

# Introduction to JRA-55

## The Japanese 55-year Reanalysis

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on behalf of JRA group



~ Introduction ~  
What is reanalysis?

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# 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.



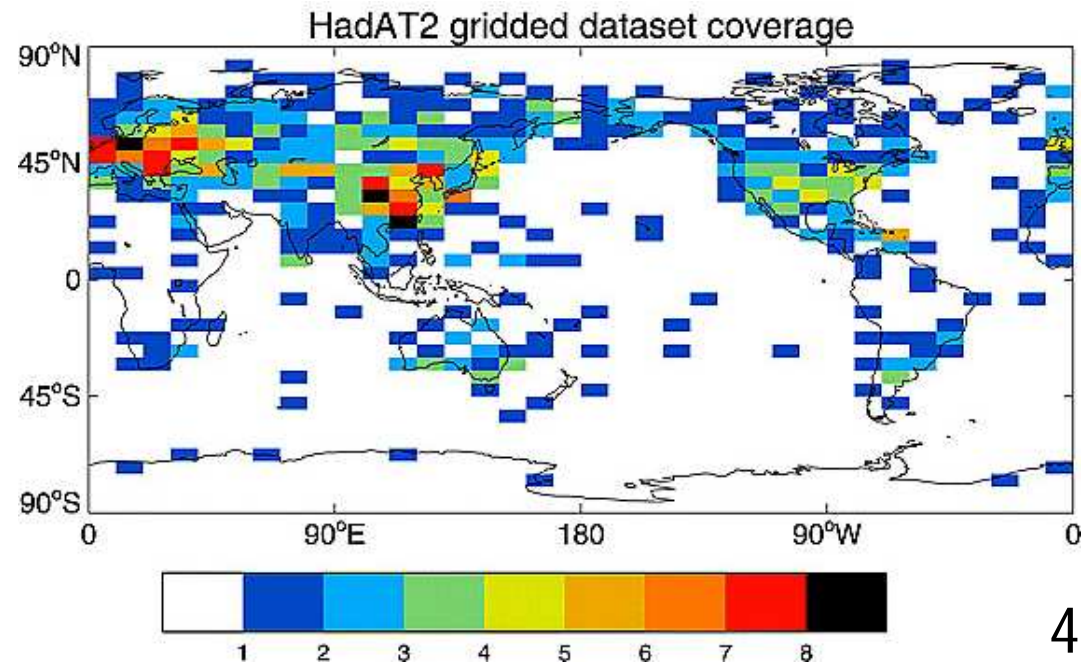
# Approach for producing climate data



## 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 grid point values 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.

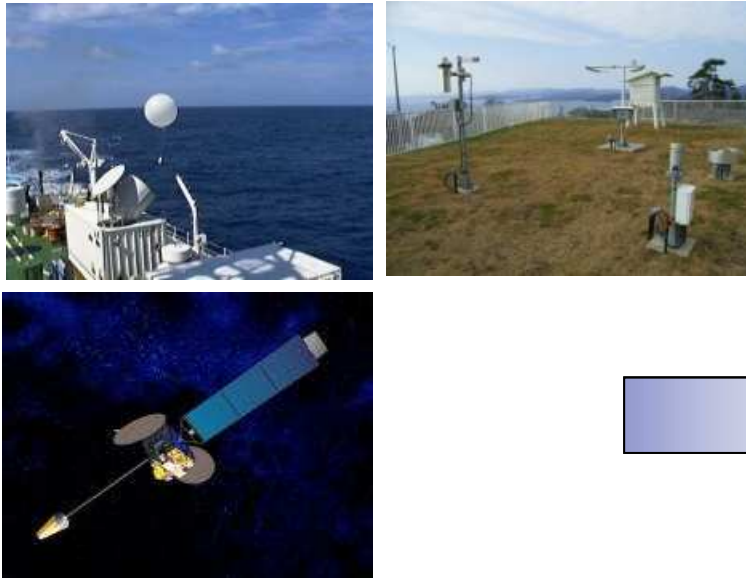
→ Long-term Reanalysis



# Outline of Data Assimilation cycle

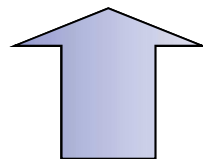


Observation

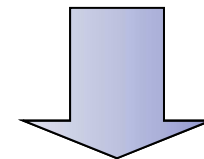


DA System  
(numerical model, quality control, etc)

