Clim. Past Discuss., 11, C1017–C1029, 2015
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Climate of the Past Discussions

Interactive comment on "Variability in terrigenous sediment supply offshore of the Rio de la Plata (Uruguay) recording the continental climatic history over the past 1200 years" *by* L. Perez et al.

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Received and published: 12 July 2015

RESPONSE LETTER TO REVIEWER 2

1. The authors claim that during the Little Ice Age, El Niño-like conditions may have helped to bring the Río de la Plata plume further north. However, Piola et al. (2005. Geophysical Research Letters) and Piola et al. (2008. Continental Shelf Research) showed that despite the increased precipitation over SE South America, during El Niño conditions the Río de la Plata plume is directed offshore. Under El Niño conditions, anomalously strong NE winds prevent an along-shore northeastward spreading of the Río de la Plata plume and force the high-nutrient fluvial waters offshore. This has not

only been characterized for the instrumental record, but also for the paleo record (Voigt et al., 2013. Marine Geology). It is noteworthy that both manuscripts (i.e., Voigt et al. (2013. Marine Geology) and Perez et al. (under review for Climate of the Past)) have a common author but the mechanisms used to explain the dispersal of the Río de la Plata plume are significantly different. An in-depth re-evaluation of the behavior of the Río de la Plata plume under El Niño conditions is necessary, and bears possible major implications for the conclusions of this manuscript.

This is rather a problematic issue. We did undertake research to address this reviewer′s comment, and came to the conclusion that further mudbelt sediment cores taken along a latitudinal gradient are needed to reliably infer the RdlP plume displacement. Therefore, we no longer argue about plume displacement, but only discuss the different degrees of continental influence.

2. The disagreement between element ratios and diatom groups described for the Current Warm Period (e.g., increase in Ti/Ca and Fe/K, and decrease in freshwater diatom group) deserve significant more attention from the authors. A single short paragraph (i.e., page 13, lines 1-15) is dedicated to the topic. The authors claim that industrial activities have increased the content of some heavy metals but it is not clear in the text if this is also the reason for the increase in the elemental ratios. Moreover, the high natural Fe content of the sediments delivered by the Río de la Plata (Burone et al., 2013. Continental Shelf Research; Razik et al., 2015. Marine Geology) raises the question what extent industrial activities could affect the used element ratios. Also, the authors claim that other anthropic activities (e.g., river damming, deforestation) modified. the Río de la Plata drainage basin, but it remains elusive if, how much, and to what direction those changes affected sediment and water discharge of the Río de la Plata. Note that processes like river damming and deforestation may have opposite effects on the total suspended sediment load of a certain river (e.g., Syvitski and Milliman, 2007. The Journal of Geology). Additionally, another key element has to be taken into consideration in this discussion, namely the marked increase in precipitation over SE

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South America during most of the last century (e.g., Liebmann et al., 2004. Journal of Climate; Barros et al. 2008. Theoretetical and Applied Climatology). I would urge to authors to perform an in-depth re-evaluation of their data, the possible mechanisms that explain the data, and the conclusions that can be drawn out of them.

Analyzing the contemporaneous record was not the goal of this manuscript. The antropogenic impact during the last century was discussed in Perez et al (in press) and natural contemporary variations were discussed in Marrero et al. (submitted, accepted, resubmitted). We are willing to provide you with the pdf files upon request.

3. Throughout the manuscript, the Intertropical Convergence Zone is inappropriately mentioned as directly related to the Río de la Plata plume (both for water discharge/precipitation, and transport of the plume) (e.g., page 2, lines 21-27; page 3, lines 16-26; page 11, lines 12-19; page 12, lines 11-16; page 13, lines 19-25). The wind patterns that control the northward/southward penetration of the Río de la Plata plume are only indirectly related to the Intertropical Convergence Zone. Note that none of the references cited by the authors in page 3, lines 16-26, for instance (i.e., Guerrero et al., 1997. Continental Shelf Research; Camilloni, 2005. In: El Cambio Climático en el Río de la Plata; Möller et al., 2008. Continental Shelf Research; Piola et al., 2008. Continental Shelf Research) even mention the Intertropical Convergence Zone as an element controlling the freshwater plume. Also, precipitation over the Río de la Plata drainage basin (and the integrated basin discharge) is only indirectly related to the Intertropical Convergence Zone, whereas the South Atlantic Convergence Zone plays a direct influence (e.g., Carvalho et al., 2004. Journal of Climate). Still, the South Atlantic Convergence Zone is not mentioned throughout the text, and should be discussed. Note that this may affect the conclusions of the authors. I would urge the authors to consider the role of the South Atlantic Convergence Zone and other southern hemisphere atmospheric elements.

