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Interactive comment on “Dissolved greenhouse gases (nitrous oxide and methane) associated with the natural iron-fertilized Kerguelen region (KEOPS 2 cruise) in the Southern Ocean” by L. Farías et al.

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Academic Editor Dr. Stephane Blain Biogeosciences discussion MS No.: bg-2014-342
Attached to this letter I am enclosing a new version of the manuscript “Dissolved greenhouse gases (nitrous oxide and methane) associated with the natural iron-fertilized Kerguelen region (KEOPS 2 cruise) in the Southern”. The manuscript has been modified regarding the main concerns of the reviewers. These modifications briefly comprise: 1) changes in the result section, where serious inconsistency in the results was presented (graphs and legends are not consistent with the interpretation); this was caused by an

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error in layout and designation of Figures; 2) rephrase of numerous paragraphs and the improving of the English language (spelling and grammar errors); 3) and re-structure Introduction and Discussion section. In addition, in this manuscript dissolved Fe data were included and used to perform a new PCA analysis. A new co-author was included because of she is membership in the data of dissolved iron. We have noticed the effort and the time devoted by the reviewers in order to improve our manuscript, reasons by which we are deeply grateful. We hope to have strengthened the manuscript. Yours sincerely,

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Reviewer # 1 Overall: The paper entitled "Dissolved greenhouse gases (nitrous oxide and methane) associated with the natural iron-fertilized Kerguelen region (KEOPS 2 cruise) in the Southern Ocean" deals with the role of mesoscale structures for methane production and subsequent sea-air gas exchange. The topic of this paper is of main interest especially concerning the origin, pathways and fate of GHG in natural Fe fertilized regions. The data are from good quality. However, it is apparent the paper is written in a great hurry. The results chapter is confusing. The description of the oceanographic conditions is not consistent with what is shown in figure 2. The legend of Figure 2 is incomplete. Figure 3 and 4 are obviously inverted. But also when I assume that Figure 3 is in reality number 4 and vice versa, I am not able to find in the figures what has been written in the text (line 8/p12542; TChla . . . peaked in the southern most stations (TNS08, -09 and A3- these stations are shown in Fig 3b and not in Fig. 4b but a peak is also not available in Fig. 3b).

R: Indeed, there was a great inconsistency in figures, legends and how figures were described in the text. I apologize for this, causing some frustration in the reviewer.

The discussion chapter gives a good description of the state of the art in this the region but more in the sense of a second introduction. However that part of the discussion

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which is really based on the data given at this paper cannot be related as the discrepancies between the message concerning the GHG, nutrient and chlorophyll distribution written in the text and the distribution really shown at the figures are considerable. I recommend major revisions.

R: We reformulated the discussion section, this also this was shortened and focused on results, as pointed out by the reviewer.

Details: Abstract: There are some repetitions and some points could be formulated more clearly, especially in the second part (from line 15 to the end). R: Abstract was changed and shortened. Repetitive ideas were eliminated.

Introduction: a short information what the message of this paper is should be given at the end of the introduction; R: as was mentioned by reviewer # 2 the main objective of this research was included. In addition, introduction section was focused on factors controlling GHG dynamics focused on dissolved iron as well. We re-updated the background of gas distributions in Southern Ocean and included new references.

Results Acronyms should be written out on the beginning of this chapter; KPR – what does it mean? SAMW and AASW are probably water masses but which ones? This should be explained when mentioned the first time, not just later in the text: R: done Page 12539/line 25 is written: Figure 2a and 2b shows. . .there is a mismatch between what is written in the text, in the legend and what is really seen in a, b c and d (while c and d is not mentioned in the legend).

R: indeed the text and figures are not consistent; here there was a mistake in the description of each figure and their legends. We correct this and ordered the figures in columns,

Page 12540/line 5 is written: . . .marked the presence of a mesoscale structure around 49°S, where the most southernmost stations (Tn10 and A3) are located. . . However, both stations are located south of 50°S, while around 49°S station 5 and 7

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are shown (Fig 1), so obviously station 10 and A3 are not located in the mesoscale structure? The text continues with. . .There intense. . .This sentences does not fit into the results chapter but rather in the discussion chapter.

