A novel method to estimate thermospheric neutral density using ionospheric velocity observations

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Using the ion-momentum equation in the ionosphere, simplified for field-perpendicular ion motion only, we derive an expression for the ion-neutral collision frequency that depends primarily on the temporal variability of the ion velocity. Ion velocity is the prime parameter observed by the SuperDARN network of HF radars in both high-latitude ionospheres. Experiments performed by the EISCAT Heater, using the CUTLASS-Hankasalmi radar for observations, show that realistic estimates of thermospheric neutral density compared to the MSIS model can be obtained from the ion-neutral collision frequency in the F-region with an hourly cadence. Since HF radio wave propagation refracts in the F-region ionosphere, a functional comparison is only possible with ray tracing. This works well, at least for low geomagnetic activity.