THE RESPONSE OF PRECIPITATION TO OROGRPAHY IN SIMULATIONS OF FUTURE CLIMATE

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Abstract: Precipitation pattern in Iceland in relatively high–resolution simulations of the future climate is investigated. In the winter and in the autumn there is much greater increase in precipitation over the mountain slopes than elswhere, indicating that a future climate may feature a topographic precipitation gradient that is different than in the current climate. The results are an encouragement to go to even higher resolutions in climate simulations, rather than to apply the so–called delta change to estimate changes in precipitation climate.

***Keywords** – Dynamical downscaling, orographic precipiation gradient, Iceland, PRUDENCE*

1. INTRODUCTION

For some time now considerations about future climate in most regions have largely bee based on reading a spatially averaged increase of mean temperature and mean precipitation from coarse–resolution general circulation simulations, based on different scenarii of change in the concentration of greenhouse gases in the atmosphere. In mountainous regions, a spatially smoothed precipitation field where the impact of non–resolved mountains is not represented may however not give a correct picture of the local climate and a possible local climate change. However, it may be possible to retrieve information on the local changes through downscaling, either by statistical methods or by simulations at high–resolution with a numerical model solving the basic equations of atmospheric flow.

In this paper, results from dynamic downscalings of flow over the mountainous terrain of Iceland are presented. Two simulations with the numerical model HIRHAM (a version of the NWP model HIRLAM) have been run with a horizontal resolution of 0.5° and boundary conditions from global simulations by the Hadley centre, based on scenarii A2 and B2. The HIRHAM simulations have been provided by the met.no in the context of the PRUDENCE project (Prediction of Regional scenarios and Uncertainties for Defining European Climate change risks and Effects, Christensen et al., 2005). The future period considered here for comparison with current climate is 2071–2100.

2. RESULTS

Figs. 1–4 show the precipitation over Iceland, simulated in a control run (1961–1990), and in runs with boundaries from a global simulation with the A2– and B2–scenarios. The figures show both

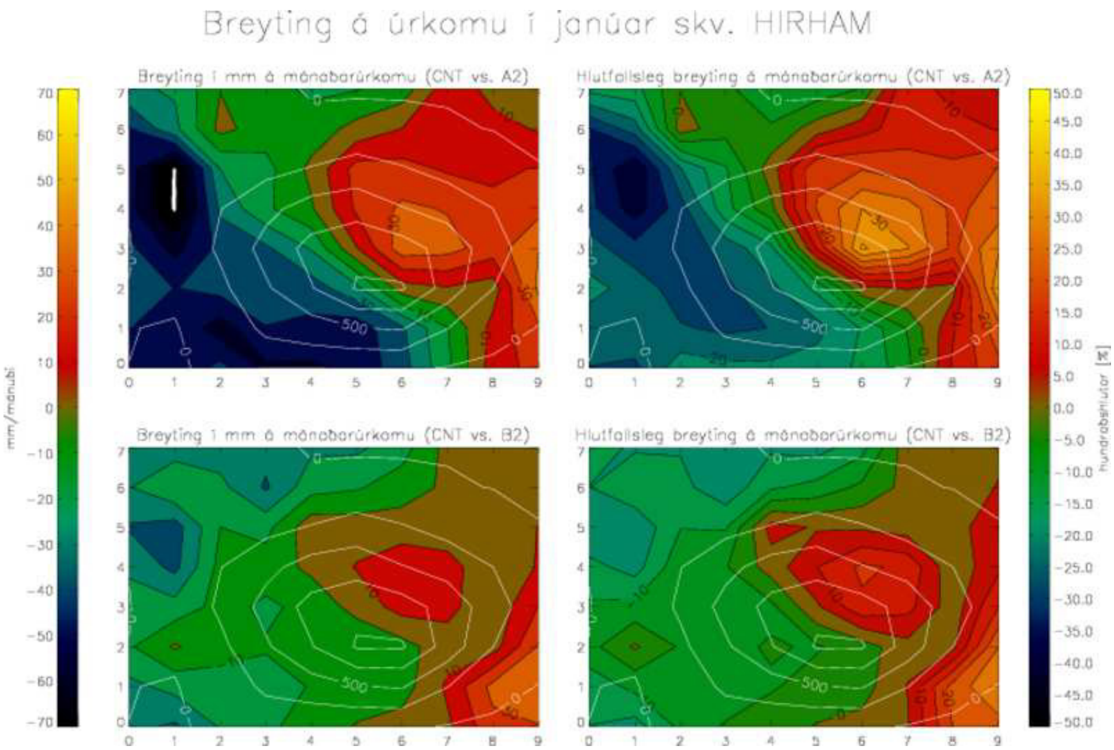

Figure 1. Absolute (left) and relative (right) change in precipitation in Iceland in January for the two scenarii, A2 (top) and B2 (bottom) from the control period to 2071–2100.

changes in mm/month (left) and in percentage (future minus control, divided by control) of the control period (right) for the months of January, April, June and October. January is representative for the mid–winter period and October is representative for the autumn. In January there is substantial increase in precipitaion in NE–Iceland, but drying in SW–Iceland.

