EGSIEM

European Gravity Service for Improved Emergency Management

Action Items Status & Upcoming Deliverables

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Upcoming Deliverables

EGSIEM
European Gravity Service for Improved Emergency Management

Deliverable (number)	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
3.1	Reference Frame Product Report	3	UL	R	PU	M10
7.2	EGSIEM Brochure	7	UBERN	DEC	PU	M14
7.3	Teaser Lecture	7	UBERN	DEC	PU	M15
2.2	GRACE/GRACE-FO Product Report	2	TUG	R	PU	M18
4.1	Concept of Scientific service	4	UBERN	R	PU	M18

Upcoming Milestones

EGSIEM

European Gravity Service for Improved Emergency Management

Milestone number	Milestone name	Related work package(s)	Estimated date	Means of verification
1	Finalisation of Processing Standards	WP 3	2	D2.1 is available
2	Implementation and preparation Review	WP 2,3,5	10	Implementation and preparation work finished, T2.2, T3.1, T3.2 finished, T5.2 and T5.4 implementations finished
3	Service Readiness	WP4,5,6	18	Scientific, NRT and Hydrological service set up, T4.1, T5.1 finished, T5.2 and T5.4 ready for service run
4	Operational NRT Service Readiness	WP5,6	27	Preparation work for operational NRT service finished
5	Final Review	WP 1-7	36	All work packages finished

Work package number	2			Start Date or Starting Event				M01
Work package title	Gravity field analysis							
Participant number	1	2	3	**4**	5	**6**	7	8
Short name of participant	UBERN	UL	GFZ	**TUG**	LUH	**CNES**	DLR	G&C
Person/months per participant:	24	18	10	18	10	17		

Objectives

- Critical analysis of GRACE processing standards, background models, reference frames and algorithms.
- Consistent orbit parameter estimation process and gravity model reprocessing for a time frame of two years by five gravity ACs
- Establishment of a realistic GRACE-FO instrumental error behavior to be used in GFZ´s E2E gravity data simulator to investigate the gain for hydrological applications which can be expected from GRACE-FO or Next Generation Gravity Missions using LRI observations.

Description of work

T2.1 Processing Standards and Models UBERN, UL, GFZ, TUG, CNES M01-M02

Input: *GRACE release 05 processing standards*

The current GRACE release 05 processing standards (e.g. IERS2010 conventions), background models (e.g. ocean tides or atmospheric and oceanic short-term mass variations), and algorithms (e.g. interpolation methods) will be critically analyzed. The results from this review shall be consistently applied to a large extent by all gravity ACs within this proposal to enable a consistent gravity model reprocessing at different centers and later combination of these harmonised individual solutions in WP 4. Additionally we will define realistic error measures for background models to be used as input for the E2E simulation (see T2.4)

Output: *D2.1*

T2.2 Improved processing tools UBERN, UL, GFZ, TUG, LUH, CNES M01-M10

Input: *D2.1*

Systematic errors will be reduced by re-processing two years of existing GRACE data with harmonised standards and improved sensor data and analysis methods. They are based on recent findings and the treasure of almost twelve years of GRACE data. This will result in better tools to analyze and improve the pre-processing of the sensor data and the gravity and orbit parameter estimation processes. We will in particular implement improved stochastic modelling and study space-time parameterizations in the established processing chains to achieve a better separation of gravitational and non-gravitational contributions in the satellite data, and to effectively reduce aliasing effects from rapid mass changes. The sum of these activities will significantly contribute to the effective scientific exploitation of the GRACE mission and will prepare the involved ACs for GRACE-FO.

Updates of the individual processing centres:

- UBERN: Enhancements are expected from improved standards and models as well as from advanced empirical error modelling using sophisticated constraints
- UL: Enhancement concerning numerical differentiation issues and the combination of the relative ranges and rates, orientation data and the positions derived by the GNSS receiver
- GFZ: Enhancements are expected from improved standards and models as well as from experience related to instrument parameterization gained during last RL05 reprocessing
- TUG: Improvements especially regarding the findings of the noise behaviour of the different sensors. A tailored stochastic modelling with an auto adapting strategy will be developed. The de-aliasing problem is faced by improved space-time representation of the time variable gravity field
- LUH: Enhancements are expected from improved pre-processing methods for sensor data
- CNES: Enhancement are expected from a refined weighting of the different data types (GPS/KBR)

