The JRA-25 Reanalysis

Kazutoshi Onogi
Climate Prediction Division, Japan Meteorological Agency, Japan
konogi @ [naps,met] .kishou.go.jp

1. Introduction

The Japan Meteorological Agency (JMA) and the Central Research Institute of Electric Power Industry (CRIEPI) completed a cooperative research project named "Japanese 25-year Reanalysis (JRA-25)" in March 2006. JRA-25 is a long-term global atmospheric reanalysis produced using JMA's data assimilation and forecast system and supercomputing resources provided by CRIEPI. JRA-25 covers 26 years from 1979 to 2004. The latest version available in 2004 of JMA's numerical data assimilation system and specially collected observational data were used to generate a consistent and high quality reanalysis dataset designed for climatological research, operational climate monitoring and seasonal forecasting. Since completion of the project, the JMA Climate Data Assimilation System (JCDAS) has been successively operated by JMA with the same data assimilation system as JRA-25, to generate quasi-real-time products. Onogi et al. (2007) provide more details.

2. Observational data and NWP system used in JRA-25

Observational data used in JRA-25 were collected from the JMA archives and those supplied by many organizations overseas such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the National Center for Environmental Prediction (NCEP), the National Center for Atmospheric Research (NCAR) and the National Climate Data Center (NCDC). Sets of observational data were also supplied by universities in Japan. In addition to conventional observations, atmospheric motion vector (AMV) wind retrieved from geostationary satellites, brightness temperature from TOVS and ATOVS, precipitable water retrieved from SSM/I radiance are assimilated with 3-dimensional variational method (3D-Var). JMA produced daily sea surface temperature (SST) and sea ice named COBE, and 3-dimensional ozone profiles for JRA-25. A new QC method for TOVS data was developed and applied in advance.

The global model used in JRA-25 has a spectral resolution of T106 (equivalent to a horizontal grid spacing of around 120km) and 40 vertical layers with the top at 0.4hPa.

3. Performance of JRA-25

JRA-25 has many advantages. Firstly, predicted 6-hour global total precipitation distribution and amount are well reproduced both in space and time. The performance of the long time series of the global precipitation is the best among the other reanalyses with few unrealistic variations from degraded satellite data contaminated by volcanic eruptions (Figure 1). Secondly, JRA-25 is the first reanalysis which assimilated wind profiles around tropical cyclones reconstructed from historical best track information; tropical cyclones were analyzed properly in all the global regions (Figure 2). Additionally, low-level cloud along the subtropical western coast of continents is well simulated and snow depth analysis is also of a good quality.

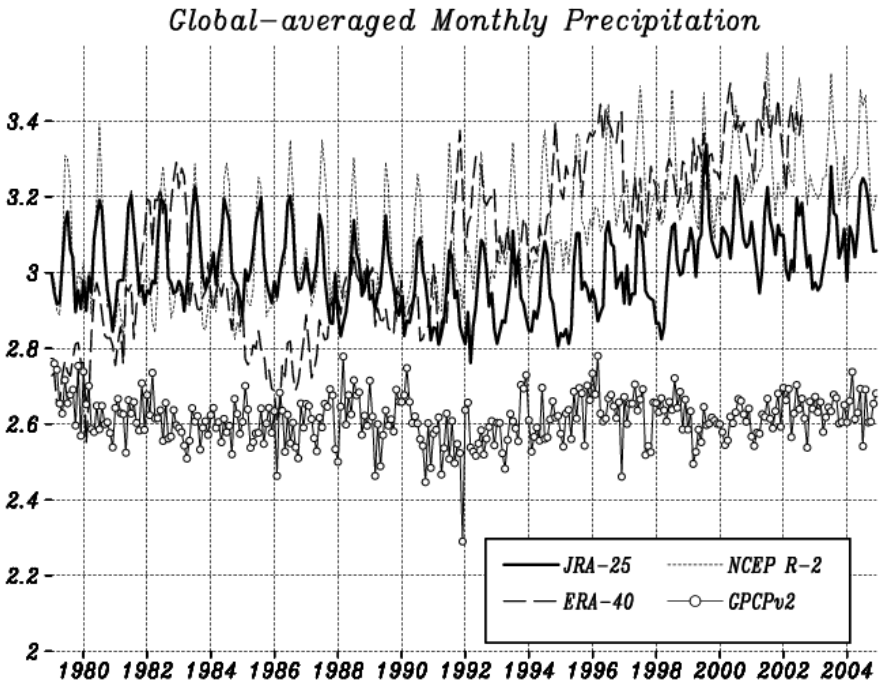

Figure 1 Global mean precipitation (mm/day)
Time series of reanalyzed global mean precipitation and independent precipitation datasets are shown. (Onogi et al. 2007)

