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EVALUATION OF SENSIBLE HEAT FLUX FROM REMOTE SENSING AND EDDY CORRELATION DATA FOR TWO PORTUGUESE CORK-OAK FORESTS

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INTRODUCTION

Energy balance is a major determinant of Earth surface temperature and climate. However, the physics of energy balance computations are complex and vary in space and in time. Most of the data available on the energy balance of non-agricultural systems is from local measurements, only representative of the area around the measuring point. To overcome this, remote sensing techniques have been widely used, particularly in studies on the temporal land-cover changes and on their influences on the energy and water balances. Several remote sensors with different spatial, temporal and spectral resolutions have been used to understand these processes. In many applications, the main objective is to understand how landscape's changes over time can influence regional climate. Orbital information enables the analysis of the spatial and temporal features of the Earth's surface, and to understand the interactions between different land-cover types with topography, atmospheric and anthropogenic action. However, to test for accuracy and precision, data from satellite sensors and their derivatives need to be compared with ground-level field data.

OBJECTIVES

This study aimed to evaluate/test sensible heat flux estimates from the SEBAL algorithm, using images by Thematic Mapper (TM) sensor aboard Landsat 5 satellite, with those measured at ground level by eddy covariance in two sites.

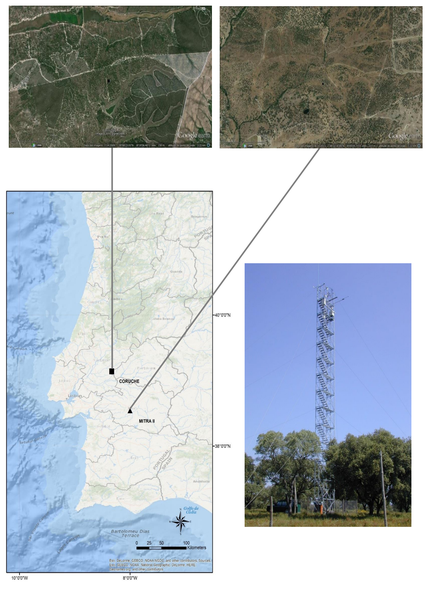
STUDY AREA

Eddy covariance data was collected at the top of micrometeorological towers installed at two different experimental sites in Portugal (Pereira *et al.*, 2007; Costa-e-Silva *et al.*, 2015).

The first site (Mitra II) is a sparse, savannah-type evergreen oak woodland with Quercus *ilex* ssp. *rotundifolia* Lam. and *Quercus suber* L. trees, located at Herdade da Alfarrobeira - Southern Portugal (38° 32' N, 8°00' W, 256 m a.s.l.). The understorey consists of grazed pasture dominated by herbaceous annuals, some drought deciduous graminea and a few shrubs (*Cistus* sp.).

The second site (Coruche), is a ca. 50-yr-old cork oak (*Q. suber*) open plantation, located at Herdade da Machoqueira - Central Portugal (39°08'N, 8°19'W, 150 m a.s.l.). Understory is native grassland and semi-deciduous shrub species (e.g., *Cistus* sp. and *Ulex* sp.) .

At both sites the topography is slightly undulating and climate is Mediterranean, with mild, wet winters and hot, dry summers. Long-term average annual rainfall and mean air temperature are around 670-680 mm and 15-16° C, respectively.

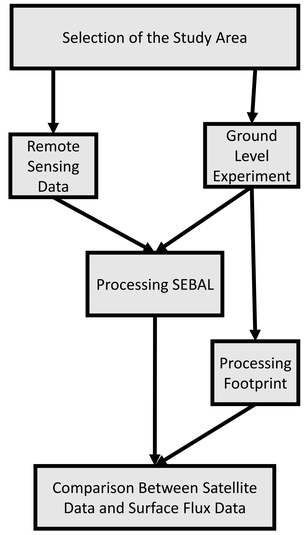


METHODOLOGICAL APPROACH

Footprints of the eddy covariance sensible heat flux measurements were calculated for six scenes of the TM sensor, allowing the comparison between satellite and surface flux data.

Sensible heat fluxes were calculated by the Surface Energy Balance Algorithm for Land (SEBAL) model (Bastiaanssen *et al.*, 1998), one of the several algorithms used to extract information from satellite sensors. Through this algorithm it is possible to estimate the components of the energy balance (Rn, G, H) and actual evapotranspiration (ET) for each image pixel (Bastiaanssen & Ali, 2003).

The footprint density function was calculated following Detto *et al.* (2006) and Li *et al.* (2008): a two-dimensional footprint model was applied extending the one-dimensional formulation of Hsieh *et al.* (2000) and assuming a Gaussian distribution in the crosswind direction. The density function was evaluated for a grid of points, dynamically adjusted to the extension of the footprint for 30-min averaged fluxes and rotated into the wind direction. This grid was overlaid with Landsat pixels, and remotely sensed modeled fluxes were averaged assigning weighting factors representing the influence of each Landsat pixel to the actual flux measurement.

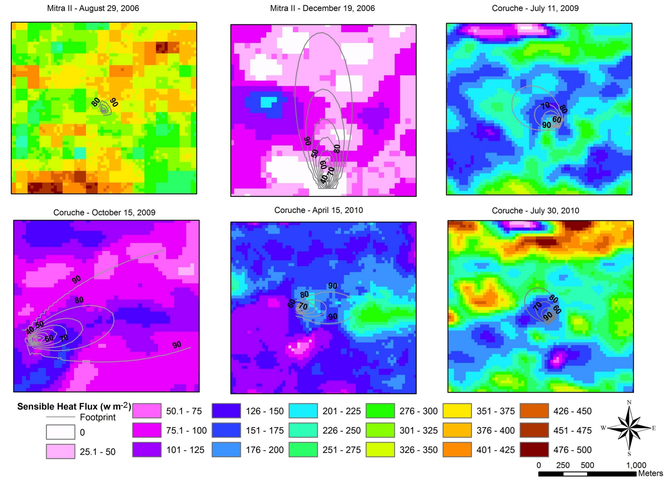


RESULTS

Results showed a high correlation between sensible heat flux data derived from remote sense and ground-level measurements (R^2=0.94).

SITE	DATE (*dd/mm/yyyy*)	SENSIBLE HEAT FLUX (W m^{-2}) SEBAL	EDDY COVARIANCE	DIFFERENCE (%)
MITRA II	29/08/2006	323.0	313.1	3.2
MITRA II	19/12/2006	44.5	49.0	-9.3
CORUCHE	11/07/2009	173.0	175.8	-1.6
CORUCHE	15/10/2009	100.4	47.8	109.9
CORUCHE	25/04/2010	166.4	149.0	11.7
CORUCHE	30/07/2010	168.8	182.9	-7.8

RESULTS



CONCLUSION

The used remote sensing technique seems useful to estimate sensible heat fluxes and may be a valuable tool for understanding vegetation dynamics in space and time.

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