Global Warming Trend and Decadal Variability

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Contents

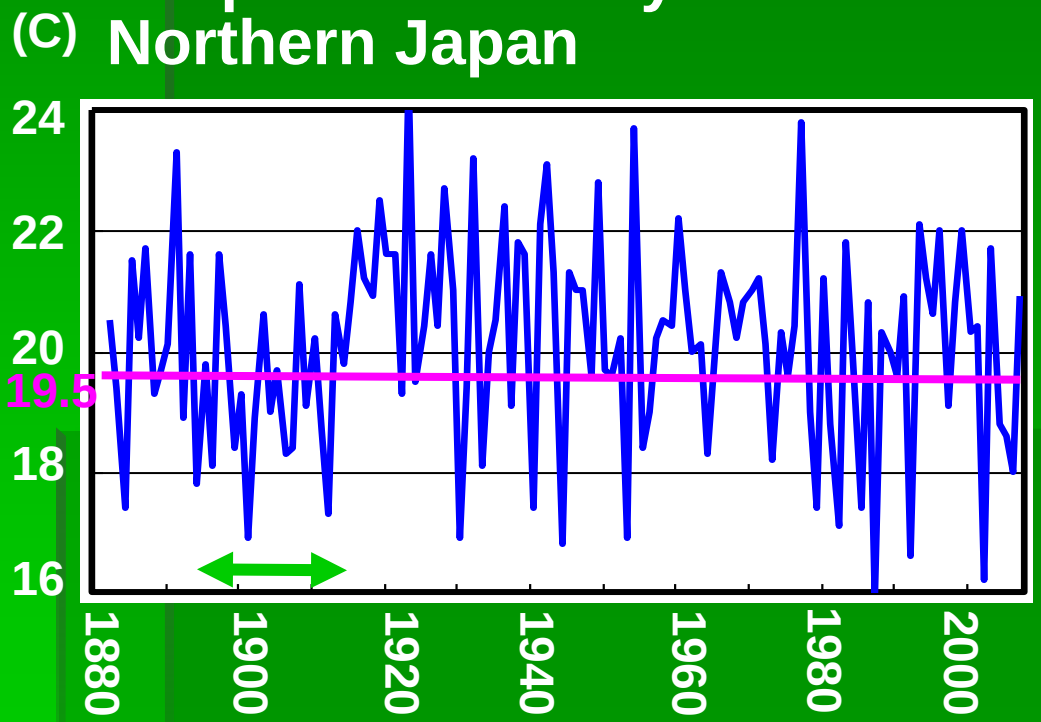
- Introduction
- Global Warming Trend
- Decadal Variability
- Trend and Decadal Variability since 1979
- Trend and Decadal Variability in the Tropical Ocean

Introduction

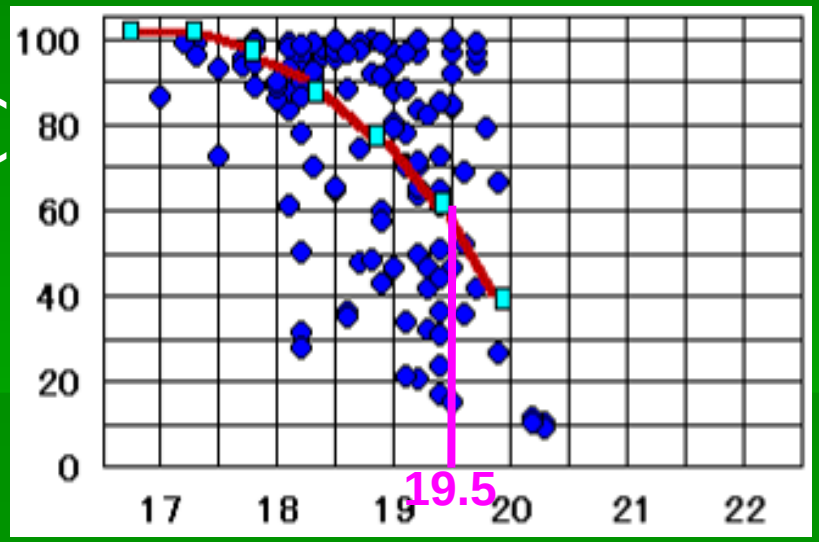
Climate Variation and History of LRF in Japan

"Northern Japan is located at the northern limit of paddy"

Interannual variation of July temperature at Miyako in Northern Japan



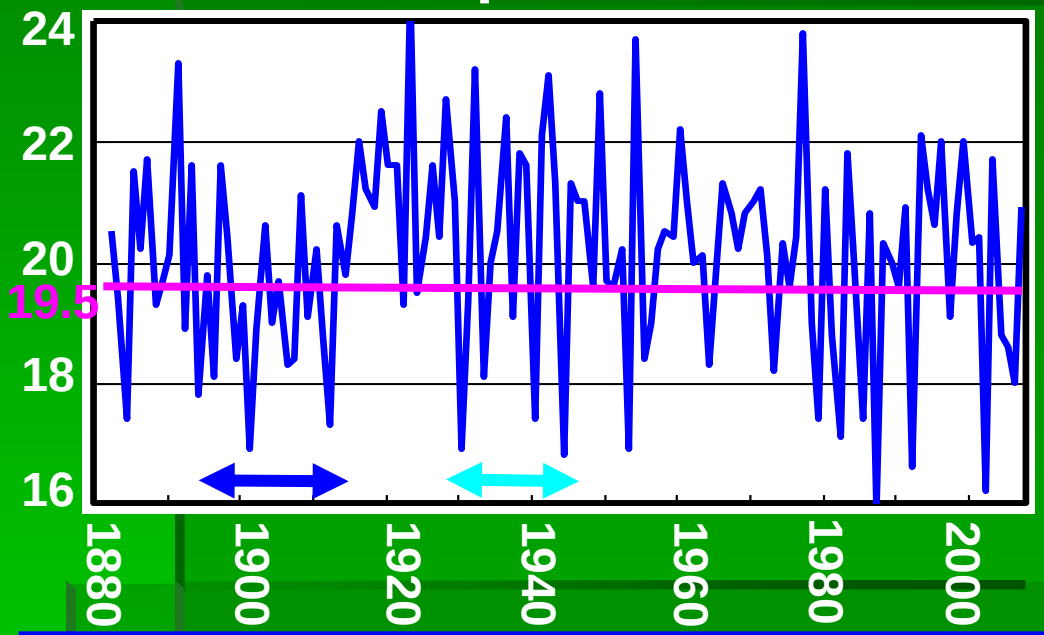
Relationship between temperature and sterile rate of paddy "Mutsuhomare"



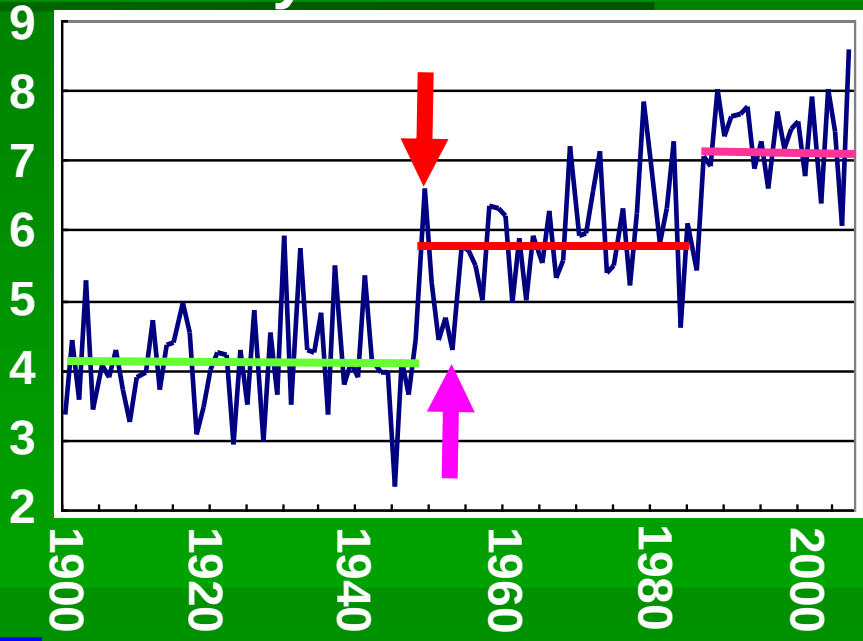
30-day mean temperature (C) before paddy ear up (by National Agricultural Research Center for Tohoku Region)

Climate Variation and History of LRF in Japan

Interannual variation of July temperature at Miyako in Northern Japan



Interannual variation of DJF mean temperature at Tokyo



Active research for cold summer

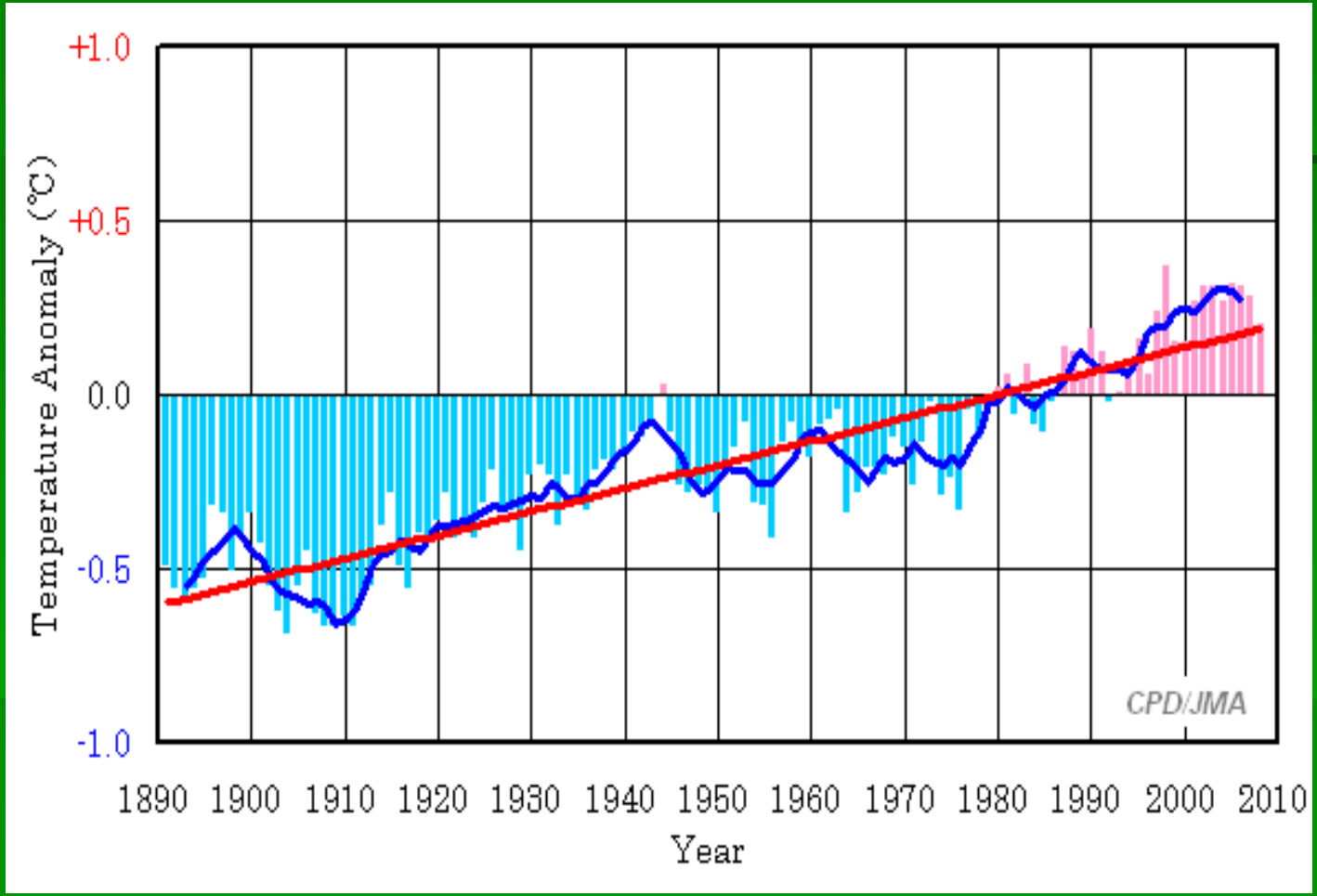
Observational network (1934)
Launch of LRF (1942)

Restart of LRF (1953)

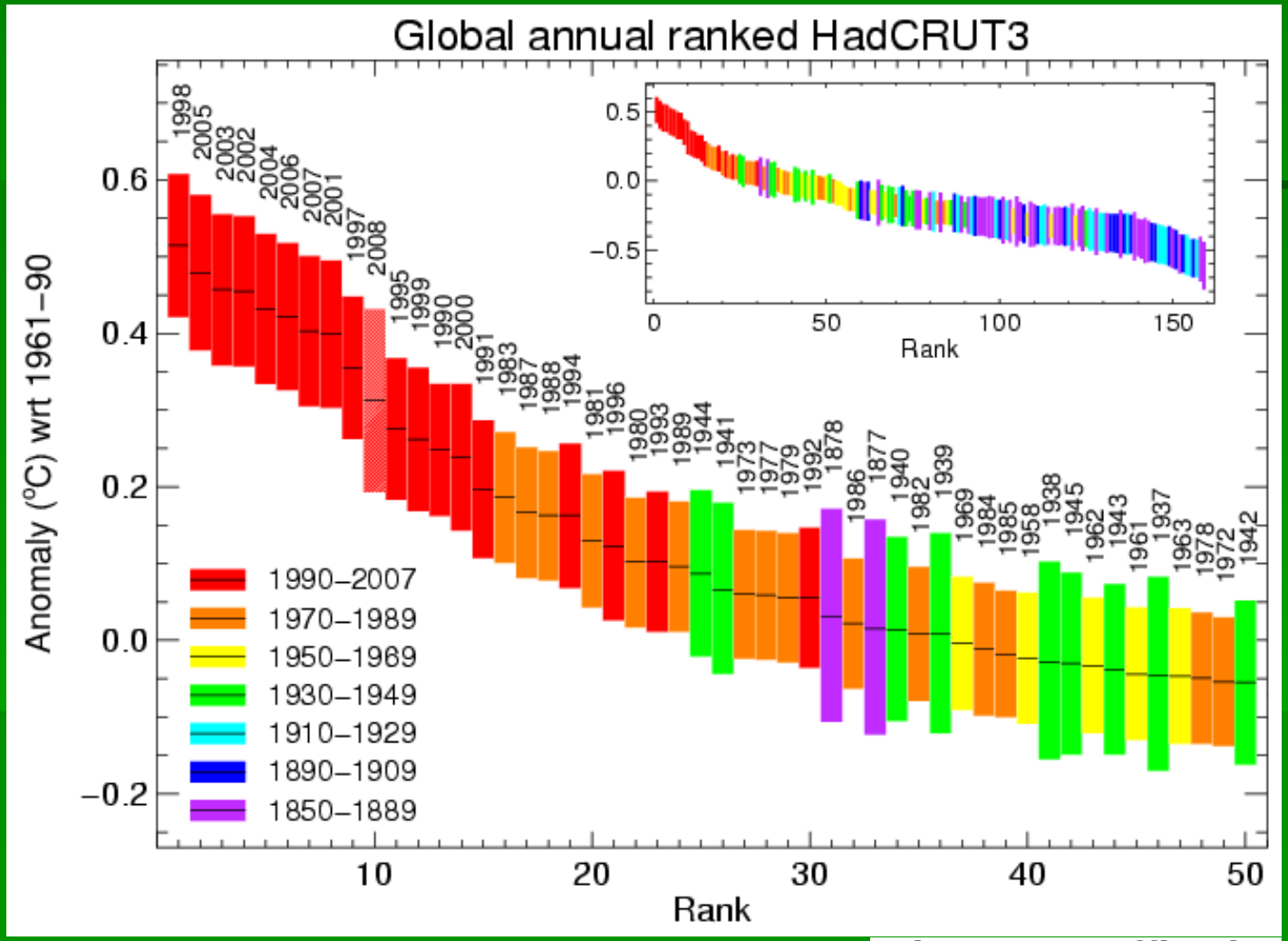
LRF was broken up (1949)

