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Spatio-temporal change modeling with array data

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Spatio-temporal change modeling of our ecosystems is critical for environmental conservation. Open access to remote sensing satellite image archives provides new opportunities for change modeling, such as near real-time change monitoring with long term image time series. Newly developed time series analysis methods allow the detection of quantitative changes in trend and seasonality for each pixel of the image. A drawback of pure time series analysis is that spatial dependence is neglected. There are several spatio-temporal statistical approaches to incorporate spatial context. One method is to build hierarchical models with spatial effects for time series parameters. Other methods include representing regression parameters as spatially correlated random fields, or integrating spatial autoregressive models to time series analysis. Apart from spatio-temporal statistical modeling, the results can be further improved by qualification of detected change points with their spatio-temporal neighbors. Spatio-temporal modeling approaches are typically complex and large in scale, and call for new data management and analysis tools. Remote sensing satellite images, which are continuous and regular in space and time, can naturally be represented as three- or four-dimensional arrays for spatio-temporal data management and analysis. The developed spatio-temporal statistical algorithms can be flexibly applied within array partitions that span the relevant array-based dimensions. This study investigates the potential of array-based Data Data Management and Analytic Software (DMAS) for fast data access, data integration and large-scale complex spatio-temporal analysis. A study case is developed in near-real time deforestation monitoring in Amazonian rainforest with long-term 250 m, 8-day resolution MODIS image time series. A novel spatio-temporal change modeling process is being developed and implemented in DMAS to realize rapid and automated analysis of satellite image time series for forest disturbance detection. The study expects results that improve over a pure time series analysis approach, and that is practically applicable to massive complex spatio-temporal data.