T2.3: Data analysis UBERN, UL, GFZ, TUG, LUH, CNES M11-M18

Input: *D2.1, Reference frame data from T3.1, SLR normal equations from T3.2, GRACE Level-1B data*

- Re-processing of two years of Level-1B sensor data; LUH
- Re-processing of two years of kinematic GRACE orbit positions (to be used by several EGSIEM ACs) and generation of auxiliary products (e.g. antenna phase centre variation maps); UBERN

Re-processing of two years of existing GRACE data for gravity field determination:

- Celestial Mechanics Approach; UBERN
- Acceleration Approach; UL
- Direct Approach; GFZ
- Short-Arc Approach: TUG
- Direct Approach: CNES

Output: *Re-processed Level-1B sensor data, GRACE kinematic orbits and five different series of monthly gravity field solutions, D2.2*

T2.4: Instrumental behaviour and End-to-End Simulator LUH, GFZ M06-M18

Input: *GRACE L1B data, Simulated instrument noise series for E2E*

The new Laser Ranging Interferometer (LRI), to be flown on GRACE-FO, is expected to substantially improve the science results. We will assess the space-time parameterization to address the aliasing problem and will also investigate still existing problems with the non-gravitational accelerations. Here, the EGSIEM consortium will also benefit from the expertise through the associated member Technische Universität München (TUM), which will share their experience for meeting the numerical challenges posed by the greatly improved measurement precision of the LRI observations.

In parallel we will update and use our E2E (end-to-end) data simulator for future space data to investigate, based on above harmonised processing standards and models, the gain for hydrological applications which can be achieved with GRACE-FO or Next Generation Gravity Missions.

Output: *Deliverable 2.2*

Deliverables

2.1 Processing Standards and Models	M02
2.2 GRACE/GRACE-FO Product Report	M18

Work package number	3	**Start Date or Starting Event**						M01
Work package title	Integration of complementary data							
Participant number	1	2	3	4	5	6	7	8
Short name of participant	UBERN	UL	GFZ	TUG	LUH	CNES	DLR	G&C
Person/months per participant:	16	6	3			1	10	

Objectives

- Pre-processing of all necessary supplementary data which are needed for the gravity field analysis in WP 2 and the combination with the gravity data and hydrological models in WP 4-6.
- Loading estimates derived from GNSS station time series are used for validation of the combined global, the near real-time and the regional gravity field solutions.
- Lake and river levels from the Hydroweb project are used together with hydrological models in WP 6 as well as Glacial Isostatic Adjustment (GIA) models for separating the hydrological trend.

Description of work

T3.1: Reference Frame reprocessing UBERN M03-M10

Input: *D2.1, IGS and ILRS data*

SLR and GNSS observations collected by the terrestrial tracking networks of the ILRS and the IGS will be reprocessed for two years for generating fully consistent input products for gravity field recovery, in particular GNSS satellite orbits and satellite clock corrections. With such a set of products kinematic trajectories for LEOs will be derived in T2.3, which are fully consistent to the GNSS and geodetic SLR orbits and to the reference frame represented by the ensemble of used ground stations. The task will provide coordinates of the SLR and GNSS tracking stations, GNSS and geodetic SLR satellite orbits, Earth rotation parameters, and GNSS satellite clock corrections. Since the number of reference stations is limited to nearly globally but sparsely distributed 250 stations, we will extend (densify) the coverage for the validation in T3.5 by processing other existing regional networks using the GNSS products generated in this task.

Output: *D3.1, Reference frame data*

T3.2: SLR normal equations UBERN M07-M09

Input: *D2.1, ILRS data*

SLR data to the satellites LAGEOS, Starlette, Stella, and AJISAI will be processed to realise the combination of the SLR tracking with the GNSS station network for T3.1. Low-degree gravity field coefficients shall be set up in the SLR analysis in addition to station coordinates, Earth orientation parameters, and satellite orbit parameters. Normal equations based on the SLR measurements will be established using D2.1. Provided that all common parameters are consistently set up, the resulting normal equations may be correctly combined in T3.1 using local ties.

