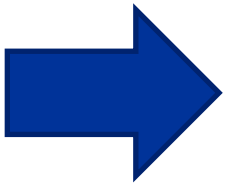

The JRA-55 Reanalysis:

quality control and reprocessing of observational data

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On behalf of JRA group

Japan Meteorological Agency

29 October 2014 EASCOF

1. Introduction

Required dataset for climate services

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

Approach for producing climate data

1. From observational data only
   - Example) GSN, GUAN managed by GCOS
   - High quality climate dataset can be generated at the observation station and surrounding region, but the regions and variables are limited.
2. **Numerical data assimilation using observational data**
   - Advanced NWP model with high performance supercomputer.
   - Uniformly distributed grid point values are generated based on consistent dynamics and physics.
   - Many kind of variables are produced at every grid point.
   - Numerical data assimilation cycle is performed for several decades. → **Long-term Reanalysis**

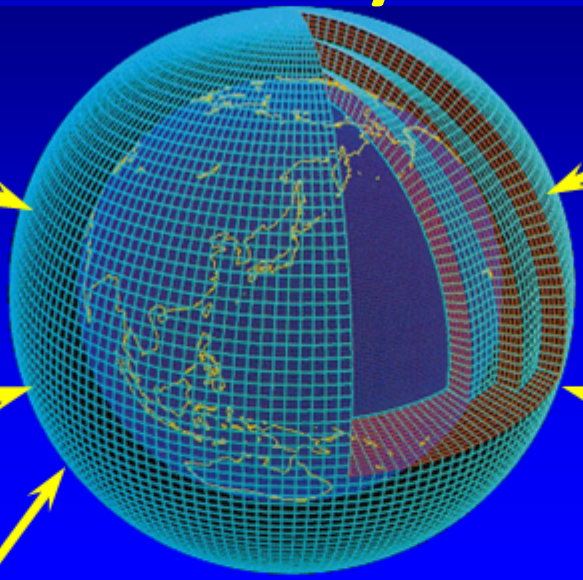
Reanalysis

Satellite

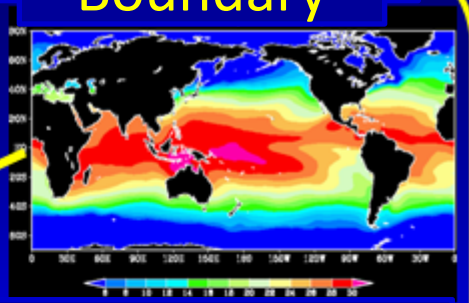
Surface, Upper

Ship, aircraft

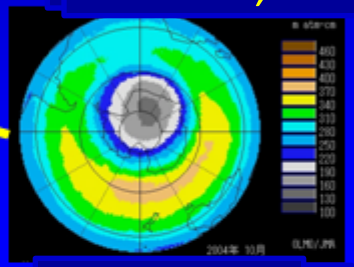
Observation



Boundary



SST, sea ice



ozone

Assimilate past observational data

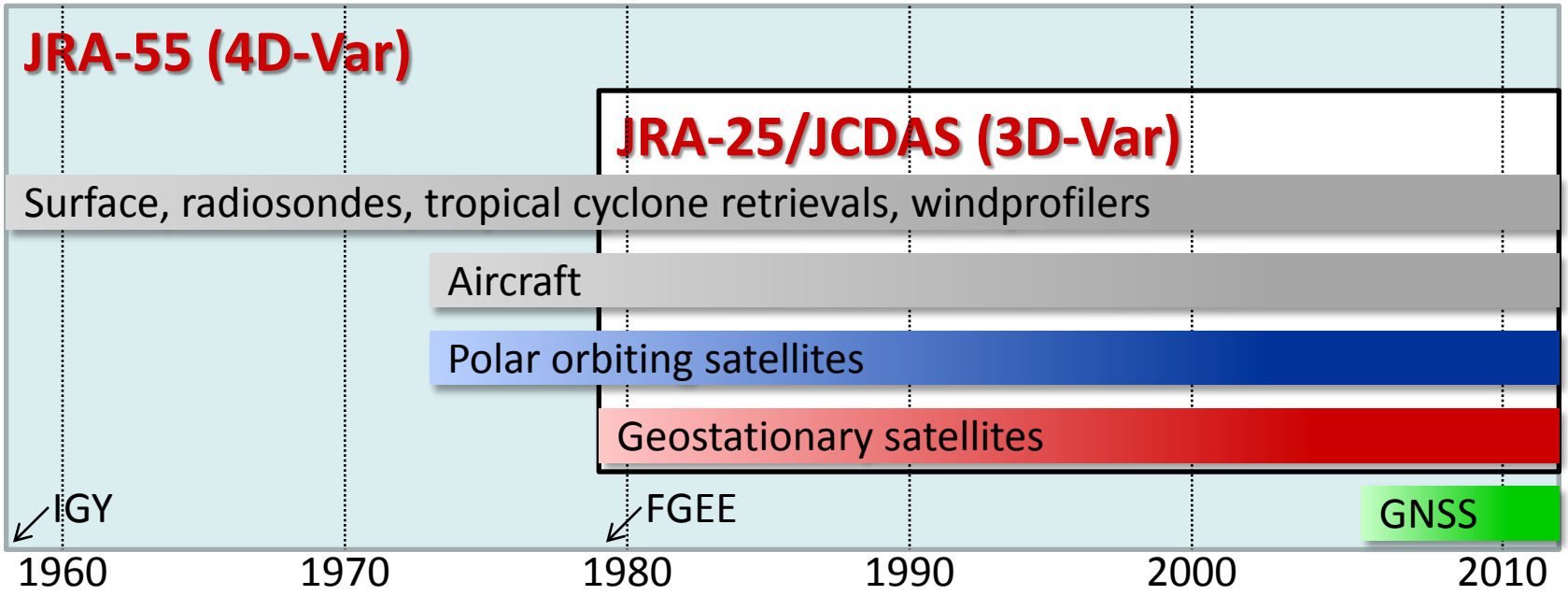
Data assimilation cycle

Consistent quality Reanalysis Product

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

Outline of JRA-55 (JRA Go! Go!)

- The second Japanese global reanalysis conducted by JMA
- The first comprehensive global atmospheric reanalysis that applies 4D-Var to the last half century
- JRA-55 is being continued operationally in real time basis.

