

d6. Groundwater and Terrestrial Water Storage

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Groundwater is a vital resource and also a dynamic component of the water cycle. Unconfined aquifer storage is less responsive to short term weather conditions than the near surface terrestrial water storage (TWS) components (soil moisture, surface water, and snow). However, save for the permanently frozen regions, it typically exhibits a larger range of variability over multi-annual periods than the other components (Rodell and Famiglietti, 2001; Alley et al., 2002). Groundwater is poorly monitored at the global scale, but terrestrial water storage (TWS) change data from the Gravity Recovery and Climate Experiment (GRACE; Tapley et al., 2004) satellite mission are a reasonable proxy for unconfined groundwater at climatic scales.

Plate 2.1k maps changes in mean annual TWS from 2010 to 2011, based on GRACE, reflecting hydroclimatic conditions in 2011 (see Plate 2.1e to i). Widespread drying occurred between 20-60°N, contrasting with wetting between 10-30°S. Severe drought impacted the southern United States and northern Mexico. Southern Europe, the north Atlantic coast of Africa, and parts of western and eastern China, experienced net losses of water in 2011 after having surpluses in 2010. Northern Sudan, which was already in drought, did not get any relief. South of the equator, the lower Amazon basin and some other parts of northern South America recovered from drought, while southern Africa had a relatively wet year. Other than continued replenishment of aquifers in the southeast, Australia reversed course from 2010, becoming wetter in the west and dryer in the northeast. Drought in equatorial Africa and recovery from drought in the Indochinese peninsula also stand out. Aquifers in central California (Famiglietti et al., 2011) and northern India (Rodell et al., 2009; Tiwari et al., 2009) which are stressed by groundwater pumping at unsustainable rates, both raised their water levels in 2011. Significant reductions in TWS along the coast of Alaska, in the Patagonian Andes (also seen in Figure 2.28), and in Greenland and Antarctica represent ongoing glacier (Section c3) and ice sheet ablation, not groundwater depletion.

Figures 2.28 and 2.29 show timeseries of zonal mean and global GRACE derived non-seasonal, monthly mean TWS anomalies excluding Greenland and Antarctica. Drying in the northern latitude band and wetting in the southern band in 2011 are clear (Figure 2.28). Overall, Earth's land was relatively wet in 2011 (Figure 2.29). From June 2010 to May 2011, global TWS increased by about 2.2 cm, which is equivalent to an 8 mm decline in mean sea level during that period, and TWS peaked again in December.

References

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Figure Captions

Figure 1. Changes in annual-mean terrestrial water storage (the sum of groundwater, soil water, surface water, snow, and ice, as an equivalent height of water in cm) between 2010 and 2011, based on GRACE satellite observations.

Figure 2. GRACE measurements of terrestrial water storage anomalies in cm equivalent height of water by latitude. The anomalies are relative to a base period of 2003-07. Gray areas indicate regions where data are unavailable.

Figure 3. Global average terrestrial water storage anomalies in cm equivalent height of water calculated using a 2003-07 base period.

Terrestrial Water Storage

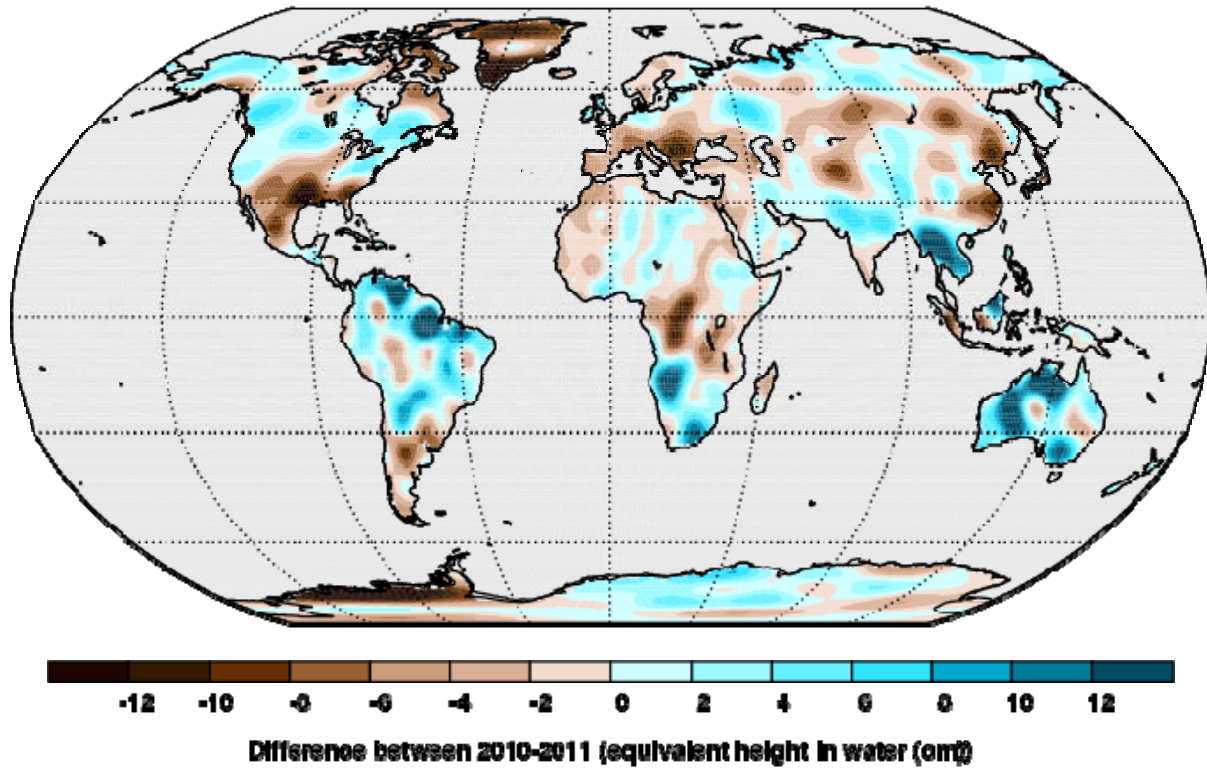


Figure 1.

