Field-Aligned Potential Drops in an Ionospheric Streamer

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Bubbles, Streamers and Our Model

- Low-entropy bubbles in the magnetosphere can form ionospheric streamers as their projections.
- Equatorward (earthiside) current band east of streamer’s (bubble’s) center.
- Poleward (tailward) current band west of streamer’s (bubble’s) center.
- Western current band involves electric field along magnetic field line into the ionosphere. Eastern band typically has no strong FAPD.

Procedure and RCM Results

- We take slices of the ionospheric streamer, and I use a code to fit the parameters and solve for the ionospheric and magnetospheric electric fields:
  1. Perform a run of RCM-E with a bubble injection.
  2. Pick a time after injection and a suitable slice across the streamer.
  3. Fit analytic model profiles for entropy, flux tube volume and conductance to slice profiles. Conductance enhancement uses the Robinson formula with average precipitation energies and energy fluxes computed using equations from Wildberger et al. 2009.
  4. Check that profiles qualitatively match and have realistic magnitudes.
  5. Solve for potential drops and magnetospheric and ionospheric electric fields at a chosen field-aligned resistivity \( R \).

Results from One Bubble Injection

The following example uses a bubble injection run of the RCM-E from Yang et al. 2014. The run proceeds in three stages:

1. A 60-minute growth phase with a polar cap potential drop of 35 kV and an average entropy \( K = PV^2 \) of \(-0.1 \text{nPa} \times (R/KT)^{1/3} \) at the high-latitude midnight boundary.
2. A 10-minute bubble injection centered at midnight with a local time width of 0.5 h. The entropy is reduced by 1/3 in the bubble, and there is a potential drop of \(-24 \text{kV} \) (pre-injection).
3. Returns the entropy and potential drops to pre-injection values.

Conclusions and Future Work

- We have used fitting to an RCM bubble injection run as input to a simple one-dimensional streamer model with field-aligned potential drops.
- The resulting FAPDs, cross-streamer electric fields, and equatorial bubble electric fields are all comparable to within an order-of-magnitude to existing observational constraints.
- The magnetospheric electric field, with FAPDs included, shows a pronounced field-reversal indicative of modified flows near the Birkeland currents which acceleration charged particles to precipitate from the magnetosphere into the ionosphere.
- In the future, we plan to perform a run of the RCM-E which includes the field-aligned potential drops to validate the model and see how the electric field and flow structures are modified in two dimensions.
- We will use parametrized bubble runs using observational constraints from magnetic reconnection in the magnetotail and streamers in the ionosphere to determine more realistic boundary conditions for bubble injections.
- We plan to integrate zeroth-order model features into global models to modify the flow patterns in the magnetosphere and improve MI coupling.

References


Acknowledgements

This work was supported by NASA TMS grant 80NSSC20K1276.