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Detecting mid-latitude Es by InSAR

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Maeda and Heki. (2014) succeeded in capturing sporadic-E (Es) over Japan two-dimensionally, using the observation of Global Positioning System – Total Electron Content (GPS-TEC). While the GPS is originally used for the crustal deformation monitoring, Interferometric Synthetic Aperture Radar (InSAR) is another space geodetic technique that allows us to detect crustal movements. SAR transmits a microwave pulse and receives the reflected pulse while a target on the ground is in the beam by using an antenna on the platform like aircrafts and satellites, so that it can implement virtually a large aperture antenna and can create high-resolution images. InSAR can detect crustal deformation signals between the two acquisition dates as a two-dimensional image by taking the difference of the phase data of the SAR images. Like GPS carrier phases, ionospheric effect sometimes appears on the InSAR images. The lower the used microwave frequency, the more notably the ionospheric effect appears. Hence, a satellite using L-band microwave like Advanced Land Observing Satellite (ALOS) is advantageous to detect ionospheric phenomena. If Es can be detected by InSAR whose spatial resolution is higher than GPS, we can understand its spatial structure in more detail and help to clarify the generation mechanism of the Es. In this study, we aimed to detect Es over Japan by InSAR.

First, we chose the dates whose critical frequencies of Es (foEs) were more than 15MHz at ionosonde in Wakkanai, Kokubunji and Yamagawa in the morning in 2006 through 2010 from May to August. Second, we chose the data of ALOS/PALSAR whose observing areas and dates are as close as possible, and generated interferometric images. An interesting phase shift appeared on one of the images, the pair of March 28, 2009 (Master) and Jun 28, 2009 (Slave), and it had northeast direction slope. Although the entire shape could not be imaged due to the sea surface, we could observe four patches; the spatial scale of each patch is about 20km. Converting this phase shift into TEC variation (△TEC), it turns out that △TEC=0.44TECU, which is close to when Es appears. However, we could not identify the altitude in the InSAR image, and thus we used GPS-TEC. As a result, a similar signal was detected near the place where the phase shift appeared on the InSAR image. We could identify the altitude of the signals to be 100km. Therefore, it turns out that the phase shift on the InSAR image is caused by mid-latitude Es.

Keywords: InSAR, sporadic-E, GPS-TEC