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SUMMARY

An experimental GRACE solution over the Arctic Ocean was done using CSR release 05 and DDK3 filtering procedure. The aim of this exercise was to investigate if it was possible to track the freshwater pulse coming from the Siberian rivers in connection with the spring thaw, and track the freshwater by GRACE as it propagates towards the Beaufort Gyre. Results show clearly the regional freshening of the ocean in front of the Siberian rivers, whereas the detection of the movements into the Beaufort Gyre was not detectable. More research and possibly improved data (GRACE follow-on mission) is needed to get a reliable signal of such mass movements.

From the GRACE analysis of the ice sheets, complementary materials have been produced to show impact of Greenland (and Antarctica) on sea level, using different GRACE solutions.

MONARCH-A CONSORTIUM

Participant no.	Participant organisation name	Short name	Country
1 (Coordinator)	Nansen Environmental and Remote Sensing Center	NERSC	NO
2	The University of Sheffield	USFD	UK
3	Universität Hamburg	UHAM	NO
4	Centre National de la Recherche Scientifique	CNRS	FR
5	Scientific foundation Nansen International Environmental and Remote Sensing Center	NIERSC	RU
6	Universitetet i Bergen	UiB	NO
7	Danmarks Tekniske Universitet	DTU	DK
8	Institut Francais de Recherche pour l'Exploitation de la Mer	IFREMER	FR

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1 Introduction

The GRACE satellite mission, especially at the most recent RL5 processing, is able to pinpoint mass changes in the earth system accuracies of a few GT-level at spatial resolutions down to 300-500 km. In this WP we investigate the use of GRACE to determine the seasonal changes of the Arctic Ocean mass signals, ideally with the aim to detect the trans-ocean flow from the Siberian rivers to the Beaufort Gyre north of Alaska.

Because the GRACE data from the two missions raw data processing centers (CSR, Center for Space Research, University of Austin; GFZ, Geoforschungszentrum, Potsdam) include corrections for known ocean mass variations from ocean models, this signal must be added back to the monthly GRACE data prior to analysis. We have here used a GRACE mass inversion scheme of Forsberg and Reeh (2007) as the basis for the mass estimation, and express the mass changes in terms of mm water/yr.

1.1 Data

1.1.1 GRACE Ocean solution

We have used the new improved CSR release 05 (Bettadpur 2012) and DDK3 destriping filtering procedure (Kusche 2007) for the Arctic Ocean freshwater pulse study. Since we need to compute the solution over the Arctic Ocean, we added back the ocean GAD product provided together with the GRACE satellite data (Bettadpur 2012). The GAD product is the background model for the ocean removed by the processing centre from the Level 1 data to provide the Level-2 data.

1.1.2 GRACE Land solution

We used the new CSR and GFZ release 05, and GRGS release 02 for a separate ice sheet solution, subsequently checked against consistency with Icesat results, and the used to minimize leakage from the very large Greenland mass change signals into the ocean. We used the same GIA correction has been applied to all datasets (revised version of Paulson GIA predictions by Geruo A and J. Wahr, U. Colorado, 2012), a state of the art model which was also used in the recent IMBIE study for both Greenland and Antarctica mass loss (Shephard et al, 2012).

1.2 Result

1.2.1 Core of D2.6.4

Results are a series of mass change grid files, containing global mass variations derived by GRACE+GAD (DTU_GRACE+GAD_solution_DDK3.zip). Files are indexed and the corresponding month for each index is indicated in the ASCII file list_time_csr.txt which has format:

[index] [month index] [year] [first day of the months for GRACE data] [month of the year]

Each grid has simple ASCII format:

[longitude] [latitude] [value in mm of w.e]

As additional product we provide the sequence of plot over the Arctic Ocean contained in the DTU_GRACE+GAD_ArticOc.pdf.

We show here some example in Figure 1 and Figure 2.

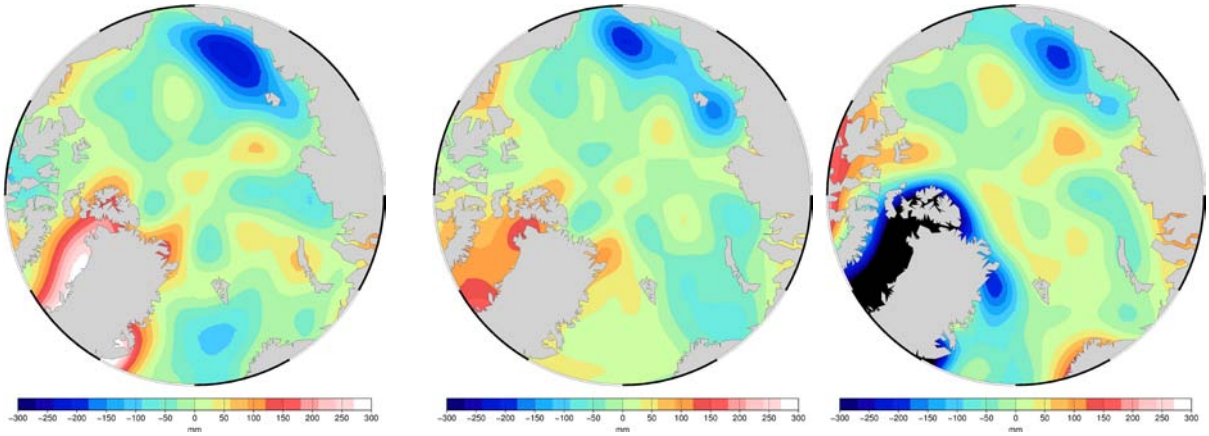

Figure 1: Three snapshot of the mass variation in the Arctic Ocean detected by GRACE. May 2004 (Left), May 2006(middle) and April 2012(right).

