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Climate of the Past
Discussions

Interactive comment on "Million-year-scale alternation of warm-humid and semi-arid periods as a mid-latitude climate mode in the Early Jurassic (Late Sinemurian, Laurasian Seaway)" *by* Thomas Munier et al.

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General comments

This paper is an interesting contribution to the paleoclimatic reconstruction of the Early Jurassic using a multi proxy approach including Clay minerals and stable isotopes. This on 2 cores located Mochras in the Cardigan bay basin (Mochras borehole) and the Paris Basin Montcornet borehole). The topic fits therefore well with the scope of the CP journal. The paper is well written and well structured. The figures are informative and of good quality. This Ms can only be accepted only after medium to major thorough revisions, since I have some important concerns about the quality of the data and some interpretations, which are not always supported by the data.

We thank the referee for assessing our work and for providing an important review.

Sample resolution

In the first line of the abstract, the authors claims that it is a high resolution study (223 clay analyses). High-resolution is may be a slight overstatement, since (if we look at figures 5-6) only some 70-80 clay samples have been analysed along a 200m section at Mochras (1 sample/2.5m). The sample resolution is a little bit better in the Montcornet Borehole (around 60 samples for a 60m thick section.

The term "high resolution" has been removed.

Biostratigraphy

It looks that all the biostratigraphy is based on ammonites, it is maybe OK for the Mochras core, but not so evident for the Montcornet borehole, where several marquers are missing. It would be good to complete the biostratigraphy using nannofossils.

Nannofossils biostratigraphy is not available in Montcornet borehole but the magnetostratigraphy has been added (Yang et al., 1996 and Moreau et al 2002, this latter ref. has been added) for Montcornet (Fig.4), as it is currently used as a reference for the Sinemurian in the GTS 2020.

At lines 128, the authors claim that the section is complicated by some important hiatuses and scarcity of ammonites. It would be important to discuss and especially locate these hiatuses.

We have modified the text dealing with the biostratigraphy based on ammonites of the Montcornet borehole.

The upper Sinemurian are made of Gryphaea accumulations, probably resulting from storms interrupted by P- rich condensed levels. This makes the correlation quite difficult and some of the ammonites may be reworked.

Gryphaea accumulations are common in the Lower Sinemurian succession and rarer in Upper Sinemurian. There is however no evidence of reworked ammonites. Effectively, scattered phosphate nodules have been observed, but no P-rich condensed levels are associated with Gryphaea accumulations that could be interpreted as condensed horizons.

Stable isotopes

This is the weakest part of this paper. δ18O values are significantly too negative and reflects a strong diagenetic overprint. I agree that these sediments have not been too much buried, since smectite and kaolinite are still present. But it does not mean that other diagenetic processes were not acting. The presence of siderite is a good indication of a strong diagenetic process. It would have been good to analyse the bulk mineralogy by XRD (easy and fast to perform). Moreover, the most negative values of both δ18O and δ13Ccarb occur in levels, in which calcite contents are quite low (<15%). Some simple cathodoluminescence analyses would help to retrace the diagenetic story of these sediments.

Yes, we agree! δ18O and δ13Ccarb have been completely removed as paleoclimatic proxies on now fig.11 and text. So we modified the text consequently. In our opinion, the δ18O values are shifted to low values and δ13Ccarb values cannot be used as environmental proxies because of carbonate diagenesis. Bulk mineralogy shows indeed the occurrence of siderite (nodules observed in the core) indicating that significant carbonate diagenesis disturbed the original signal.

δ18O and δ13Ccarb can't be use for paleoclimatic reconstructions as the authors did in their figure 10 or at line 30 of the abstract. This is clearly confirmed by the observed discrepancies between the δ13Ccarb and δ13Corg.

δ18O and δ13Ccarb have been removed from now Figure 11 and their reference as a paleoclimatic marker has been removed from the abstract and conclusion.

At Mochras the δ13Ccarb curve is really very different from the δ13Corg. This must be discussed in details. The δ13Ccarb shows a huge excursion in the oxynotum zone, which is not present in the δ13Corg curve.

Difference between δ13Ccarb and δ13Corg curves seems to be related to the impact of diagenesis on carbonates. The δ13Ccarb negative excursion of the oxynotum zone is likely the result of early diagenetic processes in this depleted carbonate interval (e.g. Ader & Javoy 1998). The δ13Corg is probably more reliable as an environmental proxy since a similar evolution is recorded in several sedimentary basins as shown by a newly added figure (Fig. 10) of correlation that show a consistent δ13Corg signal between UK and French basins .

The correlation between Mochras and Montcornet based on δ13Corg curves is not convincing, since very are too many hiatuses. The authors must also explain why the δ13Corg values are more negative in the raricostatum zone of the Mochras core (down to -28) compared with coeval Montcornet values (-26). This maybe due to a difference in organic matter origin (see Schoellhorn et al, 2020 or Suan et al, 2015).