Super Computer System



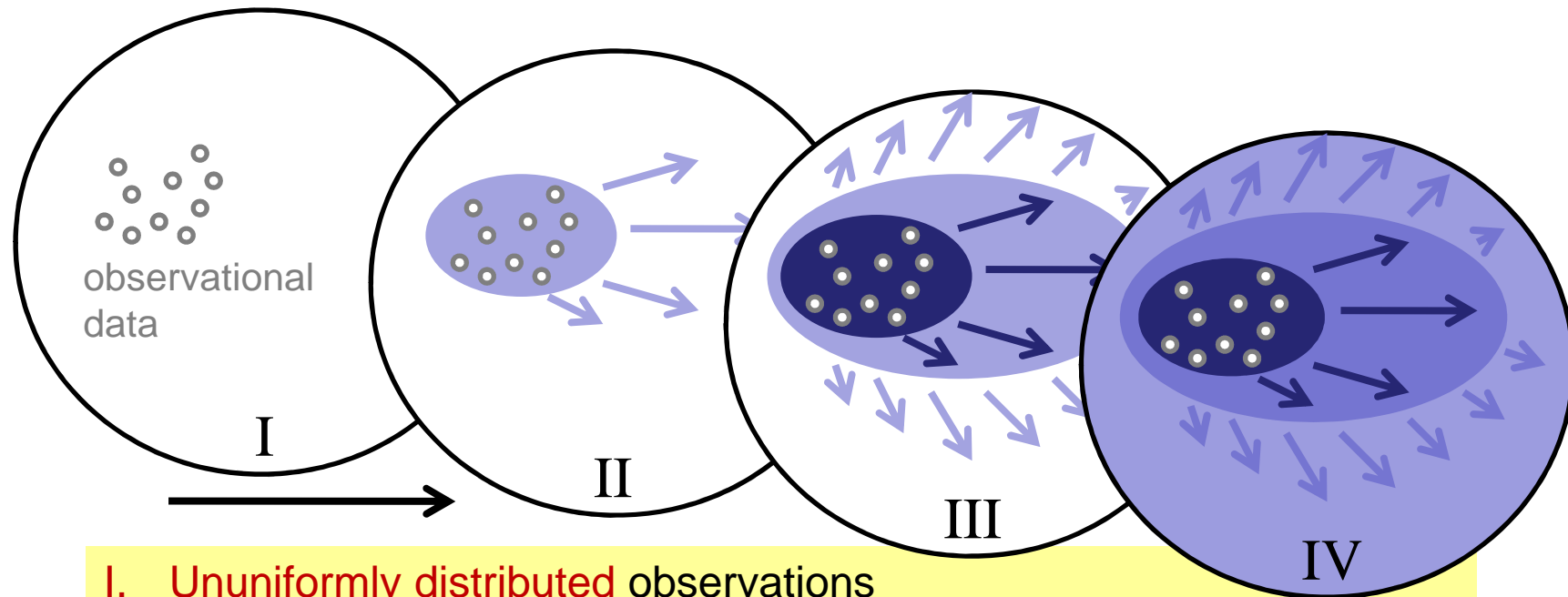
First Guess for analysis  
at the next time



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**.

# Reanalysis



Satellite

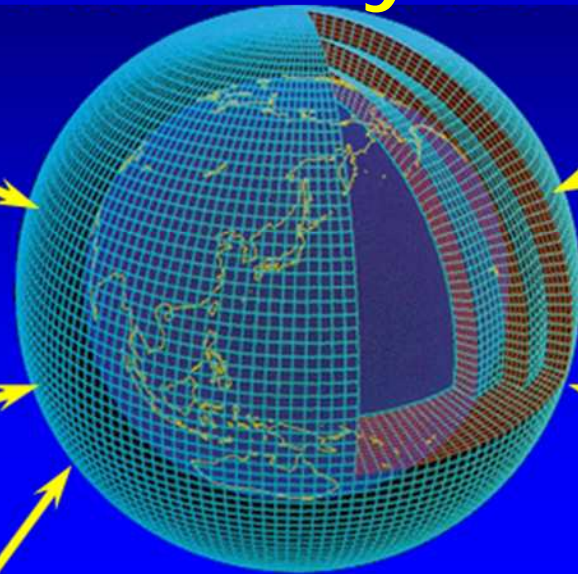


Surface, Upper

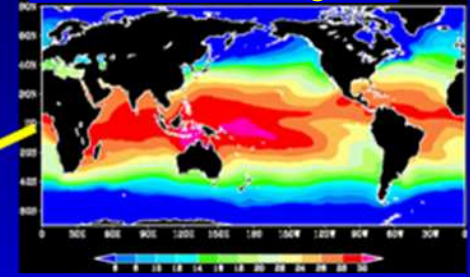


Ship, aircraft

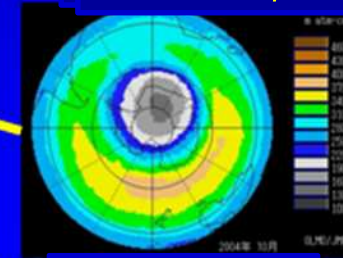
Observation



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

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# Japanese Global Atmospheric Reanalysis

