On the status of

Japanese 25-year Reanalysis Project

[JRA-25]

JMA

CRIEPI

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and JRA-25 Group

Japan Meteorological Agency

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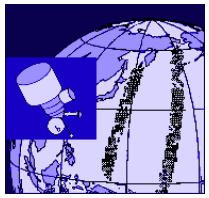
Contents

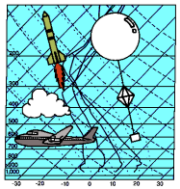
- Introduction
- Observational data and DA system
- Performance
  - Advantages and other features
  - Problems
- Product availability and plans

Japanese Reanalysis Project (JRA Project)

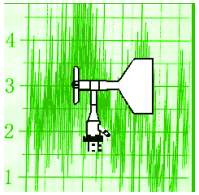
Data from Past Observation



Satellite

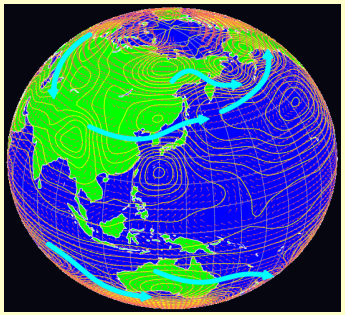


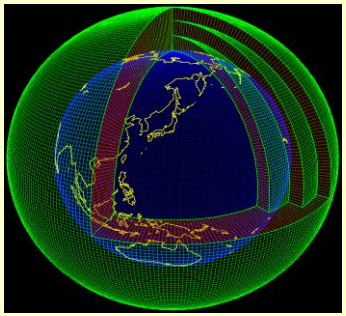
Upper Air



Surface

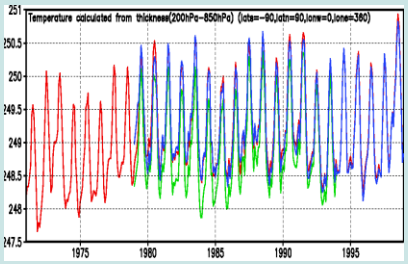
Ship



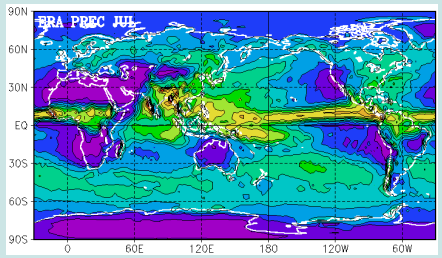


JRA-25 Project
(2001-2005)
6-hourly Climate System Datasets from 1979 to 2004 are computed based on Past Observation and the Numerical Weather Prediction Technology by JMA and CRIEPI

The Best Estimate of the State and Evolution of the Climate System



Physically Consistent Time- Series Data (No Artificial Gap)



Physically Consistent Gridded Data on the Globe (No Empty Area)

Wind, Air Temperature, Moisture, Precipitation, Evaporation, Soil Moisture, Snow Depth, Surface Fluxes, Radiation, Ground Temperature, etc.

JMA Tokyo Climate Center

Dissemination of JRA Datasets to the World

Data for Climate System Monitoring and Dynamical Seasonal Prediction

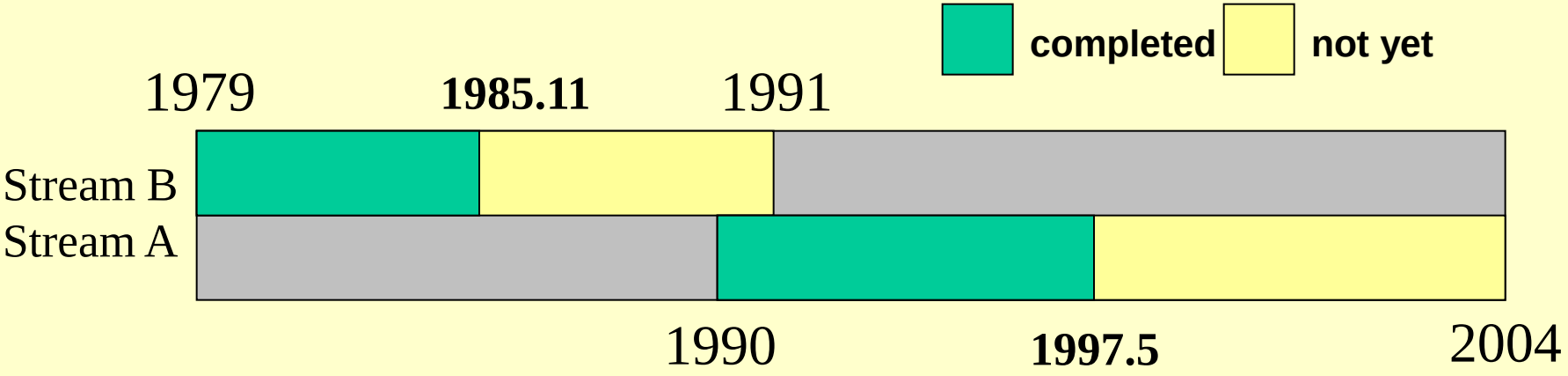
Current status of JRA-25

JRA-25 is being executed with 2 streams.

Stream B: 1979-1990

Stream A: 1990-2004

1990 will be overlapped at the end of Stream B.



53% completed

(status as of 2005.2.18)

Calculation with Fujitsu VPP5000 at CRIEPI

Observational Data(1)

- **ERA-40 observation**
  - supplied by ECMWF (- 2002.8)
  - ECMWF and NCEP merged conventional archives
- **TOVS/ATOVS level 1c**
  - from ECMWF (-2003.5) and JMA in house (2003.6-)
- **Reprocessed METEOSAT AMV**
  - 1982 - 1988, supplied by EUMETSAT : inclusive in ERA-40 observation data
    - Quality Indicator (QI) is attached.
    - Only the data with high QI are assimilated.

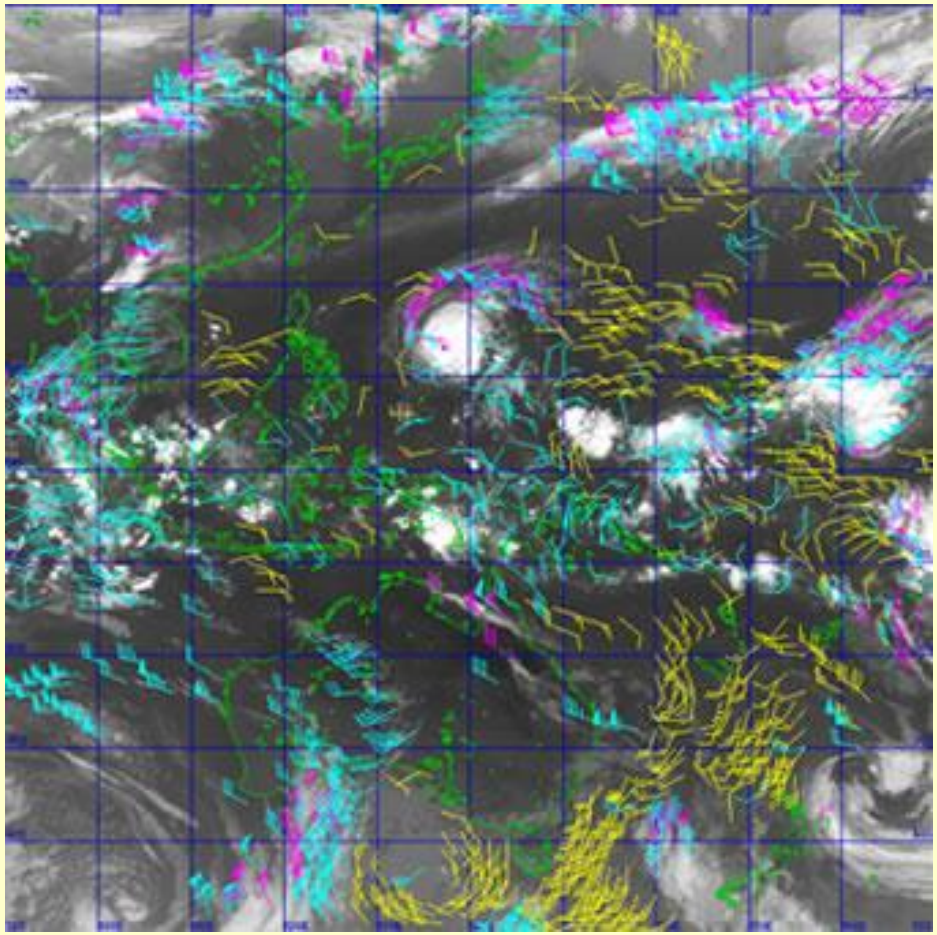
Observational Data(2)

- **Reprocessed GMS AMV**
  - 1987.3 - 2003.5, by MSC/JMA
- **Retrieved wind data around tropical cyclones**
  - supplied by Dr. Mike Fiorino (PCMDI/LLNL)
  - Firstly used in reanalysis
- **JMA archives** (conventional data only)
  - 1979 - present; used from 1984.5
  - Most of data are duplicated to ERA-40 data.
  - Less data amount in 1980s and 1970s

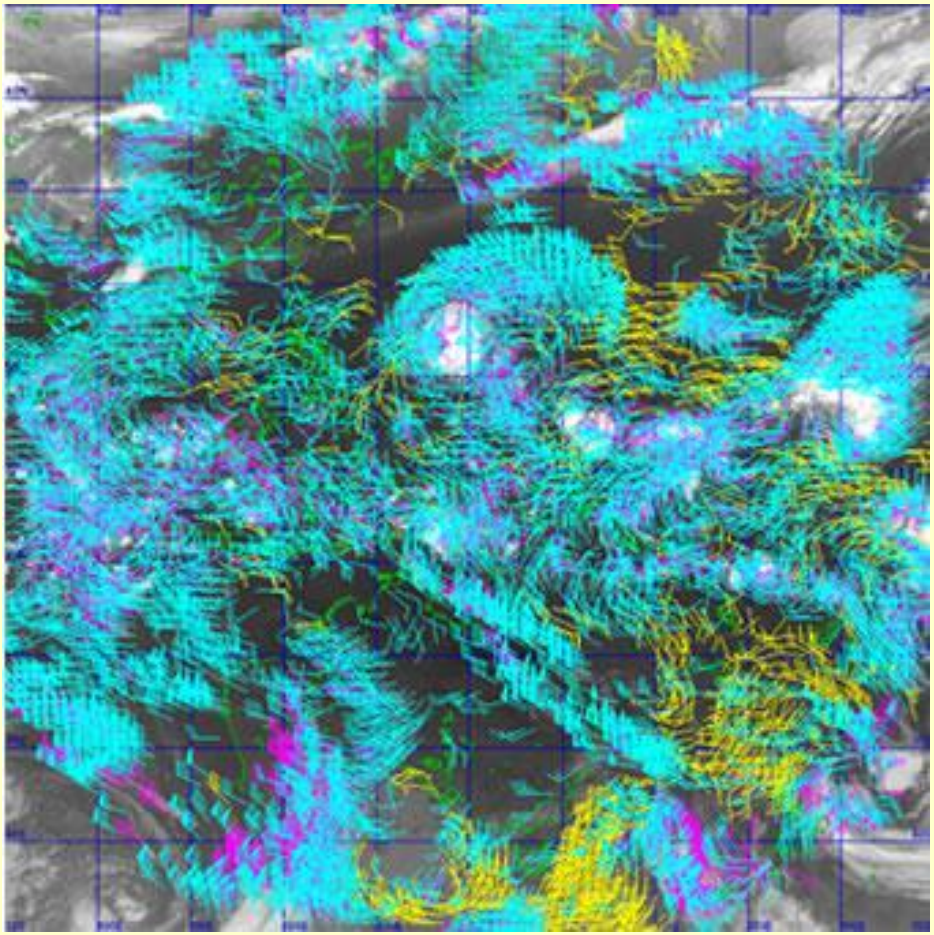
Sources Data GMS
re-processed cloud motion wind

High level
Middle Level
Low Level

Before reprocessing



After reprocessing



QI : Quality Index attached to each vector

Observational Data(3)

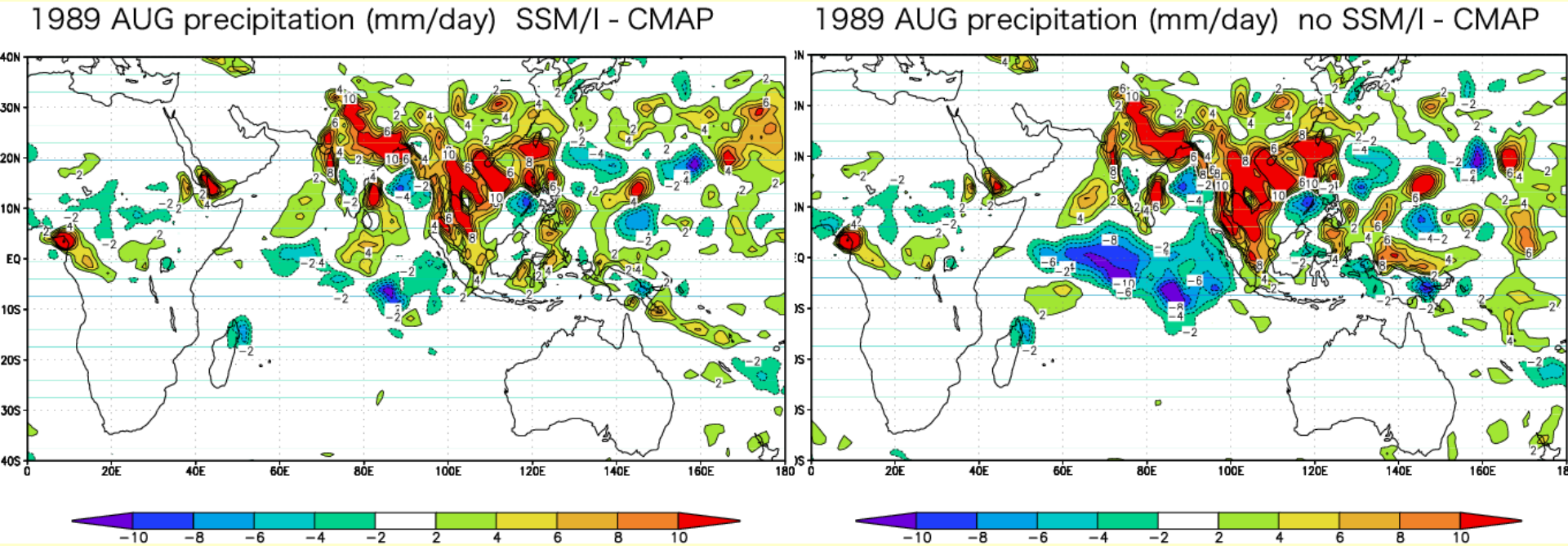
- **SSM/I**
  - supplied by NCDC (1987.6 – 1997)

    Handling charge were paid.
  - obtained from CLASS (former SAA) (1997 – present)
  - **Precipitable water** and **snow coverage** are retrieved.
- **Scattrometer**
  - **Sea surface wind**
  - ERS-1,2 from 1995.4.24 to 2001.1.17
    - Only JMA in house, not obtained additionally from ESA
  - QuikSCAT/SeaWinds from 2002.2.13 onward

