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Supplement of

GPS displacement dataset for the study of elastic surface mass variations

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S1. Offset detection in sites located in Great Lakes region (located at the southwest border part of St. Lawrence watershed).

The correlation screening metric showed a significant disagreement between GPS and GRACE(-FO) for sites located in the St. Lawrence basin. The fit between GPS annual signal and GPS/GRACE(-FO) correlation demonstrated a large negative trend $a = -1.26$. The average correlation across the basin was 0.55, which did not reflect a strong negative slope between amplitude and correlation. On top of this observation, another screening metric, trend maps, picked up a flipped trend in sites located in Michigan (part of the St. Lawrence basin) between the period 2015-2018. GPS reflected an uplift while GRACE(-FO) showed a subsidence (Fig. S1a and Fig. S1b). The pronounced disagreement triggered an investigation of the sites timeseries. Sites in Michigan exhibit an abrupt rise of about 7.6 mm and an abrupt east displacement of about 5 mm for about 24 months, starting in April 2016. There were sixty-two stations affected by such a jump. After investigation, we discovered that the issue was in the input NGL data (a mistake in the antenna heights in the header of the rinex files). Once the rinex headers were corrected and the sites were reprocessed, the overall correlation at the St. Lawrence basin improved to 0.61, the extreme negative slope stabilized to $a = -0.2$ (Fig. 2c) and GPS trends over the region aligned with trends picked up by GRACE (Fig. S1c).

