Project summary

The main objective of the project is to assess the impact of stressed conditions caused by simulated warming/heat stress and drought on top of the canopy level sun induced fluorescence (SIF) and gross primary production (GPP) of peatland vegetation. In the project we will answer for following questions: will changes in GPP fluxes be reflected in changes of SIF at canopy and ecosystem scales on peatland? Will these relationships be different for plants exposed to stressed conditions? Can we assess the status and productivity of the peatland ecosystem having a remote sensing signal? Currently, the Earth Explorer Programs of European Space Agency (FLEX) and NASA are dynamically stimulate development of innovative technologies for passive SIF measurements and SIF retrievals, as well as for pioneer research on impact of different stressed conditions on SIF-GPP relationships. However, at the current state of knowledge, are we really able to estimate GPP of ecosystems and biosphere with remote sensing SIF, considering that different stressed conditions may significantly change the SIF-GPP relationships? Considering the above, the project aims are: 1) to detect changes in SIF and to evaluate relationships between SIF, vegetation indices (e.g. NADVI, PRI) and GPP for different representative peatland plots exposed to simulated warming/heat stress and drought by using both passive and active climate manipulation techniques at the controlled manipulation experiments in Rzecin peatland, 2) to define the diurnal, seasonal and spatial variability of top-of-canopy SIF and R as well as relationships between SIF, R and GPP for selected reference plots of peatland with different amount of vascular and mosses species 3) to define whether the relationship between SIF-GPP depends on atmospheric and environmental conditions, as well as on biophysical characteristics of plant cover.

In order to reach the above aims, the measurements of SIF, GPP and spectral indices will be conducted on plots of already existed WETMAN (www.wetman.pl) climate manipulation experiment (since 2014) with active techniques of manipulation (infrared heaters are increasing the air and peat temperature, while automatic retractable curtain is used to reduce nighttime precipitation over the growing season). Measurements of CO_2 fluxes, spectral characteristics and SIF will be conducted automatically with the existing prototyped mobile platform. Moreover, two other manipulation sites will be developed, where the manipulations will be conducted with a passive approaches by means of the open top chambers (OTCs) and special roof to reduce precipitation. SIF and CO_2 fluxes measurements on these sites will be conducted periodically by means of Piccolo Doppio system with a set of two spectrometers (for SIF and reflectance measurements) as well as manual dynamic chambers (to measure net CO_2 and respiration fluxes).

The first in Poland, high-resolution map of top-of-canopy SIF distribution of Rzecin peatland will be used in the project. This map was generated during the SWAMP airborne campaign in July 2015 (FLEX campaign, ESA). We will critically assess, whether is it possible to specify some plant functional groups on peatland ecosystem based on this SIF map. Additionally, UAV platform will be used to measure SIF of the peatland surface and generate the SIF distribution map for this site. Based on the generated SIF maps and knowledge about the stress impact on SIF-GPP relationships, we will try to assess whether is it possible to estimate the status of the peatland in July 2015? Furthermore, we will assess the potential of UAV platforms to measure SIF of ecosystems characterized by heterogeneous surface. The relationships between SIF and CO_2 fluxes measured by eddy covariance system will be investigated in order to verify hypotheses, that average SIF values measured on the EC footprint area can well represent the productivity of the ecosystem (amount of assimilated CO_2).

Furthermore, the gross primary production will be calculated for all of the manipulated plots by classical LUE model (where SIF and vegetation indices will be used as proxy of the model parameters). While, by means of the SCOPE model, the SIF and GPP fluxes will be estimated for these plots. The estimation error of SIF and GPP yielded from SCOPE model will be assessed by comparison of the simulated values with the measured one. Hence, the applicability of the SCOPE model to simulate SIF of the ecosystem surface will be evaluated.

Although, the SIF measurements have been performed on many ecosystems with homogenous surfaces, till now this kind of research has never been conducted on peatlands. The proposed project has pioneering and innovative nature. By understanding how different factors determined the SIF of peatland vegetation, the dynamic ecosystem-atmosphere interactions will be better interpreted, hence the productivity of ecosystems and biosphere estimated with the remote sensing could be more accurate. This topic is of high importance for the future FLEX Earth Explorer 8 mission of ESA.