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Good practice for soil CO_2 flux monitoring applied to volcanic – tectonic evolution and gas hazard evaluation

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The processes able to modify the soil CO_2 flux are multiple and various in origin especially in volcanic and tectonic area where a deep supply is also present. Hence in-depth knowledge of all the acting processes is a necessary requirement for a correct managing of soil CO_2 flux variations, for formulating well suited interpretation of volcano-tectonic system and gas hazard evolution. In this study, we provide a detailed description of all these processes, also availing theoretical physical models. We show how to best manage the continuous measurements data of soil CO_2 flux and we settle the more adequate distribution of stations. In particular, we demonstrate as to obtain a suitable interpretation of volcano-tectonic evolution by using soil CO_2 flux monitoring network data, all processes acting on each site must be carefully analyzed. As regards the development of the network we showed how crucial it is that the monitoring sites must be placed not only in the crater area but above all in the peripheral surrounding areas. And more the stations must placed in sites with high and low soil CO_2 flux. The study is based on ten years of continuous measurements performed in eight sites at the Island of Volcano (Italy). The in depth comprehension of processes leads to design a coherent scenario of the expected changes of the gas emissions as a response to the increase of the gas availability which can be released from the magmatic system or dependent from migration of fluids in the earth crust. In this way we were able to manage unfiltered data series to acquire precious information on both magmatic system and tectonic evolution. It is to remark that such information would be lost by applying the common approach of a simple digital filtering and statistical procedure based on the assumption of homogeneous response of all the sites to the changes of environmental variables, namely temperature, pressure and rainfall. Applying this approach to the continuous monitoring network of the Island of Volcano, we identified three anomalous periods of soil CO_2 emission in 2009, 2010 and 2011-2012 and we were able to confirm a magmatic origin for 2009 and 2011-2012 periods whereas a tectonic origin for 2010 one. Otherwise for an anomalous period of CO_2, recorded from March to September 2011, only in almost all available data series recorded in crater area, we confirmed a different origin with respect to a pure magmatic or tectonic ones. As regard gas hazard evaluation, we modeled the relative flux increases in response of atmospheric pressure variations for different CO_2 flux values. The model result is of particular relevance because showed that at sites with low advective component, namely with low flux value, very high increase in the flux can be recorded, this implies that potentially dangerous situations can be take place also in an area with usually low CO_2 emission.