Auroral omega bands are a significant cause of large geomagnetically induced currents

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The strongest event of geomagnetically induced currents (GIC) detected by the North-West Russian GIC network occurred during the main phase of the magnetic storm on June 28-29, 2013. Extremely high values, 120 A, were recorded in the 330 kV transformers on Kola Peninsula in the 04–07 magnetic local time (MLT) sector. The Defense Meteorological Satellite Program (DMSP) spacecraft took a sequence of ultraviolet (UV) auroral images in the southern hemisphere and observed multiple omega bands. The ionospheric equivalent electric currents based on the International Monitor for Auroral Geomagnetic Effects (IMAGE) magnetometer network reveal a sequence of current vortex pairs moving eastward with the speed of 0.5-2.5 km/s, that fits to the electrodynamics scheme of omega bands. Although the temporal variations of the associated current system are slow, the omega bands can be responsible for strong magnetic variations and GIC due to fast propagations of currents in the azimuthal direction. The first steps towards the statistic study of the highest GIC recorded at Vykhodnoy transformer show that about 50% of events have properties similar to the comprehensively studied 29 June 2013 case.