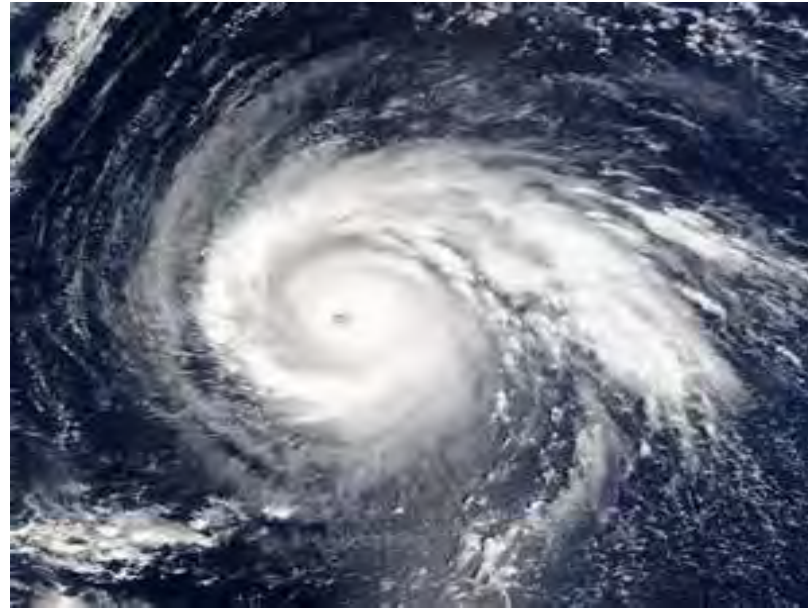


Anomalous tropical cyclone activity in the western North Pacific in August 2014



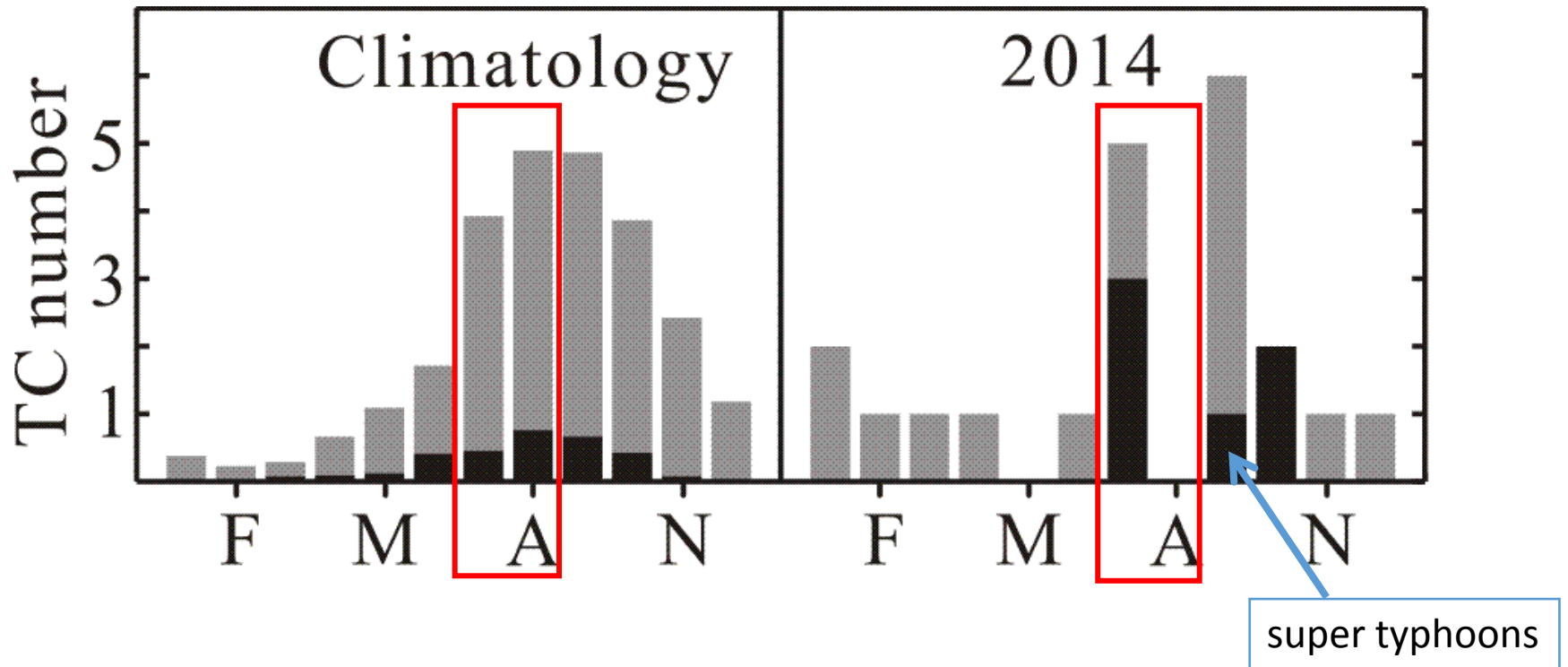
Lei Yang, Xin Wang, Ke Huang , Dongxiao Wang

Yang, L., X. Wang, K. Huang, D. Wang, 2015: The anomalous tropical cyclone activity in the northwestern Pacific, [in “Explaining Extremes of 2014 from a Climate Perspective”]. *Bull. Amer. Meteor. Soc*, 96, S1-S6, DOI: 10.1175/BAMS-D-15-00125.1., in press.



