

# Future Changes in Typhoon Frequency and Intensity Projected by the new 20km AGCM

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# KAKUSHIN Program 20km/60km AGCM Cumulus Convection Schemes

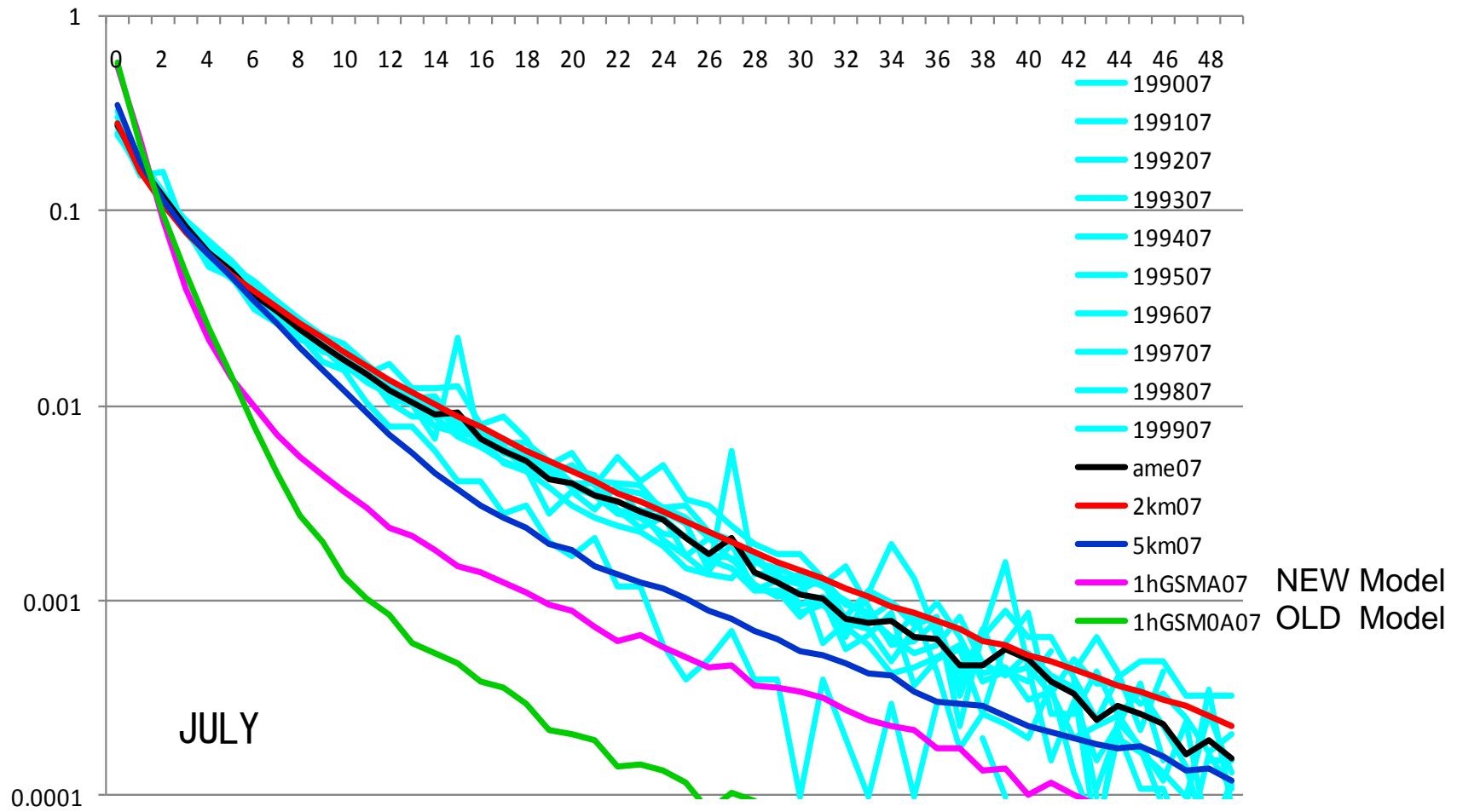
OLD MODEL: Arakawa-Schubert Scheme  
Weak Rain, Broad Area

NEW MODEL: Yoshimura Scheme

Intense Rain, Concentrated Area

# Hourly Precipitation Intensity PDF

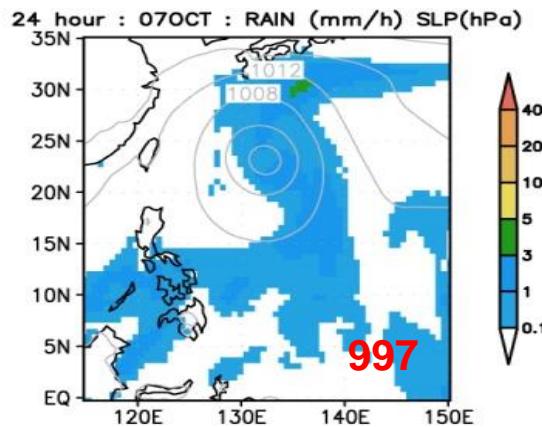
## July Western Japan (<136E)



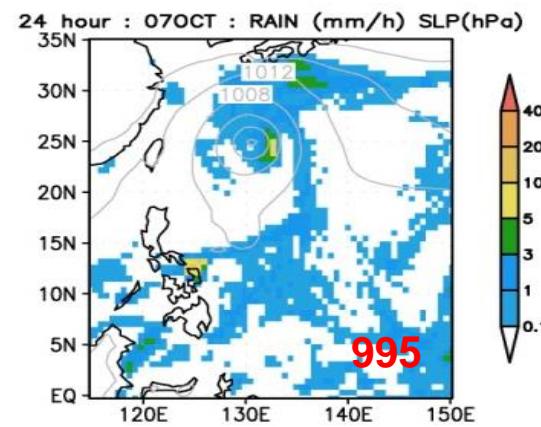
# 4 day forecast of T0422 from 2004.10.4 00UTC

TL319L40  
(60km)

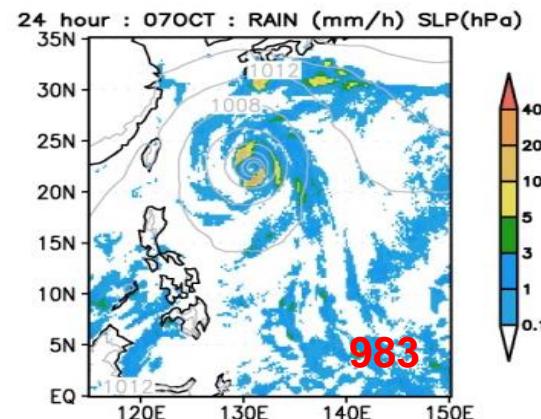
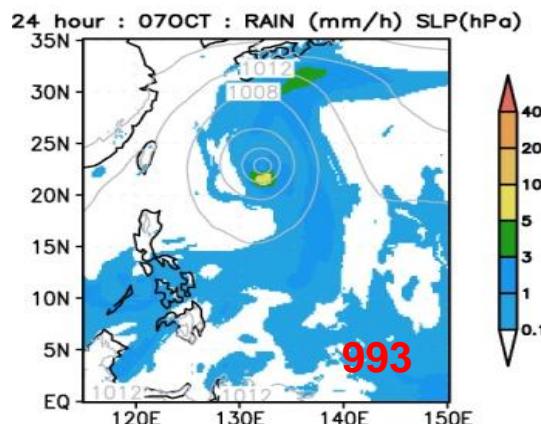
OLD  
(AS scheme)



NEW  
(Yoshimura scheme)



TL959L60  
(20km)

