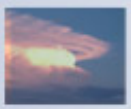
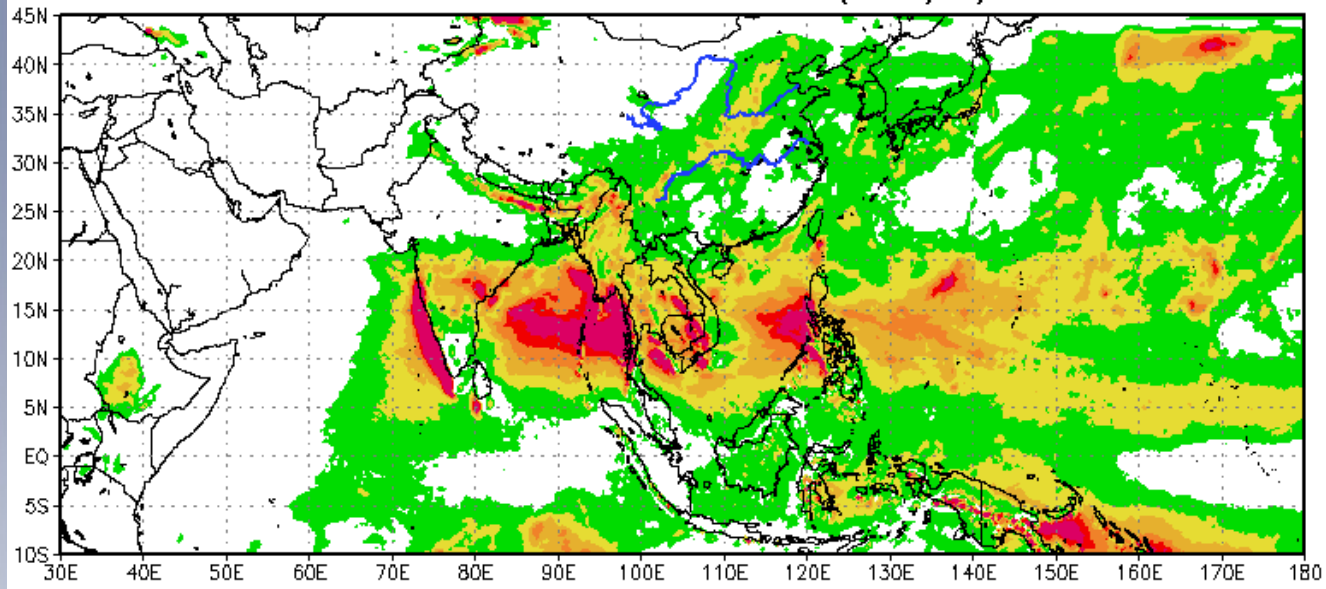
NRCM Simulation of East Asia Monsoon

Bill Kuo

Contributors: C. Bruyere, L.Y. Chang, J. Dudhia, G. Holland, R. Leung, Y. Liu, A. Suzuki, S. Tulich,


NRCM Prec. JJA 1996 (mm/d)



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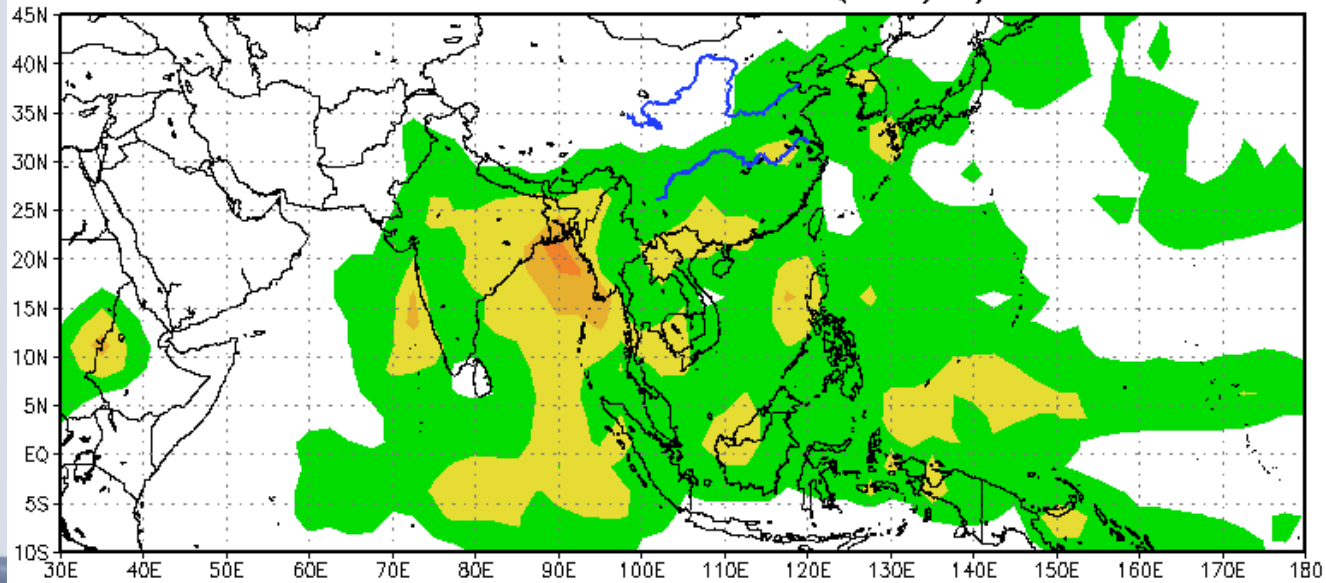
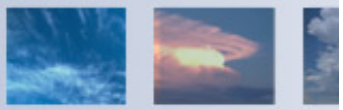
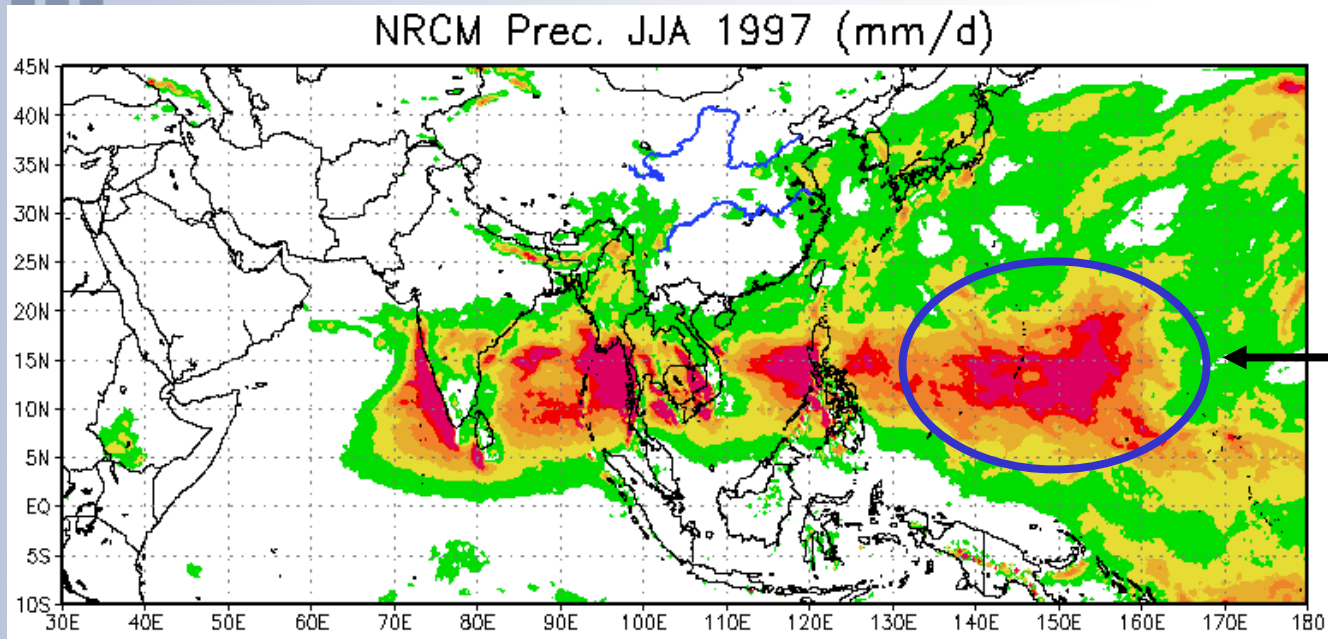


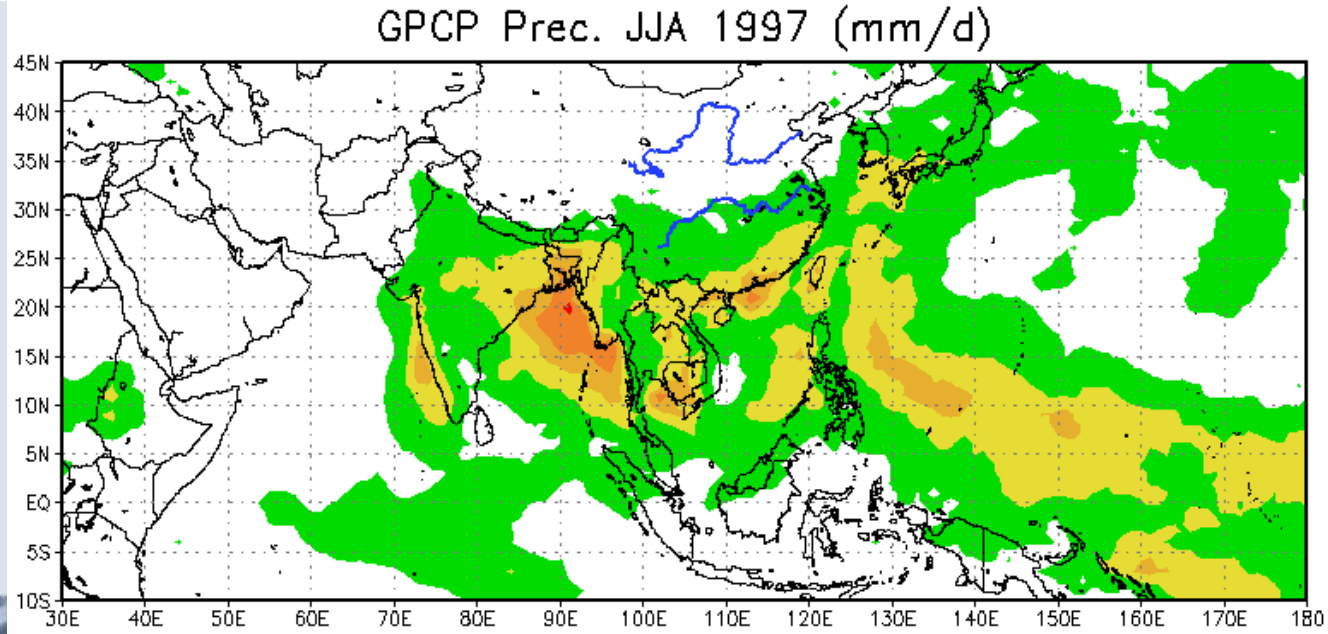


NCAR



The Great Red Spot:

