



Prediction of Tropical Cyclone Landfall Numbers Using a Regional Climate Model

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Outline

- **Model description**
- **Structure of model tropical cyclone**
- **Model climatology and interannual variability**
- **Hindcast results**
- **Forecasts and verification for 2014**
- **Summary**

The model

- **Modified version of Regional Climate Model Version 3 (RegCM3) developed at ITCP**
- **Horizontal resolution: 60 km**
- **Modified Emanuel cumulus scheme**
- **Domain: 94°E-172°W, 14°S-41°N**
- **8 ensemble members with initial conditions separated by 6 hours**

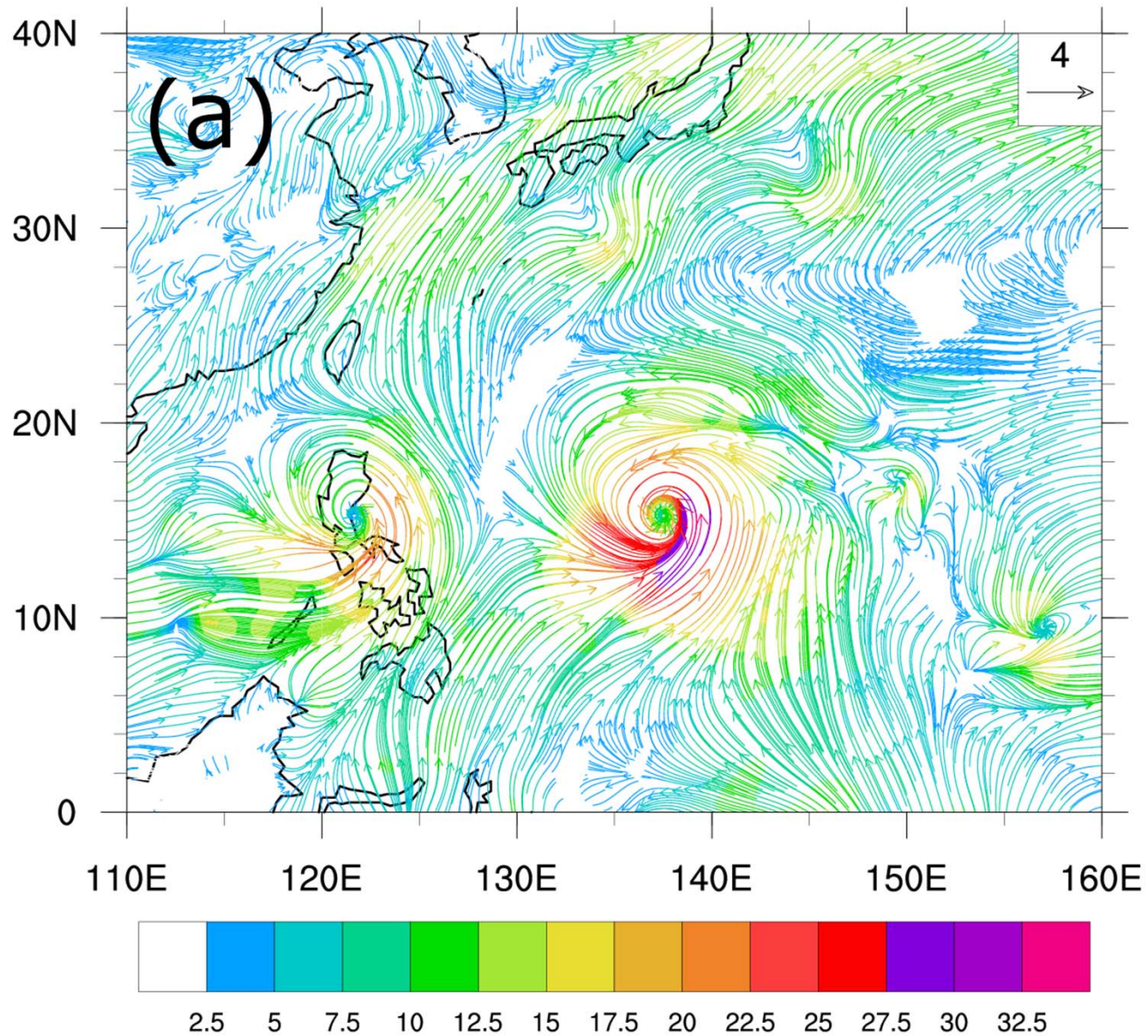
The model

- **Initial and boundary conditions:**
 - **NCEP CFS reanalysis (climatology study)**
 - **NCEP CFS hindcasts (prediction study)**

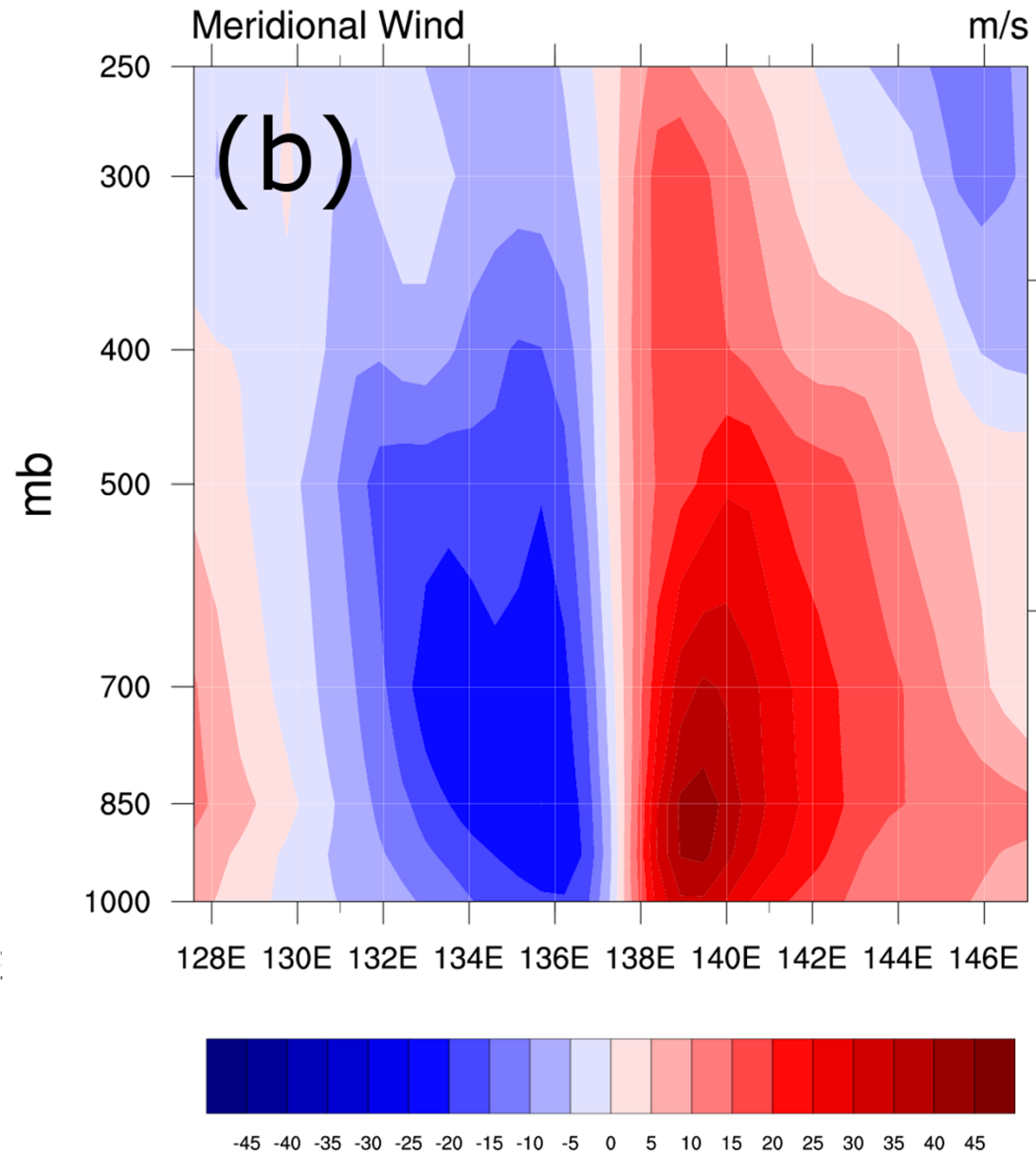
Detection of a tropical cyclone

- **Local maximum $\zeta_{850\text{hPa}} \geq 1 \times 10^{-4} \text{ s}^{-1}$**
- **$T_{300\text{hPa}}$ at centre – $T_{\text{environment}} \geq 1^\circ\text{C}$, where $T_{\text{environment}}$ is the average temperature within 15° latitude radius from the TC centre**
- **lifetime ≥ 2 days**
- **Genesis over the ocean**

