Supplement of Earth Surf. Dynam., 11, 899–915, 2023
https://doi.org/10.5194/esurf-11-899-2023-supplement

Earth Surface Dynamics
Open Access
EGU

Supplement of

Estimating surface water availability in high mountain rock slopes using a numerical energy balance model

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Figure S1 – Ice crust

Field photos showing ice crust at the bottom of the snowpack exposed during fieldwork at the Aiguille du Midi SE face. Photos were taken on 26th January 2022.

Figure S2 – Illustration of the model components

The forcing data from the S2M-FAFRAN dataset include air temperature, wind speed, rainfall, snowfall, air pressure, short wavelength solar radiation, long wavelength radiation. Snowpack processes are simulated using the CryoGrid community model and the CROCUS scheme that is incorporated into it. The rock thermal regime is modeled with heat conduction by the CryoGrid ground component. The model calculates water mass balance (blue and white arrows) and surface (rock and snow) energy balance.

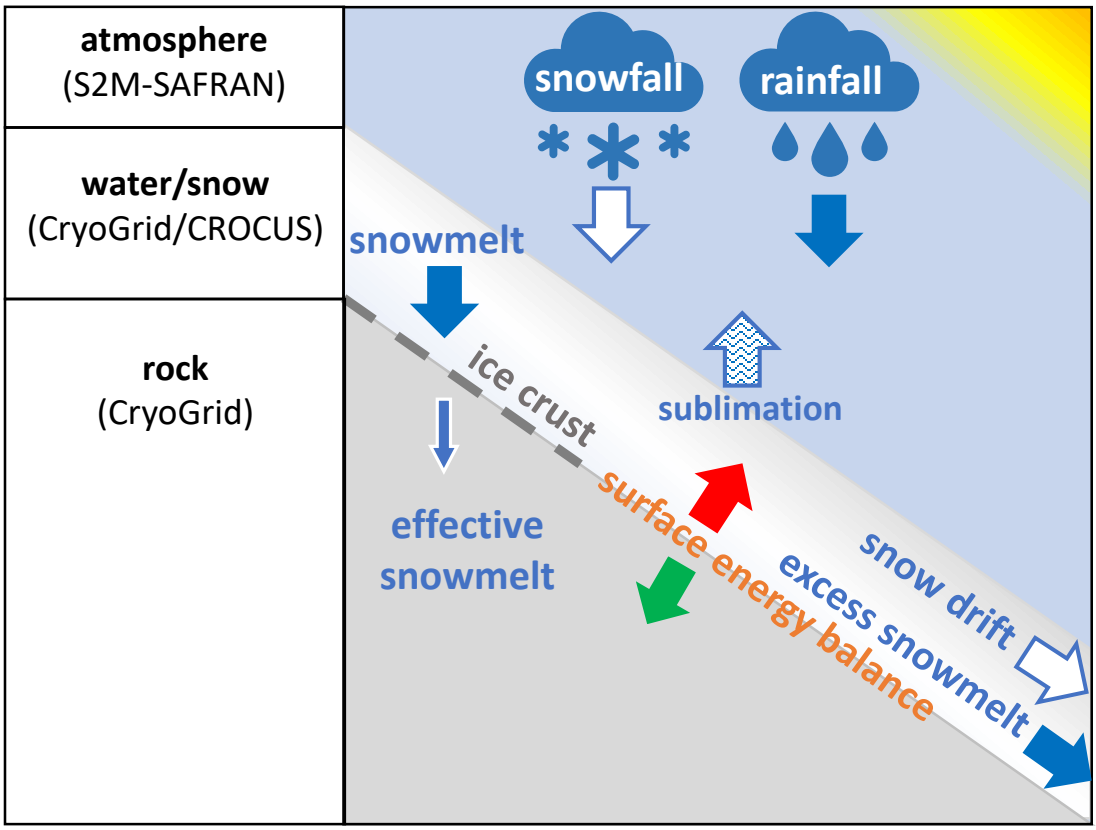


Figure S3 – Comparison of S2M-SAFRAN dataset with field measurement.

