

Introduction to JRA-55

The Japanese 55-year Reanalysis

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~ Introduction ~
What is reanalysis?



Required dataset for climate research



- For several decades
- Consistent and high quality for any time and any region
- Many meteorological variables
 - Pressure, temperature, wind, humidity, ...
 - They can be observed.
 - But these are not sufficient for climate research.
 - Variables at the top of atmosphere (e.g. radiation), surface fluxes, vertically accumulated variables (e.g. precipitable water), ...
 - They are difficult to observe.



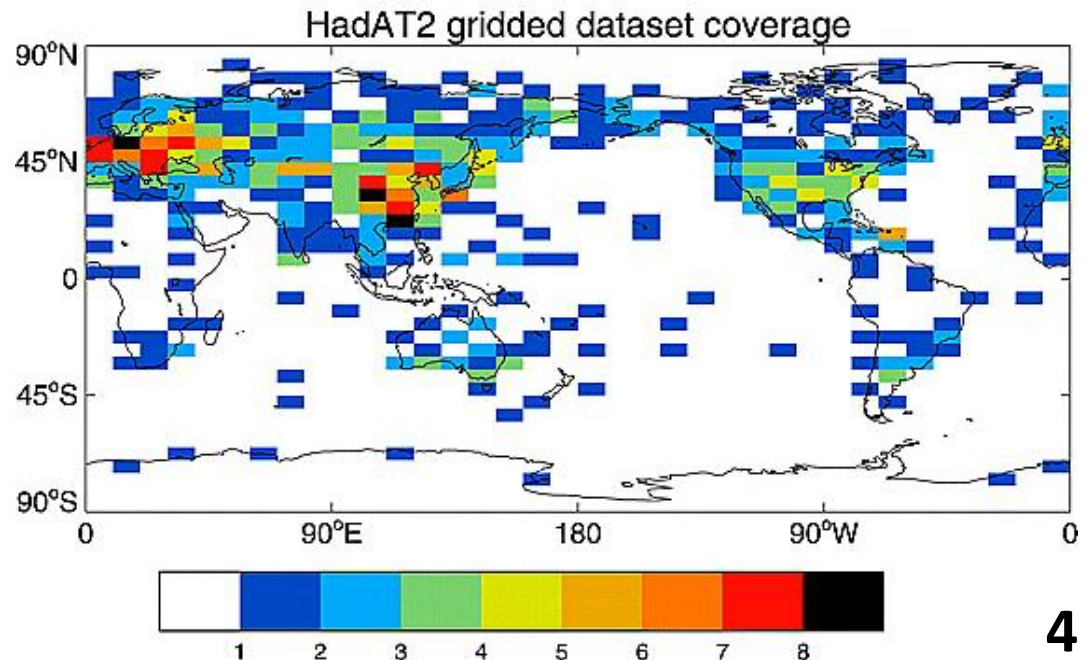
Approach for producing climate data



1. From observational data only

- Example) **GSN**, **GUAN** managed by **GCOS**
 - **GSN**: GCOS Surface Network
 - **GUAN**: GCOS Upper Air Network
- High quality climate dataset can be generated at the observation station and surrounding region.
- But the regions and variables are limited.

Thorne et al. 2005
Radiosonde data number
for each grid





Approach for producing climate data



2. Numerical data assimilation using observational data

- Uniformly distributed gridded data are generated based on consistent dynamics and physics.
- Advanced NWP model with high performance supercomputer are used.
- Many kind of variables are produced at every grid point.
- Numerical data assimilation cycle (e.g. 6-hourly) is performed for several decades.
- Data Assimilation cycle
 - Repetition of assimilation and 6-hour forecast to give first guess for the next (6 hours later) data assimilation

→ Long-term Reanalysis

Reanalysis



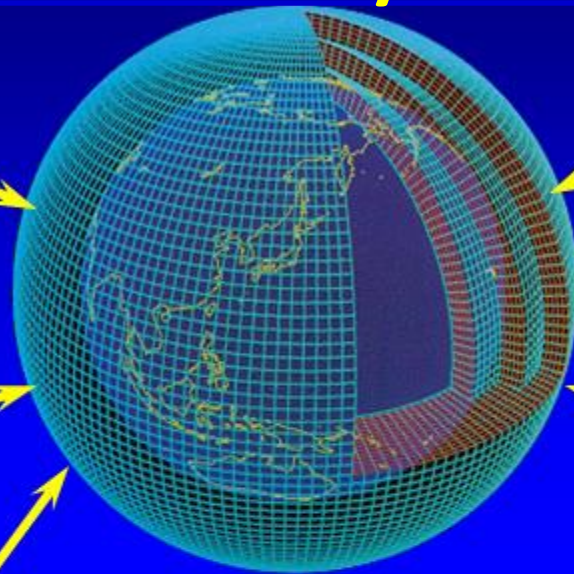
Satellite



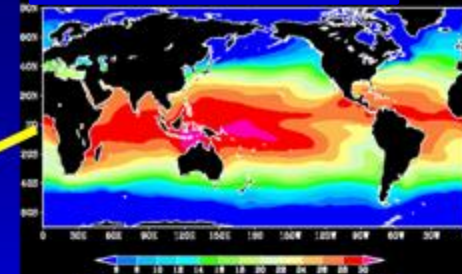
Surface, Upper



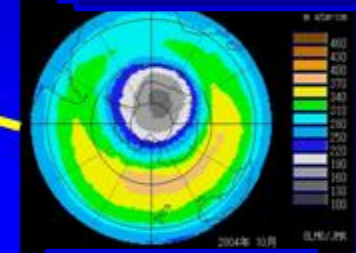
Ship, aircraft
Observation



Boundary



SST, sea ice



ozone

Assimilate past observational data

Data assimilation cycle

Consistent quality Reanalysis Product

- Provide Initial Condition and Verification data for seasonal forecast
- Climate Monitoring
- Research on climate system and water circulation etc.



