Referee: 2

COMMENTS TO THE AUTHOR(S)

In this paper, the authors present a two-dimensional radial-axial hybrid particle-in-cell (PIC) simulation of a Hall thruster. The hybrid model is a well-established approach for simulating Hall thruster discharges, and the presented simulation results appear credible. While the simulation outcomes are of interest, the authors' discussion regarding the newly introduced plume boundary condition remains unclear. My comments primarily concern the impact of the proposed boundary condition model, which the authors claim to be a significant contribution.

Major Comment:

1) The effect of the new boundary condition model—referred to as the Global Plume Condition (GPC)—is not demonstrated quantitatively. The authors state that the GPC minimizes the truncation effects of the plume boundary. Although differences between the results using the LPC and the GPC are illustrated in Figures 2 and 3, it is not convincingly shown that the results obtained using the GPC are more accurate. The manuscript claims that the GPC yields solutions “much closer” to those obtained with a larger simulation domain and provides a “significantly more robust solution,” yet these assertions lack quantitative discussion. While Table II presents a comparison of thruster performance parameters (e.g., discharge current), the data do not clearly support the claimed advantages of the GPC. A quantitative assessment—such as the convergence behavior of key physical parameters with respect to simulation domain size—would strengthen the argument and clarify the benefit of the proposed boundary model.

Minor Comments:

2) Is it possible to implement a nonlinear sheath model at the anode boundary alongside the new nonlinear plume boundary condition? In conventional electron fluid models for Hall thrusters, the anode sheath is often modeled using a nonlinear approach, whereas the plume boundary typically employs a linearized model—likely due to an issue of numerical stability. In the current study, the anode boundary is modeled with a Dirichlet condition on potential, whereas the plume employs a nonlinear condition. It would be beneficial for the authors to discuss whether a nonlinear sheath model could also be applied to the anode boundary in combination with the nonlinear plume model.

3) In Figure 3, the authors discuss differences in electron flow near the lateral plume boundary. While the directional vectors highlight these differences, the electron current density in that region is relatively small (on the order of 10^-5 to 10^-3), suggesting that the impact may be limited. Could you provide a more quantitative assessment of this difference? For instance, does the altered electron flow significantly influence the trajectories of high-divergence fast ions or charge-exchange (CEX) ions?

4) Figure 4 may be difficult for readers to interpret. It is recommended that the authors highlight selected lines or regions in the figure to better emphasize the key differences being discussed.