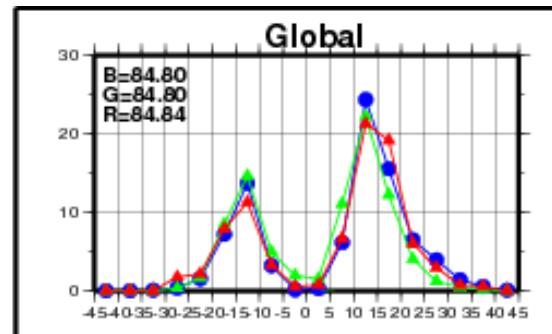


# 20km Model TC Frequency

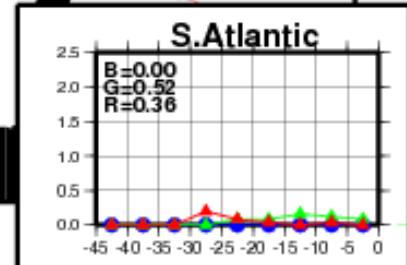
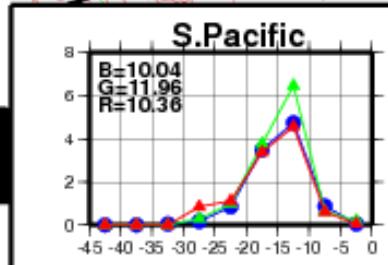
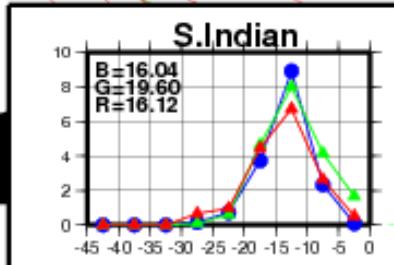
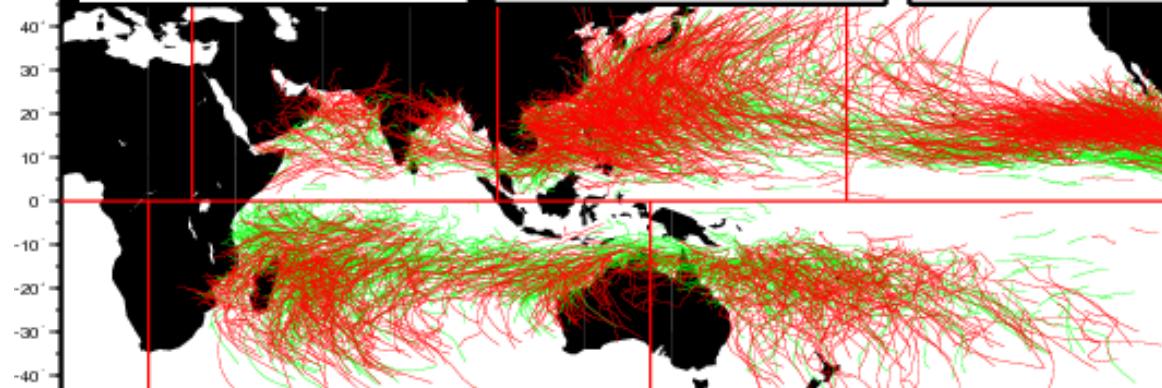
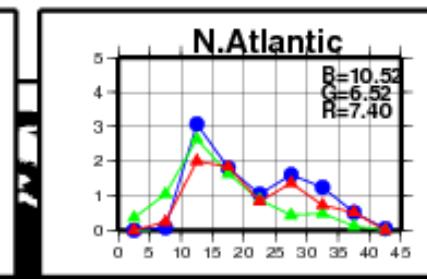
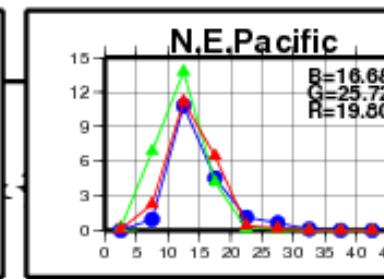
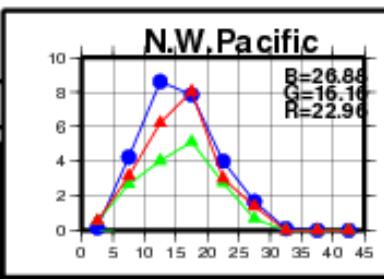
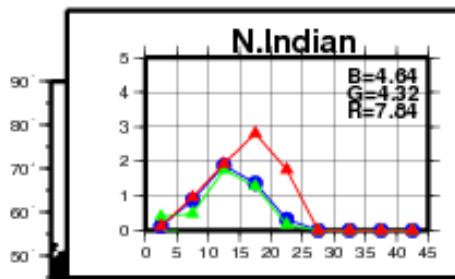
Annual Number of Tropical Storm  
Genesis for Each Latitude Belt

Best Track(over 34kt)  
Models (by Oouchi et.al(2006))

abscissa: latitude  
ordinate: annual averaged number

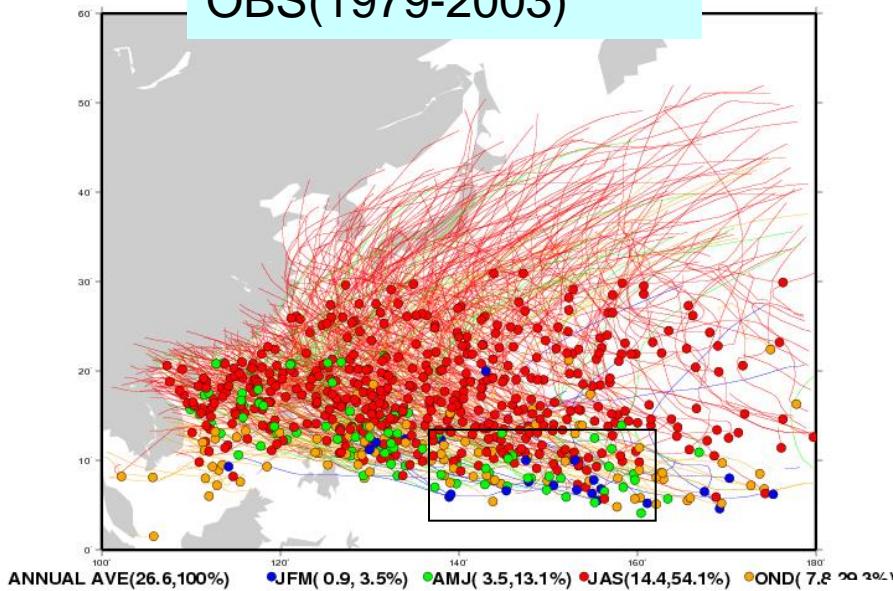


- Blue: OBS
- Green: OLD (25yr)
- Red: NEW (25yr)

