Geophysical Research Abstracts
Vol. 17, EGU2015-7509, 2015
EGU General Assembly 2015

A New Framework for Effective and Efficient Global Sensitivity Analysis of Earth and Environmental Systems Models

Saman Razavi (1) and Hoshin Gupta (2)

(1) Global Institute for Water Security, School of Environment and Sustainability, University of Saskatchewan, Saskatoon, Canada (saman.razavi@usask.ca), (2) Department of Hydrology and Water Resources, University of Arizona, Tucson, USA (hoshin.gupta@hwr.arizona.edu)

Earth and Environmental Systems (EES) models are essential components of research, development, and decision-making in science and engineering disciplines. With continuous advances in understanding and computing power, such models are becoming more complex with increasingly more factors to be specified (model parameters, forcings, boundary conditions, etc.). To facilitate better understanding of the role and importance of different factors in producing the model responses, the procedure known as 'Sensitivity Analysis' (SA) can be very helpful. Despite the availability of a large body of literature on the development and application of various SA approaches, two issues continue to pose major challenges: (1) Ambiguous Definition of Sensitivity – Different SA methods are based in different philosophies and theoretical definitions of sensitivity, and can result in different, even conflicting, assessments of the underlying sensitivities for a given problem, (2) Computational Cost – The cost of carrying out SA can be large, even excessive, for high-dimensional problems and/or computationally intensive models.

In this presentation, we propose a new approach to sensitivity analysis that addresses the dual aspects of 'effectiveness' and 'efficiency'. By effective, we mean achieving an assessment that is both meaningful and clearly reflective of the objective of the analysis (the first challenge above), while by efficiency we mean achieving statistically robust results with minimal computational cost (the second challenge above). Based on this approach, we develop a 'global' sensitivity analysis framework that efficiently generates a newly-defined set of sensitivity indices that characterize a range of important properties of metric 'response surfaces' encountered when performing SA on EES models. Further, we show how this framework embraces, and is consistent with, a spectrum of different concepts regarding 'sensitivity', and that commonly-used SA approaches (e.g., Sobol, Morris, etc.) are actually limiting cases of our approach under specific conditions. Multiple case studies are used to demonstrate the value of the new framework. The results show that the new framework provides a fundamental understanding of the underlying sensitivities for any given problem, while requiring orders of magnitude fewer model runs.