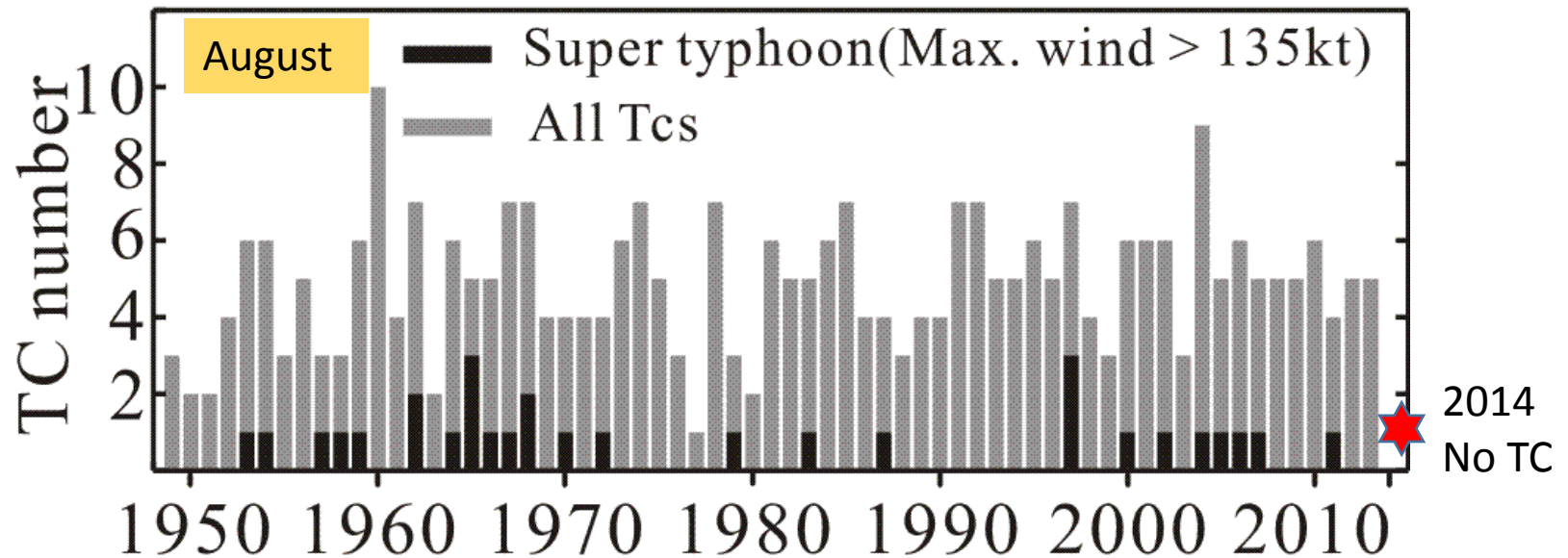
PICES
North Pacific Marine Science Organization

2015.10.16 Qingdao



- ✓ Climatologically, maximum TC genesis occurs in August in WNP
- ✓ **No TC formed from early August through early September** during the boreal summer of 2014

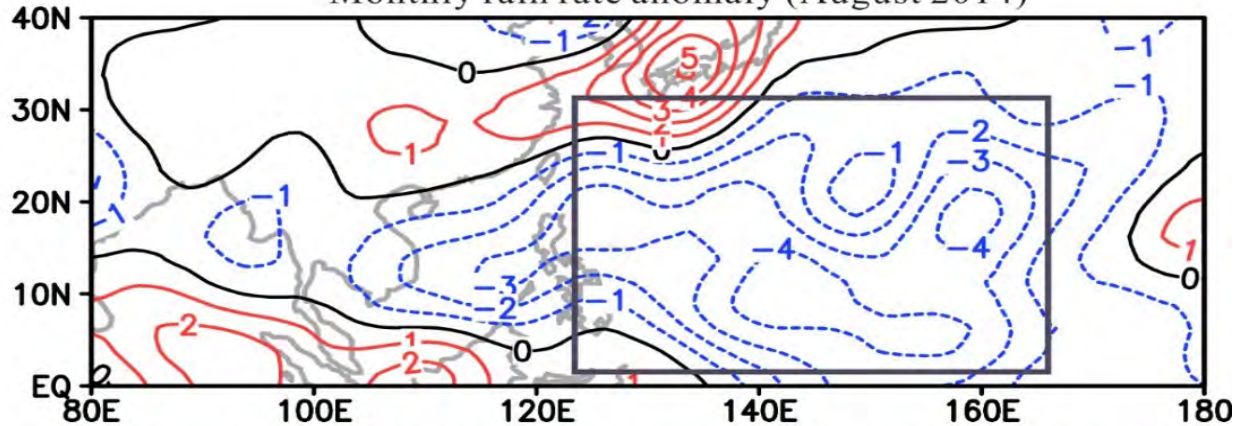
Variations of TC number in the WNP during Aug.



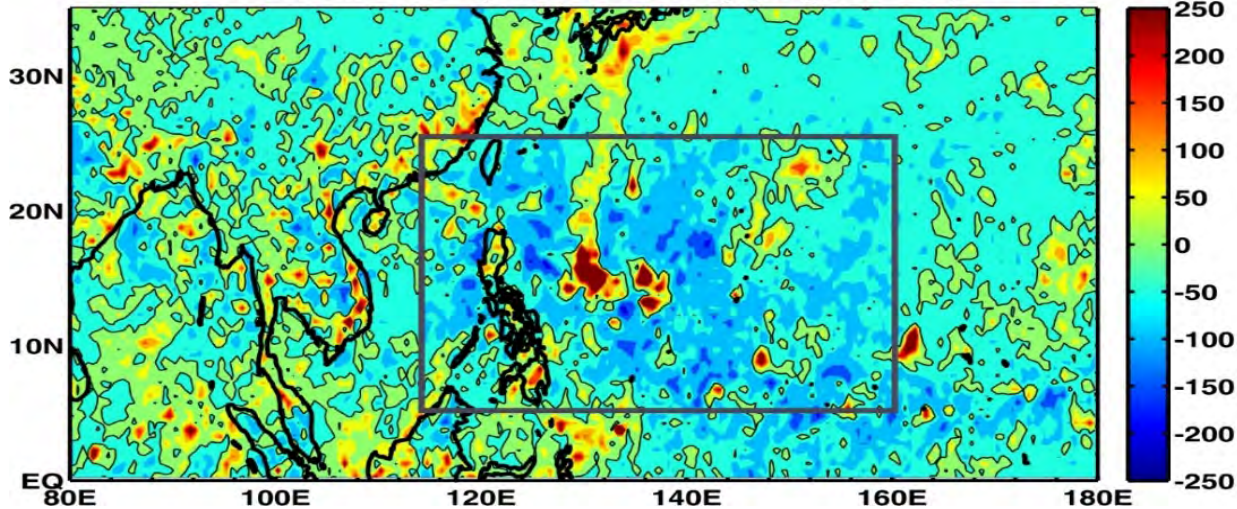
The year 2014 was the first since 1949 that no TC formed in the WNP during August, which is climatologically a peak TC month.

