Geophysical Research Abstracts
Vol. 18, EGU2016-507-1, 2016
EGU General Assembly 2016

Response of ecosystem water use efficiency to summer drought in boreal forests

Yao Gao, Tiina Markkanen, Tea Thum, and Tuula Aalto
Finnish Meteorological Institute, Climate Research Unit, Helsinki, Finland (yao.gao@fmi.fi)

Droughts that take place in boreal forests can have impacts on forest functioning and production, and even lead to tree mortality. However, drought is an elusive phenomenon that is difficult to quantify and define universally. In this study, we assessed the performance of a set of indicators describing drought conditions in the summer months over a 30 year period (1981–2010) in Finland. Those indicators include the Standardized Precipitation Index (SPI), the Standardized Precipitation–Evapotranspiration Index (SPEI), the Soil Moisture Index (SMI) and the Soil Moisture Anomaly (SMA). Herein, regional soil moisture was produced by the land surface model JSBACH. While SPI, SPEI, and SMA show a degree of anomalies from the statistical means over a period, SMI is directly connected to plant available water and closely dependent on soil properties. In particular, we investigated whether the SMI, SMA and SPEI are able to indicate the Extreme Drought affecting Forest health (EDF) which we defined according to the extreme drought that caused severe forest damages in Finland in 2006. The EDF thresholds for these indicators are suggested, based on the reported statistics of forest damages in Finland in 2006. Our results show that SMI is more appropriate for indicating EDFs in boreal forests.

Furthurmore, according to the flux measurement at Hyytiälä site (61°51'N, 24°18'E), daily plant ecosystem water use efficiency varied in a functional range defined by the ratio of daily GPP and ET. However, WUE showed high variability when SMI indicate sever drought, due to large decreases of GPP and ET during this period. At the sever drought condition, significant decreases in WUE mainly showed when ET is still higher than 1 $kgH_2Om^{-2}day^{-1}$, which means a stronger decrease in GPP than in ET compared to the normal rate. Responses of both GPP and ET to environmental variables (incoming solar radiation, temperature, SMI) were interpreted to find out the most important environmental factor in different SMI conditions. Results showed that GPP and ET are mostly dependent on SMI when SMI is less than 0.2, but mostly influenced by incoming solar radiation and secondarily by temperature when SMI is larger than 0.2. The JSBACH site simulation results showed similar features as the observation, although incoming solar radiation is always the dominant environmental control in all SMI conditions.