

***A follow-up study of the TOVS application
for the Japanese Climatic Reanalysis: JRA-25***

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- What's a climatic reanalysis? What's JRA-25?
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4.Summary

JRA-25: another second-generation reanalysis

- was achieved in 2006 as a co-operative research project between Japan Meteorological Agency (JMA) and the Central Research Institute for Electric Power Industry (CRIEPI).
- took over the observation database from ERA-40.
- used a modified the JMA operational Global Spectral Model (GSM) and 3D-VAR assimilation system at the time.
- developed a TOVS assimilation system, because JMA had not experienced operational TBB assimilation of TOVS before.

Features of JRA-25 and ERA-40

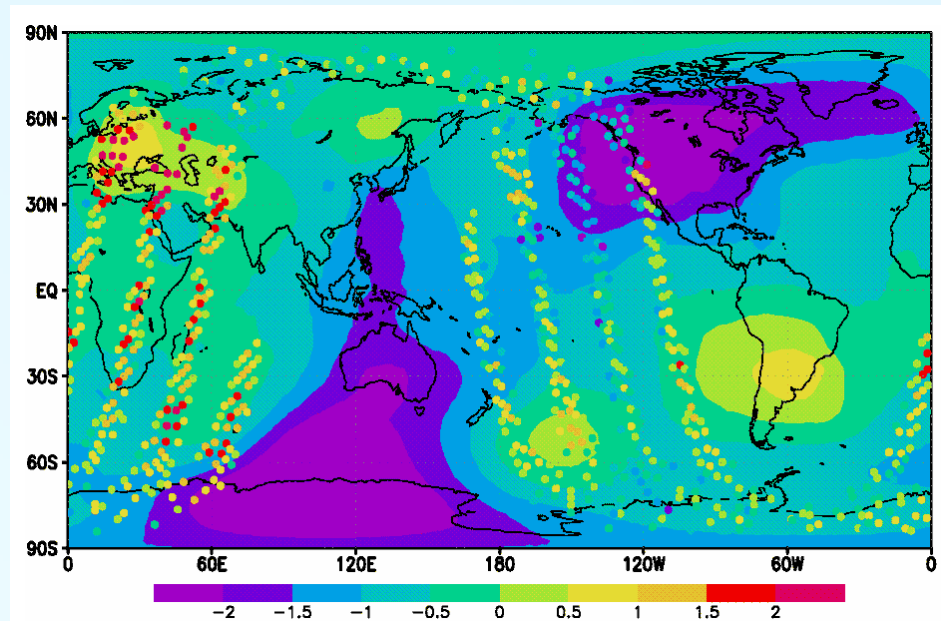
	Target period	Resolution	GCM	Assimilation
JRA-25	1979 – 2004	T106L40	Spectral Model	3D-VAR
ERA-40	1957 - 2002	TL159L60	Semi-Lagrangian Model	3D-VAR

T106 and TL159 have the same horizontal resolutions about 110km.

JRA-25 is now available on our web site: <http://jra.kishou.go.jp/>

Problems in JRA-25 system

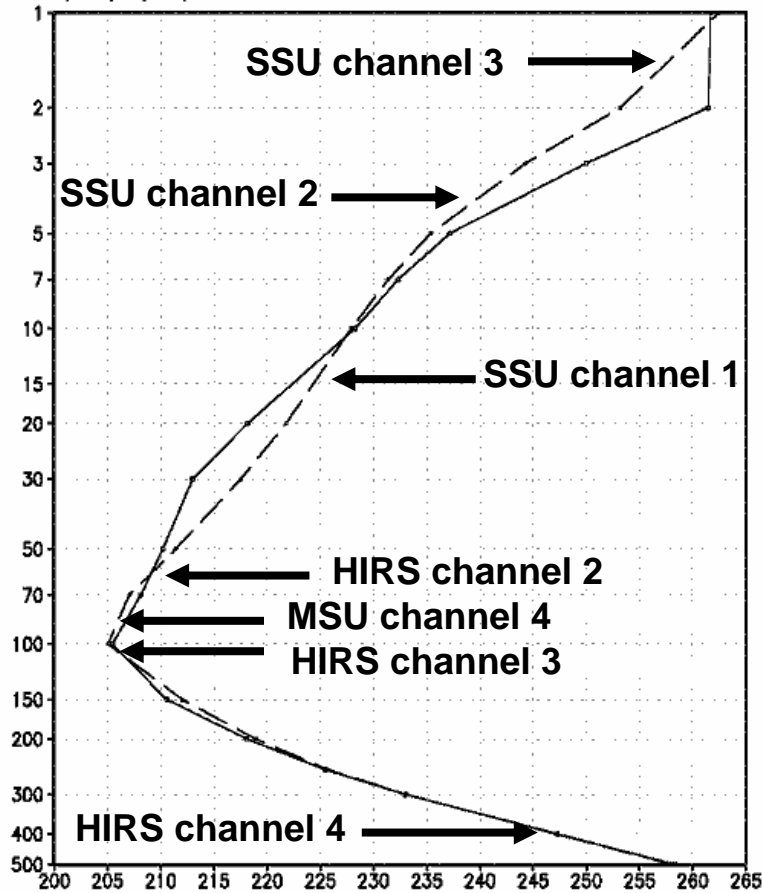
- JRA-25 did not have any time-coincident arrangement. There was difference in time between an observation and the corresponding background up to 6 hours.
- JRA-25 used an initialization procedure for a convenience of calculation. The upper boundary was handled as rigid terminal in vertical spectral modes, and statistical diurnal modes prepared beforehand substituted for diurnal change in GCM.



SSU channel 2 departure (K) and Temperature Increment (K) at 5 hPa in a impact study prior to JRA-25. Difference between Thermal Profile in the Background and observation TBB are considerably large, and fake impacts appears in no-obs areas.

Lower Stratospheric Temperature Tendency

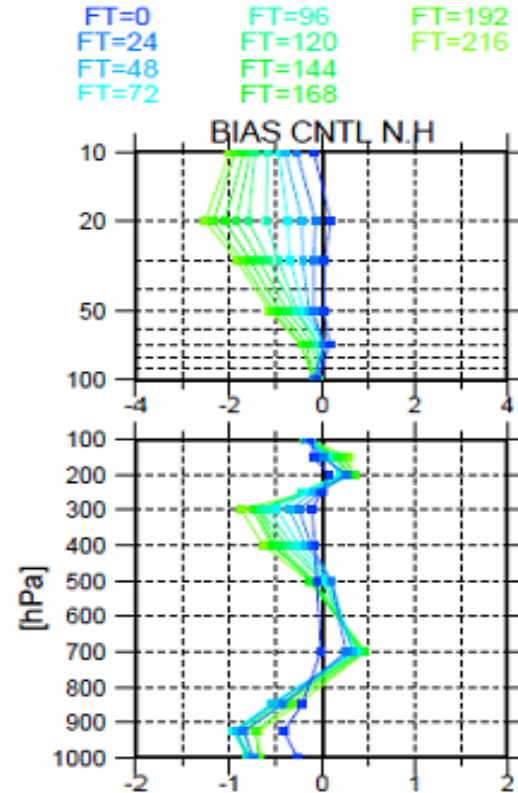
Global averaged Temperature (K)



averaged for the period from Jun. 1995 to Apr. 1997

—— JRA-25 - - - - ERA-40.

GSM Thermal Bias Profile (K)

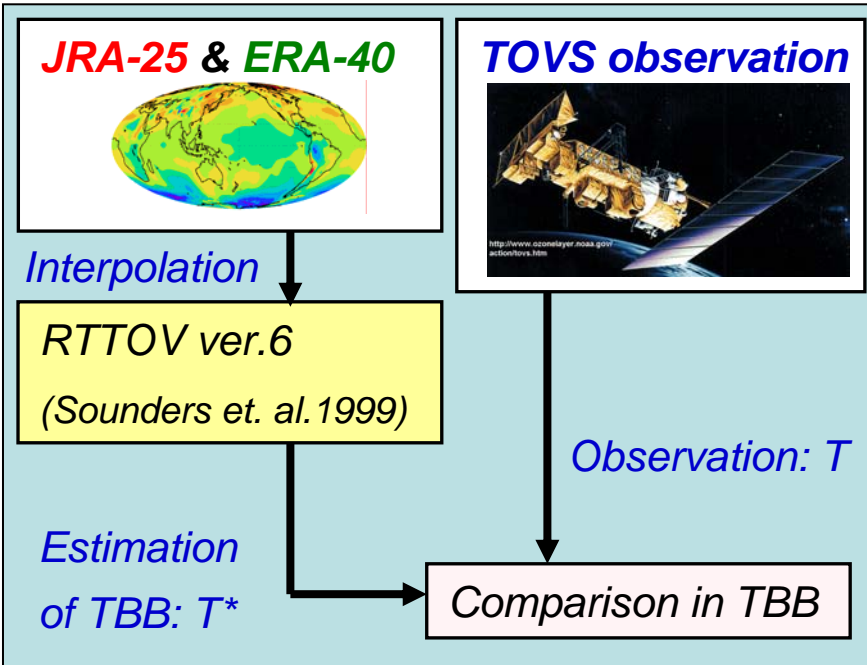


FT=0 to 216 show forecast time, as a forecast go along, the bias increase in the mid-stratosphere and the upper troposphere.

