EGSIEM

European Gravity Service for Improved Emergency Management

The EGSIEM combination service for monthly gravity fields

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IAG Workshop

Satellite Geodesy for Climate Studies

Bonn, Germany

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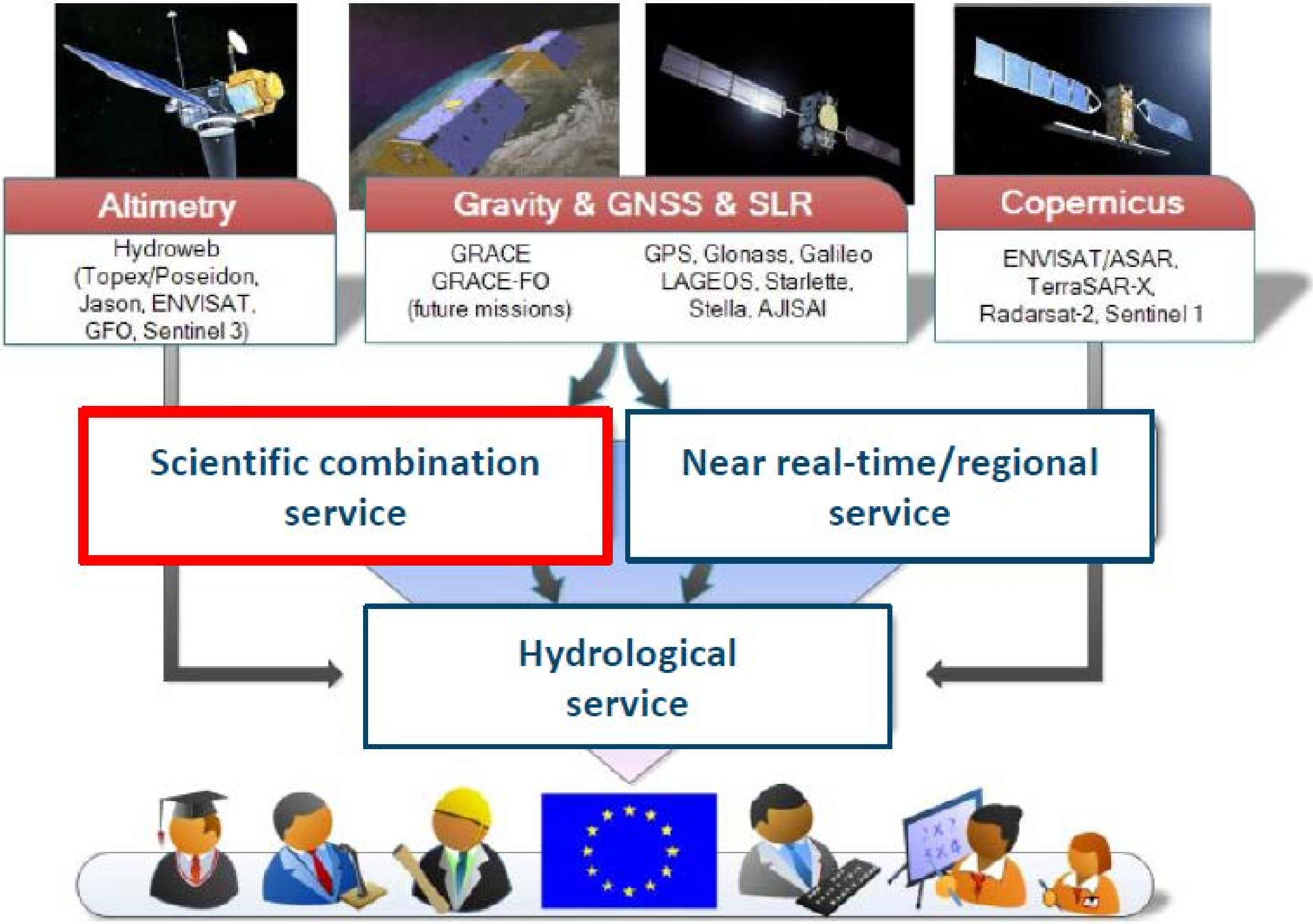
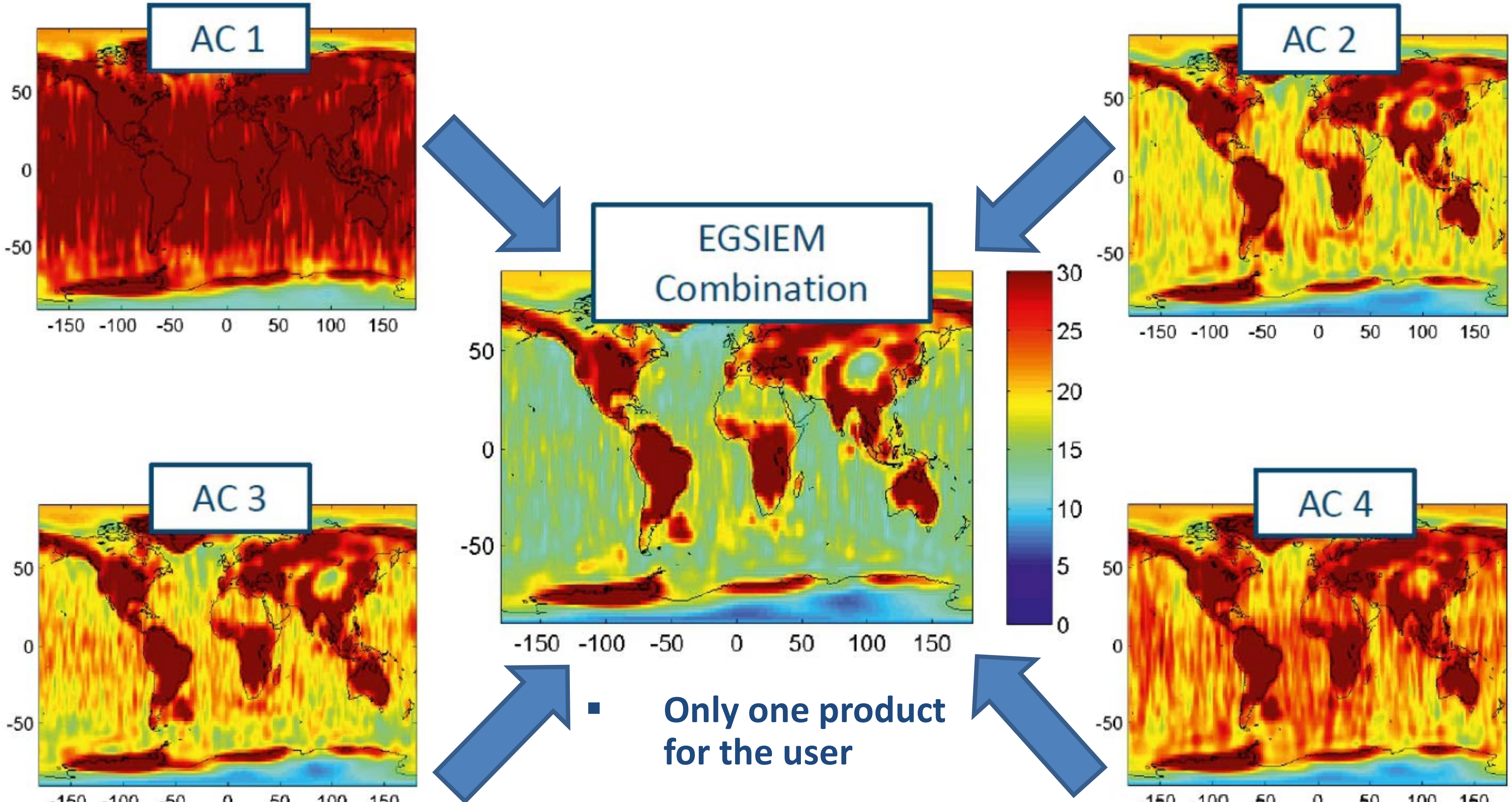
Contents