TC impacts in August 2014

Monthly rain rate anomaly (August 2014)

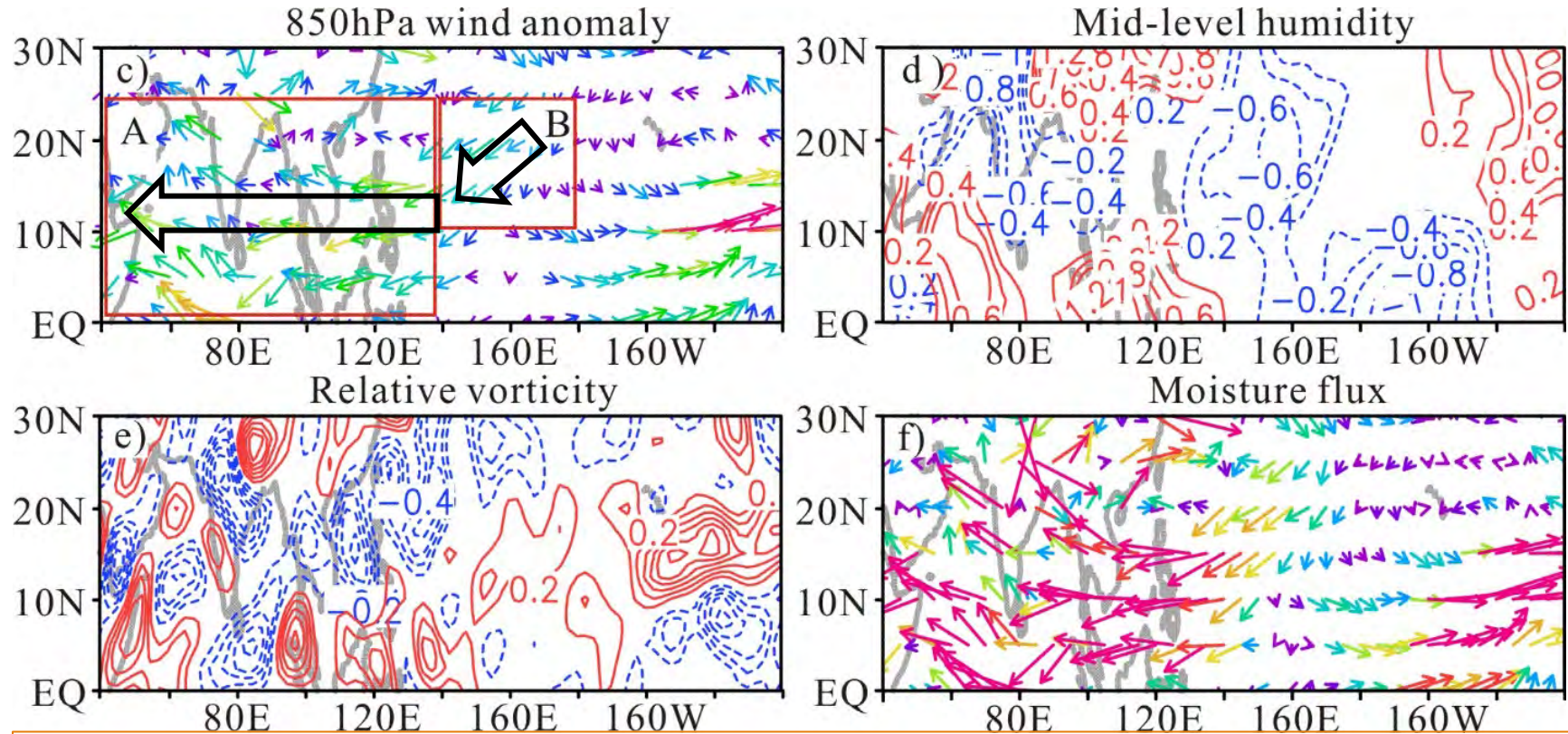


Convective Precipitation anomaly (August 2014) unit: mm/month



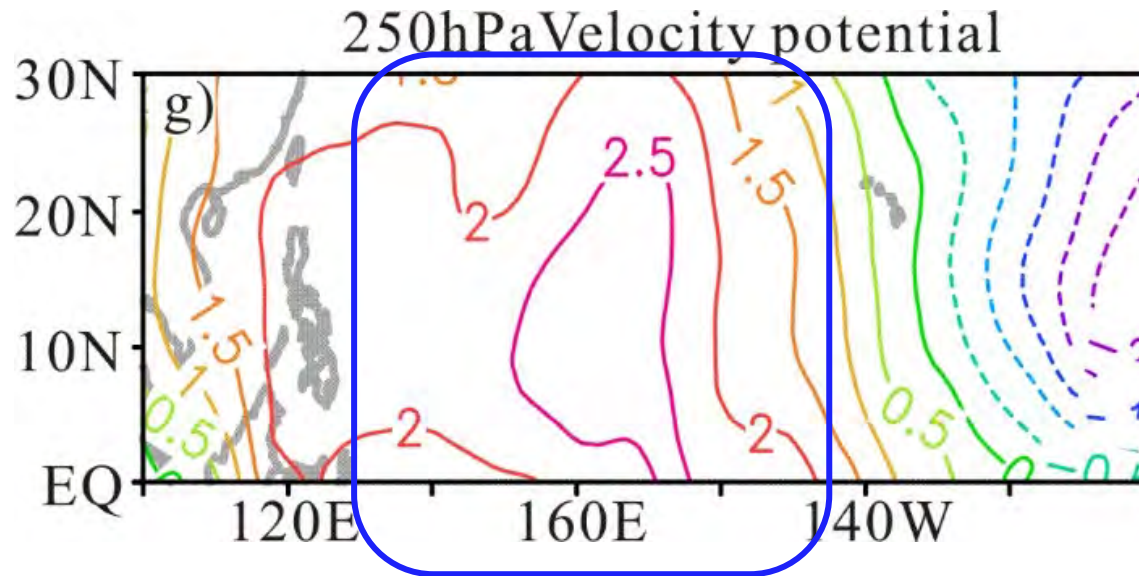
- ◆ Tropical cyclones are significant sources of summer rainfall in the WNP and its surrounding regions.
- ◆ Such low TC activity in August 2014 has directly contributed to the anomalous low precipitation in south Asia and the entire WNP

