Summer high latitude mesospheric observations of supersonic wind and emission rate of O(^1S) with the UARS/WINDII instrument and the association with polar mesospheric clouds and lightning

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An investigation of the mesosphere at high lalatitudes is performed with the observation of apparent supersonic winds with enhanced O(^{1}S) emission rate with and without polar mesospheric clouds (PMC) during summer daytime and its association with other summer phenomena, observed at 70-80 km altitudes by the Wind Imaging Interferometer (WINDII) on NASA's Upper Atmosphere Research Satellite that was launched in 1991 and operated until 2005. .

Individual interferograms were examined to evaluate the Doppler shift of the wind velocity. During summer daytime in the PMC season (June-August) interferograms below 80 km for isolated bins have a large phase shift with respect to the higher altitude normal aurora, corresponding to high velocities of 600-1500 ms^{-1}, a localized supersonic wind with $1.5 \leq$ Mach number < 5. For the same bins an enhanced limb-viewed green line integrated emission rate of 100-200 kR is observed, compared with the normal high latitude dayglow less than 30 kR at the altitudes.

The optical energy of a green line emission rate of 100-200 kR accompanied by a supersonic wind is about 330-660 kilo-joule (kJ) for an 8-second measurement.

This supersonic wind is proposed to take place in a cylindrical volume composed of 401 m radius and 25 km length, optimized for a bin. These volumes are similar to those of electrical streamer discharges, observed in images of sprites, which are electrical discharge phenomena in the mesosphere typically observed at summer nighttimes and low-mid latitude, caused by upward discharges from lightning strokes. Coincidences in space and time between supersonic wind profiles and space-based lightning detection were found in a limited number of cases. This suggests a possible association of the supersonic winds with sprites.

In summary, this study suggests for the first time that high latitude daytime sprites through a mesospheric electrical discharges are associated with observations of a supersonic wind of enhanced O(^{1}S) emission rate.