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Improved glacier dynamics from forcing an ice flow model with modelled surface mass balance

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Mass balance over alpine glaciers is traditionally obtained from direct point measurements which are then turned into continuous fields over the glacier entire area with various interpolation methods. Unfortunately, the lack of data over some unaccessible areas as well as the uncertainties on the measurements themselves unavoidably leads to sometimes large inaccuracies in the yearly surface mass balance field. A new physically-based approach using meteorological reconstruction (SAFRAN model) with a pronostic snow cover model (CROCUS) has been carried out over the Saint Sorlin glacier in order to simulate both the temporal (1-hour step) and the spatial (200-m resolution) variability of the surface mass balance. These results are used to force a semi-implicit 2-dimensional ice-flow model in order to simulate the dynamics of the Saint Sorlin Glacier.

First, mass balance fields obtained from the two methods are compared. From this, some interesting features of the modelled approach appear like a high sensitivity to the glacier surface exposure, which leads to significantly different values compared to interpolated field data over poorly-measured areas.

The ice-flow model is then forced by the two different mass balance fields and the results are compared in terms of ice dynamics. A difficulty arises when trying to assess by how much this modelled mass balance approach leads to a better representation of ice dynamics partly because of some uncertainties on the ice-flow model parameters and also because of uncertainties on field data about glacier dynamics which the model has to match.

Irrespective of its ability to provide better results, the mass balance modelled approach has the advantage of allowing for simulations of the future. From one of the IPCC

climatic scenario over the 21^{st} century, it becomes possible to propose the resulting surface mass balance evolution and therefore a rather realistic simulation of the glacier over the same period.