Large-scale circulation anomalies in Aug. 2014



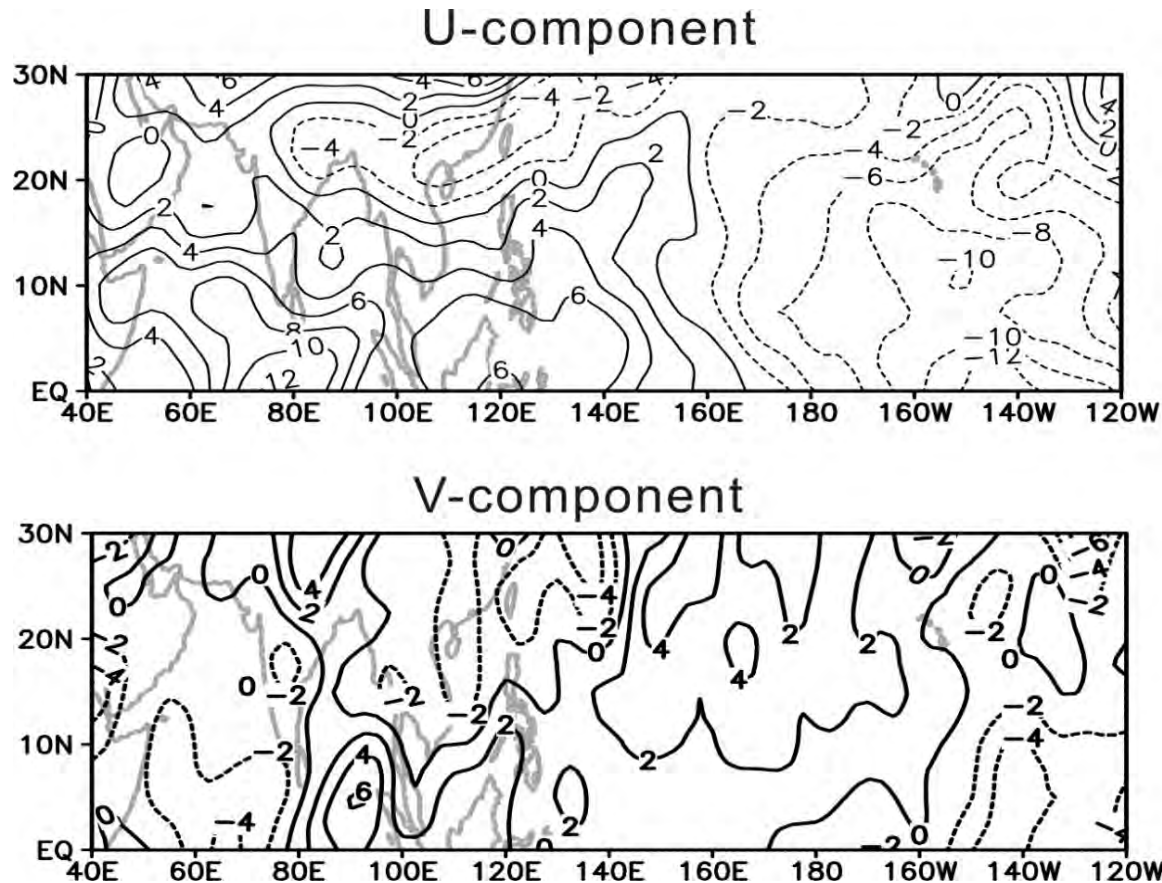
- In August 2014, anomalous low-level northeasterly flow dominated the northeast sector of the WNP and turned to easterly around 140°E until 40°E. The strong easterlies mainly prevailed over the tropical WNP and northern tropical Indian Ocean (TIO).
- Along with these prevailing easterlies, there were the midlevel dry conditions and negative low-level vorticity.
- The anomalous wind pattern played an important role in leading to the unfavorable conditions for TC genesis by continuously transporting dry air from mid latitudes into the WNP and through the western TIO.

Large-scale circulation anomalies in Aug. 2014



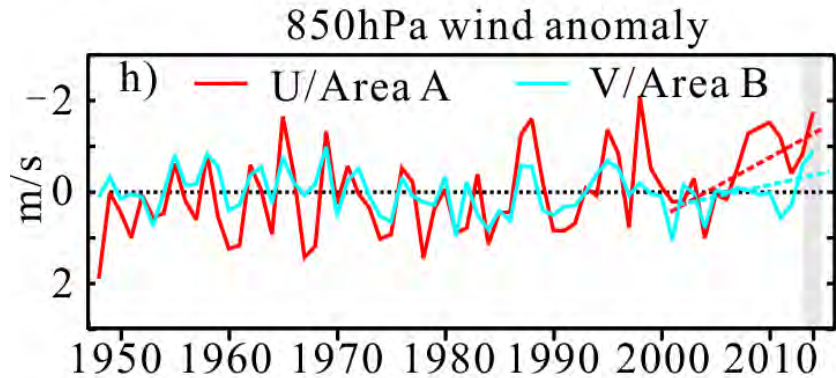
- Positive velocity potential anomaly at 250hPa dominated the WNP with a maximum around 160E, indicating strong divergence and enhanced subsidence in the region

The vertical wind shear of horizontal wind anomaly in Aug. 2014



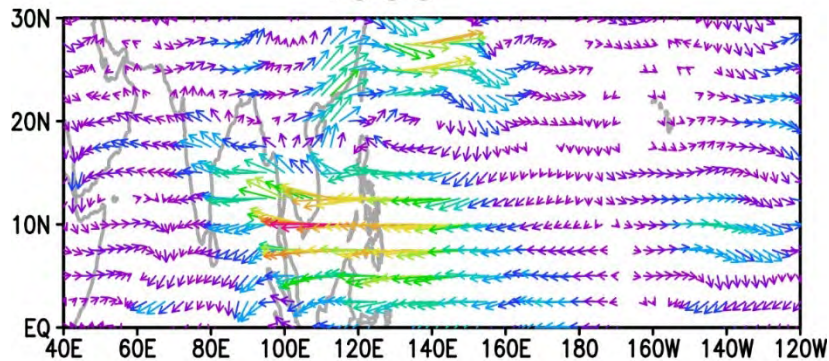
The vertical wind shear anomaly was not significant and likely had a lesser influence on the anomalous TC genesis.

The sustained easterly anomalies over the WNP in August 2014 were unusual.

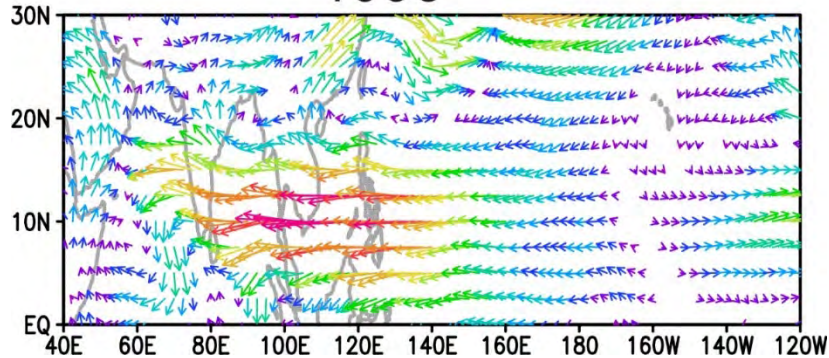


Strong anomalous easterly flow over the WNP also occurred in 1988 and 1998.