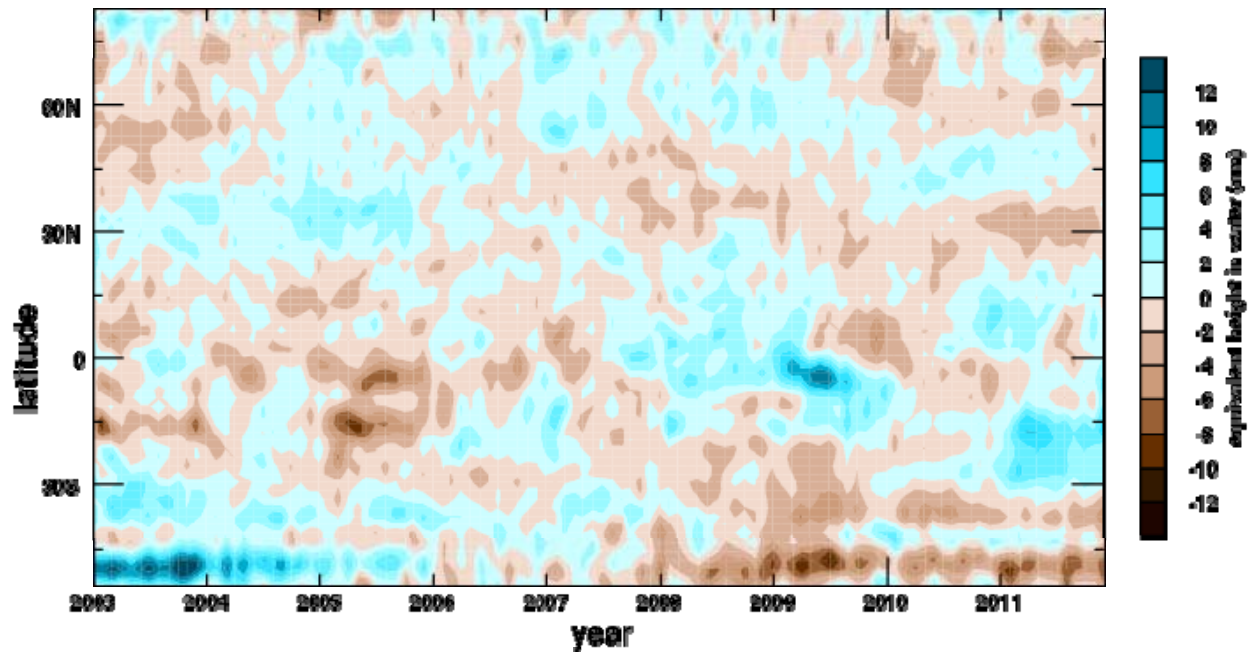


Figure 2.

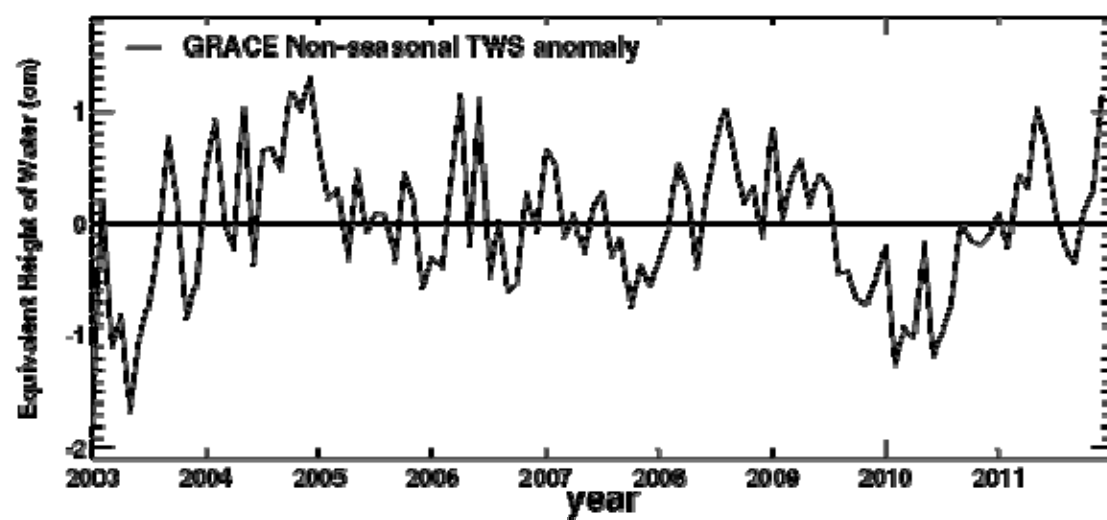


Figure 3.