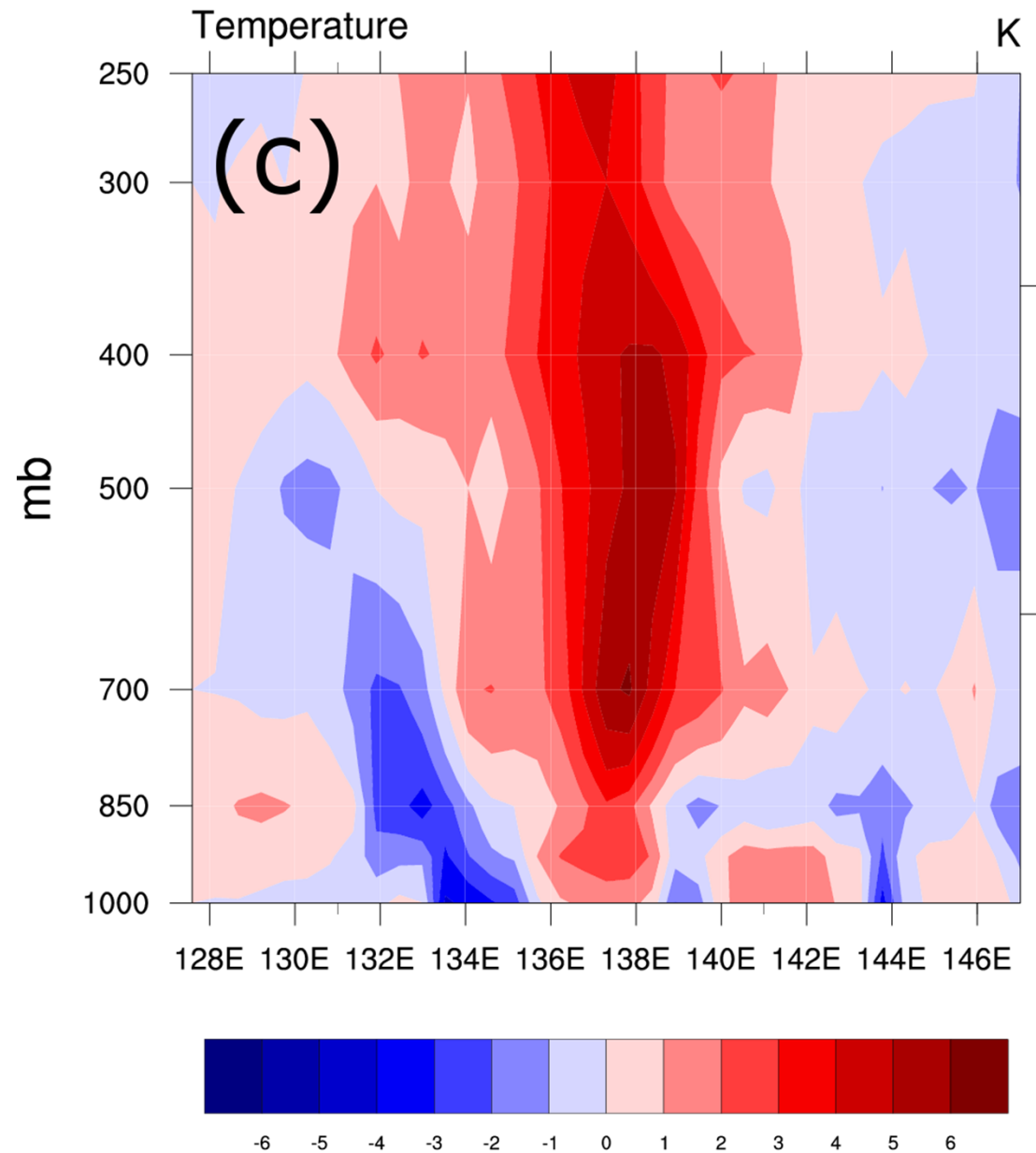
Example of a tropical cyclone in RegCM3



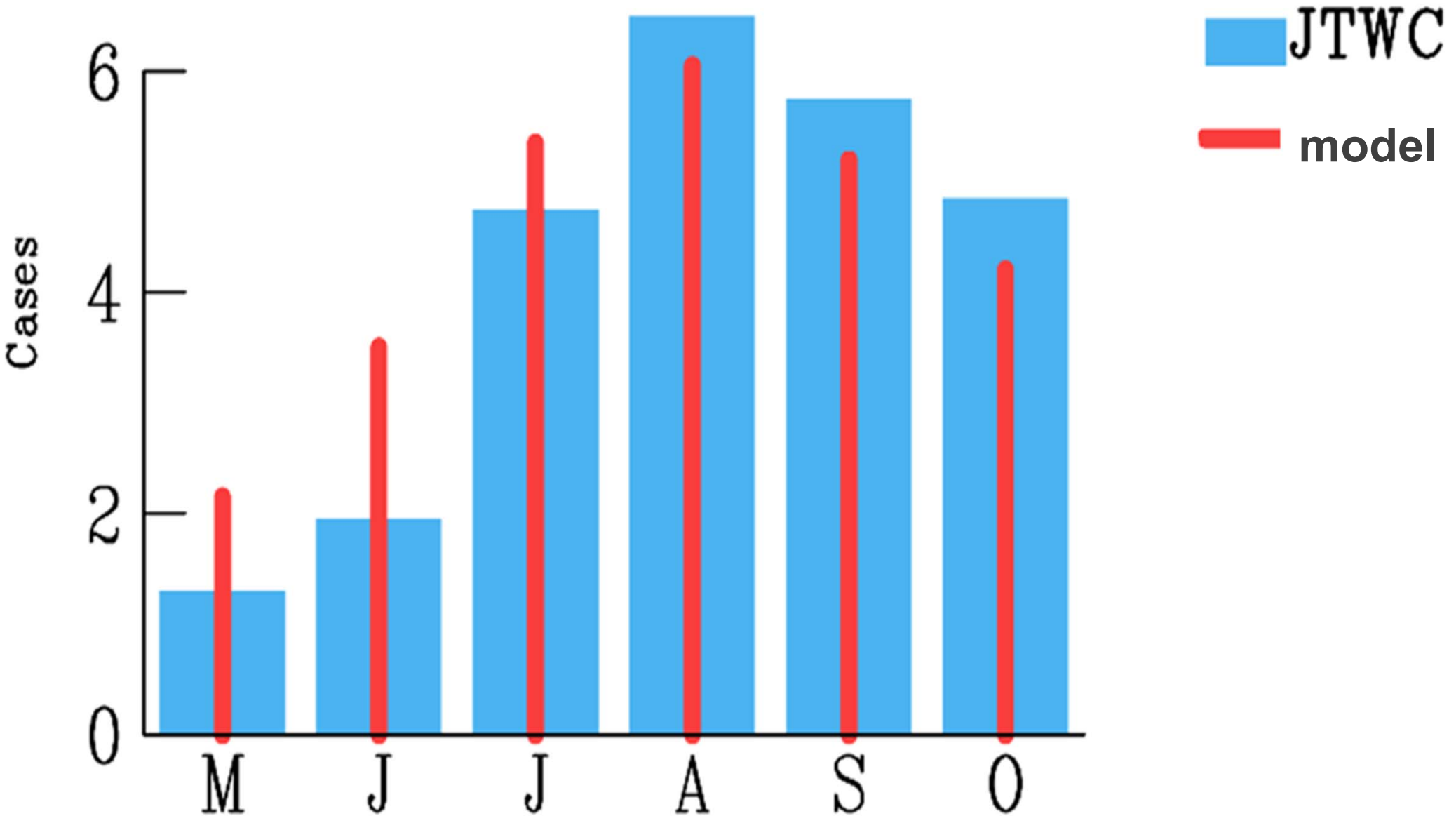
Example of a tropical cyclone in the Regional Model



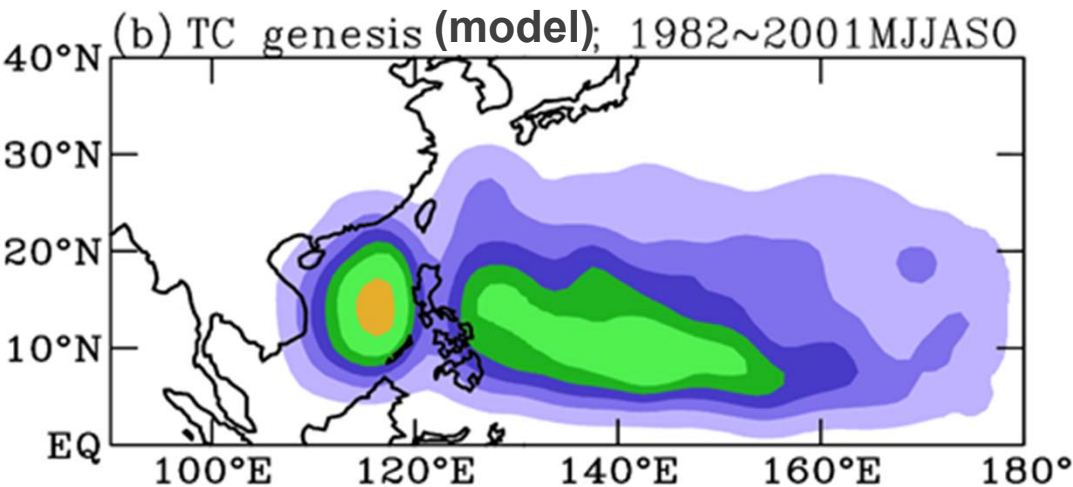
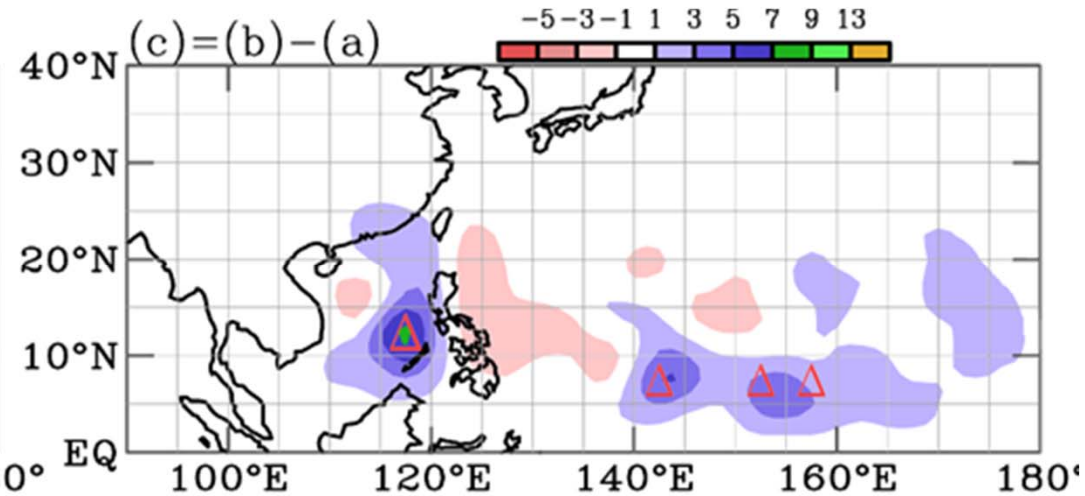
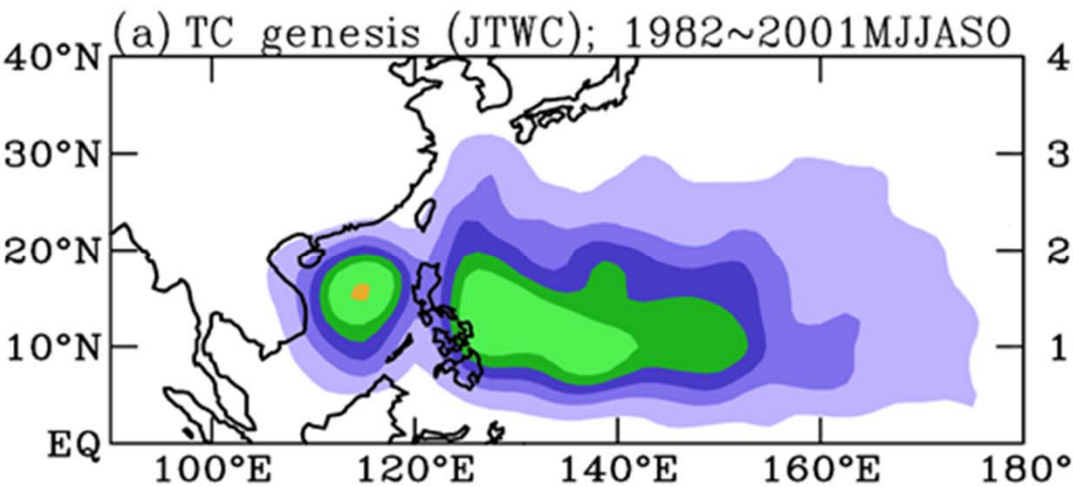
Example of a tropical cyclone in the Regional Model