Output: *SLR normal equations*

T3.3 NRT Reference Frame processing UBERN M03-M06

Input: *D2.1, Reference frame data from T3.1, IGS data*

GNSS observations collected by the terrestrial tracking networks of the IGS will be processed with a latency of one day to generate input products for the NRT service.

Output: *NRT reference frame data*

T3.4 Operational NRT Reference Frame processing UBERN M28-M33

Input: *D2.1, IGS data*

Operational NRT reference frame processing for the duration of the operational test run phase of T5.3.

Output: *Operational NRT reference frame data*

T3.5 Validation of GRACE gravity products with GNSS site displacements UL M19-M36

Input: *D2.1, Reference frame data, Combined Solution from T4.2*

The establishment of a consistent reference frame in T3.1 will also yield consistent GNSS station time series which can be used for validation. The basic concept is described in Sect. 1.3.4. Mass redistributions cause site displacements which can be observed by GNSS. The gravity field solutions from WP 4 are validated by converting these representations of mass redistributions to site displacements. Atmospheric and ocean-contributions will be added using state-of-the-art models according to D2.1. Alternative models will be tested. The site displacements can be compared to the GNSS station time series.

Output: *D3.2, D3.3*

T3.6 Validation of GRACE gravity products with Ocean Bottom Pressure GFZ M25-M36

To aid in the validation of gravity change data over the oceans, we will also use OBP data as estimated by the OMCT model and used for operational generation of the AOD1B RL05 dealiasing product.

Output: *D3.2, D3.3*

T3.7: Preparation of Hydroweb data CNES M07-M10

Input: *Altimetry data*

For comparison and integration purposes within WP6, altimetry-based water levels are needed. The Hydroweb data provides lake, reservoir and river levels for various basins worldwide. The task comprises the preparation and delivery of lake level data from merged satellite altimetry data and river level data of virtual stations defined at the intersection of satellite tracks.

Output: *Lake level data*

T3.8: GIA for Hydrology LM (covered by SLA, see Sect. 3.3.4) M11-M36

Input: *D2.1, Gravity field solutions from T2.3, combined solution from T4.2, NRT solutions from T5.2 and T5.3, regional solutions from T5.4*

Efficient monitoring tools of the available water resources on regional and local scales need to take global interactions into account. In northern latitudes, e.g. in Fennoscandia, the tilting due to the GIA will be modelled by applying the latest GIA models. This is necessary because it strongly affects groundwater flow and lake surface control. The consortium will benefit from the latest developments in GIA modelling through the associated member Lantmäteriet (LM; the Swedish mapping, cadastral and land registration authority).

Output: *GIA models*

T3.9: Compilation of representative historical flood situations DLR M01-M10

For the validation of the GRACE derived flood and drought indices, historical flooding situations are derived based on records of suitable databases and services (ZKI, DFO, and the International Charter "Space and Major Disasters"). They are based on the following parameters: a) concurrent availability of GRACE data and medium to high resolution satellite data (mainly from Copernicus contributing missions), b) considerations of scale and flood size/extent, c) flood regime and hydrological/environmental settings. SAR satellite data will be mainly acquired via ESA's GMES Coordinated Data Access System and 2-D flood masks from medium to high resolution SAR and optical satellite data will be extracted.

Output: *List of selected historical flooding situations, 2-D flood masks*

Deliverables

3.1 Reference frame product report	M10
3.2 Scientific product validation report	M36
3.3 NRT product validation report	M36

Work package number	5		Start Date or Starting Event				M01
Work package title	NRT and regional Service						
Participant number	1	2	3	4	5	6	7	8
Short name of participant	UBERN	UL	GFZ	TUG	LUH	CNES	DLR	G&C
Person/months per participant:		3	26	33				

Objectives

- Provision of NRT mass redistribution products for all areas of interest
- Provision of regional gravity field solutions with increased spatial resolution

Description of work

T5.1: Requirements and Concept GFZ, TUG M01-M03

Input: *D2.1*

We will investigate the requirements and needs for NRT gravity processing regarding instrument data (e.g. availability of GRACE Q/L Level-1B data), background models (e.g. short-term atmospheric and oceanic mass variations) and auxiliary data (e.g. IGS orbit products, Earth rotation parameters) and will setup necessary interfaces to other WPs or to the GRACE Science Data System.

