Geophysical Research Abstracts
Vol. 20, EGU2018-5503, 2018
EGU General Assembly 2018

Combined application of remote sensing biophysical parameter retrieval and groundwater observation for monitoring of the ecological status of a floodplain meadow

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Floodplain meadows can be highly biodiverse due to the numerous rare floral and faunal species inhabiting these ecosystems. However, in NW Europe, there has been a continuous decline in the area covered by these meadows, as well as in their species diversity, mainly caused by anthropogenic disturbances. As a result of the ecological significance of floodplain meadows, they have been given high conservation protection in many countries and it has become necessary to develop approaches to monitor their status. Hyperspectral remote sensing as a means to monitor biodiverse meadow ecosystems is still under-utilized. If combined with a range of sources of ground data, it can be an efficient tool to understand dynamics of meadow vegetation.
The present study has two inter-related aspects; the first part describes the development of a radiative transfer model (PROSAIL) inversion scheme that makes use of a high spatial (1m) and spectral resolution (3 to 6nm) hyperspectral image obtained from airborne remote sensing to map spread of invasive sedge and rush species within a species rich lowland UK floodplain meadow. The inversion scheme was developed to retrieve optical-functional traits: leaf area index, leaf inclination angle, leaf dry matter, chlorophyll and water content specifically over a floodplain meadow. The retrieval strategy was developed independently for individual parameters in terms of number of best solutions and cost functions. In general, canopy level parameters (leaf area index and leaf inclination) were retrieved with more accuracy than leaf level parameters. Leaf inclination was found to be a key spectral-functional trait that most successfully demarcated areas affected by erectophile wetland representative species in a biodiverse floodplain meadow, generally dominated by planophile herb species.
The second and ecological aspect of this work involved investigating the spread of wetland species, as monitored by RS, in terms of absolute groundwater level (obtained from interpolated groundwater maps and long-term groundwater timeseries) and depth of groundwater relative to the base of the alluvium layer where the vegetation's root zone resides. Combination of these data with the retrieved biophysical parameters helped explain our findings in the context of decadal changes in the soil-water conditions that have made part of this meadow more favourable for wetland species. The study, one of the firsts of its kind, convincingly demonstrates combined application of remote sensing and groundwater related data to monitor vegetation changes in groundwater-affected biodiverse ecosystems. The methodological approach followed in this study is based on the concept that functional types can be used as indicators of environmental change and can be tracked in the remote sensing data due to their distinctly different spectral response. This approach can potentially be implemented on variety of spatial scales, especially for the monitoring of floodplain ecosystems.