The last IPCC report predicts important snow falls in winter and an increase of the summer melting in Greenland. Without quantifying it precisely, General Circulation Models (GCMs) predict that this last phenomenon will dominate. A subsequent mass loss of the Greenland ice sheet will occur, with an impact on sea level and possibly on the Atlantic Ocean circulation. A more precise estimate of this mass loss requires notably a fine spatial resolution, elaborated atmospheric physics (e.g., to simulate katabatic wind) and a detailed representation of the snow ice surface, as in the coupled atmosphere-snow regional climate model MAR. The ability of MAR to simulate the Greenland climate is assessed by simulating the 1991 melting season. MAR results compare favorably with observations from weather stations or satellite derived data, including local components as the melt parameters. The comparison to ECMWF re-analysis highlights the interest of a regional climate model to study the Greenland climate and its mass balance.

Abstract

Figure 4: Vertical profiles of temperature (°C) and surface melt (mm) from Bromwich et al. (1997). The MAR overestimate precipitation in South Greenland, along the coast and steep windward margins, is probably associated to the "topography barrier effect". This overestimation in South Greenland is also present in the Polar MM5 model simulations (Casano et al., 2001) and RHnRAV4 model (Detthoff et al., 2002).

Surface Melt

Albedo

Figure 5: Time evolution of surface albedo averaged on ablation zone (up), on percolation zone (middle) and on dry snow zone (below) simulated by MAR (solid red line) and derived from AVHRR products (pseudo true color) (Fettweis et al., 2003).

*Except in dry snow zone, MAR albedo values are globally higher than those derived from satellite. Firstly, the clouds contamination in AVHRR fields tends to decrease albedo. Secondly, the initial snow height in MAR snow model can be overestimated in some places and therefore put back the appearance of bare ice (resp. soil) in ablation zone (resp. frozen), (Fettweis et al., 2003). Thirdly, the AVHRR albedo values may constitute an underestimation (Stroeve et al., 2000).

Figure 6: Monthly mass surface albedo for May, June, July and August during 1991, derived from AVHRR products (top) and simulated by MAR (bottom). AVHRR values correspond to an average of available pixels after application of the cloud mask.

Modeling of the 1991 Greenland summer with the coupled atmosphere-snow regional climate model MAR

Model setup

Figure 7: Comparison between observed (dashed black), MAR (solid red) and ERA-15 (dashed blue) weather parameters during summer 1991 at ETH-Camp (Omrans and others, 1992).