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Extraction of a kinematic model for Switzerland based on GNSS and levelling data

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Within Switzerland, the deformation rates are small compared to tectonically more active regions in Europe. Velocities are derived from GNSS campaign data incorporating measurements from 1988 to the most recent campaign in 2010 (CHTRF2010). Their magnitudes are well below 1mm per year relative to the station in Zimmerwald located on the Swiss plateau. Precise uplift rates are obtained from 100 years of levelling data (up to 1.5 mm per year relative to a station in Aarburg). All measurements and processing have been carried out by swisstopo. The major challenge is to extract the small tectonic driven deformations from the dense (over 200 GNSS points) but noisy dataset as the signal is small. Combining GNSS campaign data for the horizontal component and levelling data for the third dimension allows to estimate a 3D deformation field.

This is achieved using an adaptive least squares collocation technique including all measurements to extract simultaneously the kinematic and strain fields. The main idea of this process is to distinguish between local and regional deformations. Local parts represent the deformations caused by effects affecting only individual sites (land slides, instabilities of monumentation, etc.). The second component, the global part, is assumed to be driven by tectonics and, therefore, has a similar impact on all sites within an certain area. Local and global effects, both have a similar order of magnitude, however their spatial autocorrelations are clearly different. In order to decorrelate regions with high strain rates the used trend metric is deformed iteratively enlarging the distance between points with high strain rates. This approach does not depend on previous informations on the tectonic setting as the correlation length is adjusted using the measurements itself.

The obtained results are velocity and strain fields for the area covered by the reference network. In this paper it is shown that even though the signal in the data is small, a tectonic deformation field can be extracted. The adaptive least squares collocation technique allows to obtain sharper gradients across a transition zone compared to non-adaptive approaches.