Interhemispheric comparison of polar mesospheric clouds observed by LIDAR

Xinzhao Chu

Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder, USA (Xinzhao.Chu@Colorado.edu / Fax: +1-303-492-1149)

Advancement of laser remote sensing technology enabled the observations of polar mesospheric clouds (PMC) by lidars through full diurnal cycle in both northern and southern hemispheres over the last two decades. In particular, the extensive observations made with Rayleigh lidars and the potassium Doppler lidar in the Arctic region revealed the morphology of northern PMC, and the extensive observations made with an iron Boltzmann temperature lidar in the Antarctic region revealed the climatology of southern PMC. Both similarities and differences of PMC were found between the northern and southern hemispheres, especially the lidar observed inter-hemispheric difference in PMC mean altitude triggered a debate of inter-hemispheric differences in the middle and upper atmosphere. In this paper, we summarize the recent lidar PMC data of 1999-2005 from the South Pole and Rothera (67.5˚S, 68.0˚W), Antarctica as well as from the Arctic region to examine the PMC climatology and make a comprehensive comparison of PMC properties in both hemispheres. Significant results are obtained on the hemispheric difference, latitudinal dependence, and symmetric distribution of PMC centroid altitude, the dependence of PMC brightness on their altitudes, as well as the diurnal variations of PMC altitude and brightness. The observed mean PMC centroid altitudes are 85.03 ± 0.05 km at the South Pole and 84.12 ± 0.12 km at Rothera, which support the earlier lidar findings that southern hemispheric PMC are on average 1 km higher than corresponding northern hemispheric PMC and higher PMC occur at higher latitude. The distribution of PMC centroid altitudes over all observations is symmetric (nearly Gaussian) in both hemispheres with the most probable altitude near the center of the distribution ($\sim$85 km for South Pole, $\sim$84 km for Rothera, and $\sim$ 83 km in the Arctic). The altitude distribution of PMC brightness for individual PMC events peaks near the most probable altitudes with weaker PMC found on either side of these altitudes. However, when averaging the PMC altitude in each bin of PMC brightness, the PMC altitudes are proportional to the logarithm of the PMC brightness in both hemispheres, which can be explained by the micro-dynamics of PMC particle growth-sedimentation-sublimation and PMC brightness dependence on particle radius. These results indicate that PMC are a natural laboratory for study of the background atmosphere, as PMC are sensitive to small changes in the background temperature, wind and water vapor contents. The interhemispheric differences observed in PMC properties may reflect the interhemispheric difference in the mean state and dynamics of the background atmosphere.