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15 years of SO2 measurements at Popocatépetl volcano: from individual COSPEC measurements to real-time mini-DOAS-network measurements

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On December 21, 1994, Popocatépetl Volcano (PV) started to erupt explosively with a series of vulcanian-type events with large emissions of gas. The activity remained explosive along 1995 with a period of quiescence from August 1995 to early March 1996. On March 5, 1996 the volcano resumed the eruptive activity (vulcanian in nature) and on March 25 the eruptive style changed to effusive. The first lava dome was partially destroyed on April 30, 1996. Up to 2001, at least 12 lava domes were extruded and destroyed. Until December 2009, PV continues producing lava domes, and destroying them with vulcanian explosions.

Here, a summary of the SO2 emissions at PV during the last 15 years is presented. Work on PV's gas emissions started in early 1994. Initially, on February 1st 1994, SO2 emissions were 16 kg/s measured with a correlation spectrometer (COSPEC). Gas emissions prior to the eruption were of a magmatic signature, and with a similar order-of-magnitude as emissions during the first year of eruption (10s-100s kg/ s). The values during the period between August 1995 and early March 1996 were $\sim$9 kg/s in average (maximum of $\sim$19 kg/s, and a minimum of $\sim$1 kg/s). After 1996 the order-of-magnitude raised to an average of $\sim$130 kg/s. SO2 emissions have had a high variability through time the maximum value was measured on December 13, 2000 ($\sim$2000 kg/s).

Within the framework of the NOVAC (Network for the Observation of Volcanic and Atmospheric Change) project 4 mini-DOAS instruments have been deployed at PV, all stations acquire spectra in real-time and send the data to the receiving station at CENAPRED in Mexico City where data is collected for immediate evaluation of the volcanic activity. Automatically, data is also sent to a server in Chalmers University for archiving and other uses. Data is post-processed at CENAPRED and UNAM and a database is being built since 2005. These measurements allow to estimate SO2 emissions in real-time and in a more accurate way. The network allows that at least one but sometimes 2 or more spectrometers simultaneously observe a significant fraction of the plume, which allows observing volcanic processes that were not possible to witness before, such as the estimate of the SO2 emitted during explosive events, the behavior of the SO2 emissions days or hours prior to explosive events, or degassing patterns from different vents. Currently, the network allows observing high daily variations in SO2 emission rates (from 10s to 100s kg/s).

A review of the data set suggests that during 1995-1996 the degassing patterns may indicate: a) a progressive clogging of the shallow volcanic system, b) progressive exhaustion of gas content in the first batch of magma reaching PV's system at depth, or c) a combination of both. Also, data suggests $\sim$4 major magma intrusion events during the last 15 years and a waning of SO2 emissions through time.