



Introduction to Reanalysis and JRA-55

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1. Introduction to **Reanalysis**

- Basic dataset for climate services
- Comparison b/w operational analysis and reanalysis

2. Introduction to **JRA-55** reanalysis

- Data assimilation system and forecast model
- Basic performance
- JRA-55 homepage and user application

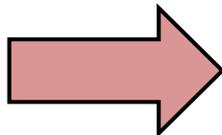
3. JMA's next reanalysis: **JRA-3Q**

Reanalysis

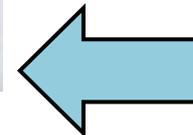
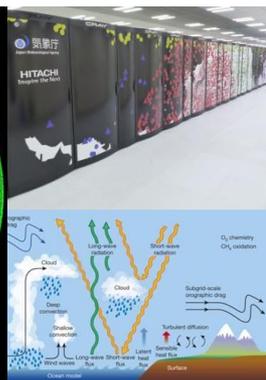
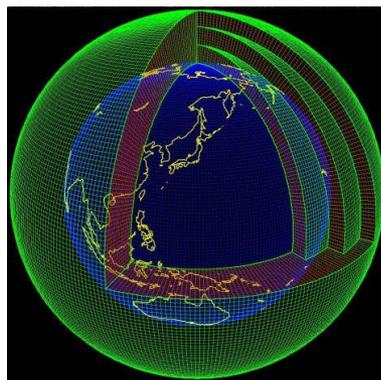
Reanalysis: “analysis of the past atmospheric conditions using a constant, state-of-the-art NWP model and data assimilation system with the latest observation to produce a high-quality, spatially and temporally consistent dataset”

“Constant” and “state-of-the-art” NWP model

Data Assimilation

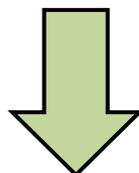


Quality Check

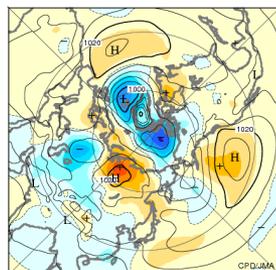


Input

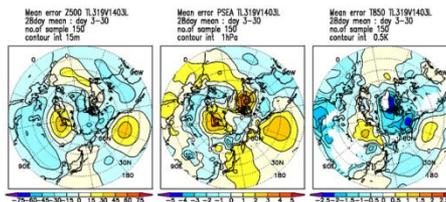
Integration for several decades



Consistent quality reanalysis product (GPV)



Climate Monitoring



Initial conditions for Hindcast (Re-forecast)



Climate Research



Surf



Upper

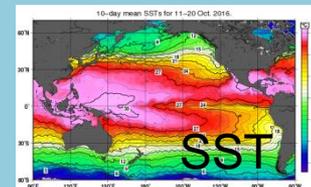


Ship

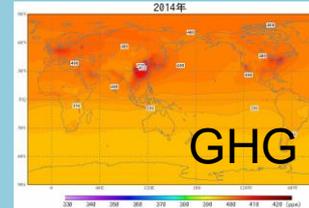


Satellite

Observation
(incl. belated data)



2016/08/20

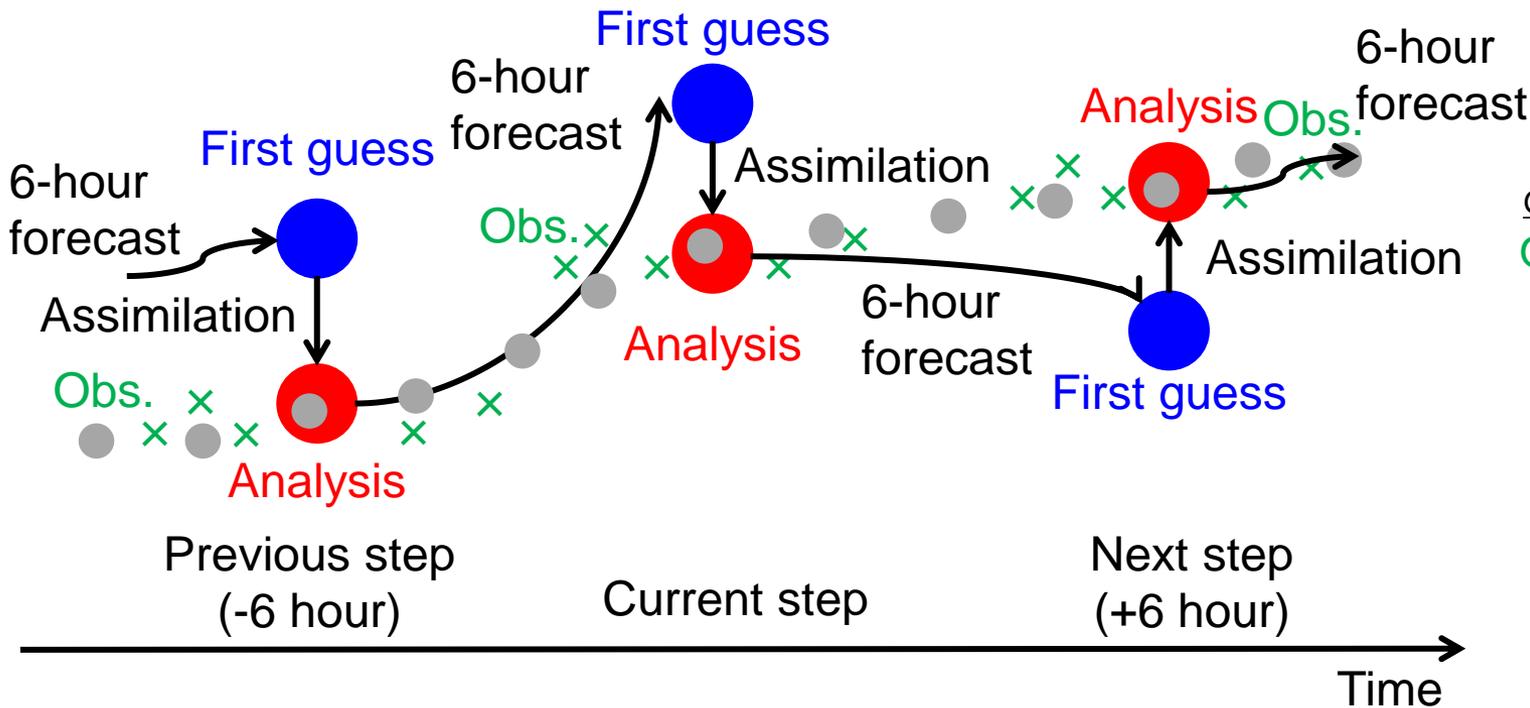


Boundary conditions
(prescribed)

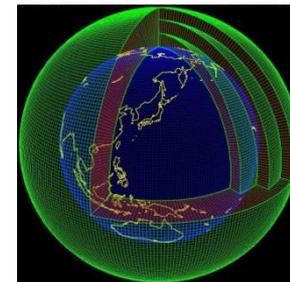
Data assimilation

Schematic diagram of the data assimilation cycle

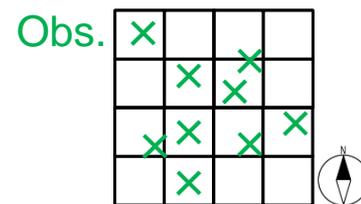
- Actual state of the atmosphere (unknown, but we want to know)



