



# JMA Reanalysis

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# Outline

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- Reanalysis at JMA
  - Overview of JRA-55
  - JRA-55 family
- Impact of satellite observations on the time-consistency of JRA-55
  - Hadley circulation
  - Walker circulation
- The next Japanese reanalysis: JRA-3Q
- Summary



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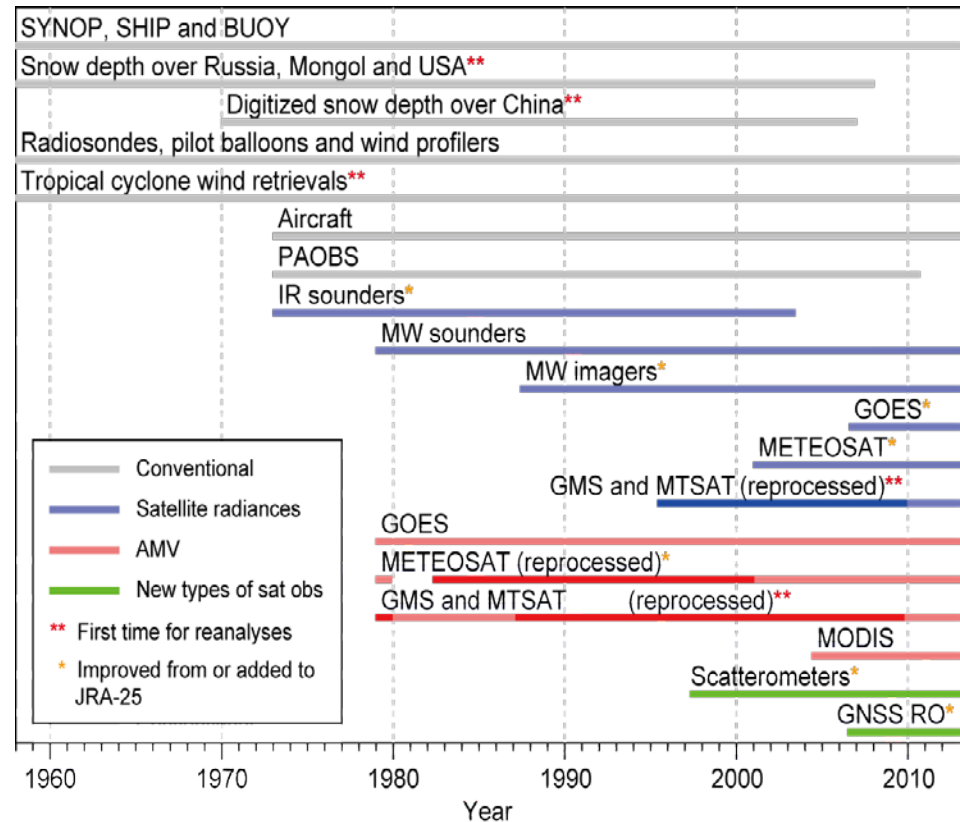
# Reanalysis at JMA

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- Reanalyses are homogeneous, high-quality climate datasets produced by analysing past observations with a constant, state-of-the-art data assimilation system.
- **JRA-25** (1979-2004, JMA/CRIEPI) and **JCDAS** (2005-2014.1)
  - produced with JMA's NWP system as of 2004.3
- **JRA-55** (1958 onward)
  - produced with JMA's NWP system as of 2009.12
- Reanalysis provides a basis for a wide range of climate research and application including
  - climate monitoring, verification of seasonal predictions, forcing for ocean models and CTMs, study of predictability etc.
- Continued improvement of reanalysis is crucial to advance climate research and improve climate services.