SSM/I Precipitable Water Assimilation Experiment

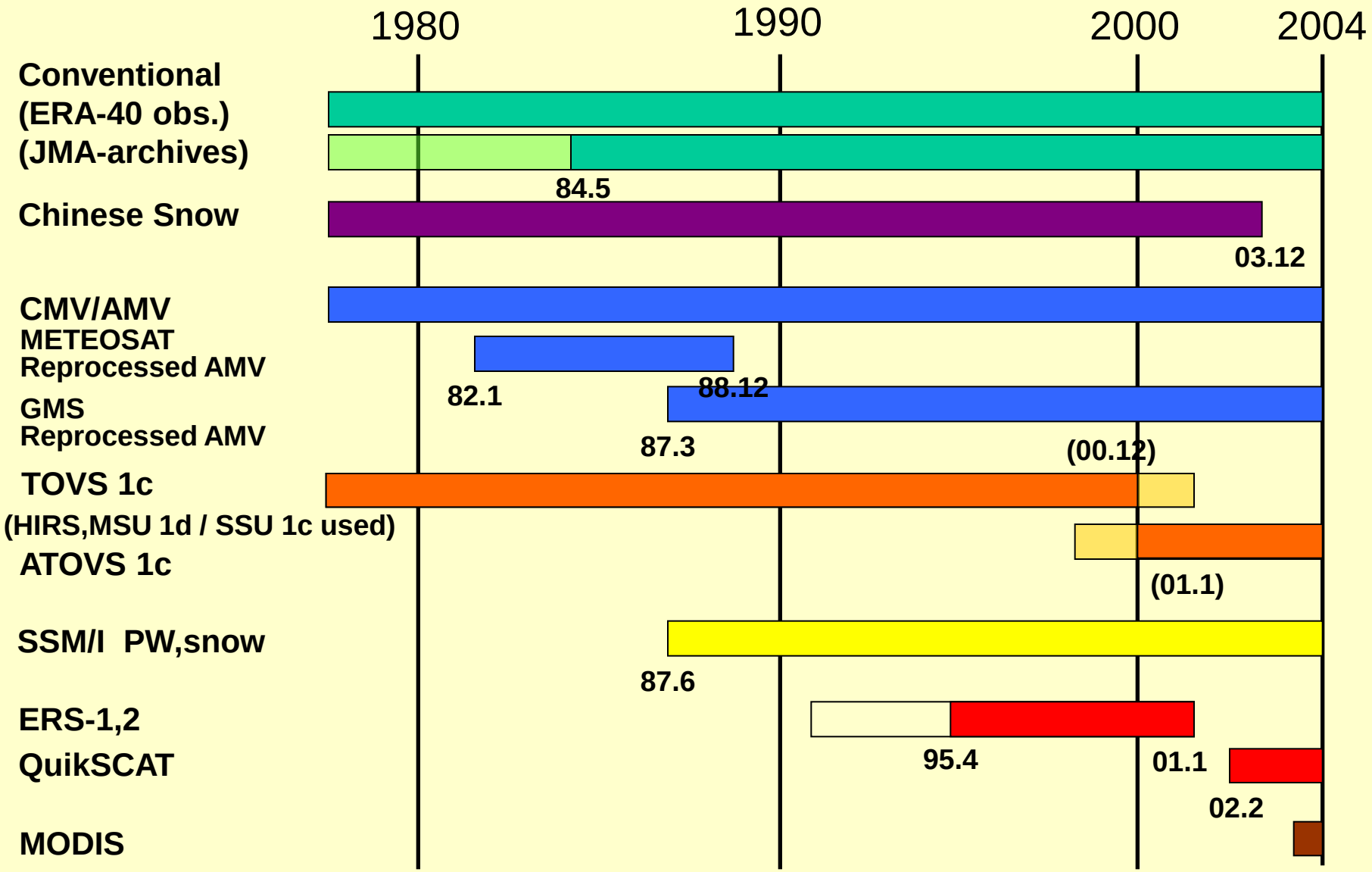
Precipitation difference from CMAP

With SSM/I **Without SSM/I**



CMAP:
CPC Merged Analysis of Precipitation

Data availability in JRA-25



Translucent : available but not used
White : not in house

Data Assimilation and Forecast System

- **T106L40** (top: 0.4 hPa)
  - Low resolution version of the operational T213L40
- **3D-Var**
  - TOVS 1d / ATOVS 1c, SSM/I PW, scattrometer, ….
- **COBE SST and sea ice**
  - COBE:Centennial comprehensive marine dataset by JMA
  - Other reanalyses used NCEP or Hadley SST.
- **Daily 3D-ozone profiles are given to GSM.**
  - by Atmospheric Environment Division/JMA
  - produced with the JMA Chemical Transport Model
- 8-day forecast is executed every 5 day.
- Ocean wave not coupled

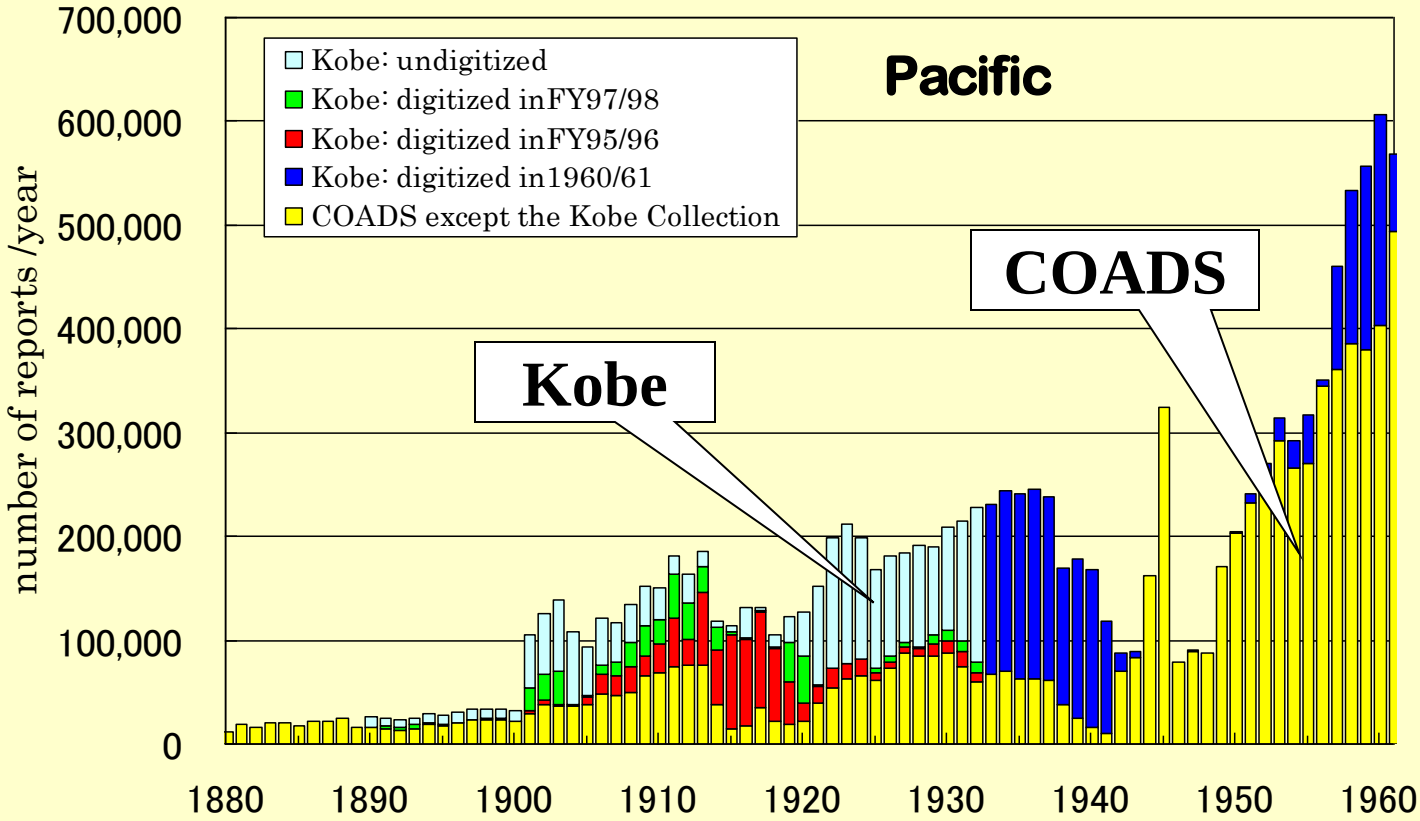
(1) COBE

Centennial in-situ Observation-Based Estimates
Of variability of SST and marine meteorological variables

Centennial SST data set from 1900 is used in JRA-25

- Ishii et al.

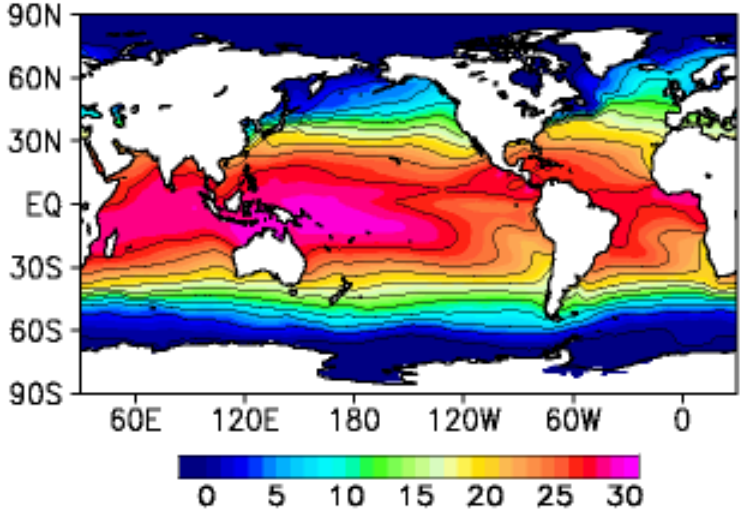
The Kobe collection marine data are assimilated.



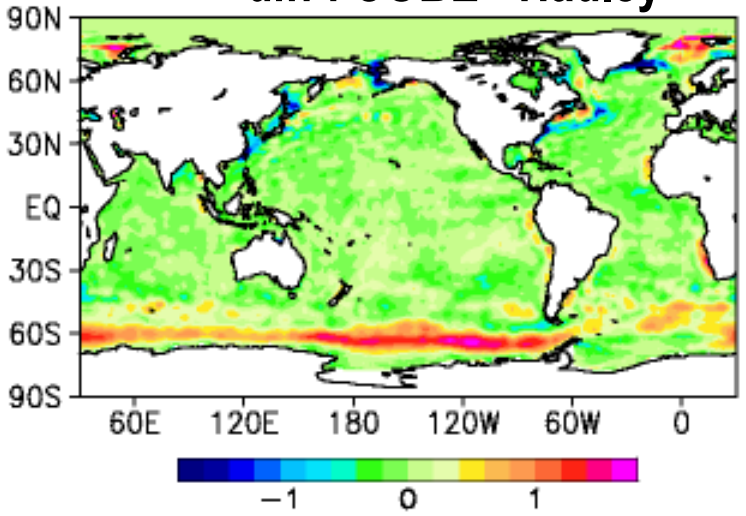
COBE SST

Comparison of SST long-term averages (January)

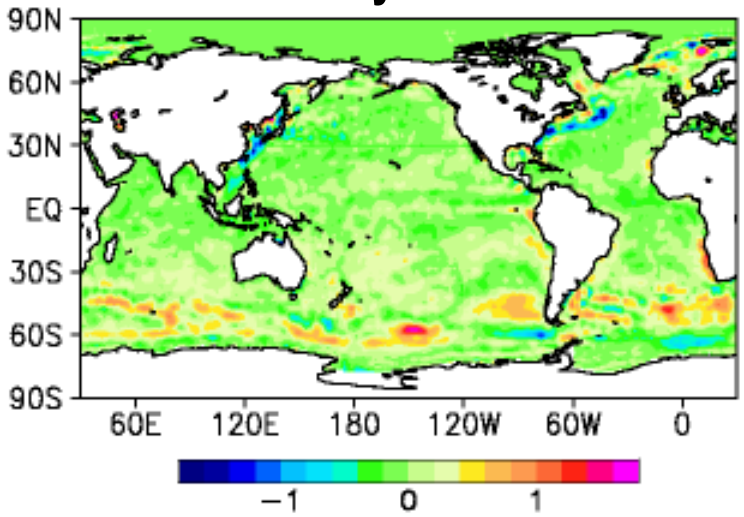
COBE



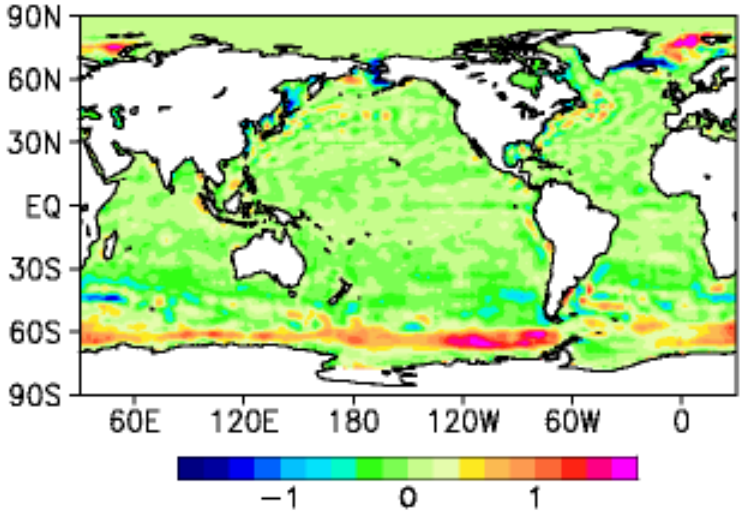
diff : COBE - Hadley



diff : Hadley - NCEP



diff : COBE - NCEP



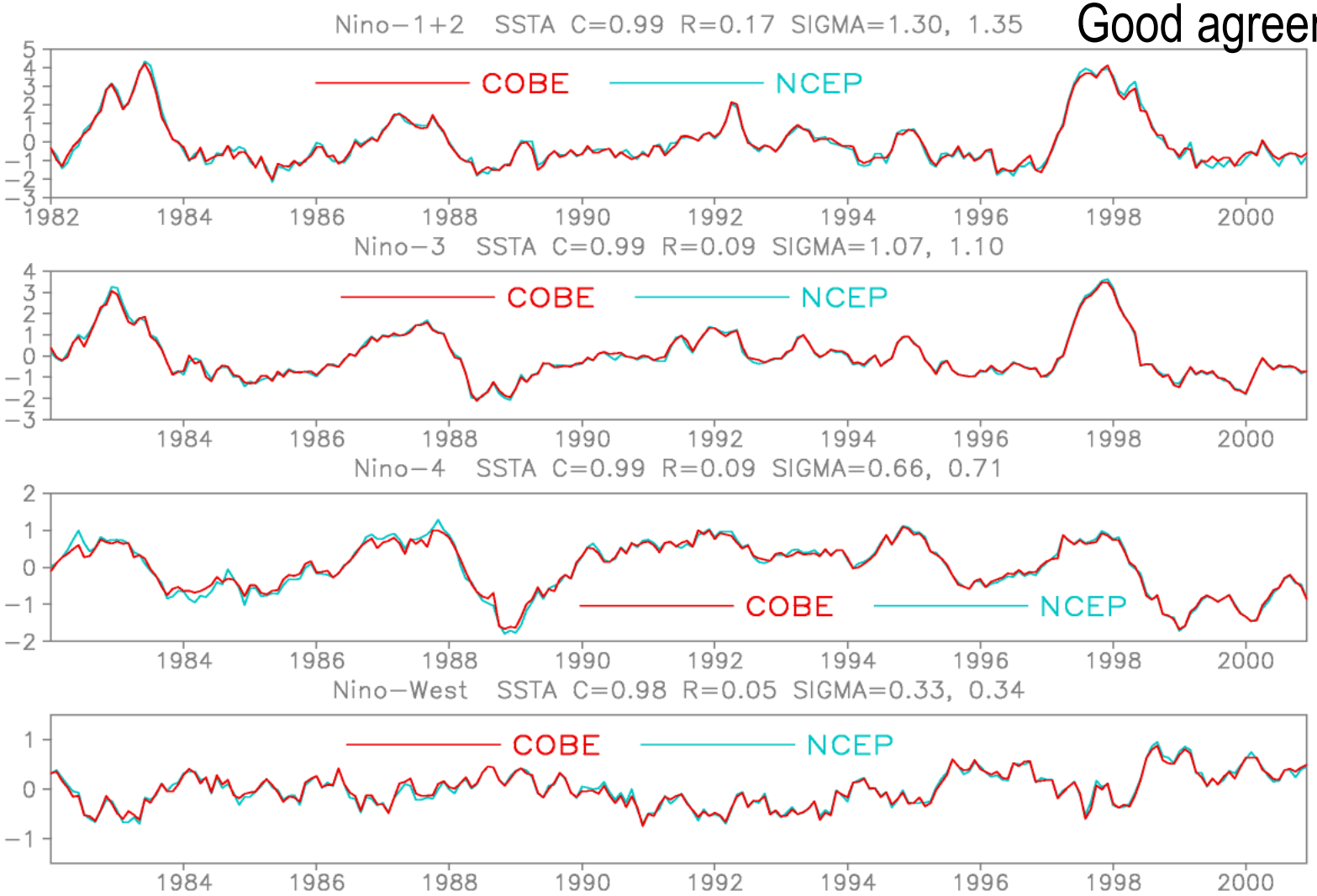
No satellite data were used in COBE. , Period: 1982-1998.

