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Furthering our Understanding of Land Surface Interactions using SVAT modelling: Results from SimSphere's Validation

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With current predicted climate change, there is an increased requirement to gain knowledge on the terrestrial biosphere, for numerous agricultural, hydrological and meteorological applications. To this end, Soil Vegetation Atmospheric Transfer (SVAT) models are quickly becoming the preferred scientific tool to monitor, at fine temporal and spatial resolutions,
detailed information on numerous parameters associated with Earth system interactions. Validation of any model is critical to assess its accuracy, generality and realism to distinctive ecosystems and subsequently acts as important step before its operational distribution.

In this study, the SimSphere SVAT model has been validated to fifteen different sites of the FLUXNET network, where model performance was statistically evaluated by directly comparing the model predictions vs in situ data, for cloud free days with a high energy balance closure. Specific focus is given to the models ability to simulate parameters associated with the energy balance, namely Shortwave Incoming Solar Radiation (Rg), Net Radiation (Rnet), Latent Heat (LE), Sensible Heat (H), Air Temperature at 1.3m (Tair 1.3m) and Air temperature at 50m (Tair 50m). Comparisons were performed for a number distinctive ecosystem types and for 150 days in total using in-situ data from ground observational networks acquired from the year 2011 alone. Evaluation of the models' coherence to reality was evaluated on the basis of a series of statistical parameters including RMSD, R2, Scatter, Bias, MAE , NASH index, Slope and Intercept. Results showed good to very good agreement between predicted and observed datasets, particularly so for LE, H, Tair 1.3m and Tair 50m where mean error distribution values indicated excellent model performance. Due to the systematic underestimation, poorer simulation accuracies were exhibited for Rg and Rnet, yet all values reported are still analogous to other validatory studies of its kind. In overall, the model demonstrated greatest simulation accuracies within ecologically stable sites, where low inter-annual change in vegetation phenology was exhibited, such as open woodland savannah, shrub land and mulga woodland, whereas poorer simulation accuracies were attained in cropland and grazing pasture sites.

This study results present its first comprehensive validation. It is also very timely due to the rapidly expanding global use of the model, both as a standalone tool used for research, education and training in several institutions worldwide, but also for its synergistic applications to Earth Observation data. Currently, several space agencies are evaluating the model 's use synergistically with Earth Observation data in providing spatio-temporal estimates of energy fluxes and / or soil moisture at operational level.

Key Words: SimSphere, Validation, FLUXNET, SVAT, Shortwave Incoming Solar Radiation, Net Radiation, Latent Heat, Sensible Heat, Air Temperature