Effects of CO_2 and Climate on water use efficiency and their linkage with the climate change

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Abstract

Gross Primary production (GPP) and evapotranspiration (ET) are the two critical components of carbon and water cycle respectively, linking the terrestrial surface and ecosystem with the atmosphere. The ratio between GPP to ET is called ecosystem water use efficiency (EWUE) and its quantification at the forest site helps to understand the impact of climate change due to large scale anthropogenic activities such as deforestation and irrigation. This study was conducted at the FLUXNET forest site CN-Qia (2003-2005) using Community land model (CLM 5.0). We simulated carbon and water fluxes including GPP, ecosystem respiration (ER), and ET using climatic variables as forcing dataset for 30 years (1981-2010). Model results were validated with the FLUXNET tower observations. The correlation showed better performance with values of 0.65, 0.77, and 0.63 for GPP, ER, and ET, respectively. The model underestimated the results with minimum bias of -0.04, -1.67, and -0.40 for GPP, ER, and ET, respectively. Effect of climate 'CLIM' and 'CO_2' were analyzed based on EWUE and its trend was evaluated in the study period. The positive trend of EWUE was observed in the whole period from 1981-2010, and the trend showed further increase when simulated with rising CO_2. The time period were divided into two parts, from 1981-2000 and from 2001 to 2010, to identify the warming effect on EWUE. The first period showed the similar increasing trend of EWUE, but the second period showed slightly decreasing trend. This might be associated with the increase in ET in the wet temperate forest site due to increase in climate warming. Water use efficiency defined by transpiration (TR) (TWUE), and inherent-TR based WUE (IT-WUE) were also discussed. This research provides the evidence to climate warming and emphasized the importance of long term planning for management of water resources and evaporative demand in irrigation, deforestation and other anthropogenic activities.

Key words: Land Surface Model, climate change, CO_2 elevation, Land-Atmosphere interactions

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