Proton Anisotropies in the Outer Magnetosphere: Effects of Spatial Inhomogeneity

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Recent studies suggest that wave-particle scattering by the proton cyclotron anisotropy instability imposes an upper bound on the proton temperature anisotropy in the magnetosheath and the hot proton temperature anisotropy in the outer magnetosphere. These upper bound relations, which are commensurate with that predicted by the linear theory, represent potential limited closure relations for global scale MHD models of space plasma. However, if these upper bound relations are to prove useful in a macroscopic fluid model, they must be examined for its robustness in the presence of plasma and field gradients and nonlocal effects. In this study, we carry out mesoscale simulations of proton anisotropies in an inhornogeneous plasma using a two-dimensional hybrid PIC code. The simulation model includes the convection and compression of magnetic flux tubes which gradually increase the magnetic field magnitude and the proton temperature anisotropy in the direction across the background magnetic field. We study how both flux tube convection and wave convection affect the proton cyclotron anisotropy instability and the anisotropy upper bound.