Geophysical Research Abstracts
Vol. 20, EGU2018-6279-1, 2018
EGU General Assembly 2018

Identifying critical stage and key factors to vegetation growth in Northern Hemisphere

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Many studies have investigated the relationship between vegetation and climate at regional and global scales, while the critical season and corresponding climate factors for vegetation growth are still not very clear. Here, relying on GIMMS NDVI3g data set and climate data, we explored the response of vegetation growth to climate change (temperature, precipitation and solar radiation) at seasonal scale, and identified the key climate factors and critical season for vegetation growth in the Northern Hemisphere (NH) from 1982 to 2013. We show that significant positive impacts of temperature on vegetation growth were observed over 39.4% area of the NH in spring, mainly concentrating in middle and high latitudes. However, the contribution of temperature to vegetation growth was greatly weakened in summer, during which vegetation growth was mainly stimulated by precipitation and solar radiation. In autumn, vegetation growth seems to be more sensitive to solar radiation than other two climate variables over majority areas. In addition, apparent legacy effects of climate on vegetation among seasons were observed. The winter temperature has a positive impact on spring vegetation in the next year, and the spring precipitation is also crucial for summer vegetation. We further determined the relative contributions of climate factors of each season to annual NDVI by using partial least-squares regression. We found that, vegetation over 41% of NH were controlled by temperature, especially spring temperature (12.8%). Precipitation and solar radiation accounted for 29.9% and 29.1% respectively.