# Observational data used for JRA-55

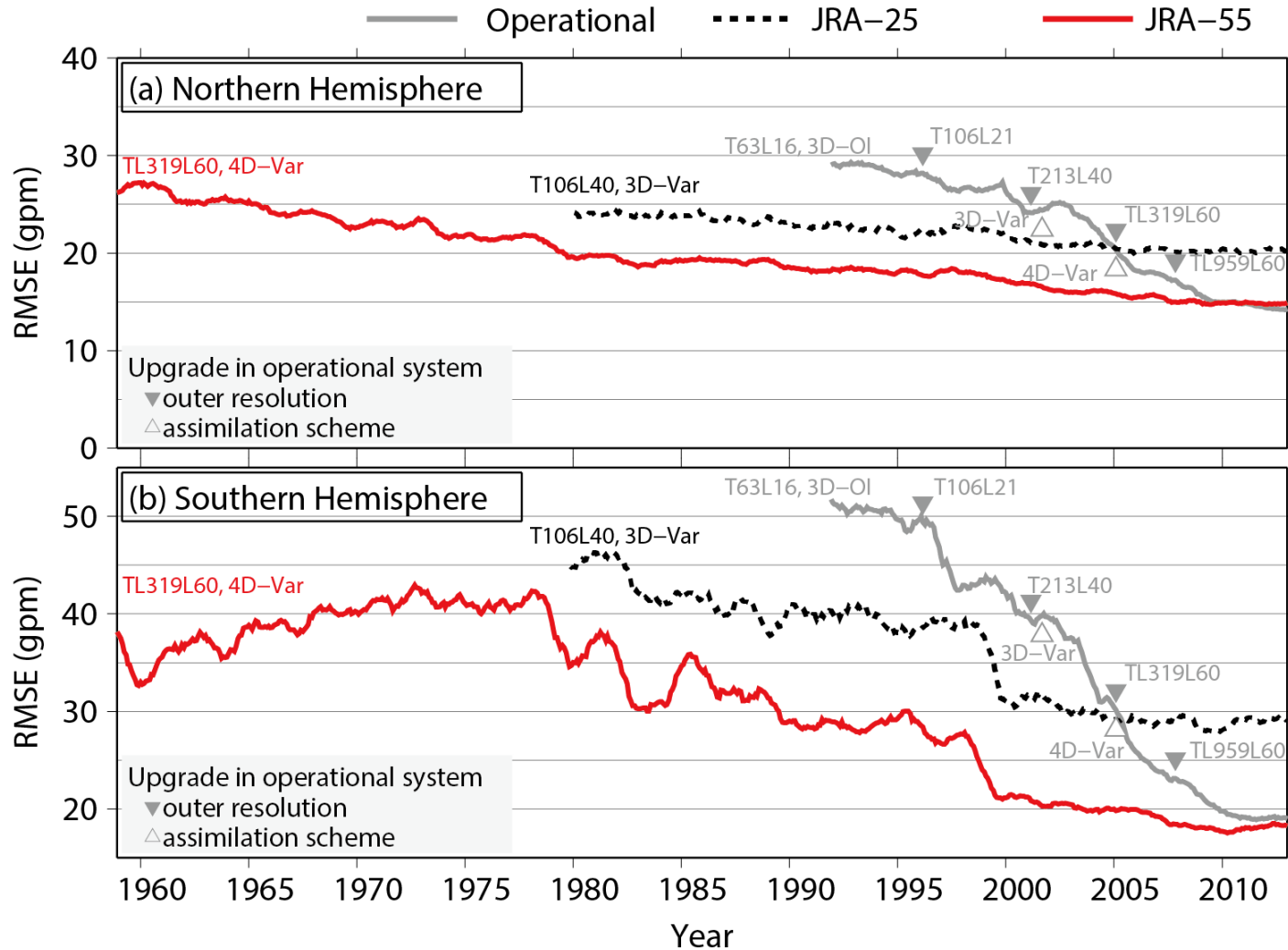


*Chronology of types of observational data assimilated in JRA-55*

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



# Basic performance of the data assimilation system



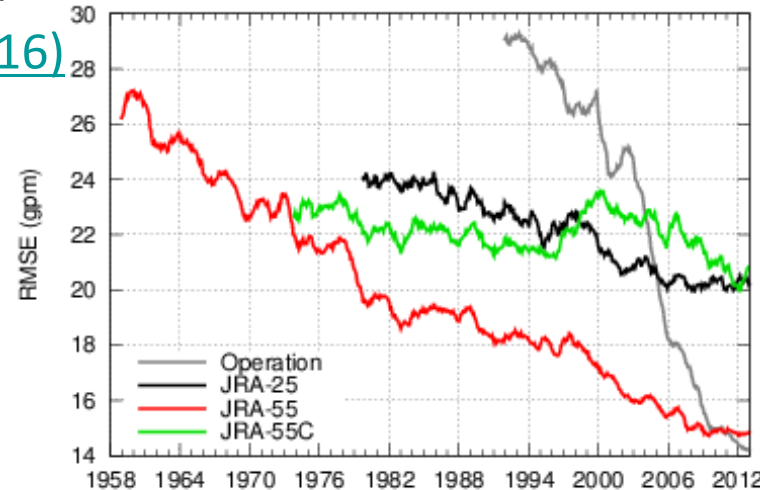
*RMS errors of 2-day forecasts of geopotential height (gpm) at 500hPa verified against their own analysis*



# JRA-55 family



- To facilitate investigations on the credibility of trends and low-frequency variability represented in JRA-55, different types of product have been produced with the common NWP system.
- **JRA-55 (JMA)**
  - Full observing system reanalysis
  - Available from JMA (<http://jra.kishou.go.jp>), DIAS, NCAR, NASA/ESGF
  - [S. Kobayashi et al. \(2015\)](#), [Harada et al. \(2016\)](#)
- **JRA-55C (MRI/JMA)**
  - Using conventional observations only
  - Available from DIAS, NCAR
  - [C. Kobayashi et al. \(2014\)](#)
- **JRA-55AMIP (MRI/JMA)**
  - AMIP type run
  - Available from DIAS, NCAR



*RMS errors of 2-day forecasts of geopotential height (gpm) at 500hPa averaged over the northern hemisphere*

[Adapted and updated from C. Kobayashi \(2014\)](#)