R: we eliminated this sentence and part of it was moved to discussion section

Page 12540/line 9/10 is written: There was a tongue of fresher and colder water. . .(Fig 2a and b) yes, the figure shows a colder lens of water (TNS 05-TNS07) (Fig 2a)but a lens of fresher water is not shown at these stations (Fig.2b).

R: yes, we mentioned only a tongue of colder water, changes in salinity was not perceptible in the mentioned figure

Page 12540/line 14: Figure 2c and d is not mentioned in the legend of figure 2. In addition in the text it reads TWE but the figure is labelled TEW R: we corrected it in the figure legend, standard nomination by all colleagues is TWE 3.2. Biogeochemical variables In the legend of Figure 3 is written: ..along the zonal transect between 69°E and 75°E but the figures show the stations TNS01-TNS10 and A3. These stations are located at the N-S transect (see figure 1) - what is right and what is wrong?

R: As you mentioned the figure were inverted, this time we take care to denominated the figures correctly

Page12541/line 6-10 describes the W-E transect however this description fits obviously to the N-S transect?

R: we denominate well each transect

Page12541/line 8 . . .elevated NO₃ concentration –elevated to what? And the sentences continue. . .typical conditions. . .than :consumption . . .was observed at 73.5°E, however in Figure3 the transect runs from 69-75°E and a depletion is shown at the first station i.e. 69°E, same situation for PO₄, Where are the stations located at the NPF and SPF?;

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R: we modified these lines, indeed nutrient trend matched with the presence of PF, less nutrient content was observed, as was expected in xxx water northward the PF

Figure 3b shows homogeneous chlorophyll a concentration of around 1 from station 2 to 10. As the figures do not show what is written in the text, the conclusions about the distribution of the component relative to the water masses cannot be related. R: we re-phased this paragraph

Discussion P12546/line 20-25 describes the methane distribution and is referred to Figure 3f and 4f but these figures show the nitrate concentration. R: it was modified.

P12548/line 14 N₂O is not shown in Fig. 3e. R: it was modified

P12551/line 1-25: in this study no DMSP/DMS data are shown therefore a discussion of a potential relationship is speculative. This chapter should be strictly shortened. R: highly speculative judgments were eliminated and two possibilities are left open about the origin of methane in the region. Figures: All figures: the numbers on the x and y axes are too small. Fig 1: the transect is called TWE while the station name in figure 2 and figure 4 (on top of each plot) is called TEW. Figure 2: the legend doesn't describe exactly what is shown in the figure; i.e. there is a c and d figure which is not described in the legend. Fig 3 and 4: the legend doesn't fit the profiles which are shown. Figure 6: symbols between CH₄ and N₂O cannot be distinguished and should be changed. R: Figures and legends were substantially improved.

Figure caption

Figure 1. Map showing the location of biogeochemical stations sampled during the KEOPS 2 cruise. Bathymetric topography is shown in the main oceanographic region. The orange line delimits the position of the polar front. The sampled transects are indicated.

Figure 2. Left column: a) Temperature (T°C), c) Salinity and e) T-S diagram for W-E transect. Station located under the influence of PFZ (purple) is shown, showing

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enhanced water mass mixing. Arrows indicate position of PF crossing this transect. Right column: b) Temperature ($T^{\circ}\text{C}$), d) Salinity and f) T-S diagram for W-E transect.

