Processing eddy covariance data of a Cork-oak "Montado" in Portugal

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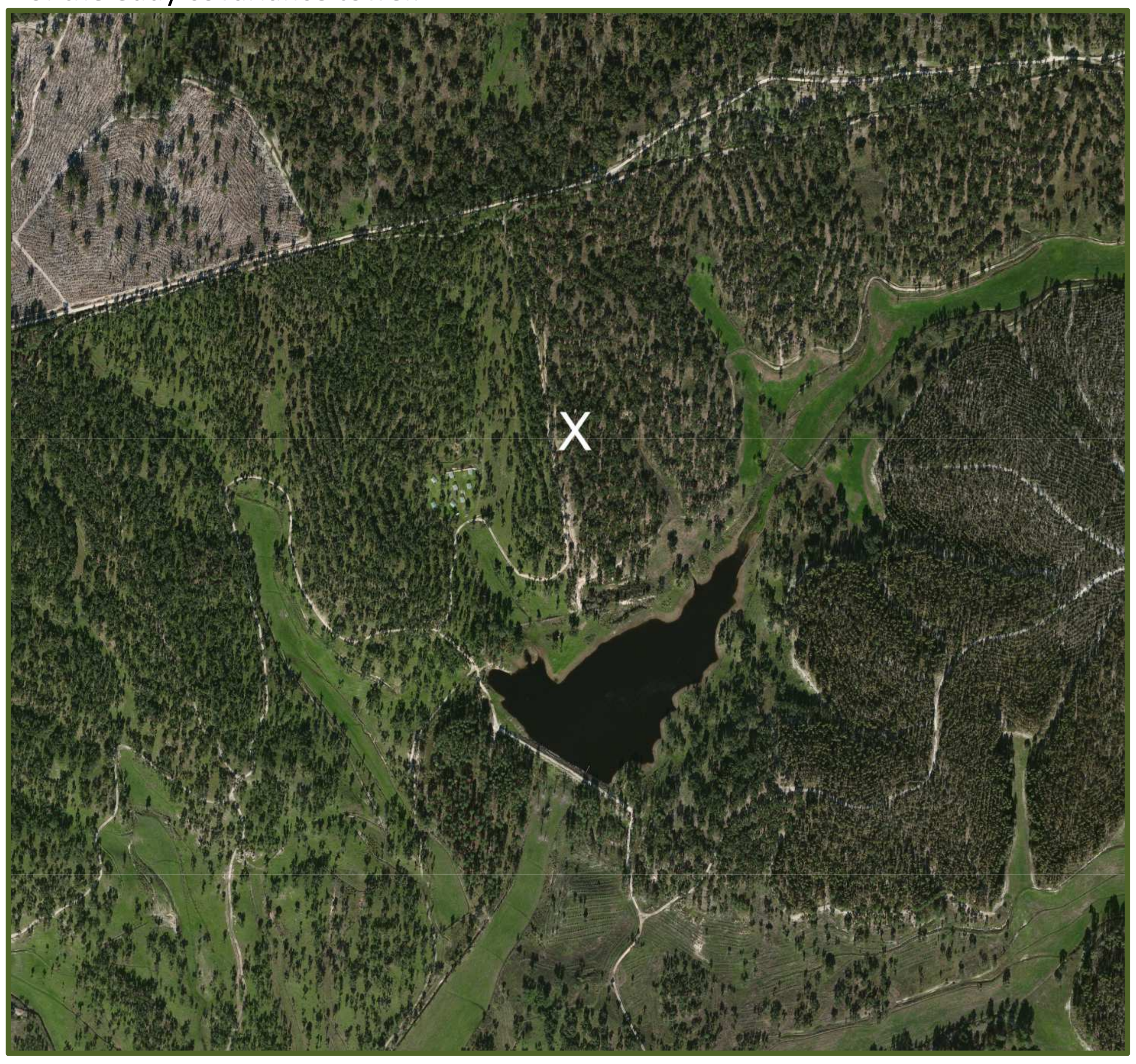
Objectives

The present work is an example of the work developed in the STSM " Eddy-Covariance data processing of a Cork-Oak Montado" (COST-STSM-FP1203-21550). The STSM took place from 19-4-2015 to 1-5-2015 in the Helmholtz-Zentrum für Umweltforschung (UFZ), Leipzig, under the supervision of Dr. Corinna Rebman. The main objective of the STSM was to transfer and share data and knowledge between the UFZ and the Instituto Superior de Agronomia (ISA) on Eddy covariance (EC) data processing in heterogeneous sites. Data collected from 2009 to 2014 was used in this STSM, allowing for tests with different meteorological conditions and different structures of data gaps.

Figure 1. Aerial view of the Machoqueira site. The cross marks the location of the eddy covariance tower.