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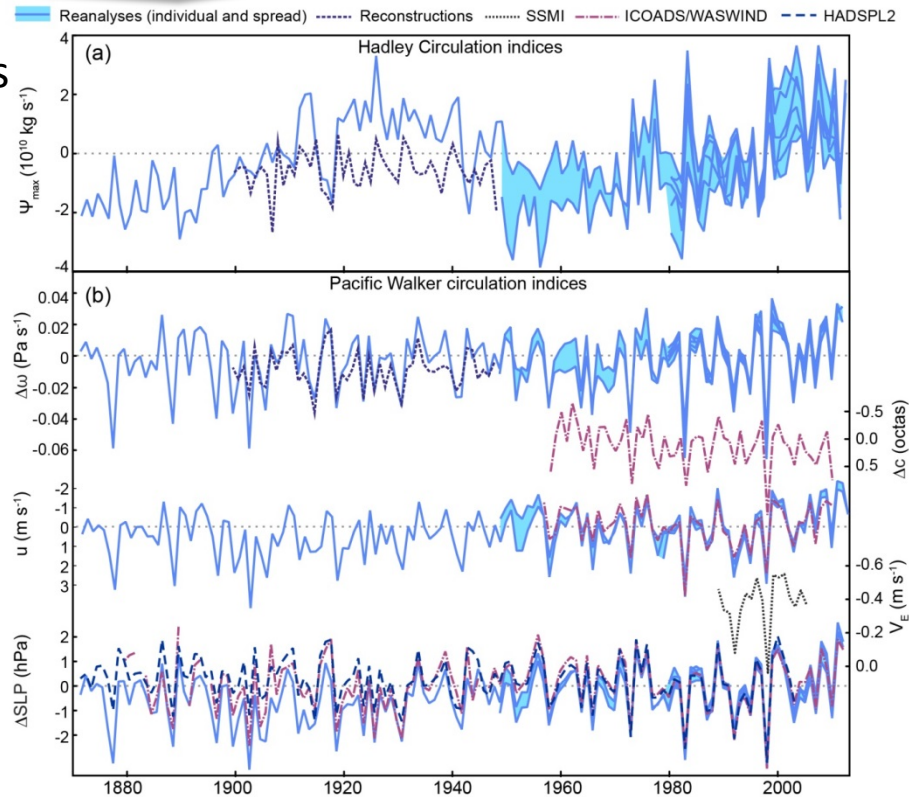


# Tropical circulation represented in reanalyses

“In summary, large interannual-to-decadal variability is found in the strength of the Hadley and Walker circulation. The confidence in trends in the strength of the Hadley circulation is low due to uncertainties in reanalysis data sets.”  
(IPCC AR5 WGI Section 2.7.5)

Hadley circulation indices

Pacific Walker circulation indices



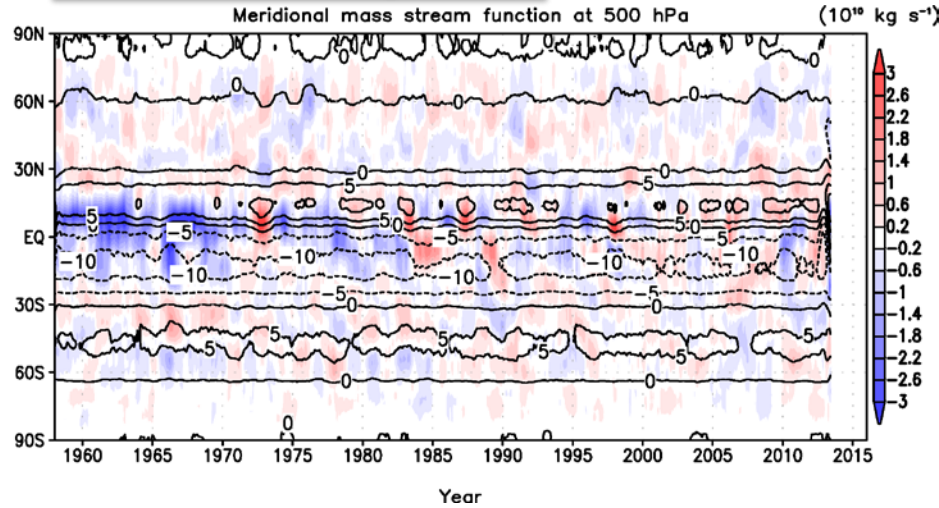
Reanalyses  
20CR  
NCEP/NCAR  
ERA-Interim  
JRA-25  
MERRA  
CFRS