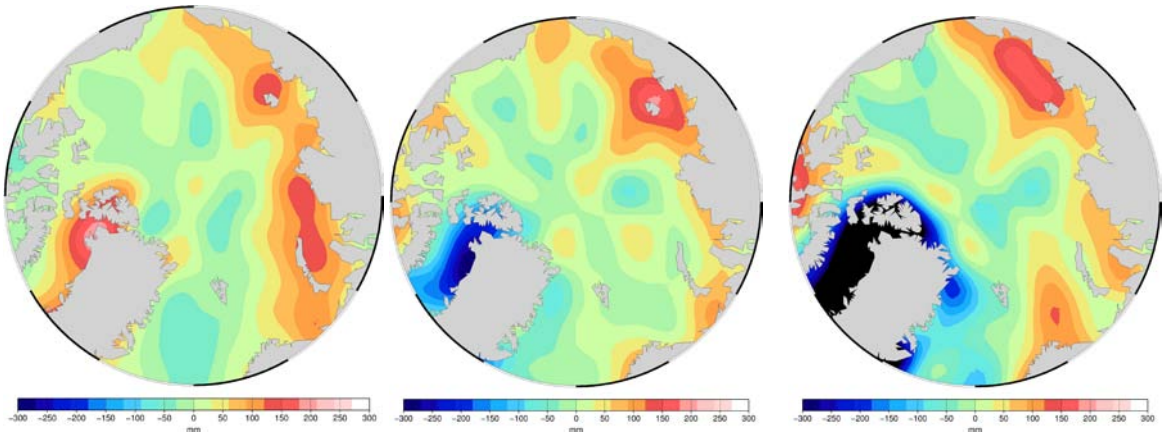

Figure 2: Three snapshot of the mass variation in the Arctic Ocean detected by GRACE. Jannuary 2006(Left), Jannuary 2009 (middle) and Jannuary 2012 (right).

The results, illustrated in Fig. 1 and Fig. 2, shows clearly a seasonal signal north of Siberia, associated with the outflow of freshwater from the Siberian rivers. A signal is of comparable magnitudes is also seen in the Russian tide gauge sea level data, and is consistent with the order of magnitude of the outflow of the Siberian rivers. It is, however, quite evident from the GRACE data that the inflow of freshwater, which provides the increase in sea level, also displace the more salty, heavier waters, and there produce a mass loss in the spring (May) period, compare to a mass gain in winter (January).

1.2.2 Complementary materials – sea level changes from Greenland and Antarctica

Contributions of Greenland and Antarctica to sea level have been computed from 3 different databases (CSR, GFZ and GRGS). Seasonal cycles have been removed and RMS computed for means of all datasets. Results are in mm (equivalent sea level, cf. Figure 3) and in Gigaton (mass loss). These GRACE-derived sea level curves provides the background signals for understanding the long-term trends in the Arctic tide gauge data.

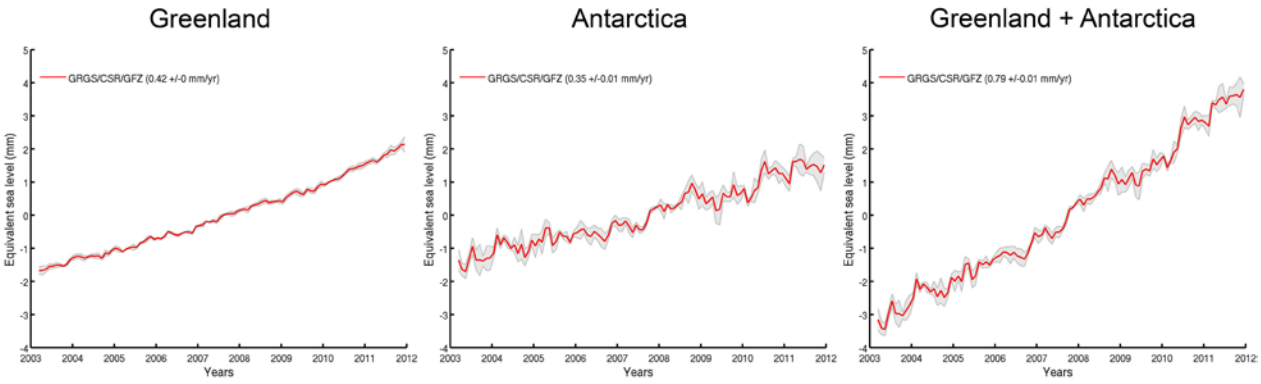

Figure 3: Mean contributions to sea level from CSR RL05, GFZ RL05 and GRGS RL02. Left panel: Greenland; centre panel: Antarctica; right panel: Greenland and Antarctica mean.

1.3 References

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