COBE SST

Comparison with NCEP OI Ver.2

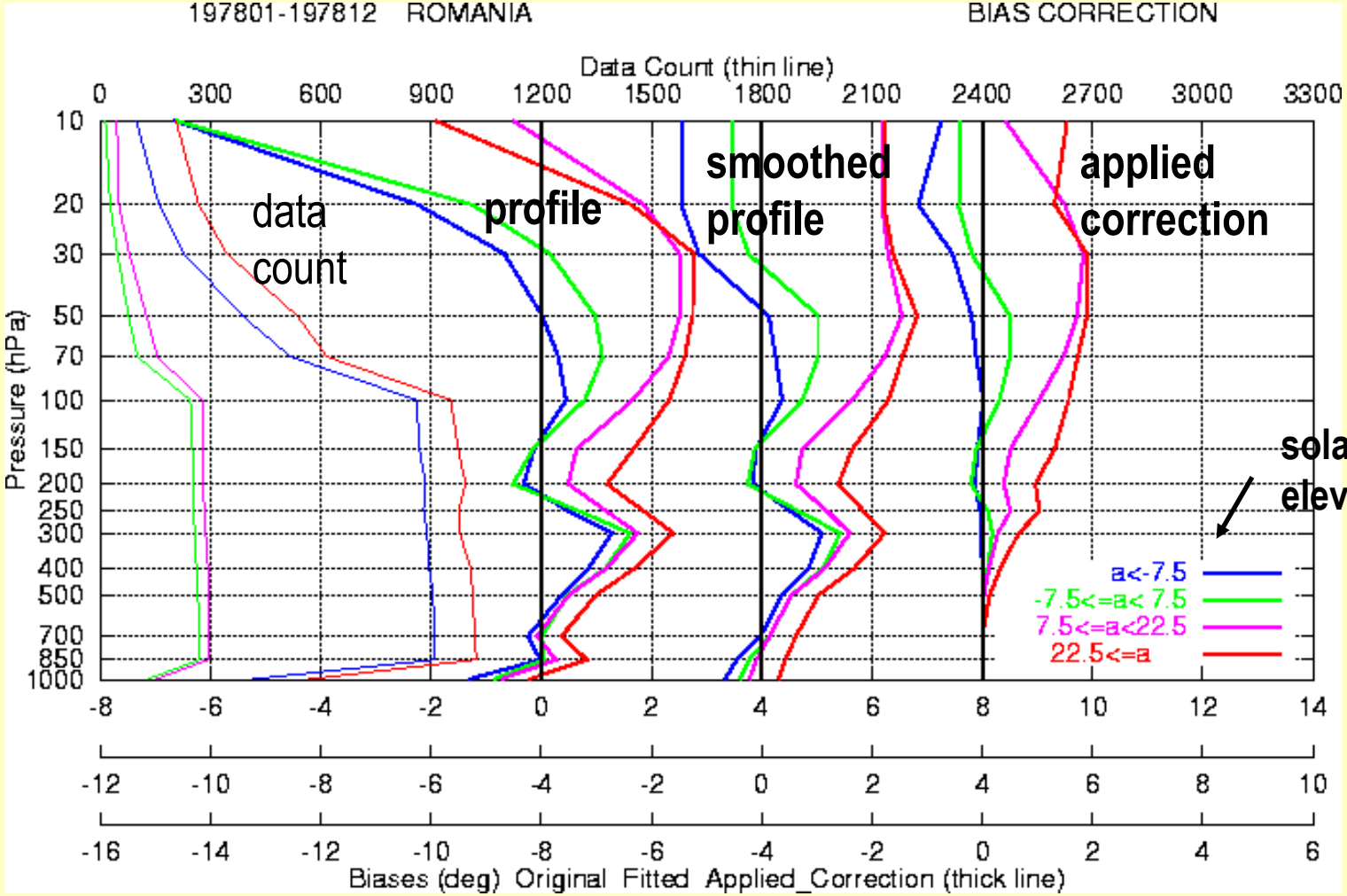
Nino area

Good agreement



Monthly SSTA, Red: Present analysis, Blue: NCEP OI, Period: 1982-2000.

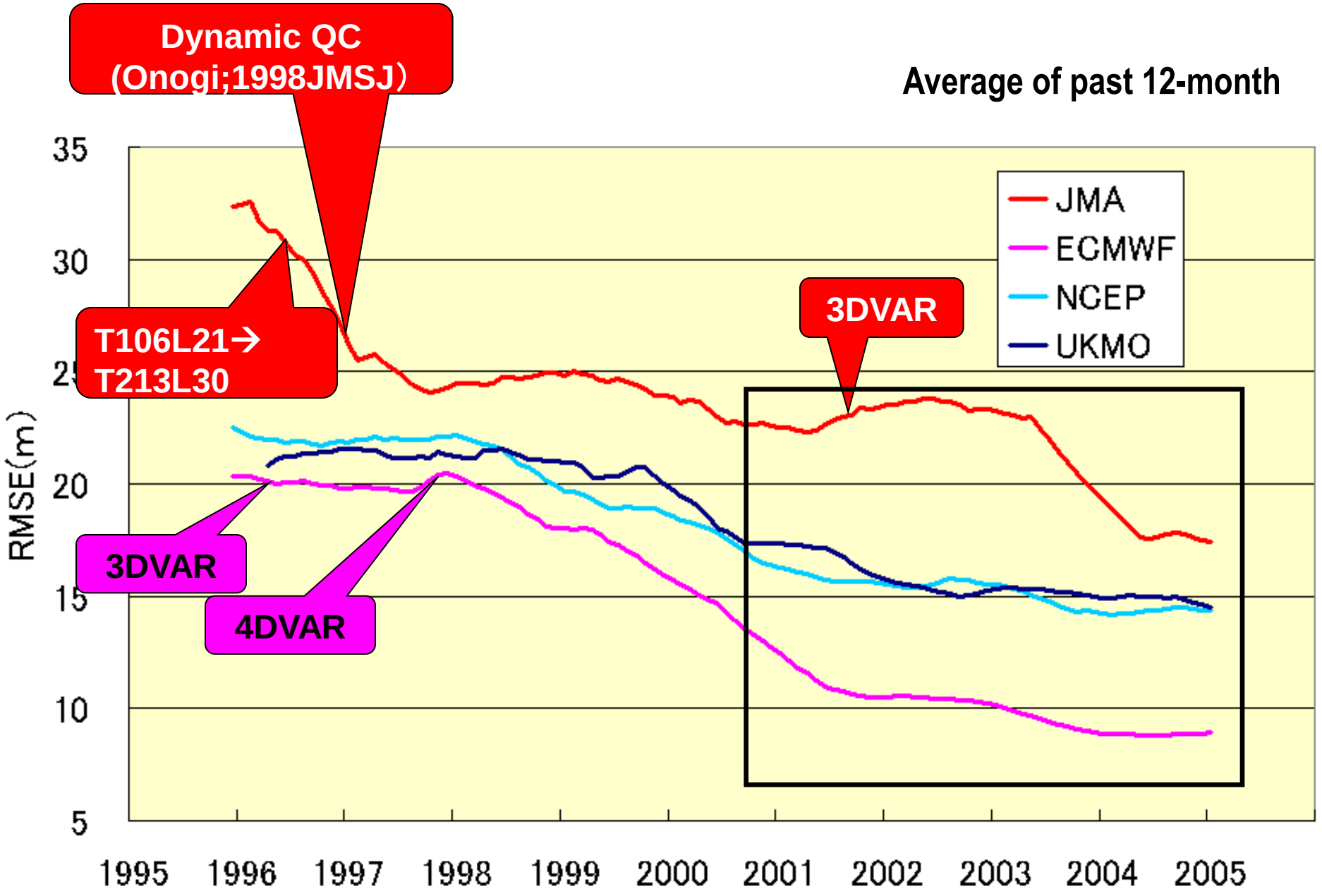
Radiosonde bias correction



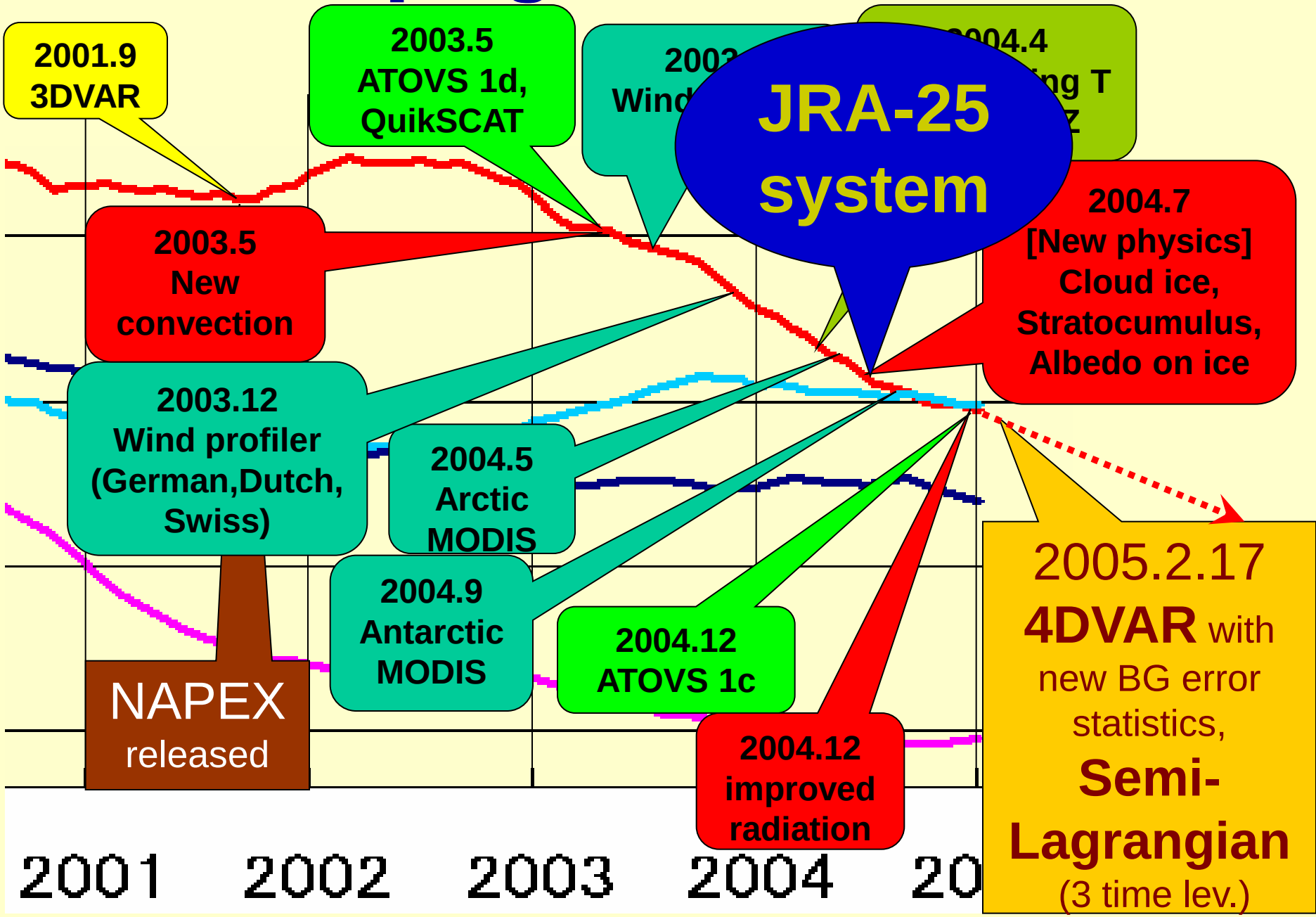
Onogi(2000), Andrae, Sokka and Onogi(2004)

Applied correction values are upgraded every month for each region using statistics of the latest 12 months.

Z500 RMSE SH (1-day forecast)



Recent progress of JMA NWP



Difference between JRA-25 and JMA operational GSM

	JRA-25	Operational (deterministic)
resolution	T106L40 (top 0.4hPa) 3DVAR Inner T106 Eularian	TL319L40 (top 0.4hPa) 4DVAR Inner T63 semi-Lagrangian
SSM/I PW	assimilated	Not yet (regional model only)
TOVS ATOVS	TOVS 1d with using RTTOV6 ATOVS 1c with using RTTOV7	ATOVS 1d with using RTTOV6 (2003.5-04.12) ATOVS 1c with using RTTOV7 (2004.12-)
Data used in snow anl.	SYNOP + SSM/I snow coverage, (-1986) CPC weekly snow cov. alternatively	SYNOP (SYNOP + SSM/I snow coverage for EPS)
SST	COBE (daily)	2D-OI (Baba) using climate FG
sea ice	COBE (daily) with using SSM/I	Monthly climate (55% concentration) (same as ERA-15 by Baba)
ozone	3-D daily	2-D climate (zonal mean)
radiation	Previous scheme (large bias of temperature in the stratosphere)	Improved scheme (reduced the bias of temperature)
background error	New BG error statistics 2003 for 4DVAR are used.	Old BG error statistics 2000 were used in the previous 3DVAR.

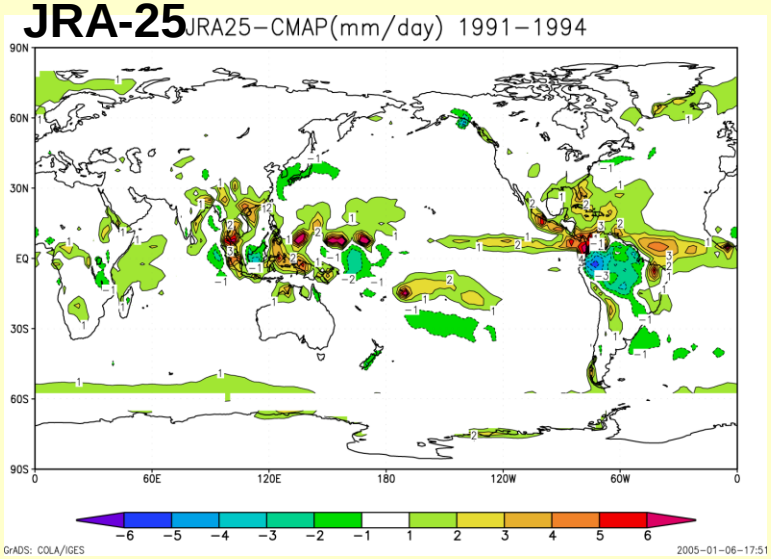
Yellow colours mean better (advanced).

Performance of JRA-25

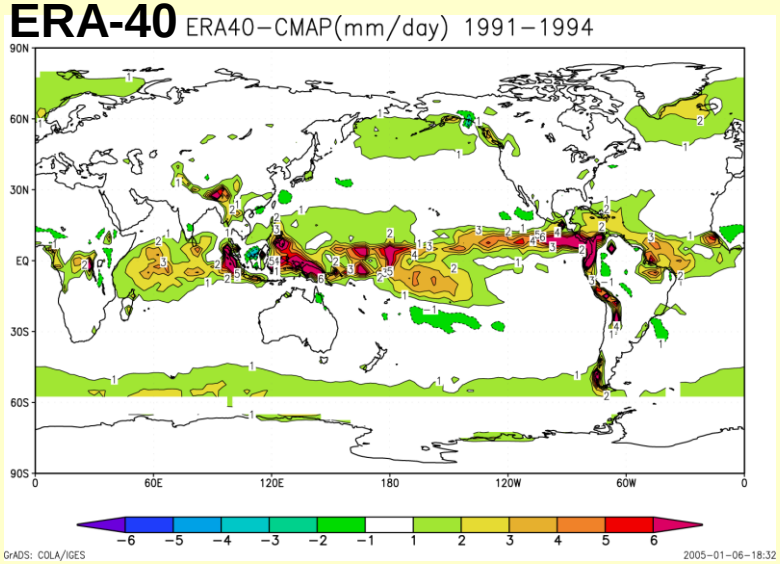
Comparison with other reanalyses

Annual mean precipitation (difference between CMAP)
(1991-1994)