Excessive rainfall



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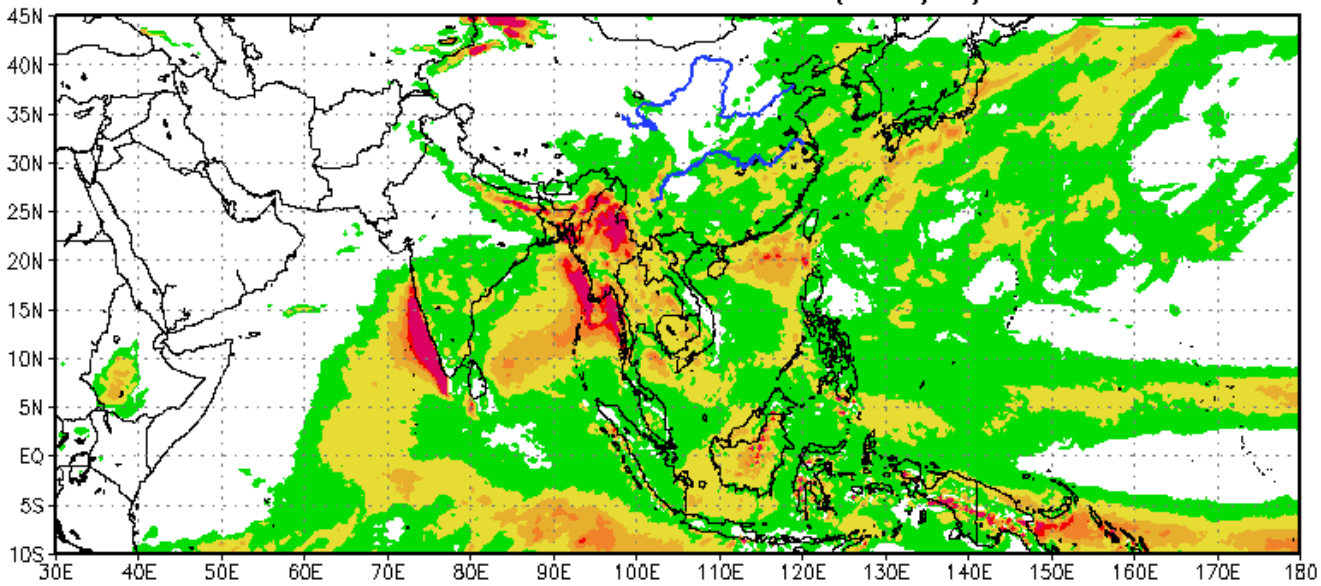

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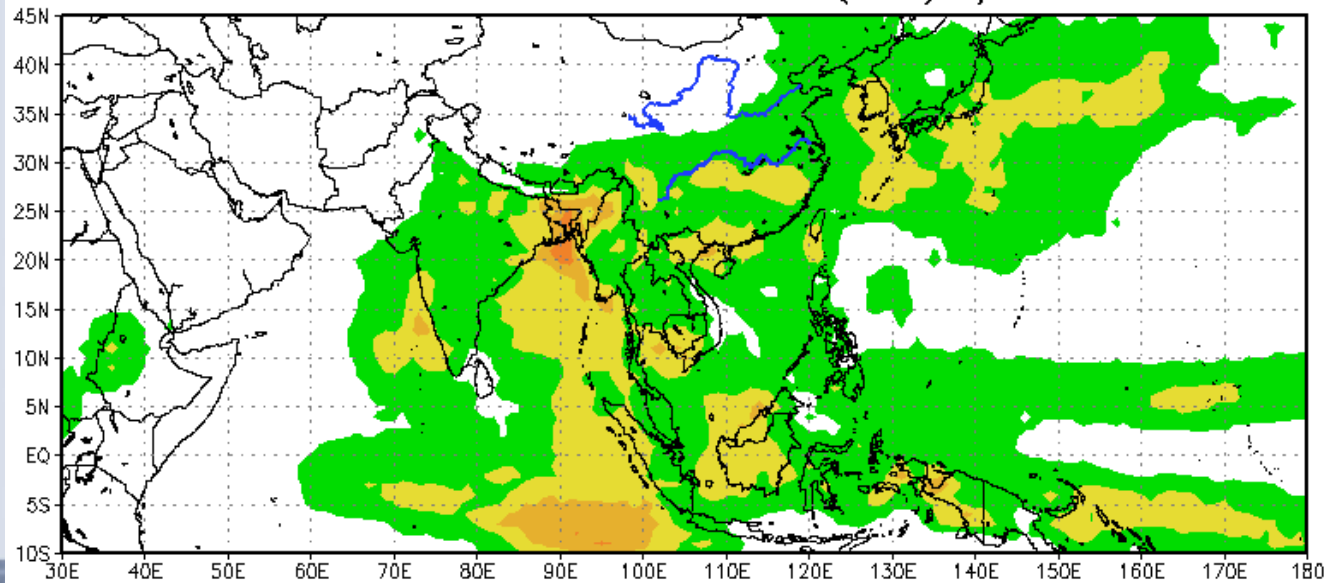

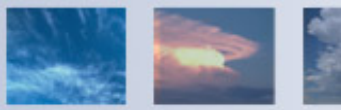

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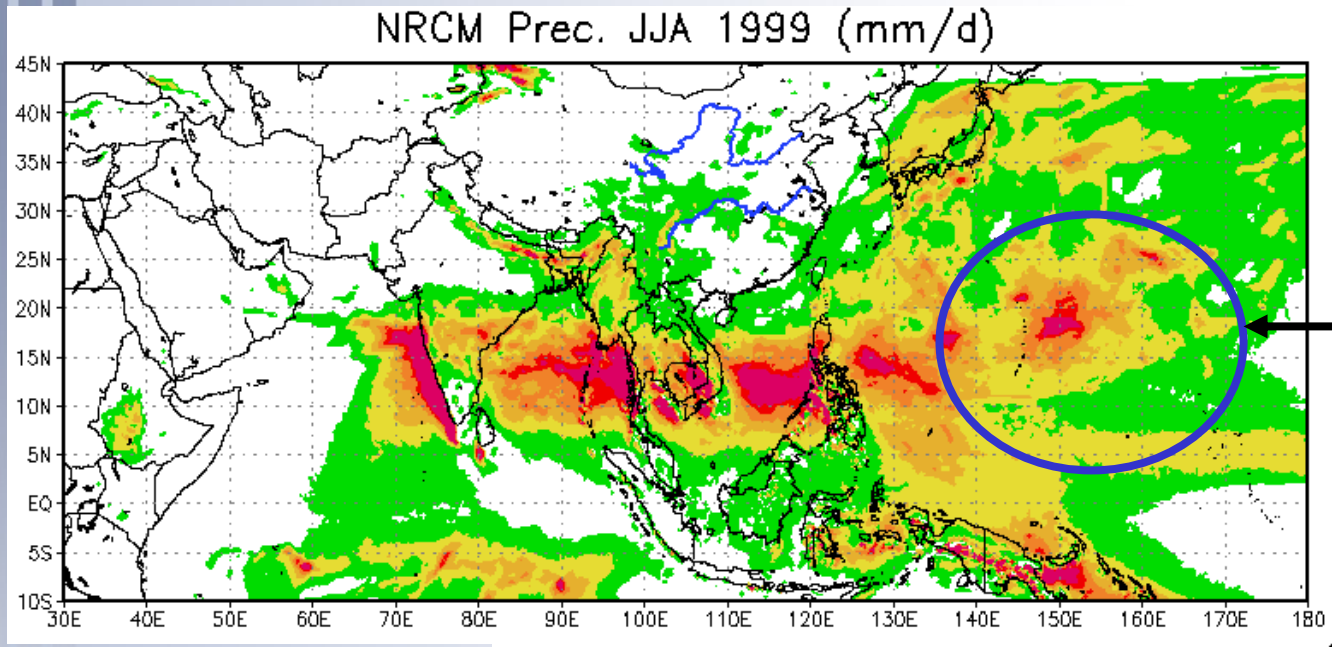

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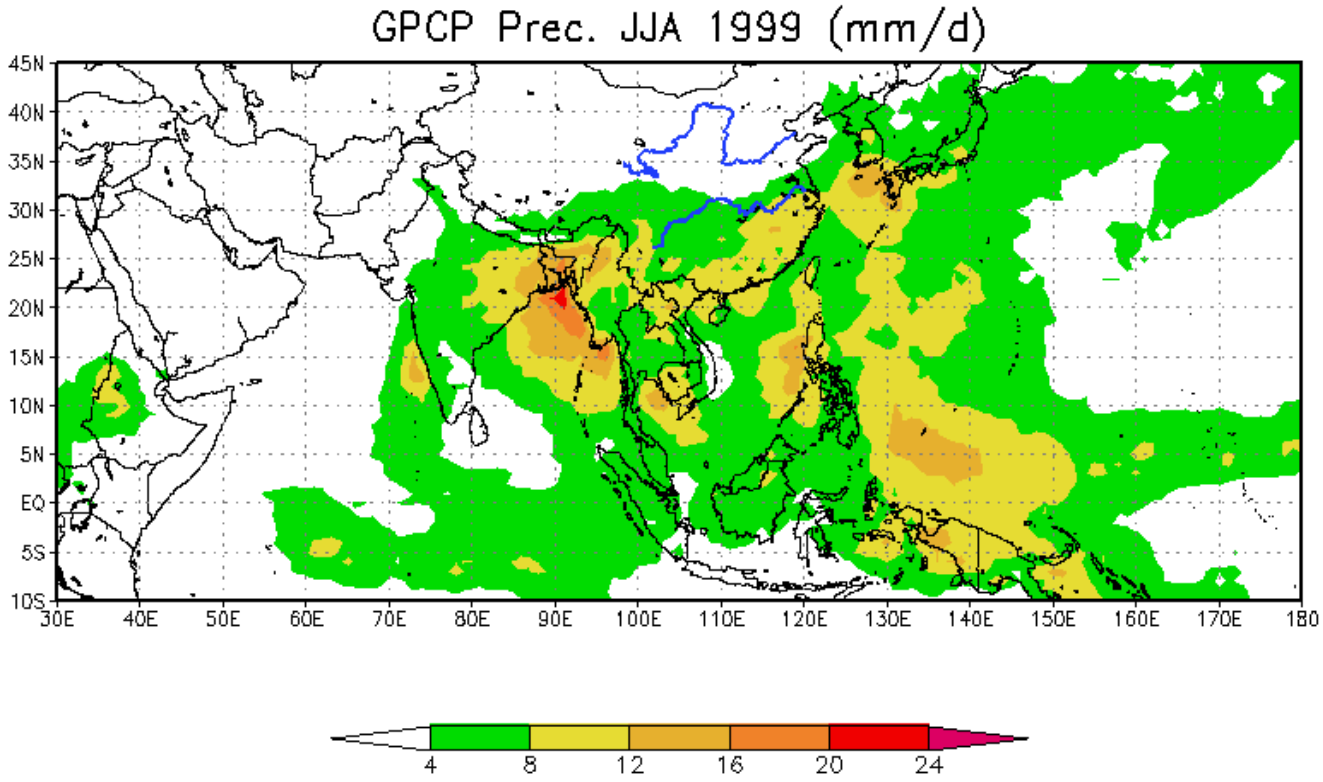

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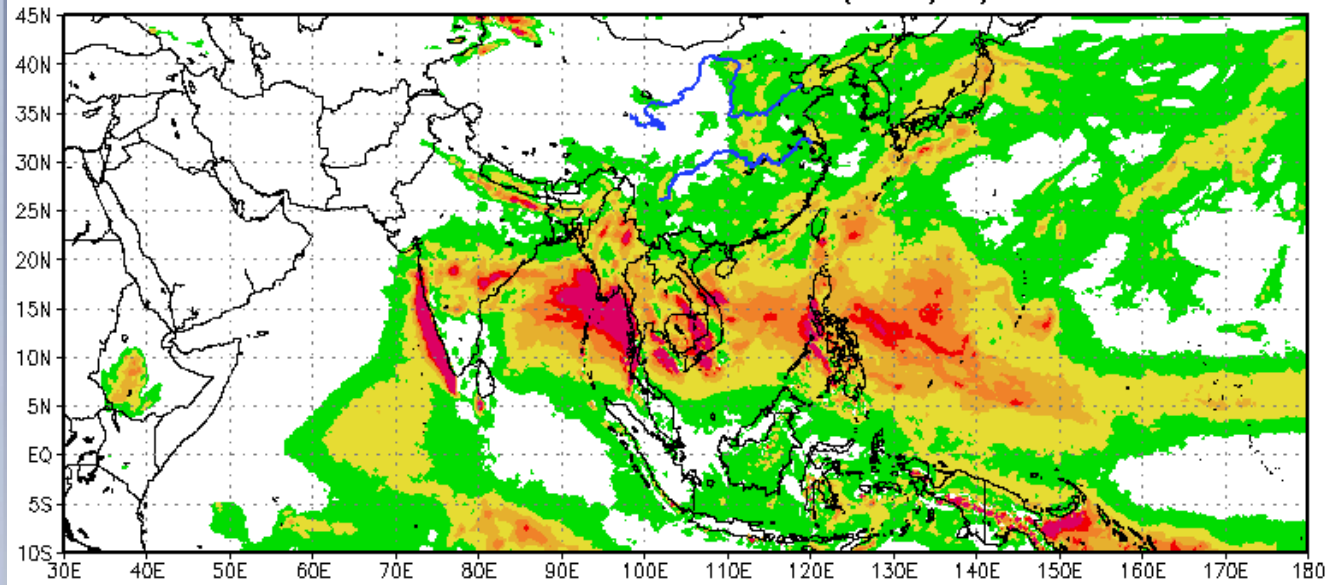