Forecast model



Grid points of the model



Supercomputer



Observations (example)

Surface

Radiosonde

Ship

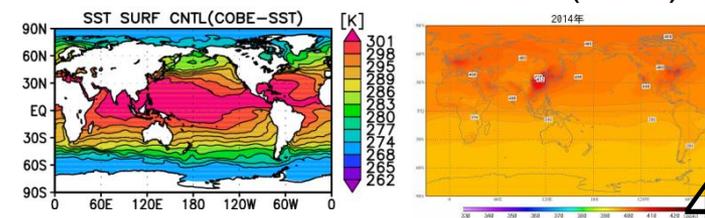
Satellite



Boundary conditions (example)

SST

GHG (CO₂)

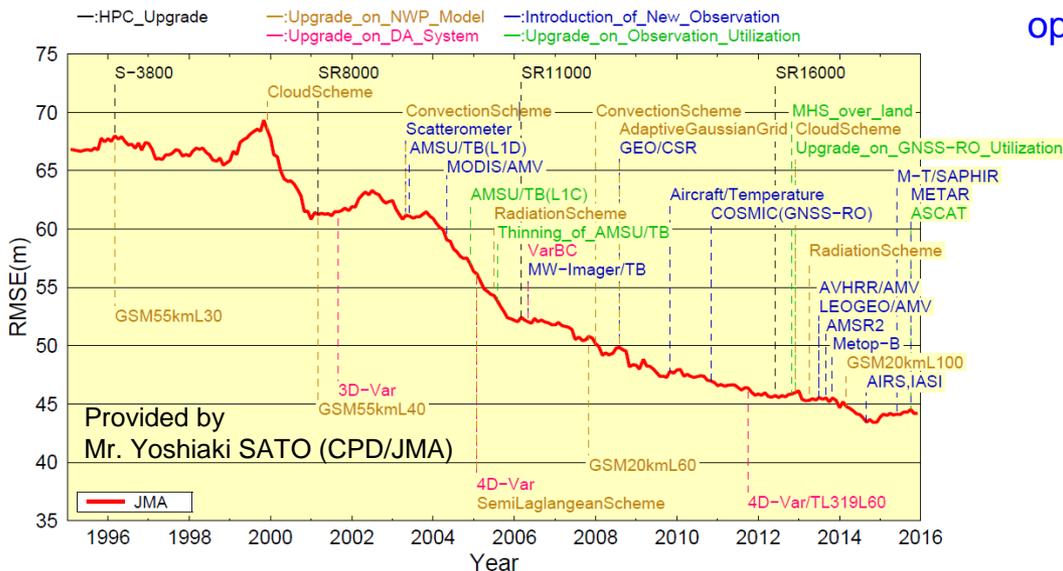


Operational analysis and Reanalysis

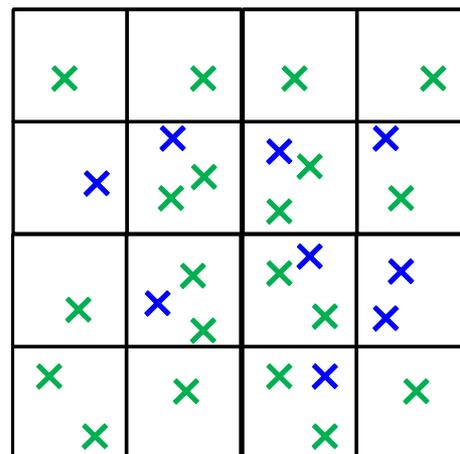
Comparison of the operational analysis and reanalysis

	Operational analysis	Reanalysis
Model and DA system	Upgraded with time (to improve forecast skills)	Constant and the latest* (to assure consistency and accuracy)
Observation data	Delayed data can't be used (because time for operational NWP is limited)	Delayed data are included (which may lead to improve the quality)

RMSE of forecast errors for Z500 in the northern hemisphere (with information of model improvements)



Obs. available at the time of operational analysis
 Obs. which become available after the time of operational analysis (delayed data)



2. Introduction to JRA-55

- 1st **JRA-25** (Onogi et al. 2007)
 - By JMA and CRIEPI* (1979-2004)
 - *Central Research Institute for Electric Power Industry
 - Near real-time extension using the same system (JCDAS) was conducted by JMA and terminated in February 2014



- 2nd **JRA-55** (Kobayashi et al. 2015)
 - By JMA (1958-2012)
 - The first reanalysis which covers more than 50 years since 1958 with 4D-VAR data assimilation system
 - Real time analysis after 2013 to present



In Japanese, “5” is pronounced as “Go”.