Comparison of S2M-SAFRAN dataset with field measurement from in-situ meteorological stations. A) Air temperature measurements from the Meteo France station at Aiguille du Midi (Poste 74056006) vs S2M-SAFRAN dataset. Air temperatures measurements are from hourly data averaged over 3 hours. Dashed line is the 1:1 line and red line is a linear regression.
B) Precipitation measurements from the Meteo France station at Chamonix (Poste 74056001) vs. S2M-SAFRAN dataset. There are no precipitation measurements available at Aiguille du midi. Precipitation measurements are summed over 3 days. Dashed line is a 1:4 ratio.

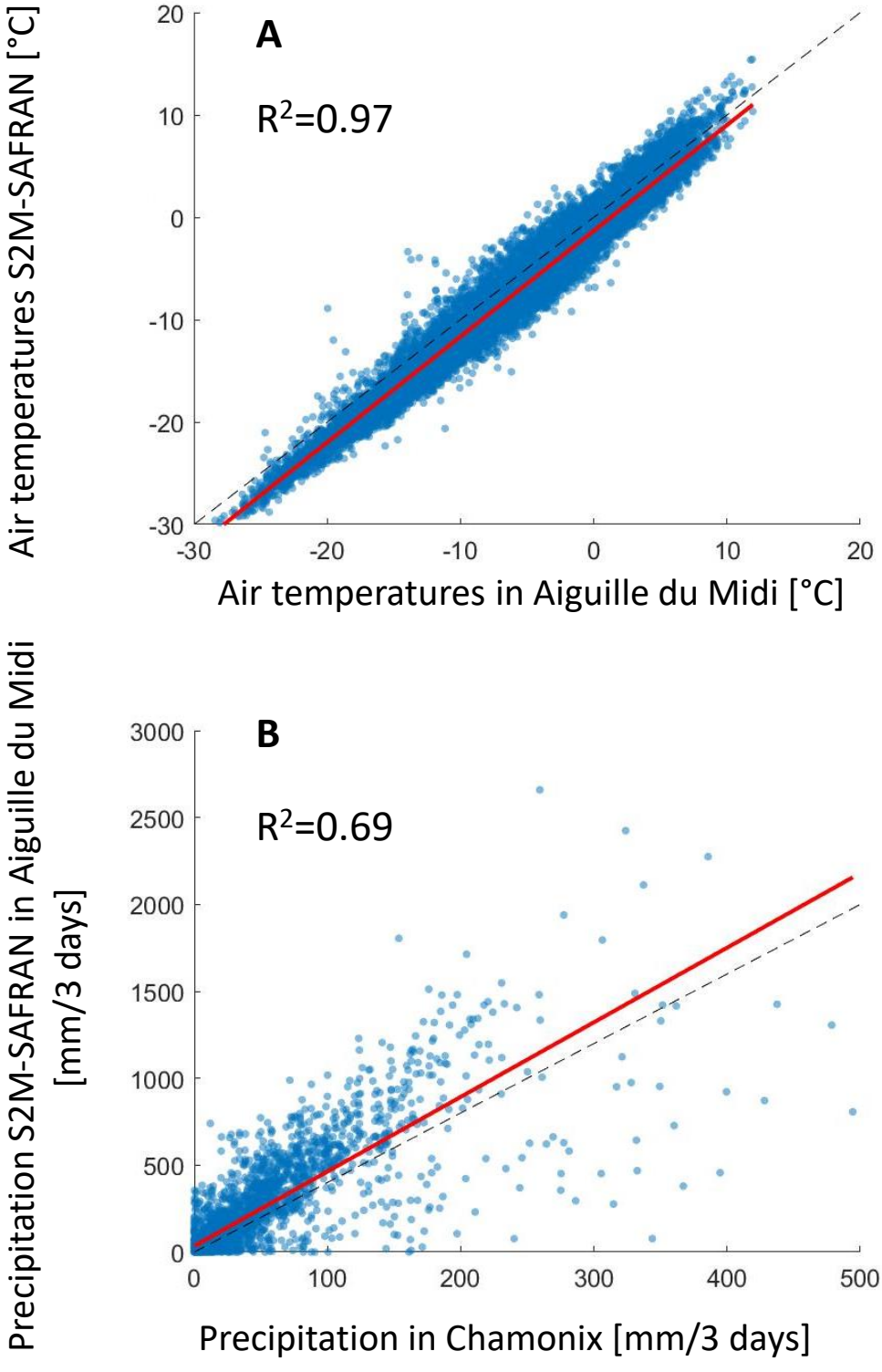


Figure S4 – validation of modeled snow depth with measurements from the east face of Aiguille du Midi.

The light blue area shows the modeled snow depth using a snow fraction parameter of 25% on the E-face validation site. The red markers are measurements from a snow depth pole monitored with a time-lapse camera.

