

Interactive comment on “Marine productivity response to Heinrich events: a model-data comparison” by V. Mariotti et al.

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The paper presents an interesting modeling study on the impact of Heinrich-type fresh-water events on marine productivity in the global ocean. The paper includes a model/data comparison and the authors have done a fair enough job to find relevant paleo-data; however, some records are missing and I will list respective references in my comments. The paper differs from previous studies by including a biogeochemical cycle model and is appropriate to Clim. Past and its readers. I recommend minor revisions before publication.

The biggest issue I have with the paper is the problem of the response in the Mauretanian/ NW African upwelling system. The authors are stating –correctly– in their paper that the problem of the contrary response between the model and data results most

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likely from the freshwater parameterization in the North Atlantic. What I am missing, in particular because of the discussion in paragraph 4.2, is a sentence that this problem that partially already occurs in the IPSL-CM4 model (p. 571) needs to be fixed in the future for more reliable predictions. This upwelling system is very important for the global carbon cycle and future food (e.g. fish) supply. Having a reduced upwelling in the NW African system will also have an impact on the intermediate depth circulation, i.e. the northward advance of the Antarctic Intermediate Water (AAIW). From paleo-data we know that AAIW was upwelled off NW Africa during glacials and that this water mass penetrated into the North Atlantic (e.g. Pahnke et al., 2008 Nat. Geosci); so I wonder if the authors ever compared biogeochemical parameters (nutrient concentrations) in the depths where AAIW is to be expected, between their Heinrich event run and a glacial or modern control run. Unfortunately, paleo-data for productivity changes in the Cape Blanc area on millennial-scales are rare because older studies focused on glacial/ interglacial changes. Nevertheless, the authors might want to look at some of the records published in Bertrand et al. (1996) in Mar. Geology; Martinez et al. (1999) in Mar. Geology or in Sarnthein et al. (1988) in Paleoceanography; Sarnthein and Winn (1990) in Schlesinger, M. (ed.) Climate-Ocean Interaction, Kluwer Ac. Publ.; or Sarnthein et al. (1992) in Summerhayes, Prell, Emeis (eds). Upwelling systems: evolution since the early Miocene. These records might not enter into the data/ model comparison but trends could be discussed and would strengthen the discussion. Indirect indicators could also be those records discussing dust (Jullien et al., 2007 Quat. Res.; is that Heinrich event dust signal comparable to the glacial one used in the model?) or ITCZ shifts (Zarriess et al., 2011 Geophys. Res. Lett.).

Specific comments:

p. 560: Though not essential for the paper, I would have liked to see reference to the ice core N₂O data and linkages to the nitrogen cycle in the introduction (e.g. Flueckiger et al., 2004 Global Biogeochem. Cycles; or Stocker & Schilt 2008 comment in Nature).

p. 561: because of the bipolar seesaw and its impact on records from the southern

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hemisphere I am missing text on how Heinrich events and the Younger Dryas were defined in the various records. Did the authors just follow the indications given by the authors they are citing? Did they define specific age intervals (thereby keeping potential difference in age models in mind, e.g. GRIP vs. GISP2 vs. NGRIP GICC05 chronologies)?

p. 546 and Table 1: please correct to ODP Site 882, etc. that is include “Site”

p. 565 first paragraph and p. 569 MAU discussion: increased productivity is also observed just a bit north of MD04-2805 CQ at site MD99-2339 (Voelker et al., 2009; GCubed) and in the Alboran Sea (Med. Sea; Moreno et al. 2004; Paleo3).

p. 567 line 12: add “cover” at end of sentence

p. 569 there are more records available for the Indian Ocean and I will list them below in relation to Table 1

p. 570 lines 8 and 9: this finding is in contrast to Rashid et al. 2007 Science; so the authors might want to comment on it.

p. 577 and following: delete the numbers (page numbers?) listed at the end of each reference after the publication year.

p. 585/ Table 1: as suggested by Schmittner either list the respective proxy used for the productivity estimation or at least indicated if the reconstruction is for PP or EXP.

Additional paleo-data references:

North and tropical Atlantic:

1) Villanueva et al. 1997 *Geochem. Cosmochem. Acta*

2) Sarnthein et al. 2001 Fundamental modes and abrupt changes in North Atlantic circulation and climate over the last 60 ky – Numerical modelling and reconstruction, in *The Northern North Atlantic: A changing environment*, edited by P. Schäfer, W. Ritzrau,

M. Schlüter and J. Thiede, pp. 365–410, Springer Verlag, Heidelberg.

This article includes two records: core M15612 from the PhD thesis of Th. Kiefer (Produktivität und Temperaturen im subtropischen Nordatlantik: zyklische und abrupte Veränderungen im späten Quartär, Berichte-Reports Geologisch-Paläontologisches Institut, Univ. Kiel, 90, 127 p.) and another published in German by Weinelt, M., A. Rosell-Mele, U. Pflaumann, M. Sarnthein, and T. Kiefer (2003), Zur Rolle der Produktivität im Nordostatlantik bei abrupten Klimaänderungen in den letzten 80 000 Jahren, Zeitschrift der Deutschen Gesellschaft für Geowissenschaften ZDGG, 154(1), 47-66.

The respective data is available from www.pangaea.de

3) Voelker et al. 2009 and Moreno et al. 2004 already mentioned above

4) Jennerjahn et al. 2004 Nature

Indian Ocean

Altabet et al. 2002 Nature

Higginson et al. 2004 Paleoceanography

Pacific

1) Higginson et al. 2003 Mar. Geology

2) Dannenmann et al. 2003 GCubed

3) Ortiz et al. 2004 Geology

4) Barron et al. 2009 Mar. Micropal.

5) Bounelle et al. 2010 QSR

6) Gebhardt et al. 2008 Paleoceanography

7) Pichevin et al. 2010 Paleoceanography

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8) Martinez and Robinson 2010 Biogeosciences

9) Saavedra-Pellitero et al. 2011 Paleoceanography

for the western and northern Pacific many records only cover H1 and YD but they might be helpful for trends or the discussion.

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