Development of High-resolution Taiwan Earth System Model (TaiESM)

Wei-Liang Lee[1], Huang-Hsiung Hsu[1], Yi-Ying Chen[1], Yi-Chun Tsai[1], Chein-Jung Shiu[1], Yi-Chi Wang[2], Hsin-Chien Liang[1], Li-Peng Hsiao[1], Cheng-Wei Lin[1], Ya-Hui Chang[1], Yu-Luen Chen[1], Li-Chiang Chiang[1], Chien-Ying Wu[1], Wen-Ming Chang,[1], and Chieh-Ting Tsai[3]

[1]*Research Center for Environmental Changes, Academia Sinica*

[2]*Swedish Meteorological and Hydrological Institute*

[3]*International Degree Program in Climate Change and Sustainable Development, National Taiwan University*

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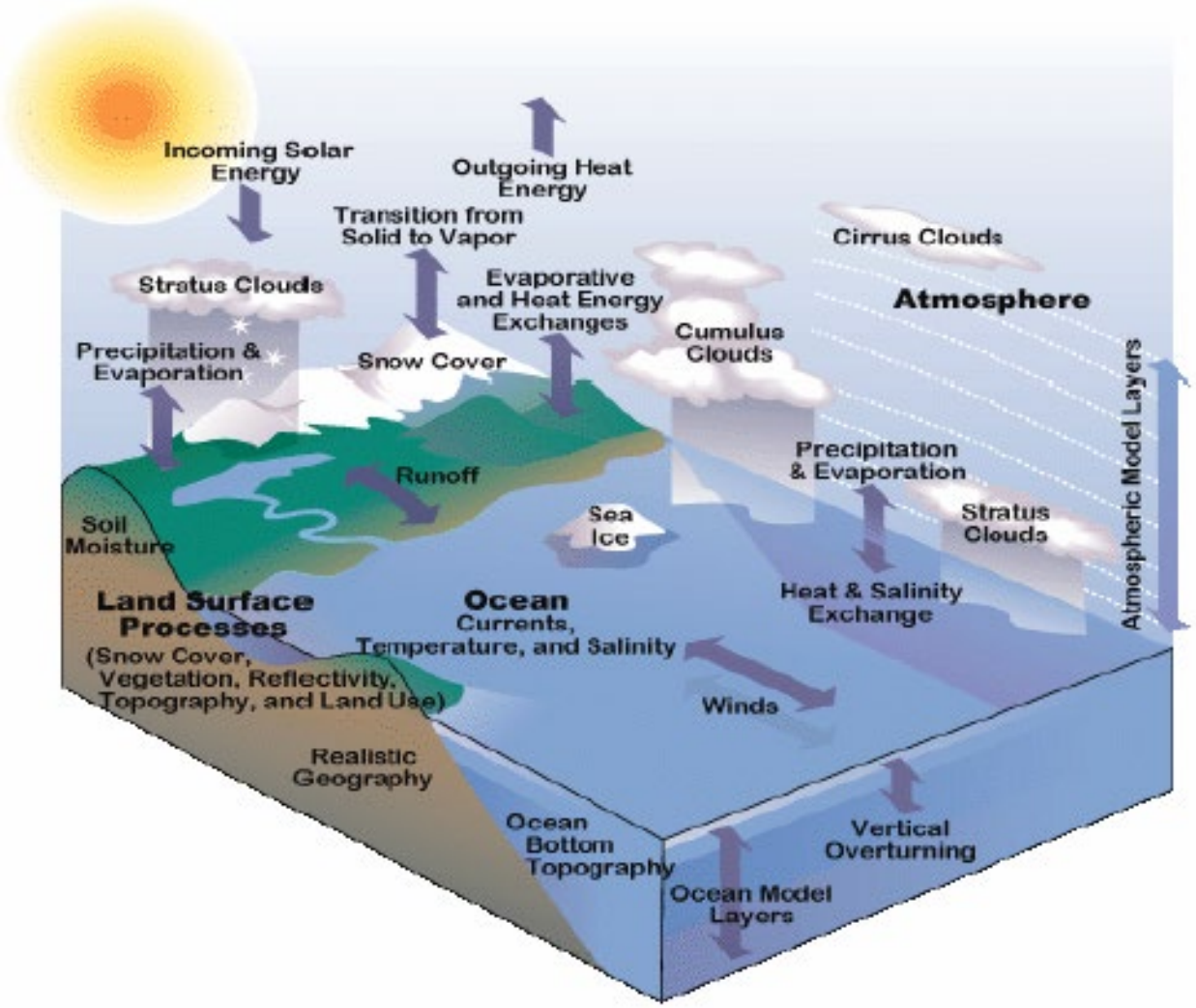
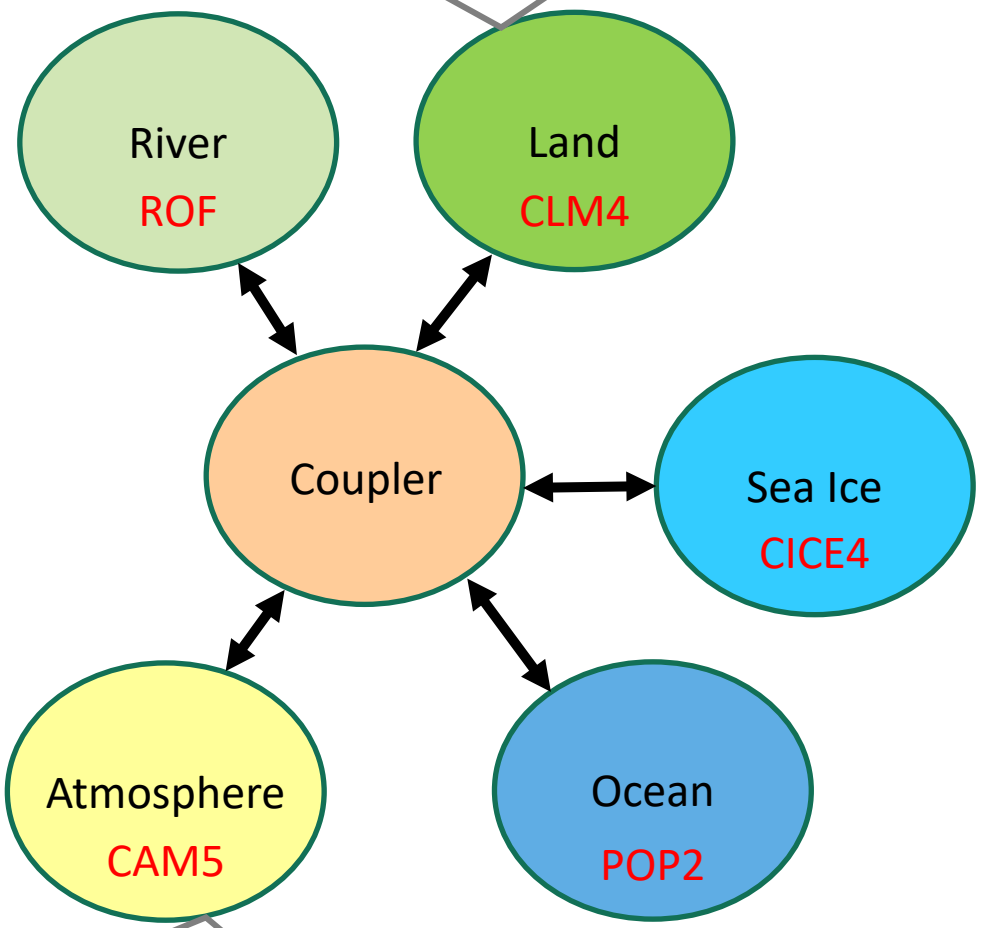
Structure of TaiESM1 – based on CESM1.2