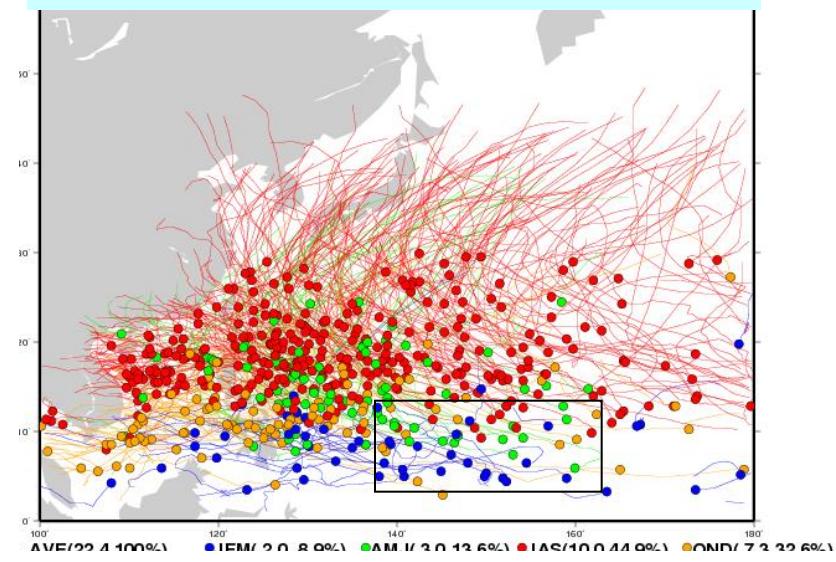


# Western North Pacific

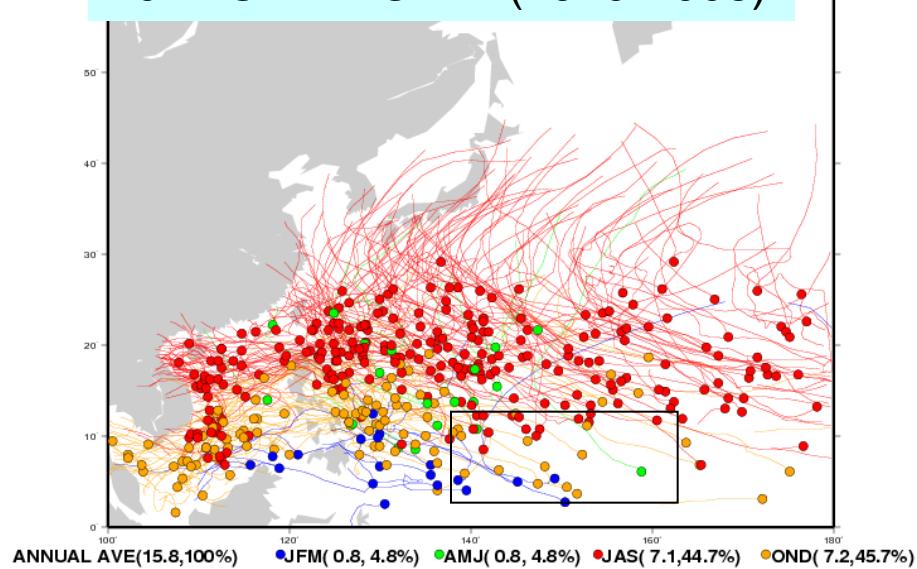
OBS(1979-2003)



20km NEW MODEL(1979-2003)



20kmOLD MODEL(1979-2003)



More genesis in the rectangular area

青:JFM  
緑:AMJ  
赤:JAS  
橙:OND

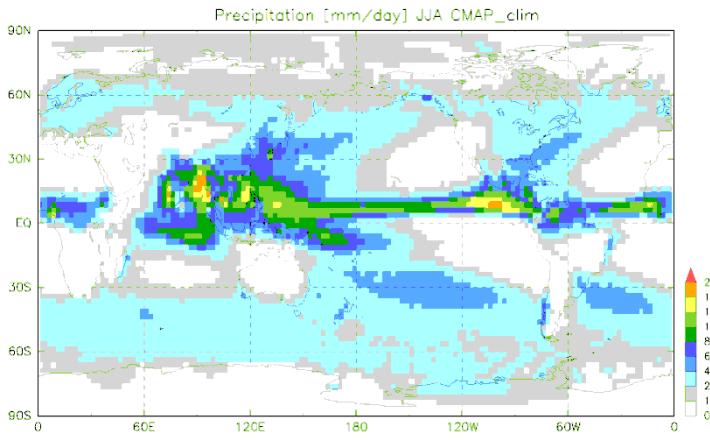
# Change in Annual TC genesis (%)

Blue : statistically significant at 95%

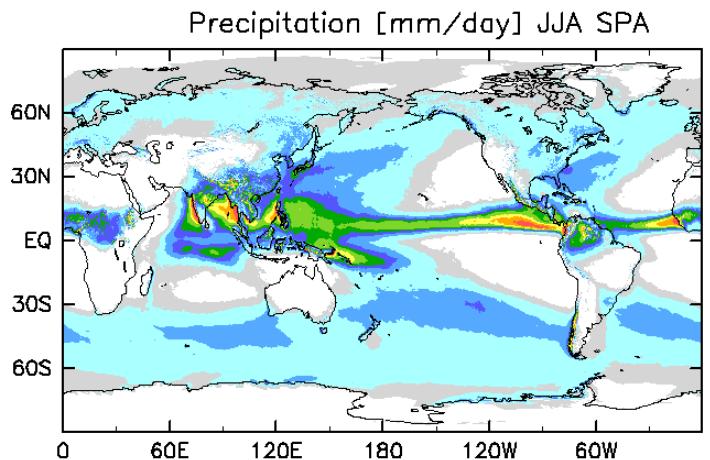
	OLD 20km	NEW 20km	OLD 60km	NEW 60km
Global	-15.8	-16.9	-18.8	-25.0
NH	-15.5	-13.0	-18.9	-24.9
SH	-16.4	-25.3	-18.5	-25.1
N Indian O.	-11.8	-10.6	+18.0	-16.0
NW Pacific	-26.8	-19.0	-11.7	-29.5
NE Pacific	-14.5	-4.4	-30.5	-12.9
N Atlantic	+5.6	-21.1	+4.2	-45.4
S Indian O.	-4.8	-23.6	-8.9	-25.4
S Pacific	-34.9	-30.4	-33.7	-24.5

# Precipitation (JJA)

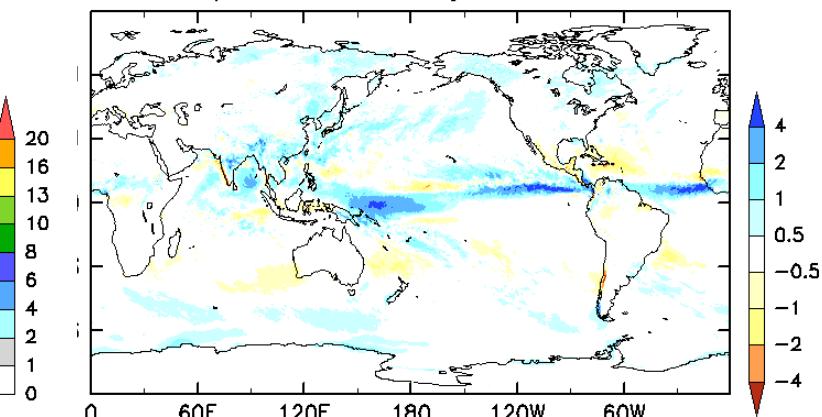
OBS(CMAP)



