OROGRAPHIC IMPACT ON THE PREDICTED CHANGE IN THE FREQUENCY OF CONDITIONS FOR WET SNOW ICING IN FUTURE CLIMATE

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Abstract: Conditions for wet snow icing are estimated in terms of mean daily values of temperature, precipitation and wind speed. On the basis of this estimation, calculations are made of the change in frequency of events of wet snow icing in simulations of future climate. In coastal areas of Iceland, a large reduction in the number of wet snow icing events is predicted for the period 2071-2100, but at an elevation of 400-700 m.a.s.l., there is a different result: in Southwest-Iceland, there is only a moderate decrease in the number of events, while in Northeast-Iceland, there is a large increase in the frequency of wet snow icing events. The decrease of the number of wet snow icing events is associated with fewer days with temperatures close to 0°C, while in the case of an increase in precipitation, the impact of the temperature increase is overrun by an increase in frequency of heavy precipitation in the mountains.

Keywords *– Wet snow icing, Iceland, future climate, dynamic downscaling,*

1. INTRODUCTION

Wet snow accretion can be a major risk for overhead power lines and other structures that are sensitve to ice loads. Icing by wet snow accretion occurs when flakes of wet snow stick to structures in temperatures close to 0°C. When the sleetflakes have accumulated on the structure, they freeze, either as a result of cooling through evaporation or as a result of general cooling of the ambient airmass. The more intense the precipitation is, and the greater the wind speed, the higher is the rate of wet snow accretion (Makkonen, 1989). Wet snow precipitation is a major problem in Iceland, particularly in North- and East-Iceland (Elíasson and Thorsteins, 2000) and unlike in many other places, wet snow icing poses a greater problem than icing by freezing of supercooled droplets (in-cloud icing). In this paper, a first step towards a prediction for the long-term change in frequency of wet snow icing in Iceland is presented. A proxy for wet snow icing conditions is defined and on the basis of this proxy, days of plausible icing are counted in high-resoultion regional numerical simulations of the future climate.

2. CONDITIONS FOR WET SNOW ICING

The simulation output available for this study has a temporal resolution of 24 hours and in order to estimate the number of wet snow icing events, a proxy based on the mean daily temperature, the mean daily wind and a 24 hrs precipitation sum has to be defined. Usually, icing events last a shorter period than 24 hours, but as far as known, no study has been made on the connection between daily values of meteorological parameters and occurrence of wet snow icing. Here a day with a high wet snow icing potential is defined to be a day with the mean tempertature between -1°C and 1°C. The 24 hours precipitation must be at least 7 mm and the mean 24 hours wind speed must be at least 7 m/s.

3. NUMERICAL SIMULATIONS

The simulations used in this study are dynamic downscalings of global simulations. Two simulations with the numerical model HIRHAM (a version of the NWP model HIRLAM) have been run with a horizontal resolution of 0.5°C and boundary conditions from global simulations by the Hadley centre, based on SRES scenarii A2 and B2 (Haugen and Iversen, 2005). The HIRHAM simulations have been provided by met.no in the context of the PRUDENCE project (Christensen et al., 2005). The future period considered here for comparison with the 1961-1990 climate (Control) is 2071 – 2100.

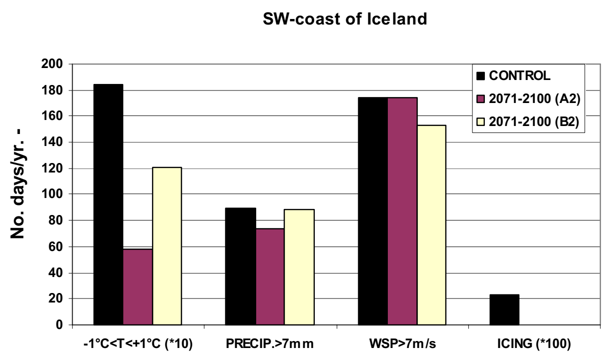

Figure 1. Mean annual number of days with wet snow icing at the coast of SW-Iceland in the control simulation and in two future scenarii. The number of days in the first and last set of columns has been multiplied by 10 (temperature) and 100 (icing).

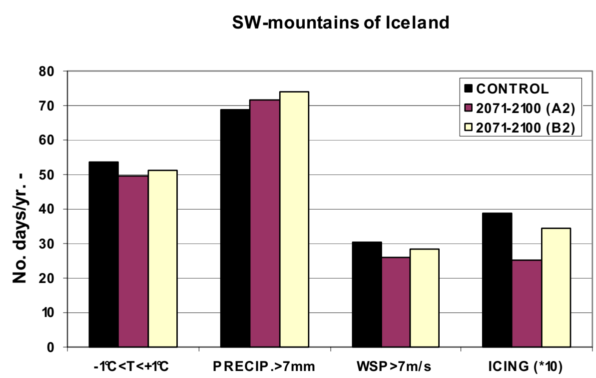

Figure 2. Mean annual number of days with wet snow icing in the mountains of SW-Iceland in the control simulation and in two future scenarii. The number of days in the last set of columns has been multiplied by 10.