The manuscript has been re-discussed and re-interpreted to include the suggestions from all the reviewers concerning with the influence of SAMS and SACZ. Refer to

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section: Introduction (lines 84-96) and Discussion (lines 309-326).

4. This manuscript is based on element ratios and diatom groups analyzed in a well dated high temporal resolution marine sediment core. The diatom data (and most probably the age model) has apparently been published previously (page 5, line 24) (Perez et al., in press. In: Applications of Paleoenvironmental Techniques in Estuarine Studies). However, the similarity of that previous publication to the present one is impossible to evaluate since Perez et al. (in press. In: Applications of Paleoenvironmental Techniques in Estuarine Studies) is not yet available. From section 5.2, it seems that there is at least some degree of overlapping between both manuscripts. This is a critical issue that needs to be addressed by the authors. The novel aspects of both contributions should be clearly stated and able to be evaluated by the reviewers. So far, this seems not to be the case.

The data presented in this MS have not been published elsewhere, i.e., in Perez et al (in press). We will gladly provide you with the pdf file corresponding to Perez et al. (in press) upon request.

5. In section 3.2.1 Runoff-indicative element ratios, the authors mention that Fe/K and Ti/Al area are proxies for fluvial vs, eolian input. However, in a site strongly affected by fluvial discharge of the second largest drainage basin in South America (e.g., Lantzsch et al., 2014. Quaternary Research) and relatively far from the area affected by the major South American dust plume (e.g., Mahowald et al., 2006. Journal of Geophysical Research) this interpretation is doubtful. Instead, relatively small changes in source region within the Río de la Plata may have produced similar features. I would urge the authors to consider how changes in sediment source within the Río de la Plata basin would affect their proxy.

The authors have re-defined and clarified concepts regarding the XRF ratios. This information is presented in lines 208-217.

6. In section 5.2 Paleo-environmental proxy records, the authors claim that Ti/Al in their

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study is a proxy for grain-size distribution. Still, no grains-size data is presented.

The manuscript has been re arranged and this phrase and Figure 4 was removed.

7. 210Pb analyses on the uppermost section of the marine sediment core analyzed here would be necessary if the authors want to make any inference on the Current Warm Period. As the age model stands now, there is no age constrain for the Current Warm Period. The closest age constrain is a 14C age of 1688 yr AD. This is not appropriate for the evaluation of the Current Warm Period. I suggest to either provide a more accurate age constrain for that portion of the record, if the discussion and conclusions are to include the Current Warm Period.

Same answer as item 2.

Page 2, line 10: “m” should not be italicized.

It was italicized by the editor.

Page 2, lines 14-15: “terrigenous water” reads awkward, please rephrase.

The authors have rewritten the final part of the sentence “to assess the variability in terrigenous sediment and freshwater discharge”.

Page 2, line 15: The terms “and sediment discharge” may have to be deleted if the “freshwater” diatoms developed in situ. See my comment above.

The term sediment discharge has been replaced with “terrigenous sediment”.

Page 2, line 18-19: Delete “such regional and global climatic episodes as”.

It has been deleted.

Page 2, lines 21-27: There is confusion on the role of the Intertropical Convergence Zone and the South Atlantic Convergence Zone on controlling rainfall over the Río de la Plata drainage basin (the transport of the Río de la Plata plume). It is rather the South Atlantic Convergence Zone that exerts a great influence on precipitation over

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the Río de la Plata drainage basin (e.g., Carvalho et al., 2004. Journal of Climate) (and regional winds that exert a great influence on the transport of the Río de la Plata plume (e.g., Möller et al., 2008. Continental Shelf Research)). Yet, the South Atlantic Convergence Zone (regional winds) is not cited in the text. Please, review the text accordingly.

The manuscript has been re-discussed and re-interpreted in order to include the suggestions from all the reviewers concerning with the influence of SAMS and SACZ. Refer to the section: Introduction (lines 84-96).

Page 2, line 22: Be more precise. Only Fe/Ca and Ti/CA are "indicative of a lower terrigenous input".

The authors mean that all four elemental ratios were used for this study.

Page 2, line 25: Delete "state".

Done

Page 3, lines 1-4: Be more specific. Neither here nor in page 13, lines 1-15, the disagreement between the element ratios and diatom groups is appropriately assessed. See my comment above.

