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Discussions

Interactive comment on "Mapping evapotranspiration with high resolution aircraft imagery over vineyards using one and two source modeling schemes" *by* T. Xia et al.

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Response to Anonymous Referee (Referee #3)

In this paper, the comparison of two SEB approaches of different complexity based on airborne TIR observations over irrigated vineyards is carried out with a rigorous approach; significant details of the elaborations performed are given and the paper is generally more informative for the reader than other similar ones.

Reply: Thank you for your positive comments.

It should be noticed that the main concept (and the core) of DATTUTDUT model has

been already published by Roerink et al., in Phys. Chem .Earth, Vol. 25 (2):147-157). This latter reference is not present in the paper, but it has been given instead in Timmermans et al. (2015), where the only addition is a simple definition of radiometric temperature end-members in order to easily extract them from the image.

Reply: The reference to Roerink et al. (2000) describing S-SEBI is sited in Introduction and Model overview Sections. The similarity and difference between two models are emphasized in the revised paper on page 5 line 11-13: "The main concept of DATTUTDUT is similar to the S-SEBI (the Simplified Surface Energy Balance Index) proposed by Roerink et al. (2000); however, DATTUDDUT has a more simplified scheme to obtain radiometric temperature end-members and radiation-related factors." Thanks for reminding!

The sensitivity tests presented for both models highlight some interesting feature of both models. According to the results presented in the Table 4, an uncertainty of +/-3°C is not acceptable in TSEB. However, in the present paper no atmospheric correction has been applied to airborne TIR data (P11919-L18), diversely from VIS-NIR data. Atmospheric effects on radiometric temperature are certainly in the order of magnitude of 2-5°C, but the authors do not comment on this issue, which is quite relevant for the correct application of TSEB in general. To this extent, it might still be useful to further explore the possibility of introducing contextual (image-based) information in the TSEB model, similarly to the approach proposed by Cammalleri et al. (2012, Remote Sensing of Environment, 124: 502–515).

Reply: In this study, the atmospheric effects appear to be insignificant since the aircraft altitude is less than 500 m above ground level. Ground-based TR (calculated from upward longwave radiation measurements) was compared with TR from aircraft imagery collected during IOP 3 in Table R1 (ground-based TR was missing for the other IOPs). On DOY 218, TR from aircraft was close to ground-based TR (difference <1 °C). But on DOY 219, aircraft TR was ~3 °C higher than ground-based TR. In general, the atmospheric attenuation tends to reduce TR observed at the sensor altitude, so aircraft TR will increased after atmospheric correction is applied. The fact that no correction was applied suggests that the bias in aircraft TR is due to sensor calibration. Therefore, the atmospheric affects are probably not significantly influencing the aircraft-based TR observation. Table R1. Comparison of ground-based TR versus TR from aircraft imagery from IOP 3 (°C). DOY Site Ground-based TR Aircraft TR 218 1 28.04 27.3 2 30.06 30.9 219 1 27.29 29.8 2 29.17 32.5

In the final part of the text, the latent heat flux is used for calculating the water consumption at plot scale, with the aim of emphasizing the impact of TIR observations in operational water management. This part raises some questions. Indeed, the proposed approaches (and the description given in the paper) do not give most relevant information on irrigation scheduling (i.e. occurrence of water stress, soil water deficit) but just a "one-shot" picture on the day of observation. It would have been interesting to highlight which threshold values of the evaporative fraction could be considered as an indication of crop water stress conditions, or to which extent the crop water requirements are met (accordingly to the "standard conditions" defined by FAO56). This element would have improved the paper rather than the simple water consumption calculation.

Reply: This reviewer makes a good point concerning vineyard water consumption and water stress. However the level of stress experienced by vine plants is likely to be dependent on a number of factors, most notably the vine variety and phenology. In addition, the estimated ET is comprised of transpiration and evaporation from the vine row and inter-row systems and so determining vine stress requires reliably partitioning the ET and T and E from these two systems. This is not easily validated without canopy level measurements of leaf conductance, water potential and photosynthesis to understand the relationship between vine T and stress. Adopting reference ET from FAO56 as an indication of crop water stress condition is not advisable without a priori detailed information concerning the behavior of the crop coefficient for this particular vine variety. A detailed discussion about the calculation of actual ET and issues in

using FAO 56 crop coefficient approach is now included on page 24 line 16-30 and page 25 line 1-13: "Current operational techniques for estimating water use of crops primarily relies on the crop coefficient technique based on the FAO 56 publication (Allen et al., 1998). The actual ET of the crop is estimated by first computing a reference ET (ET0) which is then multiplied by the crop coefficient (KC). This single crop coefficient is often divided (called the dual crop coefficient) into a basal crop coefficient (KCb), which is associated with the crop transpiration and has been related to remotely sensed vegetation indicies (Neale et al., 1989) and a soil surface evaporation coefficient (Ke). There is also included a Ks coefficient to reduce crop transpiration for a deficit in water availability in the root zone so the expression has the form ET=(KCbKs + Ke)ET0. Determining Ke and Ks requires running a soil water balance model for the surface and root zone. A recent application of this methodology over corn and soybean croplands is given by Gonzalez-Dugo and Mateos (2008) where they find this reflectance-based crop coefficient technique can significantly overestimate ET during a prolonged dry down period. There also appears to be no consistent or universal relationship between crop coefficients and vegetation indices and so this approach is not readily transferable to different crops and climatic conditions (Gonzalez-Dugo et al., 2009). As an example, the spatial distribution of KC was computed using FAO 56 estimated ET0 and the ET map from TSEB from DOY 163 (Fig. 13). There is a significant spatial variation in KC due in part to the know effect of leaf area/fractional cover (Choudhury et al., 1994), which is seen in the correlation between the KC map and LAI map of Fig. 4, but there are other factors including the vine variety and possibility of some level of stress in areas of the vineyard that cannot be reliably detected by this approach. Using the ET measurements from the flux towers and FAO 56 estimated ET0, for the north vineyard site 1, the value of KC ranged from 0.55 for DOY 100 to 0.76-0.82 for the other days. For the south vineyard (site 2), KC values ranged from 0.59 for DOY 100 to 0.62-0.65 for the other days, indicating little variation in KC with vine phenology. In contrast, the FAO 56 manual recommends KC values for vineyards at early, peak and end of the growing season of 0.3, 0.7 and 0.45. Clearly, a calibration with this approach is required, which is not only dependent on vine variety but also on vine management (i.e., row orientation and spacing, pruning, irrigation scheduling, etc.)"

Some other specific comments: - It would be useful to give some comments about the influence of the flight acquisition time on the results. Were the flights time fixed in coincidence of Landsat overpass or there were other reasons?

Reply: Yes, an attempt was made to have at least one aircraft flight during each IOP \ center around Landsat overpass time in order to compare high resolution imagery from the airborne data with the courser resolution Landsat imagery. Since the visible and near-infrared reflectance bands on Landsat were used to develop a relationship with the aircraft sensor DN values this was very useful

- Why different equations are given for the LAI(NDVI) relationship on DOYs 163 and 218?

Reply: It was determined that the DN∼reflectance calibration of the aircraft NIR sensor was not constant over all IOPs which may have contributed to this changing relationship, but also vineyard management (i.e., vine training) likely altered the structure of the vine canopy between the two IOPs, thus affecting the LAI distribution and hence the NDVI-LAI relationship.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/12/C6540/2016/hessd-12-C6540-2016-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 11905, 2015.