GSTM 2014 - Abstractlist 29.09.

12:15 **B.1**

Xiaoping Wu

Presenter Xiaoping Wu

Accelerations in Surface Mass Transport – A Global Reassessment

During the 12 years of GRACE mission operation from 2002.3 to 2014.0, accelerations in measured geocenter motion and J2 are either statistically insignificant or somewhat uncertain when compared with other estimates, despite various reports of significant accelerations in surface mass transport. This has motivated us to re-examine accelerations in spherical harmonic domain and global geographic domain. Time series of GRACE measured spherical harmonic coefficients up to degree/order 60 and their calibrated full covariance matrices are used to estimate linear, annual, semiannual and acceleration components in these coefficients. Mass acceleration and time variation budgets for major geographical regions are derived using regional spherical harmonic functions and a priori multi-regional variance functions up to degree/order 180 in addition to the estimated spherical harmonic accelerations or time series. We will also evaluate various aspects in the determination of these accelerations, including effects of interannual variations and sampling period, the fidelity and possible errors in the low degree coefficients, data error correlations, atmospheric model correction, kernel leakage, as well as reasonableness and impact of various assumed a priori variation patterns.

12:30 **B.1**

I. Sasgen, M. Horwath, V. Klemann, E. J. Petrie, N. Schoen, R. Pail, A. Horvath, J. L. Bamber, P. J. Clarke, H. Konrad, M. R. Drinkwater

Presenter Martin Horwath

The glacial-isostatic adjustment signature in Antarctica inferred from GRACE, Enivsat/ICESat and GPS (ESA-STSE project REGINA).

The glacial-isostatic adjustment (GIA) of the solid Earth to past ice-load variations in Antarctica induces contemporary trends in the gravity-field and surface displacement. Due to the lack of direct observations, GIA remains poorly constrained and represents a major uncertainty in determining the mass balance of the Antarctic ice sheet from satellite gravimetry, and, to a considerably lesser extent, altimetry measurements such as CryoSat-2. Here, we present an improved regional GIA estimate derived from improved temporal linear trends in time series of GRACE, Envisat/ICESat and GPS. First, Envisat/ICESat rates of surface-elevation are used to estimate present-day ice-mass changes and removed it from GRACE and GPS measurements, yielding our first-order GIA estimate. In the second step, remaining elastic components in the GIA estimate, related to recent ice changes, are identified using the distinctive signatures of elastic and viscoelastic processes in the rates from GRACE and GPS, and subsequently removed. The improved GIA field is interpreted using an ensemble of viscoelastic response functions, focusing on West Antarctic ice load changes of the recent past in the presence of a low-viscous upper mantle. Finally, we present how our improved GIA estimate regionally impacts the GRACE and CryoSat-2 measurements when determining ice-mass balance in Antarctica. The results are part of the ESA-STSE project REGINA, www.regina-science.eu.

12:45 **B.1**

Erik R. Ivins, David Wiese, Michael Watkins, Felix Landerer, Alexander Simms, Dah-Ning Yuan, Carmen Boening, Eugene Domack

Presenter Erik R. Ivins

Glacial Isostasy and Mass balance of Graham Land and the greater Antarctic Peninsula 2002-2014 and over the past 150 years using GRACE and GNSS station data

The process of ice shelf breakup and outlet glacier speedup has been repeating itself throughout the northern Antarctic Peninsula since the late 1980?s. Larsen A Ice Shelf breakup (LAISb) occurred, for example, in the Austral summer of 1993. Rott et al. (2011) have estimted that the speedup at the trunks of 11 LAISb outlet glaciers for which flux-gate mass transport can be measured. Butress loss caused in increase of discharge of δM = 4.3 ± 1.6 Gt/a in 2008, relative to measurements that span 1995-1999 for 11 Larsen B feeding glaciers. GRACE analysis centers have now released 12.25 years of monthly solutions (RL05) for global mass change. Solutions for the region of the Peninsula north of 69 ° S (Graham Land using both constrained and unconstrained mascon methods show 2002-2014 net ice loss to the oceans with a trend of 31.5 ± 4 Gt/yr, approximately the same as reported by Ivins et al. (2011) and Luthcke et al. (2013) over shorter time spans. We offer a new model for mass loss history that must involve substantial losses atleast back into the 1980's in order to explain the current uplift rates and patters recorrded by GNSS station data. The modeled GIA correction is 6.9 ± 1.5 Gt/yr, placing Graham Land in a negative balance of -38.4 ± 5.5 Gt/yr . We infer that much of this mass loss began at least 50 years ago, and we attempt to quantify this ice mass history as it drives a substantial viscoelastic flow in the mantle.