TC Numbers (1982-2001)



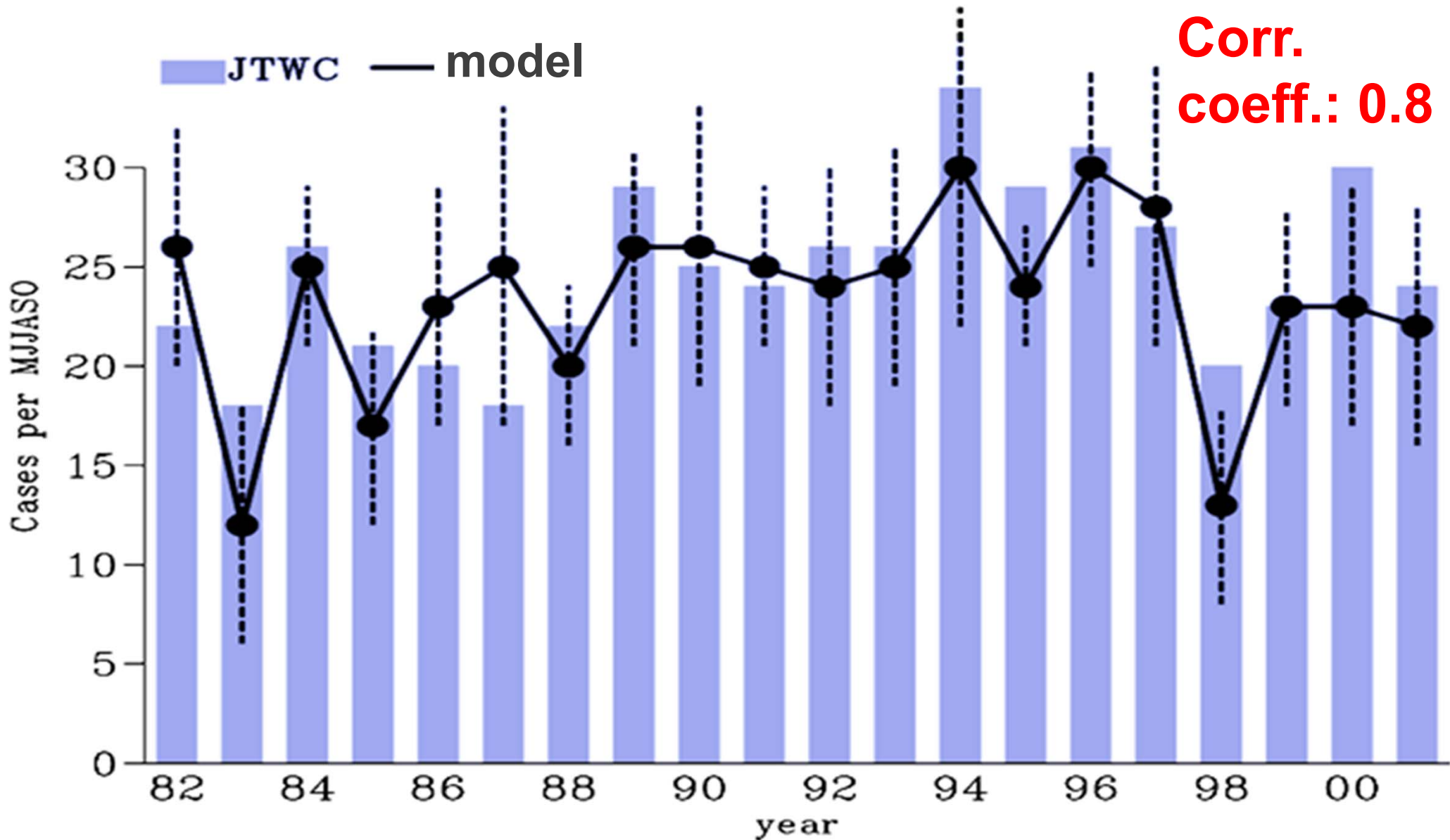
TC Climatology (1982-2001)



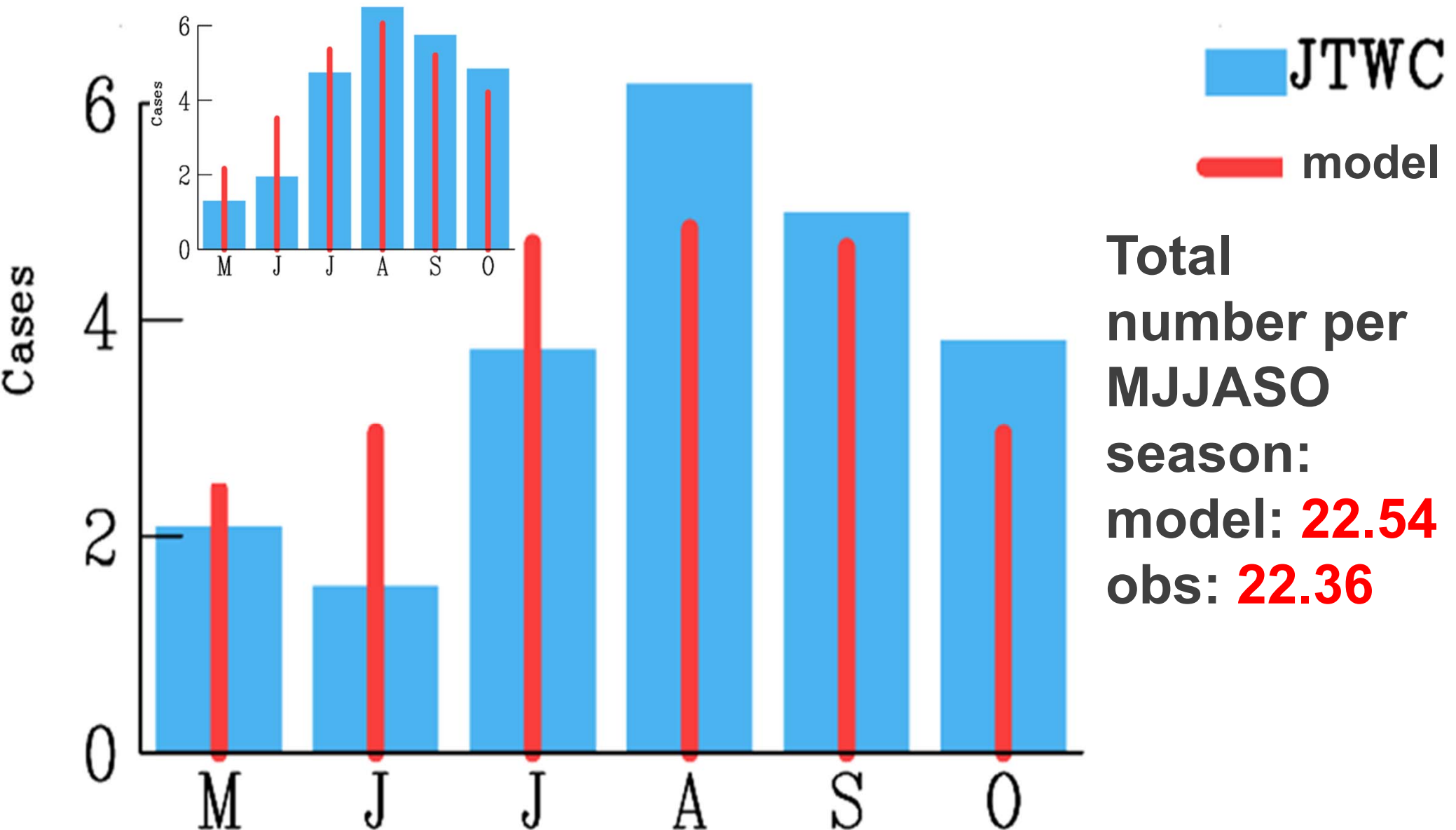
△ significant at the 95% confidence interval

Spatial correlation coefficient for (a) and (b) ~ 0.93; significant at the 95% confidence interval

