Popular Science Summary

Aoi Kasai

The SOM can evaluate heavy rainfall risk

The fifth synthesis report (AR5) of the International Panel on Climate Change suggested the frequency and intensity of heavy rainfall events has likely increased over the second half of the 20th century due to the anthropogenic forcing. Owing to the recent increase of heavy rainfall frequency, the natural disaster events related to heavy rainfall have frequently happened and caused severe damage to infrastructures and human lives in Kyushu, Japan. Despite some recent progress on bending the emission curve, RCP8.5 is the most likely scenario under current and stated policies. Under RCP 8.5 scenario, extreme precipitation events will become more frequent in Kyushu. Then, it is important to recognize what kind of meteorological fields have contributed to the occurrence of heavy rainfall events so far and to reveal whether it is possible to diagnose heavy rainfall risk and associated disasters.

This study employs an unsupervised algorithm called the Self-Organizing Map (SOM) to discover patterns of meteorological fields and provide a visualization of unlabeled multidimensional data into two-dimensional map. As a result, meteorological fields observed from 1979 to 2018 in warm seasons (June to September) are classified into 40 synoptic weather groups and they are related to the heavy rainfall frequency obtained by Radar/Rain gauge analyzed precipitation data. Then, the top 10 groups of precipitation frequency explain 76.8% of all precipitation over 50 mm/h in Kyushu area and explain all disastrous heavy rainfall events happened after 2000. Moreover, they are characterized by four reasons, the existence of 1) strong southwest wind and large amounts of precipitable water (PW), 2) counterclockwise circulation with large PW, 3) tropical cyclone and 4) stationary front. The conditions of 1) and 2) are highly contributed to heavy rainfall events the in the northern area, whereas, 3) and 4) can be particularly recognized in the southern area.

The Global Spectral Model (GSM) is combined with the structured SOM for diagnosing the probability of heavy rainfall occurrence within a range of few days. As a result of the case studies, the probability of heavy rainfall occurrence can be increased and stabilized around 36 hours before heavy rainfall events. The probability is around 40 to 80 % in three case studies. Furthermore, the SOM can relate these diagnosed patterns to historical rainfall events. For instance, the predicted unit (U596) on the SOM in Case 1 is so close to the unit including 2012/7 Northern Kyushu rainfall event (U595), which resulted in the flood disasters in the same prefecture (Fukuoka). Therefore, decision makers can learn where was mostly affected in the predicted unit on the SOM and estimate where will be affected in the upcoming rainfall events.