Mid-latitude sporadic-E detected by L-band InSAR and their dispersive and non-dispersive components inferred from split-spectrum technique

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Sporadic E (Es) is known to generate unusual propagation of VHF waves over long distances, and is caused by a layer of ionization that irregularly appears within the E region of the ionosphere. However, the generation mechanism of Es remains unclear, because the conventional ionosonde observation of Es has limited spatial resolution. Maeda et al. (2016, GRL) succeeded in demonstrating mid-latitude Es signal over Japan two-dimensionally as an image, using interferometric synthetic aperture radar (InSAR) based on the L-band ALOS/PALSAR data. Although it is known to be a useful geodetic technique to measure ground and ice displacements, L-band InSAR can image the structure of Es with unprecedented spatial resolution when displacement signals are absent. Following Maeda et al. (2016), we aim to detect mid-latitude Es over Japan by InSAR based on the follow-on ALOS2/PALSAR2.
Because the SAR satellite has rather long recurrent intervals, 46 days for ALOS and 14 days for ALOS2, we need to search adequate SAR data sets that are very likely to detect Es signals. First, we chose the dates whose critical frequencies of Es (foEs) were more than 15MHz at ionosonde in Kokubunji, Wakkanai and Yamagawa in the morning and noon in 2016 from May to June; Es is known to be frequent in the local daytime of summer season. Secondly, we chose the ALOS-2/PALSAR-2 data sets whose observation area, dates and time matches the data above as closely as possible. Thirdly, we generated Global Navigation Satellite System –Total Electron Content (GNSS-TEC) map whose areas, dates and time are the same as the above and if Es appeared in the GNSS-TEC map, we do generate interferogram. As a result, we could detect the phase changes in the pair of February 17, 2016 (Master) and May 25, 2016 (Slave) along a track from Tottori to Okayama, western Japan. The location of the phase shift is close to the Es on the GNSS-TEC image. Therefore, we can consider the phase shift as the edge of Es.
Meanwhile, we also separated the Es signals into both dispersive and non-dispersive signals, using split-band InSAR technique; dispersive components are due to the free-electrons. We applied this technique to the results by both Maeda et al and the present study. As a result, it turns out that both the dispersive and non-dispersive signals indicated similar spatial patterns, suggesting that the non-dispersive signals were closely related to the dynamics of dispersive free-electrons. The non-dispersive signals may be attributable to positively charged ions associated with the generation of Es episods.

Keywords: ionosphere, Sporadic-E, InSAR

