Multi-spectral misregistration of Sentinel-2A/MSI images

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This study aims at analyzing sub-pixel misregistration between multi-spectral images acquired by the Multi-Spectral Instrument (MSI) aboard Sentinel-2A remote sensing satellite, and exploring its potential for moving target and cloud detection. The MSI is designed in such a way, that the sensor’ s detectors for the different spectral bands are displaced from each other. This introduces a parallax angle between spectral bands that can result in along-track displacements of up to 17 km in the Sentinel-2A scene. Corresponding corrections using a numerical terrain model are performed to remove these inter-band displacements, so the MSI images, acquired in different spectral bands, are co-registered at the sub-pixel level to meet the requirement of 0.3 pixels at 99.7% confidence. However, these pre-processing routines cannot fully correct displacements for high altitude objects, e.g. clouds or fast moving objects such as airplanes or cars. Therefore, these types of objects appear displaced in images for different spectral bands. We apply a phase correlation approach to detect sub-pixel shifts between B2 (blue), B3 (green) and B4 (red) Sentinel-2A/MSI images at 10 m spatial resolution, and B08 and B8A at 20 m resolution. We show that shifts of more than 1.1 pixels can be observed for moving targets, such as airplanes and clouds, and can be used for cloud detection. We demonstrate that the proposed approach can detect clouds that are not identified in the built-in cloud mask provided within the Sentinel-2A Level-1C (L1C) product.

Keywords: Sentinel-2, misregistration, multi-spectral

