Geophysical Research Abstracts
Vol. 13, EGU2011-6555, 2011
EGU General Assembly 2011

Analysis of vegetation behaviour in a North Africa semi-arid region, using SPOT VEGETATION NDVI data

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Abstract

Vegetation cover plays a key role in land surface processes. Therefore, any change in vegetation cover could have important effect in local, regional or global scales. Particularly for arid and semi-arid areas, because of frequent drought events and other environmental problems like desertification, it is essential to have a precise description of vegetation cover and its change. In the last decades, optical remote sensing has shown a high potential in monitoring vegetation dynamic and cover changes. This requires availability of multi-temporal remotely sensed data and development of time series analysis techniques. A multi-temporal series of satellite SPOT-VEGETATION Normalized Difference of Vegetation Index (NDVI) data from 1998 to 2010 were used to analyse vegetation dynamic over the central region of Tunisia in North Africa.
The climate in this region is semi-arid, with an average annual rainfall of approximately 300 mm per year, characterised by a rainy season lasting from October to May. The mean annual potential evapotranspiration (Penman) is close to 1600 mm. The landscape is mainly flat. The vegetation in this area is dominated by agriculture (cereals, olive and fruit trees and market garden). Crops are various and their rotation is typical of semi-arid regions.
The identification and quantification of persistent behaviour are highly requested for understanding how vegetation dynamics respond to external forcing such as as those caused by climate disturbances including drought and flood. A fractal methodology is proposed for investigating the annual vegetation dynamics of three different land covers (olives, pastures and annual agriculture) in order to capture their persistent behavior. They rely on estimating the scaling properties of the vegetation dynamics, which give information about the correlation structures and memory phenomena of the arid-region ecosystems. The results of this analysis reveal that all the covers are characterized by persistent temporal fluctuations for time scales ranging between three decades and a maximum from one to two years.
In order to estimate the state of stress of vegetation cover, a new index called Vegetation Anomaly Index (VAI) is proposed. Positive VAI indicates high vegetation dynamic. Negative VAI indicates existence of vegetation stress. It is tested for the three types of vegetation during the period of study 1998-2010. This index is highly correlated to precipitation. We find that the 4-month cumulative precipitation has the highest correlation to the proposed vegetation index. In fact, vegetation response to precipitation has a time lag, and the impact of water deficits on vegetation is cumulative especially in arid regions. We observe high correlations occurred particularly in the middle of the growing season for annual agriculture, but are much lower during greenup and senescence.
Keywords: Vegetation, SPOT VEGETATION time series, fractal analysis, persistence, vegetation anomaly index