Goal: To improve the ability to simulate climate variability



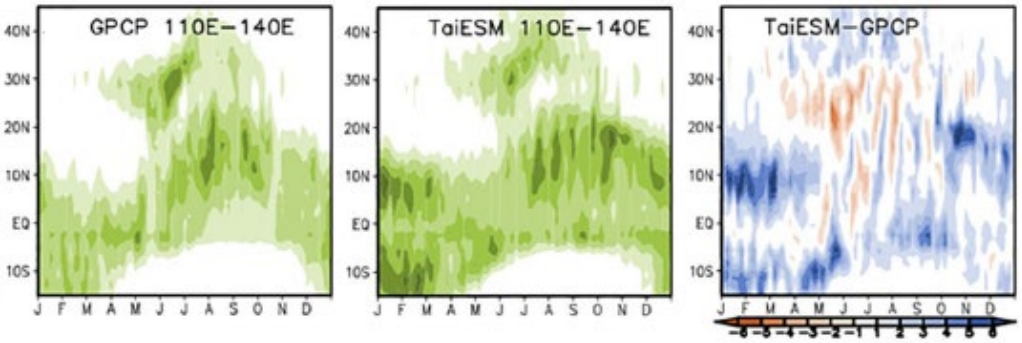
- 3D radiation-topography interactions

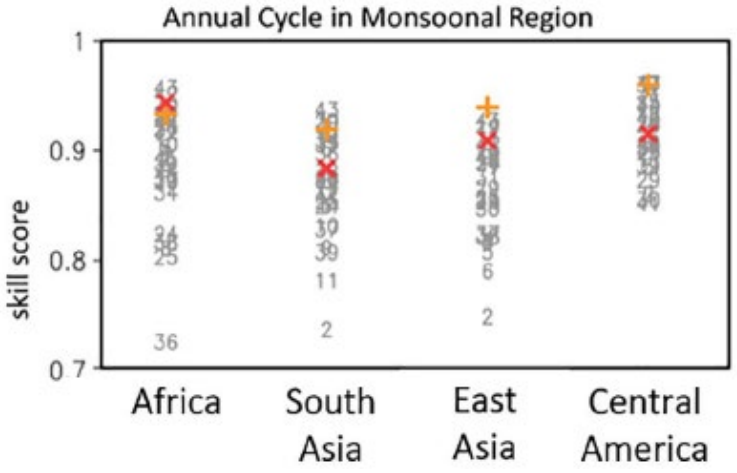


- Trigger functions for deep convection
- GTS cloud fraction
- SNAP, a prognostic 3-moment aerosol scheme

