The Japanese 55-year Reanalysis

JRA-55

--- progress and status ---

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M.Moriya, H.Onoda, **K.Onogi,** H.Kamahori, C.Kobayashi,
H.Endo, K.Miyaoka, R.Kumabe, and K.Takahashi

Japan Meteorological Agency (JMA)

Underlined names are attendees of this conference.

Japanese Reanalysis

1st JRA-25

By JMA and CRIEPI

- CRIEPI :
  Central Research Institute of Electric Power Industry

2nd JRA-55

By JMA

Nickname of JRA-55

→ JRA Go! Go!

JRA-25 (ni-go)

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1. JRA-55 Reanalysis system
   - Data assimilation and forecast system
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1. JRA-55 Reanalysis System

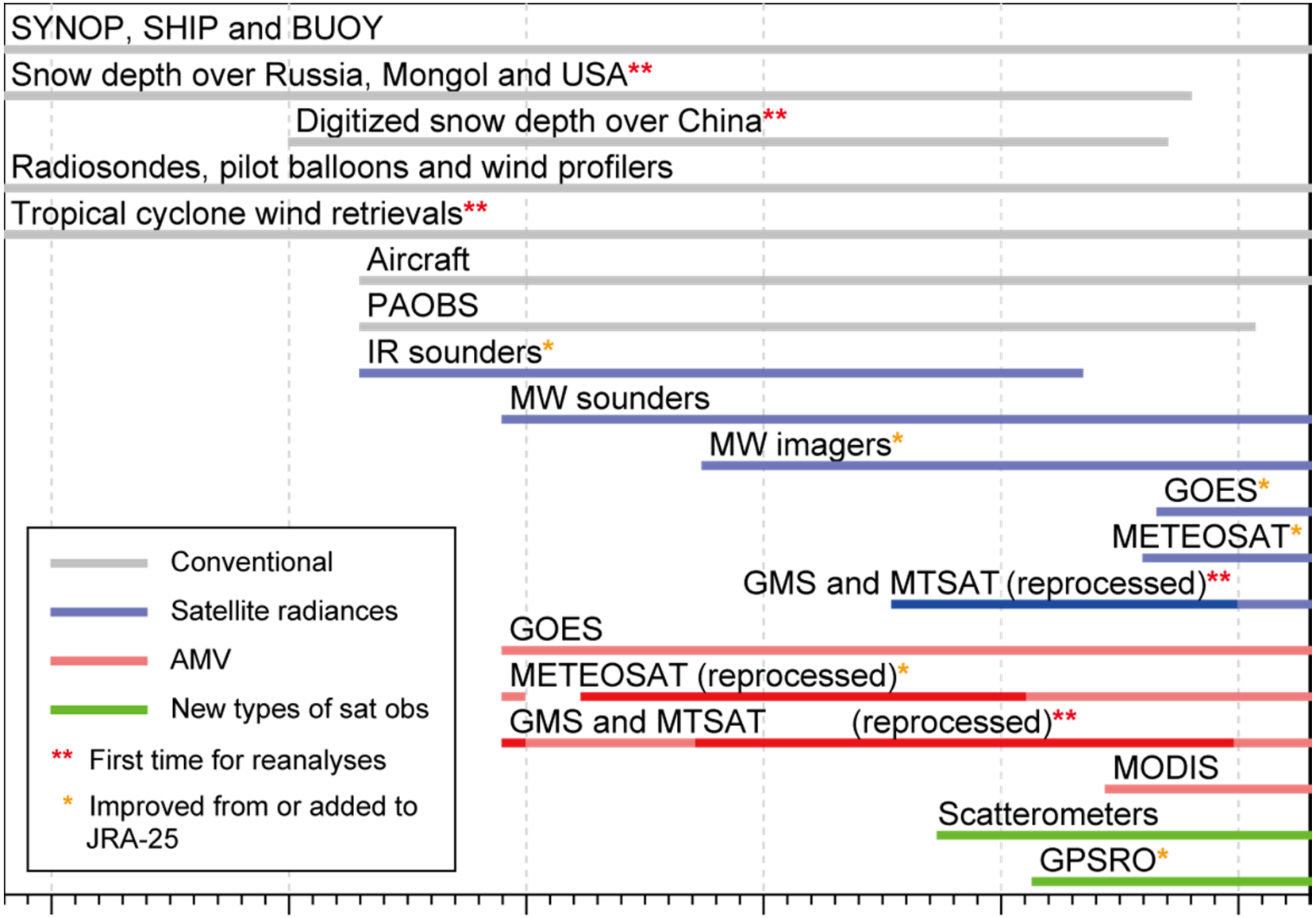
JRA-55 Reanalysis system

	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 (~120km) *(top layer at 0.4 hPa)*	**TL319L60 (~60km)** ***(top layer at 0.1 hPa)***
Time integration	Eularian	**Semi-Lagrangian**
Assimilation scheme	3D-Var	**4D-Var** ***(with T106 inner model)***
Bias correction (satellite radiance)	Adaptive method (Sakamoto et al. 2009)	**Variational Bias Correction** **(Dee et al. 2009)**
Tropical Cyclone	Wind profile retrievals (TCRs) provided by Dr.Fiorino were assimilated.	**Same as JRA-25**

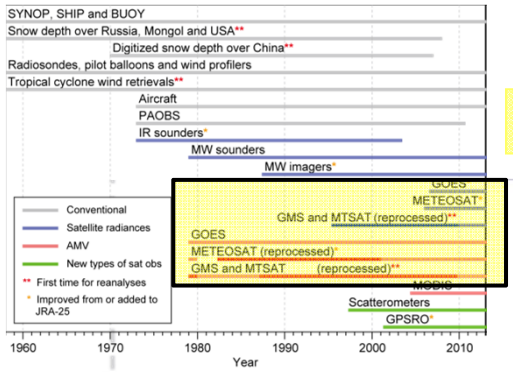
Boundary and forcing fields

	JRA-25	**JRA-55**
Radiatively active gases	H_2O, CO_2, O_3	**H_2O, CO_2, O_3, CH_4, N_2O, CFC-11, CFC-12, HCFC-22**
GHG concentrations	Constant at 375 ppmv (CO_2)	**Annual mean data are interpolated to daily data (CO_2,CH_4,N_2O)**
Ozone	Daily 3-D ozone *(produced by AED/JMA)*	**(-1978) Monthly climatology (1979-) New daily 3-D ozone *(produced using a revised CTM)***
Aerosols	Annual climatology for continental and maritime aerosols	**Monthly climatology for continental and maritime aerosols**
SST Sea ice	COBE SST (Ishii *et al.*, 2005, *I.J.Clim.*)	**COBE SST (ver. 1.5)**

Observational data used in JRA-55



Available Reprocessed AMV and CSR data



Expanding yellow part in the obs. data table

Thick line : reprocessed period

Ref. Oral on Wednesday by Mr. S. Kobayashi

Height assignment of Operational AMVs used in ERA-15 (ERA-15 Report 3, Uppala, 1997)

