INTRODUCTION

According to the ionospheric Ohm’s law there should be field-aligned currents (FACs) at the sunlit terminator due to conductance gradients. The goal of this research is to find if there is a significant radial ionospheric current associated with gradients in the Hall conductance. Previous estimates of the terminator current have predicted relatively strong currents based on a conductance gradient that is probably too strong. Here we use a more realistic smoother model of the solar extreme ultraviolet (EUV) produced conductance.

We present a theoretical analysis that uses theSwipe model to characterise the electric field, and the Lompe code to calculate the EUV conductance and resulting magnetic field perturbations. Additionally, we present an observational analysis where we calculate the FACs based on vector magnetic field measurements from Swarm A with the CHAOS model subtracted. We are looking at latitudes > 80° to find currents that are not influenced by field-aligned current in the auroral zone and investigate data from orbits that are almost perpendicular to the terminator.

THEORETICAL ANALYSIS

• We want to predict the magnetic field perturbations associated with the terminator currents.
• The Lompe (Local mapping of polar ionospheric electrodynamics) technique is used to model the conductances and to get the magnetic field perturbation vectors \( B_{\text{nor}} \) and \( B_{\text{east}} \). This represents what we can expect to see in the Swarm data.

The Swipe model (Hatch et al., 2023)

• Swipe (Swarm ionospheric polar electrodynamics), is a model for ionospheric convection and ionospheric conductances that combines the electric field model Swarm Hi-C and the magnetic field model AMPS.
• We use the Swarm Hi-C model to specify the electric field in the Lompe analysis, and to predict the magnetic field along the satellite track in the observational analysis (Fig 6).

Lompe (Laundal et al., 2022)

• In the Lompe technique the electric field is modelled in terms of electric charge densities on lines that extend radially.
• The Lompe code determines the Hall and Pedersen conductances without infinite gradients at the sunlit terminator by assuming that the neutral atmosphere is radially stratified. In other words, that the Earth is a sphere.
• To mimic the observational analysis we calculate FACs from the Lompe predictions of the cross track magnetic field \( B_{\text{cross}} \).

Radial current \( (j_r) \) derived from \( B_z \) (Lühr et al., 1996)

We calculate \( j_r \) using the technique described by Lühr et al., and the cross track component of the magnetic field measured along the Swarm satellite track.

Lompe predictions (poleward of 80°)

• Lompe predicts very weak radial currents (grey, in figure to the right) along the synthetic satellite track.
• The Hall gradient term (purple), derived from the electric field and the along-track derivative of the Hall conductance \( \partial B_z / \partial x \) (blue line), is stronger, but balanced by the \( \nabla \times \mathbf{E} \) term.
• Notice that the scale is nA/m², and not \( \mu A/m² \).

CONCLUSIONS

• Our goal is to find if there is a radial ionospheric current associated (blue) with gradients in the Hall conductance (orange).
• The structures in the predicted terminator current are mainly due to variations in the electric field and not due to the conductance gradients which are smooth.
• In future work more events should be analysed and compared. Appropriate events would be noon-midnight and have the terminator more in the polar cap.

REFERENCES


