Occurrence dependence on solar activity cycle for ordinary type III bursts and micro-type III bursts

*Yuichiro Seki[1], Hiroaki Misawa[1], Takahiro Obara[1], Fuminori Tsuchiya[1]

1. Tohoku University

Type III bursts are one of intense solar radio emissions and show a large negative frequency drift. Some of them originate above solar active regions and appear with solar flares. These type III bursts are hereafter referred to as ordinary type III bursts. On the other hand, type III bursts sometimes appear as clusters which are characterized by thousands of short-lived type III bursts lasting for a few days or more than a week. Morioka et al. (2007) proposed the term 'micro-type III bursts', which are elements of type III storms. It is suggested that micro-type III bursts originate near the edge of coronal streamers and are not just weaker versions of the ordinary type III bursts because a distribution of emitted power flux is different from that of ordinary bursts.

Generation processes of both ordinary and micro type III bursts are thought that high energy electrons originally generated with magnetic reconnections 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 reflects 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, 2001). 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 rates should reflect plasma density distributions. 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). Moreover, there has been no study that clearly classifies ordinary type III bursts and micro-type III bursts, and simultaneously analyzes the long-term variation of their drift rates.

In this study, we have investigated occurrence features of drift rates for ordinary type III bursts and micro-type III bursts to clarify their solar cycle dependences. 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). We have analyzed the low-resolution data (175 kHz frequency resolution, 1 second time resolution) of the NDA. Although the observation frequency range of NDA is 10MHz-80MHz, we have used the spectra for 30-80MHz to avoid noises below 30MHz.

An automatic burst detection system was newly developed to make the statistical analyses. Threshold methods, Convolution Neural Network (CNN) methods, and least squares methods with curve fitting are applied to our detection system. From candidates of type III bursts detected by this system, we finally selected ordinary type bursts and micro-type III bursts through a visual check.

Using the developed automatic detection system, we have analyzed 7 years of solar activity cycle 24, 2012-2014(around solar maximum) and 2017-2020(around solar minimum) so far, and detected 1145 ordinary type III bursts and 1021 micro-type III bursts in total and a preliminary result shows for ordinary type III bursts, drift rates (|df/dt|) in 2019 and 2020 are lower than those in other years, and for micro-type Ⅲ bursts, lower solar activity is, higher drift rates are. In the presentation, we will show solar cycle dependence for the occurrence characteristics of both ordinary and micro type III bursts with the discussion of their background processes.

Acknowledgments: The solar radio spectrum data was provided by the Nancay Observatory, Observatoire de Paris, France. We would appreciate Dr. L. Lamy and the NDA operation group.

Keywords: Radio emission, Particle acceleration, Nancay decameter array, Type Ⅲ bursts, Micro-type Ⅲ bursts