Yes we totally agree on the role of hiatuses in the Montcornet borehole (oxynatum Zone and the upper part of the raricostatum Zone – aplanatum subzone). The new figure of correlation (fig. 10) highlights the role of these hiatuses. Taking into account these hiatuses we can see that the isotopic are similar between UK and France. New data from Storm et al. (2020) indicates a potential shift in organic matter origin that may exacerbate SPBE. This point is discussed now in the MS

In addition, the authors may try to correlate their 13Corg curve with the one published by Peti et al, 2016, which appears to show a different trend. I suggest also to examine the δ13Corg published by Schoellhorn et al, 2020 (Dorset section), which shows several shifts in the upper Sinemurian, which can’t be found neither at Mochras nor

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at Montcornet. Note also that Schoellhorn et al (2020,) found a negative shift in both δ13Ccarb and δ13Corg curves in the obtusum zone, confirming that the isotopic data from both Mochras and Montcornet cores are quite suspicious and can't really used for correlation. It would be good to try to correlate these isotopic records together.

It was done with the new figure 10.

Clay minerals

This is the most interesting part of this MS. The alternation of humid and semi-arid periods during the Late Sinemurian at Mochras is very convincing and their paleoclimatic interpretation is correct. However, it is not the case at Montcornet, where these cycles are not present. Contrary to Mochras, the kaolinite is not showing significant variations (20-30%). Since there is almost no smectite at Montcornet, I understand that the authors can't provide a SM/K ratio for that core, but they could have shown the K/I ratio, which exhibits at Mochras nice cycles showing that illite and potentially chlorite are not coupled with kaolinite, which may have originated from coeval paleosoils weathering. A different trend seems to characterize the clays distribution at Montcornet, where kaolinite, illite and chlorite shows the same trend (a simple statistic multivariate approach would be very helpful).

Yes we agree.

I am therefore not convinced that the two cores can be correlated based on clay minerals.

Yes we agree, the two boreholes cannot be correlated using clay minerals as sources are likely different.

At line 405, the authors underline the good correlation with the most prominent kaolinite increase with increased Sr ratio in the obtusum-oxynotum zones. Interestingly, this interval corresponds to very high CIA values (Schöllhorn et al,2020).

Line 408, the relationship between CIA highlighted by Schöllhorn et al. (2020) and the increase in kaolinite was added.

The absence of smectite is difficult to understand and must be better explained. At line 465, the authors wrote that the different clay minerals trends may be due to the fact that Montcornet was located in a more distal location than Mochras. If it is the case, I would expect more smectite and it is really not the case. The authors linked the high amounts of smectite with sea-level low and the erosion of London-Brabant Massif. This is rather unlikely, since high smectite contents are generaly linked with high sea-level (e.g. Godet et al, 2008, Ruffel et al, 2002, Gibbs et al, 1977). Moreover, sea-level lows are characterized by a mix of clay minerals such as illite, chlorite, kaolinite..etc (Deckoninck, 1985).