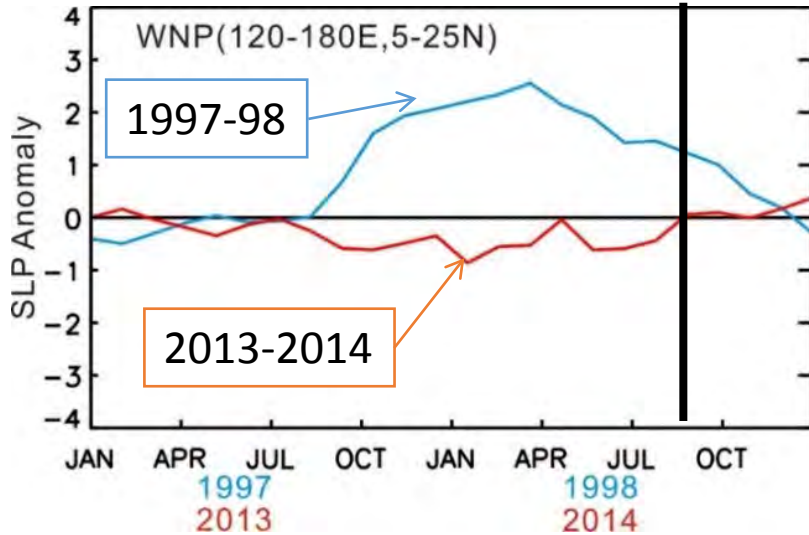
1988



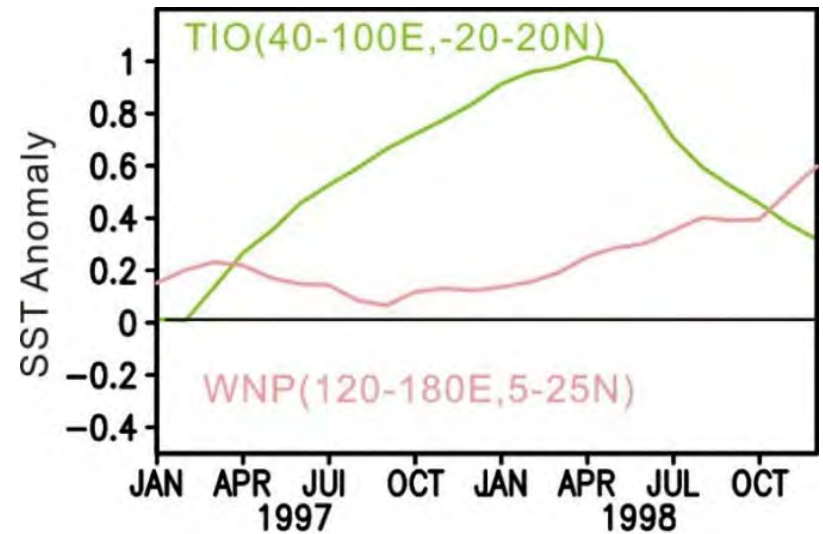
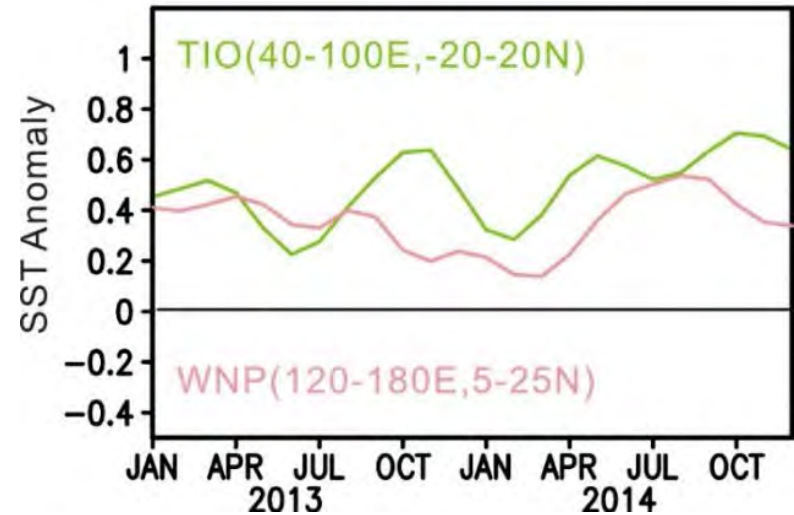
1998