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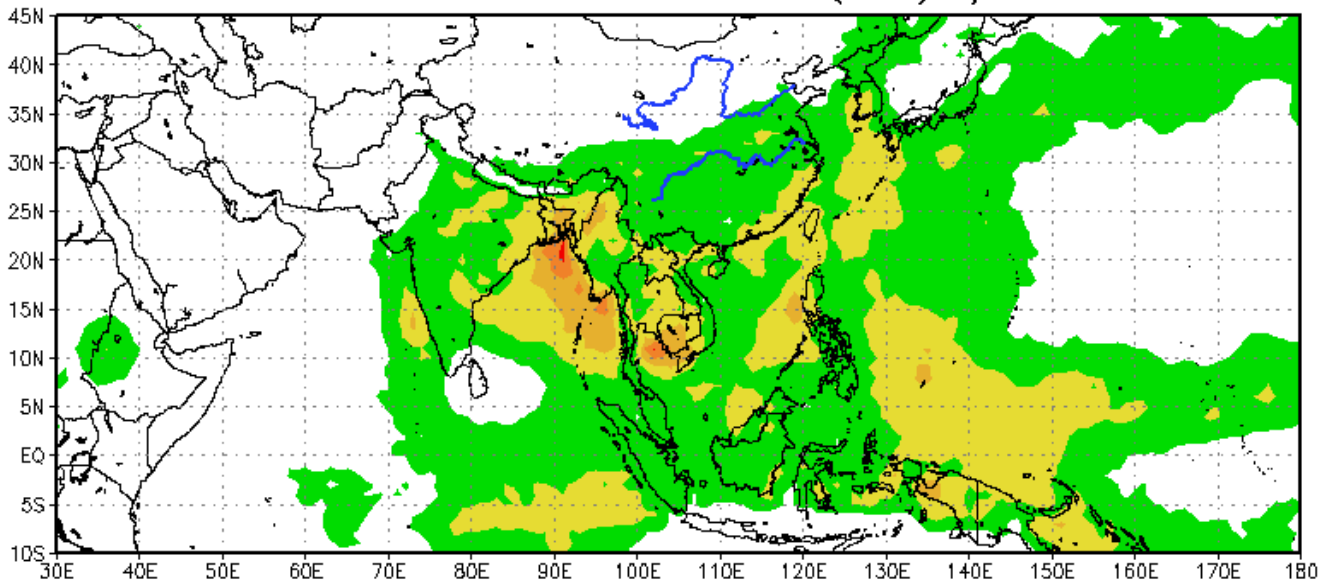
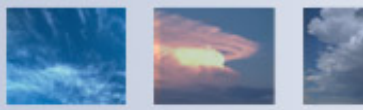
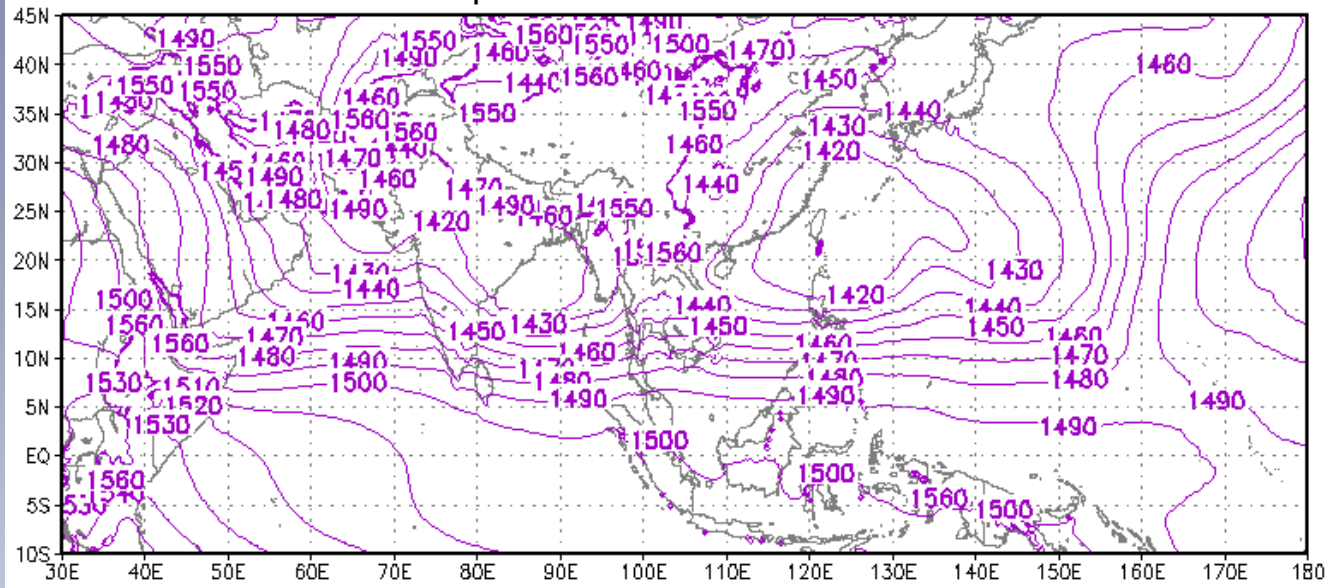