- The EGSIEM project
- The Scientific Combination Service
- Gravity Field Determination
- The EGSIEM plotter
- User-friendly L3-Products
- Transition to IAG service COST-G

EGSIEM Project – Three services are established



Scientific Combination Service



- Only one product for the user
- Reduced noise

Scientific Combination Service

- The EGSIEM combination service provides monthly GRACE K-band gravity fields combined on solution / normal equation (NEQ) Level.
- To ensure consistency, a set of common standards for reference frame, Earth rotation, force model and satellite geometry were defined.

Why combine results based on the same observations?

Errors in GRACE monthly gravity fields are still dominated by analysis and background model noise, not observation noise => AC-specific errors are reduced by combination!

Orbit and Gravity Field Determination

Linear observation equations:

$$\boldsymbol{l} = \boldsymbol{A}\boldsymbol{p} + \boldsymbol{\epsilon}$$

Weight matrix:

$$\boldsymbol{P} = \boldsymbol{C}_{ll}^{-1}$$

Solution (least-squares):

$$\boldsymbol{p} = (\boldsymbol{A}^T\boldsymbol{P}\boldsymbol{A})^{-1}\boldsymbol{A}^T\boldsymbol{P}\boldsymbol{l}$$

Linear observation equations:

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Observations

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Observations

unknown Parameters

Weight matrix:

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Linear observation equations:

$$l = Ap + \epsilon$$

Observations

Weight matrix:

unknown Parameters

$$P = C_{ll}^{-1}$$

Observation

Errors

Solution (least-squares):

Designmatrix

$$p = (A^T P A)^{-1} A^T P l$$

Linearization

Non-linear case:

$$\boldsymbol{A} = f(\boldsymbol{p})$$

A priori:

$$\boldsymbol{l}_0 = \boldsymbol{A}_0 \boldsymbol{p}_0$$

Corrections (least-squares):

$$\Delta \boldsymbol{p} = (\boldsymbol{A}_0^T \boldsymbol{P} \boldsymbol{A}_0)^{-1} \boldsymbol{A}_0^T \boldsymbol{P} (\boldsymbol{l} - \boldsymbol{l}_0)$$

Noise Model: Variance-Covariance

$$C_{ll} = \begin{pmatrix} \sigma_{l_1}^2 & \sigma_{l_1 l_2} & \cdots & \sigma_{l_1 l_n} \\ \sigma_{l_2 l_1} & \sigma_{l_2}^2 & \cdots & \sigma_{l_2 l_n} \\ \vdots & & \ddots & \vdots \\ \sigma_{l_n l_1} & \sigma_{l_n l_2} & \cdots & \sigma_{l_n}^2 \end{pmatrix}$$

Noise Model: Variance-Covariance

Variance information

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Covariance information: correlations

Problems

Simplified error model:

$$C_{ll_0} = \begin{pmatrix} \sigma^2_{\mathrm{GPS}} & & 0 \\ & \ddots & \\ 0 & & \sigma^2_{\mathrm{KBR}} \end{pmatrix}$$

Separate estimation (regularization):

$$\begin{pmatrix} \Delta \boldsymbol{p}_o \\ \Delta \boldsymbol{p}_g \end{pmatrix} = (\boldsymbol{A}_0^T \boldsymbol{P} \boldsymbol{A}_0)^{-1} \boldsymbol{A}_0^T \boldsymbol{P} (\boldsymbol{l} - \boldsymbol{l}_0)$$