Global Warming Trend

Global mean annual temperature



Rank of global annual temperature

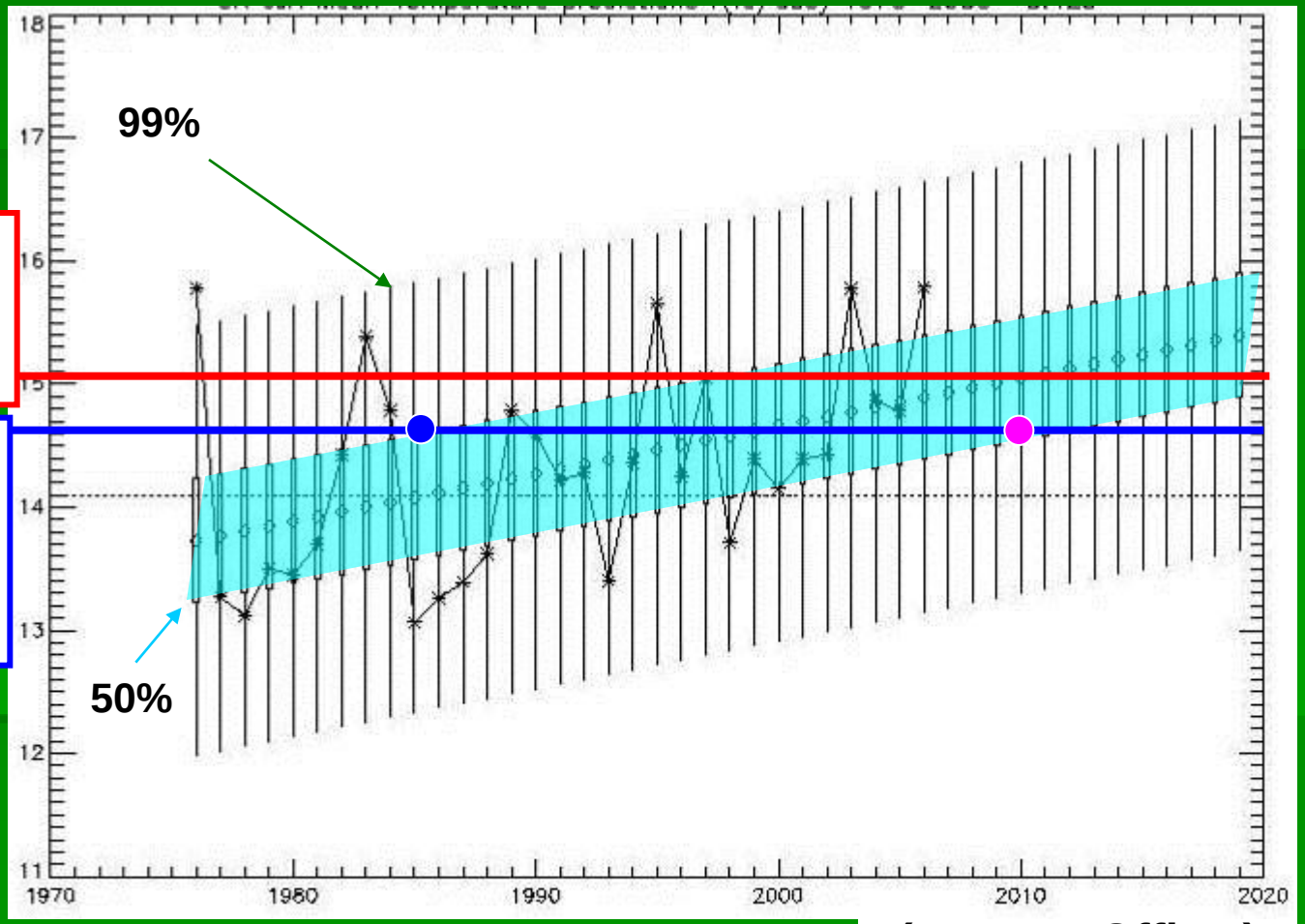


(UK Met Office)

Warming trend and climate monitoring

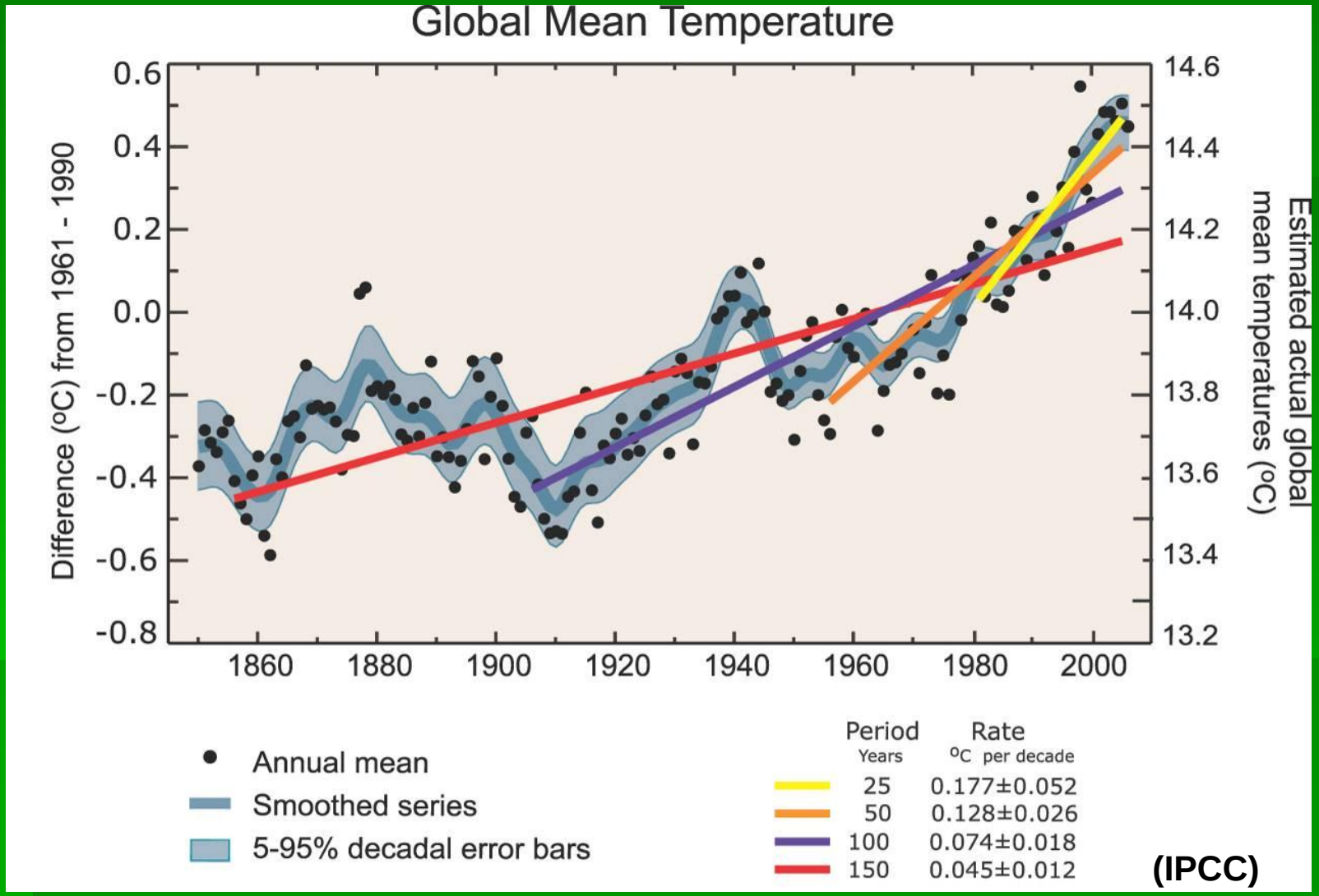
Median in 2010 estimated by a linear trend

Threshold between above and normal (1971-2000)



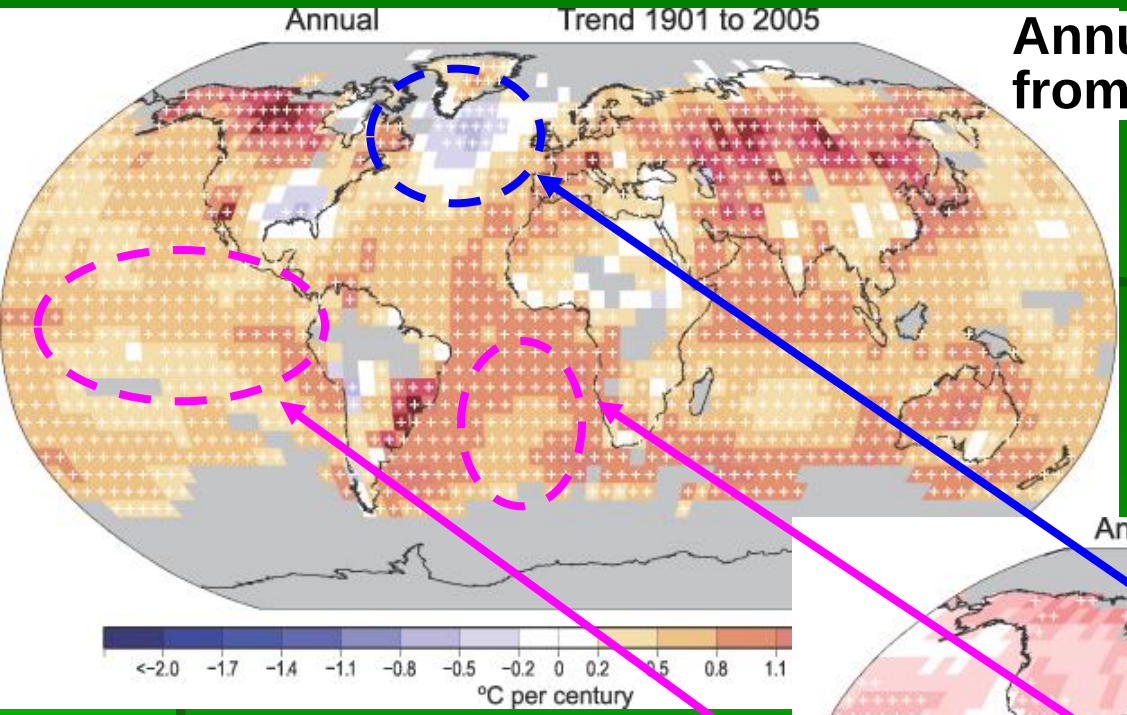
(UK Met Office)

Increasing warming trend or decadal variability ?

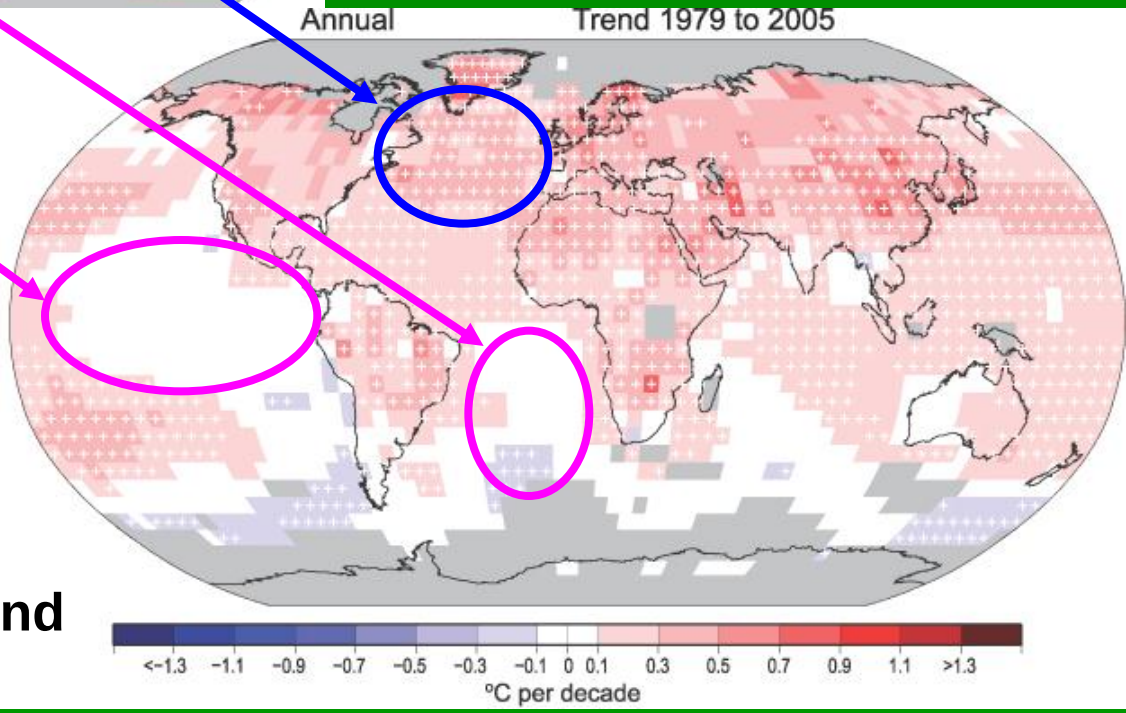


(IPCC)

