Comparison of GPS Integrated Electron Content Measurements with Electron Density Values acquired by the DEMETER Satellite before large Earthquakes in Japan

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The DEMETER satellite, designed with the objective of investigating ionospheric phenomena before earthquakes, measures the in-situ electron density at ~700 km height using a Langemuir probe. On the other hand, dual-frequency GPS data can be used to retrieve the Integrated Electron Content (IEC) along the ray path from ground stations to GPS satellites. We compare electron density data acquired by DEMETER with IEC data derived from GEONET, an ultra dense GPS network in Japan, on days preceding two $M>7$ earthquakes. To better correlate IEC and electron density, we retrieve IEC traces along the ground tracks of DEMETER. As previously reported by other authors, the two DEMETER records show irregularities of the same order of magnitude while passing over an area close to the respective epicenters two and 8 days prior to the upcoming earthquakes. In both cases, we find anomalies in the GPS-derived IEC that are coincident with those found in the DEMETER-derived electron density. Unlike the DEMETER records, the GPS-derived IEC show significantly different amplitudes. We also find a time delay of 38 seconds in the onset of the anomaly between the IEC and DEMETER data. This probably results from the different measurement geometry and sampling altitude between the two techniques. During one of the DEMETER passes a stationary, wavelike structure similar to the one reported by (Saito et al., 2001) is clearly visible in the spatial distribution of the IEC values. We confirm the presence of perturbations in the ionosphere on both days by two independent measurements. A further long-term statistical study is needed to determine whether ionospheric anomalies like the ones observed here are connected to earthquakes or just transient phenomena caused by other sources.