Geophysical Research Abstracts
Vol. 19, EGU2017-7528, 2017
EGU General Assembly 2017

Detecting Biosphere anomalies hotspots

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The current amount of satellite remote sensing measurements available allow for applying data-driven methods to investigate environmental processes. The detection of anomalies or abnormal events is crucial to monitor the Earth system and to analyze their impacts on ecosystems and society. By means of a combination of statistical methods, this study proposes an intuitive and efficient methodology to detect those areas that present hotspots of anomalies, i.e. higher levels of abnormal or extreme events or more severe phases during our historical records.
Biosphere variables from a preliminary version of the Earth System Data Cube developed within the CAB-LAB project (http://earthsystemdatacube.net/) have been used in this study. This database comprises several atmosphere and biosphere variables expanding 11 years (2001-2011) with 8-day of temporal resolution and 0.25° of global spatial resolution. In this study, we have used 10 variables that measure the biosphere.
The methodology applied to detect abnormal events follows the intuitive idea that anomalies are assumed to be time steps that are not well represented by a previously estimated statistical model [1].We combine the use of Autoregressive Moving Average (ARMA) models with a distance metric like Mahalanobis distance to detect abnormal events in multiple biosphere variables. In a first step we pre-treat the variables by removing the seasonality and normalizing them locally (μ=0,σ=1). Additionally we have regionalized the area of study into subregions of similar climate conditions, by using the Köppen climate classification. For each climate region and variable we have selected the best ARMA parameters by means of a Bayesian Criteria. Then we have obtained the residuals by comparing the fitted models with the original data. To detect the extreme residuals from the 10 variables, we have computed the Mahalanobis distance to the data's mean (Hotelling's T2), which considers the covariance matrix of the joint distribution.
The proposed methodology has been applied to different areas around the globe. The results show that the method is able to detect historic events and also provides a useful tool to define sensitive regions. This method and results have been developed within the framework of the project BACI (http://baci-h2020.eu/), which aims to integrate Earth Observation data to monitor the earth system and assessing the impacts of terrestrial changes.

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