Features of TaiESM1: Climate Variability and Extremes

Monsoon Rainfall

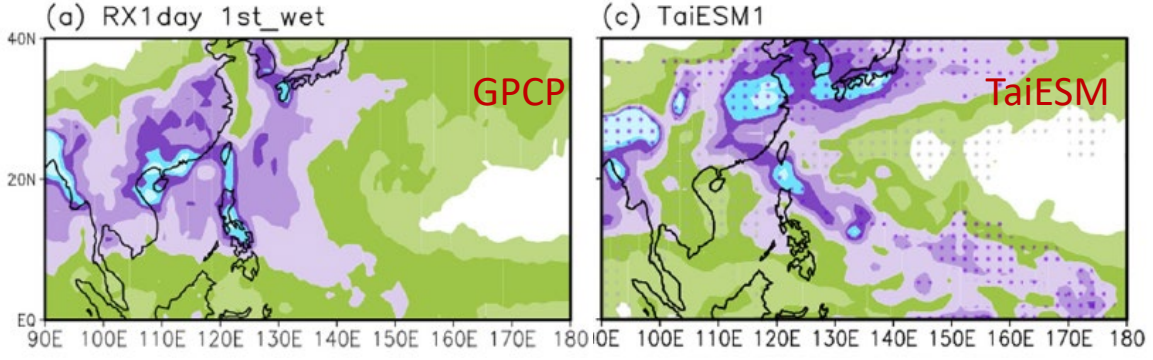




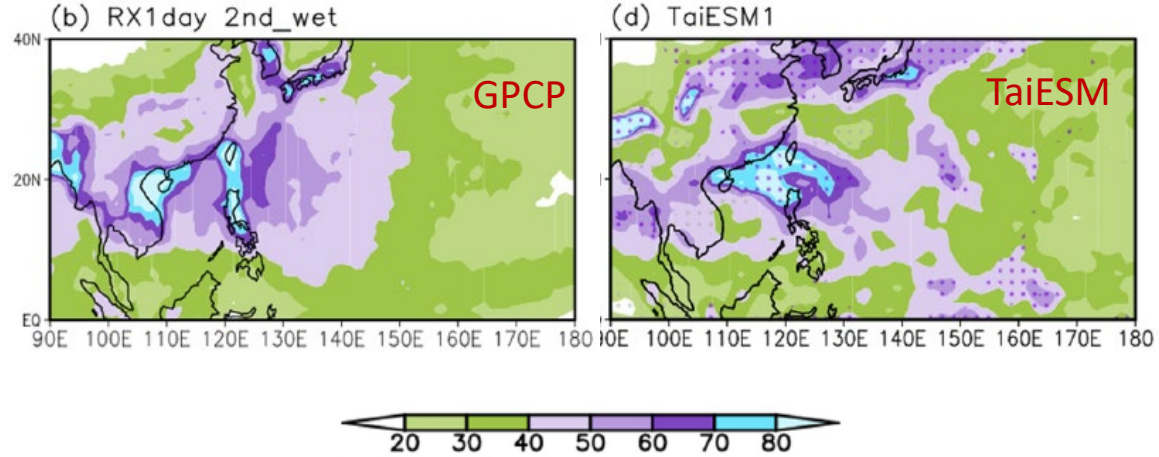
+ CMIP6 Ensemble mean

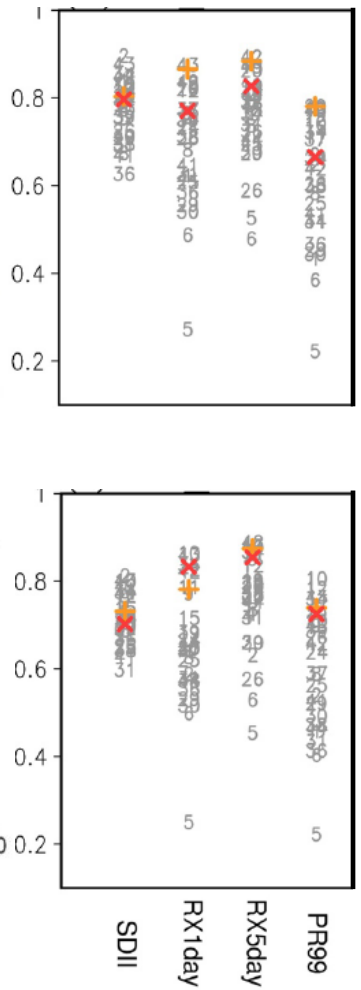
× TaiESM1

Mei-yu Season



Typhoon Season

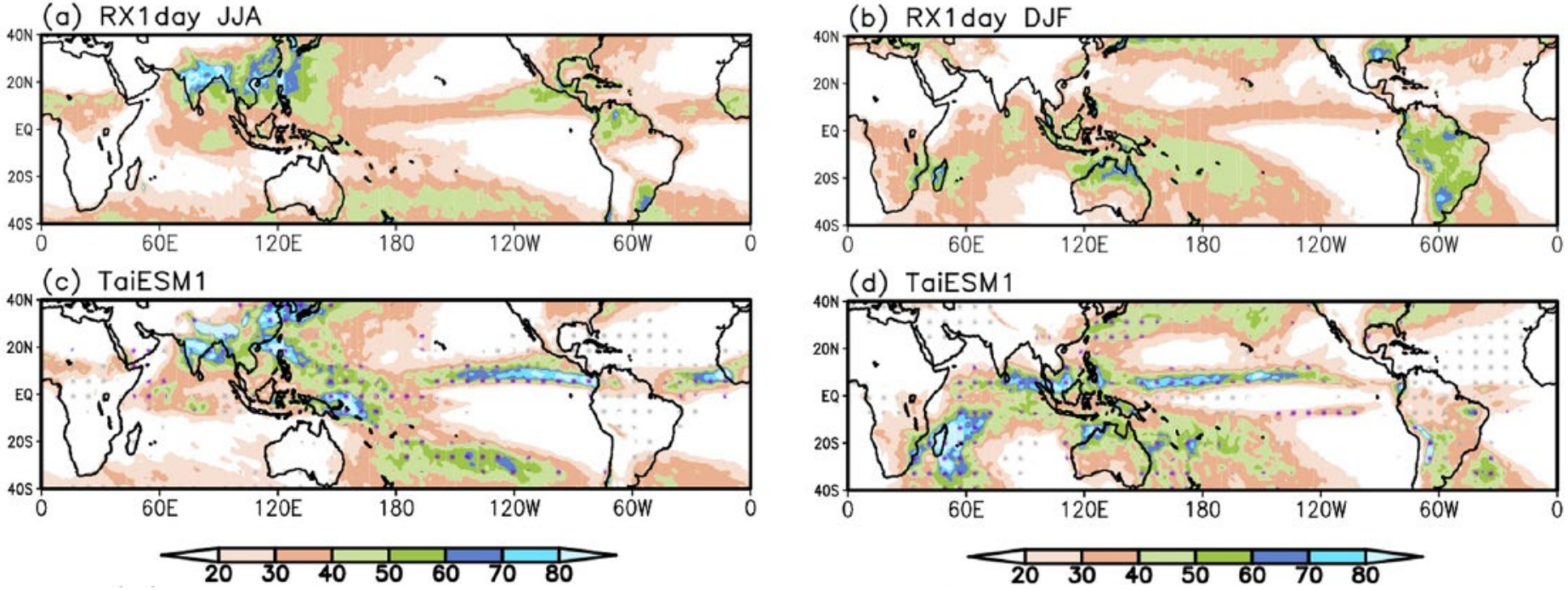


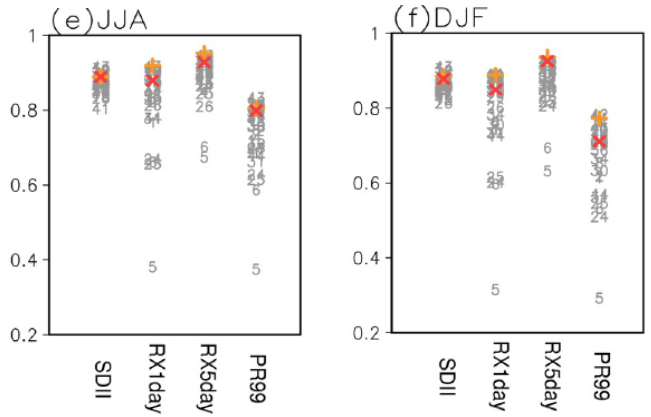


Indexes of precip. intensity

Features of TaiESM1: Climate Variability and Extremes

Extreme Precipitation





+ CMIP6 Ensemble mean

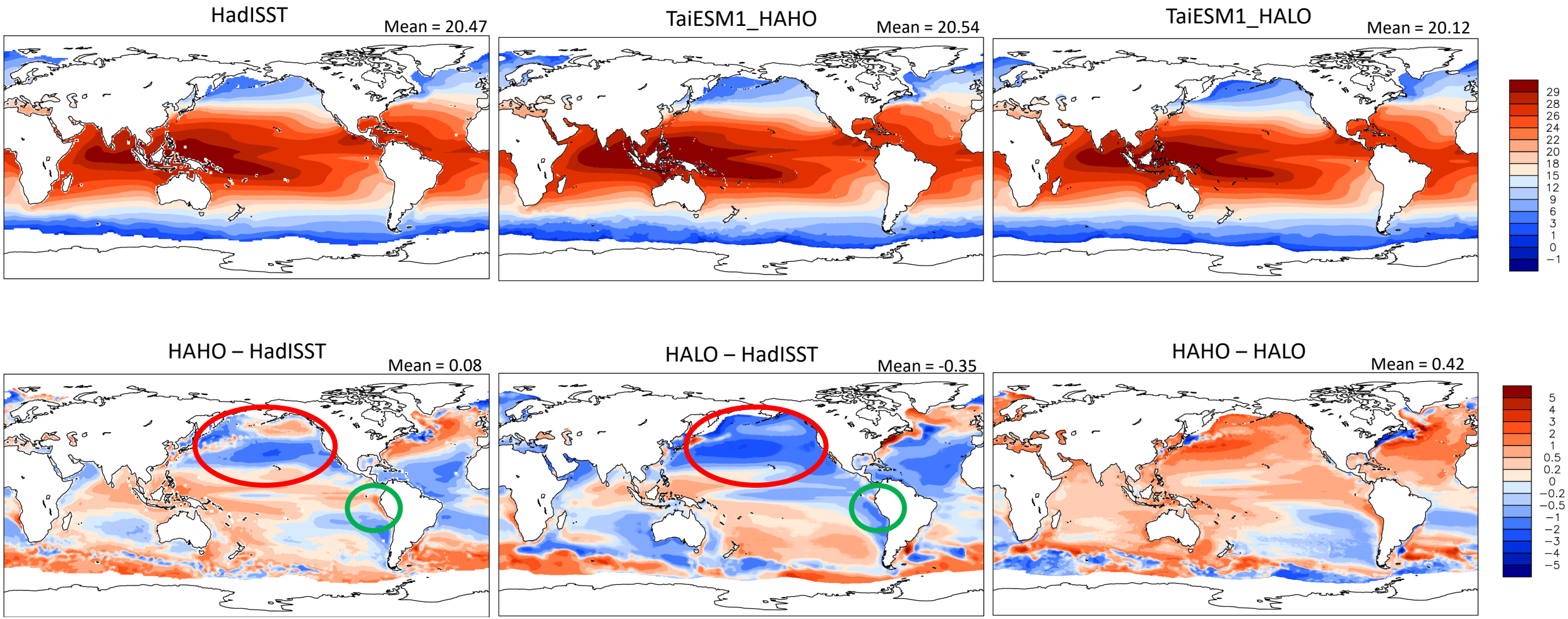
× TaiESM1

TaiESM1 Experiments

- TaiESM1-LR: 100 km for ATM & OCN, historical run (1985-2014)
- TaiESM1-HA (AMIP): 25 km for ATM with prescribed-SST of Year 2000, using years 4-33
- TaiESM1-HALO (HALO): 25 km for ATM & 100 km for OCN of Year 2000, using years 17-46
- TaiESM1-HAHO (HAHO): 25 km for ATM & 10 km for OCN of Year 2000, using years 20-49
- OBS: Means of 1985-2014