Different trends in different periods

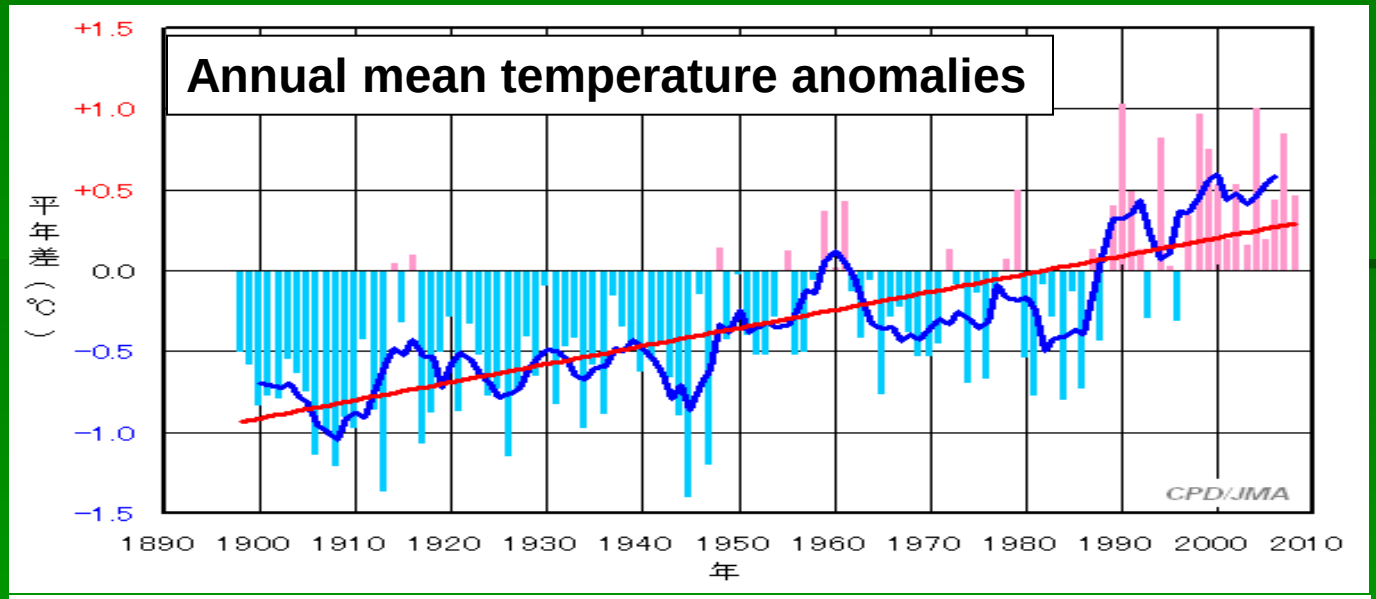


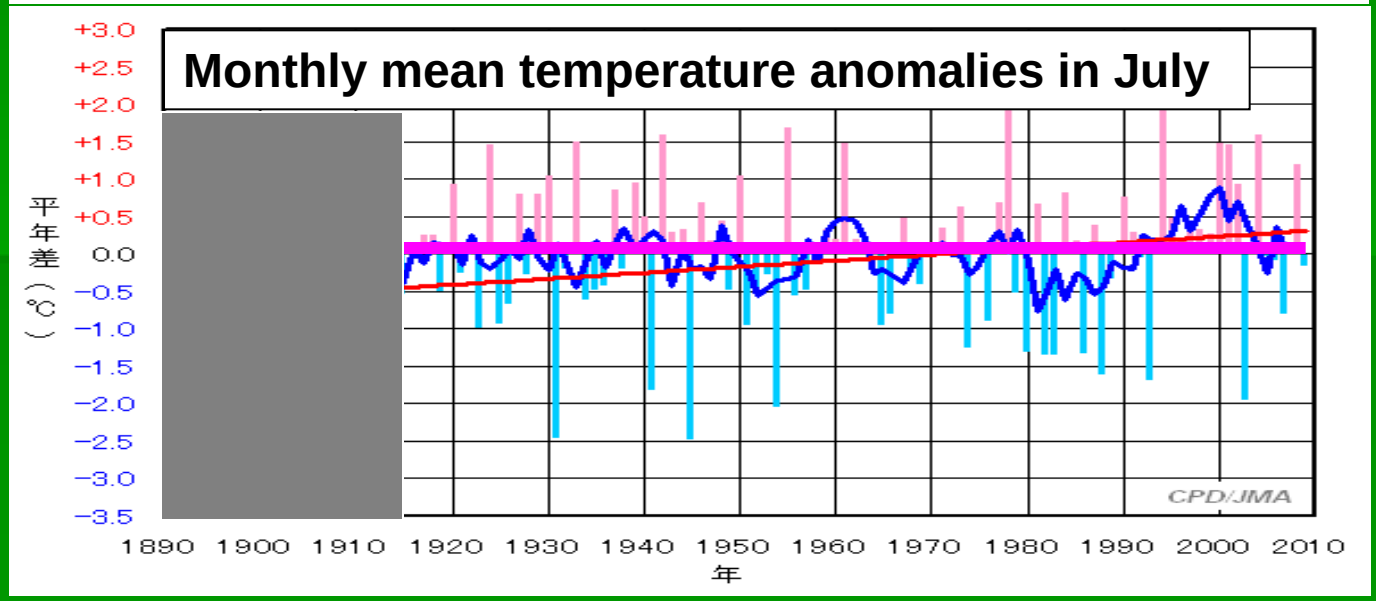
Annual mean temperature trend from 1901 to 2005 (IPCC)



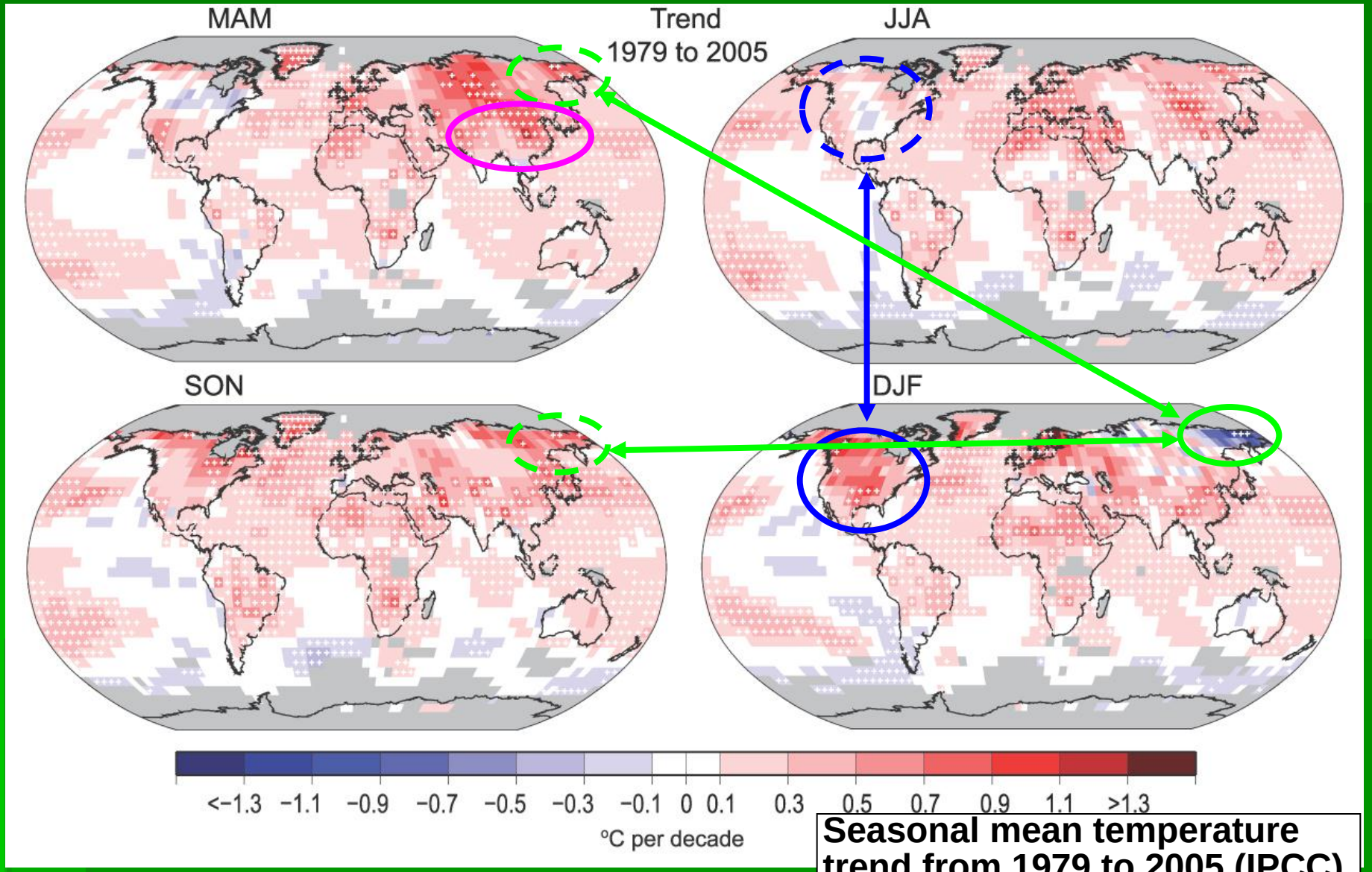
Annual mean temperature trend from 1979 to 2005 (IPCC)

Different trends in different seasons over Japan



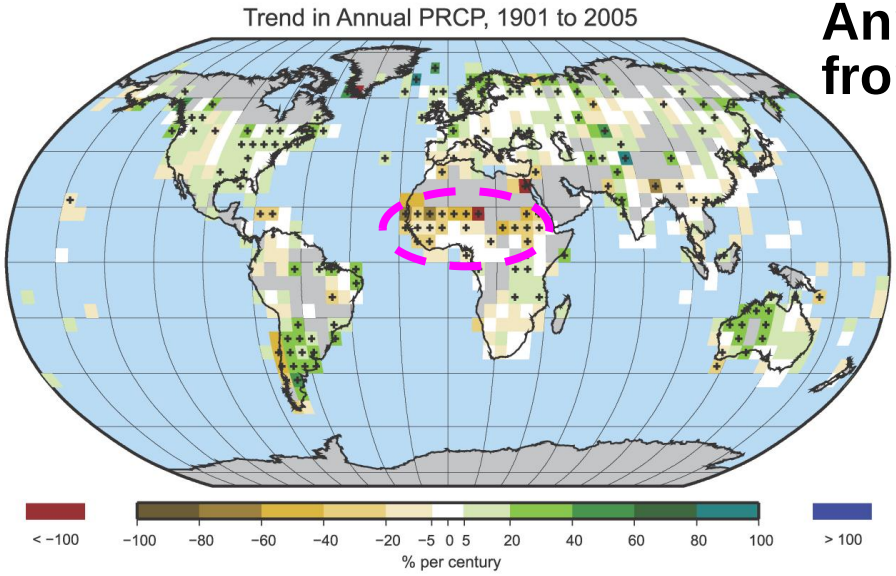


Different trends in different seasons over the world

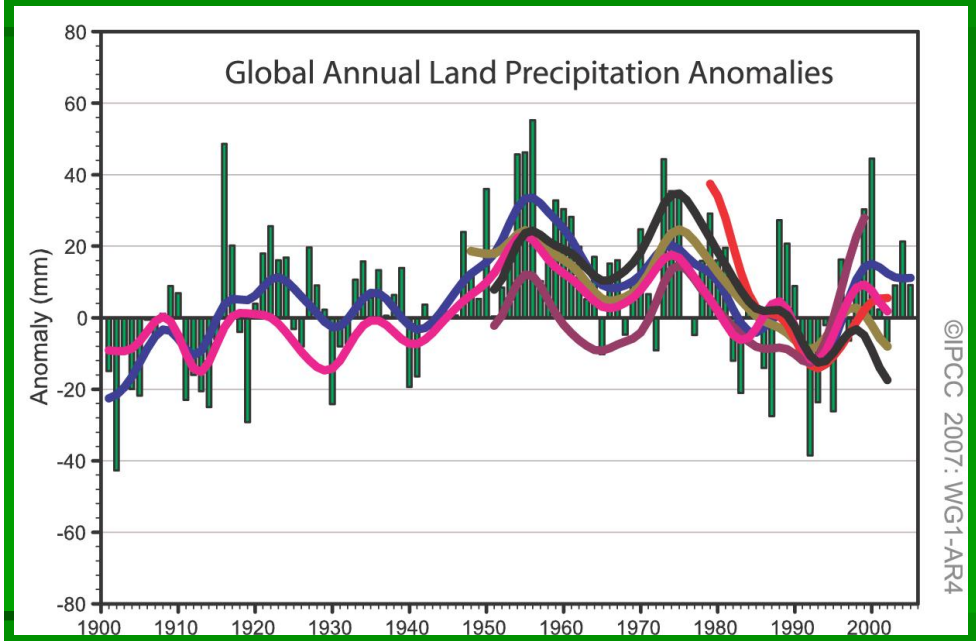


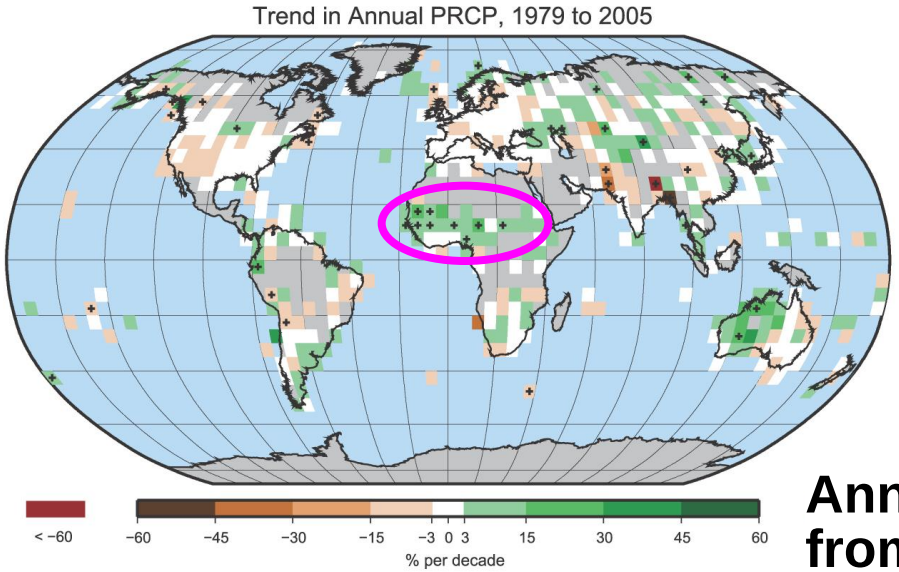
Seasonal mean temperature trend from 1979 to 2005 (IPCC)

Annual precipitation trend



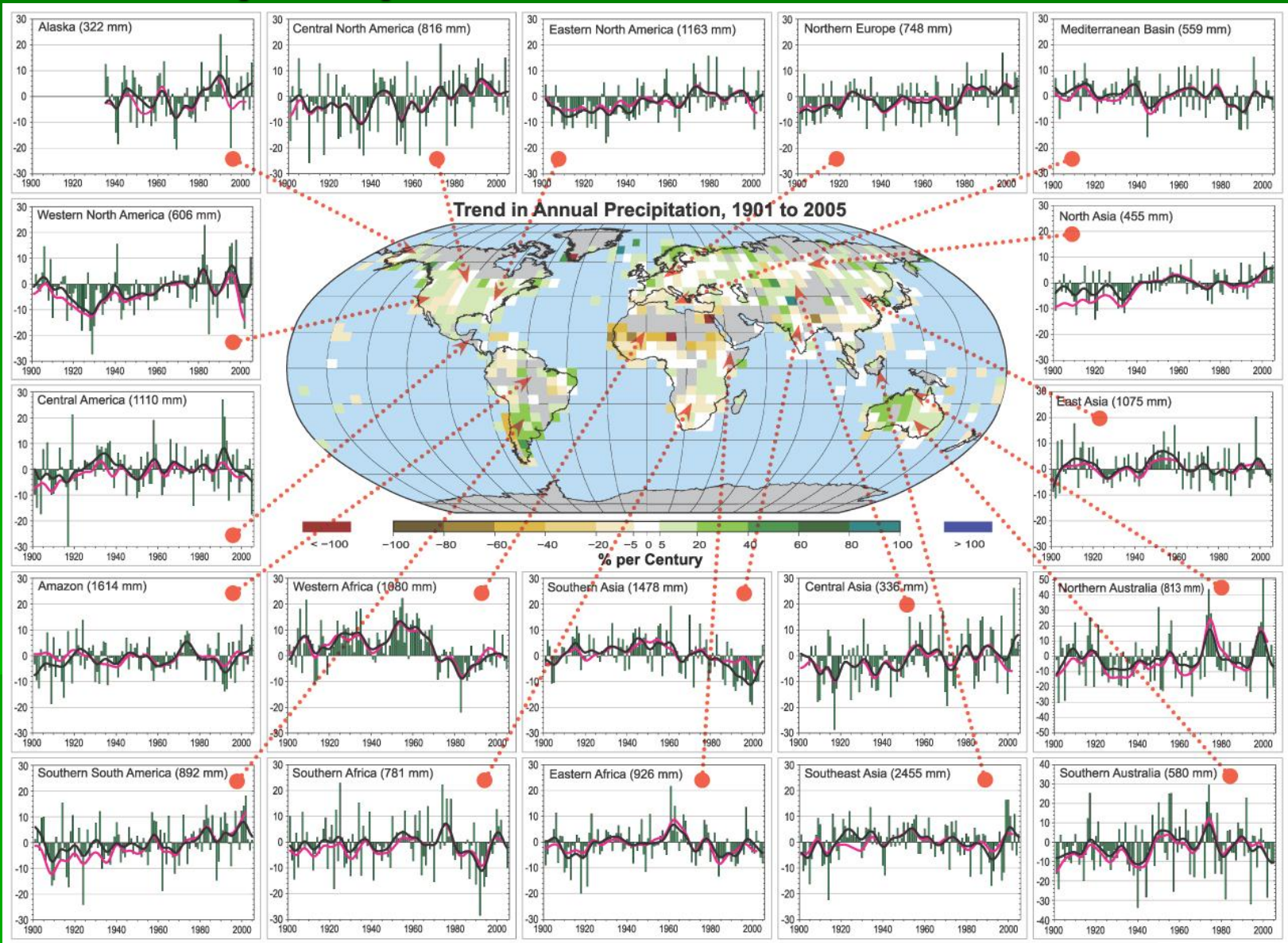
Annual precipitation trend from 1901 to 2005 (IPCC)





