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Interactive comment on "Stable isotope compositions of a late Jurassic ammonite shell: a record of seasonal surface water temperatures in the southern hemisphere?" *by* C. Lécuyer and H. Bucher

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Both reviewers consider that the filtering of oxygen isotope data for reconstructing seawater temperature seasonality is a matter of discussion and of various interpretations. We agree that the variations in carbon isotope ratios may be explained by various mechanisms (metabolic, food source etc.) which cannot be easily separated. Therefore we decided to compute two new sinusoidal curves by excluding: 1) In a first case, samples associated with the so-called "isotopic events" with low d13C values (samples G43 and 45 and samples G57 to G63) and samples from 0 to 30 mm according to Joachimski's comments (G75 to G89). This sample set was used to generate the sine wave function illustrated by a plain black curve in the new figure 3a. 2) In a second case, all samples with low negative d13C values (G43, G45 and G55 to G89) according to Joachimski's comment. This sample set was used to generate a second sine wave function illustrated by a dotted black curve in the new figure 3a. The quality of the fit, associated in both cases with the perfect statistical independence of the (normally distributed) residuals and the d18O predicted values, indicates that the fitted model accurately describes the available data. According to this refined statistical treatment of data, in legend of Figure 3 we now propose to mention the two lists of samples excluded to compute the two sinusoidal curves. As it can be observed, the new computed sinusoidal curves are not significantly different from each other and also from the previous one, thus leading to similar conclusions for the seasonal variations (frequency and amplitude) of seawater temperature.

We already emphasized that we had only access to two samples from the same sedimentary bed and that these samples record local or regional variations of seawater temperature, a point stressed in the introduction and conclusion of the revised version.

Comments by Joachimski and Price: Considering a potential diagenetic alteration of the studied samples, several strong arguments are in favour of an exceptional preservation of the mineralogy and isotopic compositions of shell carbonate. The combination of X-ray diffraction and SEM data of the ammonite shell reveals undoubtedly that the ultrastructure of the aragonite is preserved and is identical to a modern Nautilus sample (Figure 1). Moreover, Sr/Ca ratios are those of an original marine aragonite. It is noteworthy that in case of perturbation of isotopic ratios by aqueous fluids, oxygen isotope ratios are more disturbed than carbon isotope ratios, a pattern not observed here. Considering that the bivalve was found in the same sedimentary bed as the well-preserved ammonite shell, both samples were most likely buried and preserved in the same geological and chemical conditions, a hypothesis confirmed by the comparable oxygen isotope compositions they have recorded (Tables 1 and 2). As suggested by M.M. Joachimski, we propose to add the two references he indicated (Dauphin and

Denis, 1990; 1999) in the discussion.

G. Price raises the issue of counts of septa as proxy for biological age, taking Nautilus pompilius as an example. Data from aquarium reared N. pompilius (Ward, 1985) suggest that individual time series of chamber formation follow a rough exponential pattern. Despite the fact that the number of septa is constant within N. pompilius, the period of chamber formation for any particular chamber (e.g. chamber 30) varies widely among individual specimens (e.g. from 50 to 100 days for chamber 30), as stressed by Landman and Cochran (1987). Moreover, the average period of chamber formation in immature individuals is also species specific: 60-90 days for N. pompilius and 120-230 days for N. belausensis (Landman and Cochran,1987). Hence, using chamber counts as a proxy for biological age is surely not an appropriate approach and has long been dismissed by cephalopod workers. Turning now to ammonoids, it is also well known that septal spacing varies widely across variants belonging to a single species, in conjunction with the variability of the geometry of the shell tube (from compressed to depressed shapes, i.e. the so-called Buckman law of covariation). This make counts of ammonoid septa even more unsuitable for inferring growth rates or biological ages. To conclude about this point, we did not use septal counts because it would inevitably lead to wrong age estimates and did not even feel necessary to mention such an inappropriate approach.

The Astarte specimen we measured shows growth lines, and we are well aware of the many sclerochronological studies of recent and fossil bivalves. However, both the outer surface of the shell and the cross section of our specimen do not provide a clear and unambiguous ontogenetic sequence of growth line spacing. Some striae are well marked, some other are hardly distinguishable or may even coalesce with adjacent ones. It is thus impossible to obtain a reliable sequence of growth line spacing that would lend itself to growth rate analysis. Turning now to ammonoids, it is also well known that BOTH septal spacing AND THE NUMBER OF CHAMBERS vary widely across variants belonging to a single species, in conjunction with the variability of the geometry of the shell tube (from compressed to depressed shapes, i.e. the so-called Buckman law of covariation).

We agree with M. Joachimski to correct the presentation of the standard deviations in the section “sampling strategy and methods”.

According to G. Price, page 2, line 26: eiher must be replaced by either

We also propose on page 8, line 9 to replace sine wave function by cosine wave function.

We thank the reviewers for their comments, they helped us to improve this study. We also thank Dr. G. Escarguel for the statistical treatment of data.

Yours sincerely

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Legend of figure 3a:

Fig. 3. (a) Seasonal oxygen isotope variations recorded in the external shell growth layers of the Oxfordian ammonite Perisphinctes sp. The data have been fitted by least square approximations with a cosine wave function (18O={Aěcos([2ěpěLength/T]+P)}+S, where A is the amplitude, T the period, P the phase, and S a shifting constant) after removal of data corresponding to the two isotopic events (G43, G45 and G57 to G63) and the youngest studied part of the shell (G75 to G89) (solid curve: A=-0.283, T=227.1, P=0.749, S=-1.471; R2=0.75) as well as after removal of all data with negative d13C values (G43, G45 and G55 to G89) (dashed curve: A=-0.288, T=196.4, P=-0.202, S=-1.506; R2=0.79).

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