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Comparative simulations of snow and superimposed ice at the Kongsvegen glacier, Svalbard

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Kongsvegen is a high arctic polythermal glacier, with an area of 102km^2 and 25km length. A surface cold layer reaches the bedrock in the ablation area where the glacier is partly frozen to the ground. The ice is mostly temperate in the higher basins where the formation of superimposed ice is an important factor regarding the energy and mass budget of the glacier. We consider glaciological and meteorological data that were collected at about the equilibrium line of the Kongsvegen glacier (79N, 13E, 543m a.s.l.). The basic meteorological parameters are measured there, as well as the short- and long wave radiation components, snow height and snow temperatures at three depths. During the twice-yearly maintenances of the station, glaciological investigations of the snow and ice conditions were performed as well. Covering more than three annual cycles now, these data allow for detailed investigations of the seasonal evolution of the local mass and energy budget of the glacier.

Radiation exerts the dominant forcing on the energy budget at this site, with polar night conditions from late October through early February. The air temperatures can be as low as -40˚C, but the winter regime is coreless due to the vital synoptic activity enforcing episodic break ups of the otherwise persistent radiation inversions. The summer temperatures settle around 0˚C which can be attributed to the stabilizing influence of melting snow and ice surfaces. The wind regime is characterized by moderately developed glacier winds, which are influenced by topography and synoptic disturbances. Moreover, the site is characterized by a cold, 1.5 to 2m deep snow pack at the end of winter. Intensive melt starts in May, when the formation of superimposed ice is initiated too.

At this elevation and with the current climate conditions, there is multi-year formation

of superimposed ice, but the final amount strongly depends on the individual summer conditions. During certain summers, superimposed ice was observed to build up in an extent of about 0.5 m, which has important implications on the mass balance of the whole galcier. We investigate the potential of three different snow models (SNOWPACK, SNTHERM and SOMARS) to reproduce this development. The verifying data confirm that each model is well able to reproduce the overall seasonal evolution of the snow pack. As a common lack in skill, however, the standard versions of these models systematically underestimate the development of superimposed ice during certain conditions. It is demonstrated that this is mainly related to improper treatment of liquid water at the snow/ice interface. A major improvement can be achieved by modifying the model's water transport modules to properly handle ponding water, which indeed has been observed there. The local and spatial variability of such conditions is addressed as well as their overall impact on the mass balance of the whole glacier, which underlines the importance to properly include corresponding processes in related modeling.