# *Interactive comment on* "Global partitioning of runoff generation mechanisms using remote sensing data" *by* Joseph T. D. Lucey et al.

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Received and published: 17 December 2019

We thank the reviewer for their comments and wish to address each of them in detail. The reviewer has raised some valid concerns, from the perspective of improving the articulation of the motivation and approach in our work. However, there is some fundamental misunderstanding in this review that needs to be addressed in detail.

We see the reviewer's comments are distributed across three major contextual points. First, the reviewer appears to assume that the motivation of this study was to develop a sort of operational predictive tool, for which data latency would be a critical issue and for which the spatial scale of the study may be limiting. In fact, that assumption is erroneous; this study was never focused on addressing an operational need at all. It is

instead a scientific study of processes critical to better understanding global and large scale hydrology. The purpose of our work was to explore and characterize surface inundation developments with precipitation and water storage for the first time using NASA remote sensing data products. To our knowledge, this was a first attempt at considering two contributors in surface inundation generation and attempting to understand "which process dominates inundation, and where." These insights could be useful to hydrologists and global land surface modelers, but are not intended to be used for operational forecasting.

We would like to take specific note of the reviewer's comment, "Why do we need your model in the first place?", which we honestly find a bit shortsighted. To clarify, we are not proposing an operational "model" here at all; we are conducting a study of processes and their spatial distribution globally. As scientists, we perform studies to better understand the mechanisms and processes that cause the phenomena we observe. Then we assemble these studies into a manuscript and publish it to advance the community knowledge of that phenomena. That is "why we need" this study, and why we need science in general. The question of "why do we need your model in the first place" presents a bit of a ridiculous perspective.

Towards the exploration of observed surface water generation, we apply a regression model framework to better understand mechanisms, but the model itself is not a product or an outcome. It is simply a tool to address the mapping of dominant processes. This difference in motivation is important in understanding the paper we believe and it seems the reviewer has missed that point with this question.

We have modified the manuscript to make this point more clear, so that there is no confusion between a scientific process study and an operational development study. Though we had never mentioned an operational motivation for this work, we have now removed all text that may have implied an operational need, and changed the lines listed below to now read as follows:

- From "prediction" to "estimation" (Line 15).

- "We approach these goals through the application of a simple linear regression model of inundation based on remote sensing observations" (Line 58).

- From "predict surface inundation" to "represent surface inundation" (Line 89).

- "To further capture the long-term variability across the globe, we utilized each dataset's climatology" (Line 95).

- From "developed model" to "regressions" (Line 103).

- "With the final model, historical GRACE and GPCP measurements are used to estimate surface inundation (referred to as modeled surface inundation)" (Lines 120).

- From "predicts" to "estimates" (Line 279).

Second, it seems that the reviewer was concerned with the coarse scale of the study, but also simultaneously concerned that topographic heterogeneity will drive inundation patterns at fine scales. These comments can be read as inconsistent but hopefully, we can clarify our approach. For this study, we imagine a global land surface model, typically run at 1 degree globally (or at best, 0.25 degrees globally), for which topographic processes are represented empirically, and in which surface water formation follows Beven and Kirkby's 'topmodel' formulation. In this, topography and topographic heterogeneity are represented statistically, and there are truly still aggregated (or "lumped') runoff generation processes that occur at coarse resolution. At those scales, the topography is never explicitly represented, but instead, is represented implicitly as a grid-cell level characteristic that can influence lumped runoff generation. Here we have taken the same conceptual approach, for which we examine the aggregated runoff generation across the entire 0.25-degree grid cell, and those results can be associated with topographic information but without an explicit representation of topography in the regression. This is a simple and valid approach that is observation-focused, to later diagnose processes and mechanisms statistically.

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To clarify this fact for readers of the study, we have added text to this effect, between lines 54 and 55 in the manuscript.

Third, it seems that the reviewer is not convinced of the orthogonality of precipitation and terrestrial water storage anomaly time series. In fact, as the reviewer has highlighted and as explained in Humphrey et al., 2016, and many, many excellent papers before that one, there is approximately a 3-month time lag between precipitation (a flux), and storage (a state), on average globally. This time lag between the rate and the state does, in fact, create orthogonality between the two-time series, similar to the orthogonality between a sine and a cosine wave. Leveraging this orthogonality is what allows us to apply a multiple regression and disaggregate the effects of these two processes. That is the entire premise of the approach, so we empathize that having misunderstood this fact, the reviewer would be confused by our methodology.

To make this point more clearly, we have added text in the method section on the orthogonality of precipitation and storage time series (at the end of line 89):

"Precipitation and water storage long-term anomalies, a component of the total signal, are known to be globally correlated with a known lag (Humphrey et al., 2016). We utilize full signal in the regressions to ensure levels of orthogonality between precipitation and water storage that avoid collinearity."

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