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Effects of electric field component representation on estimated cross polar cap potential - Implications for interhemispheric asymmetries

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Ionospheric electrodynamics is well organized with respect to the Earth's magnetic field. The most commonly used coordinate systems which take this field into account are the apex (Richmond, 1995) and Altitude Adjusted Corrected Geomagnetic (AACGM) coordinate systems (Baker and Wing, 1989). Both coordinate systems are based on magnetic field line tracing using the International Geomagnetic Reference Field (IGRF), which resolves structures in the Earth's magnetic field at approximately 3000 km resolution. Seen in a geographic grid, both coordinate systems are non-orthogonal and non-uniform. Despite the widespread use in the space physics community, the conversion of electrodynamic vector components are often handled in an approximate fashion, treating the coordinate system as orthogonal. In this study we investigate how such approximations affect the estimated electric potential. We show that an electric potential which is symmetrical between hemispheres can appear asymmetrical when vector component conversion is not exact. We investigate how these errors depend on longitude and universal time bias in a data set. We also apply the technique to measurements from the Electron Drift Instruments on the Cluster spacecrafts mapped to the ionosphere, and compare the results to previously reported inter-hemispheric asymmetries.