Comparative Study of Microwave Polar Brightening, Polar Coronal Hole, and Polar Solar Wind

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Polar brightening of the Sun at 17 GHz observed with the Nobeyama radioheliograph shows a solar cycle dependence, brighter at a solar minimum and darker at a solar maximum. Also, it has been reported that the polar brightening highly correlates to polar magnetic field strength (r˜0.86). The plausible model to explain the cycle dependence of polar brightening is that a height scale of the solar atmosphere in the polar region depends on the solar cycle. Indeed, the polar region is covered by large coronal holes except for a short period during a solar maximum, and the size of the polar coronal hole depends on a solar cycle.

Motivated by these observational facts, we compare the polar brightening, polar coronal-hole size, and polar solar-wind speed from July 1992 to December 2017. The magnetic features in the polar regions are determined by using synoptic observation data obtained at Kitt Peak National Solar Observatory, coupling with a coronal magnetic field extrapolation technique. The solar-wind speed in the polar region is determined by using the interplanetary scintillation (IPS) observation at Nagoya University.

As results, we obtained the following results. 1) The distribution of polar brightening matches spatially and temporary to the probability distribution of coronal holes. 2) The brightness temperature of the polar brightening strongly correlates with the predicted size of the polar coronal hole (A); r˜0.95. 3) The solar wind speed (V) around the polar region highly correlates with the polar brightening; r˜0.81. From these results, we conclude that polar brightening reflects the coronal-hole area or magnetic flux expansion rate (f) in the polar region. Solar wind speed can be predicted by using the polar brightening, which is similar to the empirical relationships of A-V and f-V.