Analyzing the contemporaneous record was not the goal of this manuscript. The antropogenic impact during the last century was discussed in Perez et al (in press) and natural contemporary variations were discussed in Marrero et al. (submitted, accepted, resubmitted). We are willing to provide you with the pdf files upon request. Therefore, we have rewritten everything related to the contemporaneous period. Please refer to sections: Abstract and Discussion.

Page 3, lines 16-26: As mentioned above, the wind patterns that control the northward/southward penetration of the Río de la Plata plume are only indirectly related to the Intertropical Convergence Zone. Note that none of the references cited by the authors (i.e., Guerrero et al., 1997. Continental Shelf Research; Camilloni, 2005. In: El Cambio

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Climático en el Río de la Plata; Möller et al., 2008. Continental Shelf Research; Piola et al., 2008. Continental Shelf Research) even mention the Intertropical Convergence Zone as an element controlling the freshwater plume. Also, precipitation over the Río de la Plata drainage basin is only indirectly related to the Intertropical Convergence Zone, whereas the South Atlantic Convergence Zone plays a direct influence (e.g., Carvalho et al., 2004. Journal of Climate). Still, the South Atlantic Convergence Zone is not mentioned in the text, and should be included.

The manuscript has been re-discussed and re-interpreted to include the suggestions from all the reviewers concerning the influence of SAMS and SACZ. Refer to lines 84-96.

Page 4, lines 7-12: It is relevant to add that under El Niño conditions the Río de la Plata plume is directed rather offshore/southwards (Piola et al., 2005. Geophysical Research Letters; Piola et al., 2008. Continental Shelf Research).

The authors have added this information, see lines 118 to 121.

Page 4, lines 19-24: Discussing Vuille et al. (2012. Climate of the Past) here is of great relevance, since the authors provide well-dated, extremely high-temporal resolution data with a clear paleo-environmental significance. Moreover, the new record (i.e., Cristal cave) presented by Vuille et al. (2012. Climate of the Past) is virtually placed within the Río de la Plata drainage basin and shows increased precipitation during the Little Ice Age. A critical discussion of the results of del Puerto et al. (2013. Quaternary International) in face of Vuille et al. (2012. Climate of the Past) is necessary.

This information has been added to discussion section: see lines 363-370.

Page 5, line 4: The characterization of the study area needs more information. By not addressing in this section the atmospheric circulation over the Río de la Plata drainage basin and the oceanic circulation offshore northern Argentina and Uruguay, the authors leave the reader with extremely few elements to contextualize their own study. In a

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journal like Climate of the Past, a more comprehensive characterization of the study area is possible. I would urge to authors to include a systematic and critically prepared overview of the main aspects controlling modern atmospheric and oceanic circulation in the study area.

This information has been added to the introduction. Regarding the oceanographic system, the authors have added: The RdlP freshwater discharge, leads to a low salinity plume on the inner continental shelf, which can reach northern areas up to 28°S (Piola et al. 2000). The low-salinity waters in the inner part of the continental shelf extend downwards to an approximate depth of 50 m, while the outer part of the continental shelf (from 50 m to 200 m) is influenced by the Subtropical Confluence, where the warm, salty southward-flowing Brazil Current collides with the cold and less salty northward-flowing Malvinas Current (Calliari et al., 2009; Piola et al., 2000). Regarding the climatic and atmospheric forcing, the authors added: The Paraná River contributes with 73% of the total RdlP freshwater discharge and shows the maximum values during the austral summer (Depetris and Pasquini, 2007). This precipitation and river discharge pattern is associated with the southward expansion and intensification of the South American Summer Monsoon System (SAMS, Zhou and Lau, 1998; Chiessi et al., 2009). The SAMS is known to be a poleward displacement of the Inter Tropical Confluence Zone (ITCZ), and it is associated with a wet season that begins in the equatorial Amazon and propagates rapidly eastwards and southeastwards during austral spring (García and Kayano, 2010). The SAMS is tightly associated with the South Atlantic Convergence Zone (SACZ, Carvalho et al., 2004), which is a main component of the SAMS (Nogués-Paegle et al., 2002; Almeida et al., 2007). The SACZ is an elongated NW-SE band of convective activity that originates in the Amazon Basin, and extends above the north RdlP drainage basin boundary, and then into the adjacent SWAO (Carvalho et al., 2004). Thus, the Paraná River discharge is highly influenced by the SACZ (Robertson and Mechoso, 2000).

