

Estimating Contribution of Tropical Cyclone to Climate Variability in the Tropical Western North Pacific

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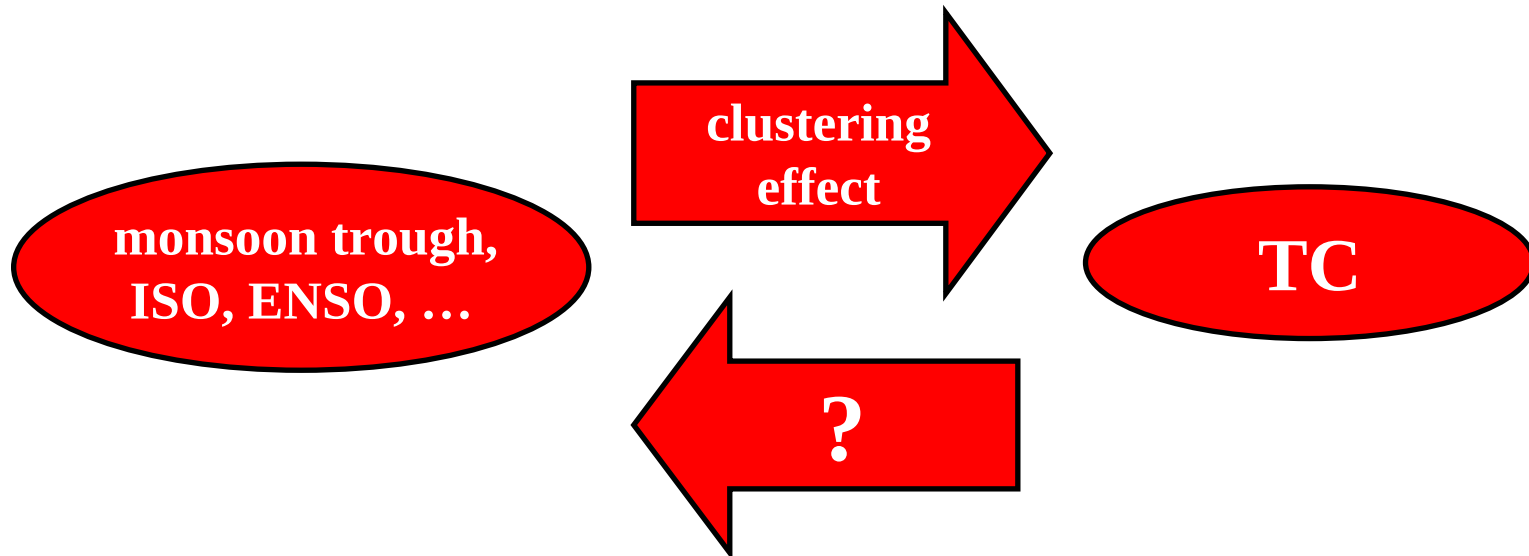


Well known (but well understood?): Influence of large-scale circulation on TC



e.g., Nakazawa (1986), Heta (1992), Hartmann et al. (1992),
Liebmann et al. (1994), ..., Maloney and Dickinson
(2003), Elsberry (2004), Wang and Chan (2002), ...

Relatively unknown: Feedback from TC?

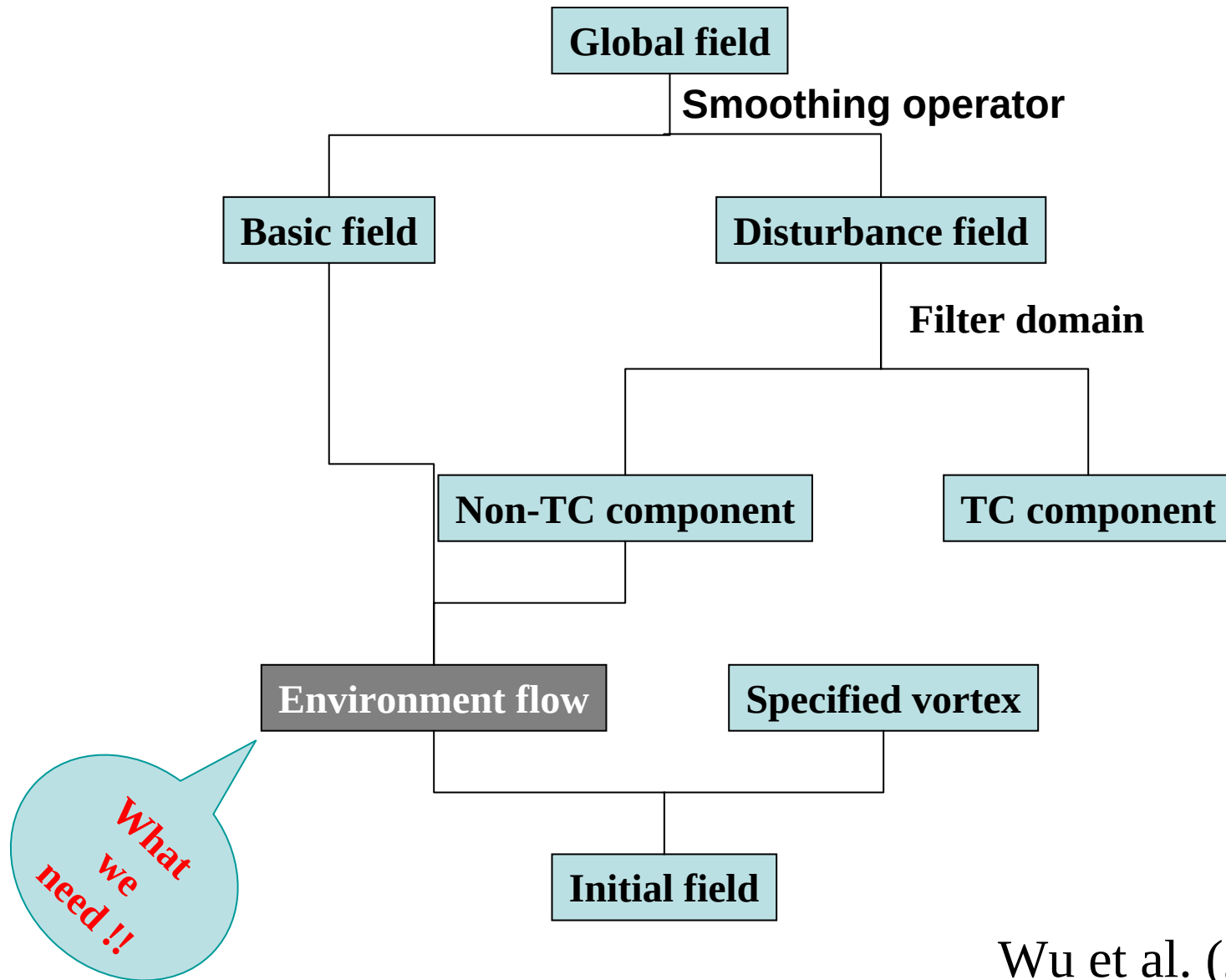


How to quantify the possible contribution of TC to climate variability?

Approach:

- artificially remove the TC from data
- not entirely realistic, but yield certain estimation

Kurihara(1995): Approach used in TC initialization



Wu et al. (2002)

Total

2004 Mindulle and Ting-Ting

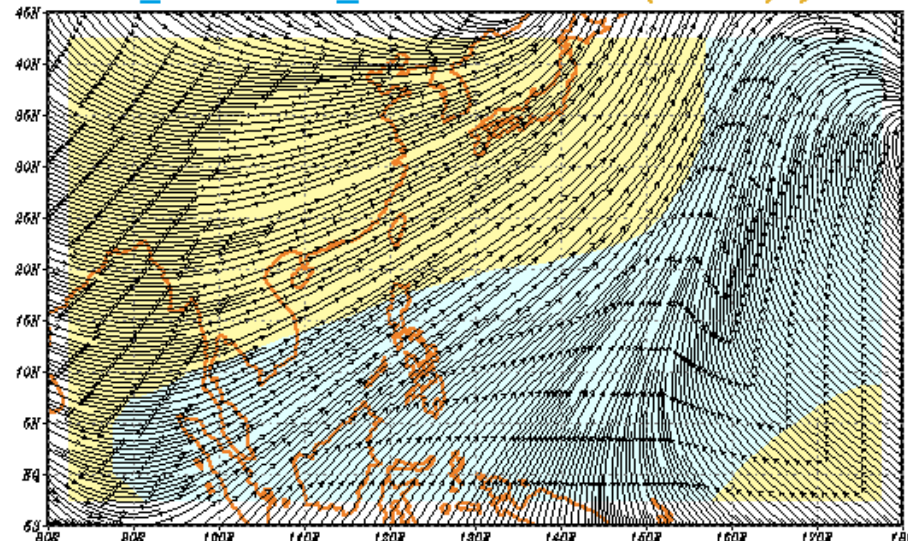
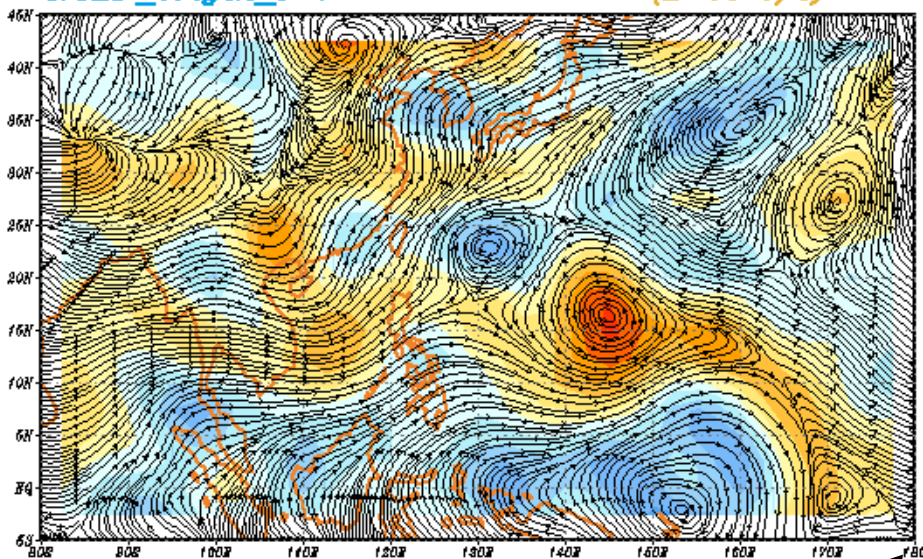
Basic

