European Gravity Service for Improved Emergency Management - Status and project highlights

Torsten Mayer-Guerr, Jäggi Adrian, Ulrich Meyer, Yoomin Jean, Andreja Susnik, Matthias Weigelt, Tonie van Dam, Frank Flechtner, Christian Gruber, Andreas Güntner, Ben Gouweleeuw, Andreas Kvas, Beate Klinger, Jakob Flury, Sean Bruinsma, Jean-Michel Lemoine, Hendrik Zwenzner, Stephane Bourgogne, and Tamara Bandikova

EGU General Assembly 2016

Vienna, April 20th
European Gravity Service for Improved Emergency Management - Status and project highlights

Torsten Mayer-Guerr, Jäggi Adrian, Ulrich Meyer, Yoomin Jean, Andreja Susnik, Matthias Weigelt, Tonie van Dam, Frank Flechtner, Christian Gruber, Andreas Güntner, Ben Gouweleeuw, Andreas Kvas, Beate Klinger, Jakob Flury, Sean Bruinsma, Jean-Michel Lemoine, Hendrik Zwenzner, Stephane Bourgogne, and
EGSIEM Project - Three services shall be established

- **Scientific combination service**
- **Near real-time/regional service**
- **Hydrological service**

**Altimetry**
- Hydroweb (Topex/Poseidon, Jason, ENVISAT, GFO, Sentinel 3)

**Gravity & GNSS & SLR**
- GRACE
- GRACE-FO (future missions)
- GPS, Gionass, Galileo
- LAGEOS, Starlette, Stella, AJISA

**Copernicus**
- ENVISAT/ASAR, TerraSAR-X, Radarsat-2, Sentinel 1
Scientific service

EGSIEM Analysis Centers (ACs):
- GFZ
- CNES
- AIUB
- TUG - ITSG
- University of Luxembourg
- More in the future ...

1. Improvements of the processing
2. Integration of complementary data
3. Harmonization of processing standards
4. Combination of the solutions
1. Improvements of the processing

A lot of tests, comparisons, discussions: instruments, calibration, background models
1. Improvements of the processing

A lot of tests, comparisons, discussions: instruments, calibration, background models

G4.2 09:00
Beate Klinger et al.:
The new ITSG-Grace2016 release

Poster X3.40
Saniya Behzadpour et al.:
Robust estimation of error covariance functions in GRACE gravity field determination
2. Integration of complementary data

- Reprocessed GPS orbits and clock corrections
- SLR for low degree gravity field
- POD from non-dedicated satellites
2. Integration of complementary data

- Reprocessed GPS orbits and clock corrections
- SLR for low degree gravity field
- POD from non-dedicated satellites
3. Harmonization of processing standards

- Common reference frame and GPS orbit constellation
- Ensemble of different background models
- Distribution of solutions at normal equation level in standard SINEX format

```plaintext
% = SNX 2.02
+ FILE/REFERENCE
+ FILE/COMMENT
+ SOLUTION/STATISTICS
+ SOLUTION/NORMAL_EQUATION_VECTOR
+ SOLUTION/NORMAL_EQUATION_MATRIX U
+ SOLUTION/ESTIMATE
+ SOLUTION/APRIORI
% ENDSNX
```
4. Combination of the solutions

- Only one product for the user
- Reduced noise
4. Combination of the solutions

- Only one product for the user
- Reduced noise

Poster X3.35
Ulrich Meyer et al.:
EGSIEM: Combination of GRACE monthly gravity models on normal equation level

Poster X3.48
Yoomin Jean et al.:
Simulation study on combination of GRACE monthly gravity field solutions
4. Combination of the solutions

Poster X3.38
Martin Horwath et al.: 
Evaluation of recent GRACE monthly solution series with an ice sheet perspective

Poster X3.43
Lea Poropat et al.: 
Validation of EGSIEEM gravity field products with globally distributed in situ ocean bottom pressure observations

Tuesday Poster X2.309
Zhao Li et al.: 
Validation of the EGSIEEM combined monthly GRACE gravity fields

- Reduced noise
EGSIEM Project

Scientific combination service

Near real-time/regional service

Hydrological service

Mayer-Gürr et al.: European Gravity Service for Improved Emergency Management - Status and project highlights