## 1<sup>st</sup> JRA-25

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



## 2<sup>nd</sup> 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.





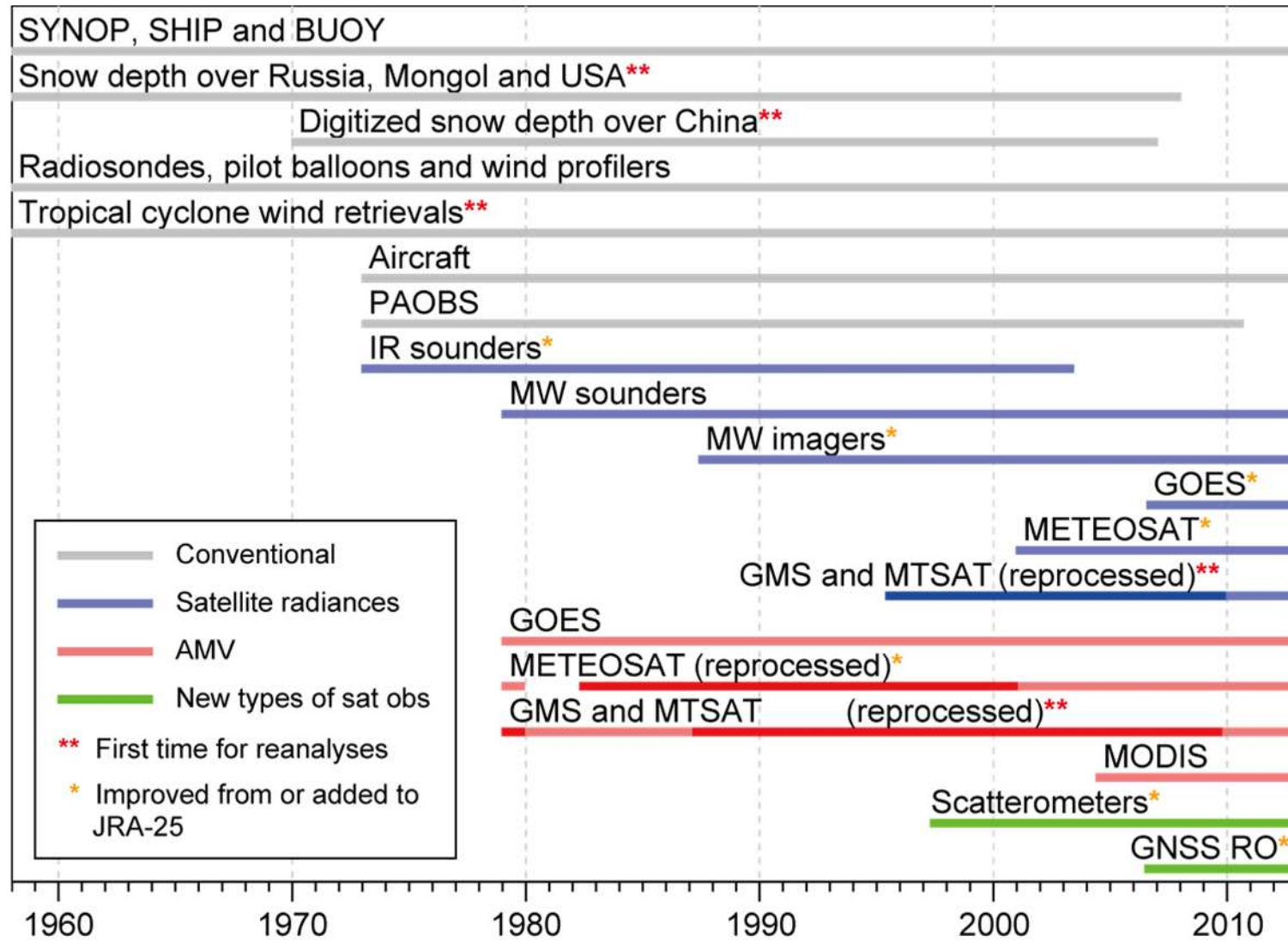
# JRA-55 Reanalysis system



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



# Observational Data available for JRA-55



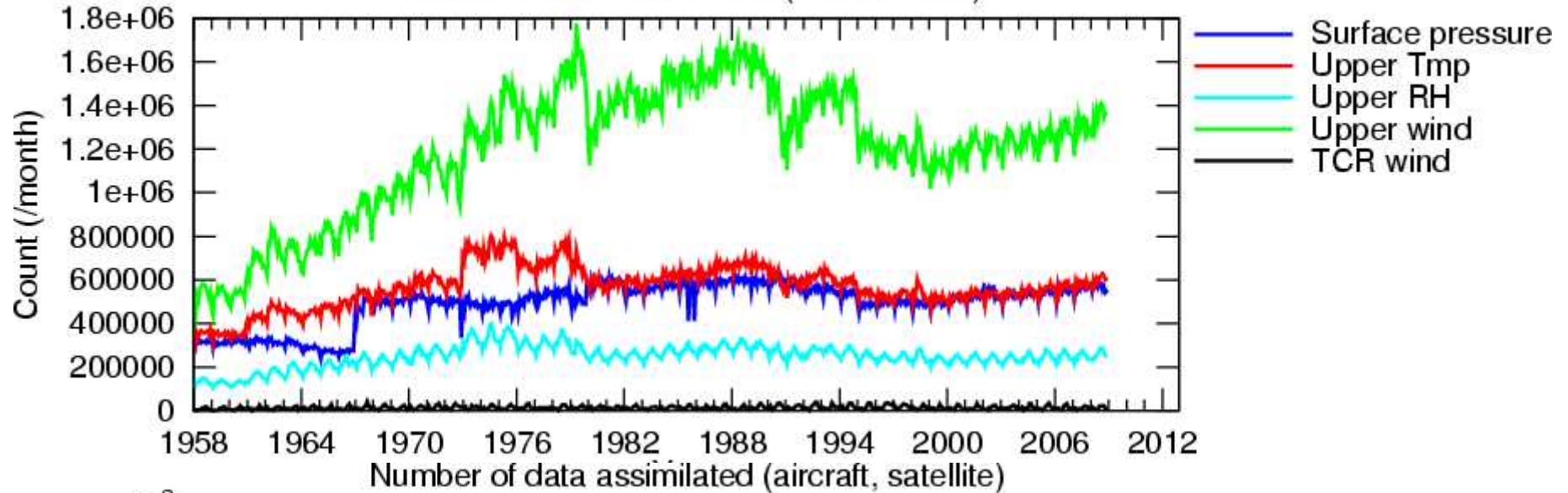
GNSS: Global Navigation Satellite System



