Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2017-72-AC2, 2017


Earth System Dynamics
Discussions

# *Interactive comment on* "Systematic Correlation Matrix Evaluation (SCoMaE) – A bottom-up, natural science-based approach to identify Indicators" *by* Nadine Mengis et al.

**Nadine Mengis et al.**

nadine.mengis@concordia.ca

Received and published: 16 November 2017

General Comments:

This paper introduces a bottom-up approach (SCoMaE) to select a climate indicator for certain climate related question, and illustrates that to answer the same question, climate indicator under different climate scenarios may be different, and common correlation matrix could be used to assess multi-scenarios question. This topic is suitable for the journal, but clarification and improvement are needed.

The paper used one example to demonstrate SCoMaE. However, the example is not



clearly described. What is the scientific question to answer? How are those variables selected? It might be better to include an experiment setting section instead of appendix, since all Figures are based on the model experiments.

Please clarify the meaning of 'correlation', as shown in Figure 1, the correlation is not simply correlation between two variables, but correlation of two variable correlations under different input parameter scenarios. It is misleading through the whole text when discussing 'correlation of variable A and variable B'. Please modify the whole result and discussion.

**Thank you for your constructive comments. We have added a section on the experimental design of our example and moved some of the appendix to the methods section. We hope this clarifies what exactly we are aiming in the example. Also we have added a definition of the term correlation to this section. What we are referring to is the correlation of changes in different variables induced by the parameter perturbations. Note, that if a parameter is causing higher global mean temperatures, the physical response in the model in turn is to reduce the sea ice extent. So there is a physical meaning behind these correlation between changes in variables. We have changed the text, wherever we talk about the example to be more explicit on which correlations we are referring to.**

Specific Comments:

Page 2, Line 14: a comprehensive assessment of what?

**As now more clearly stated in the new Section 2 (page 3) later on, we are here referring to an assessment of the sensitivity of changes in the climate system. We added that also in the text at this position, although here it is still a general point not referring to the example case. "Which ones should we select for a fully comprehensive assessment of changes in the climate system, ideally, without providing redundant information?" (page 2, lines 16-17)**

Page 2, last paragraph: Although there are more details on this topic on Page 3, line 12-21, it is not clear here whether the authors mean to use all variables from output of an Earth System Model or only certain selected variables? If variables are selected, how to select the variables regarding to certain scientific question? In addition, how about output of different time frequencies? Page 3, Line 2: What are those selected indicators presenting in this paper? What is the question to answer here?

**As discusses in Section 3.1.2 "Limitations of the analysis from the example", we are here not considering any temporal correlations apart from total changes between two points in time. This is clearly a limitation, but considering the low internal variability in the model, temporal correlations would have been unproportionally overestimated. Looking at different time frequencies would, for other experiments, be a very interesting question, we elaborate on this now in the new Section 2 (page 3). We explain the variable selection as follows: "In our example we applied the SCoMaE method to the correlation matrix concerning 46 commonly used variables for the assessment of climatic changes in the historical forcing scenario as simulated by the UVic ESCM". (page 9, lines 16-17)**

Page 3, Line 16-21: This method is bottom-up, but the selection of variables is still expert judgment, as well as how to process the variable (e.g. monthly average or seasonal average?). And as the author mentioned “The selection...is very important for the outcome of the study”. Please comment more on this.

**Thank you for pointing this out again. Yes, the preselection as well as the processing of the variables still requires expert knowledge about the possibly relevant processes and time scales that might be important to answer the research question. To strengthen this point we added a sentence. We hope that we have also made this point clearer by adding section 2. "Note, that for this preselection of the possibly relevant variables to answer the given question, as well as for the construction of the correlation information in the matrix, a certain level of expert judgement is needed." (page 7, lines 27-28)**



Page 3, line 23-32: Please clarify the example question here, if it is “the correlation between global mean ‘surface air temperature’ (A_sat) and ‘northern hemisphere sea ice area’ (O_iceareaN)”, then the correlation should be between time series of A_sat and O_iceareaN. If it is “the correlation between model output variables, given their reaction to varying model input parameters”, then should compare correlations between time series of A_sat and O_iceareaN under different scenarios (different input parameters).

**Sorry for the confusion, we hope to have addressed these issues in the new section 2, that we added following your suggestions.**

Page 3, Line 30: should mention Appendix A before Appendix B. Otherwise switch the order of A and B.

**In the original manuscript, Appendix A was called at page 3 line 4, and appendix B at the same page line 30. However, this changed, since we moved the appendix to the section 2. We have made sure that during the revision process the Appendices appear chronologically.**

Page 4, Figure 1: please don’t overlap the labels, as well as in other Figures.