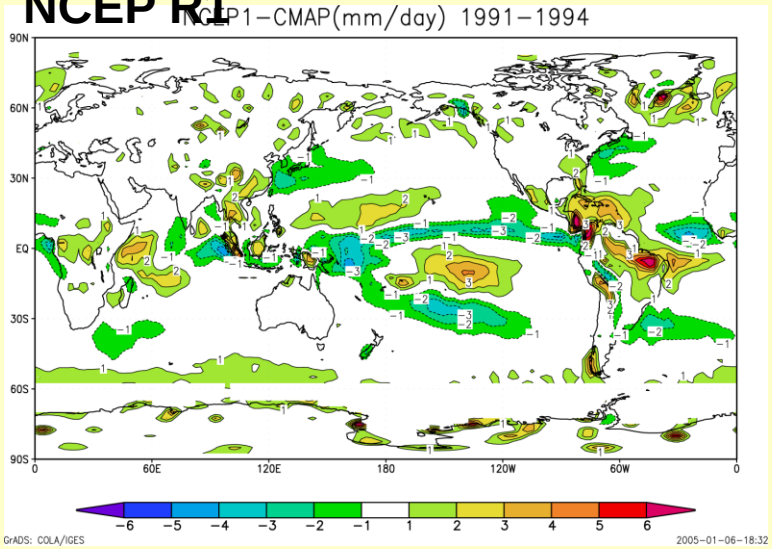
JRA-25



ERA-40



NCEP R1



ERA40

Much more than CMAP in the tropics

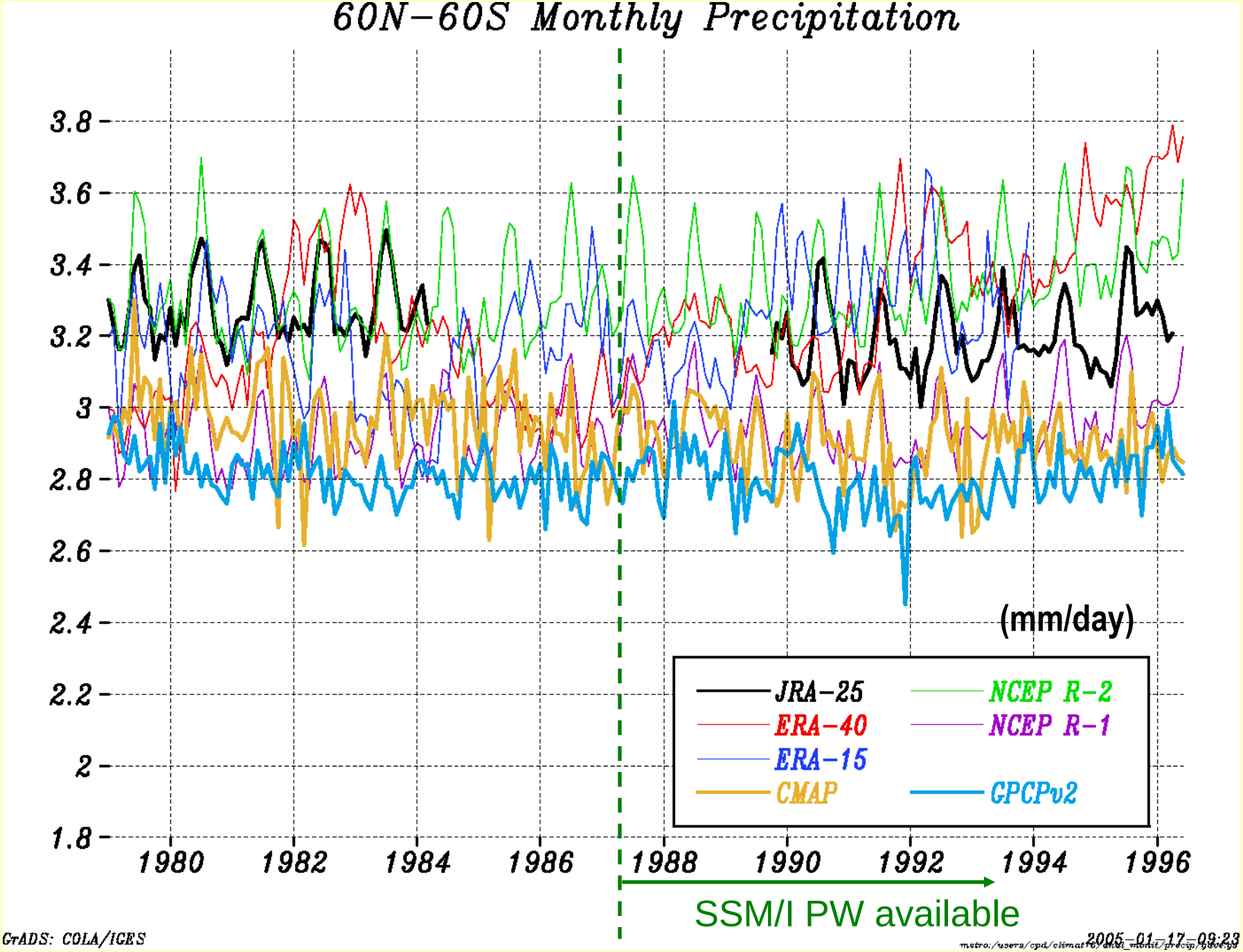
JRA-25

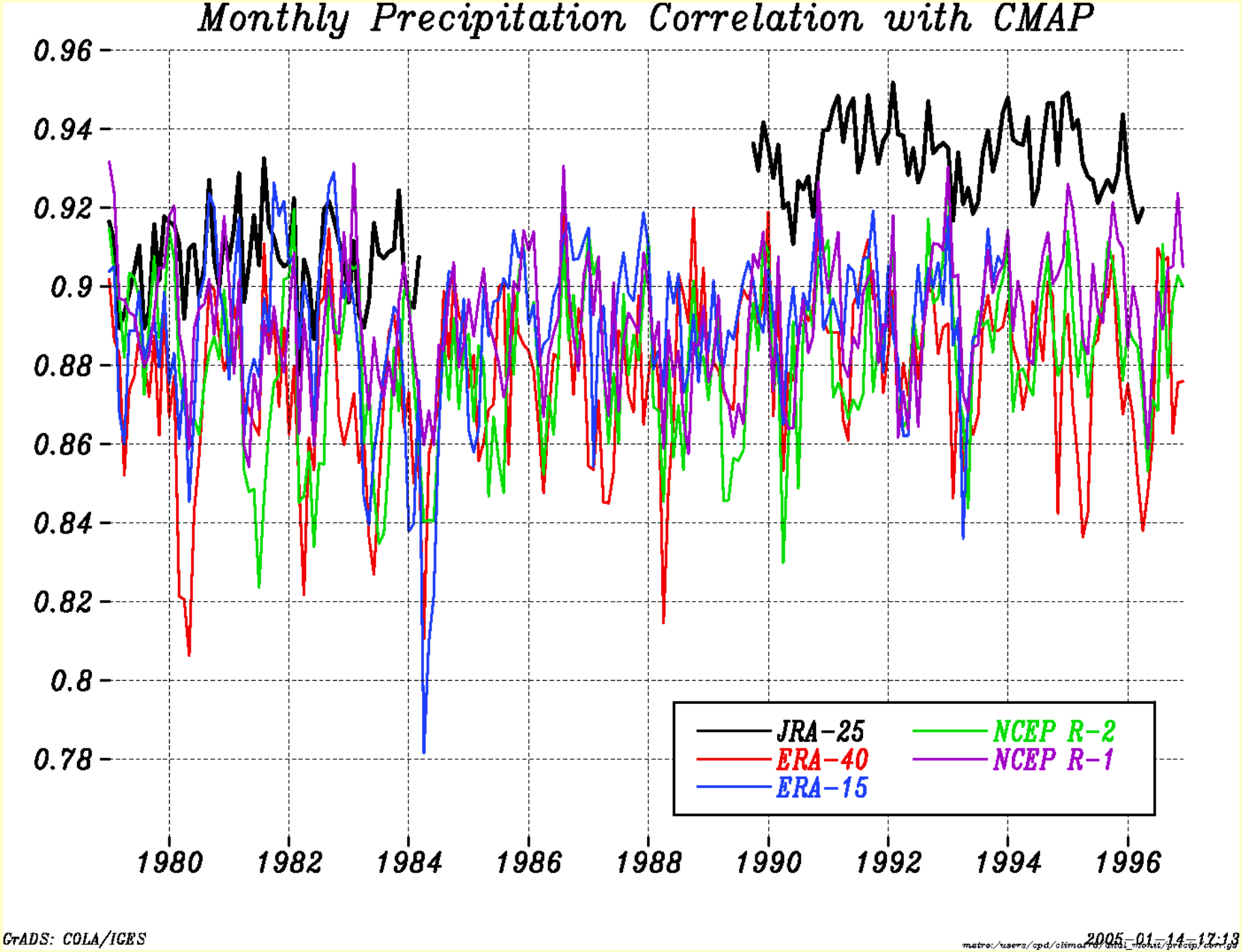
More than CMAP

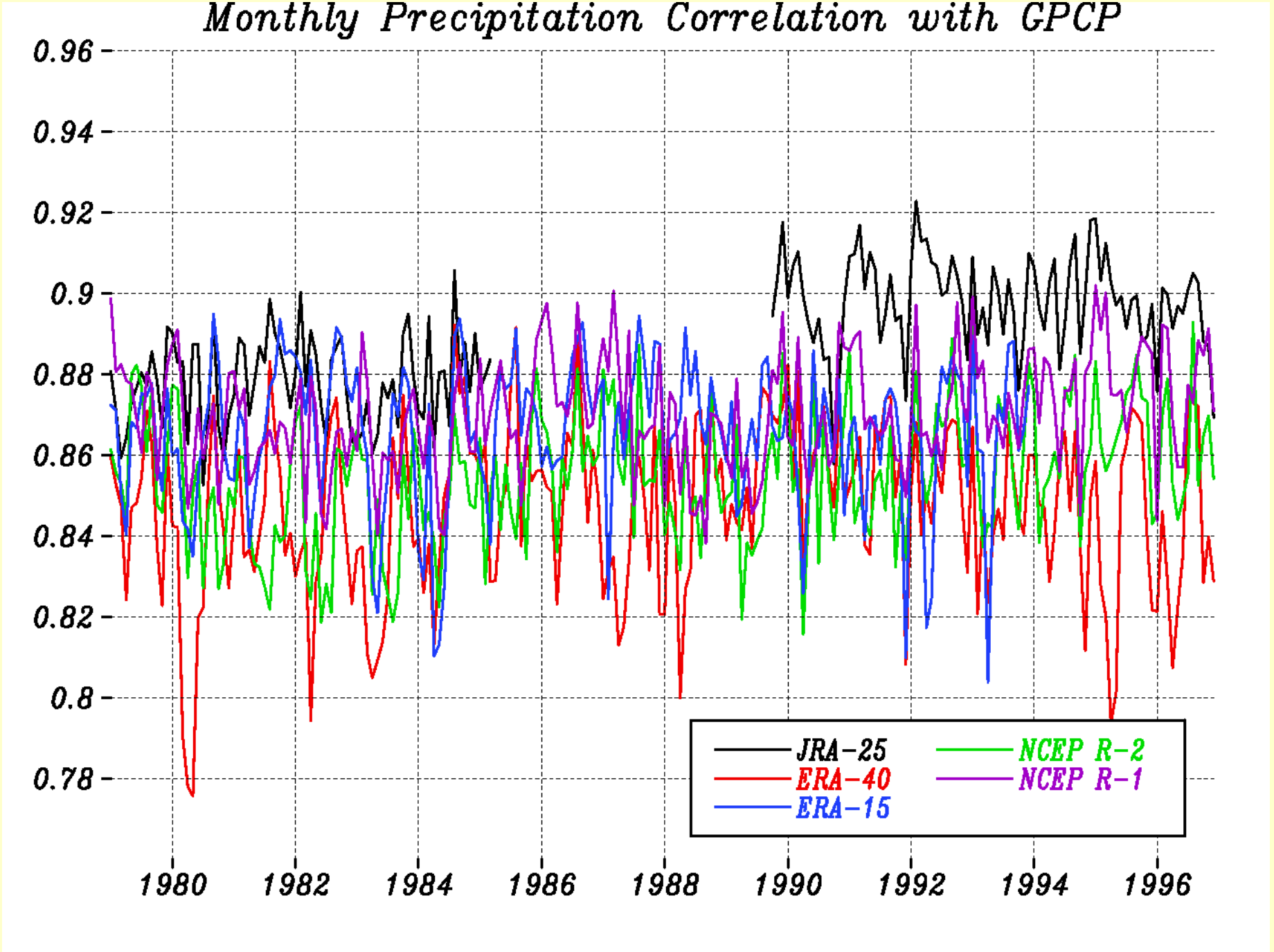
NCEP1

More than CMAP in large precipitation area

Less than CMAP in little precipitation area

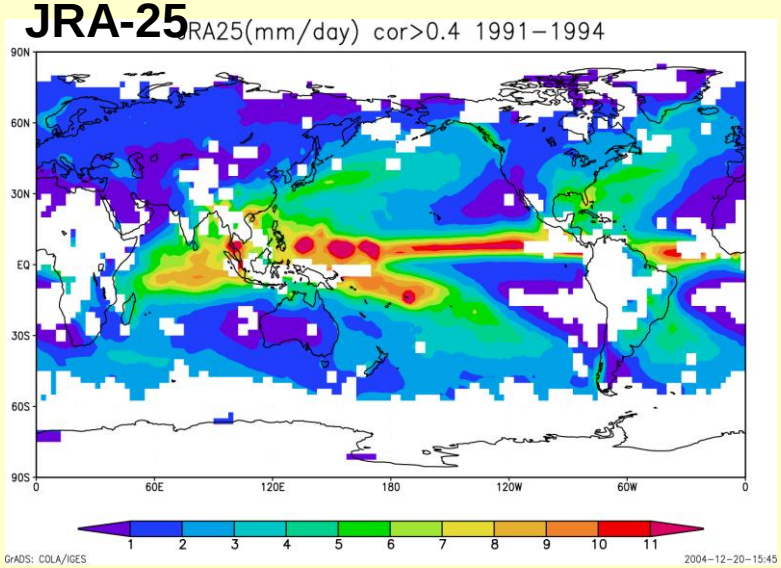

60N-60S Monthly Precipitation
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1980
1982
1984
1986
1988
1990
1992
1994
1996
(mm/day)
JRA-25
NCEP R-2
ERA-40
NCEP R-1
ERA-15
CMAP
GPCPv2
SSM/I PW available
GrADS: COLA/ICES
2005-01-17-09:23


Monthly Precipitation Correlation with CMAP
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
0.8
0.78
1980
1982
1984
1986
1988
1990
1992
1994
1996
JRA-25
ERA-40
ERA-15
NCEP R-2
NCEP R-1
GrADS: COLA/IGES
2005-01-14-17:13

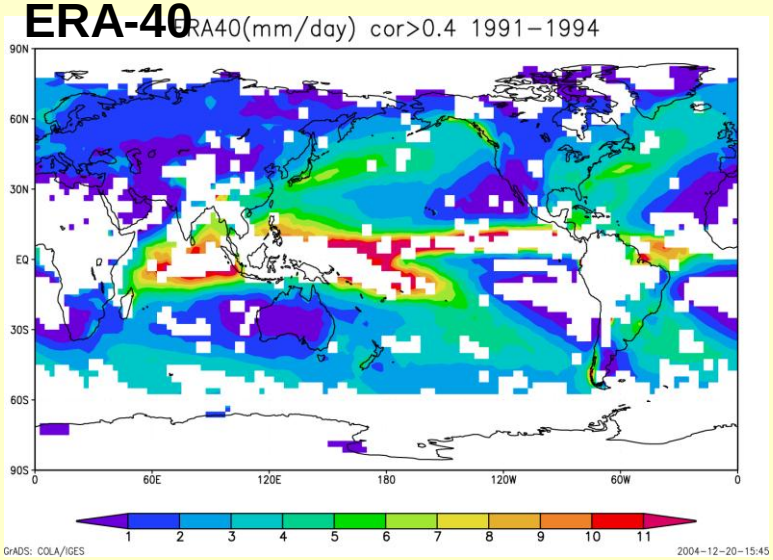

Monthly Precipitation Correlation with GPCP
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
0.8
0.78
1980
1982
1984
1986
1988
1990
1992
1994
1996
JRA-25
ERA-40
ERA-15
NCEP R-2
NCEP R-1
GrADS: COLA/ICES
2005-02-09-17:31

Annual precipitation where anomaly correlation with CMAP > 0.4 (1991-1994)

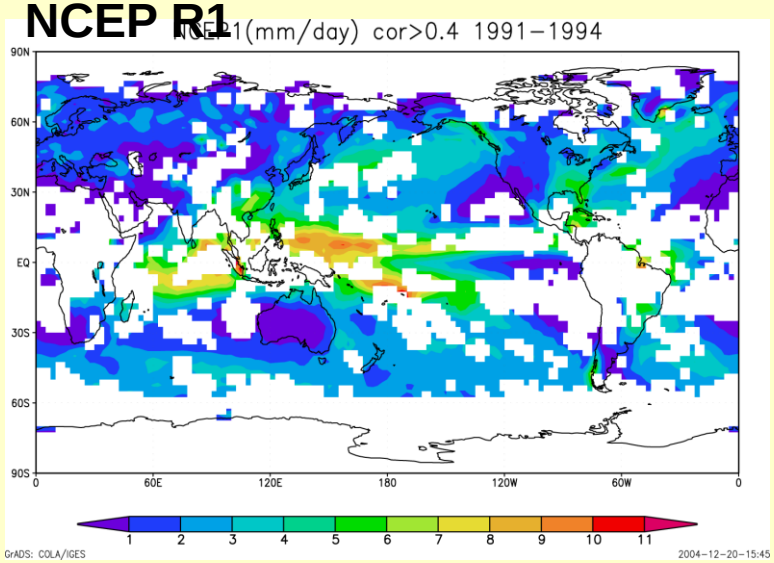
JRA-25



ERA-40



NCEP R1



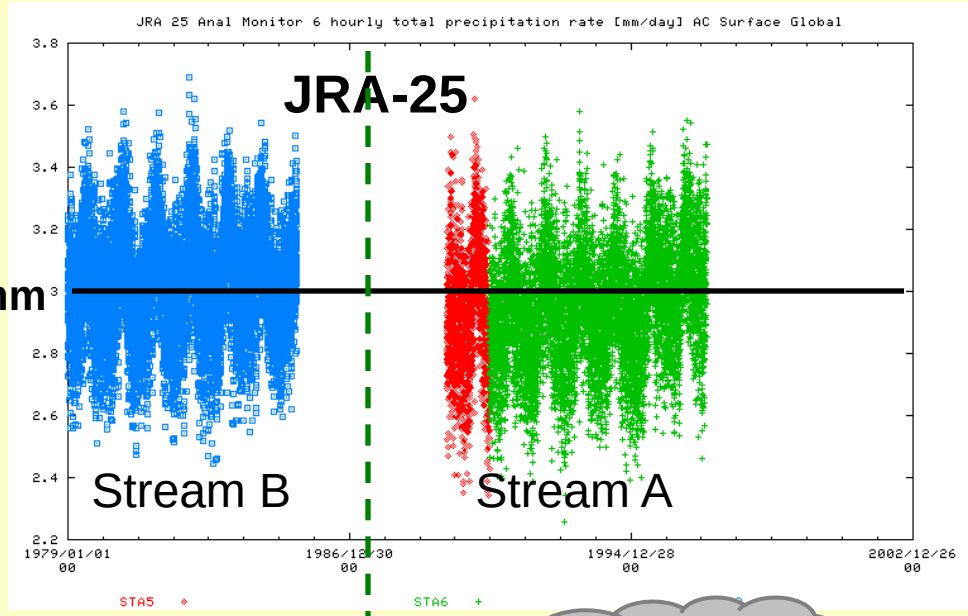
Width of the coloured area

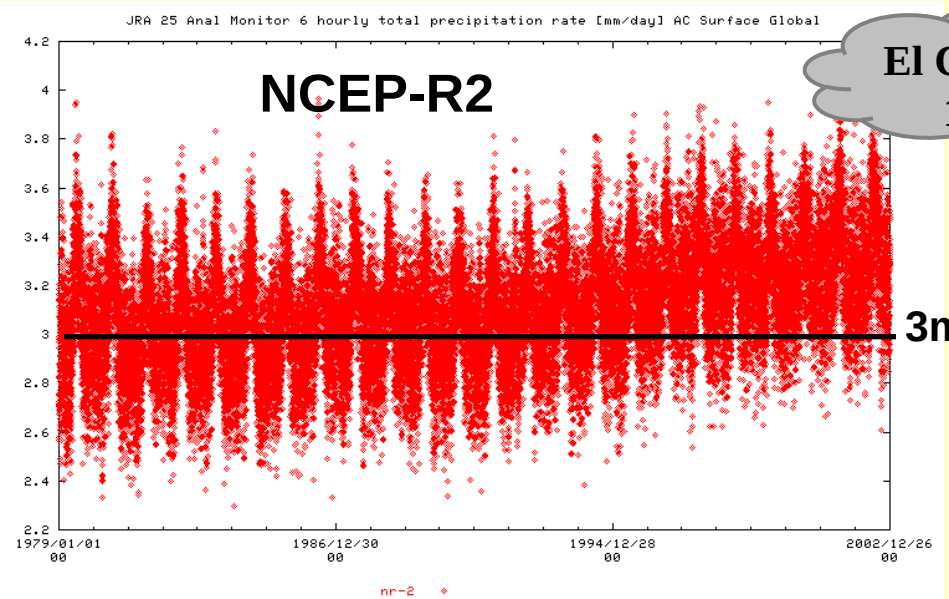
(anomaly corrilation > 0.4)