IPCC AR5 WGI Fig 2.39

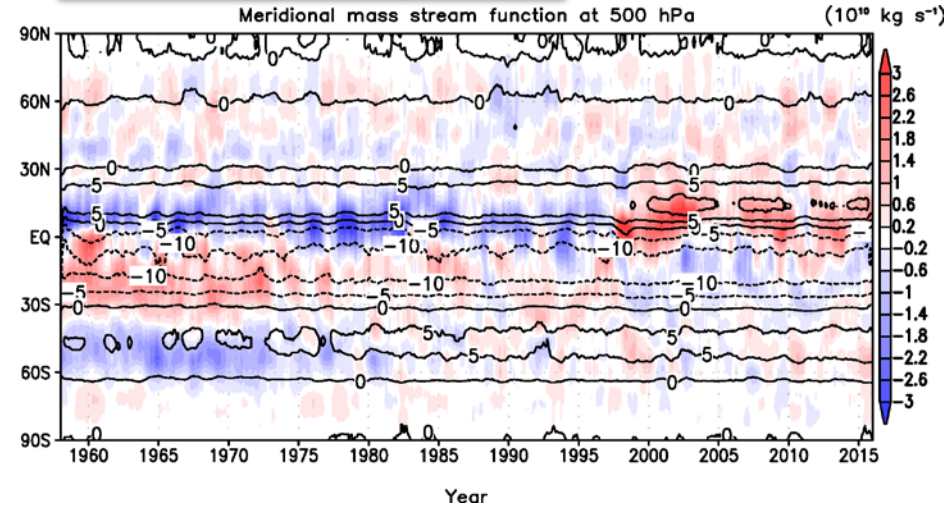


# Hadley circulation represented in JRA-55 (Meridional mass stream function at 500 hPa)

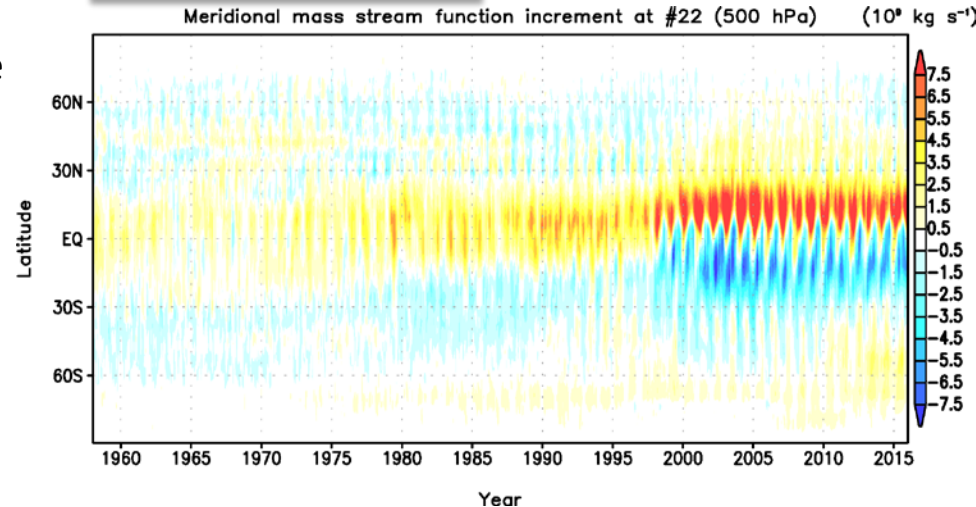
Anomaly in JRA-55AMIP  
(12-month running mean)



Anomaly in JRA-55  
(12-month running mean)



Increment in JRA-55

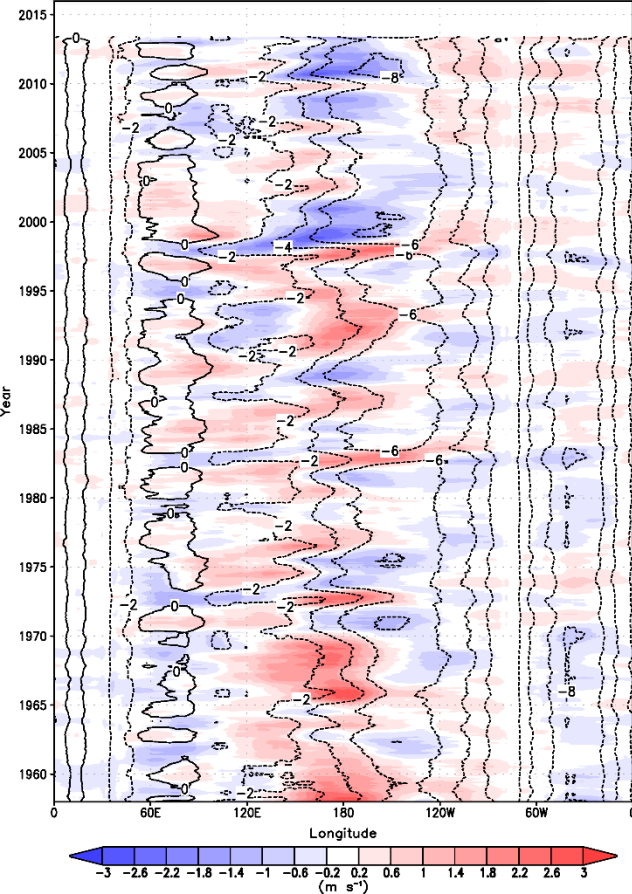


- The change of sign in the late 1990's is clearly due to changes in observing systems.
- There is also a major jump in the late 1970's, especially in the southern hemisphere.
- However, it is not clear yet which satellite observing system created a major impact, Geo-AMV, IR sounders or MW sounders?

