European Geosciences Union-General Assembly 2013

Spatial resolution effects on the assessment of evapotranspiration in olive orchards using high resolution thermal imagery

Cristina Santos [1], Pablo J. Zarco-Tejada [2], Ignacio J. Lorite [1], Richard G. Allen [3]

[1]IFAPA-Alameda del Obispo, Córdoba, Spain (*cristinam.santos@juntadeandalucia.es*), (*ignacioj.lorite@juntadeandalucia.es*)
[2] IAS-CSIC, Córdoba, Spain (*pablo.zarco@csic.es*) [3]Universiy of Idaho, Kimberly, USA (*rallen@kimberly.uidaho.edu*)

INTRODUCTION

The use of remote sensing techniques for estimating surface energy balance and water consumption has significantly improved the characterization of the agricultural systems by determining accurate information about crop evapotranspiration and stress, mainly for extensive crops. However the use of these methodologies for woody crops has been low due to the difficulty in the accurate characterization of these crops, mainly caused by a coarse resolution of the imagery provided by the most widely used satellites (such as Landsat 5 and 7). The coarse spatial resolution provided by these satellite sensors aggregates into a single pixel the tree crown, sunlit and shaded soil components. These surfaces can each exhibit huge differences in temperature, albedo and vegetation indexes calculated in the visible, near infrared and short-wave infrared regions.

Recent studies have found that the use of energy balance approaches can provide useful results for nonhomogeneous crops (Santos et al., 2012) but detailed analysis is required to determine the effect of the spatial resolution and the aggregation of the scene components in these heterogeneous canopies.
In this study a comparison between different spatial resolutions has been conducted using images from Landsat 7 (with thermal resolution of 60m) and from an airborne thermal image (with resolution of 0,8 m) flown over olive orchards at different dates coincident with the Landsat 7 overpass, in order to avoid any difference in temperature or crop characteristic.

MATERIALS AND METHODS

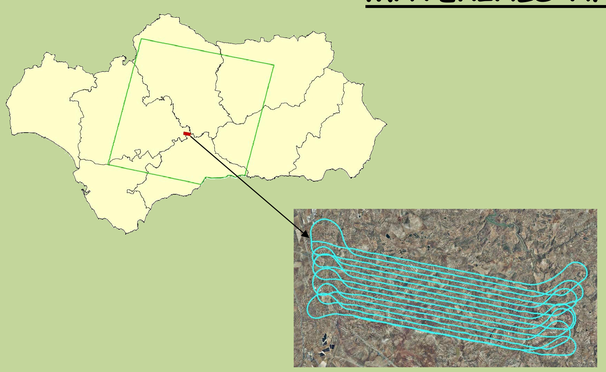


Figure 1. Study site with Landsat 7 overpass (green square) and flight area

Figure 2. View of the aircraft employed for the collection of the thermal images

The selection of the study area was made to avoid those areas with missing Landsat 7 data caused by SLC-off gaps. The selected area has a total area of around 2500 ha and is located in Southern Spain, between the provinces of Seville and Malaga (Fig. 1). This area is mainly cultivated with olive orchards with different crop practices (rainfed, irrigated, high density, traditional, young and adult olive). The METRIC surface energy balance model (Allen et al., 2007) was applied for evapotranspiration assessment using the data provided by Landsat 7 for three days during the summer of 2012. METRIC-based ET estimates were improved by Santos et al. (2012) for sparse woody canopies by using the Perrier roughness function based on LAI and tree canopy architecture, coupled with olive heights.

Thermal images with 0.8 m resolution were obtained over the study site by a Panasonic Lumix DMC-GF1 camera (4000 x 3000 pixels) mounted on manned aircraft (Figure 2).

RESULTS

The flights and the Landsat 7 dates were July 6, August 23 and September 8, 2012, and they were collected over 10:50 GMT. Figure 3 (a) shows airborne thermal imagery acquired over the study site, where surface temperature values are an average of crown, shadow and sunlit temperature values, for the three dates.
METRIC surface temperature maps from Landsat 7 (with 60 m resolution) were also obtained for the same dates (Figure 3b).
Although METRIC was not applied with the aero data, the crown/soil/shadow temperatures were used to improve understanding of the relationship between bulk Ts in Landsat and METRIC and the actual canopy temperature that impacts and indicates transpiration.
The spatial resolution of the airborne imagery shows individual tree crown, enabling pure crown temperature extraction (Figure 4). Well-irrigated trees are easily recognized from the rest of olives in the field.

