

Model parameter sensitivity analysis

A model parameter sensitivity analysis of the model C2 was carried out for a daily time step simulation at Joe Wright station for the parameters α_{m2} , α_f , T_m and α_l with the following steps:

- The starting parameter values are the optimal parameter set coming from the particle swarm algorithm;
- All the parameters except the analyzed parameter were kept constant and equal to the optimal parameter set;
- 100 random values of the analyzed parameter were picked up from a uniform distribution with lower and upper bound defined in Table 1. With this procedure 100 model parameter sets were defined.
- The model was executed 100 times with the model parameter sets defined in the previous step
- The 100 model outputs were plotted in the same graph to see the sensitivity of simulated SWE to the analyzed model parameter.
- 100 value of KGE, computed by comparing model outputs with measured time series, were plotted against each value of the analyzed parameter used in the simulation.

Figures 1- 4 presents the results of the sensitivity analysis for each parameter.

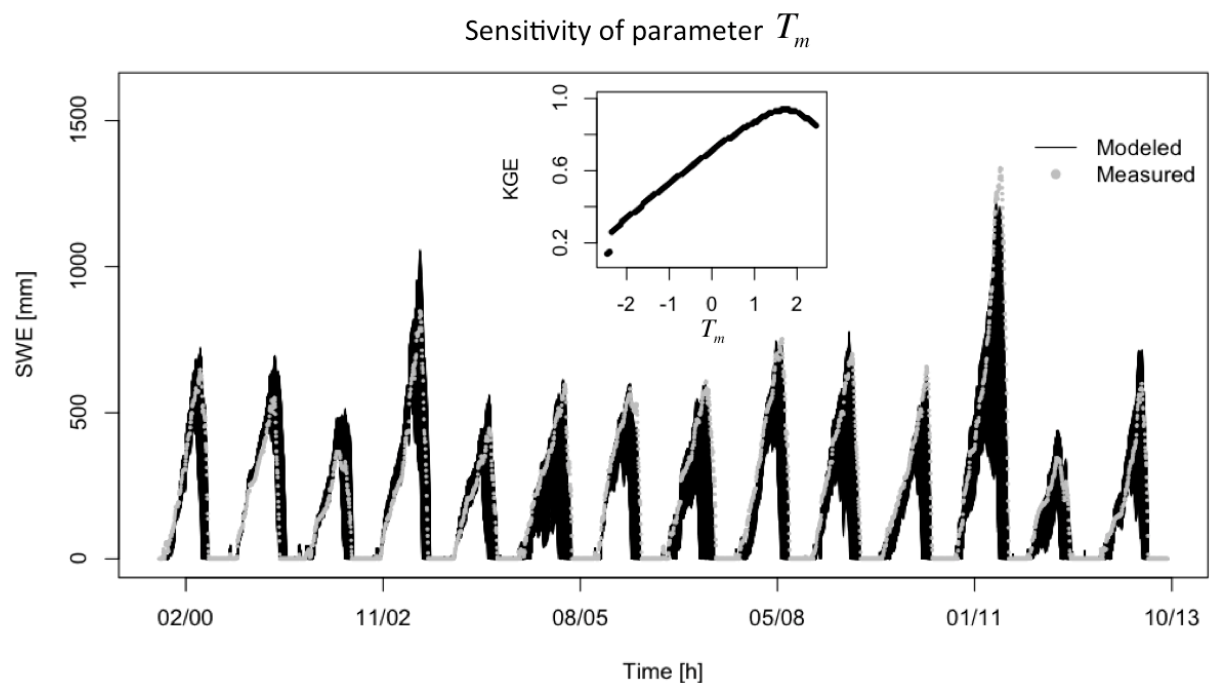


Figure 1: Sensitivity of simulated SWE to parameter T_m . In the main plot the gray dots represent the measured snow water equivalent, and the black lines the model simulations. In the small plot the KGE is plotted against the values of the analyzed parameter.

