Occurrence dependence on solar activity cycle for type III radio bursts based on the automatic detection analyses

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Type III solar radio bursts are one of intense radio wave emissions that appear with the solar flares. They appear in the wide frequency range from the GHz to kHz band, and show a large negative frequency drift. A generation process of type III bursts is thought that high energy electrons originally generated with magnetic reconnections during a flare event excite Langmuir waves in the solar corona and/or interplanetary space, then the Langmuir waves are converted into electromagnetic waves observed as type III bursts. It is therefore generally assumed that the frequency of type III bursts reflects the plasma density in the solar corona and/or interplanetary space where the radio waves are generated, and their frequency drift reflect the plasma density distribution and the velocity of high-energy electrons.

It is well known that density distributions of the solar plasma differ depending on the activity of solar surface area (ex. Aschwanden and Acton, 2000). This implies that the plasma density distribution roughly varies with the solar activity cycle and therefore the frequency drift rates of type III bursts might show solar cycle dependence since the drift rate should reflect plasma density distributions along the paths of high energy electrons and also their energies. Although the occurrence rates of type III bursts are known to show a positive correlation with solar activity, our knowledge for solar cycle dependence of the drift rates has been still limited (ex. Zhang et al., 2018).

In this study, we have investigated statistical occurrence features of type III bursts, especially drift rate, flux density and their mutual relations, to clarify their solar cycle dependence. For this purpose, we have tried to make statistical analyses of type III bursts using a database of solar radio spectra observed with the Nancay Decameter Array (NDA) in France since 1977. We have analyzed the low-resolution data (175 kHz frequency resolution, 1 second time resolution) of the Nancay Decameter Array (NDA) in Paris, France. Although the observation frequency range of NDA is 10MHz-80MHz, we have used the spectra for 30-80MHz to avoid hard artificial radio noises below 30MHz.

In this analysis, an automatic burst detection system was newly developed to make the statistical analyses. At first, the spectrum data were divided every few minutes and reduced the thermal radiation level of the sun which temporally changes with the altitude of the sun due to atmospheric extinctions. Next, candidates of solar radio bursts were picked up as the ones whose radio flux exceeded some threshold level. Then, more plausible candidates as type III bursts were sorted out automatically as the bursts appearing continuity in the frequency and time domains at some extents and also with the negative frequency drift. Finally, we identified type III bursts through a visual check.

Using the developed automatic detection system, analyses for the NDA data observed in the solar cycle 24 have been performed. A preliminary result shows that the number of detected type III bursts in 2018 (near the solar minimum) was reduced to about 1/55 compared to that in 2013 (around the solar maximum). In the presentation, we will introduce the automatic type III bursts detection system and show solar cycle dependence for the occurrence characteristics of type III bursts with the discussion of their background processes.

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