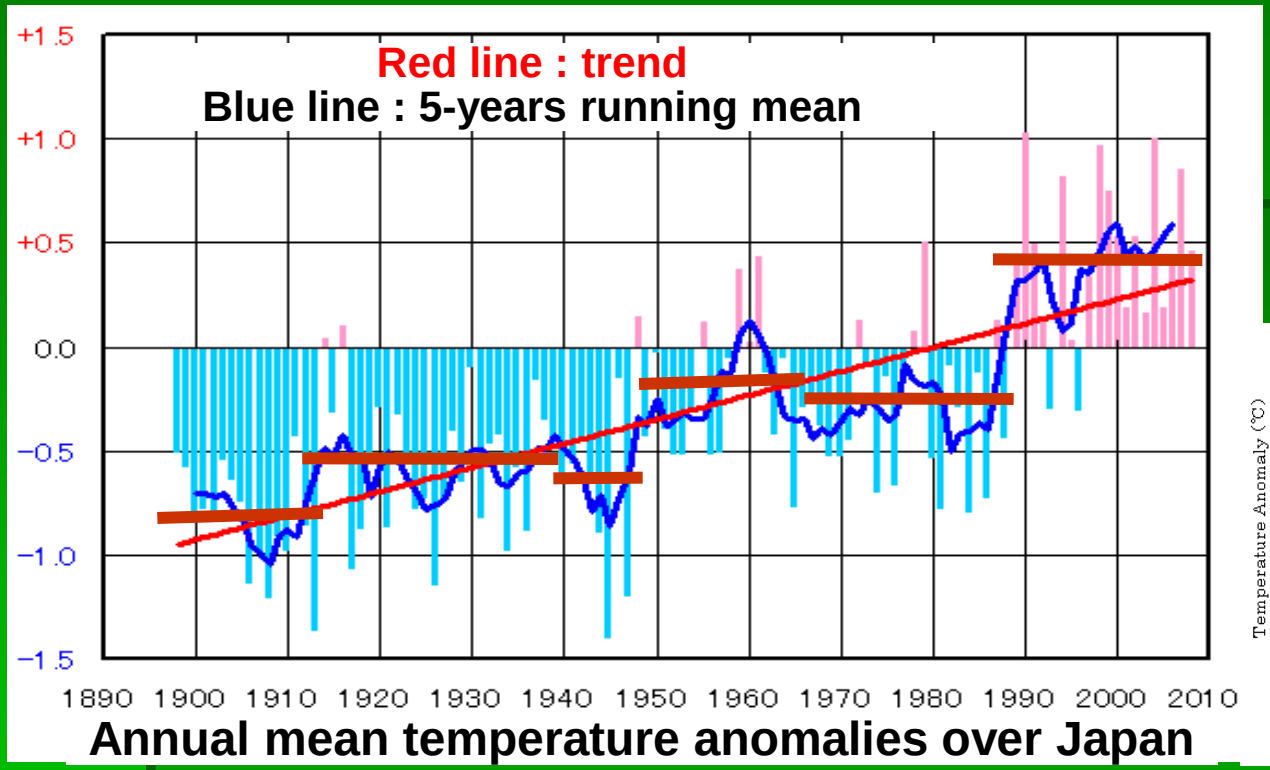
Annual precipitation trend from 1979 to 2005 (IPCC)

Different precipitation variation in different area



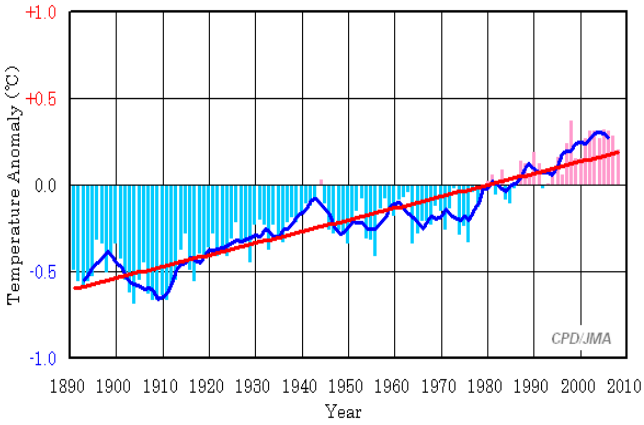
Decadal Variability

Decadal Variability in Temperature over Japan



Annual mean temperature anomalies over Japan

Annual mean temperature anomalies over the world



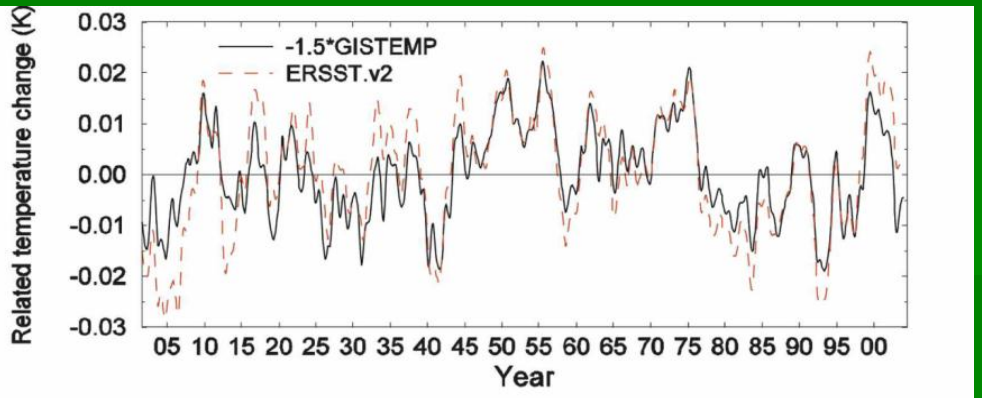
Recent Tendency

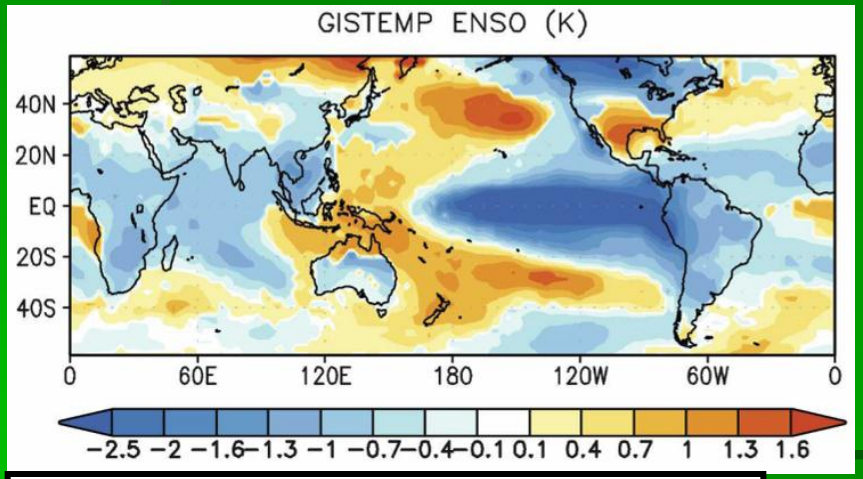
OCN	Below	Normal	Above
10years	0%	20%	80%

Western Japan has not experienced any cold springs since 10 years ago.
(Base period for normal is 1971 to 2000)

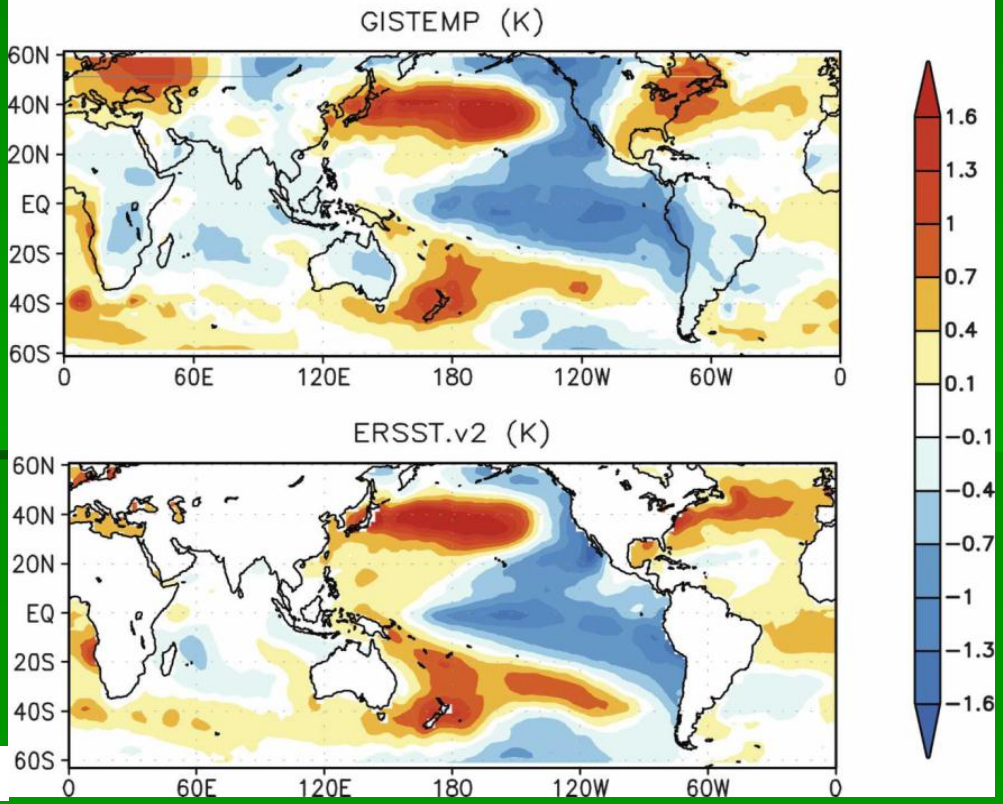
Decadal Variability in Temperature over the world

Global affect in surface temperature by Pacific Decadal Oscillation mode





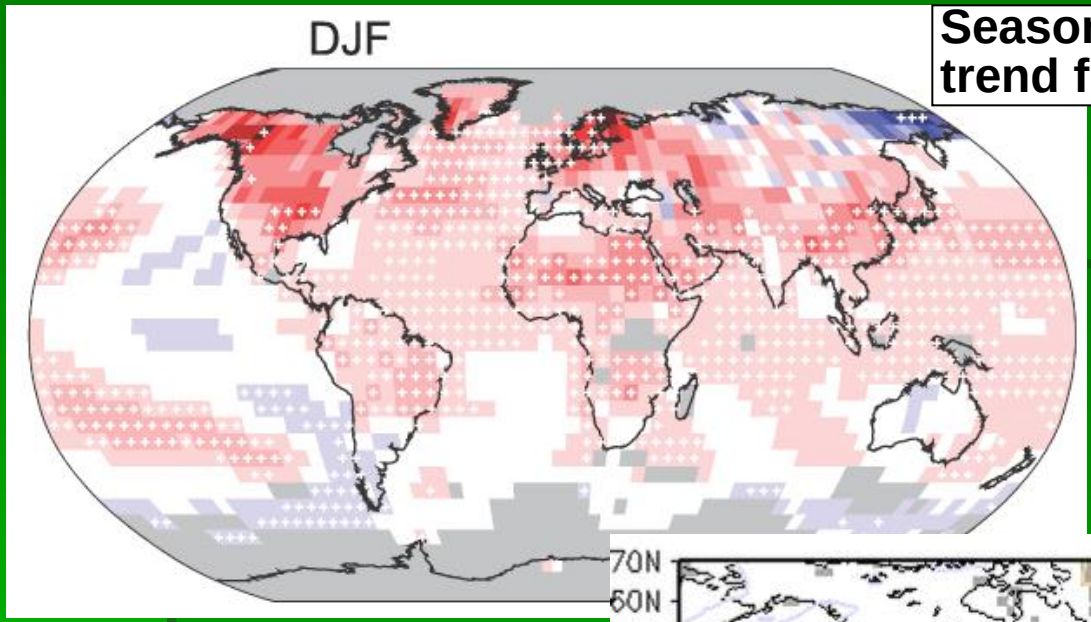
Global affect in temperature by ENSO mode



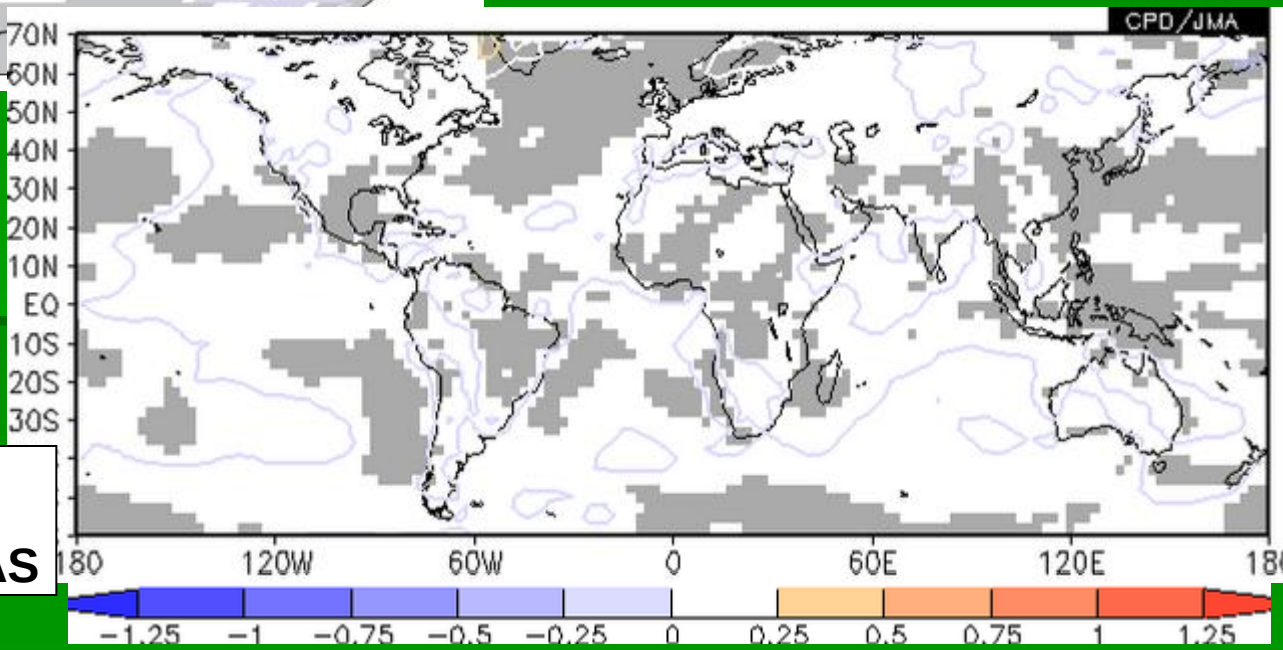
(Chen et al., 2007)