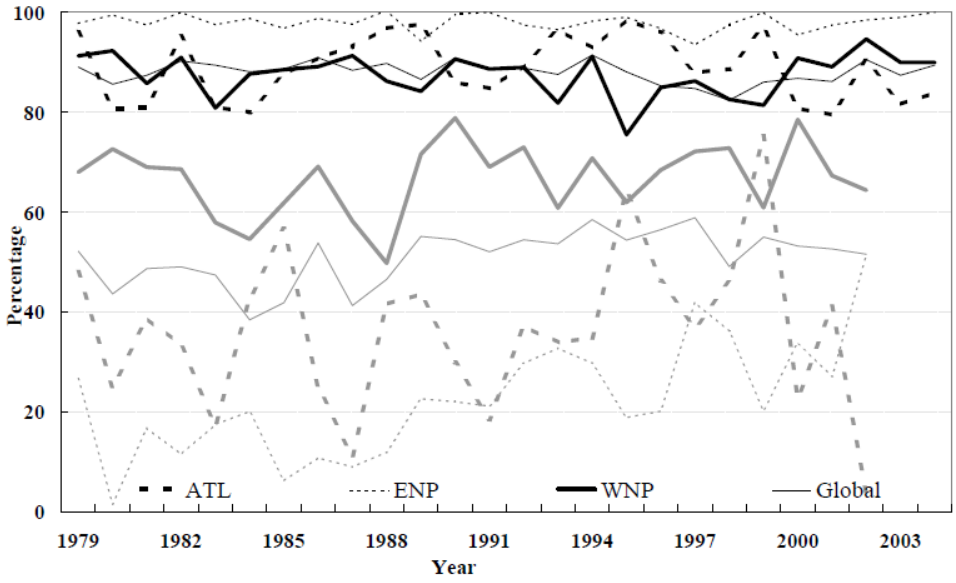

Figure 2 TC representation rates (%) for JRA-25 (black) and ERA-40 (gray)
Only TCs located near the best track positions that have typical TC structures are selected. (Onogi et al. 2007)

4. Application using JRA-25

JRA-25 was transitioned to JMA Climate Data Assimilation System (JCDAS) using the same data assimilation system of JRA-25. JRA-25 and JCDAS are used in various operational climate services of JMA and are available via the internet for research use. A new climatic normal values and related indices are produced using the consistent JRA data and the previous normal was replaced. It improves the quality of climate monitoring and is beneficial for seasonal forecast, ocean monitoring and development of seasonal numerical model. JRA data is used as a basic dataset in a newly established Japanese Advisory Panel on Extreme Climatic Events which consists of 10 prominent experts from universities and research institute. The JMA operational SST analysis and forecast were improved by a development using the JRA data. Application using JRA-25 and JCDAS data are summarized in Figure 3.

