Modelling Gross Primary Production of a Mediterranean grassland using Sentinel-2 vegetation indices and meteorological field information

Víctor Cicuéndez¹, Carlos Yagüe¹, Rosa Inclán², Enrique P. Sánchez-Cañete³, Carlos Román-Cascón⁴, and César Sáenz⁵

¹Departamento Física de la Tierra y Astrofísica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, Madrid, Spain (victcicu@ucm.es)
²Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Madrid, Spain
³Departamento de Física Aplicada, Universidad de Granada, Granada, Spain
⁴Departamento de Física Aplicada, Facultad de Ciencias del Mar y Ambientales, INMAR, CEIMAR, Universidad de Cádiz, Puerto Real, Spain
⁵Departamento de Ingeniería Agroforestal, ETSIAB, Universidad Politécnica de Madrid, Madrid, Spain

Mediterranean grasslands provide different ecosystem, social and economic services to the Mediterranean basin. Their dynamics are conditioned by the influence of the Mediterranean climate, which results in large inter-annual variability. Gross Primary Production (GPP) represents the carbon (C) uptake of ecosystems through photosynthesis, being the largest flux of the global C balance. Hence, GPP estimations are necessary to assess the dynamics of the global C cycle and to plan a sustainable management of these ecosystems. The study of grasslands GPP must be approached from a dynamic point of view, that is, temporal evolution at different spatial scales.

High frequency satellite data, such as Sentinel-2, have opened the door to study ecosystems with a high spatial (10, 20 and 60 m) and temporal resolution (5 days). Although extensive research exists about estimating GPP in grasslands with moderate resolution sensors, such as MODIS, the estimation of GPP in this ecosystem type using Sentinel-2 images is relatively new, especially in Mediterranean sites. The GPP derived from remote sensing data must be evaluated at field scales using eddy covariance (EC) measurements from flux towers. Time series analysis (TSA) represents an excellent tool to analyze high temporal resolution data, such as EC and remote sensing data. Although TSA has been widely used in economics, it is not commonly used for the analysis of environmental variables, such as GPP.

The overall objective of this research is to estimate a GPP model for a Mediterranean grassland in central Spain close to a forest influenced by the Guadarrama mountains (El Escorial, Madrid). This is done using Sentinel-2 vegetation indices and meteorological field information obtained from a GuMNet micrometeorological station where all the surface energy balance (SEB) components (and other meteorological and soil variables) are available for several years. The specific objectives are:

1. To compare different vegetation indices to estimate GPP through the ecosystem light-use
efficiency model; (2) To estimate the influence of different meteorological variables on the model; (3) To validate the remote sensing model with the measurements from an EC flux tower (GuMNet-Herrería) in terms of quantity and dynamics through time series analysis.

Some preliminary results indicate how the GPP depends strongly on the vegetation indices and on meteorological and soil variables, being the soil water content a relevant one. This approach allows to model GPP based on the information from this analysis.