Ocean Sci. Discuss., 6, C705–C709, 2009
www.ocean-sci-discuss.net/6/C705/2009/


Ocean Science Discussions



# *Interactive comment on* "Volume, heat, and freshwater fluxes towards the Arctic from combined altimetry and hydrography in the Norwegian Sea" *by* K. A. Mork and Ø. Skagseth

**Anonymous Referee #1**

Received and published: 27 October 2009

Review of "Volume, heat and freshwater fluxes towards the Arctic from combined altimetry and hydrography in the Norwegian Sea", by K. A. Mork and O. Skagseth

General comments.

This article presents interesting and useful work describing the NwAC volume transports and other derived fluxes from 1992 to 1997. The absolute currents are obtained by combining a new altimeter-derived data set of dynamic topography with hydrographic measurements from the Svinøy section. The obtained currents are compared to current meter measurements from the area to provide some confirmation that the method and data used for the velocity calculation are appropriate and provide plausi-



Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

ble results. The authors describe surface currents in the Svinøy section and propose explanations of their variability and forcing. The obtained volume, heat and freshwater fluxes agree reasonably with previous studies. The impact of the fluxes on the ecosystem is assessed and effects on the ecosystem are addressed.

This paper will eventually be suitable for publication but some revisions are required, and we wish to see the manuscript again following the revisions. More detailed comments follow.

Major Issues.

1. The major flaw in this manuscript is the inadequacy of the treatment of errors. Given that they use a mean dynamic topography which is a hybrid of satellite and other gravity data, and given that it is well known that no properly adequate geoid exists for the global oceans, what then are the effective errors passed into their "level of known motion" (the sea surface, in this case)? Furthermore, how does the gridding of the satellite product influence the errors? These errors are all eminently quantifiable. Having obtained an error estimate for the reference currents through consideration of altimeter and geoid errors, they should then proceed to determine whether these error estimates are consistent with error estimates derived empirically, by proper comparison of the current meter records with the derived section absolute velocities. The shallowest current meters are at 100 m depth, so use the measured vertical velocity shear (dv/dz) either to project the current meter velocities upwards to the surface, or to project the surface velocities down to the current meter depth. Then calculate an empirical method error as the standard deviation of the differences between current meters and section velocities. Is there any bias between the two (non-zero mean difference)? Does the method error vary with location along the section? In this regard, it is not adequate (figure 8) to compare currents at different depths: compare currents as described above. Note that the standard error calculated form the section data is a measure of data scatter and excludes the method error described above. Having completed the error analysis, add error bars to figures where appropriate (eg figures 3, 5, 8, 9). Ensure that velocity



OSD

6, C705–C709, 2009

errors are correctly transferred to associated flux calculations.

2. Section 2, p 2362 line 4, altimeter corrections. What about the wet tropospheric correction? This is significant and is not mentioned.

3. The discussion of the variability and forcing (section 4.2) is descriptive and statistical, and I think it is unconvincing. Showing pairs of correlated environmental signals only illustrates that they co-vary, it does not demonstrate that one forces the other. For example, if discussing wind stress curl effects, why not use the Sverdrup relationship to test whether the changes in the curl force approximately the same changes in transport as observed? And I don't understand the point about AW area trends and SPG trends (p 2369, lines 22-23). Figure 10 looks to have both increasing, while the authors appear to be claiming that one increases and the other decreases.

Other comments:

4. This manuscript requires editing for grammar. Authors please read carefully and ensure that singular and plural nouns and verbs match appropriately, and also check for use of adjectives where adverbs are needed.

5. Some improvements needed to figures. Figure 4, x-axis should be "distance [km]" not "Kilometer". Figure 5, the labels are too small, the figure should be bigger, all legend boxes need to be placed into the same position on each subplot (left top corner). Figures showing seasonal velocity (3, 5) – the "fall" line has the same dotted pattern as the background grid, which obscures the data; pick a different pattern for the data or remove the background grid.

6. Abstract. Replace the word "basically" (which is too conversational) with (eg) "largely" or "mainly" (line 7). Delete definition of TW (which is basic SI and so does not require definition). Line 4, "absolute topography" – state absolute dynamic topography; without qualification, this could refer to any topography (including bathymetry). Last line, replace "one year later" with "by a lag of one year".



OSD

6, C705–C709, 2009

7. Introduction. What is the “northern region”?

8. “. . . formation of the returning dense water . . .” – the appropriate reference here is Mauritzen (1996), who first drew attention to the importance of heat loss from the north-going Atlantic waters in the formation of the overflow waters.

9. Methods and data section. I’m uncomfortable with aspects of this section, which seems to have been prepared a little carelessly. Starting from the first sentence: “Assuming that the water column is hydrostatic and in geostrophic balance. . .”. It should be changed to: “Assuming that the water column is in hydrostatic and geostrophic balance. . .”. Vs is not a “surface part” of the geostrophic velocity, it is the reference velocity in a (standard) geostrophic velocity calculation using a level of known motion, the level for which is taken to be the surface, where Vs is measured. “bc” is not an abbreviation for “subsurface part” (as in Vbc), it is (presumably) an abbreviation for “baroclinic”. I doubt that the x- and y-axes are directed along and across isobaths: rather, they are directed along and across the hydrographic section,which in turn is designed to be near-normal to the isobaths. Cp is specific heat capacity. The first sentence in page 2361 is not right. The velocities are not given from the altimeter data but are calculated from the altimetry data using the geostrophic relationship and the surface gradient. The last sentence in page 2361 “ The velocities are geostrophic computed from. . .” is not a proper sentence. The velocities are computed using a geostrophic balance, calculating a slope of sea level from altimetry (MDT+SLA). The method should be clearly described so it’s easy to follow. Maybe using a formula will help here. It’s not clear what the “2 data sets (Ducet et al. 2000) means (Third line, page 2362). How were the surface velocity data interpolated? Was it linear interpolation or a different method (optimal etc.)? Missing data have not been addressed. Were there any gaps? If so, how have the authors filled them?

10. Results, page 2363, last sentence in the first paragraph: “The seasonal cycle to the west of the NwASC is minor” – there is a seasonal cycle of $\pm 5$ cm/s (maybe larger, in figure 1 it is not clear because of the greyscale); does that mean that the seasonal



OSD

6, C705–C709, 2009

cycle is not important here? Referring back to error estimation, are the errors close to or larger than the seasonal cycle of NwAFC?

11. Discussion: Errors again: what are the implications of smoothing when using the altimetry? What are the errors caused in the estimation of fluxes?

12. Variability and forcing. Why are the two branches in an antiphase relationship after 2001? What are possible mechanisms causing that?

---

Interactive comment on Ocean Sci. Discuss., 6, 2357, 2009.



OSD

6, C705–C709, 2009

Interactive Comment