No. 7
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Newsletter

EGSIEM

European Gravity Service for Improved Emergency Management

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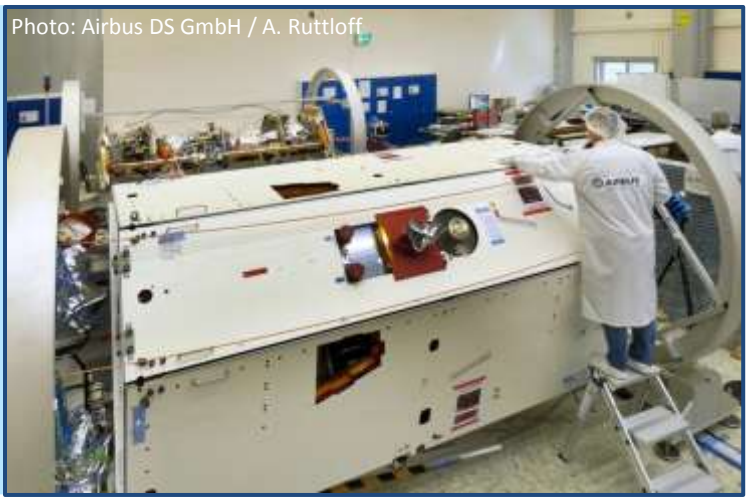


Photo: Airbus DS GmbH / A. Ruttloff

Signal-to-Noise Ratio of GRACE K-band ranging microwave system

Due to its capability to map time-variable gravity fields, GRACE is one of todays most important satellite missions, and its sensor performance is crucial in improving gravity field products for the community, which is one of the main goals of EGSIEM. We expect the next generation GRACE Follow-On mission will provide even greater performance, and we look forward to it's expected launch at the end of 2017, as the build of the first unit is now complete (see above).

GRACE K-band range-rate observations are one of the most fundamental aspects of the computation of earth's gravity field. The observations are computed from the dual K- and Ka-band frequencies (24 & 32 GHz respectively) one way microwave ranging system. Errors in these frequencies may have a direct impact on gravity field observations. Scientists at EGSIEM beneficiary Leibniz Universität Hannover have investigated Signal-To-Noise Ratio (SNR) values of the ranging frequencies to evaluate errors in the measurements of these frequencies. Their investigations show that the three SNR values (K- and Ka-band SNR of GRACE-A and K- band SNR of GRACE-B) are affected by instrument temperature drops and sun & moon intrusions causing blinding of the on board star cameras.

