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Introducing an adaptable, data-driven approach for extensive crop type and tree species mapping using Sentinel-2

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With the ongoing technical evolution of satellite systems, the interest in new, highly detailed thematic land-use maps has increased among scientists, policy makers, forest managers and farmers. In particular, the high temporal resolution of Sentinel-2 enables the realization of such map products. At the same time, however, new methods are needed that can automatically process the increasing amounts of data.

Therefore we developed an adaptable approach for pixel-based compositing and (supervised) classification that refuses the common use of static time windows or user defined temporal anchor points. This purely data-driven approach aims at autonomously defining time periods within the classification year based on the number of available cloud-free training pixels. The adapted time periods may vary in length, and their distribution over the year may vary between study sites. However, the number of periods is always maximized under certain conditions to best capture crop/tree phenology.

In each of these periods one cloud-free training pixel composite is generated. A multi-temporal composite of all time periods is then passed to a random forest classifier (RF) for training. However, pixels to be predicted might not be cloud-free in the specified periods. To classify these pixels, only a composite subset is passed to RF that corresponds to the combination of time periods in which the pixel to be predicted is cloud-free. Thus, multiple random forest models are calculated during our adaptable classification approach. This allows us to use RF's OOB error to assign the average model performance to each pixel in addition to the classification result.

Based on this method, we present a Germany-wide crop type classification, which has been developed using extensive reference data from the Integrated Management and Control System. With an overall accuracy of 88.5 %, 19 crop types (including, among others, various summer/winter cereals, maize, legumes, rapeseed, potatoes, sugar beets, grassland) could be distinguished.

Currently, the same method is applied for a nationwide tree species classification to better quantify the conservation status of forests. In a pre-study using RapidEye data to classify eight individual tree species and one mixed deciduous forest class, the overall accuracy was 71.3%. For birch, spruce, Douglas fir and pine, a producer's accuracy of over 80% has been achieved; the highest user's accuracy is 90.5% (oak). Homogeneous forest patches are clearly reflected in the classification map.

In addition to the classification results, our contribution will show that the presented data-driven and adaptable method for pixel-based compositing and classification is easily applicable to any study site with different conditions in terms of reference data, species composition, cloud cover or satellite data availability.