EFFICIENT SMOOTHING OF NDVI TIME SERIES USING THE WHITTAKER SMOOTHER

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ABSTRACT:

A new method for filtering remotely-sensed time series affected by negatively-biased noise is presented. The Whittaker smoother fits a discrete series to discrete data and balances the fidelity to the observations with the roughness of the smoothed curve. The algorithm is extremely fast, gives continuous control over smoothness with only one parameter, and interpolates automatically. This renders the smoother an appealing candidate for filtering coarse resolution NDVI time series. To demonstrate the performance and applicability of the smoother, a time series of SPOT VGT imagery (1998 - 2008) was processed. The voluminous data set covers large parts of Brazil, Argentine, Uruguay, Paraguay and Bolivia at a temporal resolution of 10 days. Visual analysis of the filtered results showed that the negatively-biased noise was efficiently removed while the overall shape of the curves could be preserved. The filtered NDVI profiles approached the upper envelope of the input data. Key phenological dates extracted from the smoothed data were spatially consistent, followed a clear meridional trend, and reflected the prevailing land cover. Compared to the unfiltered data, application of the Whittaker smoother led to a significant increase in the signal-to-noise ratio (SNR), assessed as the ratio between the average signal and the variogram-derived square root of the nugget variance. The difference between the filtered and the original NDVI - and therefore the strength of the filtering effect - was proportional to the climatological cloud coverage (IPCC) and inversely proportional to the SNR of the input data. This demonstrates that the smoother identified unfavorable observation conditions and took larger actions on low quality data. Our results suggest that the Whittaker smoother has considerable utility in filtering remotely-sensed time series.

TOPIC: Image processing and pattern recognition
ALTERNATIVE TOPIC: Change detection and process modelling