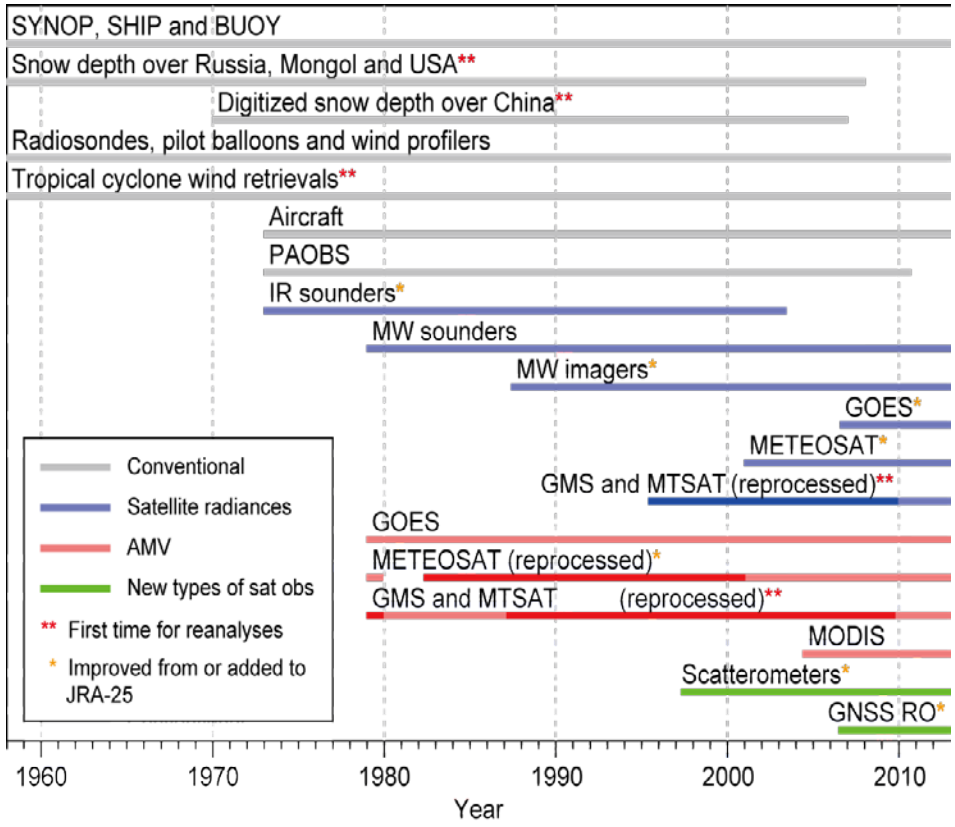


JRA-55 Reanalysis system

	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) *(top layer at 0.4 hPa)*	**TL319L60 (~55km)** ***(top layer at 0.1 hPa)***
Advection Scheme	Eulerian	**Semi-Lagrangian**
Assimilation scheme	3D-Var	**4D-Var** ***(with T106 inner model)***
Bias correction (satellite radiance)	Adaptive method (Sakamoto and Christy 2009)	**Variational Bias Correction** **(Dee and Uppala 2009)**
GHG concentrations	Constant at 375 ppmv (CO_2)	**Annual mean data are interpolated to daily data (CO_2,CH_4,N_2O)**

2. Observational data used in JRA-55

Observational data



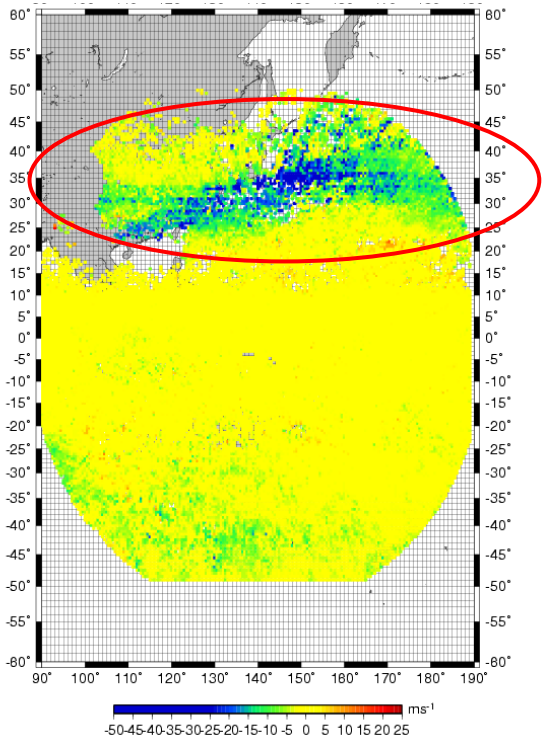
Chronology of types of observational data assimilated in JRA-55

- The major data source
  - The ERA-40 observational dataset supplied by ECMWF
- Homogenization
  - Radiosonde Observation Correction using Reanalyses (RAOBCORE) v1.4 (Haimberger et al. 2008)
- Reprocessed satellite observations
  - GMS, GOES-9 and MTSAT-1R (MSC/JMA)
    - Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring SCOPE•CM
  - METEOSAT (EUMETSAT), TMI (NASA and JAXA), AMSR-E (JAXA), QuikSCAT (NASA/PO.DAAC), AMI (ESA), GNSS/RO (UCAR)

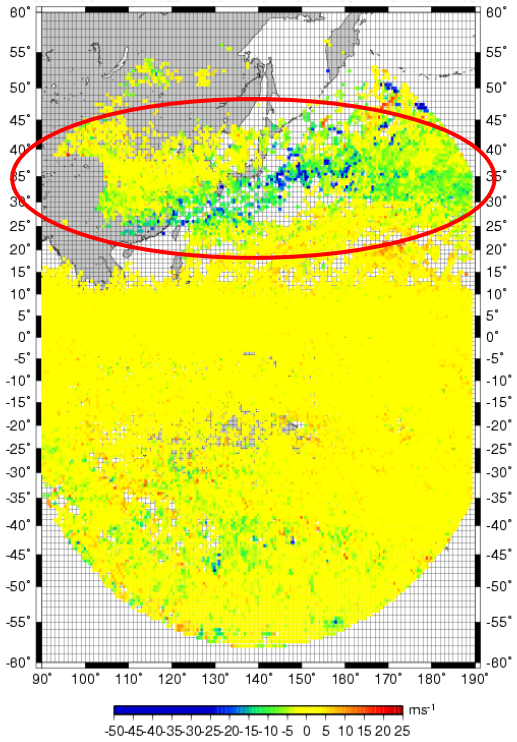
2nd reprocess by MSC for JRA-55

MSC/JMA has reprocessed AMVs from the past satellites (**GMS, GOES-9 and MTSAT-1R** between 1979 and 2009) using the latest AMV derivation algorithms. The data set of AMVs was provided for **JRA-55** and **SCOPE-CM.**

for JRA-25
(Previous reprocess)



for JRA-55
(New reprocess)



Advantages of the new reprocess for JRA-55.

- **Expansion of derivation area** (from 50S-50N to 60S-60N).
- **Mitigation of slow wind speed bias in the winter hemisphere,** owing to the improvement of height assignment scheme and resizing target box size.

