The ETAS model of seismic activity and systematization of statistical seismological theory

Reasons for the award:

The awardee is one of the founders of the new statistical seismology, whose systematic research began in the late 1970s. During his 46-year tenure at the Institute of Statistical Mathematics, the awardee has made significant contributions, both theoretical and applied, to the construction of point-process models and their parameter estimation, and to seismic modeling, including probability prediction, anomaly detection, and simulation of seismic activity. Among them, the most noteworthy result is the proposal of the Epidemic-Type Aftershock Sequence（ETAS) model. The model combines the Omori-Utsu formula with the self-excitability of point processes (Hawkes point processes) to represent the clustered nature of earthquakes as represented by aftershock activity. The core of this idea is a "conditional intensity function" defined from the perspective of predicting the degree of urgency (the differential amount of probability of occurrence) of an event (point) at a given location based on the history of occurrence of past events and other information. The incorporation of this concept into statistical seismology has opened a new door to the prediction of the probability of various earthquakes based on seismic activity data and other data.

For example, he has shown that the calming and increasing activity of regular seismic activity in the Japanese archipelago can be objectively determined by fitting an ETAS model to seismic activity data, and has shown the possibility of predicting the long-term probability of earthquake occurrence using background intensity of the space-time ETAS model. In addition to the above, the results show that the ETAS model can be applied to a variety of probabilistic prediction studies on earthquake occurrence, including the probability of causal relationships between anomalies and earthquake occurrence, and the applicability of the model to the probabilistic prediction of foreshocks, which is important for short-term prediction.

This model is now considered to be a standard model for seismic activity and is used in the evaluation of aftershock activity at the Headquarters for Earthquake Research Promotion, Japan, as well as in the International Research Project on Collaboratory for the Study of Earthquake Predictability (CSEP). It has also had a significant impact on the world, such as being used in the USGS 3rd generation forecasting model. Furthermore, the ETAS model has been used as a basic model in many attempts to construct and validate various models of seismic activity in order to understand the physical mechanisms of earthquake occurrence. In addition to these, the success of the ETAS model in seismology has attracted attention outside of the earth sciences and has been applied to many other research areas, such as plant invasions in ecology, neural and social network

interactions, software bag updates, spreading wildfire, crime occurrences, and finance.

The systematization of the statistical seismological theory based on the ETAS model proposed by the laureates will play an extremely important role in leading this trend worldwide. In addition, he is a member of the Coordinating Committee for Earthquake Prediction, Japan, and is involved in earthquake prediction and disaster mitigation from a social perspective. For these reasons, the Seismological Society of Japan Award for 2019 is hereby presented.