Reconstruction of Historical Weather with Data Assimilation Using Old Diaries

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Long-term atmospheric reanalysis data is indispensable for understanding the mechanism of climate change, but the current longest data is over 130 years only. The cause of not going back further to the past is largely due to lack of direct weather observation data. However, even in the past where modern weather observation data does not exist, the daily weather information described in the ancient document may exist for a longer time. In this regard, Japan is ideal country that has kept such old weather information. In this research, we developed a method to introduce old weather information into the latest data assimilation system, investigated the effect as the constraint condition of atmospheric condition, and proposed a method to extend existing reanalysis data in the past. We constructed a system using historical weather database, global spectrum model, local ensemble transform Kalman filter as observation data, prediction model and data assimilation scheme respectively. Analog information indicating weather should be classified into about 3 to 5 categories and it is better to correspond to the cloud amount ratio and the short wave downward radiation on the ground surface. Furthermore, it is appropriate that the ensemble number is about 30 from the balance of calculation efficiency and accuracy. Using the above setting, the data assimilation result given the weather information obtained at the meteorological observatory at 18 sites, for the modern era (1990 's), is closer to the modern reanalysis than the result without any weather information. As a result, significant improvements were observed in shortwave radiation and cloud cover, and significant improvement in precipitation was confirmed. These improvements are thought to have been brought by synchronizing the modeled synoptic-scale weather patterns to the reality. Furthermore, it was confirmed that the skill of rainfall estimation was improved by adding information of "no precipitation day" to data assimilation as an observation item. Then we conducted the experiments of the 1830s and 1860s using actual ancient diary data. It was confirmed that similar seasonal change and interannual variations can be obtained compared with temperature and precipitation in the 1860s which was actually observed in Yokohama.

Keywords: old diaries, data assimilation, weather reconstruction