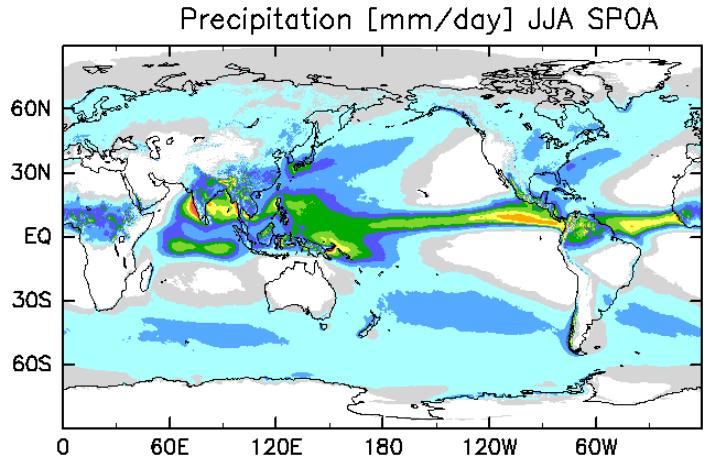
NEW Model  
20km 25yr



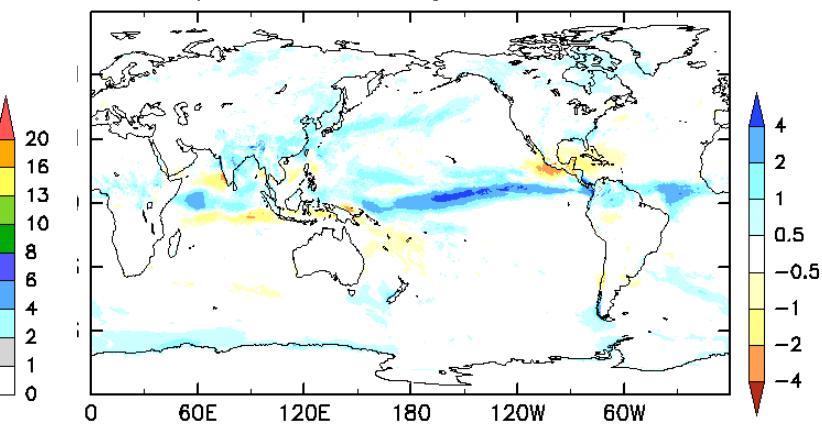
Precipitation [mm/day] JJA SFA-SPA

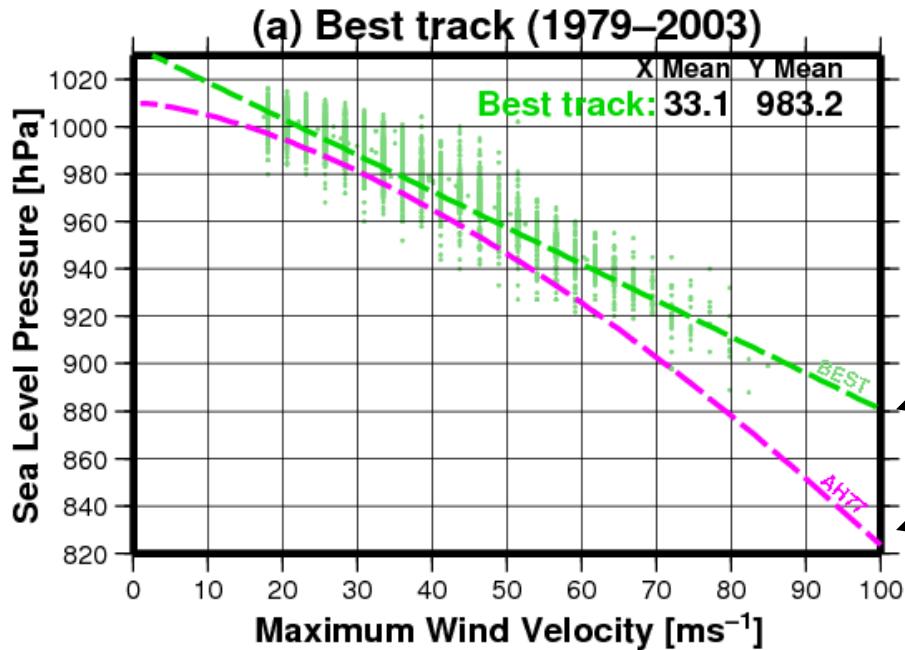


OLD Model  
20km 25yr



Precipitation [mm/day] JJA SF0A-SPOA

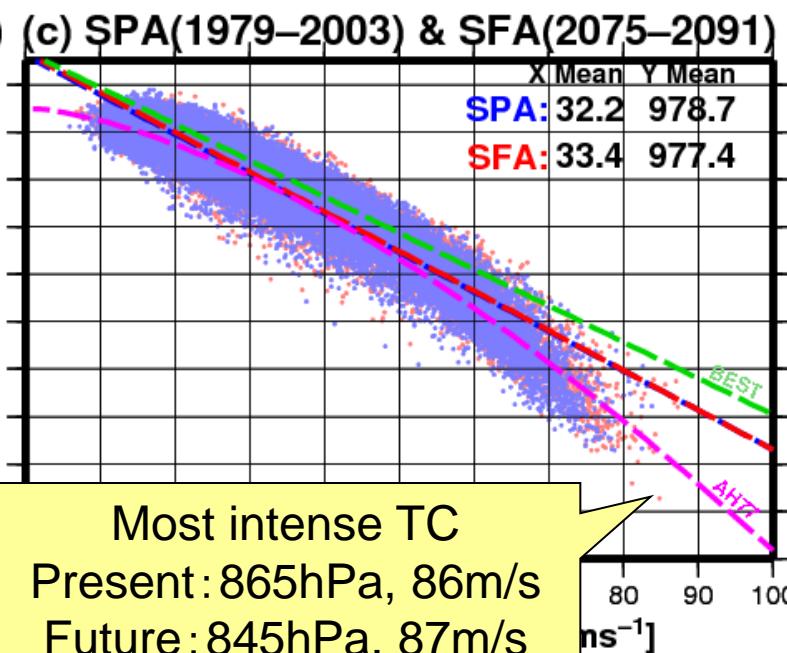
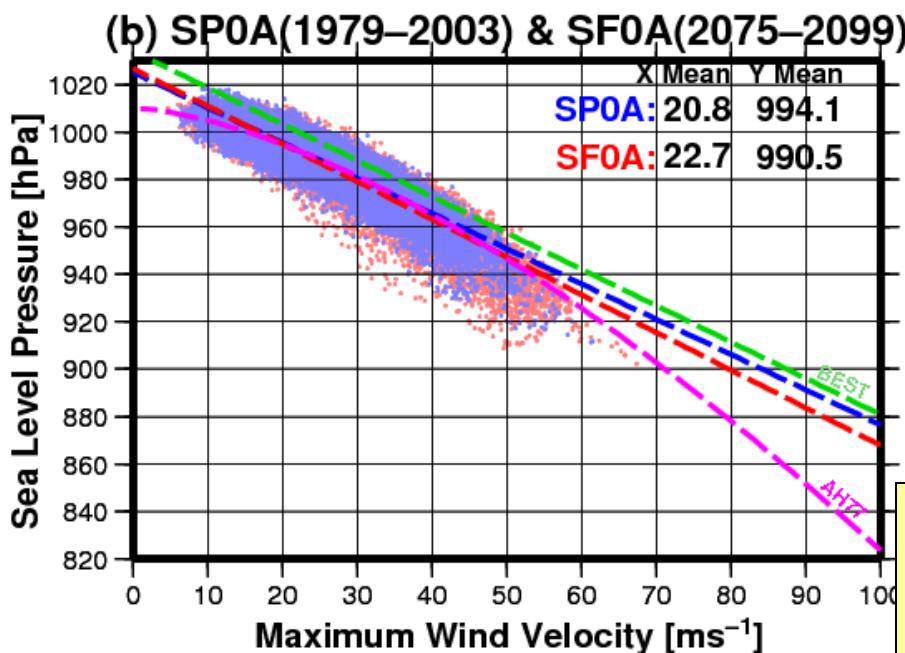




Max Wind vs. Min Pressure

Linear Regression for  
Best track (Green) data

Atkinson and Holliday (1977, MWR)  
Regression Curve based on  
NW Pacific obs.



