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Dual Source Energy Budget in prescribed or retrieval conditions with the SPARSE framework: developments over a decade, pathways for the future

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A simple yet largely realistic assumption proposed by John Norman in 1993 was a major breakthrough to use realistically the Land Surface Temperature (LST) information into an energy budget made of at least two main components, the soil and the vegetation, and thus to bypass the underdetermination of the system (two unknowns, evaporation E and Transpiration T, and one constraint, LST). Over the years, models based on this assumption like TSEB have proved more robust with local climate forcing than, say, their single source counterpart with a parameterized kB^{-1}.

Compared to TSEB, SPARSE (Soil Plant Atmosphere and Remote Sensing Evapotranspiration, [1]) provides four modes to compute the energy budget: with soil and vegetation sources organized in series ("layer" approach) or parallel ("patch" approach), either in a direct (prescribed soil and vegetation efficiencies) or an inverse mode (retrieval of E and T from LST). The "prescribed" mode enables to cap retrieval outputs by, say, potential E and T or fully stressed sensible heat components. The maximum transpiration is computed with a simple stomatal resistance model, and the aerodynamic resistances are deduced from the Shuttleworth-Wallace scheme, the latter being of course, as any residual approach, one of the most sensitive aspect of the model. SPARSE was only briefly compared to TSEB over 8 sites and 14 growing seasons (Fig. 1). Here we review the added values in combining those versions through numerous applications in the past decade over a large range of climates (Mediterranean to tropical, dry subhumid to semi-arid), land use types (herbaceous as well as sparse woody vegetation), and agricultural practices (irrigated and rainfed). We describe how the model provided valuable insight in tackling heterogeneous space and time scales (time aggregation, extrapolation from midday values, scaling from Landsat to MODIS, [2, 3, 4, 5]). We also show how the model, extended to four sources (shaded/sunlit soil and vegetation) is now ready to assimilate directional LST into simple hydrological models such as the one selected for V2 of L3 product of TRISHNA [6, 7]. Yet, violation of the core assumption on the initial stress level of the vegetation is still observed when using the sole LST information, and we discuss and illustrate challenges and opportunities to constraint the partitioning with at least one additional information stemming either from SAR backscatter data for low fraction cover (surface soil moisture constraint on E, [8]) or information related to the photosynthetic activity for more developed canopies (SWIR, PRI, SIF…, any extra constraint on T by detecting vegetation water stress). Current research avenues for SPARSE include improving the stomatal conductance parameterization to provide WUE estimates, as well as its radiative transfer scheme with more physically based transmissivity estimates.

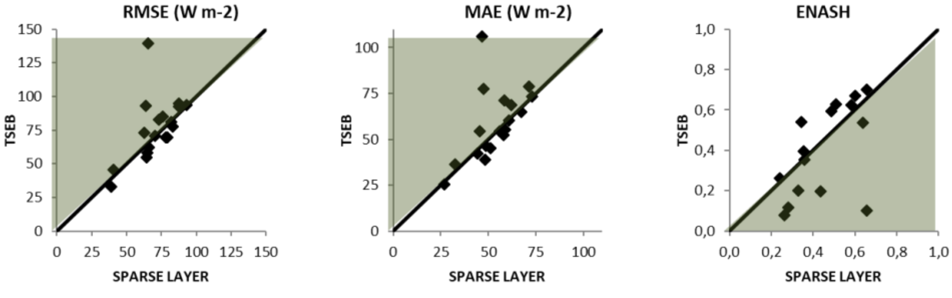

FIG. 1: Performance assessment of SPARSE and TSEB over 8 sites and 14 growing seasons (dataset from [3])

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