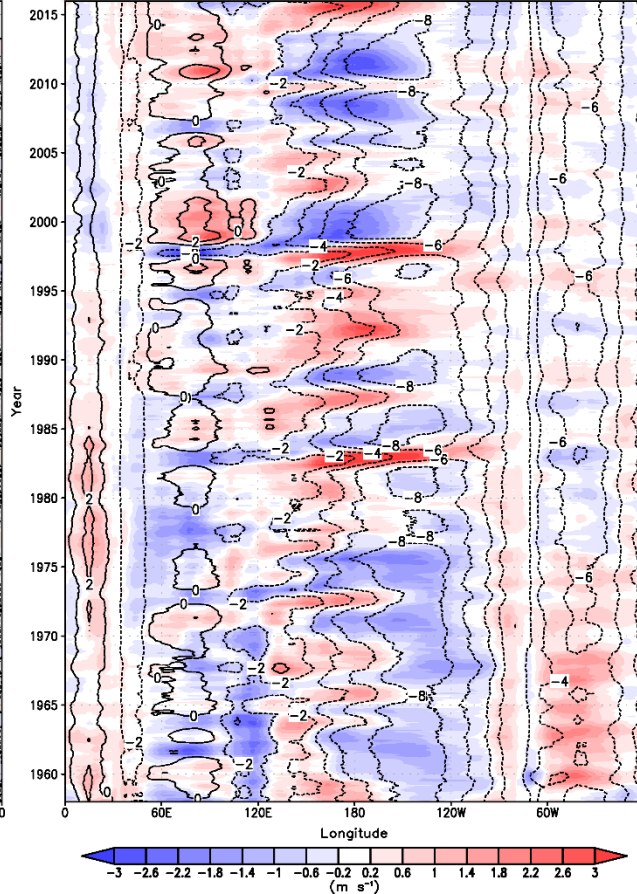


# Walker circulation represented in JRA-55 (Mean zonal wind at 900 hPa [ 10N – 10S ])

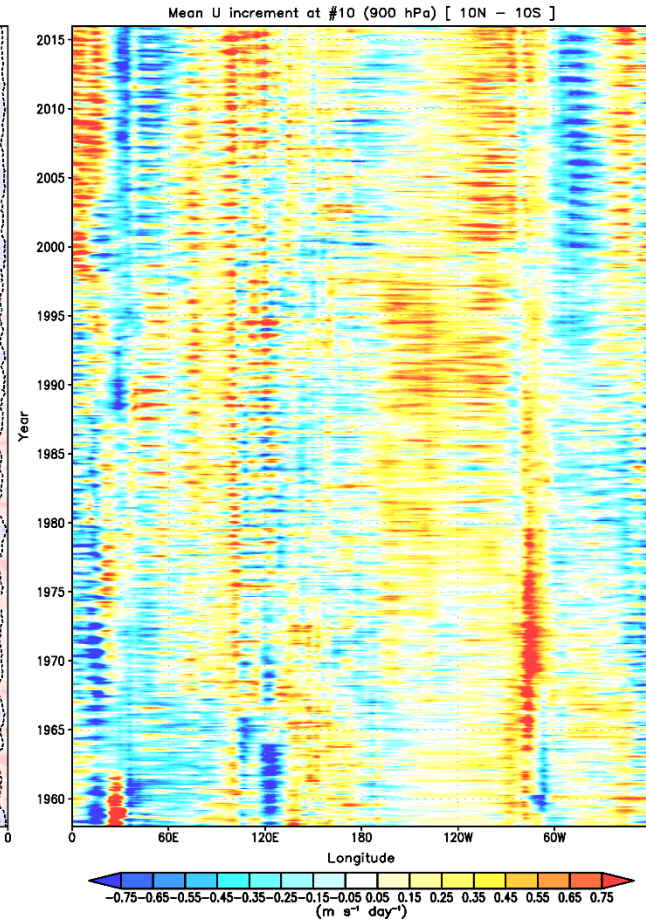
Anomaly in JRA-55AMIP  
(12-month running mean)



Anomaly in JRA-55  
(12-month running mean)



Increment in JRA-55

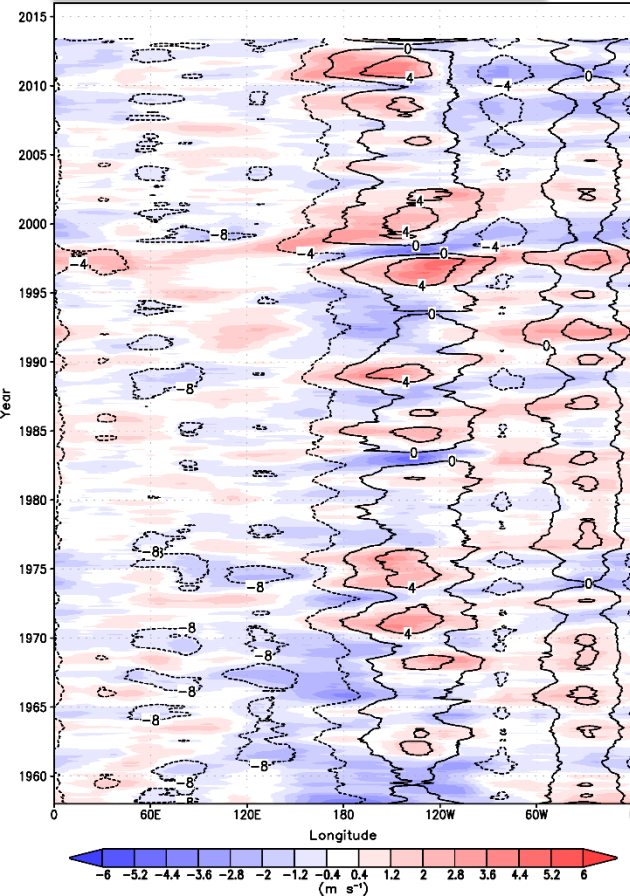


- The change of sign can be seen over the Atlantic and the Indian Ocean around the year 2000, possibly due to the introduction of scatterometer ocean surface winds?
- Large increments in the early period are most likely due to observations from upper-air stations. Their impacts were localised and failed to constrain wider areas.