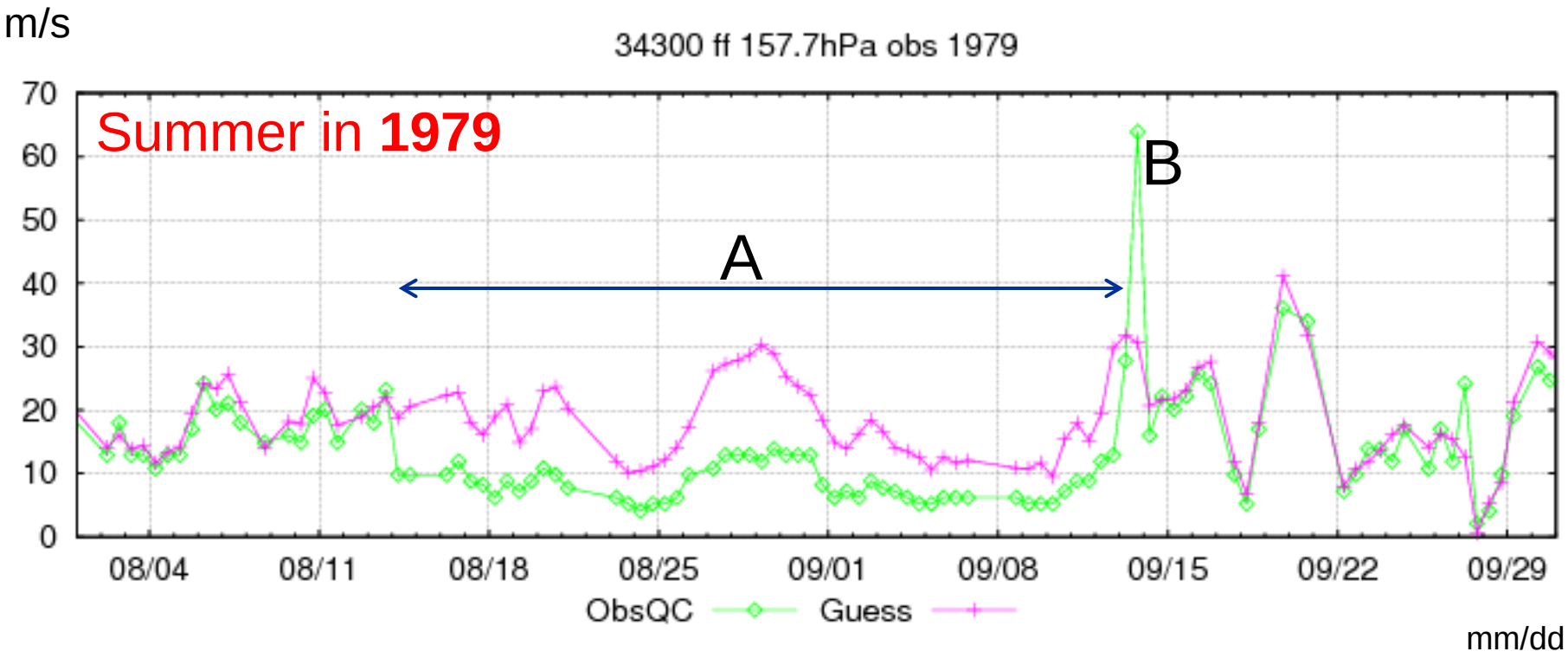
Wind speed bias (QI>0.85) of high-level IR-AMVs to JRA-25 analysis fields (Jan.1990, GMS-4)

Meteorological Satellite Center Technical Note, No. 54

Information website: http://mscweb.kishou.go.jp/product/reprocess/index.htm Oyama(2010)

Quality Control of observational data

example) wind speed observation (PILOT, 18UTC)

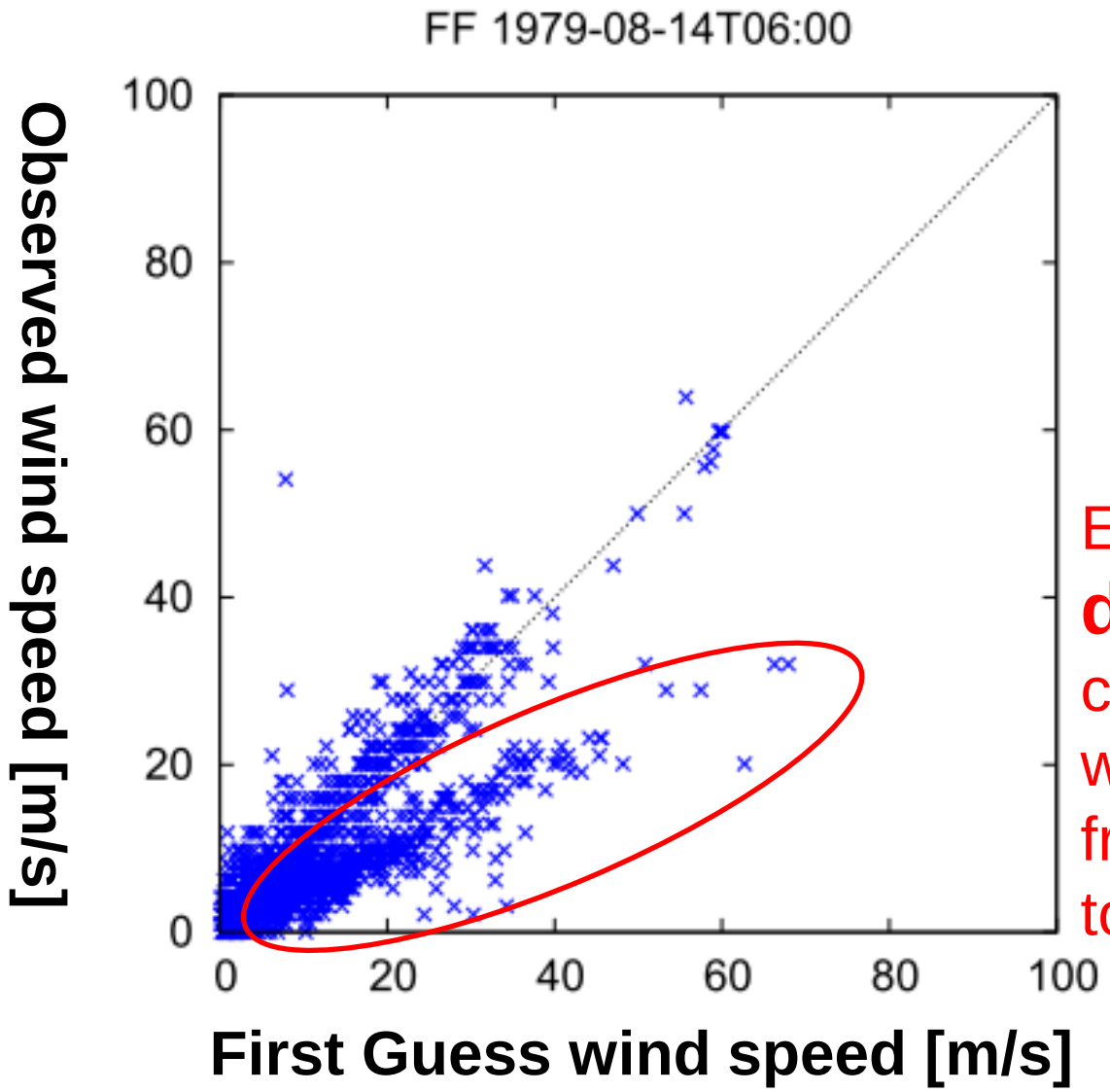


Observed

First Guess
given by
forecast model

PILOT (rawin) wind speed observations in the former Soviet Union (all levels)

