Transdimensional Estimation of Surface Strain Rates from GPS Measurements : Application to California.

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Investigating actively deforming areas often relies on strain rate calculations using geodetic data such as GPS velocities. Producing a continuous strain rate map from discrete data is an inverse problem traditionnally tackled with standard interpolation schemes. However most algorithms rely on arbitrarily user-defined regression parameters that directly determine the smoothness of the recovered velocity field, and hence the amplitude of its spatial derivatives, resulting in biased estimates of the strain rates and their uncertainties. Here we propose a transdimensional Bayesian method to estimate surface strain rates from GPS measurements.

We parametrize the velocity field with a variable number of Delaunay triangles, and use a reverse jump Monte-Carlo Markov Chain algorithm to sample the probability distribution for the surface velocity and its derivatives. In that framework, the solution is the complete probability distribution function for each parameter given the observed data which can be represented using statistical measures and cross-sections. We also use the probability distribution to define uncertainty estimates on our models. We illustrate this Bayesian approach on synthetic test cases mimicking real geophysical settings and GPS data distributions where results are compared with those obtained with bicubic spline interpolation schemes. We show that our method is more resilient to noisy and variably densified data without requesting the manual tuning of a smoothing parameter, while also providing uncertainties associated with recovered velocities and strain rates.

Finally, using GPS velocities from the MIDAS dataset (Blewitt et al. 2016), we apply this method to the western US and estimate the probabilistic strain rates along the main fault systems, including the San Andreas system.

Mots-Clés : Strain rate, bayesian interpolation, GNSS, San Andreas

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