Contribution ID: **151** Type: **Poster Presentation**

Deriving thermospheric neutral density from SuperDARN radar data

Tuesday, 26 June 2018 15:00 (2 hours)

Knowledge of thermospheric neutral density, above 200 km altitude, is important for applications such as satellite drag, which give satellite lifetime, and long-term climatic trends such as global warming. We have successfully applied theory (ion momentum equation) to incoherent scatter radar (ISR) data (e.g., EISCAT) to extract the thermospheric neutral density above 300 km. However, ISRs provide poor coverage and are expensive to operate. Hence, we now focus on coherent scatter radars, which provide great coverage and are cheap to operate. Simplification of the ion momentum equation applied to the ionosphere shows that from the rate of change in ion velocity we can derive the ion-neutral collision frequency, and from this we can calculate the neutral density if the atmosphere is a mono-species or of known composition. The SuperDARN radar global network of 35 radars covers much of the northern and southern hemisphere polar regions.
Normally, the radars observe each beam at a cadence of once per minute. For this novel experiment, we operated selected radars on a single beam with a cadence of one second. This project consists of applying the theory to selected radar data sets, all of which are available. The resultant thermospheric neutral density estimate will be compared to the standard MSIS model.

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Session Classification: Poster Session 1

Track Classification: Track D2 - Space Science