Figure 3. Vertical cross section of a) nitrate ($\mu\text{mol L}^{-1}$); b) phosphate ($\mu\text{mol L}^{-1}$); c) chlorophyll-a ($\mu\text{g L}^{-1}$); d) dissolved oxygen ($\mu\text{mol L}^{-1}$), e) nitrous oxide (nmol L^{-1}) and f) methane (nmol L^{-1}) for for zonal transect between $69\text{-}75^{\circ}\text{E}$. Arrows indicate position of Polar Front crossing this transect

Figure 4. Vertical cross section of a) nitrate ($\mu\text{mol L}^{-1}$); b) phosphate ($\mu\text{mol L}^{-1}$); c) chlorophyll-a ($\mu\text{g L}^{-1}$); d) dissolved oxygen ($\mu\text{mol L}^{-1}$), e) nitrous oxide (nmol L^{-1}); f) methane (nmol L^{-1}) for the meridional transect between $45^{\circ}\text{-}51^{\circ}\text{S}$.

Figure 5. PCA analysis with environmental data including dissolved iron obtained in the zonal transect (TWE). PCA comprises a) data from the surface to the ML's base and b) environmental data from the surface to 500 m depth. Stations along with the eigenvectors are included.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/11/C6888/2014/bgd-11-C6888-2014-supplement.pdf>

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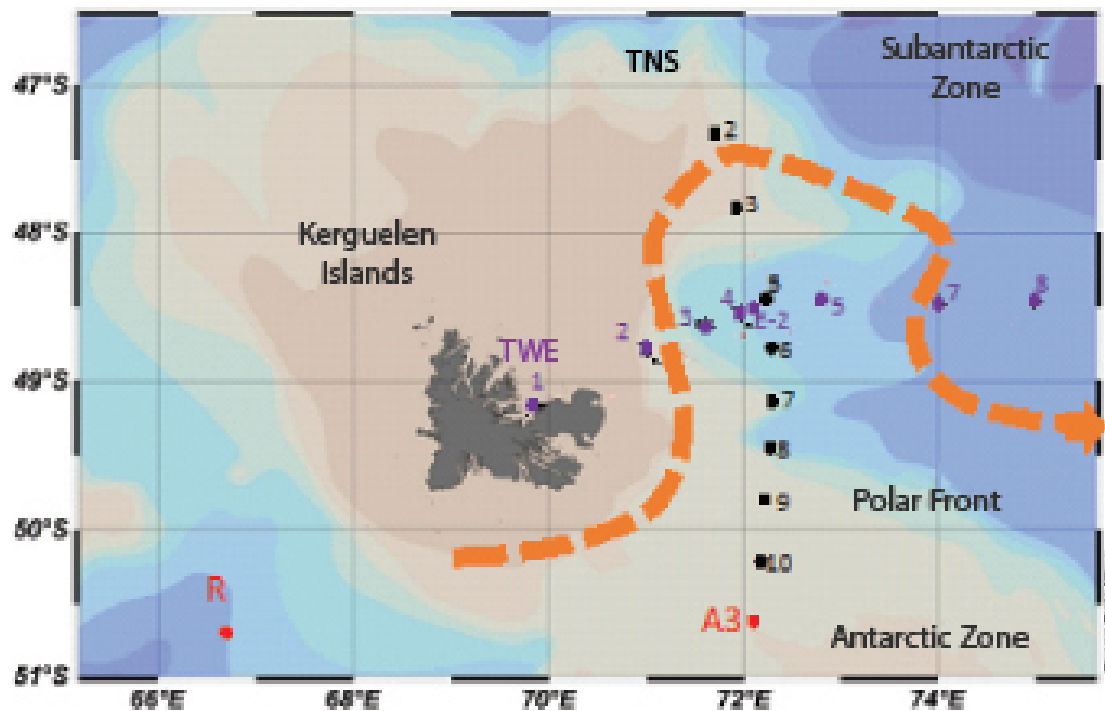


Fig. 1.