NCEP_origin_t=1

(E-05 1/s)

NCEP_basic state_t=1

(E-05 1/s)



Typhoon

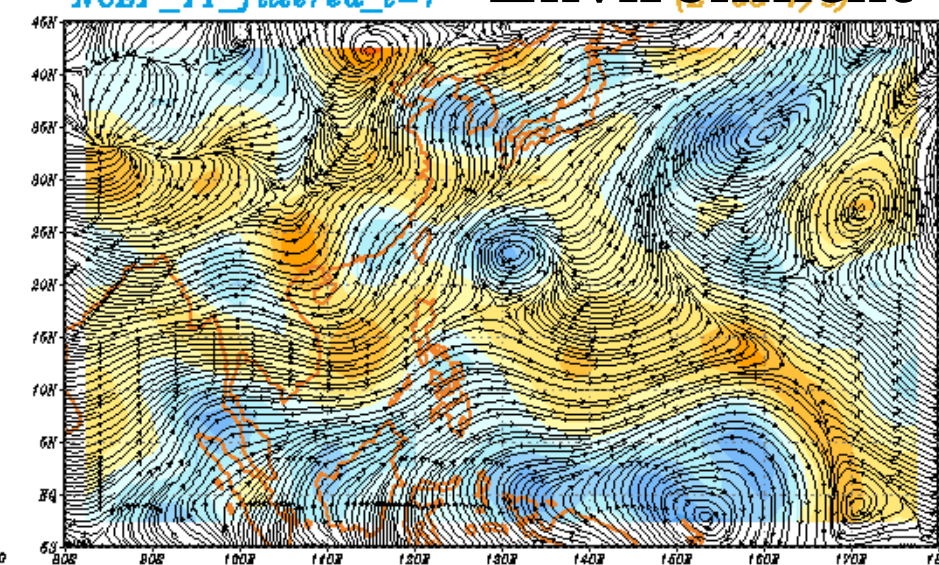
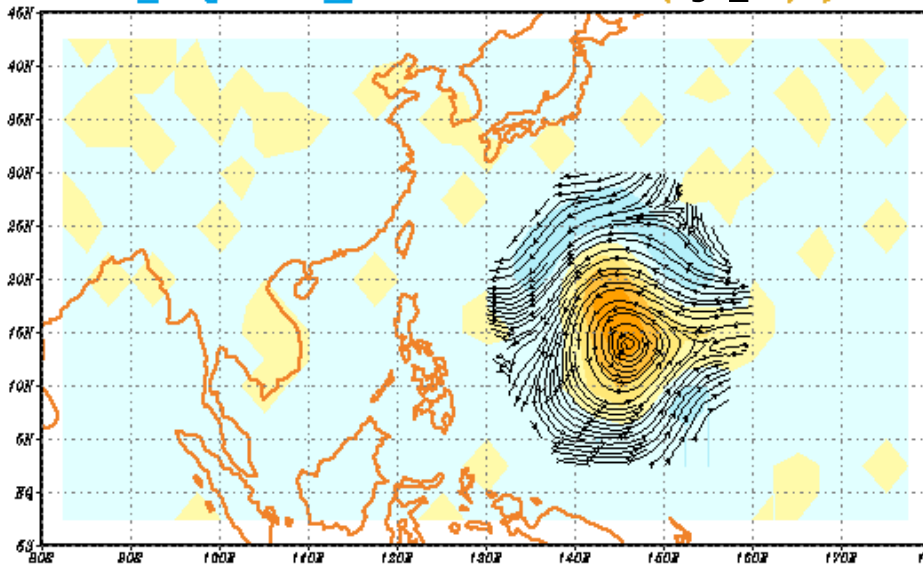
NCEP_origin-TY_filtered t=1

(E-05 1/s)

NCEP_TY_filtered_t=1

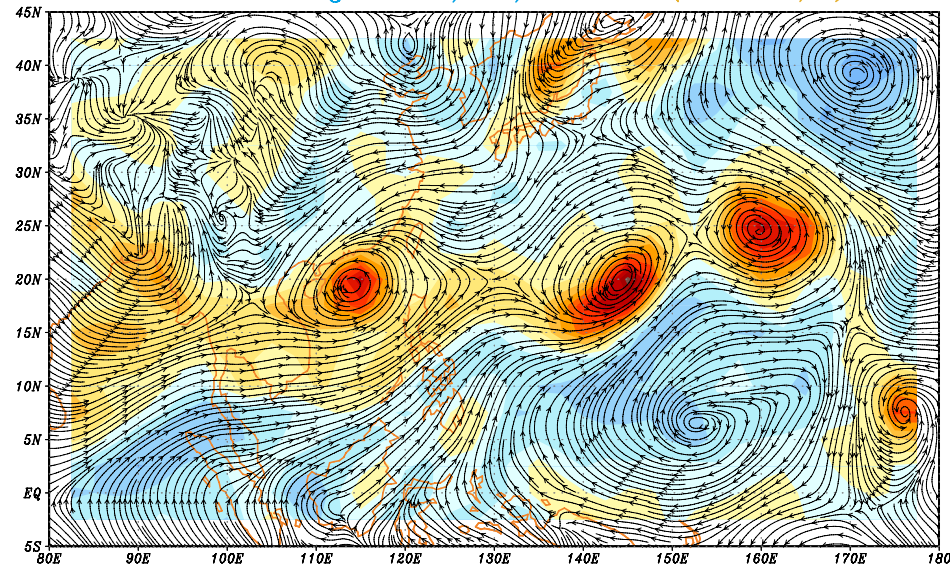
(E-05 1/s)

Environment

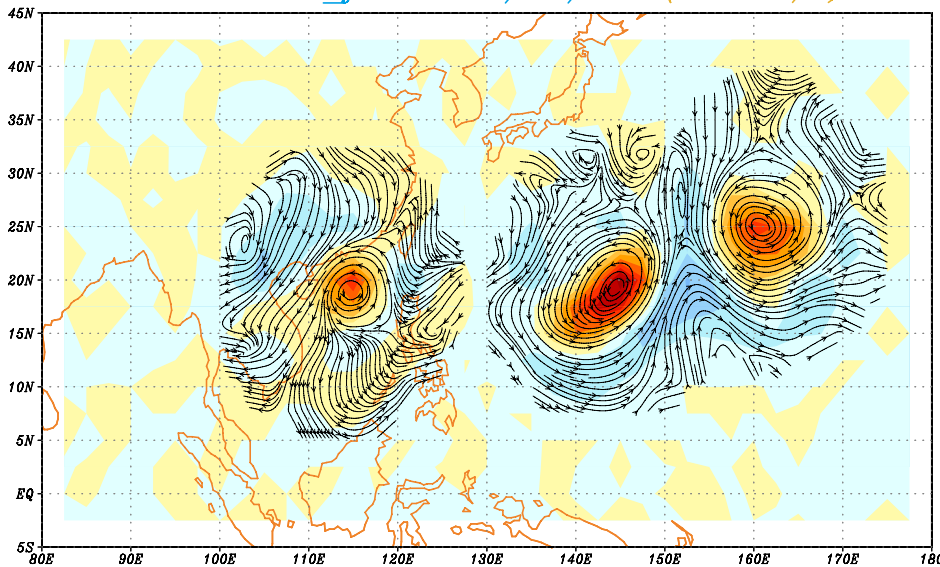


Removal of tropical cyclones from ERA40 850 hPa vorticity field (JJASO 1958-2001)

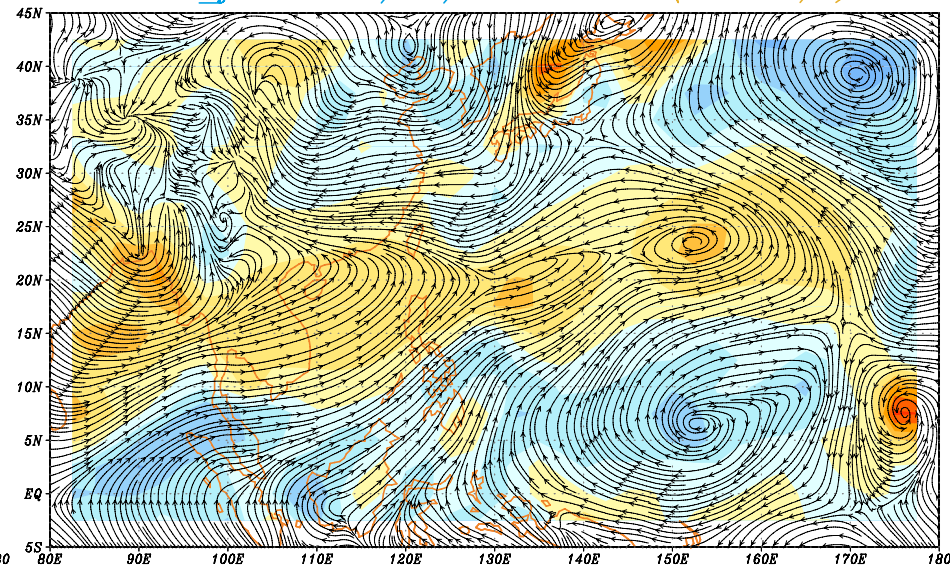
2001 ERA40 original 8/28/06Z (E-05 1/s)