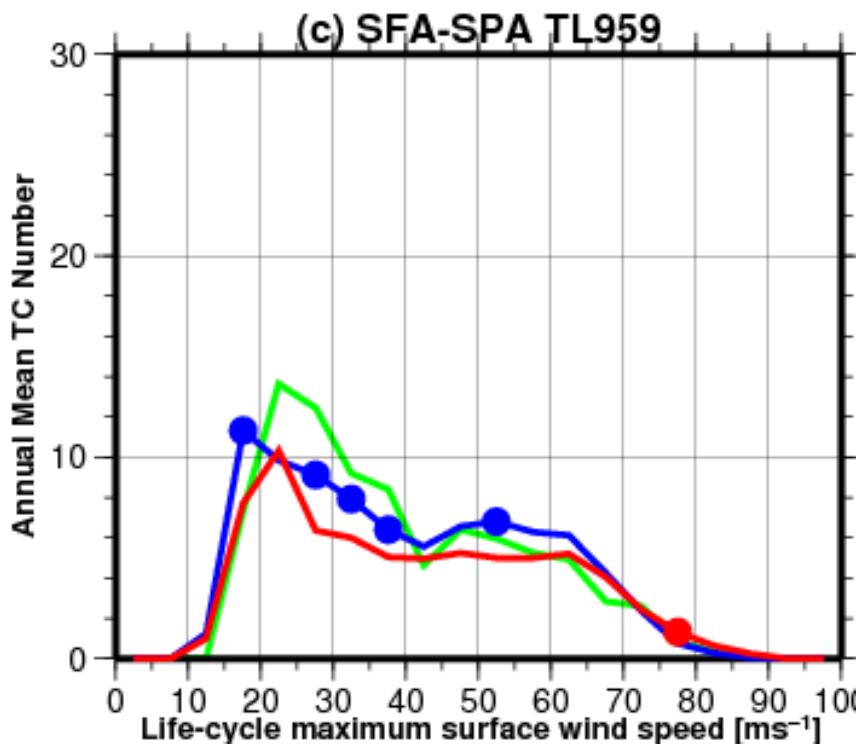
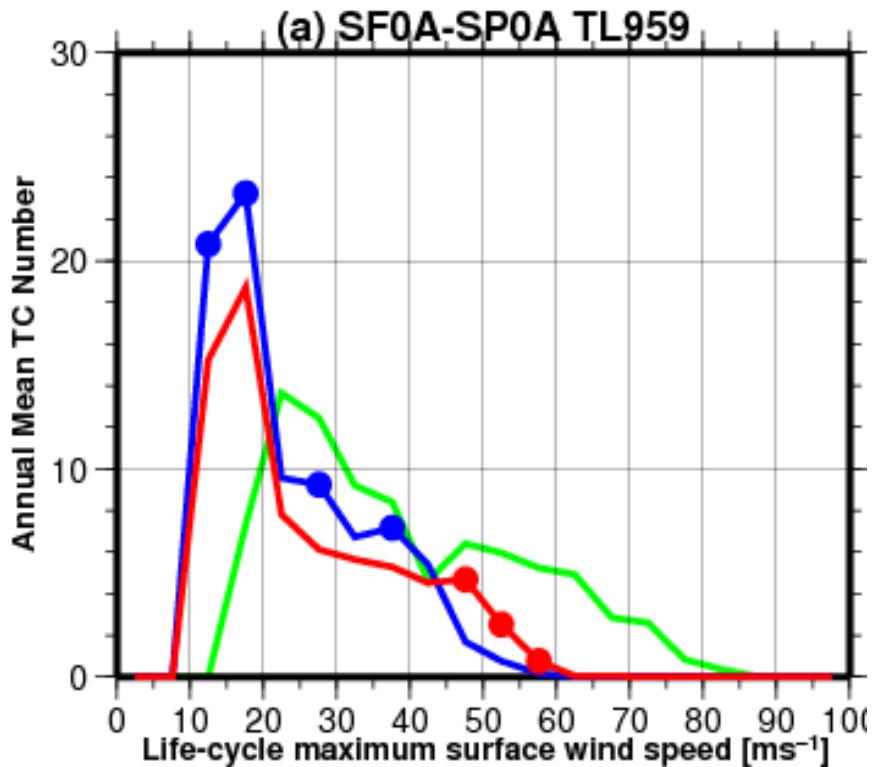
Most intense TC  
Present: 865hPa, 86m/s  
Future: 845hPa, 87m/s

# TC intensity distribution

KAKUSHIN Program

OLD : AS scheme

NEW: Yoshimura scheme



OBS (Best Track) 25year (1979-2003 )



20km Model Present 25year (1979-2003 )



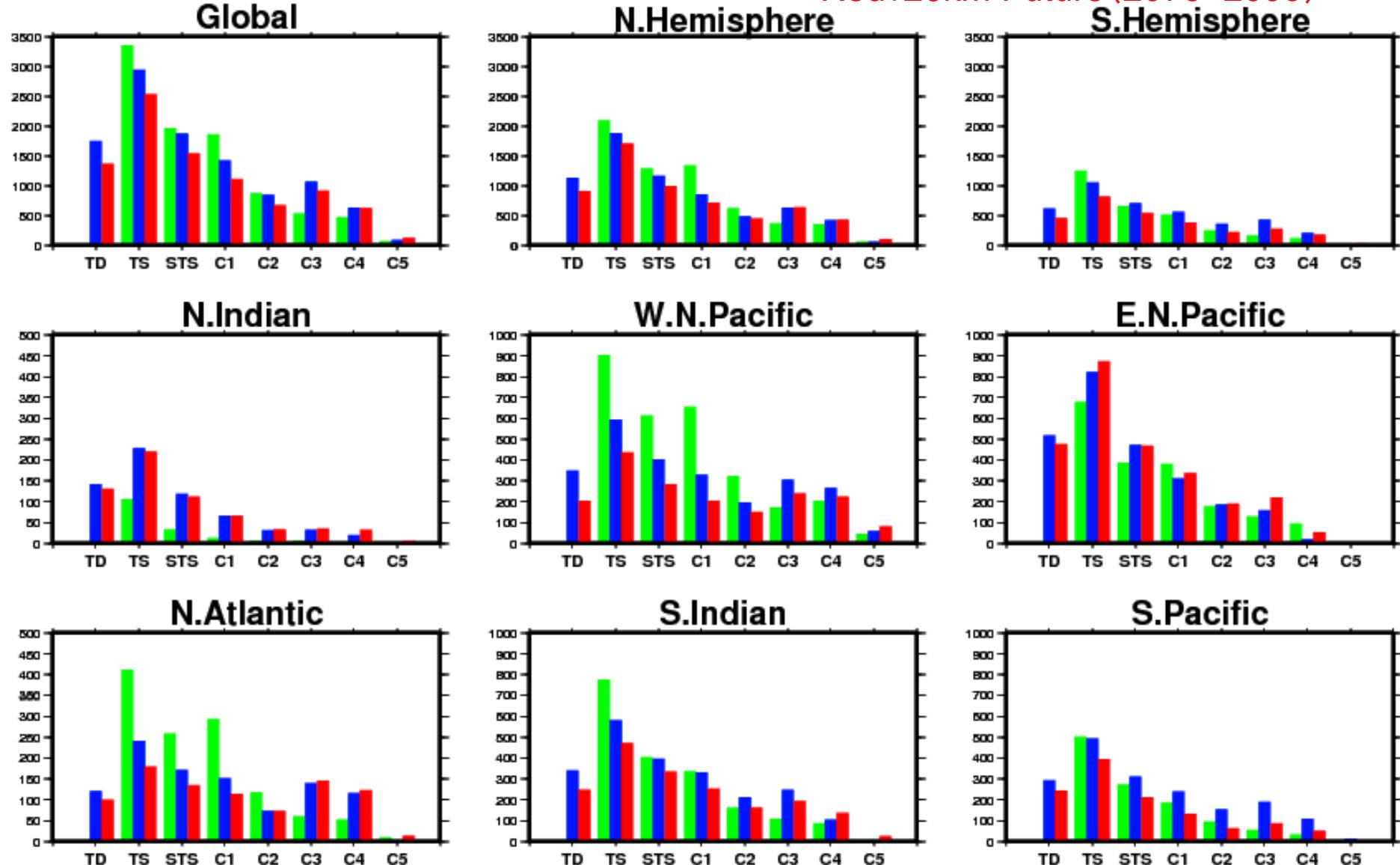
20km Model Future 25year (2075-2099 )