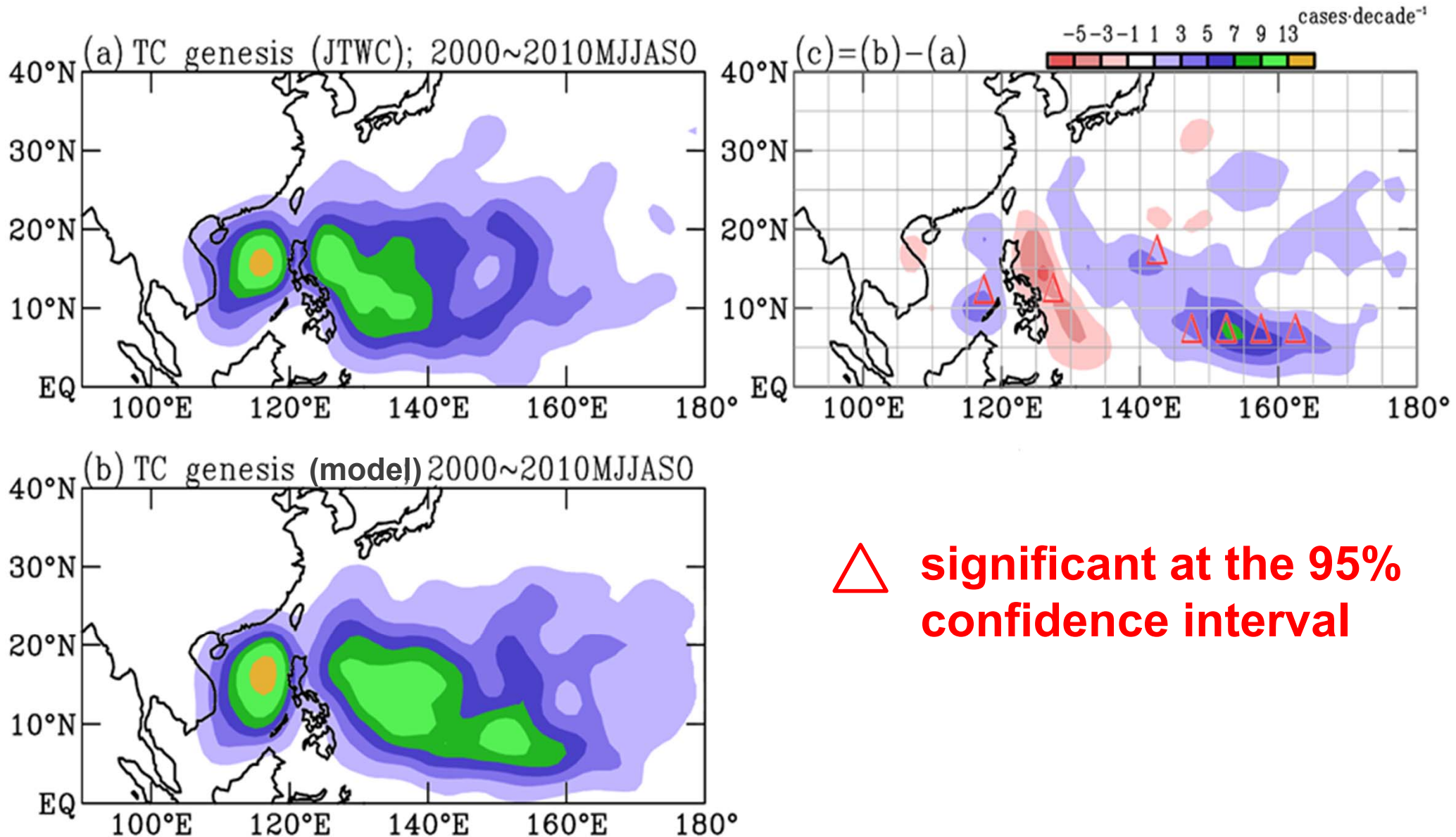
Interannual Variability (1982-2001)



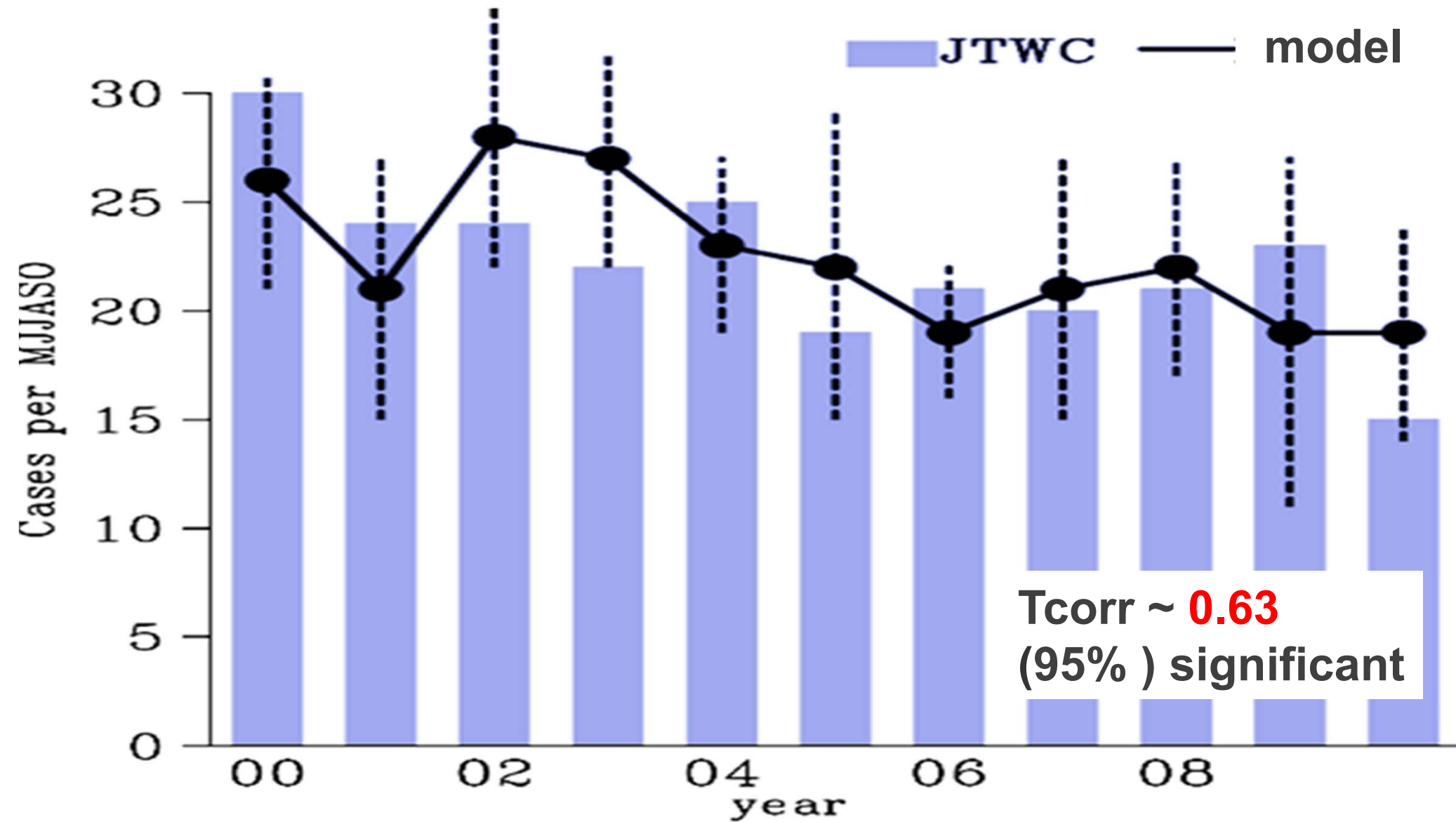
Hindcasts of TC numbers (2000-2010)



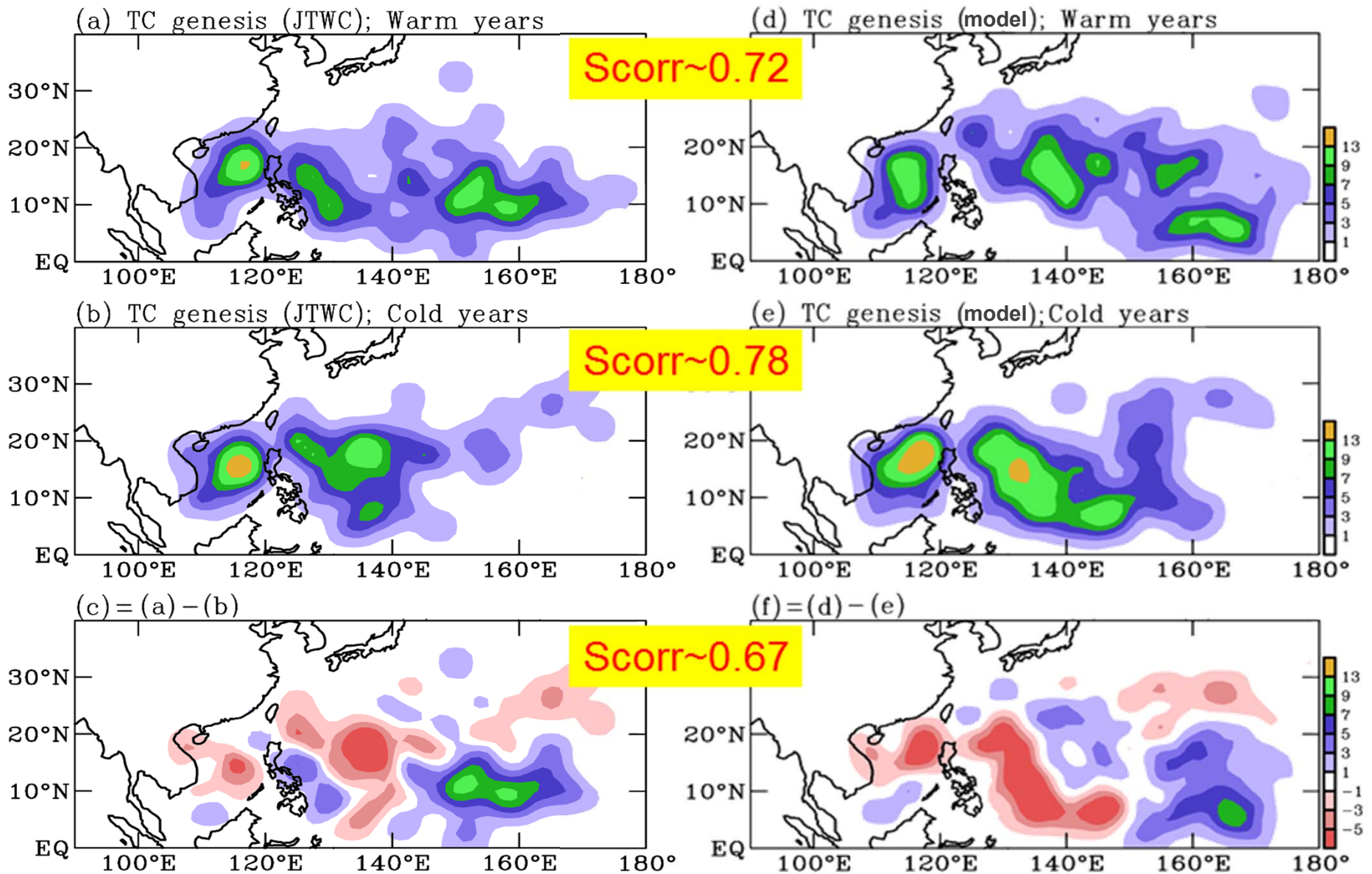
Hindcasts of Spatial Distribution (2000-2010)