After Murai, Yabu and Kitagawa 2005:
'Development of a New Radiation Scheme for the Global Atmospheric NWP Model'

Comparison with ERA-40 and TOVS

How to compare with TOVS observation;



- A real observation TBB: T (K)
- A Reanalysis derived TBB: T^* (K)
- Standard Deviation of T : S_{DT} (K)
- Departure from a Reanalysis: DT (K)
 $DT = \text{global average}(T - T^*)$
- Standard Deviation of DT : S_{DD} (K).
- Difference in Bias: DB (K)
 $DB = DT_{JRA-25} - DT_{ERA-40}$
- Dependency : DP (%)
 $DP = 100(\%) * (S_{DT} - S_{DD}) / S_{DT}$

What DB means are;

When DB is larger than zero, JRA-25's T^* is lower than ERA-40's.

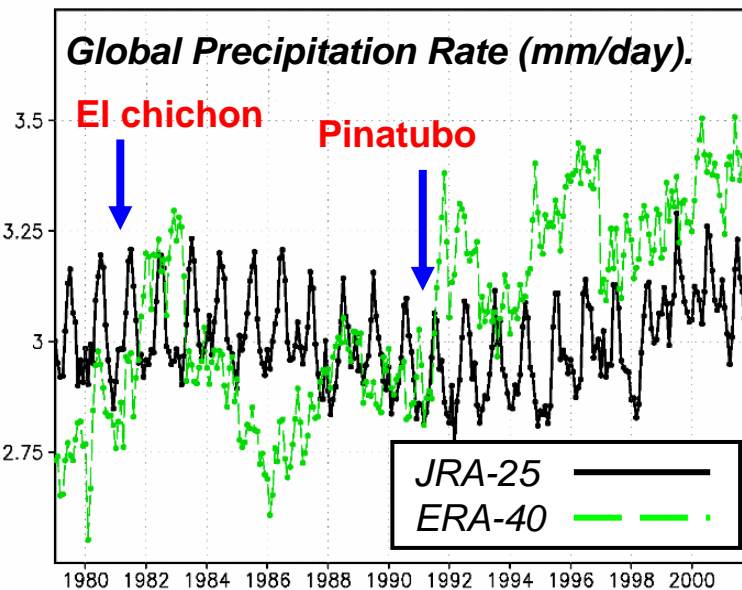
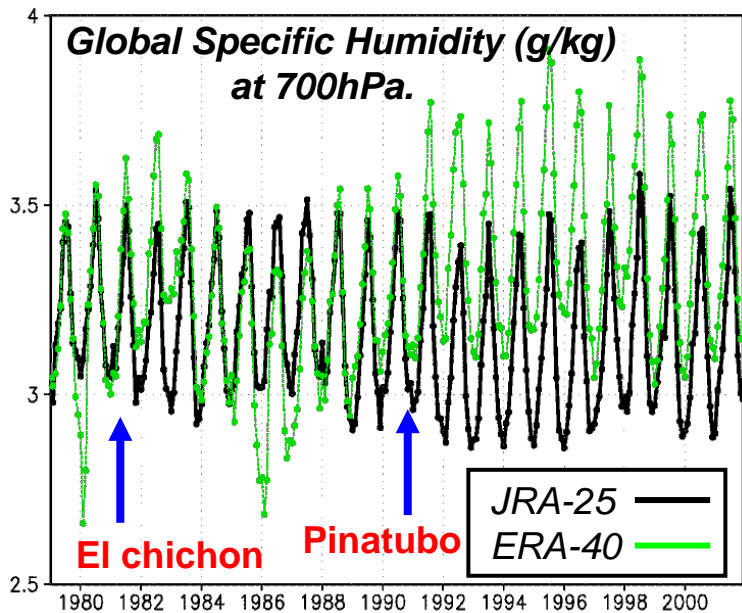
When DB is smaller than zero, JRA-25's T^* is higher than ERA-40's.

What DP means are;

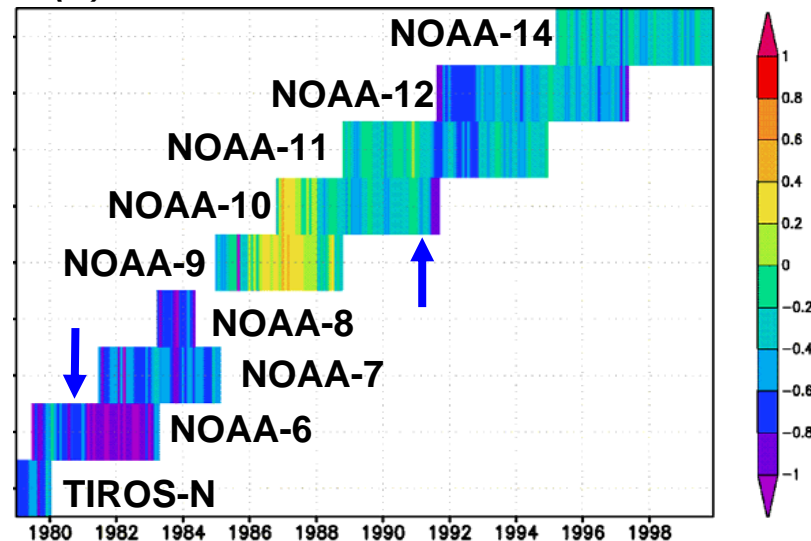
When DP for JRA-25 is larger than it for ERA-40, JRA-25 depends on the observation more.

When DP for JRA-25 is smaller than it for ERA-40, ERA-40 depends on that more.

Comparison in Water Vapor

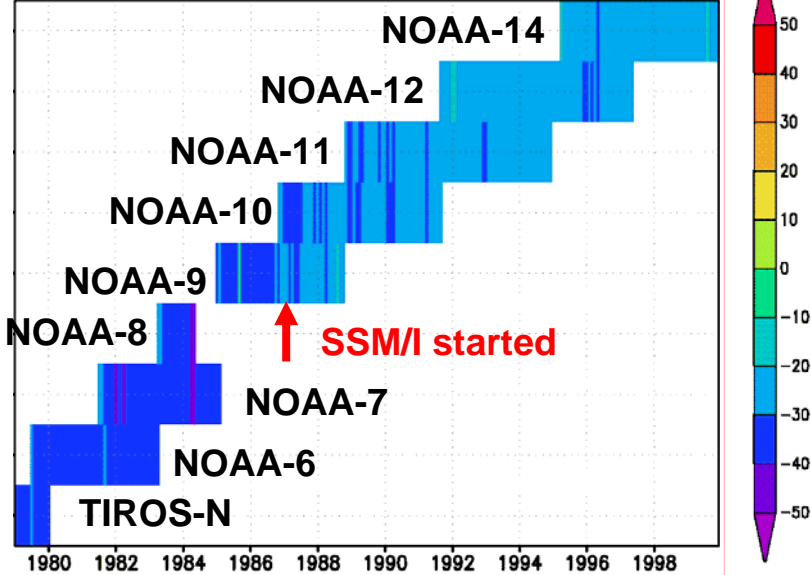


DB (K) for HIRS channel 11: $DT_{JRA-25} - DT_{ERA-40}$



Difference in DP (%) for HIRS channel 11:

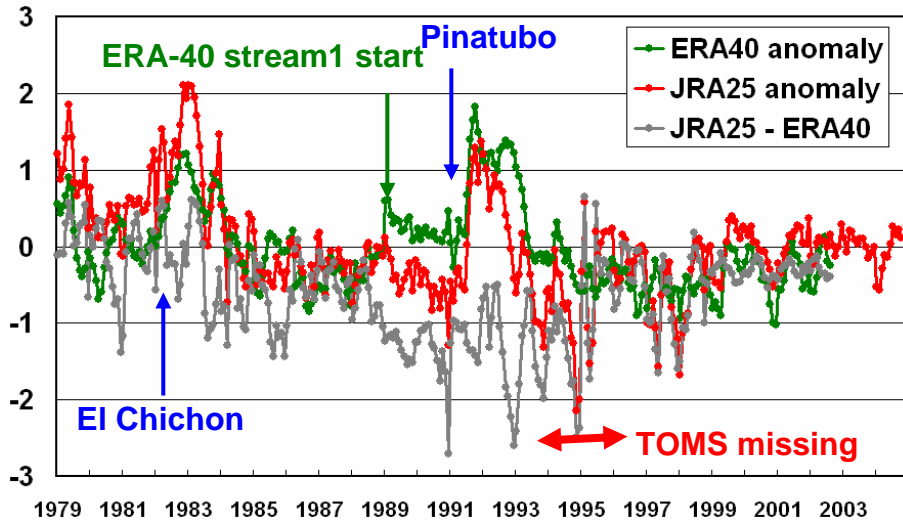
$DP_{JRA-25} - DP_{ERA-40}$



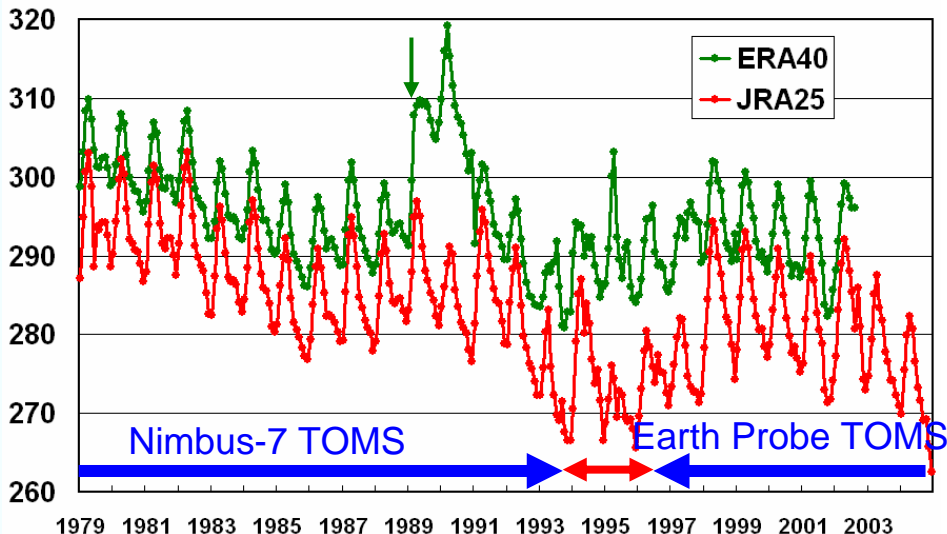
Comparison in lower stratospheric temperature

Why MSU-4 of NOAA-10, 11, 12 had different impact on JRA-25 and ERA-40?

