Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-695-AC2, 2017

Hydrology and Earth System Sciences Discussions

Open Access

EGU

Interactive comment on "Scaling, Similarity, and the Fourth Paradigm for Hydrology" *by* Christa D. Peters-Lidard et al.

Christa D. Peters-Lidard et al.

christa.peters@nasa.gov

Received and published: 5 May 2017

Please find below the comments of S. Mylevaganam and our replies (preceded by "»").

In hydrologic science, a system is associated to a set of processes by admitting the fact that there exists no universal law that can identify all the processes associated with a system. Keeping this in mind, these processes are translated into governing equations to formulate a model that can help to resolve a problem of interest. Unfortunately, the inputs data to these models do not come at the same resolution (i.e., physical and temporal dimension). Therefore there exists a need to scale the inputs data to a common resolution that is best suited for the model and its discretization. Moreover, some of the inputs data may not be readily available. This leads to derive these inputs data by relating the characteristics of the system of interest to another system.

Printer-friendly version

Discussion paper

Though the growth of hydrologic science, from empiricism (1st paradigm), to theory (2nd paradigm), to computational simulation (3rd paradigm) has yielded important advances in understanding and predictive capabilities in hydrologic science, scaling (i.e., transfer of information across scales) and similarity (i.e., relating characteristics of one system to another system) remain one of the most challenging problems in hydrologic sciences. However, as underscored in the literature, there has been a dramatic increase in the type and density of hydrologic information that is becoming available at multiple scales, from point- to meso-scale and regional to global. Therefore, in this paper, the authors assert that it is time for the hydrologic sciences community to embrace the 4th paradigm of data-intensive science for a data-driven hypothesis testing framework for scaling and similarity. Based on this review, the following comments are made: 1) The authors assert that it is time for hydrology to embrace a fourth paradigm of data-intensive science. In this paper, the authors too could have used some data to demonstrate the fourth paradigm of data-intensive science.

» In this paper, we cite the Nearing et al., work as the primary example.

2) In this paper, the authors should clearly state the difference between “concepts” and “hypotheses”.

» Here they are used interchangeably, although to be precise a concept would need to be re-stated as a testable hypothesis in order to apply the scientific method.

3) As per the authors, the advances in data-intensive hydrologic science have laid the foundation for a data-driven hypothesis testing framework for scaling and similarity. For hydrologic sciences community, the concept of hypothesis testing is not new. This concept has been floating and researched for many years. Therefore, the authors need to elaborate more on hypothesis testing that are relevant for the purpose that is outlined in this paper. The paper should also mention the criteria used in a data-driven hypothesis testing framework.

» Yes it is true that hypothesis testing is not new, and has been practiced in hydrology for many years. The new aspect promoted in this paper is that we need to seamlessly integrate computational methods and data into our scientific methodologies and processes. The point being that we have not adequately exploited the “vast troves of data” in testing existing theories and models. We hope this is clarified in the revised version.

4) Though the authors assert that it is time to embrace the 4th paradigm of data-intensive science, it is hard to understand the actual reasons that have motivated the authors to call upon the hydrologic sciences community to develop a focused effort towards adopting the fourth paradigm of data-intensive science. The authors’ assertion gives an indication that, until now, the hydrologic sciences community is reluctant to use the existing data. If this is the case, instead of asking for a paradigm shift, it would be more appropriate to find out the reasons that harbor the hydrologic sciences community from using the existing data.

» The key point that we would like to emphasize is that hydrologists have been focused primarily on integrated, external characteristics of catchments, such as streamflow, while the advent of higher-resolution remote sensing and other technologies now enables the routine observation of internal dynamics in catchments (soil moisture patterns, evapotranspiration, snowpack, etc.), so that we can now simultaneously test the validity of existing scaling concepts. These scaling concepts or hypotheses were typically developed and tested over only a few catchments, owing to limited data availability. Hence, the 4th paradigm will enable the exploitation of this rich array of hydrological variables. There have been several attempts at comparative hydrology across multiple catchments (e.g., Coopersmith et al., 2012; Berghuijs et al., 2014), but these are typically limited to “macroscale” signatures such as aridity index, runoff ratio, flow-duration curve, etc., rather than examining the internal dynamics and scaling in these watersheds.

5) From the reader’s point of view, the problem of scaling and similarity is always going to be there in hydrologic science. The problem of scaling and similarity needs to be addressed when the data is acquired. From the reader’s point of view, hydrologic

science should not be pleased for having dramatic increase in the type and density of hydrologic information, should rather be disappointed for not being able to device a proper mechanism and methodology to acquire the data that can eliminate the problem of scaling and similarity.

» As noted in the conclusions, we hope that the community will recognize the opportunity and devise a strategy to test existing hypotheses by combining multiple data types in an information theoretic framework so that we can design future experiments including key observations to reconcile this issue.

6) On page number five, “REH” is undefined.

» Thank you for catching this. Actually it should be RH for “Representative Hillslope”. We include a definition of Representative Hillslope (RH) on page 3 along with the REA, REW definitions.

7) On page number two, as per the current version of the paper, heterogeneity or variability in hydrology manifests at multiple spatial scales, from local (O(1 m); e.g.,macropores) to hillslope (O(100 m); e.g., preferential flowpaths) to catchment (O(10 km); e.g., soils) and regional (O(1000 km); e.g., geology). Are these numerical values widely accepted by the hydrologic sciences community?

» These scales come directly from Figure 6 in Blöschl & Sivapalan, HP 1995

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-695, 2017.