Trend and Decadal Variability since 1979

Global warming trend in JRA/JCDAS

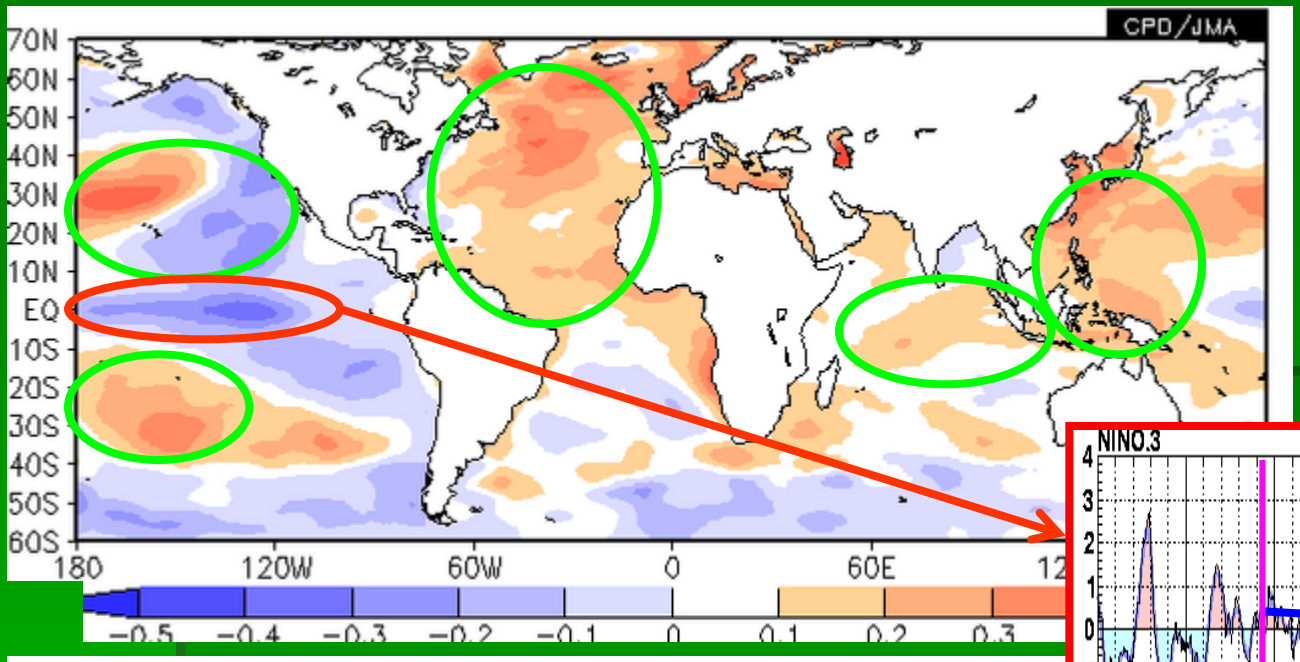


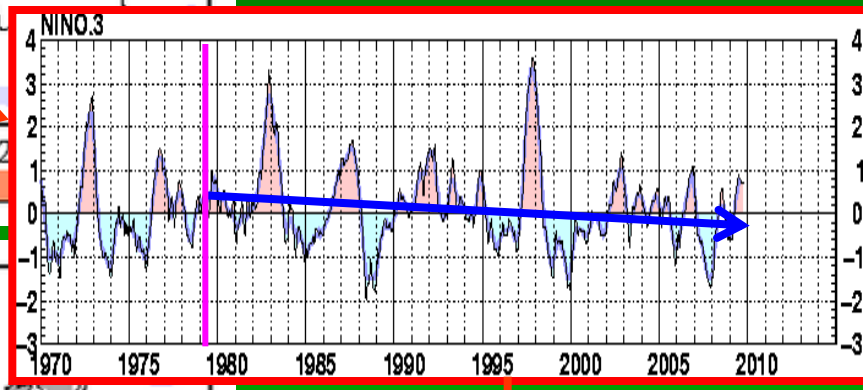
Seasonal mean temperature trend from 1979 to 2005 (IPCC)

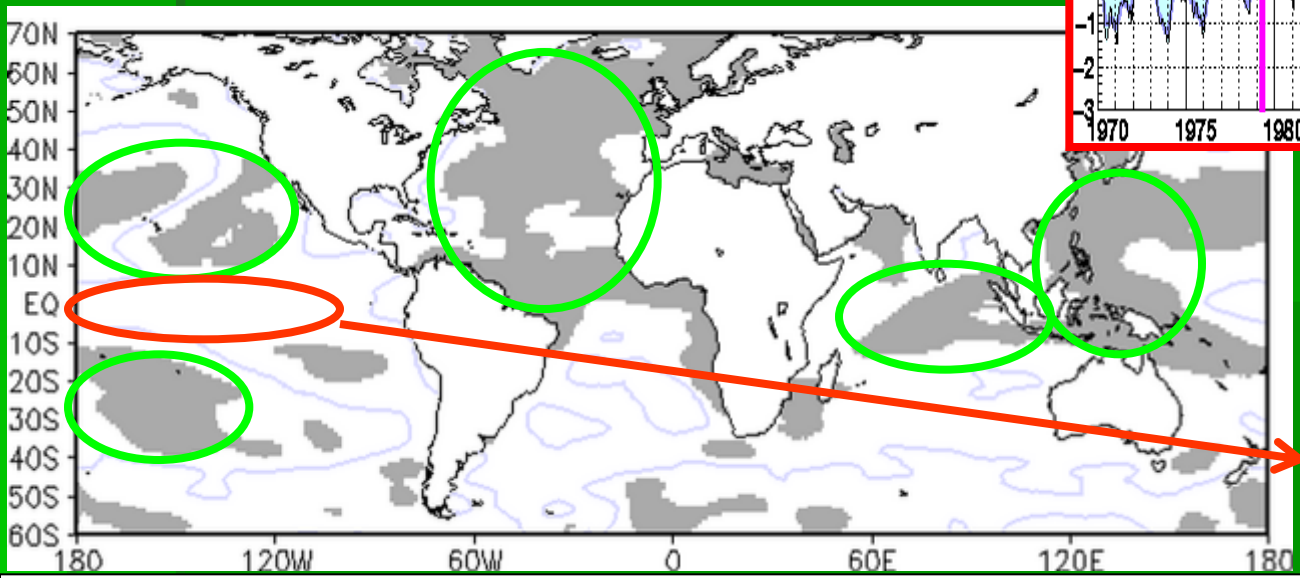


Seasonal mean surface temperature trend from 1979 to 2008 in JRA/JCDAS

Last 30-year (1979-2008) SST trend in DJF



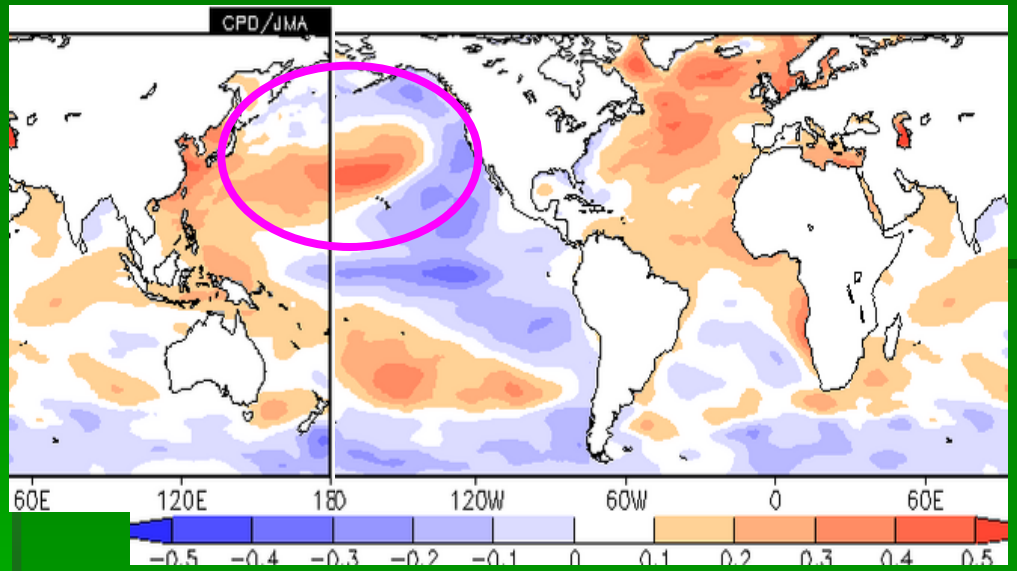




The decreasing trend in the equatorial Pacific is not significant !

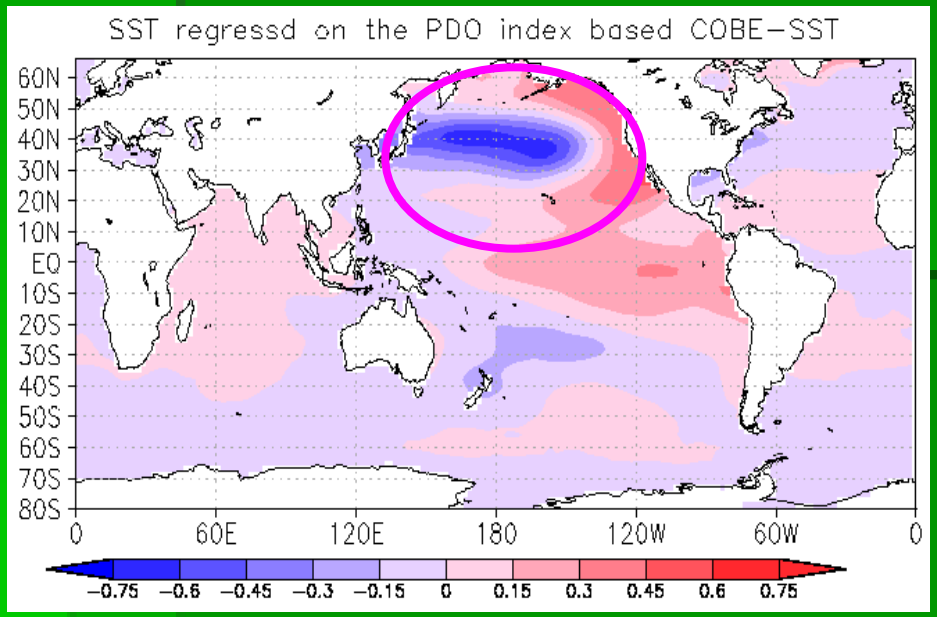
Significance test with 95% confidence level

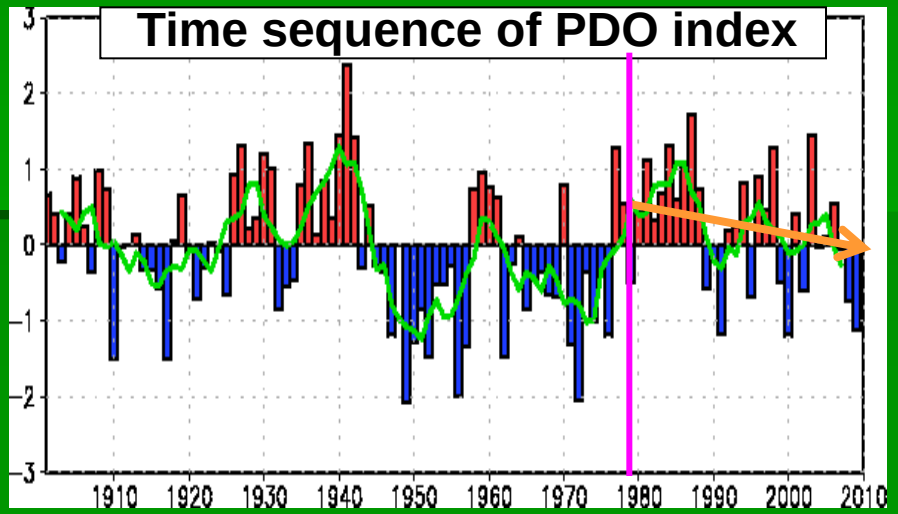
Last 30-year (1979-2008) SST trend in DJF



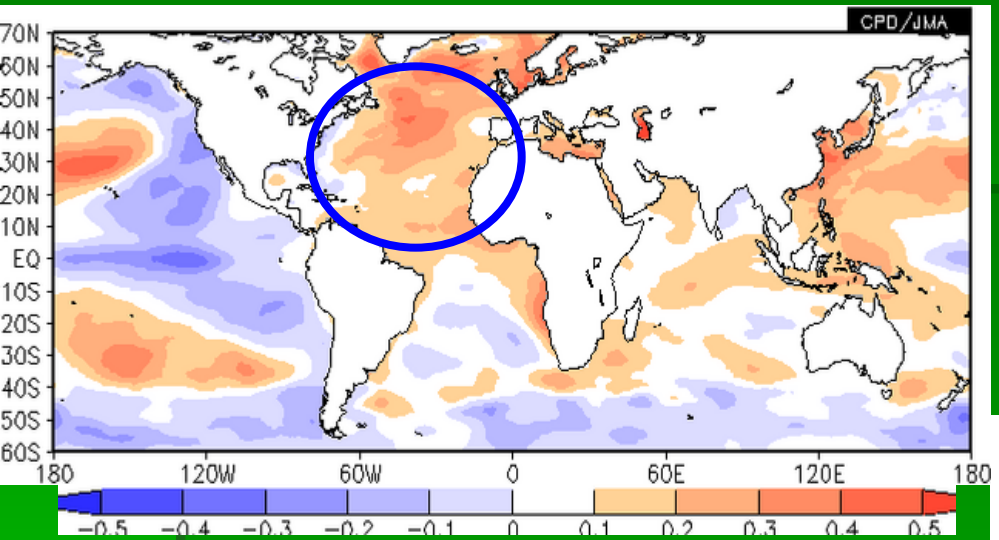
Is the trend in the North Pacific related to Pacific Decadal Oscillation (PDO) ?

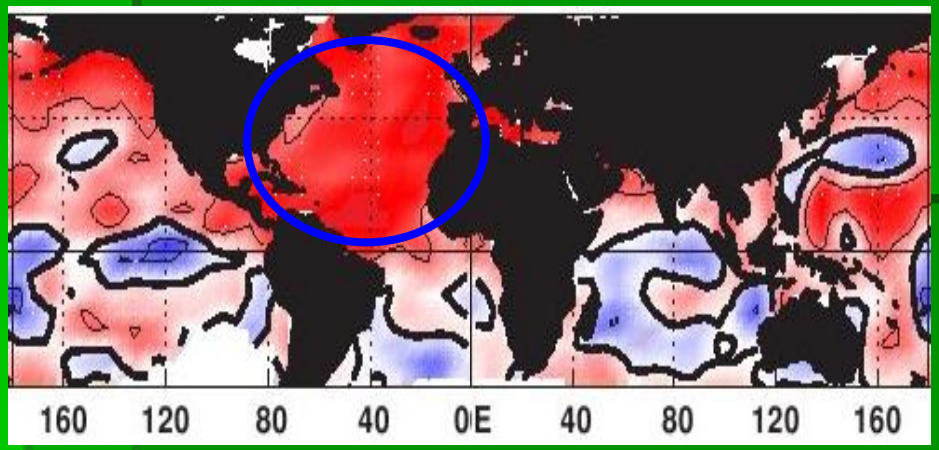
It's possible, but the pattern is somewhat different.





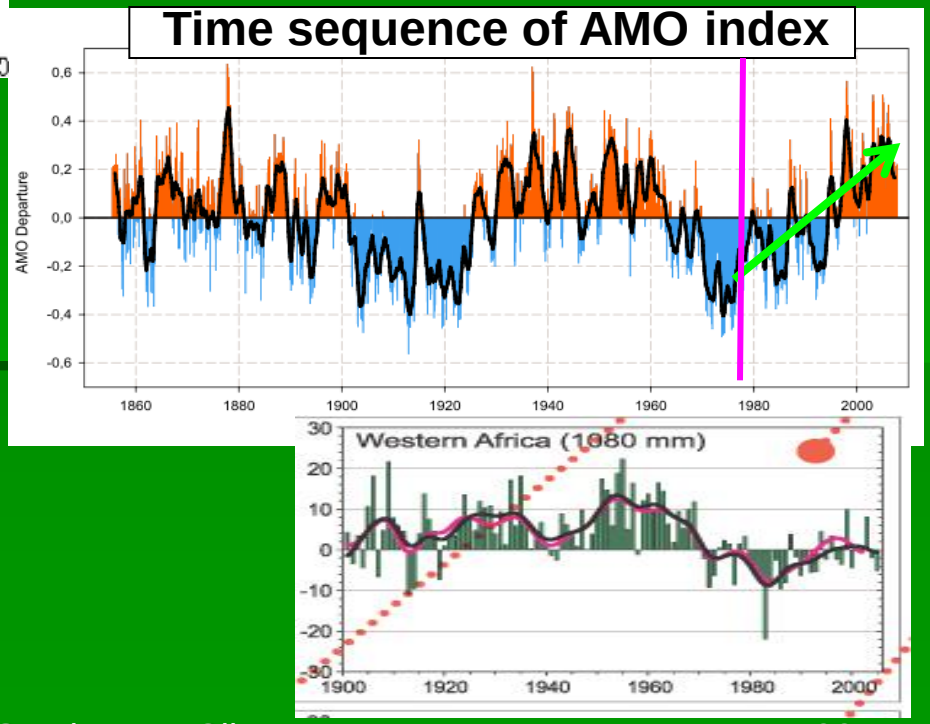
Last 30-year (1979-2008) SST trend in DJF



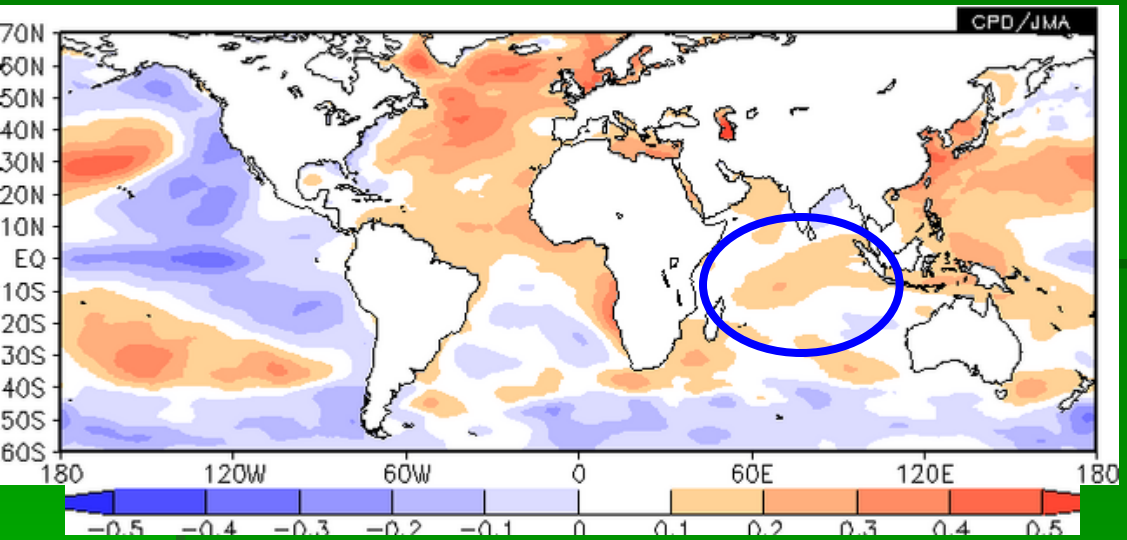


Is the trend in the North Atlantic related to Atlantic Multi-decadal Oscillation (AMO) ?

