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Long-time vegetation dynamics inferred from satellite: evaluation of characteristic time scales of photosyntetic activity trends

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1 Introduction

Vegetation cover processes play a crucial role in the water balance over a wide range of spatio-temporal scales (Betts et al., 1996; Chase et al., 1996). Unfortunately, vegetation dynamics and their interaction with climate and anthropic activities are still largely unexplored.

Under this framework, satellite data have proved to be very useful for collecting realistic data about land use change and vegetation trends from local to global scale (see, e.g., IGBP-IHDP, 1999). In particular, NOAA-AVHRR (Advanced Very High Resolution Radiometer, onboard National Oceanic and Atmospheric Administration satellites) data can provide useful information on such changes over climatic spatio-temporal scales. The sensor resolution (1.1Km x 1.1Km) represents a rather good compromise between the opposite requirements of large scale monitoring and a detailed description. Moreover, the long time series of observations (about twenty-five years) can be very useful for studying vegetation dynamics over interannual scales.

Methods

For estimating characteristic time scales of photosynthetic activity trends, we used a time series of annual maximum NDVI (Normalized Difference Vegetation Index) maps (1985–1999) suitably corrected from systematic errors due to satellite switches, changes in solar zenith angle and short-waves calibration instability (Cuomo et al. 2001; Simoniello et al. 2004)). From data relative to the Southern part of the Italian peninsula (Mediterranean ecosystems), we evaluated the temporal NDVI trends at pixel level and analyzed them for different land covers (Forests, Maquis, Pastures, and Agricultural areas). In order to infer long time stationery properties of vegetation dynamics, we applied a procedure we recently devised (Lanfredi et al, 2004) that follows a mechanical-statistical approach. It is based on the estimation of the distribution function of the photosynthetic activity trends observed from satellite.

According to this procedure, we estimated positive and negative NDVI trends starting from 1985-1995 (selected as reference period) and, then, covering time periods that increase at a 1-year rate. Form such trends, we determined the histogram of the relative life times for the main land covers and computed analytical best fits for such sample distributions.

1.1 Results and Conclusions

For all the investigated land covers, we found that the histograms were well fitted by exponential decay laws that are typical of short term correlated dynamics (red noises). Characteristic time scales ranging from a very few years ($\sim$3 years) to some decades ($\sim$ 23 years) were obtained for the different land cover classes. Generally, the investigated territory appears to be long range stationary. The characteristic scales account for recovery times from strong shocks affecting vegetation in well-being status and presumably they express dynamics that are typical of the study area.

Our results provide interesting information about the potential of dynamical studies based on satellite data for investigating vegetation dynamics and its interaction with hydrological processes.

1.2 References

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