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Climate of the Past Discussions

Interactive comment on "Past dynamics of the Australian monsoon: precession, phase and links to the global monsoon" *by* L. Beaufort et al.

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General comments

Beaufort et al. present an interesting study of Australian Monsoon variability over the last 150,000 years. Their reconstruction is based on new datasets comprised of the F. profunda (coccolith) paleo-productivity index and pollen data, both of which have been collected from a Banda Sea sediment record. The authors link variations in these datasets to variability in local wind strength, rainfall and length of the dry-season. They discuss their records also within the global monsoon concept and conclude that a common forcing mechanism underlies low latitude climate dynamics (precession and its impact on low latitude summer insolation). Data and interpretation are therefore in line with earlier studies on low latitude climate variability during the late Pleistocene. Over-

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all, the paper address scientific questions, which are clearly relevant within the scope of Climate of the Past.

I have a some general comments/questions:

- I do not fully agree with the conclusion that the low-latitudes are “already in the next ice age” (page 1061, line 11-12). As this study and other studies on the subject show, the low latitude monsoonal systems are dominated by precession-variations and not the 100-kyr ice age cycles of the late Pleistocene. Therefore, I would not speak of an ice age state in a proxy record that is dominated by precession variability. Furthermore, I think that the conclusion, that low-latitude climate variability is leading global ice volume variations (page 1046, line 14-16, page 1060 line 18-21) should be somewhat modified. The monsoon intensity apparently changes during the Holocene, at a time when the ice volume does not change yet (and also during MIS 5). Therefore the monsoon system weakens before the start of the glacial inceptions. However, the low latitude monsoon systems do not lead at glacial terminations. Many records show that the onset of strong monsoon intensity sets in after the deglaciation, probably because extremely cold conditions in the North Atlantic during the melting phase prevented the development of a strong monsoon (see the paper by Cheng et al., 2010 Science). The lead lag relationship is complicated by the fact that the different signal are asymmetrical.

- The Banda Sea record and the Chinese speleothem records show the same precession phasing (a lag of approx. 3 kyrs). For the precession phase of the Asian monsoon records we have recently suggested that the monsoonal weakening during North Atlantic cold events (e.g. Heinrich events) results in this observed precession lag (Ziegler et al., 2010 QSR). It seems that these characteristic weak Asian monsoon events do not show up in the Banda Sea record, even though the productivity record seems to have a high enough resolution over the last 50 kyr to detect these events. Still, the precession phase appears to be the same. Here might be also relevant that the age model is based on tuning of a planktonic isotope record, which will be strongly

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influenced by local SST variability. Is the precession phase of the monsoon proxies potentially influenced by this age model?

- The monsoon records of the Banda Sea are compared with the Chinese speleothem records and discussed within the global-monsoon context. It is stated that the Banda Sea record and the speleothem show a large resemblance. “This similarity suggests that the two monsoon systems are related, or at least are controlled by the same forcing mechanism”. However, I think that also the apparent differences between these records would deserve some more discussion. The productivity record shows a very strong 41 kyr component, which is not present in the Sanbao-Hulu Cave record. The number of dry months shows a strong 100 kyr variability in opposition to the speleothem record. If this record is influenced by glacial-interglacial change, does that mean, that also the precession phase is influenced by the ice volume variability?

- The method part dealing with the coccolith-based proxy is clearly outlined. However, the part on the Pollen methodology is relatively short. It would be interesting to see for example plots of the calibration datasets.

- Some of the interpretations in the paper are drawn upon modern relationships between ENSO and the Australian Winter monsoon. A recent study by Merkel et al. (2010, QSR) suggests “that glacial boundary conditions induce major modifications to ENSO teleconnections and that the “blueprint” of modern ENSO teleconnections should only be applied with caution to glacial climate periods”. Does the conclusion of Merkel and co-workers compromise the interpretations of this study in any way?

Specific comments

page 1046, line 10

“August insolation”: I understand that the authors want to say that the both data sets show the same phase lag and that this lag equals the lag of August (mid?, 1st?) insolation with respect to precession maximum. However, it implies that August insolation

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is the main forcing and this is not necessarily the case.

line 14-16

Is it possible that the change in the proxy record precedes growth of global ice volume (see the mid-Holocene), however that such a lead is less clear at glacial terminations (see the paper by Cheng et al. on the glacial terminations, science 2010)?

page 1047, line 9:

Palaeoproductivity in the Arabian Sea appears to be decoupled from the strength of the Indian monsoon variability, even though in the modern Arabian Sea primary productivity peaks during the summer monsoon season (upwelling) (Ziegler et al, in press, Paleoceanography). This can be explained by changing boundary conditions in the past, namely a change in nutrient delivery to the surface ocean related to changes in the Atlantic Merdional Overturning Circulation (AMOC). Can such an influence (not necessarily the AMOC but some other boundary condition) be ruled out for the Banda Sea productivity records? Could Banda Sea productivity on long timescales be influenced by other factors that do not change on inter-annual timescales?

page 1048, line 29:

A similar link is drawn between modern and long-term ENSO variability in the past. Recently, Merkel et al. (2010, QSR) questioned the idea of persisting ENSO teleconnections through glacial-interglacial change. Does this affect the interpretations made here as well?

page 1052, section 3.4

The details of the palynological transfer functions are not presented. A common difficulty in the interpretation of Pollen records appears to be the distinction between temperature and precipitation (which is probably further complicated by the annual precipitation versus the length of the rain season). Do such potential problems compromise the interpretation of the Pollen records?

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page 1053

line 5-7

What is the reason for the change in nannofossil abundance? What about the section from 15 to 35 m? Is it also poor in nannofossils?

line 23-25

The timeseries appears to be relatively short to analyze 100-kyr periodicity.

page 1059

line 10-15

The authors might want to refer here to a study which is currently in press in Paleoceanography (Ziegler et al., 2010, Paleoceanography, doi:10.1029/2009PA001884, in press). There we argue that the productivity proxies in the Arabian Sea do not necessarily represent the strongest summer monsoon intensity, but are instead strongly related to nutrient budget which is linked to the global ocean circulation and hence show a different precession phase.

Figure 5

At termination II the change in the summer rainfall appears to occur before

Technical corrections

Title I would suggest instead: Past dynamics of the Australian monsoon: precession-phase and links to the global monsoon concept

page 1048

line 20

larger instead of large

line 22

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upwelling instead of upwellings

page 1054

line 9

Why referring to Fig. 2 here? It does not present precipitation data.

page 1058

line 15

should be “in anti-phase”, instead of “in phase” (?)

page 1061

line 8

insolation instead of isolation

Interactive comment on Clim. Past Discuss., 6, 1045, 2010.