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Deciphering small-scale groundwater storage changes from combined interpretation of GRACE and InSAR

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GRACE has changed our vision on how water was redistributed on the continents, by providing an information on large-scale water storage changes. One important question arises from the integration scale ∼400 km, which corresponds, for example, to the distance between the plain of the Gange and the Tibetan Plateau. From aquifers to high mountains, the heterogeneity of landscapes and behaviors is dazzling. How does GRACE capture such heterogeneity, and how can we separate these different components? This question is critical for the accurate estimation of groundwater storage changes, where significant storage changes can occur in small aquifers.

We propose here a new method to transfer high-resolution information from InSAR and decipher GRACE subscale storage changes, with application to depleting aquifers in Mexico. Mexico is heavily relying on groundwater resources, which are actually exploited from a set (hundreds) of ∼10 km size aquifers. InSAR is therefore a perfect tool to capture subsidence patterns, however, it cannot be interpreted as groundwater storage changes directly.

The strategy consists in using high resolution information on the position and extend of groundwater depletion from InSAR, to feed the inversion of GRACE water storage changes on a much finer scale (∼25 km). Results are in good agreement with a high resolution water balance model published by the state of Mexico. We show that the value of InSAR is twofold for GRACE inversion: (1) localize subsurface water masses with high resolution and (2) provide a spatial structure to be recognized in GRACE data, allowing for a better separation between signal and noise.