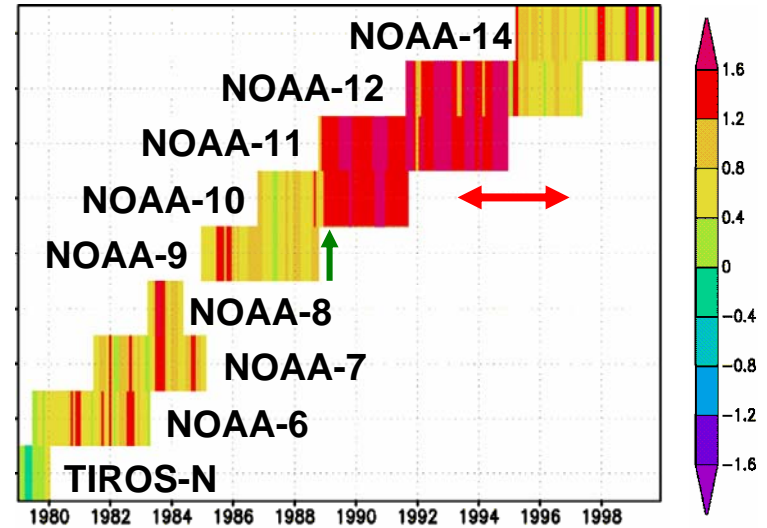
Global Temperature 50-100hPa (K)



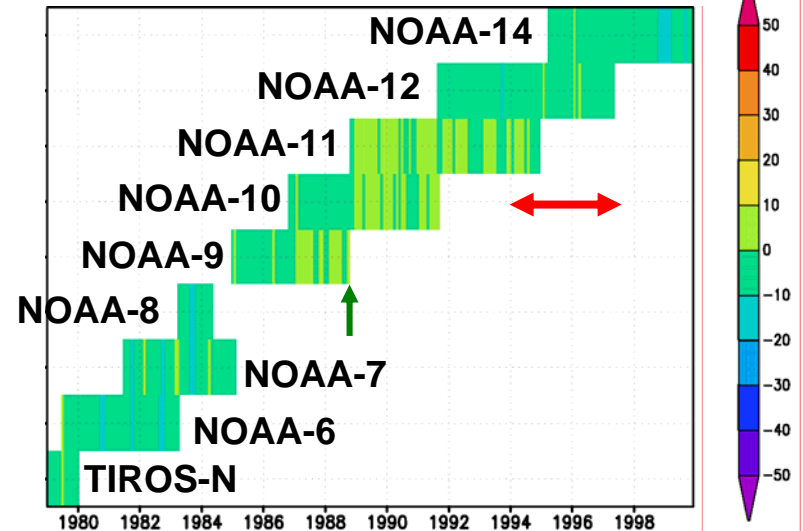
Global Mean Total Column Ozone (DU)



DB (K) for MSU channel 4: $DT_{JRA-25} - DT_{ERA-40}$



Difference in DP (%) for MSU channel 4: $DP_{JRA-25} - DP_{ERA-40}$



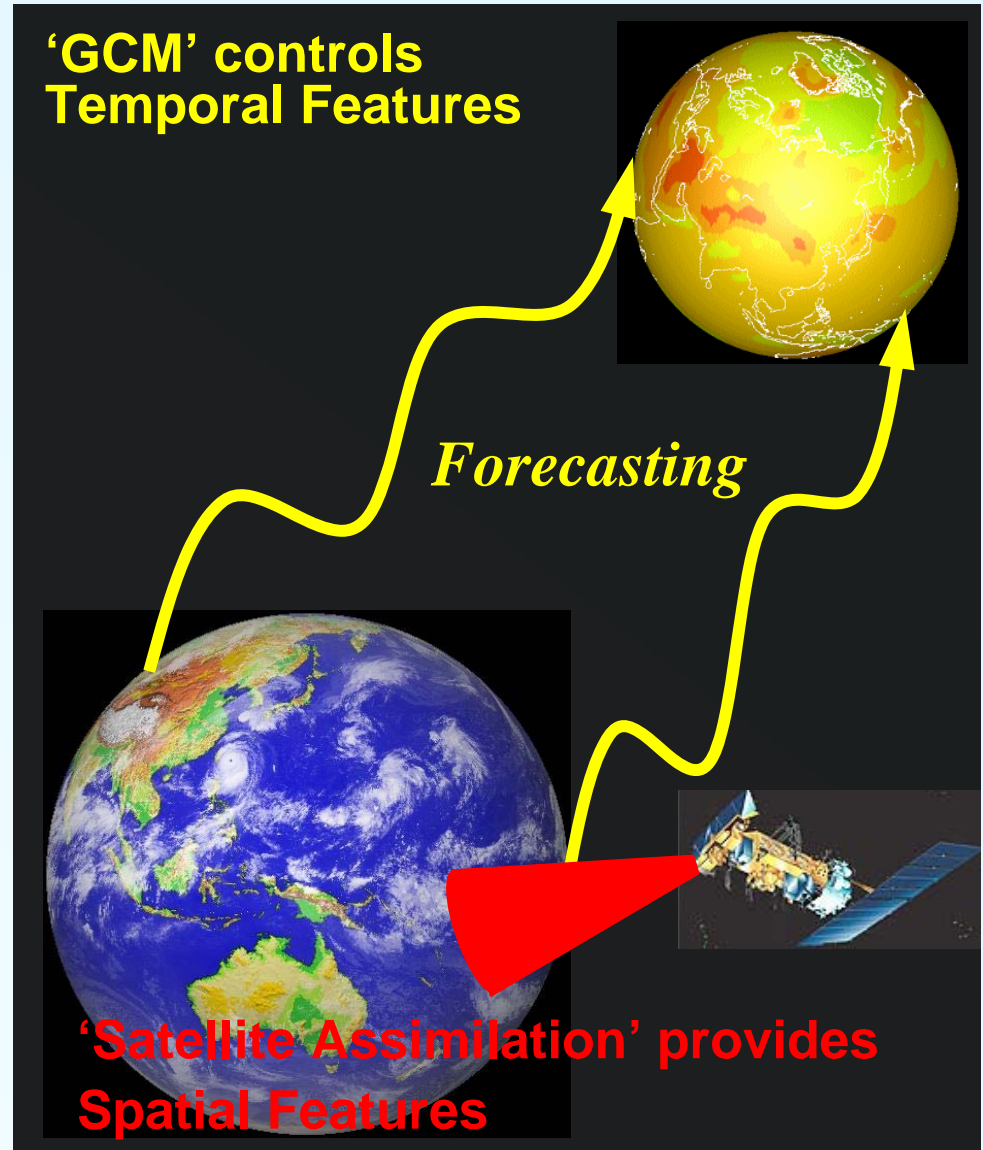
What can improve a next reanalysis ?

General Idea

So far, an Assimilation, like OI or 3D-VAR, provides 'spatial features', and GCM controls 'temporal features'.

Satellite Assimilation provides climatic trends and events in two ways. (Climatic Reanalyses)

1. Satellites provide better initial condition for GCM, and contribute to better temporal behaviors.
2. Biases (from the background) directory induce climatic trend and events.