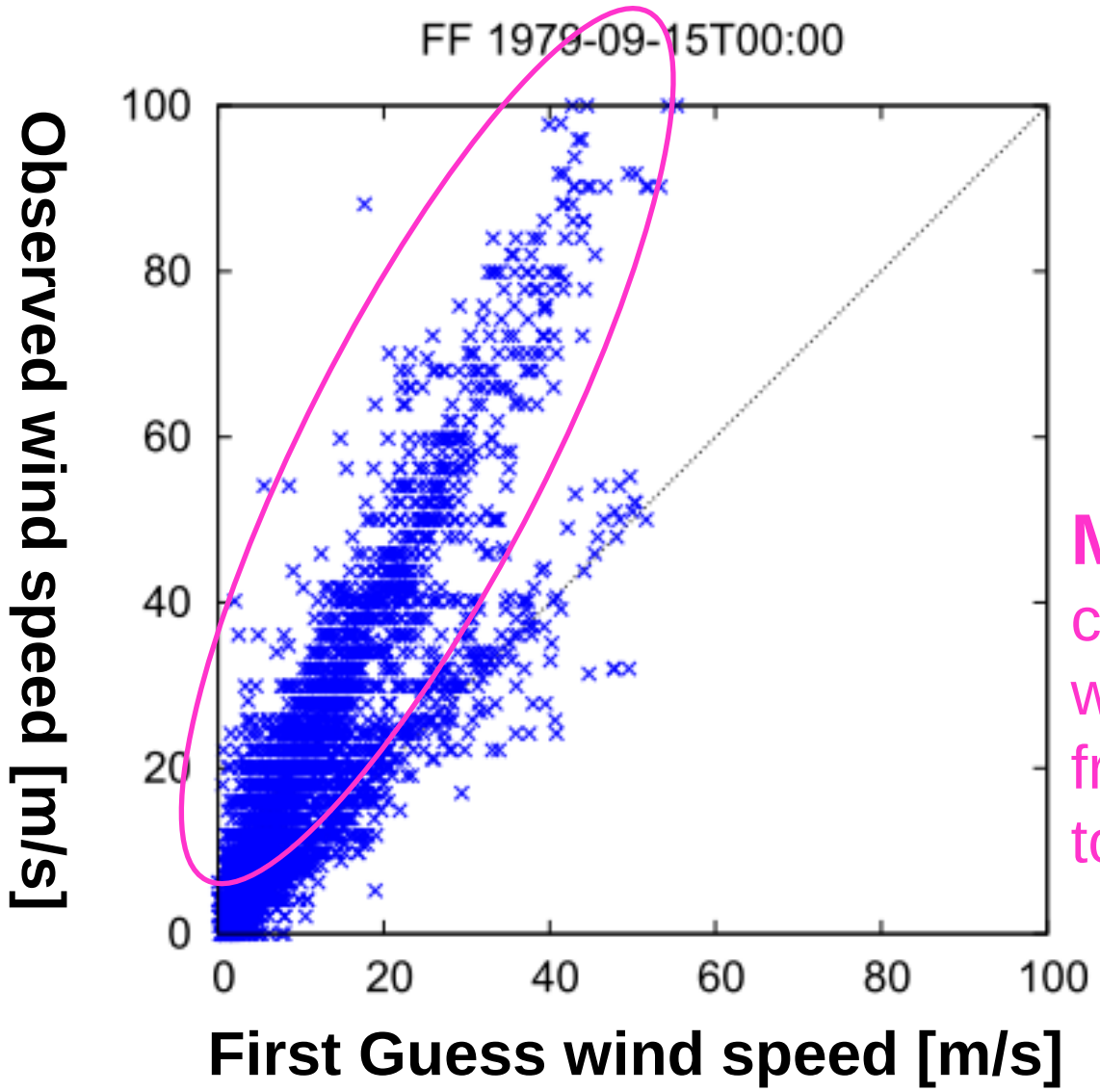
A



Erroneous **double** conversion for wind speed unit from [knot] to [m/s]

PILOT (rawin) wind speed observations in the former Soviet Union (all levels)

B



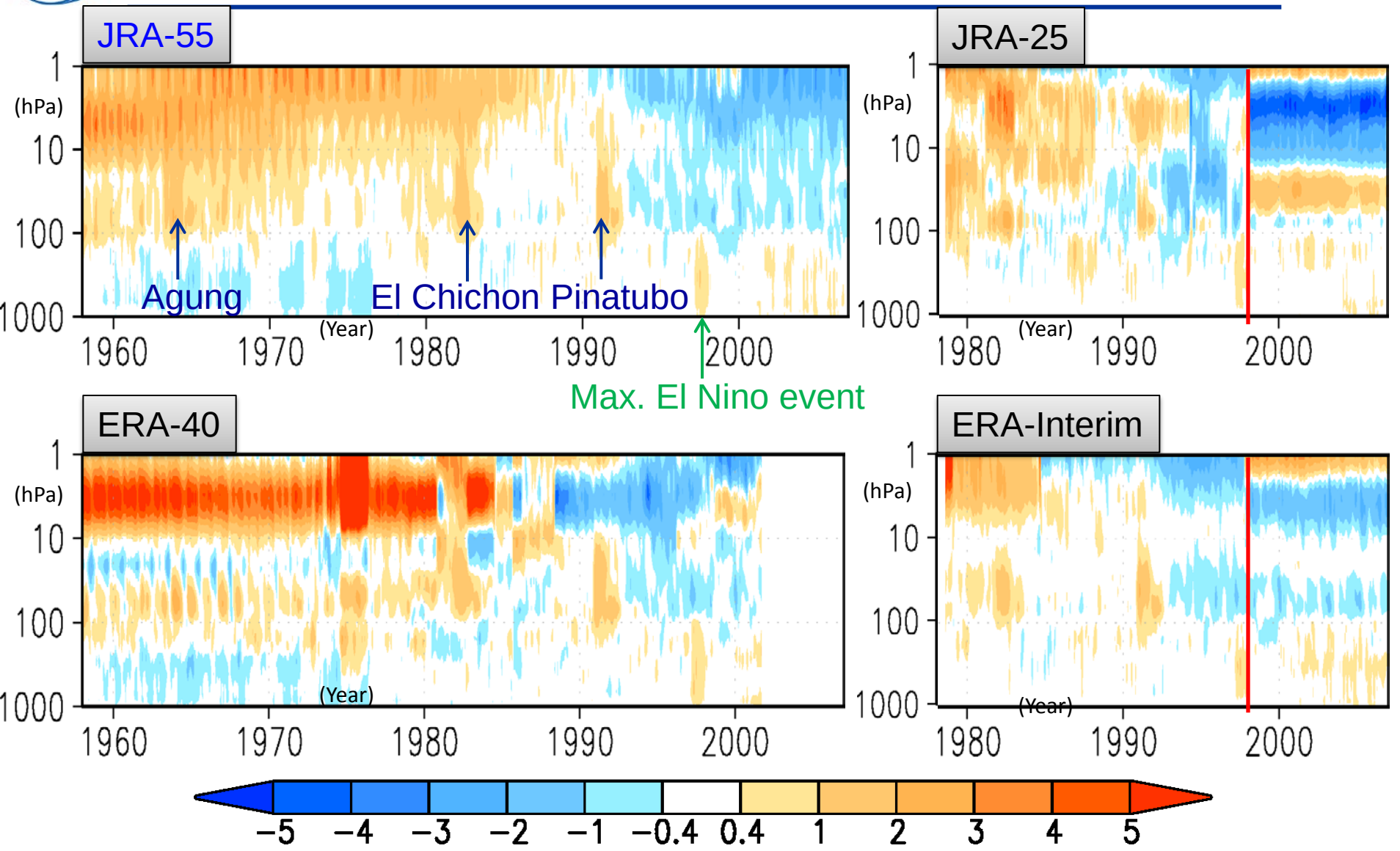
Missing
conversion for
wind speed unit
from [knot]
to [m/s]