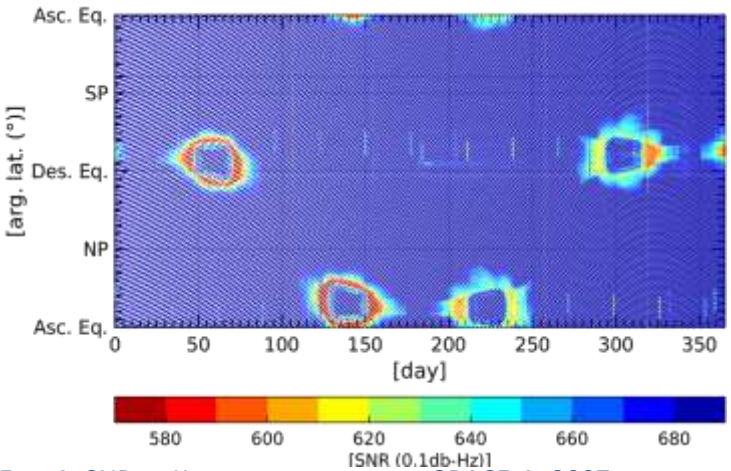


FIG. 1: SNR OF K-BAND MEASUREMENTS GRACE-A, 2007

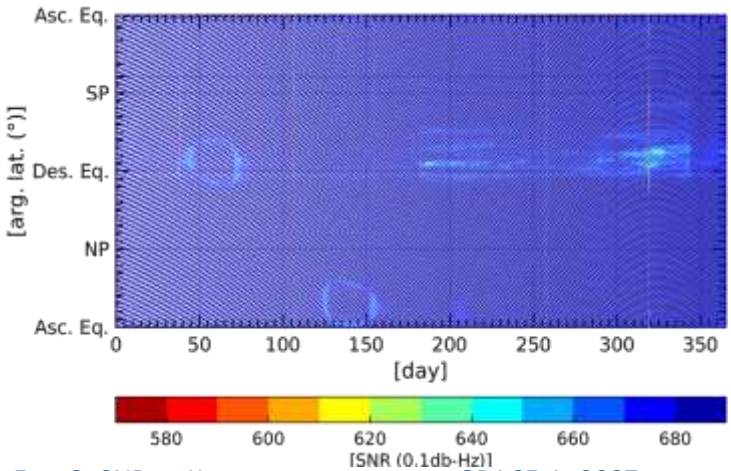
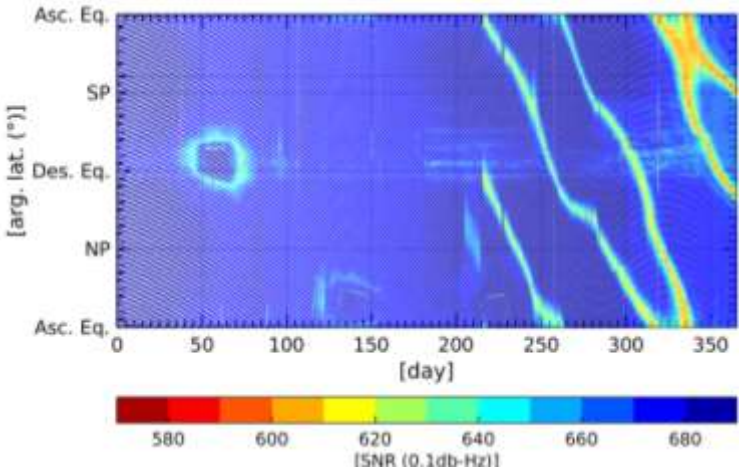


FIG. 2: SNR OF KA-BAND MEASUREMENTS GRACE-A, 2007

SNR of GRACE K-band ranging microwave system...

The SNR of Ka-band from GRACE-B was anomalous during most of the mission period, therefore it is not shown here. In addition, in Figs. 1-3, SNR measurements of these three frequencies are plotted for one year i.e. 2007. SNR values dropped instantly during the transition from normal to sun or moon blinding phase of star camera heads (cf. Fig. 4). Intrusion effects are higher on SNR of K-band of GRACE-A than the other two SNR values. Note that there are two star cameras on each GRACE spacecraft, which are referred as head one (head#1) and head two (head#2) in Fig. 4.



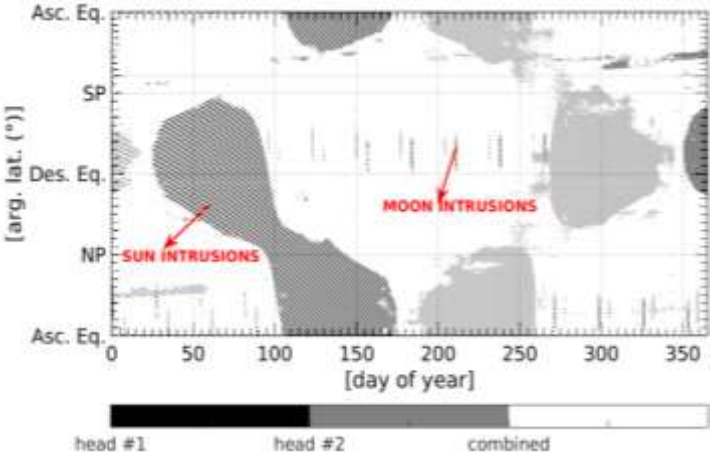
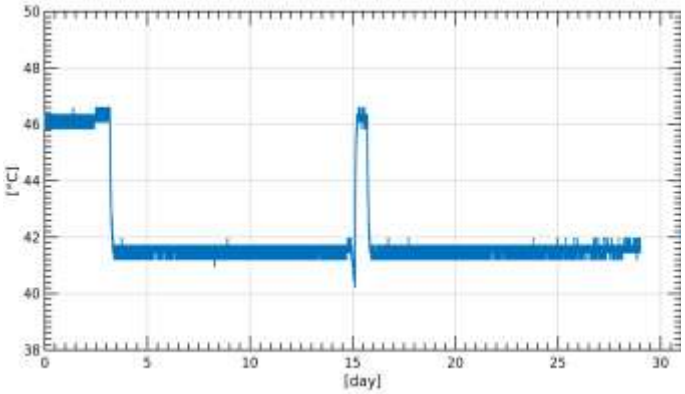