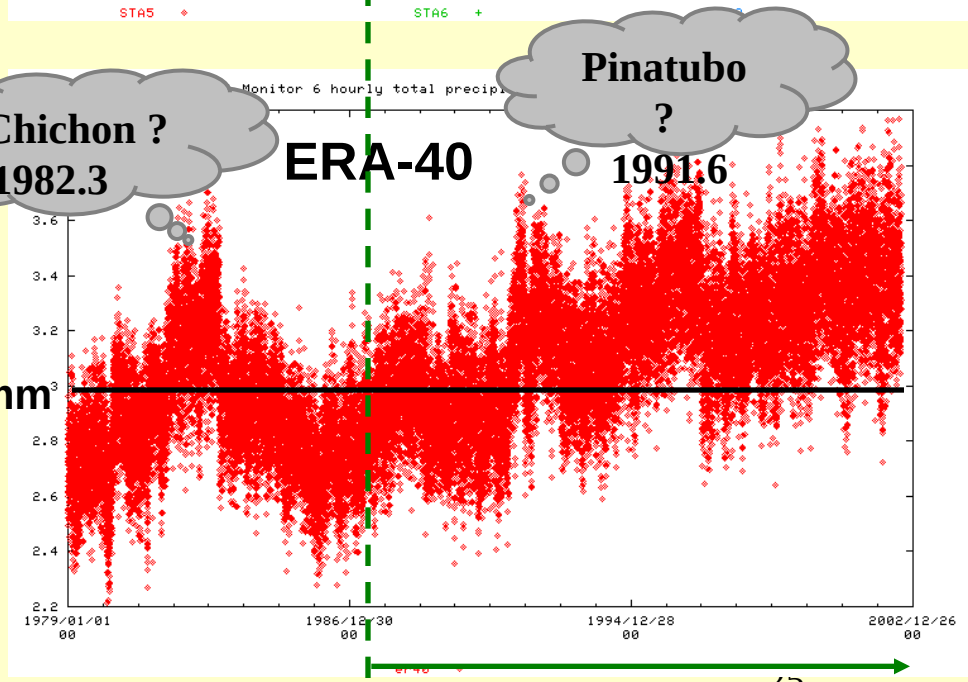
JRA-25 > ERA-40 > NCEP R1

Global Total precipitation

1979.1 – 2002.12
(mm/day)







Kobayashi's comprehensive monitor

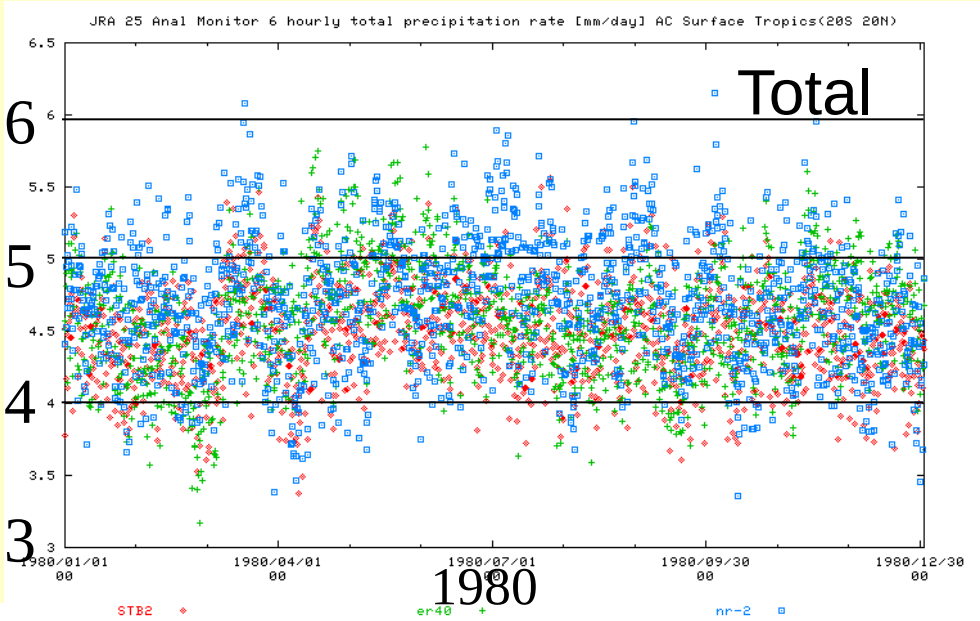
SSM/I PW available

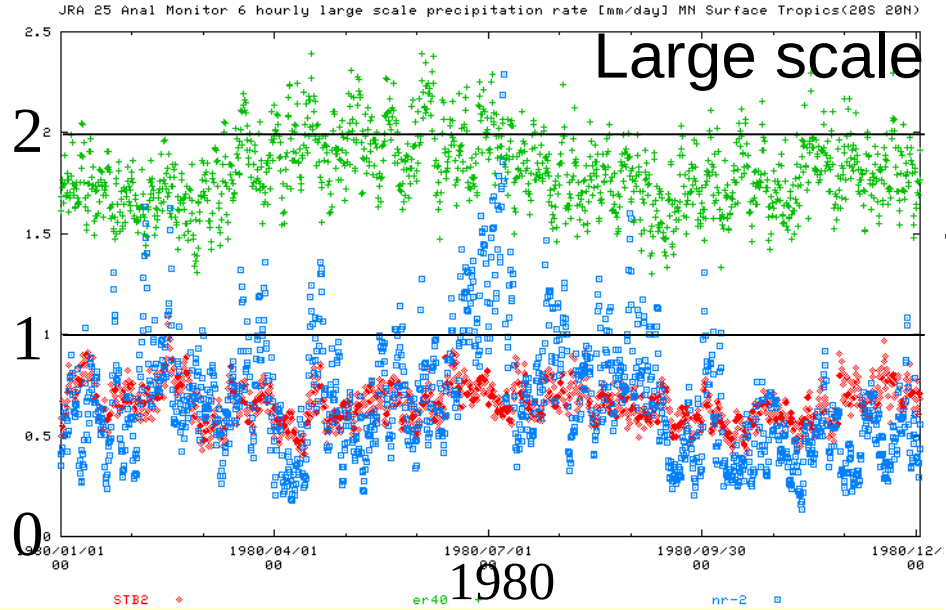
6 hourly (FT=0 to 6) precipitation in the tropics (1980)

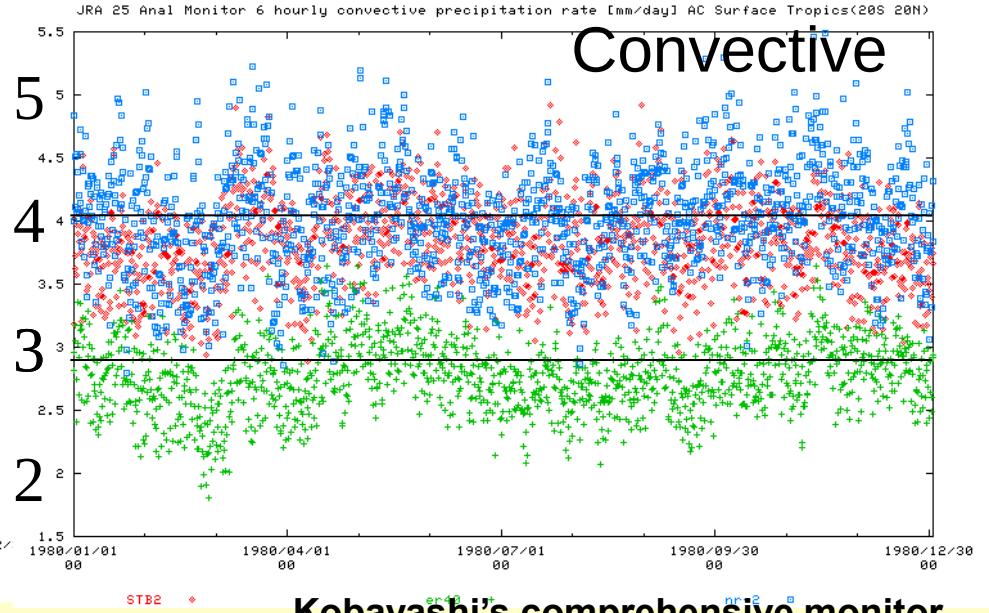
(20N-20S; mm/day)