Hindcasts - Interannual Variability (2000-2010)



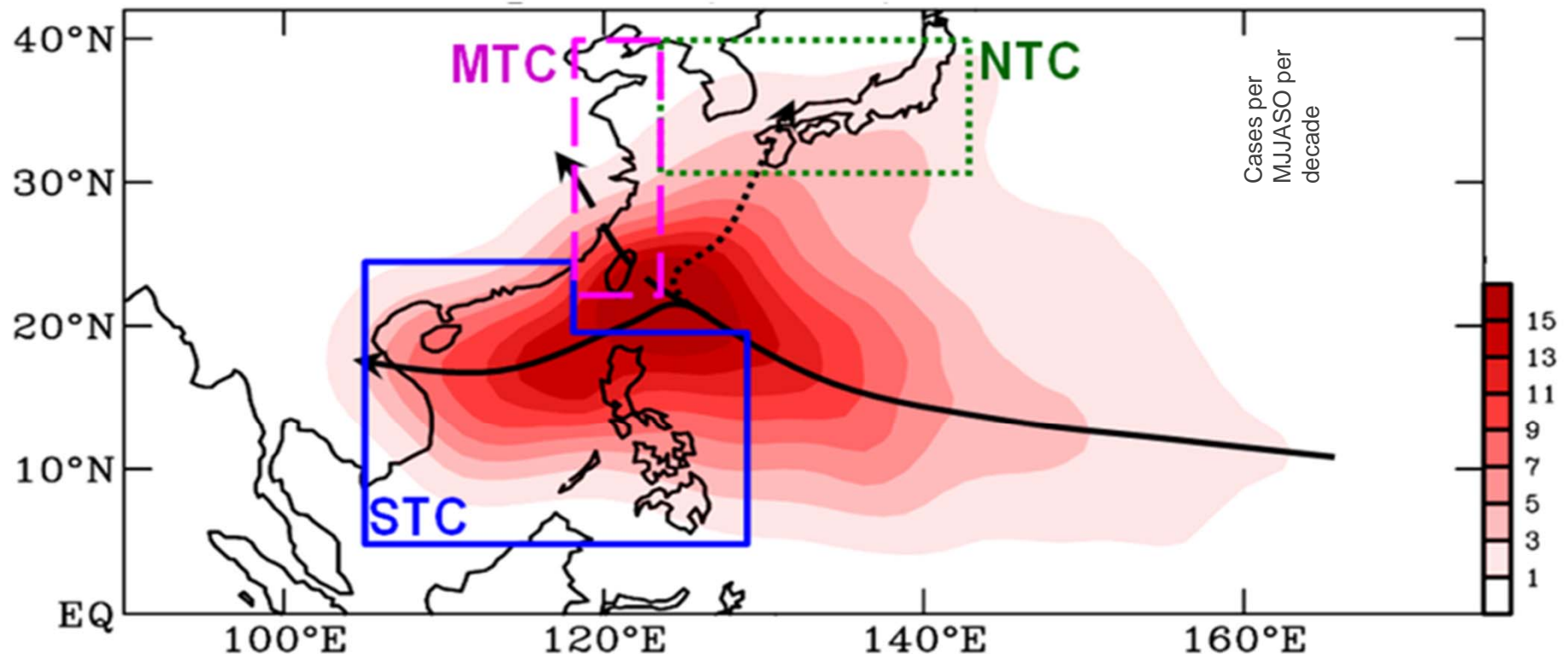
Hindcasts – Warm vs Cold Years



TC Landfall

Chan and Xu (2009)

(a) Climatology of percentage of TC occurrence



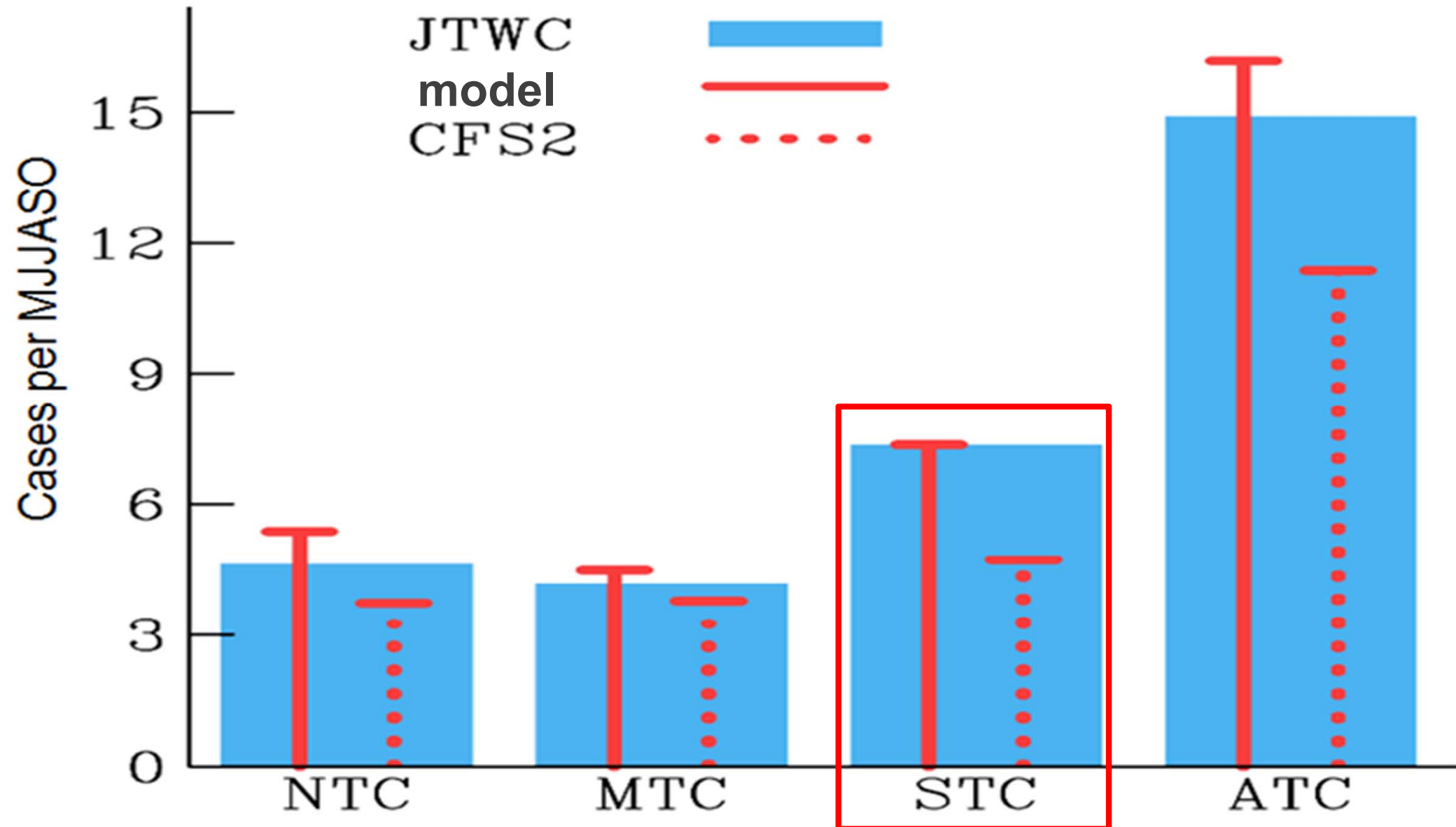
South TCs (STC) – TC landfall in South China, Vietnam and the Philippines

