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A 2D FEM approach to understanding the current surface motion in the swiss alps, with particular focus on the role of friction between tectonomorphic units in a complex geometry

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Surface motion is, apart from the obvious topography, the most easily accessible and best quantifiable characteristic of a typical alpine-style orogen. While it is understood that several different processes, such as i.e. isostatic unloading and thermodynamic effects contribute to the overall motion, it is mostly unclear how large the individual contributions are, and how much of the observed motion is a consequence of ongoing tectonic shortening.
A number of methods, such as enhanced GPS measurements, Interferometric Synthetic Aperture Radar (InSAR) and fission track (FT) dating, as well as precise leveling can now provide us with a good description of the vertical motion at present as well as in the fairly recent history of the orogen. This in turn, provides us with reliable, and often much needed, criteria for calibrating conceptual and numerical models of orogenesis and the involved processes.

We present a series of finite element models, that attempt to reproduce the observed vertical surface motion on a roughly north-south cross section of the Swiss Alps in the 'ABAQUS' commercial FEM package. Unlike most comparable modeling approaches, we apply a fairly simple formulation of rheology, and focus on a highly complex geometrical representation of the cross section, constructed of individual tectonomorphic units such as the Aar- and Gotthard massifs, the Helvetic and Penninic nappe structures as well as the underlying subduction of the European crust.
The models simulate a short timespan, with a fixed rate of shortening prescribed by the boundary conditions and the various interactions between the tectonomorphic units being the dominant adjustable parameters. The resulting motion at the surface of the model, as well as the internal deformation of the individual tectonomorphic units is then examined, interpreted and compared to their real-world counterparts. The models incorporate variations in the chosen physical descriptions of the materials, deforming in purely elastic and partially elasto-plastic fashion, as well as in the description of the friction dominated interactions at the interfaces between units. Further parameter variations within these model sub-series provide insight into the relative relevance of these factors.