Sensitivity of parameter α_l

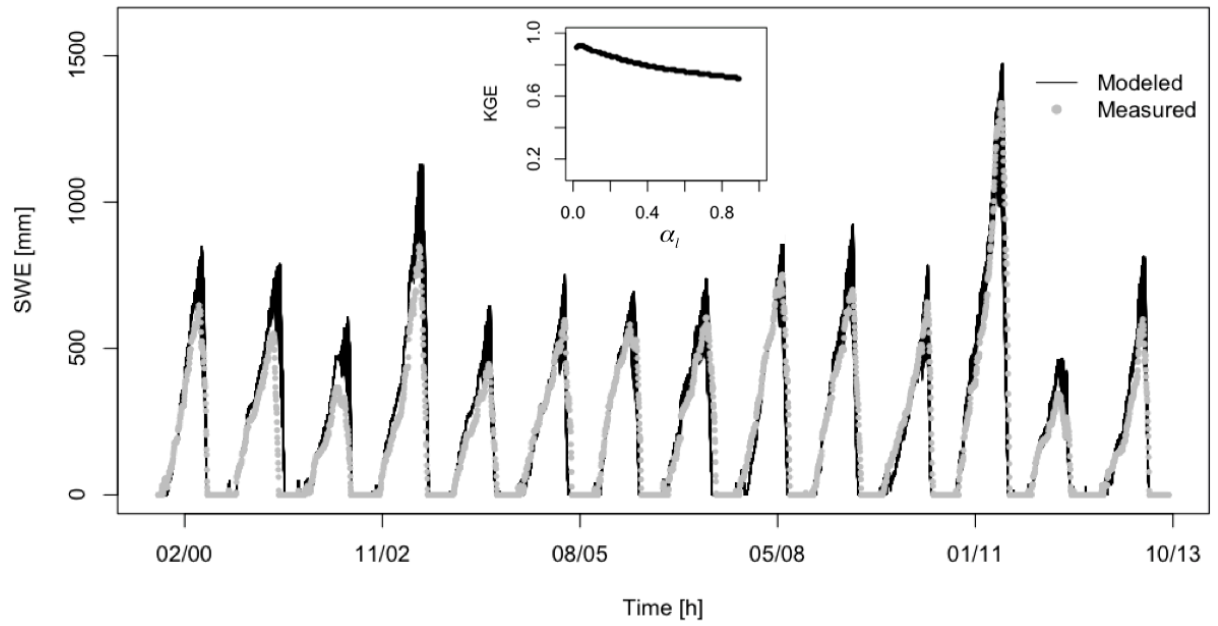


Figure 2: Sensitivity of simulated SWE to parameter α_l . In the main plot the gray dots represent the measured snow water equivalent, and the black lines the model simulations. In the small plot the KGE is plotted against the values of the analyzed parameter.