The JRA-55 reanalysis

Japanese Global Atmospheric Reanalysis

1st JRA-25

By JMA and CRIEPI (1979~2004)
(Central Research Institute for Electric Power Industry)



2nd JRA-55 (JRA Go! Go!)

By JMA (1958~2012)

JRA-55 is the first reanalysis
which covers more than 50 years since 1958
with 4D-var data assimilation system.

JMA operates JRA-55 continuously
in real time basis after 2013.





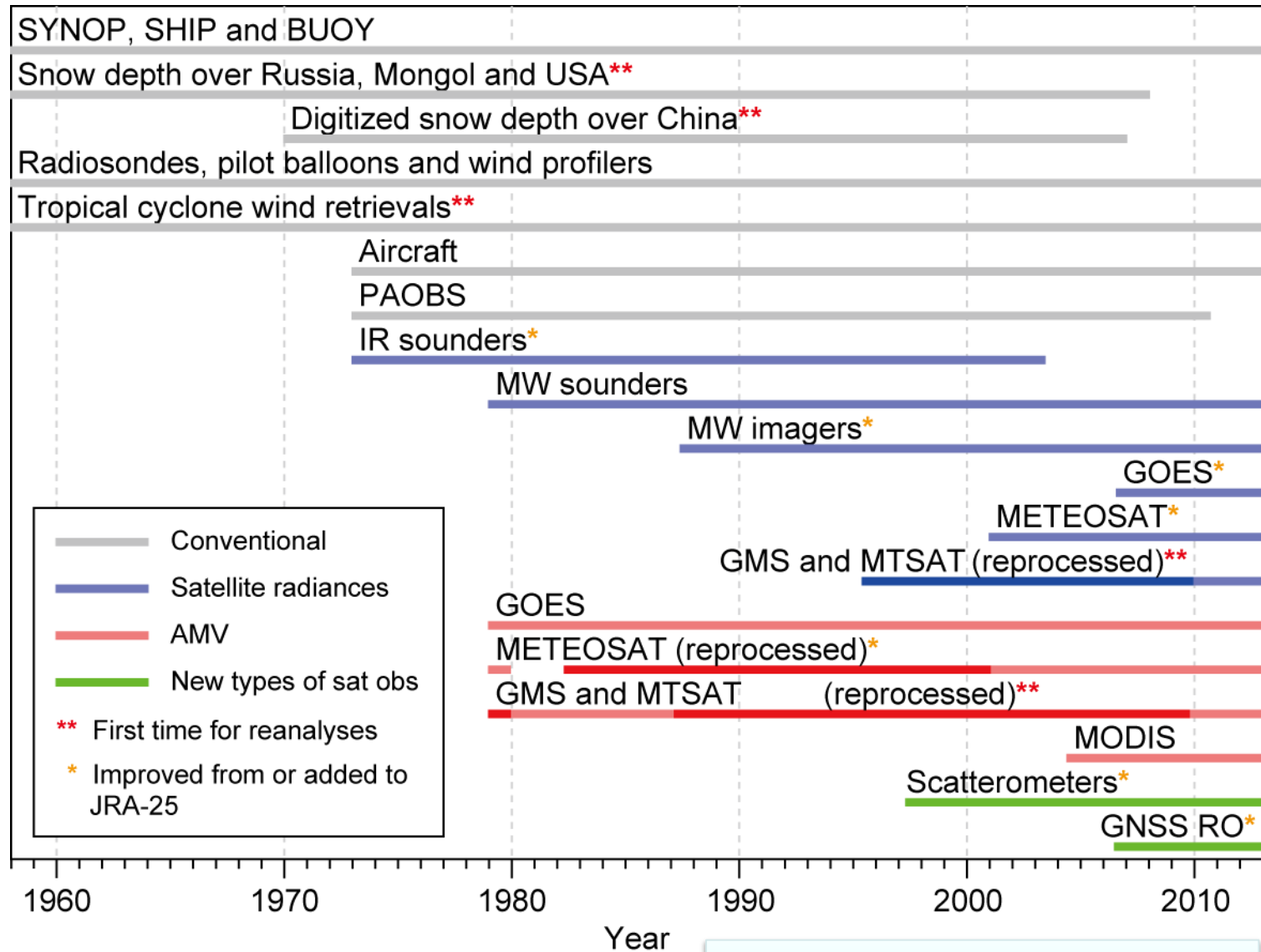
JRA-55 Reanalysis system



	JRA-25	JRA-55
Reanalysis years	1979-2004 (26 years)	1958-2012 (55 years)
Equivalent operational 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>
Time integration	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 (CO₂,CH₄,N₂O)



