29B7 Climatology of the Mesopause Region Over Fort Collins, CO (40.6°N,105°W)

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Since the first report on temperature measurements in the mesopause region using the two-frequency narrowband Na temperature lidar [She et al., 1990], active research continues. Several publications, presenting results of geophysical significance [She et al., 1991; Bills and Gardner, 1993] have already appeared in the literature, and the technique has been extended to measure horizontal winds [Bills et al., 1991].

In order to investigate seasonal variations and thermal structure of the mesopause region, long-term routine temperature measurements at different altitudes and locations should be made. The first step in this direction was taken by von Zahn and his associates who conducted observations at Andoya, Norway (69°N), using the University of Bonn Na lidar [Fricke and von Zahn, 1985], and published several studies on the thermal structure of the mesopause region at polar latitudes [Lubken and von Zahn, 1991]. Due to permanent daylight conditions in summer months at polar latitudes, their Na lidar results were supplemented by other measurements. With no data available in April, May and September, Lubken and von Zahn [1991] have concluded that the observed annual variation of the polar mesopause temperature (and altitude) follows a bistable pattern with a summer value near 130 K (and 88 km), and a winter value near 190 K (and 99 km).

Regular observations of the nighttime temperature structures in the mesopause region are possible year-round at a midlatitude. The ease of laser tuning with our two-frequency Na temperature lidar has made it possible to produce considerably more data with high temporal and spatial resolution in a nighttime observation. Climatology of a midlatitude mesopause may then be derived solely from high quality lidar data. The Colorado State Na temperature lidar has been in regular nighttime operation since 1991. A preliminary report on the thermal structure of the mesopause region based on 94 nights of quality data collected with more than 4 hrs each night to the end of January 1993 have been published [She et al., 1993]. By the end of January 1994, a total of 147 nights of quality data have been collected and all data have been re-analyzed recently to improve the signal-to-noise of the nightly averaged profiles near the top and bottom of the Na layer, giving rise to more extended high resolution seasonally and nightly averaged temperature and Na density profiles, from which the climatology of a midlatitude mesopause will be investigated in this paper.

Figure 1 shows four three-year monthly averaged temperature profiles, each representing a distinct season. Contrary to the reference atmosphere commonly used for this region, such as CIRA 1986, two prevailing temperature minima are clearly seen in spring and fall at altitudes near 85 km and 100 km. The lower minimum reaches a low of 177 K near in the summer and it disappears into the high background winter temperature of 210 K. As in the polar regions, this seasonal variation from a cold summer solstice to a warm winter solstice is a clear signature of a wave-driven diabatic circulation [McIntyre, 1989] observed at a midlatitude. The temperature of the upper minimum fluctuates around 186 ± 8.9 K year-round. Based on the seasonal variations shown in Fig.1, the mesopause altitude follows a bistable pattern as it is in a polar mesopause.

Although the detailed mechanisms responsible for the formation of double temperature minima in spring and fall are not certain and is a topic of ongoing model studies [Roble and Ridley, 1994] The observed data as well as a month-altitude temperature contour map for the mesopause region over Fort Collins, CO will be presented in the meeting. The observed patterns of mesopause altitude and temperature in a midlatitude will be compared with the available observation from a polar region [Lubken and von Zahn, 1991] to aid the investigation of a much needed global picture for the zonally averaged mesopause region.

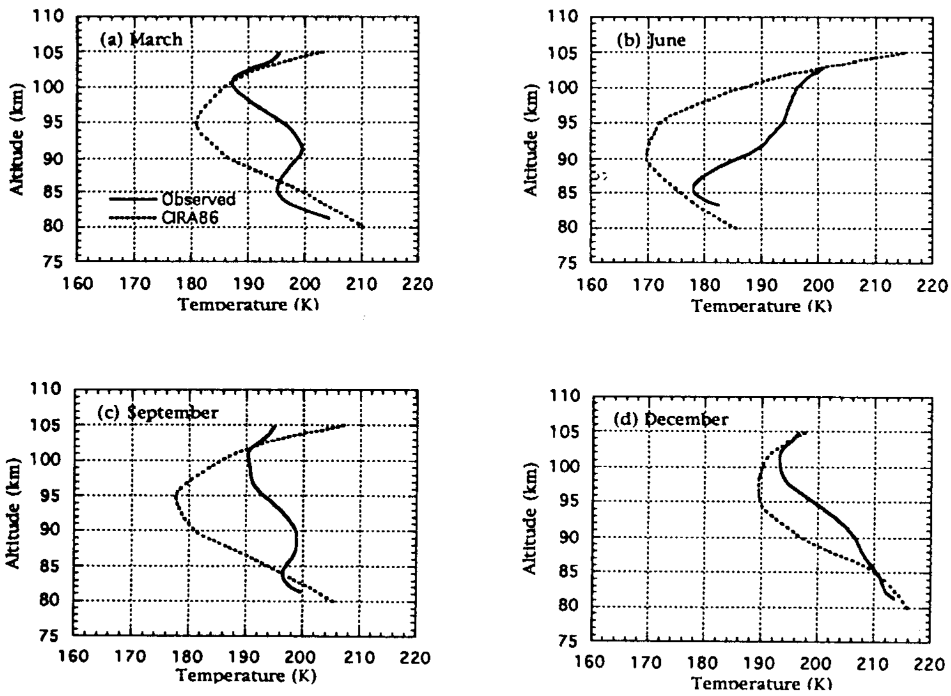

Fig. 1 Observed mean temperature profiles (solid curves) in months of (a) March, (b) June, (c) September, and (d) December compared to CIRA 1986 temperature profiles.

References

Bills, R. E., C. S. Gardner, and S. J. Franke, J. Geophys. Res., 96, 22701-22707,1991.

Bills, R. E., and C. S. Gardner, J. Geophys. Res., 98, 1011-1021, 1993.

Fricke, K. H., and U. von Zahn, J. Atmos. Terr. Phys., 47, 499-512, 1985.

McIntyre, M. E., J. Geophys. Res., 94, 14617-14628, 1989.

Lubken, F. J. and U. von Zahn, J. Geophys. Res., 96, 20841-20857, 1991.

Roble, R. G., and E. C. Ridley, Geophys. Res. Lett. (to be published), 1994.

She, C. Y., H. Latifi, J. R. Yu, R. J. Alvarez II, R. E. Bills, and C. S. Gardner, Geophys. Res. Lett. 17, 929-932, 1990.

She, C. Y., J. R. Yu, J. W. Huang, C. Nagasawa, and C. S. Gardner, Geophys. Res. Lett., 18, 1329-1331, 1991.

She, C. Y., J. R. Yu and H. Chen, Geophys. Res. Lett., 20, 567-570, 1993.