It seems to be the signal of AMO.

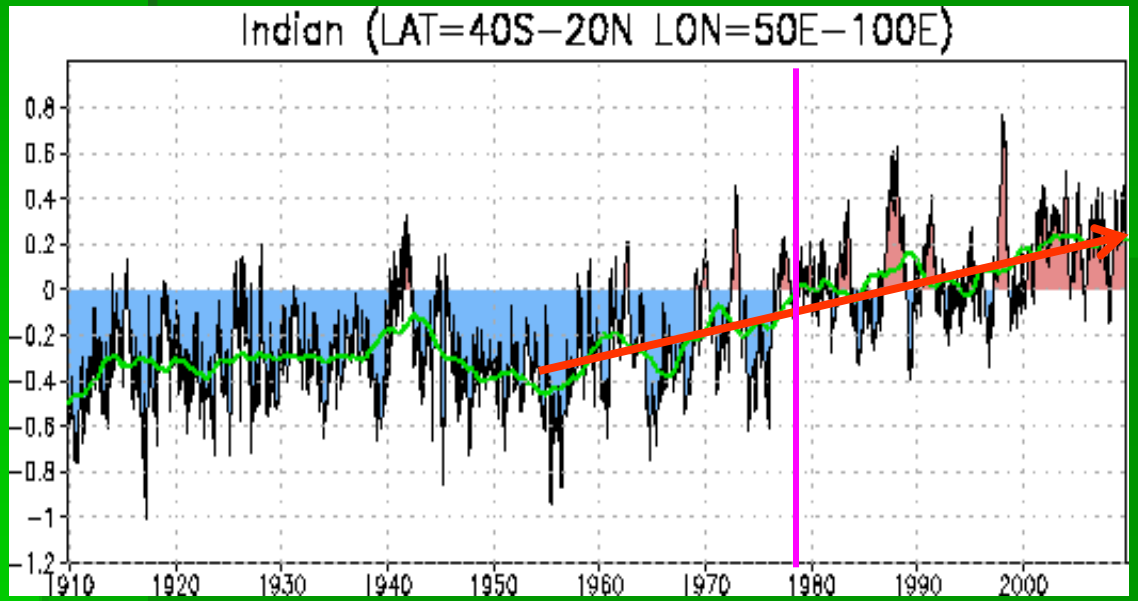


Last 30-year (1979-2008) SST trend in DJF

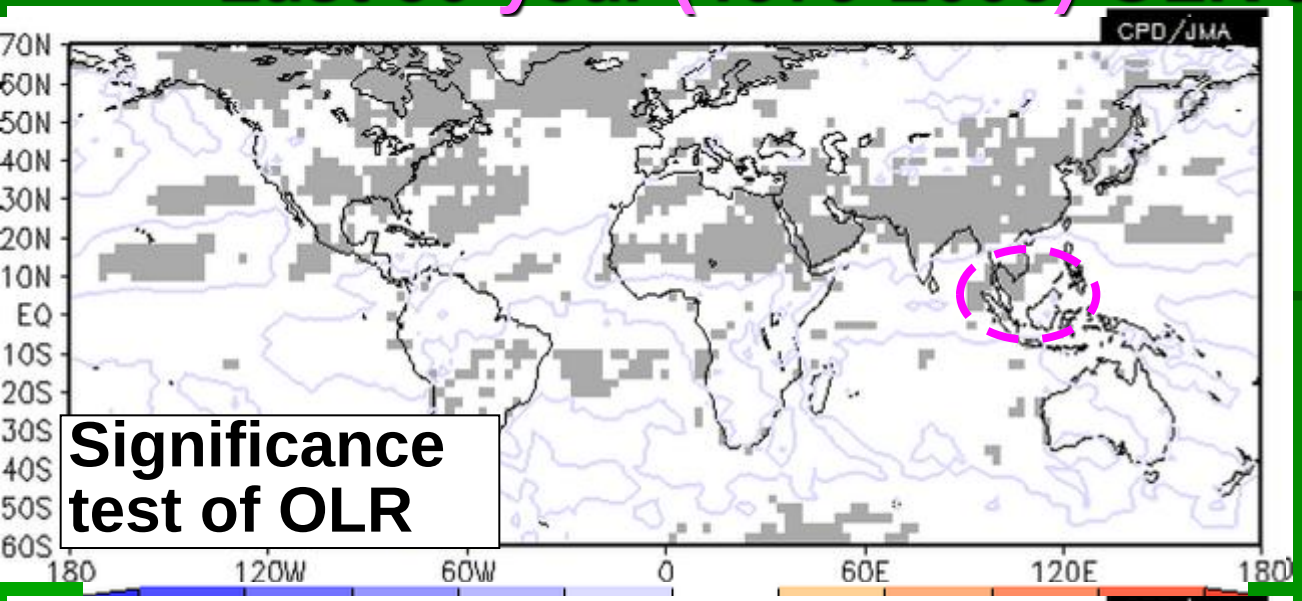


Is the trend in the Indian Ocean related to any decadal Oscillation ?

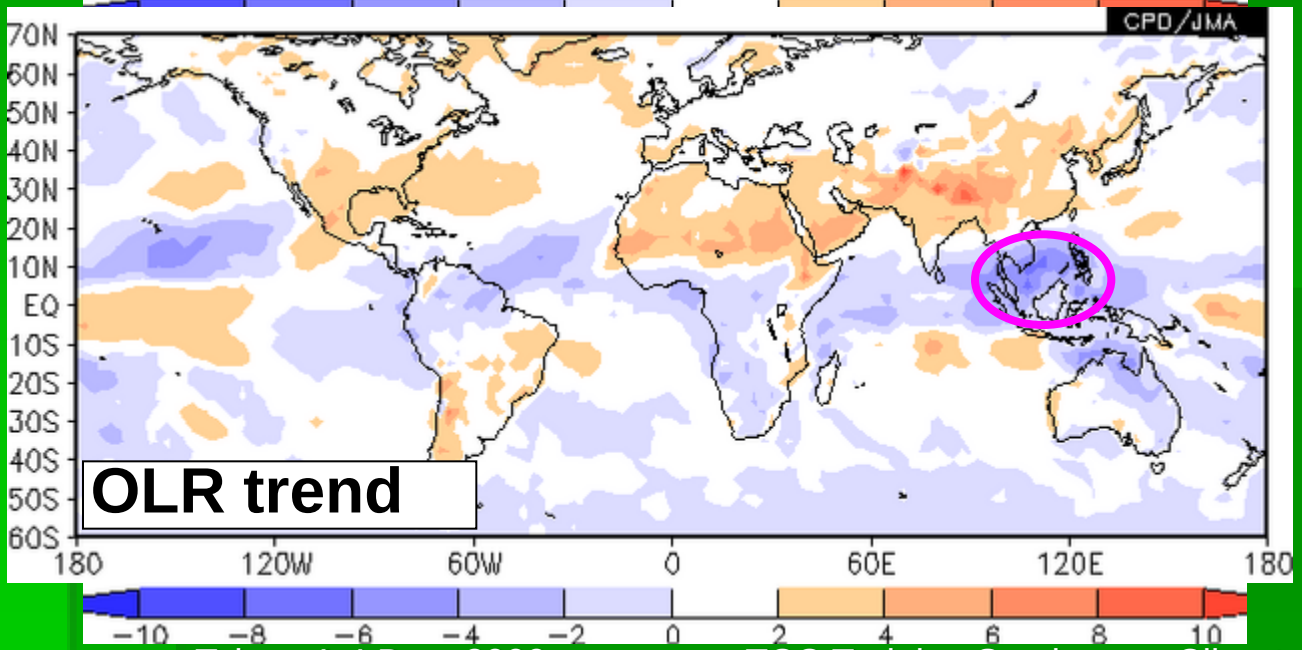
It seems to be a global warming trend.



Last 30-year (1979-2008) OLR trend in DJF

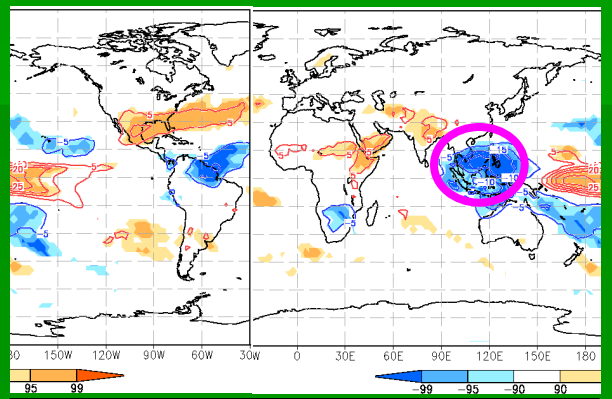


Significance test of OLR



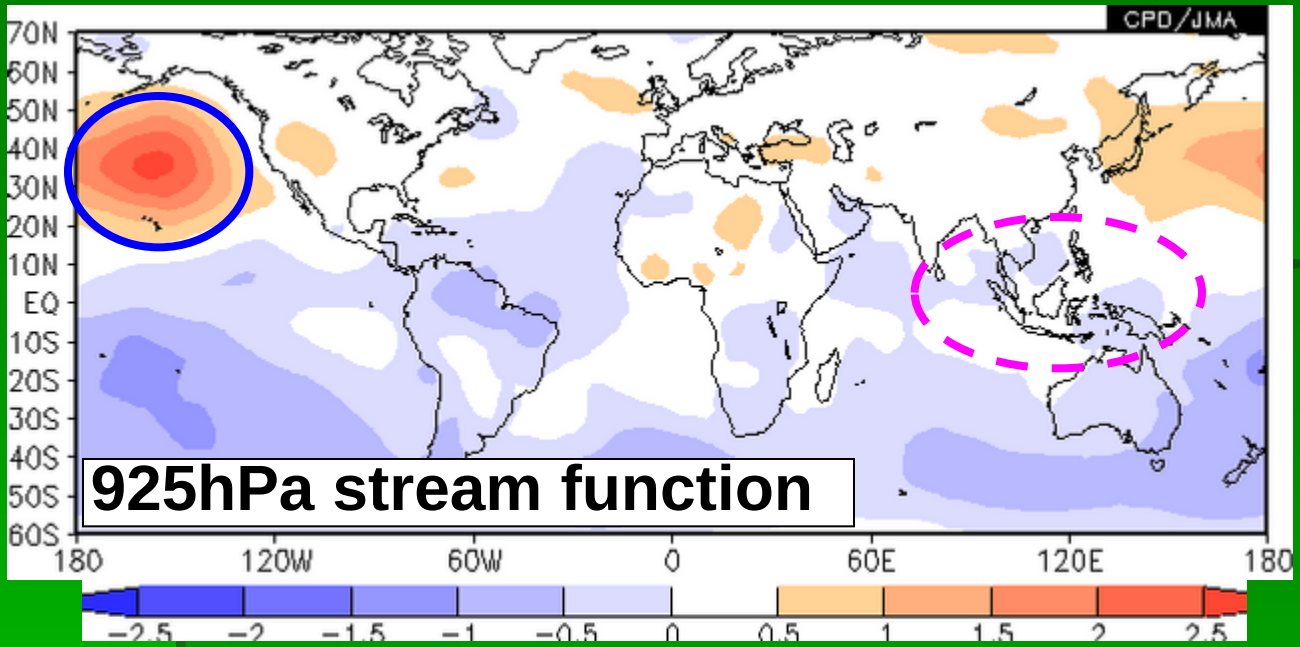
OLR trend

- **Active convection trend over the warm pool region.**
- **OLR trend pattern is similar to the composite in La Nina.**
- **Asian winter monsoon has a strengthening trend in last 30 years.**