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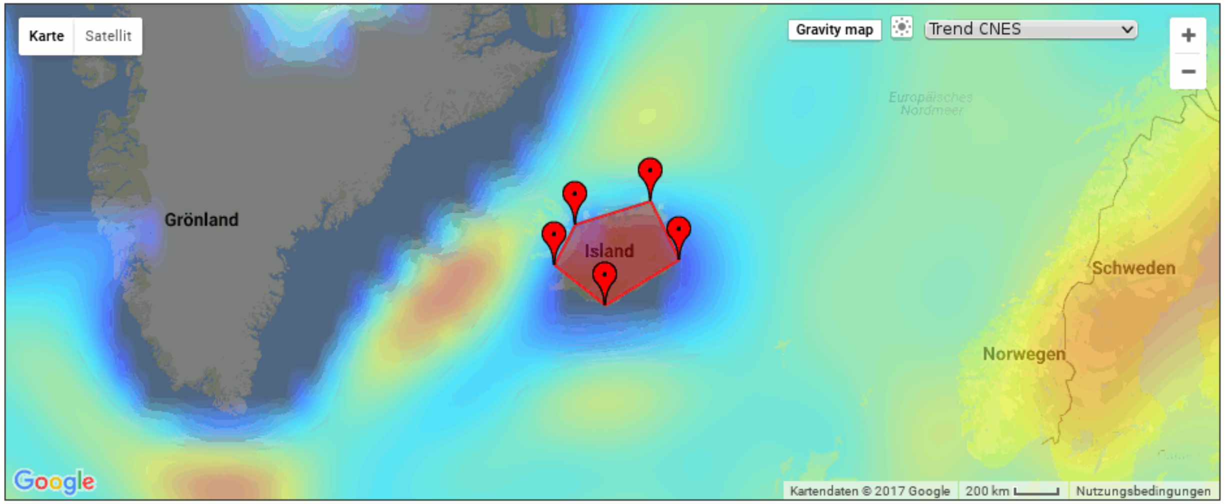
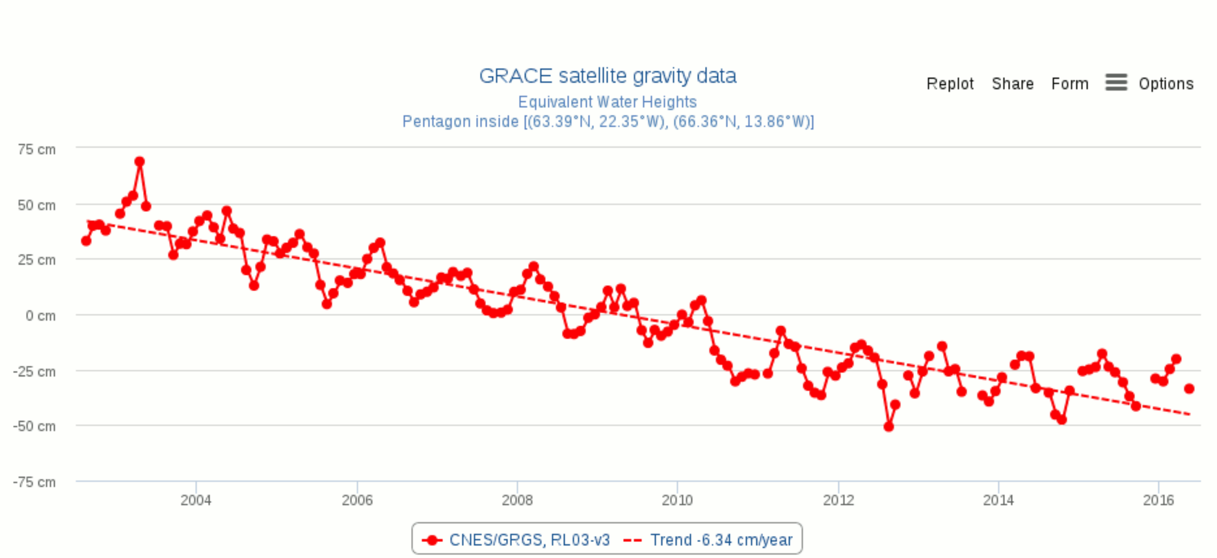
EGSIEM-Plotter (plot.egsiem.eu)