Lessons learned

- Careful QC (quality control) for historical observations is essential.
- Time series monitoring of observed value with background field is quite beneficial to find and detect erroneous observations.

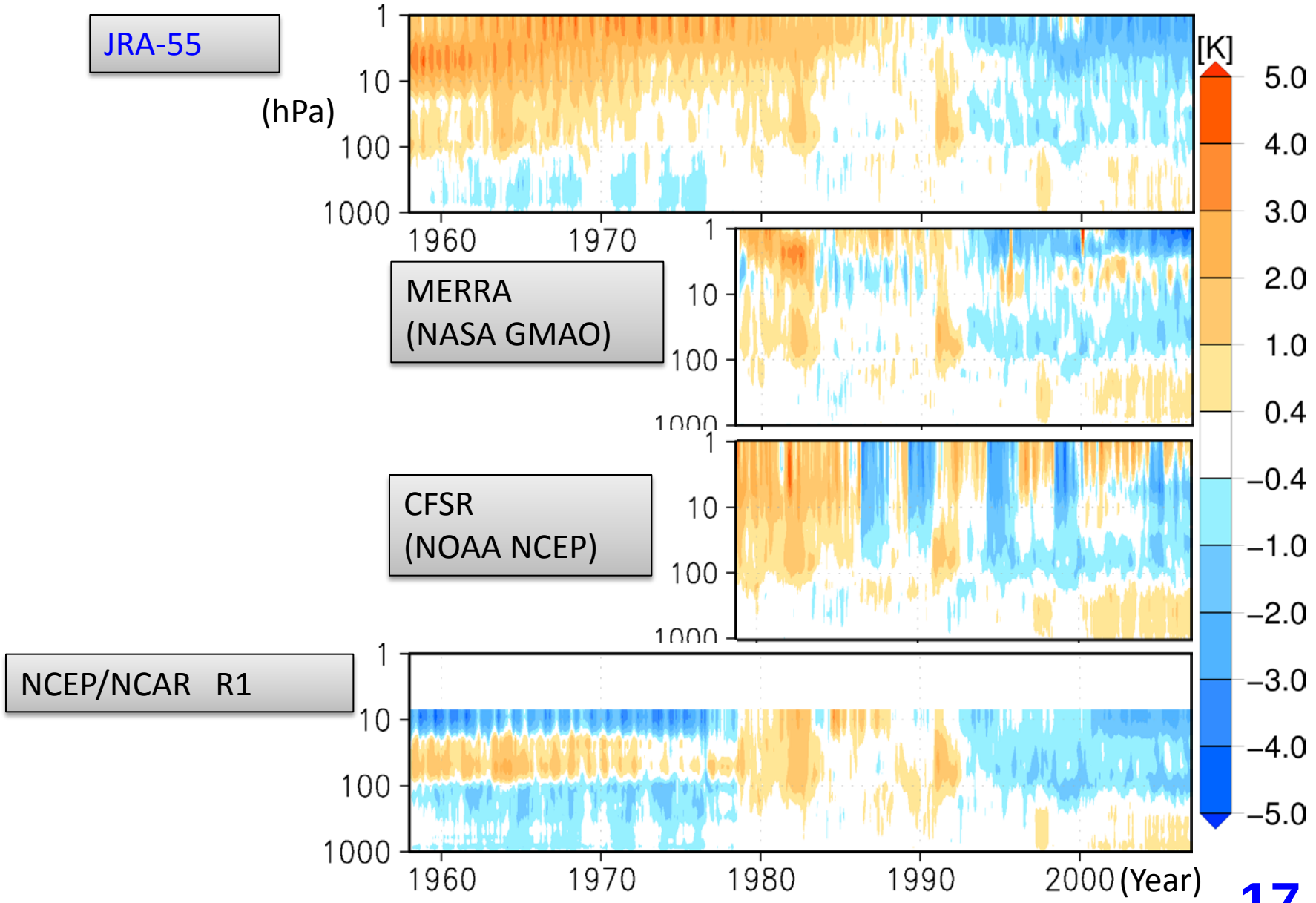
3. JRA-55 performance

Time-Height cross sections of global mean Temperature [K] anomalies in the JRA and ERA reanalyses



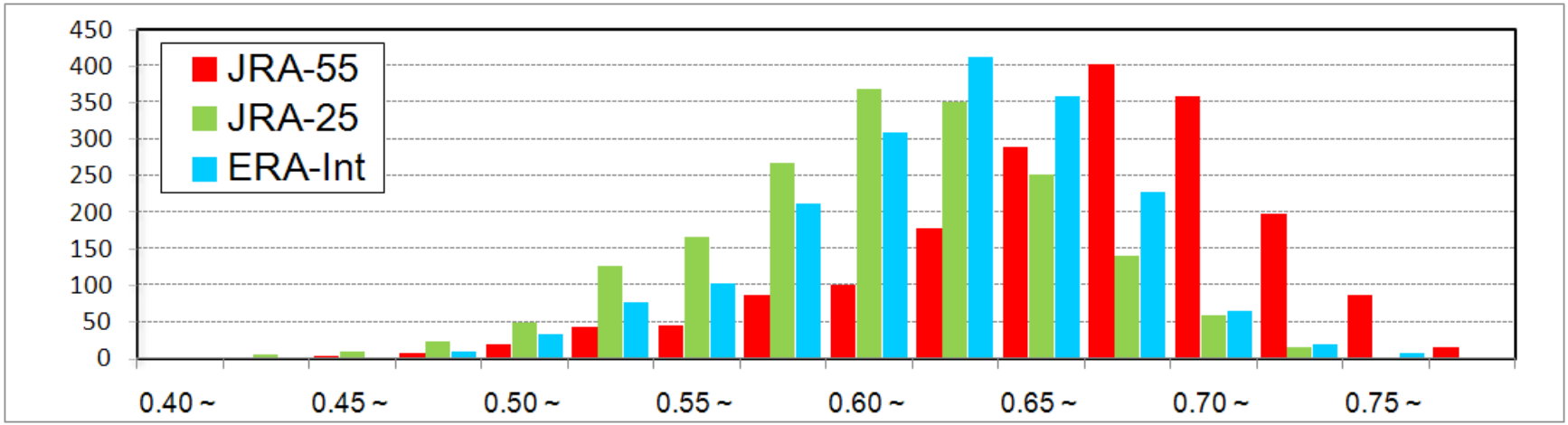
Anomalies from the mean temperature at each pressure level for years 1980 to 2001 of each reanalysis, JRA-55, ERA-40, JRA-25 and ERA-Interim , respectively.

