Numerical experiment for comparison between smoothing and triangulational approaches to analyze heterogeneous distribution of Earth surface deformation based on GPS data

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A numerical experiment was done to compare different methods of computing 2D Earth crust strain rate tensor values. The computation was made based on synthetic data imitating a catalogue of geodetic sites' velocities. Such a catalogue is normally obtained by processing the data from several years of high precision GPS observations. In this study we generated the catalogue from a simple model of Earth crust. The model contained a single rigid block moving relative to its surrounding. Borders of this block were like virtual faults and certain kinematic effects emerged on them. These effects must be typical for various geodynamic modes: thrust, transpression, lateral shift, transtension and normal faulting. To compose the synthetic catalogue of velocities we chose around 70 points on the model surface in such a way that they form triangles and quadrangles were arranged in geometrically different ways relative to virtual fault lines. Velocities of these points were assumed to be equal to velocities of model blocks they belong to (without adding random noise). Then based on catalogue of coordinates and velocities of these points we computed 2D strain rate tensor values among the model surface using two different approaches: (1) using spatial smoothing and (2) by separate triplets and quadruplets of the points. We compared results of both approaches with what we expected based on the a-priori block deformation model. We show that the smoothing approach gives a trustworthy picture in general but does not show clear boundaries between areas with different deformation types. Computing 2D strain rate tensor based on separate triplets of velocity points gives results with distorted deformation types and direction of principal axes. When we choose such three points let's consider two of them that are at the same side from the fault line. If distance between the fault line and the first point is equal to distance between the fault line and the second point then result of the strain computation will not be distorted. If these two distances differ significantly then it will be distorted. The extent of the distortion depends on relative difference between these distances and also on some other geometrical features of points' locations.