13:00 **B.1**

Jolanta Nastula, Małgorzata Wińska, Monika Biryło

Presenter Jolanta Nastula

Comparison of polar motion excitation functions computed from different sets of gravimetric coefficients

Poster **B.1**

M. Srinivasan, E. Ivins, M. Jasinski, J. Famiglietti, M. Rodell

Presenter Margaret Srinivasan

Developing a Comprehensive GRACE Applications Strategy

Successful strategies to enhance science and practical applications of the proposed GRACE-FO mission will require engaging with and facilitating between science and societal applications communities. The NASA Applied Science Program supports development of a systematic approach to identify existing and potential users of GRACE-derived products and models to engage applications-oriented users and stakeholders and to identify projects where GRACE data may improve decision-making. We will engage GRACE Science Team members in this effort to incorporate information and knowledge towards solutions for broadened applications of GRACE data. Extending the time series of observations with GRACE FO and GRACE II may provide unique and innovative solutions to some of the most pressing hydrological issues facing society. Recent applications from both academic and operational users will be presented. We want to identify solutions to relevant societal needs, and how they can help guide our GRACE Applications strategy. Some key objectives include:
• Document existing science and applications projects using GRACE, • Engage current users and GST to identify potential projects, • Develop an Applications and Implementation plan, • Facilitate contact, exchange of ideas, and partnering between GST, project, data experts, stakeholders, international partners, • Identify GRACE capabilities, • Promote applications; special sessions, town halls, publications, • Engage science and applications community via web, plan, printed items, workshops, etc. • Assess user data needs and access for decision support.

14:15 **B.4**

Matthew Rodell

Presenter Matthew Rodell

Hydrological Extremes in the GRACE Record

This presentation will identify wet and dry extremes around the world based on GRACE's ~12 year record of terrestrial water storage anomalies. These will be explained in the context of other information on major floods and droughts during 2002-2014. In most cases the GRACE based extremes are consistent with other measurements and newsworthy events. In other locations the maximum and minimum anomalies occur at the ends of the data record, reflecting ongoing climate- or human-induced trends in TWS.

14:30 **B.4**

Sarah Elizabeth McCandless, Srinivas Bettadpur, Teresa Howard, Gordon Wells

Presenter Srinivas Bettadpur

Utilizing GRACE TWS, NDVI, and Precipitation for Drought Identification and Classification in Texas

The "Merged-dataset Drought Index" (MDI) is a new quantitative drought index calculated using GRACE total water storage (GRACE TWS), MODIS-derived normalized difference vegetation index (NDVI), and precipitation data. These datasets constitute MDI because each correlates with a different drought type. Dataset deviations from established climatology are used, where negative deviations indicate deficits. MDI is objectively and transparently calculated based on dataset z-scores. GRACE TWS is the least mature dataset used in these calculations, but TWS solution variance does not negatively impact MDI. A new classification scheme to categorize drought severity is also proposed. MDI is studied in Texas and its smaller sub-regions. Within these sub-regions, MDI identifies multiple droughts during 2002 - 2014, with the most severe beginning in late 2010. Drought analysis using MDI shows for the first time that GRACE data provides information on a sub-regional scale in Texas, an area with low overall signal amplitudes. Past studies have shown TWS capable of identifying drought, but MDI is the first index to quantitatively use GRACE TWS in a manner consistent with current practices of identifying drought. MDI also establishes a framework for a future, completely remote-sensing based index that can enable temporally and spatially consistent drought identification across the globe. This study is useful as well for establishing a baseline for the necessary spatial resolution required from future geodetic space missions for use in drought identification at smaller scales.