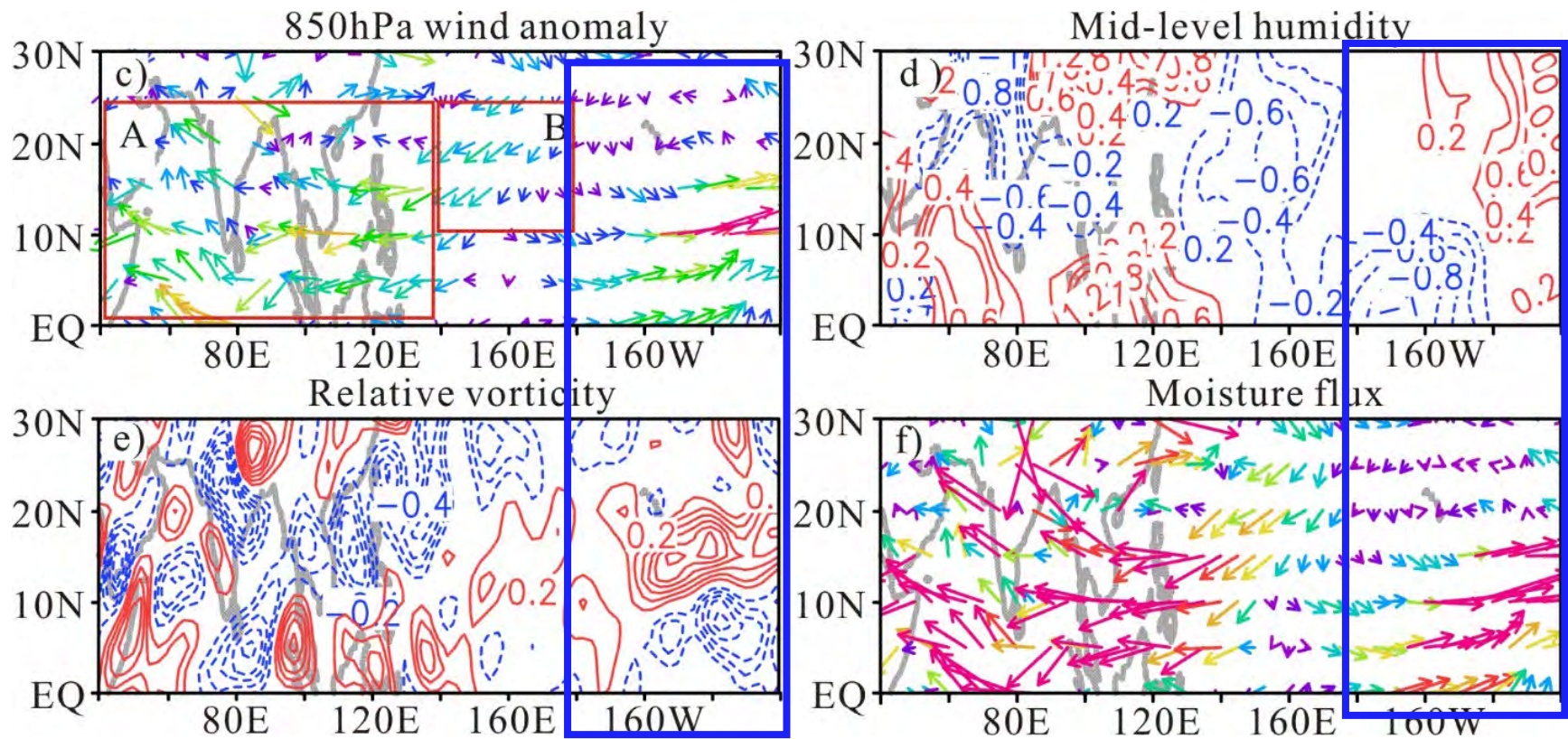
- The easterly flows in 1988 and 1998 prevailed from the central Pacific, but weakened and diverged at the eastern TIO.
- It is well known that 1988 and 1998 were strong La Niña years, during which the easterly winds were mostly related to the strong sea surface temperature gradient (SSTG) due to strong cooling in the eastern Pacific.



The SLP anomaly was slightly positive over the WNP in August 2014, which is different from that in 1998, when the TIO warming after the strong El Niño (1997) induced strong Kelvin wave propagation into WNP, leading to anomalous high pressure over the WNP



WNP SST was also slightly warm during 2014, which is different from that in 1998.



- In contrast to the anomalous atmospheric circulation in the WNP in August 2014, the central North Pacific (CNP) and ENP experienced an almost exactly opposite situation, with strong westerlies, moist midlevels, and increased vorticity and convergence.
- Correspondingly, more TC activities were recorded in the CNP/ENP during the period. The differences in the atmospheric circulation anomalies and TC activity between WNP and ENP suggest a possible connection to the ISO phase.

ISO propagation during July-August of 2014

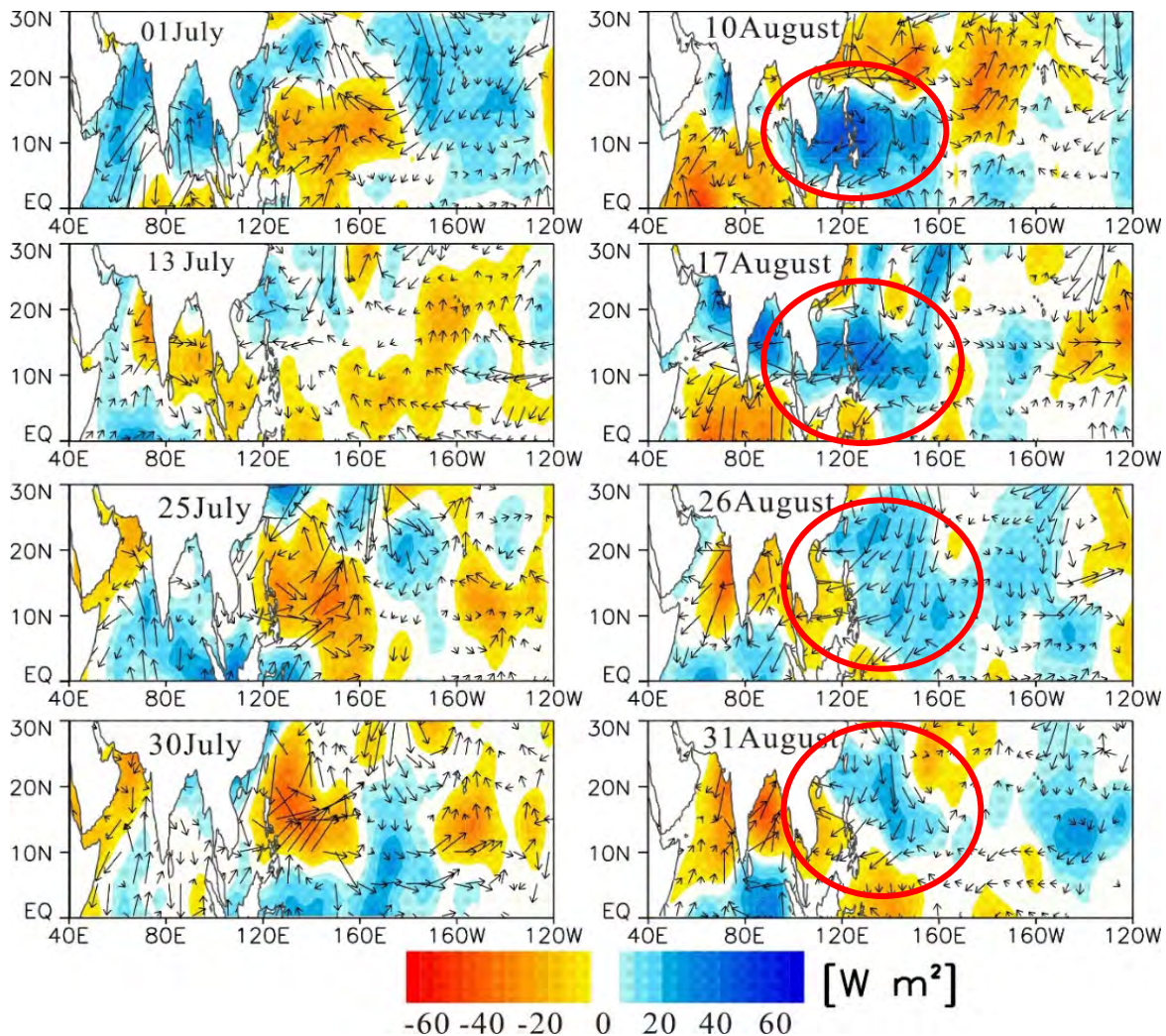
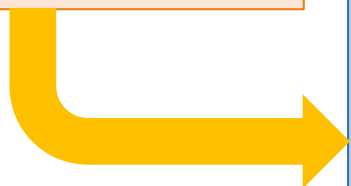
In early July of 2014, strong positive convection dominated the WNP and western TIO, while negative convection was located in the CNP and ENP.



