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Title: Modeling the impact of metal ions on equatorial spread F with SAMI3/ESF

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Metal ion layers (e.g., Mg^+, Fe^+) can form in the E region in the altitude range 90 - 150 km and lead to sporadic E events. The impact of E region metal ion layers on the development of equatorial plasma bubbles is investigated using the SAMI3/ESF model. We vary the density and distribution of metallic ions in the E layer to determine their influence on the conductances, and their role in altering the electrodynamics of the system. We also consider the important role of the neutral wind in affecting the transport of metallic ions which may play a role in the seasonal and/or longitudinal dependencies of spread F. We find that metal ion layers reduce the growth rate of the generalized Rayleigh-Taylor instability (GRTI) and act to suppress the development of equatorial plasma bubbles. This is consistent with theoretical expectations [1, 2] and observations [3], and is attributed to the increase in both the Pedersen and Hall conductances. Additionally, inhomogeneities in the E region metal ion layer can map into the F layer and alter the morphology of ESF bubble evolution. Interestingly, Hanson and Sanatani (1971) reported observations that suggest an 'intimate relationship between the presence of Fe^+ ions and irregularities in the total ion composition.' In this regard, we find that if equatorial spread F bubbles develop in the presence of a metal ion layer, then the electric fields generated by the instability can lift the metal ions into the F region. This is consistent with observations of Fe^+ in the F region during equatorial spread F [4].

References

[1] Haerendel, G., Theory of equatorial spread F, preprint, Max-Planck Inst. für Extraterr. Phys., Munich, Germany, 1974.

[2] Sultan, P.J., Linear theory and modeling of the Rayleigh-Taylor instability leading to the occurrence of equatorial spread F, *J. Geophys. Res. 101*, 26,875, 1996.

[3] Stephan, A.W., M. Colerico, M. Mendillo, B.W. Reinisch, and D. Anderson, Suppression of equatorial spread F by sporadic E, *J. Geophys. Res., 107*, 1021, 2002.

[4] Hanson, W.B. and S. Sanatani, Relationship between Fe^+ ions and equatorial spread F, *J. Geophys. Res., 76*, 7761, 1971.