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Mass balance sensitivity to meteorological parameters

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A new physical mass balance model has been developed to study alpine glacier mass balance. We use the CROCUS snow model, developed by Météo-France and adapted to glaciers. At the surface, the snow/ice model is driven by prescribed hourly meteorology : 2-m air temperature, 10-m wind speed, 2-m air relative moisture, precipitation quantity and phase, incoming direct and diffuse solar radiation, incoming long wave radiation, and cloudiness. As there are no meteorological observations available on or next to studied glaciers, we use the synthetic data SAFRAN that combine disaggregated large-scale meteorological analysis and observations nearby. This model has been validated with success on two French Alpine glaciers : St Sorlin in the Grandes Rousses range and Argentière in the Mont Blanc range. Typically when studying climate impact on mass balance with past records, it is hard to separate the different meteorological parameters which vary concurrently, so it is mainly combined sensitivity which are given up to day. As our snow/ice model is explicitly and separately driven by the various meteorological terms that determine the mass balance, it is therefore particularly suited to evaluate the impact that climate change has on glaciers. We have both studied change in mass balance and change in equilibrium line altitude for an alteration of each different meteorological parameters in CROCUS input. The order of magnitude of these alteration were taken from climate change scenarii for the XXIst century computed by general circulation model over the Alps. Temperature change is confirmed to be the main parameter involved in future glacier shrinking. For example, equilibrium line sensitivity to temperature is found to be 125 m/K and up to 160 m/K if concurrent long-wave radiation change from atmosphere is taken into account.