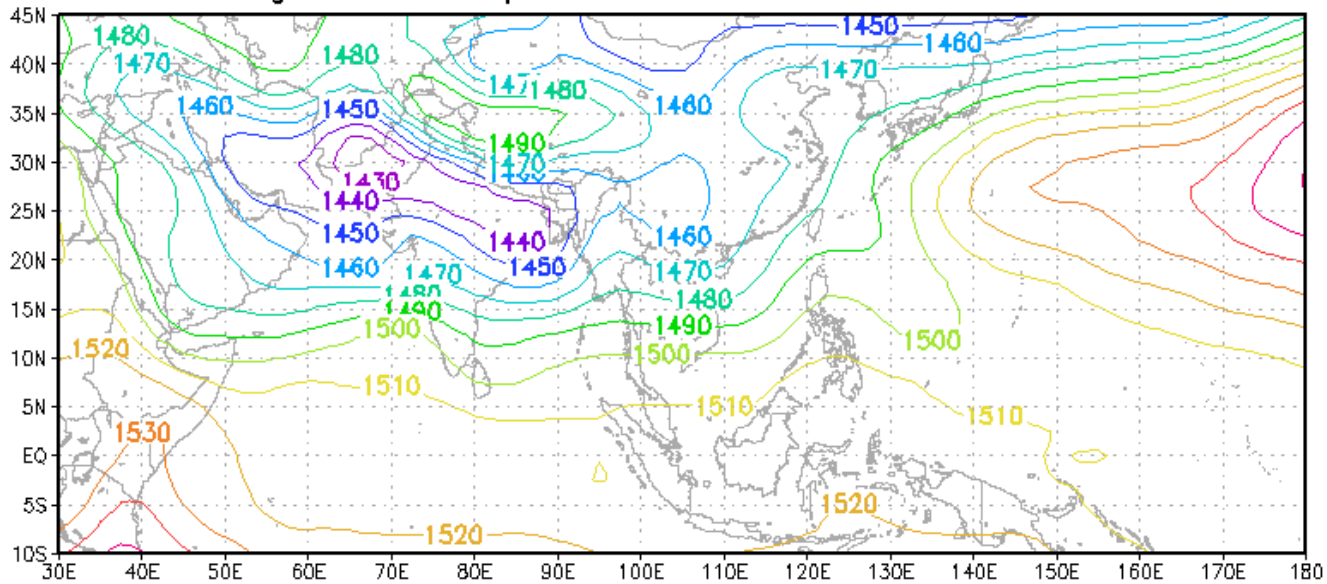


ICAR

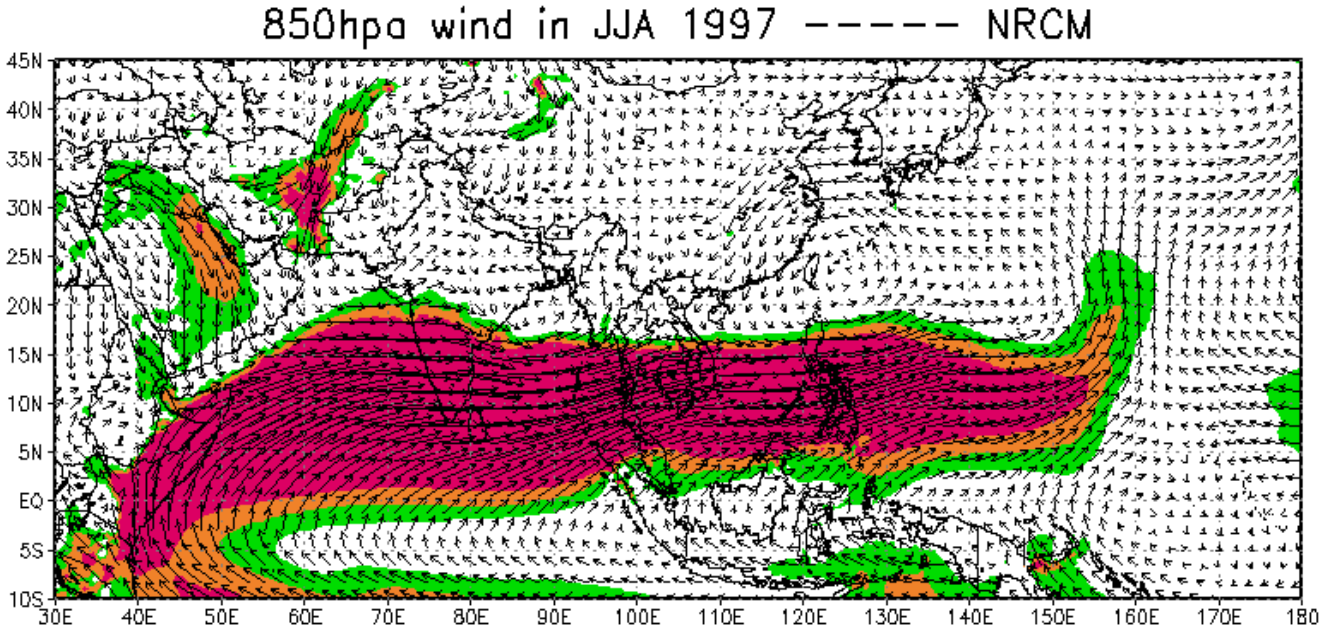
h in 850hpa in JJA 1997 ----- NRCM

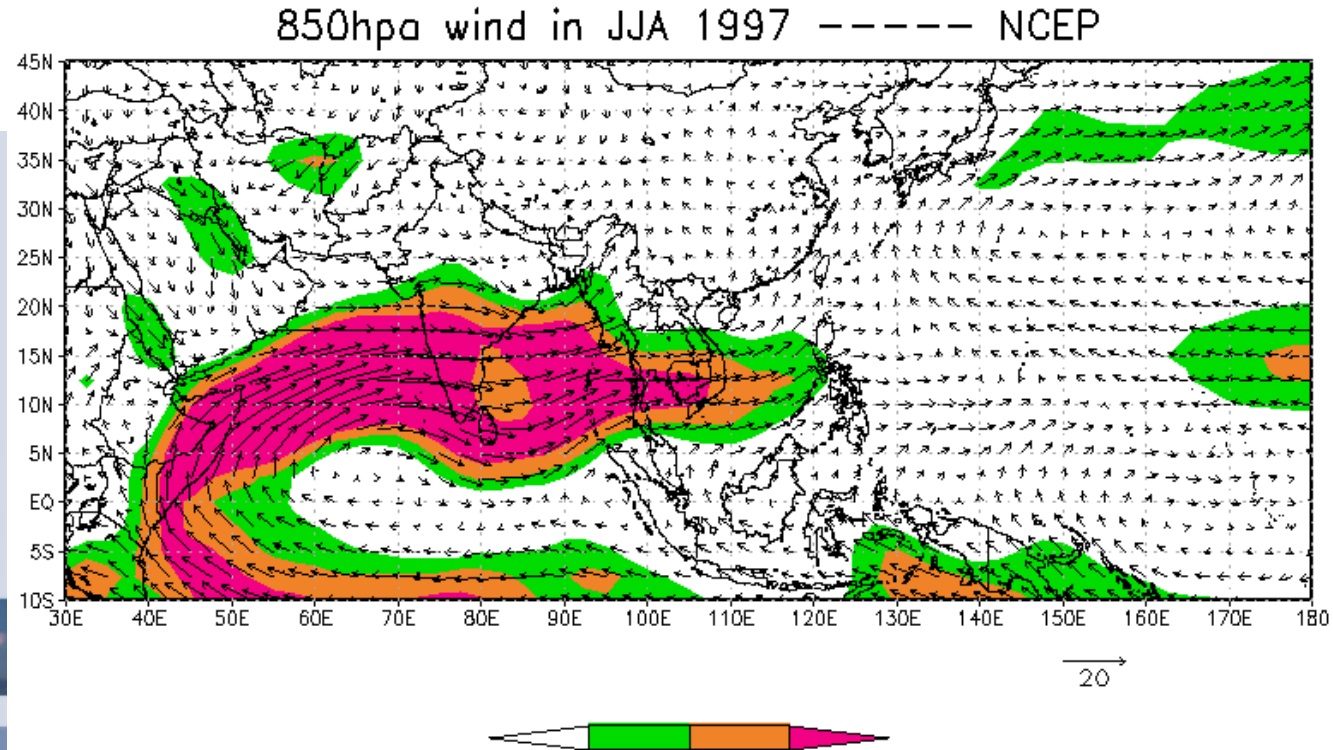


hgt in 850 hpa in JJA 1997 ----- NCEP



ESSL NCAR


850hpa wind in JJA 1997 ----- NRCM
45N
40N
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
30E
40E
50E
60E
70E
80E
90E
100E
110E
120E
130E
140E
150E
160E
170E
180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80E
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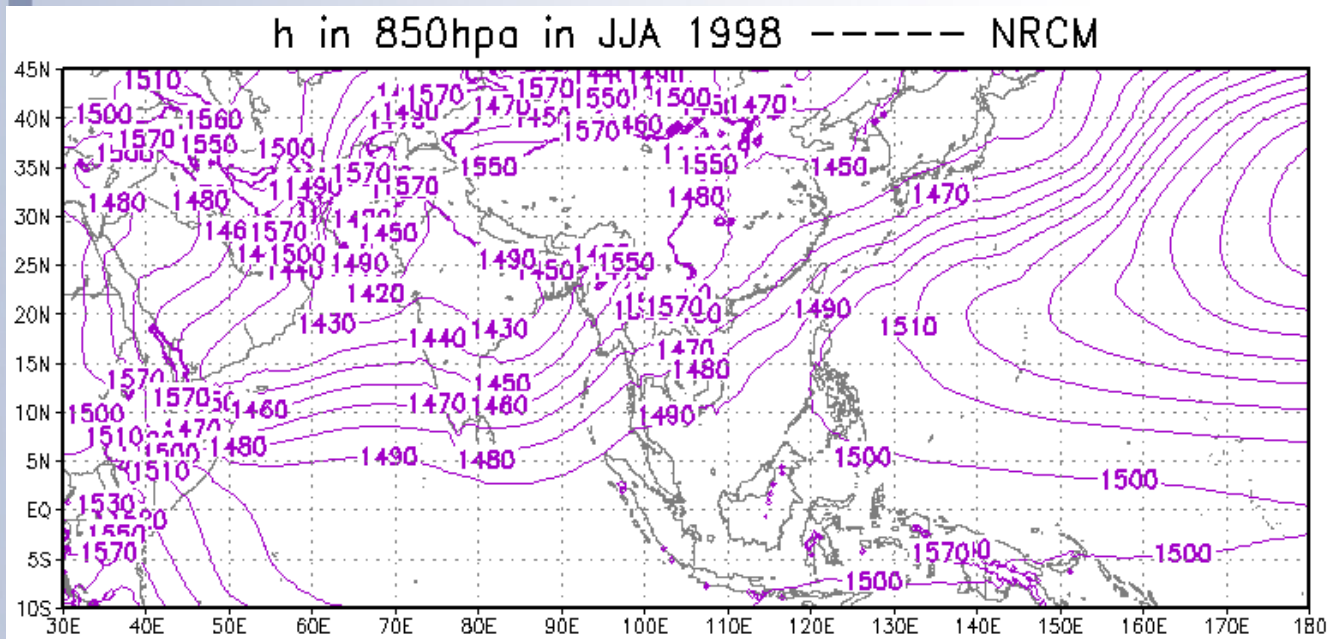
ESSL NCAR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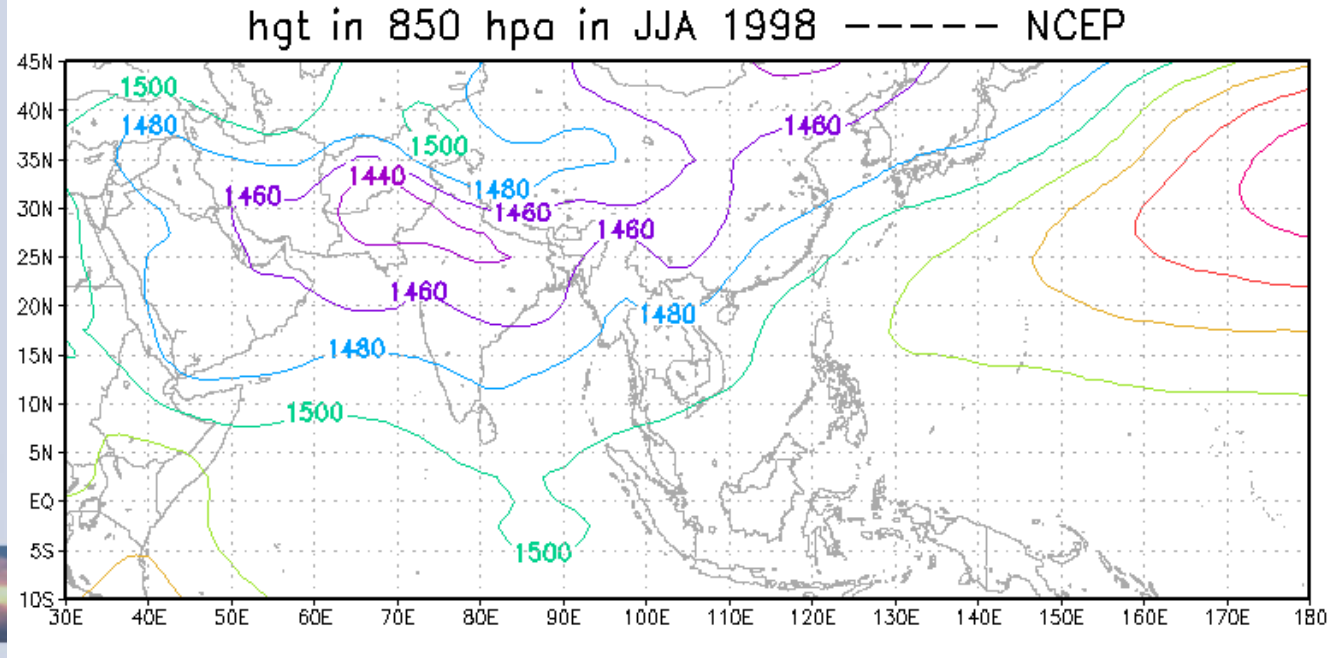
hgt in 850 hpa in JJA 1998 ----- NCEP
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30N
25N
20N
15N
10N
5N
EQ
5S
10S
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50E
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70E
80E
90E
100E
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140E
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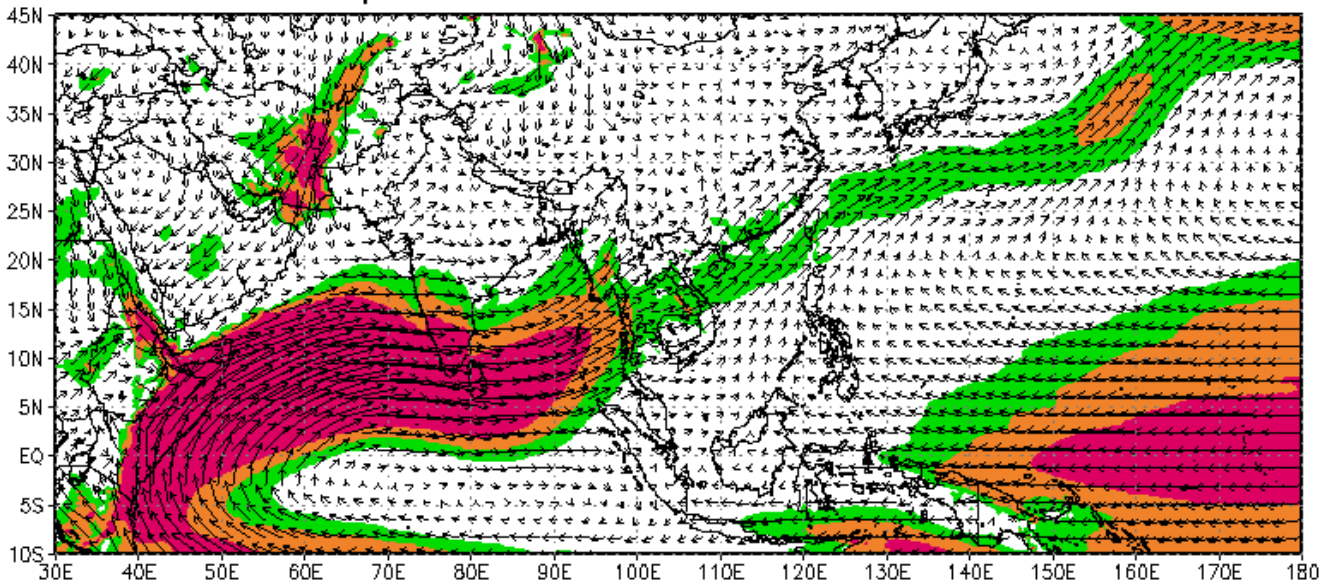
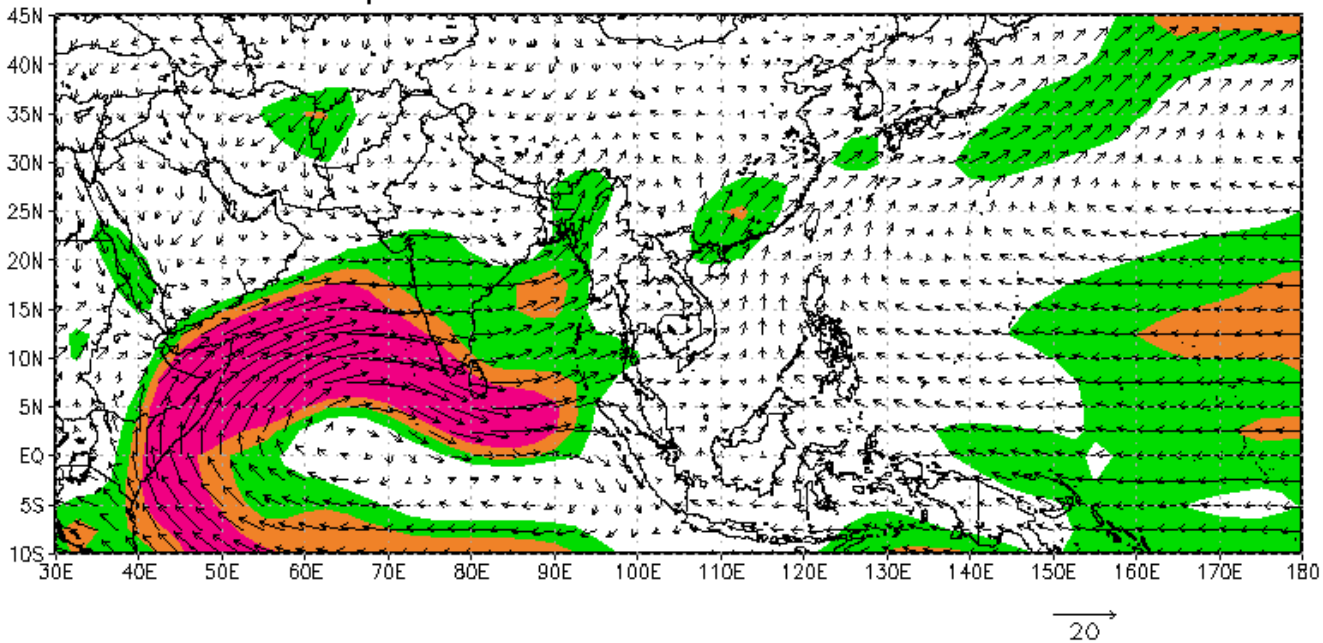
170E
180

