1 - Annual Amplitudes

The following map shows the amplitude of an annual cycle fitted to GRACE data from January 2003 until September 2006 are included. The black dots have been removed using the filter described in Swenson et al. 2003 to avoid spurious effects. The black dots are located in mountainous regions with high topographic relief. The gravity fields have been post-processed using the filter described in Swenson, et al 2006. The gravity fields are then converted to an equivalent thickness of water as in Wahr et al 1998.

The following maps show the amplitude of an annual cycle fitted to GRACE level 2 data from CSR (release 4). Data from Figure 2 - Annual Amplitude Over Africa (smoothed at 350 km)

Figure 1 - Annual Amplitude Over North America (smoothed at 400 km)

Figure 2 - Annual Amplitude Over Africa (smoothed at 350 km)

Figure 3 - Annual Amplitude Over Australia (smoothed at 350 km)

Figure 4 - Annual Amplitude Over Southern Asia (smoothed at 400 km)

Figure 5 - GRACE (black) and GLDAS (orange) over the Mackenzie River Basin

Figure 6 - GRACE (black) and GLDAS (orange) over the Yenisey River Basin

Figure 7 - GRACE (black) and GLDAS (orange) over the Mississippi River Basin

Figure 8 - GRACE (black) and GLDAS (orange) over the Macaranse River Basin

2 - River Basin Time Series

Most time variability in GRACE is attributed to hydrological processes. Therefore, comparisons between hydrological models and GRACE provide independent estimates of both the models and GRACE’s accuracy. We choose to compare GRACE to the Global Land Data Assimilation System (GLDAS), which have land surface water models such as Noah using meteorological observations. To ensure our model meets the GLDAS product, it has been modified by adding a spatially uniform signal to the ocean at every time step. These time series are presented in Figure 2 - River Basin Time Series.

3 - Cross-Correlation Analysis

After examining time series from several river basins, a pattern emerged: the hydrology signal from GLDAS tends to peak to GRACE a few months later than expected. The lag was varied in integer steps between -3 and +3, and the value of lag which maximized the cross-correlation at each point is plotted below. Because there is no GLDAS signal over the oceans, they have been masked out. The phase lag is also observed in the Mackenzie River Basin, another possible explanation for the time lag in this case is that GLDAS/NOAH is known to melt snow too early. Also, GLDAS/NOAH doesn’t include a groundwater component and a river routing scheme in the water storage model underlying GLDAS.

4 - Summary

- The destriping procedure described in Swenson et al. 2003 reduces high topographic signals. These time series illustrate how the GLDAS and GRACE data can be used to study the hydrological cycle.
- Agreement between GRACE and GLDAS is generally good - GLDAS lies within or near the 1 sigma error bars and both time series peak at the same time. Agreement is poor in the Mississippi River Basin, likely due to GLDAS leading GRACE in regions with significant snowfall.
- GRACE generally lags GLDAS by 1 month. This could be due to the model losing water as fast as it enters rivers, but the gravity signal from that water remains until the water leaves the basin.
- Agreement is good in the Mississippi River Basin, likely due to GLDAS leading GRACE in regions with significant snowfall.
- The Yenisey also exhibits the phase lag seen in the Tocantins.
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