JRA-55 reanalysis system

JRA-55 reanalysis system was extensively improved since JRA-25

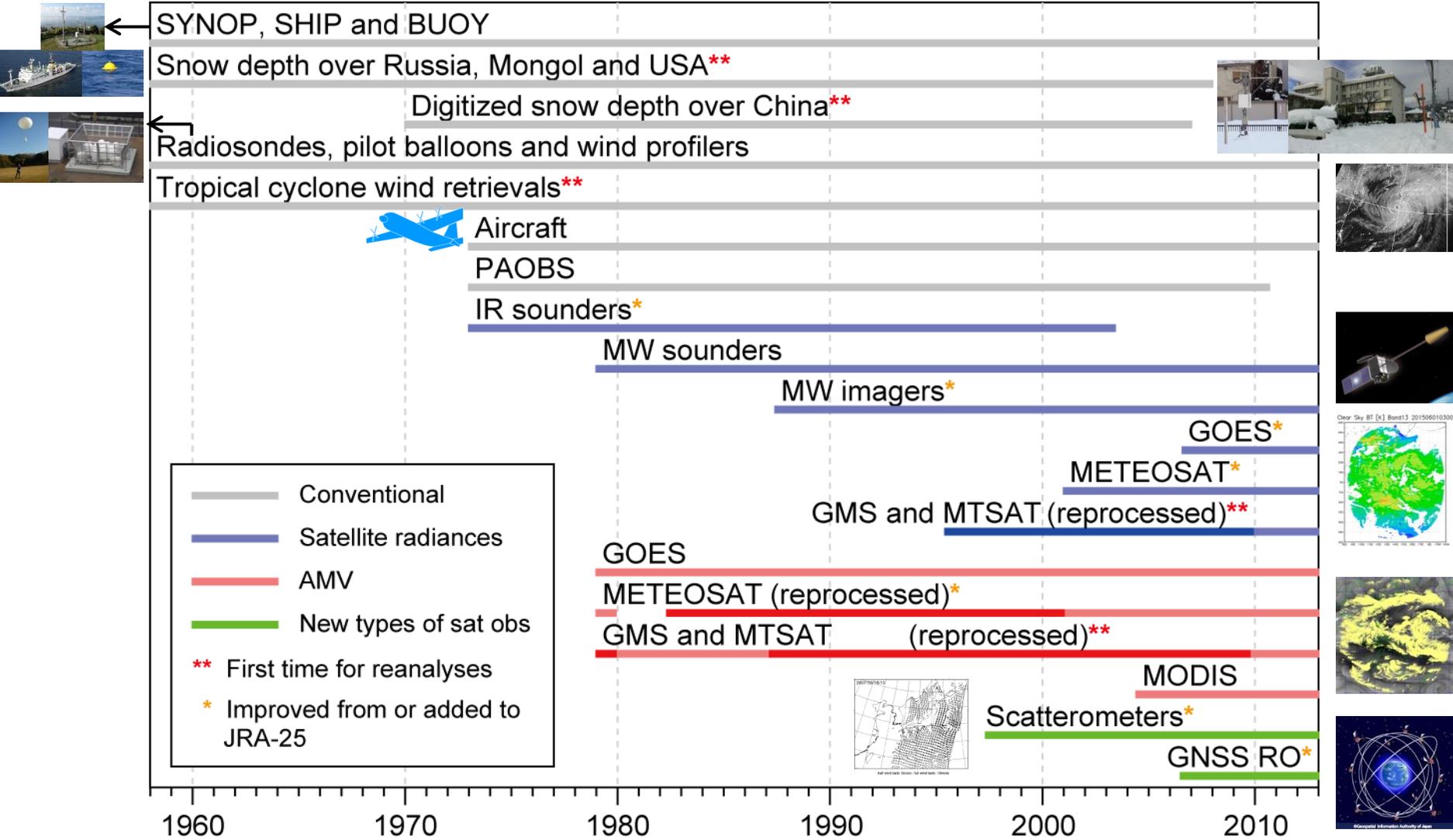
	JRA-25	JRA-55
Period	1979-2004 (26 years)	1958-2012 (55 years)
NWP system	As of Mar. 2004	As of Dec. 2009
Resolution	T106L40 (~110km) <i>(top layer at 0.4 hPa)</i>	TL319L60 (~55km) <i>(top layer at 0.1 hPa)</i>
Advection scheme	Eulerian	Semi-Lagrangian
Assimilation scheme	3D-Var	4D-Var <i>(with T106 inner model)</i>
Bias correction (satellite radiance)	Adaptive method (Sakamoto et al. 2009)	Variational Bias Correction (Dee et al. 2009)
GHG concentrations	Constant at 375 ppmv (CO ₂)	Annual mean data are interpolated to daily data (CO ₂ ,CH ₄ ,N ₂ O)

Observation data for JRA-55 (1)

Newly available and improved past observations are included in JRA-55

(image)

(image)



AMV: Atmospheric Motion Vectors

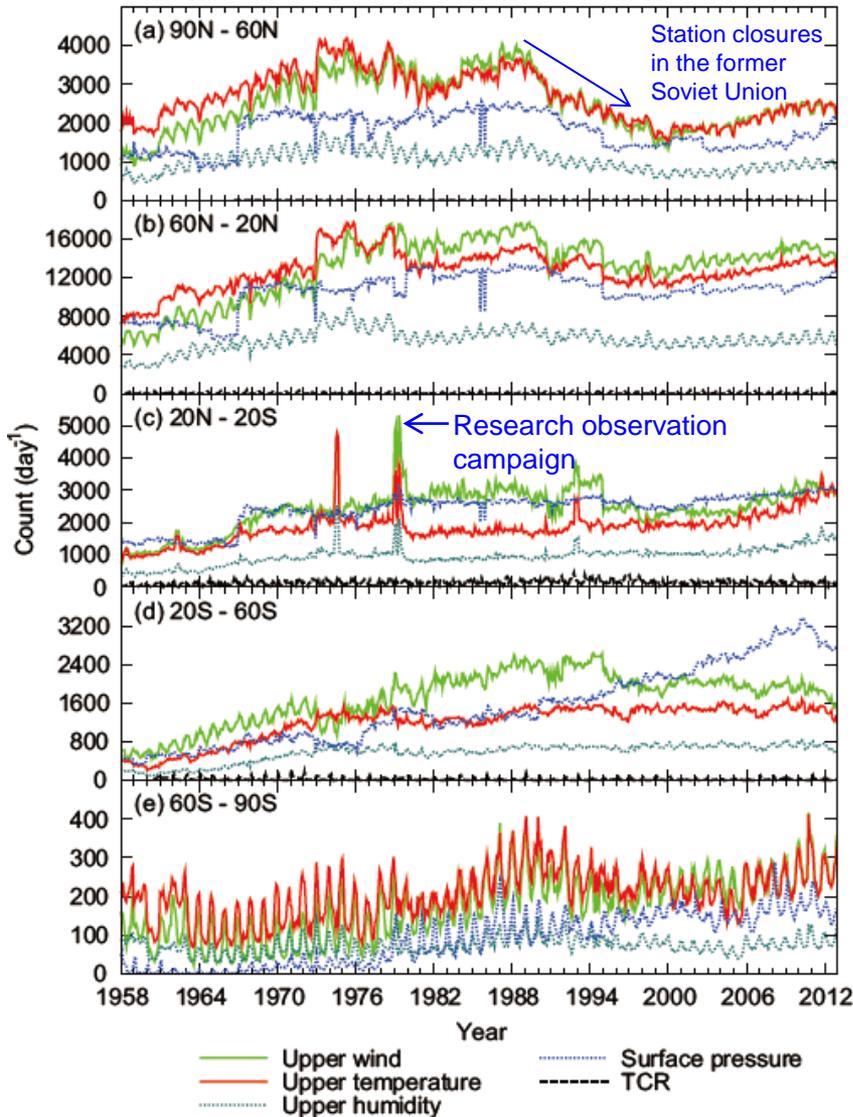
Year

GNSS: Global Navigation Satellite System

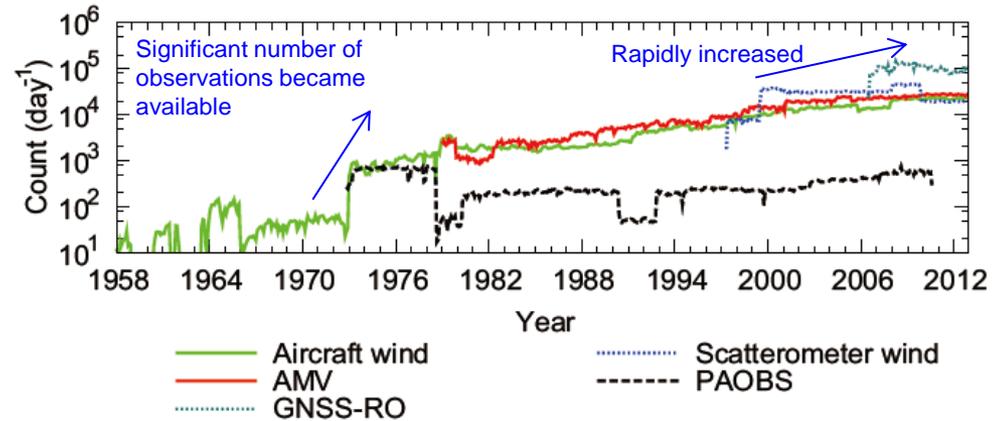
Observation data for JRA-55 (2)