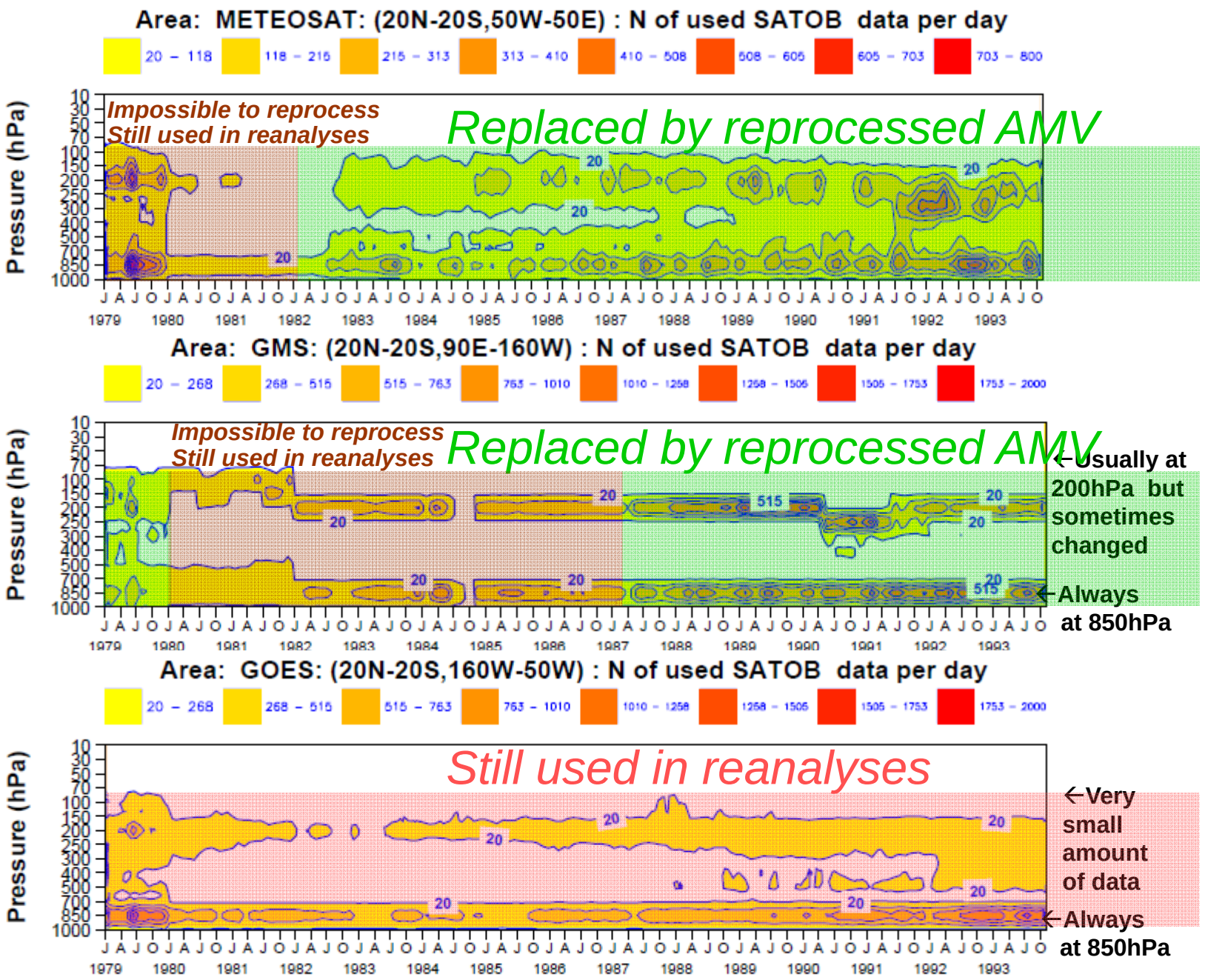
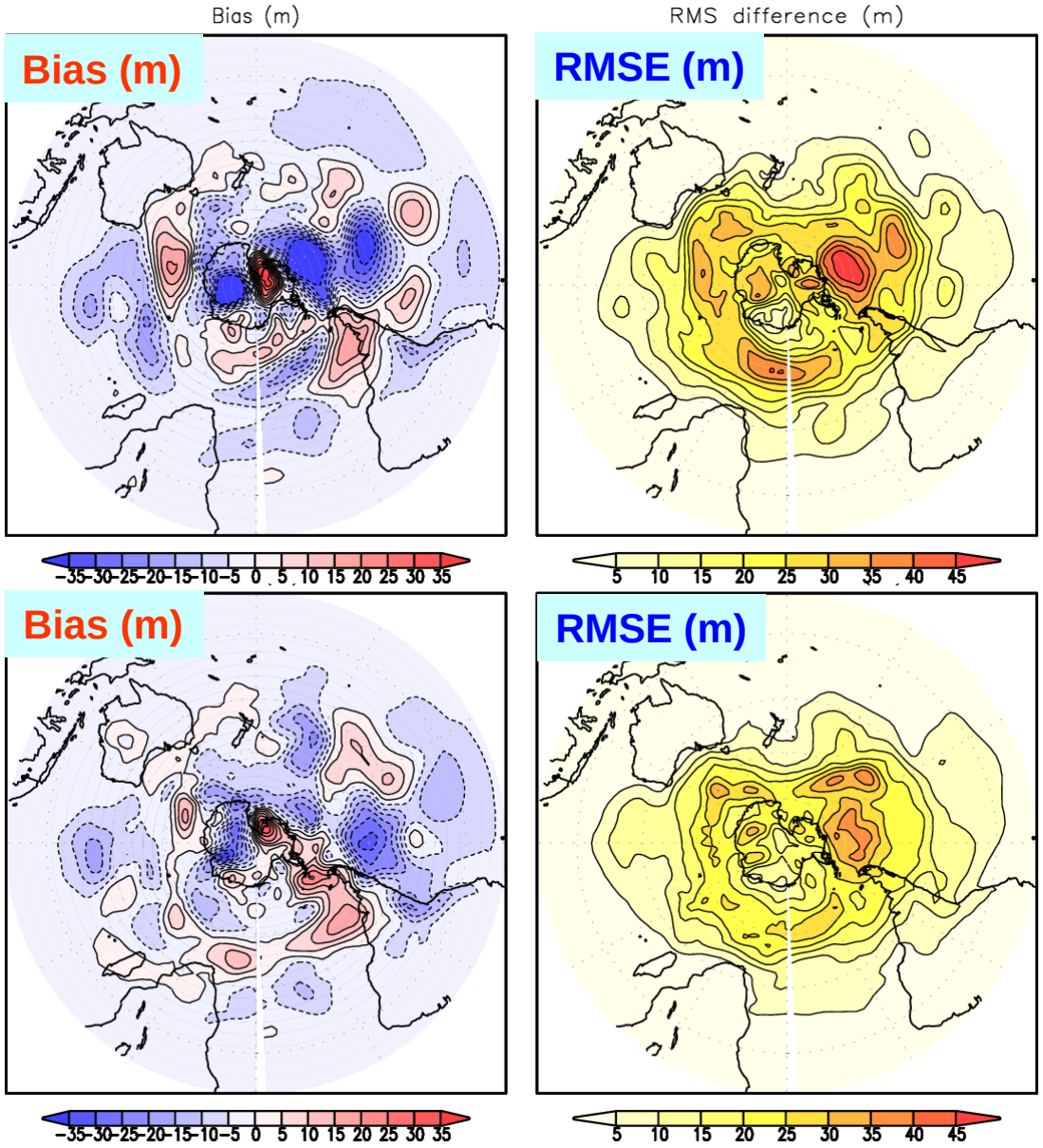


Figure 70. Time-height variability of the 91-day moving average of the number of cloud motion winds used per day (00+06+12+18 UTC) in the ECMWF reanalysis in the Tropics.

Background error estimation

- Analysis quality largely depends on the background error covariance matrix B when/where observational data quantity is small.
- Estimation of background error statistics for no-satellite years is required.
- Experimental DA cycle without satellite data was performed to estimate the effect of sat. data.
- “1.8 times larger background error” gives the best performance.
  - 1.8 : appropriate scaling factor
  - 1.8 x **B** is used for “no satellite” years.

Background Error estimation for no-satellite years
(Z500: Experiment for March 1991)