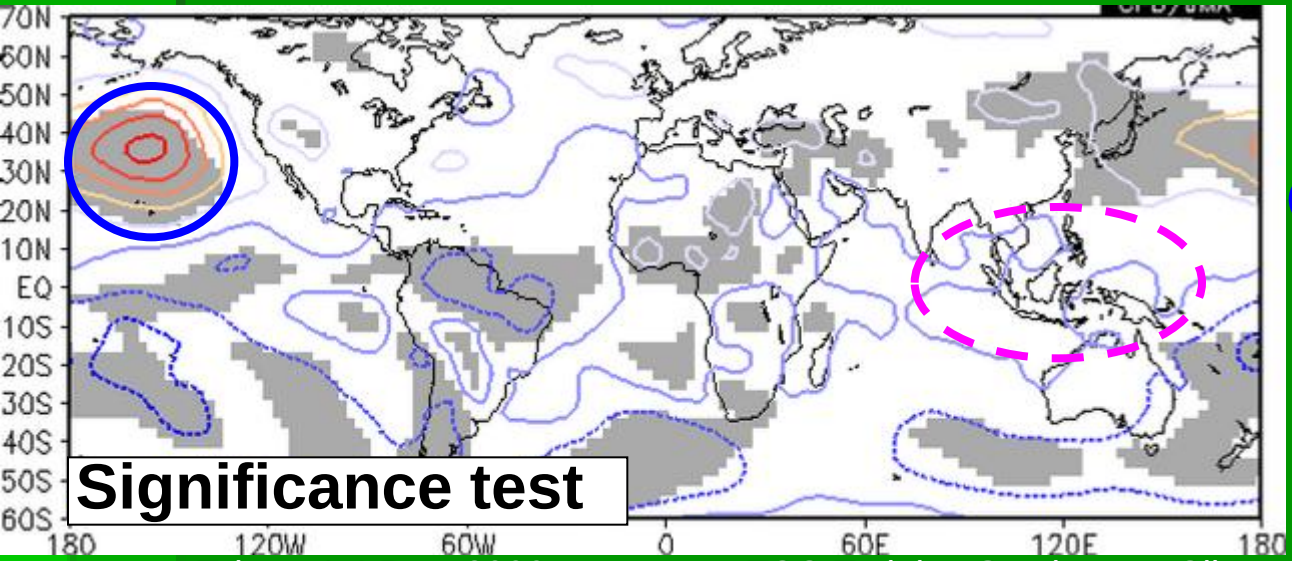


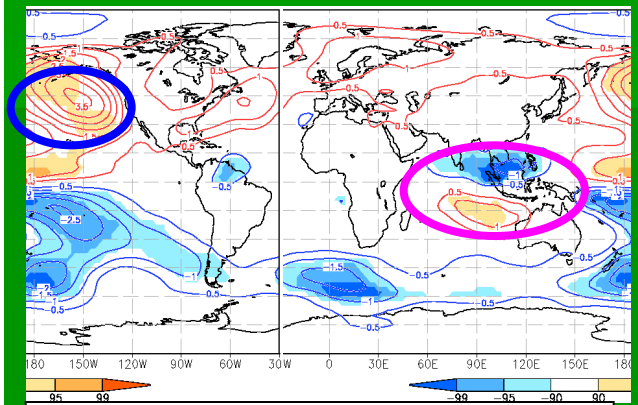
OLR composite in La Nina

Last 30-year (1979-2008) ψ925 trend in DJF



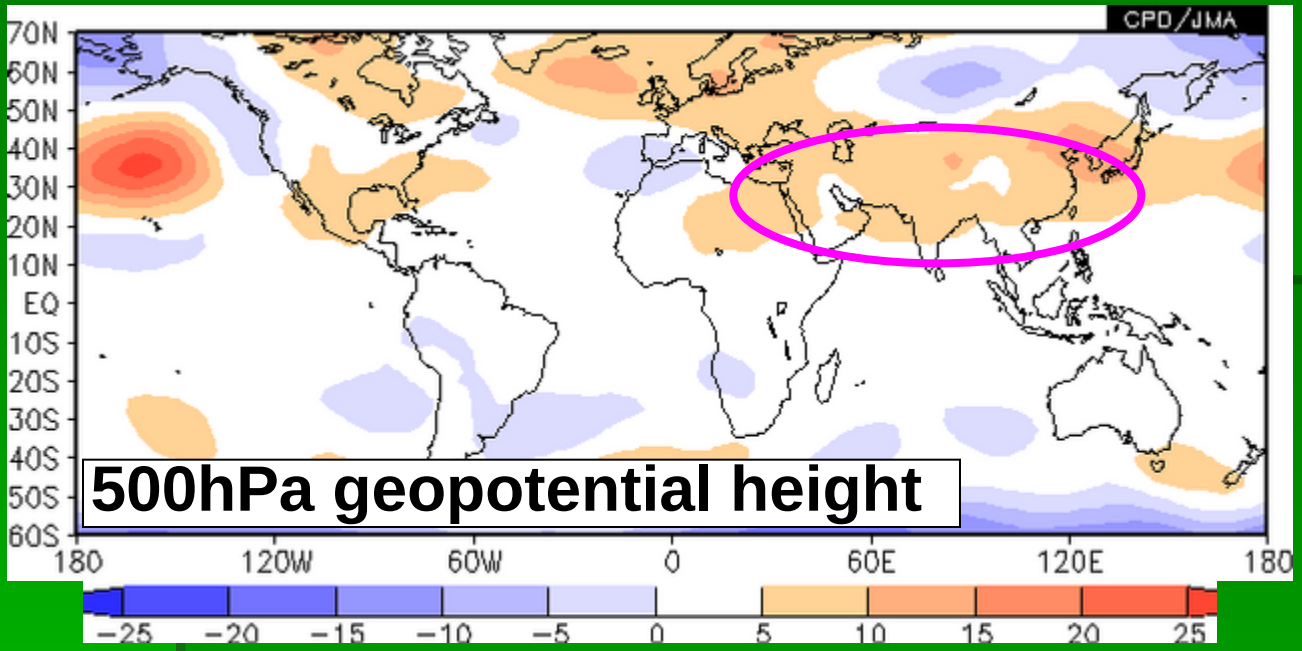
- No trend over the warm pool region.
- Dominant anti-cyclonic trend in the north Pacific which is similar to the composite in La Nina.



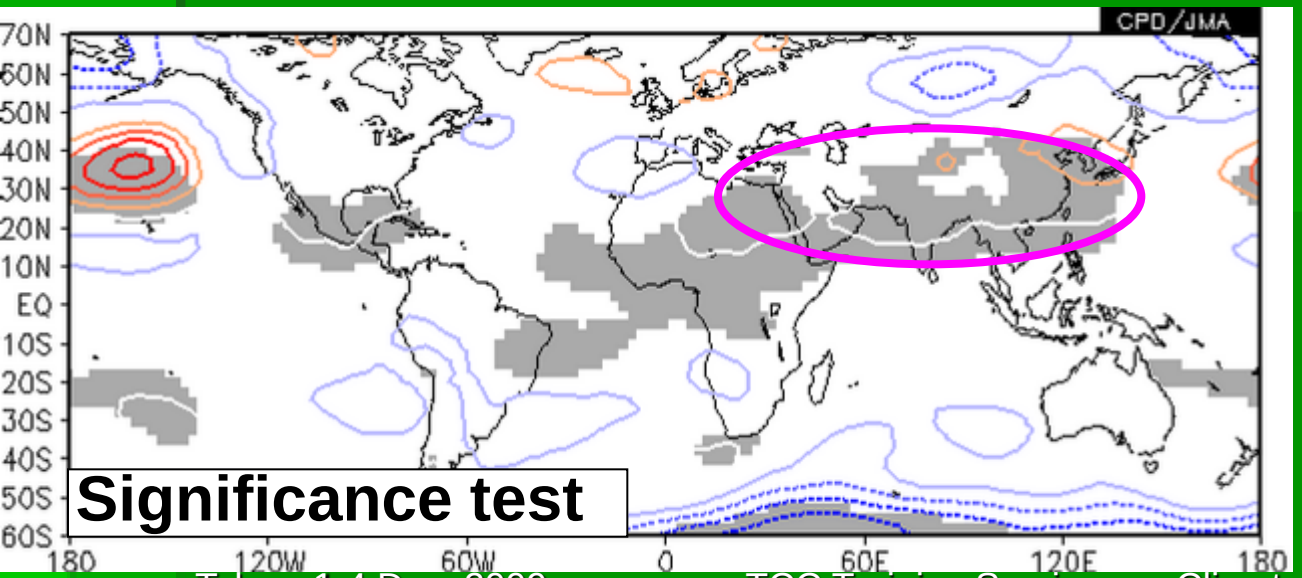


ψ850 composite in La Nina

Last 30-year (1979-2008) Z500 trend in DJF

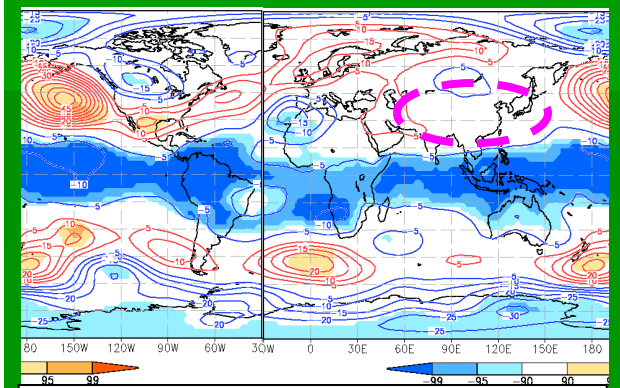


500hPa geopotential height



Significance test

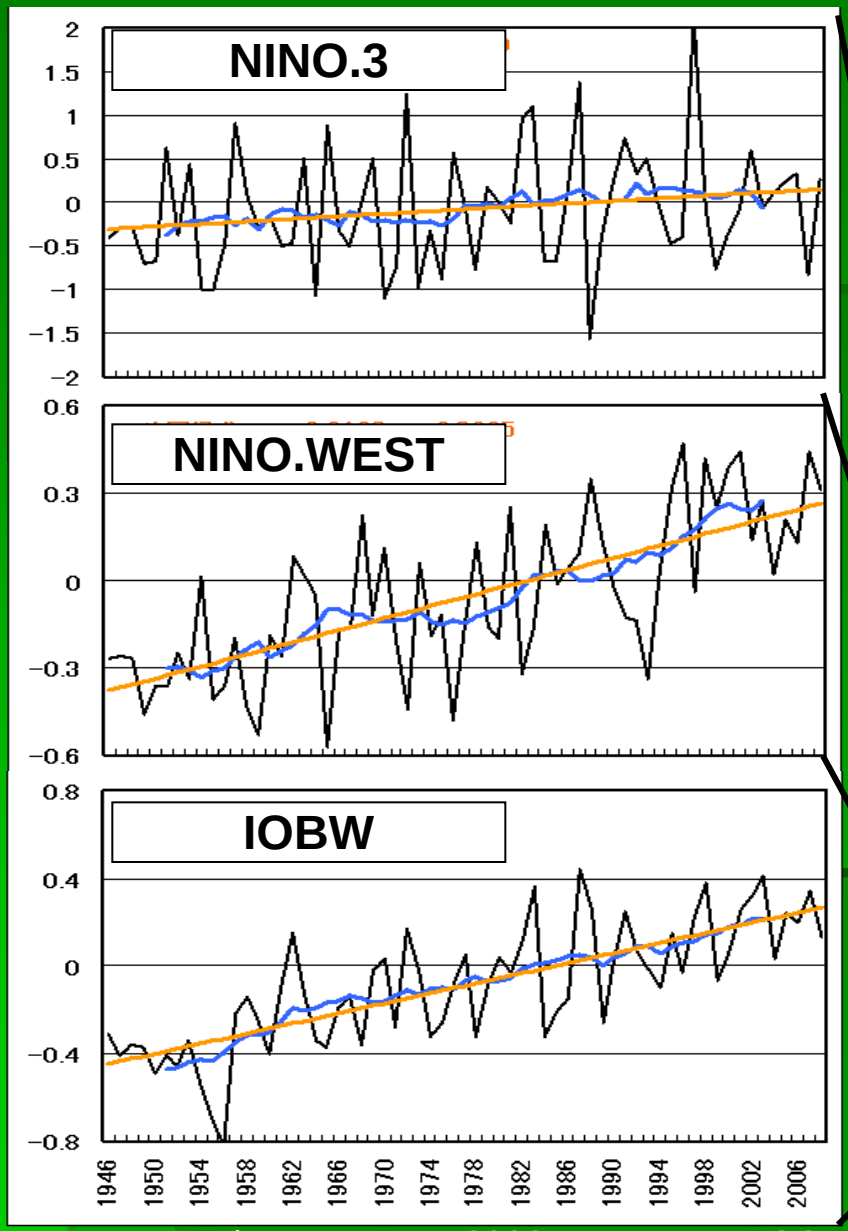
- Active convection trend over the warm pool.
- OLR trend pattern is similar to the composite in La Nina.
- Asian winter monsoon has a strengthening trend in last 30 years.

