Inverting for wind velocity and air temperature using volcano infrasound

We use travel times of infrasound waves generated by the active Volcan Tungurahua (Ecuador) to invert for wind velocity and air temperature over the course of 2010 to 2012. Infrasound data provided by the Instituto Geofísico in Quito corresponds to eruptive activity including strombolian, vulcanian, and subplinian. Data were recorded on five stations distributed around Volcan Tungurahua with radial distances to the vent between 4.8 and 6.4 km and azimuthal gaps less than 112 degrees. Lag times of correlated infrasound recorded across the network are calculated for 40-s overlapping windows. During periods of high signal correlation atmospheric structure is modeled. Sound speed in the atmosphere is controlled by temperatures and winds. We calculate these parameters assuming a uniform temperature and a two-dimensional wind velocity. In this study we obtained temperatures varying between -20 °C and 20 °C, matching diurnal cycles, and wind speeds up to 5.5 m/s with a predominance of easterlies. For a large eruption occurring in August 2012 the ash fallout distribution matched the infrasound-inverted wind field. We also observe systematic changes in infrasound lag times across the network, which may be attributable to source location variations. We speculate that infrasound source position within the crater may change as the vent morphology is altered during eruptive phases. Overflights and photogrammetry over Volcan Tungurahua confirm a 13 m increase in crater diameter between 19 May 2011 and 20 September 2013 as well as other changes in crater morphology, such as deepening of the crater. Estimates of wind velocity can help improve accuracy of SO2 gas flux measurements, which rely upon accurate wind models, and can also provide parameters for numerical simulations of tephra dispersal. In the future, calculating wind velocities during eruptions using infrasound may help the local authorities forecast andmitigate ash effects on population, crops, livestock, and upon aviation.

Varying lag times and inverted wind velocities for August 2012 eruption. a) A correlogram using infrasound records from BBIL and BMAS stations, indicates changes in wave travel times during five hours of eruptive activity. Changes in travel times are produced due to changes in the atmospheric structure. b) Wind velocities are inverted from five days of continuous degassing.