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Climate of the Past Discussions

Interactive comment on "Orbital control on late Miocene climate and the North African monsoon: insight from an ensemble of sub-precessional simulations" *by* A. Marzocchi et al.

Anonymous Referee #2

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GENERAL COMMENTS

The paper explores the sensitivity of Miocene climate to changes in orbital forcing, as well as changes in CO2 and paleogeography to a lesser extent. The primary set of experiments covers a full precessional cycle in the late Miocene, with snapshot equilibrium simulations conducted every 1 ka over the period. In these simulations, geography is set to late Miocene conditions and CO2 is set to 280 ppm. Additional sensitivity simulations set CO2 to 400 ppm (at extremes of the precessional cycle), and another simulation uses modern geographic conditions. In these simulations, the authors explore several facets of the climate system. In response to changes in precession, temperature has strong seasonal anomalies, but smaller annual-mean values. Precip-

itation shows large shifts over the monsoon regions, shifting north in the North African monsoon region in response to minimum perihelion. These precipitation shifts result in increased grasses in the northern Africa in the dynamic vegetation model, consistent with some inferred changes in past vegetation. When comparing model results to proxy records, accounting for the effect of orbital forcing on the Miocene climate helps improve the model/proxy match, although some discrepancy still exists.

The paper fits in well with previous research on the effect of orbital, CO2, and geographic changes on past climate. Running simulations over an entire precessional cycle, rather than just using precessional extremes, helps the authors discuss potential leads and lags in the climate response, which may be useful for refining the dating of past records. That said, the paper could be improved in several ways (see the first three "specific comments" below). First, some discussion should be given to the possible effects of the obliquity forcing in the orbital experiments. Second, some sections of the paper have paragraphs that simply list results without much insightful synthesis. More effort should be taken to emphasize the important results and trim the rest. This would shorten the paper and make the interesting results (of which there are several) stand out better. Finally, the writing is sloppy in places, with occasional references to the wrong figures.

In the "specific comments" below, the first three are the most important. The other comments discuss finer points.

SPECIFIC COMMENTS

1) Not enough discussion is given to the possible effects of obliquity. Over the course of the obliquity experiments, obliquity decreases from a max of ∼23.9 degrees to a minimum of ∼22.8 degrees, a change which should have effects on the climate system. While it is not clear how to explicitly separate the effects of precession and obliquity in these simulations, additional discussion should be made regarding the possible effects of obliquity. At the moment, obliquity is essentially ignored throughout much of the

paper, and (except for brief moments) the entire variability in the orbitally-forced experiments is implicitly attributed to precession. Among other places, obliquity is potentially relevant for the leads and lags of temperature and precipitation response discussed in connection to Fig. 13. The paper does mention on p.2202 that this will be covered in a future study. However, since obliquity is almost never mentioned in this paper, the reader gets the implication that precession is the only orbital forcing that matters, which is an over-simplification.

2) Much of Section 3.1.2 "Global climate response to orbital forcing: precession extremes" offers too many details without enough synthesis. This results in a listing of observations (which the reader can see in the figures alone) that doesn't offer much insight. The authors are encouraged to decide what details are most interesting/relevant to their argument, and leave the rest for readers to see in the figures for themselves. Much of the paper does not suffer from this, but it does occur in places.

3) The writing in the paper is occasionally sloppy, with references to the wrong figures and a few confusing sentences. Some examples are given in the "technical corrections" section below.

4) The abstract introduces the orbitally-forced simulations, but then discusses climate sensitivity to CO2 without mentioning the additional CO2 sensitivity simulations. This was confusing. It would be better to briefly mention those CO2 simulations in the abstract, rather than waiting until later in the paper.

5) The introduction should mention why the authors are studying the Miocene, rather than a different time period.

6) The paper includes much comparison with results from Bradshaw et al. (2012). Do the authors account the corrected data from the corrigendum of that paper?

7) p.2185, line 23: "global circulation model" should be "general circulation model".

8) p.2187, line 20-21: "relatively high amplitude of the precessional cycle itself" means

the same thing as "high eccentricity values". The sentence is repetitive.

9) p.2189, line 11: The paper says "we only consider maximum and minimum values". This is not true. The paper often considers seasonal averages or monthly differences (e.g. Fig. 13), which are influenced by the calendar effect.

10) p.2191: It may be useful to state that changes in precession alone (ignoring eccentricity) have no effect on global, annual-mean insolation.