Time-Height cross sections of global mean Temperature [K] anomalies in the US reanalyses



Frequency of daily precipitation correlation against TRMM

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.

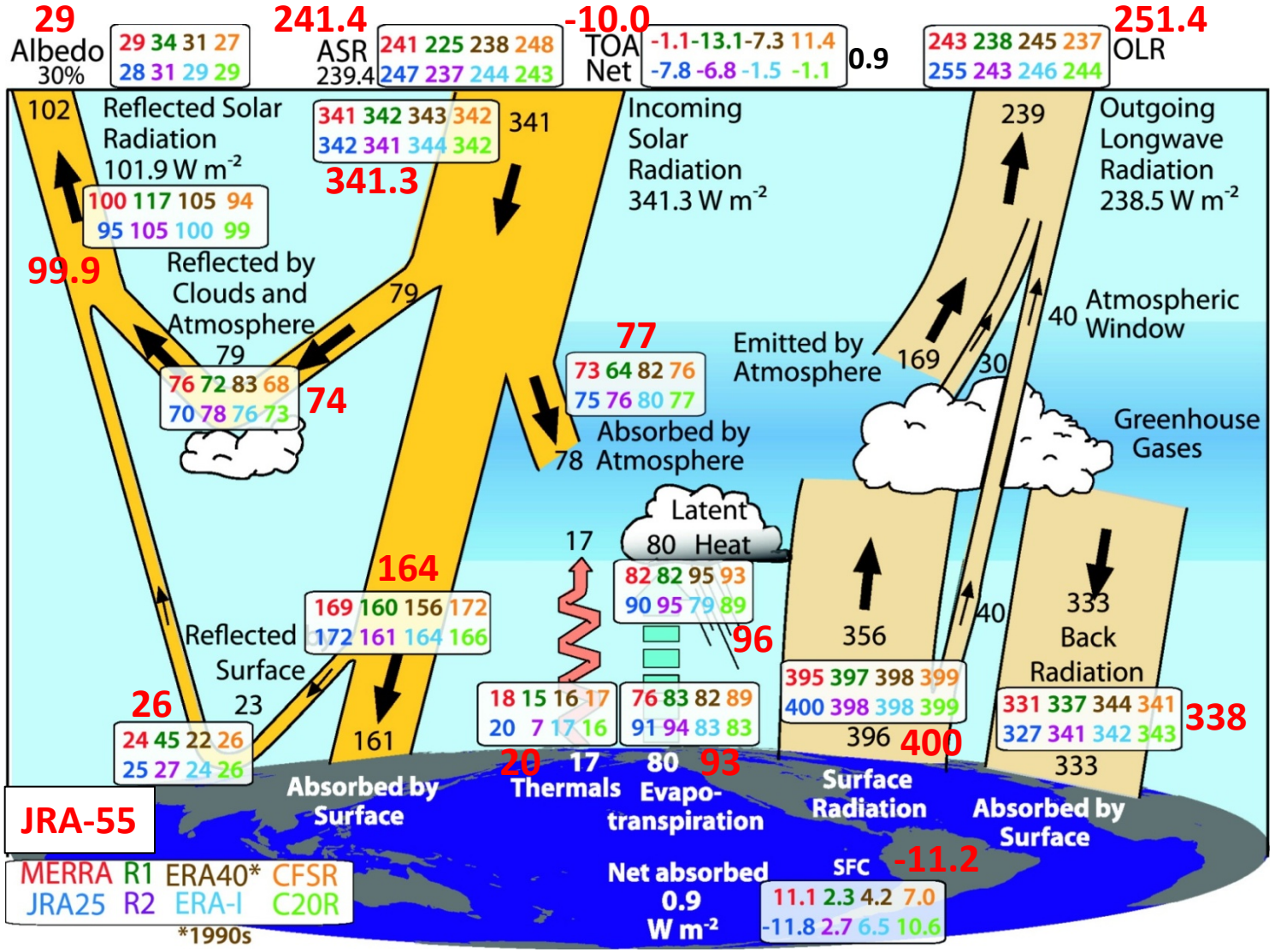
Global Energy Budget

Global annual mean energy balance at the TOA values (upper table) and at the surface values (lower table) from JRA-25 and JRA-55 are for the period 2002–2008, whereas those from Wild et al. (2013) represent present-day climate conditions at the beginning of the 21st century with their uncertainty ranges in parentheses.

TOA ($W\ m^{-2}$)	Wild et al. (2013)	JRA-25	JRA-55
Incoming solar	340 (340, 341)	341	341
Solar reflected	100 (96, 100)	95	100
Thermal outgoing	239 (236, 242)	255	251
Residual (downward)		–7.9	-10.0

Surface ($W\ m^{-2}$)	Wild et al. (2013)	JRA-25	JRA-55
Solar down	185 (179, 189)	197	189
Solar reflected	24 (22, 26)	25	26
Solar absorbed surface	161 (154, 166)	172	164
Solar absorbed atmosphere	79 (74, 91)	75	77
Residual (downward)	0.6 (0.2, 1.0)	–11.6	–11.2
Thermal down	342 (338, 348)	327	338
Thermal up	397 (394, 400)	399	400
Sensible heat	20 (15, 25)	20	20
Evaporation	85 (80, 90)	91	93

