Working towards a global-scale functional relationship between L-band optical depth and forest water content

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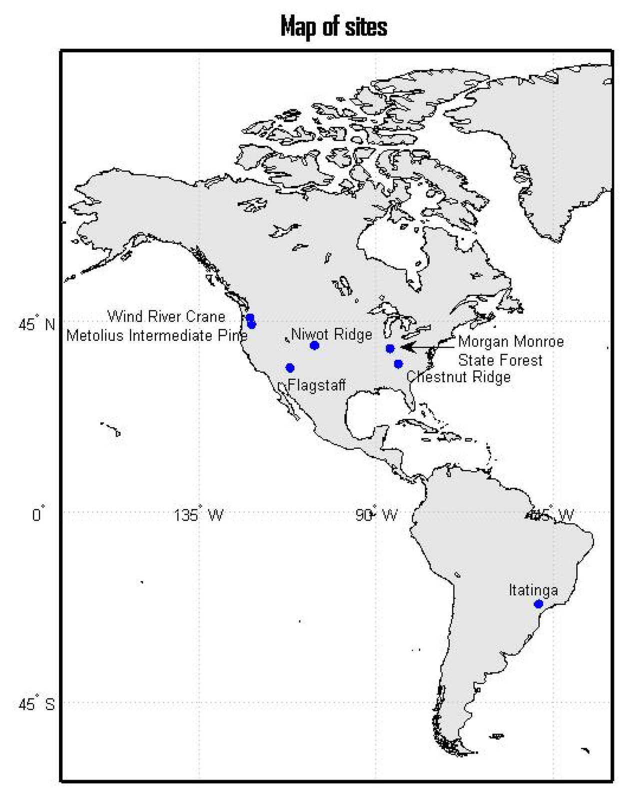
Background & Methods

This study concerns the search for a functional relationship between SMOS optical depth and vegetation properties such as water content and/or vegetation structure. The focus lies on different forest types in North and South America, in order to maximize the influence of the vegetation layer in the SMOS signal, and minimize the influence of RFI.
Forest sites belonging to the FLUXNET network or EUCFLUX project were chosen as focus areas. The in situ networks provided measurements of e.g. temperature, soil moisture and precipitation.
Values of optical depth were taken from L2 SMOS data, and retrieved from L1C SMOS data with the LMEB model. This was done using the nearest most representative SMOS gridcell (DGG). All SMOS data were reprocessed.
Vegetation indices LAI (~ primary production), NDVI (~ photosynthesis), EVI (~ canopy structure) and NDWI (~ vegetation water content) were computed from MODIS data over approximately the same area. The results show a comparison between the MODIS vegetation indices and the SMOS optical depths for the year 2010.