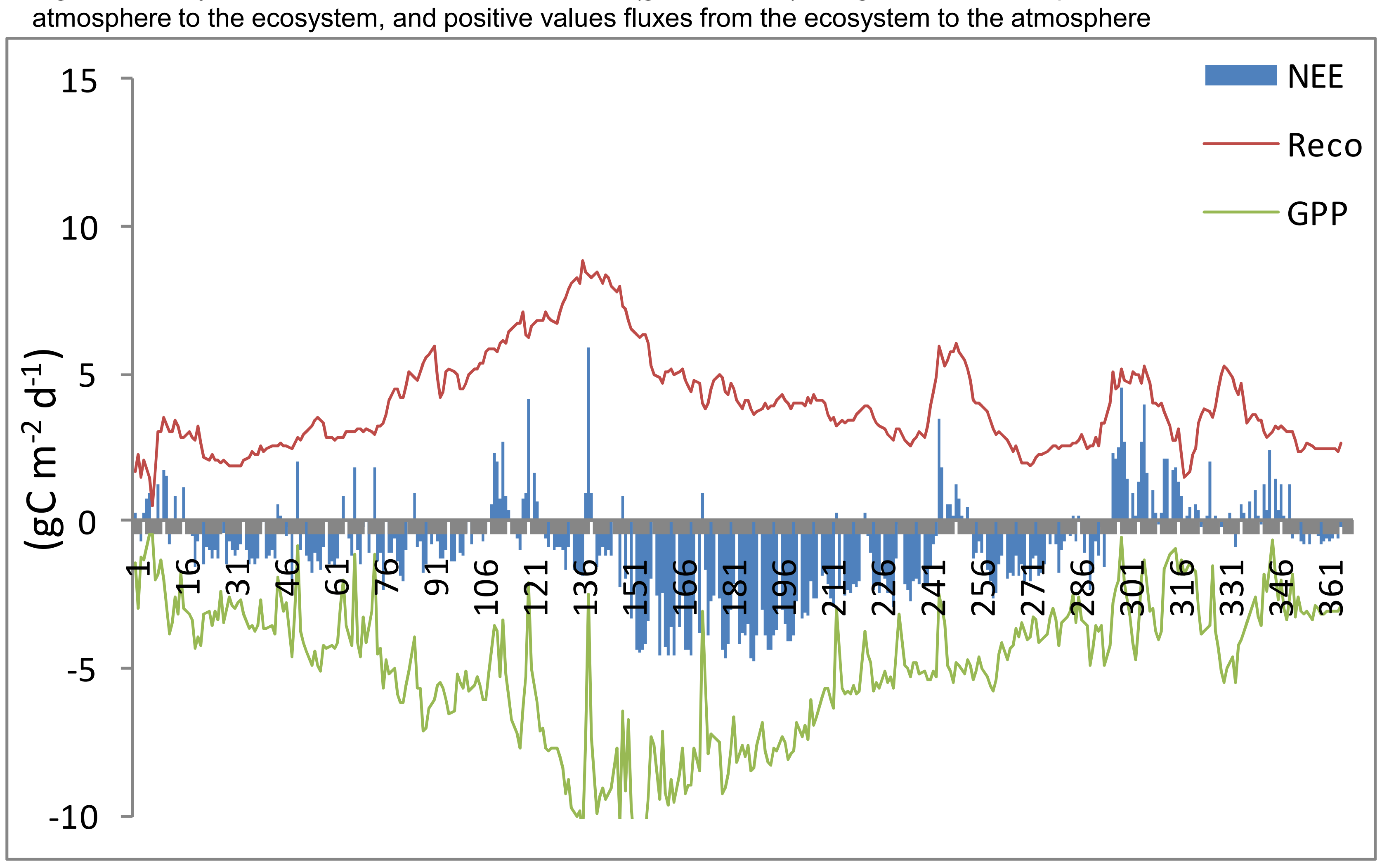


Methods

The study site is the PT-Cor savannah-type flux observation site of the European Integrated Carbon Observation System (ICOS). It is located in a private property (Herdade da Machoqueira do Grou) near the town of Coruche (39º8 0' N, 8º20' W, 162 m.a.s.l.). The dominant vegetation is cork-oak (*Quercus suber* L.), managed for cork production and cattle (Figure 1). There are two main types of understory vegetation: to the East of the tower native grasses, herbs and shrubs and to the West a permanent improved pasture of mixed legumes and grasses, without shrubs. The pasture emerges in the Autumn, after the first rains, typically peaks in the Spring and dies out in the beginning of the Summer, when summer drought begins to dry out the top soil layers. The cattle management is extensive, typically 7 ha/cow, which allows the natural regeneration of cork-oak. The site's climate is Mediterranean with moist and mild winters and dry and hot summers.