Difference of Analysis fields

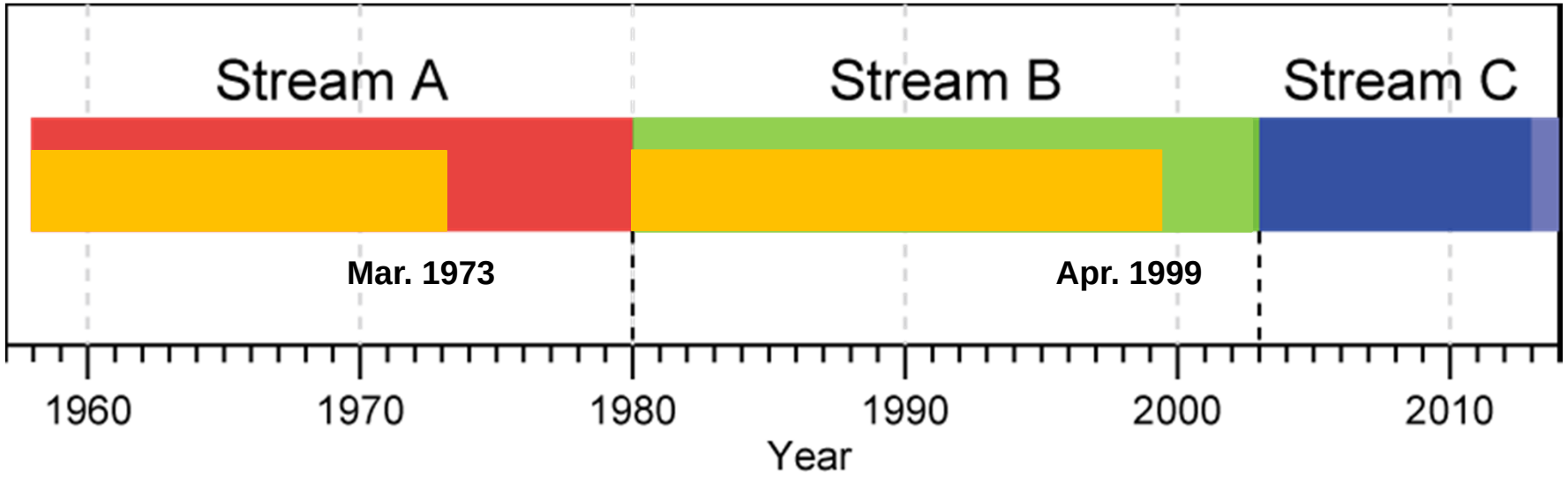
With Satellite – Without Satellite

1.0 x B

With Satellite – Without Satellite

1.8 x B

JRA-55 progress status



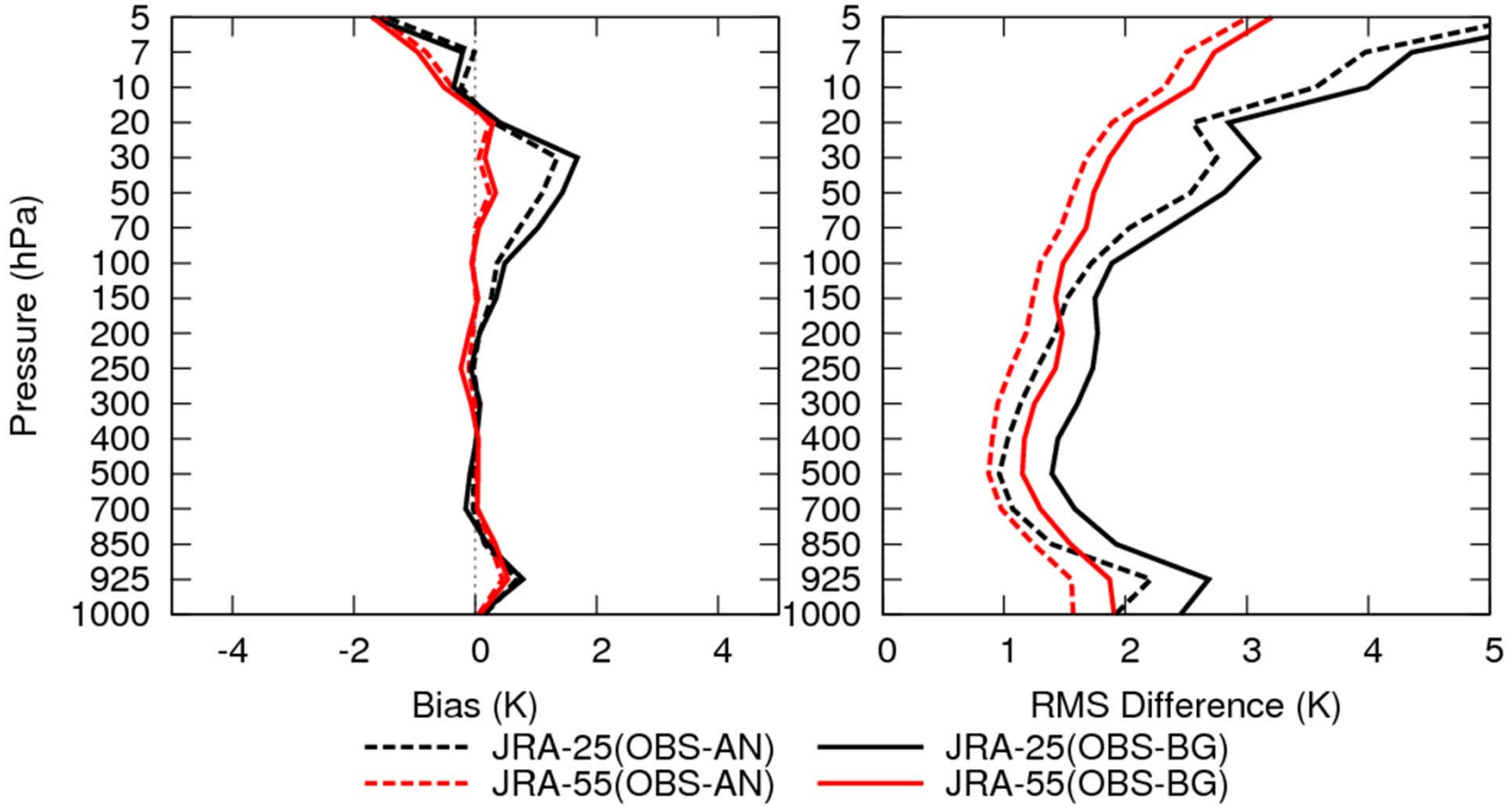
Completed periods as of 1 May, 2012

JRA-55 will be completed in the spring of 2013.

2. Early results of JRA-55

Red line is JRA-55 in the following graphs.
Note that only completed years are plotted.

Improvement of vertical temperature profiles

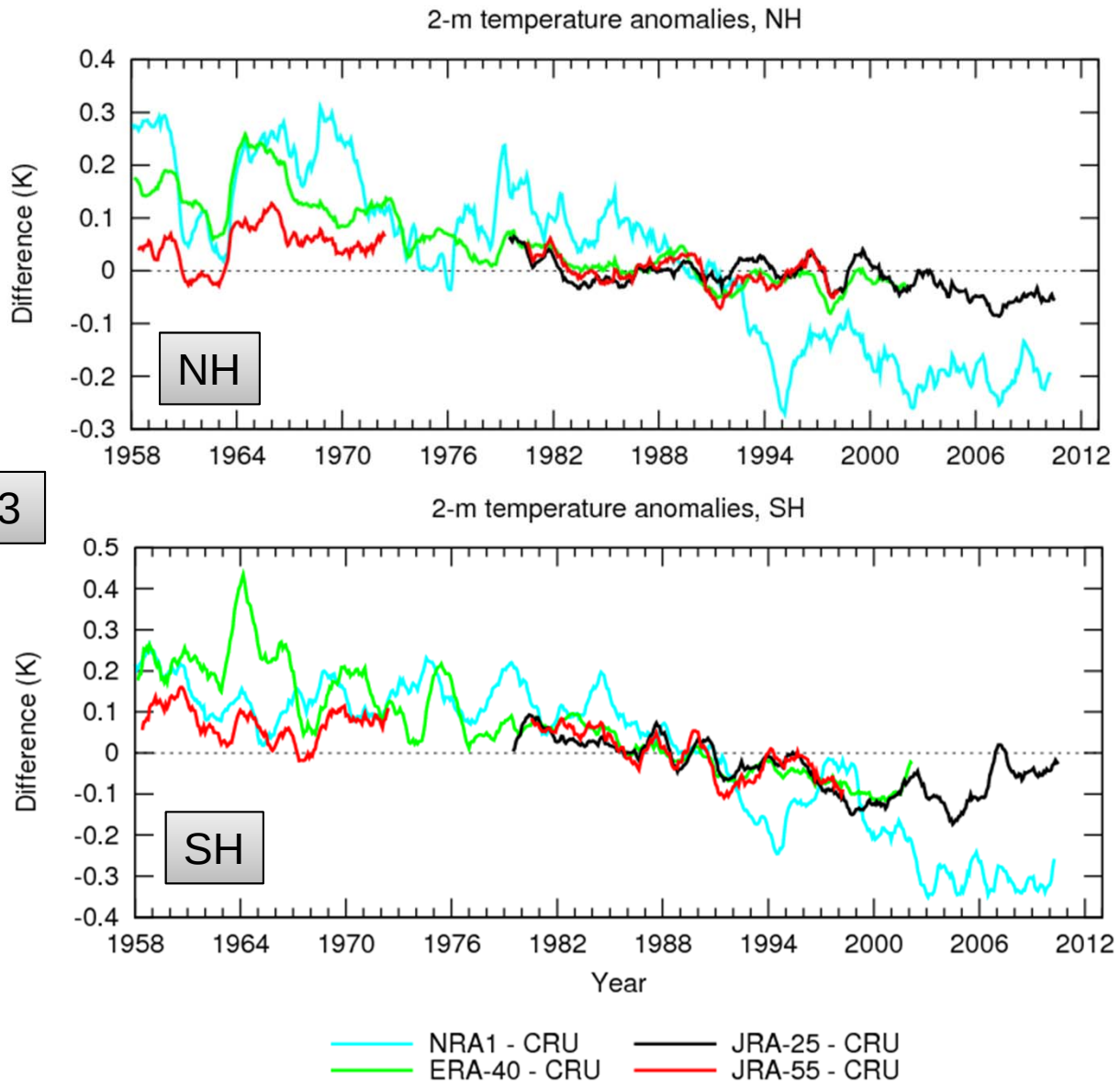


Vertical profiles of global mean bias and RMS difference between radiosonde temperature measurements and the background (solid lines) / analyzed fields (dotted lines) from JRA-25 (black) and JRA-55 (red) in January 1981.

Surface (2m) temperature

Reanalysis - CRUTEM Ver. 3

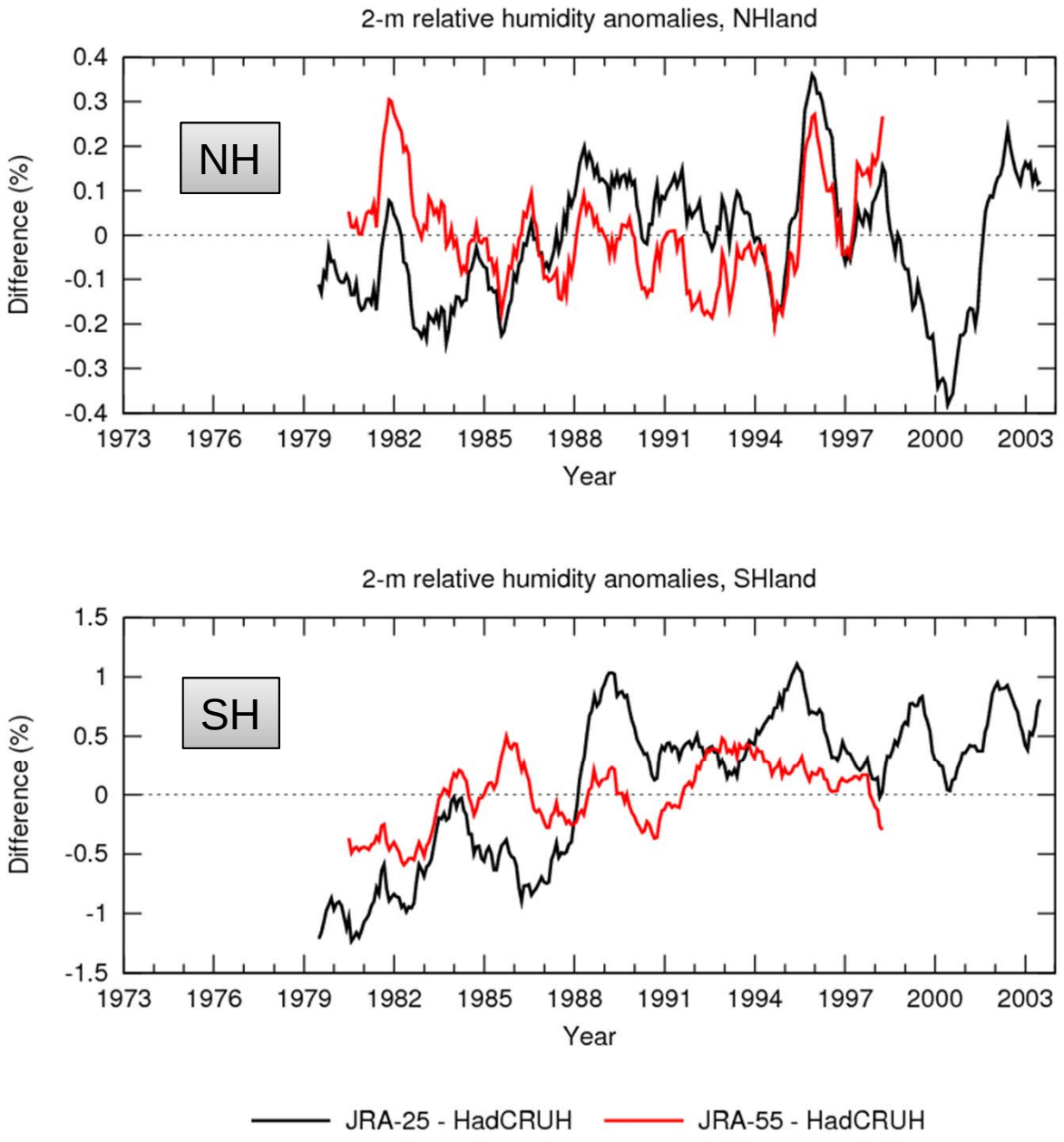
JRA-55 is the best among these reanalyses.



