Geophysical Research Abstracts
Vol. 18, EGU2016-298-1, 2016
EGU General Assembly 2016

In situ measurement of the Icelandic Holuhraun/ Bárðarbunga volcanic plume in an early "young state" using a LOAC

Damien Vignelles (1), Tjarda Roberts (1), Elisa Carboni (2), Evgenia Ilyinskaya (3), Pavla Dagsson Waldhauserovà (4), Gwenael Berthet (1), Fabrice Jegou (1), Jean Baptiste Renard (1), Haraldur Olafsson (5), Baldur Bergsson (6), Richard Yeo (6), Njall Fannar Reynisson (6), Roy Grainger (2), Melissa Pfeffer (6), Thibaut Lurton (1), Vincent Duverger (1), and Benoit Coute (1)

(1) LPC2E/CNRS / université d'Orléans, 3A, avenue de la recherche scientifique 45071 Orléans, France, (2) Sub-Department of Atmospheric, Oceanic and Planetary, University of Oxford OX1 3PU, UK, (3) British Geological Survey, Murchison House, West mains road, Edinburgh EH9 3LA, United Kingdom, (4) Agricultural University of Iceland, Faculty of Environmental Sciences, Hvanneyri, Iceland, (5) University of Reykjavik, Iceland, (6) Icelandic Meteorological Office, Bustadavegi 7-9, 150 Reykjavik, Iceland

Volcanic eruptions have huge societal and economic consequences. In Iceland, one of the best known examples is the Laki eruption (1783-84 CE) (Thordarson and Self, 2003) which caused the death of > 20% of the Icelandic populations and likely increased European levels of mortality through air pollution (Witham and Oppenheimer, 2004). The recent fissure eruption at Holuhraun (31 August 2014 – 27 February 2015) was a major source of sulfur gases and aerosols and caused also both local and European-wide deteriorations to air quality (Gislason et al. 2015; Schmidt et al. 2015).
The capability of atmospheric models to predict volcanic plume impacts is limited by uncertainties in the near-source plume state. Most in-situ measurements of the elevated plume involve interception of aged plumes that have already chemically or physically evolved. Small portable sensors airborne drone or balloon platforms offer a new possibility to characterize volcano plumes near to source.
We present the results of a balloon flight through the plume emitted by Baugur the main vent during the night of the January 22th 2015. The balloon carrying a LOAC (Renard et al. 2015) has intercepted the plume at 8km distance downwind from the crater which represents a plume age of approximately 15 minutes. The plume was located in altitude between 2 and 3.1km above the sea level. Two layers were observed, a non-condensed lower layer and a condensed upper layer. The lower layer of 400m thick was characterized by a mode of fine particles centered on 0.2μm in diameter and a second mode centered on 2.3μm in diameter and a total particle concentration around 100 particles per cubic centimeter. The upper layer of 800m thick was a cloud-like signature with droplets centered on 20 μm in diameter and a fine mode, the total particles concentrations was 10 times higher than the first layer. The plume top height was determined between 2.7 and 3.1 km, the plume height is in good agreement with an estimate made by analysis of IASI satellite remote sensing data, thus demonstrating in-situ validation of this recent satellite algorithm (Carboni et al. 2015).
This experimentation shows that under such difficult field campaign conditions (strong wind, low temperatures, only car batteries for power supply, night time and active volcano close to the launch site) it is possible to launch meteorological balloons with novel payloads to directly sample in-situ the near-source plume, determine the plume altitude, identify dynamical phases of the plume and document the size distribution of particles inside a plume which is only a quarter of an hour old.

Carboni, E., Grainger, R., Walker, J., Dudhia, A., Siddans, R.: A new scheme for sulphur dioxide retrieval from IASI measurements: application to the Eyjafjallajökull eruption of April and May 2010, Atmos. Chem. Phys., 12, 11417–11434, 2012/doi:10.5194/acp-12-11417-2012, 2012.
Gíslason, S.R., Stefánsdóttir, G., Pfeffer, M.A., Barsotti, S., Jóhannsson, Th., Galeczka, I., Bali, E., Sigmarsson, O., Stefánsson, A., Keller, N.S., Sigurdsson, Á., Bergsson, B., Galle, B., Jacobo, V.C., Arellano, S., Aiuppa, A., Jónasdóttir, E.B., Eiríksdóttir, E.S., Jakobsson, S., Guðfinnsson, G.H., alldórsson, S.A., Gunnarsson, H., Haddadi, B., Jónsdóttir, I., Thordarson, Th., Riishuus, M., ögnadóttir, Th., Dürig, T., Pedersen, G.B.M., Höskuldsson, Á., Gudmundsson, M.T.: Environmental pressure from the 2014–15 eruption of Bárðarbunga volcano, Iceland. Geochem. Persp. Let. 1, 84-93, 2015.
Renard, J.B., Dulac, F., Berthet, G., Lurton, T., Vignelles, D., Jégou, F., Tonnelier, T., Thaury, C., Jeannot, M., Couté, B., Akiki, R., Verdier, N., Mallet, M., Gensdarmes, F., Charpentier, P., Duverger, V., Dupont, J.V., Mesmin,

S., Elias, T., Crenn, V., Sciare, J., Giacomoni, J., Gobbi, M., Hamonou, E., Olafsson, H., Dagsson-Waldhauserova, P., Camy-Peyret, C., Mazel, C., Décamps, T., Piringer, M., Surcin, J., and Daugeron, D.: LOAC: a small aerosol optical counter/sizer for ground-based and balloon measurements of the size distribution and nature of atmospheric particles – Part 1: Principle of measurements and instrument evaluation, Atmos. Meas. Tech. Discuss., 8, 9993-10056, doi:10.5194/amtd-8-9993-2015, 2015.

Schmidt, A., Leadbetter, S., Theys, N., Carboni,E., Withman, C.S., Stevenson, J.A., Birch, C.E., Thordarson, T., Turnock, S., Barsotti, S., Delaney, L., Feng, W., Grainger, R.G., Hort, M.C., Höskuldsson, À., Ialongo, I., Ilyinskaya, E., Jòhannsson, T., Kenny, P., Mather, T.A., Richards, N.A.D., Sheperd, J.: Satellite detection, long-range transport, and air quality impacts of volcanic sulfur dioxide from the 2014–2015 [U+FB02]ood lava eruption at Bárðarbunga (Iceland), J. Geophys. Res. Atmos., 120, doi:10.1002/ 2015JD02363, 2015.

Thordarson, T., and Self, S.: Atmospheric and Environmental Effects of the 1783–1784 Laki Eruption: A Review and Reassessment. J. Geophys. Res. 108, no. D1 (January 8, 2003): 4011., 2003.

Witham, C. S., Oppenheimer, C.: Mortality in England during the 1783–4 Laki Craters Eruption. Bulletin of Volcanology 67, no. 1 (May 11, 2004): 15–26. doi:10.1007/s00445-004-0357-7, 2004.