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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 #2

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A generic problem in reconstructing the past climate is the "deconvolution" of temperature and salinity in the proxy records. Often investigators try to solve this problem by putting their hope in novel trace elements and novel analytical techniques. However, no single proxy for temperature, nor for salinity is found so far. Implicitly, investigators agree that such a hypothetical proxy should be related to temperature or salinity in a simple manner (read: linear). The novelty presented in this paper is that the track of

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simple one to one relations is left and is replaced by more complex nonlinear relations, where multiple proxies are used simultaneous to reconstruct temperature. The good news is that this approach is working. As such this study definitely deserves to be published.

One the other hand, I remain with some general questions and several more case specific questions and hope that the authors could provide more background about these topics.

General:

- Can you explain why many studies find linear relationships while other fail to find such linear systems?

- Can you compare qualitatively the manifold approach with the linear approach. What are the advantages and disadvantages of the manifold approach. Where will it fail?

- Why did you reconstruct only temperature and not for example salinity and temperature from the proxy records?

- Elaborate on how the trace elements where gathered or give the appropriate reference.

- Do you think that this method can easily be extrapolated to other species, like corals, etc... Can you use the manifold approach trained on mussels and apply them on corals? How good do they apply on e.g. mussels from different regions...

- Personally, I do not know statistical studies which are clearly able to explain physical or biological effects from a black box model. For that reason, I think that the interpretation in terms of kinetic effects is rather speculative. On the other hand, I am aware that most readers will probably be most interested in this interpretation, rather than in the statistics.

- systematic errors: I am wondering how powerful this manifold approach is. Is it

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possible that it is too powerful and can for example mimic systematic errors. If for example errors in the time base of the proxies are present or due to e.g. time averaging. Will the manifold method be able to incorporate such systematic errors? Do you see possibilities to avoid this?

- To explain anything, it is always better to model this by a more complex model. Non-linear models are usually more complex than linear ones. (How) does WDMR penalize for complexity?

Specific: p 1108, line 7: elaborate on this type of multiproxy model. E.g. dynamic effects are not taken into account; relation distance-time is assumed to be known.

p 1108, line 20: do you mean weighing by measurement uncertainty or by prior knowledge about the proxy (Mg is good, Sr less,...).

p 1110, line 14: what are the underlying assumptions of each of these methods and is it possible to relate these to the success of these methods to predict temperature?

p 1111, line 12: matching temperature and proxies by e.g. anchor point method implies that the investigator has already some idea about the relationship to be expected. I assume a linear relation was used here to construct a time base for the proxy. Does this "choice" for the time base influence further results? Are these nonlinear multiproxy models able to mimic systematic errors (systematic measurement errors, time base errors, time averaging errors, etc...)? Is it possible to solve the calibration problem (relating proxies to environmental parameters) without solving the time problem?

p 1112, line 14: second disadvantage is unclear.

p 1114, line 12: what do you mean with laser ablation crater. Leave this out or elaborate.

p 1114, line 17 (paragraph 3.2): what is the conclusion? Is it worth using NL models?

p 1114 (paragraph 3.3): provide more content. The aim is unclear.

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I think the readability is improved by reconstructing the text: put results immediately after the test. Now, you first describe the tests, where it is unclear what the outcome is and afterwards the results are discussed.

p 1115, line 4: change "4" to "four".

p 1116, line 23: improvement factor: how to read this: is this a number between -1 and 1, where 1 is good and -1 bad?

p 1117, line 8: a linear model is, generally spoken, a special case of a nonlinear one. So, by applying a model selection criterion, the optimal model complexity could be selected.

p 1118, line 6: elaborate, the conclusion is unclear.

p 1119, line 24: SST, use temperature, as is done in the rest of the manuscript.

p 1120, line 5: additive noise and model errors: is the WDMR not based on a least squares estimator, which implies additive noise?

Interactive comment on Geosci. Model Dev. Discuss., 3, 1105, 2010.