Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM06-19 会場:304 時間:5 月 21 日 17:45-18:00

Strom-time characteristics of 630 nm airglow intensity associated with polar-cap patches
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Observing the optical intensity of 630 nm airglow (I_{630}) radiated from polar cap patches with all-sky imagers is an important method to understand the dynamics of the F-region ionosphere at polar latitudes. A series of all-sky images provides information about spatial distribution of electron density structures and their motion as well as relative magnitude of F region electron density. To interpret these data quantitatively we need to know the height profile of airglow emission, namely the volume emission rate (V_{630}), which cannot be obtained by ground-based optical measurement. It is known that I_{630} is proportional to the peak electron density of the F region (NmF2) but is inversely correlated to the height of the F region peak (hmF2). This suggests that some ionosonde or incoherent scatter radar observations of NmF2 and hmF2 inside the field of view (FOV) of an all-sky imager may help us estimate the height profile of V_{630} over the FOV of the imager. However, since V_{630} is largely dependent on neutral gas profiles, particularly on molecular oxygen (O_2) and molecular nitrogen (N_2) profiles, it is not easy to estimate the peak emission height from regular ionospheric observations. Furthermore, during a disturbed period, when both neutral gases and the ionosphere are significantly lifted, estimating the emission height can be more complicated.

In this study, we examine the optical intensity of 630 nm airglow associated with polar cap patches during a magnetic storm that occurred on 22 January 2012. Optical intensity is measured by an all sky imager located at Longyearbyen, Svalbard. The time variation of the optical intensity is compared with the time variation of the F-region electron density observed by the EISCAT Svalbard Radar (ESR). The observed I_{630} variation is in good agreement with the NmF2 variation, and I_{630} is inversely correlated with the hmF2, which is consistent with the known relationship between I_{630}, NmF2 and hmF2. To estimate the height profile of V_{630} we adopt a simple V_{630} model using MSIS-modelled neutral gas profiles and IRI-modelled O^+ ion profile. Optical intensity is calculated by height-integrating the V_{630} and the result is in good agreement with the observation. The modelled V_{630} calculations for several magnetic storms, ranging from D_{st}=0 nT to -400 nT, revealed that (1) I_{630} is strongly affected by scale heights of molecular gases, (2) peak V_{630} height is determined by F region height but usually lower than hmF2, and (3) under disturbed conditions lifted O_2 tends to enhance V_{630} while lifted N_2 tends to quench it, and the overall outcome is increased I_{630}. This set of conclusions indicates that special care, in particular for the height profiles of ionized and neutral densities, must be taken when we interpret airglow observations during severe magnetic storms.

キーワード: polar cap patch, 630 nm airglow, ionosphere, magnetic storm
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