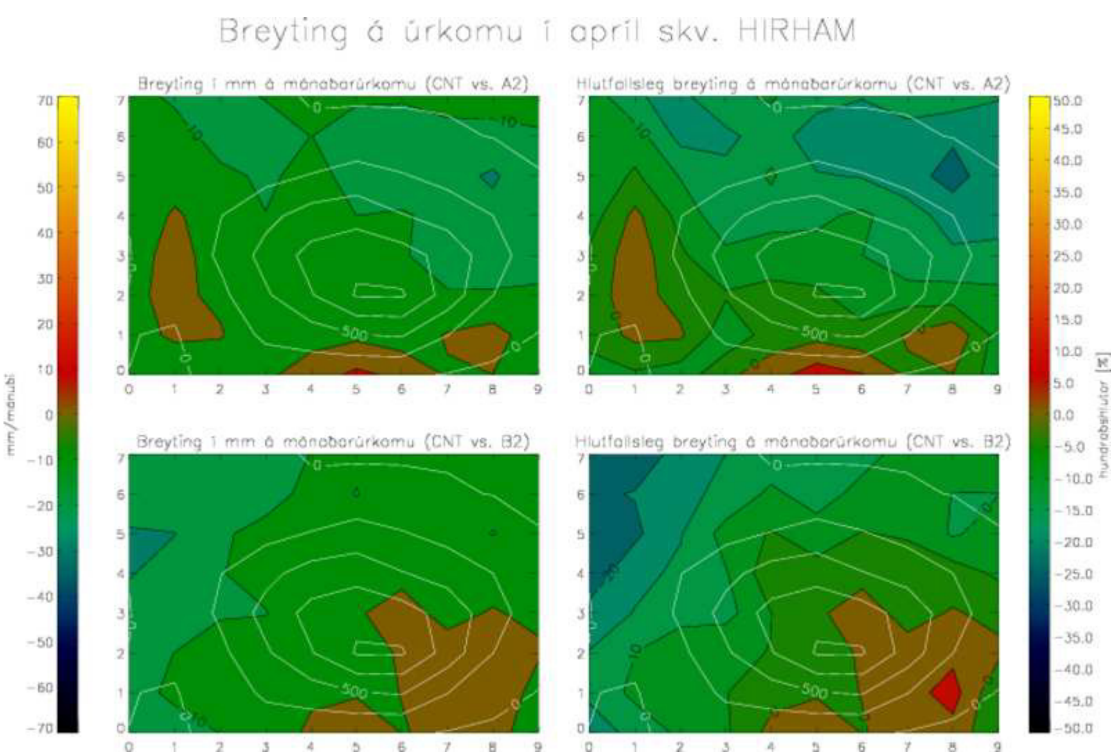

Figure 2. Absolute (left) and relative (right) change in precipitation in Iceland in April for the two scenarii, A2 (top) and B2 (bottom) from the control period to 2071–2100.

In April, the predicted precipitation changes are relatively small, while in July there is an increase in precipitation in NE–Iceland.

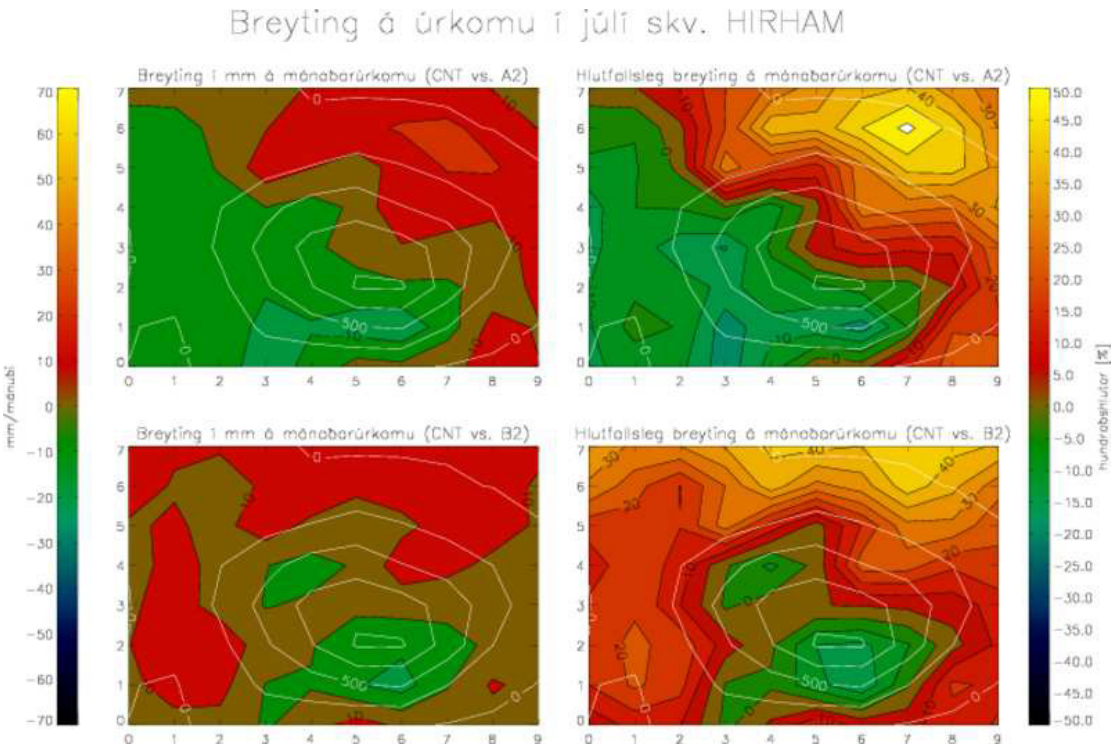

Figure 3. Absolute (left) and relative (right) change in precipitation in Iceland in July for the two scenarii, A2 (top) and B2 (bottom) from the control period to 2071–2100.