# Storm-Days

## Accumulated Storm-Days

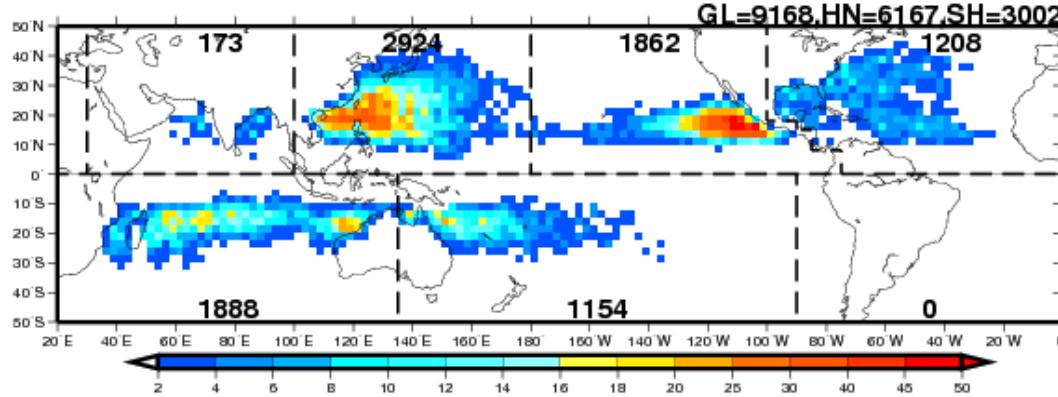
**NH(May–October), SH(November–April): TC Detection : k959k**  
**Green: Observations, Blue: Present-day, Red: Future**

Green: Obs. (1979-2003)  
Blue: 20km Present (1979–2003)  
Red: 20km Future (2075–2099)



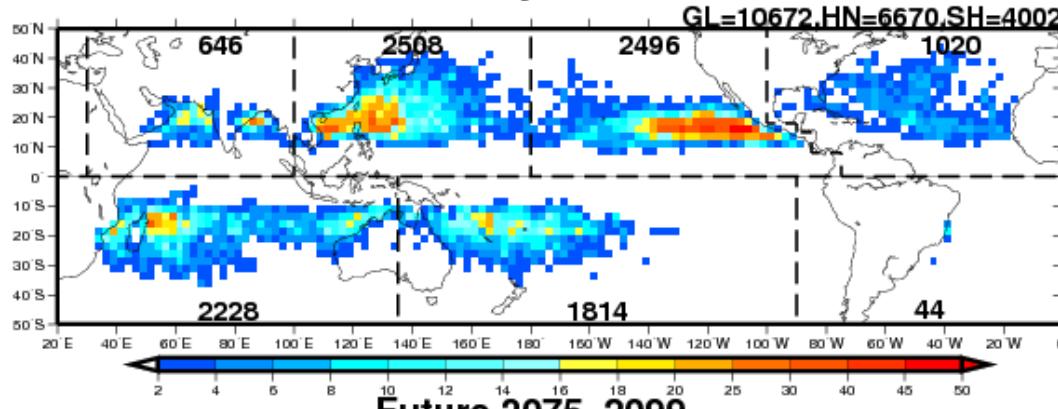
# All TCs

Besttrack 1979–2003

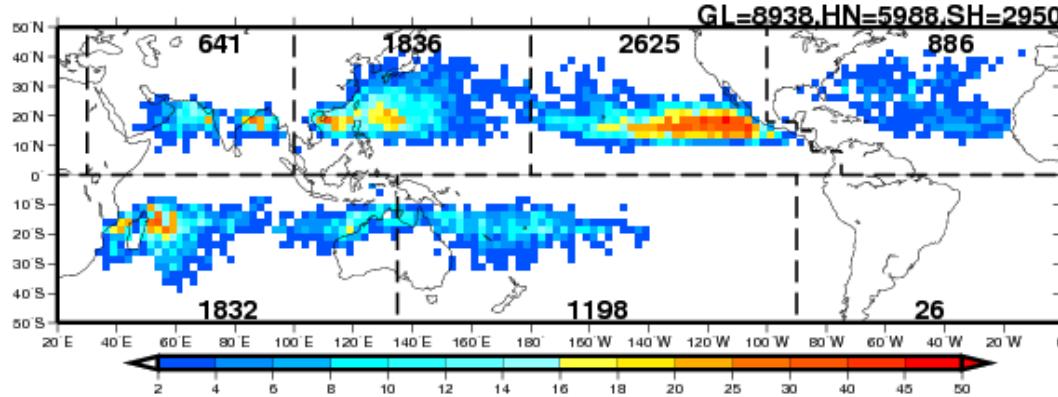


Numbers :  
Total Storm-days in  
Each Ocean Basin per  
25 Years

Present-day 1979–2003

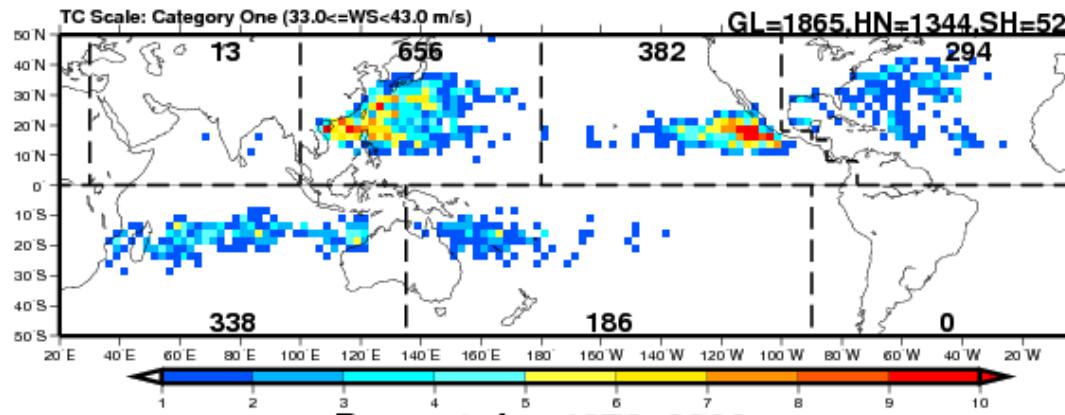


Future 2075–2099



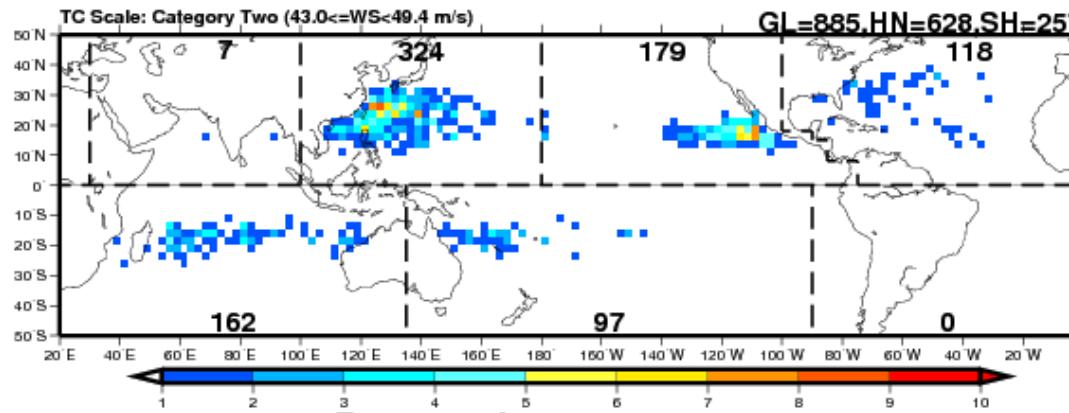
# Category 1 ( $33.0 \leq WS < 43.0$ m/s)

