

Title: An accuracy assessment of the Polar MM5 model of annual snow accumulation on the Greenland Ice Sheet

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Key Words: snow accumulation, Polar MM5 model, accuracy assessment, CReSIS, ArcGIS

Abstract:

Models provide useful and necessary tools to identify future climate patterns. One such model, the Fifth Generation Mesoscale Model modified for polar climates (Polar MM5), has been produced to represent the annual snow accumulation over the Greenland Ice Sheet. Before this model can be used to predict future accumulation rates on the Greenland Ice Sheet, it must be tested against observed annual accumulations which have been derived from radio echograms produced by accumulation radar developed by CReSIS (Center for Remote Sensing of Ice Sheets). The echogram used shows the accumulation layer along a 375 km traverse from NGrip to NEEM stations in central Northern Greenland. The radar produces a very high resolution echogram that display distinct layers formed by changes in density caused by annual climate patterns. The echogram is calibrated to deep ice cores at both NGrip and NEEM located at the ends of the traverse, validating that the radar data does in fact illustrate annual accumulation layers. Using the observed accumulation layer found in the echogram as truth measurements, a comparison can be made against the model accumulation value to test the model's accuracy.

To assess the accuracy of the Polar MM5 model the accumulation rates will need to be extracted from both the model and the radar data. The Polar MM5 model has been converted into ArcGIS raster files which show each year's accumulation spanning from 1958 to 2007 for the entire Greenland landmass, with each raster pixel designating the accumulation for that given point on the landmass. Another ArcGIS shapefile maps the traverse where the radar data was

taken from. The model raster values for each are then extracted to the points in the traverse shapefile so that the model accumulation will be compared to the same geographic points that the radar echogram displays. Next, annual accumulation needs to be derived from the radar data. Using MatLab to visualize the radar echogram, the annual layers are digitized so that the accumulation of each annual layer can be extracted. The depth and thickness between the digitized layers are extracted and calculated to show the amount of accumulation that occurred for each year. The observed accumulation from the radar is then compared to the model accumulation for each year between 1958 and 2007. A mean square error between the radar data and the model data is measured for each year and shows how accurately the model predicts the actual accumulation.

One other focus of this project is to compare the accumulation rates with respect to the North Atlantic Oscillation to see if a correlation exists with the observed annual accumulation and this climatic phenomenon. The North Atlantic oscillation (NAO) is an atmospheric event between high and low pressure systems that changes the position and severity of wind patterns in the North Atlantic. Each year can be described by the position of these pressure systems; breaking each year into positive, neutral, and negative years in a NAO index. The amount of snow accumulation is compared to this index to see if a correlation exists.

This project will show how accurate the Polar MM5 model is in mapping and predicting snow accumulation on the Greenland Ice Sheet by seeing how well it compares to observed accumulation readings from radar echograms. It must be noted that the assessment will only see how accurately the model has predicted accumulation patterns in the area of the radar traverse. This assessment will be a useful tool in testing the accuracy of the model, but cannot be used to

assess the entire Polar MM5 model. Other truth points will need to be measured throughout Greenland to better assess the accuracy of the entire model.