850hpa wind in JJA 1998 ----- NRCM



850hpa wind in JJA 1998 ----- NCEP



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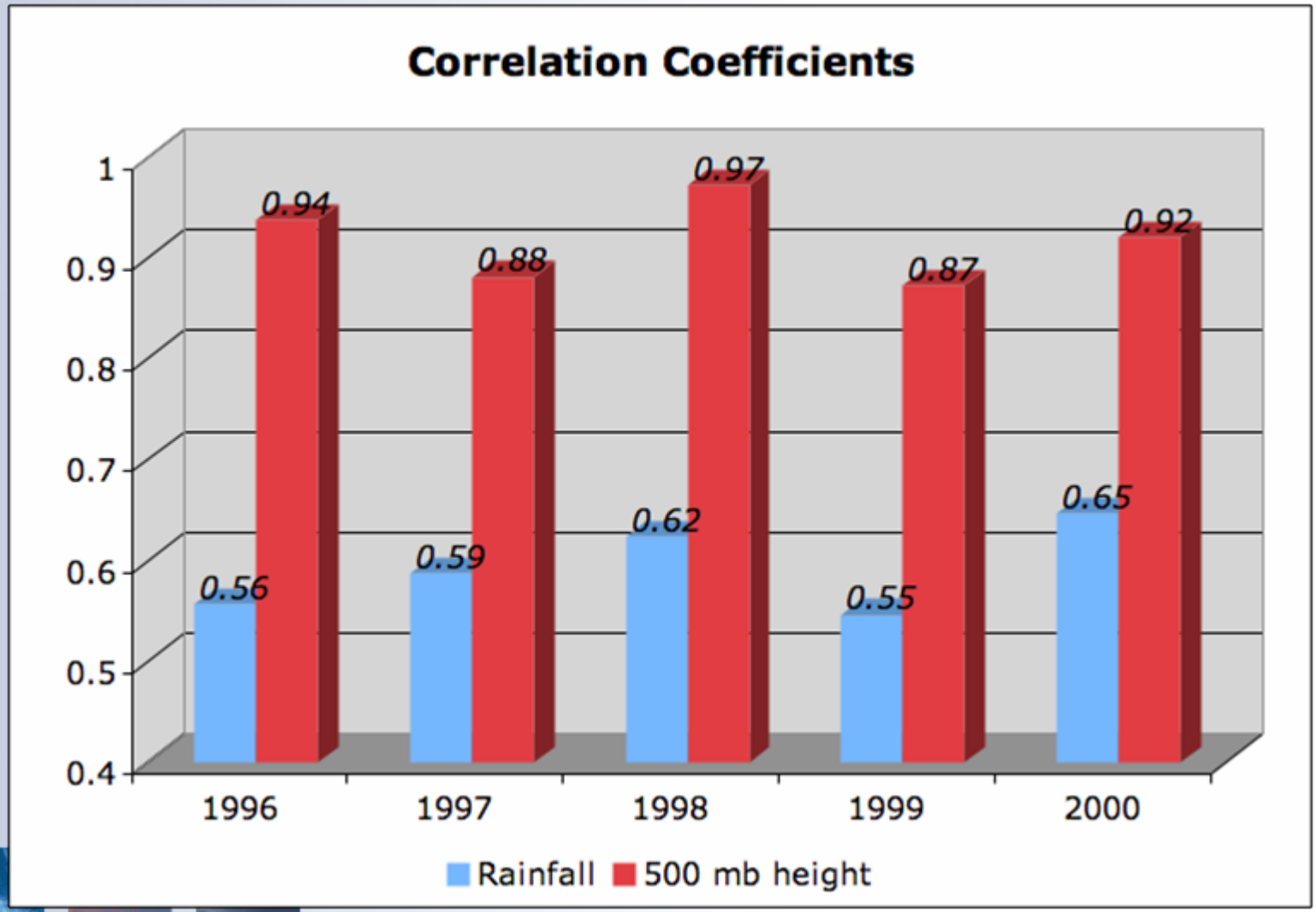
Precipitation and 500 mb height anomalies



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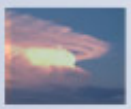
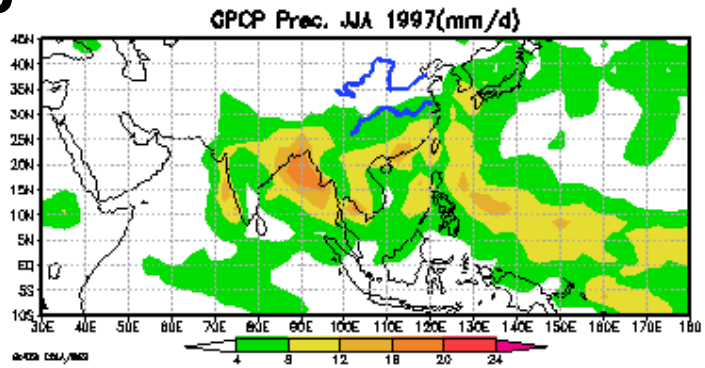
Sensitivity Experiments - 1997

- **In order to understand the problems associated with erroneous rainfall, we conducted a few sensitivity experiments:**
  - ***Change the cumulus parameterization scheme from Kain-Fritsch to Betts-Miller scheme.***
  - ***Remove cumulus parameterization (explicit only).***
  - ***Replace the 1997 SST by 1998 SST***
  - ***Initialize NRCM model with new initial condition from NCEP/NCAR reanalysis***
  - ***Repeat the simulations from 1 May 1997 (from the continuous NRCM 36-km run) and integrate for four months.***


JJA 1997 Precipitation

GPCP



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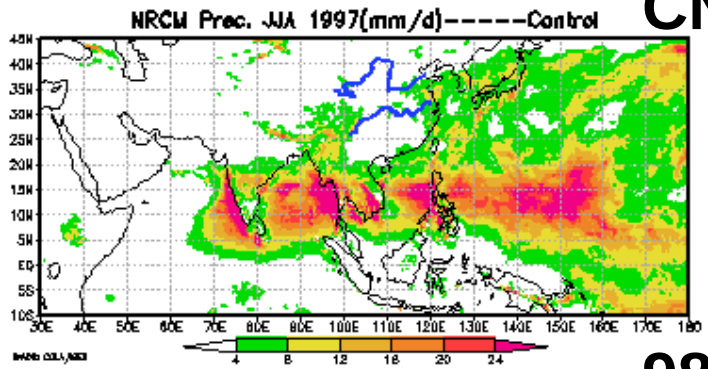
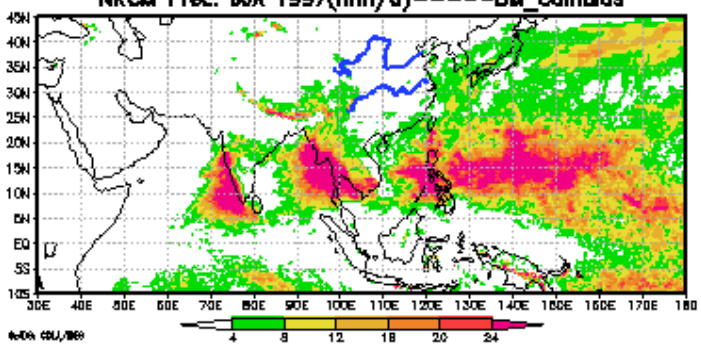
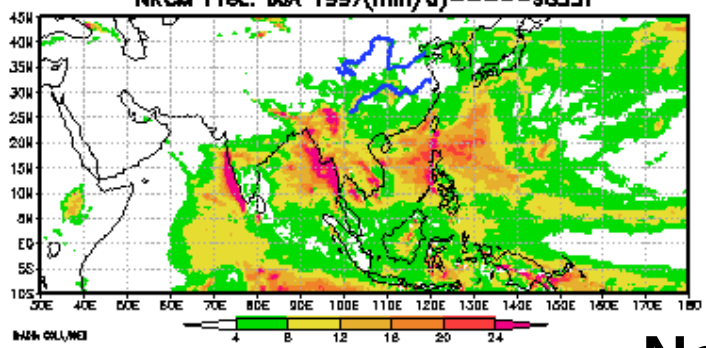


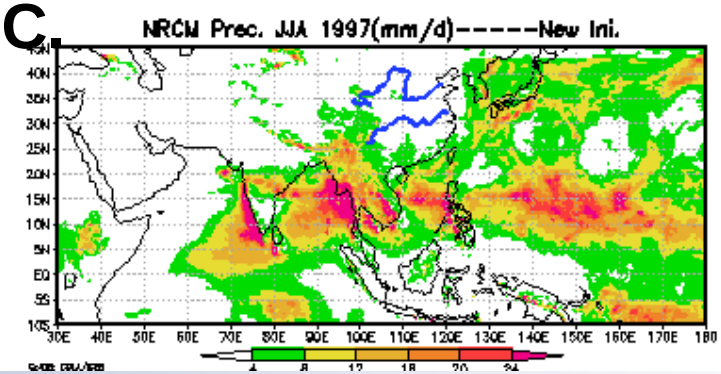
B-M



98 SST



New I.C.