In October there is substantial increase in predicted precipitation in S– and W–Iceland.

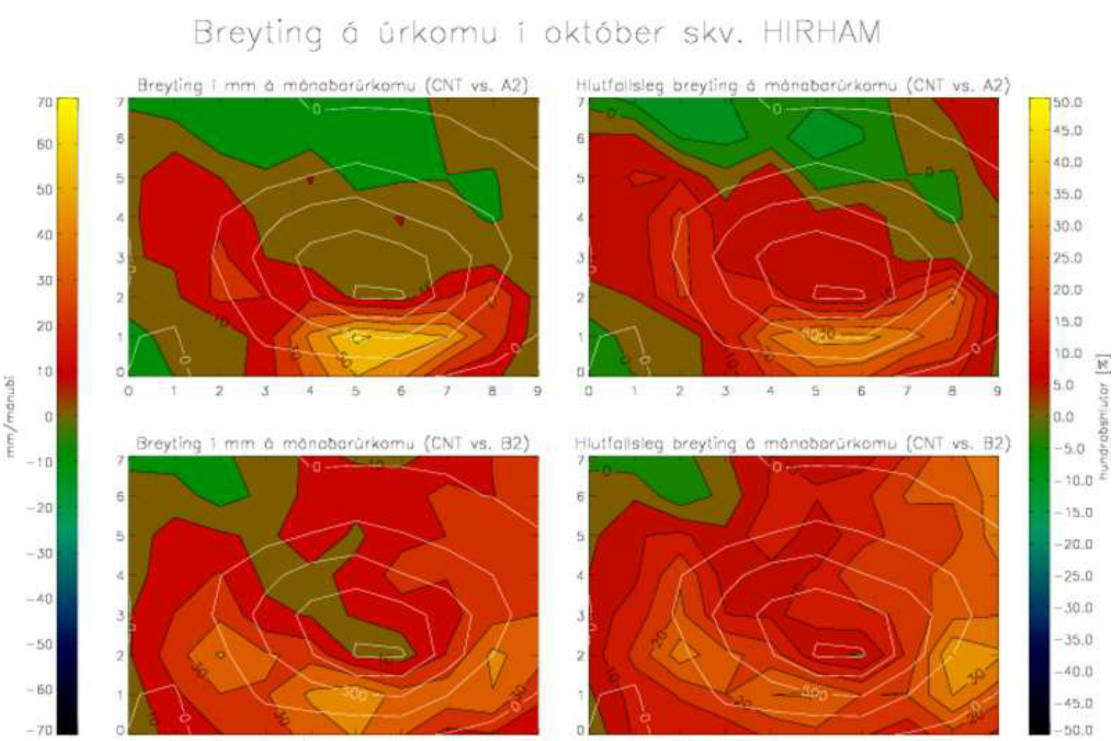

Figure 4. Absolute (left) and relative (right) change in precipitation in Iceland in October for the two scenarii, A2 (top) and B2 (bottom) from the control period to 2071–2100.

The maximum changes in precipitation in January in NE–Iceland and in October in S–Iceland are located close to the areas of maximum steepness of the slopes of the terrain. The predicted precipitation change in the spring and summer does not show a similar maximum over the slopes.

3. DISCUSSION

The most striking feature of the precipitation pattern is the strong signal over the slopes of NE–Iceland in January and over the slopes in S–Iceland in October. These simulations indicate that the climatic topographic precipitation gradient may increase in a future climate. Previous studies of the topographic precipitation gradient in SW–Iceland show that the gradient is very sensitive to the low level wind speed, but much less sensitive to other parameters of the flow (Ólafsson and Rögnvaldsson, 2004). The current results indicate therefore stronger onshore winds during precipitation events in a future climate. This needs to be verified with daily data. If this is the case in the simulations presented here, the credibility of the orographic signal of the precipitation pattern is intimately linked to the credibility of the predicted winds.

4. CONCLUSION

The simulations presented in this paper indicate that precipitation in a future climate may increase substantially in NE–Iceland during mid–winter and mid–summer and in S–Iceland in the autumn. The precipiation increase in mid–winter and autumn is much greater in the mountain slopes than at the coast, indicating that a future climate may have a new and different precipitation change with height. This speaks agains applying the so–called delta change in estimating changes in the precipitation climate. This encourages applying even higher resolution as better represented mountains may give a prediction of even greater change in the precipitation climate.

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