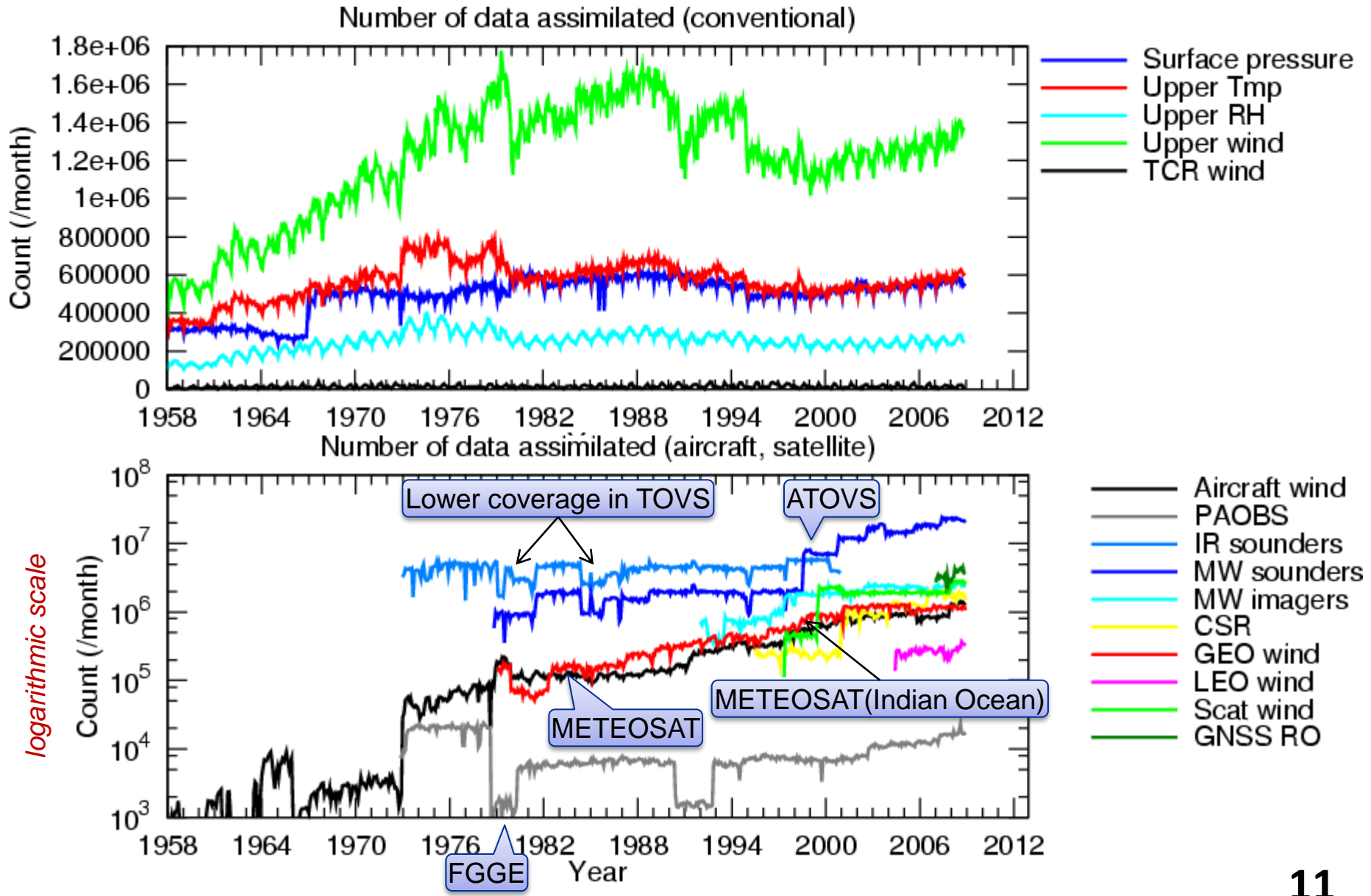
Observational Data available for JRA-55



GNSS: Global Navigation Satellite System

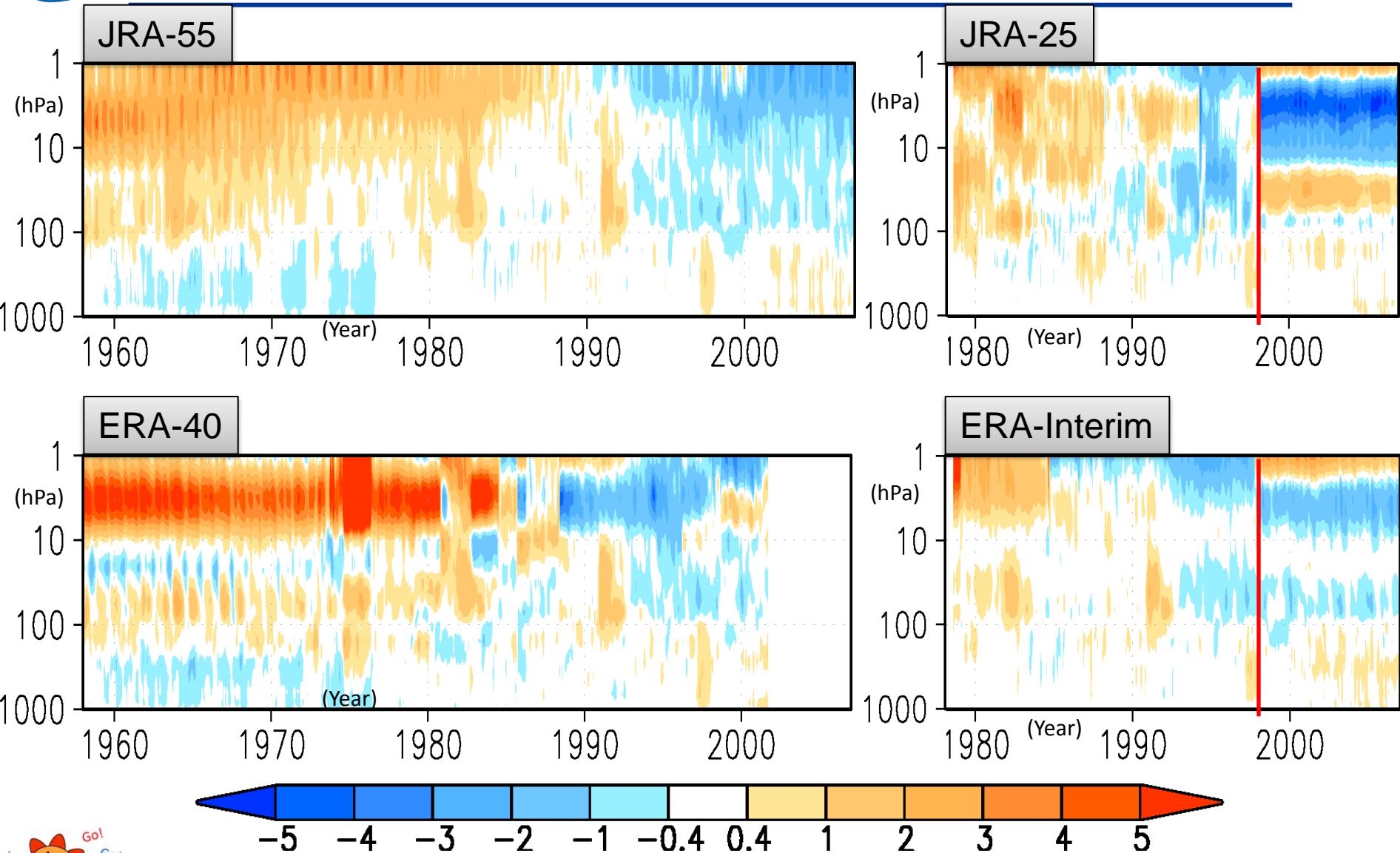


Number of observations assimilated (Global)





Time-Height Cross Sections of global mean Temperature [K] anomalies in JRA and ERA reanalyses



Anomalies from the mean temperature at each pressure level for years 1980 to 2001 of each reanalysis, JRA-55, ERA-40, JRA-25 and ERA-Interim, respectively.

