LOWER IONOSPHERE MODEL OF THE POLAR REGIONS DURING SUMMER NOONTIME

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ABSTRACT

Measurements of various parameters in both Arctic and Antarctic mesosphere are available in the literature. These have been first examined to identify the similarities and differences between them in the two polar regions. Then an attempt has been made to reproduce them using an ion-chemical scheme in which both positive and negative ion processes have been included. Temperature and nitric oxide density are found to play a crucial role in the formation of these features. Finally a theoretical model of ion composition for Antarctic summer noontime condition is given.

INTRODUCTION

In this paper we have concentrated on the ionization and ionization related parameters of the two polar D-regions. The characteristics of electron density \(N_e\) distribution in the polar regions during summer and when particle precipitation is absent are the same as those in the mid-latitude including electron biteouts at the altitude of the NLC (Kopp and Hermann, 1984; Kopp et al., 1984; Bjorn et al., 1985; Ulwick et al., 1985; Blix, present issue). Danilov and Vanina (present issue) after analysing a large number of rocket measurements at Heiss Island and Moldezhnaya find that \(N_e\) at Antarctic is systemetically higher than that at Arctic. Measurements of electron density in the polar D-region by ground-based techniques also exist. For Arctic there are several measurements (see Conf. Proc., 1967). For Antarctic, measurements are very few. Gregory (1961) did a back-scatter experiment at Scott Base during IGY period. But he was not very confident about his result. Later vonBiel (1989) repeated the experiment of Gregory (1961) and reported that \(N_e\) distribution in the Antarctic sometimes is distinctly different from that of the Arctic.

There are several measurements of total positive ion density and ion composition in the Arctic (e.g. Kopp et al., 1984; Bjorn et al., 1985), but no measurements in the Antarctic are available. At Arctic, hydrated heavy positive clustered ions have been found. They also display day to day variability. As for example on 30 July 1978 heavy clustered ions were found up to ~90 km, whereas as on 3 August 1982 they were not seen above ~87 km (Bjorn et al., 1985; Kopp et al., 1984). In the negative ion side no measurements are available.

The variability of ion composition is partly due to the variability of temperature. Several measurements of temperature are available in the Arctic and temperature as low as 100 K has been seen around the mesopause region (Theon et al., 1967). It appears now that temperature is not minimum at the NLC region. It is ~30 K lower at altitude ~10 km higher than the NLC region (Philbrick et al., 1984; Lubken, 1996; Thomas, 1991). In the Antarctic, direct measurement of temperature is sparse. Balsley et al. (1995) from the results of wind profiler at Machu Picchu find almost no evidence of PMSE at Antarctic which is a predominant feature in the Arctic. They conclude that the southern polar summer mesopause temperature is 4-5 K warmer than its northern counterpart. Warren et al. (1997) observed sunlit cloud at the south pole around 83 km 4 months after summer. Simultaneous airglow measurements show that temperature did not fall below 155 K. POAM II results also show that the height of NLC at Antarctic is around 82-83 km (Debreestian et al., 1997). Cho and Rottger (1997) made a detailed review of the available studies of the two polar regions. They