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Soil CO_2 emissions from the lower SW flank of Mt. Etna: Estimate of organic and magmatic contributions to the total degassing.

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Abstract

The Earth degassing plays a primary role both in the carbon cycle and in the climatic evolution of our planet. Notwithstanding the relevant number of diffuse and focused CO_2 efflux measurements in active volcanic areas, data regarding the diffuse degassing of organic CO_2 are usually scarce and come from soils with different types of cultivations in areas with very different climatic characteristics. In order to discriminate the biogenic contribution to the CO_2 output from the hydrothermal-magmatic one the measurement of the carbon isotope composition of CO_2 together with that of CO_2 efflux is of the utmost importance. In general in the case of active volcanic areas, statistical analysis on CO_2 efflux data show different populations that are interpreted as due to the contribution of different sources of CO_2 (i.e., biogenic or magmatic or a mixture of the two). In the case of Mt. Etna volcano, a detailed investigation on soil CO_2 emissions was carried out on a wide area of the lower SW flank. The use of log probability plot on CO_2 flux data allowed to recognise three distinct populations. The first one entails CO_2 fluxes <23 g $m^{-2}d^{-1}$, which can be set as the upper limit for background soil CO_2 flux levels due to biogenic activity in the soil. The population that entails values >150 g $m^{-2}d^{-1}$ should include anomalous soil CO_2 flux values entirely produced by deep, hydrothermal or magmatic degassing. A third population includes values between the above two limits, and it is probably due to mixing of the two previous sources. Literature data at a global scale show a wide variability of CO_2 flux values only due to a biogenic source. In particular, CO_2 fluxes associated

with areas characterized by scarce vegetation, uncultivated meadows, Mediterranean maquis or semiarid steppe have average values of 7.6 g m^{-2} d^{-1}, with maximum values around 40-50 g $m^{-2}d^{-1}$ during the summer season (Raich and Schlesinger, 1992; Gambardella et al., 2006 and reference therein). Because of this variability, we studied a sedimentary area (Pietranera Farm, near Agrigento in Sicily, that is an experimental crop of the Faculty of Agronomy of the University of Palermo) in order to verify and quantify the temporal variability of biogenic CO_2 effluxes. Soil CO_2 fluxes were measured for two different crop rotations (wheat-wheat and wheat-bean) and for different soil management (traditional, ploughing 30-35 cm depth, 2 layers tyllage; chieser 40 cm and 15 cm depth; no till) under controlled conditions of soil temperature and humidity. The data obtained refer to measurements carried out during a two year-period and show highly variable biogenic effluxes as a function both of the different months of the year and of plant growth rate. Statistical analysis of our data shows large variations in the biogenic CO_2 efflux (ranging from 10 to $>$100 g $m^{-2}d^{-1}$), with highest values measured in the periods of highest biologic activity in the soil. These values are almost comparable to the anomalous soil CO_2 efflux values measured at Mt. Etna. The large temporal and spatial variability observed in the biogenic contribution of CO_2 to soil degassing stress the need of a verification of CO_2 efflux data using concurrent measurements of carbon isotope composition in the same measuring sites, in order to achieve a correct estimate of the anomalous diffuse CO_2 output both in active volcanic and tectonic areas.