The eddy covariance set up consists of a Gill R3A-50 ultrasonic anemometer (Gill Instruments Ltd., UK) and a LI-7000 closed path CO2/H2O Infra-Red Gas Analyzer (LI-COR, USA), mounted at the top of a 22 m tower (measurement height: 23.5 m). Eddy flux data was processed using the software package EddySoft (Kolle and Rebmann, 2007) and Python scripts provided by the UFZ. Half-hourly fluxes were calculated by block averaging. The time lags between vertical wind speed and CO_2 and H_2O were calculated by cross correlation analysis (Aubinet *et, al.* 2000). When relative humidity is high, the cross-correlation fails, and a dependency of the time-lag for H_2O on relative humidity was used (Ibrom *et al.*, 2007). Attenuation of high frequency signals were corrected using inductances calculated with co-spectral analysis (Eugster and Senn, 1995). The coordinate rotation of wind vectors used the sectorial planar fit method (Wilczak et al., 2001). Quality control, following the flagging policy of Mauder and Foken (2011), was applied via tests on the high frequency data for exceeded physical limits, change rates, and variances; and stationarity (50% deviation criterion). Half-hourly data was filtered for friction velocity (u*) following Reichstein *et al.* (2005). Gap filling and separation of the net ecosystem exchange (NEE) into gross primary productivity (GPP) and ecosystem respiration (Reco) followed Reichstein et al. (2005).

Figure 2 Daily NEE, GPP and Reco for 2011 (gC m-2 d-1). Negative values represent fluxes from the atmosphere to the ecosystem, and positive values fluxes from the ecosystem to the atmosphere



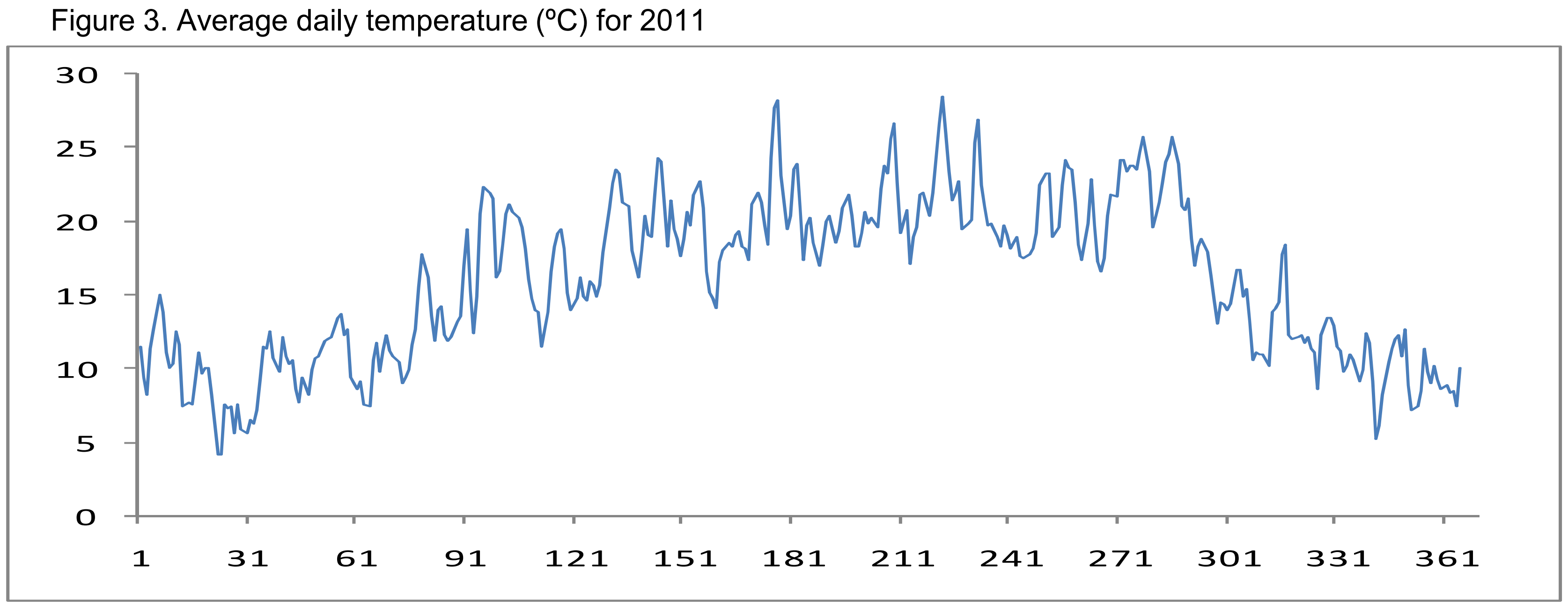
Results

Figure 2 illustrates the daily NEE, GPP and Reco for the year of 2011. The site was a net carbon sink during most of the year (annual total: 341 gC m-2). The mild Autumn and Winter temperature allows the trees to continue to photosynthesize, and the newly sprouted understorey layer to grow, albeit slowly, while decreasing respiratory rates.

The increasing temperature in Spring (Figure 3), has a marked effect on ecosystem respiration, both through increased growth and higher respiration rates, and on gross photosynthesis, which allows the ecosystem to function as a carbon sink for most of this season. Source activity in the spring is related to lower radiation from rain events and the renewal of the canopy of cork-oaks (April-May).

In the end of Spring – beginning of Summer, as the top layers layers of soil begin to dry out, Reco starts to decline, and the grasses and herbs of the understorey become senescent. Photosynthesis also declines, but at lower rates that Reco, due to the hability of the trees, and, to a lesser extent, of the shrubs, to tap water from deeper soil layers, resulting in a peak of carbon sequestration in this season.

Figure 3. Average daily temperature (ºC) for 2011



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