Land Surface (2m) Relative Humidity

JRA - HadCRUH

JRA-55 is better than JRA-25.



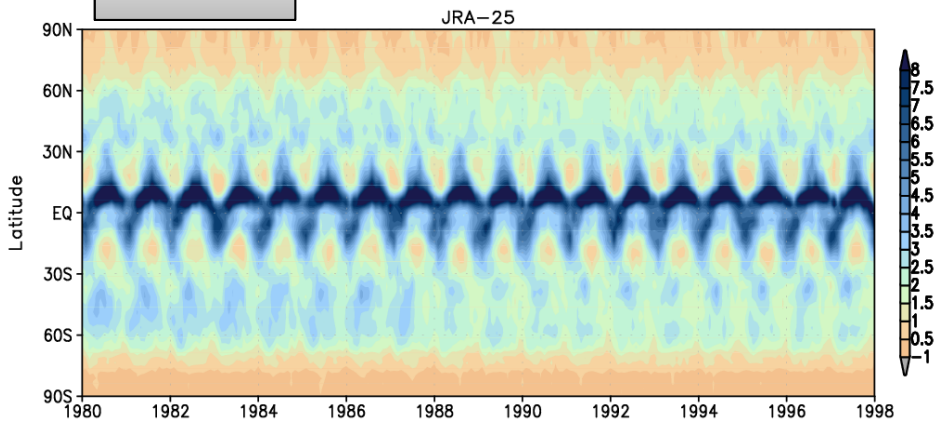
Zonal Mean Precipitation

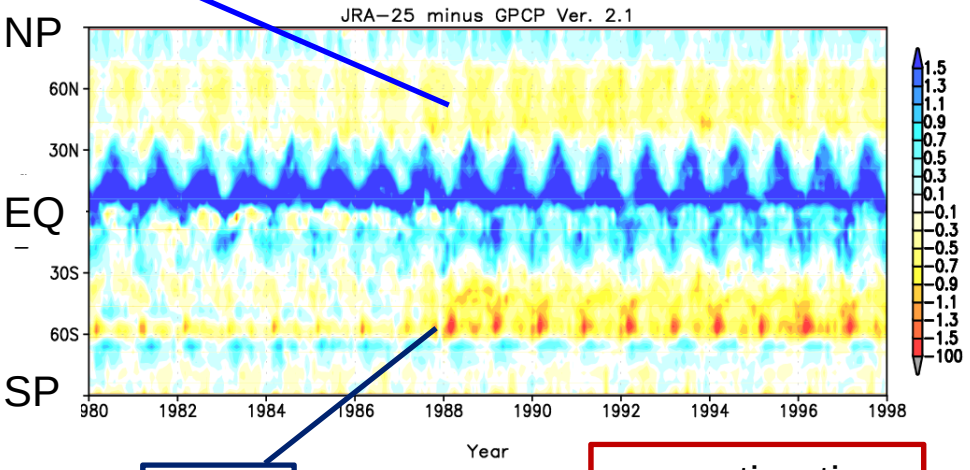
Reanalysis

Reanalysis - GPCP

dry bias

JRA-25

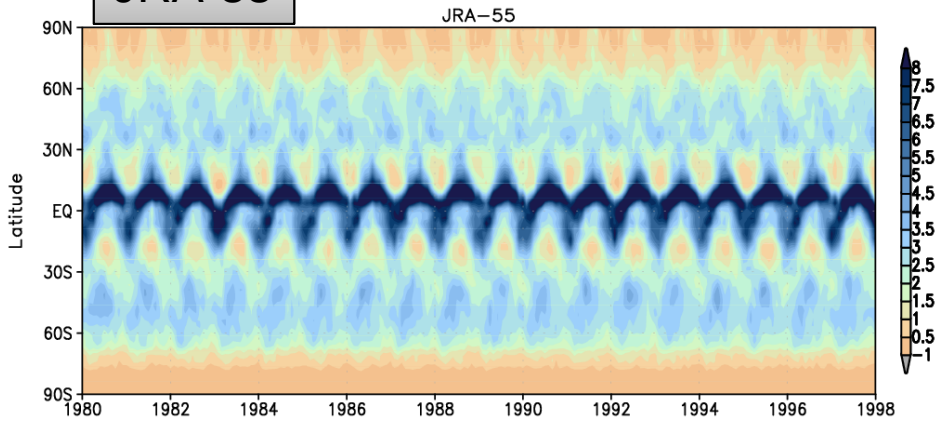


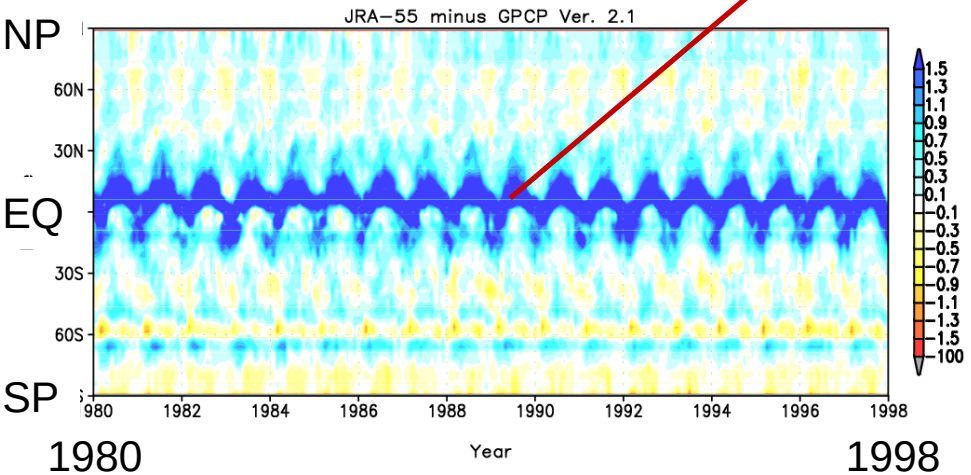


jump

overestimation

JRA-55