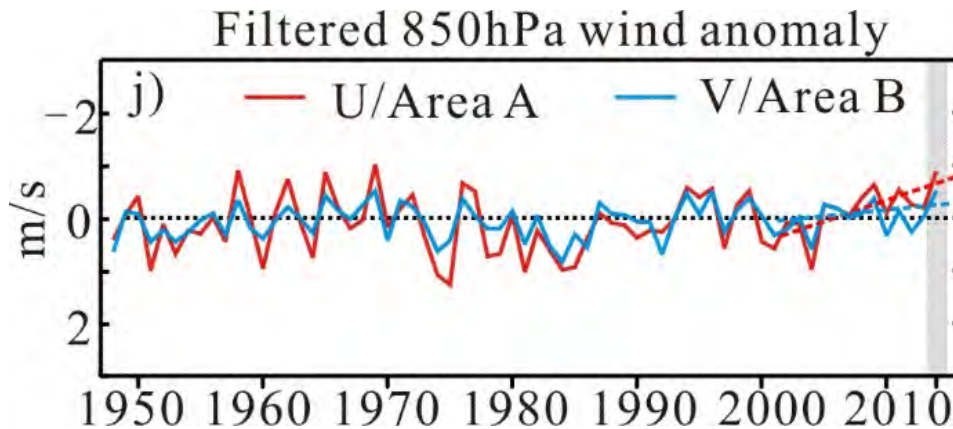
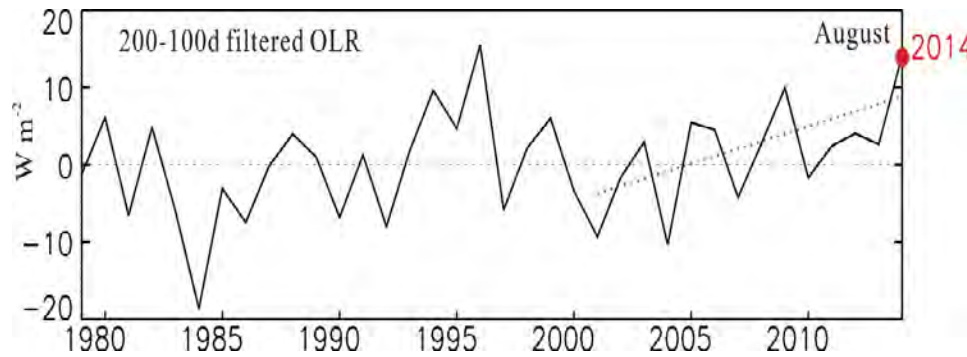
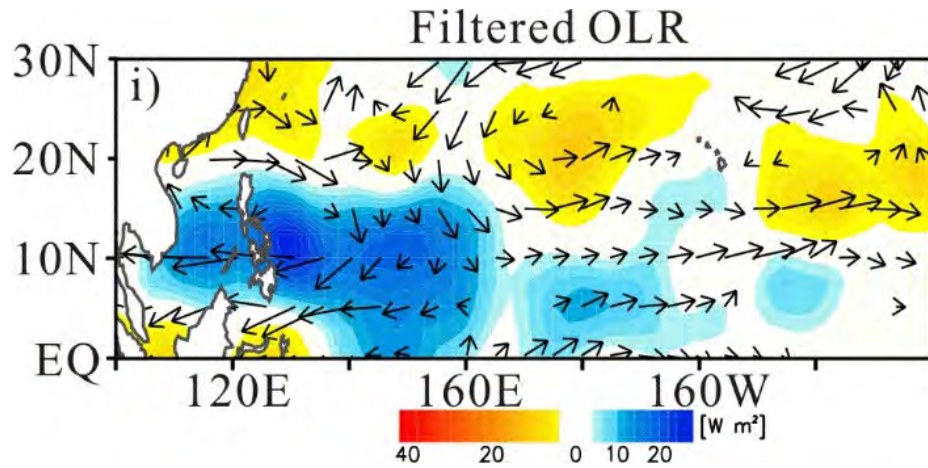
The positive convection center in the western TIO gradually moved northward into the WNP and combined with the positive center in the WNP.



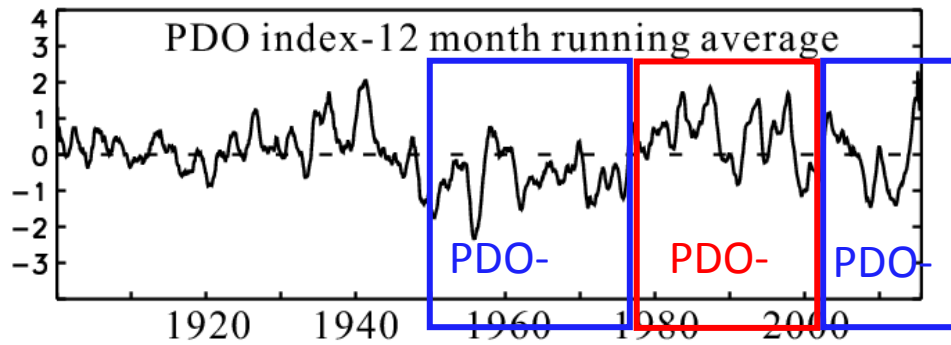
At the end of July, the positive center started to move out of the WNP and split into two branches, one moving northward and one eastward and marking a phase change from positive to negative (negative to positive) in the WNP (ENP).



