

Using MOD16 products for analyzing evapotranspiration and evaporation on the surface of lakes. Case studies in Romania

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Evapotranspiration and evaporation are some of the most complex atmospheric processes and major components of the water balance. The knowledge of these processes at several spatial and temporal scales has great practical importance in the field of water resources management and agriculture. However, the direct measurement of these parameters is generally a problem, because it requires accuracy and instruments (lysimeters and pans) difficult to install; therefore many equations based on physical processes or vegetation stages have been proposed by different scientists (Thornthwaite, Penman, etc.). The use of remote sensing is a good alternative to estimate the evapotranspiration, by taking advantage of the new generation of Earth Observation Satellites. In recent years, a remote sensing product from the MODerate Resolution Imaging Spectrometer - MOD16 has been developed. The MOD16 algorithm (Mu et al. 2007) combines on the one hand remote sensing data on land cover, albedo, leaf area index and in the other hand radiation, air temperature and vapor pressure deficit data, in order to estimate real evapotranspiration (ET) and potential evapotranspiration (PET), at 1 km² resolution. Until now the MOD16 products were not used in the Romanian studies, so the product accuracy is unknown.

The main objective of this study is to correlate the MOD16 ET and PET products with the evaporation (E) data measured at the surface of some lakes (Căldărușani, Solești, Cinciș), located in different climate and landform conditions in Romania, in order to establish the relationships between those parameters, that could allow estimate indirectly the evaporation, based on the MODIS products. We correlated the daily recorded pan evaporation data with the MOD16 products, by taking into account R² coefficients. Eight-day cumulative evaporation data from the considered pans was calculated to coincide with the eight-day MOD16 products over 2010 - 2012. A secondary purpose of the paper is to analyze the spatial distribution of PET on the surface of the studied lakes, based on the data derived from satellite images, using GIS analysis functions.

The results indicate strong correlation (R² up to 0.85) between E measured on the surface of the lakes and PET, and lower correlation between E and ET (R² up to 0.31), based on eight-day cumulative data. Results are further improved when aggregated to the annually time scale (e.g. only for 2010), so for the relation between E and PET the R² is up to 0.90, and for E and ET R² is up to 0.92. Concerning the spatial distribution of PET on the lake surfaces, maximum values were identified, where the lake presents the greatest width.

Based on the strong correlation identified between PET satellite product and E, we could use this relationship in the future for estimating the evaporation for unmonitored lakes. Considering the low spatial resolution of the MOD16 products, the possible errors related to land cover around the lake should be considered, especially if the lakes are small.

Keywords: evapotranspiration, evaporation, lakes, MODIS, MOD16 products, Romania.