Earth System
Dynamics
Discussions

Interactive comment on "A mathematical approach to understanding emergent constraints" by Femke J. M. M. Nijsse and Henk A. Dijkstra

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We thank the referee for the careful reading and the useful comments and will adapt the manuscript accordingly. Below is a point by point reply with the referee's comments first, followed by our reply and the changes in manuscript.

1. Comment of the referee: This manuscript is dealing with the problem of the understanding of emergent constraints in projections based on climate models. The main idea is to develop a mathematical framework based on the linear response theory. The approach is applied in the context of several models of increasing complexity. A classification of emergent constraints is also proposed. This is a very interesting approach to the problem that is worth publishing. The organization of the manuscript is however

confusing to me. Section 2 is mixing the general development of the approach and the application to an Ornstein-Uhlenbeck process. It is therefore difficult to figure out what is general or not. I would suggest the authors to reorganize this section 2 (and also section 3), by first presenting the general framework based on Response theory and then the specific application to the O-U C1 ESDD Interactive comment Printer-friendly version Discussion paper process, maybe by putting a section 2.1 and a second section 2.2 (or by rearranging section 2 and 3 together).

Author's response: We will follow the suggestion of the referee to clarify better what is general and what applies to the OU case and reorganize the paper accordingly.

Changes in the text: The sections 2 and 3 will be reorganized to better separate the general and specific cases.

2. Comment of the referee: Page 1, Line 14, remove "variable"

Author's response: Suggestion followed.

Changes in the text: 'variable' will be removed.

3. Comment of the referee: Page 3, Line 12. O=x. Is it really a mean value?

Author's response: It was meant to indicate the identity operation.

Changes in the text: We will mention this now in words in the revised text.

4. Comment of the referee: Page 4, Eq 2.12-2.13. The way to compute the g_l and h_l should be explained.

Author's response: Suggestion followed.

Changes in the text: A reference to the appendix will be added. The appendix will contain the explicit computation of g_l and h_l.

5. Comment of the referee: Page 5, Eq 3.1. Is it only valid for O-U process? This point is related to the general comment above. What is general and what is specific to the

O-U process? This should be clarified.

Author's response: This is valid in general.

Changes in the text: In the revised paper this will be made clear by restructuring the material as mentioned under comment 1 above.

6. Comment of the referee: Page 6. Same as the previous point for Eq 3.4 and 3.5

Author's response: These results are also general.

Changes in the text: In the revised paper this will be made clear by restructuring the material as mentioned under comment 1 above.

7. Comment of the referee: Page 6, line 29. Remove "the".

Author's response: Suggestion followed.

Changes in the text: 'the' will be removed.

8. Comment of the referee: Page 8, Eq. 4.3. References to these type of models are needed. You can go back to the pioneers on that topic.

Author's response: Suggestion followed.

Changes in the text: Several references will be added, e.g., Budyko (1969), Sellers (1969), Fraedrich (1979) and Satura (1981) .

9. Comment of the referee: Page 9. Eq. 4.6, one omega_2 should be omega_1, I guess.

Author's response: Thanks.

Changes in the text: The equation (4.6) will be corrected.

10. Comment of the referee: Page 9. Eq 4.8. Is this model presented elsewhere? References are needed.

Author's response: No, as far as we know this is the first time such a formulation has been used.

Changes in the text: None.

11. Comment of the referee: Page 10. Line 12. What means "a 50-year spin-up was used"? Before the 20th and 21th centuries?

Author's response: A spin-up was used before the 20th century, so from 1850-1900. This will be clarified in the revised text.