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Increasing the accuracy of MODIS products by novel preprocessing methods

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The Moderate Resolution Imaging Spectroradiometer (MODIS) instruments mounted on NASA's Terra and Aqua satellites have been providing continuous observations on 36 spectral bands between 0.405 and 14.385 micrometers, with three spatial resolutions: 250m, 500m and 1km nominal pixel sizes at nadir every one to two days. MODIS data are made available free of charge to the scientific community. A whole suite of derived products is produced in a systematic manner and can be used for research purposes. Therefore, MODIS data have been increasingly used among different disciplines. However, these data have some intrinsic characteristics that make their processing a delicate issue. With 55-degree across-track scan angle of MODIS and the view zenith angle being larger than the scan angle, the observation dimensions increase both in along-track and along-scan directions. This means that the actual ground pixel size changes continuously off-nadir, and also causes an increasing overlap of the scan lines. A raster dataset, by definition, cannot store observations of varying dimensions without the need of resampling and thus modifying the data itself. All kinds of resampling carried out due to the fixed cell size inevitably result in artefacts in the data. The MODIS gridding process also has a large influence. The MODIS Data Processing System (MODAPS) uses predefined grids for storing and processing MODIS observations. The predefined MODIS grid cells have a size corresponding to the nominal observation dimensions at nadir. In the gridding process, all observations (image pixels) are stored in a grid cell based on a nearest neighbour resampling algorithm. Therefore, close to the swath edge, several adjacent grid cells

will share the same observation. Moreover, the average overlap between grid cells and "real" observations (referred to as "observation coverage") is less than 30%. In addition, the triangular shape of the MODIS Point Spread Function causes that for a MODIS pixel, approximately 25% of the signal is originating from adjacent pixels while 75% comes from the nominal observation area. As a consequence of the above-mentioned effects, the accuracy of current MODIS data at its original resolution is not sufficient for carrying out pixel- or subpixel-level studies such as spectral unmixing or pixel-level change detection. Spatial or temporal aggregation are widely used to cope with these issues, but they lead to a considerable loss of information. In this work, we propose and demonstrate an alternative solution. This solution is based partly on the vector data model, widely used in GIS applications. By using MODIS swath products and geolocation datasets instead of gridded MODIS data, all necessary information is available to determine the accurate ground location, dimensions and orientation of each MODIS pixel. Then, a polygon layer is created, in which each polygon represents the real Earth surface sensed during image acquisition. Thus, the image is stored in polygon instead of raster format. Although the vector data model requires more effort and computing power, it represents the observations in a more adequate and reliable way. On the other hand, the effects of the triangular PSF are minimised by deconvolution. For temporal studies, MODIS time series can then be calculated by intersecting spatial object boundaries (or a standard grid) with the MODIS polygons and calculating area-weighted averages. To test the increase of accuracy yielded by the new methods, high resolution (HR) SPOT and ASTER satellite images are used. The correlation of the same-day HR and MODIS observations in the same spectral bands is used as an indicator of data accuracy. The results are encouraging. The original 250-m MODIS reflectance products in the red and near infrared domains show coefficient of determination values of 0.4-0.6, whereas with the new method we have reached 0.8 with the HR images over the same study areas. The effects on the time series are still being investigated, and the results could be presented at the Conference.