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Surface deformation of the European Mediterranean region and Asia Minor from inversion of GPS motion vectors

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For the European-Mediterranean region and Asia Minor, we collected GPS motion vectors from 76 publications of the past 10 years from which we selected about 1500 surface motions with standard errors less than 2.5 mm/yr. Our study concentrates on the inversion of this point-wise information into estimates of the surface velocity-gradient field, which is the sum of the strain-rate and rotation-rate fields.

The relative motion between any two GPS-sites equals an integral over the velocity gradient field along an arbitrary integration path connecting the two points. If an integration path crosses an active fault, an additional surface-creep term accounts for the jump in velocity across the fault. In case the two GPS-points belong to different observation networks a third term accounts for the possible relative Euler rotation between the two networks. The collection of such three-term equations of relative motion for all possible combinations of two stations represents our starting set of observation equations. Model parameterization of the velocity gradient field (linear in triangles), surface creep (linear along fault segments), and relative network Euler poles (discrete vectors) enables a conversion to an ordinary matrix-vector equation which is solved with regularized least squares.

The resulting velocity gradient field shows much more detail of surface deformation than can be inferred from a direct analysis of the velocity field (which is an integral measure of deformation). We will present results of e.g. the present-day contraction

between the Western Mediterranean and Africa, and of deformation patterns associated with major subduction and collision zones in the Mediterranean region and in Asia Minor. Our analysis is only kinematic, i.e. involves no assumption on rheology or stress field, and the results can be used as a detailed surface constraint on dynamic modeling of crust-mantle processes of the region in which a test against model predictions may help to discern between the separate contributions of crust and mantle to surface deformation.