Slide 13
Daily updated gravity field solutions from GRACE

- Data distribution is a challenge
Daily updated gravity field solutions from GRACE

- Data distribution is a challenge

- Additional information is introduced in form of a **process model**
  - Prediction based on spatio-temporal correlations from geophysical models
  - Solution is weighted mean between GRACE observations and prediction

\[ t - 2 \quad \Rightarrow \quad t - 1 \quad \Rightarrow \quad t \]

GRACE obs. \( l_{t-1} \)

GRACE obs. \( l_t \)

**GRACE Kalman Filter** (Kurtenbach et al. 2012)
Example: The Danube basin
Example: The Danube basin

River discharge at Bazias, 2006
Example: The Danube basin

River discharge at Bazias, 2006

Water storage: GRACE monthly solutions
Example: The Danube basin

Water storage: GRACE monthly solutions
Daily Kalman solutions

River discharge at Bazias, 2006

EWH [cm]

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Q [m³/s]

CSR (350km Gaussian filter) ITSG-Grace2016
Example: The Danube basin

Water storage:
- GRACE monthly solutions
- Daily Kalman solutions

G3.2/CR2.4/HS11.7/OS4.9 Monday 14:30
Andreas Kvas et al.:
Near real-time GRACE gravity field solutions for hydrological monitoring applications

HS2.1.1 Monday Poster A.66
Ben Gouweleeuw et al.:
Evaluation of GRACE daily gravity solutions for hydrological extremes in selected river basins

River discharge at Bazias, 2006
Near real time (max. 5 days delay)

- Adapted daily gravity field processing scheme:
  - Rapid GNSS constellation and Earth orientation
  - forward only filtering → increased high frequency noise
Integration into automatic flood emergency management services

- Rapid mapping service request via end-users
- Satellite data ordering
- Flood peak
- 1\textsuperscript{st} satellite acquisition
- 2\textsuperscript{nd} satellite acquisition
- Satellite-based crisis response

Time [h]

-72 -48 -24 0 24 48 72
Integration into automatic flood emergency management services

- Satellite data ordering
- Satellite data acquisitions
- Rapid mapping service request via end-users
- Flood-alert via GRACE-based early warning indicators
- Flood peak
- Satellite-based monitoring of evolving flood situations and crisis response

Time [h]

-72 -48 -24 0 24 48 72
Summary (1/2)

Scientific combination service

Near real-time/regional service

Hydrological service
Summary (2/2)

- Much effort is going on
Much effort is going on

**EGSIEM: Combination of GRACE monthly gravity models on normal equation level**

Ulrich Meyer et al.

**Simulation study on combination of GRACE monthly gravity field solutions**

Yoomin Jean et al.

**Validation of the EGSIEM combined monthly gravity fields**

Lea Poropat et al.

**SLR in the framework of the EGSIEM project**

Andrea Maier et al.

**Evaluation of recent GRACE monthly solution series with an ice sheet perspective**

Martin Horwath et al.

**Near real-time GRACE gravity field solutions for hydrological applications**

Ben Gouweleeuw et al.

**Validation of the EGSIEM combined monthly gravity fields**

Martin Horwath et al.

**Simulation study on combination of GRACE monthly gravity field solutions**

Yoomin Jean et al.

**Robust estimation of error covariance functions in GRACE gravity field determination**

Saniya Behzadpour et al.

**Gravity field models derived from Swarm data**

João de Teixeira da Encarnação et al.

Saniya Behzadpour et al.

**The new ITSG-Grace2016 release**

Beate Klinger et al.

**Evaluation of GRACE daily gravity solutions for hydrological extremes in selected river basins**

Zhao Li et al.

**Validation of the EGSIEM combined monthly gravity fields**

Martin Horwath et al.

**Evaluation of recent GRACE monthly solution series with an ice sheet perspective**

Martin Horwath et al.
News and updates will be regularly published on various media, e.g., by the quarterly EGSIEM Newsletter.

www.egsiem.eu

EGSIEM is also present on social media:
https://twitter.com/EGSIEM
www.facebook.com/egsiem
https://egsiem.wordpress.com
This project is funded by the Horizon 2020 Framework Programme of the European Union under grant agreement No 637010.