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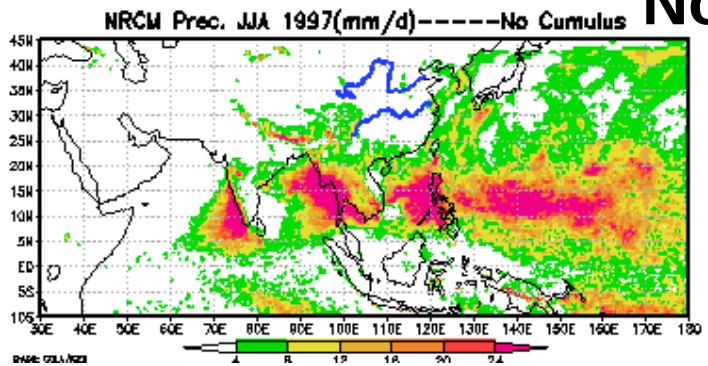

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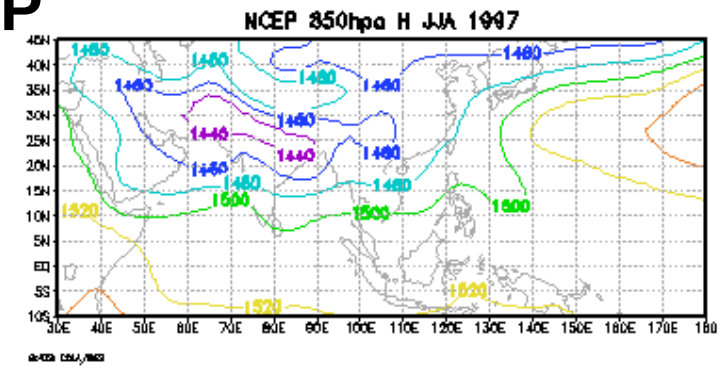
June-July-August 1997

NCEP



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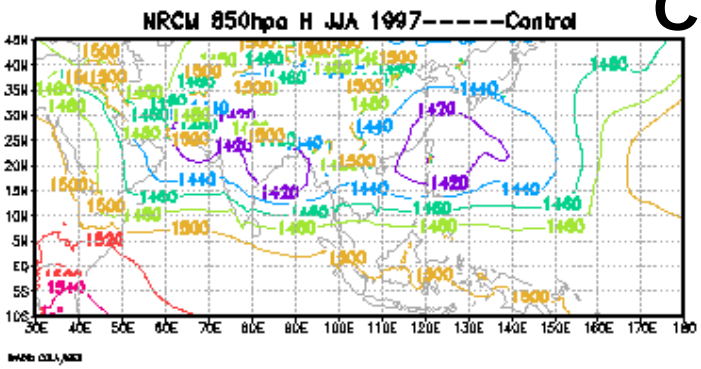
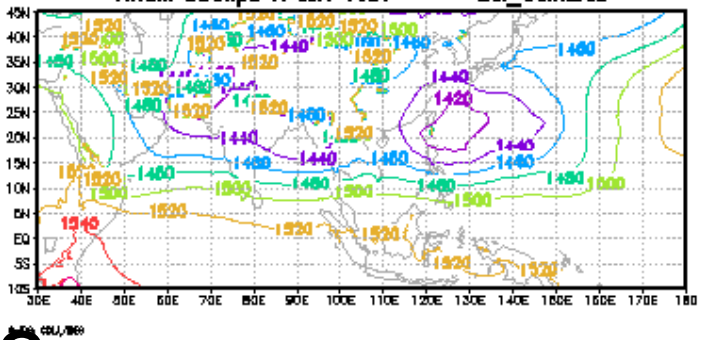
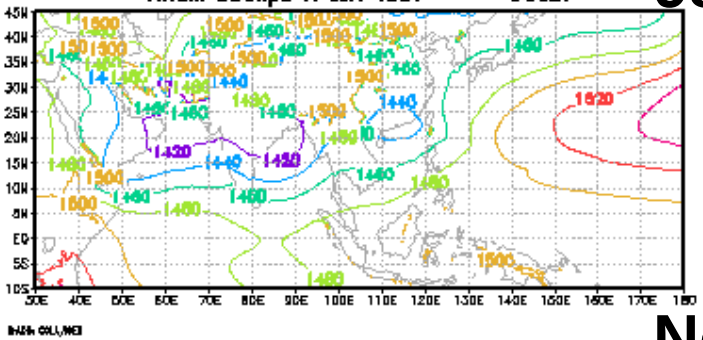


B-M



98 SST



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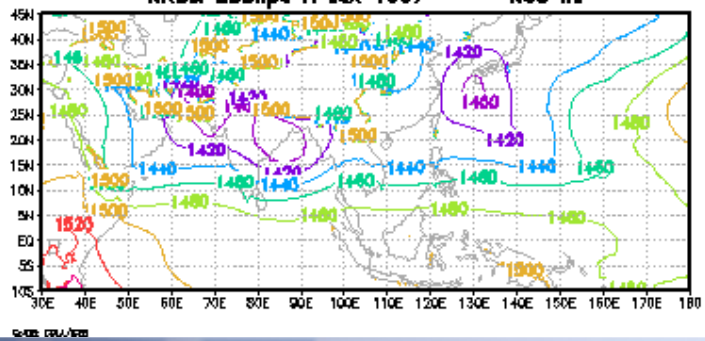

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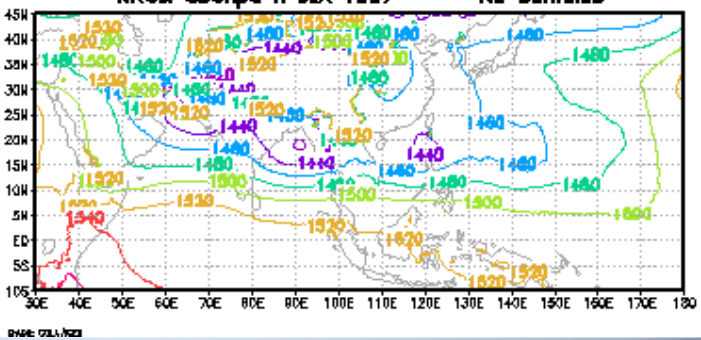

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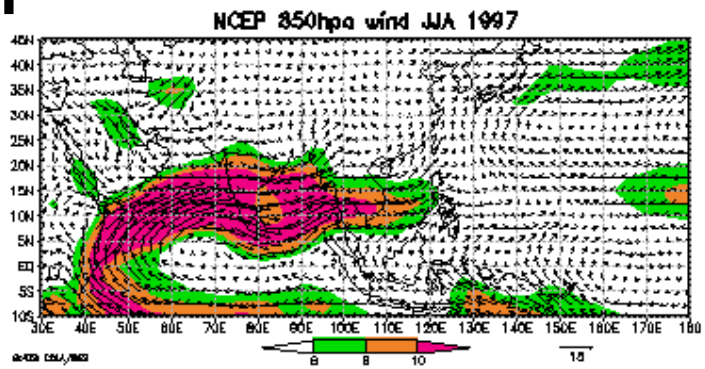
850 mb flow field - JJA 1997

NCEP



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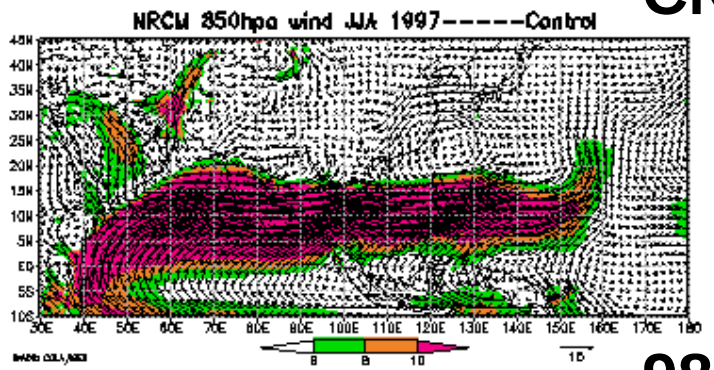
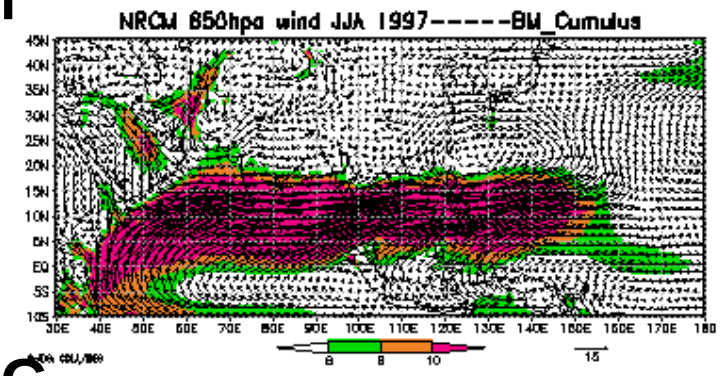


B-M



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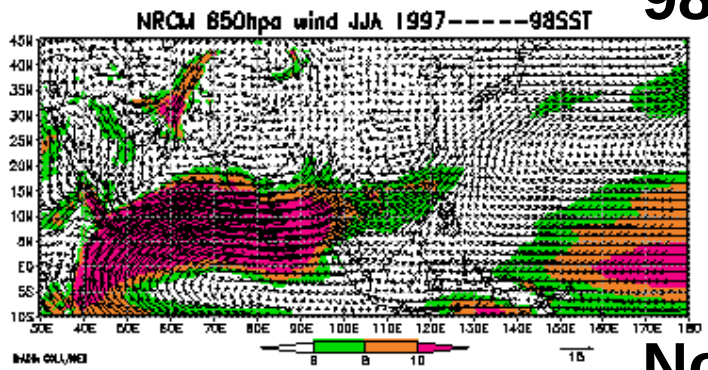

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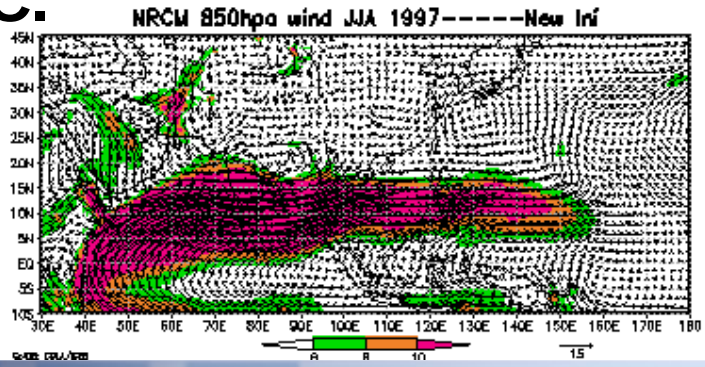

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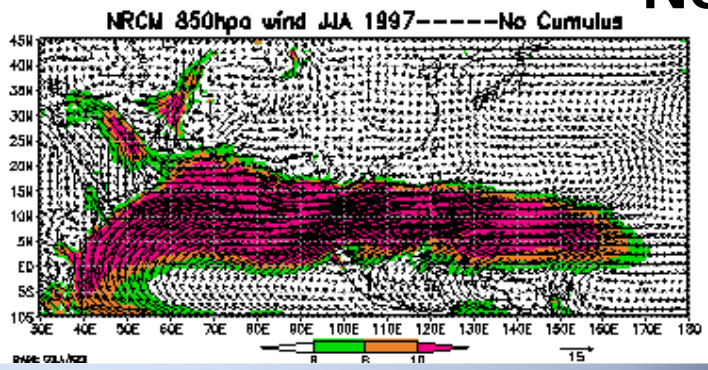

