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A comparison of MERIS and MODIS data for land cover characterization

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Abstract. Knowledge of land cover characteristics and spatial distribution of landscape features is important for many activities, including environmental monitoring, land planning, and resource management. Amongst all those different fields of action, land cover characterization and change analyses are common tasks that undoubtedly benefit from the use of earth observation images and are increasingly dependent on such information. With the recent launch of MODIS and MERIS imaging sensors, a wide range of new possibilities for high periodic land cover characterization at regional scale is available. We believe that the exploitation of data obtained by these new sensors fills previous technological gaps, improving land cover classes discrimination. In this work we compare the ability of MODIS and MERIS imagery for the regular production of land cover cartography in Portugal. Moreover, we exploit some unconventional algorithms for land cover classification, such as Support Vector Machines, still of confidential use in the remote sensing community.

Keywords: land cover classification, MODIS, MERIS, Support Vector Machines, classificação de ocupação do solo, MODIS, MERIS, Support Vector Machines.

Extend Summary

At regional level, a number of remotely sensed data sources, including Landsat Thematic Mapper (TM), *Satellite Probatoire d'Observation de la Terre* (SPOT), and Advanced Very High Resolution Radiometer (AVHRR), have been commonly applied to derive comparable land cover products (Defries and Belward 2000). In Portugal, these products have been recurrently employed in a broad number of different applications, including vegetation mapping, estimation of biomass, and forest fire risk predictions from numerical models that require updated land cover information. Indeed, vegetation is the most favoured land cover type in mapping activities within the Portuguese mainland territory. Every year, hundreds of hectares of wooded areas disappear as a consequence of severe forest fires and illegal clear cuts, thus demanding regular inventories, while agricultural areas need to be constantly supervised and managed to guarantee European Community supports. Time series of satellite images acquired by sensors with high spatial and spectral resolutions seem to be the most adequate data to map vegetation, namely by following their phenologic status along one year period (Knight *et al.* 2006). Until recently, 1 km spatial resolution AVHRR was the only sensor on orbit with a temporal resolution large enough (one day) to follow vegetation temporal spectral profiles. However, the AVHRR instrument possesses only two broad spectral bands for land observation that are sometimes insufficient to distinguish subtle differences in vegetation types with similar annual phenologies (Borak and Strahler 1999). On the other hand, sensors with higher spatial and spectral resolutions, such as Landsat TM and SPOT, have incomplete spatial coverage, infrequent temporal coverage with inevitable atmospheric contamination, and the associated large data volumes not practible in operational program contexts, thus making difficult the regular production of comparable regional land cover products (Defries and Belward 2000).

Recently launched Earth Observation (EO) sensors, such as the MEdium Resolution Imaging Spectrometer (MERIS) and the Moderate Resolution Imaging Spectroradiometer (MODIS), exhibit enhanced spectral and temporal resolutions, wide geographical coverage and improved atmospheric corrections, while offering new potentials and challenges to automatic land cover classification (Carrão *et al.* 2006). Specifically, MERIS and MODIS possess temporal resolutions comparable to that of AVHRR, but superior spectral and spatial resolutions (up to 300 and 250 m, respectively). Thus, MERIS and MODIS data are better suited for a broad range of national applications that require frequently updated fine-scale land cover information with a broad number of classes. However, while similar in spatial resolution, these sensors present significantly different ranges of spectral wavelengths. MERIS sensor measures the solar radiation reflected by the Earth in 15 spectral bands, ranging from the Visible to the Near-Infrared spectral regions (390 nm to 1040 nm) at a maximum ground spatial resolution of 300 m, and provides the most radiometrically accurate data on Earth surface that is currently acquired from space (Curran and Steele 2004). On the other hand, MODIS imagery data with 500 m spatial resolution measures the Earth's surface reflectance in seven spectral bands, ranging from the Visible to the Mid-Infrared spectral regions (459 nm to 2155 nm). The narrow spectral bands of MERIS covering a small range of the electromagnetic spectrum and the broad spectral bands of MODIS covering a considerably large region will certainly provide different means for automatic land cover classification.

In this study we compare the overall classification performances achieved with MODIS and MERIS spectral data acquired during 2005 summer time in Portugal. This is a preliminary study in the framework of an on going research work that aims at developing a systematic classification methodology for the regular production of land cover cartography from medium spatial resolution satellite imagery. We do not explore classification techniques that take advantage of the enhanced temporal resolution of these sensors (e.g. temporal composites of spectral bands and vegetation indices), because previous studies have shown that high spectral data, acquired within particular periods of the year, provide enough information in quantifying biophysival characteristics of vegetation (e.g., Gonçalves *et al.* 2006; Carrão *et al.* 2006). To completely evaluate the ability of the high spectral resolution of these data for land cover characterization, we seek for the separation between 19 land cover classes within a single date. Moreover, we discuss per class accuracies derived from data of each sensor and evaluate the differences that occur in a spectral mixing context. The spectral analysis per land cover class expose the efficiency of each sensor on the discrimination of specific land cover types and henceforth particular classification strategies in each situation. Land cover classification results were computed with Support Vector Machine (SVM), a recently proposed supervised classification system that is insensitive to space dimensionality of input data, while yielding better classification results than conventional algorithms, such as Artificial Neural Networks and Maximum Likelihood Classifier (Pal and Mather 2005).

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