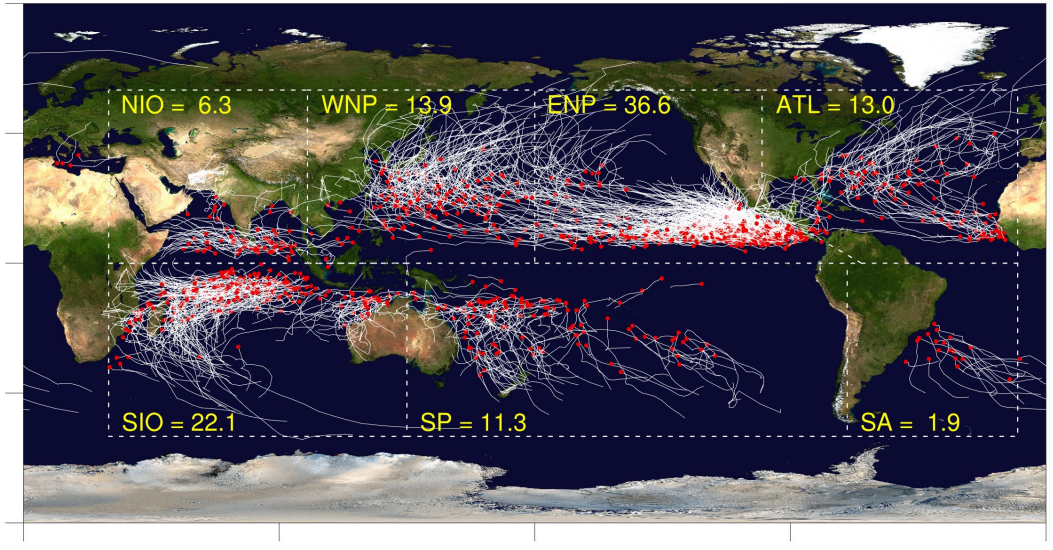
Variables	OBS	TaiESM1-LR	AMIP	HALO	HAHO
RESTOM	0.810	0.910	2.325	0.258	0.377
RESSURF	~ 0.8	0.870	2.322	0.253	0.38
CLD_HGH	-	44.854	44.877	43.174	43.344
CLD_LOW	-	41.863	40.725	40.848	40.140
CLD_MED	-	28.793	24.614	24.328	23.885
CLD_TOT	66.824	69.503	69.098	68.15	67.762
FLNT	239.669	240.607	240.761	241.791	242.961
FSNT	240.478	240.698	243.086	242.049	243.337
ICE_AREA	-	21.579	19.309	20.272	19.059
LHFLX	82.367	90.807	90.689	88.64	89.964
LWCF	26.063	21.767	19.129	18.634	18.613
PRECT	2.674	3.106	3.095	3.026	3.073
SHFLX	19.372	19.525	20.429	21.629	21.502
SWCF	-47.146	-45.813	-44.155	-43.746	-43.34
TREFHT	287.605	287.098	287.105	287.002	287.635

TaiESM1-HR: SST

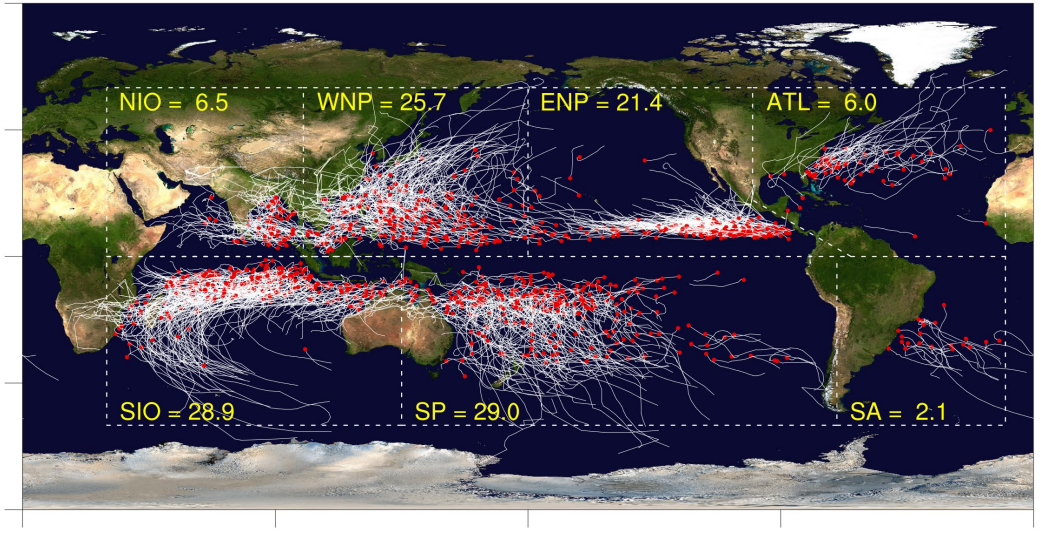


More Realistic TC in Coupled TaiESM1-HR in the Pacific

TaiESM1_HA



TaiESM1_HALO



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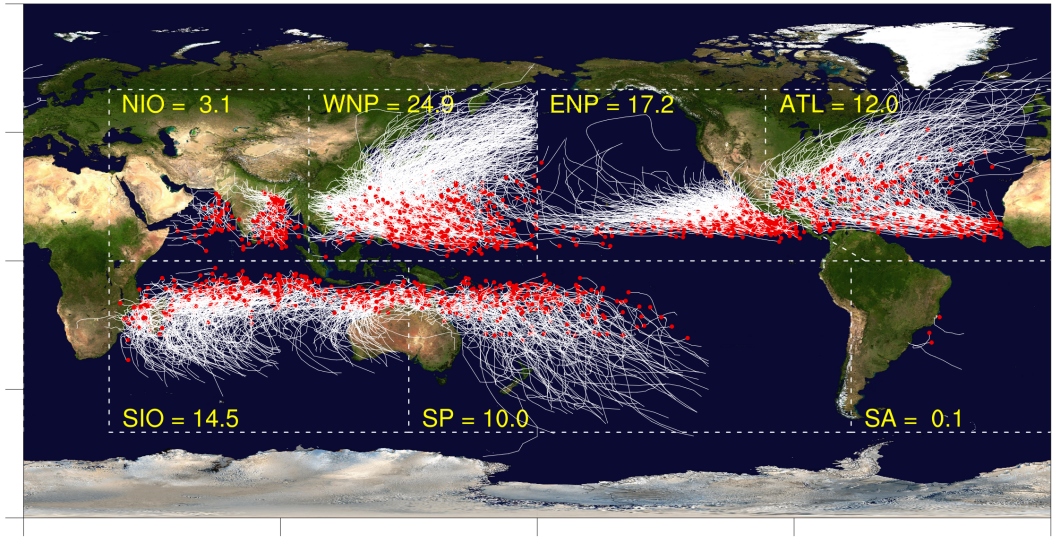
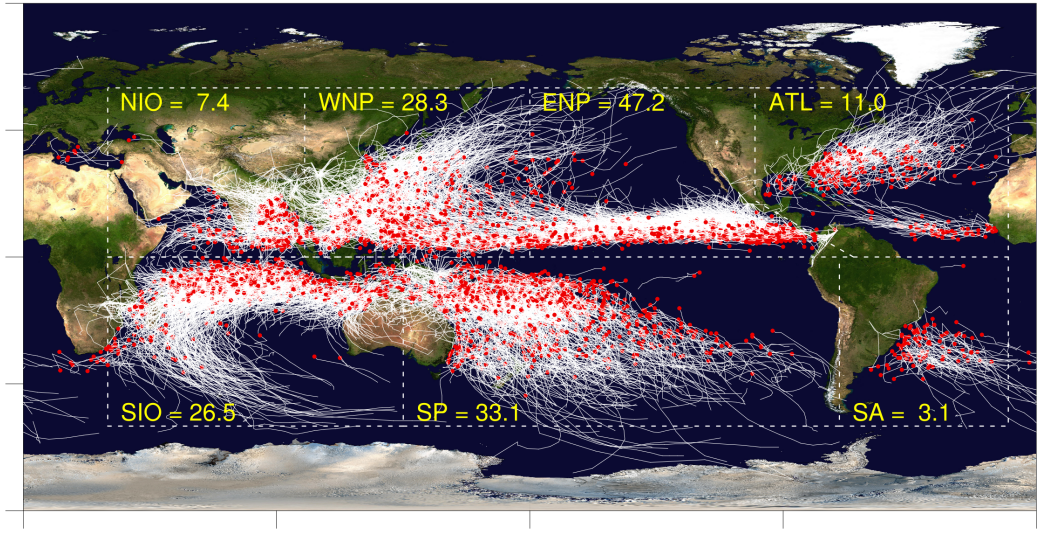
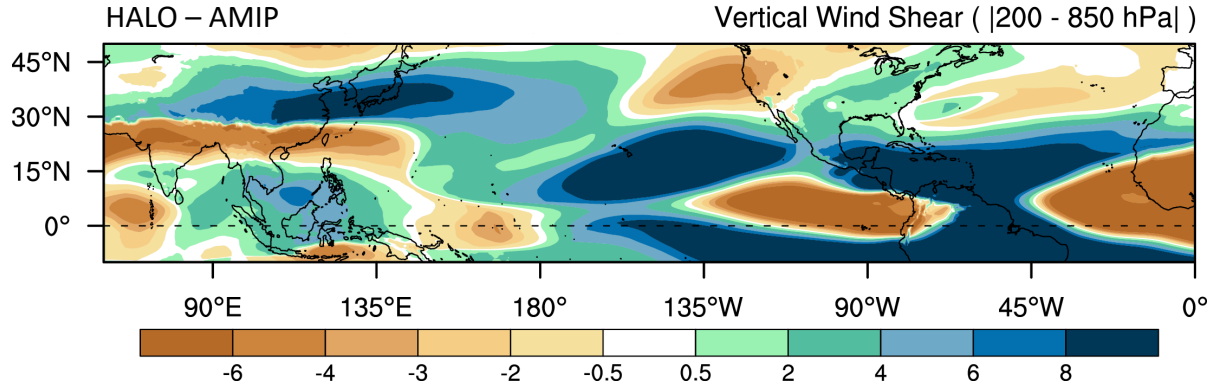
1985-2014