2001 ERA40-TY_filtered 8/28/06Z (E-05 1/s)



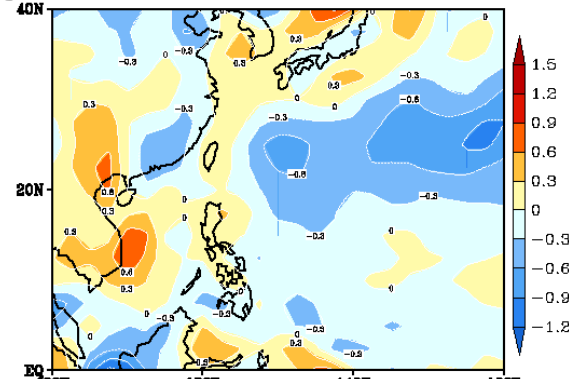
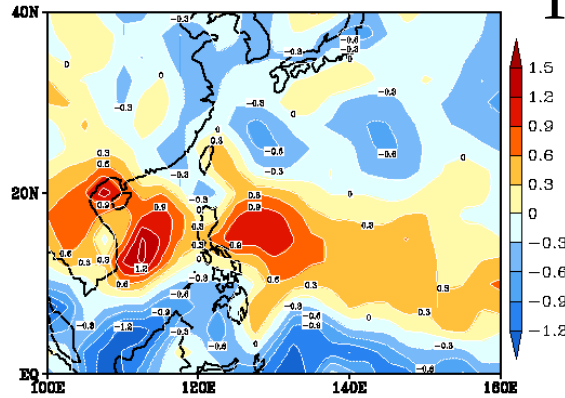
2001 TY_filtered 8/28/06Z (E-05 1/s)



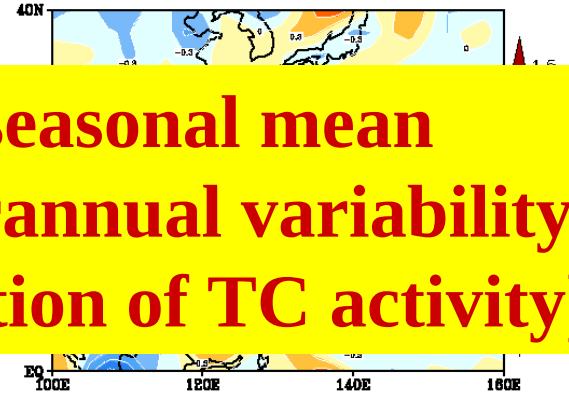
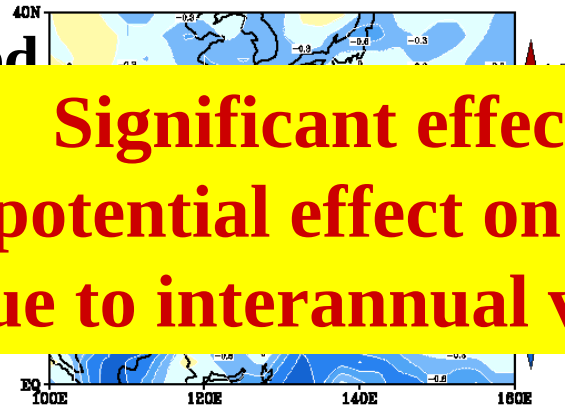
1994 (TS=32) JJASO mean 850-hPa vorticity 1998 (TS=11)

TS=20.3

original

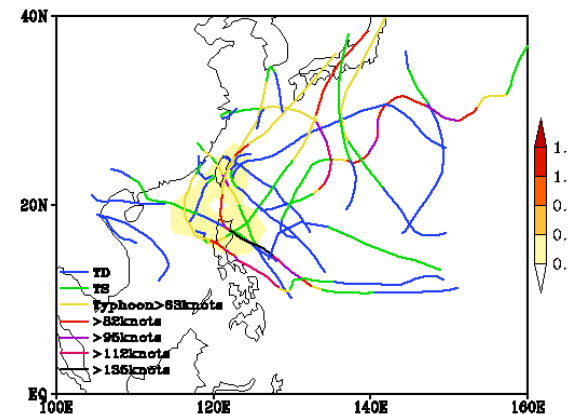
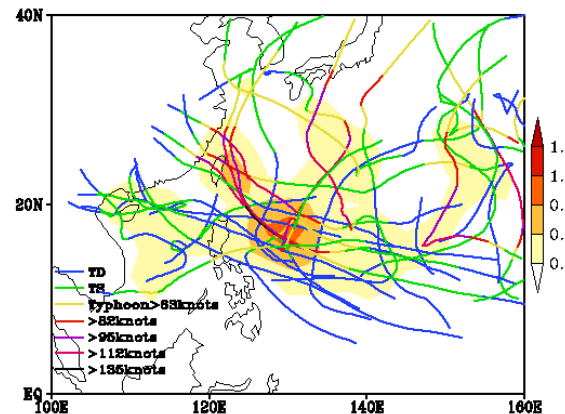


TC-removed

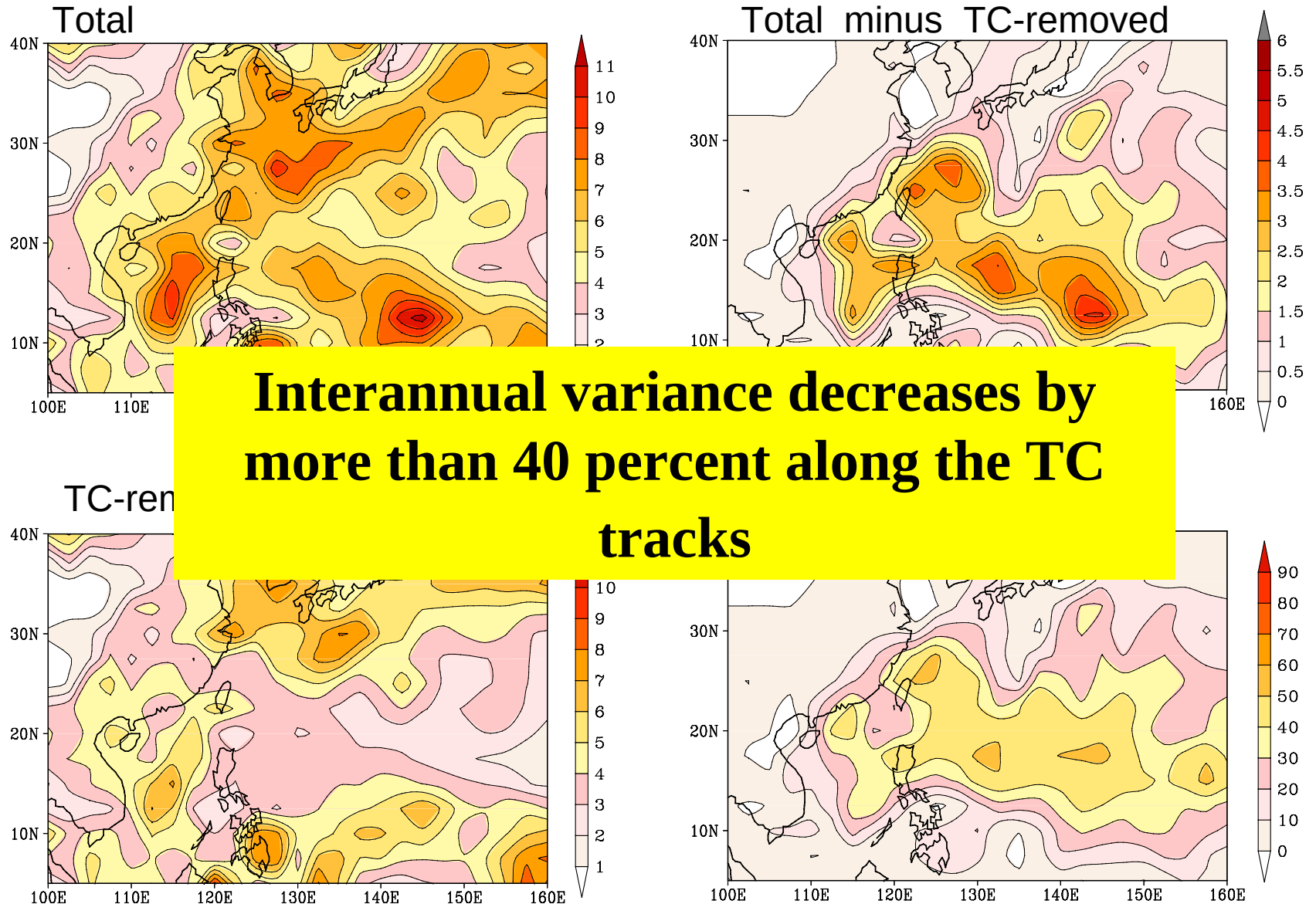


**Significant effect on seasonal mean
– potential effect on interannual variability
(due to interannual variation of TC activity)**

