Hyper-spectral sensor measurements at an Arctic Atlantic raised bog in northern Norway

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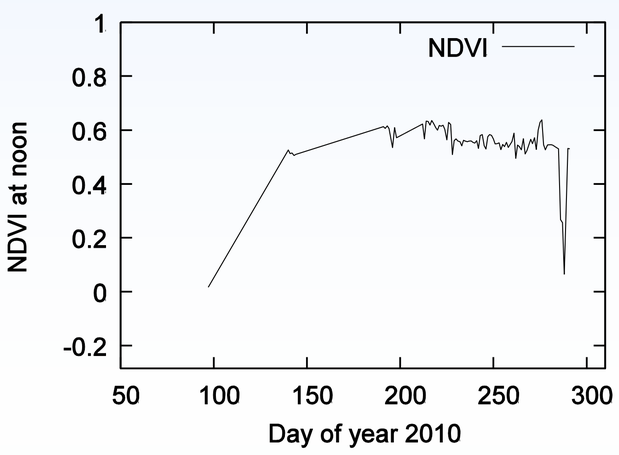
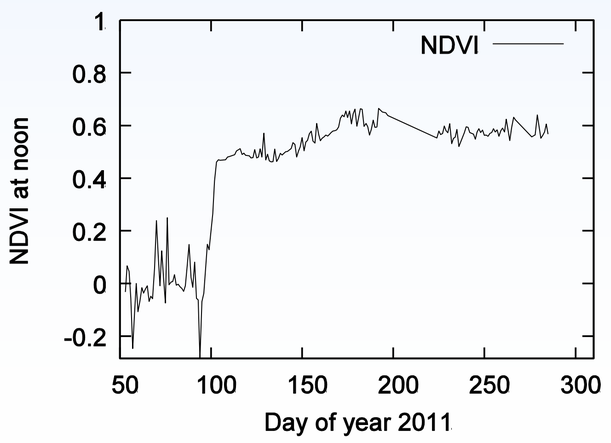
Abstract: The objective of this study was to monitor the carbon uptake of a terrestrial ecosystem in the Arctic using high spectral resolution radiometric measurements in combination with carbon flux measurements. The study was conducted at the Saura bog site in Andøya, northern Norway, equipped with an eddy covariance flux tower and autonomous in-situ hyper-spectral sensors since 2009.

The mires at northern Andøya are dominated by ombrotrophic bogs and poor fens. Some of the best developed Arctic Atlantic raised bogs of Norway are found at Andøya. The Saura bog consists of numerous thick hummocks which have a relatively dry surface. Between the hummocks runs a reticulate network of wetter depressions, termed lawns or carpets. Because of this micro-relief we decided to place plots at both humidity types. The hummocks cover much larger areas than the lawns or carpets and the ratio might be ca. 70:30. The hummocks are characterized by cloudberry (*Rubus chamaemorus.* crowberry (*Empetrum nigrum*), the heath lichens *Cladonia portentosa*, *C. rangiferina* and *C. uncialis*. At slightly wetter hummocks, peat mosses can make up a quite substantial cover, especially *Sphagnum fuscum*, but the peat mosses are all most abundant in the depressions. Other species which are abundant or scattered

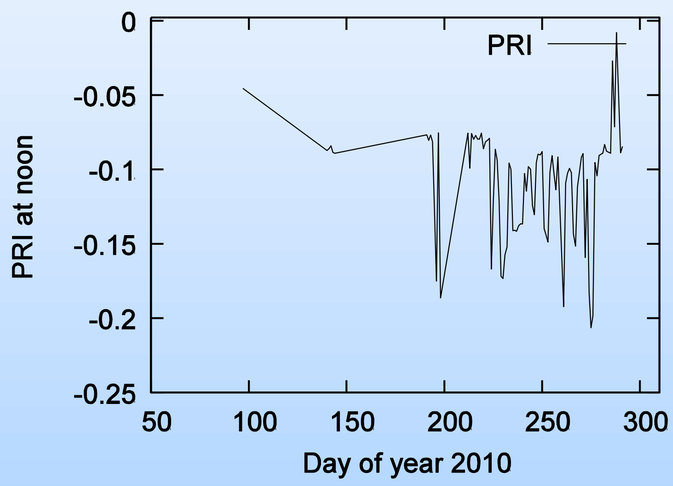
in the depressions are the loose-flowered sedge (*Carex rariflora*).

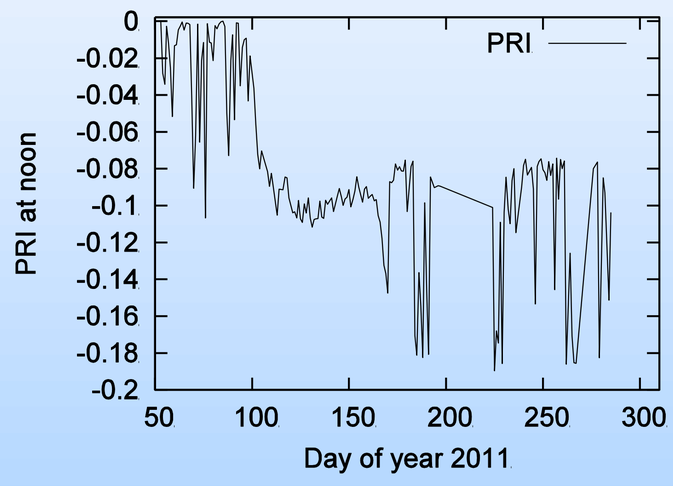
Since the sensors do not cover the SWIR wavelengths, only the NDVI-values were used in this study in order to monitor the development of the growing season from year to year in the period 2009-2012. NDVI-values calculated from the ground hyper-spectral measurements showed a steep increase in the beginning of the growing season, reaching maximum values in July. The exception is the year 2010 when the peak was in August a month later than in 2009 and about two weeks later than in 2011 and 2012. MODIS NDVI data derived for the same site confirmed the same yearly patterns. NDVI then slightly decreases in autumn. The reason for this is that the bog system mainly is dominated by turf mosses (*Sphagnum* spp.) and lichens (*Cladonia* spp.).





In addition, the Photochemical Reflectance Index values (PRI) were calculated using TriOS data. The PRI derived from narrow-band spectro-radiometers/hyper-spectral sensors is a spectral index increasingly being used as an indicator of photosynthetic efficiency and indirectly related to CO_2 fluxes. We compared PRI-values with the CO_2 flux data obtained from the Eddy-Covariance tower and this comparison assumed higher PRI-values in the beginning (before day 125) and the end of the growing season (after day 280) when the bog emits CO_2 and lower values in the peak season when the bog take up CO_2. The exception is also here the growing season of 2010 - with a significant later indication of the start of the CO_2 uptake (around day 200) compared to 2009, 2011 and 2012.





We used two autonomous TriOS Ramses hyper-spectral radiance sensors (radiance and irradiance) in order to measure the spectral radiances during the growing seasons March to end of October 2009-2012. TriOS sensor has a wavelength range of 320 - 950 nm. The radiance sensor measured the surface in an oblique off-nadir angle of 52° and the Field of View is 7 °. The irradiance was measured with a hemispheric field of view.

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