Besttrack 1979–2003

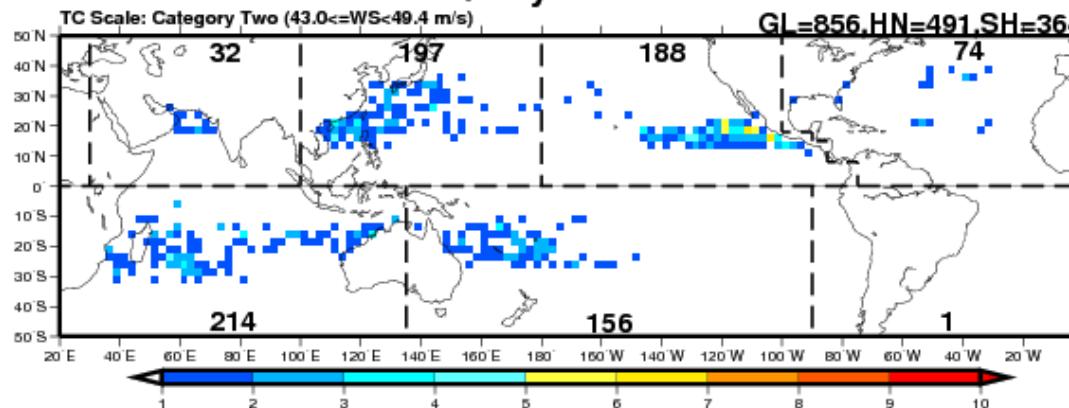


# Category 2 ( $43.0 \leq WS < 49.4$ m/s)

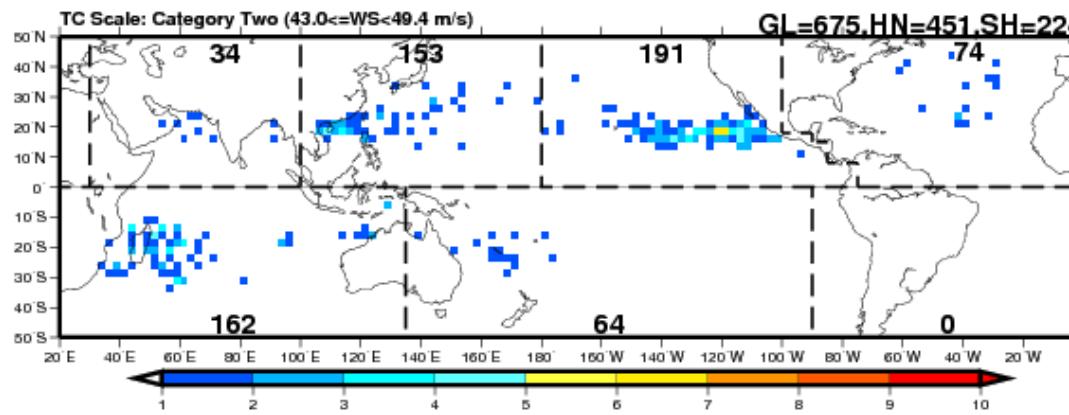
Besttrack 1979–2003



Present-day 1979–2003

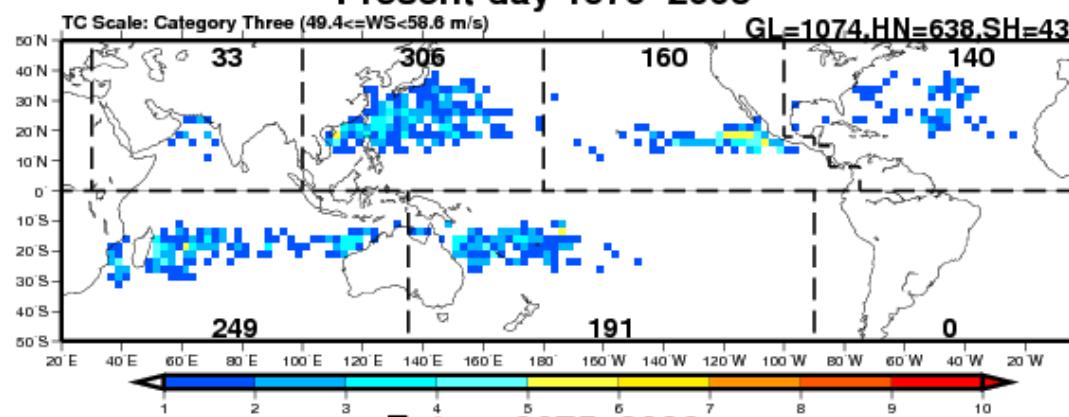
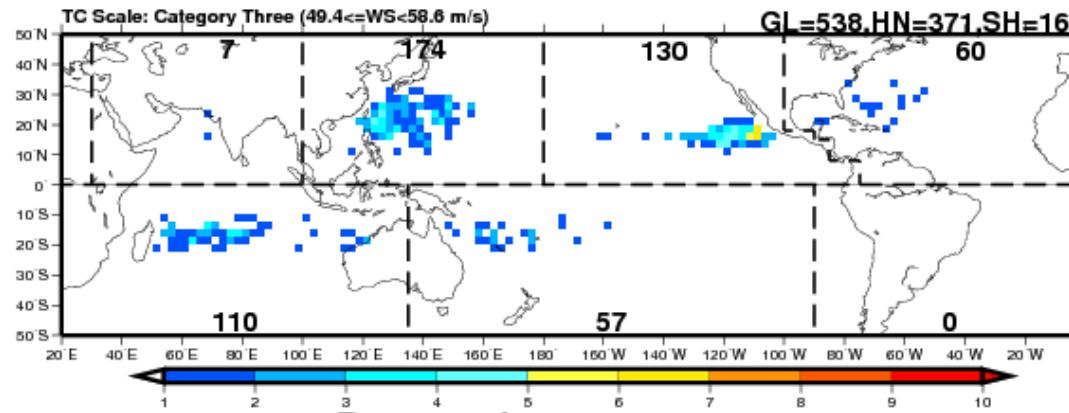