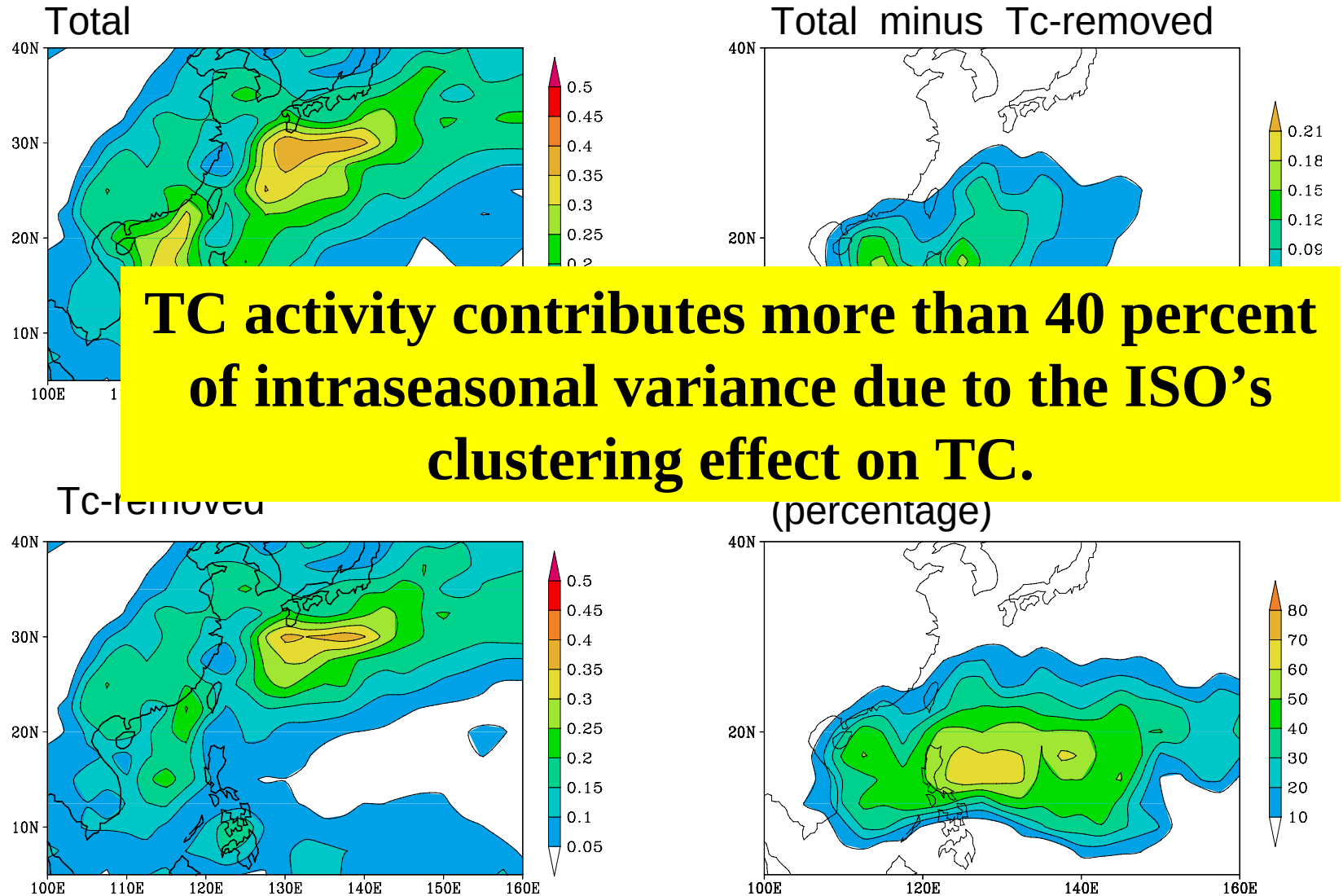
difference



1958-2001(44yr) interannual variance



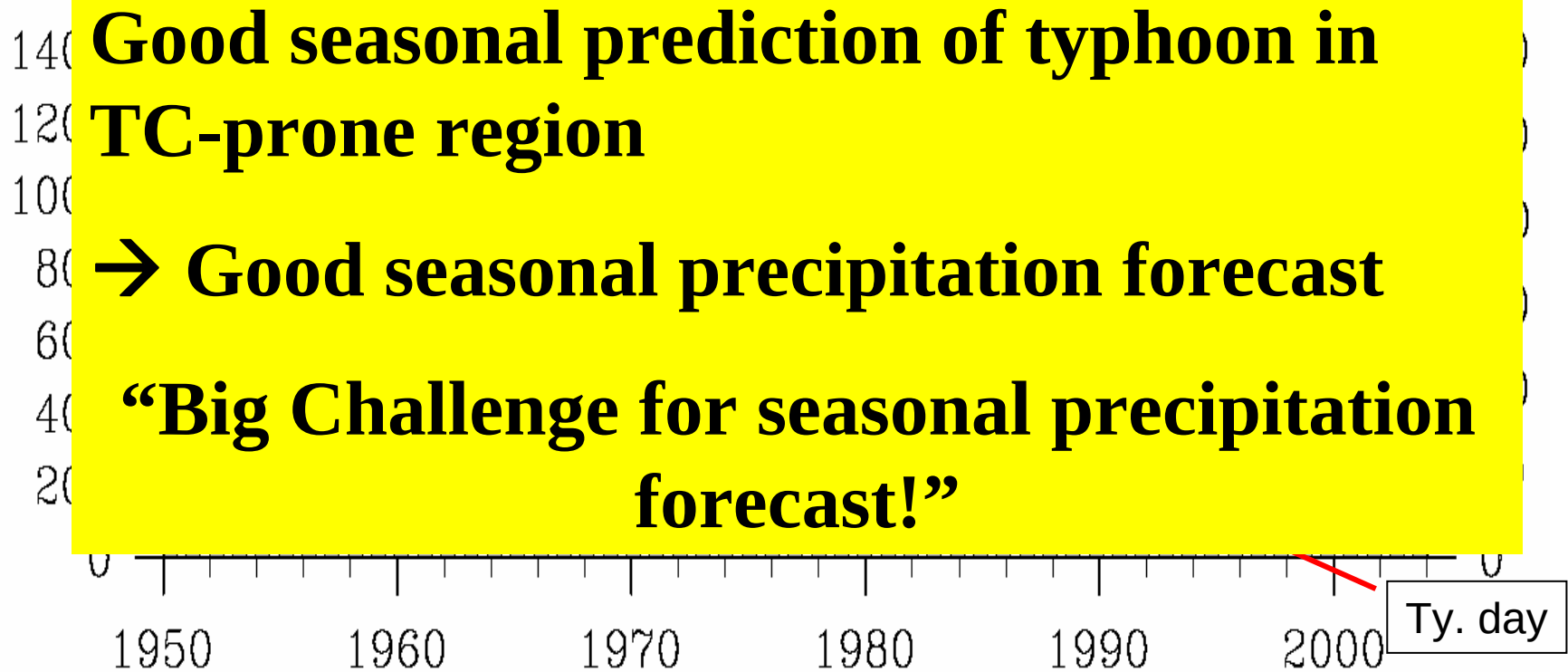
1958-2001 (44yr) intraseasonal variance (20-80 day)



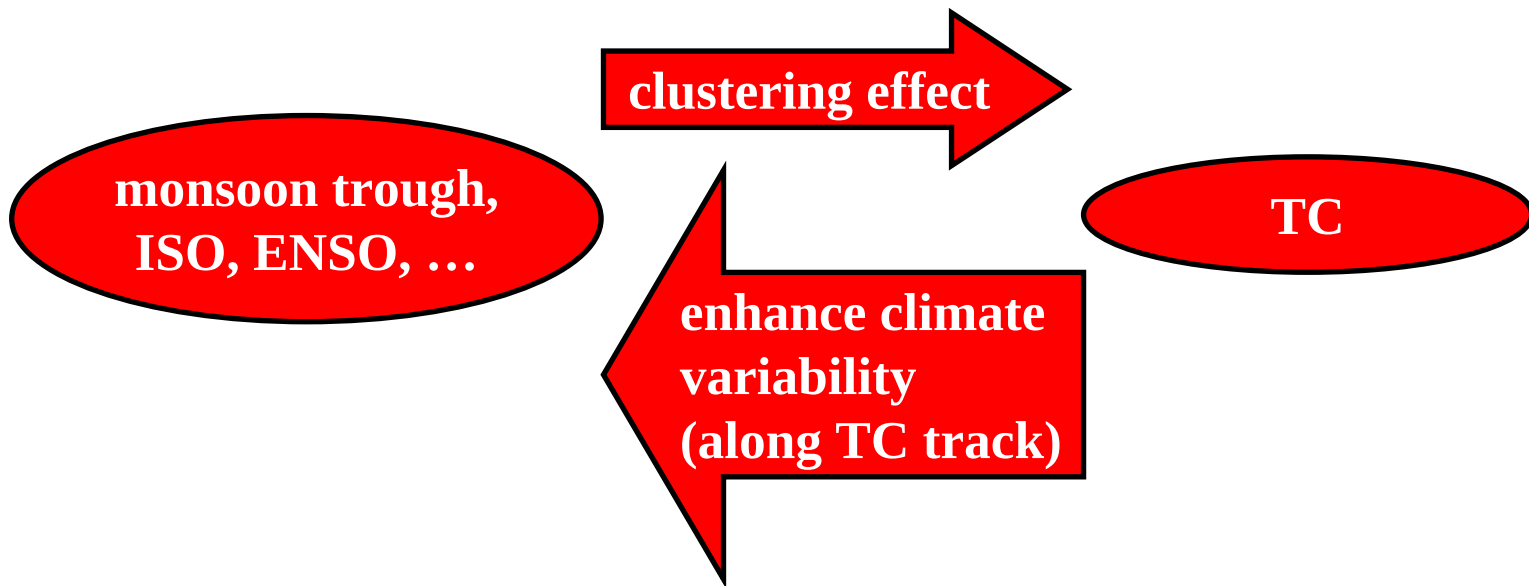
Influence of TC on Station Precipitation

Taiwan as an Example

1950~2004 JASO Typhoon rain .Season rain & Typhoon rain days



TC and Climate Variability



Discussion

Conventional Wisdom:

High-frequency perturbations can be removed through averaging or filtering procedures

This study suggests

- **Large positive vorticity can not be cancelled by much smaller negative vorticity**
- **Large precipitation can not be cancelled by ‘negative’ precipitation**
- **long-term average will not be able to remove the perturbation associated with TC**
- **climate variability (the way we defined) includes the contribution from TC**

Questions:

- **How to define climate variability?**
- **To what extent the TC contribution affect the characteristics of climate variations (ISO, interannual variability, etc.) in the TC-active regions?**
- **How does TC affect low-frequency, large-scale climate variability?**
- **How does this affect our understanding on certain climate processes?**