Number of observations assimilated in JRA-55 is continuously increasing

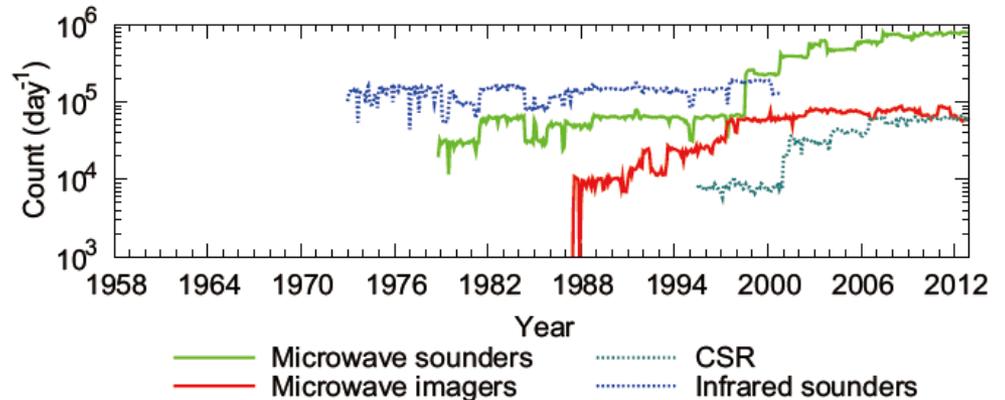
Conventional observation and TCRs



Aircraft and satellite winds, PAOBS, and GNSS-RO



Various types of satellite radiances



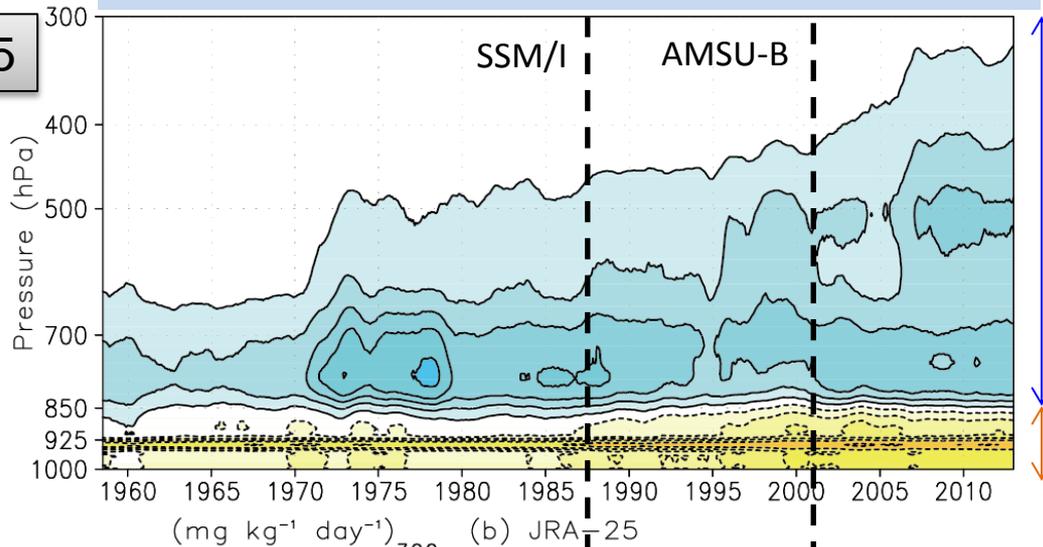
Unit: 1/day [Monthly mean counts]

Basic performance (1): Analysis increments

Temporal consistency of analysis is improved compared to JRA-25.
JRA-55 has moistening increments above 850hPa and drying increments below it.

*Time-height sections of global mean specific humidity increments**

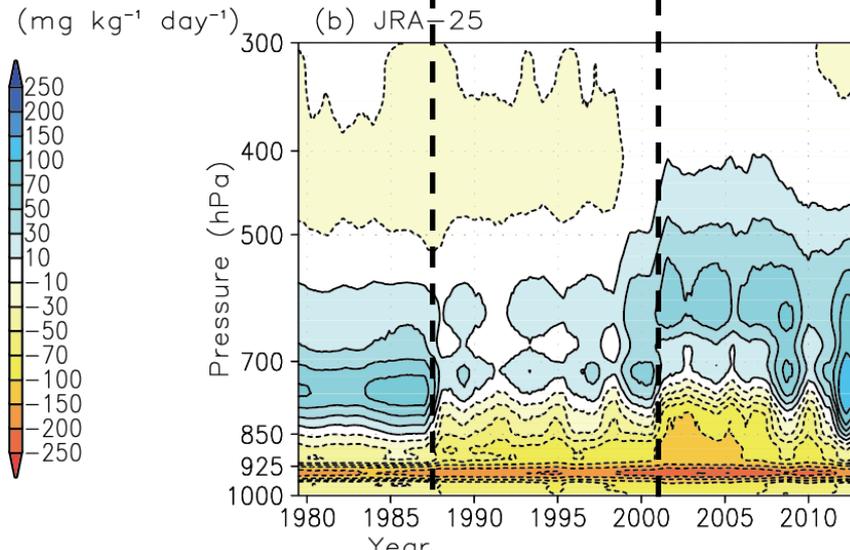
JRA-55



Moistening increments (dry bias)

Drying increments (moist bias)

