Dependence of height-integrated Pedersen conductivity in high-latitudes on the solar and geomagnetic activities

Yang Lu (yang.lu@mavs.uta.edu), Yue Deng¹, Cheng Sheng¹, Xinan Yue²
1. University of Texas at Arlington 2. COSMIC program office, University Corporation for Atmospheric Research, Boulder, CO, USA

**ABSTRACT:**
Alitudinal distribution of Joule heating is very important to the thermosphere and ionosphere, which is roughly proportional to the Pedersen conductance at high latitudes. Based on the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) satellites observations from 2009-2014, the height-integrated Pedersen conductivities in both E (100–150 km) and F (150–600 km) regions and their ratio have been calculated. The variation of the ratio according to the solar and geomagnetic activity conditions in both hemispheres and the inter-hemispherical asymmetry have been examined. Interestingly, the dependence of Pedersen conductivity ratio on Ap and F10.7 indices show different trends, which can be explained as different alitudinal distribution of ionization caused by auroral particles and solar irradiation.

**Motivation:**
1) Joule heating is the most important process dissipating magnetospheric energy in the upper atmosphere. Joule heating is roughly proportional to the Pedersen conductivity at high latitudes.
2) Joule heating is generally studied in two-dimensions, and now we analyse the ratio of Pedersen conductivity between E and F region which gives us a rough idea of the alitudinal distribution of Joule heating.
3) Pederson conductivity

\[ \sigma_P = \frac{\varepsilon_0}{B} \left( \sum \sigma_n \left[ \frac{(\varepsilon_0 B)^2}{10^6} \right] + \frac{1}{\gamma} \right) \]

**Methodology:**
1) Joule heating
2) The ratio
3) Pederson conductivity

- To study the dependence of Pederson conductivity ratio on the geomagnetic activity, we bin the data into three different categories according to the Ap index: [0-15], [15-80], [80-∞].
- As the Ap index increases, the ratio increases. Meanwhile, the maximum of ratio, which is in [00 – 02] LT, expands to the lower latitude.
- The maximum value of the ratio in North hemisphere is larger than the South hemisphere in the auroral region.

- Variation of F10.7 from years 2009-2014
- To study the dependence of Pederson conductivity ratio on the solar activity, we bin the data into three different categories according to the F10.7 index: [0-100], [100-150], [150-∞].
- As the F10.7 index increases, the ratio decreases and the maximum of ratio appears in [00 – 02] LT.
- The maximum value of the ratio in North hemisphere is larger than the South hemisphere in the auroral region.

**Data coverage & Validation**
- In the auroral regions the counts are around fifteen thousands.
- Comparison with ground observations
  - Ground observations at Poker Flat Incoherent Scatter Radar (PFISR).
  - NCAR/TIE-GCM: the National Center for Atmospheric Research thermosphere- ionosphere-electrodynamic general circulation model.
  - Climatologically, COSMIC observations agree with ground measurements very in most local time during the summer.

**Conclusion:**
- The maximum of ratio appears in [00 – 02] LT.
- The ratio increases as the Ap index increases, while it decreases as the F10.7 increases.
- The maximum ratio expands to lower latitude as the Ap increases.
- The variations of the ratio in the two hemispheres according to the Ap and F10.7 indices show a similar trend, but a strong inter-hemispheric asymmetry can be identified.

**Future works:**
- More data will be included in the analysis, including observations in 2008 and 2014 winter.
- More detailed comparison of ratio variation will be conducted such as different seasons.
- More accurate information of the alitudinal distribution of the Pederson conductivity will be estimated.
- Comparison with other models, such as data assimilated model and general circulation model (GCM).