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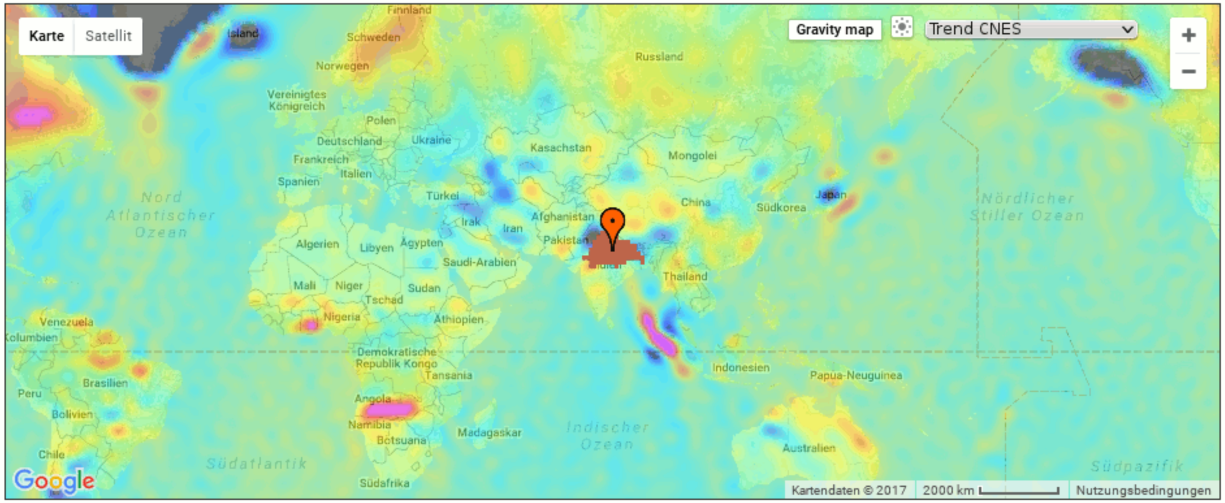