JRA-25



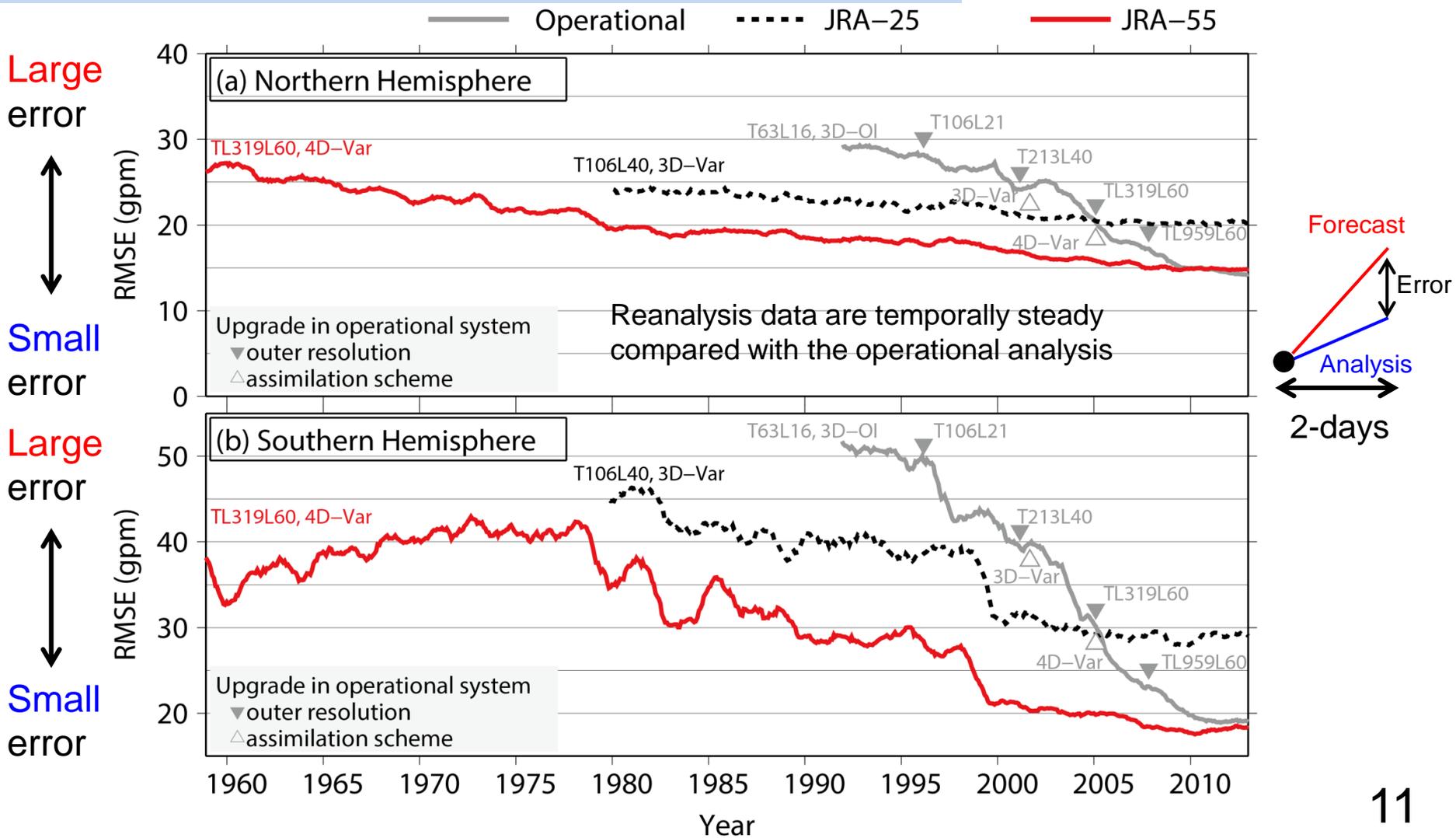
* Increment = Analysis – First guess

Basic performance (2): forecast scores

The forecast scores of the JRA-55 system are considerably better than those of the JRA-25 due to new satellite observation data and improvements of the DA system

RMSEs of 2-day forecasts of the geopotential height at 500hPa

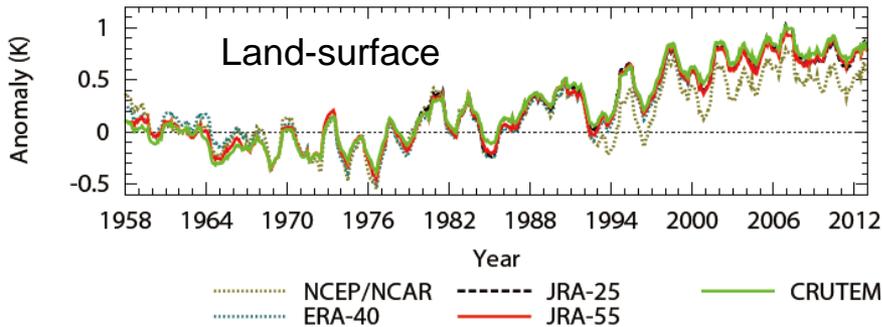
*Average over the extratropics



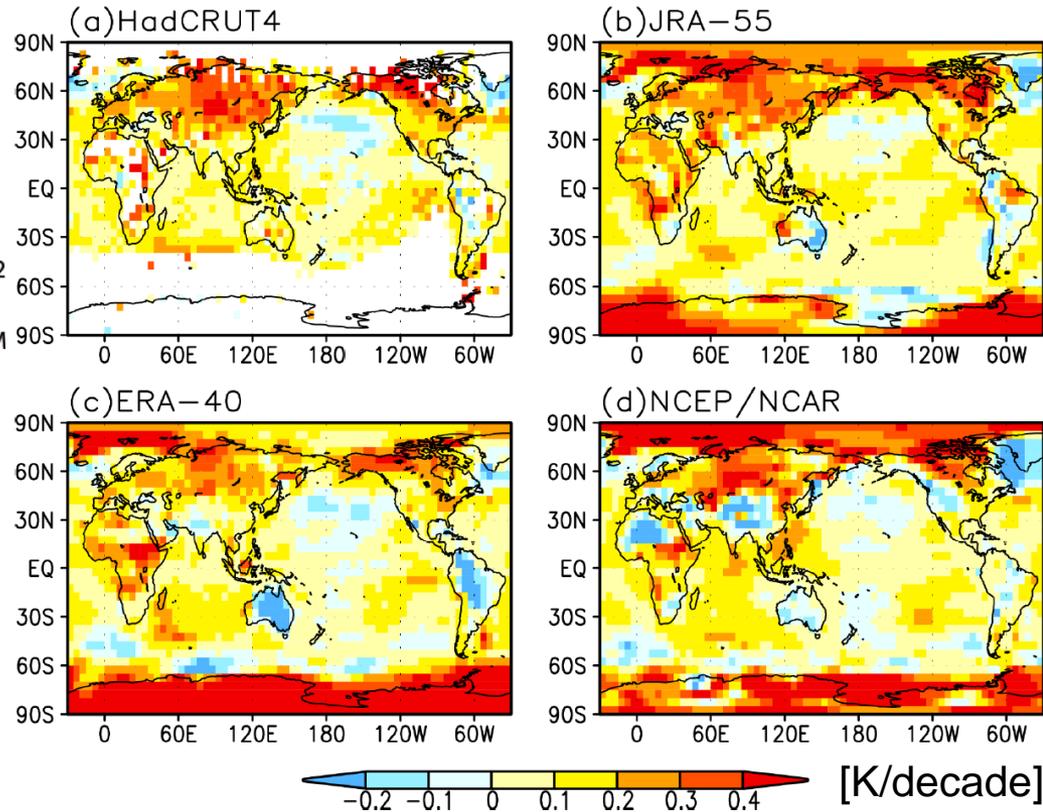
Basic characteristics (1): Surface temperature

Long-term trends and variation of temperature in the land-surface and troposphere are well reproduced by JRA-55 reanalysis