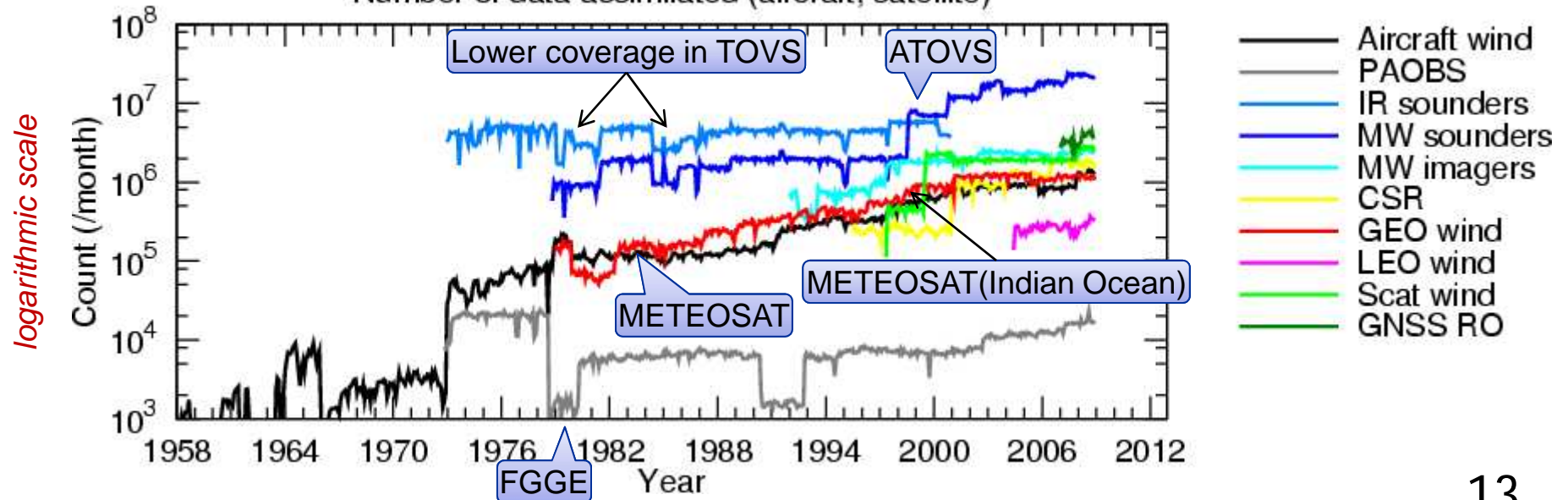
# Number of observations assimilated (Global)



Number of data assimilated (conventional)