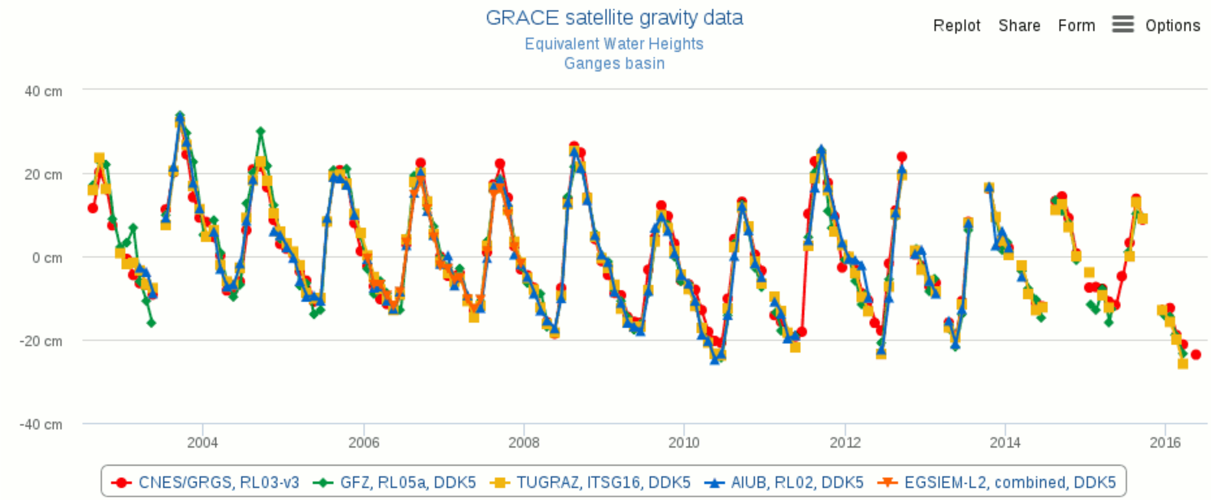

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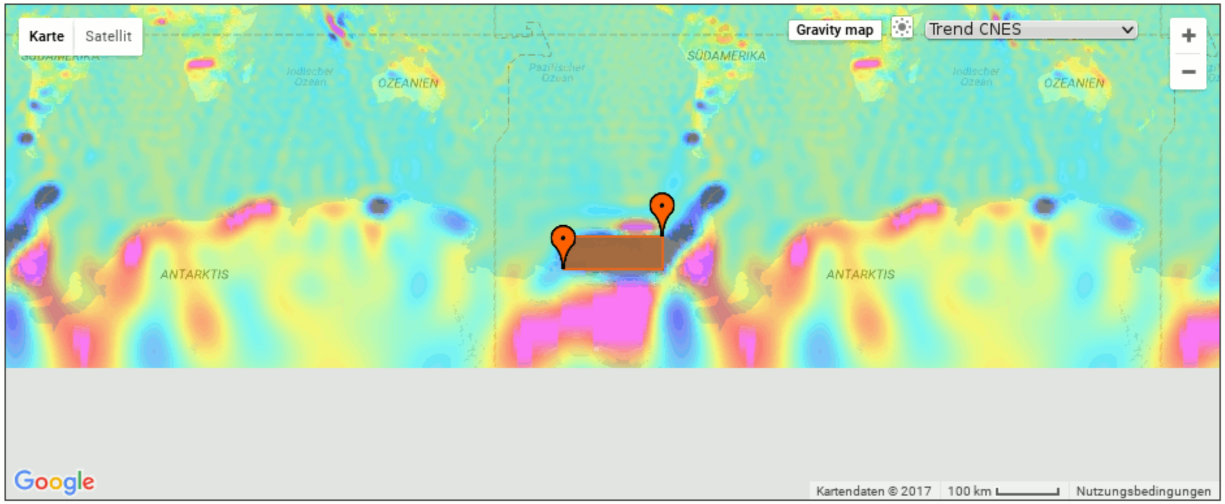