14:45 **B.4**

Mohamed Ahmed, Mohamed Sultan, John Wahr, Ahmed Mohamed, Eugene Yan

Presenter Mohamed Ahmed

Quantifying recharge and depletion rates of the Nubian Sandstone Aquifer System: An integrated approach

An integrated approach using the GRACE, outputs of the CLM4.5 model, remote sensing, geological, and geochemical data were used to quantify the recharge and depletion rates of the Nubian Sandstone Aquifer System (NSAS) over the past 10 years (2003–2012). The adopted approach includes: (1) extraction of recharge rates over the NSAS outcrops in Sudan and Chad (area: 0.83 million square km [msk]); (2) estimation of depletion rates over the NSAS in Egypt (area: 0.66 msk); and (3) removal of contributions from non-groundwater Terrestrial Water Storage (TWS) compartments (i.e., soil moisture and river channel) using outputs of CLM4.5 model. Findings include: (1) average annual precipitation over recharge areas in Chad and Sudan was estimated (from TRMM data) at 65 billion cubic km (bck), (2) GRACE-derived NSAS recharge rates were estimated at 2.79 ± 0.98 bck/yr over Sudan and Chad and up to 3.20 ± 1.0 bck/yr if annual extraction rates (~ 0.40 ± 0.20 bck) over these areas were considered; (3) GRACE-derived groundwater depletion rates of NSAS in Egypt were estimated at 2.04 ± 0.99 bck/yr of which 0.50 bck/yr are related to natural discharge; (4) replenishment of the NSAS in Egypt by groundwater flow from the south is hindered by the East-West trending Uweinat-Aswan basement uplift; and (5) assuming current GRACE depletion rates, the recoverable groundwater of the NSAS in Egypt (5180 bck) will last for 2500 years. Plans are underway to quadruple the artificial extraction rates in Egypt; under such conditions, the recoverable groundwater will last for some 800 years.

15:00 **B.4**

Carmen Boening, Marie-Estelle Demory, David Wiese, Pier Luigi Vidale, Malcolm Roberts, Reinhard Schiemann, Matthew Mizielinski, Michael M. Watkins

Presenter Carmen Boening

The use of GRACE satellite data to validate the global hydrological cycle as simulated by a global climate model

This study investigates the use of the Gravity Recovery and Climate Experiment (GRACE) data to validate the global hydrological cycle as simulated by an atmospheric General Circulation Model (GCM), particularly the transport of water from the ocean to the land and vice-versa. We make use of the UPSCALE campaign, a traceable hierarchy of global atmospheric simulations, with mesh sizes ranging from 130 km to 25 km, for which five-member ensembles of 27-year, atmosphere-only integrations are available, using present-day forcing. We show here the ability of this climate model, to simulate the inter-annual variability of terrestrial water storage, compared to GRACE. We particularly find that the model is able to capture the regional distribution of changes in terrestrial water transport during El Nino Southern Oscillation events, implying its ability to import more or less water over land during an ENSO event.

15:15 **B.4**

Annette Eicker, Maike Schumacher, Jürgen Kusche, Hannes Müller Schmied, Petra Döll

Presenter Annette Eicker

Calibration/data assimilation approach for WGHM using gridded GRACE observations

Global hydrological models contribute to the understanding and quantification of the global water cycle. However, large model uncertainties persist due to climate forcing data not being available with sufficient spatial/temporal resolution on the global scale. The GRACE mission provides an independent observation of water storage change with global coverage, which can be used to improve global hydrological models. In our group, an ensemble Kalman filter approach has been developed to improve the WaterGAP global hydrological model (WGHM) by assimilating GRACE-derived gridded terrestrial water storage changes and by calibrating WGHM steering parameters within the same step. In this presentation we will show the current state and results of our assimilation approach. In particular we will discuss the influence of the GRACE spatial discretization to explore as much spatial information of the GRACE data as possible, and we will show some validation experiments.