Sensitivity of parameter α_{m2}

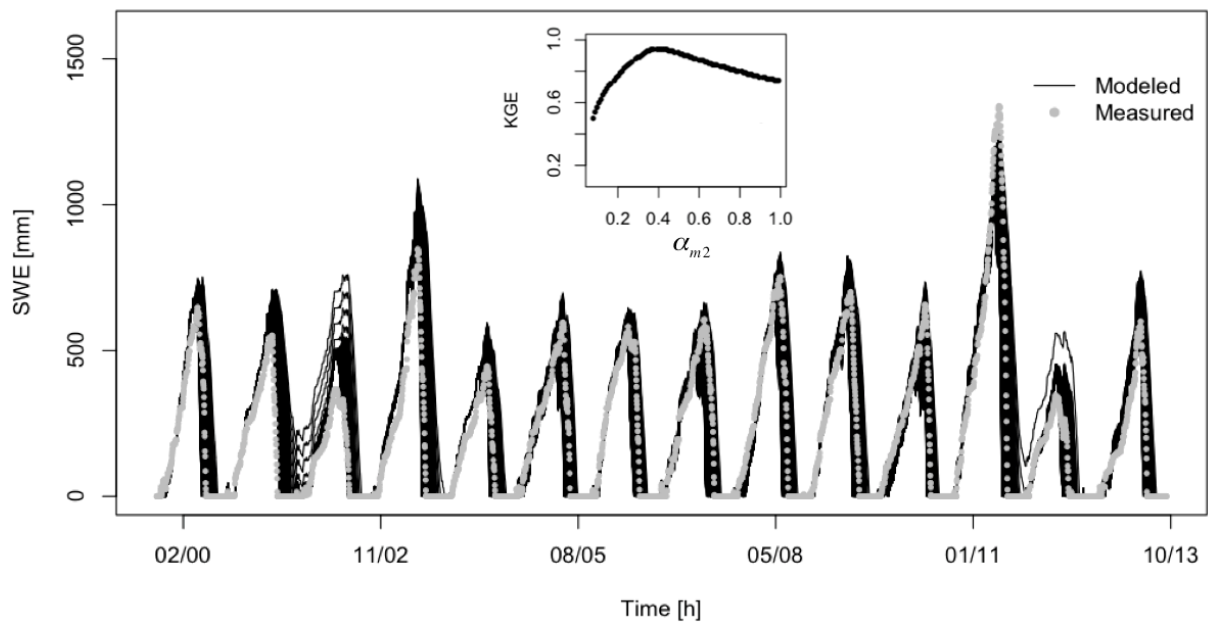


Figure 3 Sensitivity of simulated SWE to parameter α_{m2} . In the main plot the gray dots represent the measured snow water equivalent and the black lines the model simulations. In the small plot the KGE is plotted against the values of the analyzed parameter.

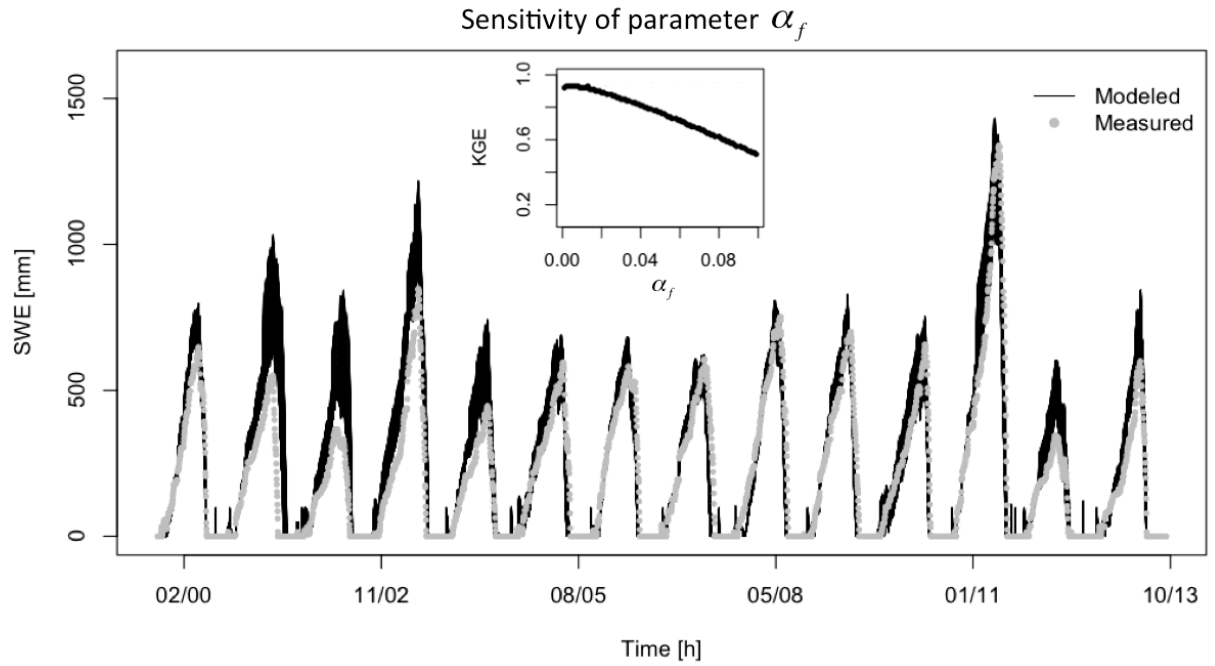


Figure 4: Sensitivity of simulated SWE to parameter α_f . In the main plot the gray dots represent the measured snow water equivalent and the black lines the model simulations. In the small plot the KGE is plotted against the values of the analyzed parameter.

