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Ocean Science
Discussions

Interactive comment on "Time and space variability of freshwater content, heat content and seasonal ice melt in the Arctic Ocean from 1991 to 2011" *by* M. Korhonen et al.

Anonymous Referee #1

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This manuscript uses Arctic Ocean hydrographic data spanning two decades to describe freshwater content variability in the Arctic Ocean and to draw conclusions about heat content and seasonal ice melt. I cannot recommend it for publication in its present form as it displays considerable naivety in its approach to uncertainties, surface fluxes, and methodology generally. I describe below the major problems as I perceive them.

1. Use of NCEP reanalysis output. This is a very important element of the manuscript, employed for surface heat flux calculation, and the authors display no awareness of the shortcomings of NCEP, which have been widely documented, and known for a very long time. I refer the authors (for example) to:

Renfrew et al., J. Climate, 2002; Smith et al., J. Climate, 2001, for detailed diagnoses of problems; Trenberth et al., OceanObs'09 overview paper on reanalyses ("ATMOSPHERIC REANALYSES: A MAJOR RESOURCE FOR OCEAN PRODUCT DEVELOPMENT AND MODELING"), available at http://www.oceanobs09.net/proceedings/cwp/cwp90/index.php, and the WCRP report no. 112 from November 2000, "Intercomparison and validation of ocean-atmosphere energy flux fields", particularly section 11, "evaluation of flux products".

Essentially NCEP is outdated and should not be employed for quantitative analysis. The authors should take a look at https://reanalyses.org/. Modern reanalyses comprise (eg) ERA-Interim, MERRA, JRA-25, CFSR. A serious manuscript should appreciate that all reanalyses have their weaknesses, and that the only sensible way to proceed is to compare results from several of them, starting with modern ones.

2. Uncertainty.

There are many procedures adopted in the manuscript which display no appreciation of the potential uncertainties inherent in those procedures, and no appreciation therefore of the potential impact of uncertainties on the conclusions. The treatment of surface fluxes employing NCEP output is one example (see above). What are the uncertainties in NCEP as a whole, compared with other, more modern reanalyses? What are the component uncertainties in the elements contributing to heat flux? Another is the treatment of the meltwater component of the upper ocean, which assumes a salinity criterion with little formal justification. There is no discussion of the existing literature which addresses the freshwater problem properly, using oxygen isotopes to distinguish between (some of) the source components of freshwater in a properly-quantified manner. The approach to seasonal ice melt does not clearly describe the "baseline" for upper-ocean freshwater content; seasonal cycling will keep the upper-ocean net salinity and freshwater content steady, when winter freezing and brine rejection are "reversed" (to some extent, allowing for [a] input variability, [b] geographic separation of ice from its formation region by winds / currents) by summer melt and subsequent mixing. This is

by no means a complete or exclusive list.

3. Final

Many processes and procedures are explicitly acknowledged as arbitrary ("we choose"). This is a narrative paper, but it draws its conclusions from numerical calculations which are not soundly based. I think that quite a lot of extra work is needed to make it publishable. That includes sourcing additional oceanographic data: the authors say (section 3.4) that data from the Canada Basin was not available for the study – have they asked the PIs of the Beaufort Gyre Exploration Project for access to their now-extensive, multi-year archive of Canada Basin hydrographic survey data? Also wider reading of the literature would be advisable, particularly papers by Polyakov looking at the multi-decadal property evolution in the whole Arctic.

Interactive comment on Ocean Sci. Discuss., 9, 2621, 2012.