First Results from a Long-Term Incoherent Scatter Radar Investigation of E-region Thermospheric Winds

Stephen R. Kaeppler*(1), Miguel F. Larsen (2), Rafael A. Mesquita(2), Roger H. Varney(1), Ashton Reimer (1), and Michael J. Nicolls (3),
(1) SRI International, Menlo Park, CA, 94025, USA, http://www.sri.com
(2) Clemson University, Clemson, SC, 29634, USA
(3) LeoLabs Inc., Menlo Park, CA, 94025, USA

1. Extended Abstract

High-latitude E-region thermospheric winds are crucial for electrodynamic coupling between the ionosphere and magnetosphere, as well as dynamic coupling between the lower thermosphere that is driven by atmospheric forcing from below. One of the key roles E-region neutral winds play is to modulate energy transfer and dissipation. In some cases, the response of E-region winds is clearly driven by strong magnetospheric convection; however, in moderate forcing situations it is ambiguous whether the dominant source of driving is from the magnetosphere above or from atmospheric sources below. A statistical investigation of E-region neutral winds is required to quantify the response over a range of magnetospheric and lower-atmospheric driving conditions. The Poker Flat Incoherent Scatter Radar (PFISR) near Fairbanks, Alaska, USA has been collecting nearly continuous data in the International Polar Year (IPY) mode since 2007 that is suitable for making estimates of E-region neutral winds. This dataset is ideal for addressing this problem.

Remote sensing E-region neutral winds has been accomplished using incoherent scatter radar (ISR) since the 1970s [1]. The technique measures the deflection of the plasma flow velocity away from the F-region E x B direction toward the neutral wind flow direction in the lower E-region due to the influence of increased ion-neutral collisions at lower altitudes. More recently, the problem of determining the altitude resolved plasma flow and neutral winds has been updated using a linear Bayesian estimator that was optimally designed for the Advanced Modular Incoherent Scatter Radars (AMISRs) [2]. While this methodology is routinely applied to the plasma flow data that are part of the standard AMISR data products, the neutral winds have not been as commonly calculated. Moreover, these winds have not been validated against other measurements. In particular, sounding rocket chemical tracer experiments are the most accurate method to derive neutral winds to date.

We present initial results from an investigation of E-region neutral winds using primarily PFISR IPY data spanning the past 10 years. A brief review of the methodology for deriving E-region neutral winds is presented, along with a comparison of our methodology to the neutral winds derived from chemical tracer experiments from sounding rocket missions launched at Poker Flat Research Range, adjacent to PFISR. We present results of monthly mean zonal and meridional wind profiles and make comparisons of these results relative to auroral activity indices and lower-atmospheric driving proxies. We also present initial results of sustained vertical winds and Joule heating estimates.

2. References

1. Rino, C. L., A. Brekke, and M. J. Baron (1977), High-resolution auroral zone E region neutral wind and current measurements by incoherent scatter radar, *J. Geophys. Res.*, 82(16), 2295–2304, doi:10.1029/JA082i016p02295.

2. Heinselman, C. J., and M. J. Nicolls (2008), A Bayesian approach to electric field and E-region neutral wind estimation with the Poker Flat Advanced Modular Incoherent Scatter Radar, *Radio Sci.*, 43, RS5013, doi:10.1029/2007RS003805.