AOB Seminar

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講演題目&要旨：

On Signal Processing Problems in Seismology

In Japan, as part of an attempt to predict big earthquakes, a nation-wide seismological network system was established in 1979, and a large database of various observations has been accumulated. However, in analyzing these data, we must confront two significant difficulties. Firstly, the seismic signals observed by seismometers are contaminated by various kinds of natural effects, such as microtremors, microseisms, wave, wind, tide, air pressure, precipitation and a variety of human induced sources. Since the noise level is an independent of the seismic signal, the effect of the background noise becomes more severe for earthquakes with smaller magnitudes. Therefore, to analyze seismic signals with smaller magnitudes, we need to develop a more sophisticated procedure that can handle very noisy data. Secondly, the number of earthquakes increases exponentially as the magnitude decrease and linearly as the number of data increases. Therefore, for signal processing of increasingly many earthquakes, it becomes necessary to develop a computationally efficient statistical method that can automatically detect seismic signal from noisy data. Statistical modeling procedures mainly consist primarily of three parts, namely models, computational methods and the model evaluation criteria. In this paper, we review the systematic use of state space models for the modeling of seismic signals. For the extraction of the signal and for the decomposition of noisy data, various models have been developed and all of them can be expressed in the general state space model form. The method is based on the general state space model, recursive filtering and smoothing algorithms. The self-organizing state space model is used for estimation of the time-varying parameters of the model. We show five specific examples of time series modeling for signal extraction problems related to seismology; 1) estimation of the arrival time of a seismic signal; 2) extraction of small seismic signal from noisy data; 3) extraction of the coseismic effect in volumetric strain data contaminated by various effects from air pressure etc.; 4) estimation of changing spectral characteristics of seismic records, and 5) spatial-temporal smoothing of OBS data.