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Estimating water change at Earth's surface using GRACE gravity and GPS positioning: Inferring groundwater change in the United States

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We estimate change in total water and its components each month from January 2006 to the Present using geodetic observations from space and complementary hydrologic measurements. Estimates of changes in total water inferred from GPS elastic displacements are used to strengthen the spatial resolution of GRACE observations of mass change, resulting in sharper images of water change. We furthermore distinguish between different components of water change. Change in surface water in man's artificial reservoirs and natural lakes are known from gauging measurements of water levels. The distribution and magnitude of snow accumulation is inferred from sticks and scales on the ground. We remove the effect of surface water and snow to infer change in water in the ground, consisting of soil moisture and groundwater. This determination is bringing powerful insights into understanding the water cycle. We are finding more water to be lost during drought and gained during heavy precipitation than in the hydrology models, suggesting that the hydrology models must be revised to have a greater capacity to store water in the ground. Not all rain and melting snow that falls on the mountains of California, Oregon, and Washington is found to runoff into rivers taking water to the ocean. Rain and melting snow is instead found to infiltrate the ground in the wet fall and winter and to be parched from the ground in the dry spring and summer.