Geophysical Research Abstracts
Vol. 18, EGU2016-2008, 2016
EGU General Assembly 2016

Information-Theoretic Benchmarking of Land Surface Models

Grey Nearing (1), David Mocko (1), Sujay Kumar (1), Christa Peters-Lidard (1), and Youlong Xia (2)
(1) NASA Goddard Space Flight Center, Hydrological Sciences Lab; Maryland, USA, (2) NOAA National Center for Environmental Protection, Environmental Modeling Center; Maryland, USA

Benchmarking is a type of model evaluation that compares model performance against a baseline metric that is derived, typically, from a different existing model. Statistical benchmarking was used to qualitatively show that land surface models do not fully utilize information in boundary conditions [1] several years before Gong et al [2] discovered the particular type of benchmark that makes it possible to *quantify* the amount of information lost by an incorrect or imperfect model structure. This theoretical development laid the foundation for a formal theory of model benchmarking [3].

We here extend that theory to separate uncertainty contributions from the three major components of dynamical systems models [4]: model structures, model parameters, and boundary conditions describe time-dependent details of each prediction scenario. The key to this new development is the use of large-sample [5] data sets that span multiple soil types, climates, and biomes, which allows us to segregate uncertainty due to parameters from the two other sources. The benefit of this approach for uncertainty quantification and segregation is that it does not rely on Bayesian priors (although it is strictly coherent with Bayes' theorem and with probability theory), and therefore the partitioning of uncertainty into different components is *not* dependent on any a priori assumptions.

We apply this methodology to assess the information use efficiency of the four land surface models that comprise the North American Land Data Assimilation System (Noah, Mosaic, SAC-SMA, and VIC). Specifically, we looked at the ability of these models to estimate soil moisture and latent heat fluxes. We found that in the case of soil moisture, about 25% of net information loss was from boundary conditions, around 45% was from model parameters, and 30-40% was from the model structures. In the case of latent heat flux, boundary conditions contributed about 50% of net uncertainty, and model structures contributed about 40%. There was relatively little difference between the different models.

1. G. Abramowitz, R. Leuning, M. Clark, A. Pitman, Evaluating the performance of land surface models. Journal of Climate 21, (2008).
2. W. Gong, H. V. Gupta, D. Yang, K. Sricharan, A. O. Hero, Estimating Epistemic & Aleatory Uncertainties During Hydrologic Modeling: An Information Theoretic Approach. Water Resources Research 49, 2253-2273 (2013).
3. G. S. Nearing, H. V. Gupta, The quantity and quality of information in hydrologic models. Water Resources Research 51, 524-538 (2015).
4. H. V. Gupta, G. S. Nearing, Using models and data to learn: A systems theoretic perspective on the future of hydrological science. Water Resources Research 50(6), 5351–5359 (2014).
5. H. V. Gupta et al., Large-sample hydrology: a need to balance depth with breadth. Hydrology and Earth System Sciences Discussions 10, 9147-9189 (2013).