Page 5, line 24: The diatom data has apparently been published previously (Perez et

al., in press. In: Applications of Paleoenvironmental Techniques in Estuarine Studies). The similarity of that previous publication to the present one is impossible to evaluate since Perez et al. (in press. In: Applications of Paleoenvironmental Techniques in Estuarine Studies) is not yet available. See my comment above.

The data presented in this MS have not been published elsewhere, i.e., Perez et al (in press). We will gladly provide you with Perez et al. (in press) pdf-file upon request.

Page 7, line 3: It has been shown (e.g., Weltje and Tjallingii, 2008. Earth and Planetary Science Letters) that the use of log ratios of element intensities are more appropriate that simple ratios. Please, use log ratios instead of normal ratios. Note that some features of the records may change significantly potentially affecting the conclusions of this manuscript.

Here, the reviewer makes critical comments about the reliability of our data. In this sense, we must point out that we only intend to undertake semi-quantitative reconstructions using XRF-data, and since we are not performing any parametric statistics, a log-transformation of the data is not necessary, and the use of elemental ratios is sufficient to reconstruct the main long-term trends of our paleoenvironmental record. However, if the editor still considers it necessary, we will provide the log-transformed data. Refer to lines 187-194.

Page 6, lines 8-10: The authors mention that Fe/K and Ti/Al in their study area are proxies for fluvial vs, eolian input. Instead, relatively small changes in source region within the Río de la Plata may have produced similar features. I would urge the authors to consider how changes in sediment source within the Río de la Plata basin would affect their proxy.

The authors have re-defined and clarified the concepts dealing with the XRF ratios. This information is presented on lines 208 to 217.

Moreover, the reference “Garvin et al. (2012)” is not listed in References. See my

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comment above.

The authors have made a mistake. It should read Govin et al. 2012 instead of “Garvin et al. (2012)”.

Page 8, lines 18-20: Please provide a thorough time-series analyses if the aim is to explore any cyclical behavior of the records.

We are not aiming to publish about time series analysis in this paper. However, we are currently discussing this issue in detail with a mathematician and it will still take further analyses and discussions before we can show reliable findings.

Page 9, lines 3-6: No grain-size data is presented in Krastel et al. (2012. Report and preliminary results of RV METEOR Cruise M78/3). Please delete this sentence and any related discussion/conclusion or show the grain-size data (e.g., page 12, lines 6-10).

This sentence has been deleted. Concerning the grain size data, nothing has been mentioned.

Page 10, lines 16-18: Why should there be “less energetic hydrodynamic conditions between the Medieval Climate Anomaly and the Little Ice Age”? Please provide thorough rationale.

The sentence was deleted, as also suggested by Reviewer 1.

Page 11, lines 10-11: The northernmost record evaluated by Moy et al. (2009. Past Climate Variability in South America and Surrounding Regions) is located to the south of 40oS, and this citation is inappropriately placed here.

We agree with reviewer and have removed the said citation.

Page 12, lines 16-23: The authors need to consider that a strengthening of the westerlies and stronger El Niño conditions would produce opposing effects over the transport of the Río de la Plata plume (e.g., Piola et al., 2005. Geophysical Research Letters;

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Piola et al., 2008. Continental Shelf Research). Please consider this opposing effects in the discussion.

This paragraph has been modified as suggested by all the reviewers.

Page 13, lines 11-15: The "freshwater" diatoms found on core GeoB13813-4 developed in situ or were transported. The authors suggest in a rather indirect way that they are transported. This point needs further clarification since the interpretation of the record may change significantly in the occurrence of the one or the other phenomenon. The diatom flora can be either transported or grown in situ. Table 1: 210Pb analyses on the uppermost section of the marine sediment core analyzed here would be ideal given the high sedimentation rate of the core. Also, the discussion and conclusions from the Current Warm Period would have been significantly better constrained with an 210Pb based age model for the uppermost section of the core. As the age model stands now, there is no age constrain for the Current Warm Period. The closest age constrain is a 14C age of 1688 yr AD. This is not appropriate for the evaluation of the Current Warm Period. See my comment above.

Same answer as item 2. "Analyzing the contemporaneous record was not the goal of this manuscript. The antropogenic impact during the last century was discussed in Perez et al (in press) and natural contemporary variations were discussed in Marrero et al. (submitted, accepted, resubmitted). We are willing to provide you with the pdf files upon request."

In Lantzsch et al. (2014. Quaternary Research) a 14C age of 1600 +/- 30 yr has been reported for a sample collected at 964 cm core depth (with lab identification of Poz-42431). The similarity to the deepest dated sample shown in the present manuscript, I wonder if they are the same sample

Yes it is the same sample.