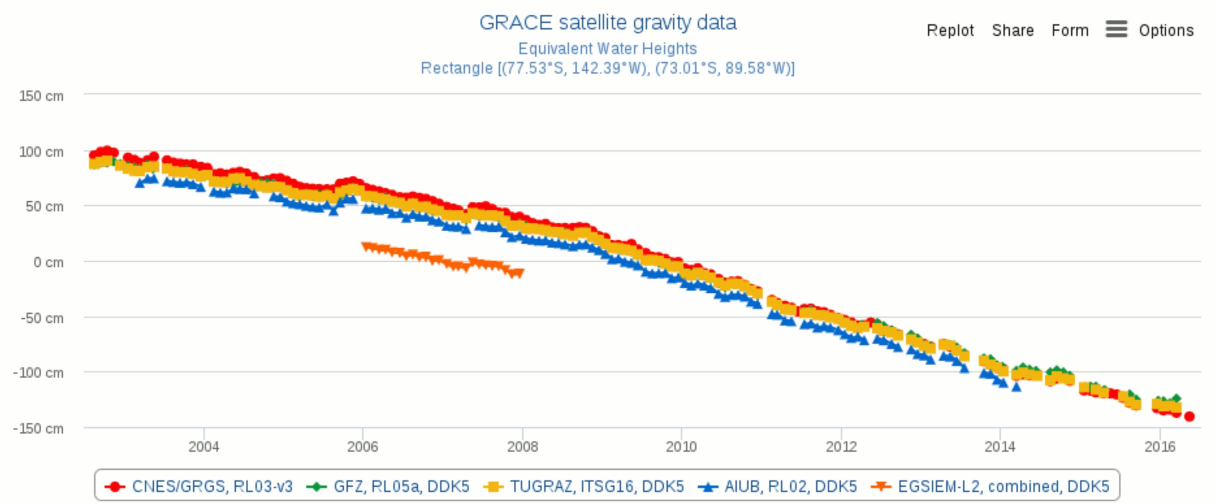

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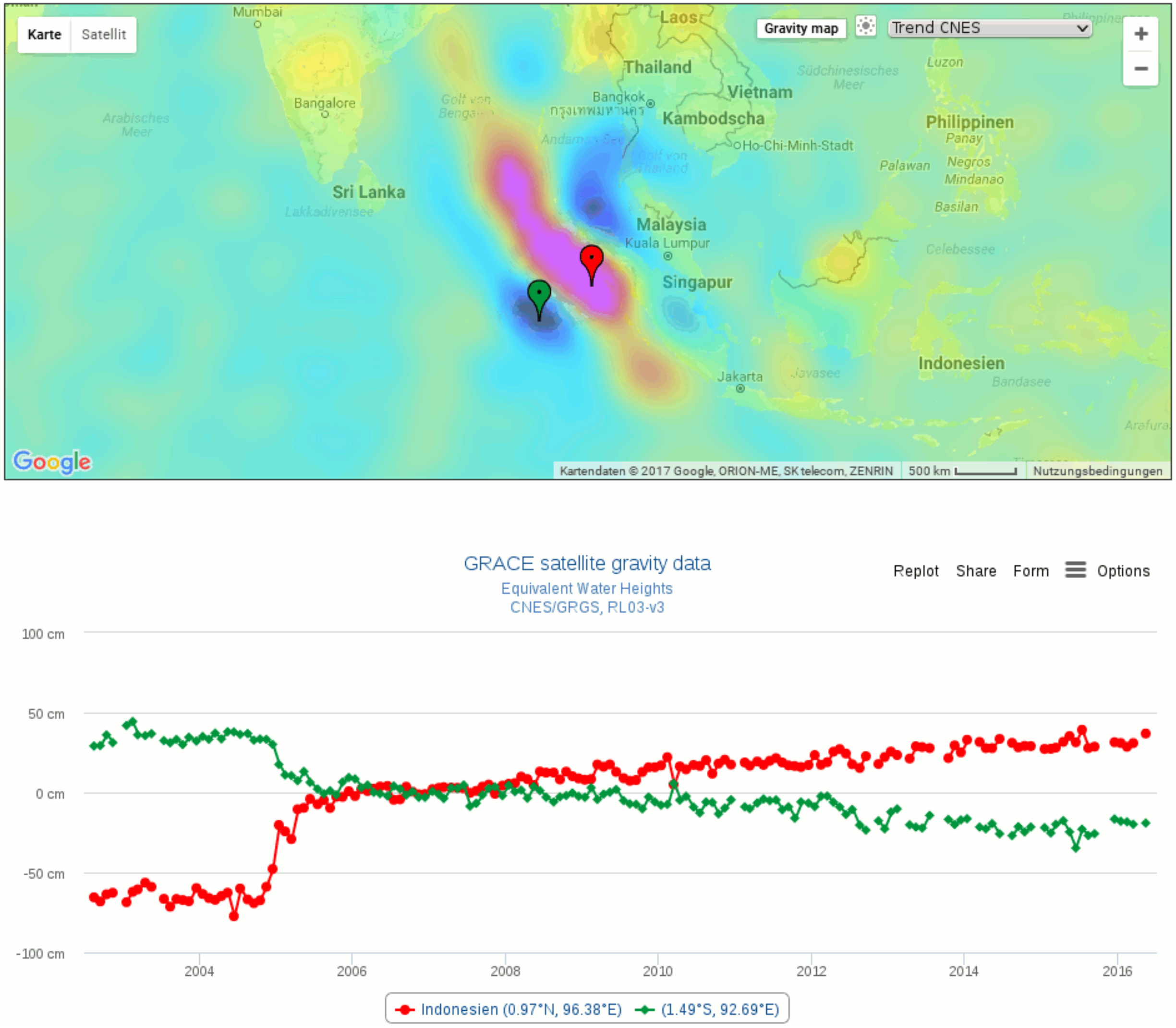
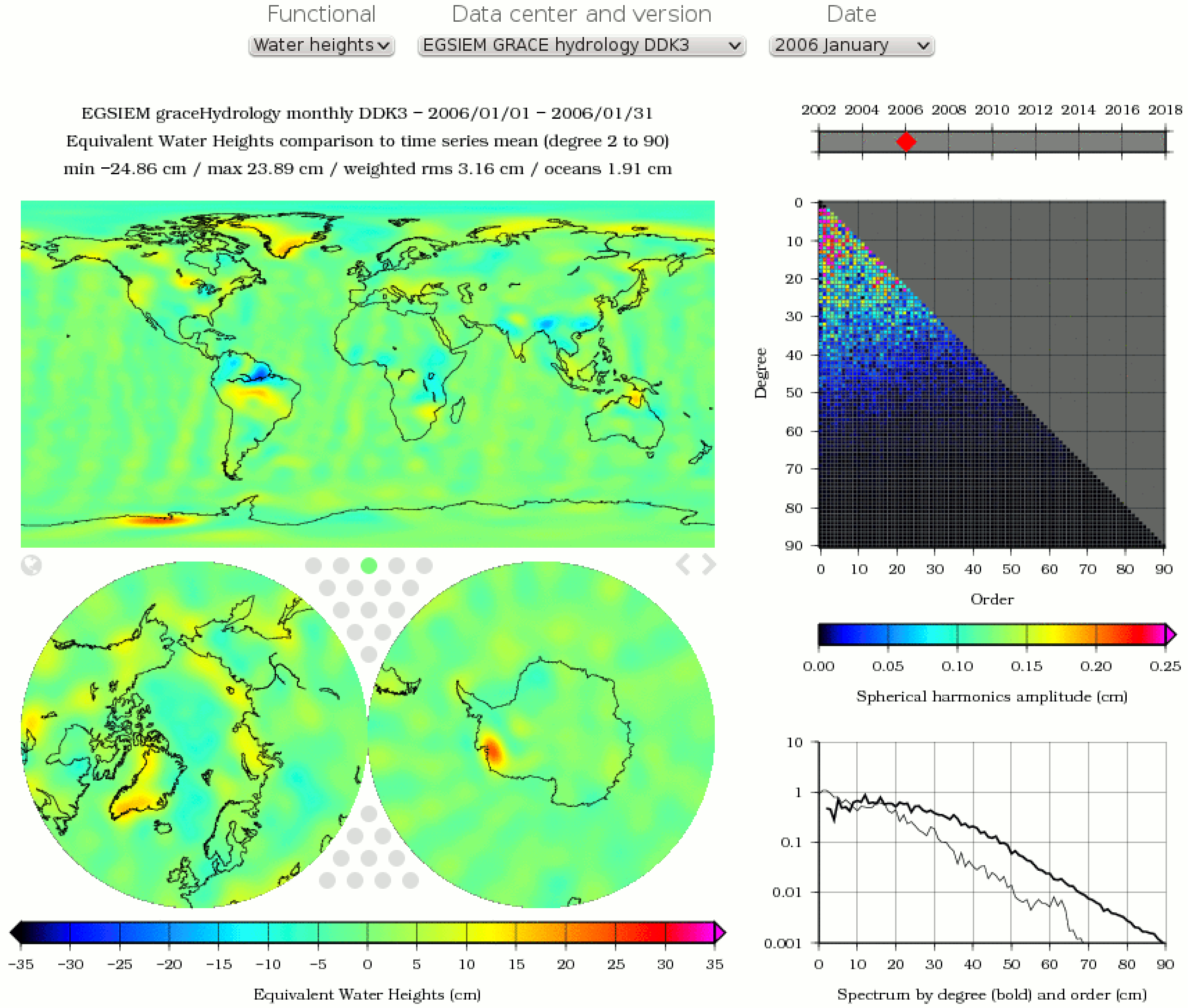


EGSIEM-Plotter: L3-products



Concluding Remarks

- The products of the EGSIEM combination service are available at:
  - SH-coefficients (Level-2): www.icgem.de
  - grids and de-aliasing (Level-3): www.egsiem.eu
- The combination service will be continued as a Combination Center (COST-G) under the umbrella of the International Gravity Field Services (IGFS) of the International Association of Geodesy (IAG).