Middle TCs (MTC) – TC landfall in East China

North TCs (NTC) – TC landfall in the Korean peninsula and Japan

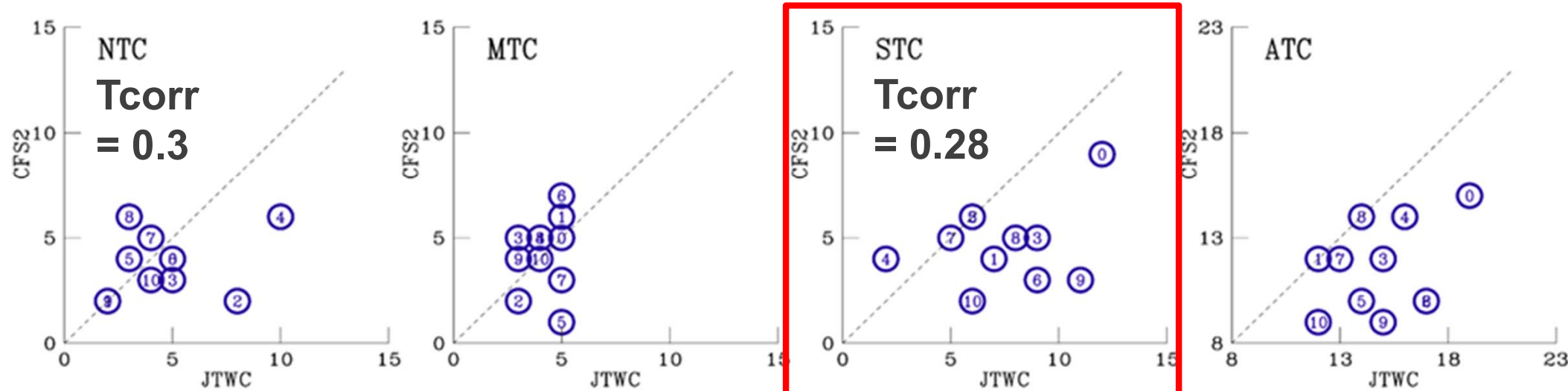
All TC (ATC) – the total number of landfalling TCs in Asia

Hindcasts of TC Landfall (2000-2010)

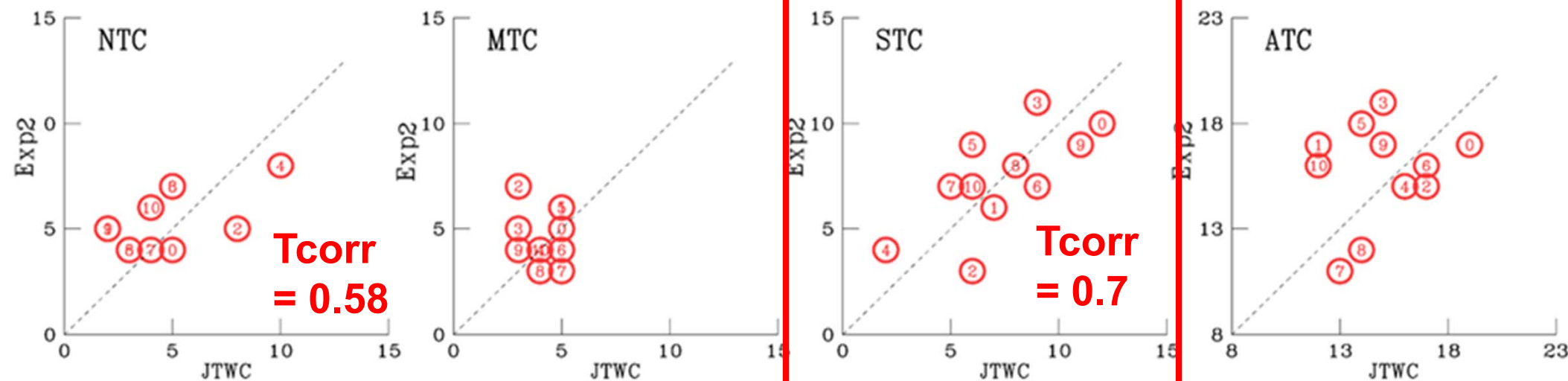


Hindcasts of TC Landfall (2000-2010)

(a) Landfalling TCs from JTWC and CFS2 (2000~2010 MJJAS0) **CFS2**



(b) Landfalling TCs from JTWC and model (2000~2010 MJJAS0) **model**



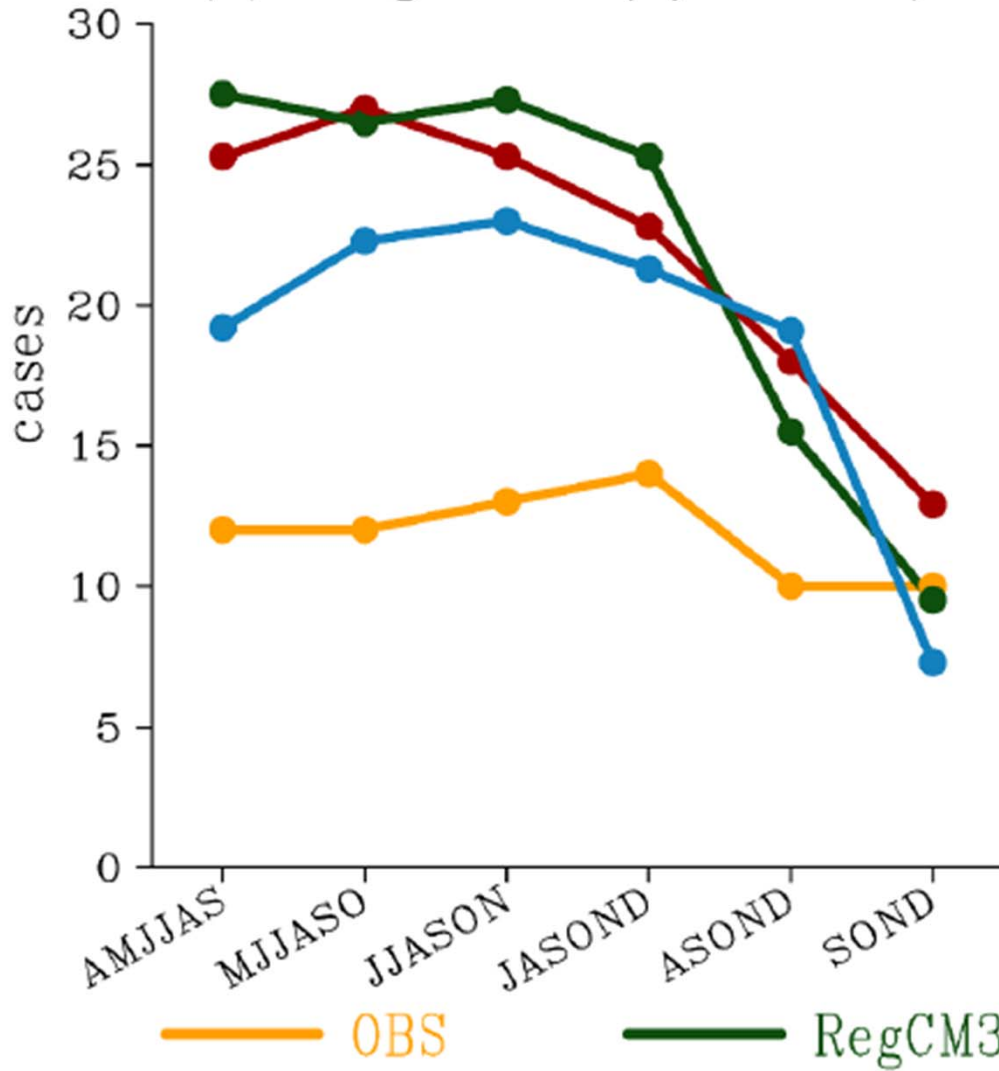
Hindcasts of TC Landfall (2000-2010)

$$S = \left(1 - \frac{\text{RMSE}_{\text{model}}}{\text{RMSE}_{\text{CFS2}}} \right) \times 100\%$$

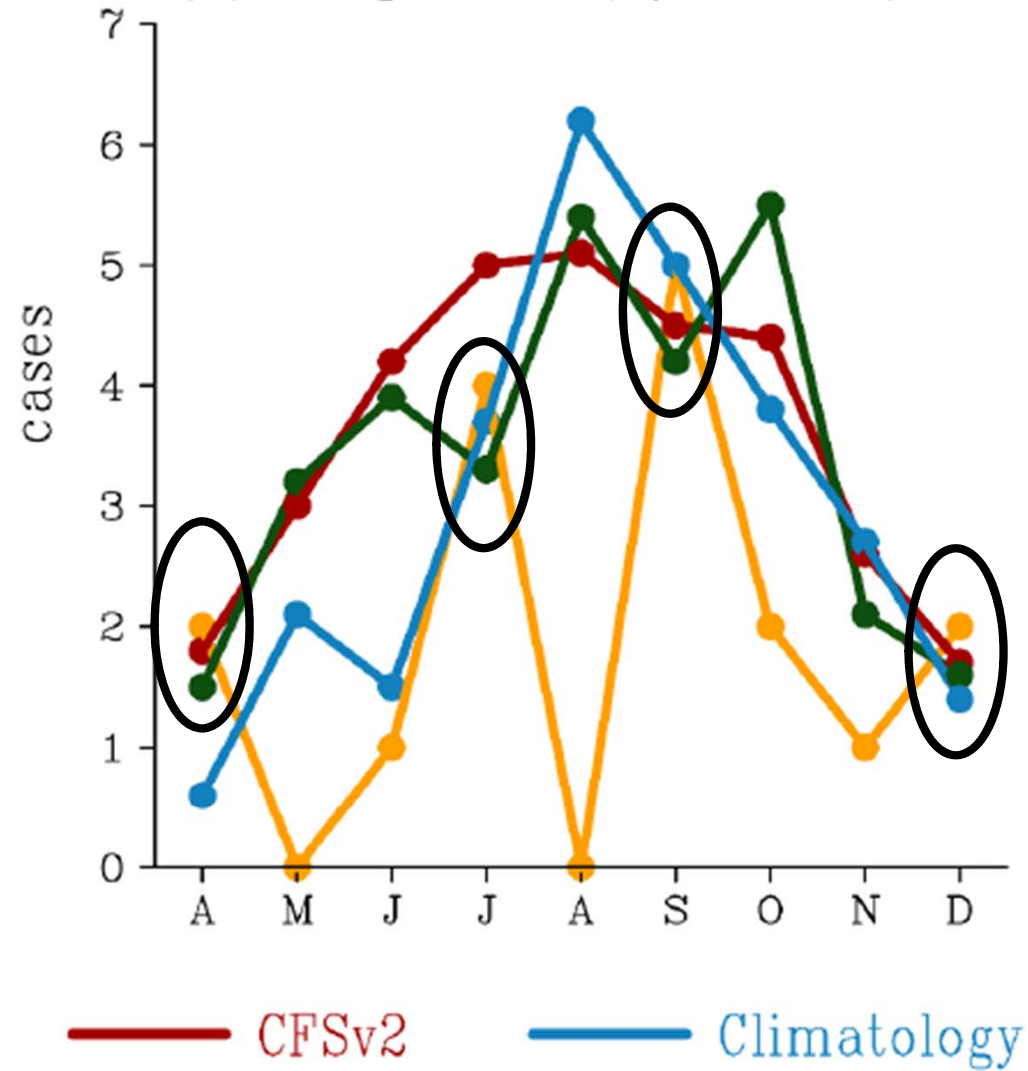
| Forecast skill Type of landfalling TCs | $S = \left(1 - \frac{\text{RMSE}_{\text{model}}}{\text{RMSE}_{\text{CFS2}}} \right) \times 100\%$ |
|---|--|
| NTC | 18.9% |
| MTC | 6.2% |
| STC | 48.0% |
| ATC | 11.7% |