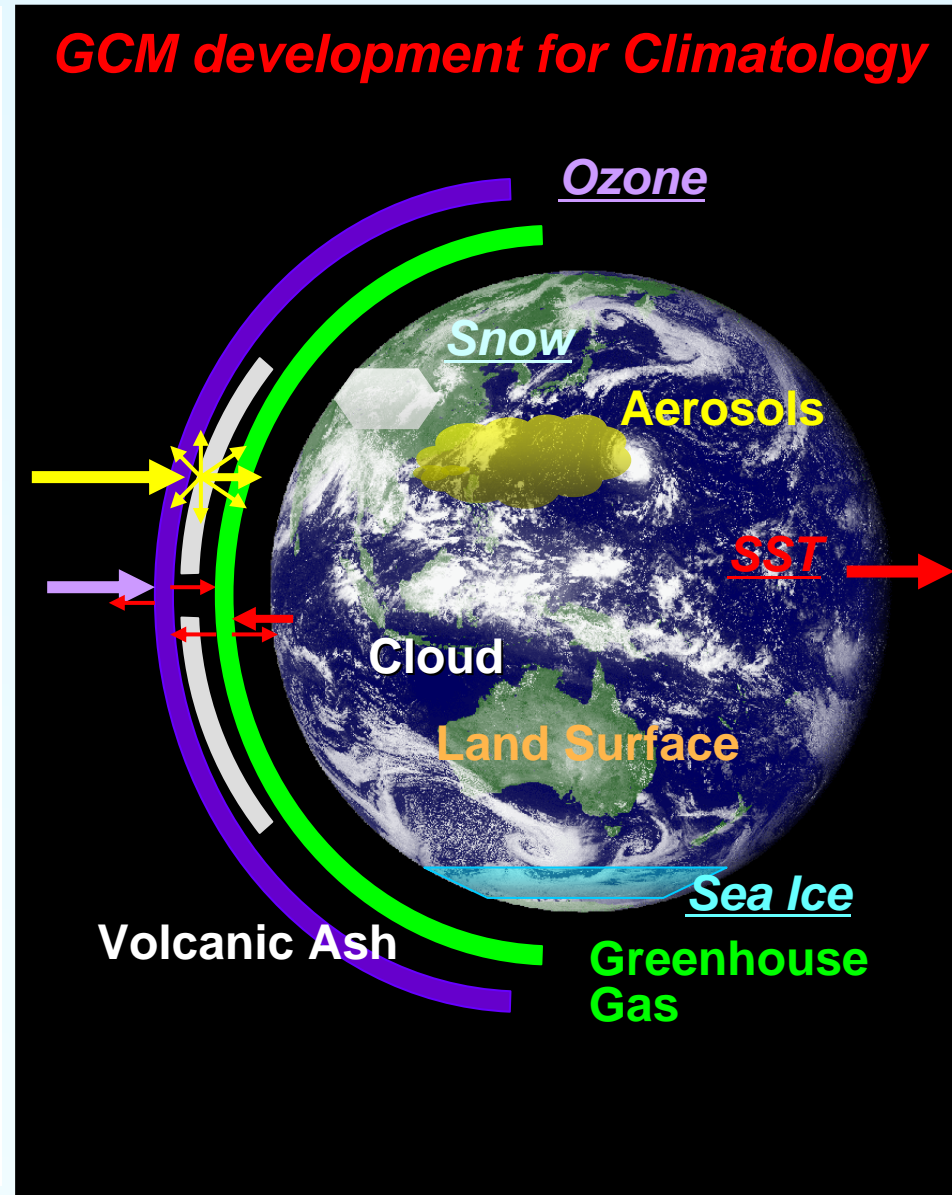
GCM development for Climatology

Without GCM developments aimed at climatological trends and events, more consistent applications of Satellite Sounding Systems is impossible.

[i.e. Observation missing can induce discontinuity, an adoptive bias correction arrangements might mislead climatic trends.]

Such GCM developments require many consistent forcing datasets. Some of them are still under development.

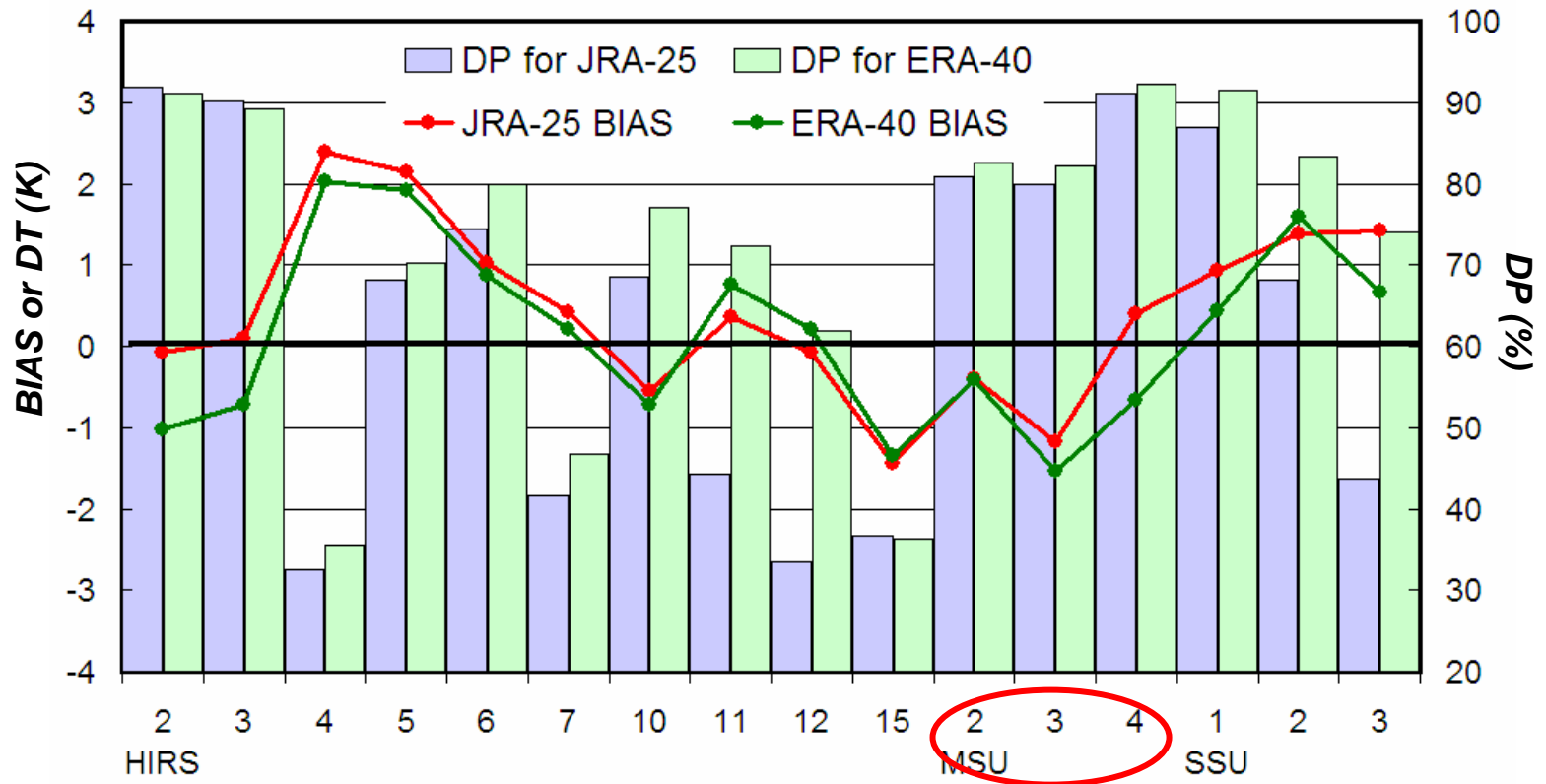
If such developments are insufficient, we have to rely on some 'trend-setting' observation. The most reliable observation system with long-term global coverage will be still 'Satellite Sounding System' !



What can be the best 'Climatic Trend Setter' ?

- Microwave Thermal Sounding Units (MSU / AMSU-A) should be the best candidates.
- HIRS can supplement precise spatial features with an adaptive bias correction arrangement.

Averaged DT (BIAS) and DP for JRA-25 / ERA-40 for Jan. 1979 - Dec. 1999



Summery

JRA-25 attained the following results with sparser TOVS application;

1. Relatively consistent tropospheric water vapor and precipitation,
2. Lower stratospheric thermal tendencies well corresponding to the ozone concentration trend.

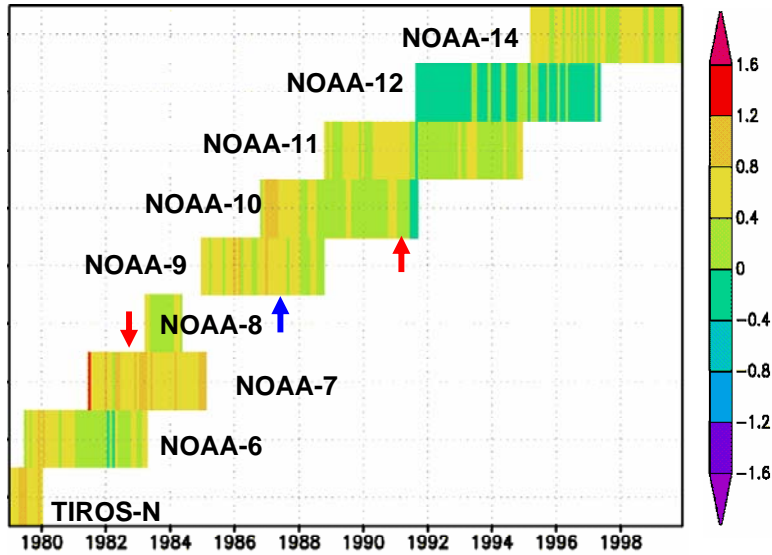
For a next reanalysis, the following strategies would be desirable;

- a. GCM improvement to describe climatic trends and events
- b. Sensible Instrumental Usage in an assimilation process
 - MSU (AMSU-A) can provide most accurate trends, and can be used as 'climatic trend-setter' without an adaptive bias correction arrangement
 - HIRS (HIRS/2, HIRS/3) can provide Precise Spatial Features with an adaptive bias correction.
 - SSU can provide large-scale climatic features in the upper stratosphere with adaptive bias correction.
 - VTPR has difficulty in cloud detection, and should be used to provide better spatial features to initial fields for GCM forecasting.