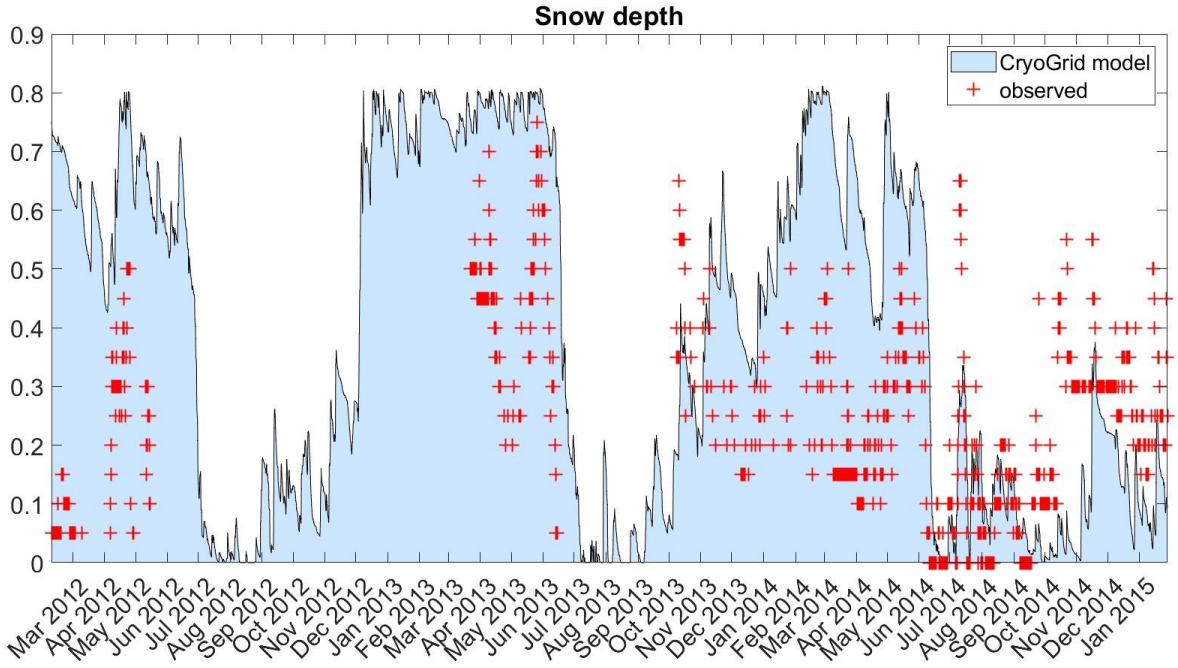
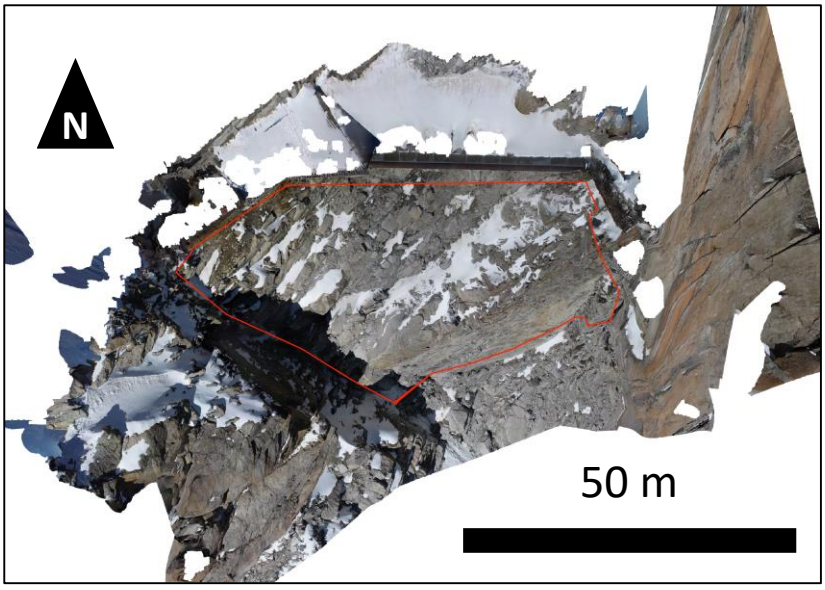
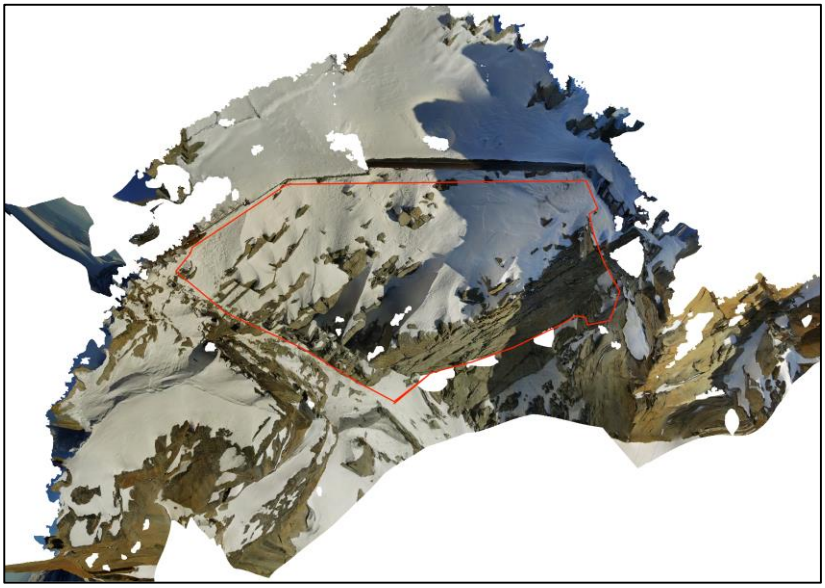


Figure S5 – UAV images and calculated snow thickness. The red polygon marks the area on the SE face that was analyzed (~500 m^2) for the spatial distribution of snow thickness.