15:30 **B.4**

Liangjing Zhang, Henryk Dobslaw

Presenter Liangjing Zhang

Validation of MPI-ESM Decadal Hindcast Experiments with Terrestrial Water Storage Variations as Observed by GRACE

Time-variations in the gravity field as observed by the GRACE mission launched in 2002 provide for the first time quantitative estimates of the terrestrially stored water masses at monthly resolution over more than one decade. TWS from GRACE is applied here to validate different sets of ensemble hindcasts performed with the coupled climate model MPI-ESM that have been prepared within the German Research Initiative on Decadal Climate Prediction (MiKlip) during recent years. Moderately positive skill scores of the initialized hindcasts are obtained both with respect to the zero anomaly forecast and the uninitialized projections in particular for leadyear 1 in particular in moderate to high latitudes of the Northern Hemisphere. Skill scores gradually increase when moving in more recent experiments and also for experiments performed at higher spatial resolution, thereby documenting improvements of the MPI-ESM decadal prediction system during course of the Miklip project. Analyses indicate that the skill changes obtained here reflect in particular changes in the large-scale precipitaiton pattern between the individual experiments, which itself is an important target quantity of the climate prediction. We will explain in this talk how GRACE-based TWS might contribute to the validation of precipitation changes in particular in regions of the world where reliable in-situ observations are sparse.

16:15 **B.4**

Akbar Shabanloui, Jürgen Müller

Presenter Jürgen Müller

Assimilation of GRACE, satellite altimetry and hydrological data for determining mass variations in the Siberian permafrost region

The permafrost in Siberia (Russia) plays an important role for the global water cycle and climate change in the Earth system. In this study, data from satellite altimetry missions, hydrological models and GRACE are assimilated to retrieve a more realistic pattern of surface mass variations in Siberia. GRACE provides the integral mass variations with different spatial-temporal resolution depending on the applied filters and reduction models. We used the new release L2 products from GFZ (RL05a) and tested various filters. Geometrically, surface mass variations are determined based on satellite (radar/laser) altimetry tracking data (e.g. Jason-2, ICESat), where especially lake level variations are extracted. In addition, hydrological surface mass variations are obtained from hydrological water cycle models based on observations of precipitation, evapotranspiration and run-off data. We tried to quantify the individual signal contributions in Siberia and to consistently combine the various data to get a better estimate on how big the real permafrost change might be.

16:30 **B.4**

Mohamed Sultan, Mohamed Ahmed, John Wahr, Eugene Yan

Presenter Mohamed Sultan

Assessing the performance of land surface models over Africa using GRACE and remote sensing data

There has been an increased interest in integrating Land Surface Model (LSM)-derived TWS (TWS[LSM]) compartments with GRACE-derived TWS (TWS[GRACE]) given the fine vertical resolution of the LSM. We evaluated the performance of TWS[LSM] simulated from GLDAS/NOAH, and CLM4.5 over Africa's major watersheds (10 basins) using monthly (2003–2012) TWS[GRACE] and relevant remote sensing datasets: (1) temporal GLDAS/NOAH-derived TWS (TWS[GLDAS]) and CLM4.5-derived TWS (TWS[CLM]) were extracted, (2) spatial and temporal correlations of TWS[LSM] with TWS[GRACE] were performed to examine the degree to which simulated TWS estimates (TWS[LSM]) correspond to measured (TWS[GRACE]) values, (3) the degree to which differences in LSM forcing precipitation (P) influence model outputs was evaluated by conducting spatiotemporal correlations with TRMM-derived precipitation, (4) the validity of evapotranspiration (ET) outputs from LSM was evaluated by comparisons to MODIS-derived evapotranspiration. Our findings include: (1) high correspondence between TWS[GRACE] and TWS[GLDAS] (R square range for 10 basins: 0.34 to 0.88) compared to TWS[CLM] (R square range for 10 basins: 0.05 to 0.90); (2) the similarities in total precipitation across examined basins for GLDAS and CLM suggest that variations in model forcing parameters are not responsible for observed differences in TWS[LSM] outputs, and (3) the poor correspondence between ET[CLM] (range: 83 to 100 % precipitation) and ET[MODIS] suggests that TWS[CLM] could be improved if the evapotranspiration algorithms are reevaluated.

