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Simulations of Polar-Region Atmospheric Ionization Induced by the Large Solar Storm on January 20, 2005

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Ionizing radiation in the Earth's troposphere is mainly due to Galactic cosmic rays, high-energy particles from outside the Solar System. Typical solar energetic particles do not have enough energy to penetrate to aircraft or cloud altitudes. However, occasionally solar storms can produce relativistic ions with such enormous intensity that their ionization effect in the Earth's lower atmosphere is significant. One of the largest solar storms ever observed occurred on January 20, 2005, which resulted in very large increases in the count rates of ground-based particle detectors, especially near the polar regions. We use data recorded by two neutron monitor stations located near the magnetic south pole (McMurdo) and north pole (Inuvik) to reconstruct particle energy spectra at the top of the atmosphere for each location as a function of time. We create realistic atmospheric models from measured meteorological data and use them along with the reconstructed particle flux to perform Monte Carlo simulations of particle-air interactions. We calculate atmospheric ionization at different altitudes and times during the 2005 solar storm for each location. The real-time ionization profiles obtained will be useful for studying aircrew health effects, correlations with cloud formation, and climate change.

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