A New Statistical Model of Convection Based on Referencing SuperDARN Velocity Data to Auroral Arc Boundaries Determined from Polar UVI Observations

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Abstract: Statistical models of convection continue to find important research applications. In the 1990s several new models were derived using quite different data sets and analysis techniques. These largely agreed on essential aspects of the IMF dependence of the global convection pattern. The development of SuperDARN has provided us with the opportunity of testing the predictions of these models for quasistatic conditions against observations. We have found a significant discrepancy, namely, the inability of the newer models to reproduce the sharp structures and boundaries of the convection pattern. It is probable that the variability of the pattern even under stable IMF conditions causes the smaller-scale structure to smear out in the course of averaging. We have begun the derivation of a new statistical convection model based on the large set of velocity data collected with the SuperDARN radars. We are exploring the value of scaling the velocity data using the location of auroral arc boundaries as determined by Polar UVI observations. In this talk we present examples of the new statistical patterns and discuss the improvement in resolution of structure that results from properly locating the velocity data within the auroral geometry.

Discussion:

Numerous statistical models have been derived using data from satellites, radars, and magnetometers. Several recent models have basically agreed on the basic IMF dependencies of the global convection pattern (*Rich and Hairston* [1994], *Weimer* [1995], and *Ruohoniemi and Greenwald* [1996]). However, there are profound disagreements between the 'bin-averaged' patterns of these authors and the pattern recognition studies of *Heppner and Maynard* [1987]. In essence, the Heppner and Maynard patterns show much more structure. This structure is washed out in the bin-averaging approach because of the variability intrinsic to convection. We have found that this is a severe shortcoming of the newer models as predictors of the instantaneous convection mapped with the SuperDARN radars.

We have decided to take a new approach to the derivation of a statistical convection model. We aim to combine the mathematical rigor of the bin-averaging approach with the need to preserve the structure of the convection pattern through a form of pattern recognition. The basic idea is to use the position of the boundary of auroral luminosity seen by the UVI imager on the Polar satellite to scale SuperDARN velocity data. This will preserve the geometrical relation of the velocity data to the auroral boundary and reduce the amount of smearing of structure that occurs in the bin-averaging step. In this note we summarize the philosophy of this new approach and describe some early results. For a set of figures that illustrate some of these points refer to the Appendix containing viewgraph materials.

We have developed an algorithm for finding the locations of the poleward and equatorward boundaries of the auroral luminosity. The latitudes of the boundaries are tabulated at steps of 3 hours in MLT. The poleward boundary data are fit to a circle. The fitting parameters are the position of the center of the circle (latitude, MLT) and the radius of the circle. The velocity data from an integration period can be compared with the position of the auroral circle. The essential step is to map the velocity data into arc-referenced coordinates. These express the distance of the point from the center of the auroral circle and the longitude of the point reckoned from the sun-earth line passing through the center of the auroral circle. If the geometry of the auroral circle varies between two events but the velocity pattern in the auroral reference frame is unchanged, then the velocity data will look identical in arc-coordinates. The variability of the auroral geometry as a source of smearing of structure in the velocity pattern will then have been eliminated.

We are in the testing phase of this analysis, with certain fitting and mapping factors still being refined. To support this effort, several periods of prolonged By+ have been tabulated and processed. We can compare the results of processing the data into convection maps in arc-coordinates versus default coordinates. We find that the convection velocities tend to be ordered by the auroral geometry. Consequently, the convection pattern for the test case of By+ conditions shows more structure and organization when averaged in arc coordinates. This result supports the viability of this new approach. We are in the process of compiling a bank of arc-referenced convection patterns keyed to the IMF.

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