Annual Global Energy Balance



Statistics period:
Reanalysis: 2002~2008, Observation (B&W): 2000~2005

Trenberth et al., 2011:
J. Climate, **24**, 4907–4924

4. JRA-55 Family

JRA-55

JRA-55C

JRA-55AMIP

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

QBO reproducibility

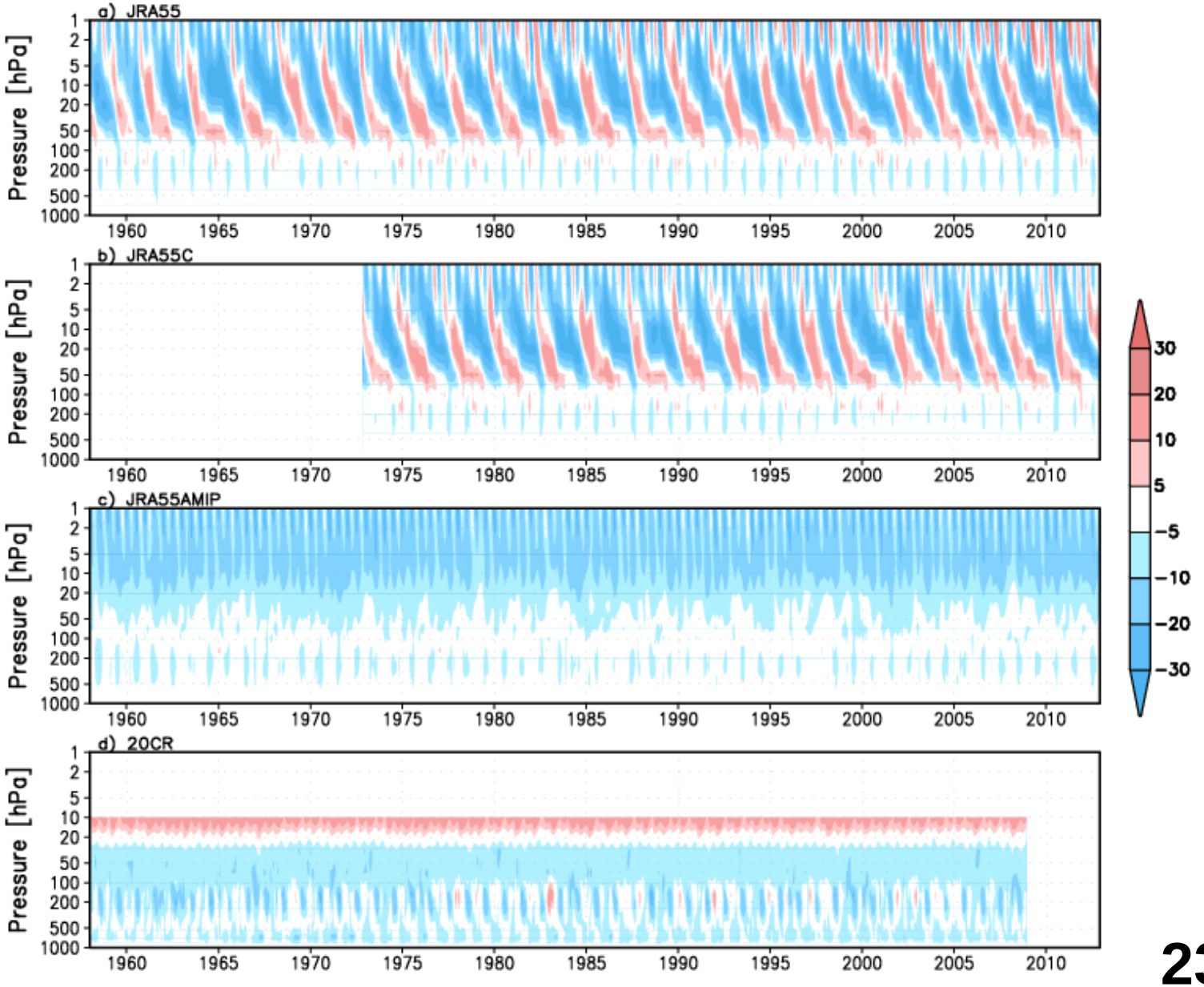
equatorial (5S-5N) zonal mean U wind component (m/s)

JRA-55

JRA-55C

JRA-55AMIP

20CR

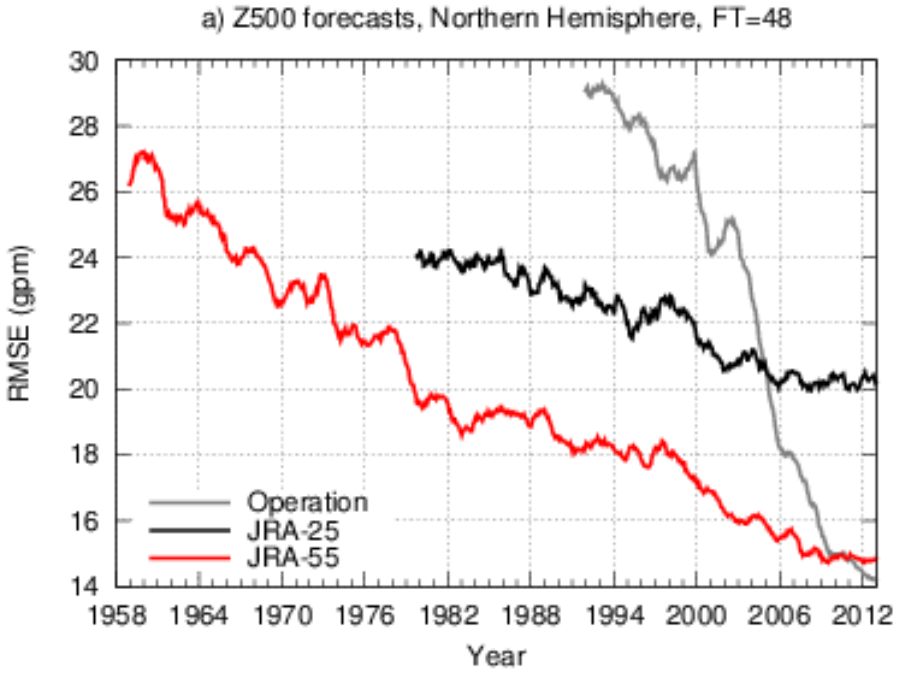


Quality of JRA

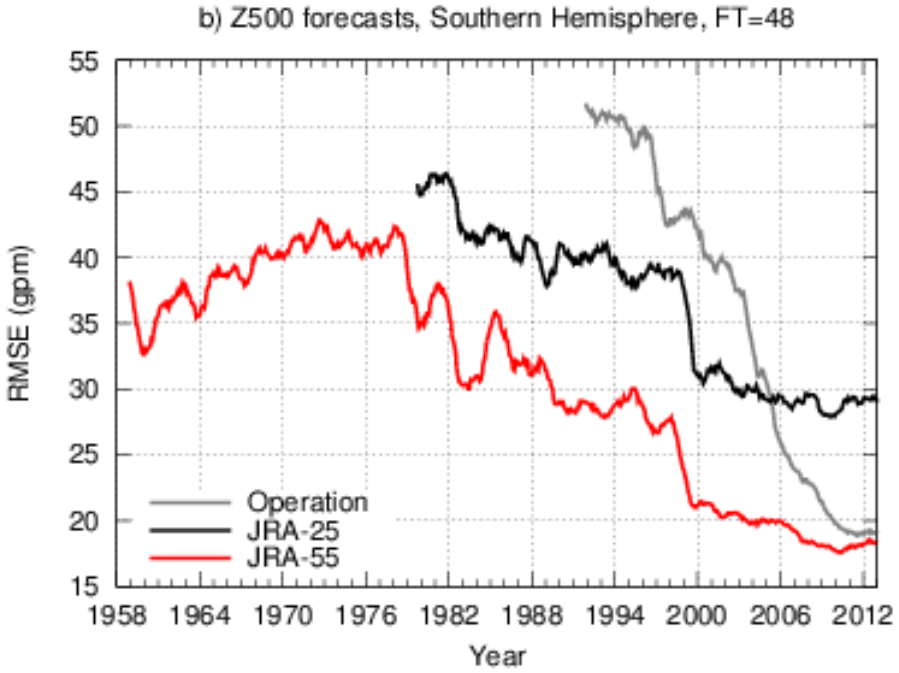
Forecast [FT=48] Scores

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

N.H.