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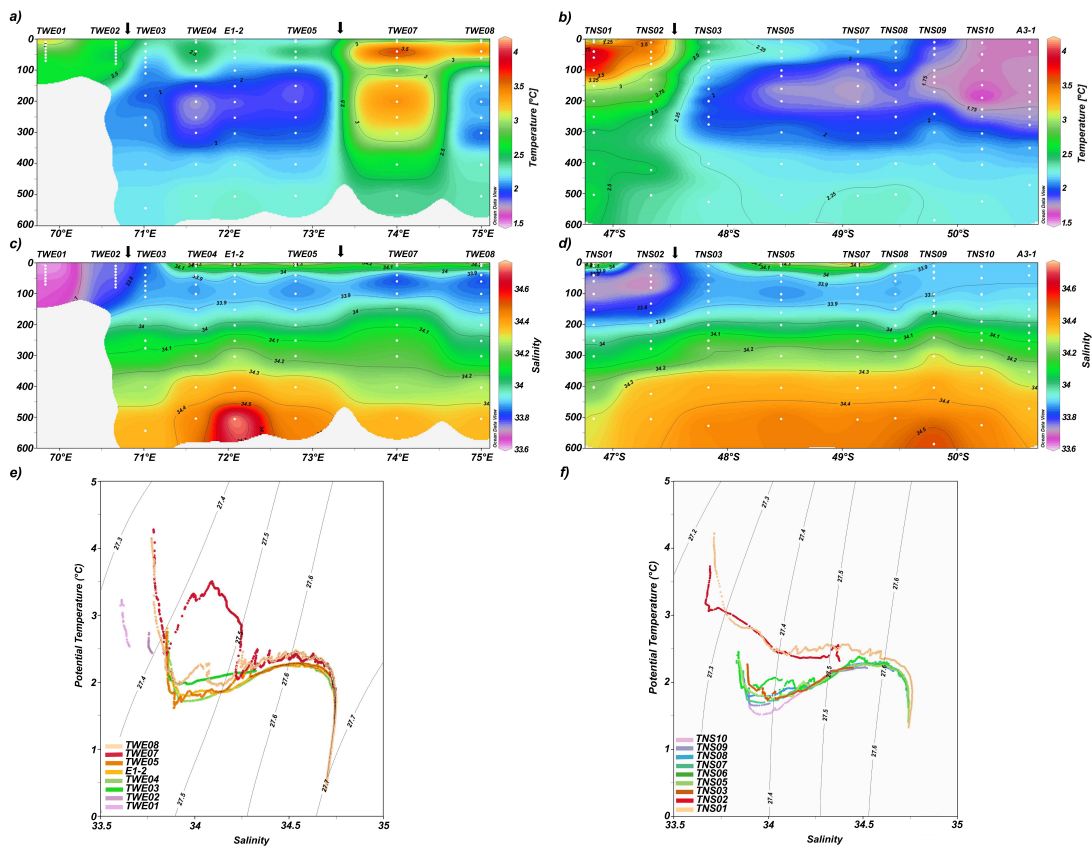


Fig. 2.

