

## Reply of the authors to the comments of reviewers

The authors thank referees for their useful remarks.  
We joined our replies to three referees in one file.  
The comments by referees are in bold face.  
Our replies are in regular face.

### Referee 1

**P541: The bottom temperature at the entrance of the Chain Fracture Zone should be updated according to Mercier and Morin (1997, their table 1) who reported a bottom temperature of 0.682\_C at the entrance of the Chain Fracture Zone, a value very similar to the bottom temperature found at the entrance of the Romanche Fracture Zone (0.674\_C)**

We updated the temperatures, referenced the publication and added our recent measurements in the Romanche FZ in 2011 (0.508°C).

**P541: An AABW transport of 0.4 Sv through the Vema Fracture Zone is in the lower bound of published estimates. This should be reported.**

It is reported, special thanks for a list of references. We missed some of the papers.

**P541: Most studies on AABW transport in the eastern North Atlantic haven chosen to define AABW as potential temperature less than 2\_C. It would be better to systematically give the transport estimates for this temperature limit as well as for potential temperature less than 1.9\_C. (eg in a table summarizing all transports values).**

We present such a summary in our book (Abyssal Channels in the Atlantic Ocean, Springer, 2010). This is indicated in the text. Sometimes it is not possible to calculate the transport below 2°C isotherm because there are no solid boundaries that constrain the flow. Another option is to introduce vertical liquid boundaries, but in these cases we selected the 1.9°C isotherm as the upper boundary.

**P541, last paragraph: This is an oversimplified view of the AABW dynamics. The fact that the colder temperature observed at Kane Gap is 1.85\_C does not necessarily mean that AABW with potential temperature less than 1.85\_C away from the Kane gap does not flow through the Gap. It could also be that it warms up while flowing.**

No doubt warming due to mixing takes place as the waters approach the Kane Gap, but only the waters warmer than 1.85°C exchange over the sill. We wrote that only the warmest part of Antarctic Bottom Water can exchange over the sill of the Kane Gap.

**P542: Some explanation about the choice of the mooring deployment location is needed. Why on the western side of the Kane Gap (and not in the middle or on the right side)?**

When we were deploying the mooring in 2010, we had much less information about the bottom topography compared to the later surveys. We thought that we were deploying it approximately in the middle. There were no special ideas to displace it to the western side.

**P542, the dataset is made of 5 CTD/LADCP sections. Only one CTD/LADCP is shown**

We added the text and figures with the profiles in May 2009 and temperature and velocity sections in 2009-2012.

**P542: I suggest a stand-alone section for the technical presentation of the data set and not to mix it with the scientific discussion of the data set.**

We added a special technical section describing the data

**P543, l28. The bottom potential temperature value of 1.8\_C should be indicated in Figure 2.**  
We excluded this text portion.

**P544, l1-3: This assertion should be documented by a study of the evolution of the vertical temperature profile along the bottom water path. Also, it seems from Figure 2 that the bottom potential temperature in the Gambia Abyssal Plain is very close to the one observed at the Kane Gap, which is in contradiction with your statement.**

Unfortunately we do not have profiles of the evolution along the pathway of AABW

**P544, l5-9. Since the LADCP section is not shown in Morozov et al. (2010d), it should be presented in this paper.**

The temperature and velocity profile in May of 2009 is given.

**P544, l9-11. The coldest bottom water is also found at the western side of the Kane gap in Figure 4. Again it is necessary to show all the CTD and LADCP sections such that the reader can make its own opinion on the cross-channel variability of the flow. The statement on the role of the Ekman frictional boundary layer should be substantiated by (at least) adequate reference to literature.**

We give all sections of temperature and velocity and cite the paper by Speer and Zenk 1993 where the authors write about the displacement of the cold core to the eastern wall of the Vema Channel in the Southern Hemisphere.

**P544, l11-19: please show the data!**

We present the sections of temperature and velocity.

**P545, l1: Thierry et al. (Ocean Dynamics, 2006) have shown that the seasonal signal which is observed in the Romanche Fracture Zone was caused by the vertical propagation of equatorial Rossby waves generated at the eastern boundary. This signal is thus likely to be confined to the equatorial band.**

We interpret it as a remote response to an increase in the eastward velocity and transport in the Romanche FZ. This could increase the amount of AABW in the Guinea Basin that could partly discharge to the Sierra Leone Basin through the Kane Gap and the northerly flow in the passage could be a remote response to the seasonal signal in the Romanche Fracture Zone.

**P545: The vertical structure of the flow should be discussed based on the three current meter records obtained in 2010-11.**

We present the figures with the rose of directions and transport for three current meters

**P545, l6: Was this transport computed using the three current meter records?**

Yes, and we indicated this in the text

**P545, l22: Bottom potential temperature does not reach 1.92\_C in Figure 5.**

The figure is based on the daily average data, while 1.92°C is the measured temperature with a time interval of 10 min

**P545, l19-20: This statement is true only for waters in the vicinity of the Kane Gap.**

This is added

**P546, l4: This transport variability of +/-0.3 Sv should be presented before. The conclusion is not the place where presenting a new number (especially without any explanation on how it was obtained).**

Yes, we changed it

**P545, l7-8: This statement was not proven (and I believe it is false).**

We added the explanation in the text, which values are daily average and the other (wider range) are measured ones.