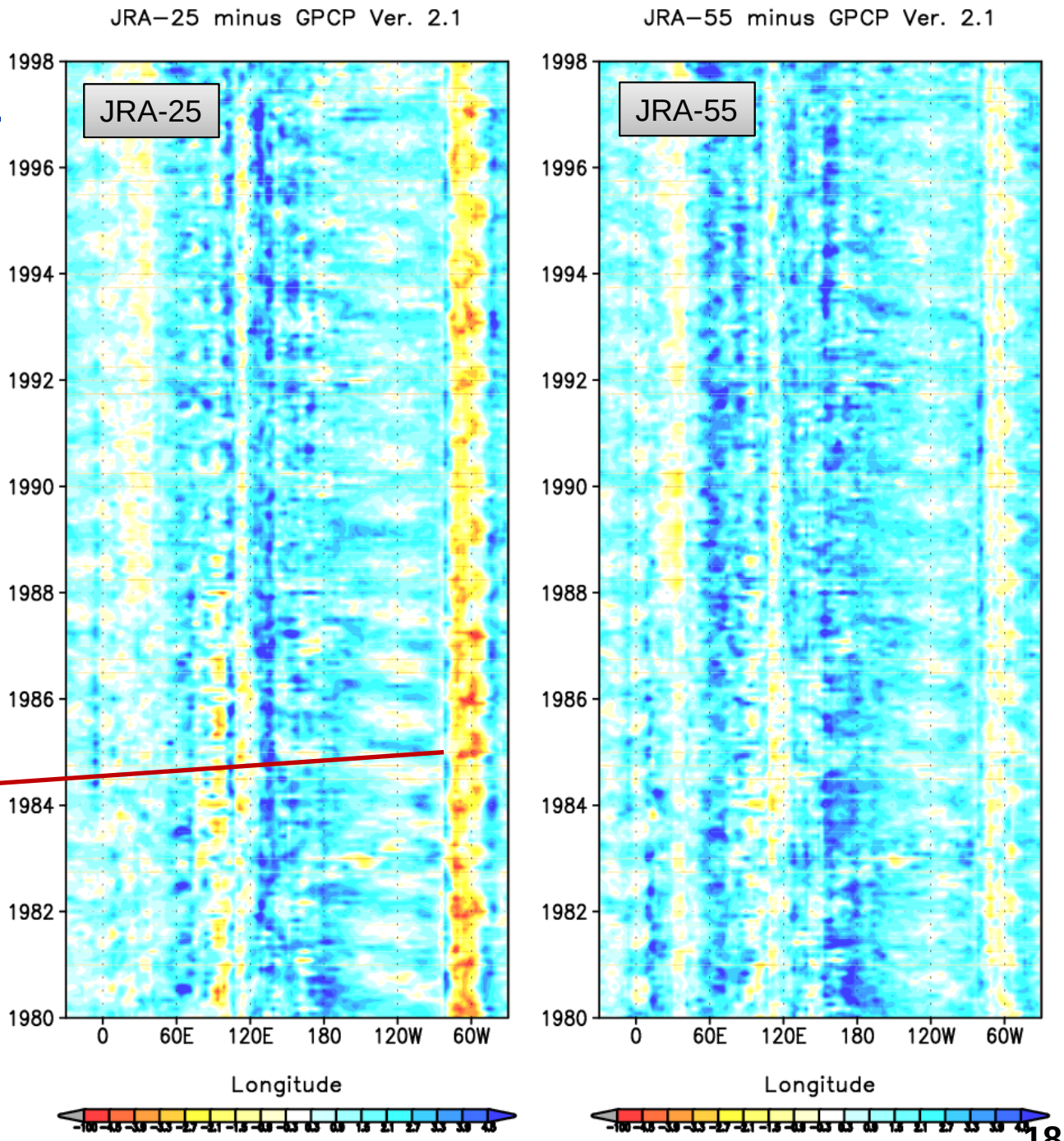


1980 1998 1980 1998

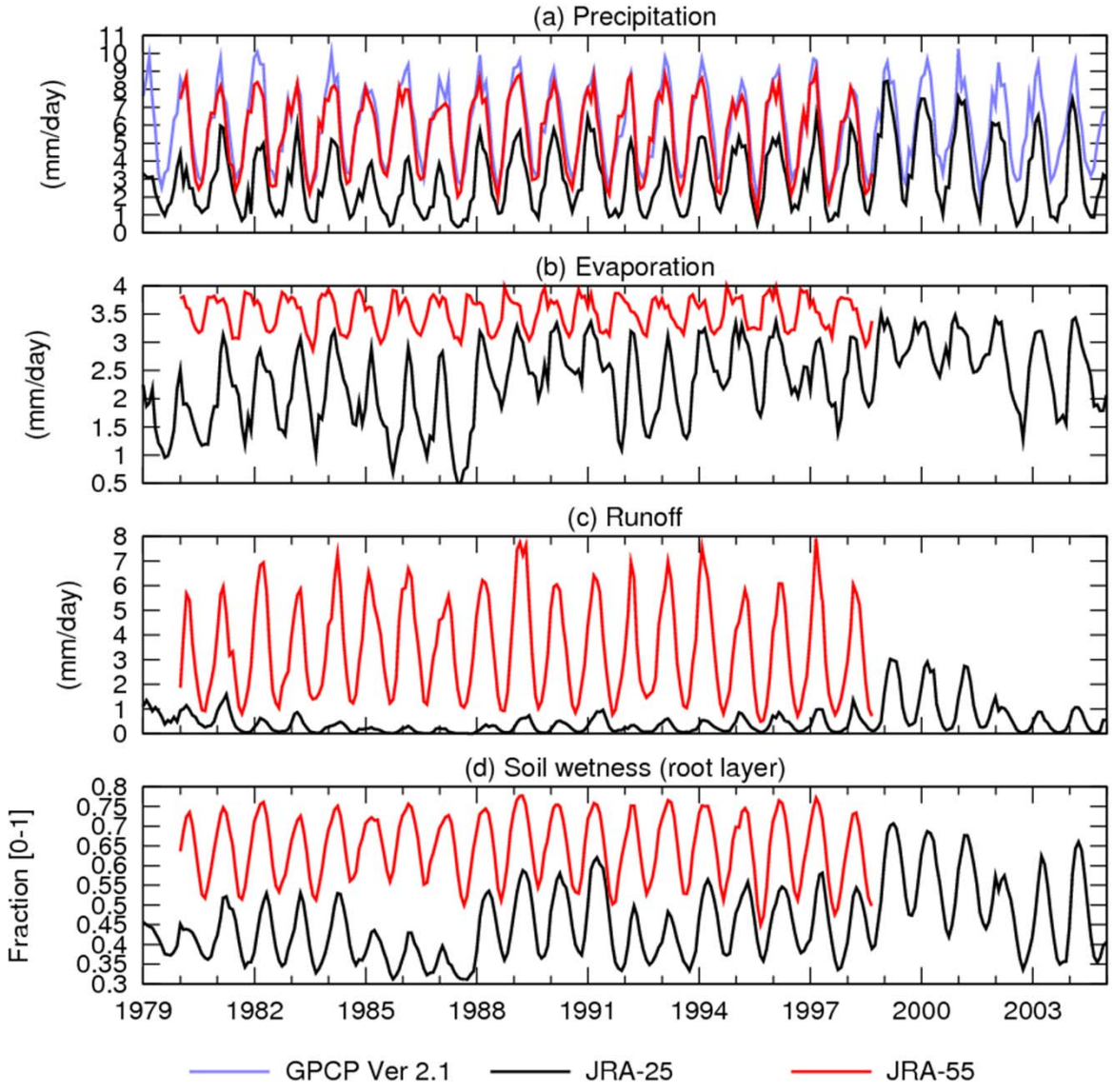
Precipitation in the tropics

JRA - GPCP

Dry
Amazon basin



Water budget in Amazon

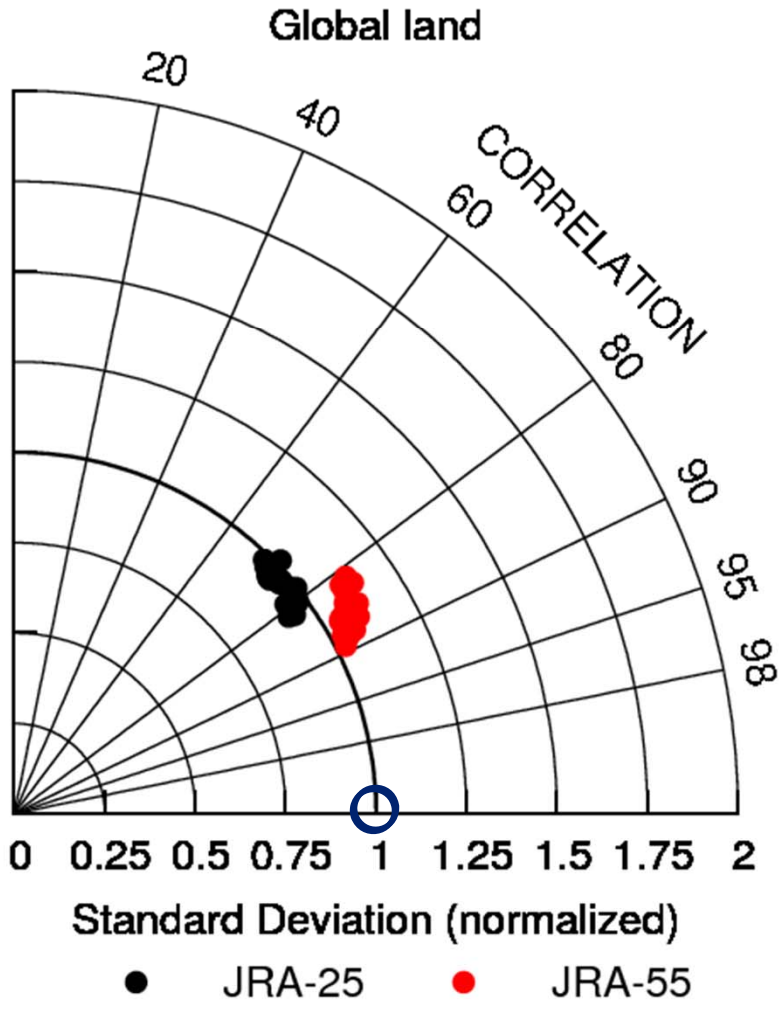


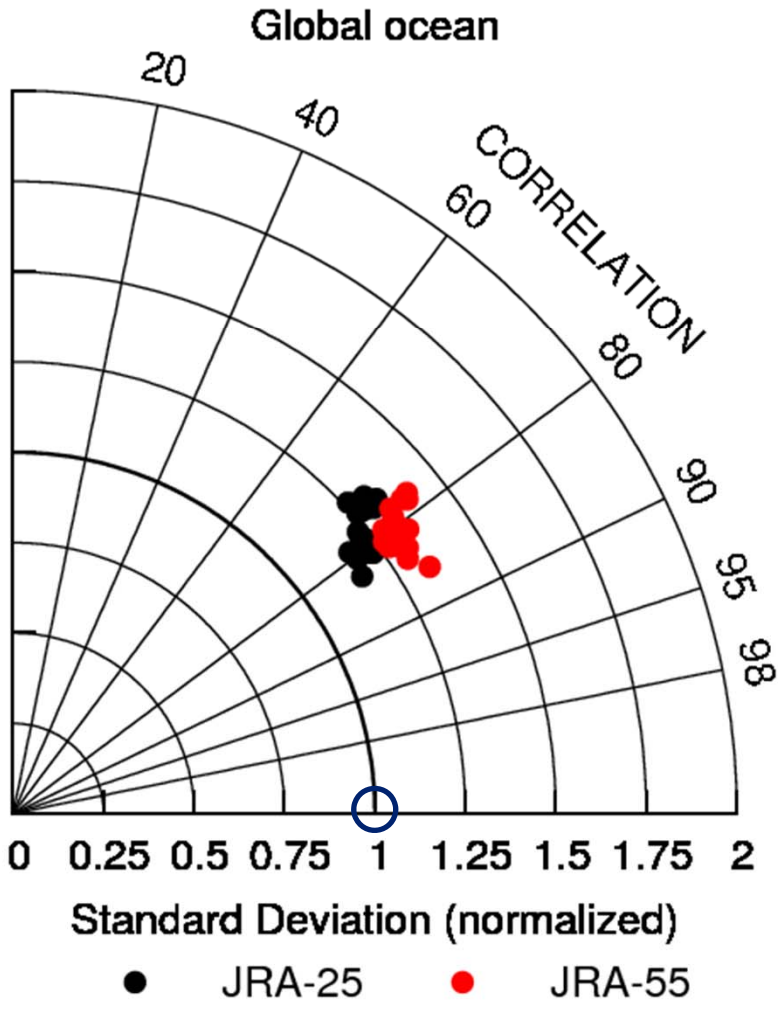
←Good agreement with GPCP

In JRA-25, *unrealistic dry bias* is found over the Amazon River basin.

