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Hydrology and Earth System Sciences Discussions

Interactive comment on "Combining remote sensing and GIS climate modelling to estimate daily forest evapotranspiration in a Mediterranean mountain area" *by* J. Cristóbal et al.

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Reviewer general comments: Quantifying ET for a long time period and at large scale remains difficult. The researchers conducted an interesting study that aims at evaluating estimation errors by comparing multiple remote sensing techniques and measured sapflow data for pine forest. The methods of estimating daily ET are sound and well documented, and the paper is easy to read. The authors concluded that MODIS data are not appropriate to estimate local ET of a pine forest.

Reviewer Comment 1.1: My only concern is the validation data are not well described

and so difficult to judge how the models perform. For example, it is unclear what the data points for daily ET in the figures represent.

Authors reply to comment 1.1: We have improved the figure 1 caption in order to clarify this in the text. In addition we have included a reference of the symbols of figure 1 in the text.

"Figure 1. Location of SMC meteorological stations and Vallcebre research catchments in Universal Transversal Mercator (UTM) projection (UTM coordinates are expressed in km). The white dots are meteorological stations from the SMC that include air temperature sensors, the black dots are meteorological stations from the SMC that include net radiation sensors, and the black triangle indicates the Vallcebre research catchments. Figure A is the Landsat-TM LST of 01/07/2003 and figure B is the TERRA MODIS LST of 10/07/2003 of the Vallcebre research catchments (black triangle). The red square represents a Landsat-TM thermal band pixel (120m) and the yellow square represents a TERRA MODIS thermal band pixel (1000m). In A and B figures, the white dot is the Scots pine stand."

Page 1131, line 8: Figure 1 shows the location of the Vallcebre research catchments where the sap-flow measurements were taken (black triangle).

Page 1131, line 8: "Figure 1 shows the spatial distribution of these two sources of meteorological data (meteorological stations that include an air temperature sensor are represented by white dots and meteorological stations that include a net radiation sensor are represented by black dots).

Reviewer Comment 1.2: Are they averaged from several days in a month or just for one day. If they are only periodic measurements of sapflow, I would say the validation data are too short to make any conclusions.

Authors reply to comment 1.2: The data is not an average from several days or a month. Sap flow data was measured every 10 seconds and 15-minute means were stored in

a datalogger. Then, these values were aggregated to obtain daily stand transpiration, which is the value directly compared against remotely-sensed ET. We have improved the text in order to clarify this fact:

“Sap flow density in the outer xylem was measured with 20 mm long heat dissipation probes constructed according to Granier (1985); 15-minute averages of data collected every 10 seconds were stored in a datalogger, DT 500, DataTaker, Australia.“

“Stand transpiration was then calculated by multiplying the average sap flow density within a diametric class by the total sapwood area of trees in that class. Instantaneous values (15-minute averages) were then summed to compute daily stand transpiration”

Reviewer Comment 2: In addition, I challenge that daily ET estimated by the energy balance method can be compared to stand level total ET for two reasons 1)Canopy interception, often 10-20% of precipitation, has to be considered unless the comparisons have been made to days, ie, ET = T; 2) understory T is minor - the author stated so.

Authors reply to comment 2: In order to avoid canopy interception and to make sap-flow measurements fully representative of ET canopy we selected clear sky dates where no precipitation was present during at least 15 days before and after the selected day.

For a better understanding of the text we have included this in the “2.2 Meteorological and remote sensing data” section.

“A set of 30 TERRA-MODIS images and 27 AQUA-MODIS images and a set of 11 Landsat-7 ETM+ and 10 Landsat-5 TM images from paths 197 and 198, row 31 were selected to perform the ETd modelling of the Scots Pine forest stand from 2003 to 2005. In order to avoid canopy interception and to make sap-flow measurements fully representative of ET canopy we selected clear sky dates where no precipitation was present during at least 15 days before and after the selected day.”

Reviewer Comment 3: Has the author compared reference ET to sapflow. During wet period, reference ET can be a good guide for estimating forest ET. I suspect the re-

ported ET for a pine fores was too low. No error discussion was made to the measured data.

Authors reply to comment 3: Reference evapotranspiration (ETo) is usually defined as the evaporation from low-statured vegetation (i.e. grassland or crop), completely covering the ground, under non-limiting conditions of water availability (Allen et al.,1998). Forests, in general, and particularly in a Mediterranean location, do not transpire at the rate expressed by ETo due to water limitations and the differences in structure between the a forest stand and the reference short vegetation cover. This has already been shown for our study site (Poyatos et al. 2005). Indeed, in the mentioned study it is clear that forest transpiration follows ETo more closely under no water deficits, but still, transpiration is much lower than ETo. Therefore, even during wet periods, reference ETo can be 50% higher than stand transpiration in the studied stand.

Seasonal values of stand transpiration are certainly not lower than those found in other Scots pine forests, and very comparable to Mediterranean pine stands (see section 4.2 in Poyatos et al. 2005).

Reviewer Comment 4: Also, insights can be drawn from comparison studies when the comparisons are conducted for different seasons when vegetation characteristics vary. It is unclear how long this study has been conduct and at what seasons.

Authors reply to comment 4: In page 1131, lines from 9-12, there is the period of time and the total number of images we used in this study. Monthly temporal distribution (percentage of images) of satellite data during 2003-2005, when the sap-flow measurements were taken, is showed in Figure 2 so, we think that this figure also explains the seasonal temporal distribution.

References

Allen RG, Pereira LS, Raes D, Smith M (1998) Crop evapotranspiration. Guidelines for computing crop water requirements. In: FAO (ed) FAO Irrigation and Drainage Paper

No.56, vol 56, Rome, p 290

Poyatos R, Llorens P, Gallart F (2005) Transpiration of montane Pinus sylvestris L. and Quercus pubescens Willd. forest stands measured with sap flow sensors in NE Spain. Hydrology and Earth System Sciences 9:493-505

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 1125, 2011.