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Modelling the evolution of supra-glacial lakes on the Greenland ice sheet

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Supra-glacial lakes form during the summer melt season in the ablation zone of the Greenland ice sheet. Their distribution is according to ice sheet surface topography and their maximum volume determined by amount of melting in the drainage basin.

These lakes have two main impacts on the ice sheet. Firstly they have an impact on the area averaged surface albedo of the ice sheet, as lake surface albedo is significantly lower than bare and snow covered ice. This can lead to enhanced melting beneath and around the sides of the lake. In addition to albedo effects, these lakes have been observed to drain rapidly once a critical volume of meltwater has been reached. It is likely that hydraulic connections are established at this time between the lake and the glacier bed creating a conduit for meltwater which then drives increases in glacier velocity. This effect of supra-glacial lake drainage can provide a means for rapid glacier response to climate change. However, these processes are imperfectly understood and it is not known how their role in Greenland's mass balance will change in the future.

Greenland mass balance has been negative for a number of years with equal responsibility attributed to a negative precipitation-melt balance and dynamical discharge of ice from outlet glaciers into the sea. If observed warming is consistent with IPCC projections we can expect to see an increase in amount of meltwater and melt zone extent which would imply a corresponding increase in supraglacial lake volume and area coverage.

We present a comprehensive physically based supra-glacial lake model for Greenland. The model is based on the latest understanding of lake behaviour and governing physics including drainage modes and employs new high resolution digital elevation data. The model is optimised for coupling with atmospheric data, providing the input for Meteorological parameters of precipitation, temperature, wind-speed and cloud cover. We then use this model to make initial investigations into the future distribution of the lakes, both spatially and temporally. The overall aim is to improve the representation of supra-glacial lakes in climate models in order to better understand the effects they have on the Greenland mass balance now and in the future.