Precipitation (Land and Ocean)

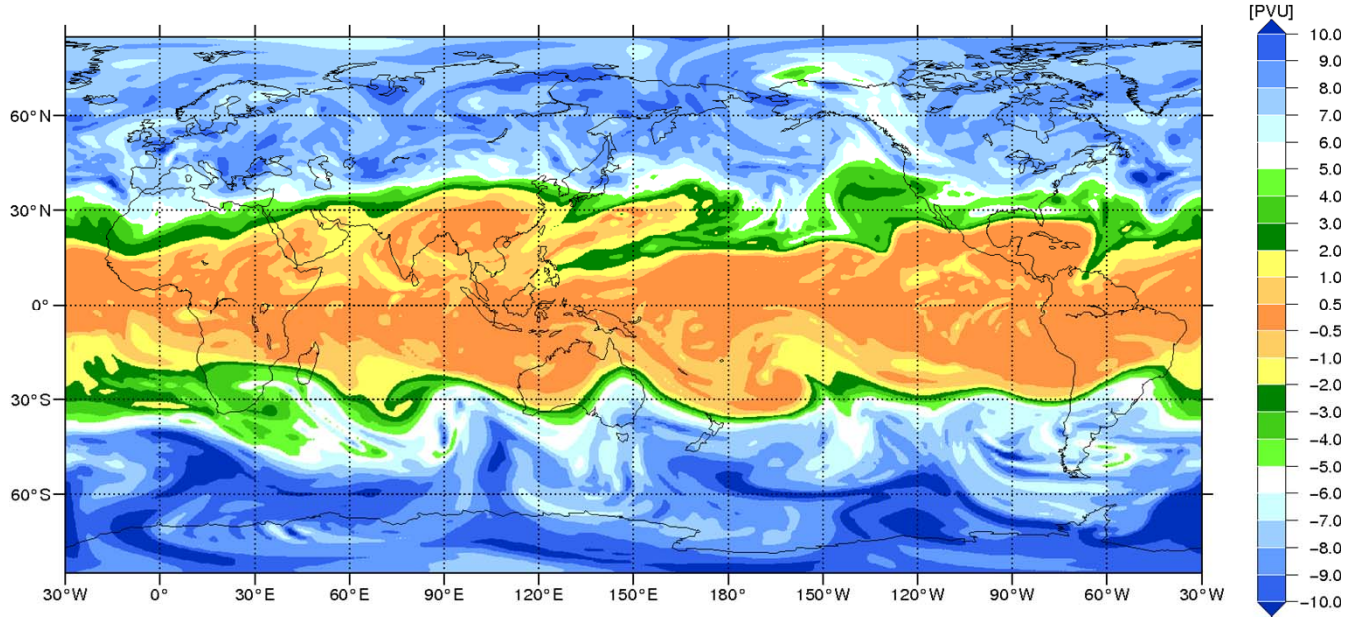
Correlation and standard deviation with GPCP.



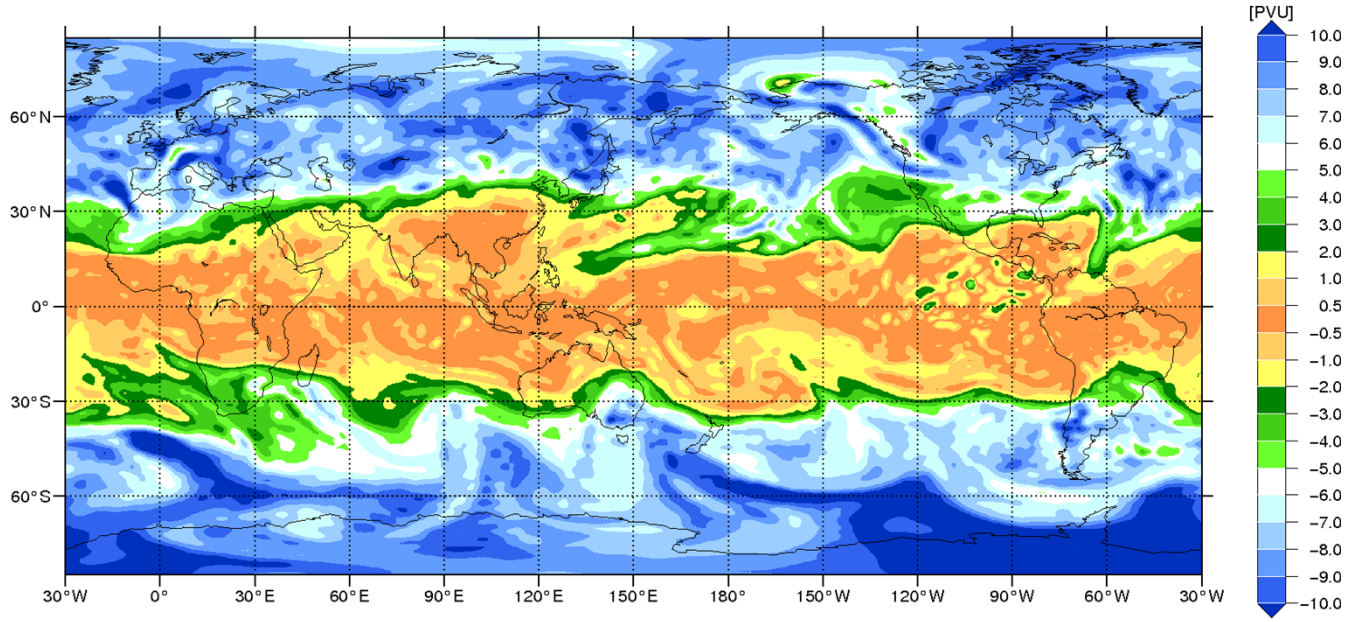


Isentropic Potential Vorticity (at 360 K)
1 June 1983 00UTC – 6 June 1983 00UTC

JRA-55
(4D-var)

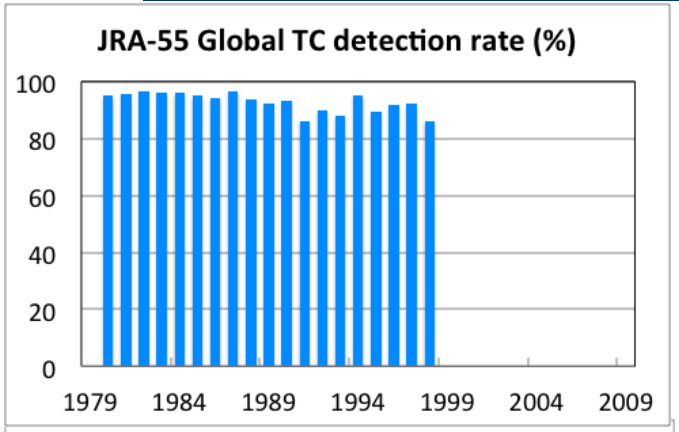


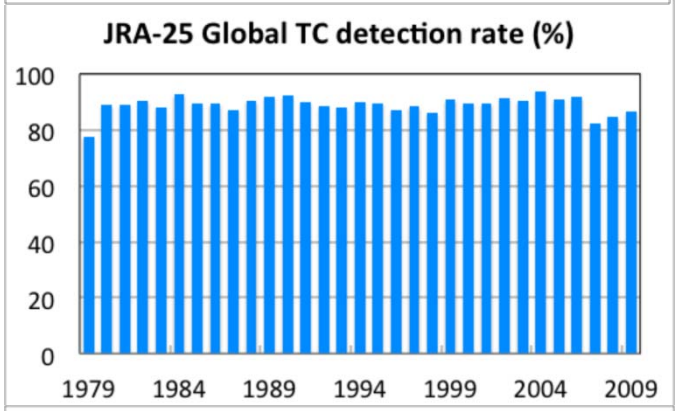
JRA-25
(3D-var)

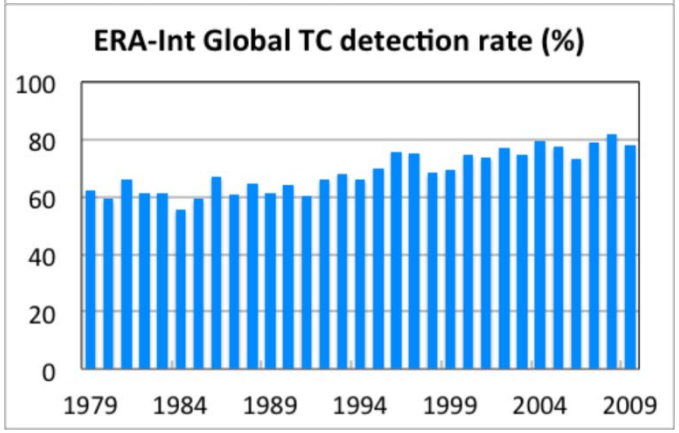


Ref.
Poster
AT-18
(Ms. Y.
Harada)

