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Comparison of modelled radiation budgets with observations over lichens and shrubs at Mount Imingfjell, Norway

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Mountains are some of the most inaccessible regions, where not many weather stations located due to the high altitudes. Thus, the amount of available mountain meteorological data is limited. One of the modern solutions to data insufficiency is modelling. However, it remains challenging to assess how well a model simulates local climate conditions.

The main goal of this study was to check the model accuracy by comparing its results to observed data, with a focus on the radiation budget.

The Community Land Model 4.5 (CLM4.5) provided by the University of Oslo was used. It is a one-dimensional model and the default land component in the Community Earth System Model 1.2. CLM4.5 simulates various biogeophysical and biogeochemical processes based on surface energy, water, and carbon balances [Oleson et al. 2013]. Here, the model was run from 1901 to 2014 in the offline mode, meaning it was getting input from a pre-existing dataset. Modelled fluxes from the radiation budget, such as incoming (K_{in}) and outgoing shortwave (K_{out}) radiation, incoming (L_{in}) and outgoing (L_{out}) longwave radiation, net all-wave (Q*), net shortwave (K*) and net longwave (L*) radiation, were used for compassion with observations.

A 2.5×0.2 km site on Mount Imingfjell (1191 m) in southern Norway was selected as the study object. Different microclimatic parameters, including radiation fluxes, were measured separately over lichens and shrubs for 44 days in the 2018-2019 summers [Aartsma et al. 2020]. These vegetation types were chosen to understand the differences between them and see the potential impact of “shrubification” on surface albedo. Since there was no time overlap between modelled and observed data, we had to make datasets more comparable. 44 days from field data were used to create composite datasets that represent three temperature regimes based on data from the nearest weather station: “cold”, “normal” and “warm”. Each observation was assigned to one of these temperature regimes. In CLM4.5, recently available years were analysed to find ones with average summer temperatures closest to the stated temperature regimes. Statistical analysis, such as a two-sample t-test, was performed to see if there were any significant differences between the datasets.

T-tests showed that modelled K_{in}, L_{in} and K* were always similar to measurements, except for L_{in} and K* in “cold” conditions. CLM4.5 K_{out} differed from observed ones in almost all regimes. Simulated L*, Q* and L_{out} varied between temperature conditions and vegetation types. Still, about

70% of the modelled fluxes closely resembled the shrub ones, while only around 50% resembled lichens. Modelled albedo was also closer to shrub albedo.

In conclusion, CLM4.5 most likely modelled credible values for radiation fluxes, but further research is needed for greater clarity.

References

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