Possible shear instability in the daytime midlatitude sporadic-E observed with InSAR and GPS-TEC

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Small-scale horizontal structures of daytime midlatitude sporadic E are studied by interferometric synthetic aperture radar (InSAR) and GPS total electron content (TEC) observations over Japan. With GPS-TEC observations, sporadic E with foEs higher than 16 MHz can be detected [Maeda and Heki, 2014]. A dense array of GPS receiving stations in Japan (GEONET) enables us to image horizontal shapes of sporadic E by plotting vertical TEC anomalies on a map. Such TEC maps revealed that sporadic E over Japan has a common shape which is elongated in the east-west (E-W) direction with typical length and width of ~200 km and ~20 km, respectively, regardless of occurrence latitudes [Maeda and Heki, 2014; 2015]. In this study, we observed smaller-scale structures by InSAR as well as GPS-TEC observations. The spatial resolution is ~300 m for InSAR and ~2 km for GPS-TEC (by analyzing raw slant TEC time series).
The results show that small-scale plasma patches are embedded in large scale frontal structures and such small patches are quasi-periodically located both in zonal and meridional directions.
There are two major candidates for the generation mechanism of daytime sporadic E structure, i.e, namely, atmospheric gravity waves, and the Kelvin-Helmholtz (K-H) instability. We speculate that the K-H instability in the neutral atmosphere under the presence of vertical shear of zonal winds would create billow structures elongated in the zonal direction. On the other hand, secondary instability, such as secondary turbulance in the neutral atmosphere or gradient-drift instability are the two major possible drivers for the patch structuring in the meridional direction.

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