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Variational Bayesian Independent Component Analysis for InSAR displacement time series with application to California

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The exploitation of ever increasing Interferometric Synthetic Aperture Radar (InSAR) datasets to monitor the Earth surface deformation is an important goal of today's geodesy. Surface geodetic deformation observations are often the result of the combination of a multitude of sources (either volcano-tectonic deformation associated with seismic events, post-seismic relaxation, aseismic transients, long-term creep loading, magma intrusions or non-tectonic deformation associated with hydrological loads, poroelastic rebound, anthropic activity and various sources of noise). In this regard, we are facing a so-called Blind Source Separation (BSS) problem. Natural approaches to tackle BSS problems are those multivariate statistical techniques which attempt to decompose the dataset into a limited number of statistically independent sources, under the assumption that the different physical mechanisms underlying the observations have independent footprints either in space or time. Multiple algorithms have been proposed to separate the various independent sources, and here we show the capabilities of a variational Bayesian Independent Component Analysis (vbICA) algorithm. In particular, we show through synthetic test cases its superiority with respect to other commonly used multivariate statistical techniques like the Principal Component Analysis (PCA) and the FastICA algorithm. Application of vbICA to InSAR time series from European Space Agency (ESA) Sentinel-1 satellite in the Central Valley and on the Central San Andreas Fault segment, California, spanning the time range 2015-2019, shows that the algorithm provides a viable way to separate elastic and inelastic deformation in response to the aquifer charge/discharge as well as creeping signal from seasonal loading.