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Reliable Ozone Measurements in Volcanic Plumes: A Way to Resolve the Volcanic Ozone Enigma

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In addition to CO_2 and sulphur dioxide (SO_2), volcanic plumes also contain reactive halogen species. Bromine monoxide (BrO) can reliably be quantified by remote sensing measurements and is known to catalyse ozone (O_3) destruction. Therefore, local O_3 depletion is commonly assumed inside volcanic plumes.
Contrary to popular belief, a calculation comparing atmospheric turbulent mixing with the rate of O_3 destruction inside the (young) plume suggests no significant halogen catalysed O_3 loss (1% or less) in the plume.

So far, however, O_3 and its concentration distribution in volcanic plumes have only been insufficiently determined since commonly used short-path ultraviolet (UV) absorption O_3 monitors show a severe, positive interference with SO_2, an abundant volcanic gas.
This interference problem can be overcome by using a chemiluminescence (CL) O_3 monitor, a standard technique for O_3 measurements in the 1970s (and still the standard instrument for air pollution monitoring), which shows no interference with trace gases in volcanic plumes and therefore allows reliable O_3 measurements in volcanic plumes.
However, field measurements with existing CL O_3 monitors are challenging, since they are usually heavy and bulky. We therefore designed an improved and lightweight version of the CL O_3 instrument (1kg, shoebox size), which can be easily carried or mounted onto a drone, thus opening up completely new measurement possibilities.

After test measurements in Heidelberg, including ground-based as well as drone-based measurements, during which we determined vertical O_3 profiles, we performed drone-based O_3 measurements in the plume of Etna volcano. The latter data show an anti-correlation between O_3 and simultaneously determined SO_2, suggesting an O_3 depletion of up to ~60% in the plume of Etna. This raises the question which – probably unknown - process leads to this observed O_3 depletion.