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Temporal variations of fumarolic CO2 outgassing at Campi Flegrei caldera: two approaches based on IR Spectroscopy

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In volcanological applications of optical remote-sensing techniques, the measurements of volcanic CO2 emission is still problematic, due to its natural background concentration in the atmosphere. Here, we report on novel approaches, by using a near-infrared tunable diode laser, in order to estimate fumarolic CO2 flux from Campi Flegrei high-risk caldera (Southern Italy), adding new unpublished results to the previous campaigns. At first, in a previous approach, we derived tomographic maps of fumarolic CO2 concentrations and, by integration and combination with vertical plume transport speed, we inferred the CO2 flux directly (range ~ 400-1000 t/d). Here, we propose a second approach involving a Lagrangian Stochastic (LS) model to simulate the transport of CO2 from single or composite sources that could be performed in several volcanic areas, in high-risk state. Starting from known CO2 concentrations open-path measurements (diode laser datasets), and known meteorological conditions, LS model provides a technique, mathematically straightforward, for inferring unknown CO2 emission rates from the fumarolic sources. The surface layer model used in the simulation requires that at least four parameters are known: the surface roughness length; the friction velocity; a measure of atmospheric stability called the Monin-Obukhov length; and the mean horizontal wind direction. We believe in the development of an automatic continuous system in the field, to be applied in volcanic monitoring, coupled with the pre-existing surveillance techniques.