Long-term Global Solar Activity Observed by the Nobeyama Radioheliograph

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The Nobeyama Radioheliograph has been observing the Sun since 1992 for more than 20 years. It can synthesize full disk images of the Sun at 17 GHz. Due to its long and steady operation and well calibrated uniform data, long-term global solar activity of the Sun can be studied. By using about 7,200 daily images, a butterfly diagram is synthesized and is studied [Figure 1]. The radio butterfly diagram has different features from sunspot butterfly diagrams. Polar regions are bright at 17 GHz. The brightness of polar regions are well correlated with magnetic field strengths at polar regions. Both are anti-correlated with activities at low latitude, such as active regions and solar flares. We can see both high and low latitude activities in one radio butterfly diagram. During the observation of 20 years, high and low latitude brightness shows gradual decline. In the northern hemisphere, brightness at low and high latitudes are well anti-correlated. On the other hand, the correlation is rather weak in the southern hemisphere. We can find weakening of synchronization of activities between north and south hemispheres and also between high and low latitude activities in the southern hemisphere.

Microwave enhancement associated with unipolar strong magnetic field regions is an important message to chromospheric heating mechanisms. As the emission mechanism at 17 GHz from non-flaring regions is free-free, enhanced microwave brightness requires hotter plasma around the upper chromosphere. In unipolar filed regions, magnetic field has open structure and heated atmosphere has to flow out along the field. Continuous heating at or below the upper chromosphere proportional to photospheric magnetic flux is necessary. To understand chromospheric heating in open field structures, detailed studies of temperature structure above unipolar magnetic field regions in coronal holes are needed.

Even though NoRH was designed and constructed for studies of high energy phenomena on the Sun, it turned out to be also a good instrument for studies of long-term global solar activity. Observing frequency of 17 GHz best fit to detect polar activity of the Sun which plays important roles in global activity. Due to good design and proper maintenance, operation of the instrument is quite stable. Even after more than 20 years of continuous operation, observations are almost perfect. This enables us to synthesize a radio butterfly diagram with which long-term global solar activity can be studied. We are currently facing a low solar activity period we have never experienced with modern observing facilities in hands. This unusual activity is a good chance to deeply understand solar activity itself and also its influence to surrounding interplanetary space including the earth's upper atmosphere. Especially, polar regions are known as the sources of solar wind which fills the whole interplanetary space inside the heliosphere. We hope NoRH can continue operation further and contribute to understand global solar activity [1].

Reference

[1] Shibasaki, K.: 2013, *PASJ*, **65**, S17.

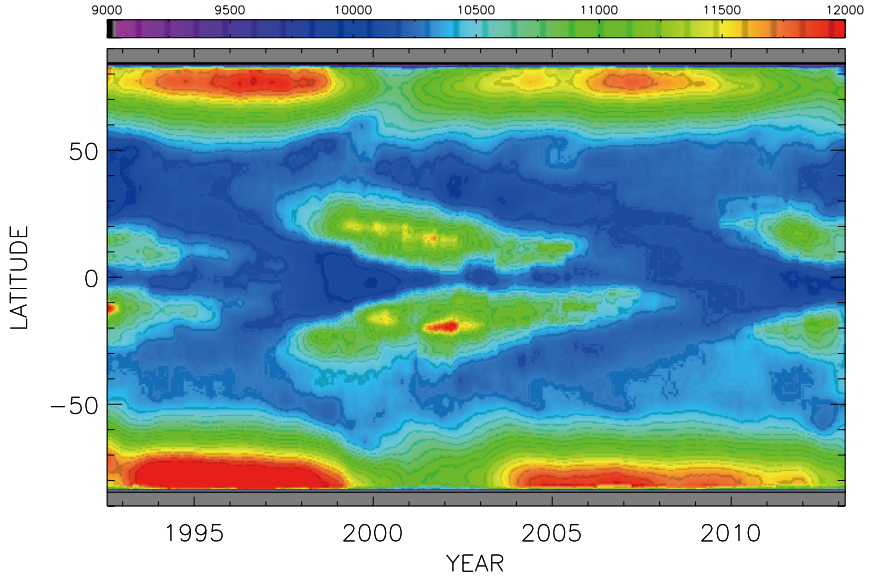

Figure 1: Radio Butterfly Diagram.