Temporal compositing using the hyperspectral DESIS image archive

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Building temporal composites using the extensive archives of the multispectral workhorses Landsat and Sentinel-2 becomes increasingly important for environmental studies such as land cover classification, urban studies, and soil parameter retrievals. With the recent launches of spaceborne hyperspectral instruments such as DESIS, PRISMA, and EnMAP, the generation of hyperspectral temporal composites is enabled. The hyperspectral DESIS instrument onboard the ISS has been acquiring hyperspectral data since 2018. With about 240,000 scenes, the DESIS mission has generated the largest hyperspectral archive worldwide with many areas that are observed more than 40 times. The accumulation of long-standing observation requests now permits the temporal stacking of its data. DESIS is designed to capture radiation within the visible to near-infrared spectrum, encompassing wavelengths spanning from 400nm to 1000nm, subdivided into 235 bands. Each DESIS scene provides coverage over a geographic expanse of up to 1500 square kilometers, at a spatial ground resolution of 30 meters.

In the context of the German state of Bavaria, our dataset comprises an extensive collection of over 560 DESIS scenes, all of which were acquired between the years 2018 and 2022. These scenes serve as components for generating several hyperspectral cloud-free composites, which are obtained by the following methods.

First, the distribution of these scenes across the state is not uniform, prompting an investigation into the minimum number of individual scenes required to produce visually seamless composites. Second, our study explores diverse methodologies to address outliers, including cloudy pixels that remain unmasked by cloud detection. We conduct a comparative analysis including basic statistical measures such as mean and median compositing, alongside more intricate approaches. Additionally, we incorporate an extra step to eliminate hazy pixels from the composite stack. Finally, in areas of higher data density, we apply pixel classification techniques to generate specialized composites, such as a dedicated soil composite. These in turn allow for the modeling of topsoil parameters such as soil organic carbon in a higher accuracy than using multispectral composites.