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Reconciling Empirical and Theoretical Ion Outflow Scaling Laws

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The ionosphere is known to be a significant source of heavy ions, especially during geomagnetically disturbed times. In the past, global magnetohydrodyamic simulations implicitly assumed that the solar wind is the source of the plasma. In recent years significant efforts have been put into methods for including ionospheric mass outflows within the global simulations. One approach has been to use empirically derived scaling laws that relate the flux of escaping ions to the energy input from the magnetosphere to the ionosphere. The main disadvantage with this approach is that while the empirical scaling laws may provide some insight into the processes responsible for the outflows, they do not explicitly address the physics of the outflows. Theoretical models such as the Dynamic Fluid Kinetic (DyFK) model, on the other hand, are physics based. Using the scaling laws provided by DyFK we have begun an analysis that uses empirical quantities that more closely correspond to those used by the DyFK model. From this analysis we find that first it must be recognized that the escaping ions can drift significantly as they move away from the ionosphere. Thus the local energy input does not necessarily correspond to the energy deposited in the region were most of the outflows are initiated. For this reason averages over the outflow region may be more useful than point-by-point comparisons. Second, while the DyFK model suggests that the precipitating electrons control the density of the upflowing ions, our preliminary analysis of the measurements by the FAST spacecraft does not provide any evidence for such control. It appears more likely that the primary controlling factor for the density of outflowing ions is the underlying ionospheric condition.