16:45 **B.4**

J. Kusche, A. Springer, C. Ohlwein, K. Hartung, L. Longuevergne, S. Kollet, J. Keune, H. Dobslaw, E. Forootan, A. Eicker, P. Krahe, W. You

Presenter J. Kusche

Synergies between GRACE and regional atmospheric modeling efforts

In the meteorological community, efforts converge towards implementation of high-resolution data-assimilating regional climate modelling/monitoring systems; driven by improving process understanding, better representation of land surface interaction, atmospheric convection, orographic effects, and the wish to better forecast. It is relevant for GRACE since (1) these models may provide improved atmospheric de-aliasing when compared to ECMWF, (2) they inherit high temporal resolution from the NWP models, (3) efforts are directed towards improving the land surface component and coupling groundwater models; this provides hydrological mass estimates at sub-diurnal resolution, (4) re-analyses provide consistent long time series, (5) GRACE data can help validating model outputs. A coupled atmosphere - land surface - groundwater modelling system is currently being implemented for the European CORDEX region at 12.5 km resolution, based on the TerrSysMP platform (COSMO-EU NWP, CLM land surface and ParFlow groundwater models). We report results from Springer et al. (J. Hydromet.) validating the water cycle in COSMO-EU using GRACE and P, ET and R data. We show that after GRACE bias correction, hydrological conditions prior to 2002 can be reconstructed. Comparing GRACE with CLM allows identifying processes needing improvement. Finally, we compare COSMO-EU surface pressure with ERA-I at timescales < and > 1 month and spatial scales below/above the resolution of global models. We find differences with magnitude 1-3 hPa (1-3 cm EWH); relevant for post-GRACE mission concepts.

17:00 **B.4**

J. Huang , G. Pavlic , A. Rivera

Presenter Jianliang Huang

How well can synoptic groundwater storage variation be mapped from GRACE? - A case study in Alberta, Canada

In Canada, groundwater levels are monitored by recording water table changes at wells However, the distribution of the wells is uneven across the country. Volume changes in groundwater storage can only be estimated with large uncertainties because specific yields are usually poorly known or inexistent. The GRACE measurements can provide the total water storage (TWS) variations at a large scale and have been successfully used to study groundwater depletion trends in large water basins worldwide. In this study, we chose the province of Alberta, Canada, for a pilot study as a first step to assessing national-scale GWS variations using GRACE. The province operates a provincial-wide groundwater observation well network. Wells are equipped with data loggers and sensors that continually record groundwater levels. These wells provide in situ data for the validation of GRACE.
The objective of this study is to map GWS variations in Alberta, using the Release 5-monthly Earth gravity models derived from GRACE observation and the land surface model (LSM). We try to derive the seasonal GWS variation as 12-monthly maps from averaged over 2003-2013; a synoptic trend map of GWS variation; and the GWS time series over the study region to find seasonal and inter-annual patterns of groundwater storage variations.

Poster **B.4**

Leonid Zotov, Viktor Yushkin, Jaakko Makinen, Mirjam Bilker-Koivula,
Roman Sermyagin, Natalya Frolova

Presenter L. Zotov

Mass changes over Russia from GRACE and absolute gravimetry

We extract the mass changes in the hydrological basins of large Russian rivers by applying MSSA (Multichannel Singular Spectrum Analysis) filtering technique to GRACE data. Separation of annual cycles and trends into different PCs allows studying regional hydrological changes, climate-induced variations in precipitation, floods, etc. We also compare regional changes with gravity changes obtained in particular regions by absolute gravimeters.