2014 Forecasts and Verification

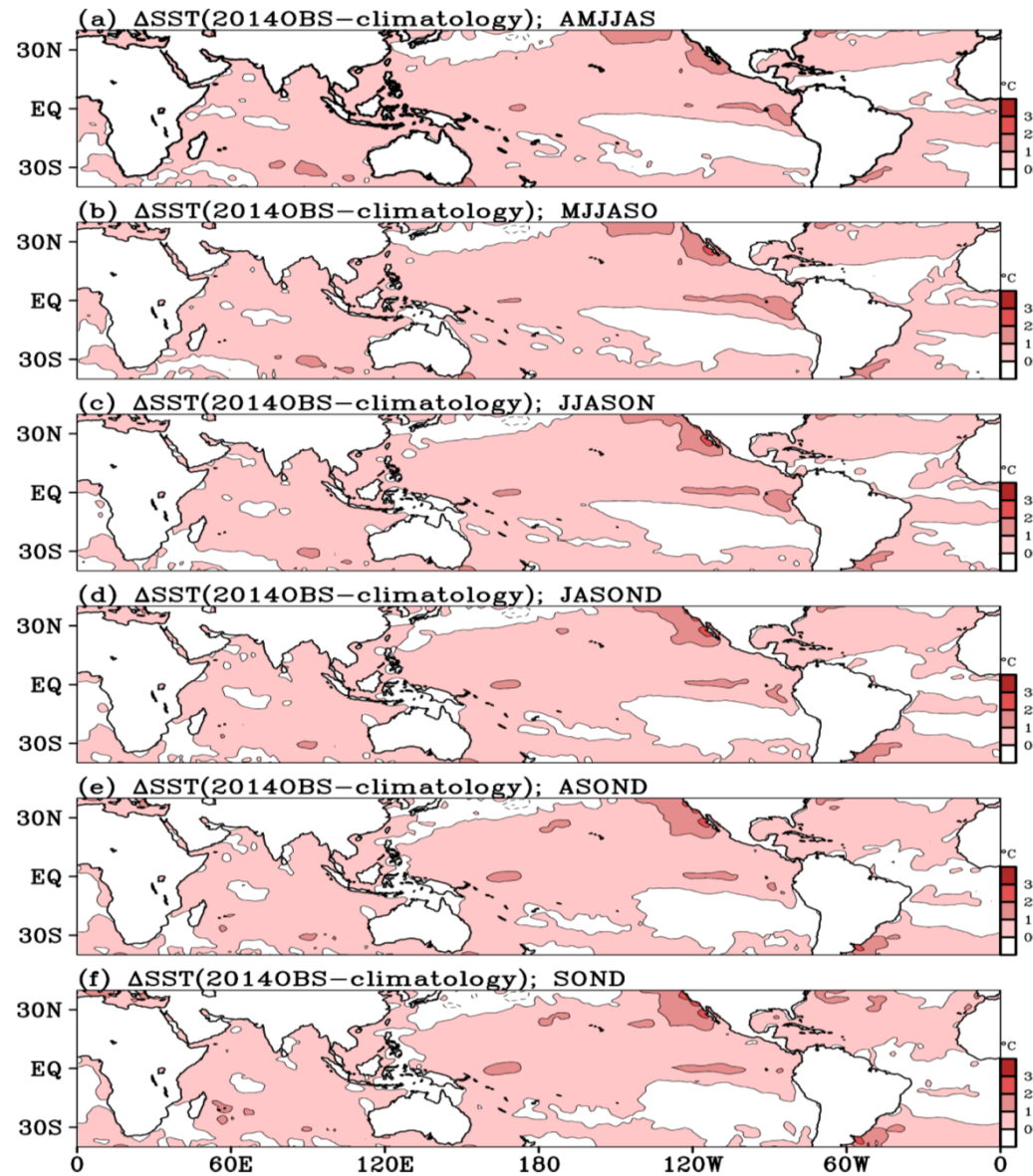
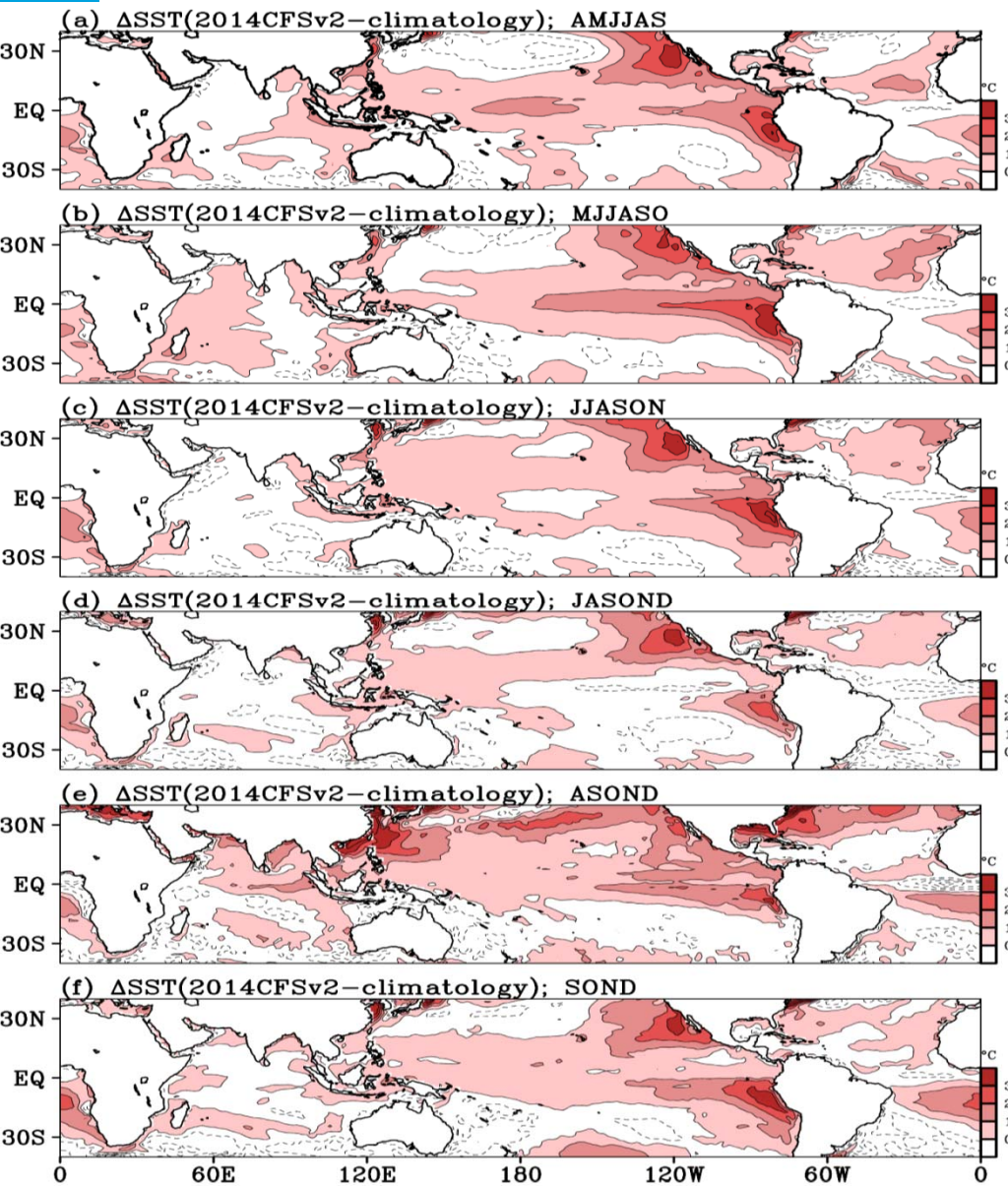
(a) TC genesis (by season)



