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Probabilistic reconstruction of GPS vertical ground motion and comparison with GIA models

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The vertical position time-series of GPS stations have become long enough for many parts of the world to infer modern rates of vertical ground motion. We use the worldwide compilation of GPS trend velocities of the Nevada Geodetic Laboratory. Those rates are inferred by applying the MIDAS algorithm (Blewitt et al., 2016) to time-series obtained from publicly available data from permanent stations. Because MIDAS filters out seasonality and discontinuities, regardless of their causes, it gives robust long-term rates of vertical ground motion (except where there is significant postseismic deformation). As the stations are unevenly distributed, and because data errors are also highly variable, sometimes to an unknown degree, we use a Bayesian inference method to reconstruct 2D maps of vertical ground motion. Our models are based on a Voronoi tessellation and self-adapt to the spatially variable level of information provided by the data. Instead of providing a unique interpolated surface, each point of the reconstructed surface is defined through a probability density function. We apply our method to a series of vast regions covering entire continents. Not surprisingly, the reconstructed surface at a long wavelength is dominated by the GIA. This result can be exploited to evaluate whether forward models of GIA reproduce geodetic rates within the uncertainties derived from our interpolation, not only at high latitudes where postglacial rebound is fast, but also in more temperate latitudes where, for instance, such rates may compete with modern sea level rise. At shorter wavelengths, the reconstructed surface of vertical ground motion features a variety of identifiable patterns, whose geometries and rates can be mapped. Examples are transient dynamic topography over the convecting mantle, actively deforming domains (mountain belts and active margins), volcanic areas, or anthropogenic contributions.