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Session 8B Paper 5
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Use of ionospheric GNSS measurements for detection of volcano eruptions

It is known that a sudden ejection of matter during a volcano eruption generates a broad spectrum of pressure oscillations, from infrasonic to gravity waves. These low atmospheric waves can further propagate into the upper atmosphere and grow in amplitude with height. At ionospheric heights, the perturbation in the neutral component is transferred to the ionized component, and can be detected by ionospheric observational tools. In this work, we show how the ionospheric GNSS (GPS and GLONASS) measurements can be used for detection of the eruptive volcanoes, as well as for estimation of the eruption time onset. We first analyze ionospheric total electron content (TEC) response to two eruptions on 22-23 April 2015 of the Calbuco volcano that is located in Southern Chile. The TEC was estimated from measurements of numerous ground-based GNSS receivers based around the volcano. We find that the co-volcanic ionospheric disturbances (CVID) are of quasi-periodic waveform; they occur ~15-30 minutes after the seismically-estimated eruption onset, last for 30-50 minutes following the beginning of the eruption.

From the observed CVID, we estimate the arrival time of the perturbation into the detection point, and we can also estimate the coordinates of the detection points (each detection point is from the line-of-sight between a receiver and a satellite at some fixed altitude, which is the ionospheric thin shell height). We further use an approximation of a spherical wave propagating at constant speed from a point source to calculate the source position, i.e. the location of the volcano. After that, it is possible to estimate the onset time of the eruption. For the 22-23 April 2015 eruptions, we were able to “localize” the eruptive source within several degrees of latitude/longitude.