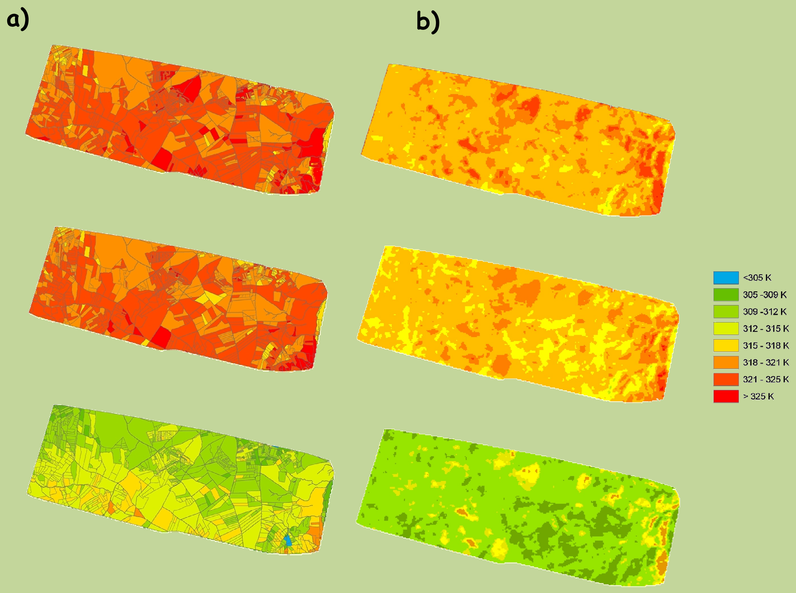
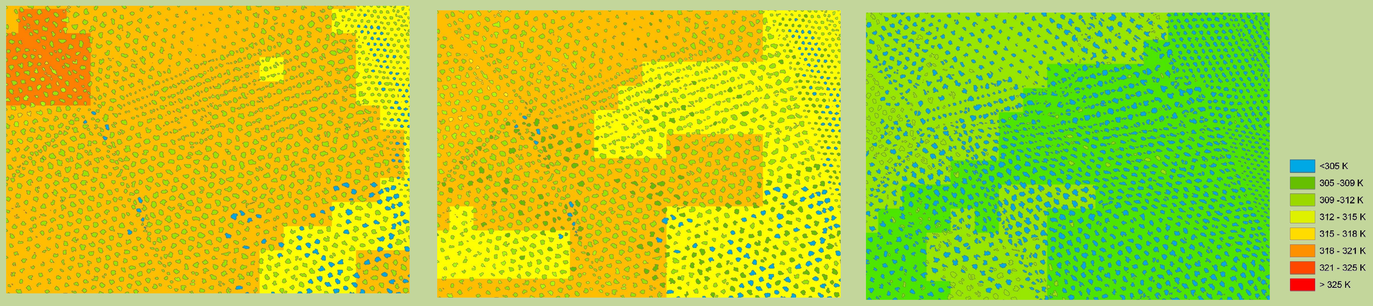


Figure 3. Airborne and Landsat 7 thermal imagery acquired over the study site over 10:50 GMT on July 6, August 23 and September 8, 2012

Figure 4. Olive pure crown temperature values over METRIC surface temperature maps for the three dates



Evapotranspiration from the olive fields was assessed using the METRIC satellite-based energy balance model improved using a methodology that tailored z_{om} estimation to the olive crops by using an average Perrier factor of 0.089, similar to that defined by Santos et al. (2012), and olive heights (Figure 5).

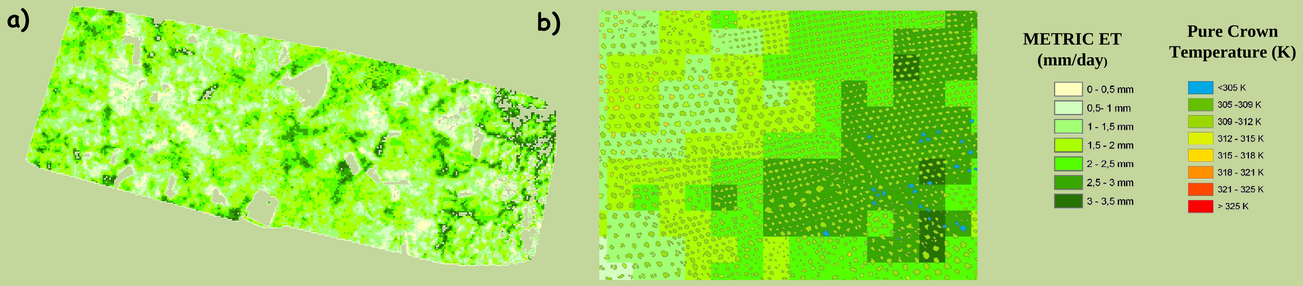


Figure 5. a) Daily olive evapotranspiration determined by METRIC on July 6, 2012 for the study area; b) Detail of olive field evapotranspiration and tree shaped crown temperature

REFERENCES

Allen RG, Tasumi M, Trezza R (2007) Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC) – Model. Journal of Irrigation and Drainage Engineering ASCE 133(4):380-394

Santos C, Lorite IJ, Allen RG, Tasumi M (2012) Aerodynamic Parameterization of the Satellite-Based Energy Balance (METRIC) Model for ET Estimation in Rainfed Olive Orchards of Andalusia, Spain. Water Resources Management 26:3267-3283