

High Resolution (1km x 1km) Annual Mass Balance Estimates for the Devon Island Ice Cap (1980-2006)

Dataset Documentation

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This document describes the public Devon Island Ice Cap mass balance dataset provided by the Arctic and Alpine Research Group of the University of Alberta, Canada which can be found on their website: arctic.eas.ualberta.ca. The dataset contains high resolution (1km by 1km) annual glacier mass balance model output of several key glaciological variables ranging from net mass balance to melt onset and freeze up dates. The dataset was created using the temperature-index model described in Gardner and Sharp (2009). The dataset is free for all to use, we only ask that the users reference Gardner and Sharp (2009) and acknowledge Alex Gardner for providing the dataset where appropriate. Please direct all questions or comments to Alex Gardner.

1. Overview of the Glacier Mass Balance Model

Please read Gardner and Sharp (2009) for details on the temperature-index glacier model used to produce the Devon Island Ice Cap mass balance dataset. The key features of the model are:

- Daily 2 m air temperatures were downscaled from North American Regional Reanalysis (NARR: Mesinger et al. 2006) summit elevation temperatures using a variable mean daily lapse rate.
- NARR summer (JJA) summit elevation temperatures have been corrected for a mean temperature offset of +4°C and systematic underestimations of maximum and overestimations of minimum temperatures.
- Following Gardner et al. (2009), daily lapse rates are calculated using a linear regressive relationship with lower tropospheric temperature anomalies (750 mbar).
- Melt has been calculated using degree day factors of 3.3 and 8.2 mm d⁻¹ °C⁻¹ for snow and ice respectively (Braithwaite 1995)
- Daily precipitation was derived from the NARR and corrected for a mean over-precipitation bias of 100mmw.e. a⁻¹ and has been linearly interpolated based on horizontal distance to match the 1km by 1km model grid.
- Meltwater refreeze has been accounted for using the method proposed by Wright (2007).

Net mass balance estimates generated using this model agree well with stake annual measurements (1980-2003) made by the Geological Survey of Canada along a 40 km-long stake network following a path from the glacier summit (1880ma.s.l.) to the terminus of the Sverdrup outlet glacier in the northwest sector of the ice cap..

2. Model Terrain & Grid

The model was with a constant distance (1km by 1km) 180 x 285 model grid encompassing the Devon Island Ice Cap as displayed in Figure 1:

Latitude range: 74.45 - 75.86 °N

Longitude range: 79.26 - 88.12 °W

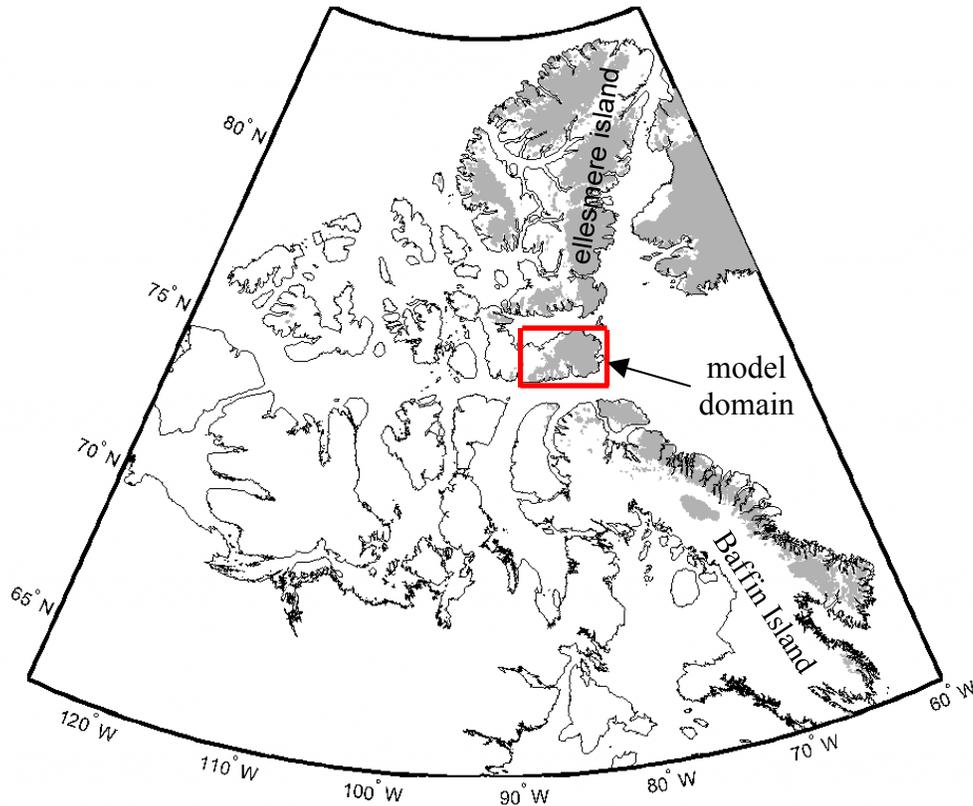


Figure 1: Devon Island Ice Cap model domain.

The Devon Island Ice Cap ice mask is derived from Vector MAP level 0 and grid point elevations were derived from the Canada3D digital elevation model: available from Natural Resources Canada.

3. Model Output

At present the model has been run for the years 1980-2006 and will be updated as additional NARR output comes available. Annual mass balance values are based a glaciological year with the accumulation season preceding the ablation season. For the Devon Island Ice Cap we take the accumulation season to start on September 16th and the ablation season too start on May 15th. The year assigned to the annual output is the year in which the ablation season occurs. For example, the 2005 net mass balance is calculated based on the accumulation season starting in 2004 and the ablation season occurring in 2005.

Annual model outputs are stored as 180x285 ASCII format comma-separated values. File names are specified as:

fileName = 'variableName'.year.csv

Latitude (degrees North) and longitude (negative degrees East) coordinates corresponding to each grid cell are given in the ‘*lat.csv*’ and ‘*lon.csv*’ files respectively. Values outside of the ice mask are given a value of ‘NaN’, the IEEE standard for “not a number”. All variable names and units are provided in Table 1. Model output has been saved as annual totals too keep file numbers and sizes small. If daily outputs are required please contact Alex Gardner.

Table 1: Model output

variableName	description	units
Bn	annual net mass balance	mm w.e.
freezeUp	day after last day of melt (0 = no melt)	day of year
lat	latitude of grid cell	°N
lon	longitude of grid cell	°W
melt	annual snow and ice melt	mm w.e.
meltDays	total number of days in which melt occurs	days
meltOnset	first day of melt (0 = no melt)	day of year
PDD	sum of positive mean daily air temperatures	°C d
rain	sum of precipitation for days with mean daily temperature > 0 °C	mm w.e.
refreeze	total amount of meltwater and rain that refreezes on the glacier during a given mass balance year and can re-melt later in that year and run off	mm w.e.
snow	sum of precipitation for days with mean daily temperature ≤ 0 °C	mm w.e.

References

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