Output: *NRT service requirements and D5.1*

T5.2: NRT Solutions: Processing TUG, GFZ M04-M27

Input: *D2.1, NRT service requirements from T5.1 and D5.1, NRT reference frame data from T3.3, List of historical flooding situations and 2-D flood masks from T3.9*

We will improve current methods based on either (TUG) daily Kalman filter modelling (up to degree 40) or (GFZ) alternative and experimental representations of the gravity field (e.g. radial base functions) to derive NRT mass transport solutions with daily updates and will reprocess these models using NRT input data and models at least for all GRACE data since 2006 (first time availability of L1B Q/L solutions at JPL) for all areas of interest.

Output: *D5.2*

T5.3: Operational NRT Solutions: Processing TUG, GFZ M28-M33

Input: *D2.1, NRT service requirements from T5.1, operational NRT reference frame data from T3.4*

Operational test run phase of NRT service

Output: *D5.3*

T5.4: Regional Solutions: Concept and Processing TUG, GFZ M04-M27

Input: *D2.1, NRT reference frame data from T3.3, List of historical flooding situations and 2-D flood masks from T3.7*

GFZ and TUG will improve current methods based on alternative representations of the gravity field (e.g. radial base functions) to derive regional mass transport solutions and will process these alternative and experimental models for the complete mission period for all areas of interest.

Output: *D5.4*

T5.5: Generation of Area Mean Values GFZ M19-M36

Input: *D2.2, D4.2, D5.2, D5.4, 2-D flood masks of WP3*

We will derive for all areas of interest and all flooded regions area mean values (AMV) based on gridded equivalent water heights of gravity field time series derived in WPs 2, 4 and 5 and masks defined in WP3. Resulting AMVs will be used in WP6 e.g. for derivation of flooding indicators and will be visualised in WP7.

Output: *area mean values for all selected areas of interest*

T5.6: Validation/Feedback UL M19-M36

Input: *D2.1, NRT reference frame data from T3.3, gravity field solutions from T5.2, T5.3, T5.4*

The gravity field solutions from T5.2, T5.3, T5.4 are validated with hydrological models, e.g. GLDAS, WGHM, and with independent GNSS loading time series. For the latter approach the representations of mass redistributions are converted to site displacements. Atmospheric and ocean-contributions will be added using state-of-the-art models according to D2.1. The procedure will be automated to allow for a just-in-time validation of the NRT service products.

Output: *D5.5*

Deliverables

5.1 Concept of NRT Service	M03
5.2 NRT Service product report	M27
5.3 Operational NRT Service product report	M33
5.4 Regional solution product report	M27
5.5 NRT validation report	M36

Action Items Status

EGSIEM
European Gravity Service for Improved Emergency Management

Action Item Status List (open and new AI's)				
A.I.	**Originator**	**Actionee**	**Action Description**	**Due Date**
001	EGSIEM	EGSIEM ACs	GFZ, UBERN: Review of the comparison table	31.01.2015
			TUG, CNES, UL: Complement the comparison table	31.01.2105
			UBERN: Summarize potential harmonization of Standards	08.02.2015
			UBERN, UL, GFZ, TUG, CNES: Input to other processing details (parametrization, …)	08.02.2015
			UBERN: Create a draft EGSIEM Standards document, highlight commonalities/differences between EGSIEM ACs	15.02.2015
			UBERN, UL, GFZ, TUG, CNES: Review and finalize the EGSIEM Standards Document	28.02.2015

Action Items Status

EGSIEM

European Gravity Service for Improved Emergency Management

002	EGSIEM	TUG	Initiate discussion about the proposal to add back the monthly mean of all gravitational accelerations reduced during the processing before combination. Clarify needs for a practical realization, e.g. concerning data gaps.	31.05.2015	
003	EGSIEM	EGSIEM ACs	Each AC to provide information necessary to incorporate the SINEX format for the exchange of gravity field information	31.05.2015	
004	EGSIEM	GFZ	Definition of cooperation with UBONN for integration of new GRACE products into WGHM data assimilation scheme.	31.05.2015	
005	EGSIEM	UBERN, TUD	Service Level Agreement with ESA's Climate Change Initiative	31.05.2015	
006	EGSIEM	WP Managers	Collect ideas for paper topics to set up a publication plan.	31.05.2015