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Interactive comment on "Frontal structures in the West Spitsbergen Current margins" *by* W. Walczowski

Anonymous Referee #2

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General Comments

This paper summarises a huge effort by researchers at IOPAN to conclusively survey, describe and understand the processes and state of the West Spitsbergen current system and domain of Atlantic Water in the northern Norwegian sea and Fram Strait over the period 2000-2010 with some data reaching as far back as 1995. They particularly identify the important role of the western branch of the WSC and set this in context with the eastern branch WSC. This paper should be published and the paper could become the key reference that is used to define the area of work by other researchers once a few issues are addressed. Firstly the paper needs to take this opportunity to really clarify terminology for the community, they need to use their own terms consistently

and clearly and I think make the structure of the paper clearer to the reader. Secondly the use of some of the quantitative analysis needs tightening-up, there are some trends plotted that are not discussed in detail and some of the transport calculations need to address uncertainty either in terms of errors (and errorbars) or significance of any discussed differences or changes. Both of these issues should be easily addressed and are relatively small concerns in what is a really interesting and generally well written paper.

The first of these issues has 2 parts and relates to the entire manuscript and figs:

i) The subject really hangs on the definitions of fronts their associated currents, and domains of influence that these border.The terms are well defined, and the definitions justified but then the author does not use them consistently. This is particulary true for the eastern branch of the WSC and what is defined as the Polar Front (PF). Sometimes this is termed the eastern branch of the WSC, sometimes the core, the PF naming convention is not made clear and when the idea of a Polar Front is first introduced on *p992 lines14-17* it refers to a boundary between Polar and Arctic waters (I think a boundary west of the AD associated with the EGC) but what the author refers to as the PF later (in section 5) is the boundary between Atlantic and Barents Sea/Svalbard coastal waters is mentioned here too. The author has to choose a naming convention and stick to it- the key features discussed in the paper are *AD*, *AF*, *PF*, *AW*, *WSCwest* and *WSCeast* or *WSCcore*. Of the choice between WSCeast and WSCcore I would stick with WSCeast having referred to the WSCcore option at *p987 line 5* initially. A table with these 6 definitions made clearly would be really useful for the reader. Also to help the reader the author should retitle the sections 5 & 6 and their subsections reinforcing that they are about the AF and PF systems respectively.

ii) The dataset is very impressive but not presented to best advantage and sometimes not consistently. I think the number of figures displayed is appropriate and the author has resisted the temptation to show too much of the dataset. A table listing the occupations by year, vessel, institute, sections occupied and possibly data availability would

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be really useful. The sections names are defined early on (Fig 3) but are not always used to label the figures where the data is presented (eg Fig 4 & 7 but also elsewhere). Tidying this presentational issue will make the paper a much more valuable and usable resource for the community.

The second issue is best dealt with alongside other specific points:-

Specific Comments

Abstract

I feel this is too generic, needs some greater specific detail on the findings of this paper.

1 Introduction

Good introduction that clearly sets of the state of knowledge relevant to the investigation in the paper.

p987 line 1 - Rewrite the sentence "One stream of AW in the NASC enters the Barents Sea...through the Santa Anna Trough east of Franz Josef Land(...)."

p987 line 5 - in this line specify which of the two options you would use, I prefer eastern branch, and then use this throughout the paper.

p987 line 23 - replace 'solid' with 'fixed'

p988 line 13-14 - Hansen et al (1999) is cited, a more recent citation in standard literature would be better, would Larsen et al (2012) or Hansen et al (2003) work? I think there should also be some reference to work in the Norwegian Sea (particularly at Svi-

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noy section) that deals with the two branches of inflow eg Skagseth et al (2008), Mork and Blindheim (2000),Orvik et al (2001) or Høydalsvik et al (2013).

2 Data and methods

This section works well with almost the right amount of detail, I would like to see a table with the summary information for each occupation given as suggested above.

p989 line 26 - please give the reasoning behind the choice of -0.1 ◦ C as the reference temperature with citation of the other studies that have used it. Something like "...this is chosen for consistency with previous studies (refs) as the average temperature of returning water ..."

3 The Atlantic domain structure and currents pattern

This part really sets the scene illustrating how the AD, the geographical locations,the currents and the observations fit together, using Figs 1, 3 & 4. This works well, but Fig 1 should be redrawn to make the WSC and its branches clearer making sure the naming of the branches of the WSC fits the choice made for the whole paper. Reducing the number of depth contours plotted might help make the image clearer. The PF should also be marked. Referring to cross-sections in Fig 4 works well for the fronts but it would be nice to mark the positions of the features on the figure.

p991 line 8 - Do the isolines actually outcrop? The author should refer to the location of this feature in terms of distance along the section.

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4 The western boundary of the AD

Could this be titled "Western boundary of the AD: Arctic Front and western branch of the WSC" I think this would help give the reader the full scope of section 4. If section 5 were to be renamed similarly the reader would be very clearly signposted to the content of each section.

