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Trend change detection in vegetation greenness time series: Contrasting methodologies, data sets and global vegetation models

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Newly developed satellite datasets and time series analysis methods allow the quantification of changes in vegetation greenness. However, the estimation of trends and trend changes depend often on the applied time series analysis method and the used satellite dataset. Thus, the environmental plausibility of the estimated trends and trend breakpoints is often questionable. We compared four trend and trend change detection methods to assess their performance. We applied the methods to NDVI and FAPAR time series from global satellite datasets and from global vegetation models. We generated surrogate time series with known trends and breakpoints and applied the methods to re-detect the known trends and trend changes. Our results demonstrate that the performance of methods decrease with increasing inter-annual variability of the time series. An overestimation of breakpoints in NDVI time series can result in wrong or even opposite trend estimates. Trend slope estimates based on annual aggregated time series or based on a seasonal-trend model show better performances than methods that remove the seasonal cycle of the time series. The application of the trend change detection methods to real time series allows assessing the multi-method ensemble of trend estimates. Nevertheless, the interpretation of the environmental plausibility of these trend estimates is challenging. For example, some methods suggest a weakening of greening trends in the Tundra after the early 2000s while other methods suggest an ongoing greening. Comparison with vegetation model simulations suggest that this weakening is not an artefact of the satellite dataset or of the applied trend change detection method but might be caused by real changes in environmental conditions. Our results demonstrate the need for a critical appraisal of trend change detection methods. All methods require a careful assessment of the environmental plausibility of detected trend changes in vegetation greenness time series.