Clim. Past Discuss., 9, C1304–C1311, 2013
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Interactive comment on "The role of East-Tethys seaway closure in the middle Miocene climatic transition (ca. 14 Ma)" *by* N. Hamon et al.

Anonymous Referee #2

Received and published: 1 July 2013

The presented and discussed model outcomes are very interesting, and contribute towards the ongoing discussion on the causes of the Middle Miocene Climatic Transition (MMCT) and consequences of the closure of the eastern Tethys seaway – the connection between the Indian Ocean and the (proto-)Mediterranean. The author's also try to use their model outcome to constrain the timing of the closure of this seaway, linking the end of Tethyan Indian saline water (TISW) production to the MMCT (Woodruff and Savin 1989 and other references giving in the manuscript), but the identification of TISW in Indian Oceans isotopes is, to date, controversial (e.g. Smart et al. 2007).

The manuscript would benefit greatly from re-structuring and re-writing the results and discussion in such a way that the focus is more on the TISW and AMOC, the actual outcome of the modeling experiments, and that the closure had very little effect on the

global climate. In this sense, many details concerning previously published model outcomes and the Middle Miocene climate should be part of the Introduction/Background. Consequently, I suggest a moderat to major revision for this manuscript.

I have the following comments concerning Hamon et al.'s manuscript.

- A reference and discussion on the oceanic box model and ocean circulation model by Karami 2011 and Karami et al. 2011 (see references below) is entirely missing even though these are relevant for the presented model data and results.
  - Karami 2011 finds a flow reversal between the western Mediterranean and the Atlantic Ocean when introducing a sill of 500m in the eastern Tethys connections. This flow reversal is found here in the shallow eastern Tethys experiment (Mio250), which is suggested to intensify the MOC (AMOC?)
- I advocate to use 'Paratethys' for the northeastern geographic extend, an intercontinental sea following Rögel 1998, Rögel 1999, Harzhauser et al. 2007, Harzhauser and Piller 2007, de Leeuw et al. 2011 and many more. The region of the present-day Mediterranean during the Miocene is referred to as the Mediterranean basin or Proto-Mediterranean (see Rögel 1999, Harzhauser et al. 2007, Harzhauser and Piller 2007). As a consequence, the author's draw incorrect conclusions and use incorrect citations in the discussion of their model results. For instance, on page 2127, line 21, the reference de Leeuw et al. 2013 is incorrect in this context. De Leeuw et al. 2013 dated the onset of the Badenian salinity crisis at 13.82 Ma, which is triggered by the glacio-eustatic restriction of the connection between the Central Paratethys and the Mediterranean and not the Paratethys and the Indian Ocean as written in the text. Again, the Paratethys-Indian Ocean connection differs significantly from that of the (proto-)Mediterranean and the Indian Ocean (see Harzhauser et al 2007). See also Karami et al. (2011) for

CPD
9, C1304–C1311, 2013

modeling experiments concerning the (proto-)Mediterranean and Paratethys disconnection during the Miocene.

- The link between the closure of the seaway and the demise of the TISW should be emphasized more as this is a very important result. Previous work should be summarized and additional references included, such as Ramsay et al. 1998 and Smart et al. 2007 that pick up the hypothesis of Woodruff and Savin (1998). In particular Smart et al. (2007) argue that the published stable isotope data from two Indian Ocean DSDP sites (from Woodruff and Savin 1991) do not unequivocally show the presence of TISW/TOW between 17 and 5 Ma in the Indian Ocean. It is still a very interesting point, which the authors should address in more detail and could potentially suggest that identifying and dating the end of TISW production could date the most significant step in the closure of the eastern Tethys seaway. But for this, they need to discuss all available published data on the TISW production and TOW into the Indian Ocean.

- The intensified AMOC when the eastern Tethys seaway is shallow (Mio250) and closed (MioC) is a very interesting model result and needs to be discussed in more detail in terms of the effects on the palaeoceanographic circulation and on Middle Miocene climate (see also Holbourn et al. 2013, Ramsay et al. 1998, but also Karami 2011 etc). See Holbourn et al. 2013 on the importance of meridional overturning circulation (MOC) and orbital forcing of the Middle Miocene Climatic Transition.

- All description and results of previously published models should be summarized in the beginning of the paper in order to show the need of the here presented model and model outcome.

- Also, all information on the Miocene climate, tectonic and oceanographic changes should be part of the Introduction/Background.