FIG. 3: SNR OF K-BAND FREQUENCY OF GRACE-B FOR YEAR 2007 **FIG. 4:** STAR CAMERA HEADS BLINDING STATUS FOR YEAR 2007

Beside the drops in SNR related to sun and moon intrusion, the SNR of GRACE-B is affected by drops in instrument temperature. In Fig. 5 and 6, temperature and the SNR of GRACE-B of August 2007 show perfect correlation with each other. Due to low temperature (Fig. 5), bands with low SNR values are seen in argument of latitude plot (Fig. 6). When temperatures normalise (see situation on day 15 in both figures) the SNR values are again high in that region. GRACE-A SNR values do not show any temperature dependent correlation. Their impact on GRACE gravity field solutions is suspected and has to be investigated.

However, in the case of the GRACE Follow-On mission this effect is not expected to be seen in K-band measurements, due to increased thermal shielding of the instruments on-board the twin-satellites.



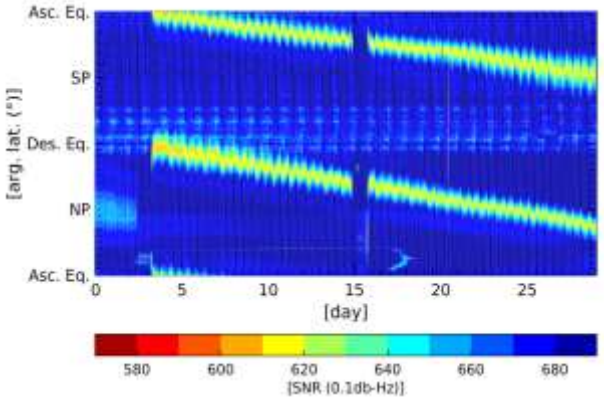


FIG. 5: INSTRUMENT TEMPERATURE OF GRACE -B DURING THE MONTH OF AUGUST 2007

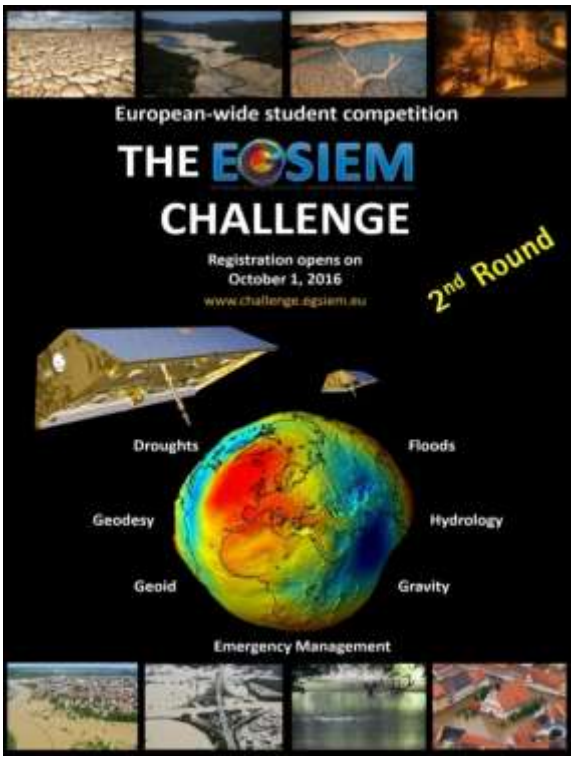
FIG. 6: SNR OF K-BAND FREQUENCY OF GRACE-B DURING AUGUST 2007

For more information about KBR SNR errors, please refer to Sujata Goswami (M. Tech), Institut für Erdmessung (IfE), Leibniz Universität Hannover and the following article:

Goswami S. and Flury J. (2016): *Analysis of errors of K-band microwave system and their impact on GRACE range-rate observations*. In Celestial Mechanics and Dynamical Astronomy (under review).