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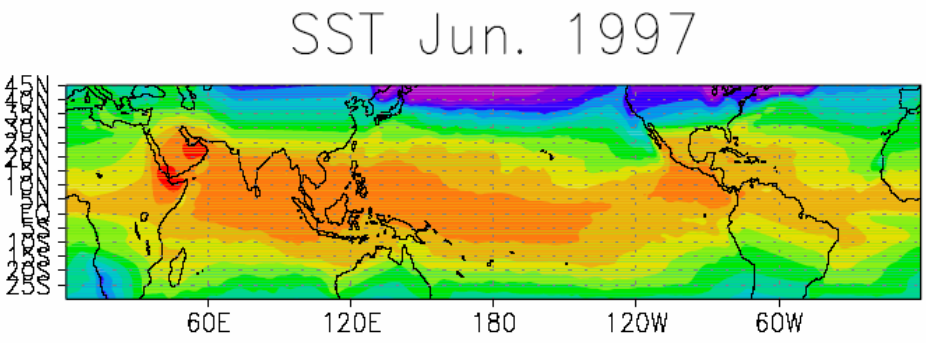
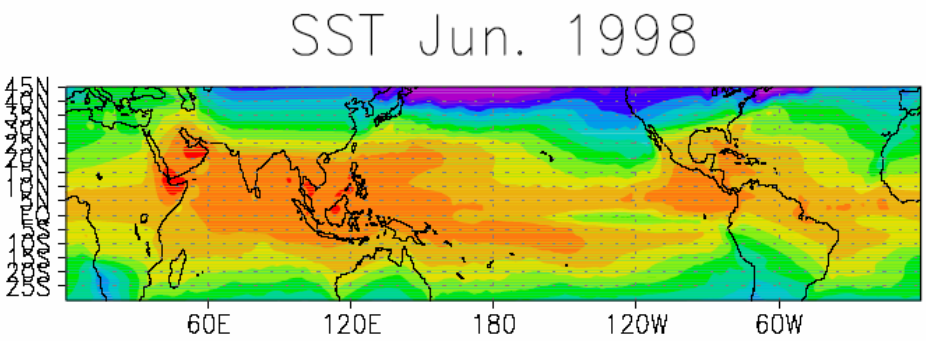
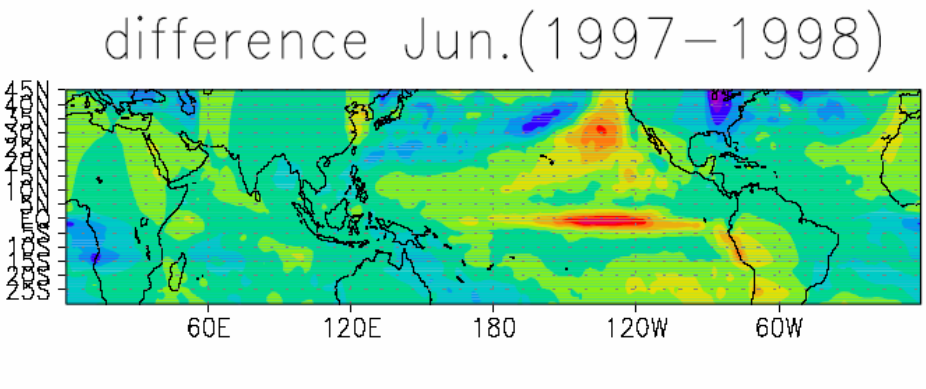






1997

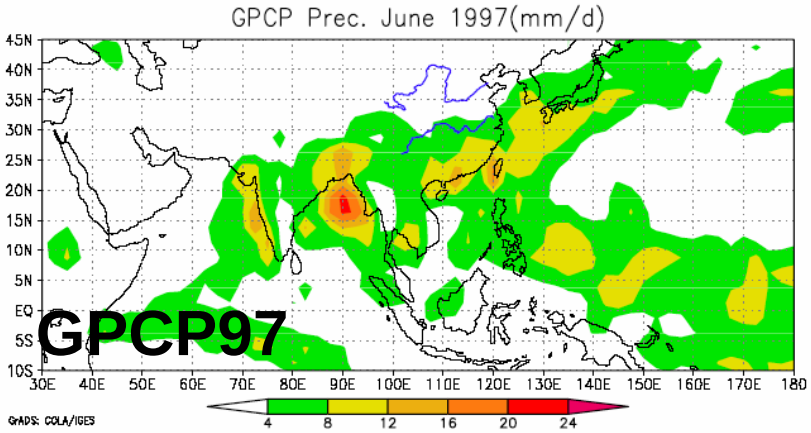
1998

SST and

Their differences

For June

ESSL NCAR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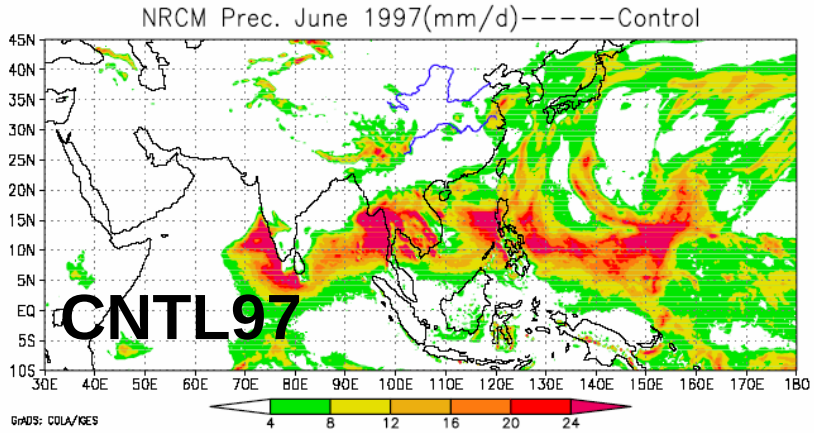
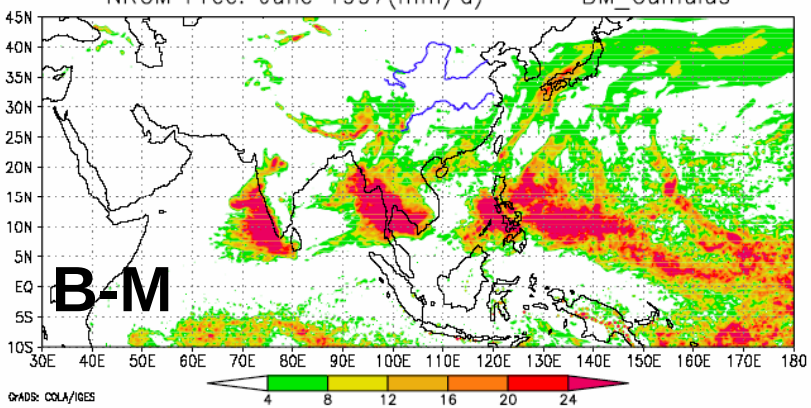
GPCP97
GrADS: COLA/IGES


NRCM Prec. June 1997(mm/d)-----Control
CNTL97
GrADS: COLA/IGES


NRCM Prec. June 1997(mm/d)-----BM_Cumulus
B-M
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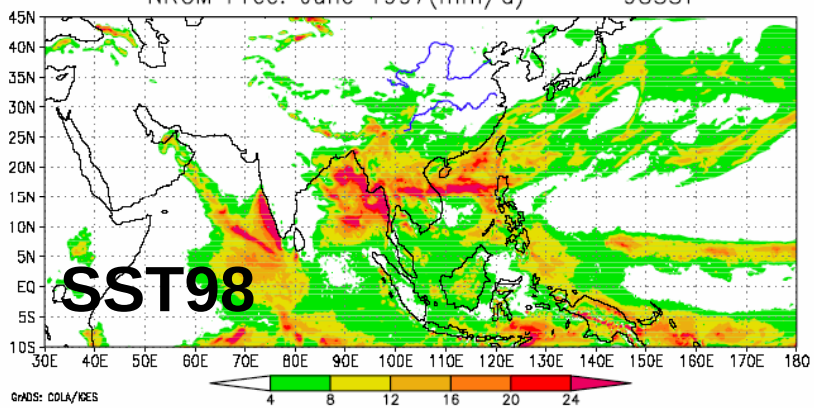
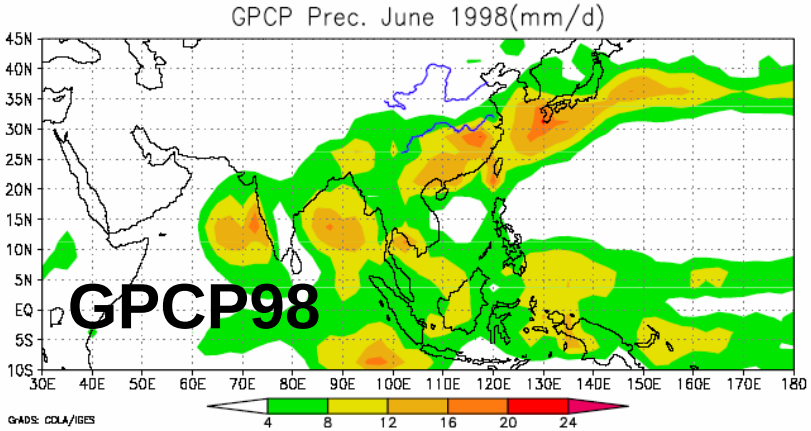

NRCM Prec. June 1997(mm/d)-----98SST
SST98
GrADS: COLA/IGES


GPCP Prec. June 1998(mm/d)
GPCP98
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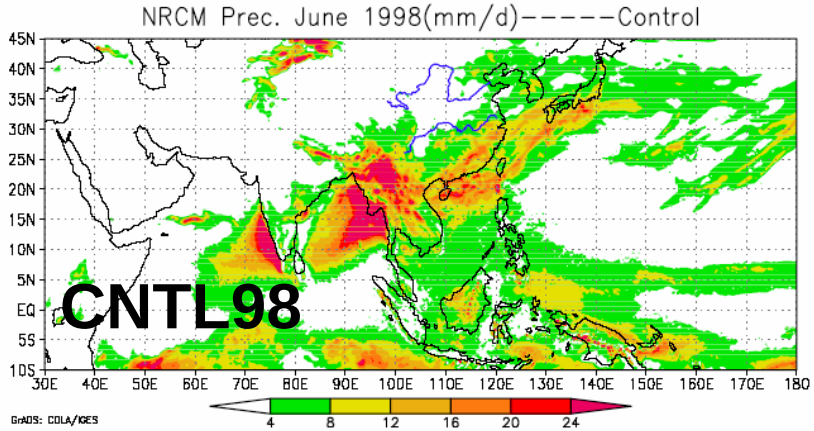
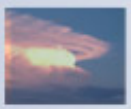

