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Harmonic analysis of desertification processes measured by vegetation greenness data from GIMMS3g NDVI

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Desertification is a spatio-temporal process caused by both natural climate changes (e.g. drought) and anthropogenic disturbances (e.g. overgrazing and excessive agricultural developments). To monitor this, long-term remote sensing observations are useful for finding vegetation activities using by vegetation indices such as Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI). Previous remote sensing studies have sometimes ignored detailed desertification processes. As unstable vegetation conditions on the edge of deserts, the observed time series data in those areas tend to produce anomalies. To overcome this issue, it is beneficial to focus on phonological process by vegetation indices because such anomalies may represent the vegetation conditions on land. The aim of this study is therefore to understand the desertification process by identifying phenological events using long-term historical remotely sensed imagery. Harmonic analysis is applied to Global Inventory Modeling and Mapping Studies (GIMMS) 3g NDVI time series for 1981-2012. GIMMS3G data is an update version of GIMMS NDVI data covering recent 31 years. Harmonic analysis is a decomposition technique which allows extracting individual harmonic oscillation terms from time series data. This model can assess the statistical significance of each decomposed wave term through Fisher's test and has a great advantage compared to related models such as the seasonal-trend decomposition model and structural time series models. Using these methods, we investigate vegetation phenological signals around the boundary of deserts. The harmonic analysis approach provides insights into long-term desertification processes from the interpretation of the amplitude and phase terms of the individual harmonic terms.

Keywords: Desertification, GIMMS3g, NDVI, Harmonic analysis