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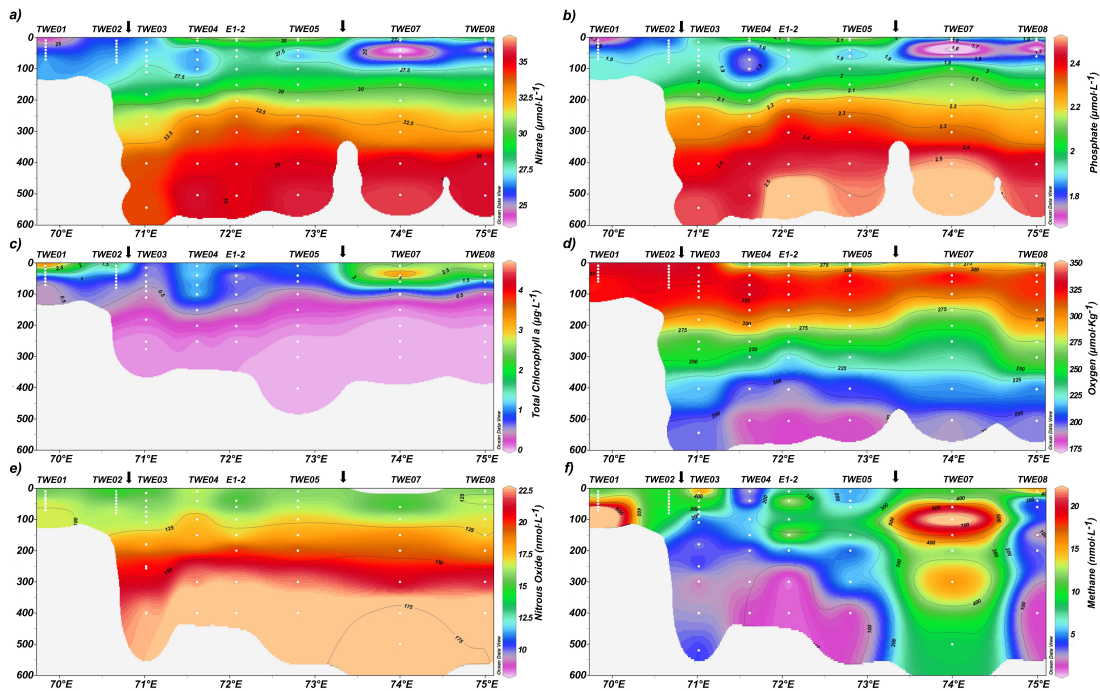
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Fig. 3.

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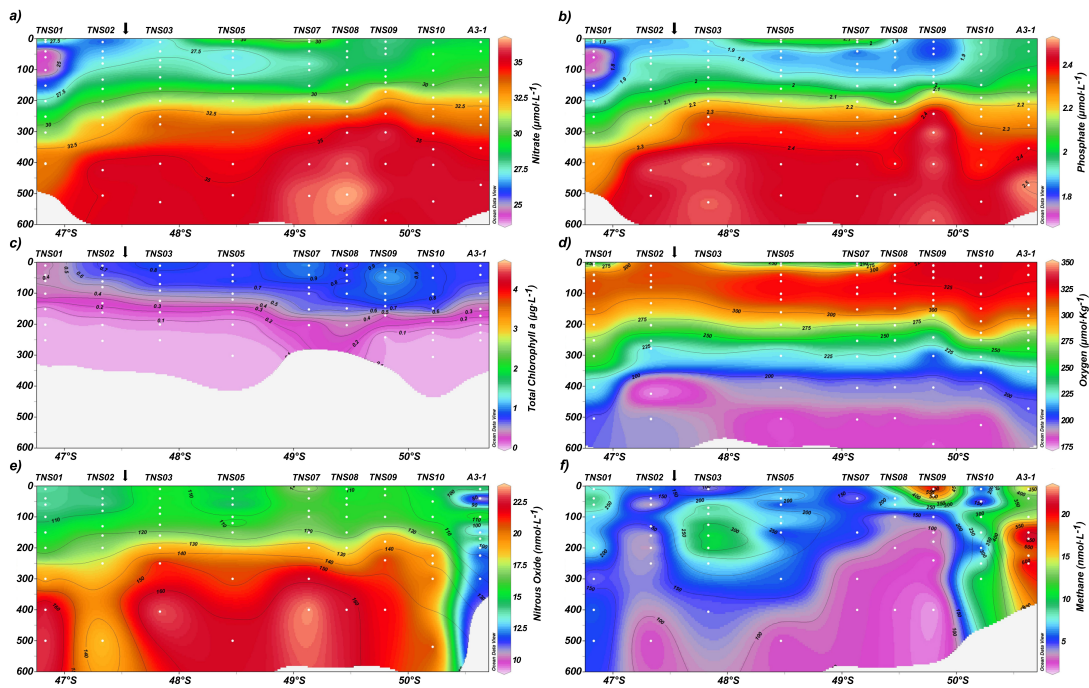
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Fig. 4.

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