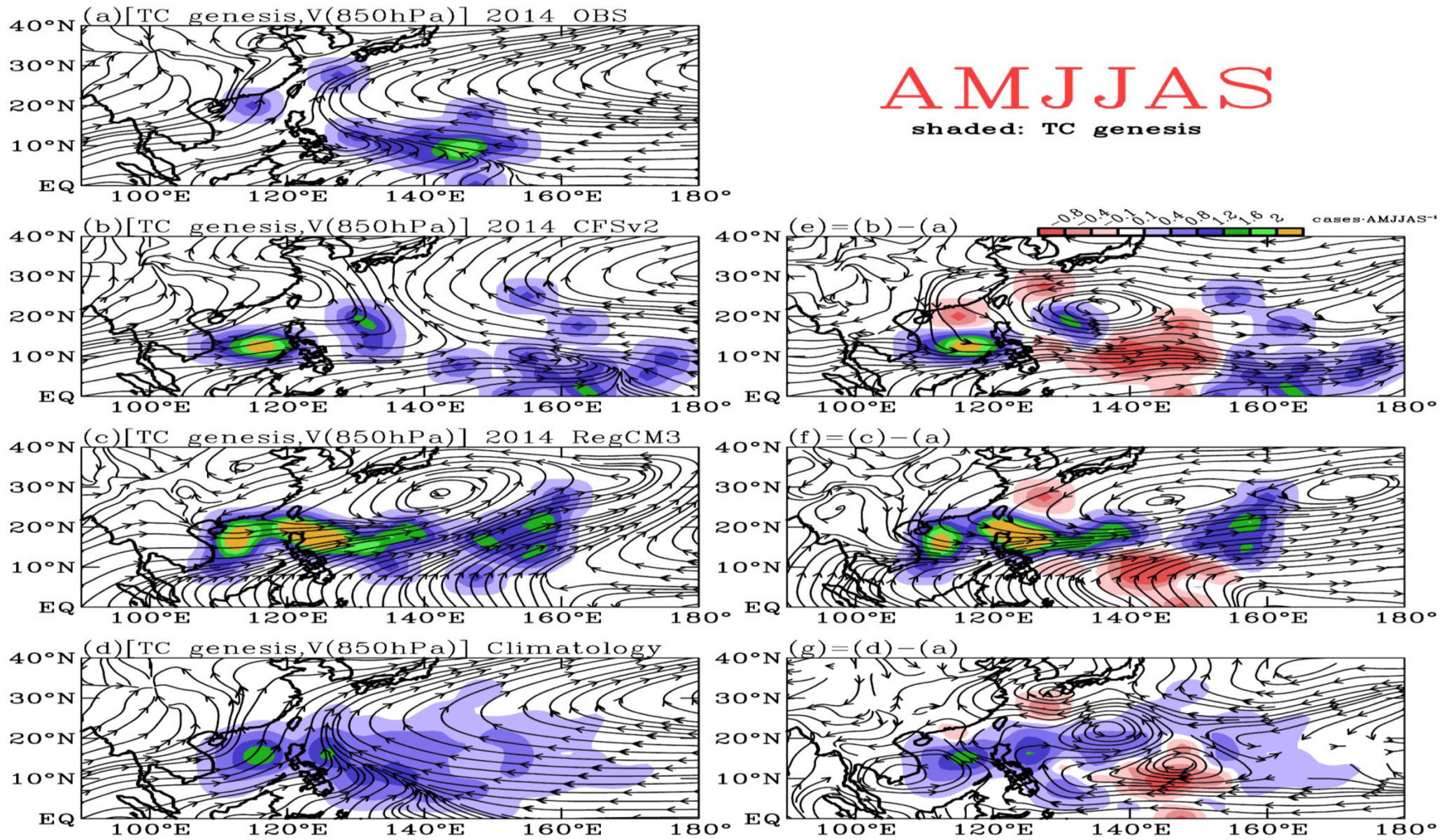
(b) TC genesis (by month)



2014 Forecasts and Verification (SSTA)

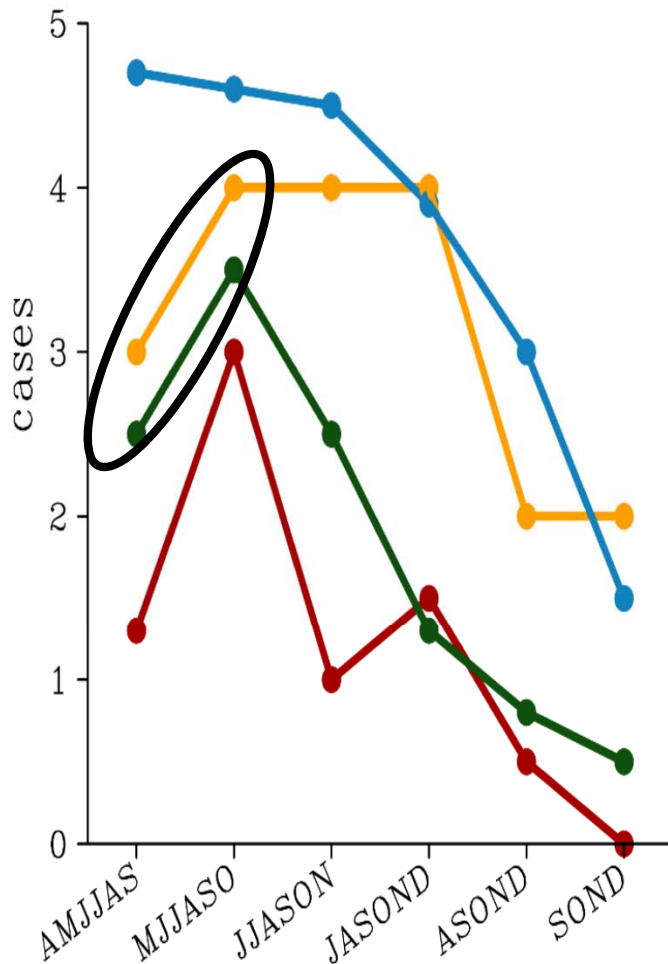


2014 Forecasts and Verification (850-hPa flow and genesis)

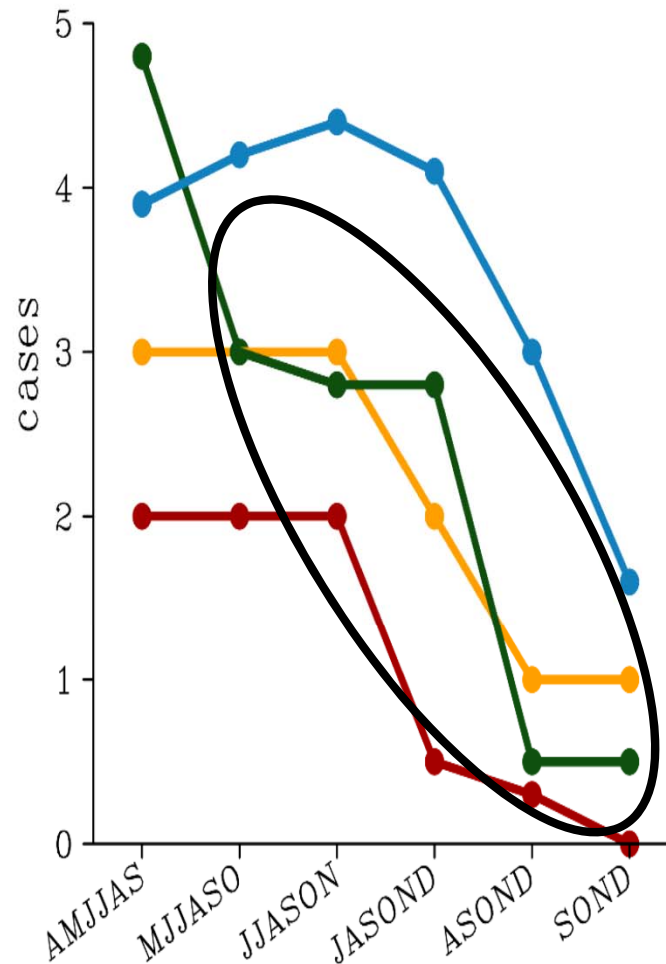


2014 Forecasts and Verification (Landfall)

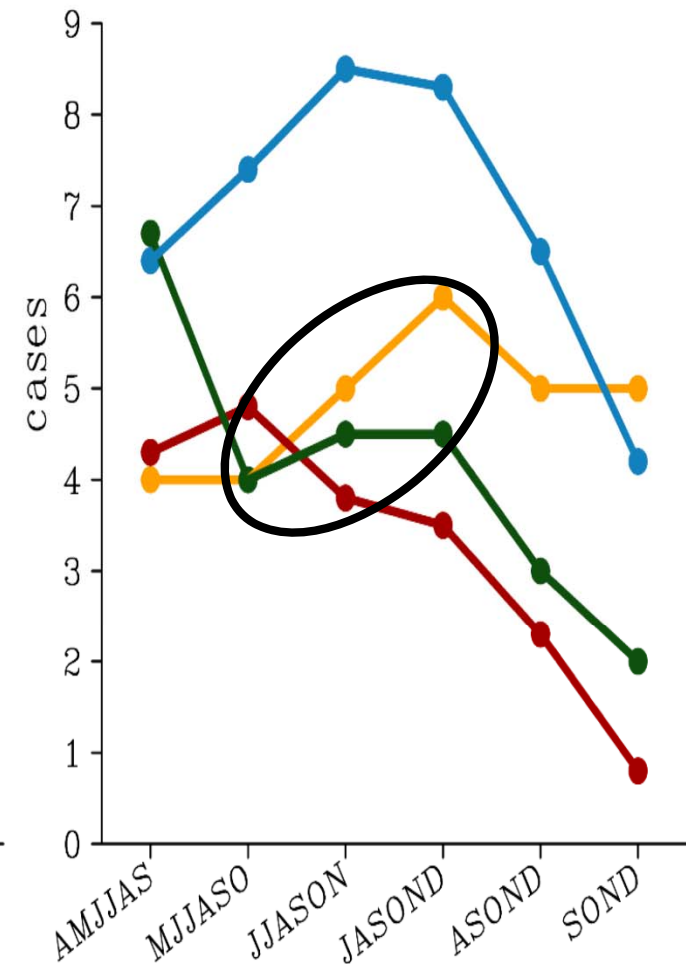
NTC landfall



MTC landfall



STC landfall



—●— OBS
 —●— RegCM3
 —●— CFSv2
 —●— Climatology

Summary

- Even with a 60-km resolution, RegCM3 is able to generate vortices with structures that resemble those of real tropical cyclones.
- The model is capable of reproducing the basic climatology and interannual variability of tropical cyclones in the western North Pacific.
- The model can produce good hindcasts of the number of TC landfall especially in the South China region.

Summary

- 2014 real-time forecasts and verifications suggest that the ability of the regional model to predict seasonal activity depends strongly on the ability of the global model to predict the large-scale atmospheric and ocean conditions
- Despite the relatively poor performance of the global model, the landfall predictions for the main TC season from the regional model are close to observations, which suggests the ability of the model to predict seasonal landfall frequency