**Figure 2: The oval is too thin on the plot and I can hardly distinguish it from the background.**

We made a heavy square

**Figure 5: Indicate that those are daily values.**

We did this

**Figure 6: Add confidence intervals. It might be interesting to average the highest frequency to reduce the noise.**

We added confidence intervals. Averaging of high frequencies is not necessary because in this study we are interested only in the low frequency signal

## Referee 2

**I have concerns over whether the structure of the flow – and therefore the net flow through the Kane Gap can be accurately represented from a single current meter. Mercier and Speer (1998) used at least 10 current meters in each of the Romanche and Chain fracture zones with which they could resolve both the vertical and horizontal velocity structure.**

We added the figures and description of the flow measured at three depths. Unfortunately we could not deploy more moorings in this interesting place.

**The LADCP section displayed in Figure 4 shows that the flow is not homogenous through the Kane Gap. I would like to see the corresponding sections from the other hydrography cruises too so that how representative of the structure each section is – this would then shed more light on whether one mooring is sufficient, or at least give some idea of the error from using just one site.**

**Why was only one current meter record discussed if there were three instruments deployed?**

**From the potential temperature section shown in figure 4 and the description of the mooring it seems that 2, and maybe all 3 of the current meters will be below the 1.9\_C isotherm and so be recording flow of AABW. How coherent are the current meters with each other? Again this gives some indication of the error of using the bottom current meter to infer the net flow through the gap.**

The corresponding sections are given. Actually all three current meters were planned to measure the AABW flow. The initial plan of the paper was to make it very short and present a concise result.

**Please include a mooring schematic or representation of it in Figure 4 so that it is easier to see where the current meters are relative to the data from the CTD sections. (I know it is slightly to the south of the ridge so doesn't strictly fit on the axes used, but the x axis could be changed to distance across the gap or just longitude).**

We made a special figure located on the section slightly to the south of the CTD sections

**Please also include a table of the CTD/LADCP derived calculations of the transport so that these can be compared more easily.**

**You give an estimate of the errors of the transport calculations for the LADCP sections, but not for the corresponding calculation from the current meter – as mentioned above this would be beneficial to show how representative the transport derived from a single point current meter is of the whole gap.**

We added more explanation how we calculated the errors

## Specific comments:

**Abstract: Assuming the net flow through the fracture zone can be sufficiently resolved from one (or three if using the whole mooring) current meter record(s) I think the discovery of a long-term mean transport that is “almost zero” (0.016Sv) should be highlighted in the abstract.**

This was done

**Page 542, Line 21: “measured currents at 15m from the head”. 15m seems very high and is beyond the measurement range of the Aquadopps. Do you mean you were using a blanking distance of 1.5m?**

Yes, Sorry for the technical error. The blanking distance was 1.5 m. Thanks for noticing the error that we missed.

**Page 543, Line 20-: The discussion of errors seems to come into the document in the wrong place as it states what the errors for subsequent cruises is before even stating the transport estimates from these cruises. I suggest moving this line to after the discussion of all the cruise results.**

These lines are moved down.

**Page 543-544, Lines 28-3: What you are trying to say is not clear – to me it seems the AABW measured to the north of the gap has been subjected to more mixing (and therefore warming) than that to the south. You discuss this further at the end of the discussion section, so these paragraphs could be combined.**

We did our best to clarify this

**Page 544, Line 25: “resolve such long period and” – mismatch in pluralisation. Suggest “resolve such long periods and”**

Yes, thanks, we made the change

**Page 549, Figure 2: It is not east to see the different shades of grey in the potential temperature scale. I suggest using a change of symbol as well as colours if restricted to black and white figures. Also the oval of the work area is not really visible.**

This was done

**Page 551, Figure 4: As discussed in the general comments, I suggest changing the x-axis to be distance across the gap rather than latitude and longitude. If you prefer to continue using latitude and longitude, please make the units decimal degrees to match figures 2 and 3, or change figures 2 and 3 to degrees and minutes to match here. Also as mentioned above, please include the mooring position from the Octobe**

The sentence was not ended on the OS site. It seems that it was truncated.

We added the horizontal scale and a special figure with the location of the mooring

### Referee 3

**The paper is very short, and certainly would have room to show the vertical and horizontal structure of the flow such as would be obtained from fully utilizing the CTD and LADCP data to support the conclusions as to velocity structure and total transport through the Gap.**

Now the paper is longer, More discussion is added.

**There are also discrepancies between the conclusions drawn in the text, and the figures. For example, it is stated in both the abstract and the text that the maximum velocity reached in .21 m/s, yet the velocity time series in Fig. 5 does not show the velocity reaching this magnitude. Presumably this is due to the rotation of the velocity into an along-gap direction for the figure, but if so this should be clearly stated.**

These values (0.21 m/s are related to the measurements with a 10 min sampling. The figure shows daily average data. This is clarified in the text.

**The all-important transport results are not backed up by a suitable discussion of computational methods and error analysis. This is the potentially most significant result to come out of this data set, and needs a far more careful and transparent treatment than is given.**

We explained the details how transport was calculated

#### **Specific comments:**

**1. The abstract is too short, and fails to mention the most important result, which is the mean transport through the Gap, although it gives the variability.**

The abstract is made longer and the zero mean transport is included.

**2. The introduction needs to include a longer and more organized discussion of what is already known about the deep regional flow from the literature, and how the new observations will add to the body of knowledge in a significant way.**

We widened the introduction

**3. The measurements section suffers from a lack of organization, and should be divided into two sections. First, the data should be fully described, with locations of instruments and a mooring diagram (with bathymetry), computational methods, error analyses, etc. Then the next section should describe the results, and be greatly expanded to include all of the data available.**

We wrote special section about the data and then a section of the data analysis

**4. The conclusions, like the abstract, are too short and again fail to note the main result, the mean transport through the passage. The most important results should be better organized, and more fully discussed and compared with what was previously known.**

We modified the abstract and conclusions

