Energy balance closure over a banana orchard in the semi-arid region of Brazil

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1. Introduction

Eddy covariance (EC) is a micrometeorological technique that has several distinct advantages, particularly over tall canopies (Baldochi, 2003) and it is the most advanced "in situ" measurement technologies that directly provide actual evapotranspiration, but it is widely known to have energy balance closure problems. This closure requires that the sum of the measured latent (LE) and sensible (H) heat fluxes be equivalent to all other energy sinks and sources (Wilson et al., 2002). The typical value of the closure ratio for agricultural land is 0.8-0.9 (Twine et al., 2000).

Wilson et al. (2002) suggested that the surface energy fluxes (LE+H) are frequently, but not always, undermeasured by about 10-30% relative to estimates of available energy, i.e. the difference between net radiation (R_n) and soil heat flux (G).

Due to the need for information about energy balance in tropical regions, an important goal of this study is to analyze the energy balance closure in banana crop in the semiarid region of Brazil.

2. Materials and methods

The experiment was carried out at the Frutacor farm during the months of October/2005 to June/2006. This farm is located within the irrigation district of Quixeré, in Ceará state, Brazil. The crop was irrigated using subsurface drip irrigation.

The data were divided into two periods representing the dry season (October–December) and the wet season (February–May).

The eddy covariance (EC) system was used to conduct the turbulent flux measurements, it is composed of a gas analyzer (model LI-7500); a sonic anemometer (model CSAT-3); a net radiometer (model

CNR1); and two soil heat flux plates (model HFP01SC-L), as well as, a CR23X datalloger. In this data analysis was applied only the WPL correction (Webb et al., 1980). As the energy balance components were measured independently, it was necessary to check the energy balance closure:

$$CR = (H + LE)/(R_n - G) \tag{1}$$

3. Results and discussion

Energy balance closure is an important criterion for evaluating the quality of measured heat flux data from EC systems. In general, various studies have shown that this balance typically does not close (Twine et al., 2000).

In the dry growing season the energy balance closure varied between 0.79 and 1.05 with the mean value of 0.93, which can be considered as a good result (Figure 1a).

In the wet growing season, the energy balance closure values varied between 0.63 and 1.06 with a mean value of 0.86 (Figure 1b). These results are in agreement with Stannard et al. (1994) who reported typical values of energy balance closure for agricultural lands lie between 0.80 and 0.90 and according to Twine et al (2000) this error is tolerable for irrigation scheduling.

4. Conclusions

The energy balance closure presents good results for the banana crop area, with mean values of 0.93 and 0.86 for the dry and wet growing seasons, respectively.

5. References

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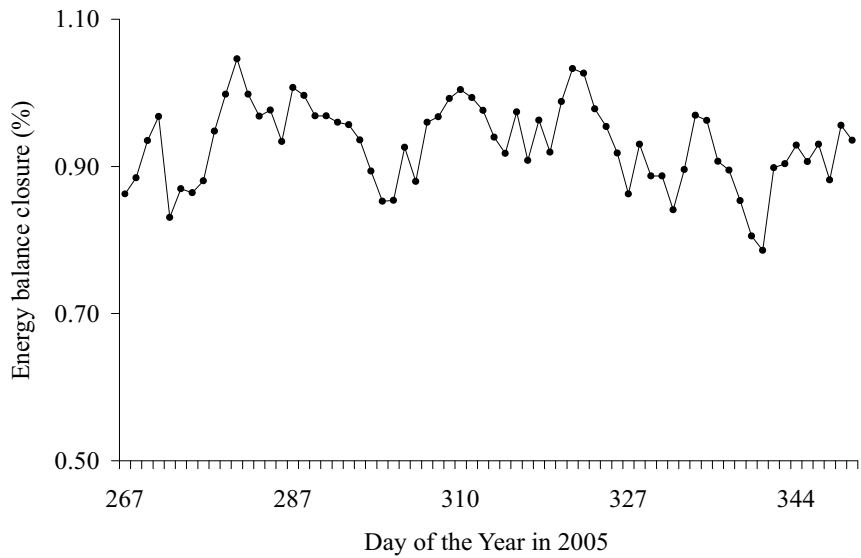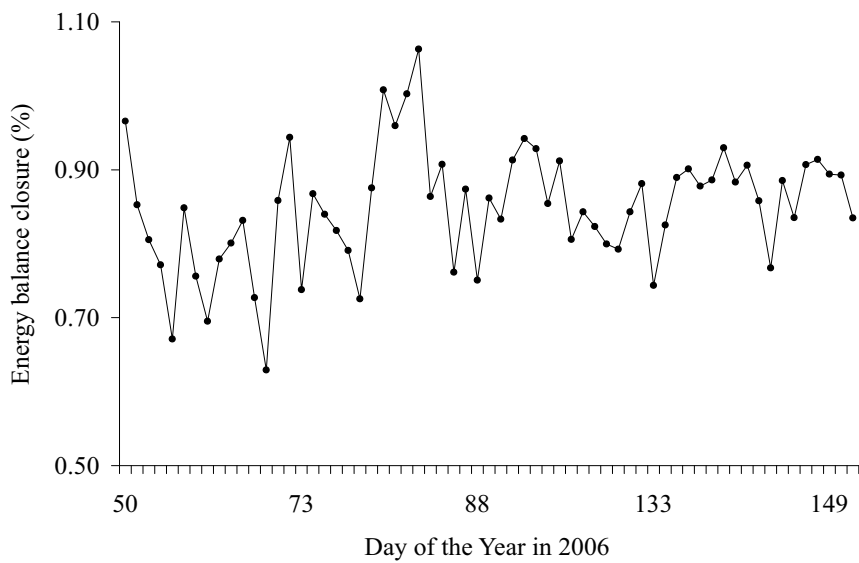
Figure 1. Energy balance closure for (a) 2005 (dry season).

Figure 1. Energy balance closure for (b) 2006 (wet season).