Possible implication for climate simulation and prediction in the western North Pacific

Fact:

Poor GCM simulation and low predictability in the summer rainfall

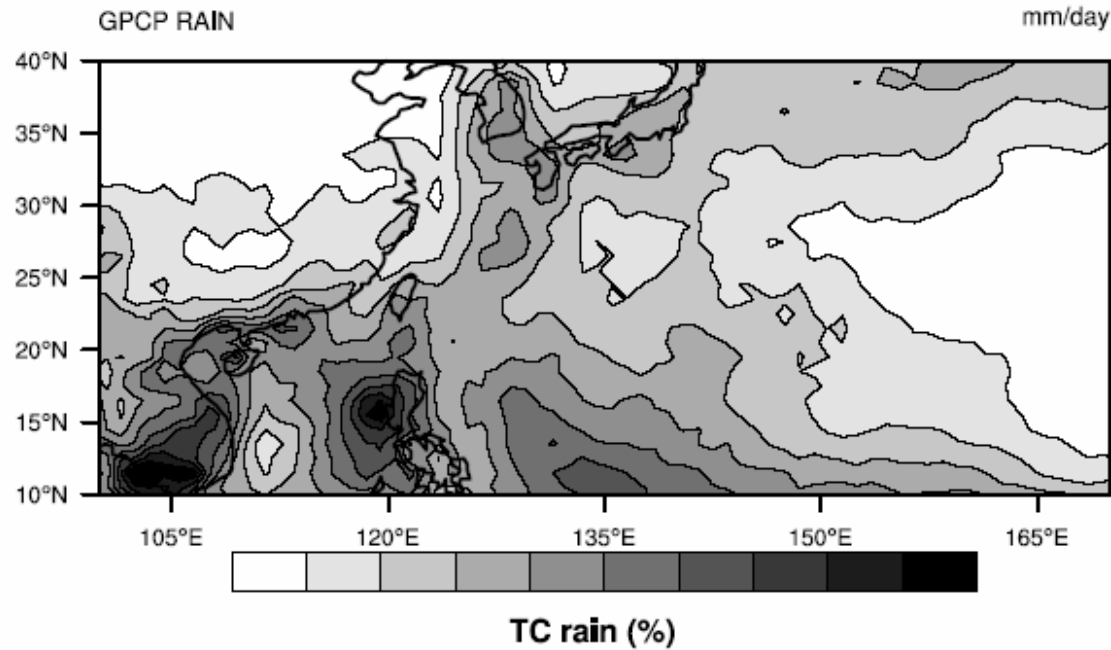
➤ **Better simulation, prediction, and projection:**

Need to reasonably resolve the TC activity ?

➤ **High-resolution AOGCM is needed for climate (and change projection) simulation ?**

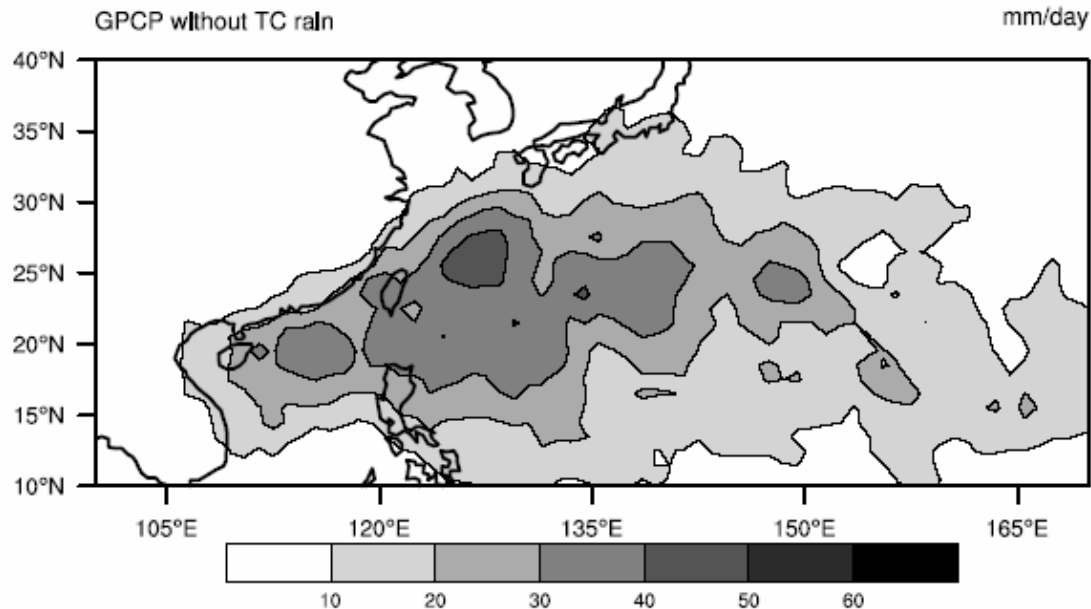
GPCP 1997-2003 JASO

Original data



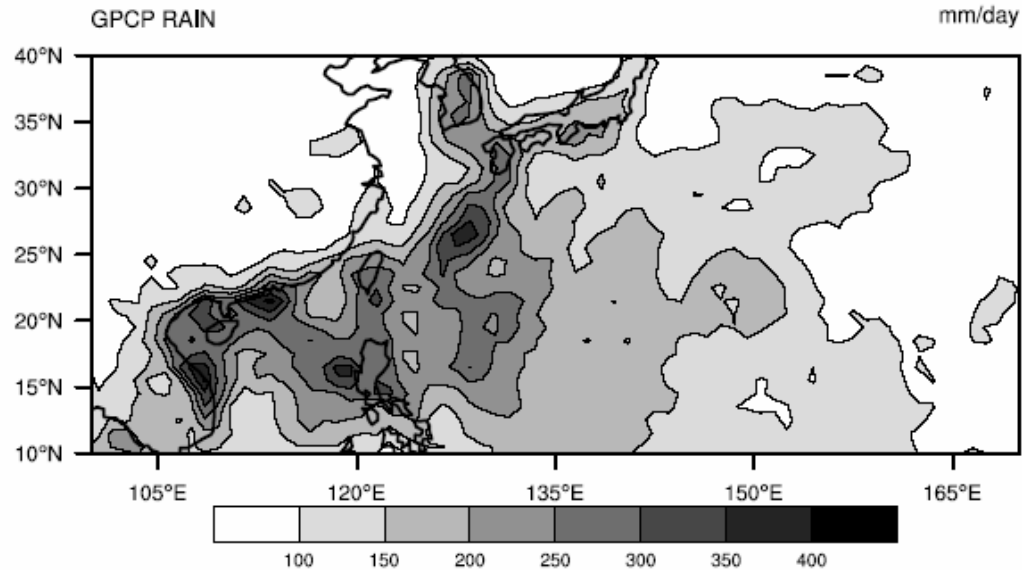
**GPCP mean
daily precip.
1979-2003**

**TC precip.:
5*5 box
centered at
TC**



GPCP 1997-2003 JASO

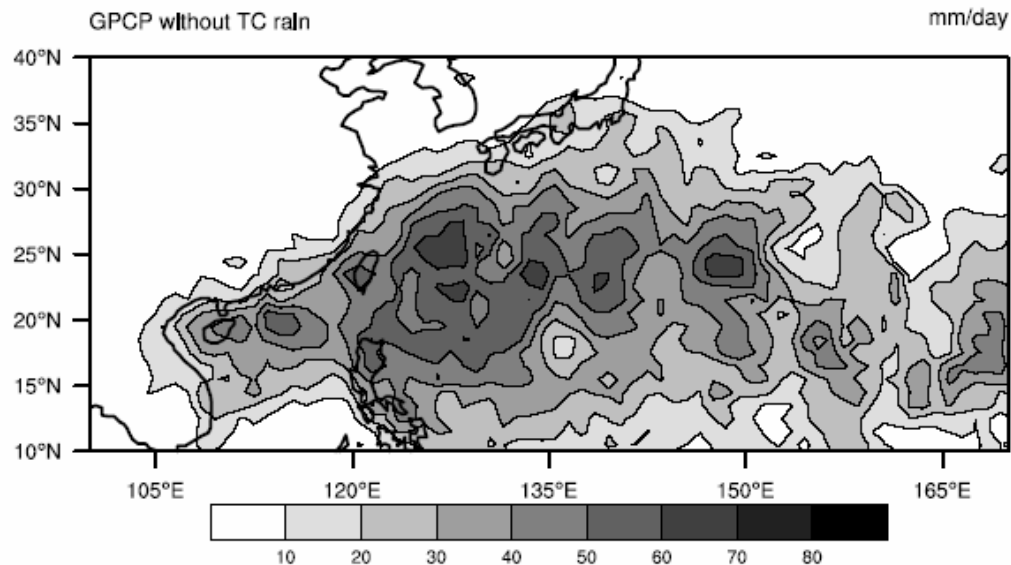
Variance: Original data



**GPCP variance
daily precip.
1979-2003**

**TC precip.:
5*5 box
centered at
TC**

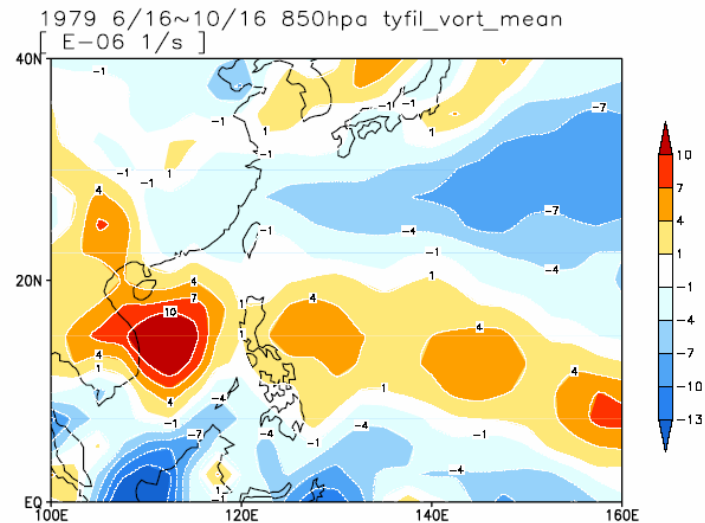
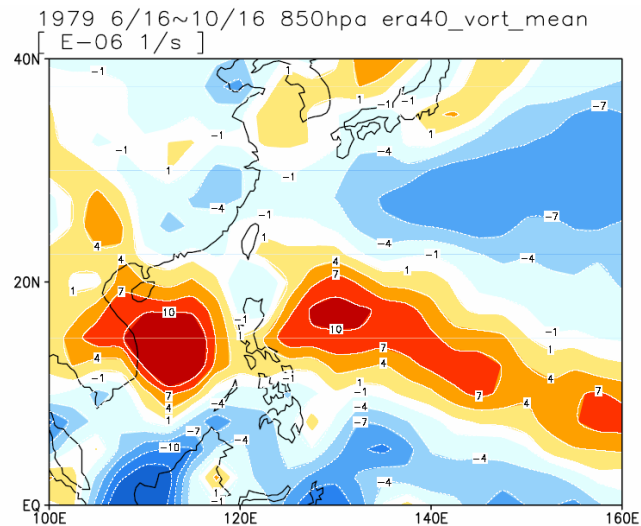
TC rain Variance (%)



