CURRICULUM VITAE

Zbyněk Malenovský holds MSc. in Nature and Environmental Protection from Palacky University in Olomouc and PhD. in Production Ecology and Resource Conservation from the Wageningen University (The Netherlands), with a special focus on imaging spectroscopy and quantitative remote sensing. Until 2007 he worked as researcher at the Academy of Sciences of the Czech Republic. From 2009 until 2011 he accepted position of research associate and lecturer at Remote Sensing Laboratories of the University of Zürich (Switzerland). Between 2012 and 2015 he conducted his research at the University of Tasmania and the University of Wollongong (Australia), including three summer expeditions in Antarctica. Since 2015 till the end of 2016 he worked as scientist at the NASA Goddard Space Flight Centre (USA) and from 2017 he is researcher at the Global Change Research Institute of the Czech Academy of Sciences. His main research interest is the interaction of radiation with plants at the leaf and the canopy level. He is using radiative transfer models for physically based estimation of vegetation biochemical and biophysical parameters from air- and space-borne imaging spectroscopy data. He focuses on plant functional traits indicating eco-physiological processes, for example photosynthesis and related stress reactions, under influence of environmental changes.

Multi-scale imaging spectroscopy and radiative transfer in vegetation canopies

Zbyněk Malenovský[1, 2, 3], Růžena Janoutová[1], Lucie Homolová[1], Petr Lukeš[1], Jan Hanuš[1] and Jean-Philippe Gastellu-Etchegorry[4]

[1] CzechGlobe, Global Change Research Institute of the Czech Academy of Sciences, Brno, Czech Republic

[2] School of Land and Food, University of Tasmania, Hobart, Australia

[3] Centre for Sustainable Ecosystem Solutions, School of Biological Sciences, University of Wollongong, Australia

[4] CESBIO, Centre d'Etudes Spatiales de la Biosphère, Toulouse, France

Abstract

Correct interpretation and validation of present and future space-borne imaging spectroscopy observations (e.g. the Copernicus operational mission Sentinel-2, the future German hyperspectral mission EnMAP or the planned ESA 8th Earth Explorer mission FLEX) requires a full understanding of the radiance signal reflected and/or emitted by vegetation at various scales. Spatial and spectral interpretation of visible and near infrared light, reflected and/or emitted to the space by vegetation canopies, can be facilitated by physical scaling field-to-airborne-to-space measurements using a landscape radiative transfer modelling.

At the CzechGlobe institute we are currently developing a conceptual framework for estimation and validation of Sentinel-2 satellite products, particularly leaf chlorophyll content and leaf area index, for European forest ecosystems dominated by spruce (Picea abies) and beech (Fagus sylvatica) trees. The

estimation is based on machine learning inversion of extensive forest spectral signatures, which were scaled from leaf up to the canopy level with the Discrete Anisotropic Radiative Transfer (DART). The validation of products was attempted through a multi-scale approach, where maps retrieved from high spatial resolution airborne imaging spectroscopy data are first verified with ground measurements and then compared per pixel for quantitative and spatial similarity with maps obtained from Sentinel-2 imagery.

The DART model was recently extended to simulate also emissions of solar induced chlorophyll fluorescence (SIF) of vegetation canopies. Although there is a general expectation that most of the SIF signal observed at canopy level originates from sunlit foliage, it is not the case in spatially heterogeneous canopies. DART capability to simulate interactions of photons with detailed three-dimensional representation of each leaf provides an excellent virtual tool to investigate not only partitioning of SIF contributions originating from sun and shade adapted foliage, but also sensitivity of the top-of-canopy SIF on leaf size, angularity, spatial distribution and density of leaves (clumping) in vertical and horizontal dimensions. Such sensitivity analyses offer a unique insight in formation of SIF by canopy structures and allow causal understanding of the SIF signal, which will be acquired by the future ESA FLEX fluorescence mission.