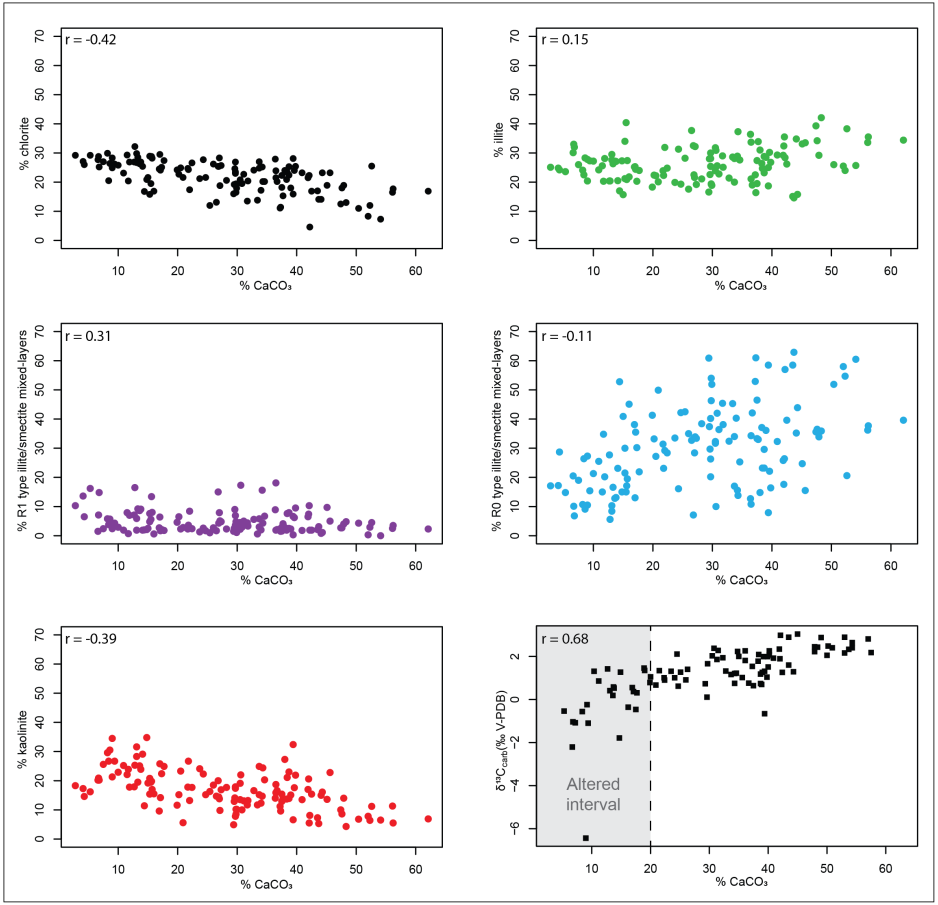
We do not agree with this comment. It is true that usually the proportions of smectites are more important during periods of high sea level (e.g. Deconinck and Chamley, 1995), partly due to the differential sedimentation of clays, but on the border of the London-Brabant massif, the situation is particular. In reality, in the Jurassic (but also in the Cretaceous), this very flattened massif was very often submerged (contrary to what is indicated on most paleogeographic maps) and consequently, the clay sedimentation on its borders was the result of more distant contributions. However, during periods of low sea level, this massif had emerged and smectite pedogenesis could develop. It is clear that this massif constitutes the source of smectite. This very particular situation was highlighted in the Kimmeridgian and the Tithonian of the North-West of the Paris Basin (Boulonnais) where the lower offshore facies are rich in illite and kaolinite and devoid of smectite, while the shoreface facies are rich in smectite (see e.g., Hesselbo et al 2009). This situation is identical in the Callovian/Oxfordian on the Ardennes border (Pellenard & Deconinck, 2006) as well as in the Pliensbachien (Bougeault et al., 2017), a publication in which we explain this singularity in detail.

I suggest that the authors try to correlate their clay minerals data with the ones published by Schöllhorn et al (2020) in the Dorset. The upper Sinemurian (even if more condensed) is characterized by similar K/I and Sm/K cycles confirming that these cycles can be globally correlated and represent true paleoclimatic (semi-arid-humid) changes.

Yes, we agree, but the very different resolution of Iris Schollhorn's study makes the comparison quite difficult. However, we added a sentence in the text indicating that the results presented in Schollhorn et al 2020 are quite comparable with ours.

Please also note the supplement to this comment:
https://cp.copernicus.org/preprints/cp-2020-99/cp-2020-99-AC2-supplement.pdf

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2020-99, 2020.



r = -0.42
% chlorite
% CaCO₃
r = 0.15
% illite
% CaCO₃
r = 0.31
% R1 type illite/smectite mixed-layers
% CaCO₃
r = -0.11
% R0 type illite/smectite mixed-layers
% CaCO₃
r = -0.39
% kaolinite
% CaCO₃
r = 0.68
δ¹³Ccarb(‰ V-PDB)
Altered interval
% CaCO₃

Fig. 1.