THE EGSIEM STUDENT CHALLENGE | 2nd Round

As mentioned in EGSIEM Newsletter No. 6 the first round of the EGSIEM Student Challenge was launched on **01.10.2016**. In the first round, students were asked to answer twenty multiple-choice questions about gravity, hydrology and their application in emergency management. Around one hundred B.Sc. and M.Sc. students from around Europe and from different disciplines participated in the challenge. The 1st round closed on 10.11.2016.



We are pleased to announce that the 2nd round of the EGSIEM Student Challenge began on **15.11.2016.** Thirty-seven B.Sc. and M.Sc. students successfully passed the first round. In the second round, students will be expected to provide written answers to another twenty questions. This will involve some online study, but will also incorporate some textbooks which should already be familiar to students in the Geodesy, Hydrology, Geophysics fields. The deadline to submit your answers to the questions of the second round EGSIEM student challenge is **15.12.2016**. We will announce the winner of the EGSIEM Student Challenge before Christmas on **20.12.2016.**

Towards operational daily Kalman solutions in (NRT)

At GFZ, Near-Real-Time (NRT) mass transfer solutions have been improved by enhancements of the individual methodologies (radial basis functions, spherical harmonic solutions) and through feedback from dedicated evaluations against ground truth for the case of extreme events. Currently, the necessary adoptions for the near real time processing chain, concerning access, availability and quality of NRT data and predictions are undertaken and tested. Both NRT processing centers, TU Graz and GFZ, have established the full NRT data life-cycle from acquisition of the quick-lock data as well as predicted Earth orientation parameters, GNSS orbit constellations and clocks from AIUB. After the definition of the interface routines, the software framework allows for an automated processing of daily batches with even shorter latencies than the initial forecast. This is due to high efforts concerning software efficiency for the implemented algorithms, as well as the availability of required auxiliary data with shorter delays than expected. This means, that extreme events can be tracked well below the anticipated 3-5 days. Differences to the consolidated, i.e. post-processed data that serves as a reference, have been detected and are being investigated further to foster development and improvements towards convergence. Before all historical data had been processed in two updated versions (v100, v101 for radial basis functions and ITSG2015, ITSG2016 for the spherical harmonic solutions) that serve for validation, comparison and feedback. During the next months and the time after the upcoming General Assembly in January 2017, we will gear up efforts for the operational NRT service to become fully operational around **01.04.2017**.

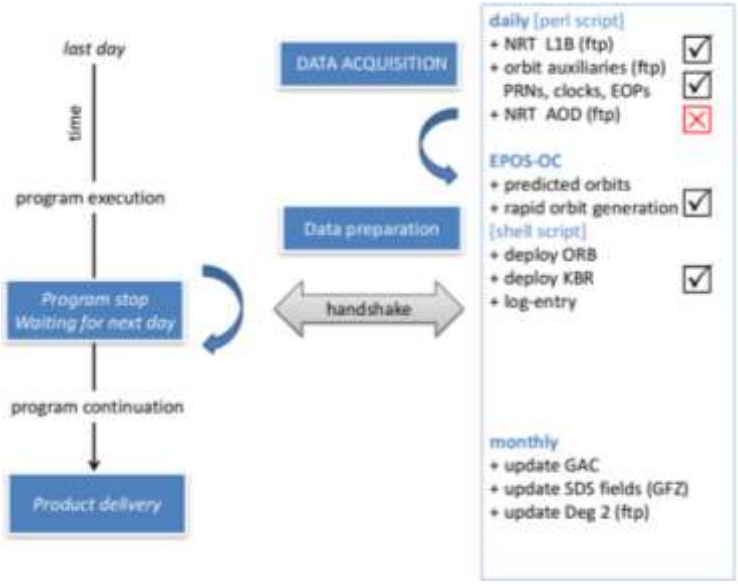


FIG 7: EXCEPT FOR THE NRT DE-ALIASING PRODUCT, AOD, CURRENTLY ALL THE REQUIRED DATA HAS BECOME AVAILABLE WITHIN THE REQUIRED TIME-FRAME.