October 2021
UAV orthoimage

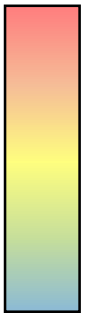


January 2022
UAV orthoimage



January 2022
snow thickness

>1 m



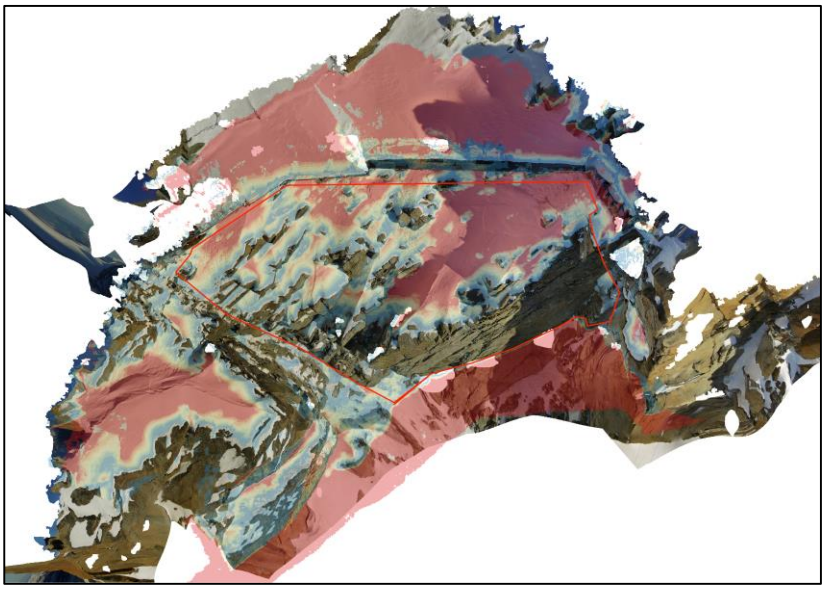


Figure S6 – Example of time-lapse images of a snow depth pole installed on the east face. Pole height is 1m with black/white scales of 10 cm.

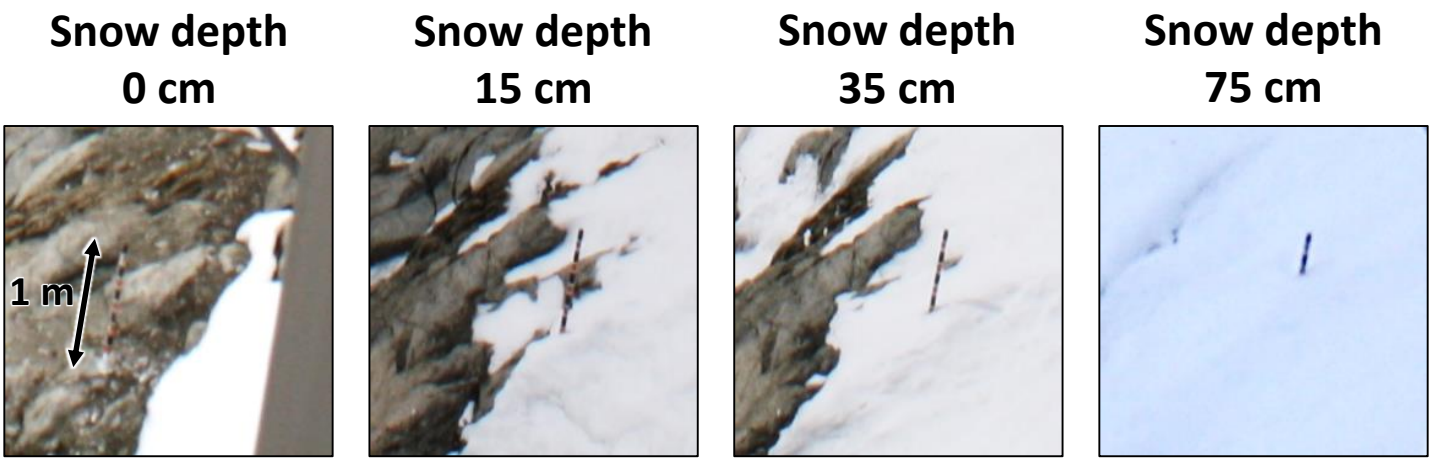


Figure S7 – Sensitivity analysis of sublimation rate to surface roughness length (Z0). Note that sublimation remains a dominant snow mass loss process in the tested range of 0.0001 m – 0.02 m. a) Average annual sublimation and net snowmelt during the simulations years. b) Annual sublimation and snowmelt.