Results

Coniferous | Coniferous | Deciduous | Eucalypt

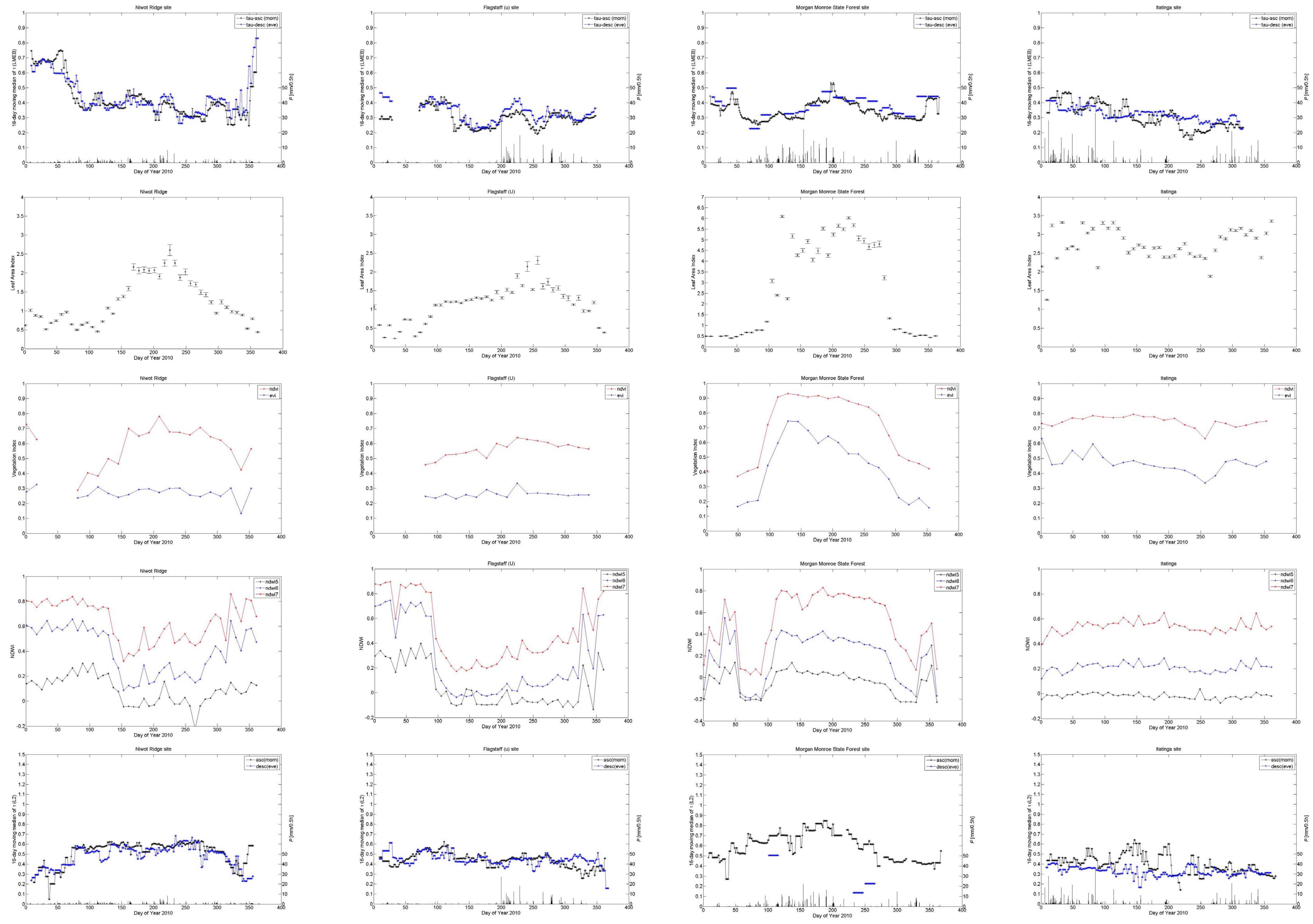
Optical depth (τ) retrieved from SMOS L1C data using L-MEB with in situ values of temperature and soil moisture (SM). Simultaneous retrievals done of τ and SM, with a tight constraint on SM. Resulting values of τ smoothed by using a 16-day median moving window.

Leaf Area Index (LAI) computed from MODIS product MCD15A2 (8-day temporal and 1 km spatial resolution), using 2 adjacent pixels to cover the area of interest.

Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) computed from MODIS product MOD13A1 (16-day temporal and 500 m spatial resolution), using 3 adjacent pixels to cover the area of interest.

Normalized Difference Water Index (NDWI) computed from MODIS product MOD09A1 (8-day temporal and 500 m spatial resolution), using 3 adjacent pixels to cover the area of interest. NDWI computed using band 2 (NIR) and bands 5, 6 or 7 (SWIR).

Optical depth (τ) product taken from SMOS L2 data and smoothed using a 16-day median moving window.



NB. Not all sites shown in the results; selection was based on completeness of the available datasets and clearest results.

Discussion

In general, it seems that EVI, NDWI and precipitation patterns are reflected most strongly in the optical depth signal. This matches expectations based on the literature; optical depth is linearly related to both vegetation structure and vegetation water content (Jackson & O'Neill, 1990) and precipitation is also known to directly influence the canopy optical depth (e.g. Saleh *et al*., 2006). At this stage of the study, the relative influence of each factor does not seem related to forest type. The ascending orbit of SMOS seems to give slightly better results in terms of the visual "correlations" shown above.
It should be noted that these results are very preliminary and still need some kind of quality control (e.g. flag check & RFI filtering), which will be performed in a next step of the study. Future objectives are to better understand the temporal patterns of SMOS optical depth and the relative influence of vegetation structure and water content. The potential to monitor vegetation water status on a global scale could prove invaluable in extreme-event forecasting, agricultural applications, and studies of landscape dynamics and ecosystem production.