Estimation of gross primary production of irrigated maize using Landsat-8 imagery and Eddy Covariance data

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Abstract A study was conducted to understand the potential of Landsat-8 in the estimation of gross primary production (GPP) and to quantify the productivity of maize crop cultivated under hyper-arid conditions of Saudi Arabia. The GPP of maize crop was estimated by using the Vegetation Photosynthesis Model (VPM) utilizing remote sensing data from Landsat-8 reflectance (GPPVPM) as well as the meteorological data provided by Eddy Covariance (EC) system (GPPEC), for the period from August to November 2015. Results revealed that the cumulative GPPEC for the entire growth period of maize crop was 1871 g C m⁻². However, the cumulative GPP determined as a function of the enhanced vegetation index – EVI (GPPEVI) was 1979 g C m⁻², and that determined as a function of the normalized difference vegetation index – NDVI (GPPNDVI) was 1754 g C m⁻². These results indicated that the GPPEVI was significantly higher than the GPPEC ($R^2 = 0.96$, $P = 0.0241$ and RMSE = 12.6%). While, the GPPNDVI was significantly lower than the GPPEC ($R^2 = 0.93$, $P = 0.0384$ and RMSE = 19.7%). However, the recorded relative error between the GPPEC and both the GPPEVI and the GPPNDVI was −6.22% and 5.76%, respectively. These results demonstrated the potential of the landsat-8 driven VPM model for the estimation of GPP, which is relevant to the productivity and carbon fluxes.

1. Introduction

The gross primary production (GPP) is a critical parameter for carbon cycle and climate research. It is used to quantify the total amount of energy or biomass produced by vegetation through photosynthesis over a unit of time (Pingintha et al.,...