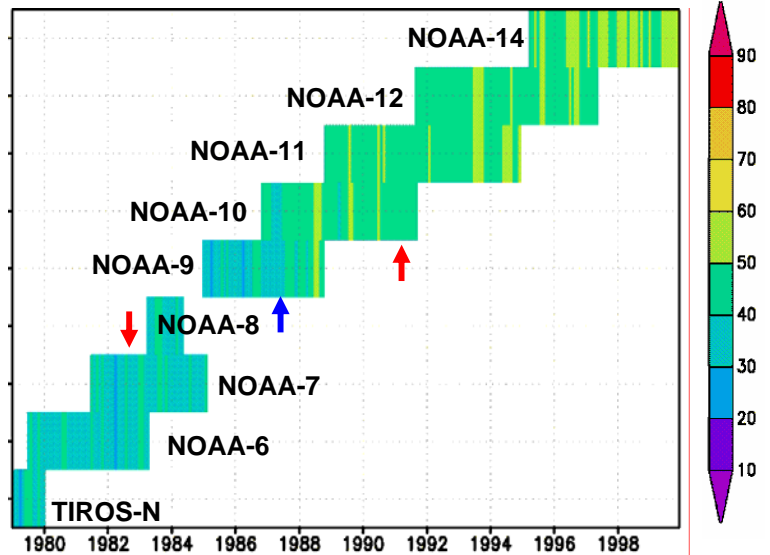
Thank you for listening

Grazie!

