Geophysical Research Abstracts
Vol. 13, EGU2011-2448, 2011
EGU General Assembly 2011

Greenland in a changing climate: topographic feedback on snow accumulation

Maria Hakuba (1), Doris Folini (2), Martin Wild (3), and Christoph Schär (4)

(1) ETH Zurich, Institute for Atmospheric and Climate Science, Switzerland (mhakuba@student.ethz.ch), (2) ETH Zurich, Institute for Atmospheric and Climate Science, Switzerland (doris.folini@env.ethz.ch), (3) ETH Zurich, Institute for Atmospheric and Climate Science, Switzerland (martin.wild@env.ethz.ch), (4) ETH Zurich, Institute for Atmospheric and Climate Science, Switzerland (christoph.schaer@env.ethz.ch)

The Greenland Ice Sheet (GIS) not only plays a crucial role for the freshwater budget and sea level, but is one of the most dominant orographic obstacles in the Northern Hemisphere, affecting the large-scale atmospheric circulation, and the location and characteristics of the storm tracks.

In this study, we investigate mainly two effects that a strongly reduced height of the GIS topography could have, regionally and on the entire Northern Hemisphere: 1. A direct topographic feedback on snow accumulation over the Greenland Ice Sheet, induced by changes in precipitation amount and distribution, and the associated changes in surface mass balance. 2. Changes in the planetary wave pattern, determining the location of the semipermanent ridges and troughs in the middle troposphere.

Using the ECHAM5 global atmosphere model at T106 resolution, we have run five 15-year simulations comprising a control simulation that includes the present Greenland topography and climatological atmospheric conditions representative of the late 19th century, and four simulations including reduced topographies of 75, 50, 25 and 5% the size of the present Greenland.

Our results show that a stepwise reduction of Greenland’s topography leads to an overall increase in annual liquid and solid precipitation - a combination of a significant increase in east Greenland and a reduction along the west coast. The associated increase in snow accumulation is counteracted by strongly enhanced melting, such that the positive mass balance found for the control Greenland, declines in the simulations with reduced Greenland topographies. We examined wind fields, sea level pressure and geopotential height composites and show that the reduced topographies are in favor of overflow events, providing precipitation to regions that are presently desert-like. At the same time the orographically induced lee cyclone to the southeast of control Greenland weakens in the simulations with reduced Greenland topographies, resulting in progressively fewer heavy precipitation events at the southern tip. The presence of Greenland gives the Northern Hemispheric planetary wave its characteristic shape. For reduced Greenland topographies the major troughs at the 500 hPa geopotential level are not as well developed as in the control simulation.