SSM/I PW not available

JRA-25
ERA-40
NCEP-R2





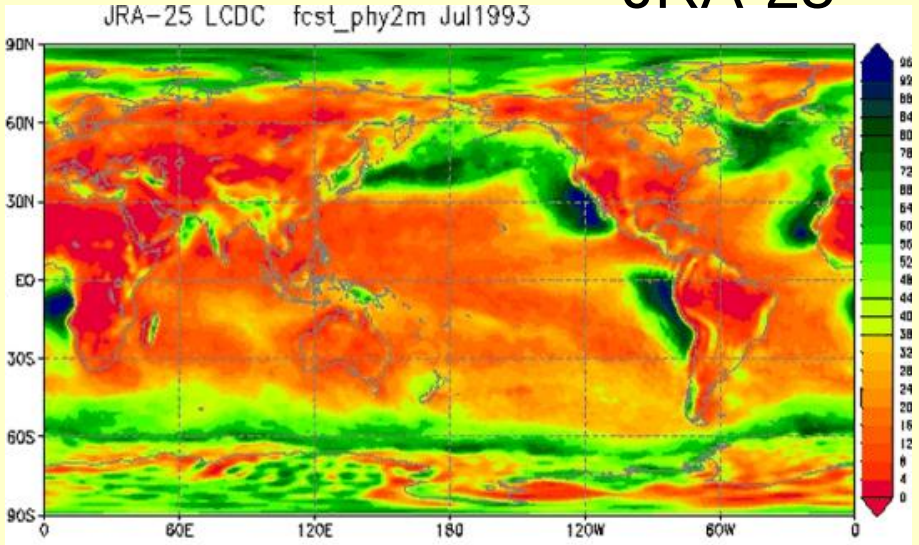


Kobayashi's comprehensive monitor

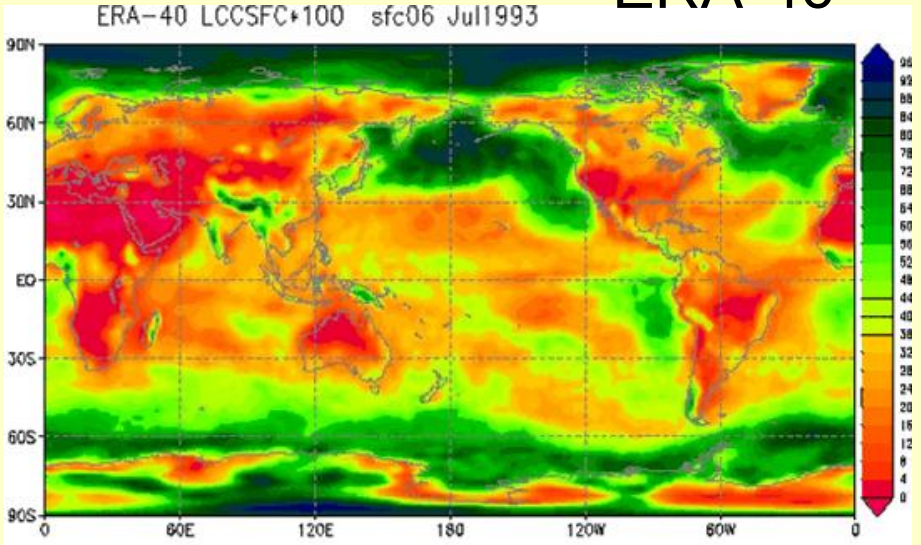
Low level cloud along western coasts

July 1993

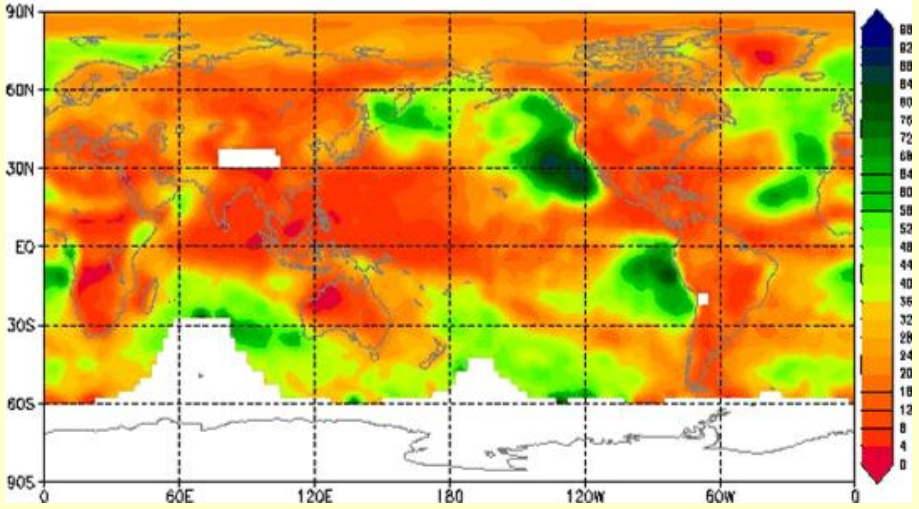
JRA-25



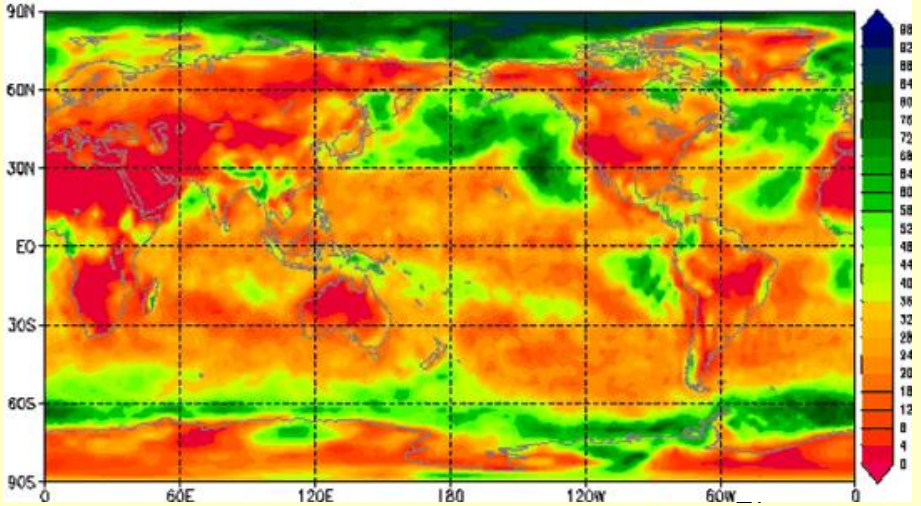
ERA-40



ISCCP



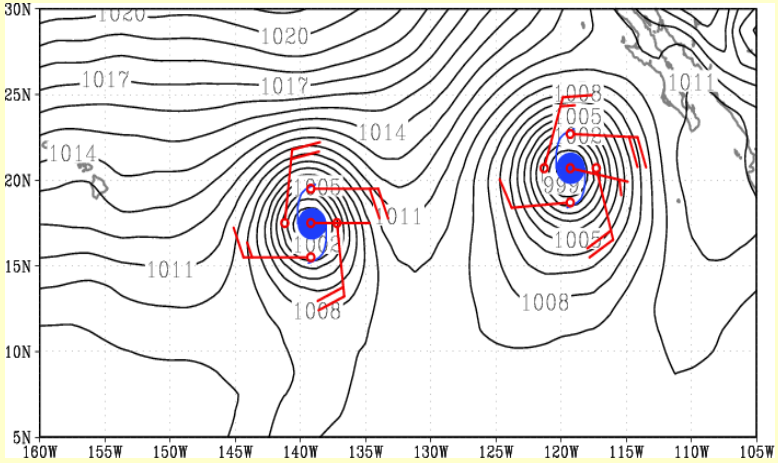
ERA-15



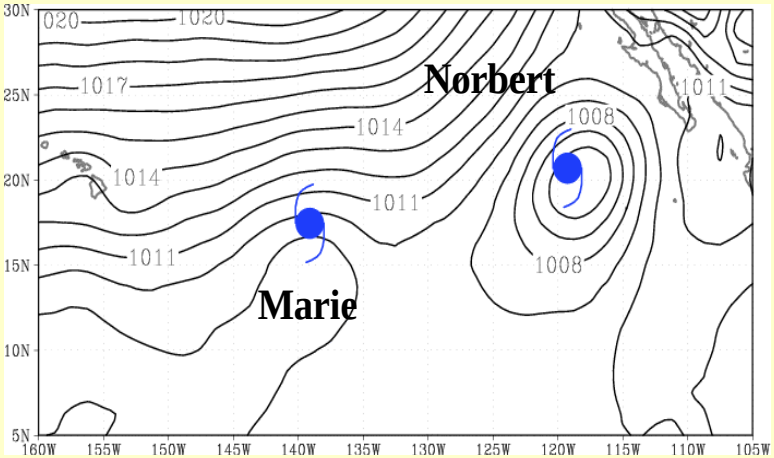
Impact of Fiorino's TC Wind Data

1200 UTC 15 September 1990 in the eastern North Pacific

JRA-25

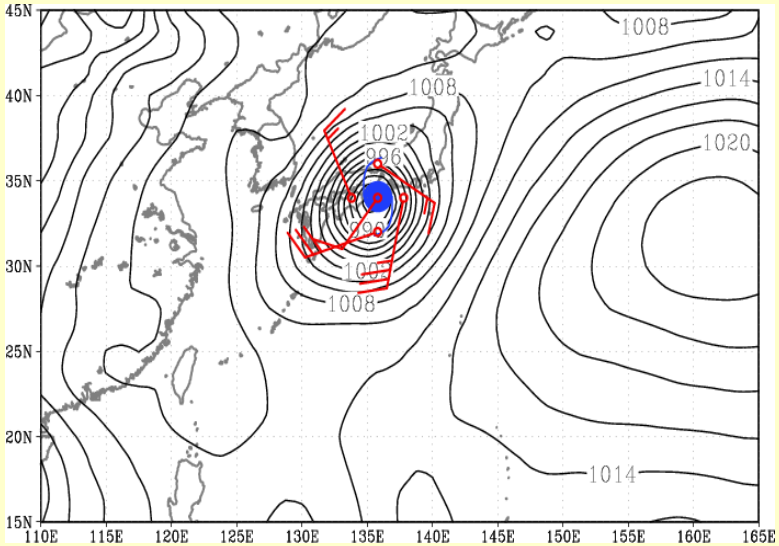


Control

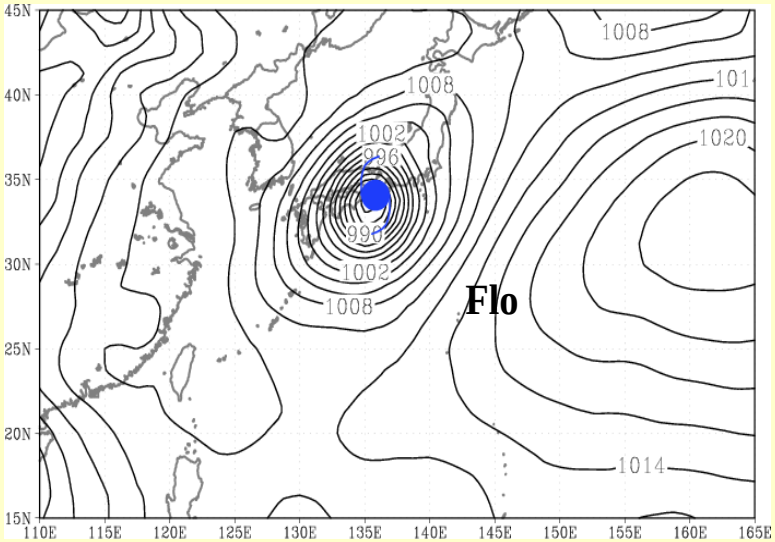


1800 UTC 19 September 1990 in the western North Pacific

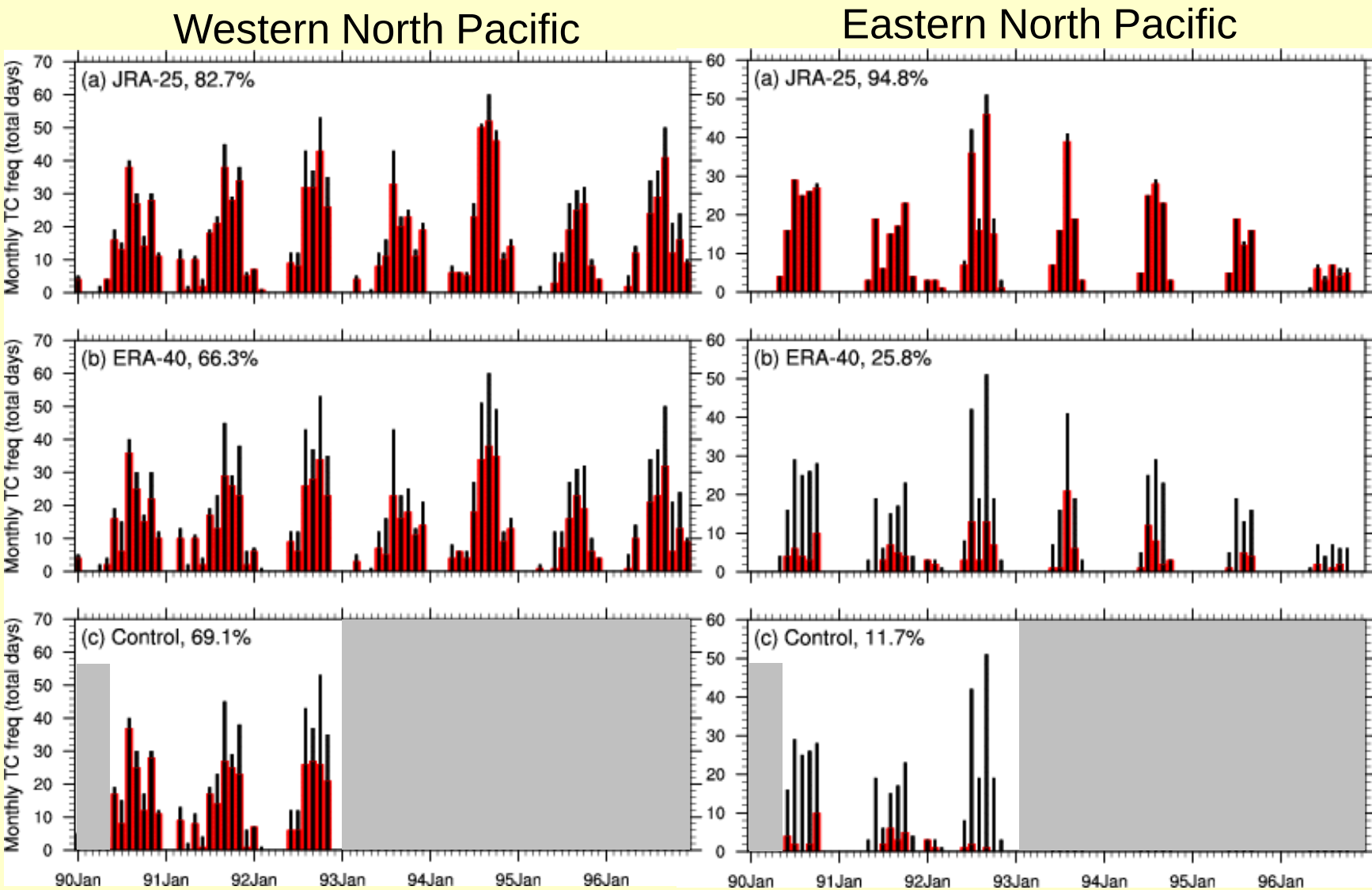
JRA-25



Control



TC detection (1991-1997)



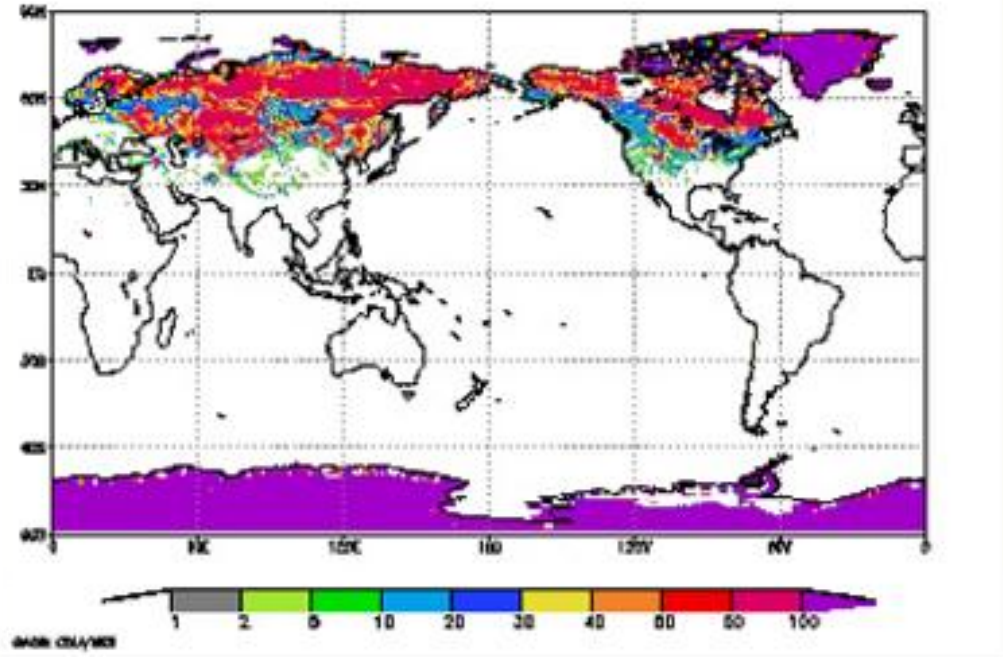
red: reanalyses black: best track

2.5deg. Lat-Lon grid

Snow coverage retrieved from SSM/I

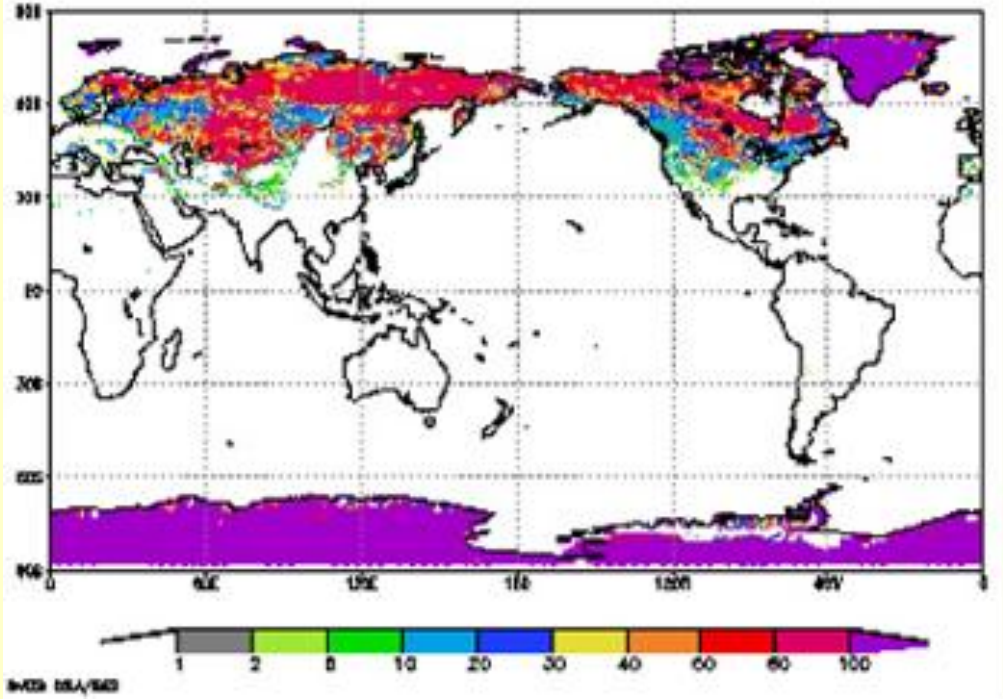
DMSP-10

Example; 1994. 2. 1



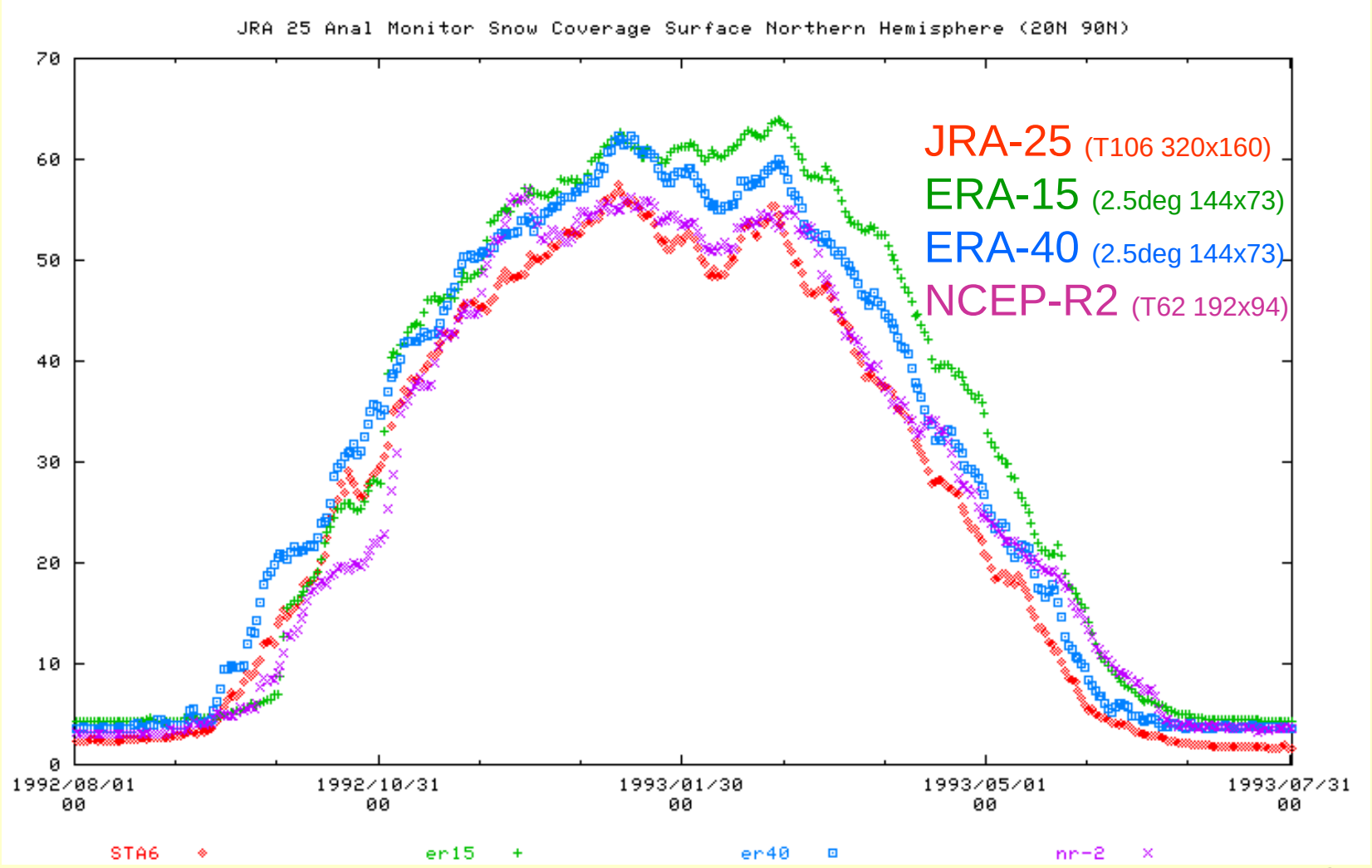
SSM/I snow coverage contributes consistent snow analysis.