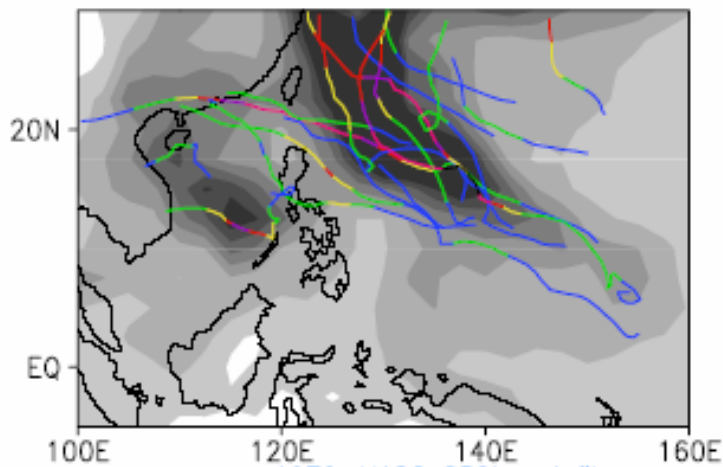
an example: 1979

original

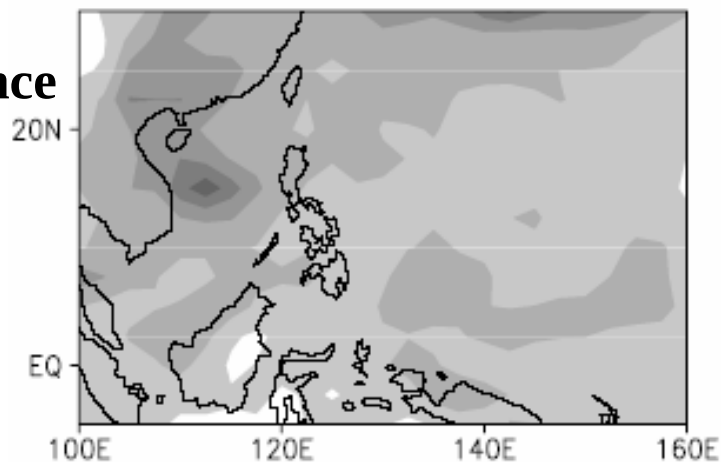
TC-removed



1979 JJASO 850hpa era40_mean_vort_totalvar
[E-10 1/s**2]



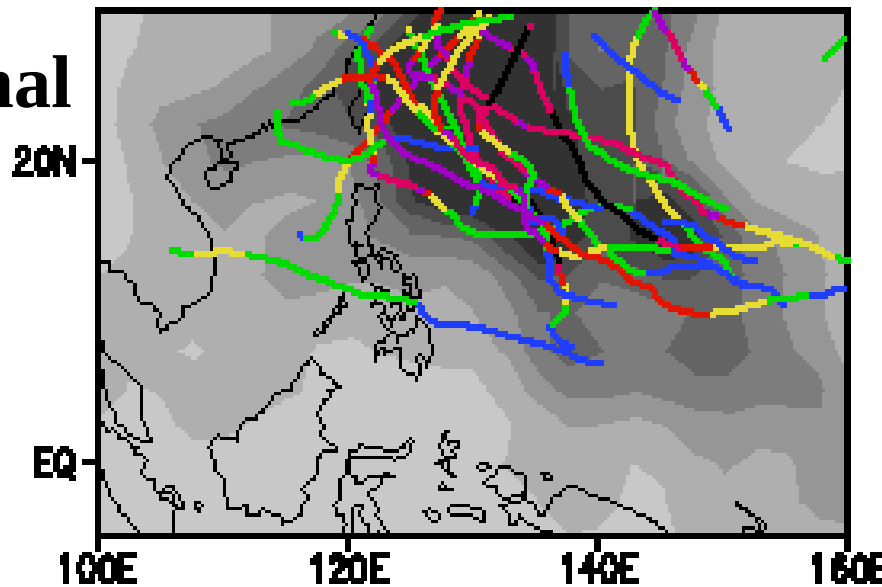
1979 JJASO 850hpa tyfil_mean_vort_totalvar
[E-10 1/s**2]



variance

2004 JJASO 850hpa ncep_mean_vort_totalvar
[E-10 1/s²]

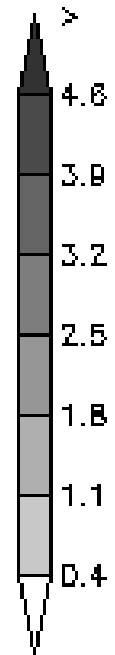
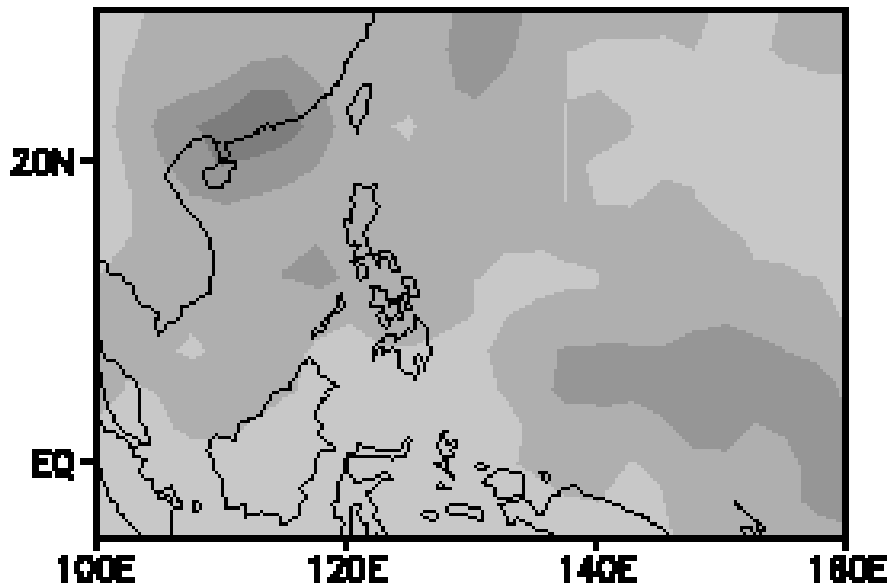
Original



An example: 2004

2004 JJASO 850hpa tyff_mean_vort_totalvar
[E-10 1/s²]

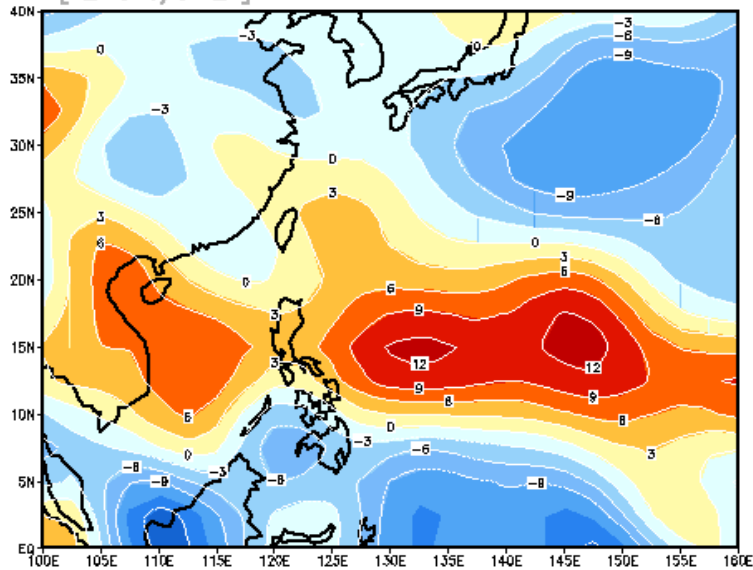
- TD
- TS
- Typhoon > 63 knots
- > 63 knots
- > 85 knots
- > 112 knots
- > 135 knots