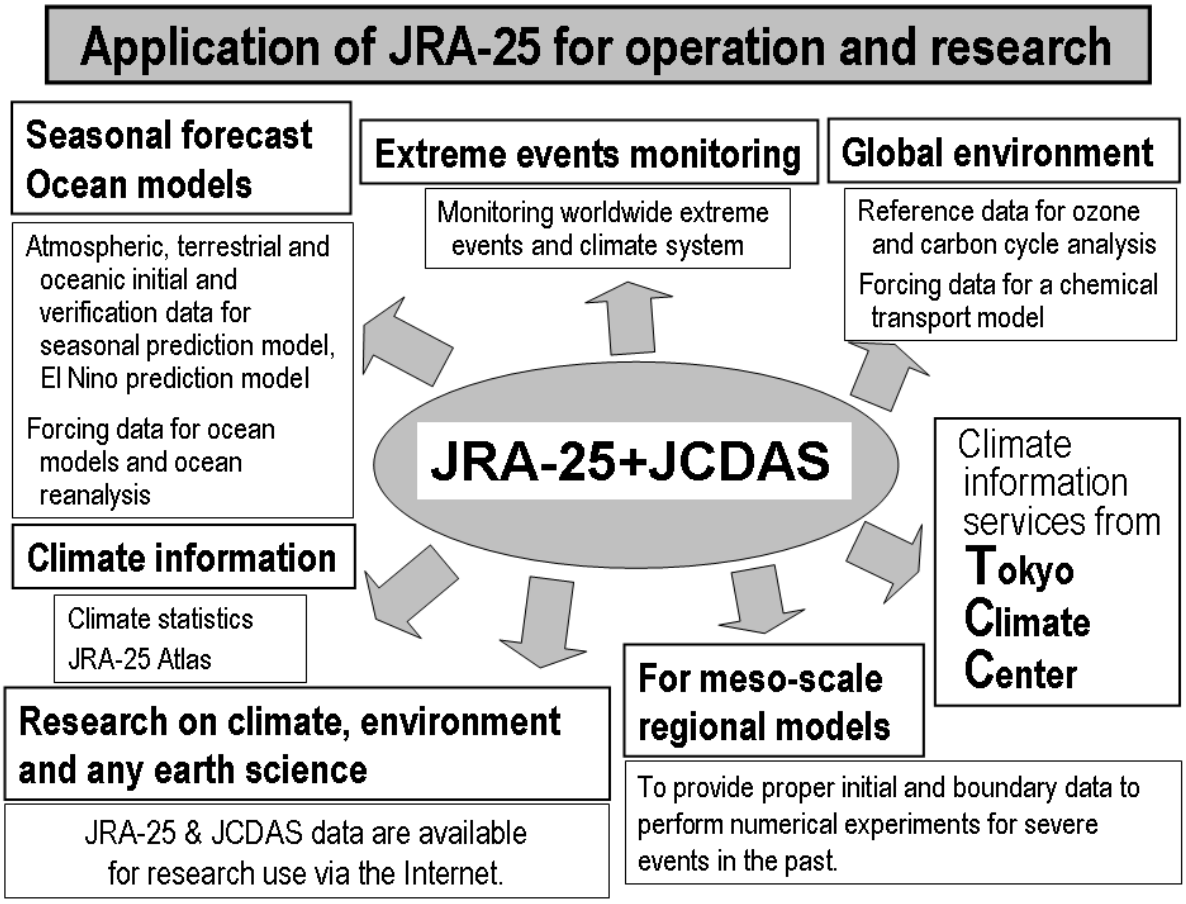

Figure 3 Application of JRA-25 for operation and research

5. JRA-25 Atlas

"JRA-25 Atlas" which visualized many kinds of meteorological climate fields of JRA-25 has been published. The Atlas contains maps, cross sections and plots of time series. Maps and cross sections include annual and seasonal averages. Figures for interannual variability show standard deviations for the 26 years that are calculated and drawn for annual averages. Seasonal averages are shown for Dec. - Feb., Mar. - May, Jun. - Aug. and Sep. - Nov. except for figures relating to tropical cyclones. Most of the figures are drawn directly from monthly averages or monthly normal values available from the JRA-25 official web page, using T106 Gaussian grid data. Some figures are drawn from 2.5-degree latitudinal-longitudinal grid data. A few sample maps of the Atlas are shown in Figure 4.

The Atlas is going to be available on the JMA official web site including maps of monthly averages as well as annual and seasonal averages.

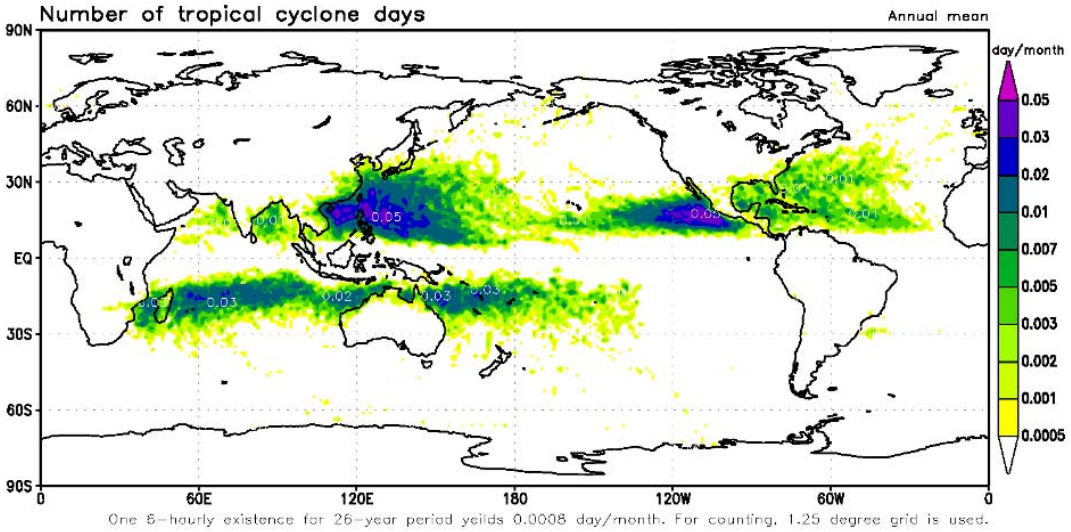

Figure 4 (1) JRA-25 Atlas : Distribution of tropical cyclones (annual mean; existing day/month)

