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A new global approach to obtain three-dimensional displacement maps by integrating GPS and DInSAR data

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We propose a new technique, based on the elastic theory, to efficiently produce an estimate of three-dimensional surface displacement maps by integrating sparse Global Position System (GPS) measurements of deformations and Differential Interferometric Synthetic Aperture Radar (DInSAR) maps of movements of the Earth's surface.
The previous methodologies known in literature, for combining data from GPS and DInSAR surveys, require two steps: the first, in which sparse GPS measurements are interpolated in order to fill in GPS displacements at the DInSAR grid, and the second, to estimate the three-dimensional surface displacement maps by using a suitable optimization technique.
One of the advantages of the proposed approach is that both these steps are unified. We propose a linear matrix equation which accounts for both GPS and DInSAR data whose solution provide simultaneously the strain tensor, the displacement field and the rigid body rotation tensor throughout the entire investigated area. The mentioned linear matrix equation is solved by using the Weighted Least Square (WLS) thus assuring both numerical robustness and high computation efficiency.
The proposed methodology was tested on both synthetic and experimental data, these last from GPS and DInSAR measurements carried out on Mt. Etna. The goodness of the results has been evaluated by using standard errors. These tests also allow optimising the choice of specific parameters of this algorithm.
This "open" structure of the method will allow in the near future to take account of other available data sets, such as additional interferograms, or other geodetic data (e.g. levelling, tilt, etc.), in order to achieve even higher accuracy.