Integrating In Situ Forest Traits and Airborne Hyperspectral Data to Support the Development of High Level Spaceborne Imaging Spectroscopy Products

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Introduction

The development of high level vegetation products from emerging spaceborne imaging spectroscopy data requires high quality in situ data to support accurate product calibration and validation. In general, such data are more readily available for crop ecosystems than for forests due to their simpler canopy structure and easier accessibility of leaf samples. Leaf trait sampling in forest ecosystems is more challenging due to the complex 3D canopy structure, variability in species composition, phenology, and environmental effects. Reaching the top, sunlit parts of forest canopies and obtaining representative leaf samples to reflect the natural trait variability within the canopy can be particularly tedious.

In this poster, we present a comprehensive dataset of in situ measured forest biochemical and structural traits combined with plot-averaged hyperspectral signatures derived from airborne data collected using the Flying Laboratory of Imaging Systems (Fig 1, Table 1). The airborne data include simultaneous acquisitions of hyperspectral signatures in the VNIR and SWIR ranges, spectral emissivity in the TIR range, and point cloud descriptive statistics derived from an airborne laser scanner. Measured traits include leaf chlorophyll, carotenoids, nitrogen, cellulose, protein, water content, leaf mass per area, and leaf area index. Data were acquired during several campaigns in the Czech Republic, conducted in temperate forests dominated by Norway spruce, European beech, or English oak species. Trait data are presented as plot-level means and standard deviations (Fig 2), calculated from samples taken from the upper, sunlit branches. The associated spectral data represents mean reflectance from the 30 x 30 m area around the field sampling locations (Fig 3 and 4).

This forest trait dataset will be made available to the scientific community as open data to support further research and development of vegetation products from upcoming spaceborne hyperspectral instruments such as COPERNICUS CHIME, or SBG.

Fig. 1 Location of forest sites

Fig. 3 Mean spectral reflectance (airborne vs. Sentinel-2) for two forest plots from the Bílý Kříž 2016 campaign