NRCM Prec. June 1998(mm/d)-----Control
CNTL98
GrADS: COLA/IGES

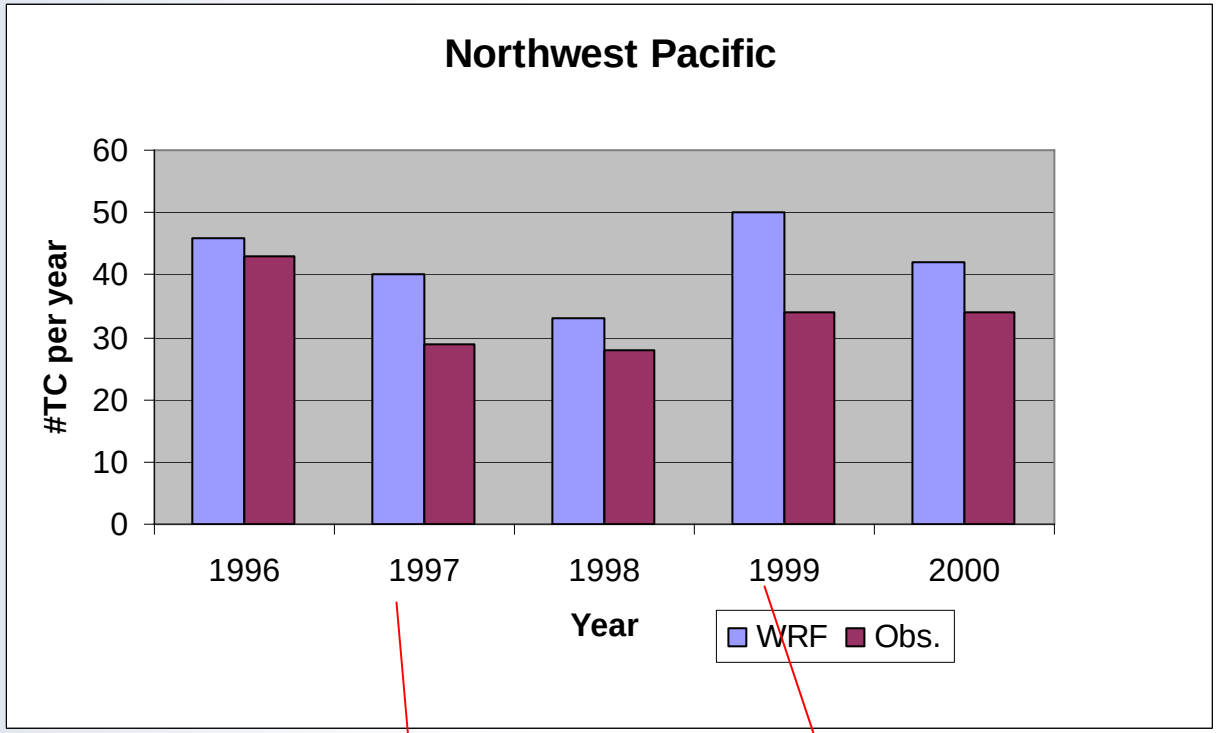
NCAR

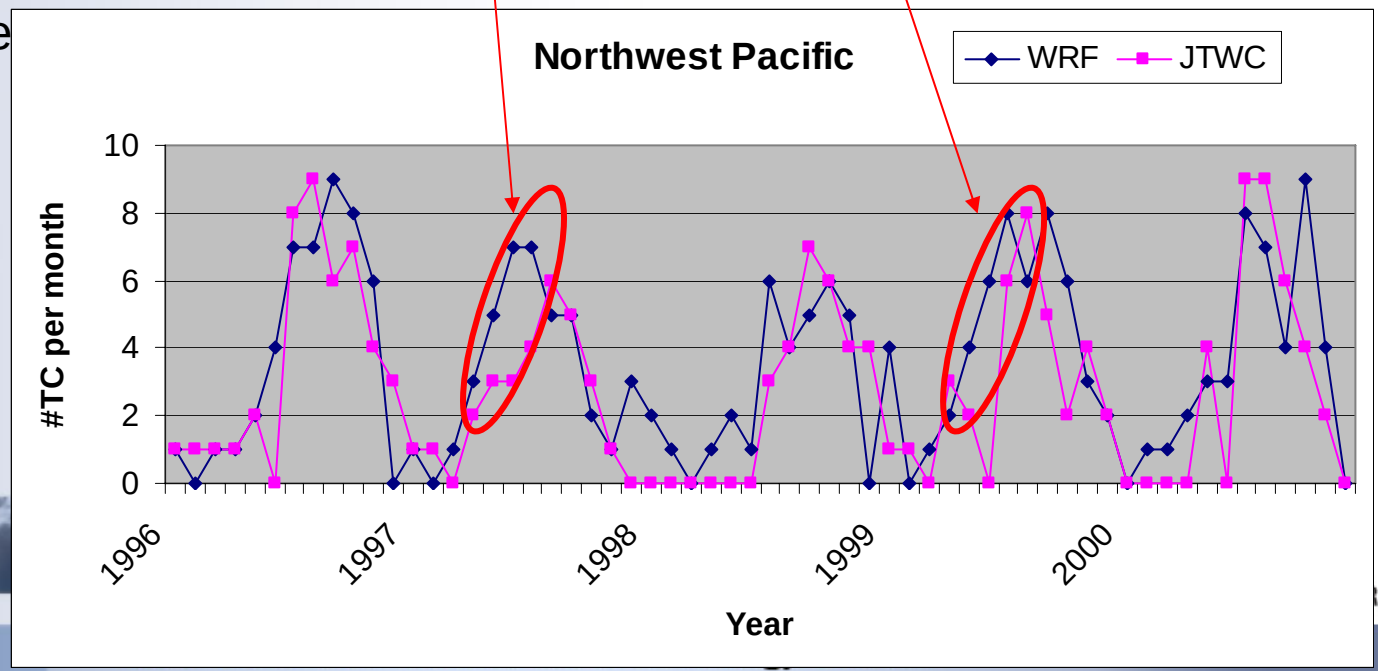
Impact of SST on NRCM simulation

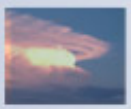
- **SST has a profound influence on precipitation prediction.**
- **For the NRCM simulation, SST has a stronger influence than precipitation parameterization, or model initial conditions.**
- **Why the use of 1998-SST is producing better simulation for 1997?**
  - ***SST is prescribed from monthly mean***
  - ***No diurnal variations***
  - ***No "interaction" between atmosphere-ocean***
  - ***No "cut-off" of solar radiation as a result of convection, and no "cooling-off" of SST***
  - ***The warm (just by a few degree) 1997 SST keeps triggering convections***

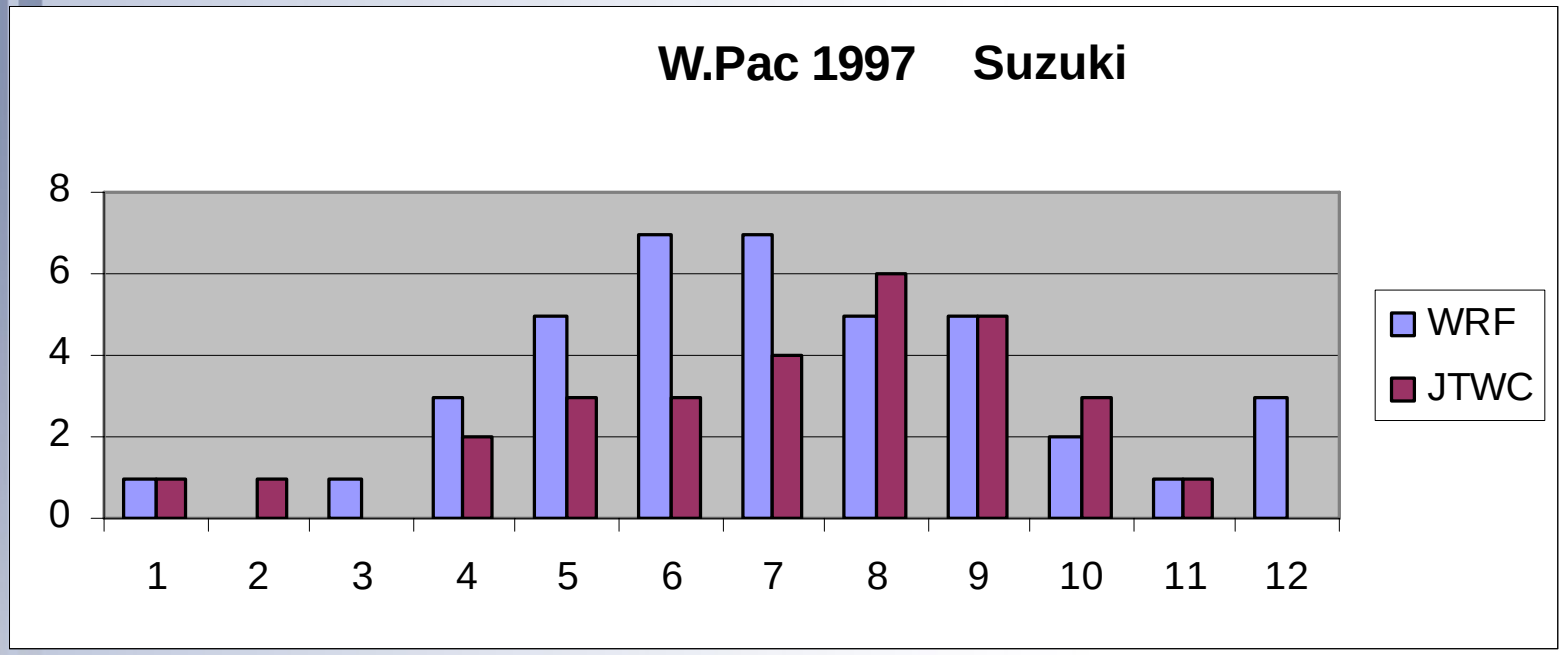




The number of NCM tropical cyclones are exceedingly high for 1997 and 1999, particularly in the early seasons from April to July. It is clearly related to the monsoon simulations.





Objective Typhoon Detection Scheme (A. Suzuki):

1) Existence of a distinctive SLP minimum
2) Maximum wind > 18m/s at 1000hPa
3) Relative vorticity > $5x10^{-5}$ s^{-1}at 850hPa
4) Existence of warm-core at 500hPa
5) Symmetry measure by wind field (make sure general wind pattern makes the circular flow)
6) Above condition lasts more than two days

Excessive Rainfall over Western Pacific:

-Results in dry East Asia monsoon.

-Produces more early season typhoons over the western N. Pacific.

Atmosphere-Ocean Coupling and improved precipitation parameterization are needed!!

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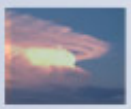
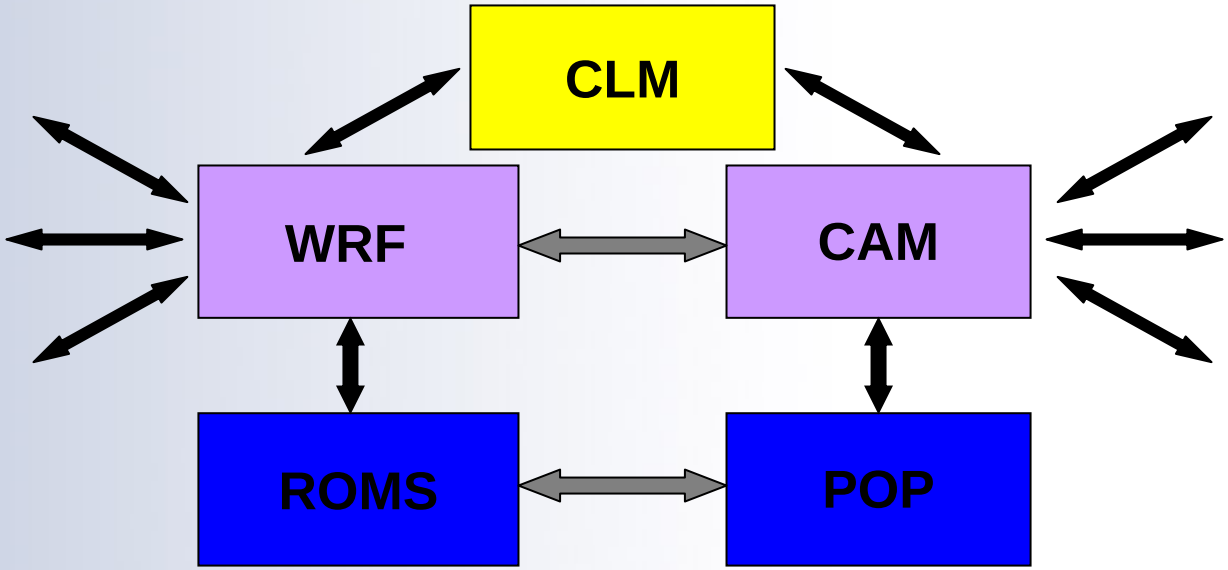
Future work

- We are testing the skin SST prognostic scheme of Zeng and Belgaars (2005)
- In the long run, we should implement the full coupling of WRF with ROM, as we have originally proposed.


Proposed Modeling Framework

- WRF/ROMS (regional ocean modeling system) nested within CCSM with WRF interacting with ROMS and CAM, and ROMS interacting with WRF and POP (global ocean model)



OR...

- Develop global WRF into a good global nonhydrostatic cloud-resolving climate model with full coupling capabilities.