4.1 Structure of the Arctic Front

The first paragraph is really important to get right. It does provide the right amount of background and the author refers to the multitude of different naming conventions that could lead to confusion, which the author needs to conclusively clarify. But the last 2 sentences *p992 line13-17* need to be re written to make it very clear why this paper chooses the Swift terminlology. Also explain and link the Soloranta Svendsen 'Arctic Front' to section 5 where it will be named the Polar Front. Is the Polar Front on line 15 the same PF as named later or referring to an area to the west? If you should include something along the lines of "...called the Polar Front and defined later (Section 5.1) as the eastern edge of the AD where the AW in the WSC eastern branch is adjacent to Barents Sea waters or Svalbard coastal waters of a more polar nature (cold and fresh)." If not then it needs to be very clear on the different usage of the Polar Front term.

p994 line 3-10 Equs 1-3 - The introduction of the 3 equations seems a slightly over complex way to explain the stratification. Figure 5 shows profiles that illustrate the point and should be referred to but the textual description suffices in my opinion. Suggest delete from "It is possible..." to Equ. 3. If you were to colour the profiles as either Arctic domain or Atlantic domain this would help illustrate the last sentence.

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4.2 The AF dynamics

The final part of this section reports volume and heat transports for AW in the WSCwest at 76° 30'N (which is section N) and plots these with trend line in Fig 7. Can the author include some estimate of errors or uncertainty in the transports and suggest whether the changes are significant, can errorbars be added to the time-series. Why is the trendline plotted and not referred to? The main point is clear - that variations in the heat transport depend on the volume transport.

4.3 The mesoscale activity within the AF

This section works well in general.

p996 line7-9 -is confusing and should be rewritten more clearly.

4.4 Cross-frontal eddy transport

Could this be renamed 'Eddy transport across the AF' ?

The section has some very interesting findings that could be expanded upon a little.

p999 line11-13 Could the author add a sentence expanding on the justification of the choices -particularly the 40 days, and how sensitive the results would be to these assumptions?

p999 line 20-28 A really interesting paragraph that needs expanding. What do the differences or similarities to the litereature mean. In particular why is the diffence with van Akens estimate so large? Or maybe it is within the accuracy of the estimates?

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5 The eastern border

In line with section 4 this should be renamed as either 'The eastern boundary of the AD' or following my preference 'Eastern boundary of the AD: Polar Front and eastern branch of the WSC.'

5.1 Structure

Suggest renaming section as 'Structure of the PF'.

The section is clear and works well, the only slight issue is that the 'Svalbard branch' term is used elsewhere in Section 5 but has not been defined alongside the other definitions in Section 5.1. It is part of the divergence of the WSC as it enters the AO and occurs after the western and eastern branches have joined and as such is defined in section 7. The structure of the sections works well so I don't think you can define the Svalbard Branch in section 5.1, but where the branch is discussed in Section 5 it should refer to Section 7.

5.2 Dynamics

In line with section 4 this could be renamed 'The PF Dynamics' The section is concise but needs to keep the terminlogy consistent the naming of WSC core or WSC eastern branch should be kept the same and the link to the Svalbard branch is important here but needs to refer to Section 7.

p 1001 line 24-26 The diagnosed decrease in mean transport northward is large but equally the standard deviations of the observations are large- can the author be sure this is significant? Would the calculation of the difference between the sections in the same year throw any light on this?

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5.3 The transfrontal exchange

Suggest renaming section as 'Exchange across the PF' or 'Eddy transport across the PF and cross slope exchange'

6 The fronts variability

Suggest renaming section as"Comparing variability of the AF and PF"

The first paragraph seems to re summarise the AF and PF and should use the same naming convention.

p1003 line 26 - p1004 line 5 - This paragraph uses Fig 16 to look at the relative stability in position of the WSCeast and WSCwest. It needs to refer to the section names and use the naming convention for the features elsewhere. Would Figure 16 work as a Hovmoeller plot, making the variation through time easier to visualise?

p1004 lines 17-19 Perhaps add other more formal references to support Hansen et al (1999) here for instance Larsen et al(2012), Hansen et al (2003), Holliday et al (2008) and Holliday et al (2009).

7 Front bifurcation

Suggest renaming section as ' The AF and PF in Fram Strait and northward'

Well written and clear but could be supported by a figure, perhaps a Hovmoeller of Section EB?

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8 Conclusions

p1006 line 1-2 - make clear that you are referring to the WSC east and WSC west again here.

Editorial corrections

Correct spelling of variations of 'fjord' not 'fiord' (eg Storfjordrenna)

p1007 line 16 - mis-spelling of 'Dickson' and 'Meincke'

Possible additional references

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Interactive comment on Ocean Sci. Discuss., 10, 985, 2013.