A concept for deriving a spatial and temporal high resolution LAI from multi-scale remote sensing data

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Motivation

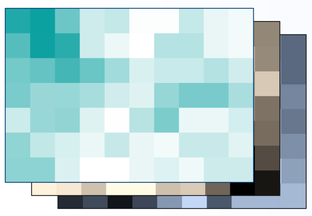
Global changes alter climate, water resources, and ecological systems. Monitoring changes, and thereby especially the spatial and temporal variability of vegetation properties, is one of the foremost fields of research within remote sensing. The knowledge of these variables is crucial for understanding terrestrial biosphere processes and can be used for the parameterization of various physical models, quantifying the exchange of energy and matter between the land surface and the atmosphere [1]. Due to the role of green leaves in controlling biological and physical processes in plant canopies, the Leaf Area Index (LAI) is a key element of vegetation structure and an important input parameter to hydrological models [2].

Aim

We aim at deriving a temporal and spatial high resolution LAI product for grassland and forests in the River Ammer catchment in Bavarian alpine upland, Germany. The algorithm is based on multi-scale remote sensing data in order to combine and thus fully utilize the temporal and spatial resolution properties of different sensors.

RapidEye reflectance data

Land cover classification



Cover fraction maps

RapidEye data

Spatial resolution: 6.5 m
Temporal resolution: about 5-6 scenes / year

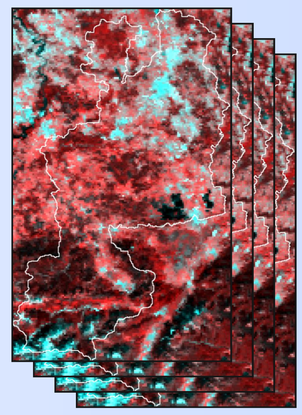
Basis for:
- Land cover classification
- Fractional cover map at MODIS scale
- LAI derivation in PROSAIL [2,3,4]

Application in **PROSAIL**:
- Reflectances as input data
- Land cover a priori information, defining the specific LUT applied during the LAI derivation [5].
- Input parameter sensitivity test

MODIS time series

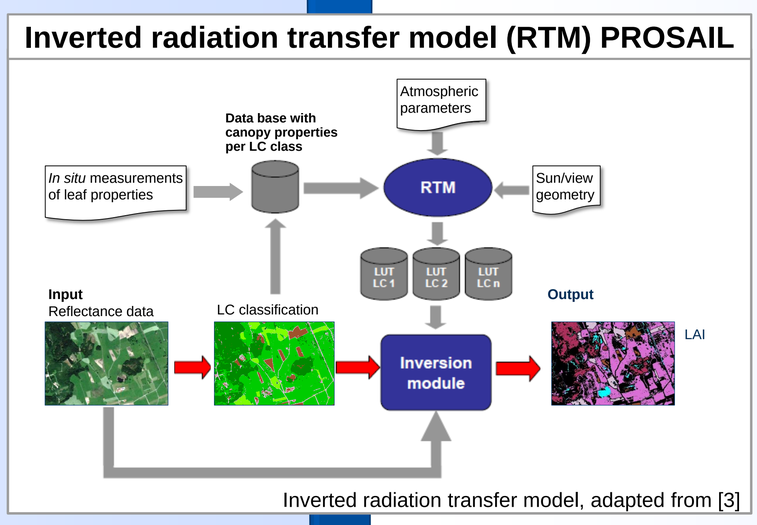
Spatial resolution: 250 m
Temporal resolution: 24 scenes / year

Continuous MODIS data are used to fill the gaps in the phenological cycle detected with Rapid Eye data.



MODIS 09Q1 time series

Application in **PROSAIL**:
- Reflectances as input data
- Land cover a priori information
- Input parameter sensitivity test
- Test of advanced canopy reflectance models (see [6])



Inverted radiation transfer model, adapted from [3]

High spatial resolution data

Training & Validation

Validation

High resolution LAI maps [6.5 m]

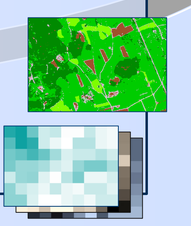
Validation

High spatio-temporal resolution LAI product

Applicable in various monitoring and modeling activities.

Medium resolution LAI time series [250 m]

Downscaling
Weighted disaggregation
- Land cover map
- Cover fraction maps
- Considering spatial non-stationarity of biomes (see [7])

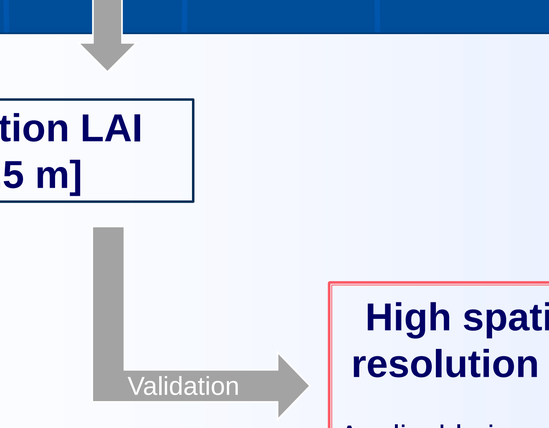


Validation

High temporal resolution data

In situ measurements

- 5 survey campaigns in spring and summer 2011 in the TERENO prealpine observatory region.
- Measured parameters:
  - LAI
  - average leaf inclination angle
  - Chlorophyll
  - brown matter and water content
- Nested sampling design



Sampling design

- Measurement techniques:
  - Hemispherical photographs (in forests)
  - LAI 2000 PCA (on meadows)
  - Destructive sampling

According to [8,9]

Hemispherical web cam

Above: Cameras positioned on a meadow (left) and inside a beech/spruce forest (right)
Below: Camera views

- 2 hemispherical outdoor webcams
- Recording frequency: 2 photos / day
- Derived parameters:
  - Continuous LAI time series
  - Leaf inclination angles
  - Canopy closure

→ Observation of phenological phases and abrupt changes

References

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