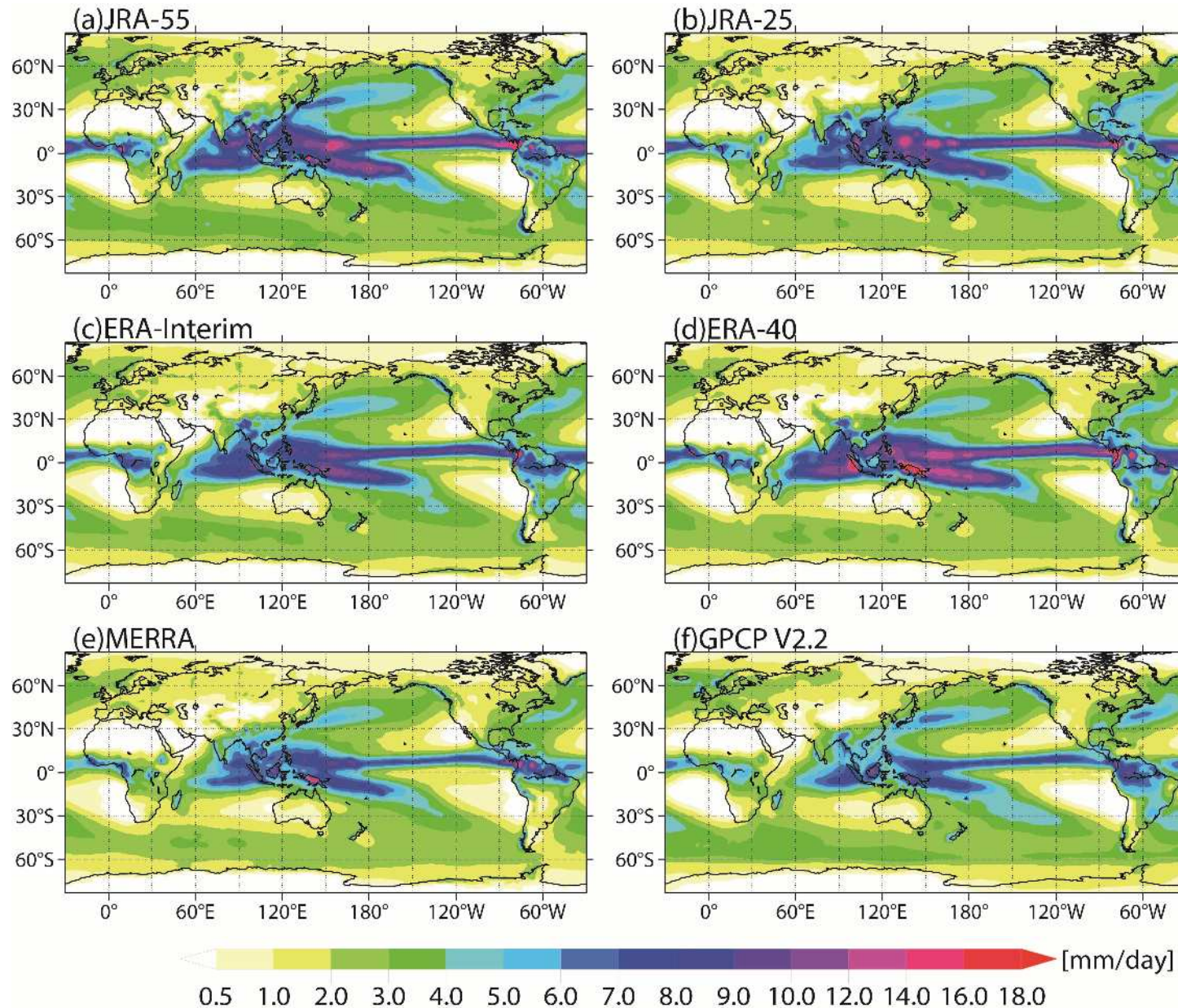


Number of data assimilated (aircraft, satellite)





