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Supplementing ice core time series at a small scale Alpine glacier with a 3D full stokes ice flow model using Elmer/Ice

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The cold glacier saddle Colle Gnifetti (CG) is the unique drilling site in the European Alps offering ice core records substantially exceeding the instrumental period. In spite of an ice thickness not much exceeding 100 m, CG provides long-term ice core records due to its low net accumulation and rapid layer thinning. However, net accumulation at CG is characterised by strong spatio-temporal variability causing depositional noise and, combined with a complex flow regime, upstream-effects. These intricate glaciological settings hamper the full exploitation of the unique potential for long-term ice core records of this site.
Here we present first results from developing a new model attempt, i.e. full stokes with consideration of firn rheology, specifically tailored to the complex CG settings, and utilizing the 3D finite element model Elmer/Ice in combination with existing CG ice core as well as geophysical data. A major objective is to map source trajectories of existing ice core sites in order to evaluate potential upstream effects. Since dating the CG ice cores becomes a challenge already after the last 100 years or so, an additional focus is to assist in finding a reliable age scale, especially targeting depths where annual layers can no more be counted. This includes the calculation of isochronous surfaces for intercomparison of different drilling sites within the CG multi core array.
As already known from previous model attempts at CG, a main limitation arises from insufficient knowledge of the bedrock topography. The currently known bedrock topography for CG is based on recent GPR measurements and ice core drillings, but is still not precise enough. Here we present first results concerning the reconstruction of the bedrock topography by inverse modelling, using an iterative sequence of diagnostic runs. Relying on empirical evidence from direct measurements, bedrock topography used as model input is adjusted to achieve best possible agreement among other calculated and measured quantities, e.g. surface accumulation.
Next steps in refining the model are concerned with obtaining better constrained model parameters and boundary conditions, e.g. basal heat flux, using an iterative sequence of prognostic runs, similar to the adjustments for bedrock topography.