Real-time analyses of continuous relative gravity data collected at Sakurajima Volcano

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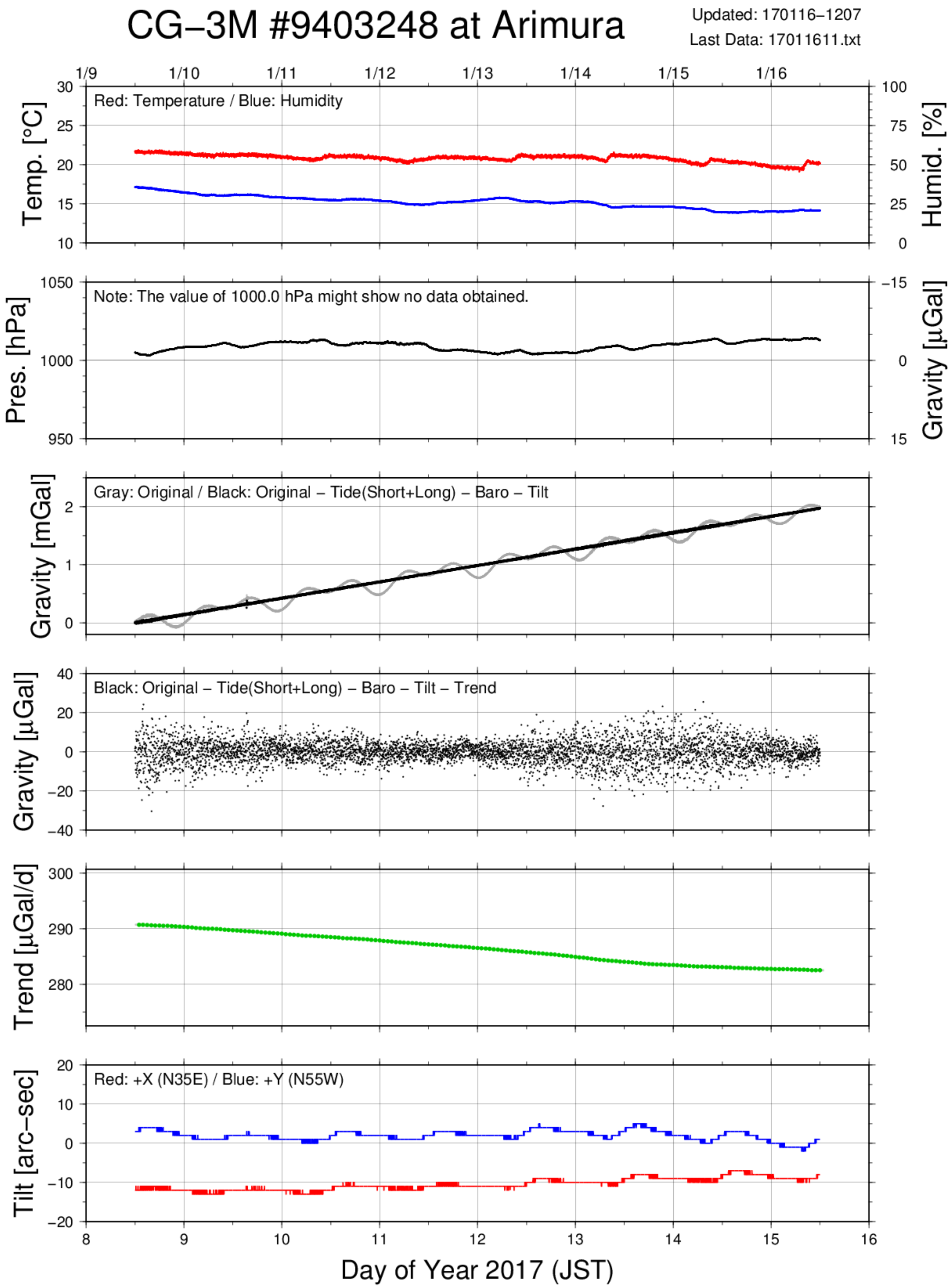
Continuous gravity observation is one of the most powerful methods to monitor mass redistributions in volcanoes. In Japanese volcanoes, absolute gravimeters have detected gravity changes of less than 10 microGal originating from volcanism, with those time period of more than a few days (e.g., Kazama et al., JGR, 2015). However, absolute gravimetry cannot precisely detect short-period (< one day) gravity changes due to the low signal-to-noise ratio in the high frequency domain. On the other hand, broadband volcanic phenomena have been monitored by other geodetic observations at many active volcanoes (e.g., Iguchi et al., JVGR, 2008). If the short-period volcanic gravity signals can be detected by continuous gravity observations other than absolute gravimerty, volcanic phenomena will be minutely discussed in terms of mass redistributions.
Kazama et al. (Kazan, 2016) thus installed a CG-3M relative gravimeter at Arimura in the southern part of Sakurajima Volcano, and started collecting continuous gravity data at one-minute interval. They succeeded in detecting a rapid gravity decrease of -5.86 microGal during the rapid inflation event on 15 August 2015; this gravity change is smaller than the typical observation error of relative gravimeters (~10 microGal), but the high-frequency measurements of relative gravity contributed to the detection of the small gravity change in the case of Sakurajima Volcano. They also pointed out that the gravity change was consistent with one of the dike intrusion models provided by Geospatial Information Authority of Japan (2015) if the density value of 0.97 +/- 0.37 g/cm3 was assumed, which implies the drastic foaming of the intruded magma.
We utilized their method to construct the real-time analysis system of continuous relative gravity data collected at Sakurajima Volcano. The following procedures are automatically executed every hour in this system. (1) Continuous data of relative gravity and air pressure are uploaded from logging laptops to a server. (2) The gravity/pressure data is downloaded from the server to a computer installed in Kyoto University. (3) Three effects are corrected from the raw gravity data: tidal gravity change, gravity change due to air pressure change, and artificial gravity change due to instrumental tilts. (4) Instrumental drift is removed, by fitting a linear function to the corrected gravity data of the past seven days. (5) Graphs of the collected/analyzed data are drawn and uploaded to a web server.
We show one of the graphs drawn by this system at noon on 16 January 2017. This graph displays the seven-day variations in air pressure, raw gravity, corrected gravity, drift rate, and instrumental tilts. If significant mass redistributions occurred associated with volcanism, rapid time variations could be included in the panels of corrected gravity and drift rate, and/or instrumental tilts might change due to volcanic inflations, as detected on 15 August 2015 (Kazama et al., Kazan, 2016). We are going to maintain this analysis system in order to monitor mass redistributions associated with volcanism in Sakurajima Volcano instantaneously.

Keywords: Sakurajima Volcano, volcanism, gravity change, relative gravimeter, mass distribution


CG–3M #9403248 at Arimura
Updated: 170116–1207
Last Data: 17011611.txt
Red: Temperature / Blue: Humidity
Temp. [°C]
Humid. [%]
Note: The value of 1000.0 hPa might show no data obtained.
Pres. [hPa]
Gravity [μGal]
Gray: Original / Black: Original – Tide(Short+Long) – Baro – Tilt
Gravity [mGal]
Black: Original – Tide(Short+Long) – Baro – Tilt – Trend
Gravity [μGal]
Trend [μGal/d]
Red: +X (N35E) / Blue: +Y (N55W)
Tilt [arc–sec]
Day of Year 2017 (JST)