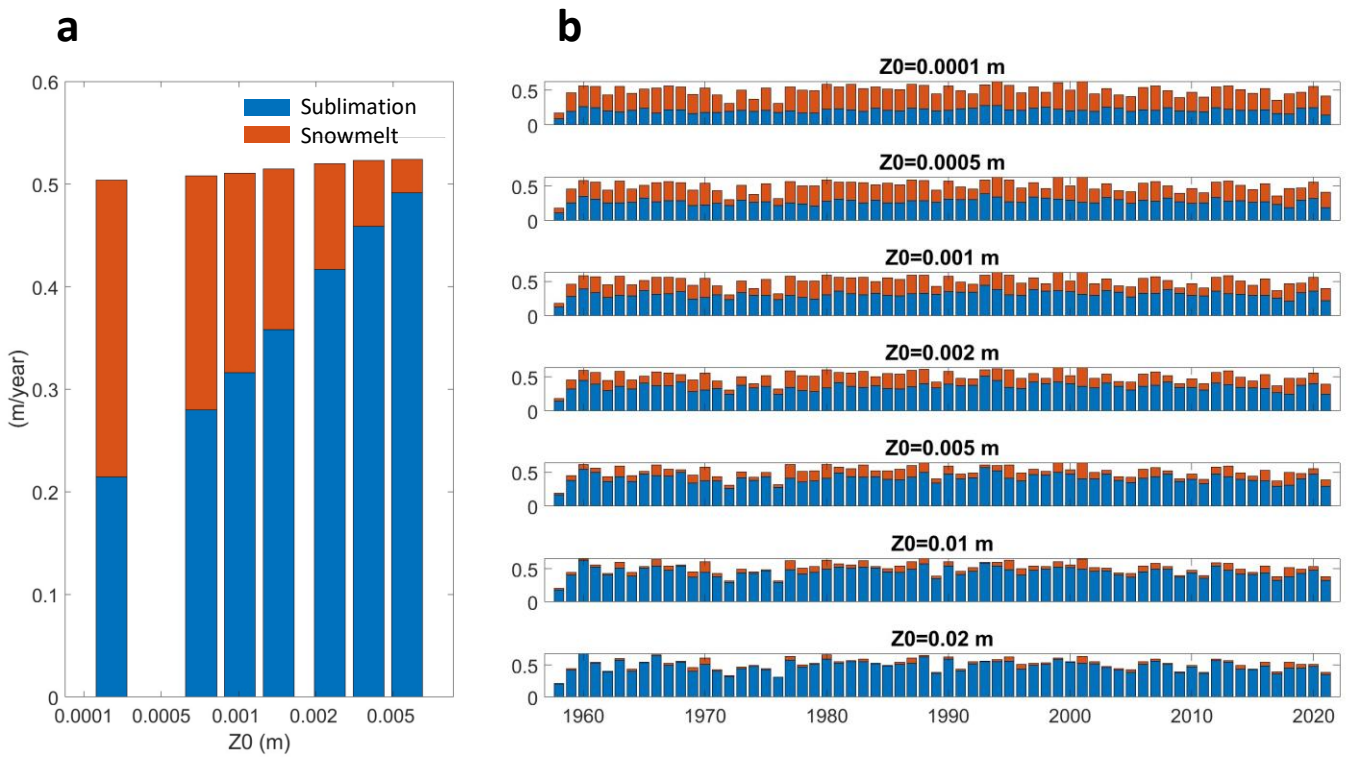


Figure S8 – Effective snowmelt rates converted to equivalent hydraulic conductivity. These are the hydraulic conductivity values required for complete infiltration of the effective snowmelt. Green and red lines show the range of values of estimated hydraulic conductivity of the rock in Aiguille du Midi.