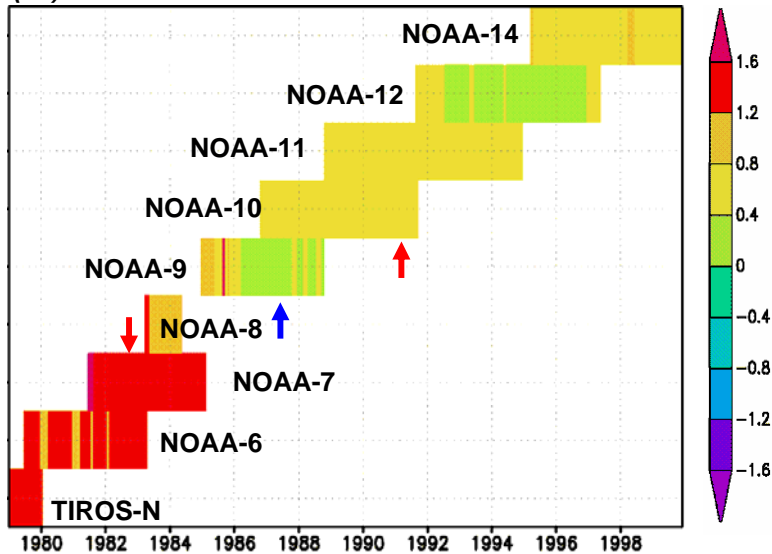
DT(K) for JRA-25



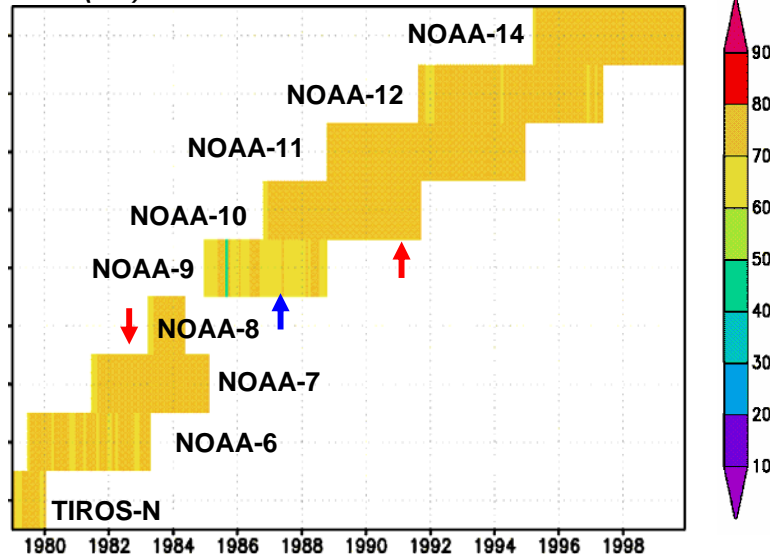
DP(%) for JRA-25



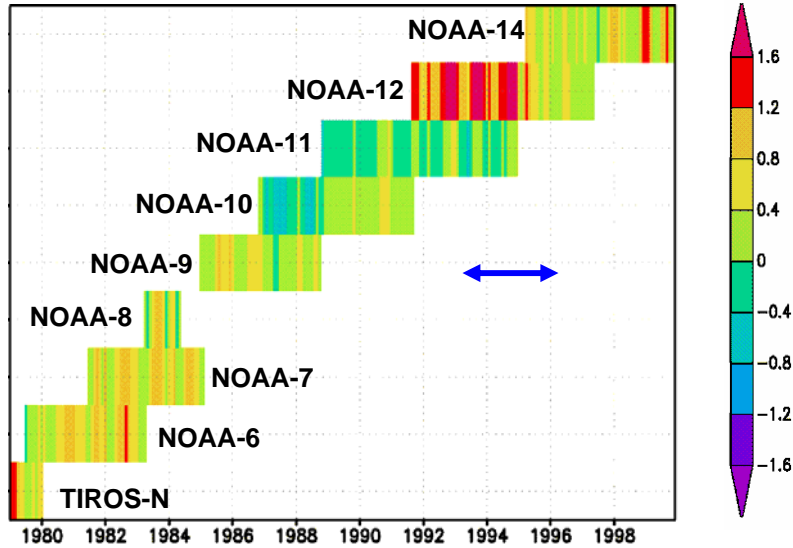
DT(K) for ERA-40



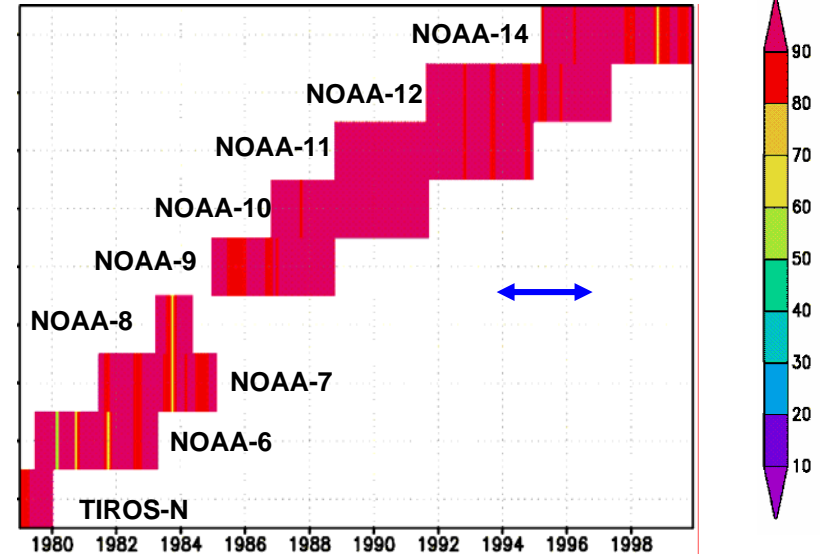
DP(%) for ERA-40



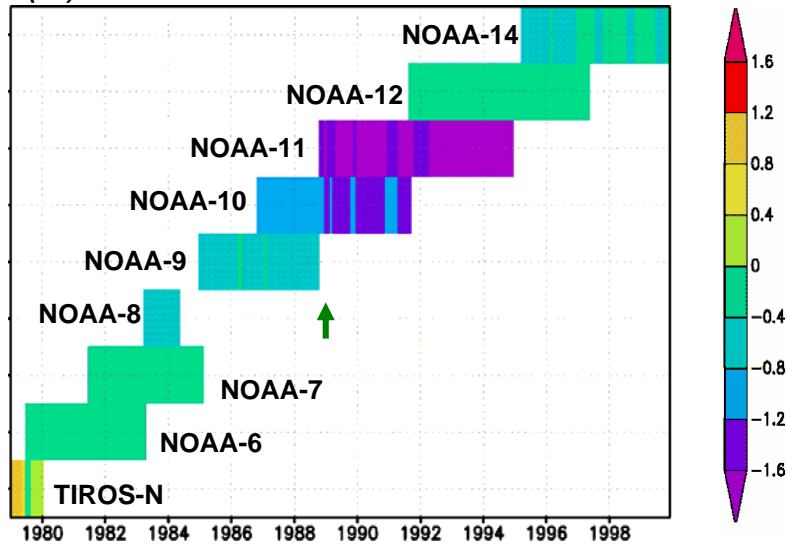
DT(K) for JRA-25



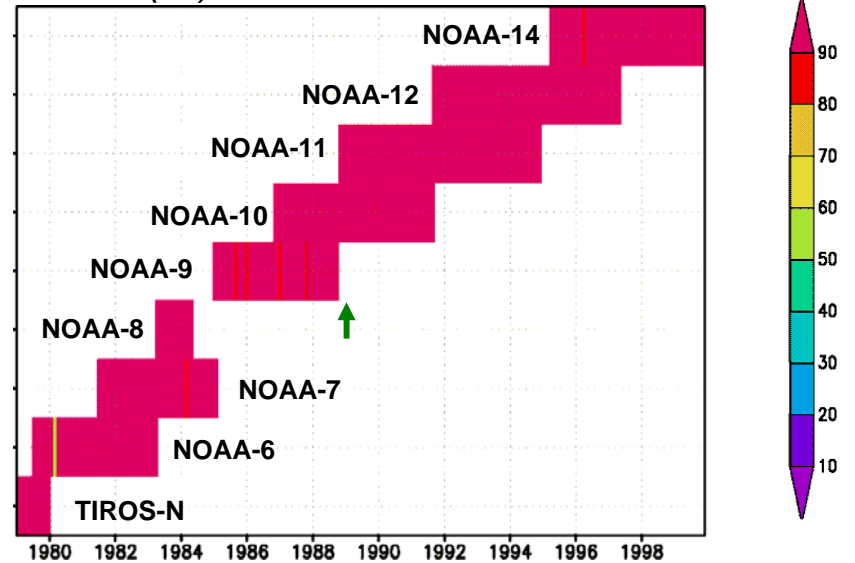
DP(%) for JRA-25



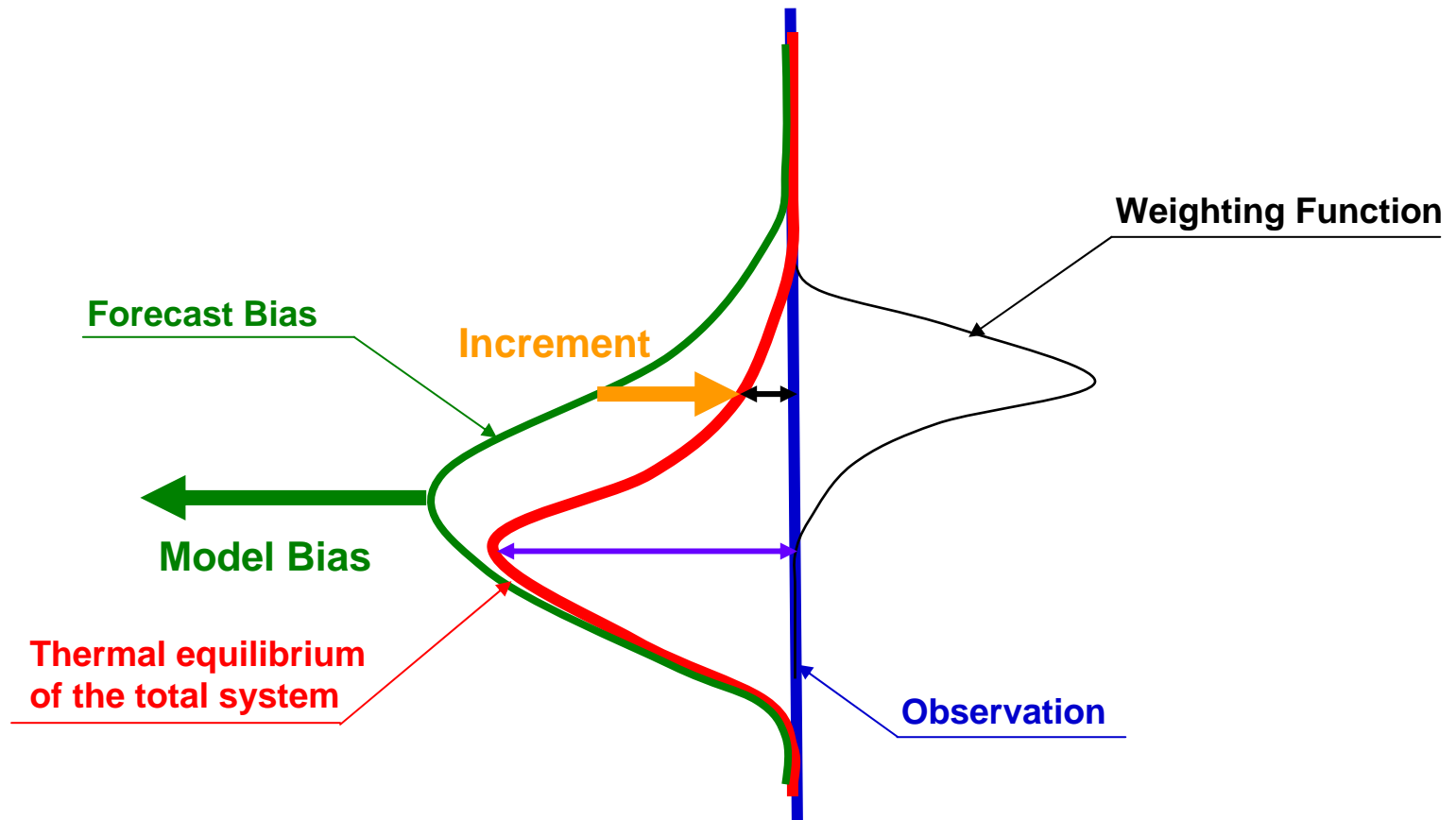
DT(K) for ERA-40



DP(%) for ERA-40



Lower Stratospheric Temperature Tendency

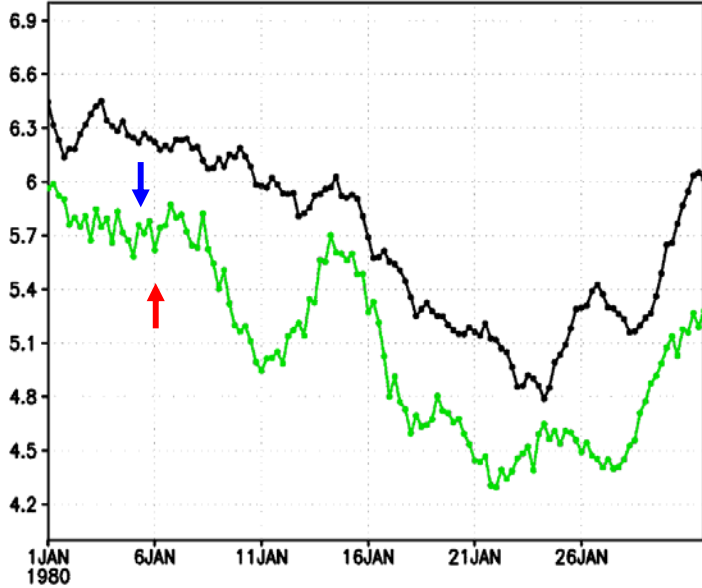


$$\text{Analyzed Field} = \text{Forecast} + \text{Assimilation} + \text{"?"}$$

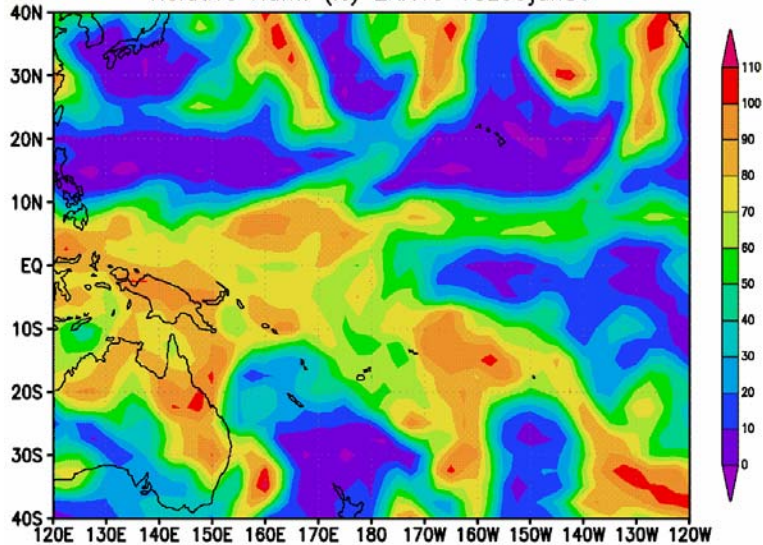
If forecast bias is remarkable and difference in observation bias correction is rather smaller, Difference is small ***around peaks of weighting*** function and large ***in between them***.