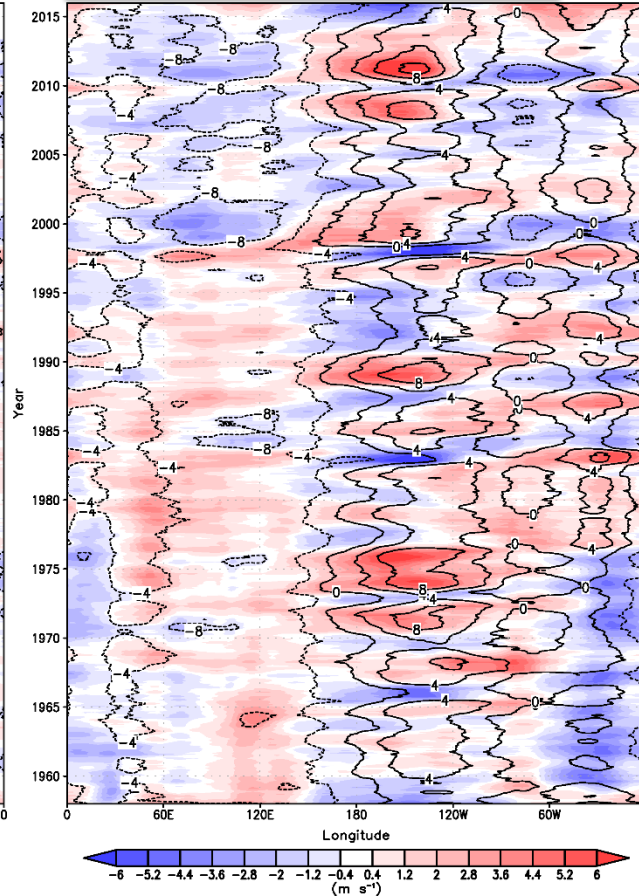


# Walker circulation represented in JRA-55 (Mean zonal wind at 250 hPa [ 10N – 10S ])

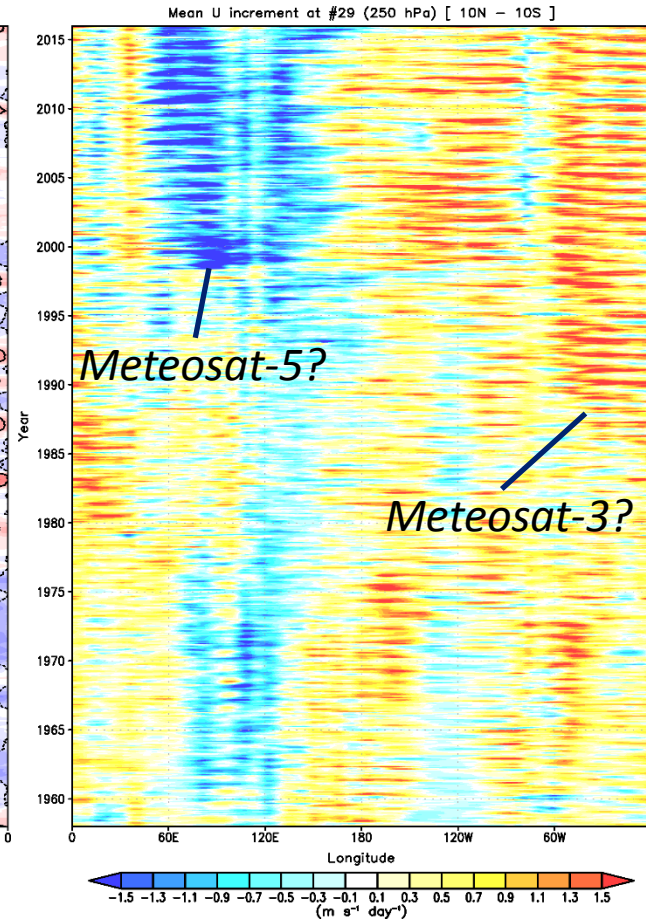
Anomaly in JRA-55AMIP  
(12-month running mean)



Anomaly in JRA-55  
(12-month running mean)



