

Comments on: "Barents Sea heat – transport, storage and surface fluxes. By L.H. Smedsrud, R. Ingvaldsen, J.E.Ø. Nilsen and Ø. Skagseth.

General:

The aim of this work, as far as I can understand, is to describe the evolution of the Barents Sea water column over the year using a 1-D model subject to seasonal atmospheric and radiation forcing and advective heat transport. The model is found to reproduce the seasonal cycle in the southern part of the Barents Sea. The model is then used to explore the possible changes in the Barents Sea water column arising from changes in the inflowing water, the strength of the flow and the temperature of the water as well as variations in air temperature, thus estimate the possible effects of climate change.

The Barents Sea is divided into two boxes, one southern, mostly warm and ice free, and one northern with a seasonal ice cover. Mean monthly temperature and salinity profiles are constructed from the observations and taken to represent the average salinity and temperature evolution of the two boxes. The model is initiated in August using the August profiles and is then run with constant monthly forcing for a few years. Heat and volume are supposed to enter the box by the Atlantic water inflow at the Barents Sea opening to the west and then exit as colder and less saline water, mainly between Franz Josef Land and Novaya Zemlya but also through Kara Gate and there is a weaker return flow in the Barents Sea opening. The freshwater input to the Barents Sea is simulated by adding freshwater to the upper part of the water column and remove some in the lower part to account for the Atlantic water being more saline than the reference salinity (35). This appears to work in the southern box but fails in the northern box where the model cannot reproduce the seasonal cycle and leads to a continuous increase in salinity in the deeper layers.

I have difficulties with this approach. The Barents Sea, especially its southern part, is not a horizontally homogenous box but a broad and long through-flow channel, where the inflowing Atlantic and Norwegian Coastal Current waters are transformed, cooled and freshened, before they are discharged into the Arctic Ocean via the Kara Sea. Therefore I would have taken the inflow in the western opening for each month and computed how the water column characteristics evolve as they flow through the Barents Sea subject to the monthly forcing and how the speed and width of the through-flow have to be adjusted to get the expected mean outflow characteristics and how these vary in the vertical and over the season. A very crude and simplified attempt to such approach was made by Rudels (1986).

Specific comments (in order of appearance not significance)

Title: I think that the position of the dash (–) here is misleading.

Abstract, line 19: I do not think that a heat loss can be robust, possibly the estimate of it.

Introduction

Page 1439, Line 2: change "allows" to "allow"

Page 1439, line 6: change "remain" to "remains"

Page 1439, line 6: "cooled to the bottom" I think that this is not generally true. Only in fairly shallow areas does this take place and as the dense water drains into the deeper depressions the ventilation there does not reach the bottom. See also the observed profiles in Fig 4, which are not homogenous in the lowest layer.

Page 1439, line 17: what does "recapture" mean here?

Page 1440, line 2: change "a necessity" to "necessary"

Page 1440, Barents Sea volume budget: I read this part with great expectations since some of the authors have been working on these problems for more than a decade in VEINS, ASOF and DAMOCLES. I became rather confused. The VEINS and ASOF number for the inflowing Atlantic water usually was a net inflow of 1.5 Sv, which in the ASOF book was increased to 1.8 Sv. To this was commonly added 0.7-0.8 Sv of Norwegian Coastal Current (NCC) water with a reference to Blindheim (1989). Here I find 1.0 net AW inflow and a NCC inflow of 1.0 Sv again with reference to Blindheim (1989). Now Blindheim (1989) does not give any estimate for the NCC inflow and I expect that it derives from Aagaard and Carmack (1989), who give the number with reference to Blindheim. It would be nice if the authors update this section thoroughly.

Page 1440, line 25: "excluded from"

Page 1443, line 23: change "were" to "where"

Page 1448, lines 10-15: I think that this paragraph is in the wrong place. Also, being slow, I had some difficulties to figure out what "the sampled Atlantic inflow + 1.3 Sv" really meant. I think most

readers like me will have forgotten the discussion in section 2.2 (page) 1443, and I believe that it is better to state the volume, heat and freshwater forcing used, where the transports are discussed, i.e. in sections 2.2 and section 23.

Page 1449, lines 1-8: I think that I understand what is done here but this part would benefit from a more detailed explanation.

Pages 1451-1452, the Northern box: I am not sure if I understand this. Is the same volume input assumed but with different temperature (heat input)? Is there any justification for this? What freshwater forcing/redistribution is used? If most of the heat of the Atlantic and NCC inflow is taken out in the southern box to me this suggests that the through-flow does not extend to the northern box. This is then a horizontally fairly homogenous area with sluggish exchange with the surroundings and the 1D model should actually work better here. The explanation of how the northern box is forced is not sufficient for me to judge what has gone wrong.

Page 1455, lined 3: How is the Barents Sea flushing time estimated?

Pages 1455-1457: This is a quite interesting discussion about possible effects of changes.

Page 1457, line 18: change "box is" to "boxes are"

Page 1457, line 20: change "produce" to "produces"

Page 1458, line 24: use "Bear Island" for consistency

Page 1459, lines 10-15 & table 2: Why does the outward going long wave radiation decrease in this case? I would expect that a colder atmosphere would have a smaller back radiation to the surface.

Page 1459, line 26: change "is" to "are"

Page 1461, lines 18-23: To me the model approach does not separate but rather connects these three changes.

Figures

Generally I find the figures very difficult to interpret, especially 6 and 8, and the choice of symbols in figures 4 to 8 leaves much to be desired.

Summary: I am hesitant to recommend publication, at least not without major revisions.

Especially the volume and heat transports through the Barents Sea opening should be updated and the approach used for the freshwater forcing should be explained in more detail. Also the northern box should be discussed more thoroughly.