

Seasonal variation of Mesopause temperatures over Fort Collins, CO (40.6°N, 105.1°W)

Chiao-Yao She⁽¹⁾ and Chester S. Gardner⁽²⁾

⁽¹⁾*Department of Physics, Colorado State University, Ft. Collins, CO, 80523, USA*

⁽²⁾*Department of Electrical & Computer Engineering, University of Illinois, Urbana, IL, 61801, USA*

The two-level thermal structure (of midlatitude and polar region) in the upper mesosphere and lower thermosphere (MLT) is by now well-known [1]. The altitude of the low/summer mesopause remains nearly constant at ~ 86 km, while the altitude of the high/winter mesopause varies a bit but remains more-or-less around ~ 100 km. The temperature of the mesopause on the other hand varies throughout the year with minimum, depending on latitudes, occurs near summer solstice and maximum occurs in winter.

Using 20 years and 956 nights of observation over Fort Collins, CO (40.6°N, 105.1°W), She et al. [2] recently reported the two-level mesopause structure over this lidar site with clarity. The mesopause altitude exhibits bistable behavior with high winter mesopause varying between 98 and 103 km and the low summer mesopause at 84 ± 1 km with sharp transitions between them, giving rise to a 102-day summer season between 121 and 222 Day of the Year (DOY). The mesopause temperature has a complicated variation throughout the year with a minimum of 171°K on the 172 DOY, increasing both ways gradually towards the high/winter mesopause where the temperatures vary between 176 K and 187 K. The authors [2] suggested that this complex mesopause temperature variation (throughout the year) is the result of the interplay between solar insolation and the upwelling/cooling and downwelling/warming (pole-to-pole) residual circulation [3]. This deserves a bit more study.

Thus, the purpose of this paper is to use the well-known insolation at 40.6°N and the rare, but available lidar measured residual circulation in meridional wind climatology [4] to qualitatively explain this observed complex mesopause temperature variation throughout the year over Fort Collins, CO (40.6°N, 105.1°W).

1. She, C. Y. and von Zahn, U. (1998), The concept of two-level mesopause: Support through new lidar observation, *J. Geophys. Res.*, 103, 5855 - 5863.
2. She, C. Y., Z. A. Yan, C. S. Gardner, D. A. Krueger and X. Hu (2021), Climatology and Seasonal Variations of Temperatures and Gravity Wave Activities in the Mesopause Region Above Ft. Collins, CO (40.6°N, 105.1°W), submitted to *J. Geophys. Res. Atmosphere*.
3. Pan, W., and C. S. Gardner (2003), Seasonal variations of the atmospheric temperature structure at South Pole, *J. Geophys. Res.*, 108(D18), 4564, doi:10.1029/2002JD003217.
4. Yuan T., She, C.-Y., Krueger, D. A., Sassi, F., Garcia, R., Roble, R. et al. (2008), Climatology of mesopause region temperature, zonal wind and meridional wind over Fort Collins, CO (41°N, 105°W) and comparison with model simulations, *J. Geophys. Res.* 113, D03105, doi:10.1029/2007JD008697.