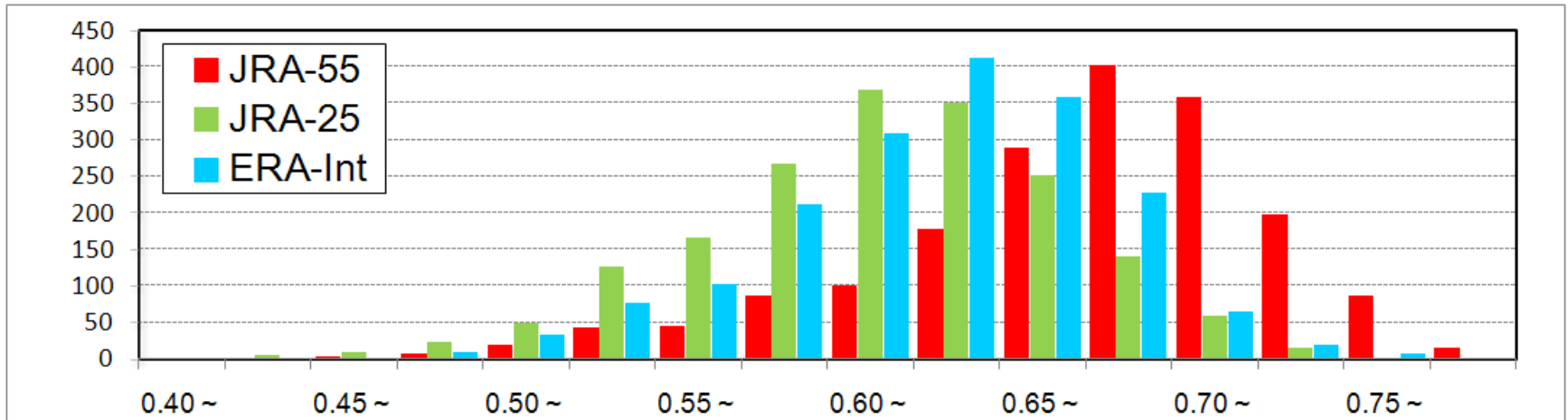


Frequency of daily precipitation correlation against TRMM



The Tropical Rainfall Measuring Mission (TRMM) since 1998

Warm season in the Northern hemisphere (1 May. – 30 Sep.)



Frequency of spatial correlation of daily precipitation over tropical region (22°S-22°N) against TRMM from 1998 to 2009

The red, green and blue bars show JRA-55, JRA-25/JCDAS and ERA-Interim.