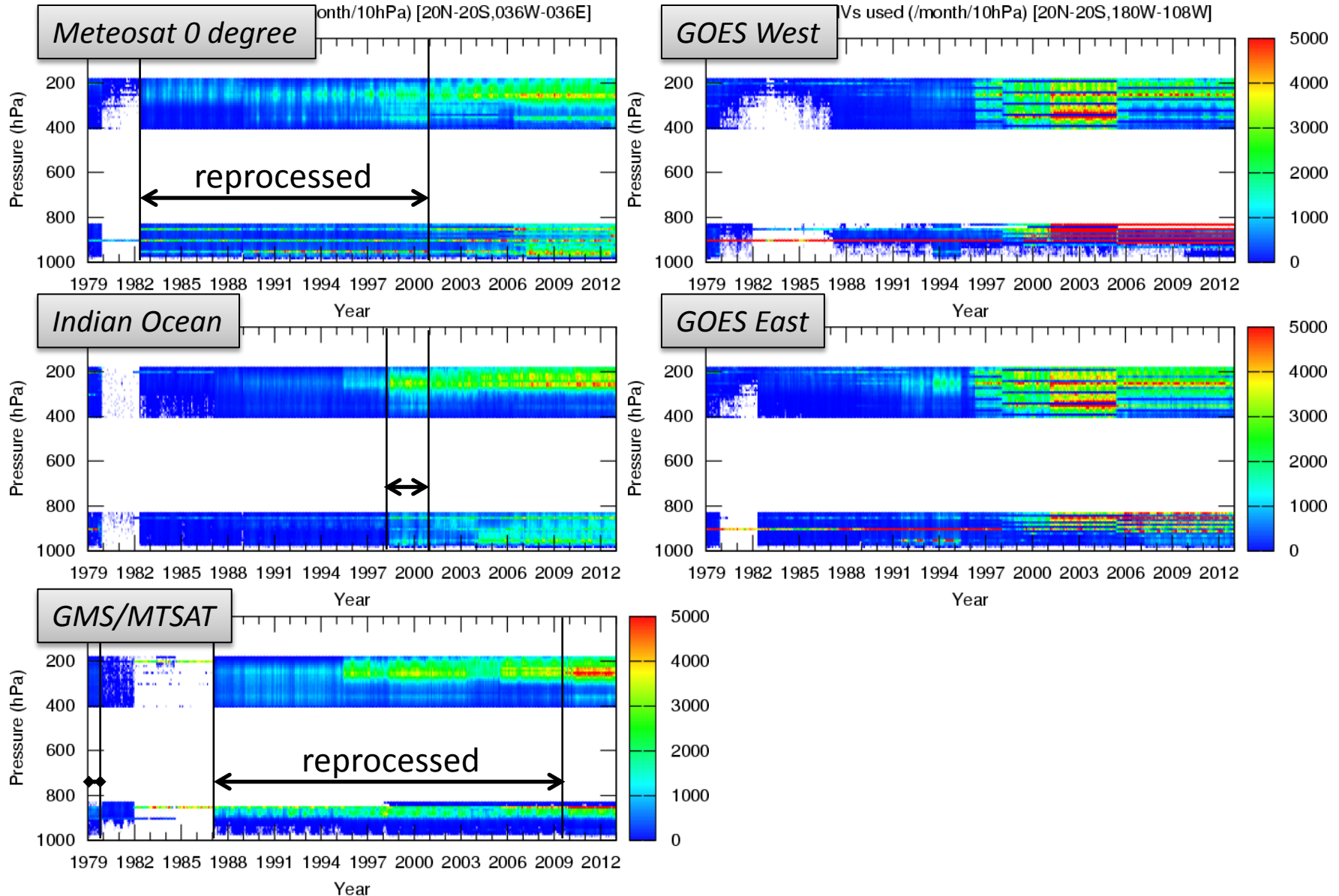
Increment in JRA-55



- The change of sign over the Indian Ocean in the late 1990's is most likely due to the introduction of AMVs from *Meteosat-5*.
- There are also jumps over the Atlantic in the late 1980's (reprocessed *Meteosat-3*?) and over the Western Pacific in the late 1990's.



# The number of AMVs assimilated in JRA-55





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# The next Japanese reanalysis

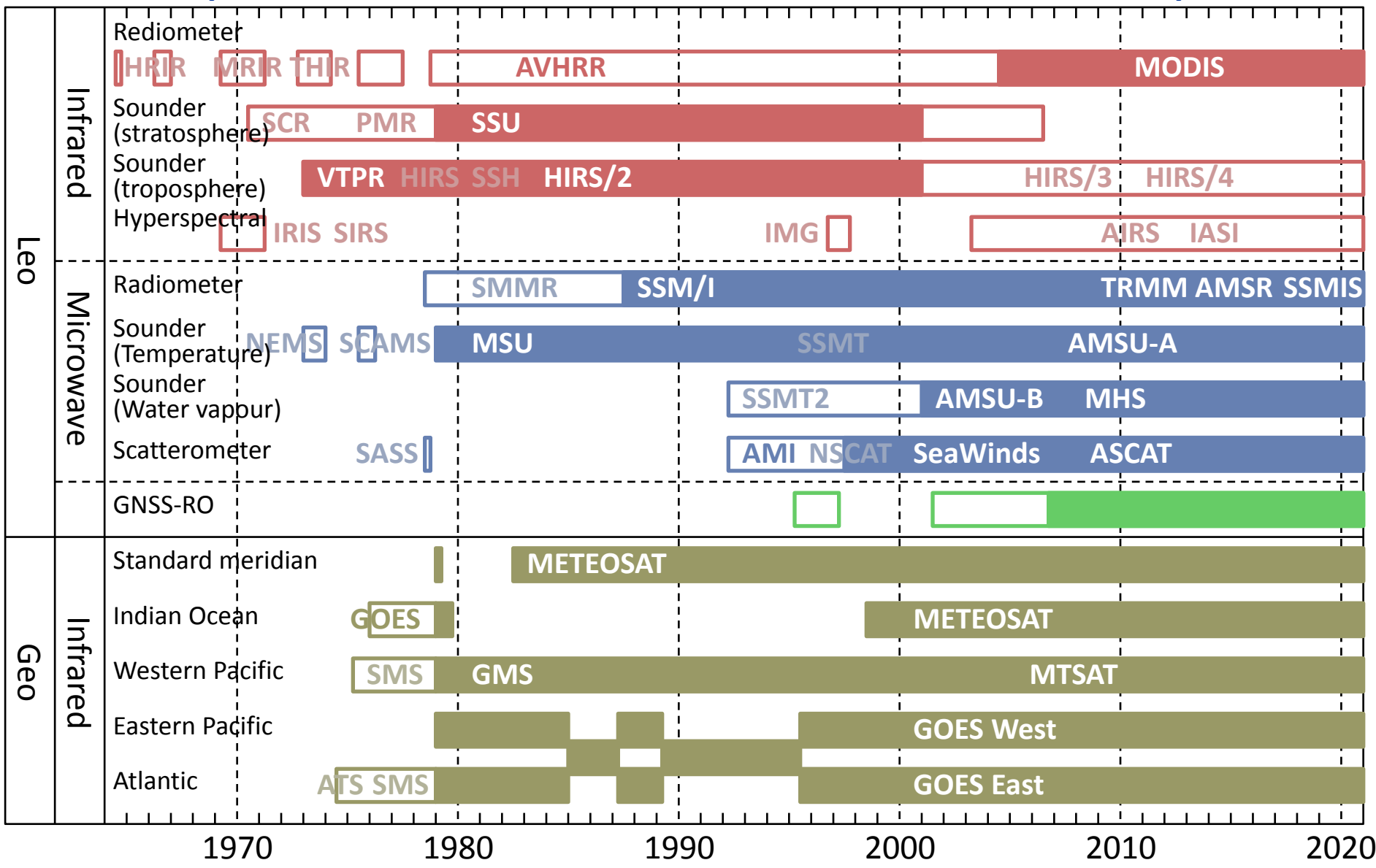
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- **JRA-3Q** (pronounced as “Thank you!” in Japanese)
  - Japanese Reanalysis for Three Quarters of a Century
- **Provisional specifications**
  - **Higher resolution**: T<sub>L</sub>319L60 -> T<sub>L</sub>479L100
    - 40 km in horizontal, 100 layers up to 0.01 hPa in vertical
  - **Extending the reanalysis period back in time**
    - Atmospheric reanalysis from 1948 (planned) to present
  - **New boundary conditions and forcing fields**
    - COBE-SST2 (from the beginning to 1981)
    - MGDSST (satellite-based SST from 1982 onward)
  - **New observations**
    - Observations newly rescued and digitised by ERA-CLIM et al.
    - Improved satellite observations through reprocessing
    - JMA’s own tropical cyclone bogus



