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Comparison of satellite observations of the atmospheric emissions from the April 2015 eruption of Calbuco volcano, Chile

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Calbuco volcano, Chile, erupted in three distinct phases in April, 2015. The first two phases, on 22^{nd} and 23^{rd} April, produced large ash and gas eruption columns, reaching $\sim$ 12 and 15 km respectively. The third phase of the eruption, on 30^{th} April, produced a weak ash column not exceeding 4.5 km. The plume was observed by numerous passive and active satellite instruments, including IASI, OMPS, OMI, MLS, CALIOP and CATS.

Total atmospheric loading of SO_2 was retrieved from OMI, IASI and OMPS while the atmospheric loading of ash was retrieved from IASI.

Direct observation of volcanic plume altitude is possible with active lidar instruments such as CALIOP and CATS. CATS was installed on the International Space Station (ISS) in January 2015 but the data have thus far been under-utilised. We will present comparisons between these lidar measurements and altitude retrievals from passive satellite instruments – IASI, MLS and OMPS (both the limb and nadir instruments). These comparisons provide as close to a 'true validation' of the altitude retrievals from the spectrometers as possible. The addition of data from CATS increases the frequency of lidar measurements, providing observations at different times of day due to the lower ISS orbital altitude.

Visible lidars are unable to directly observe SO_2 or H_2S plumes and so their retrievals of volcanic products are limited to sulphate aerosol and ash. This means that the comparison instrument has to be able to directly retrieve volcanic ash or aerosol, or an assumption has to be made that the ash and SO_2 plumes are co-located. Within the first several hours to days, this assumption should be reasonably reliable, however this is a likely source of error between the measurements and will increase with time.

The orbital tracks of all of the instruments following the Calbuco eruption produced measurements through, or very close to, the centre of the eruption plume; many of them within the first 24 hours following the main collapse. This allowed for comparison of the retrieved altitudes for the plume immediately following release, as well as facilitating tracking of the plume as it moved both vertically and longitudinally over time.

The volcanic plume was caught in a cyclonic system for several days off S. Africa, constraining it to an unusually small region. This meant the gas concentrations remained high for several weeks and allowed both the spectrometers & the lidars to track the in-plume conversion of SO_2 into sulphate.