DMSP-11



Average of snow coverage is taken for available satellites.

Annual changes of snow coverage rate (%) in NH (1992.8 – 1993.7)



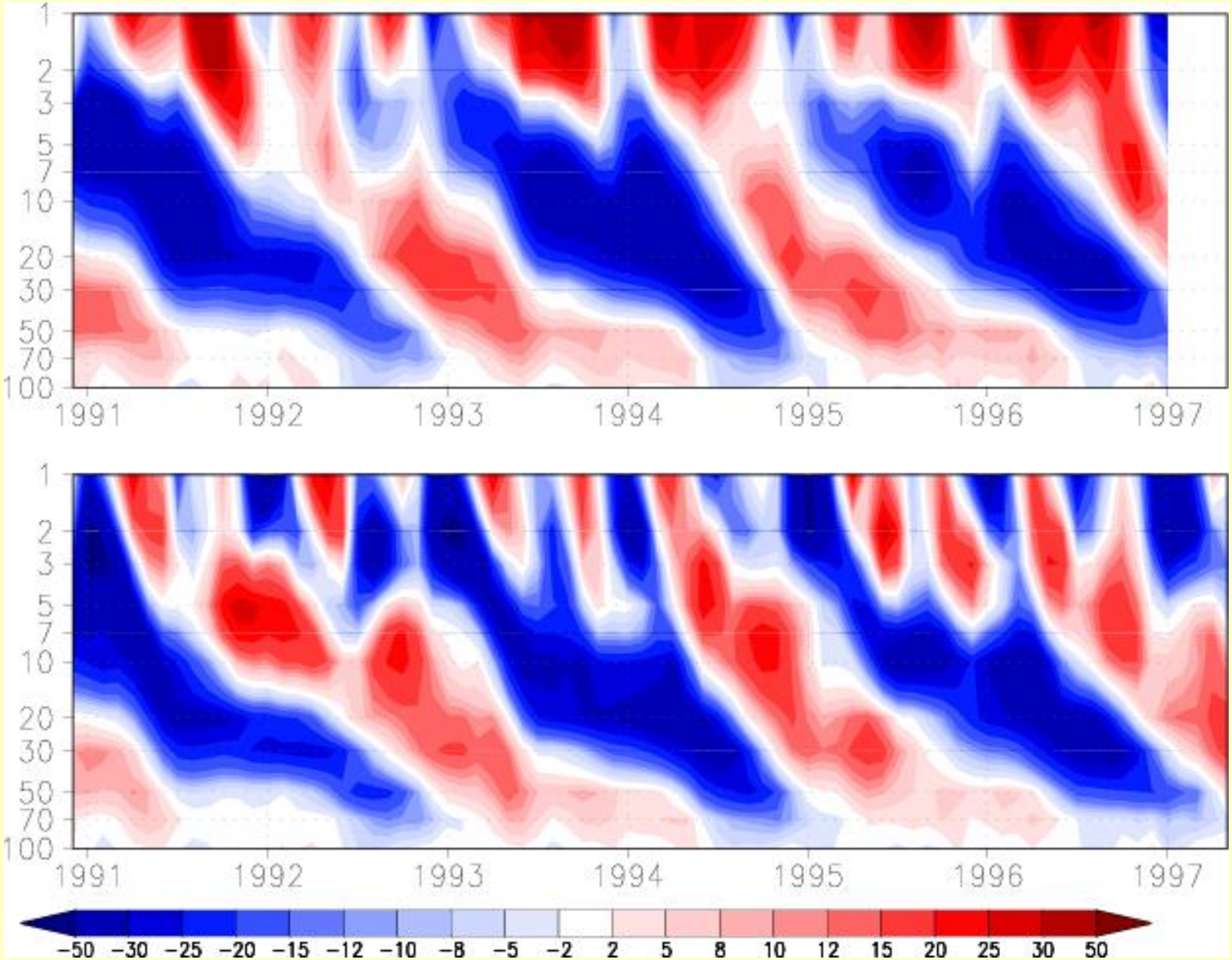
Kobayashi's comprehensive monitor

QBO and SAO (1991-1997)

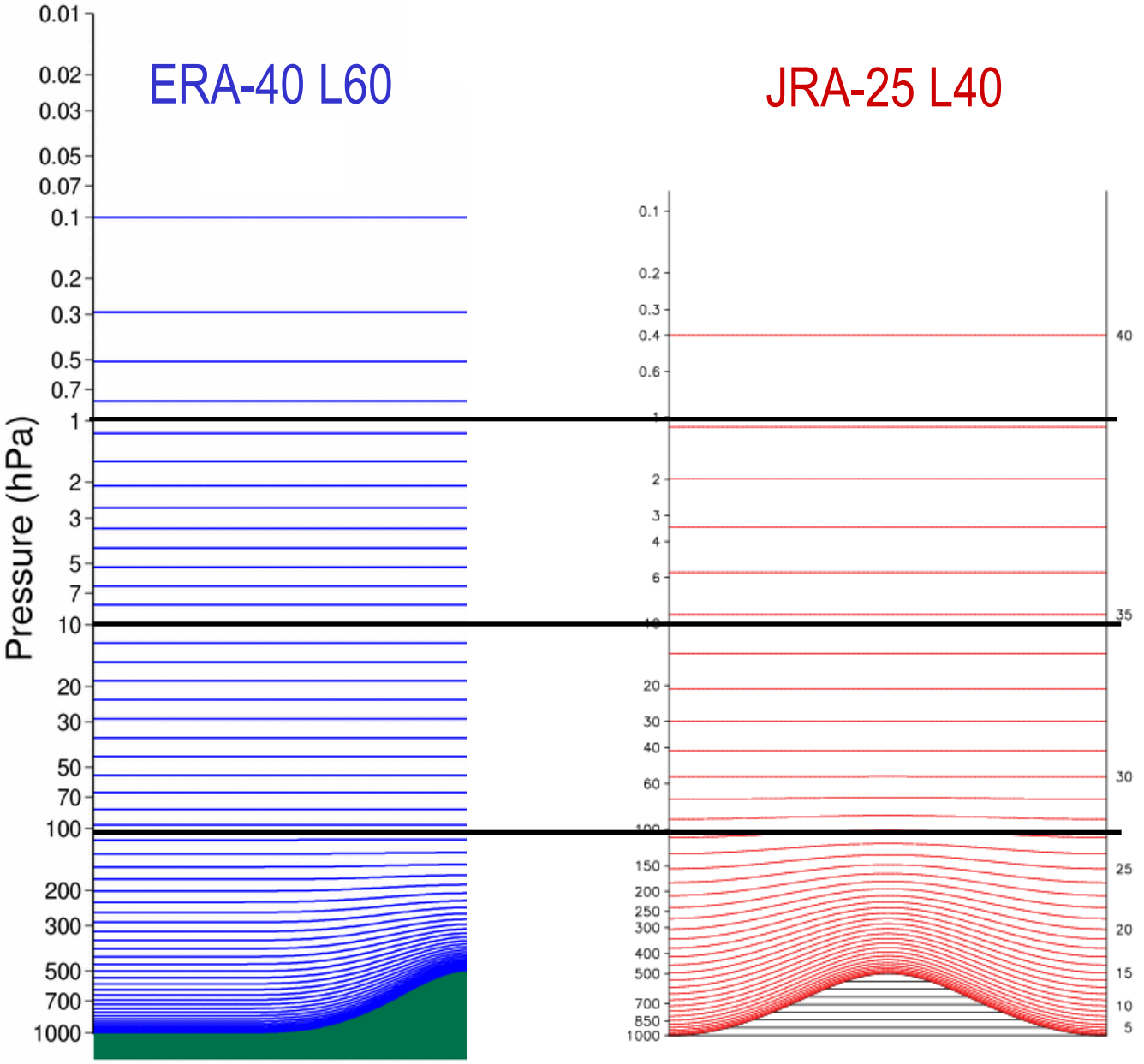
Zonal mean U [m/s] at Equator

JRA-25

ERA-40



Vertical resolution



Surface 2m temperature

Anomaly from climate (1961-90 ERA-40)

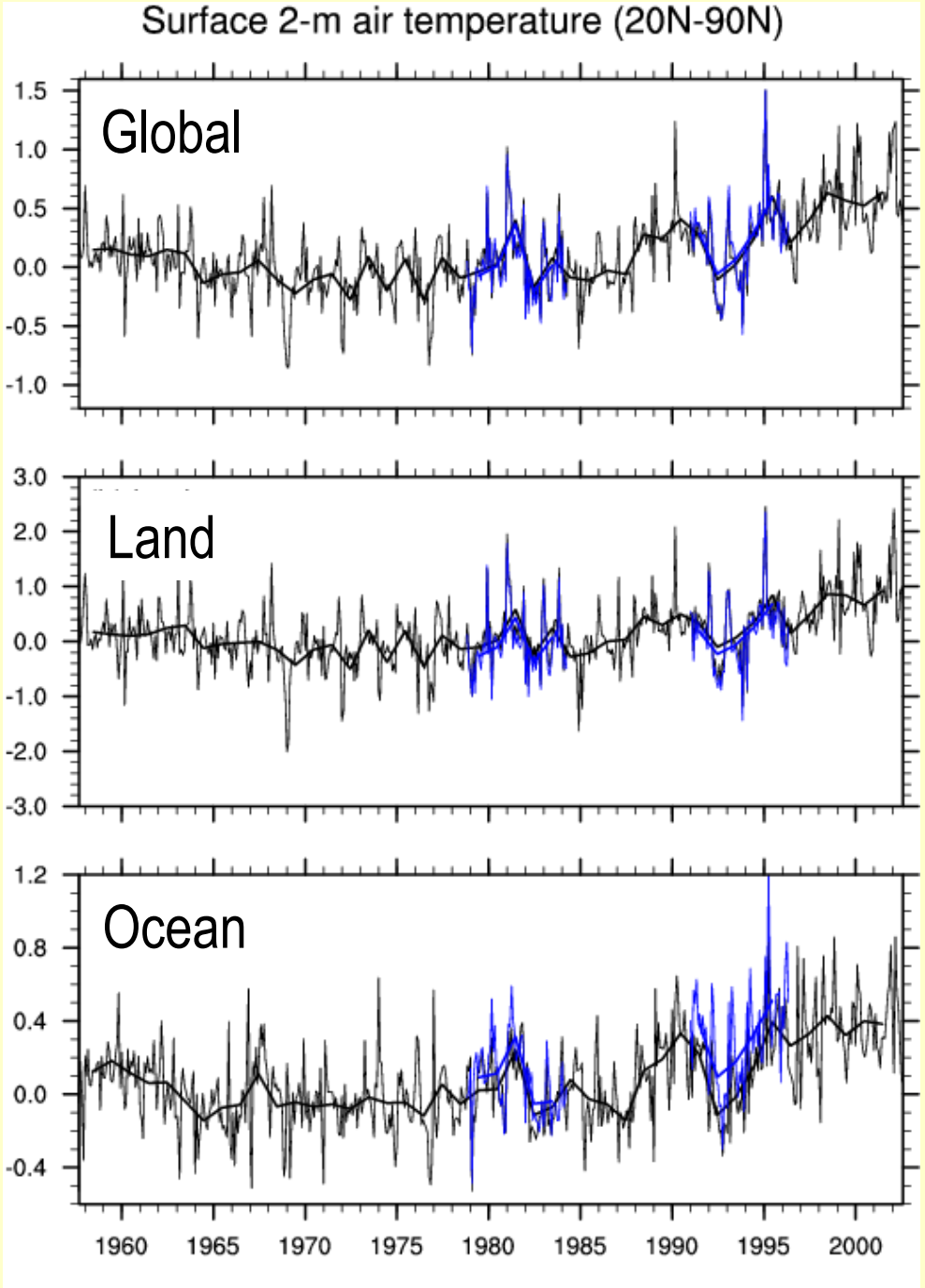
T2m is analyzed with 2D-OI in JRA-25.

ERA-40

JRA-25

Thin : monthly mean

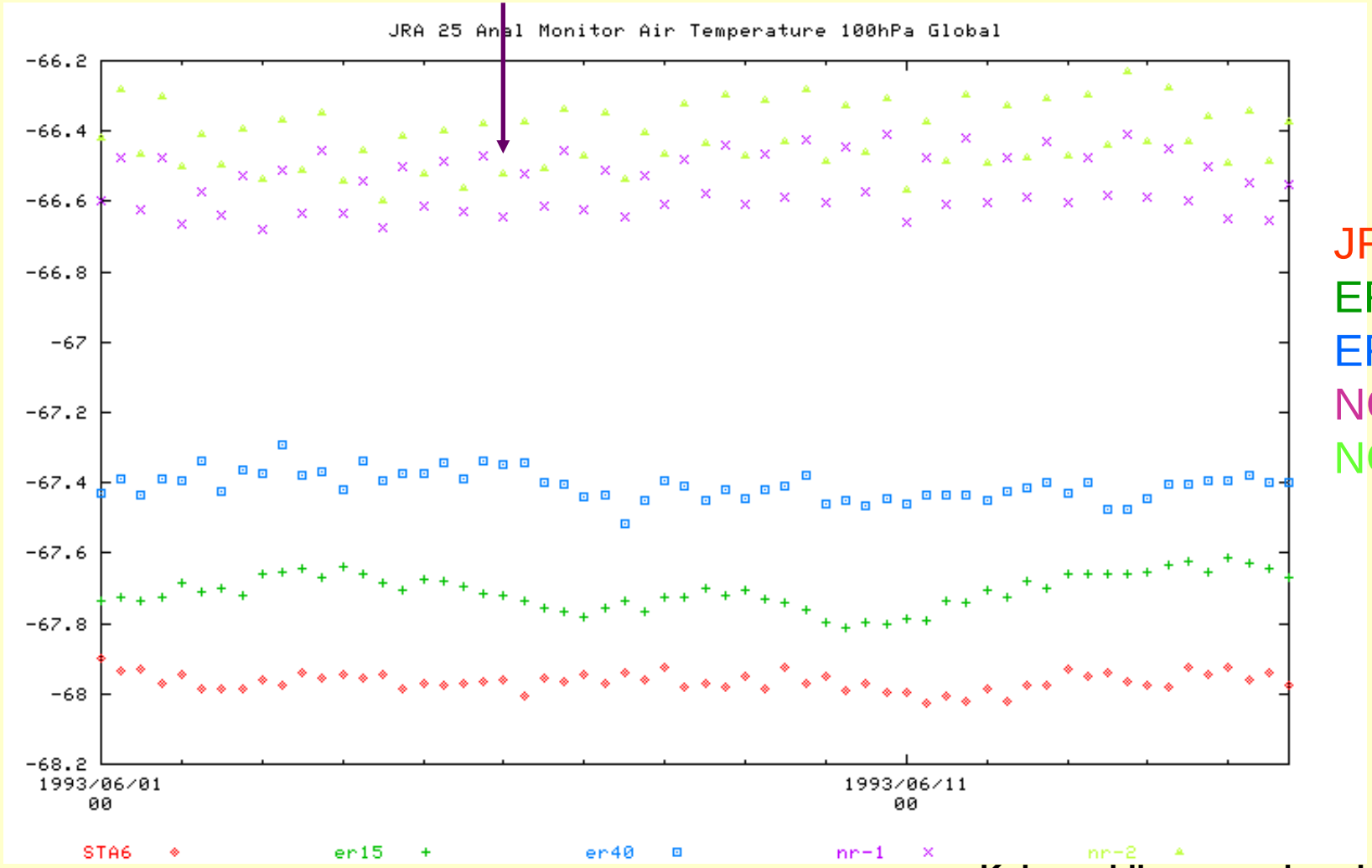
Thick : annual mean



Short time scale fluctuation

(example : Global T100 : 1993.6.1-15)

