

Long-Term Lidar Observations of Polar Mesospheric Clouds in Antarctica for Studies of Solar Cycle and Polar Vortex Effects

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Polar Mesospheric Clouds (PMCs) are the highest clouds on Earth occurring in summer around 85 km in the mesosphere and lower thermosphere (MLT) region. Using 10 years of Fe Boltzmann Lidar observations of PMCs at McMurdo, Antarctica along with 15 years of PMCs observed from CIPS instrument onboard NASA's AIM satellite, this study gives insights on long term trends of PMCs in Antarctica in relation to climate change, solar cycle and polar vortex break up.

Polar Mesospheric Clouds (PMCs) are potential indicators of climate change. These are water ice particles present in the MLT region. They display a unique state of the summer polar mesosphere – temperatures lower than the frost point and supersaturated water vapor region, primarily. Increased emission of greenhouse gases – CH₄, CO₂ and Water Vapor, aids in PMC formation. Photo-dissociation of CH₄ results in more water vapor and CO₂ in the mesosphere acts as a temperature sink, causing radiative cooling. The 11-year solar cycle could also be playing a role in the formation of these clouds. Photolysis of mesospheric water vapor and changes in mesospheric temperatures due to the varying heating rates at different phases of the solar cycle could affect PMCs. Using Lyman – alpha as a proxy for the solar cycle, this study will answer whether the PMC data show a solar cycle signature?

Since both dynamical forcing and radiative forcing determine the thermal structure and chemistry of the mesosphere, this study dives into the impact of the timing of stratospheric polar vortex breaking on the mesospheric environment leading to PMC formation, using wind reversal dates as a proxy for the polar vortex breakup. The timing of polar vortex breakup in the stratosphere controls the mesospheric winter to summer transitions, directly affecting the temperatures in the MLT. Could the dynamical forcing of the polar vortex overshadow radiative forcing, causing the solar cycle to take a back seat in driving PMC variability? This study is a demonstration of how long-term lidar observations could contribute to the research of climate changes on Earth.