Year-to-year variation in polar mesospheric clouds observed by geostationary earth orbit satellite, Himawari

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Polar mesospheric clouds (PMCs) or noctilucent clouds (NLCs) consist of water-ice particles, which can be produced in summer at the mesopause region, mainly at high latitudes. It is considered that the formation of the water-ice particles is sensitive to mesospheric conditions which are the atmospheric temperature, the mixing ratio of water vapor (H_2O), etc. Thus, observations of the PMCs can be a useful diagnosis to understand dynamics as well as chemistry in the mesosphere. For example, the long-term PMC activity may be related to the global change, because the water-ice particle production can be enhanced by CO_2 radiative cooling and H_2O increase which may be induced by greenhouse gases such as CO_2 and CH_4.

Since the first report on PMCs in 1885, various methods have been used to perform PMC observations. Optical observations by ground-based cameras, imagers, or lidars are often limited by weather conditions because a clear sky is required for such observations. Hence, satellite observations from space are also valuable for more continuous observations, which enable significant systematic data coverage. PMC observations by low-earth-orbit (LEO) satellites have a long history. By contrast, there are only a few reports of PMC observations by geostationary-earth-orbit (GEO) satellites, which include Meteosat First Generation (MFG), Meteosat Second Generation (MSG), and Himawari-8. This kind of GEO satellite can produce full-disk images including the Earth's limb, which would provide valuable opportunities for PMC observations by continuous limb-viewing from its almost fixed location relative to the Earth.

Recently, we developed a near real-time PMC monitoring system by utilizing full-disk imaging of Himawari-8. Based on its PMC data obtained from 2015 to 2021, in this study, we have investigated PMC variations in the most recent years. We have derived the PMC occurrence rates from the near real-time and continuous PMC data, which are provided by the Himawari-8 PMC monitoring system. Concerning to year-to-year variation in the Northern hemisphere, it seems that the PMC occurrence rates tended to gradually increase during 2015-2020, and the occurrence rate was highest in summer 2020. These results may imply a relation to the fact that NLCs were observed over Hokkaido, Japan, during 12-14 June 2020. On the other hand, the PMC occurrence rates in the Southern hemisphere showed more complex features. For example, the PMC occurrence rate was not high in summer 2020-2021, compared with those in the other years. In the presentation, we will show these results, and discuss the observed PMC variations, together with the mesospheric temperature and H_2O mixing ratio data obtained by Aura/Microwave Limb Sounder (Aura/MLS). Furthermore, to extend data coverage, we plan to examine a possibility of PMC observations by Himawari-6/7 in 2005-2015.

Keywords: Polar mesospheric clouds, Noctilucent clouds, Geostationary earth orbit satellite, Himawari

