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An Extended Global Sensitivity Analysis Implemented on a 1D Land Biosphere Model

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The implementation of sophisticated mathematical models is undoubtedly becoming increasingly widely used in a variety of fields in geosciences. SimSphere belongs to a special category of land biosphere models called Soil Vegetation Atmosphere Transfer (SVAT) models. Those provide representations, in a vertical profile, of the physical mechanisms controlling the physical interactions occurring in the soil/vegetation/atmosphere continuum at a temporal resolution that is in good agreement with the dynamic timescale of the atmospheric and surface processes.

This study builds on previous works conducted by the authors and aims at extending our understanding of this model structure and further establishing its coherence. Herein we present the results from a thorough sensitivity analysis (SA) performed on SimSphere using a cutting edge and robust Global Sensitivity Analysis (GSA) approach, based on the use of the Gaussian Emulation Machine for Sensitivity Analysis (GEM-SA) tool. In particular, the sensitivity of selected key variables characterising land surface interactions simulated by SimSphere were evaluated at different times of model output. All model inputs were assumed to be normally distributed with their probability distribution functions (PDFs) defined using mean and variance taken from the entire theoretical range that these inputs can take in SimSphere. The sensitivity of the following SimSphere outputs was evaluated: Daily Average Net Radiation, Daily Average Latent Heat flux, Daily Average Sensible Heat flux, Daily Average Air Temperature , Daily Average Radiometric Temperature, Daily Average Surface Moisture Availability, Daily Average Evaporative Fraction and Daily Average Non-Evaporative Fraction.

Our results showed largely comparable trends in terms of identifying the most sensitive model inputs in respect to the model outputs examined. In addition, a high percentage of first order interactions between the model inputs were reported, suggesting strong model coherence between inputs and outputs. Among the most sensitive model inputs for the outputs examined were the Fractional Vegetation Cover, Soil Moisture and topographically-related parameters (i.e. slope, aspect). Our study represents a significant step forward in the global efforts towards SimSphere verification given that its use is progressively expanding including present efforts to explore its synergy with Earth Observation for operationally deriving key land surface parameters at a global scale from space.

KEYWORDS: Global Sensitivity Analysis, BACCO method, GEM-SA