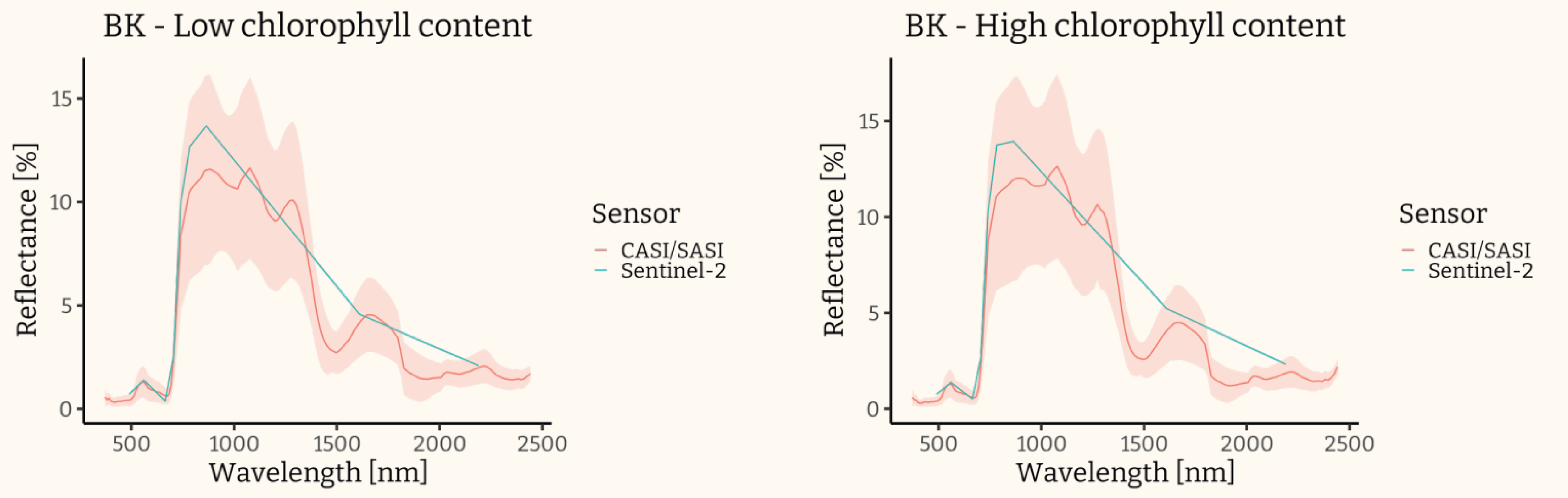


Table 1 Summary of ground campaigns with airborne hyperspectral flights

Name	Year	Species	No of trees	Leaf/canopy traits						Airborne			Satellite	
				Pigments	LMA	Water	N	Other	LAI	HS	LS	TIR	S2	HS
Bílý Kříž	2016	Picea abies	21	X	X	X			X	X	X	X	X	
Geomon	2017	Picea abies	124	X	X	X	X	X	X	X	X	X	X	
Lanžot	2019, 2020	Quercus spp, Carpinus betulus, Fraxinus angustifolia, Tilia	9, 4, 4, 2*	X	X	X			X	X	X	X	X	
Štítná	2020, 2021	Fagus sylvatica	10*	X	X	X			X	X	X	X	X	
Bílý Kříž	2020, 2021	Picea abies	10*	X	X	X			X	X	X	X	X	
Krknoše	2022	Picea abies	72	X	X	X	X		X	X	X	X	X	
Rájec	2023	Picea abies, Fagus sylvatica, Quercus spp.	6, 4, 3	X	X	X	X		X	X	X	X	X	
Krkonoše	2024	Picea abies, Pinus mugo	60, 10	X	X	X	X		X	X	X	X	X	X

HS - Hyperspectral, LS - Laser Scanning, TIR - Thermal Infrared
* leaf trait measurement repetead 2 - 4 times per season

Fig. 2 Mean trait values per plot. Each plot is represented by 3-5 trees. For Bílý Kříž 2020/21 the plot ID represents the sampling during the vegetation seasons 2020 and 2021