Future 2075–2099

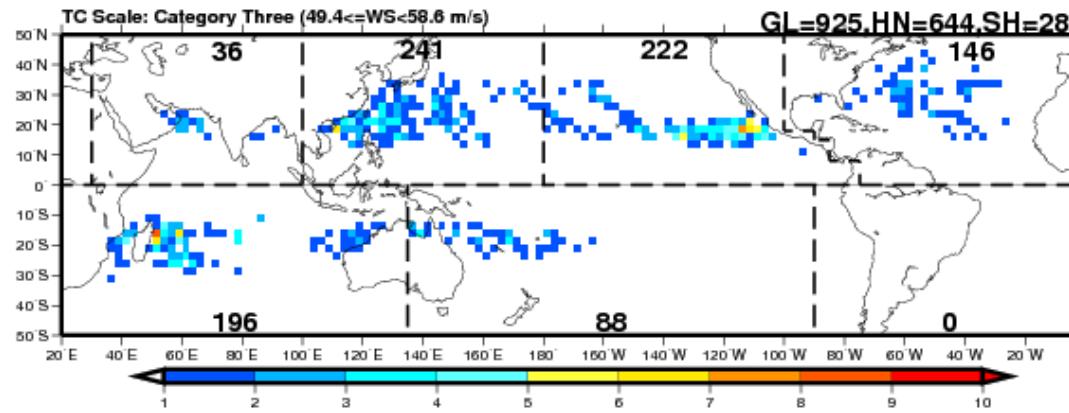


# Category 3 ( $49.4 \leq WS < 58.6$ m/s)

Besttrack 1979–2003

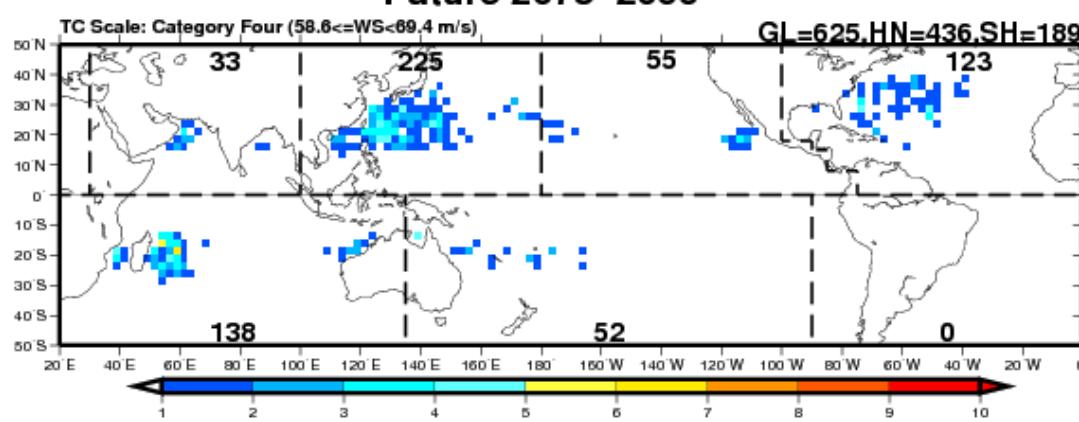
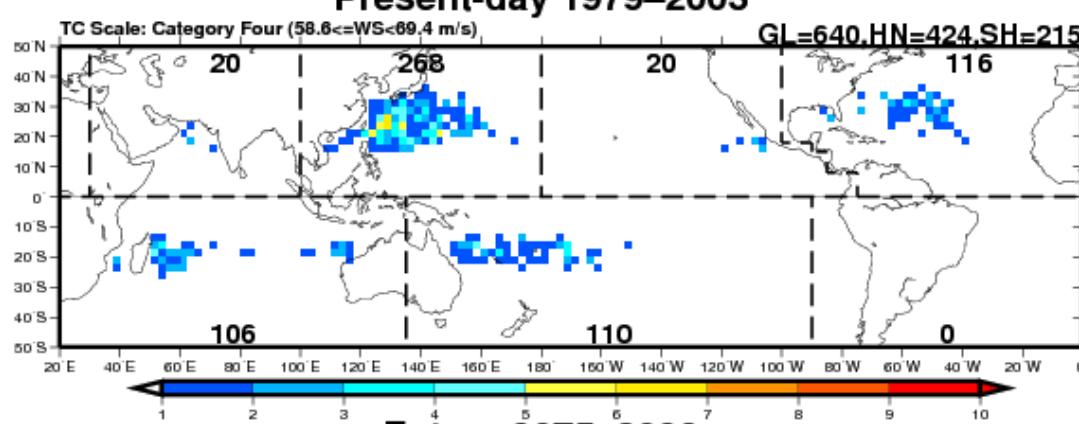
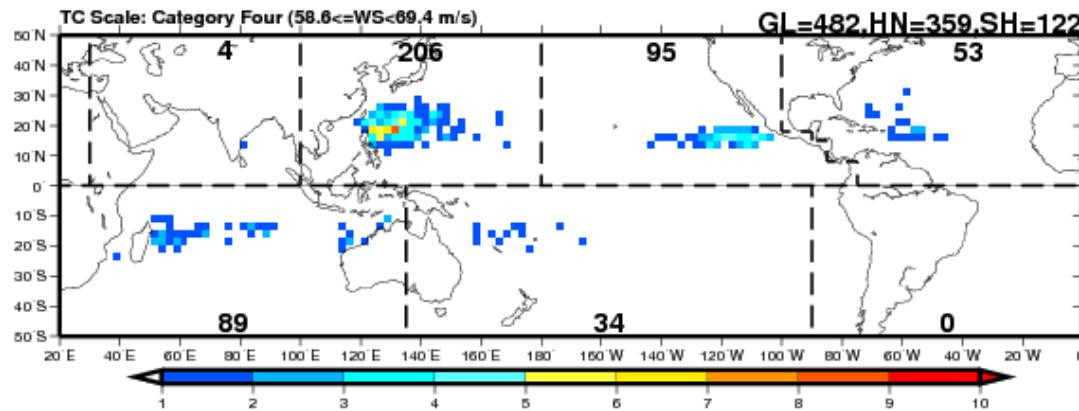


Future 2075–2099



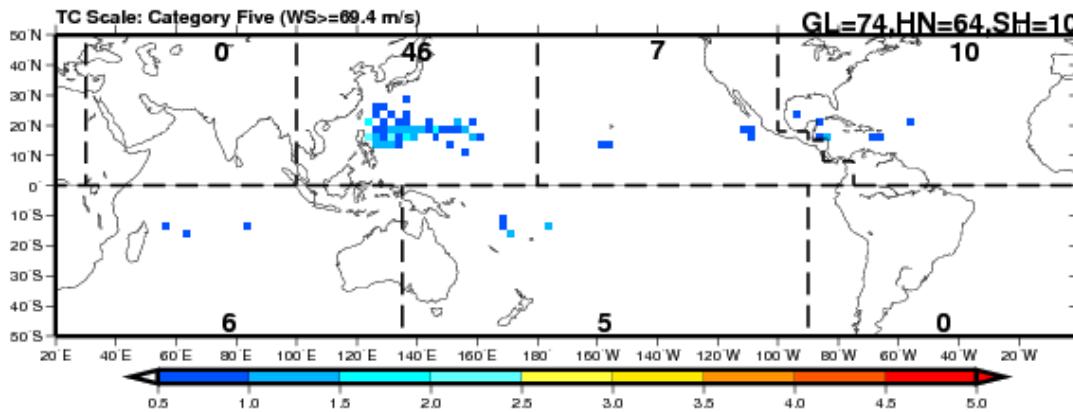
# Category 4 ( $58.6 \leq WS < 69.4$ m/s)

Besttrack 1979–2003



# Category 5 ( $69.4 \text{ m/s} \leq \text{WS}$ )

Besttrack 1979–2003



# CONCLUSIONS

- ◆ TC-days of Category 5 (most intense) typhoons may increase in the future in the areas to the east of Taiwan and to the south of Japan.
- ◆ There are large uncertainties in the projection of regional typhoon frequency and intensity changes.
- ◆ To reduce the uncertainties, we need further improvement of the cumulus convection and TC climate in the model. Also, we need a large number of ensemble experiments to increase the statistical significance.

## FUTURE DIRECTIONS

- ◆ Improve Cumulus Parameterization
- ◆ Higher Resolution
- ◆ Larger number of Ensemble