

Development of a package of correlation analysis and statistical tests for various solar-terrestrial environment data

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The Earth's upper atmospheric variations are generated under both the influences of the lower atmosphere and solar activity. Then, in order to clarify the generation mechanism of the atmospheric variations, we need to perform the integrated analysis of various observation data. However, various ground-based observation data and their databases of the upper atmosphere have been maintained by each institution that conducted the observations so far. Therefore, when researchers try to perform the comprehensive analysis of several kinds of observation data, there have been several problems of data search, acquisition, and analysis.

In order to solve the above problems, the "Inter-university Upper atmosphere Global Observation NETWORK: IUGONET" project was initiated in 2009 by the five Japanese universities and institutes (NIPR, Tohoku University, Nagoya University, Kyoto University, and Kyushu University). This project is proposed to construct a metadata database of observation data maintained by each institution and to develop the IUGONET Data Analysis Software (UDAS). This software is a plug-in software for THEMIS Data Analysis Software suite (TDAS) written in IDL, and can easily display several time-series plots of various observation data such as geomagnetic field, aurora, and neutral wind.

With the aid of the IUGONET metadata database and the analysis software (UDAS), we can access easily the data or database maintained by each research institution, and can perform the comprehensive analysis of various data sets in different fields. The UDAS has a lot of tools to display time series plots of various observation data, but does not include statistical test tools for correlation analysis of a pair of observation data. In this study, we aim to develop a package of statistical tests to judge whether the correlation analysis results are statistically significant or not. In the future, we plan to implement the statistical test package into the IUGONET analysis software (UDAS).

The statistical test package consists of five parts: First is calculation of cross correlation and decorrelation test for the value of correlation coefficient, second is power spectrum and coherence analyses and test for the coherence value, third is anomaly analysis to investigate the deviation from the reference variation with the dominant frequency in both the data determined from the coherence calculation, fourth is to judge whether the distribution of two data is the same or not, and fifth is to check whether observation data has significant trends (decrease or increase) or not. Due to changes of the observation condition or failures of instruments, observation data generally contain missing values and the time interval is not necessarily constant. Therefore, this package of statistical test includes several data processings such as linear interpolation and exclusion of missing value, in order to align the number of two subject data points.

To evaluate the effectiveness of our developed statistical test tools in this package, we applied the trend test to the long-term variation in the altitude distribution of meteor echoes obtained from the meteor wind radar at Kototabang. This instrument has been operated for a long period from November 2002 to present by the Research Institute for Sustainable Humanosphere, Kyoto University. As a result, the altitude of the maximum meteor echoes does not show a significant trend (decrease or increase) between 2003 and 2011 on the basis of the trend test at significant level of 1%. This result suggests that the altitude distribution of the density of the upper atmosphere around the meteor height almost do not change during this period. Therefore, it can be concluded that global warming is not recently in progress.

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