# Changes in satellite observing systems

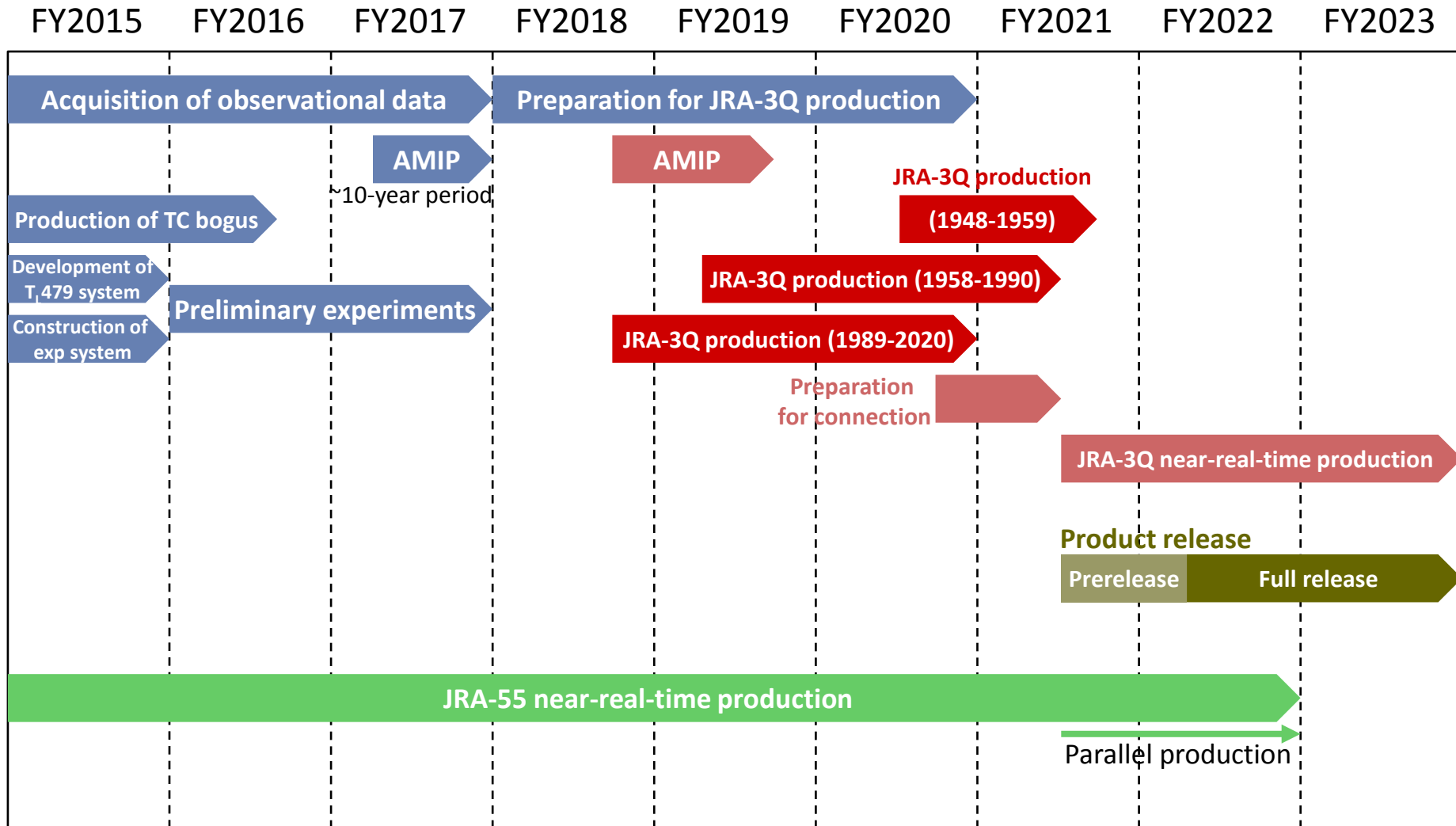
(shaded: used in JRA-55, blank: not used in JRA-55)







# Production schedule (as of Nov 2016)





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- JRA-55 is significantly improved in terms of temporal consistency compared to previous reanalyses, but there are still considerable uncertainties.
- Fundamental problem is impact of changes in observing systems in the presence of large model biases.
- “Family” of reanalyses could provide a useful means of assessing the time-consistency.
- A key to improve the time-consistency is availability of “anchoring observations” that constrain model biases.
  - Data rescue of early meteorological satellites
  - Homogenisation through recalibration and reprocessing
- Improvement of observational data sets is essential for further improving quality of future reanalyses.



**3Q for your attention!**

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