CPD
9, C1304–C1311, 2013

  - The authors should discuss the Monterey event, which has been attributed to contribute to the Middle Miocene climatic change.
  - Also, a discussion on the Langhian transgression and its implications for the eastern Tethys seaway is missing.

- A more detailed summary of the significant tectonic event (e.g. diachronous collision of Africa with Eurasia, i.e. Robertson 2000, Golonka et al. 2004 and many more) and the evolution of the restriction of the eastern Tethys seaway as described by Harzhauser et al. 2007, Harzhauser and Piller 2007, Rögel 1998, Rögel et al. 1999, Reuter et al. 2007 etc. - including the timing of mammal migration (gomphotherium landbridge) - should from part of the Introduction/Background and should be later referred to in the Discussion, in particular on the timing of the closure.
- A short description of the four chosen model set-ups, including water depth, width of gateway and location of gateway is missing but would help the reader.
- A more detailed discussion on (the implication of) the width of the gateway is missing as other models have shown to be an important factor.
- Please show all four models configurations at least once in a figure.
- The authors should integrate their model results also with biogeographic and tectonic evidences of the gateway closure
  - If the isotope data does not unambiguous point towards TISW production and TOW in the Indian Ocean (Smart et al., 2007) between 17-5 Ma, then a temporal link to the timing of separation of bioprovinces, and the gomphotherium landbridge cannot be ruled out and the main step in the disconnection, the shallowing to ~250m of the eastern Tethys seaway is not unambigeouly linked to the MMCT. The authors do argue that the closure has very little impact on ice sheet build-up and therefore climatic cooling.

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- A discussion on the link between TISW production/TOW in the northern Indian Ocean and the Middle Miocene Climatic Transition is missing, but would greatly improve the manuscript. In particular, considerung the model finding that the closure of the eastern Tethys seaway, which stopped TISW production, has very little influence on the cooling, precipitation and ice sheet growth over Antarctica, which, in turn had been argued to be the trigger (Woodruff and Savin 1989, Wright et al. 1992 etc.).

- An entire paragraph (4.3 The cause of the Middle Miocene Climatic Transition) is dedicated to the discussion on the effect of changing pCO_2 on the Middle Miocene Climate Transition, which is purely based on previously published data, while the model experiments neither take pCO_2 into consideration, nor provides any insight into this issue. I advise to describe the effects of changing pCO2 in the Introduction/Background, while only in the conclusion refer to it as one of the most likely trigger for the Middle Miocene climatic cooling in the author's opinion.

- Concerning the reference Allen and Armstrong (2008): The suggested mechanisms explaining pCO_2 drawdown, in particular total organic carbon storage, is referring to the Maykop and Menilite units in the Paratethys, not Mediterranean basin.

- Use capital letters for the Middle Miocene Climatic Transition, and Middle Miocene Climatic Optimum as they are the names for these events.

- In Figure 5, upper panel, the (proto-)Mediterranean basin is labeled Tethys Sea, while in the figure caption it is referred to as the Paratethys. Please be consistent in naming the oceanic basins. Again, it is not the Paratethys, but the (proto-)Mediterranean basin. The Paratethys Sea was already partly separated from the (proto-)Mediterranean basin during the early Miocene, and in particular during the Middle Miocene (see e.g. Harzhauser et al. 2007, de Leeuw et al. 2011).

CPD
9, C1304–C1311, 2013

Specific comments:

p.2116, l.2: Despite being well documented. . . .

p.2116, l.27: . . . the oceanic changes due to. . .

p.2117, l.5: the Mi3b event is astronomically dated at 13.8 Ma by Abels et al. 2005

p.2120, l.18: It is not the Paratethys-Indian exchange that is discussed here, but the exchange between the (proto-)Mediterranean and Paratethys or western Tethys with the Indian Ocean or eastern Tethys.

p.2120, l.19-21: What configuration is referred to? The Paratethys has actually very low salinity ranging from 30 to 33 in a configuration of open gateway (Mio4000).

p.2120, l.24: The Mio1000 model set up is not shown and the reader can therefore not see what the differences and/or impacts are. Please add these figures.

p.2122, l.13: . . . outflow feeds the North Atlantic. . .

p.2122, l.22: Figure 10 is mentioned in the running text before figure 9. Please either reverse the order of figures 9 and 10, or change the reference to these figures in the running text.

p.2127, l.19: the water exchange between the Paratethys and Indian Ocean is geographically and temporally different to the water exchange between the (proto-) Mediterranean and the Indian Ocean, which is again different to the water exchange between the Paratethys and the (proto-)Mediterranean basin. I advise the authors to familiarize themselves better with this terminology and the historical geographical changes in the region of the different connections between the Paratethys, Mediterranean and Indian Ocean.

