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Do river profiles record low uplift rates? Example of the Sundgau, Upper Rhin Graben (France)

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Landscapes that have not reached a steady-state can be used to identify and quantify faults activity. The problem however is to determine which, of the tectonic or climatic forcing, is responsible for this disequilibrium in low deformation rate environments ($<$1mm/y). We evaluate the respective contributions of low folding and uplift rates ($<$0.1mm/y) and Quaternary climatic oscillations on the Largue and Ill river profiles in the Sundgau (southern Upper Rhin Graben, France).

Since Pliocene times, the Sundgau region has been tilted northward and folded locally under the effect of the Jura fold-and-thrust-belt propagation (Nivière and Winter, 2000). The total relative uplift of the Sundgau is ca. 300m whereas folding imposed relative local uplift of 30 to 100m as testified by the Sundagu gravel basis, a Pliocene marker of paleo-horizontality (Nivière and Winter (2000), Giamboni et al (2004)). These observations imply an average post-pliocene uplift rates of the order of 0.1mm/y at the most.

The Largue and Ill rivers flow accross the Sundgau from the Jura belt and join in Mulhouse, at the northern edge of the uplifted domain. Along their course, their profiles show knick-points and concavity variations. To evaluate which of localized uplift or quaternary climate variation drove these anomalies, we compare the observed profiles with those predicted by a detachment limited numerical model including i) realistic stochastic short term, ii) cyclic long term variations, iii) bedrock detachment threshold and iv)observed patterns of uplift. This model is based on the analytical solution proposed by Tucker (2004) which expresses the mean incision rate as a sum of stochastic incremental scour events. Modelling results predict that the Ill and Largue profiles anomalies are more likely to be due to tectonics than climate oscillations. This is a result that sounds counter-intuitive under temperate climatic conditions and very low

uplift rates. A plausible explanation, however, is that the very low gradients of the rivers did not allow Quaternary climate variations to drive large amplitude oscillations of the river bed, even when detachment thresholds are neglected.