

# Upcoming Deliverables

| <b>Deliverable (number)</b> | <b>Deliverable name</b>         | <b>Work package number</b> | <b>Short name of lead participant</b> | <b>Type</b> | <b>Dissemination level</b> | <b>Delivery date</b> |
|-----------------------------|---------------------------------|----------------------------|---------------------------------------|-------------|----------------------------|----------------------|
| 1.1                         | Management guidelines           | 1                          | UBERN                                 | R           | CO                         | M02                  |
| 2.1                         | Processing standards and models | 2                          | TUG                                   | R           | PU                         | M02                  |
| 5.1                         | Concept of NRT service          | 5                          | GFZ                                   | R           | PU                         | M03                  |
| 3.1                         | Reference Frame Product Report  | 3                          | UL                                    | R           | PU                         | M10                  |
| 7.1                         | EGSIEM project website          | 7                          | UBERN                                 | DEC         | PU                         | M03                  |

# Timeline

| EGSIEM                                                                         | Duration in months | Year 1              |   |   |   |   |   |   |   |   |    |    |    | Year 2 |    |    |    |    |    |    |    |    |    |    |    | Year 3 |    |    |    |    |    |    |    |    |    |    |    |
|--------------------------------------------------------------------------------|--------------------|---------------------|---|---|---|---|---|---|---|---|----|----|----|--------|----|----|----|----|----|----|----|----|----|----|----|--------|----|----|----|----|----|----|----|----|----|----|----|
|                                                                                |                    | 1                   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13     | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25     | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| <b>WP1 Management</b>                                                          | 36                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T1.1 Legal and financial Management                                            | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T1.2 Scientific Coordination                                                   | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP2 Gravity field analysis</b>                                              | 18                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T2.1 Processing Standards and Models                                           | 2                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T2.2 Improved processing tools                                                 | 10                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T2.3 Data analysis                                                             | 8                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T2.4 Instrumental behaviour and End-to-End Simulator                           | 13                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP3 Integration of complementary data</b>                                   | 36                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.1 Reference frame reprocessing                                              | 8                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.2 SLR normal equations                                                      | 3                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.3 NRT reference frame processing                                            | 4                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.4 Operational NRT reference frame processing                                | 6                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.5 Validation of GRACE gravity products with GNSS site displacements         | 18                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.6 Validation of GRACE gravity products with Ocean Bottom Pressure           | 12                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.7 Preparation of Hydroweb data                                              | 4                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.8 GIA for Hydrology                                                         | 26                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T3.9 Compilation of representative historical flood situations                 | 10                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP4 Scientific service</b>                                                  | 27                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T4.1 Design and concept                                                        | 12                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T4.2 Operation                                                                 | 15                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T4.3 External Validation                                                       | 15                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP5 Near realtime and regional service</b>                                  | 36                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.1 Requirements and Concept                                                  | 3                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.2 NRT Solutions: Processing                                                 | 24                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.3 Operational NRT Solutions: Processing                                     | 6                  | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.4 Regional Solutions: Processing                                            | 24                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.5 Generation of Area Mean Values                                            | 18                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T5.6 Validation/Feedback                                                       | 18                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP6 Hydrological service</b>                                                | 36                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T6.1 Evaluation of historical flood events                                     | 24                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T6.2 Develop. & evaluation of gravity-bas. ind. for flood & drought forecastir | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T6.3 Rapid mapping concept                                                     | 30                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP7 Dissemination and Exploitation</b>                                      | 36                 | [Blue bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.1 Project information                                                       | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.2 GRACE plotter                                                             | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.3 Competition                                                               | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.4 Public education                                                          | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.5 Dedicated sessions at conferences                                         | 36                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| T7.6 Summer school                                                             | 12                 | [Grey bar]          |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>General Assembly meetings</b>                                               |                    | [Red vertical bars] |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>Consortium meetings</b>                                                     |                    | [Red vertical bars] |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>Advisory Board meetings</b>                                                 |                    | [Red vertical bars] |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>WP meetings</b>                                                             |                    | [Red vertical bars] |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |
| <b>Periodic reports</b>                                                        |                    | [Red vertical bars] |   |   |   |   |   |   |   |   |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |

# Administration

- In case of questions:
  - Check the GA and CA
  - Contact Keith

# WP2

- Improvement of AC processing:
  - See presentations about individual improvements
  - TG: Advise to avoid duplication of Level-1B processing
- E2E Simulator:
  - Presentation postponed, slides not yet shown
- Standards:
  - Agreed on proposal how to proceed (see action items)
  - Main conclusion (at moment): clear documentation of various processing, GGOS table provided by TG as a possible starting point
  - Update of the document later on planned
  - Points of discussion:
    - add back monthly mean of dealising products before combination. What would be needed for practical realization (data gap problem)? Who takes care of this?