Parameter	Lower Bound	Upper Bound
α_f	0.001	0.1
α_l	0.1	1.0
α_{m2}	0.1	1.0
T_m	-2.0	2.0

Table 1: Lower and upper bound of the parameters in the sensitivity analysis.

Refreezing at hourly time step

In order to show the models' capability to simulate processes that are relevant and occur on sub-daily scale such as refreezing, Fig. (4) shows snow water equivalent simulated and modeled, solid water and air temperature for a period that goes from 7-02-2008 to 15-02-2008 and for the three models C1, C3 and C3.

Models mimic the process of refreezing, and this is evident around 10-03-2008 where the temperature is around -10 C, and the red curve representing the solid water increases by around 1.5 cm. C1 and C3 are much more sensitive to refreezing relative to the C2 model, which has the lower T_m parameter (equal to -1.31 °C).

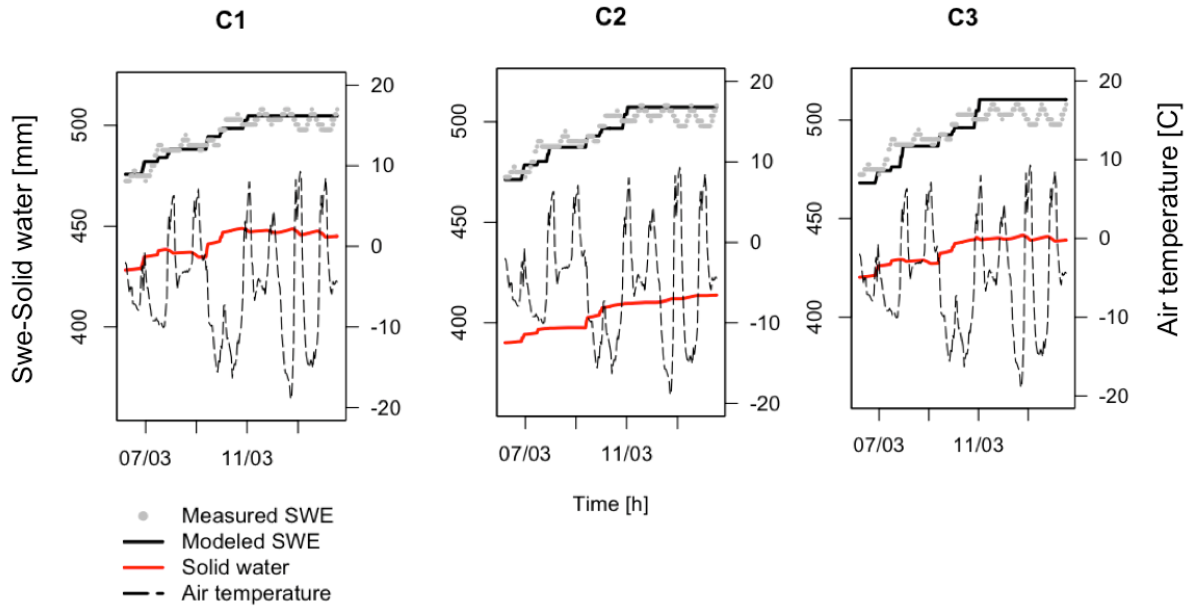


Figure 5: Refreezing processes in the C1, C2 and C3 models. The solid water (red line) increases during the period around March 10 when air temperature decreased around -10 C.