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Author(s)	小山内, 尚
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Description	Supervisor:ホー ツー バオ, 知識科学研究科, 修士

Using Clustering Techniques to Investigate Acidic and Oxidative Components in East Asia

Hisashi Otsu

School of Knowledge Science
Japan Advanced Institute of Science and Technology
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The East Asian area is one of the largest regions for the anthropogenic emission of NO_x and SO_2 [Rodhe 89]. In fact, because of population growth and the rapid development of industrial activity, it has been projected that this area will become the largest source of NO_x and SO_2 in the world in the 21st century [Galloway 89]. It is important to analyze the present status of air pollution over the East Asian region, to evaluate the amount of the anthropogenic emission, to accurately predict the future situation by the use of computer models, and to apply these results to work out countermeasures.

The book "Studies on the behavior of Acidic and Oxidative Components in East Asia" which investigated the pollution state of the present atmosphere is offered by National Institute for Environmental Studies (NIES).

Accumulated huge data currently, exceeds human's information processing capability. Therefore, there is a need of establishment of computer methods to exploit effectively these data. Recently, data mining methods have been expected to be efficient methods to extract knowledge and unknown information from large databases. It is well known that ozone of the troposphere background is an important compound that influences atmospheric oxidization phenomenon. Also, ozone is a very important component from the view point of the global warming as a greenhouse gas.

The increase of tropospheric ozone in the Northern Hemisphere is reported recently in Europe and America, and the study of this increase attracts much attention from researchers. A report for these phenomena in East Asia region is indispensable. It is known that only NO_2 becomes the outlier object of ozone in the troposphere, and there is an indication that the increase of the anthropogenic emission of NO_x also includes NO which has brought the increase in such ozone concentration. Thus, it is important to see the increase of ozone and NO_x from various angles, to govern chemistry of the tropospheric atmosphere, and to know the three-dimensional concentration distribution. It is an indispensable factor when considering the change of the tropospheric atmosphere. On the one hand, SO_2 has played an important role as an outlier object of sulfuric acid of cause material of acid-rain.

It is said that a lot of SO_2 flows in Japan from the part of East Asia area containing China and the Republic of Korea

The purpose of this study is to find new knowledge about behavior of acidic and oxidative component in East Asia using clustering techniques. Especially, we want to detect regimes which have deep influences on climate model and prediction.

This research consists of the following tasks which are required in main-steps of KDD (preparation of data, mining, analysis and understanding of results).

First, as the preparation of data, we do the removal of missing values and transformation of the different NIES databases into one unified database which is convenient for processing. These tasks are done by using Perl and PostgreSQL. Secondly, the data mining process is done on the unified database by using PAM clustering method and "natural" K discovery method. The programs for these algorithms were implemented by C language on UNIX workstation. Finally, the tree-dimensional structure of clusters discovered by the above methods are expressed visually.

Eventually, the following analysis results were obtained:

- (1) The "natural" number of clusters is four.
- (2) The pollution state of the cluster of the Northern part of the Chugoku district is severer than the contamination of other clusters.
- (3) In the cluster of the Southern part of Kyushu district, there is a significant correlation between temperature and sulfur dioxide.

The following conclusions can be drawn from the above-mentioned analysis results:

Each cluster discovered in (1) has no characteristics of the regime defined in this study, therefore it is not a regime. However, these clusters provide us insights to obtain results (2) and (3).

From the result (2), we can see clearly the relation between a pollution state and the transportation distance of an acid-rain contaminant.

From the result (3), we extracted a relationship between temperature and sulfur dioxide, that is the key point of the global cooling system. It can be considered that this is a precious relation that supports the global cooling system observed from actual data.

We hope that these results, especially (2) and (3), can be considered as a significant contribution to the field of environment studies.