Production of Long-term Reanalysis Data for the Global Atmosphere (JRA-25)

Background

Reanalysis data of the global atmosphere are generated by conducting analysis processes (Figure 1) in past weather forecasts throughout a certain period. The reanalysis, unlike historical analyses in past weather forecasts, employs a complete set of past observations with the latest system of numerical models to realistically represent the state and variability of the atmosphere. The reanalysis is a fundamental dataset for meteorology and climate studies, which need to be more advanced under the development of computing techniques and facilities. Our institute and the Japan Meteorological Agency (JMA) have conducted a collaborative study to produce a new reanalysis dataset to be used as reference for global warming studies and climate system monitoring.

Objectives

The objective of the present study is to construct a reanalysis production system based on numerical models of the JMA's weather forecast system and to produce the first long-term reanalysis dataset (JRA-25) undertaken in Asia. The reanalysis period is about 25 years after 1979, when an advanced satellite observing system was established. It is intended that the JRA-25 has higher quality in Asia and the tropical ocean than existing reanalyses by European and American institutes.

Principal Results

1. Outline of the JRA-25

The reanalysis employs various observations as input data. The JRA-25 input observations include empirically retrieved winds near tropical cyclones and Chinese daily snow depths based on printed reports in addition to primary observation archives of conventional radiosonde and satellite remote sensing. Output data consist of six-hourly global gridded data for more than 200 meteorological variables, which amount to 8 TB in size for 25 years. These outputs have spatial resolutions of approximately 1.1-degree horizontal grid spacing and 40 vertical layers with the top of 0.4 hPa pressure level.

2. Quality of the JRA-25

The JRA-25 has better quality with regard to the representation of tropical cyclones and the spatial distribution of precipitation rates (Figure 2). These high-quality features are maintained throughout the reanalysis period. However, the quality and amount of input observations are generally time-variant, which inevitably degrades temporal homogeneity. The present study reveals potential problems of the reanalysis providing precautions for application studies.

3. Spatial distribution of surface air temperatures

As an example of information derived from the reanalysis, Figure 3 illustrates spatial distributions of surface air temperature anomalies in February 1998. In this period, a major El Nino event in addition to a long-term warming tendency resulted in the highest global-mean temperature on record. Surface observations are limited in particular over the ocean and the hinterland of continents. The reanalysis statistically merges observations and numerical models considering each error characteristic and produces the optimum distribution of global temperatures. These surface temperatures are generally consistent with upper-air temperatures and other meteorological variables, which are beneficial to understanding of climate change and other related matters.

Future Developments

The JRA-25 dataset is open to the public for scientific studies like other reanalyses by European and American institutes. Our institute will use the JRA-25 intensively for studies on tendencies in typhoons and heavy precipitation in the framework of research into the adaptation of the electric power industry to global warming.

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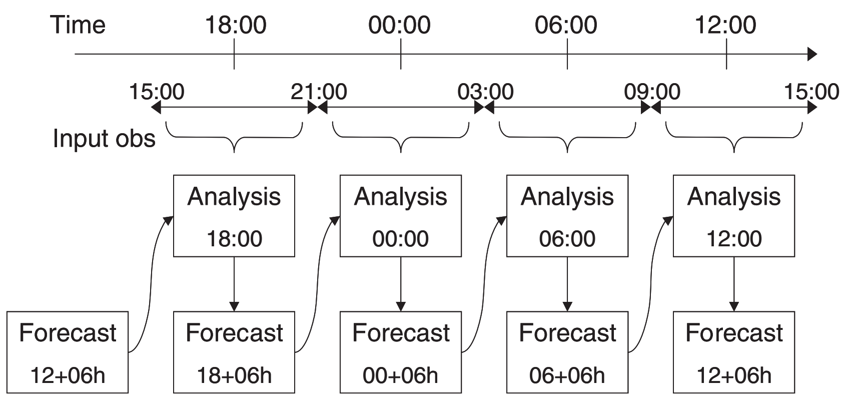
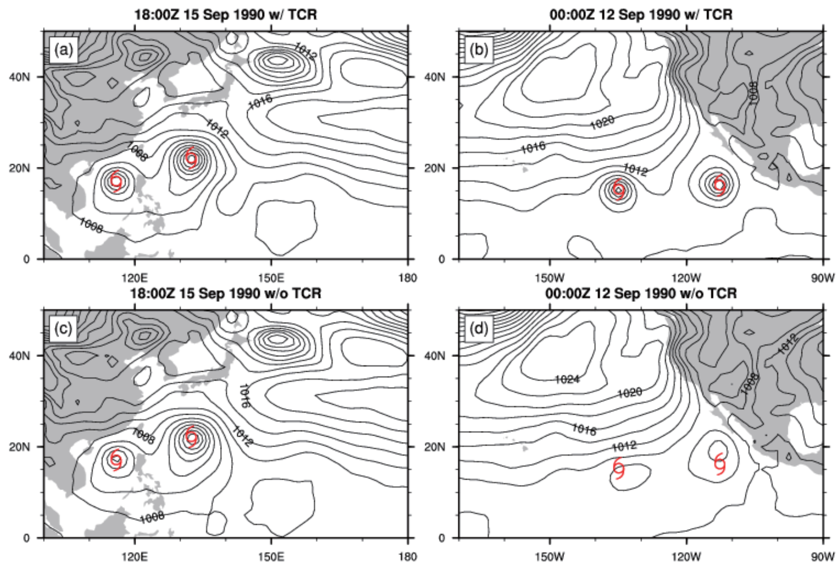
Reference