# Precipitation in Reanalyses



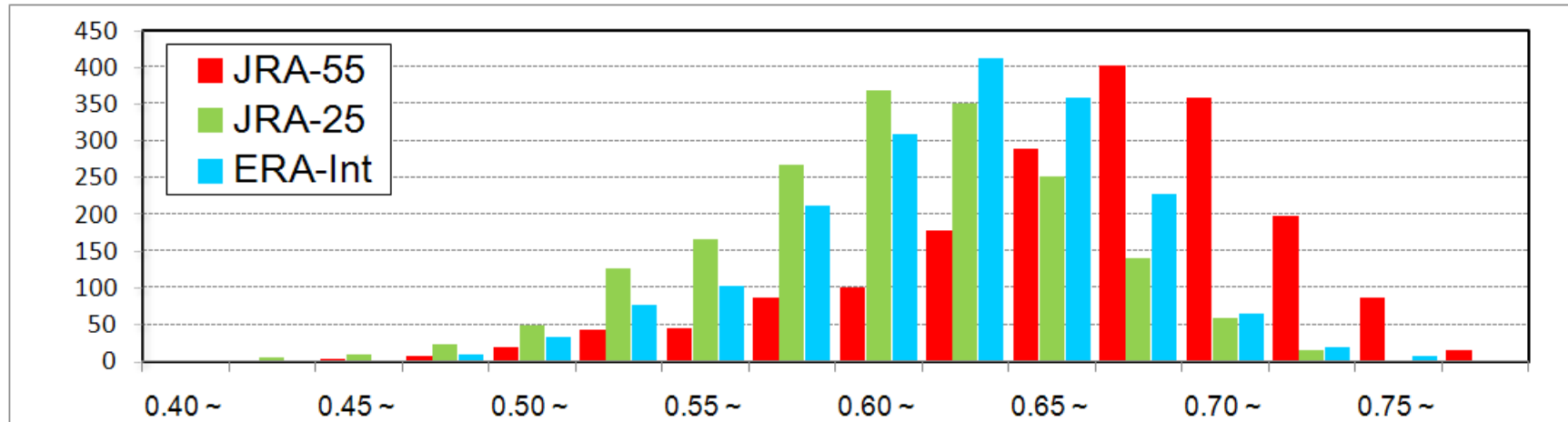


# Frequency of daily precipitation correlation against TRMM



The Tropical Rainfall Measuring Mission (TRMM) since 1998

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

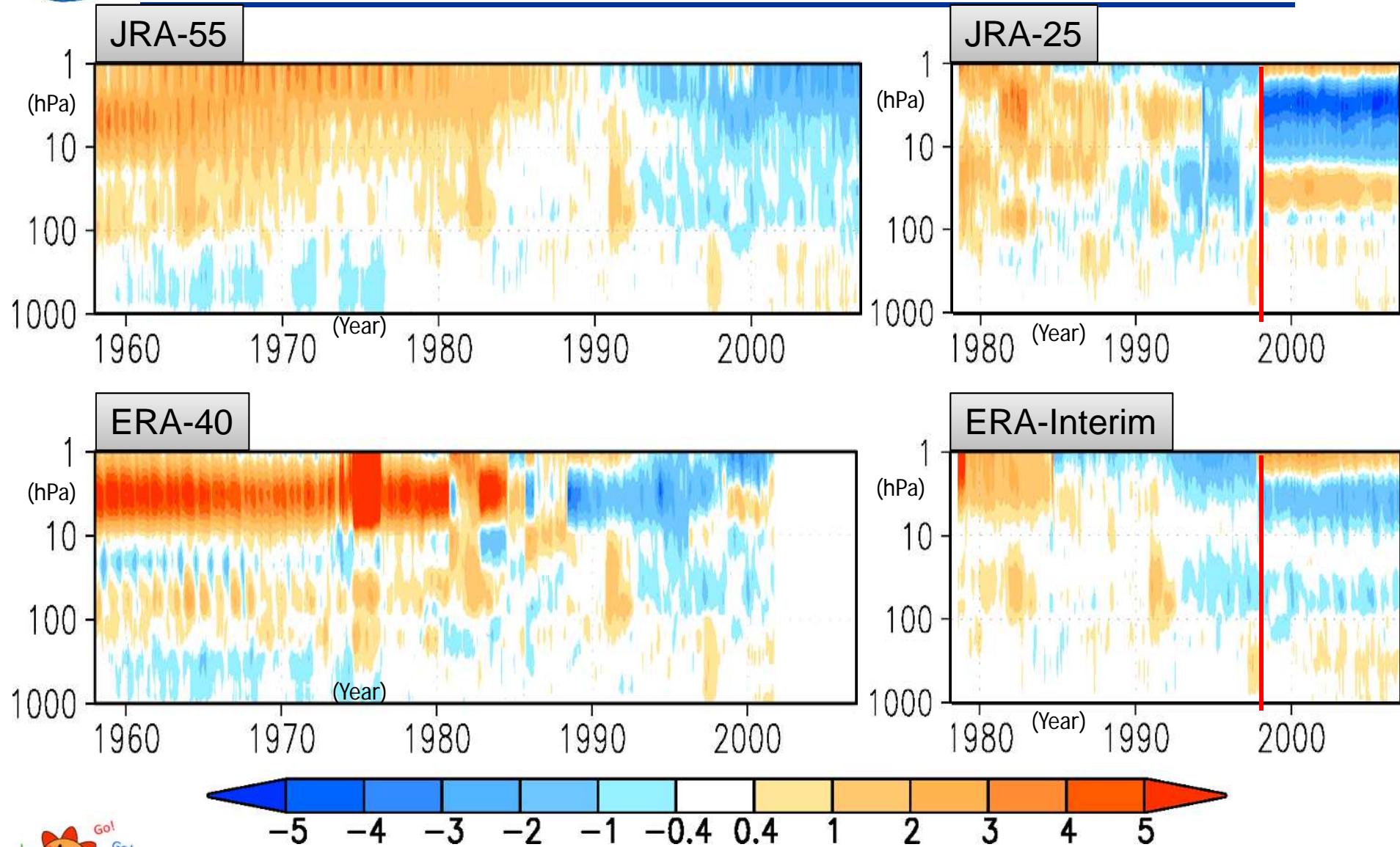


Frequency of spatial correlation of daily precipitation over tropical region (22°S-22°N) against TRMM from 1998 to 2009

