**Geoscientific
Model Development
Discussions**

Interactive comment on "

A nonlinear multi-proxy model based on manifold learning to reconstruct water temperature from high resolution trace element profiles in biogenic carbonates" *by* M. Bauwens et al.

Anonymous Referee #1

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The paper untitled " A nonlinear multi-1 proxy model based on manifold learning to reconstruct water temperature from high resolution trace element profiles in biogenic carbonates." from Maite Bauwens, Henrik Ohlsson, Kurt Barbé, Veerle Beelaerts, Frank Dehairs and Johan Schoukens deals with the mathematical treatment necessary to convert geochemical tracers into environmental parameters. This is of prime importance for all reconstructions based on biogenic material especially applied on recent

past requiring an accuracy better than that provided by empirical calibrations. The manuscript proposes one method well suited to non-linear systems. However, it could not be published without modifications. The data used in the paper are well suited to demonstrate that the reconstruction quality is improved by using a non-linear treatment of multi proxies. But there is great confusion between the origins of the non-linearity, the incorporation of the trace elements, the role of the physical fractionation. This is revealed along the paper by multiple aspects. It could be judicious to explain first what is a proxy and to examine the different steps making that a chemical measurement may be a relevant tracer. It is necessary to highlight how the non-linearity between the chemical measurement and the reconstructed parameter may be reflected. The reader needs to be prepared to the assumptions formulated in the conclusion, the possible role of the metabolism or/and growth rate.

In the introduction it is never mentioned that the chemical measurement, the indirect tracer, the "proxy" (in this case trace element) is derived from biogenic material, which seems to me the main reason of the non-linearity of the signal. The authors could refer to: Weiner S. and Dove P. M. (2003) An overview of biomineralization. Process and the problem of the vital effect. In Reviews in Minералogy and Geochemistry Volume 54 "Biomineralization" (eds. P. M. Dove, J. J. De Yoreo and S. Weiner). Mineralogical Society of America, pp. 1–29. For example: p3-line22, you could argue that the "vital effect" term which is often used when the chemical response is not understood, necessitates a multi-proxies model.

p4-line8 - The most often applied multi-proxies are the couple $\delta 18O$-Mg/Ca for the foraminifera and $\delta 18O$-Sr/Ca for the corals, which implies the addition of the errors of the empirical calibrations used for isotopes and trace elements.

p9-line3 – Salinity and kinetics are referred at the same level. It is not possible to compare salinity, an external forcing with kinetics, which is corresponding to the process of the mineral deposit. For example, temperature (an external forcing) may affect the proxy through kinetics. Incorporation of the trace elements or effects of growth rate are

occasionally mentioned but the physical and/or chemical fractionation is never taken into account.

About the choice of the multi proxy method well suited to non-linear system applied on the temperature reconstruction, it would be important to notice that temperature is the prominent factor acting on proxies, which determines the response to several tests.

p10 – It seems clear that there are three paragraphs: 1- comparison with multiple linear regression 2- evaluation of proxy combination 3- salinity robustness test why the proxy combination is mixed with the salinity test ?

p13-line23 -It is true that Mg/Ca has not been so far identified as a SST proxy for bivalves but this proxy is commonly used for foraminifera.

p14-line3 - I do not see an explanation justifying the link between a physiological "optimal" temperature and the shell growth. Is it also an "optimal" temperature for growth rate?

p15-line9 – Could you develop the linkage existing between Sr/Ca and Ba/Ca?

p15-line26 – Could you highlight the linkage existing between Pb/Ca and Ba/Ca, which could justify the assumption of a common parameter?

p16-line25 – Are you obliged to mention diagenesis which is another crucial question, but it does not add any new argument for the demonstration.

The figure 5 and 7 do not provide strait forward information.

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