Tropical Cyclone



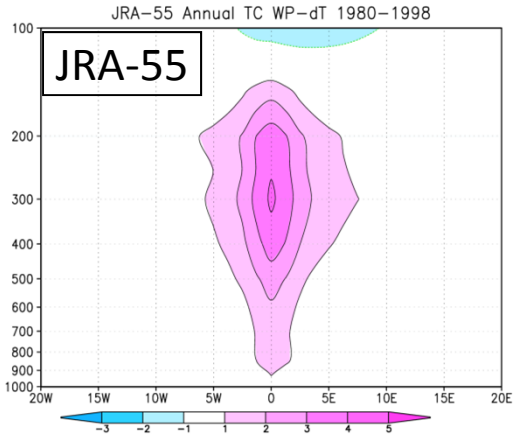


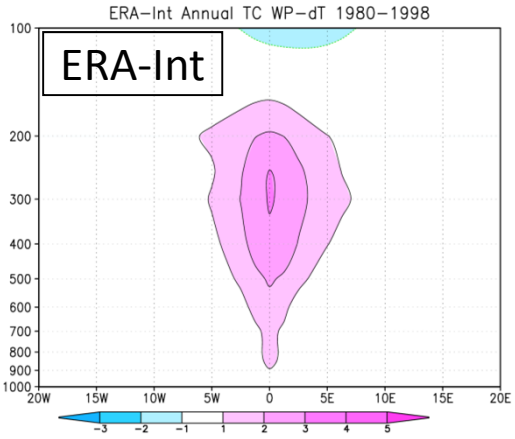


Annual global TC detection rate (%) for 1980-1998

(%)	WP	EP	AT	NI	SI	SP	GL
JRA-55	93	92	90	84	94	95	93
JRA-25	88	98	98	72	82	85	89
ERA-Int	76	37	67	56	64	73	65

XZ-cross section for TC temperature anomaly in WP



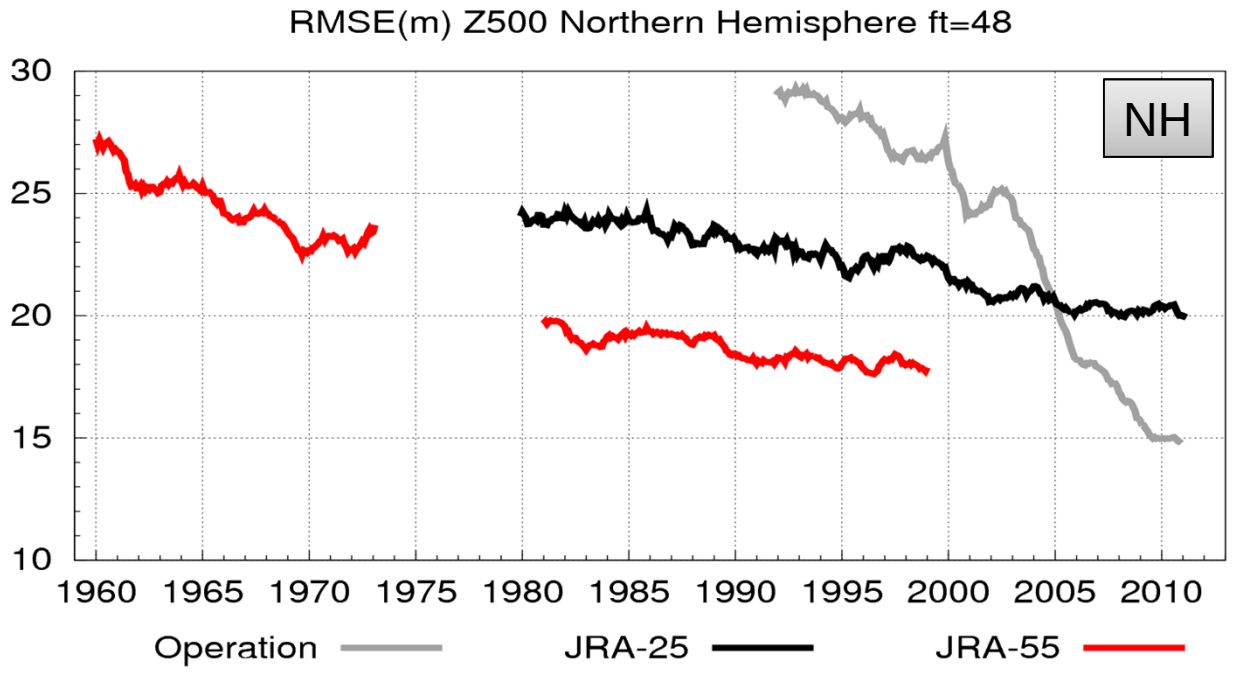


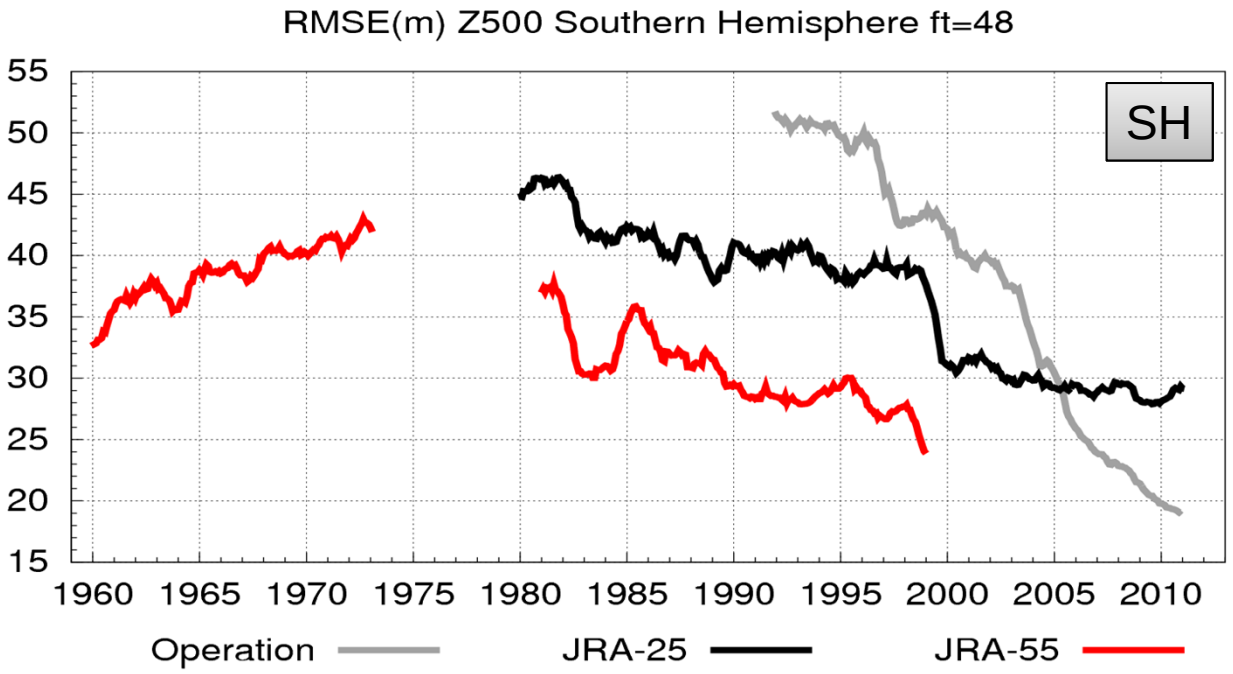
Detection criterion of this study is taken from Hatsushika et al.(2006), JMSJ

Ref. Poster AT-26 (Dr. H. Kamahori)

Forecast Scores

RMSE of Z500
(48-hour forecast)
for NH and SH





3. JRA-55 Family

JRA-55

JRA-55C

JRA-55AMIP

JRA-55 Family

JMA

Global Atmospheric Reanalysis

JRA-55

1958-2012 (55years)

Full use of satellite data

To be continued as new JCDAS in real time basis (JRA-55 version)

MRI/JMA

In-situ data only

JRA-55C

1972-2012

With no observational data

JRA-55AMIP

1958-2012

Sub-products of JRA-55

JRA-55C and JRA-55AMIP

Purpose

- JRA-55C and JRA-55AMIP are conducted;
  - to retain consistency throughout the years.
  - to detect climate change signals among less observation system changes.
  - to be compared with JRA-55.

Usefulness

- JRA-55C
  - Influences by satellite data changes are checked.
- JRA-55AMIP
  - Basic features of the forecast model used in JRA-55 are confirmed.

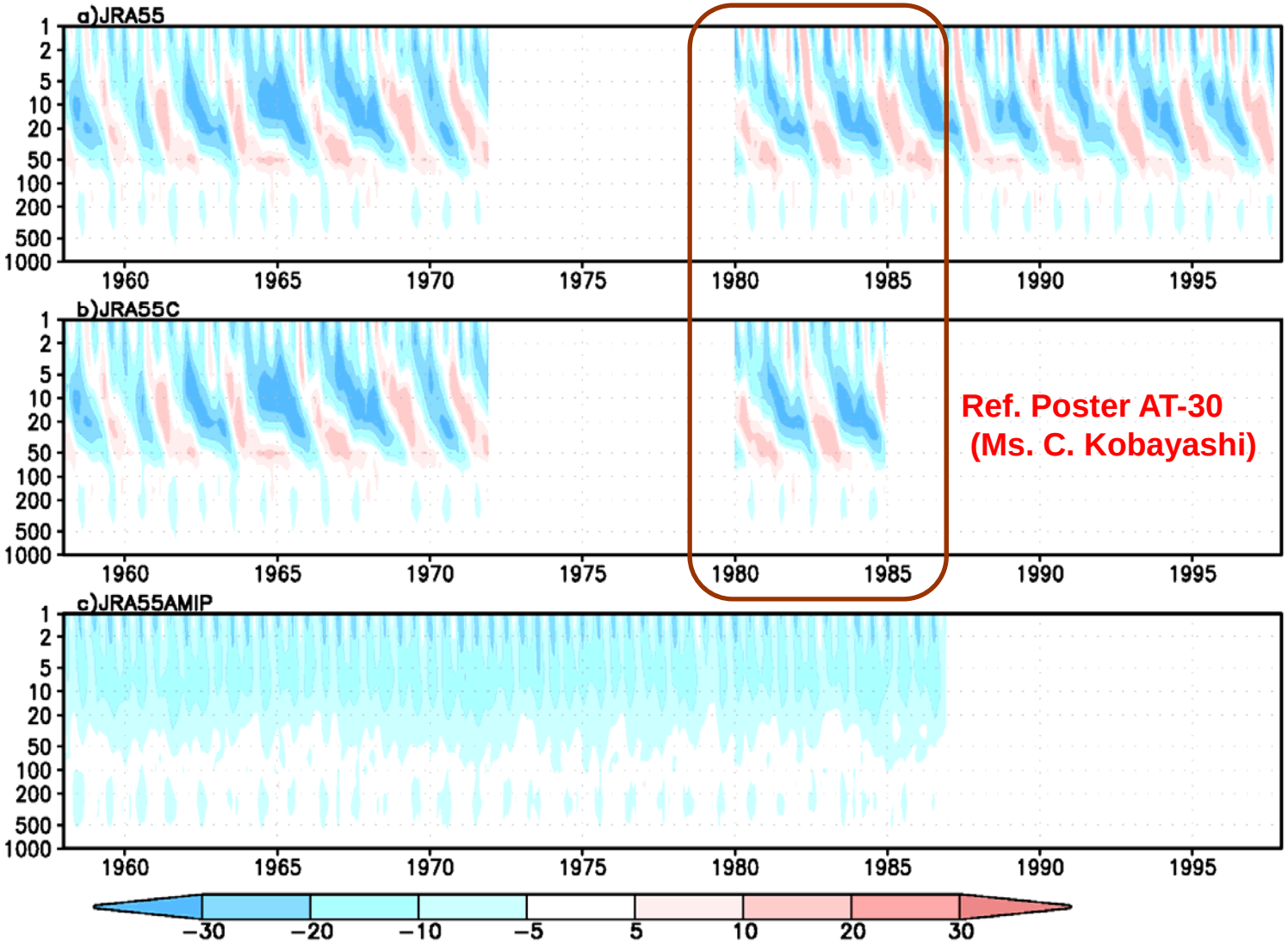
QBO in JRA-55 family

Equatorial (5S-5N) zonal mean U-wind time series from 1958-1997 [m s^{-1}]