# Proposal

- Action Item (End of January):
  - GFZ, UBERN, (CSR): Review the comparison table
  - TUG, CNES, UL: Fill out the comparison table
  - UBERN: Summarize KO outcome of Standards harmonization
  - UBERN, UL, GFZ, TUG, CNES: Provide input to other processing details (parametrization, ...) identified at KO
- Action Item (Mid of February):
  - UBERN: Create the EGSIM Standards document (inspired by the GRACE Standards from GFZ/CSR) and point out commonalities/differences between individual EGSIM ACs
  - TELECON UBERN, GFZ, TUG, CNES, UL
- Action Item (End of February):
  - UBERN, UL, GFZ, TUG, CNES: Review and Finalization of EGSIM Standards Document

|                                       |                        |    |                                     |            |     |      |     |     |
|---------------------------------------|------------------------|----|-------------------------------------|------------|-----|------|-----|-----|
| <b>Work package number</b>            | 2                      |    | <b>Start Date or Starting Event</b> |            |     |      |     | M01 |
| <b>Work package title</b>             | Gravity field analysis |    |                                     |            |     |      |     |     |
| <b>Participant number</b>             | 1                      | 2  | 3                                   | <u>4</u>   | 5   | 6    | 7   | 8   |
| <b>Short name of participant</b>      | UBERN                  | UL | GFZ                                 | <u>TUG</u> | LUH | CNES | DLR | G&C |
| <b>Person/months per participant:</b> | 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: Enhancements 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 EGSIM 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 EGSIM 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 |

# WP3

- Reference frame:
  - Role of SLR for GNSS orbit determination not yet decided (co-location on satellite level?)
- Hydroweb:
  - How will the data be used in the project
- GIA:
  - Model not yet fixed



|                                       |                                   |    |                                     |     |     |      |     |     |
|---------------------------------------|-----------------------------------|----|-------------------------------------|-----|-----|------|-----|-----|
| <b>Work package number</b>            | 3                                 |    | <b>Start Date or Starting Event</b> |     |     |      |     | M01 |
| <b>Work package title</b>             | Integration of complementary data |    |                                     |     |     |      |     |     |
| <b>Participant number</b>             | 1                                 | 2  | 3                                   | 4   | 5   | 6    | 7   | 8   |
| <b>Short name of participant</b>      | UBERN                             | UL | GFZ                                 | TUG | LUH | CNES | DLR | G&C |
| <b>Person/months per participant:</b> | 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 (ZKL, 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
- 3.2 Scientific product validation report
- 3.3 NRT product validation report

M10  
M36  
M36





# WP4

- Combination:
  - simple average vs. weighted average (how to derive?), combination on normal equation level? Strategies will be evaluated in the course of the project.
  - Slides on SINEX Format for exchange of normal equations postponed.
- Level-3:
  - Which filters should be used?
  - Disseminated from where?

|                                       |                    |    |                                     |     |     |      |     |     |
|---------------------------------------|--------------------|----|-------------------------------------|-----|-----|------|-----|-----|
| <b>Work package number</b>            | 4                  |    | <b>Start Date or Starting Event</b> |     |     |      |     | M07 |
| <b>Work package title</b>             | Scientific Service |    |                                     |     |     |      |     |     |
| <b>Participant number</b>             | <u>1</u>           | 2  | 3                                   | 4   | 5   | 6    | 7   | 8   |
| <b>Short name of participant</b>      | <u>UBERN</u>       | UL | GFZ                                 | TUG | LUH | CNES | DLR | G&C |
| <b>Person/months per participant:</b> | 30                 | 3  | 2                                   |     |     |      |     |     |

#### Objectives

- Combination of the global monthly gravity models from the individual ACs
- Provision of user-friendly Level-3 products
- Validation of the individual and the combined gravity field solutions

#### Description of work

##### T4.1: Design and concept UBERN, UL

M07-M18

Input: *D2.1*

The required scientific service products will be defined. This includes Level-2 gravity field products (spherical harmonics) and Level-3 gravity field products (e.g. in equivalent water heights or surface mass densities on global scales). Standard data formats will be used and new formats defined if necessary. Feedback from the AB board and the user community on the defined products, as well as requests for additional products, will be addressed throughout the operational phase of the service;

Two methodologies for the combination of the individual AC solutions will be established:

- Pair-wise comparison of solutions to derive approximate empirical weights for the individual ACs,
- Combination of all AC gravity fields to generate a combined field using two schemes:
  - Calculate a weighted average of the gravity field parameters based on the previously derived weights.
  - Define the combined solution based on the NEQs generated by the individual ACs.

