Validation of CHRIS/PROBA chlorophyll content map for Norway spruce forest stands using airborne imaging spectroscopy data of very high spatial resolution

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Chlorophyll a+b (C_{ab}), the green foliar pigments, are one of the most important organic molecules on Earth, as they directly participate on the processes of photosynthesis. They are able absorb the energy of incident solar radiation, which is then transformed into the organic bounds of carbohydrates. Norway spruce (*Picea Abies (L.) Karst.*) is one of the dominant tree species of boreal forest ecosystems of the northern hemisphere. The leaf chlorophyll content of spruce canopy varies per phenological phase and actual environmental stress load. Therefore, information on leaf chlorophyll content of canopy can be used as indicator of actual forest stand health state.

The state-of-the-art satellite sensors (e.g., imaging spectrometer CHRIS onboard of PROBA satellite platform – C/P) are able to provide, by means of the radiative transfer models' inversion, or an appropriate optical vegetation index, a map of C_{ab} content. Due to the low or medium spatial resolution and a wide swath (pixel size of 17m, swath of 13x13km in case of C/P) space borne sensors can cover larger areas than airborne imaging spectroradiometers (e.g. AISA Eagle – maximal pixel size of 5m with swath of 5km). However, the major drawback of a lower spatial resolution is thorough the problematic validation of the product uncertainty, e.g. accuracy of the retrieved C_{ab} maps. The broad pixel size introduces spectrally mixed per pixel information, which disables identification of individual tree crowns with pure foliage spectral information. Moreover, to conduct extensive ground (laboratory) chlorophyll measurements on statistically significant number of sample trees for satellite product validation is unfeasible. To overcome this drawback, we propose to use a combined validation scheme, where the satellite C_{ab} map (spatial resolution of 17m) is cross-validated with the airborne high-spatial resolution C_{ab} product (spatial resolution of 0.4m), which accuracy is know from comparison with ground/laboratory measurements. We are demonstrating this validation scheme within the case study over the spruce forest stands located at Bily Kriz test site (Moravian-Silesian Beskydy Mts., Czech Republic). The mutual spatial co-registration of both nadir satellite and airborne image data collected on the same day of September 14th, 2006 was performed via accurate geo-othorectification into the UTM34N-WGS84 projection. The average positional rectification error was 15m for C/P data and 1m for AISA Eagle image mosaic. The C_{ab} values of sunlit spruce crown parts of the areas corresponding with CHRIS/PROBA image pixels were aggregated and used as the C_{ab} 'ground truth' spatial reference. The first results showed quite close correlation between C/P and airborne C_{ab} products, with root mean square error – RMSE = 5.14 $\mu g/cm^2$ for immature and RMSE = 6.63 $\mu g/cm^2$for mature spruce stands.

Key words: satellite chlorophyll map, validation, Norway spruce, CHRIS/PROBA, AISA Eagle

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