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Modeling Greenland ice sheet present-day and near-future runoff contribution.

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The last IPCC report [AR5, IPCC] has shown an increasing contribution from Greenland melting to global sea-level over the last decade, increasing from 0.09 mm/year (period 1992-2001) to 0.59 mm/year (period 2002-2011). Given its strategic location, i.e. close to the main North Atlantic ocean convection sites, it is therefore of importance to better assess ice sheet melting and its impact on regional ocean processes. So far, runoff estimate from ice sheet has been poorly constrained (e.g. [Hanna et al., 2005], [Hanna et al., 2008]) and most of the time the few estimates comes from regional atmospheric models or general circulation models (e.g. [Edwards et al., 2013], [Fettweis et al., 2013]).

Here, we present the results from the implementation of a routing scheme into the thermo-mechanical ice sheet-ice shelves model GRISLI [Ritz et al, 2001], applied to the Greenland ice sheet mass evolution over the 20th and 21st centuries.

The routing scheme is based on the "multiple flow direction" developed by [Quinn et al., 1991]. We further improved this scheme by considering topographic depressions as possible "lakes" to be filled by meltwater. In this way, when a depression is filled, only the extra water is routed towards the Greenland coasts.

This allow us to obtain an estimate of the total amount of freshwater reaching the ocean at each time step of the model integration, as well as a time-varying spatial distribution of the runoff along the coasts of Greenland.

This routing scheme is applied in routing both surface and basal meltwater. Surface meltwater is computed by means of a PDD method [Fausto et al., 2007] on which only a fraction is considered for routing while the basal melting rate is part of the heat balance at the ice-bed interface.

Runoff is simulated on a 5km x 5km horizontal grid and validation is performed over the 20th century using mean annual total precipitation and air temperature at 2 meters from Era-Interim reanalysis [Dee et al., 2011]. Near future projections are then computed using the climate forcing from CMCC 21st century CMIP5 simulations (RCP 8.5 and RCP 4.5).

Since the results could be dependent on the ice dynamics and on the surface mass balance method, the runoff scheme is also implemented in the land-based model SICOPOLIS [Greve, 1995] and results are compared to those obtained with GRISLI.