11) p.2191-2192: The paper discusses correlations with both insolation and with precession (here and in other places), making the paragraphs here overly complex. Additionally, discussion of correlations and anti-correlations with precession (as opposed to insolation) isn't very useful. The timing of "maximum" and "minimum" precession is somewhat arbitrary, so positive vs. negative correlations are not insightful. Limiting the discussion to correlations with insolation would be more straightforward and satisfying. (This may be considered a personal opinion. If you have reason to believe that such discussion is useful, you can keep it. However, because of the large amount of numbers in these paragraphs, this data may be better summarized in a table.)

12) p.2203, lines 17-19: The sentence which starts "In addition, where good agreement is. . ." is arguable. Models and proxies may agree for the wrong reasons.

13) p.2210, line 17 says "The evolution of global mean annual SATs is not influenced by changes in insolation". You show in Fig. 3e that this is not true.

14) Fig. 1: Why is the obliquity scale given in radians instead of degrees. I think that most readers would find degrees easier to conceptualize.

15) Fig. 2: The differences in insolation scales for panel (a) versus the other panels is so large that it should be explicitly pointed out in the caption. Also, the fact that panels show the same seasons for NH and SH (e.g. DJF for NH and JJA for SH) rather than the same months (e.g. DJF for both) is a little confusing.

16) Fig. 4: Labels on panels a and b say "JJA" but the caption says "JJAS". Which is

it?

17) Fig. 8: Some of the colors chosen for this figure may be difficult for red/green colorblind people to distinguish. You don't need to change it, but I thought I would point it out.

18) Fig. 13: The numbers on your color bars do not correspond with the boundaries between colors. This makes it difficult to determine exact values from your figures. Please fix this.

19) Fig. S1: Optionally, you could overlay a few words on this figure pointing out the major geographic changes from modern (i.e. the differences you point out in the text).

20) Fig. S3: Why is the contour interval different between positive and negative?

TECHNICAL CORRECTIONS

(For each of the comments below, examples are given. These examples should not be taken as comprehensive, and the authors should look for additional instances themselves, as well as double-check the one's I've listed.)

1) Some figures or table references in the text specify the wrong number. Examples: a. p.2197, line 7: "Fig. 5b" should be "Fig. 5c". b. p.2205, line 10: "Fig 10c" should be "Fig. 10b". c. p.2205, line 13: Fig. 10d does not need to be cited here. d. p.2205, line 24: "Fig. 10b" should be "Fig. 10c". e. p.2205, line 26: "Fig. 10a, c" should just be "Fig. 10a". f. p.2206, line 5: "Table 1" should be "Table 2". g. p.2206, line 25: "Fig. 10b and d" should be "Fig. 9b and d". h. p.2211: line 14: "Fig. 6" should be "Fig. 5". i. p.2211, line 18: "Fig. 5" should be "Fig. 6". j. Fig. 9 caption: On the last line, "(c) precession mimimum and (d) precession maximum" are switched. (c) is precession maximum, correct? k. Fig. 10 caption: "Fig. 8" should be "Fig. 9".

2) The use of parentheses around citations is inconsistent and sometimes distracting. Examples: a. p.2207, line 14: "Pound et al. (2012)" should be "(Pound et al. 2012)" b. p.2210, lines 2-3 and 11: "(Tuenter et al., 2005)" should be "Tuenter et al. (2005)" in

both instances. c. p.2212, line 24-25: "Prescott et al. (2014)" should be "(Prescott et al. 2014)".

3) Some sentences have errors or are confusingly written. Examples: a. p.2192, line 14: Is "result in" the right phrase here? b. p.2196, line 15: "Patterns are less pronounced. . ." in some regions, but not in others. c. p.2200, line 12: "the the" d. p.2200, line 19: ". . .where 9 are 8 the gridcells. . ." is confusing. e. p.2204, lines 19-26: The sentence starting "In the northern region. . ." is badly written. f. p.2209, line 11: "northern region" should be "southern region". g. p.2209, lines 19-22: This sentence is confusingly written. h. p.2210, lines12-13: the phrase ". . .during precession minimum, throughout their entire simulated time slice" seems self-contradictory. i. p.2210, line 18: "The" is capitalized. j. p.2212, line 14: ". . .a full the precession cycle" has an extra "the". k. Fig. 2 caption: "througout" should be "throughout". l. Fig. 6 caption: ". . .maximum/minimum SAT. . ." should be ". . .maximum/minimum precession parameter. . ." (if I understand things correctly). m. Fig. 10 caption: "Southern "box"" should be "Northern and Southern "boxes"". n. Fig. 12 caption: Be consistent about whether you put figure letters before or after the relevant descriptive text. o. Fig. 13 caption, line 2: "annual" should be capitalized. p. Fig. 13 caption, lines 6-7: The sentence which starts "Note that panel (c) is. . ." is confusingly written.

Interactive comment on Clim. Past Discuss., 11, 2181, 2015.