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SimSphere: a software toolkit to facilitate teaching and research in the study of Land Surface Interactions

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Climate change is facilitating large scale changes within the atmosphere, biosphere, geosphere, and hydrosphere evidenced globally at a variety of geographical scales. Thus, understanding physical processes and the ways the different components of the Earth system interact has been identified today as a topic of key research investigation. Use of simulation process models has played a key role in extending our abilities to study Earth system processes and enhancing our understanding on how different components of it interplay. This is due to their computational efficiency, accuracy, and ability to provide results at fine temporal scales. Soil Vegetation Atmosphere Transfer (SVAT) models have emerged recently as the preferred scientific tool to assess various parameters characterising the Earth system. Those can also be often combined with Earth Observation (EO) data, blending the horizontal coverage and spectral resolution of EO data with the fine temporal continuity and vertical coverage of those models. Several studies have drawn attention to this as a promising direction towards improving our ability to estimate key state variables characterising land surface interactions. SimSphere is such a software toolkit written in Java for simulating the interactions of soil, vegetation, and atmosphere layers of the Earth's land surface. It is being used either as a stand-alone application or synergistically with EO data. This model since its foundation has evolved significantly both architecturally and functionally and its use has been widely demonstrated so far in a wide spectrum of interdisciplinary science investigations. Furthermore, it is currently used as an educational resource for students in several Universities Institutes globally. Herein, we focus on SimSphere which is used as a case of a successful paradigm of a SVAT model used in teaching and research activities relevant to the study of land surface processes. We provide an overview of the model use so far in a variety of applications and teaching activities whereas we also present the latest advancements conducted from our group in enhancing the model functionality which aim at making its use more robust when used both as a standalone application and synergistically with EO data. The present work is not only an important contribution to the continuously expanding group of the model users

community, but it is also very timely more generally as it feeds to efforts currently ongoing by different groups globally towards the development of relevant operational products.
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