Geophysical Research Abstracts
Vol. 21, EGU2019-11370, 2019
EGU General Assembly 2019

Net ecosystem exchange and evapotranspiration in a contrasting climate and land-use conditions in a tropical deciduous dry forest in Brazil

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The largest single block of seasonally dry forest in the world is the Caatinga biome found in northeastern Brazil. It covers 844,453 km2 and houses a high level of endemic plant species adapted to the low precipitation (400-800 mm year-1), high mean air temperature (26-28 oC), and elevated potential evapotranspiration (over 2,500 mm year-1). The Caatinga biome has about 55% of its original area preserved, and 45% with some degree of degradation related to anthropogenic impacts such as unsustainable natural resources management and land cover clearing for agricultural and grazing activities. Since 2012 the region has been experiencing the most severe drought of the last 50 years. Under this scenario, the caatinga vegetation performs a crucial role due to its capacity to fix atmosphere carbon dioxide even when water is scarce. Quantifying radiation, energy, CO_2 and evapotranspiration in different caatinga areas is essential for a better understanding of their functioning and for evaluating possible changes in their interaction with the atmosphere due to dynamic climate and environmental change. Eddy covariance is a widely accepted method to evaluate energy and carbon fluxes over ecosystem scale, and was used to study two sites in the Pernambuco state of Brazil within the Caatinga biome. The first study site is a pristine caatinga (PC) located in Petrolina municipality, Brazil (09.03S, 40.32W). This site has an area of 600 ha and has been preserved for over 40 years. Its vegetation comprises a mix of shrubby-arboreal hyperxerophilic species plants with average height of 5 m. The second study site, characterized by 5 ha of degraded caatinga (DC), is located in Araripina (07.45S, 40.42W), about 176 km north from PC. It was used as a rainfed agricultural area during the 1980s and 1990s and has slowly been reclaimed by caatinga species since the beginning of the last decade. Micrometeorological measurements were conducted at both sites for an average rainfall year (2011) and an unusually extremely dry year (2012). The towers monitor turbulent fluxes by measuring three-dimensional wind velocity and temperature with an ultrasonic anemometer, and CO_2 and H_2O concentrations with an open path infrared gas analyzer at a frequency of 10 Hz. The collected high-frequency data were filtered, despiked, rotated, and corrected using standard eddy covariance (EC) processing methods. In addition, air temperature, air humidity, net radiation, soil heat flux, soil temperature, and photosynthetically active radiation were measured. Data were processed and analysed on daily and seasonal time scales. The dynamics of net ecosystem exchange and of latent heat flux (evapotranspiration) over these two contrasting land use of caatinga were compared for the two years with very different water availability, revealing the importance of long term ecosystem studies across the Caatinga biome and its various physiognomies.
Founded by: CNPq, Brasilia, Brazil - Caatinga-FLUX Research Project (483223/2011-5) and INCT-ONDACBC (465764/2014-2); FACEPE, Recife, Brazil - Caatinga-FLUX Phase 2 (APQ 0062-1.07/15), and INCT-ONDACBC (FACEPE/CAPES 88887.136369/2017-00).