p.2127, l.21: The reference de Leeuw et al. 2013 is cited wrong in this context. De Leeuw et al. 2013 dated the onset of the Badenian salinity crisis at 13.82 Ma, which is triggered by the glacio-eustatic restriction of the connection between the Central

CPD
9, C1304–C1311, 2013

Paratethys and the Mediterranean.

p.2127, l.25: Hüsing et al. 2009 date the upper limit of the disconnection at 11 Ma, because the date comes from westernmost transect of the seaway between Indian Ocean and Mediterranean basin and because of diachronous collision of Africa and Eurasia can still have been deep marine while the eastern transect has been closed.

p.2130, l.16-19: What are the geological evidences for enhanced organic productivity and carbon storage when the eastern Tethys seaway was closed?

p.2130, l.22-24: earlier, i.e. p.2123, l.23-26 and p.2124, l.17-19, the results were interpreted as not being enough to stimulate Antarctic ice sheet development.

p.2136, l.22-25: Reuter et al. 2007

p.2145, Fig.5: MOC is referred to in the running text as AMOC. Explain the abbreviation in the figure caption.

It is drawdown and not drowdawn.

References:

Abels, H.A., Hilgen, F.J., Krijgsman, W., Kruk, R.W., Raffi, I., Turco, E., and Zachariasse, W.J., 2005, Long-period orbital control on middle Miocene global cooling: Integrated stratigraphy and astronomical tuning of the Blue Clay Formation on Malta: Paleoceanography, 20, 1-17.

Karami, M.P., de Leeuw, A., Krijgsman, W., Meijer, P.Th., Wortel, M.J.R., 2011. The role of the gateways in the evolution of temperature and salinity of semi-enclosed basins: An ocean box model for the Miocene Mediterranean Sea and Paratethys. Global and Planetary Change, V.79, 1-2, pp.73-88.

Karami, M.P., 2011, Palaeoceanography of the Miocene Mediterranean Sea and Paratethys: Regional ocean modeling of the response to the closure of the Tethys Seaway. Geological Ultraiectina, No. 338 (PhD Thesis, Utrecht Univeristy)

http://igitur-archive.library.uu.nl/dissertations/2011-0331-200559/karami.pdf

Golonka, J., 2004, Plate tectonic evolution of the southern margin of Eurasia in the Mesozoic and Cenozoic, Tectonophysics, 381, 235-273

Harzhauser, M., Kroh, A., Mandic, O., Piller, W.E., Göhlich, U., Reuter, M., and Berning, B., 2007, Biogeographic responses to geodynamics: A key study all around the Oligo-Miocene Tethyan Seaway: Zoologischer Anzeiger. doi: 10.1016/j.jcz.2007.05.001

Holbourn, A., Kuhnt, W., Frank, M., Haley, B.A., 2013. Changes in Pacific Ocean circulation following the Miocene onset of permanent Antarctic ice cover. Earth and Planetary Science Letters, 365, 38-50.

Ramsay, A.T.S, Smart, C.W., Zachos, J.C., 1998. A model of early to middle Miocene deep ocean circulation for the Atlantic and Indian Oceans. In: Cramp, A., MacLeod, C.J., Lee, S.V., Jones, E.J.W. (Eds), Geological Evolution of Ocean Basins: Results from the Ocean Drilling Program, Vol. 131, Geological Society of London Special Publication, 55-70.

Robertson, A.H.F., 2000, Mesozoic-Tertiary tectonic-sedimentary evolution of a south Tethyan oceanic basin and its margins in southern Turkey, In: Bozkurt, E., Winchester, J.A., and Piper, J.D.A., (Eds), Tectonics and magmatism in Turkey and the Surrounding Area, Vol. 173, Geological Society of London Special Publication

Rögel, F., 1998. Palaeogeographic considerations for the Mediterranean and Paratethys Seaways (Oligocene to Miocene). Ann. Naturhist. Mus. Wien, 99A. 279-310.

Smart, C.W., Thomas, E., Ramsay, A.T.S, 2007. Middle-late Miocene benthic foraminifera in a western equatorial Indian Ocean depth transect: Paleoceanographic implications. Palaeogeography, Palaeoclimatology, Palaeoecology, 247, 402-420.

Interactive comment on Clim. Past Discuss., 9, 2115, 2013.