JRA-55

JRA-55C

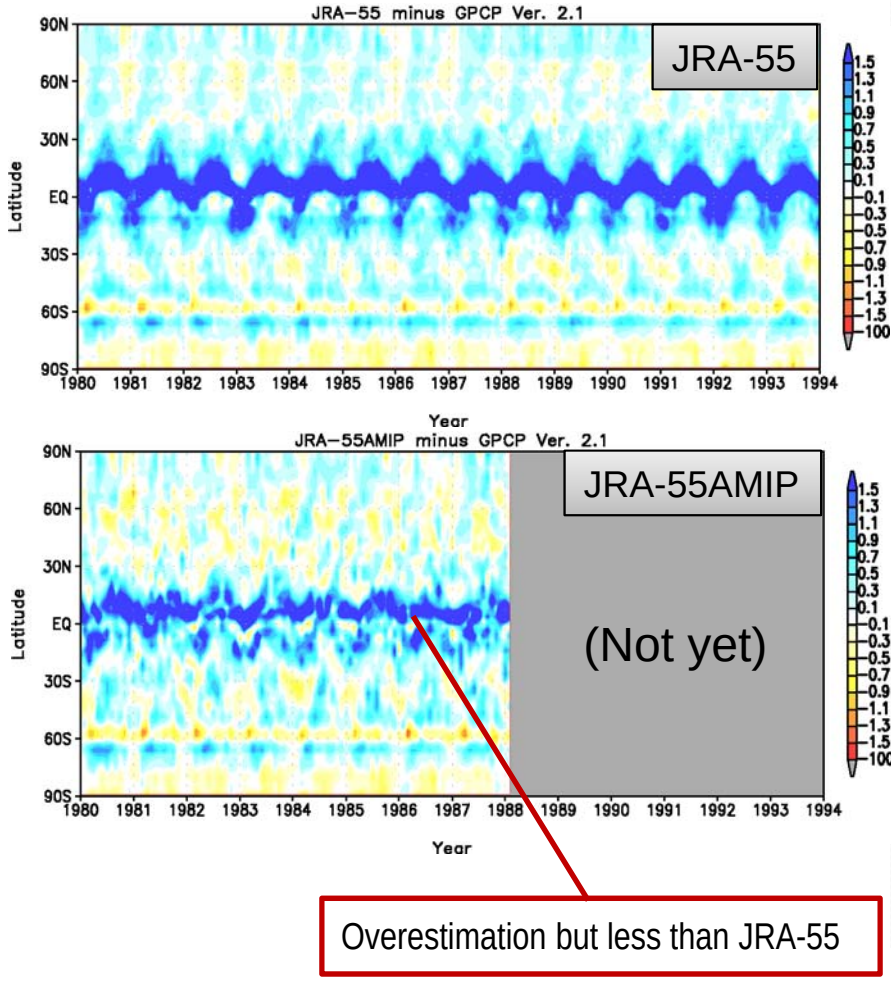
JRA-55AMIP

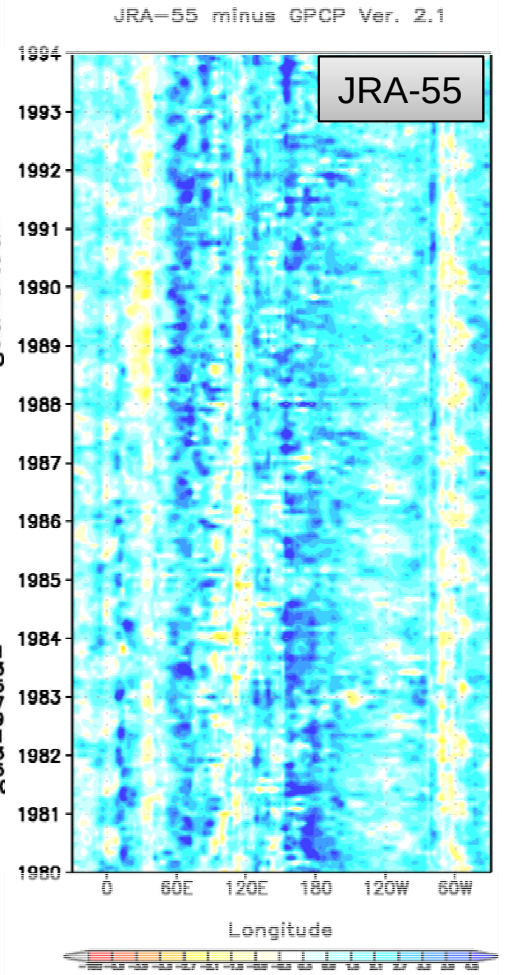


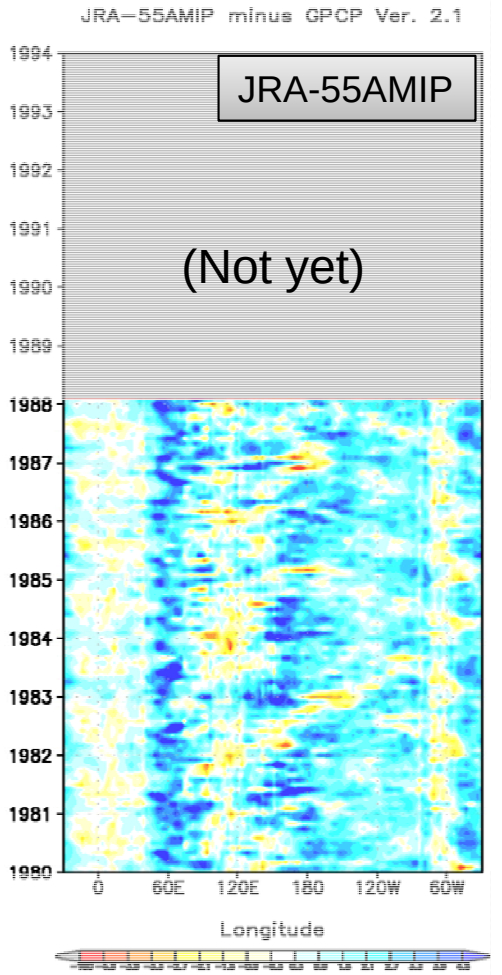
Ref. Poster AT-30 (Ms. C. Kobayashi)

Precipitation anomaly of JRA-55 and JRA-55AMIP against GPCP

Precipitation in the tropics







4. Information and Summary

JRA-55 schedule

- Spring 2013
  - JRA-55 calculation will be completed.
- Autumn 2013
  - JRA-55 products will be released for research use.
  - Basic products of JRA-55C and JRA-55AMIP will be released as well but it may be delayed.
- Spring 2014
  - JRA-55 based JCDAS will be released.
  - Note that current JRA-25 based JCDAS will be replaced.
    - JCDAS: JMA Climate Data Assimilation System

JRA future plan

- We are concentrating on JRA-55 now.
- Details of the next JRA plan has not been discussed yet.
- Basic strategy of the JMA reanalysis will be introduced in the panel discussion on Friday.

JRA-55 reference

- Ebita et al. 2011
  - **Ayataka Ebita**, Shinya Kobayashi, Yukinari Ota, Masami Moriya, Ryoji Kumabe, Kazutoshi Onogi, Yayoi Harada, Soichiro Yasui, Kengo Miyaoka, Kiyotoshi Takahashi, Hirotaka Kamahori, Chiaki Kobayashi, Hirokazu Endo, Motomu Soma, Yoshinori Oikawa and Takahisa Ishimizu;
  - “The Japanese 55-year Reanalysis “JRA-55”: An Interim Report”, **SOLA,** Vol. 7, pp.149-152 (2011) .
  - https://www.jstage.jst.go.jp/article/sola/7/0/7_0_149/_article

JRA-55 related presentations

- Mr. Shinya KOBAYASHI (JMA Hq.)
  (**Oral on Thursday**: Remote Sensed Observation)
  - Use of the reprocessed GMS/MTSAT data in JRA-55
- Ms. Yayoi HARADA (JMA Hq.) (Poster AT-18)
  - Verification of the Japanese 55-year Reanalysis "JRA-55" quality focused on the various time scale variability of the stratospheric temperature and the atmospheric flow on the isentropic surface in the troposphere
- Dr. Hirotaka KAMAHORI (MRI/JMA) (Poster AT-26)
  - Tropical Cyclones Represented in JRA-55
- Ms. Chiaki KOBAYASHI (MRI/JMA) (Poster AT-30)
  - Introduction and Early Results of JRA-55C: Subset of JRA-55

Other Presentations from JMA

- Mr. Toshiyuki ISHIBASHI (MRI/JMA)
  (**Oral on Wednesday**: Data Assimilation)
  - Diagnosis of Data Assimilation Systems: Observation Impact Estimation, Error Covariance Matrix Optimization, and Analysis Error Estimation
- Mr. Hirokazu ENDO (MRI/JMA) (Poster UA-13)
  - Long-term variations of circulation in East Asian summer during the past half century

Summary of JRA-55 feature

- Improvements from JRA-25
  - Significantly reduced cold bias in the lower stratosphere owing to the improved radiation process
  - Much smoother atmospheric flow
  - Improved quality of precipitation over land
  - Reduced dry bias over the Amazon basin
  - Much better forecast performance
- Deficiencies that still exist in JRA-55
  - Overestimation of precipitation in the tropics
    - We are aware of the necessity to improve the convection scheme.

Thank you for your attention