JRA-55 family



- **JRA-55 (JMA)**
 - Full observing system reanalysis
- **JRA-55C (MRI/JMA)**
 - Fixed observing system reanalysis
 - Using conventional observations only
 - surface, radiosondes, tropical cyclone retrievals and windprofilers
- **JRA-55AMIP (MRI/JMA)**
 - AMIP type run (with no observations assimilated)
- Providing a range of products using the common base NWP system for investigating impact of changing observing systems and model biases



Quality of JRA

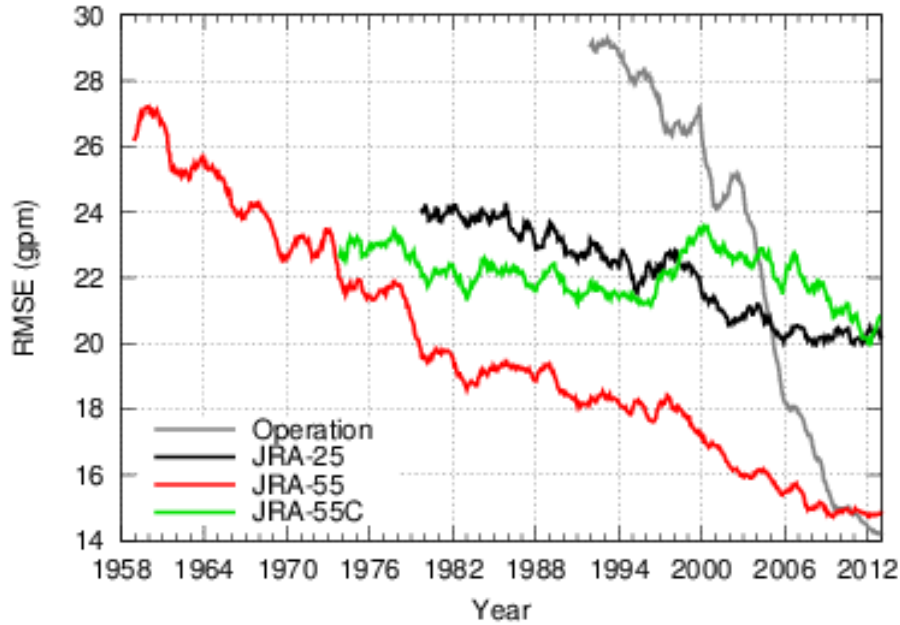
Forecast [FT=48] Scores



RMSE of Z500 for N.H. and S.H. [gpm]

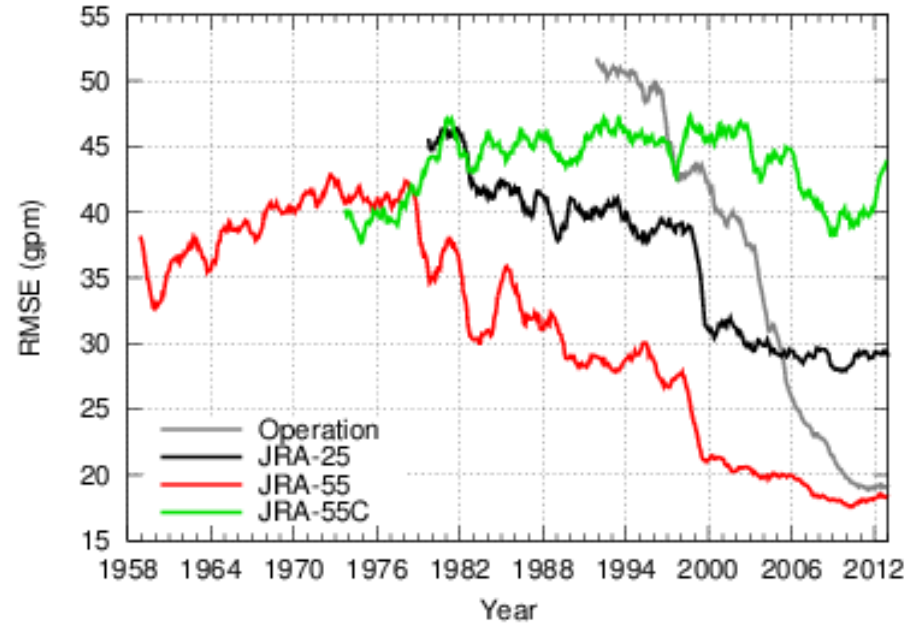
N.H.

a) Z500 forecasts, Northern Hemisphere, FT=48



S.H.

b) Z500 forecasts, Southern Hemisphere, FT=48





JRA-55 data available



<http://jra.kishou.go.jp/>

JRA project

JRA-55 : Japanese 55-year Reanalysis



気象庁55年長期再解析

1958年以降を対象とした、気象庁による日本で2回目の長期再解析プロジェクト。

Japanese 55-year Reanalysis

The second Japanese reanalysis project conducted by the Japan Meteorological Agency (JMA), which covers the period from 1958 onward.

日本語

JRA-55

English

JRA-55



JRA-55 data available from coop. org.

- JRA-55 data are also available from some cooperating organizations.
 - DIAS (University of Tokyo, Japan) #
 - NCAR (US) #
 - NASA ESGF (US, WCRP database)
 - ECMWF (UK) (in preparation)
 - University of Cantabria (Spain) (in preparation)

All products of JRA-55 (65TB) , JRA-55C (16TB), and JRA-55AMIP (5TB) are available.



