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Geoscientific Model Development Discussions

Interactive comment on "On the Effect of Model Parameters on Forecast Objects" *by* Caren Marzban et al.

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Dear Reviewer 2,

Thank you for your review. Below, please find your original comments (denoted with a ">") and our responses.

> However, it is not clear that this approach is significantly different from established sensitivity analysis methods. The SA practitioner has to select a "response variable" which is typically a statistic based upon a subset of the full model output. Here, the authors use different cluster analysis approaches to define that subset and various statistics to summarize the model output from that subset. They do not argue for any specific cluster analysis method or statistic, and mention that clusters identified sub-

jectively could also be used. This sounds like traditional SA using subjectively selected subsets of model output, therefore, it is not clear that this is a novel/new approach.

The proposed object-based SA is a great deal more than a simple application of traditional SA to a clustered field. In attempting to perform an object-based SA, the SA practitioner will be faced with numerous technical problems whose solutions form the foundation of our proposed methodology. To make that point more clear, we propose to include some version of the following discussion in the paper. It highlights the methodology's novel ingredients, the accompanying problems, and our solutions to them.

1) Clustering, as a method for objectively identifying the objects of interest, is a relatively obvious approach. However, it is important for the SA practitioner to be aware that there are at least two distinct ways in which objects can be defined in clustering algorithms, based on a) the number of clusters, and b) the size and distance between clusters. GMM and DBSCAN are the two methods that we have chosen to represent those two approaches.

2) Selecting features of the objects, too, may seem straightforward. However, it is not at all obvious that the features can be derived from the covariance matrix. In fact, our initial attempt involved "fitting" closed curves to the objects, a task which is considerably more complicated. In the covariance-based feature selection approach, although we extracted only the simplest of features, there exists a large body of literature which can be of great utility to an SA practitioner.

3) Assessing the distribution of each feature presents a more complete picture of the underlying sensitivities than point estimates. The use of multivariate regression (with multiple responses) is a novel (and non-obvious) solution to the problem of summarizing that distribution.

4) In a statistical approach to SA, it is important to display both the strength and the statistical significance of the sensitivities. A p-value measures only the latter. The use of boxplots, and the accompanying interpretation we provide, effectively accomplishes

both tasks (with some trade-offs, of course).

Once again, it is true that each of these ingredients, and even the very notion of an object-based SA, could be (re-)discovered by an SA practitioner; what we have described in our paper is the lessons that we have learned from tackling that problem. We believe all of these lessons will be useful for the GMD readership.

> Since the results in this manuscript were found to be consistent with previous sensitivity analysis work (Marzban et al. 2014) that did not use objects, it is also not clear that there are significant benefits to using the object-based approach described here.

It is true that our proposed method, when *specialized* to a "non-object" (e.g. the mean of a field), reproduces results that are consistent with traditional SA results. However, none of our object-based results can be obtained without the object-based SA. In other words, the object-based approach allows one to address questions that a non-object-based approach cannot.

> This leads the reader to question the value of going through the extra effort of object segmentation for sensitivity analysis versus traditional SA approaches.

The reference to "extra effort" suggests that the reviewer may have in mind a situation where the user has an option of choosing between an object-based SA and a non-object-based one. In reality, there is no such option; if the problem at hand calls for SA of object features, then the object-based approach is the only choice; and the "extra effort" is not extra, but necessary.

> It is also not clear if this method has general relevance to the geo-scientific model development community beyond the weather/precipitation prediction application presented here. What other kinds of "objects" could be analyzed in other types of models?

"Objects" are ubiquitous in Earth Systems. In addition to the meteorology example discussed in the paper, objects arise in models of the ocean (warm/cold eddies, convective plumes, oil spills, ocean garbage transport), volcanic plumes, planet interior,

sea ice, vegetation growth, forest fires, and more.

> I cannot recommend acceptance for publication unless the authors provide a convincing argument for the novelty of the method and provide evidence of the benefits of performing sensitivity analysis on objects in model output.

We hope to have presented sufficient arguments to change the reviewer's opinion.

Thank you, Authors.

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