Figure 1: What does the stars at the right-hand margin of panel c means? Are they

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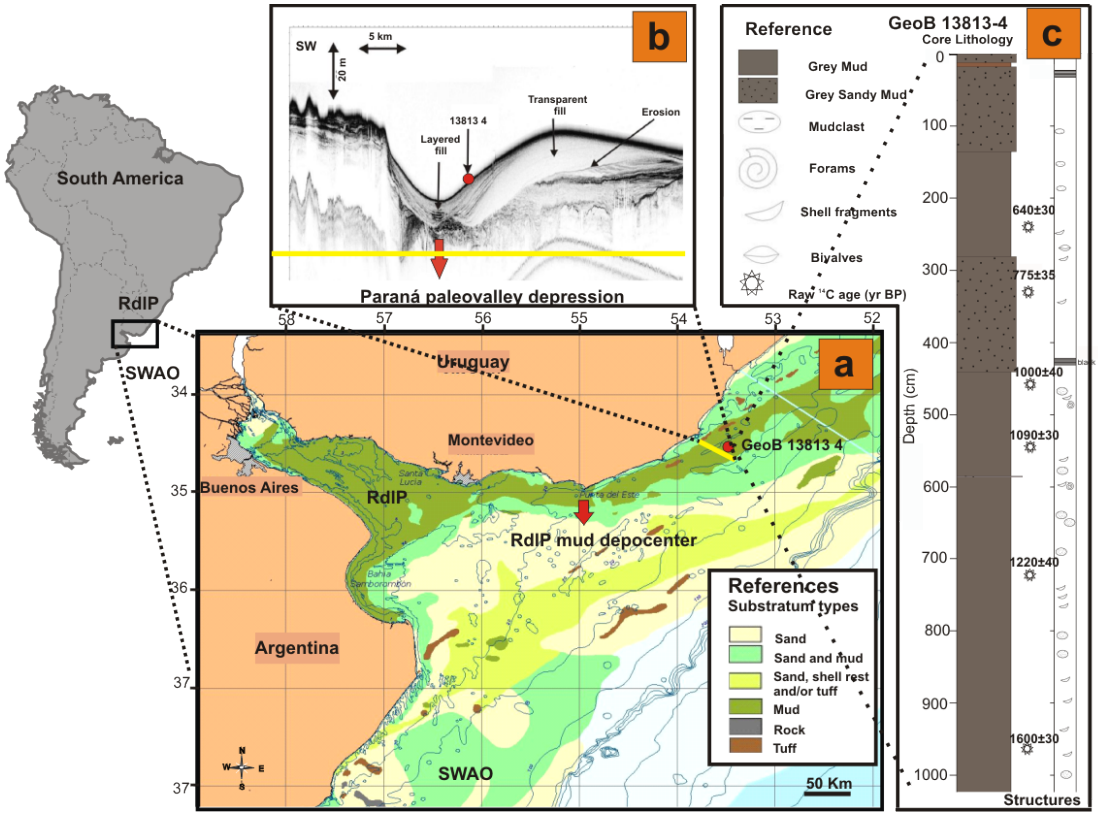
representing the 14C ages?

The stars indicate 14C-dated intervals, but were removed from the legend of Figure 1 in the original manuscript during the edition process. Furthermore, there was a mistake in the values which has now been corrected. Refer to figure 1.

Figure 4: The 2 mm XRF data presented here is virtually not explored in the text. I would urge the authors to make full use of this precious dataset.

We agree with the reviewer that we have not fully used Figure 4 in the discussion of data. Since the scope of this paper is not to undertake ultra-high-resolution analyses, we have decided to delete this figure from the paper since this issue deserves much more critical analysis and further interpretation.

Interactive comment on Clim. Past Discuss., 11, 1343, 2015.


South America
RdlP
SWAO
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SW
5 km
20 m
Transparent fill
Erosion
13813 4
Layered fill
Paraná paleovalley depression
Reference
GeoB 13813-4
Core Lithology
c
Grey Mud
Grey Sandy Mud
Mudclast
Forams
Shell fragments
Bivalves
Raw ¹⁴C age (yr BP)
640±30
775±35
1000±40
1090±30
1220±40
1600±30
Depth (cm)
Structures
a
Uruguay
Montevideo
GeoB 13813 4
Buenos Aires
RdlP
RdlP mud depocenter
Argentina
SWAO
References
Substratum types
Sand
Sand and mud
Sand, shell rest and/or tuff
Mud
Rock
Tuff
50 Km

Fig. 1.