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Multivariate Analysis of Geophysical Time-Series Data on a Cloud Computing System

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A multivariate analysis of time-series data based on the Bayesian statistics is always time-consuming especially in its complex programing and much computation time. Although Research and Development Center for Data Assimilation, the Institute of Statistical Mathematics provides software related to such Bayesian analysis, multivariate analysis requires many computer resources, which are often hardly obtained.

We have developed web application ”CloCK-TiME” (Cloud Computing Kernel for Time-series Modeling Engine), which enables users to analyze their time-series data by using a networked PC cluster in a cloud computing system. A state space model decomposes uploaded time-series data into trend, seasonal, autoregressive and observation noise components, each of which are estimated using the particle filter algorithm. We show an application example in the case of tide gauge data recorded along the coastline of Japan. Tide gauge observations along the coastline of Japan have recorded the land sinking due to the continuous subduction of the oceanic plates. The proposed software extracts such long-term activities of the Earth’s crust together with rapid displacements related to earthquakes, even before the establishment of the global positioning system, from monthly mean data of the sea levels. The spatial and temporal distributions of the extracted trend component clearly indicate the subduction, near which giant earthquakes have occurred or are predicted to occur. A multivariate analysis of the observatories located at the northeast coast of Japan successfully determines the past crustal displacement in the case of the 1978 Off-Miyagi Earthquake.

Keywords: cloud computing, time-series analysis, multivariate analysis, tide gauge