Application of JRA for operation and research

Extreme Event / Climate system Monitoring / Seasonal Forecast

Monitoring worldwide
extreme events and
climate system

Atmospheric, oceanic and
terrestrial initial and
verification data for
coupled seasonal
prediction model

Forcing data for ocean
reanalysis

Climate and environmental research

Extreme events, climate change, development and improvement of seasonal
prediction model

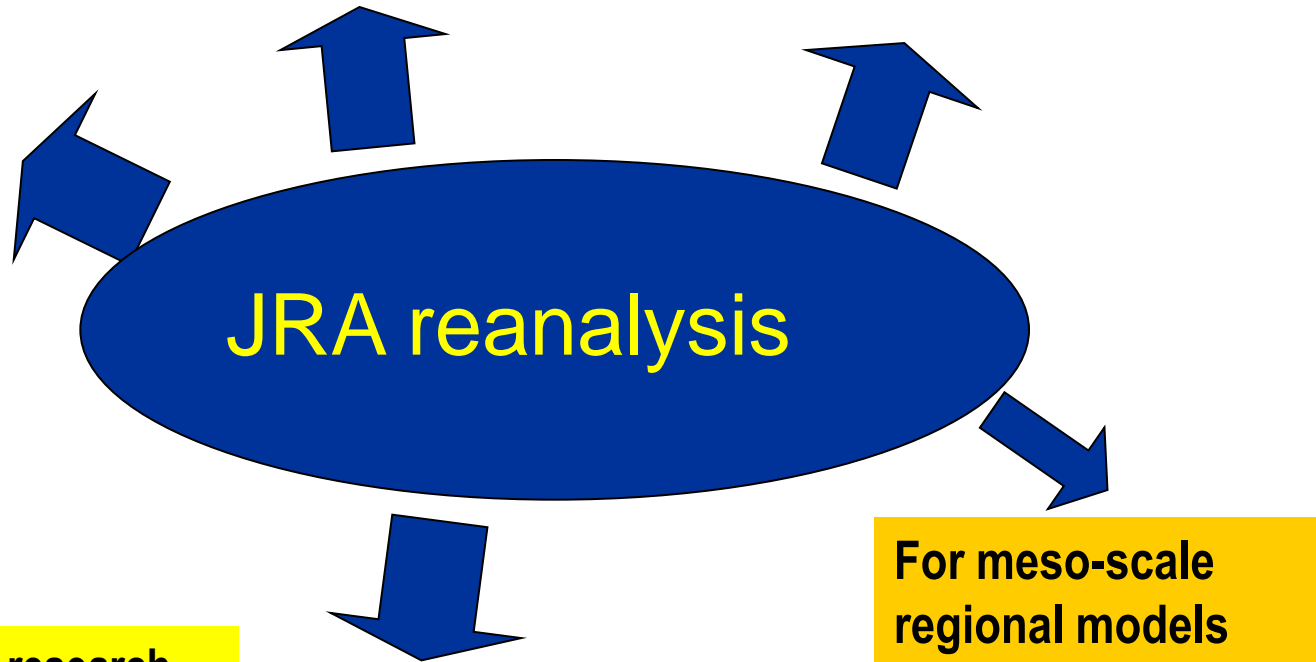
Analysis of Energy and water cycle, for any research

Climate information

- Time series of a point
- JRA-25 Atlas, JRA-55 Atlas

Earth Environment

Carbon cycle, reference data for ozone analysis
Forcing data for a chemical transport model



To provide proper initial and
boundary data to perform
numerical experiments for
severe events in the past.



Summary



- **Approach for generating climate dataset**
 - Numerical DA is better approach for diagnosing the past climate.
- **Validation of JRA-55**
 - JRA-55 has much better quality than JRA-25.
 - Precipitation correlation with TRMM is good.
- **Use of JRA-55**
 - JMA's operational climate information:
 - Climate system monitoring, seasonal forecast, forecast model development, initial field for reforecast, boundary condition for ocean reanalysis ...
 - Basic data for "iTacs"
 - Various kind of research use
- **Reference**
 - Kobayashi et al. (2015) *JMSJ*, **93**, 5-48, DOI:10.2151/jmsj.2015-001
 - The JRA-55 Reanalysis: General Specifications and Basic Characteristics





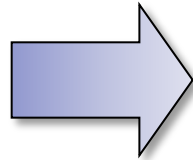
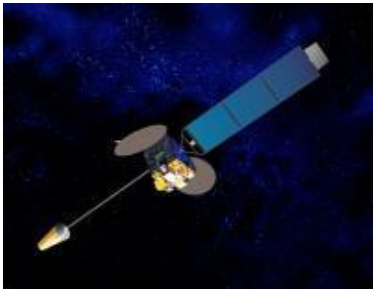
Backup slides



Outline of Data Assimilation cycle



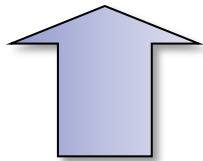
Observation



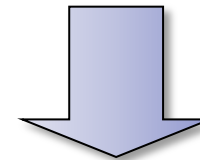
DA System

(numerical model, quality control, etc)

