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Evaluation of the gross primary production derived from MODIS for a Seasonally Dry Tropical Forest in Brazil

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Gross primary production (GPP) is a key component of the global carbon cycle, as it refers to the entry of carbon into terrestrial ecosystems and thus can indicate the health of a given ecosystem and their responses to environmental changes. In Brazil, there is still a lag in the monitoring of carbon flows on a regional scale, especially in the semi-arid region, where the domain of the seasonally dry tropical forest well known as Caatinga biome. This kind of study has been done globally by a network of flux towers equipped with eddy covariance system, being the results representative only for their area of influence. Thus, the use of remote sensing products, especially the MODIS sensor, represents an alternative in the biome-scale research because it has great spatial and temporal coverage, low cost and is not a destructive method for biomass or carbon stock measurements. Considering that, the objective of this study was to evaluate the gross primary production (GPP) derived from MODIS in an area of tropical dry forest of Caatinga in Brazil. In addition, we aimed to improve GPP estimation by using locally measured parameters, such as evaporative fraction and incoming solar radiation, and also by replacing the fraction of photosynthetically active absorbed radiation (FAPAR) by the Improved Vegetation Index (EVI). The analysis were performed with MODIS version 6 products (MOD17 gross primary production and liquid photosynthesis, MOD15 Leaf Area Index - LAI - and FAPAR, and MOD09 surface reflectance) obtained for the study area from 2011 to 2015. The MODIS GPP were compared the Caatinga-FLUX tower GPP derived from eddy covariance technique. The results indicated that the seasonal variation of GPP was conditioned by the rainfall, with higher values in the rainy season, mainly for 2011 (in averaged precipitation). During 2012-2015 years occurred severe drought in the Semiarid area of Brazil, reflecting on the GPP Caatinga-FLUX tower and MODIS values. GPP-MODIS and GPP-Caatinga-FLUX tower presented a moderate relation (r^2= 0.5; p <0.001; RMSE: 1.81 gC m-2). The MOD17 product overestimated GPP during the dry season and underestimated it in the rainy season for a normal year (2011), what doesn't occurred for 2012, 2013, 2014 and 2015, that experienced a prolonged drought. The insertion of the evaporative fraction to constrain maximum LUE (light use efficiency) in the processing of the MODIS algorithm improved estimative of GPP (r^2 = 0.83, p <0.001, RMSE: 1.47 g C m-2), and reduced overestimation during the period of prolonged water deficit, thar is common during the second semester in the studied area. The estimative of GPP with the MODIS reflectance and local parameters was more accurate when compared with the GPP-Caatinga-FLUX tower. These results were find by studies carried out in semi-arid and arid environments of other continents. The validation and updating of GPP-MODIS are essential for a more precise monitoring of carbon exchanges in the Caatinga biome and the perception of responses to climate variability and environmental changes.
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