4. RESULTS

Figures 1-4 show the number of days fulfilling the above critera at gridpoints at the coast of SW-Iceland (92 m.a.s.l.), in the mountains of SW-Iceland (464 m.a.s.l.), at the NE-coast of Iceland (74 m.a.s.l.) and in the mountains of NE-Iceland (654 m.a.s.l). In the coastal regions, there is a large decrease in the frequency of wet snow events, and this appears to be connected to a substantial reduction in the number of days falling within the given temperature criteria. In the mountains of the south, there is some reduction in the number of wet snow icing days. There is also quite some difference between scenarii A2 and B2, but both agree upon reduction of days falling within the temperature critera, but increase in number of days with high precipitation. In NE-Iceland, there is a small reduction in the number of days falling inside the temperature criteria, some increase in precipitation, but a large increase in the number of wet snow icing events.

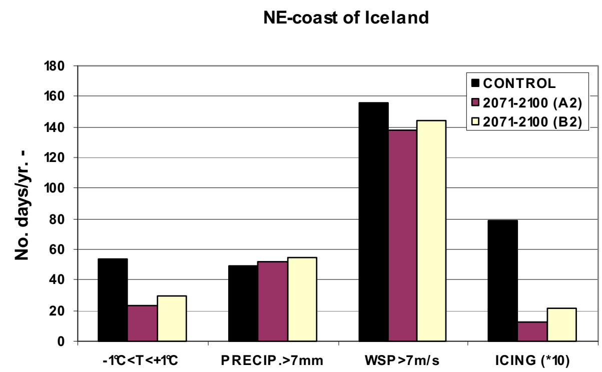

Figure 3. Mean annual number of days with wet snow icing at the coast of NE-Iceland in the control simulation and in two future scenarii. The number of days in the last set of columns (icing) has been multiplied by 10.

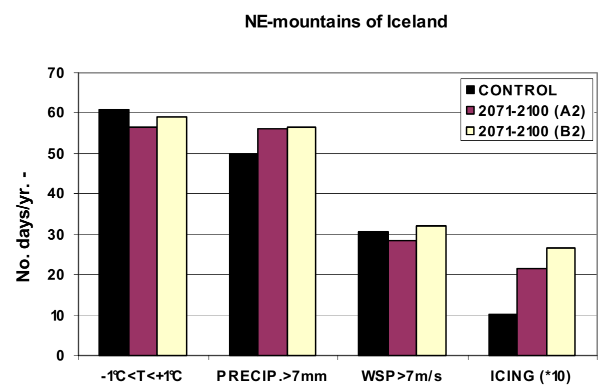

Figure 4. Mean annual number of days with wet snow icing in the mountains of NE-Iceland in the control simulation and in two future scenarii. The number of days in the last set of columns (icing) has been multiplied by 10.

4. SUMMARY AND DISCUSSION

The results in Fig. 1-4 are summarized in Fig. 5. There is a substantial decrease in wet snow icing events in the coastal regions, some decrease in the mountains in the southwest and a large increase in the mountains in the northeast. It is quite clear that a predicted increase in the number of heavy precipitation events is a dominating factor in the increase of the frequency of wet snow events in the NE-mountains. A plausible increase in temperature is in other words more than compensated by more precipitation in the simulations. The increase of heavy precipitation events appears to be relatively high at temperatures close to 0°C. The relatively low frequency of high wind speeds in the mountains is not realistic and needs to be looked into. The difference between the control simulations and the future climate simulations may nonetheless be realistic, as the same error in the surface wind speed is present in all simulations.

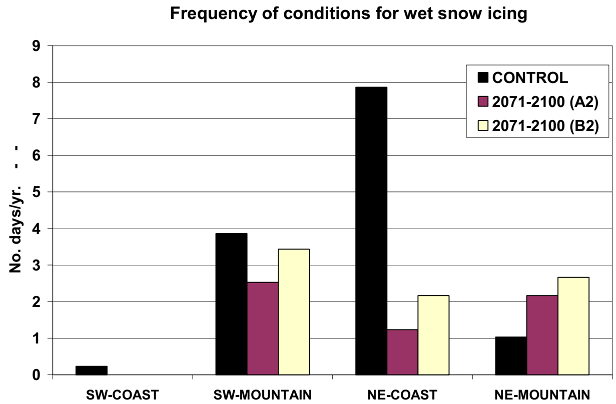

Figure 5. Mean annual number of days with wet snow icing at the four locations considered in this study.

5. CONCLUSIONS

The results indicate that the frequency of wet snow icing events may change in both directions in future climate, depending on region and height above sea level. They also indicate that changes in precipitation pattern or even wind may be as important as changes in temperature. More simulations at even higher spatial and temporal resolution with boundaries from a larger collection of global simulations would allow for an ensamble prediction of future changes in the frequency of wet snow icing.

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