12-month running mean temperature anomalies averaged over the globe



Surface air temperature trends from 1958 to 2001

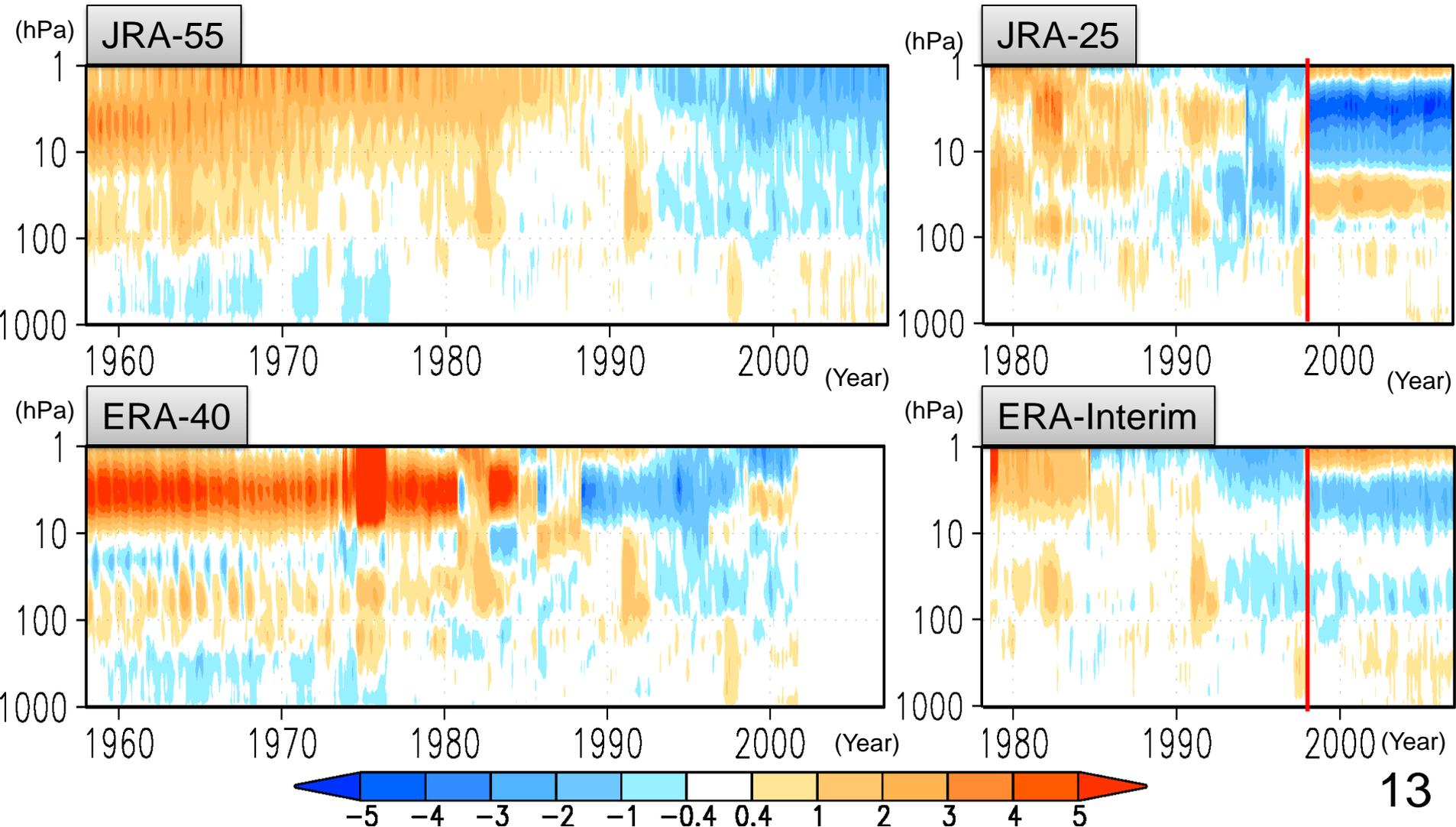


Reanalysis data were re-gridded to 5x5 resolution

Basic characteristics (2): Stratospheric temperature

Cold bias in the stratosphere, one of the major problems of JRA-25, is extensively reduced in JRA-55 due to the revision of longwave radiation scheme

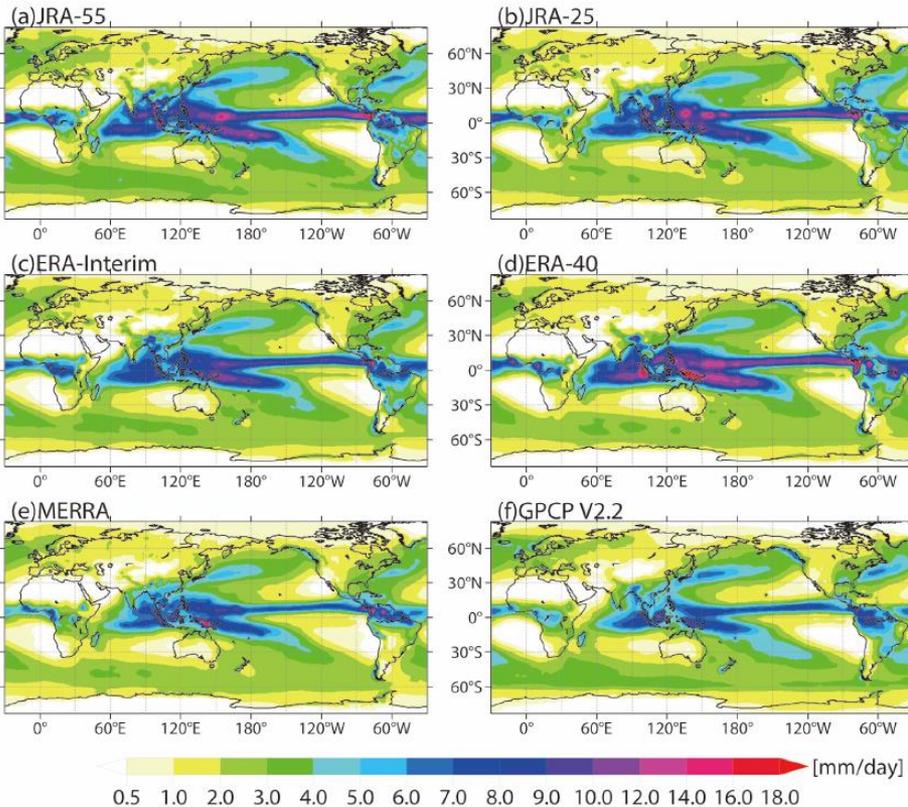
Time-height sections of global mean temperature anomalies (1980-2001 mean)



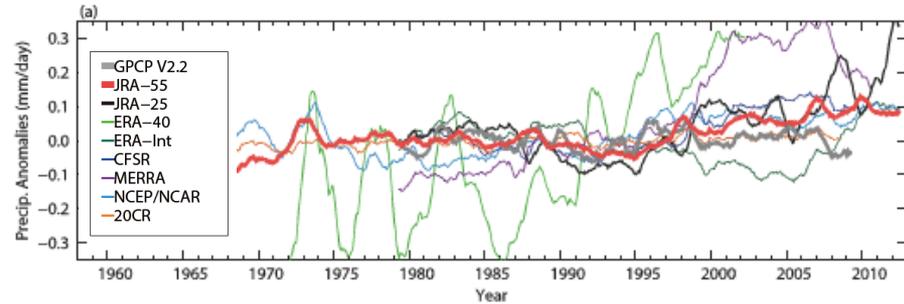
Basic characteristics (3): Precipitation