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



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



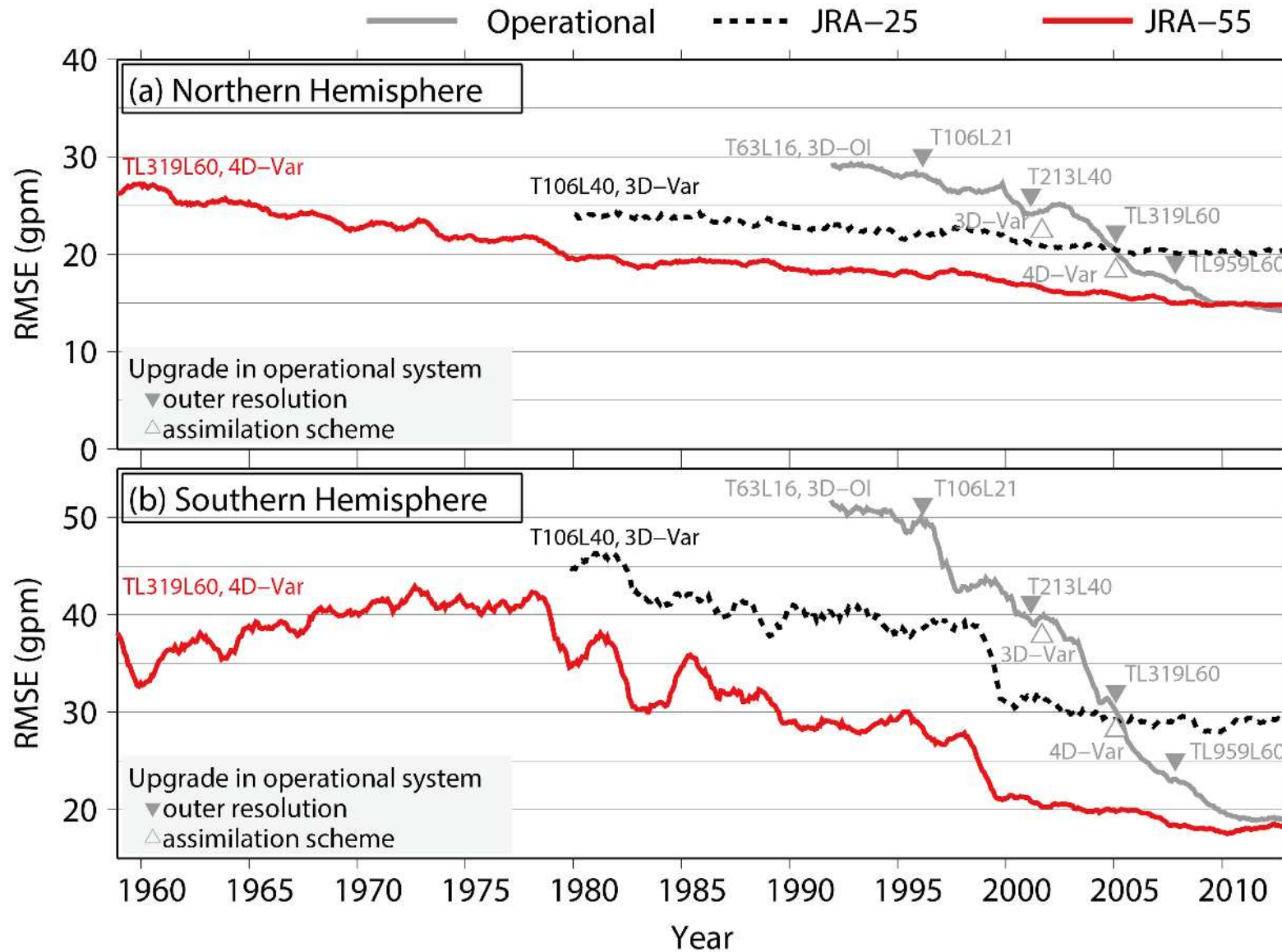
Anomalies from the mean temperature at each pressure level for years 1980 to 2001 of each reanalysis, JRA-55, ERA-40, JRA-25 and ERA-Interim, respectively.





# Quality of JRA

Forecast [FT=48] Scores RMSE of Z500 for N.H. and S.H. [gpm]



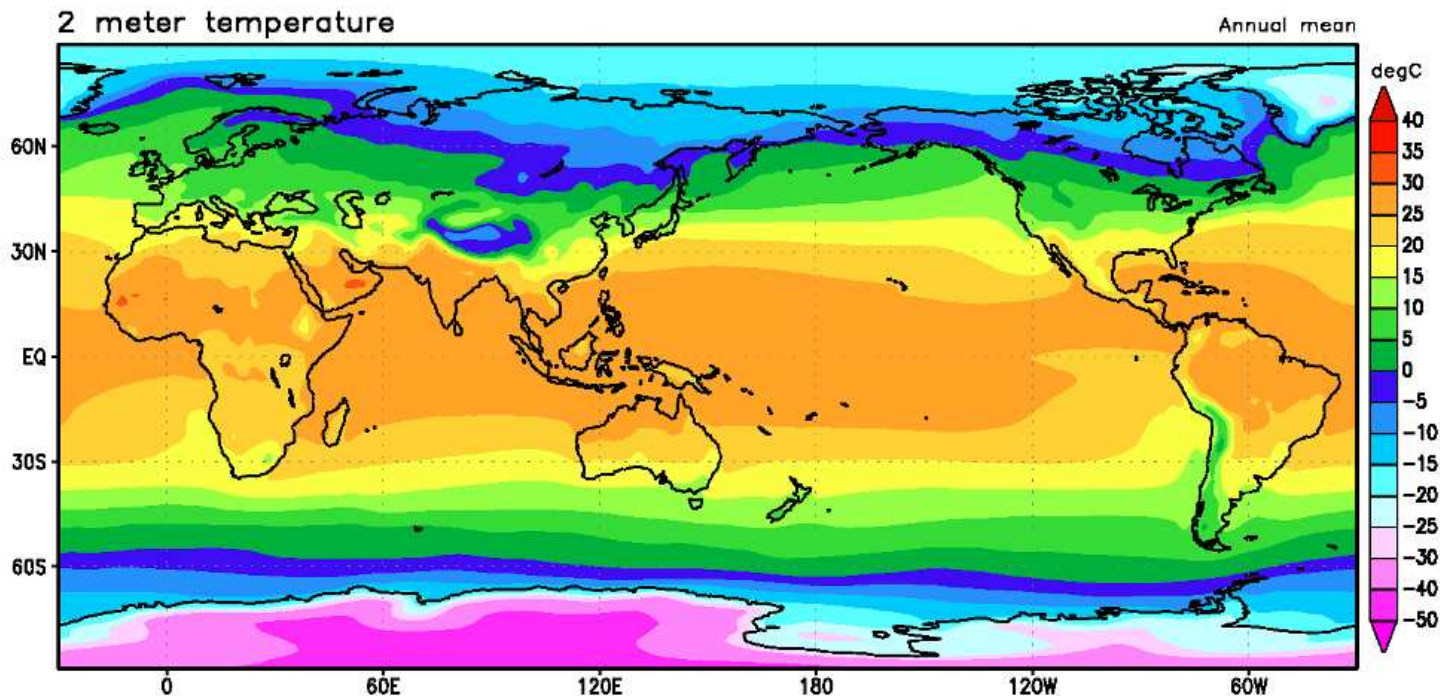


# JRA Atlas (climate maps)

- JRA-25 Atlas
  - <http://ds.data.jma.go.jp/gmd/jra/atlas/eng/atlas-tope.htm>
- JRA-55 Atlas (in preparation)