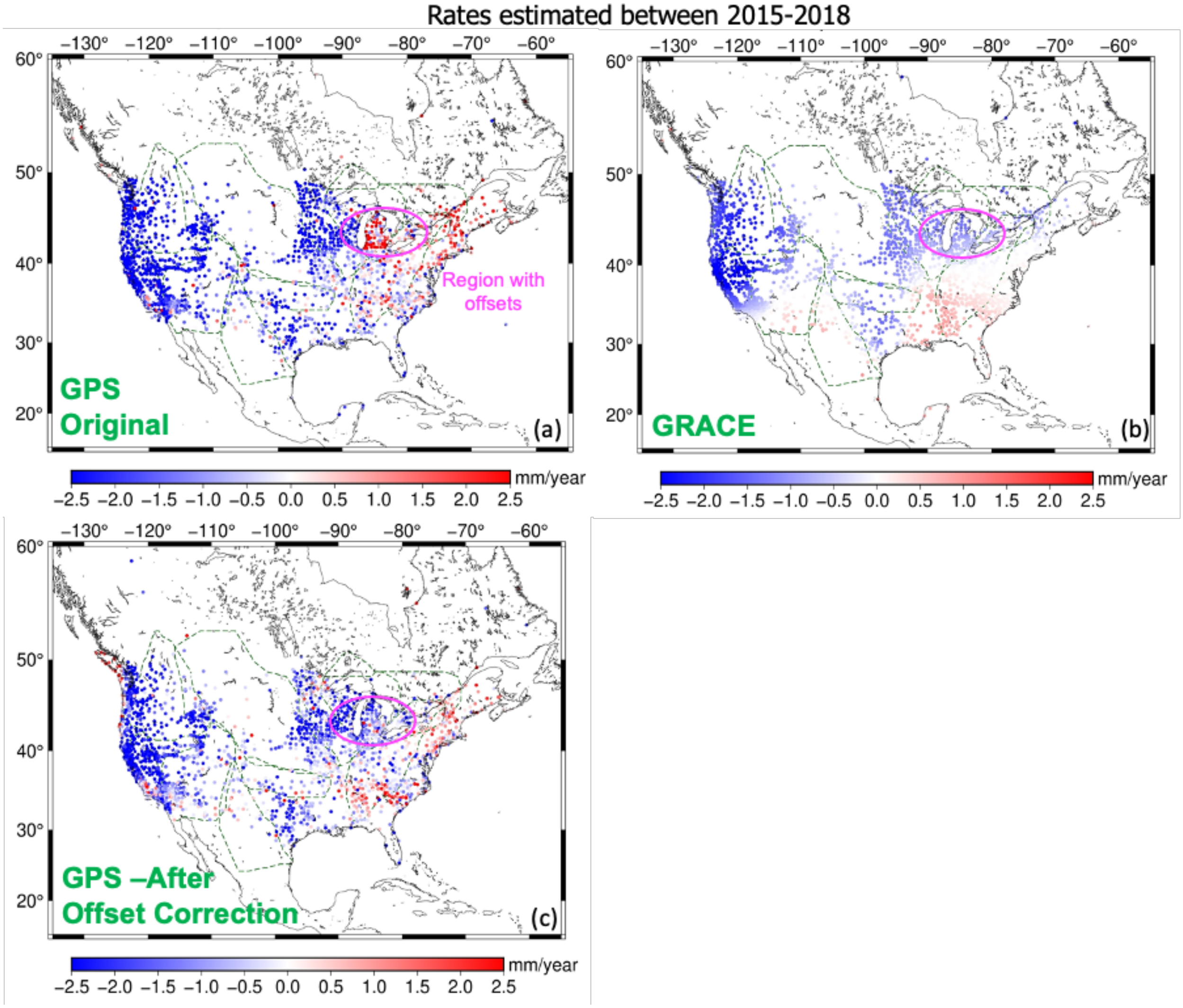

Figure S1: Rates estimated between 2015-2018 for a) GPS original data (with the unlogged offset); b) GRACE(-FO); and c) GPS after the fixing antenna heights in rinex headers.

S2. Timeseries of vertical displacements estimated from different techniques, i.e., GPS, GRACE(-FO), GLDAS

