Assessing a parsimonious eco-hydrological model implementation to an Aleppo pine semiarid forest through available remote sensing data

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Arid and semi-arid climates cover a large portion of Earth's terrestrial surface and most of the ecosystems under these conditions represent hot spots in terms of Global Change consequences. In fact, the ecosystems are controlled by water availability, inducing a tight interconnection between the hydrological cycle and the vegetation dynamics. For this reason, it is essential to model these two systems, vegetational and hydrological, concurrently. However, frequently, in operational applications the available information is quite limited. Therefore parsimonious models together with available satellite information can be valuable tools to predict the vegetation dynamic. In this work, a parsimonious dynamic vegetation model is applied to a semi-arid Aleppo Pine forest area in the south-east of Spain. The model simulates biomass increase as related to the absorbed photosynthetically active radiation (APAR) through the light use efficiency (LUE). The model is then tested against several available products offered by MODIS instruments flying onboard the Terra and Aqua satellite. The satellite information used in this study is the following: the Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI), both included in the products MOD13Q1 and MYD13Q1 and provided every 16 days at 250-meters spatial resolution; the Leaf Area Index (LAI), included in the products MOD15A2 and MYD15A2 and provided every 8 days at 1000-meters spatial resolution; the actual Evapotranspiration (ET), included in the MOD16A2 product and provided every 8 days at 1000-meters spatial resolution. These satellite data were analyzed for the period 2000 – 2011 over the study area, averaging the spatial distributed data to obtain the evolution through time. All four products showed a marked seasonal quasi-sinusoidal behavior, but differences between them were noticed regarding the timing of peaks. NDVI showed a strong dependence on soil moisture and leaf water content, explainable by the impact of water-stress on chlorophyll content in Aleppo Pine leaves. The EVI proved to be strongly related to biomass dynamics and to LAI in particular. As for the LAI values provided by LP DAAC, they are too low relative to published ranges for the same species in similar climatic conditions. A possible explanation for this difference was found in the wrong land cover classification used by the algorithm that provides an estimation of this index, based on satellite data. Concerning the model performances, Pearson correlation coefficients (r) between modelled LAI and EVI series was 0.57; to compare model's results with NDVI, the simulated LAI was corrected by plant water-stress. The resulting correlation coefficient was r=0.6, while the RMSE was 0.162. Two tailed t-distribution statistical tests were performed to test the existence of statistically significant correlations between the considered variables. All correlations were highly significant, with $p<0.0001$.