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Instantaneous and localized temperature changes in atmosphere associated with the Icelandic eruption in April 2010 obser

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GPS radio occultation is a technique to observe phases of microwaves from GPS satellites near the horizon of the Earth with a receiver on board a low earth orbiter. Changes of the received phase are converted to the vertical profile of the atmospheric refractive index, which are further converted into quantities such as temperature and water vapor pressure of neutral atmosphere and electron density of ionosphere. With this technique, one can observe global atmosphere with high vertical resolution and accuracy comparable to radiosonde observations. FORMAT-3/COSMIC, launched in April 2006, is composed of six low earth orbiters, and is capable of obtaining up to 2500 profiles per day. As a brand-new application of the GPS radio occultation, Wang et al. (2009) analyzed temperature profiles obtained by COSMIC, and reported that temporary cooling occurred locally in the lower stratosphere above the volcanic fumes of the Chaiten volcano, South America, shortly after its eruption in May 2008. Temperature was found to have increased/decreased beneath/above the height of 12 km. SO_2, a major constituent of volcanic gas, often reacts with atmosphere and forms sulfuric acid aerosols. By staying for a long time in the lower stratosphere, they bring about climatic impacts by blocking sunlight and performing as a greenhouse gas (McCormick et al., 1995). Water vapor is also included in volcanic gas and is another greenhouse gas that warms/cools troposphere/stratosphere. However, we still do not understand the mechanism responsible for the instantaneous atmospheric changes after the eruption as reported in Wang et al. (2009). Eruption of the Eyjafjallajokull, Iceland, started 14 April, 2010, and its volcanic ash and fumes reached maximum height of 11 km. They were carried to the European mainland causing disruptions in civil aviation. In this study, we use the temperature profile obtained with COSMIC, and try to detect localized changes in atmosphere after this eruption. We will then compare the results with the Chaiten volcano case. We first compiled the daily temperature profiles by COSMIC and calculated day-to-day average temperatures at a certain altitude. We then subtracted the reference temperature distribution forecasted from the atmosphere at 0 UT on the previous day by the NCEP GFS (Global Forecast System). We found that significant cooling above the volcano around the tropopause (height ˜10 km) started on the next day of the eruption. This is similar to the Chaiten volcano case, but we could not find warming in troposphere as reported by Wang et al. (2009). Altitude of maximum cooling was ˜14 km in the Chaiten volcano, but it was ˜10.5 km in the present case. This possibly reflects the difference in the heights that the volcanic fumes of the two eruptions reached (Chaiten: ˜20 km, Iceland: ˜11 km). In addition to that, we found significant warming at the height of ˜13 km to the east of the volcano where cooling was observed on the next day of the eruption. Such warming in the stratosphere was not observed in the Chaiten volcano case, and we do not know if it has a causal relationship with the eruption. Atmospheric cooling above the volcanic fumes might be due to the blocking of the long wave radiation from the lower atmosphere by the fumes, but definitive answer cannot be given until we get more examples. In the future, we would like to re-evaluate the reliability of the reference temperature and analyze other volcanic eruptions to get more examples.

Keywords: GPS, Radio occultation, Volcanic eruption, Iceland