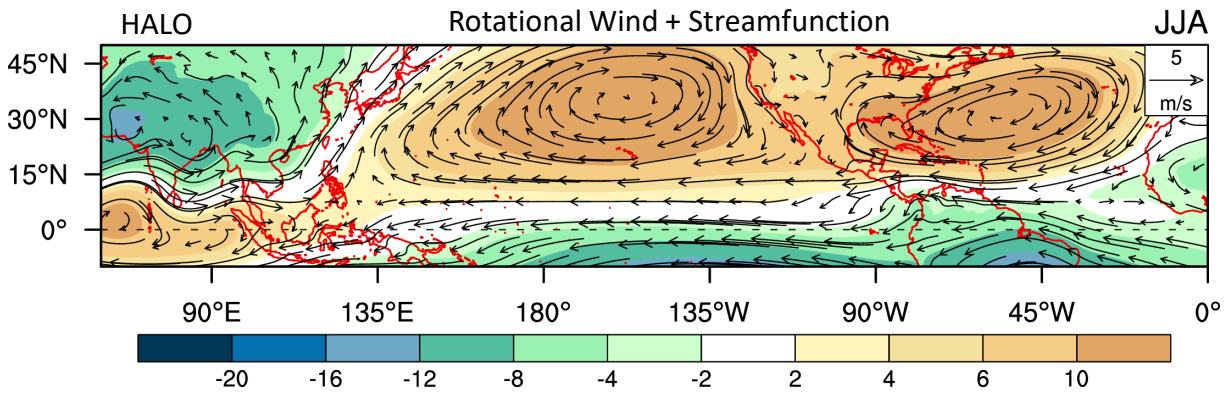


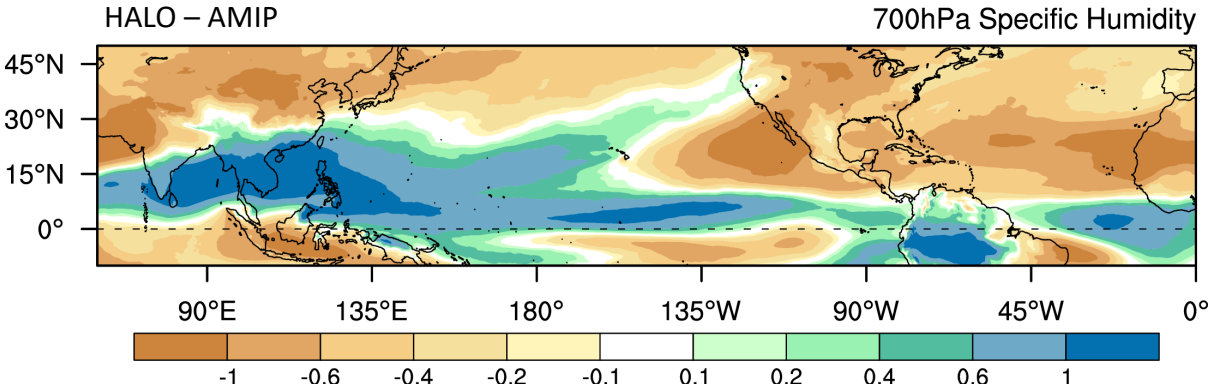
TaiESM1_HAHO

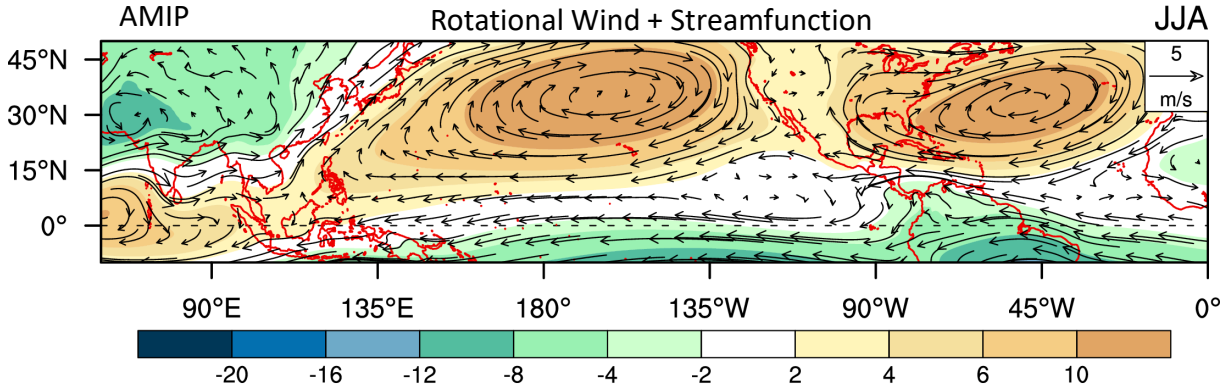


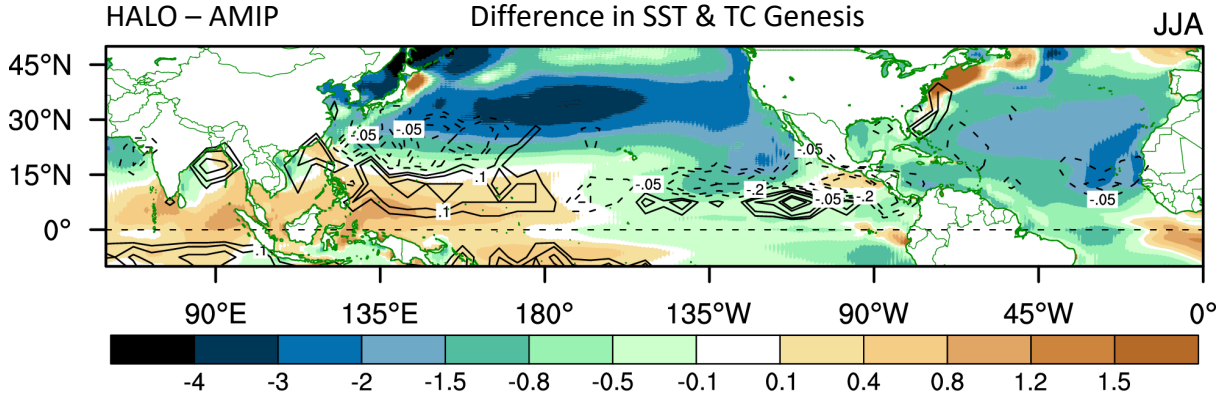
How Coupling Changes TC number in the Pacific?