Surface climatologies (Pressure, wind, temperature)

Select element and period \*\*\* 2m temperature Annual mean





# 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

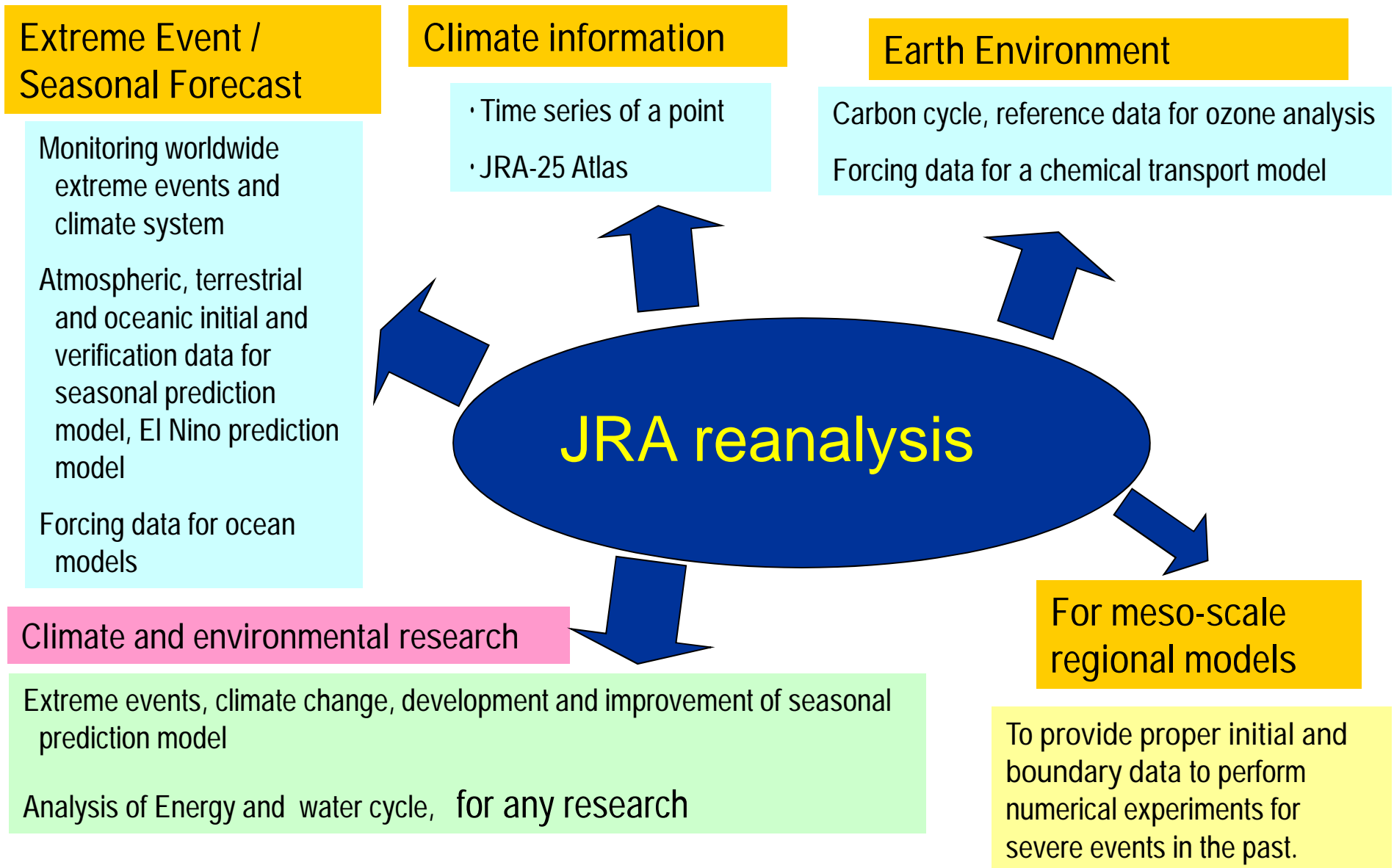
**JRA-55**

English

**JRA-55**



# Application of JRA for operation and research





# Summary



- **Approach**
  - Numerical DA is better approach for diagnosing the past climate change.
- **Observational Data for JRA-55**
  - Improvement in both quality and quantity from JRA-25
    - Many reprocessed Satellite data and newly available data
- **Validation of JRA-55**
  - JRA-55 has much better quality than JRA-25.
  - Unnatural gaps in temperature have been significantly reduced.
  - Precipitation correlation with TRMM is good.
- **Reference**
  - Kobayashi et al. (2015) JMSJ, DOI:10.2151/jmsj.2015-001
    - The JRA-55 Reanalysis: General Specifications and Basic Characteristics



Thank you.

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