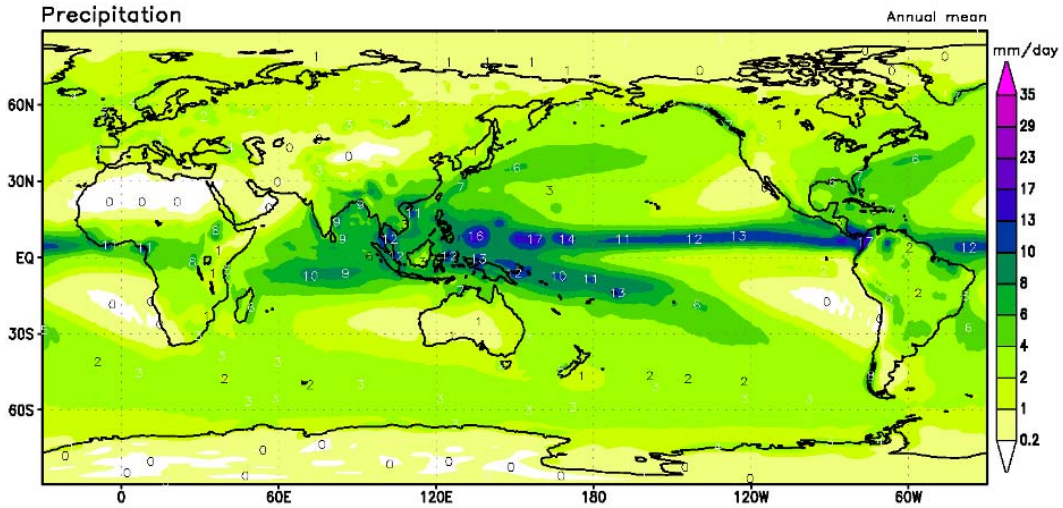

Figure 4 (2) JRA-25 Atlas : Annual mean precipitation (annual mean; mm/day)

6. JRA-50 : The next Japanese Reanalysis

JMA will conduct the next new reanalysis named JRA-50, which covers more than 50 years from 1958 to present. JRA-25 provides consistent climate data and contributes largely for research and operational activities, but the 26 years of JRA-25 are not sufficient period for comprehensive analysis of climate change and global warming. The purposes of JRA-50 is to 1) produce longer climate database with higher quality than JRA-25; 2) resolve deficiencies of JRA-25; 3) analyze past global warming with higher quality. Since the performance of the JMA operational numerical prediction has been improved significantly in recent years, we can take the improvements into account for JRA-50 data assimilation system. JRA-50 production will be started from early 2009 after preparation and experiment stage in 2008. The production requires about 5 years and will be terminated at the end of 2013.

Differences between JRA-25 and JRA-50 are summarized in Table 1.

Table 1 Comparison between JRA-25 and JRA-50

	JRA-25	JRA-50
Years	1979-2004 (26 years)	1958-2012 (55 years)
Model Resolution	T106L40 top at 0.4hPa	TL319L60 top at 0.1hPa
Data Assimilation	3D-var (Inner T106)	4D-var (Inner T106)
Numerics	Eular scheme Normal Gaussian Grid system	Semi-Lagrangean scheme Reduced Gaussian Grid system
Physics	Previous scheme except cloud scheme	Improved radiation (bias reduced) Improved land surface scheme
Forecast Score (Z500 RMSE FT=24)	13m (NH), 19m (SH) (as of Mar. 2004)	9m (NH), 12m (SH) (as of Dec. 2007, to be improved more)
Sounder data	TOVS 1d, ATOVS 1c	TOVS 1c, ATOVS 1c, VTPR, AMSR-E etc.
reprocessed AMV	Meteosat-2 and GMS-3,4,5	Meteosat-2 to 7 and GMS-3,4,5(revised) GOES?
SSM/I	Precipitable water	Radiance
CO2	constant (space & time)	Historical
Observation history and QC	specified QC for TOVS Andrae et al.(2004) with Onogi(2000) for RAOB	Feedbacks from ERA-Interim Using JRA-25 archives
Ozone	3D-daily profile	3D-daily profile (revised)
CDAS mode	JCDAS (operational)	To be transitioned to New JCDAS

Reference

Onogi, K., J. Tsutsui, H. Koide, M. Sakamoto, S. Kobayashi, H. Hatsushika, T. Matsumoto, N. Yamazaki, H. Kamahori, K. Takahashi, S. Kadokura, K. Wada, K. Kato, R. Oyama, T. Ose, N. Mannoji and R. Taira, 2007: The JRA-25 Reanalysis. J. Meteor. Soc. Japan, **85**, 369-432. http://www.jstage.jst.go.jp/article/jmsj/85/3/369/_pdf

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