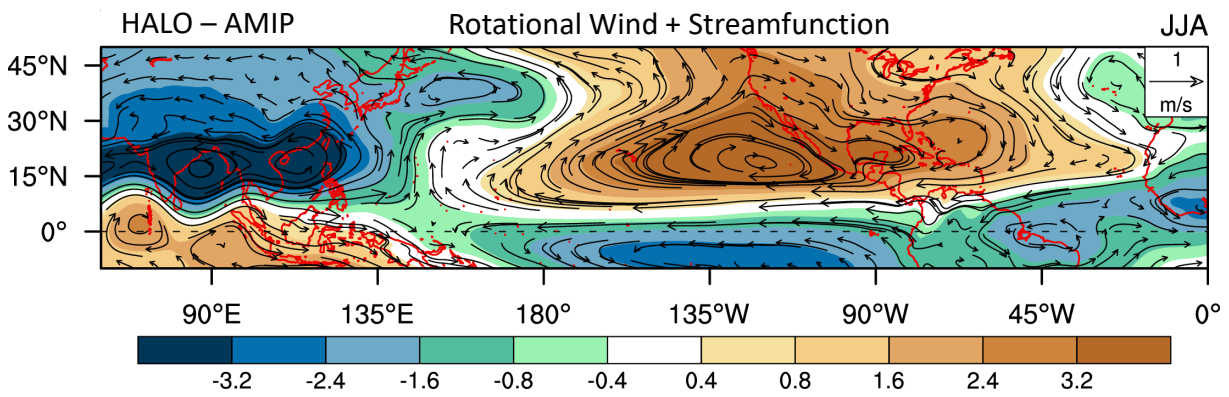




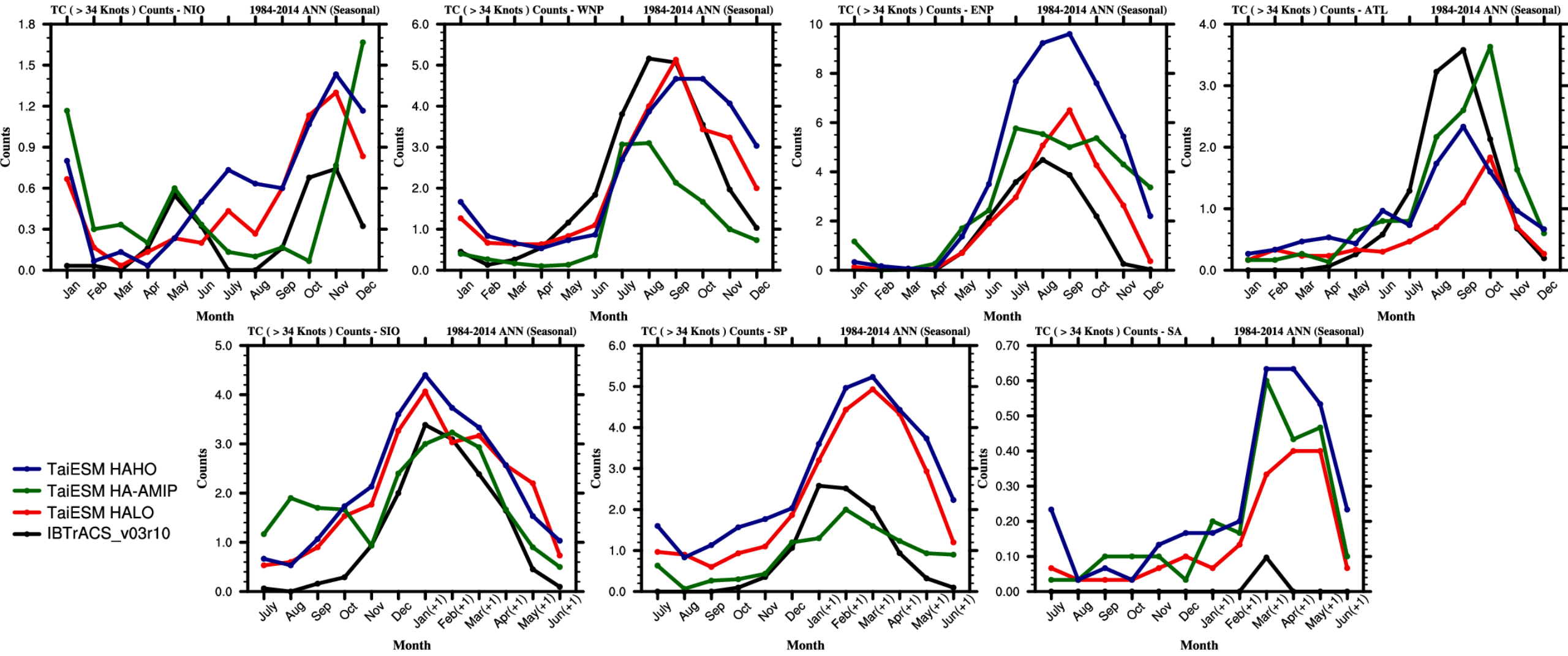




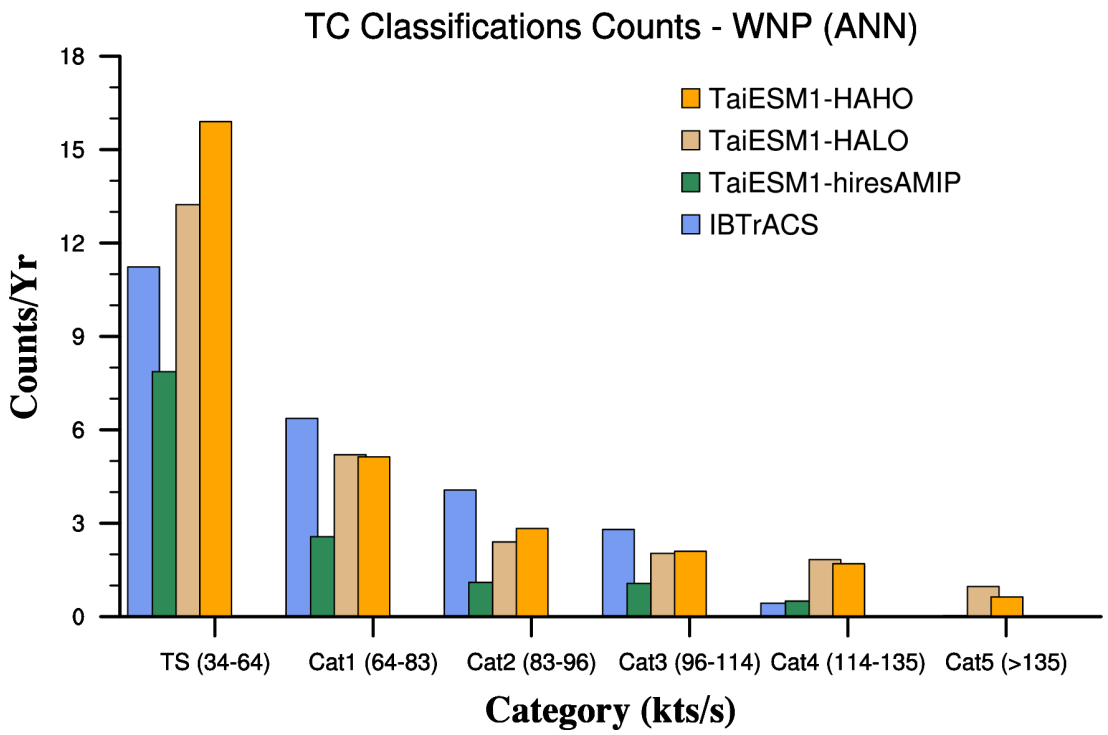


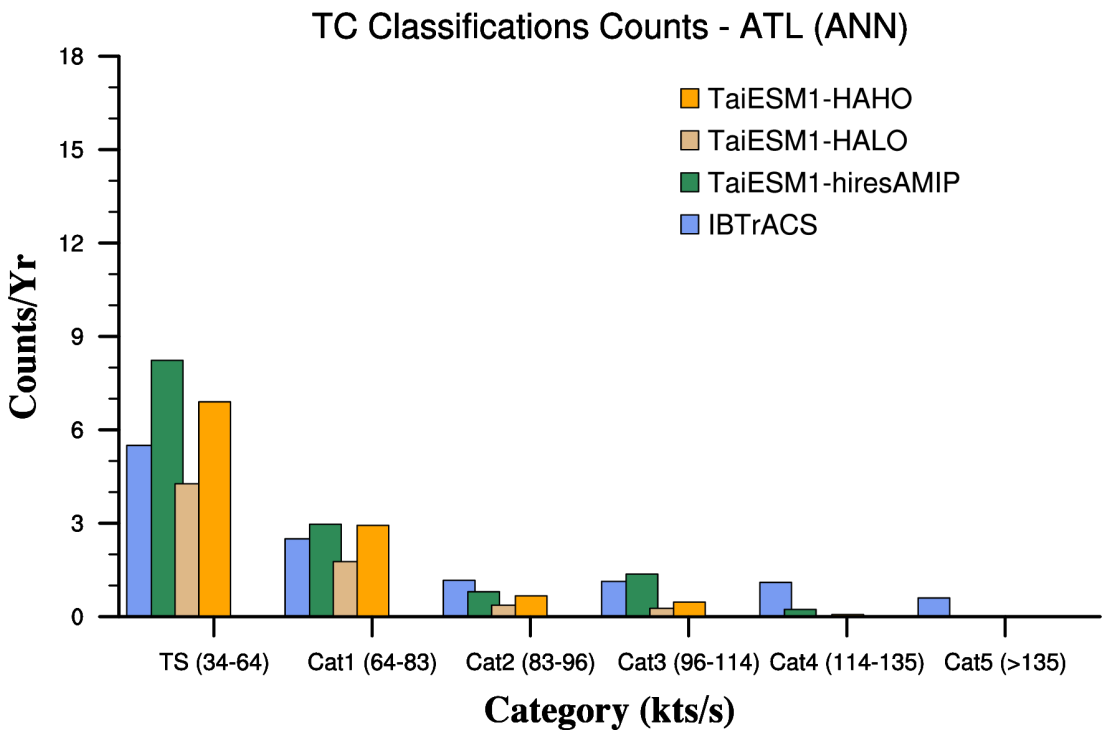


TaiESM1-HR: Annual Cycle of TC Numbers



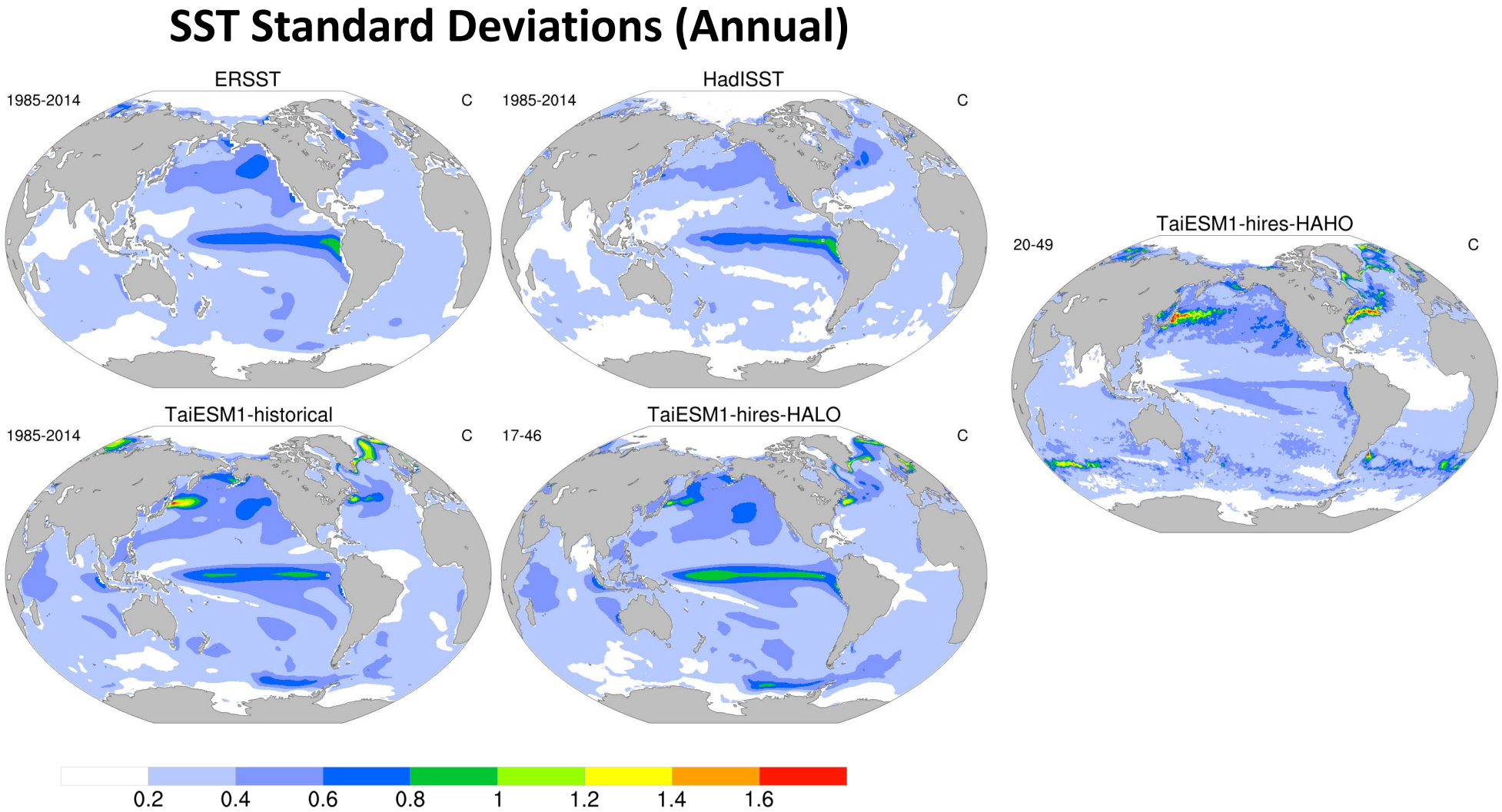
TaiESM1-HR: TC Intensity



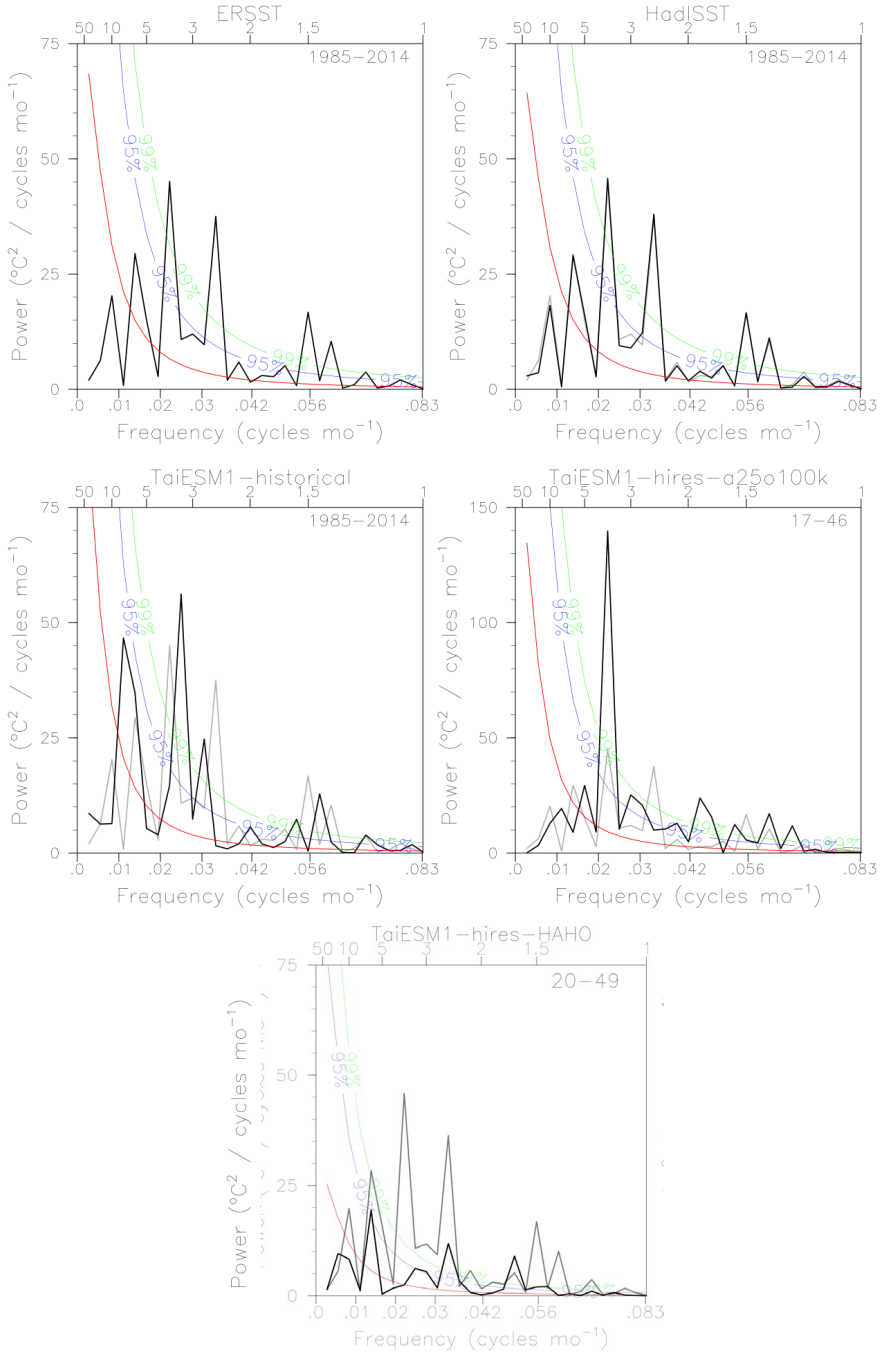


- Too many weak TCs in HAHO