JRA-55 well reproduce the precipitation in middle and high latitude
 Spatial pattern of daily precipitation in the tropics are well reproduced by JRA-55

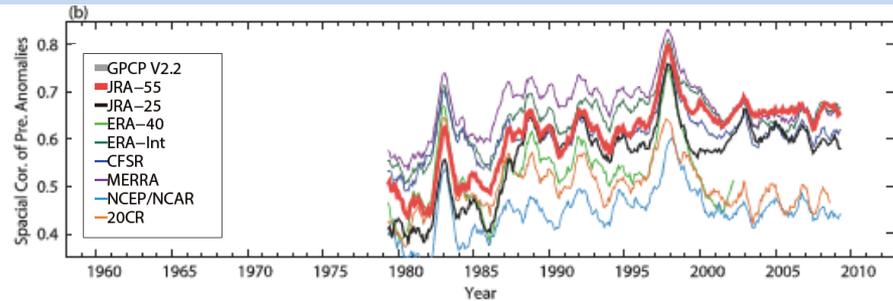
Annual mean precipitation averaged over 1980-2001



Global monthly mean precipitation anomalies from reanalyses and GPCP



Spatial correlation of monthly precipitation anomaly against GPCP



Year

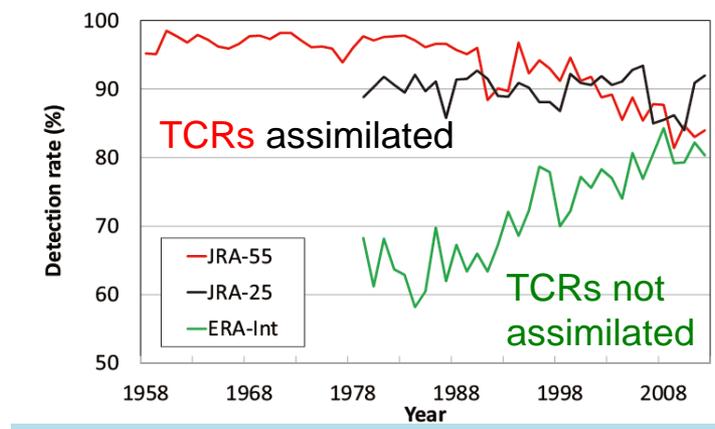
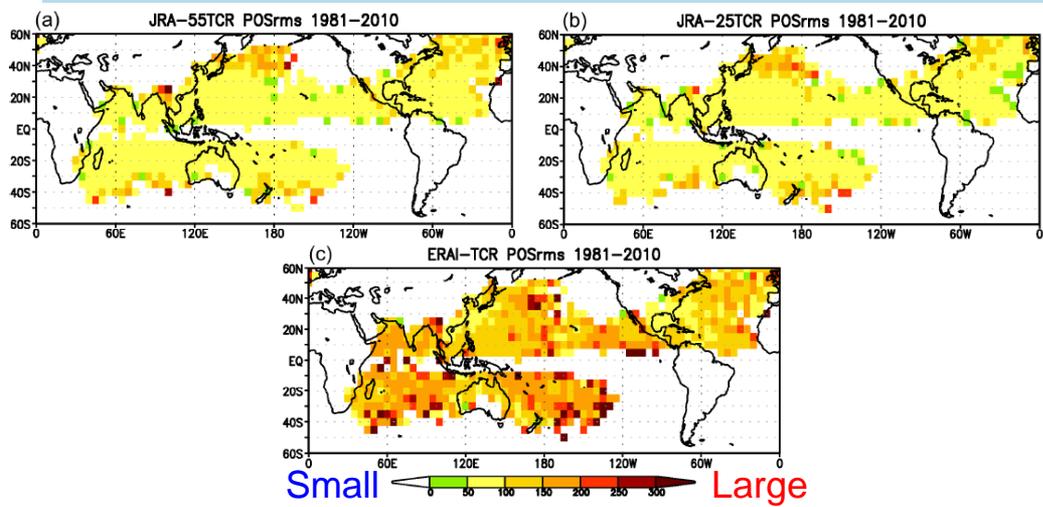
Region: Global
 12-month running mean

Basic characteristics (4): Tropical cyclones

Position of TCs is well represented in JRA-55. However, detection rates of TCs show artificial decreasing trends in JRA-55.

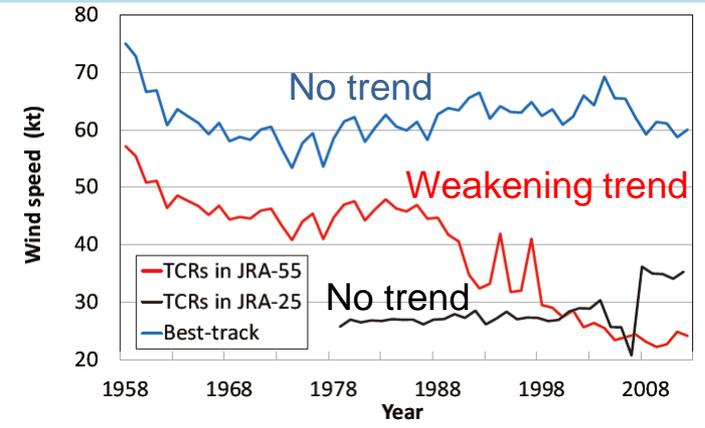
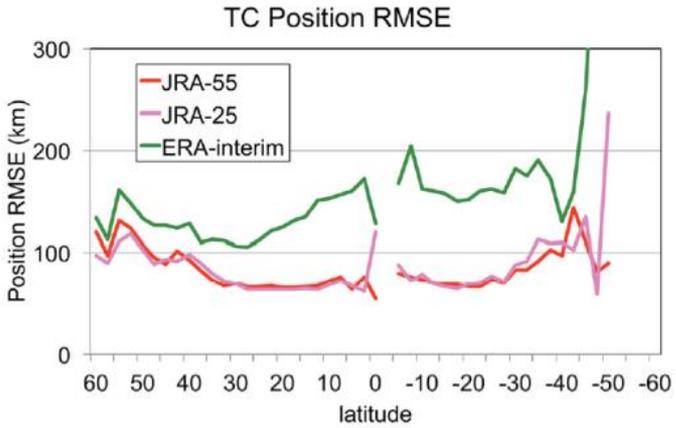
Distribution of RMSE of TC position with respect to the best track

Global detection rates of tropical cyclones



Global mean wind speed of the TCRs assimilated in JRA-25 and JRA-55

Zonal mean of the RMSE of TC position



JRA-55 homepage and user application

Basic information of JRA-55 is provided from JMA's homepage.
Registered users can download JRA-55 products from the JDDS* using FTP.

http://jra.kishou.go.jp/JRA-55/index_en.html

*JMA Data Dissemination System

About

Basic information of JRA-55 including background, references, and leaflets

Manual

Guides on JRA-55 products

JRA-55 Product Users' Handbook

Model grid data

Climate Prediction Division
Global Environment and Marine Department
Japan Meteorological Agency
March 2014

JRA-55 Product Users' Handbook

1.25-degree latitude/longitude grid data

Climate Prediction Division
Global Environment and Marine Department
Japan Meteorological Agency
September 2013

JRA Data User Application

Applicants must first accept the [Terms and Conditions of Use for JRA Products](#).
By registering, applicants are considered to have agreed to the conditions of data use.

