Recent Volcanic deformation around Zao and Azumayama Volcanoes

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Mt. Zao is an active volcano located in northeastern Honshu and has histories of phreatic or phreato-magmatic eruptions in the last 2 ka. Unrest of Zao volcano started in January, 2013 with a volcanic tremor (JMA, 2013) followed by activated seismicity mainly in the lower crust and very -long-period seisimic events (VLP) up to today. Since a burst of shallow volcanic earthquakes initiated in April 2015, JMA announced a Volcanic Warning for the area near crater, which was lifted in June because of the quiescence of the seismicity.
Mt. Azumayama is an active volcano located in northeastern Honshu and has repeatedly erupted around the Oana crater within recorded history, and currently a fumarolic area extends across its southern and eastern flanks (JMA, 2013). Recent seismicity between 2001 and 2009 are characterized as repetition of active and quiet periods with intervals of around 2 to 3 years, while it shows steady activity after 2010 (JMA, 2014a). Seismic activity looks gradually increasing since October 2014. A volcanic tremor with a duration of about 35 minutes occurred on December 12, 2014, and the monthly number of volcanic earthquakes in December 2014 counted 576, and a volcanic alert (Level 2) was applied by JMA and is lasting at present.
GNSS data obtained around the two volcanoes are processed using the precise point positioning strategy (Zumberge et al., 1997) of GIPSY-OASIS II ver. 6.2 with IGS08 precise ephemerides and GMF mapping functions (GMF, Boehm et al., 2006). Since the wide area of northeastern Honshu still suffers the long lasting postseismic deformation following the 2011 Tohoku-oki earthquake (M9.0), we extract volcanic deformation related to the unrest of the volcano by fitting an approximation function of time consisting of linear, logarithmic, annual, and semi-annual terms. The coefficients of each term are estimated by the least-squares method.
Resulting displacements around Zao and Azumayama volcanoes show radial expansion and uplifting, and suggest the existence of pressure sources for the periods between January 2015 and May 2015, and October 2014 and May 2015, respectively. These deformations can be modeled with an point pressure source at a depth of around 5 km and 3 km, respectively beneath the summit, and related to raised volcanic activity.
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