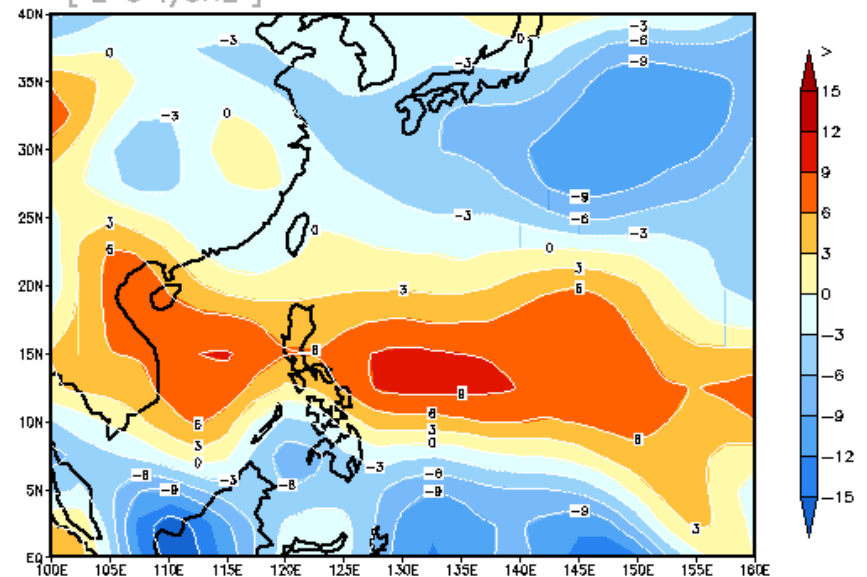
TC
removed

mean

2004 6/16~10/16 850hPa ncep_daily vorticity mean
[$E-6 \ 1/s^{**2}$]



2004 6/16~10/16 850hPa tyfi_daily vorticity mean
[$E-6 \ 1/s^{**2}$]

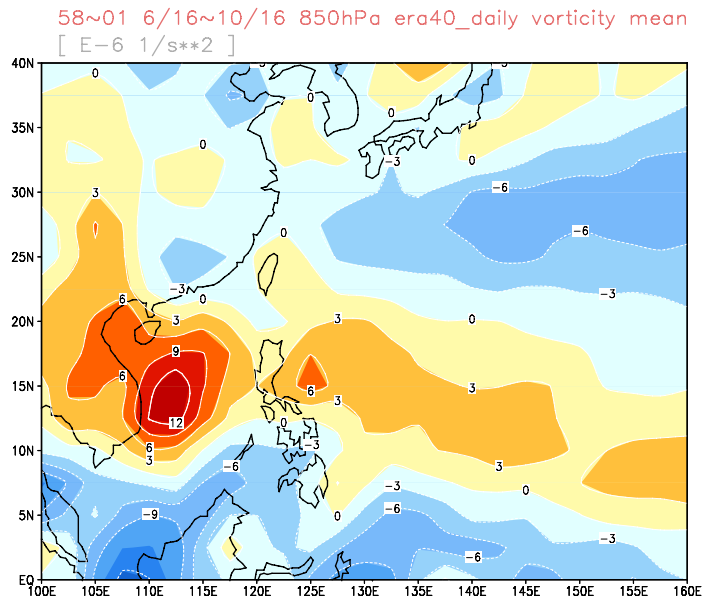


Significant effect on seasonal mean and variance
– potential effect on interannual variability
(interannual variation of TC activity)

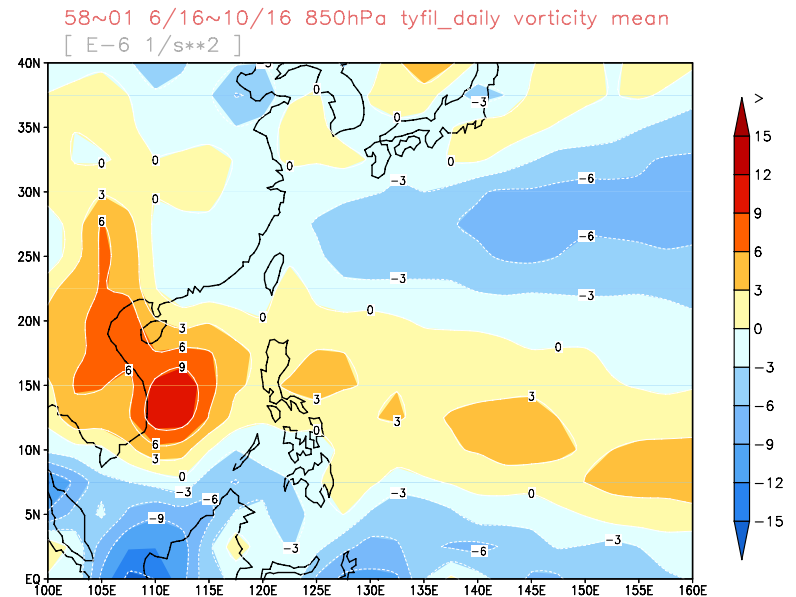
1958-2001

JJASO mean 850 hPa vorticity

original

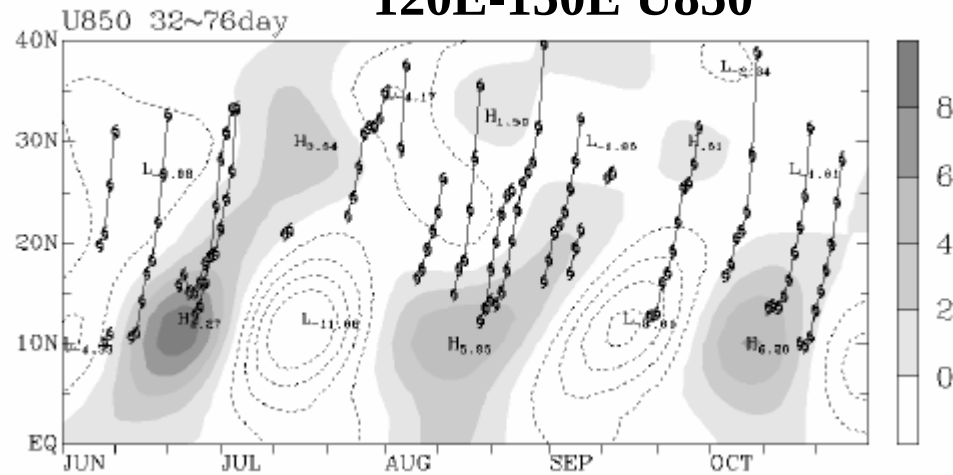


TC-removed



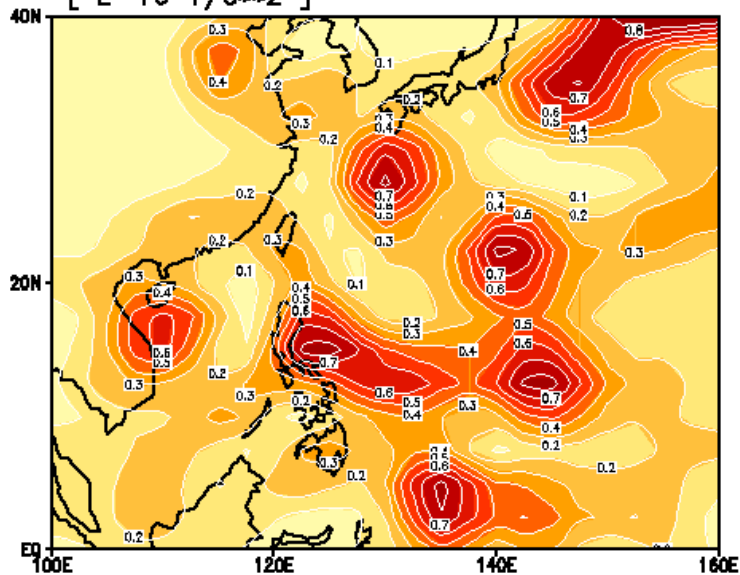
**Notable differences in long-term means
- affect interdecadal (and longer time scale) variability ?**

120E-150E U850



original

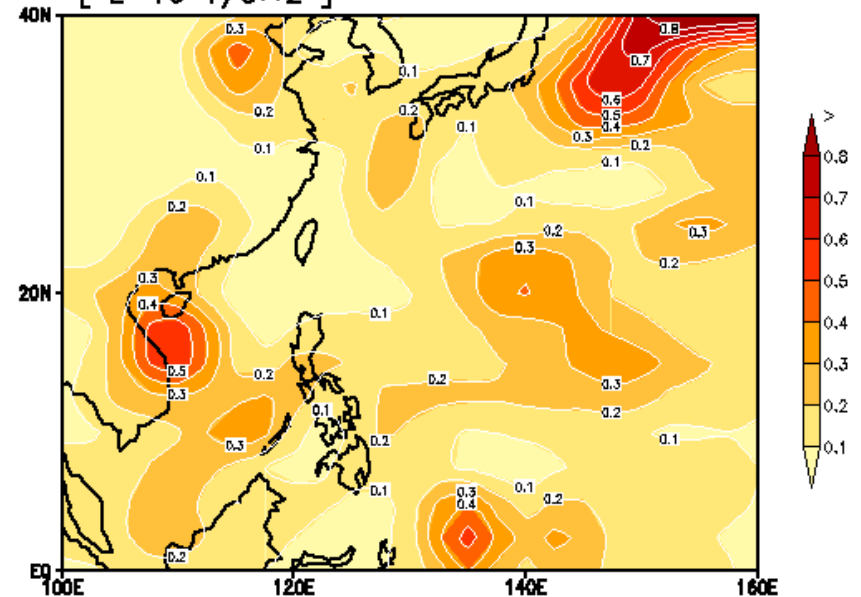
2004 6/16~10/16 ncepvort_variance
[E-10 1/s**2]



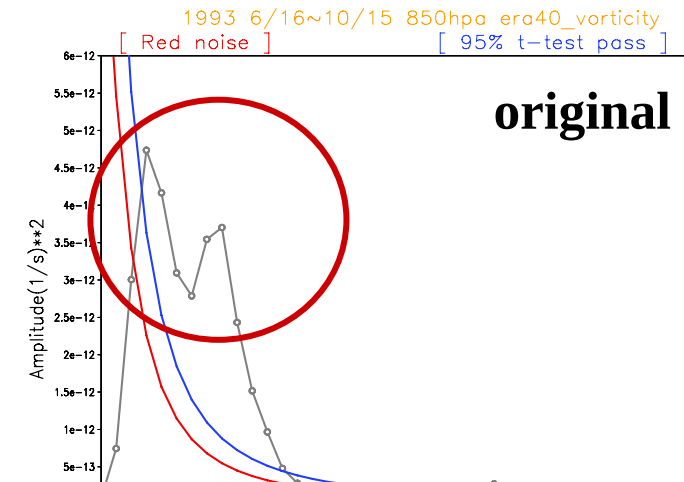
IS variance

2004 6/16~10/16
[E-10 1/s**2]