S.H.



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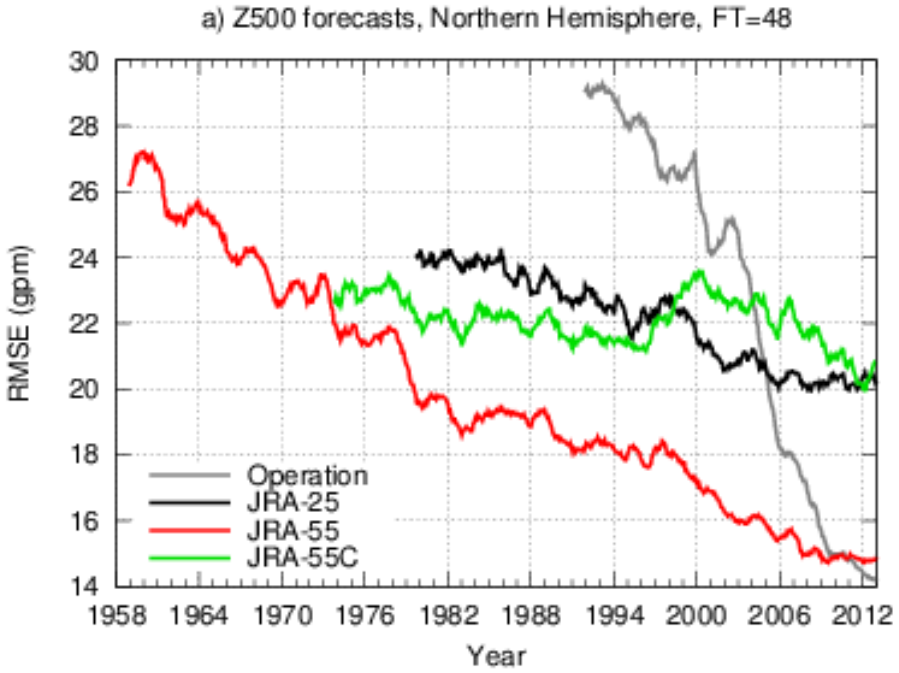
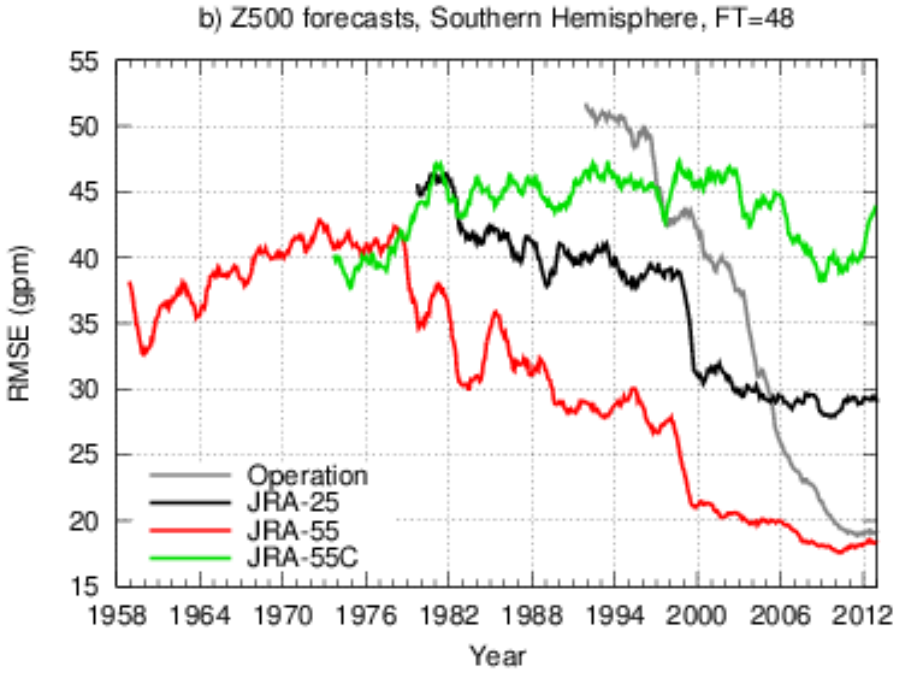


S.H.



JRA-55 data available

JMA http://jra.kishou.go.jp/

DIAS http://dias-dss.tkl.iis.u-tokyo.ac.jp/acc/storages/filelist/dataset:204

NCAR Daily 3-Hourly and 6-Hourly Data http://rda.ucar.edu/datasets/ds628.0/

Monthly Means and Variances http://rda.ucar.edu/datasets/ds628.1/

ESGF

JRA-55C and JRA-55AMIP data are in preparation.

Summary & References

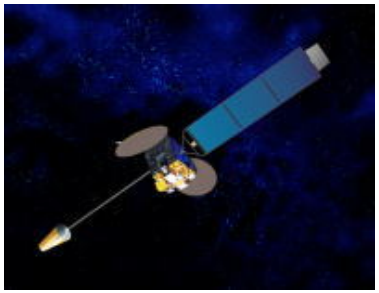
- Summary
  - Results of quality assessment have suggested that many of deficiencies in JRA-25 have been diminished or reduced in JRA-55.
  - Temporal consistency of temperature analysis of JRA-55 has the best performance with few jumps among the reanalyses.
  - Inter-comparison among the "JRA-55 family" provides an opportunity for quantitative assessment regarding representation of climatic trends and low-frequency variations.
- References
  - S. Kobayashi et al. (2015) (in press)
    - " The JRA-55 Reanalysis: General Specifications and Basic Characteristics "
    - It has been accepted on 18th Sep. but not in time for publication in 2014.
    - JMSJ, 2015, Vol.**93**, doi:10.2151/jmsj.2015-001
    - EOR http://jmsj.metsoc.or.jp/EOR/JMSJ2015-01.html
  - C. Kobayashi et al. (2014)
    - "Preliminary Results of the JRA-55C, an Atmospheric Reanalysis Assimilating Conventional Observations Only"
    - SOLA, 2014, Vol.10, 78-82, doi:10.2151/sola.2014-016
    - https://www.jstage.jst.go.jp/article/sola/10/0/10_2014-016/_article

Thank you!

Backup slides

Outline of Data Assimilation

Observation



DA System
(numerical model, quality control, etc)

Super Computer System

First Guess for analysis
for the next time

Best Estimation of the Global Atmospheric field