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Automatic recovery of background seasonal motions from GNSS time series

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In estimating the tectonic motion at a permanent GNSS station it is necessary to perform a signal decomposition of the processed daily time series. This is because seasonal oscillations tend to obscure the transient tectonic signals of interest. Therefore, finding an automatic method of robustly performing this separation is desirable. If we assume that the seasonal motions in the time series (mainly due to hydrological loading) are perfectly cyclical consisting of annual and semi-annual angular frequencies, we can decompose the signal using the regression approach. By imposing a sparsity condition on a dictionary of transient basis functions, we are able to find a minimum number of transient functions to explain the motion in the time series that is additional to the seasonal, subject to the regularization weighting. Riel et al. (2014) demonstrated this approach using a sparse dictionary of b-spline basis functions. In this presentation, we show a similar approach that uses a greedy optimization method and alternative dictionary of sparse basis functions designed to capture a variety of transient process timescales: from sudden displacements (steps) to decades long postseismic decay signals. Such consideration of gradually decaying transients is in keeping with the recent findings of non steady-state motions at some permanent stations during the interseismic phase of the earthquake cycle (see Melnick et al., 2017; Loveless 2017; Heki & Mitsui 2013; Loveless & Meade, 2016). The greedy algorithm requires no knowledge about the onsets of steps or decay functions in the data and is therefore completely automatic. We demonstrate the recovery of signals on both synthetic and processed solutions for South America, Japan, and Germany. Finally we show the background seasonal motion for all study regions and compare to the hydrological loading data.