**Sorry for the subpar figure. We have changed the figure accordingly.**

Page 5, line 1: what does the ‘negative correlation’ indicate to? If it indicates to the locations of all crosses in the top right panel in Figure 1 (positive SAT change associated with negative sea ice change), it is correct. If it indicates ‘-0.955’, the negative correlation of correlations in different input scenarios, it is wrong.

**The location of the crosses in Figure 1, do give us a -0.955 correlation between the positive SAT change associated with negative sea ice change. So the negative correlation we mention here does refer to the correlation between changes in the two variables. We attempted to make this more clear in section 2.**

Page 5, Line 5: Figure 3 should show after Figure 2. Or change the order of figures.

**We removed this figure reference. The order of the figures are following the logical order of the method and should now be correct.**

Page 5, Line 21: precipitation over ocean areas is the first indicator of what?

**The new section explaining the set up for the example hopefully clarifies this, but we also added text here. "We find that the first indicator for our research question in the historical period is precipitation over ocean areas (F_precipO)" (page 10, lines 10-11).**

Page 5, Line 20-30: Do Figure 2 and Figure 3 also use the same way to calculate correlation as in Figure 1 (r=-0.955)? If so, then those correlations are not correlations between variables, but the correlations of correlations under different input scenarios. If Figure 3 is showing the correlations between variables, I strongly doubt that A_sat (global surface temperature) and F_uplwr (surface upwelling longwave radiation) show no correlation. It is impossible, higher surface temperature results stronger surface upwelling longwave radiation according to black body radiation. If Figure 3 is showing correlations among different input scenarios, it makes sense, as in all input parameter scenarios, black body radiation should be the same. In that way, please change the way of description through the whole text: the colorbar is not indicating the correlations of variables.

**Sorry for the confusion, we have improved figure 1, hoping to make more clear, which information is taken to construct the correlation matrix in the example. We have also corrected the phrasing of the correlation information throughout the text. On Page 5, lines 20-23 in the original text we just wanted to point out, that the output variable surface net upwelling long wave radiation in our model is influenced not only by the global mean surface air temperature, but also by processes like evaporative cooling. These two processes are in turn influenced differently by our chosen parameter perturbations than global mean temperature. Therefore we find a significant correlation e.g. between changes in net upward**



**long wave radiation (F_uplwr) and changes in evaporation over land (F_evapL), but not to changes in temperature. A fact that we learned about during these analysis, and which we might have overlooked, if we had assumed a perfect correlation between those two variables. This is exactly the kind of learning process the correlation matrix analysis enables.**

Figure 2: not clear how many model output variables are tested until Figure 3. Instead of "clustered variables", it might be better to list all variable names. How are those variables selected to answer the question of what is "the correlation between global mean 'surface air temperature' (A_sat) and 'northern hemisphere sea ice area"? Or other questions? Please clarify.

**The correlation between the A_sat and O_iceareaN, is supposed to be one example to explain how the correlations in the matrix have been calculated in this exemplary case study. We edited Figures 1 and 2 to make it more clear.**

Why Figure S5-S10 are after reference and tables?

**Thank you for pointing this out. We changed this.**

Figure 3: need to explain all the variables.

**This is done in the text, whenever we actually refer to the variables, apart from that we provided a table in the appendix and point to it in the figure label.** âĂĺ
Page 8, 2.3: please clarify the meaning of correlation first, if the correlation is based on different input parameter scenarios, then the text needs to be modified.

**Yes, we have edited the text, defining the correlation more clearly. See also the new section 2 and the edited Figure 1 for more details on the correlations.**

Page 13, Line 27: RCP4.5 and RCP8.5 has more CO2 emission than historical scenarios and higher sea temperature will contain less CO2 gas in the ocean. Therefore according to Henry's Law, larger CO2 gradient over the atmosphere and the ocean will enhance the air to sea carbon flux. In addition, under RCP4.5 and RCP8.5, soil

respiration enhanced also due to higher temperature.

**Yes, these two physical processes are acting here, we added a statement on this to the text. But the fact that the correlation between changes in the variables is changing sign between the two regarded time periods is linked to the imposed parameter perturbations, as stated in the text.**

Page 14, 3.1.2: The method assumed that two time periods have the same climate sensitivity regarding to the input parameter change. But it is not true. For example, CO2 fertilization effect is different under different temperatures. In addition, how to select the variables for analysis will make a big difference in the result.

**The parameter perturbations are now described in the section 2.3, and not novel, since we applied previously used parameter perturbations that have been studied for this model. The preselection of the variables for our example is also explained now. "In our example, we applied the SCoMaE method to the correlation matrix concerning 46 commonly used variables for the assessment of climatic changes in the historical forcing scenario, simulated by the UVic ESCM (See Section 2.1 for details on the simulations)." (page 10, lines 12-13).**

Please also note the supplement to this comment:
https://www.earth-syst-dynam-discuss.net/esd-2017-72/esd-2017-72-AC2-supplement.pdf

---

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2017-72, 2017.