J. Tsutsui, et al., 2006, "Long-term reanalysis of global meteorological data: Specification and quality of the JRA-25 reanalysis data and an application study on climate change", CRIEPI Report V05024 (in Japanese)



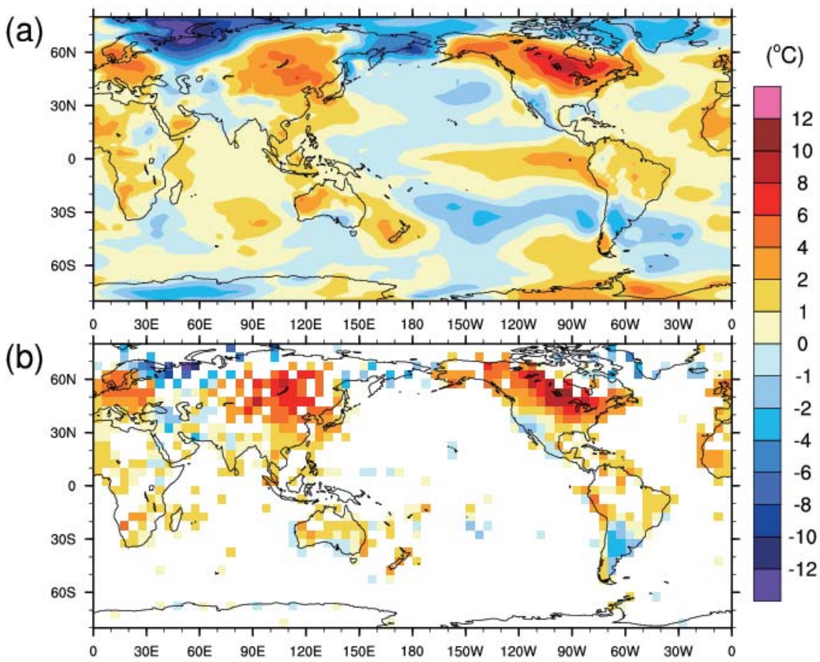
The procedure of the JRA-25 reanalysis is a six-hourly cycle of temporal extrapolation of global gridded data by a numerical forecast model and correction to the forecast data by observations, the latter of which is called analysis.

Fig.1 Procedure of the analysis of meteorological observation data



Contours are drawn by 2-hPa interval, and red weather symbols denote central positions of typhoons or hurricanes. Panels (a) and (b) show the JRA-25, and panels (c) and (d) show control experiments without the retrieved winds near tropical cyclones. These results suggest a large impact of the retrieved winds in the eastern North Pacific.

Fig.2 Examples of sea level pressure maps in September 1990 focusing on tropical cyclones in the western and eastern North Pacific



Panels (a) and (b) show, respectively, the JRA-25 and the reference data by Jones and Moberg (2003) based on surface observations. Both distributions are similar. Unlike the reference observations, the JRA-25 provides global data covering data-sparse areas.
Jones and Moberg, 2003, J. Climate, 16, 206-223

Fig.3 Spatial distributions of monthly surface air temperature anomalies in February 1998