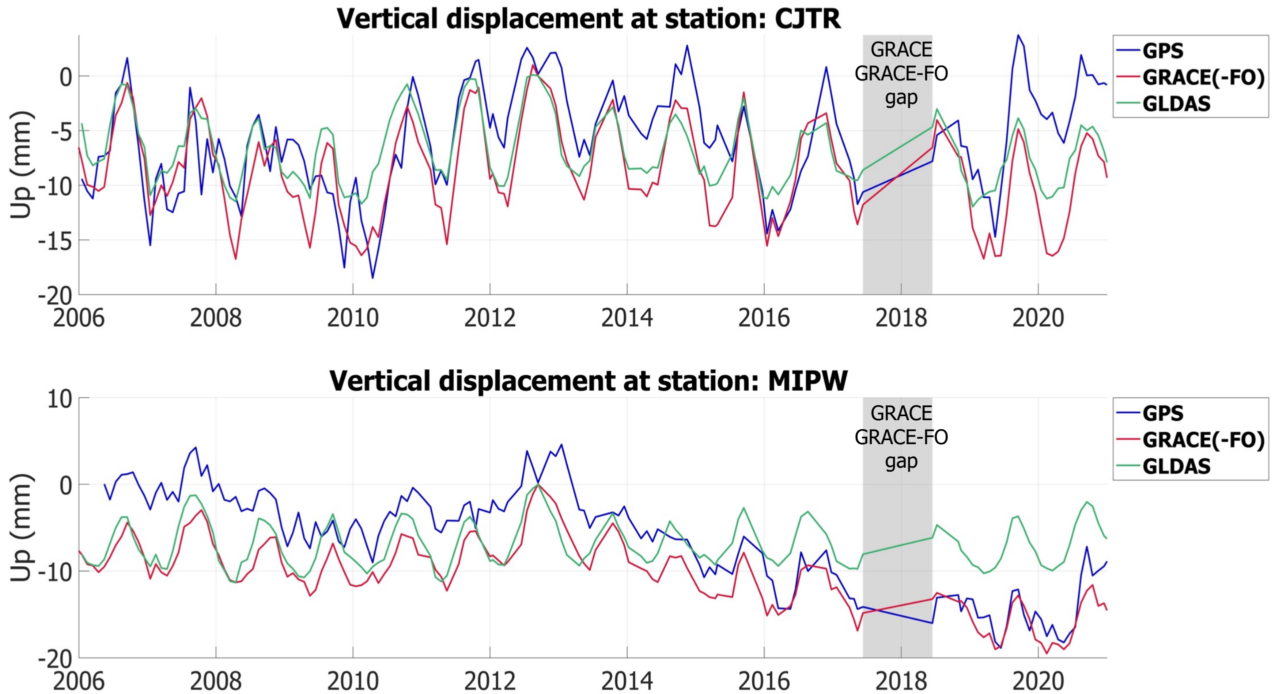

Figure S2: Timeseries of the vertical displacement (up) for two stations, i.e., CJTR (lon, lat = -92.273, 34.822 degrees) and MIPW (lon, lat = -85.657, 42.463degrees). GPS vertical displacements are in blue; GRACE(-FO) in red and GLDAS in green. Note that during GRACE/GRACE-FO gap (shaded grey area) there are no records.

S2. Relative contribution of Flicker Noise and Random Walk Noise to WN+FN+RW

When all three noise models are considered, we notice that white noise does not describe even minimally the noise of the GPS timeseries residuals. It is flicker noise and random walk the two noise models that describe the total uncertainty of the estimates. We performed a detailed analysis to understand the structure and the contribution of each of the two noise models to the total noise. Hector software provides the fraction (percentage) contribution, which we plot on S3. The contribution of a noise model to the total noise estimated to describe the uncertainty of a GPS timeseries ranges between [0 1]. Almost half of the stations' noise is described exclusively from flicker noise (dark green point centered at x,y=1.0, 0.0) and one fifth of the datasample (600 stations) are described exclusively by random walk noise (green point centered at x , y = 0.0 , 1.1) and from random walk for 600 stations. Residuals of the rest of the stations (~800) demonstrate noise characterized by a combination from both noise models shown (see S3).

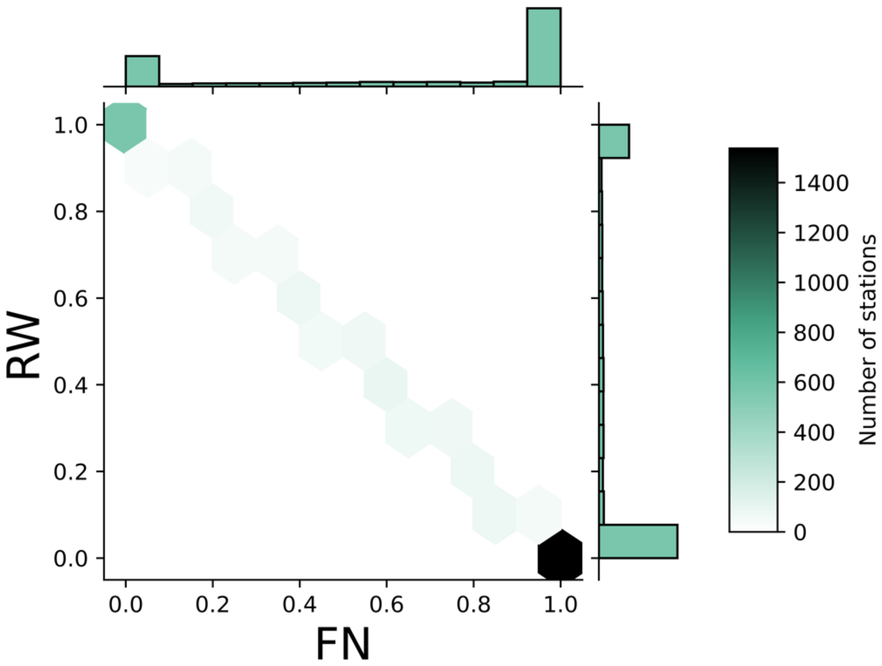

Figure S3: Diagram representing the contribution of random walk and flicker noise to a combined WN+FN+RW uncertainty quantification. The percentage contribution of FN is shown on x-axis and of RW on y-axis. Color variations denote the number of stations exhibiting the percentage contribution. A histogram with the number of stations is also plotted at the x and y-axes.