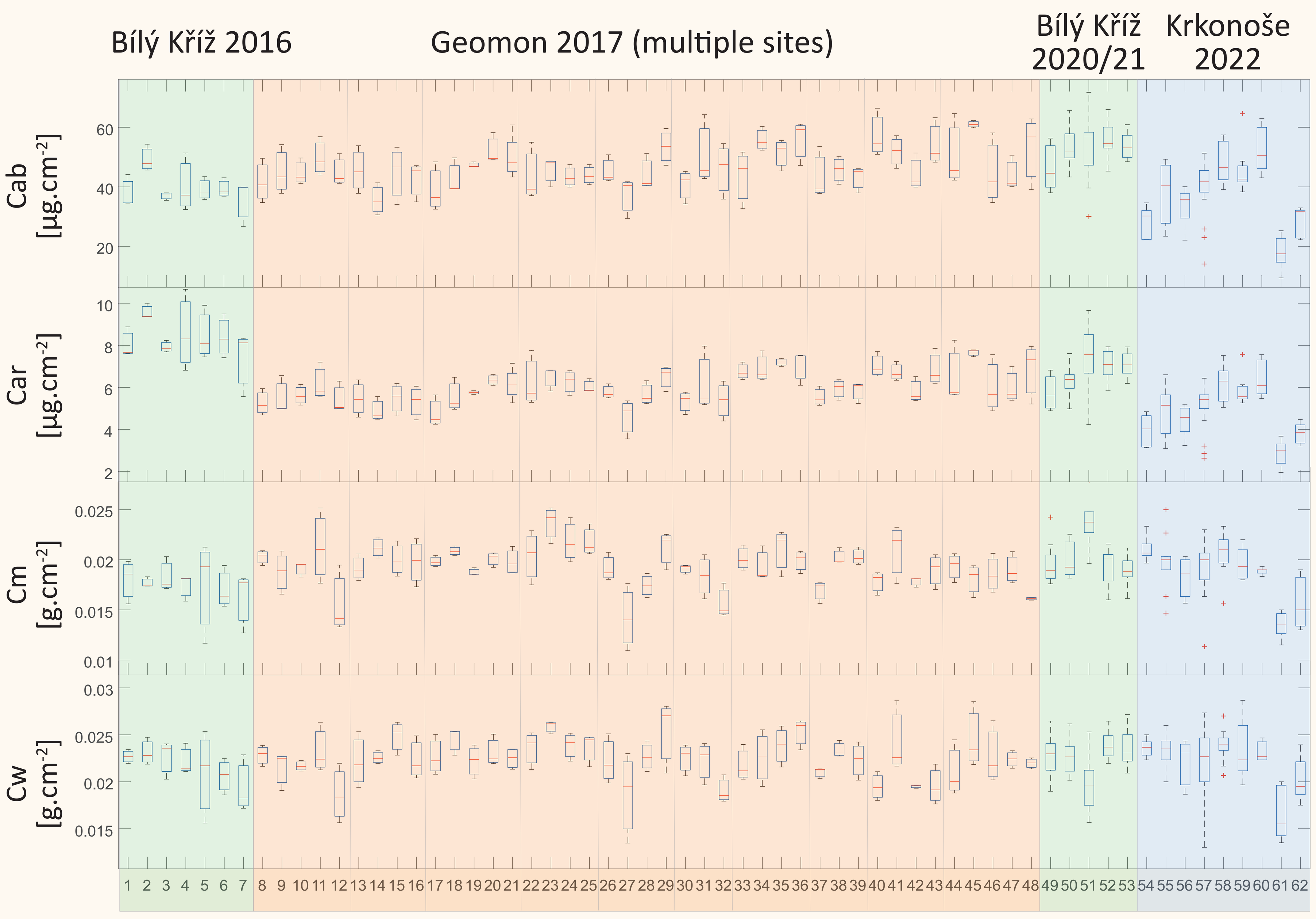
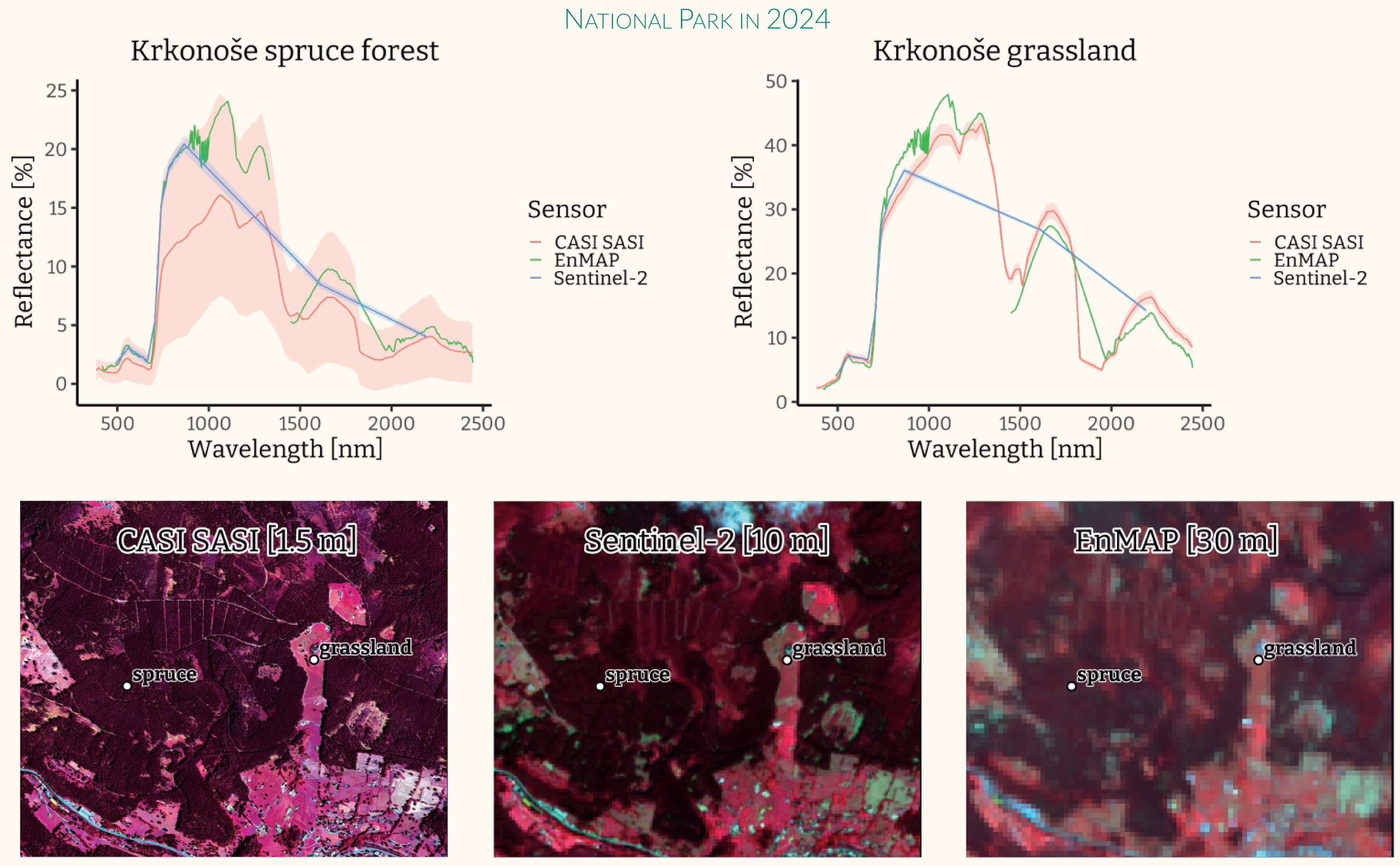


Fig. 4 Mean spectral reflectance (airborne vs. Sentinel-2 vs. EnMAP) from our latest campaign in the Krkonoše National Park in 2024



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