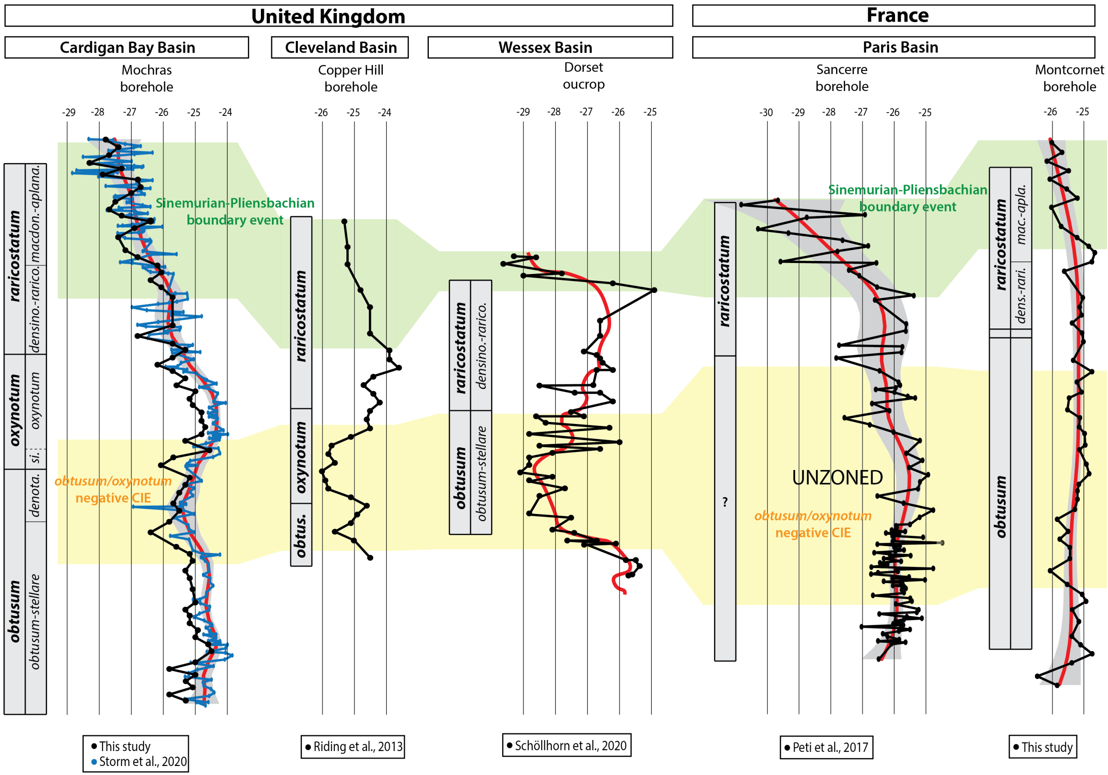


Fig. 2.

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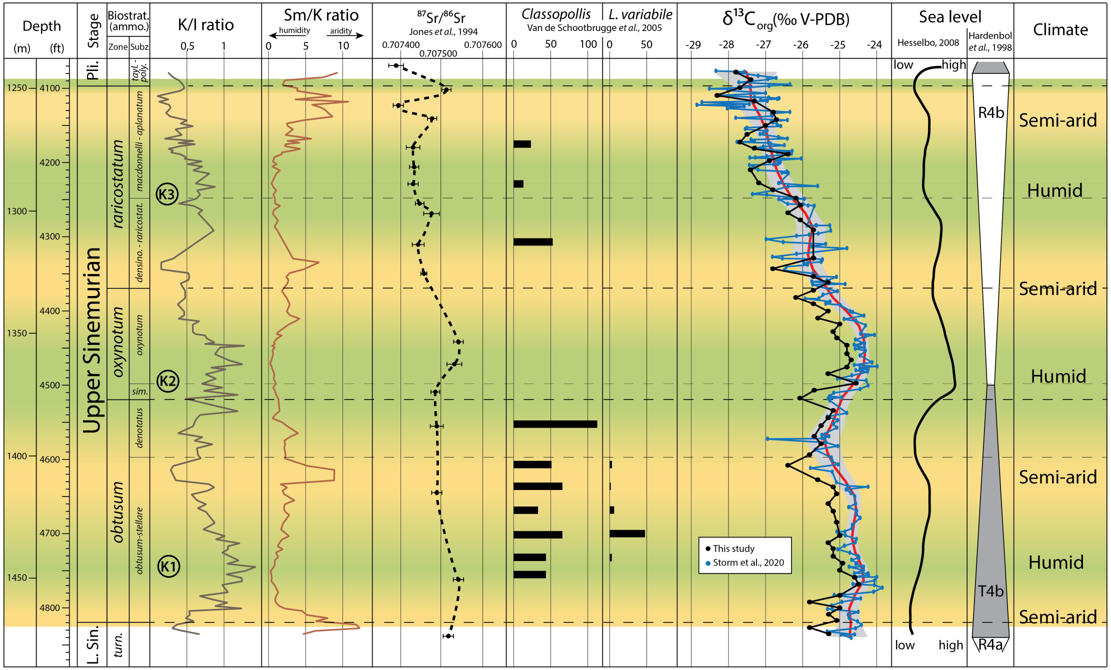
Depth
(m) (ft)
Stage
Biostrat. (ammo.)
Zone Subz
K/I ratio
Sm/K ratio
humidity aridity
87Sr/86Sr
Jones et al., 1994
Classopollis
Van de Schootbrugge et al., 2005
L. variabile
δ13Corg(‰ V-PDB)
Sea level
Hesselbo, 2008
Hardenbol et al., 1998
Climate
Upper Sinemurian
L. Sin.
Pli.
raricostatum
oxynotum
obtusum
macdonnelli - aplanatum
densino. - raricostat.
denotatus
obtusum-stellare
K1
K2
K3
This study
Storm et al., 2020
low
high
R4b
T4b
R4a
Semi-arid
Humid
Semi-arid
Humid
Semi-arid
Humid
Semi-arid

Fig. 3.