible for developing activities that evaluate the GRACE-based gravity products from a hydrological perspective, and that transfer these data into hydrological products. In particular, I am coordinating the work that explores the value of GRACE for characterizing and forecasting hydrological extreme events, i.e., floods and droughts. I am responsible for the development of EGSIEM products that may feed into flood and drought monitoring and warning services.

3 – One main point of interest in EGSIEM for me is to explore whether there is significant information content in GRACE at monthly and higher time resolution that is of value for flood and drought monitoring. The appealing challenge I see is to set up adequate processing, visualization and data distribution chains that serve as a prototype and blueprint also for future gravity satellite missions.

Dr. Ben Gouweleeuw

1 – To be perfectly honest, I'm somewhat of a novice when it comes to geodesy. Having said that, I've always been keen on the application of novel satellite remote sensing concepts and techniques to the field of hydrology. I think it's true to say the GRACE mission has been a game changer in this regard, providing an unprecedented type of terrestrial water storage information.

2 – The hydrological interpretation of the GRACE-based gravity products is the main aspect of my work in EGSIEM. More specifically, this involves the development and evaluation of gravity-based indicators for flood forecasting and drought monitoring to provide added value to early-warning services for hydrological extremes.

3 – One of the novelty aspects of EGSIEM is to investigate whether there is hydrological information content in GRACE solutions at higher than monthly (read: daily) time resolutions for flood and drought monitoring. It will be really interesting to see if this information will help to extend (seasonal) forecasting lead times.

Helmholtz-Centre Potsdam
GFZ German Research Centre for Geosciences
http://www.gfz-potsdam.de

Dr. Christian Gruber

1 – Geodesy is a merger of individual disciplines such as geophysics and mathematics with a strong engineering touch. Measurement systems and their error models need to be well understood in order to improve results or develop new sensors and measurement concepts. As a good example may serve the effect of anomalies of the gravity field leading to perturbations of the orbital trajectories of artificial satellites. If they are known then the counterpart can be concluded by forward or inverse modeling. But the connection of a theory in lab conditions with the real world data as it has been detected truly poses a major challenge.

2 – My role is to process available GRACE ranging data and develop appropriate algorithms that enable to improve the temporal resolution and latency of GRACE products for the user community. Currently one month of data needs to be accumulated and the availability of background models for necessary reductions takes several weeks. In the future the models will be available within 5 days and the GRACE ranging data are processed directly, which means that there will be no accumulation any more. Increasing the temporal resolutions also means that we can sensor relevant mass transport on shorter time-scales than before. If this succeeds then hydrological extreme events can be detected and quantified by indicators for prediction of floods and droughts. This would then become a true added value for users that wish to track and monitor mass transport in the Earth system.

3 – EGSIEM covers a variety of important aspects to improve available gravity field models towards consistent and user friendly products. The newly feedback from these improvements can hopefully again improve our knowledge of the error models and understand the (mis)conceptions that we were using before.

MEET EGSIEM

Earth Observation for Water Cycle Science, Frascati, Italy, October 20th-23rd, 2015

AGU Fall Meeting, San Francisco, CA, USA
December 14th-18th, 2015

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