- Too many TCs in winter in HAHO
- Algorithms for detecting and tracking TCs may require adjustment.

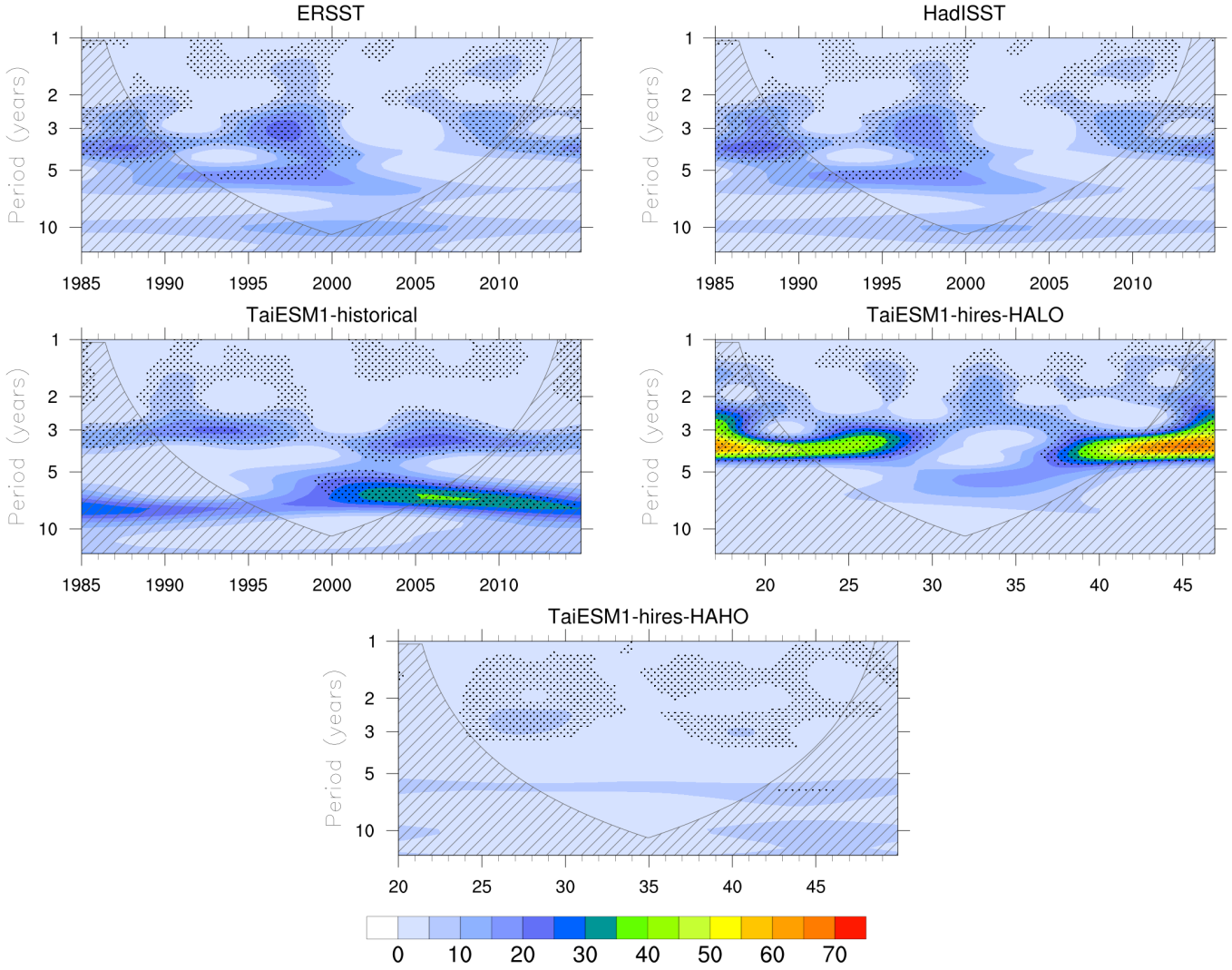
TaiESM1-HR: ENSO



Niño3.4 (Monthly, detrended)



Niño3.4 Wavelet (Monthly)



Summary: TaiESM1-HR

- TaiESM1-HALO (25 km ATM & 100 km OCN) outperforms TaiESM1-HR-AMIP & TaiESM1-LR in terms of TC in the North Pacific, but TCs are too few in the Atlantic, probably due to the simulated SST pattern.
- TC numbers in TaiESM1-HAHO (25 km ATM & 10 km OCN) is comparable to HALO in NWP. Although the TC number in HAHO in the Atlantic is close to observation, too many TCs occurs in spring.
- HALO has too strong ENSO variability.
- ENSO in HAHO almost disappears.