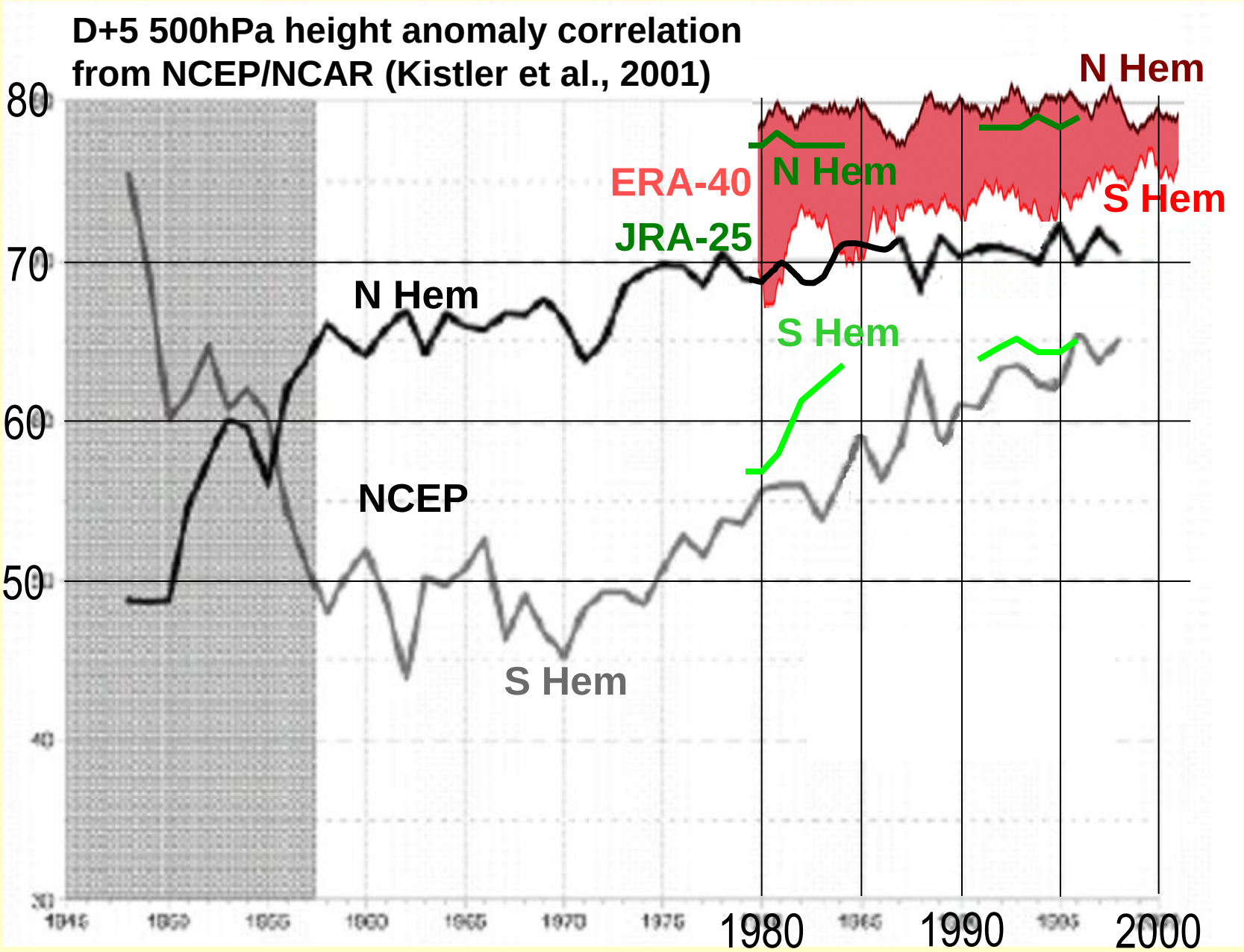
Apparent 12-hourly oscillations are found in NCEP R1 and R2.



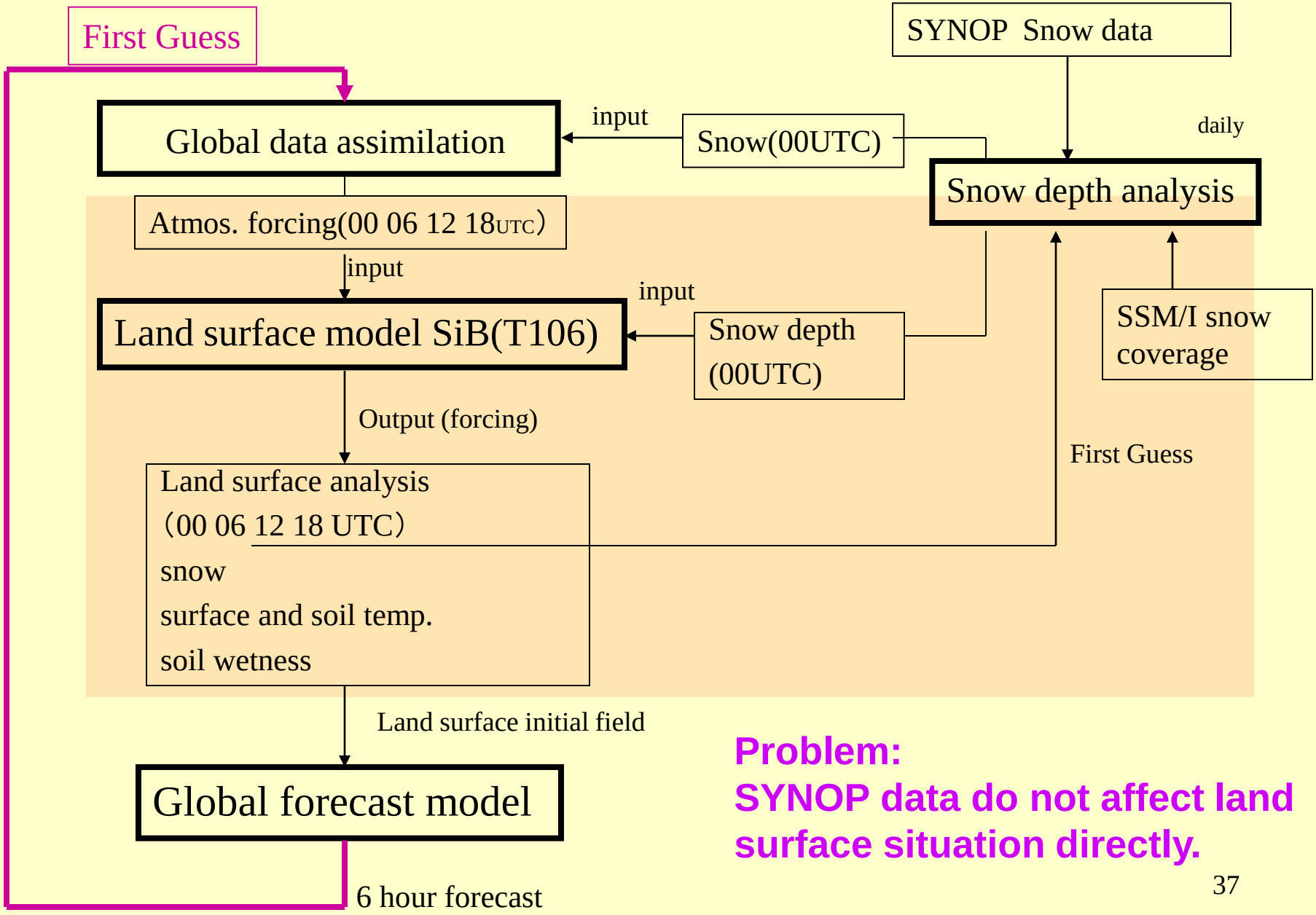
JRA-25
ERA-15
ERA-40
NCEP-R1
NCEP-R2

Kobayashi's comprehensive monitor

Comparison of forecast scores



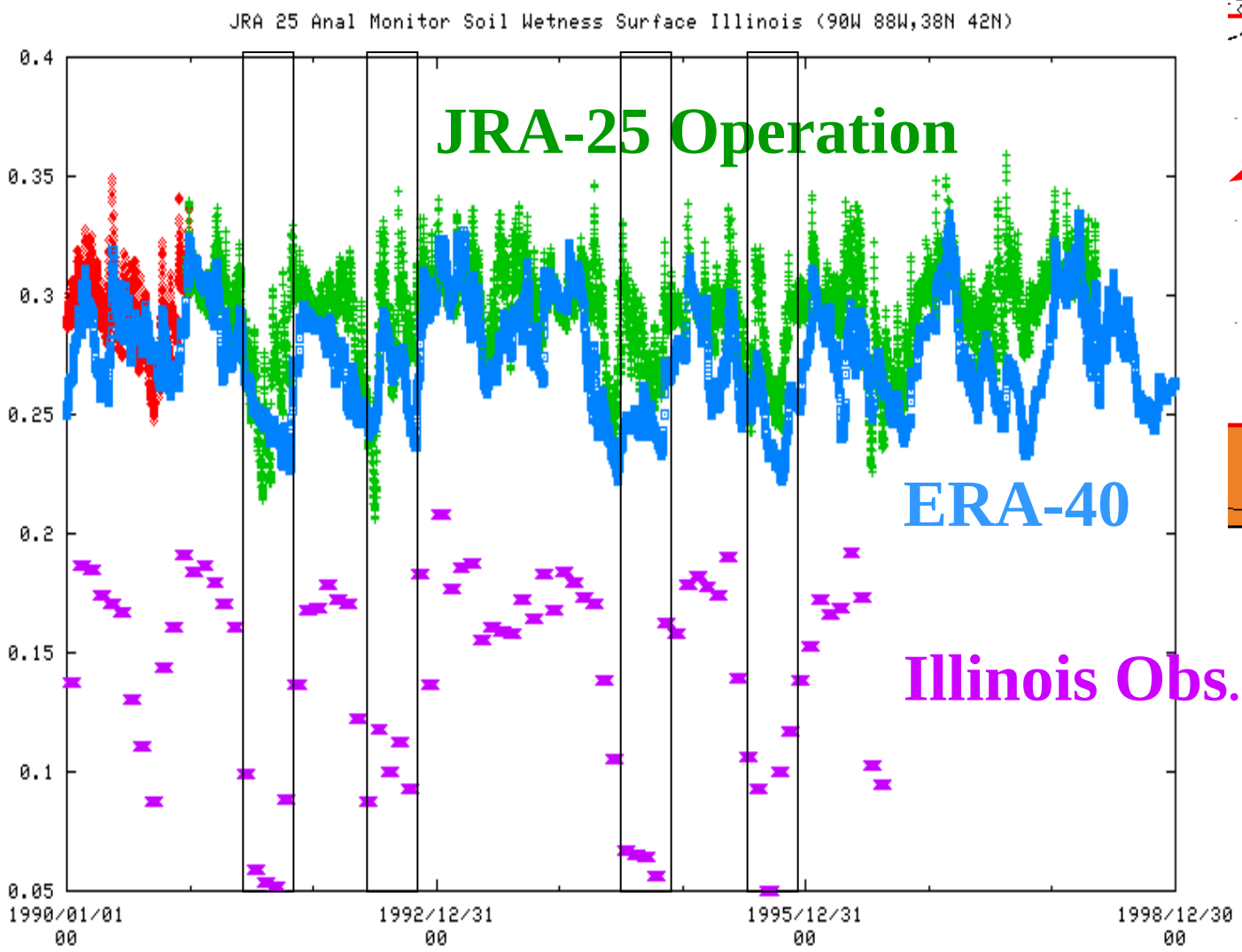
Land Surface Analysis in JRA-25 (T106)

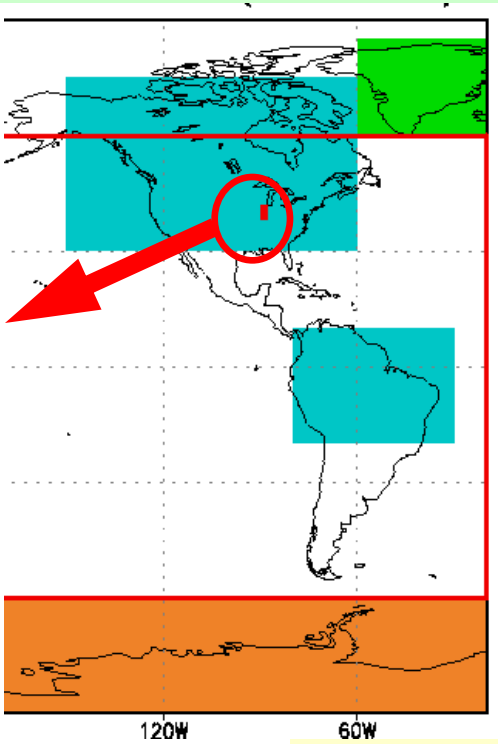


Problem:
SYNOP data do not affect land surface situation directly.

Product Detail

Soil Wetness in Illinois (Root Depth)





Summary

Advantages of JRA-25

- **Best performance of 6-hour precipitation**
  - Assimilating SSM/I PW effective without biases
  - Limited selection of TOVS channels led good performance
  - Not suffering from volcanic eruption
- **Best performance of low level cloud along subtropical western coasts**
  - Corresponding radiation improved as well
- **Good tropical cyclone analysis**
  - Thanks to Mike Florino
  - Very effective to data sparse area
- **Good snow analysis**
  - SSM/I snow cov.

Summary
Problems of JRA-25

- **Drying soil in Amazon**
- **Jumps of temperature** in the lower stratosphere and around the tropopause
  - Triggered by changes of TOVS data
  - Model bias of the temperature
  - JRA-25 is more sensitive to the changes than ERA-40.
- **Ripple-marked moisture over polar regions**
- **Mistake in the snow analysis until 1983**

- 2 streams (ST-B and ST-A) connect smoothly?

JRA-25 Product available via internet

- Basic products are available
- For research use only
- Registration to the JRA-25 evaluation group is needed.

  Just writing :

  Name and affiliation

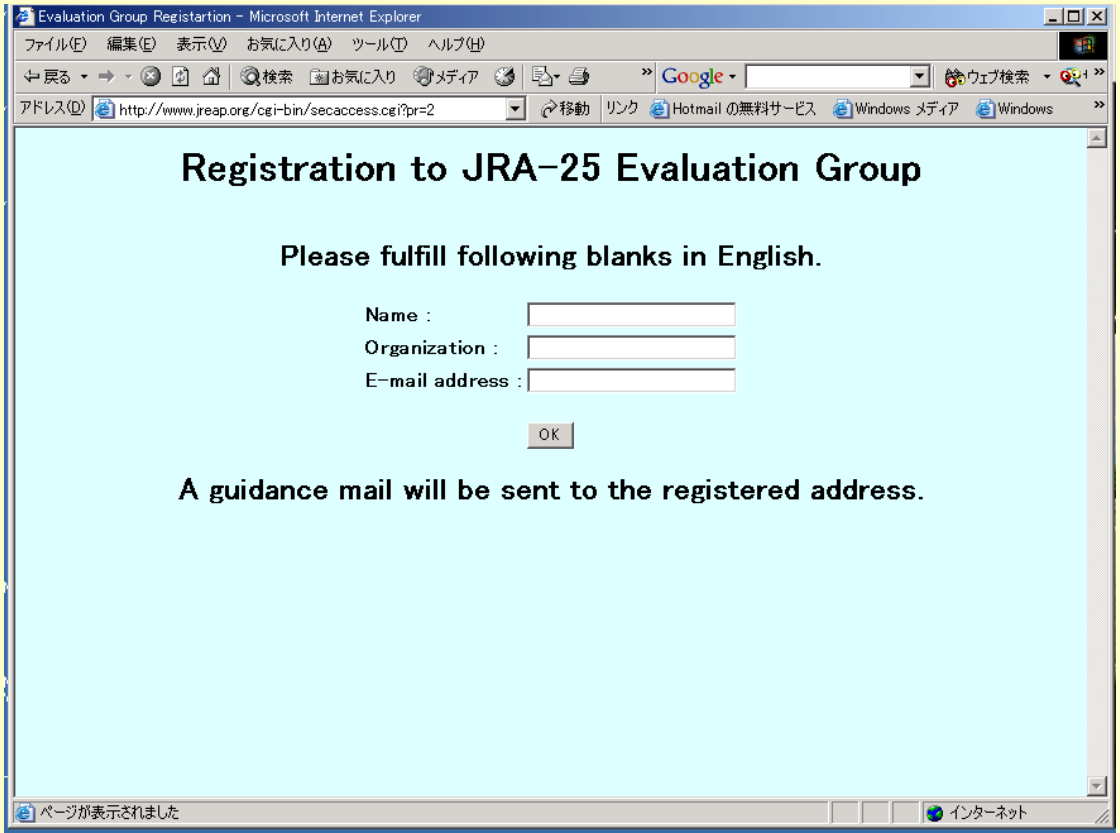
  (Purpose of your research briefly)

http://www.jreap.org/indexe.html

http://www.jreap.org/download/howto-e.html

Data distribution from http://www.jreap.org

Basic Dataset : up to 500GB in our web server.
Full Dataset : 7 TB and more. Not Available at present



Plans

- Comprehensive report of JRA-25
- JCDAS (JMA CDAS)
  - JRA-25 DA cycle will be continued in real time.
- 2nd Japanese reanalysis (JRA-50)
  - Project 2006-2011 (preperation period inclusive)
  - Reanalysis 1958-2010
  - Supercomputer JMA in house
    - HITACHI SR11000 (27.5 Tfrops)
  - TL319L60 (top 0.1hPa)
  - 4DVAR
  - Semi-Lagrangian scheme
  - Improved physics
    - Radiation, Gravity wave, boundary layer, …….
  - Improved land surface

Appreciation to ECMWF

- ERA-40 observation data were made available to JMA.
  - Conventional (NCEP/NCAR data merged)
  - TOVS/ATOVS level 1c
  - METEOSAT reprocessed AMV
  - Blacklists for ERA-40
  - VTPR (to be used in future)

For reanalysis activities

- International collaboration essential
  - Observational data available each other
  - Experiences of problems should be informed each other
  - Products should be opened.

Thank you.