Spec. Hum. At 700hPa in Cent. Pacific

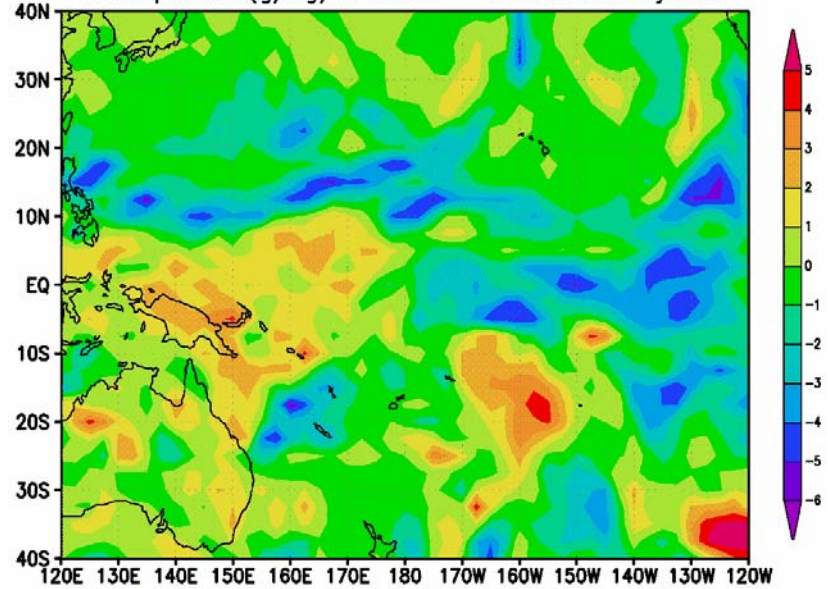
Specific Humidity 700hPa : 20S - 20N, 150E-150W



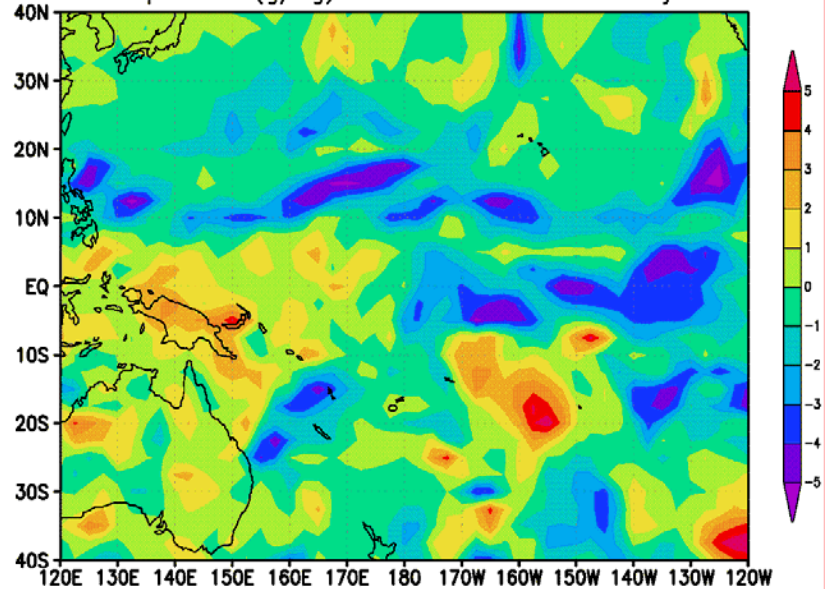
Relative Hum. (%) ERA40 18z05jan80



Dif. Spc.Hum(g/kg) : ERA40 - JRA25 18z05jan80



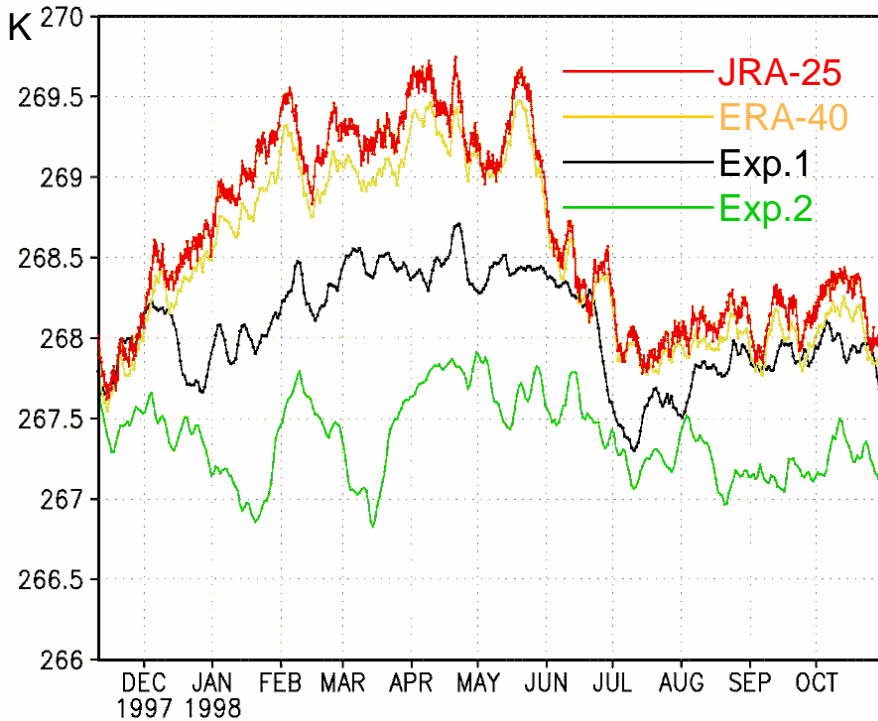
Dif. Spc.Hum (g/kg) : ERA40 - JRA25 00z06jan80



Oct. 4 2006

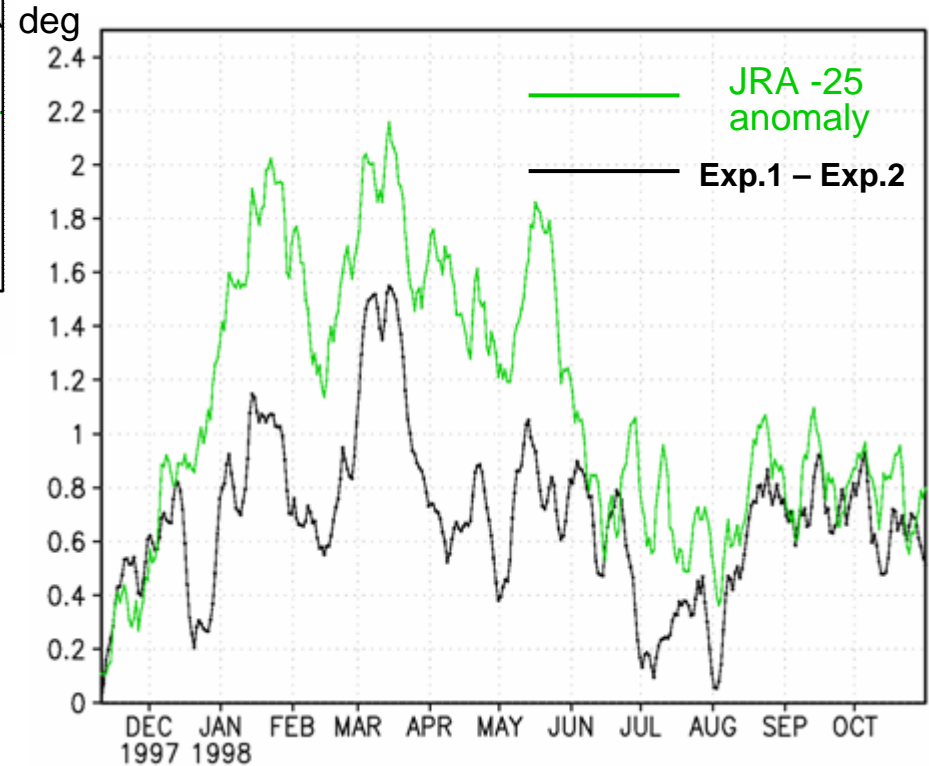
ITSC-15 4.2 Masami Sakamoto

Temperature 850 – 300hPa (S20-N20) in GCM Experiments



Exp.1: JMA TL319L40 with KOBE-SST
(analyzed SST) 1 year run.
from Nov. 10, 1997 to Oct. 31, 1998

Exp.2: JMA TL319L40 with normal SST
(derived from KOBE) 1 year run.
from Nov. 10, 1997 to Oct. 31, 1998

