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Relevant methane emission to the atmosphere from the geological gas manifestation of the LUSI eruption study case, Indonesia

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Quantifying natural geological sources of methane (CH_4) allows to improve the assessment of anthropogenic emissions to the atmosphere from fossil fuel industries. The global CH_4 flux of geological gas is, however, an object of debate. Recent fossil (^{14}C-free) CH_4 measurements in preindustrial-era ice cores suggest very low global geological emissions (~ 1.6 Tg year-1), implying a larger fossil fuel industry source. This is however in contrast with previously published bottom-up and top-down geo-emission estimates (~ 45 Tg year-1) and even regional-scale emissions of ~ 1–2 Tg year-1.

Lusi is a spectacular eruption site located in the back-arc sedimentary basin of NE Java Island, Indonesia. Since May 2006 Lusi has been erupting impressive amounts of water, oil, gas and mud breccia reaching the record peak of 180,000 m^3/day. This geological phenomenon is fueled by the activity of the neighboring magmatic complex that is flushing magmatic/hydrothermal CO_2-rich fluids in the hydrocarbon-rich back-arc sedimentary basin. The interaction between these two domains triggers the formation of CO_2 and CH_4 over-pressured gas pools. These large volumes of gas are released at the surface from two, and sometimes three, large (~100 m in diameter) active vents and from thousands of satellite seeps that are scattered in a region of 7.5 km^2 surrounding the crater site. We completed extensive measurements and measured gas emissions by ground-based and satellite (TROPOMI) techniques. Both techniques indicate a total CH_4 output of ~ 0.1 Tg year-1, equivalent to the minimum value of global geo-emission derived by ice core $^{14}CH_4$ estimates. Our results are consistent with the order of magnitude of the emission factors of large seeps used in global bottom-up estimates, and endorse a substantial contribution from natural Earth's CH_4 degassing. The preindustrial ice core assessments of geological CH_4 release may be underestimated and require further study. Satellite measurements can help to test geological CH_4 emission factors and explain the gap between the contrasting estimates.