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Ocean Science Discussions

# *Interactive comment on* "Short-term impacts of enhanced Greenland freshwater fluxes in an eddy-permitting ocean model" *by* R. Marsh et al.

**R. Marsh et al.**

rma@noc.soton.ac.uk

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Authors' Response to Referee Comments on "Short-term impacts of enhanced Greenland freshwater fluxes in an eddy-permitting model"

We will revise the manuscript in response to the comments of both reviewers.

In response to Ref. 1 (RC C1010):

A) General Comments

As suggested, we will revise the Abstract/Discussion to state that the present results may differ from previous studies due to location and magnitude of freshwater fluxes applied to the ocean. In the present experiment, we are effectively prescribing month-



by-month Greenland mass loss by coastal location, as predicted for the 1990s. This is largely a climatological influx of runoff and calved ice (a loss nearly in balance with accumulation of snow), as opposed to the anomalous runoff/calving specified in other studies.

Regarding the provision of "some comparison with observations and/or a coarse resolution version of their model", we can easily show two further panels for mean and standard deviation of surface current speed for a 1 degree version of NEMO control simulation, otherwise identically forced. We will look to the literature for further comparison (of both 0.25 and 1 degree NEMO currents) with observations from moored current meters (e.g., Holliday et al., 2009) or surface drifters (e.g., Cuny et al. 2002).

B) Specific Comments

As outlined above, we will modify the Abstract accordingly.

In addition to simulated currents, we can show simulated sea ice extent for both resolutions of NEMO, referring to satellite observations.

We will provide full details of the salinity relaxation in NEMO.

We will look more closely at our results in relation to those of Stammer (2008), recognizing the major differences between the two experiments.

We note the shifted peak in Greenland mass loss (from June to July) in Fig. 1, but there is no clear reason for this – the "default" runoff data is perhaps biased to south Greenland, where melting may start earlier in the spring, whereas the ice sheet model prediction also includes melting further to the north.

We agree that the meridional overturning circulation may respond to enhanced Greenland freshwater flux (as prescribed in the sensitivity experiment) on longer (decadal) timescales. We will note this in the revised manuscript.

We hope to show the anomalous circulation around Greenland in a plot of the difference in depth-averaged current (sensitivity minus control).

We are not optimistic that the small sea-level signal (a few cm change) is detectable in satellite altimeter data, especially that part of the signal close to the coast of Greenland (where the altimetric signal is compromised). The experiment is not necessarily representative of changes in the real world during the 1990s, but rather serves as a measure of sensitivity (of salinity, sea level, circulation) to modest freshwater influx from Greenland. This also addresses the comment on point 3 of the conclusions. We will revise the discussion accordingly.

In response to Ref. 2 (RC C1043):

We will look more closely at the thermohaline controls on MLD, and implications for the development of temperature and salinity anomalies in the wider Labrador Sea. We will also consider the extent to which freshening off Greenland leads to changes in heat and salt transports in the Labrador Current.

We will consider the salinity budget north of Greenland in terms of anomalous salt transport across a selected (approximately zonal) section.

We did originally diagnose freshwater transport in the Labrador Sea, and found it to be little affected – most freshening is due to Greenland freshwater flux (after relaxation), although some changes in surface salinity could be linked to changes in mixed layer depth. We will show total surface freshwater fluxes (2-D fields) for the control simulation, and the difference (sensitivity minus control), annually-averaged for selected years, as suggested.

Salt content is evaluated for the entire water column, but the majority of the negative anomaly is located in the upper 100 m.

We will further explain why we consider that Godfrey's rule is relevant to Greenland (as highlighted by Joyce and Proshutinsky 2007).

References (additional to those cited in the manuscript):



Cuny, J., Rhines, P. B., Niiler P. P., and S. Bacon (2002). Labrador Sea boundary currents and the fate of Irminger Sea Water. Journal of Physical Oceanography, 32, 627–647.

Holliday, N. P., Bacon, S., Allen, J. T. and E. L. McDonagh (2009). Circulation and transport in the western boundary currents at Cape Farewell, Greenland. Journal of Physical Oceanography, 39, 1854-1870.

Interactive comment on Ocean Sci. Discuss., 6, 2911, 2009.