Non-linear Ohm's law in the polar ionosphere

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Strong electron temperature enhancements in the polar E-region have been reported by many authors. Now it is generally accepted that they are due to electrostatic waves excited by the modified two-stream instability, or Farley-Buneman instability. When such electron heating events occur, electrons must drift partially along the background electric field. This means that a part of Pedersen currents are carried by electrons in such cases. Since the instability sets on when the strength of electric field, E, exceeds a certain threshold value, Eth, the current-voltage relation (Ohm's law) should have a non-linear kink at Eth. We have estimated the relationship between the height-integrated Pedersen current and cross field voltage. The results show that the relation has a non-linear kink at about 20 mV/m and electron Pedersen currents becomes up to about 20% of classical Pedersen conductivity which is carried only by ions. Although this non-linearity looks rather innocent, it could potentially destabilize magnetosphere-ionosphere (M-I) coupling. We will discuss the effects of this non-linearity on M-I coupling.

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