TC removed

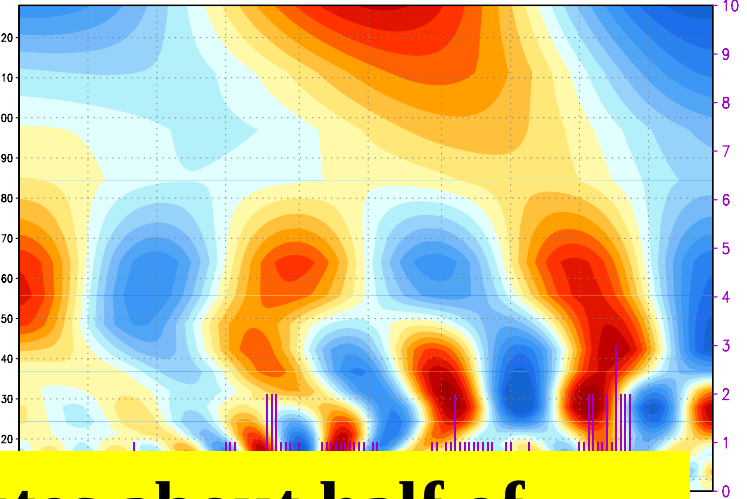


Effect on ISV

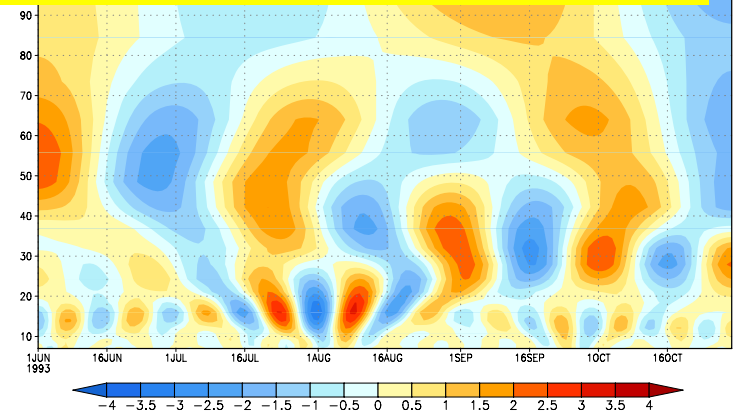
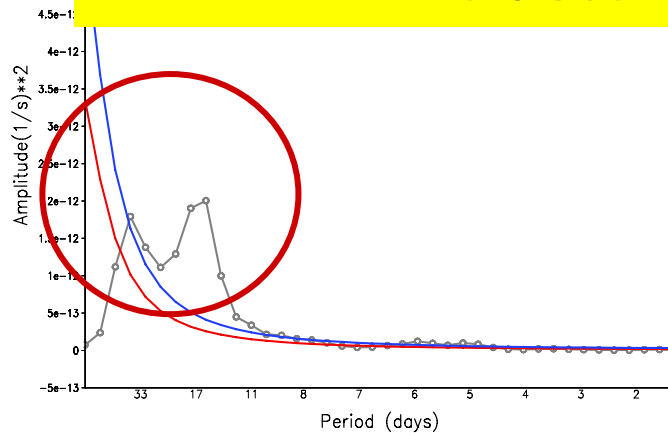


1993

1993 JJASO wavelet analysis era40 (E-5 1/s)

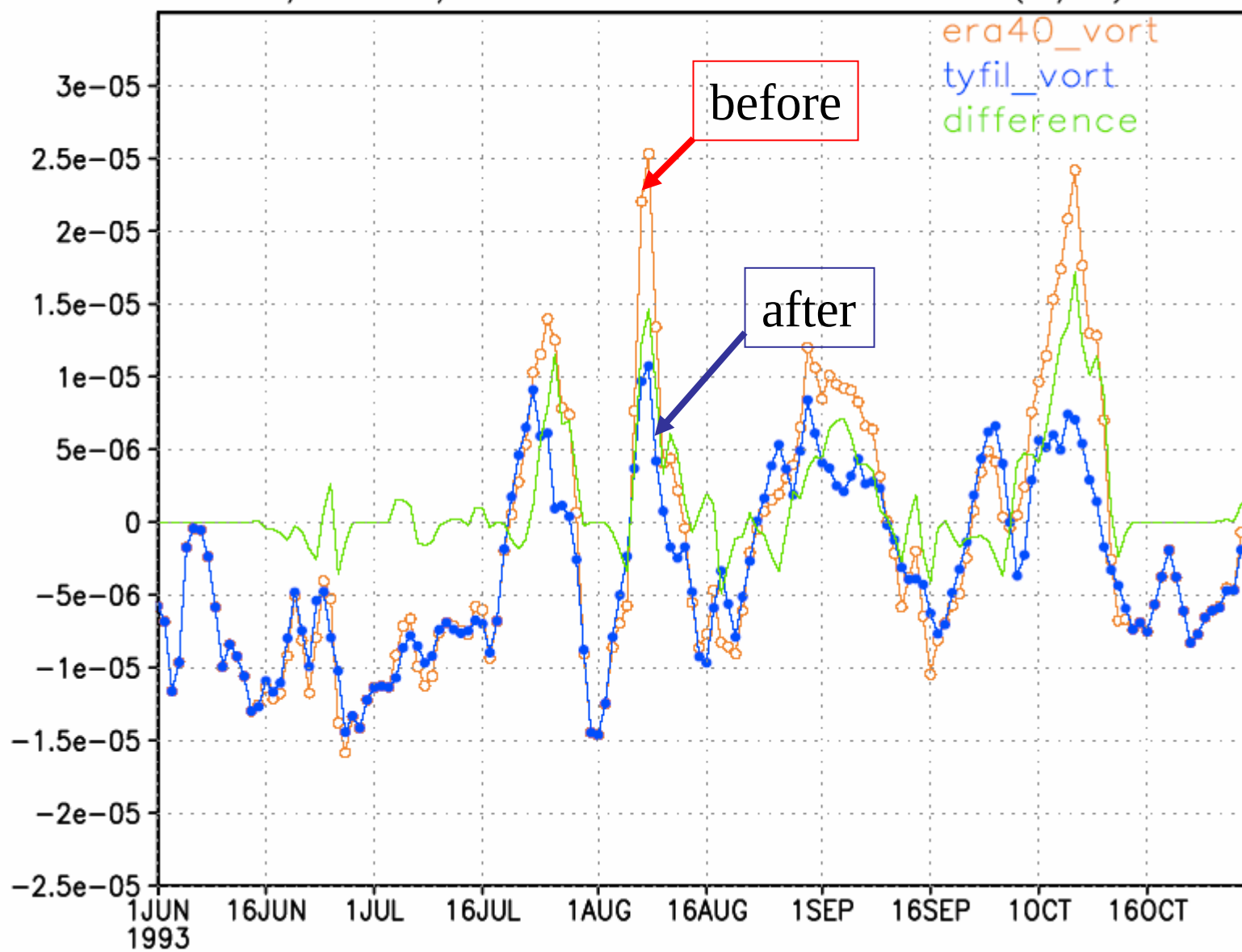


TC activity contributes about half of intraseasonal variance due to the ISO's clustering effect on TC.

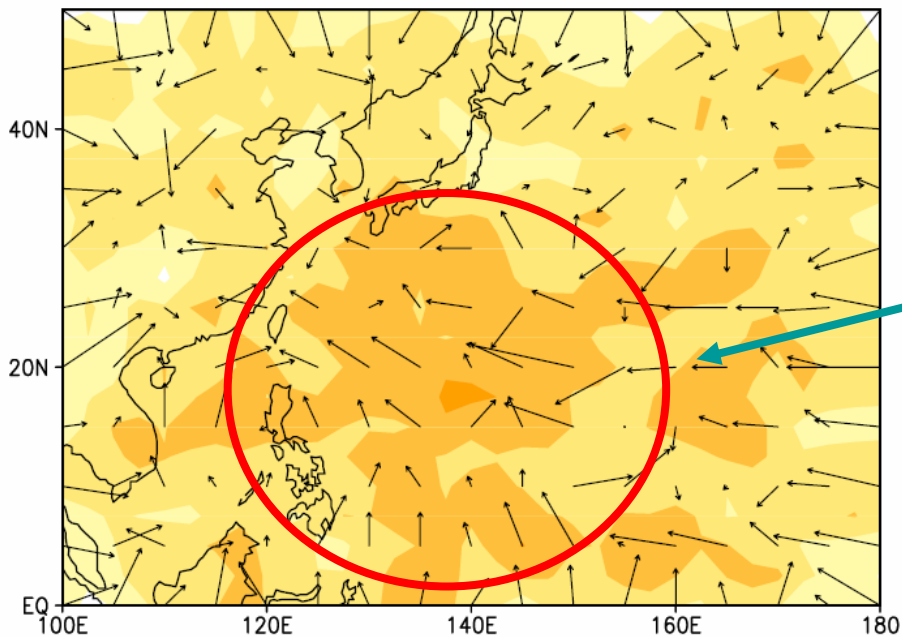


from: An-Kai Lo

1993 6/1~10/30 15~30N 123~138E (1/s)



92~01 era40vort_30-60_lag-vector_5dys



original:

Better organized

Propagation tendency vector

TC-removed:

Less organized

92~01 tyvort_30-60_lag-vector_5dys