Output: *D4.1*

##### T4.2: Operation UBERN, UL

M19-M33

Input: *D2.1, D4.1, GRACE orbit and gravity field solutions from T2.3*

- Service operations will be performed for the GRACE solutions. The operations will consist of internal (mutual) validations of the products of the five ACs. Validations will be performed for the monthly gravity field solutions and include the derivation of more realistic error estimates and the calibration of formal errors.
- Eventually the monthly gravity field solutions will be combined according to the methodologies described in D4.1
- Readily useable products for geophysics and climate research are derived from the combined products. This includes gridding, filtering, and converting them into equivalent water heights.

Output: *D4.2, Combined solution, Products for geophysical applications*

##### T4.3: External Validation GFZ, UBERN, UL

M19-M33

Input: *Gravity field solutions from T2.3, Combined solution from T4.2*

The operations of the service will also consist of external validations of the monthly solutions of the five ACs and the combined GRACE solutions:

- Comparison and assessment of the times series of gravity field parameters from T2.3 and the combined solutions from T4.2 with solutions from external sources, e.g. JPL, CSR
- Comparison and assessment of all times series of gravity field quantities using available hydrological models, e.g. GLDAS, WGHM.
- Comparison and assessment of the time series of gravity field parameters with GNSS loading time series from T3.6.
- Error budgeting: Quantify the performance of each monthly solution for different applications.

Output: *D4.3*

#### Deliverables

- 4.1 Concept of Scientific service
- 4.2 Scientific service product report
- 4.3 Validation report

M18

M33

M33



# WP5

- Latency:
  - NCEP models are available within 5 days, but quality is not convincing. How to do the validation. According to the proposal, validation has to be done in NRT

|                                |                          |    |                              |     |     |      |     |     |
|--------------------------------|--------------------------|----|------------------------------|-----|-----|------|-----|-----|
| 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

|                                       |                      |    |                                     |     |     |      |            |     |
|---------------------------------------|----------------------|----|-------------------------------------|-----|-----|------|------------|-----|
| <b>Work package number</b>            | 6                    |    | <b>Start Date or Starting Event</b> |     |     |      |            | M01 |
| <b>Work package title</b>             | Hydrological Service |    |                                     |     |     |      |            |     |
| <b>Participant number</b>             | 1                    | 2  | <u>3</u>                            | 4   | 5   | 6    | 7          | 8   |
| <b>Short name of participant</b>      | UBERN                | UL | <u>GFZ</u>                          | TUG | LUH | CNES | <u>DLR</u> | G&C |
| <b>Person/months per participant:</b> |                      |    | <u>30</u>                           |     |     |      | 6          |     |

Input: *flood indicators from T6.2, List of flood events and flood masks from T3.9, water level time series from T3.7, NRT solutions from T5.2, operational NRT solutions from T5.3*

- Definition of user requirements for rapid mapping and emergency management
- Development and evaluation of operational workflows for improved on demand programming of high/medium-resolution satellite data using gravity-based indicators for flood forecasting.

Output: *D6.2*

#### Objectives

- Validation of new gravity products for historical flood events
- Provision of gravity-based indicators for forecasting of hydrological extreme events with lead times of several months up to near real time
- Improved mechanisms for automatic satellite-based flood services

#### Deliverables

|                                                     |     |
|-----------------------------------------------------|-----|
| 6.1 Hydrological Service product report             | M30 |
| 6.2 Operational hydrological service product report | M36 |

#### Description of work

**T6.1: Evaluation of historical flood events** GFZ, DLR M07-M30

Input: *List of flood events and flood masks from T3.9, water level time series from T3.6, GIA-based trends from T3.8, combined solution products for geophysical applications from T4.2, NRT solutions from T5.2, regional solutions from T5.4*

- Validation and evaluation of the daily, near-real time and regional gravity products on water storage anomalies for selected flood events by a combination of complementary observation data sets and hydrological/hydraulic modelling
- Understanding mechanisms of the formation and dynamics of extreme events
- Preparation of a flood data catalogue to summarise the suite of multi-method data sets for the selected extreme events

Output: *D6.1, Contribution to D4.3, contribution to D5.2, contribution to 5.4*

**T6.2: Development and evaluation of gravity-based indicators for flood forecasting and drought monitoring** GFZ M01-M36

Input: *combined solution products for geophysical applications from T4.2, NRT solutions from T5.2, operational NRT solutions from T5.3, regional solutions from T5.4*