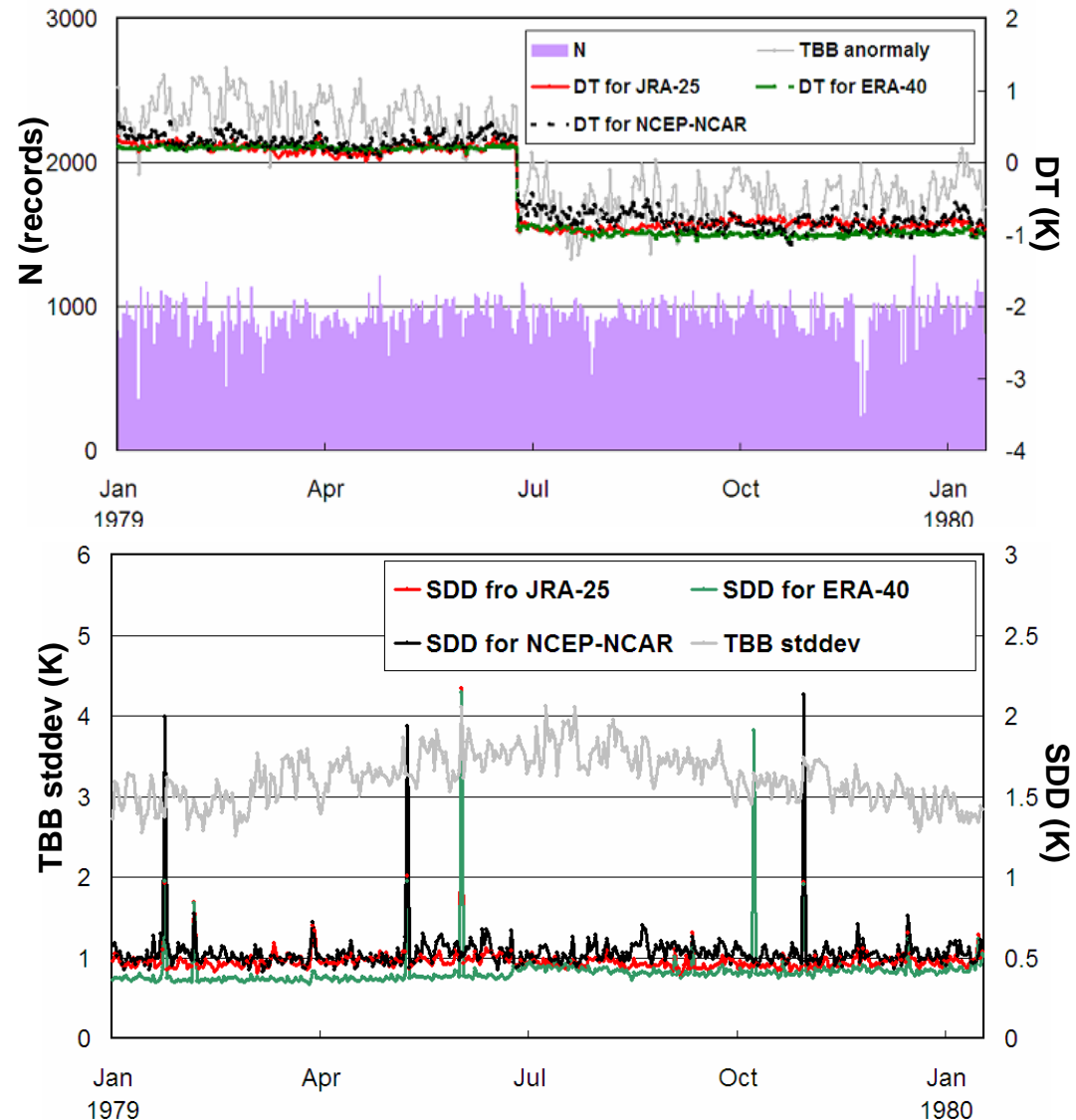


SST sure have potential to describe the tropospheric climatological features.

Microwave Sounding Unit (MSU)

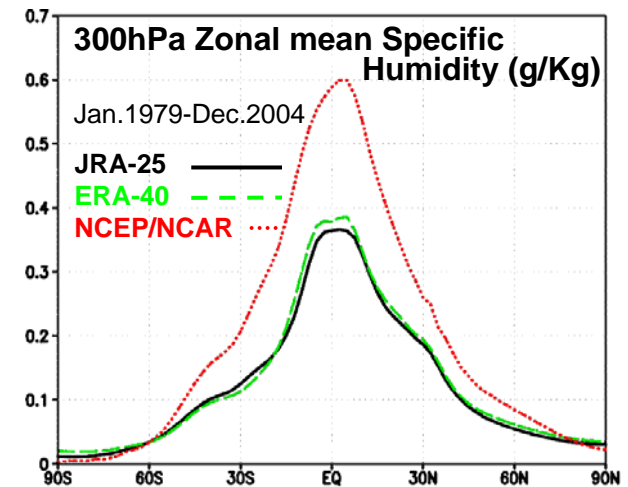
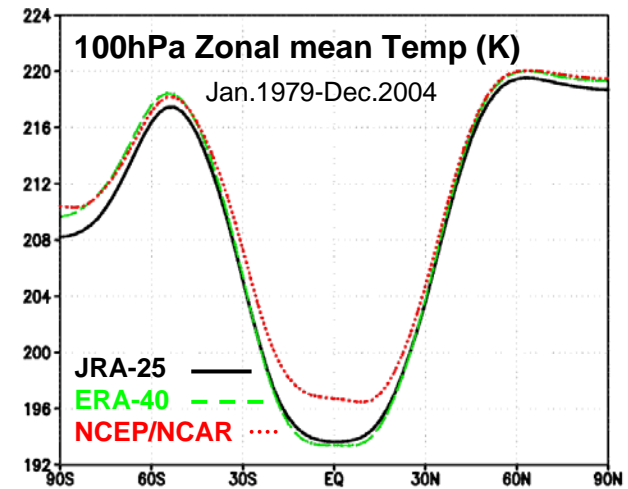
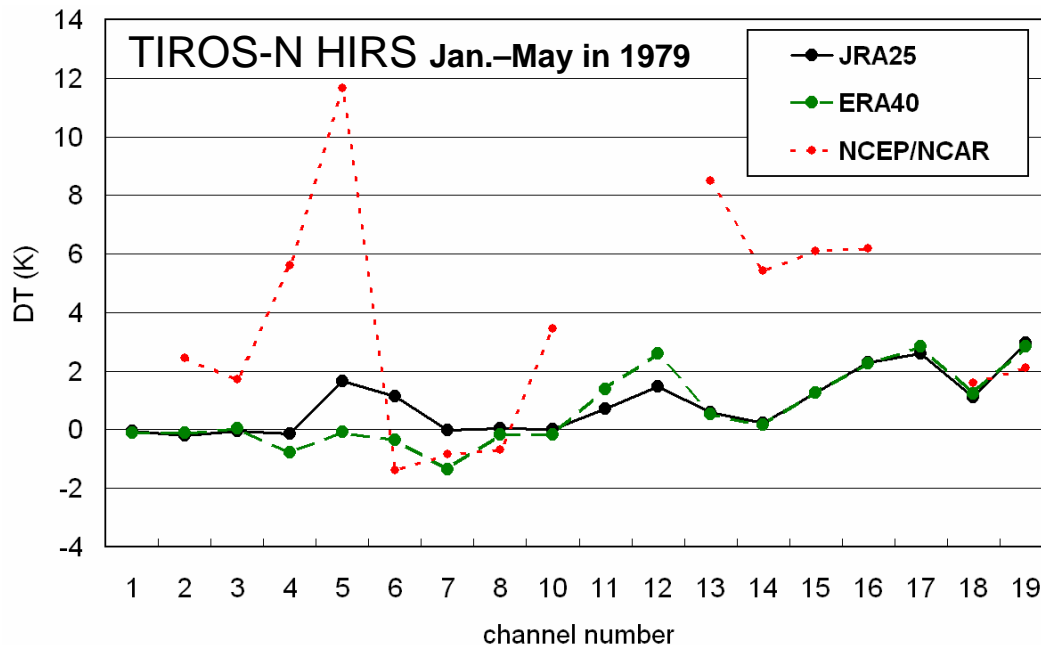
- DTs for all the reanalyses seem quite stable, show a good agreement.
- When observation error periods, SDDs and DTs for all of the reanalyses clearly reveal the error existences.
- e. g. , When NOAA-6 came into operation, TIROS-N's channel-2 TBB shifted. All the reanalysis shows similar DT and similar SDD. That probably shows effective information would have left, after the event.

TIROS-N MSU channel 2



High-resolution Infrared Radiation Sounder (HIRS)

- For NCEP/NCAR, DTs are different from and larger than other two, because its upper climate is quite different.
- Among these climatic reanalyses, ERA-40 shows the best agreement with HIRS, because it relied on the observation most.
- JRA-25 has some room to use HIRS more effectively.



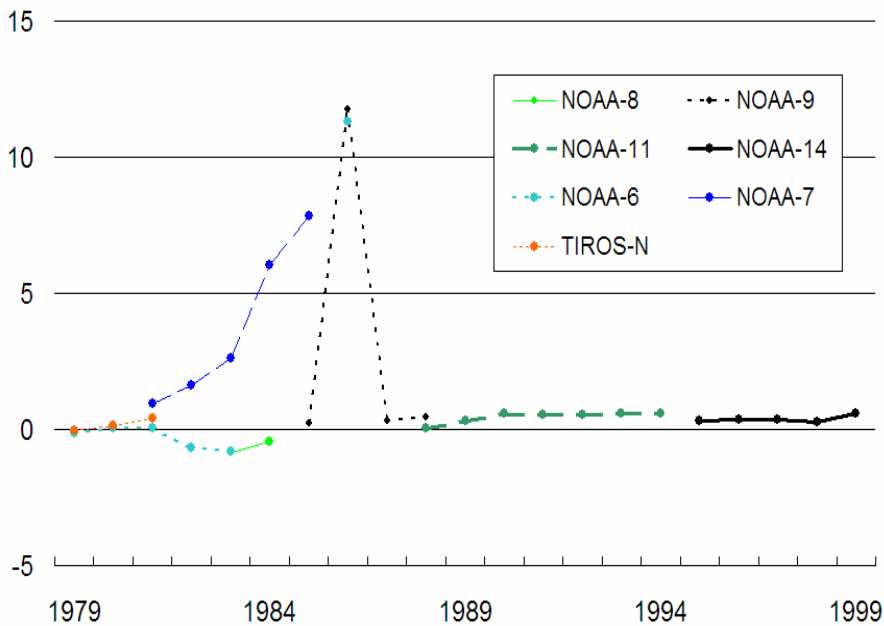
GCM development for Climatology

With special arrangements in GCM for climatological trends and events, the adoptive bias correction arrangements would be more positive.

Satellite Sounding System as a leading guide for climatic trends / events

- Usage of each instrument is Important.

*DT of SSU channel 2 against JRA-25 (K)
for each satellite and for each year*



*DT of SSU channel 2 against ERA-40 (K)
for each satellite and for each year*