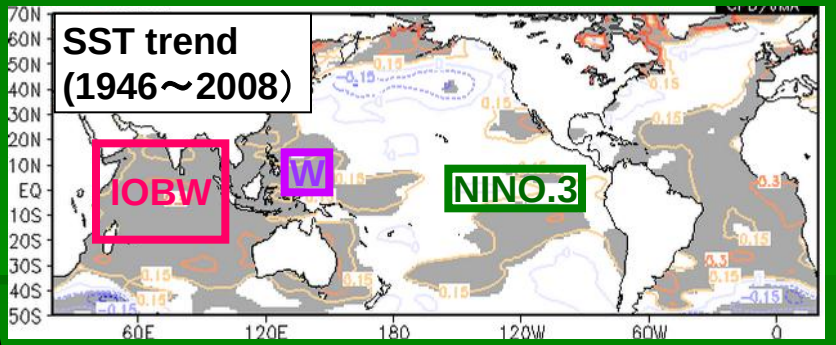


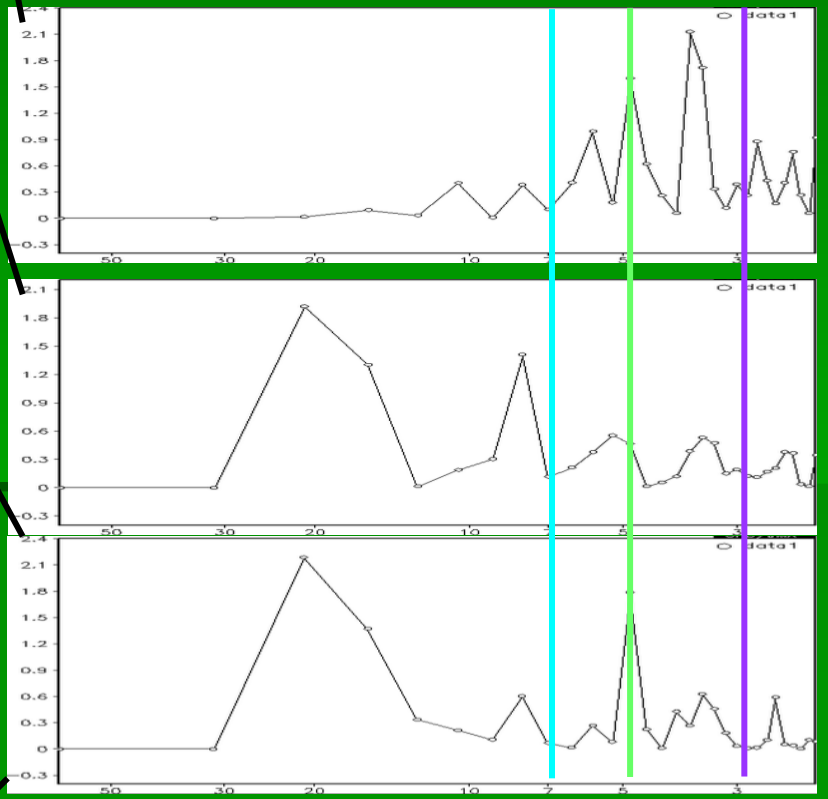
Z500 composite in La Nina

Trend and Decadal Variability in the Tropical Ocean

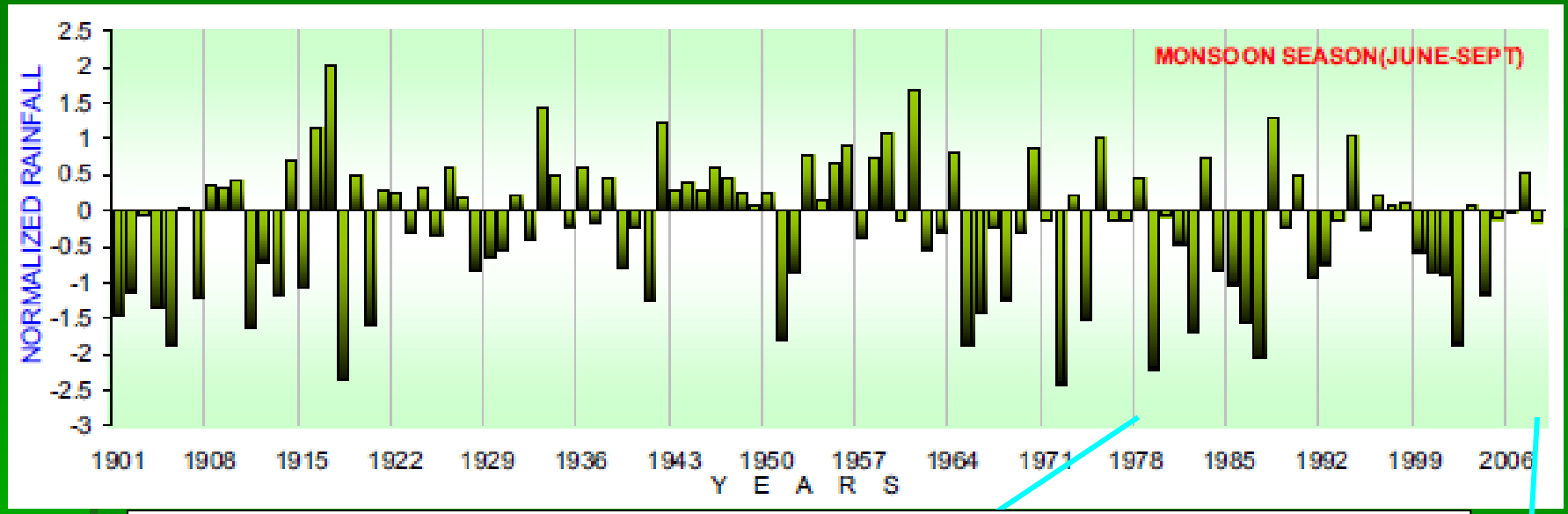
SST Trend and dominant frequency in JJA



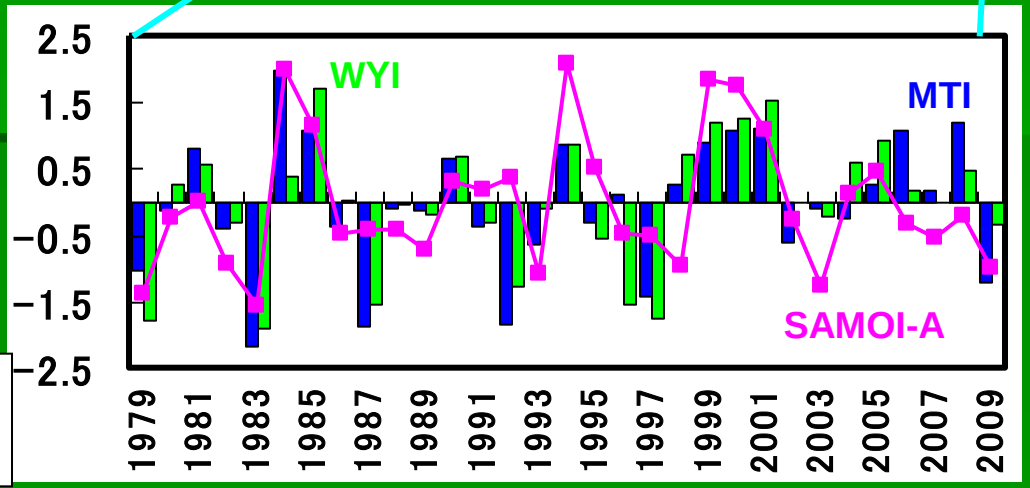




Asian summer monsoon variability

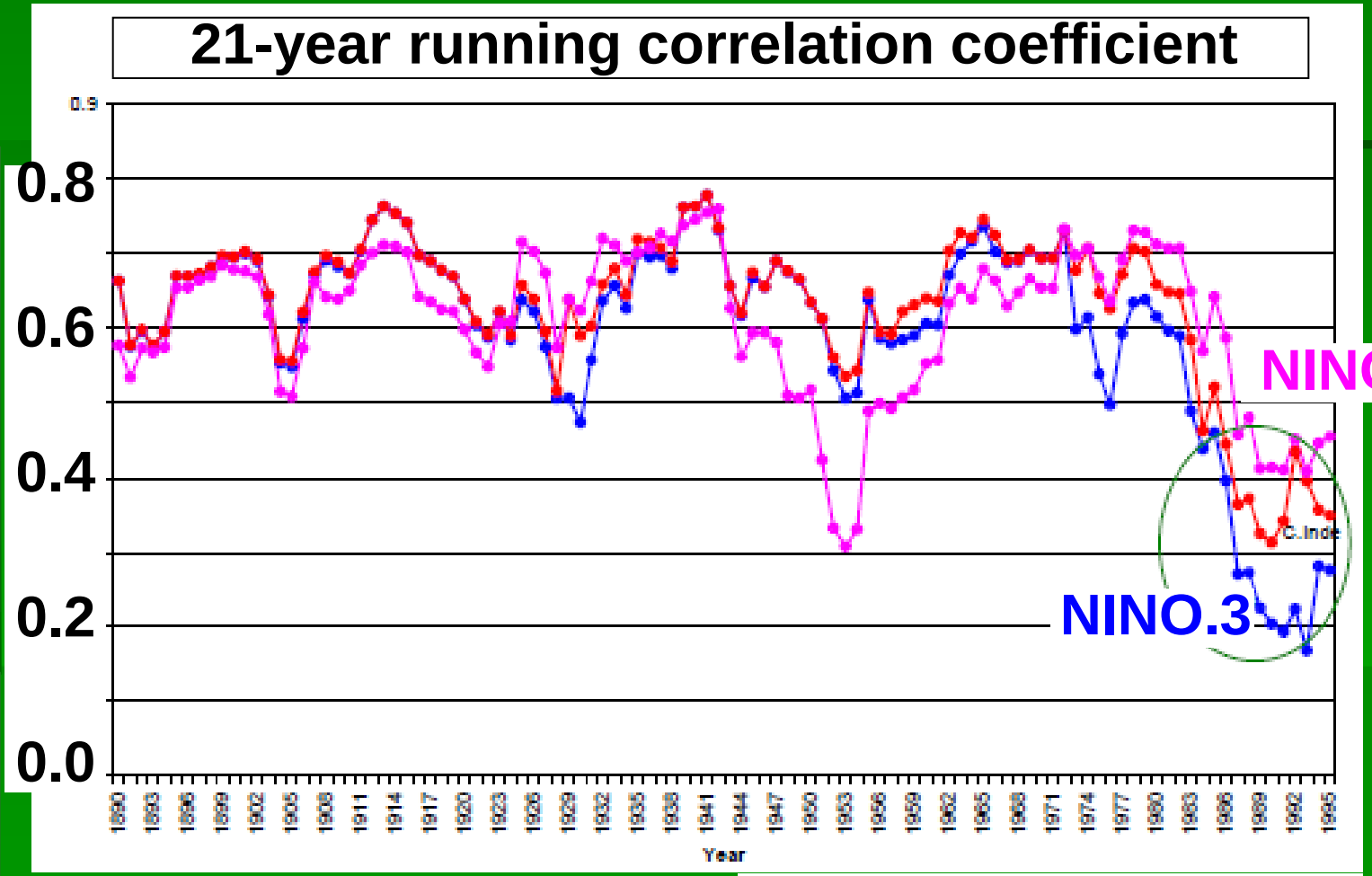


Indian Summer Monsoon Rainfall (ISMR) (IMD)



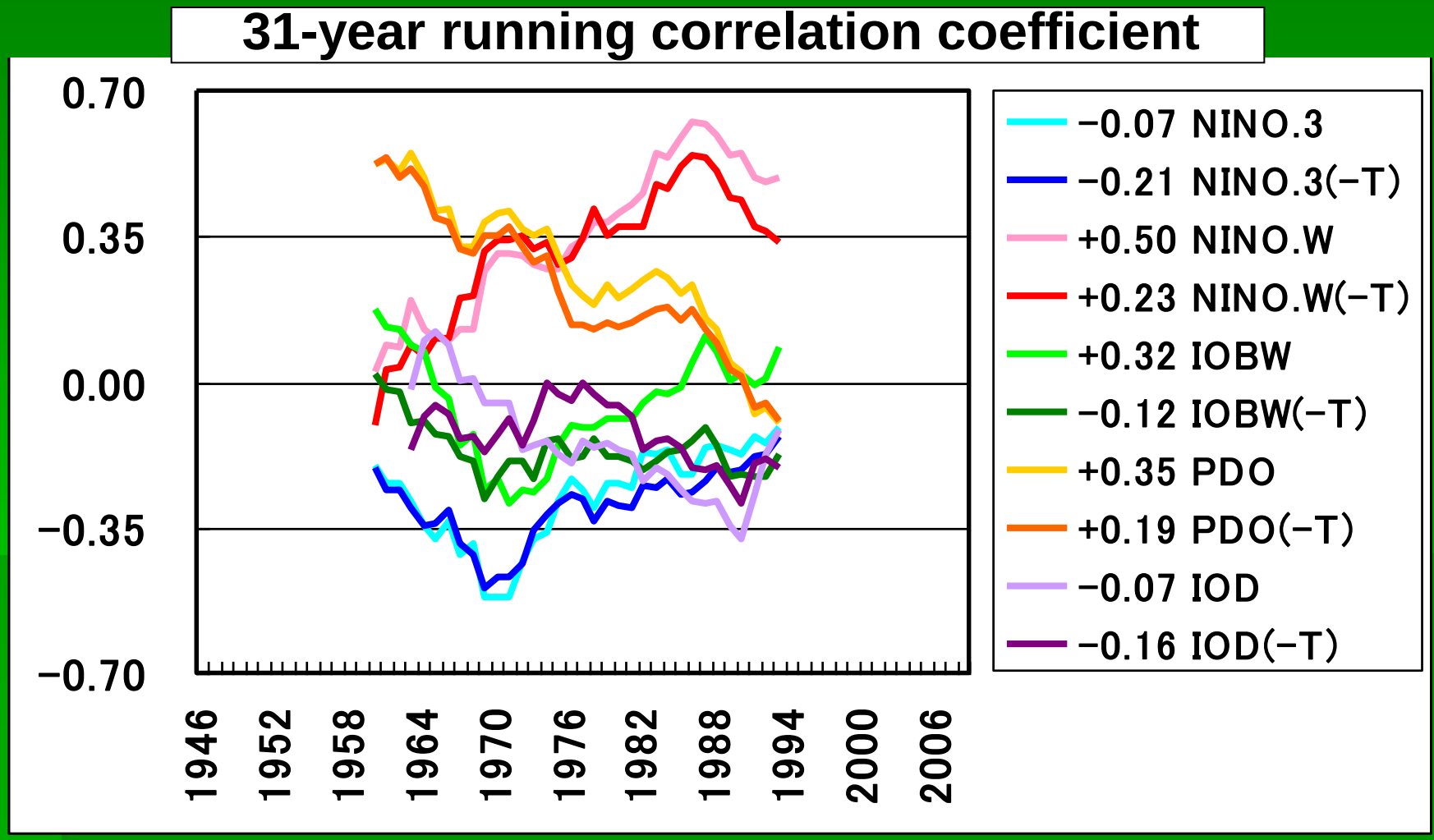
Asian summer monsoon indices

Recent change of relationship between ISMR and NINO.3



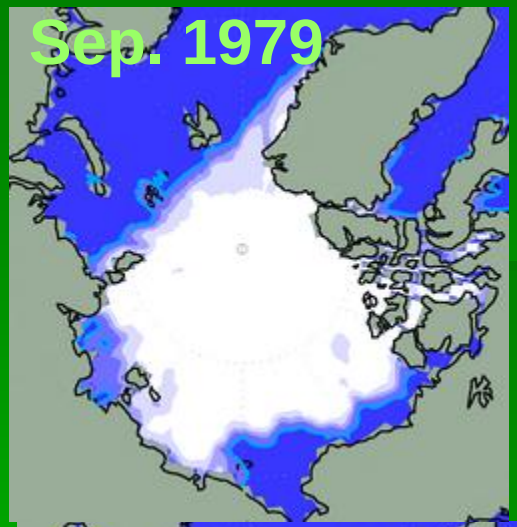
(M. Rajeevan and D. S. Pai)

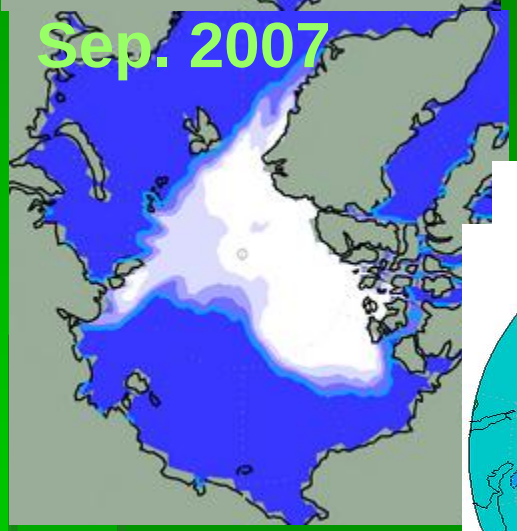
Recent change of correlation between summer temperature in western Japan and Ocean indices

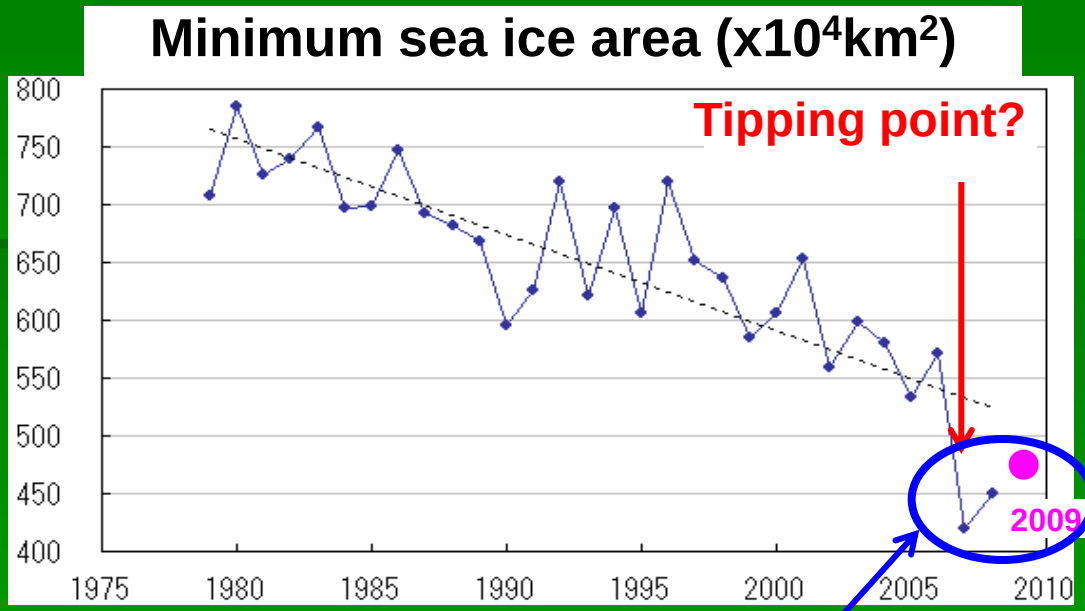


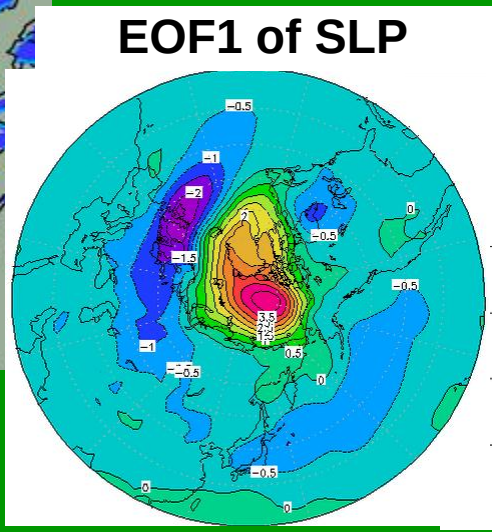
Other notable Variability

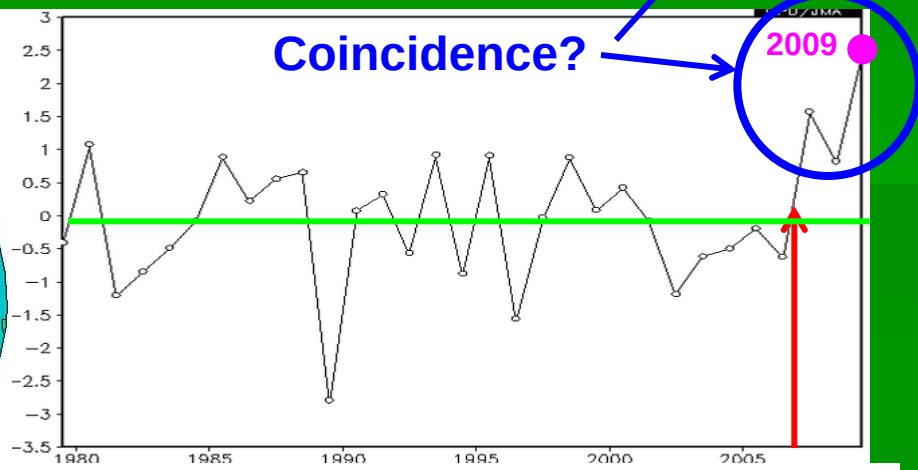
Decreasing Arctic Sea Ice











Summary

- Observed global warming trends are different in different periods, different seasons and different regions.
- There are monotone warming trends with no significant decadal variability in the SSTs over the Indian Ocean and the warm pool region.
- Major decadal variabilities such as PDO and AMO have larger amplitude than warming trends in a specific region in a few decadal time scale, but it is not large for global mean.
- Recent 30-year trend in the tropical circulation is a little similar to the composite in La Nina.
- Relationship between Asian climate and El Nino has changed recently probably due to the warming of other tropical Ocean.

Thank you