- Definition of user requirements for flood and drought indicators in monitoring and forecasting systems
- Development of indicators as a measure of catchment wetness from gravity-based water storage anomalies
- Evaluation of indicators in their performance for forecasting hydrological extreme events by calibration and data assimilation schemes for hydrological models and by statistical forecasting approaches
- Contribution to early-warning services for hydrological extremes

Output: *D6.1, D6.2, contribution to D5.3, flood and drought indicators*

**T6.3: Rapid mapping concept** DLR M07-M36





|                                |                                |    |                              |     |     |      |     |     |
|--------------------------------|--------------------------------|----|------------------------------|-----|-----|------|-----|-----|
| Work package number            | 7                              |    | Start Date or Starting Event |     |     |      |     | M01 |
| Work package title             | Dissemination and exploitation |    |                              |     |     |      |     |     |
| 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: | 8                              | 6  | 1                            |     | 8   |      | 2   | 10  |

#### Objectives

- Dissemination, exploitation and communication of and about the objectives and results of EGSiEM

#### Description of work

**T7.1: Project information** UBERN, UL, LUH, DLR M01-M36

As a standard dissemination instrument for project information the **EGSiEM website** will be implemented. The website will not just provide static information about the project but will be a living platform for disseminating, exploiting and communicating essentially all products and results generated according to the data management concept (see Sect. 2.2.2) to the users from the geodetic, geophysical, hydrological, oceanographic, atmospheric, and environmental science communities. The progress and scientific findings will be placed and regularly updated by providing a newsletter, setting up a blog and by connecting to new media. Most important findings are made public by press releases.

Output: D7.1

**T7.2: GRACE plotter** G&C M01-M36

The purpose of this task is to provide a well-designed, modern, fast, interactive, and user/public-friendly website for the visualisation and exploitation of gravity data from the GRACE and GRACE-FO missions. This website will allow instantaneous comparison of gravity time-series issued from the ACs in the consortium, after extraction over user-defined geographical areas (Level-2 and Level-3 data). A preliminary live demo is available at <http://www.grace-fo.eu/demo/plot>; password: **Horizon2020**.

**T7.3: Competition** LUH M01-M36

- Design the competitions with different complexity levels (i.e. for high school, Undergraduate students etc.)
- Generate the necessary data and processing tools for each competition run and publishing them.
- Communication with participants, further supports, keeping deadlines, defining the prizes, receiving the results and declaring the winners.

**T7.4: Public education** UBERN, UL, GFZ, LUH, DLR, all M01-M36

The benefit of the project, the steps to achieve these benefits, and the impact on the environment, economy and society will be communicated. In order to address the public at large and the press, brochures are generated and released electronically and by print media.

A Teaser lecture will be prepared to attract scholars to the field of engineering and science.

Contributions are foreseen for, e.g. UBERN "Physik am Freitag", UL/FNR "Chercheurs à l'école" and contacts to TV channels are given to promote the results and findings of the project in dedicated profiles.

Output: D7.2 D7.3

**T7.5: Dedicated sessions at conferences** UBERN, UL, GFZ, LUH, all M01-M36

We will submit regularly proposals for sessions at scientific conferences in order to bring the user community together, introduce new developments and exploit EGSiEM and its products. This will also allow

us to gather valuable feedback on the usability and requirements of the data access.

Output: *Summaries of these sessions*

**T7.6: Summer school** UBERN, all M25-M36

Young scientists and students will be prepared for the usage of the products in a one-week summer school to be conducted in the third year of the project. We will prepare half-day presentations (morning sessions) on the topics covered within the project and train the participants in the usage of the data (afternoon sessions). The presentations will be augmented by inviting high profile guests giving presentations on selected topics. Lecture notes will be prepared and distributed resembling also a comprehensive manual to the products. The notes will be made available on the website.

Output: D7.4

All tasks contribute to the plan for the dissemination and exploitation (living document).

#### Deliverables

|                                 |      |
|---------------------------------|------|
| 7.1 EGSiEM project website      | M 03 |
| 7.2 EGSiEM Brochure             | M 14 |
| 7.3 Teaser lecture              | M 15 |
| 7.4 Summer school lecture notes | M 36 |



# EGSIEM publication plan

According to the Description of Work, EGSIEM targets at least 2, preferably up to 4 publications per year.

- How can this be achieved?
- What kind of rules do we need?

Suggestions:

- Project overview
- ... (Input from WPs needed, action item to WP managers)

# Next Meeting

- Location: Bern
- Date: 11.-12. June, 2015

# Executive Board Meeting (during coffee breaks)

- Appointment of the Management Support Team