Super Computer System



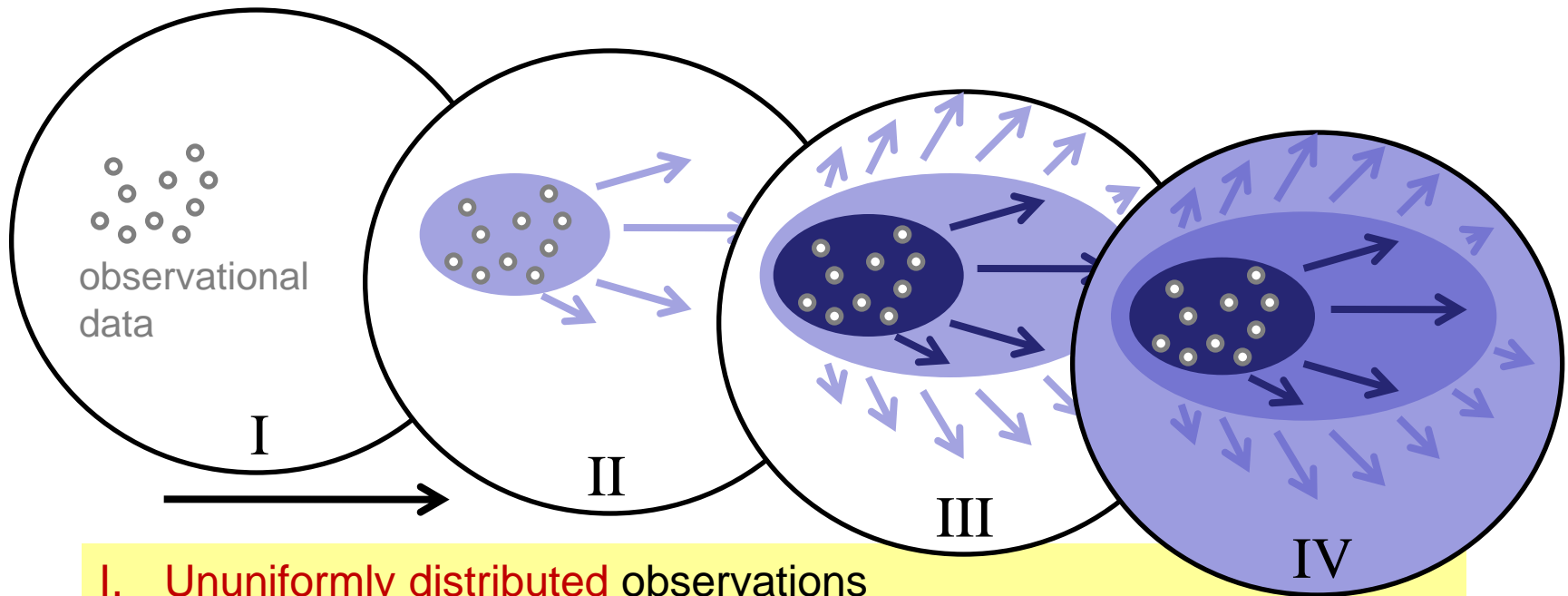
First Guess for analysis
at the next time



