

Determination of spring events of boreal coniferous forest from MODIS time-series

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We studied the extraction of spring phenological events from Moderate Resolution Imaging Spectrometer (MODIS) time-series for coniferous forest in the boreal region. The start of the photosynthetic active period, determined from CO₂ flux data, was used as primary reference for the start of season in boreal coniferous forest. Furthermore, phenological observations on pine trees, such as the beginning of growth of new shoots were used for comparison.

Cloud-filtered daily time-series of Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) and Snow Covered Area (SCA) were extracted from homogenous areas near *in situ* stations for seven coniferous forest sites in Finland. Comparison between satellite time-series and *in situ* events were done for the period from 2001-2008. The onset of the growing season in coniferous forest showed correspondence with minimum value of NDVI before the increase of its temporal profile during spring and coincided with the SCA change from full snow cover to patchy snow cover. The beginning of growth of new shoots of pine occurred later after complete snow melt, when NDWI profile showed a minimum and NDVI profiles reached more than 50 % of its amplitude.

The start of season was determined from NDVI-time series with good accuracy ($R^2=0.8$, RMSE 4 days). Validation was based on three CO₂ flux measurement stations (two in northern Finland and one in Southern Finland). The start of growth of new shoots was extracted from NDWI time-series using a similar approach as proposed by [1] for the detection of greening up in the boreal region. Correspondence was lower than for the start of season with R^2 of 0.57 and an RMSE of 10 days based on validation with *in situ* data from four phenological sites.

References

[1] N. Delbart, L. Kergoat, T. Le Toan, J. L'Hermitte, and G. Picard, "Determination of phenological dates in boreal regions using normalized difference water index", *Remote Sensing of Environment*, 97, pp.26-38, 2005.