ESD-2020-3: Editor Decision

June 10th, 2020

Dear Authors,

Following a fertile interaction discussion where pertinent concerns were raised and careful and concrete responses were put forward, the natural consequence most beneficial to the manuscript and to the audience that it addresses is clearly the diligent and thorough revision that already began to emerge from the discussions.

At this stage, additionally to all the relevant issues raised and debated in the interactive discussion stage, which are well motivated and discussed, I simply add a few supporting reflections are hereby shared in support and wrapping of the recent discussion.

It has become progressively clearer over the last two decades (even long before the studies from recent months) that uncertainties are consistently and vastly underestimated in earth system models (even beyond the scope of land surface processes) and that confidence runs excessively high in modelling efforts - both in forward and inverse modelling to be more precise.

There is a significant body of literature on the dynamics of model errors and uncertainty propagation in physics and in the geophysical sciences (for the sake of neutrality and to avoid expressing any preference, I will not give examples, but these can be found in geophysical and physical journals).

However, the relative disconnection between the communities most active in uncertainty modelling and those in more practical operational modelling has kept the latter mostly unaware of the most advanced developments in the dynamics of prediction errors and in uncertainty modelling at large.

Contributing to model errors are various factors ranging from formulations, parameterisations, initialisation, assimilation and calibration procedures, the narrow set of uncertainty propagation mechanisms (model structures are overly simplified and uncertainty propagation is often tied to such, so typically model errors are under-dispersive). The formulation of how such errors interact and propagate across the system is also found in the literature and actually provide helpful insights that assist in adjusting and improving model structures and data collection to cope with such problems.

As far as the present manuscript is concerned, it is still possible to preserve its scope wherever possible despite all of the above. While it is indeed important to make the inherent caveats of any modelling endeavour to the readers, it is also important to elicit the importance of such modelling investigations. Models will also be imperfect as they only capture a subset - if at all - of the system under analysis.

Using an inherently limited formulation that takes certain aspects of the dynamics into consideration has valid inspective and analytical merits that, even in an approximate or hypothetical setting, still contribute to formulate better hypothesis about key aspects in the system behaviour.

If we think of the ingenious stylised yet over-simplified model for convection that Lorenz put forward in the famous deterministic non-periodic flow paper in 1963 that is cited in endless papers about nonlinear dynamics in general and chaotic flows in particular, that model, albeit being admittedly physically unrealistic for its original intended purposes, was a genial system dynamic laboratory in itself. This is what models actually are: numerical laboratories, which provide important insights but at their core they do not need to be perfect if they are transparently taken for what they actually are.

Once the cards are clearly laid out on the table, and the scientific procedure is clearly explained for what it does represent and what it does not, for its merits and limitations, a scientific publication can still stand and be useful for the community.

This way, while recent developments cannot be ignored, the narrative of the manuscript can be aptly adjusted - especially with further analysis as suggested and within feasibility constraints - to incorporate such findings without entirely compromising the overall message. A message that indeed becomes more tentative and reflective of a modelling exercise to guide system interpretation and ignite scientific discussion rather than a factual proof of system behaviour.

All in all, it is crucial that the revised manuscript makes the workflow and results clear to the readers in a way that makes them understand that the study does not aim to state absolute facts but rather advance science by shedding new insights over relevant subsystem interactions in the earth system and especially on an area that really benefits from such studies given the scarcity of hard evidence to support stronger claims.

The authors are therefore encouraged to proceed with the intended revisions taking into careful consideration the concerns raised during the discussion stage, with the author responses already providing good promise in the right direction.

Thank you for your attention and best wishes.

Rui Perdigão

(ESD Editor)