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Long term analysis of ionospheric polar patches based on CHAMP Total Electron Content observations

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GPS derived Total Electron Content (TEC) from topside sounders aboard low Earth orbit satellites offers great possibility to sound the upper ionosphere and plasmasphere. We describe a method that is used to derive absolute TEC observations aboard CHAMP considering multipath effects and receiver differential code bias. The long term data set of 9 years GPS observations by CHAMP is used to investigate the climatological behavior of high latitude plasma patches in both Northern and Southern hemispheres. The occurrence of polar plasma patches has a clear correlation with the solar cycle, which is less pronounced in the Southern hemisphere. Summed over all years, we observed a higher number of patches in the Southern than in the Northern hemisphere. The two latter observations can be explained by the larger offset of the geomagnetic pole from the geographic pole in the Southern hemisphere. The maximum occurrence rate of polar patches has been found at the dayside polar cusp and during 12 - 18 MLT supporting the mechanisms for plasma patch creation by local precipitation of soft particle and by intrusion of subauroral plasma into the polar cap through tongues of ionization. The latter mechanism seems to be even more important in the Southern hemisphere. Investigating the patches in comparison with IMF conditions, we found that decreased IMF Bz and enhanced merging electric field preceded the patch observation, hence patch creation follows a period of enhanced solar wind input into the magnetosphere/ionosphere. We further found an annual cycle rather than a seasonal cycle in patch occurrence with maxima at equinox and December solstice and a June solstice minimum in both hemispheres. We suggest that enhanced TEC at mid and low latitudes during December solstice provide a greater possibility to transport high density plasma to the polar region through the buildup of TOIs.