Best Estimation of the Global Atmospheric field



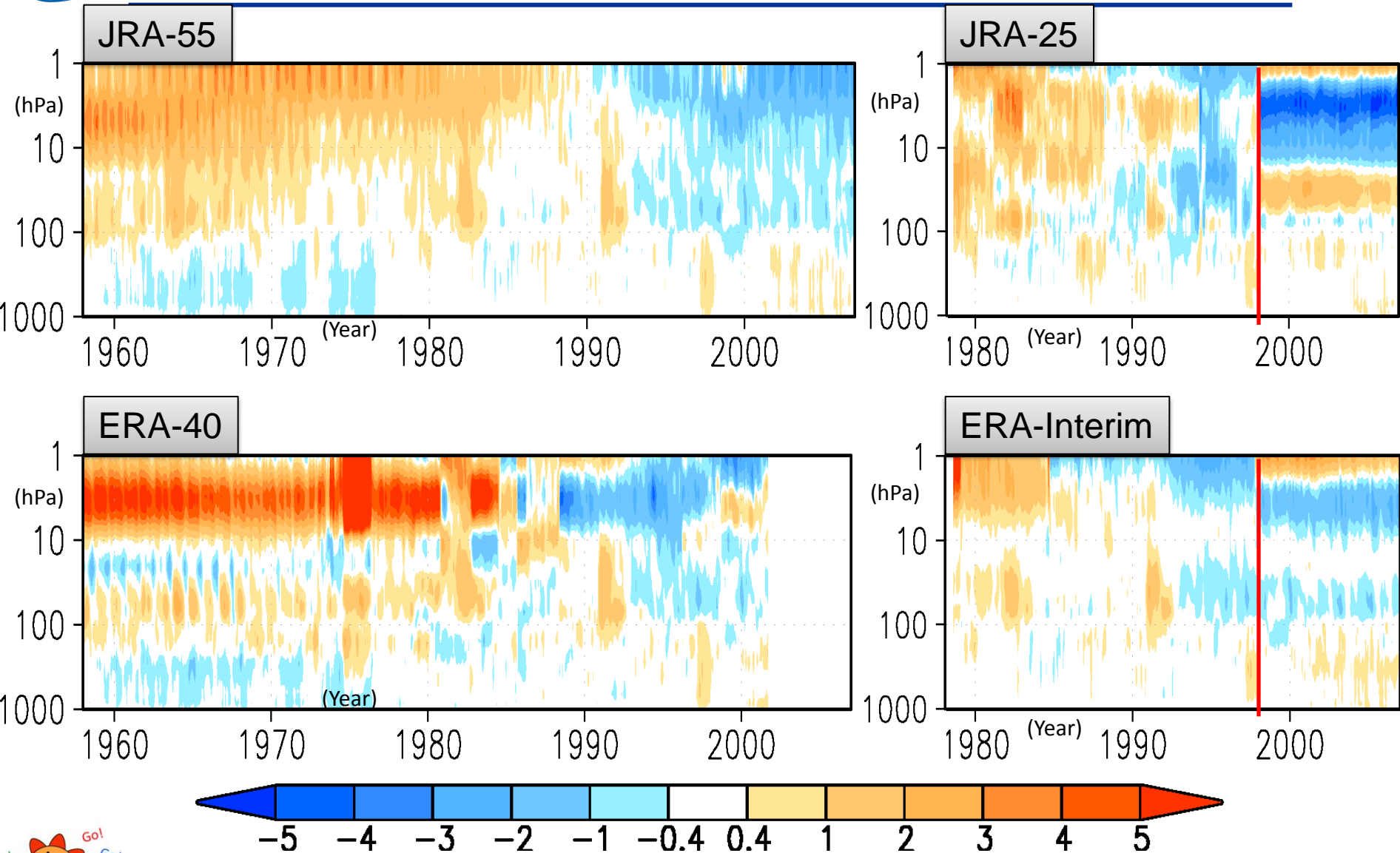
Data Assimilation Cycle



- I. **Ununiformly distributed** observations
- II. The hatched area **surrounding observations** are analyzed with **high quality**. The high quality area **extends by forecast**.
- III. In the next data assimilation, the **deep colored area** surrounding observations are analyzed **with much higher quality**. The higher quality area **extended further by the next forecast**.
- IV. The **repetition of data assimilation and forecast** is called “Data Assimilation cycle”. DA cycle plays **very important role to keep a certain high quality** even in the area with **no/less observational data**.



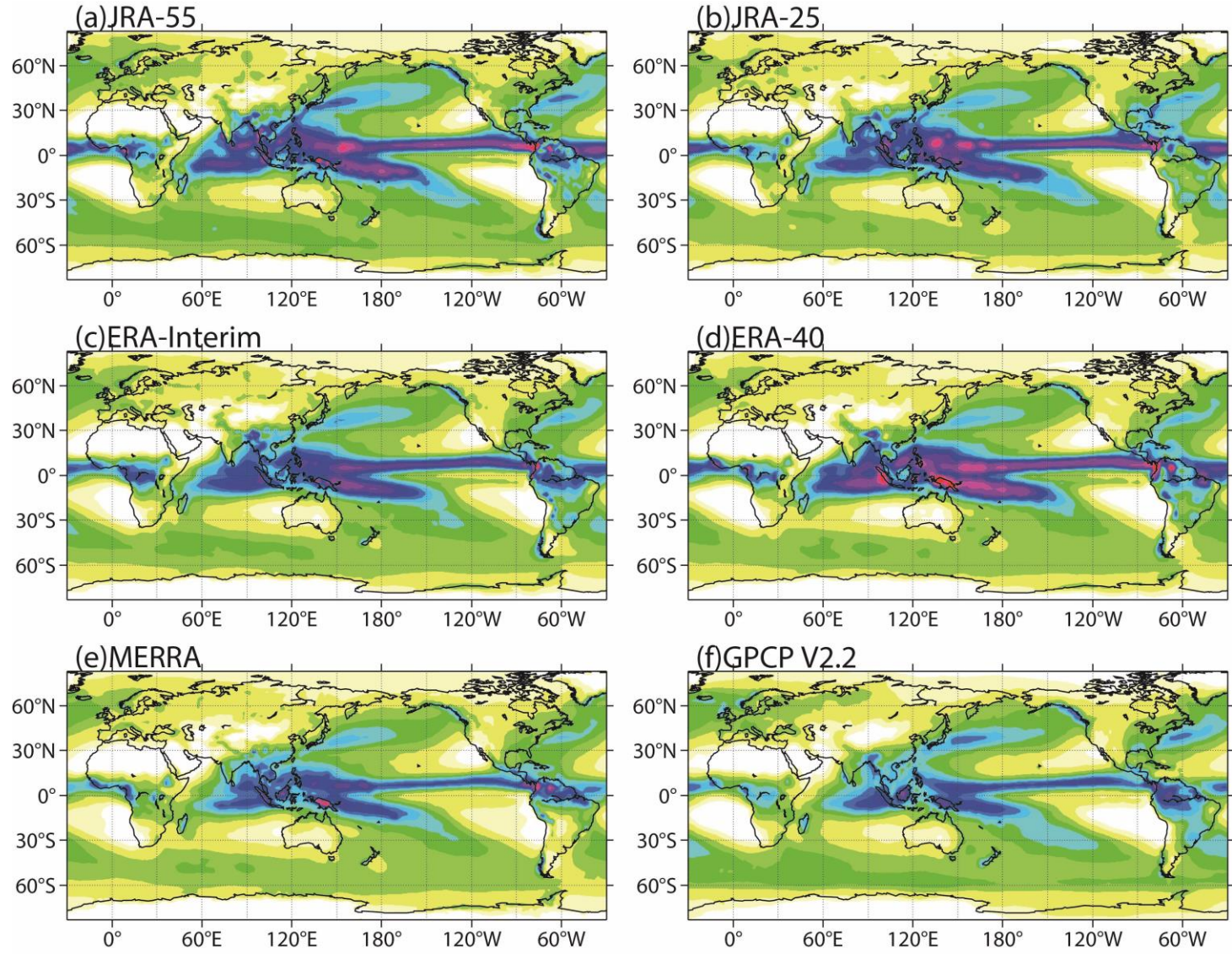
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Precipitation in Reanalyses





Quality of JRA

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