EGSIEM CONSORTIUM INTRODUCES ITSELF

Jean-Michel Lemoine

1 – About everything interests me in Geodesy! If it was not the case I would certainly not have spent the last 27 years working in that discipline.
Because it is at the crossroads of many sciences, it brings you to very varied environments: you have to deal with physics, mathematics, flight dynamics, solar radiation pressure, albedo, Earth and ocean, tides, hydrology, electromagnetics, high precision metrology, relativity… and perhaps the most delicious and the most common activity to all sciences: writing reports.

2 – We, at CNES, together with our colleagues form UBERN, GFZ, TU-Graz and the University of Luxembourg are, so to say, at the frontline of the EGSIEM project. We process the GRACE data and provide to the EGSIEM community the monthly normal equations which are then combined with the ones from the other groups. This is the start of the process which allows the computation of the most precise European gravity field solution and which will eventually lead to terrestrial water storage assessment and to flood/draught disaster prevention.

3 – Probably the most interesting aspect of EGSIEM in our case is the confrontation with our colleagues at the European level. Not only this combination of efforts leads to a result that is better than any one of the individual contributions, but it has also allowed each of us to improve on our processing and has been therefore mutually beneficial to all.

Géode et Cie
http://geode-et-cie.fr http://plot.egsiem.eu

Stéphane Bourgogne

1 – Geodesy is the most surprising of all sciences! It has shaken the common man's knowledge through history. For example, in the early days, we knew for sure that the Earth was flat. Then came Pythagoras and Eratosthenes, and together they brought geodesy to a new dimension: the Earth became spherical. Further refinements by Cassini provided the ellipsoid, and modern science offered the geoid.
Geodesy is an exciting science because it involves a wide spectrum of disciplines: mathematics from non-planar geometry to linear algebra, physics from Newtonian dynamics to Einsteinian relativity, engineering and measurement techniques from rope and stick to satellite technology. Geodesy is timeless: GPS positioning is merely a modern version of the early maps used by explorers and navigators at the time of Columbus and Magellan. Calculating satellite trajectory using a spherical harmonics gravity model is but an advanced version of the study of the fall of the apple. Therefore, no matter when you were born, at any time in history, geodesy has everything to please the scientific mind!

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?

Centre National d'Etudes Spatiales (CNES)
https://cnes.fr/en http://grgs.obs-mip.fr/grace

Dr. Richard Biancale

1 – Space geodesy is a science at the frontier between mathematics and physics and driven by technology and computer science. In that sense working on geodesy needs an open mind over a variety of challenging activities. It may be surprising that few are afforded the privilege of studying space geodesy while its use is broadly global. This is pretty exciting and requires geodesists a responsible attitude.

2 - Working for several decades on space geodesy in general and on gravity field modelling in particular, both on algorithm development and processing, I am glad to play now a advisor role in the CNES/GRGS team helping in algorithms, methods, processing strategies…

3 - EGSIEM works prefigure advantageous cooperation and right organization between expert European teams for improved reference Earth gravity field modelling and further for societal applications. For sure gravity satellite systems will become a very important source of information for monitoring environmental phenomena.

2 - In the 21st century, we use gravity field not only to calculate precise satellite trajectories, but also to monitor variations of mass at the surface of the Earth: droughts, floods, ice melt, etc. Once we have calculated gravity models, it is essential to have a tool that provides easy control and monitoring of the results. Géode & Cie has designed an online interactive software that allows everyone to quickly and easily compare and exploit the scientific results. You can visit us at plot.egsiem.eu to have a glimpse of the possibilities: you will be able to extract gravity time series over custom-designed areas, plot harmonic coefficients, visualize maps of gravity solutions, etc.

3 - EGSIEM is a very interesting project in the sense that it provides a framework for active cooperation between European groups. Besides interactive visualization skills, Géode & Cie is also actively involved in the regular production of GRACE gravity models with CNES, and therefore is completely aware of the scientific part of the project. Being able to access the gravity models and normal equations from other groups, test inversion techniques, make combinations and compare the results is a real benefit and a source of progress for the future.

MEET EGSIEM

American Geophysical Union Fall Meeting (AGU)
San Francisco, California, USA
Dec. 12 - 16, 2016

Fourth SWARM Science Meeting
Banff, Canada
Mar. 20-24, 2017

KEEP IN TOUCH

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