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Temporal and spatial variations of GPS TEC and phase scintillations during substorm and auroral breakups

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It is known that ionospheric structure caused by precipitation of energetic particles adversely affects the GPS signals resulting in phase scintillation and cycle slips (loss of lock). GPS phase scintillation has been found correlated with auroral emission intensity, particularly with rapid changes in auroral forms and their brightness [1,2,3]. Total electron content (TEC) enhancements that were observed during substorm expansion phase within the night side downward (R1) current appear to be associated with enhanced precipitating particle fluxes [4]. Such TEC enhancements cause phase scintillation, which is most intense just after substorm onsets and auroral breakups. Phase scintillation is computed for sampling rate of 50 Hz by specialized GPS scintillation receivers from the Canadian High Arctic Ionospheric Network (CHAIN). A proxy scintillation index is obtained from dual frequency measurements of geodetic-quality GPS receivers sampling at 1 Hz, which include globally distributed receivers of RT-IGS network that are monitored by the Canadian Geodetic Survey in near-real-time. Temporal and spatial changes of TEC and phase scintillation are investigated in the context of equivalent ionospheric currents derived from ground magnetometer network using the spherical elementary current method [5,6]. The relation of phase scintillation with auroral emission observed by THEMIS all-sky imagers and the far-ultraviolet scanning imager SSUSI onboard the DMSP satellites is also examined. In general, GPS phase scintillation is mapped to regions of strong westward electrojet (upward R2 currents or the interface with downward R1 currents) and to the poleward edge of the eastward electrojet (upward R1 currents). Following substorm onsets and auroral breakups, strong phase scintillation associated with TEC enhancements are mapped mainly to the upward R2 current or the equatorward edge of the downward R1 current at or near the Harang discontinuity region [7].

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