Please fill out the fields below in English.

Name: Full name

Affiliation: Indicate the full organization name. Applicants who have retired or resigned from the organization should indicate their former affiliation. (e.g., Climate Prediction Division of the Japan Meteorological Agency)

Nation of affiliation: Country only (e.g. Japan, USA, UK)

E-mail address: In principle, an email address with an affiliation-specific domain name is required.

Purpose of use: Indicate the purpose in detail. Simply stating "study" or "research" is not acceptable. (e.g., Research on tropical cyclone intensity/tracks and water circulation)

A response will be sent to the email address provided within a few days.

JRA-55 dataset is also available from the collaborative organizations:

- <http://dias-dss.tkl.iis.u-tokyo.ac.jp/ddc/viewer?ds=JRA55&lang=en>
- <http://gpvjma.ccs.hpcc.jp/~jra55/index.html>
- <http://rda.ucar.edu/datasets/ds628.0/>

Improvements and problems of JRA-55

● JRA-55 has significantly improved from JRA-25

- Reduction of Cold bias in the stratosphere
- Reduction of the dry bias in the Amazon basin
- Increase of spatial temporal consistency

● Problems to be addressed (→The next reanalysis)

- Dry bias in the upper and middle troposphere
- Warm (cold) bias in the upper (lower) troposphere
- Unrealistic long-term trends in tropical cyclones

3. The next Japanese reanalysis: JRA-3Q

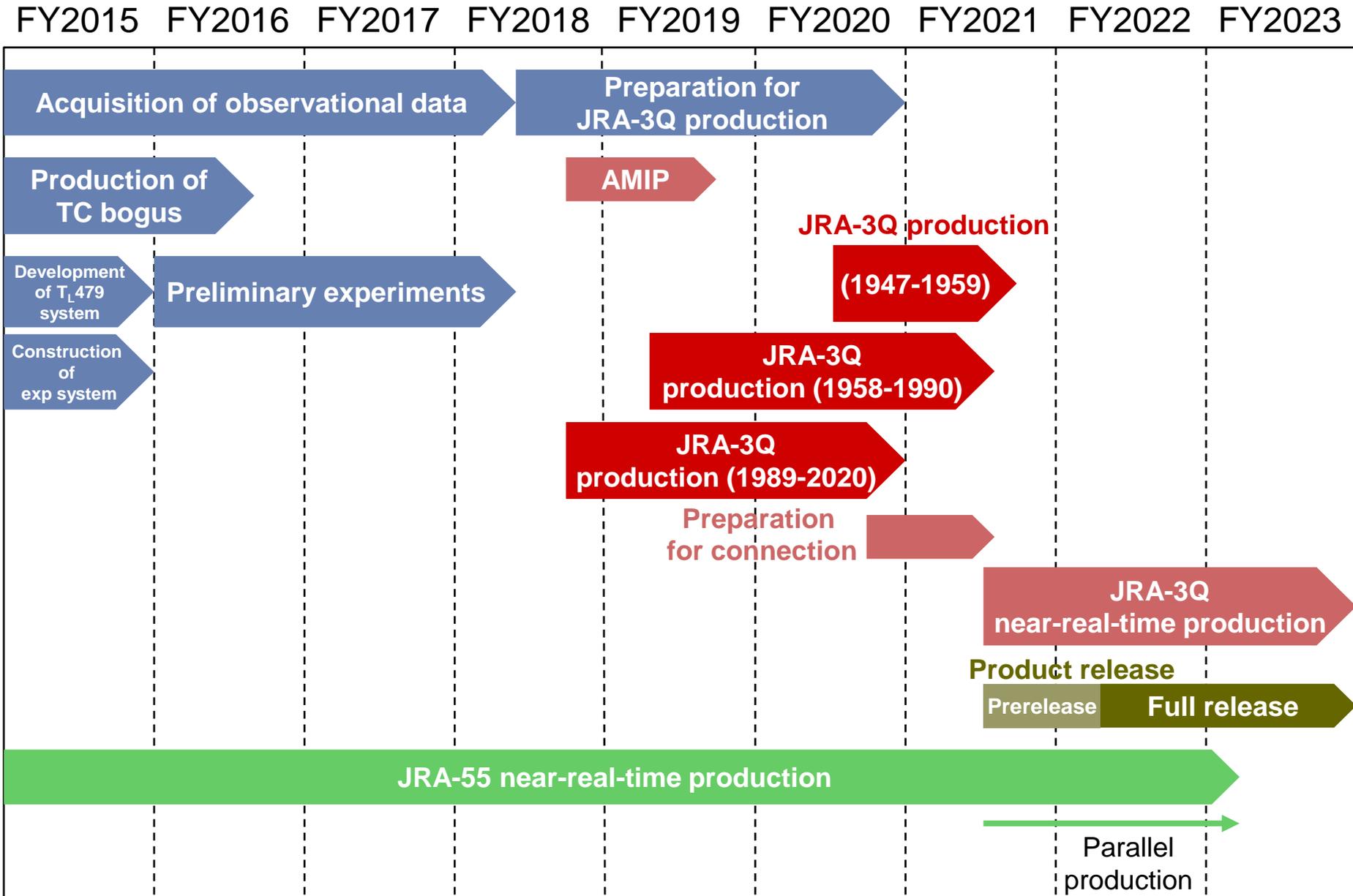
● JRA-3Q (Japanese Reanalysis for Three Quarters of a Century)

In Japanese, “3” is pronounced as “San”.
San-Q → San-kyuu → Thank you ☺

● Provisional specifications

- Higher resolution: T_L319L60 -> T_L479L100
 - 40 km in horizontal, 100 layers up to 0.01 hPa in vertical
- Extending the reanalysis period back in time
 - Atmospheric reanalysis from 1947 to present
- New boundary conditions and forcing fields
 - COBE-SST2 (1 deg., up to 1985)
 - MGDSST (0.25 deg. from 1985 onward)
- New observations
 - Observations newly rescued and digitized by ERA-CLIM et al.
 - Improved satellite observations through reprocessing
 - JMA’s own tropical cyclone bogus

Schedule for JRA-3Q (plan)



Summary

● Reanalysis

- ❑ Analysis of the past atmospheric conditions using a constant, state-of-the-art NWP model and data assimilation system with the latest observation data
- ❑ Production of a high-quality, spatially and temporally consistent dataset is vital for operational climate monitoring

● JRA-55: the latest reanalysis by JMA

- ❑ Improved NWP system and newly available observational data are used to produce consistent climate dataset from 1958 onward
- ❑ Registered users can download JRA-55 products from the JDDS

● JRA-3Q: the next reanalysis by JMA

- ❑ Currently in preparation to produce higher quality and more consistent dataset for climate monitoring

**Thank you...
3(san) Q**

**...for
your
attention!**

