

Observations of Polar Mesospheric Clouds from Space and Their Scientific Implications

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Observations of Polar Mesospheric Clouds (PMCs), also called Noctilucent Clouds, were first reported in 1885 by the amateur astronomer Robert Leslie. Since that time there has been a growing public and scientific interest in these beautiful, iridescent clouds. This is most probably because they can be easily seen from the ground at latitudes above about 55 degrees and in addition numerous papers have reported quantitative cloud properties from space borne measurements. In recent years the focus on PMCs has intensified as a result of satellite measurements that show increasing cloud brightness and frequency of occurrence over the last ~ 27 years. Also, while not conclusively shown, it seems that there are more frequent cloud sightings at lower latitudes, e.g. 40 N, than have been reported in the past. Finally, there is the unproven but plausible theory that the observed changes in cloud properties are connected with global change due to the buildup of the greenhouse gases, CO₂ and CH₄, in the atmosphere.

This paper will present an overview of space-based observations of PMCs and scientific implications of the data. The clouds have been extensively observed by a number of satellite experiments including SME, HALOE, SNOE, SCHIAMACHY, OSIRIS, SBUV, OMI and AIM. The latter mission, AIM, is the first mission dedicated to the study of PMCs with the overall goal being to understand why they form and vary. PMC temporal variability on time scales of a solar cycle and the 27-day solar rotation have been reported. We also now know that PMCs are highly variable from orbit-to-orbit and day-to-day with significant complex structure. Other analyses show that temperature change is a dominant factor in controlling season onset, variability during the season and season end. Rising water vapor levels at the beginning and falling values at the end also play a key role in season initiation and cessation. Structures seen in the clouds look very much like complex features seen in tropospheric clouds including large regions of near circular ice voids. Planetary waves modulate PMC occurrence and can effectively extend the PMC season by providing several days of localized regions of saturated air in the troughs of the waves. By contrast, gravity waves appear to locally diminish PMC frequency even though global scale gravity wave drag is acknowledged as the prime cause of the cold polar summer mesopause. Satellite results also provide evidence that interhemispheric coupling, from the winter hemisphere to the summer hemisphere affects PMC variability.