With the continuing northward propagation of the ISO signals, a strong negative convection anomaly center dominated the WNP and lingered until the end of August, leading to unfavorable conditions for TC genesis

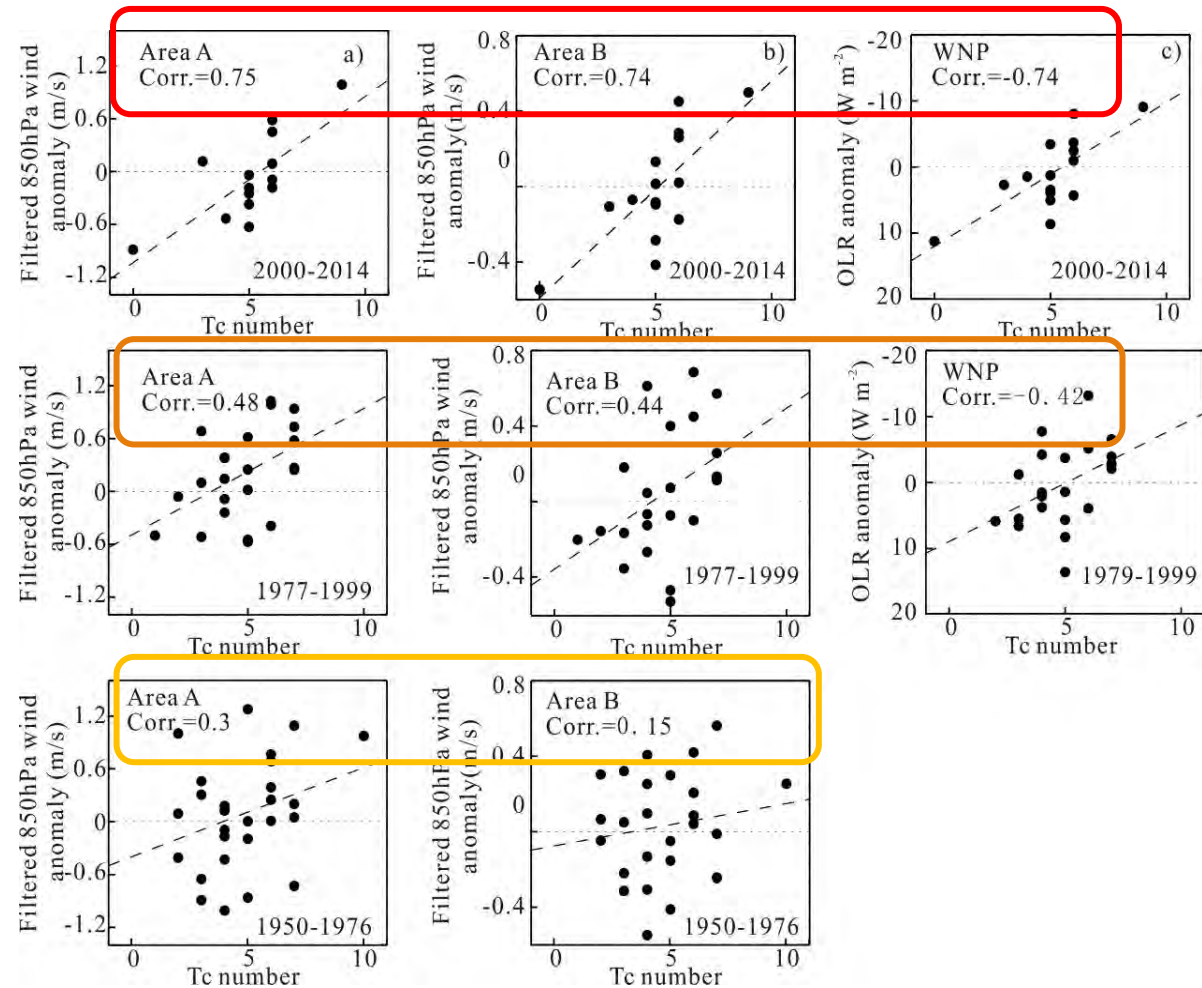


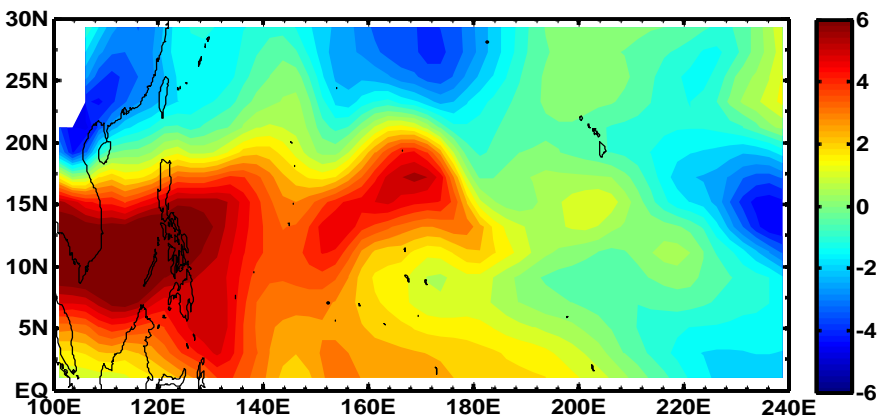
Averaged 20–100- day filtered 850-hPa wind anomaly over the WNP in August showed an increasing trend during 2000–2014, which corresponded well with the increasing easterly anomalies and thus decreasing trend in TC frequencies



The strength of the modulation of TC frequency by the ISO over the WNP during August has been increasing since 1948 under three PDO phases with the strongest during the recent negative PDO phase.

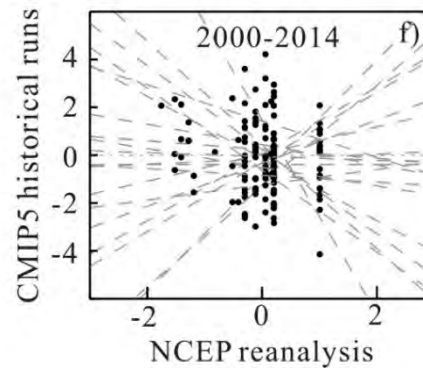
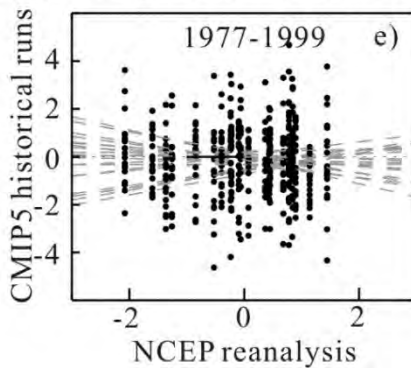
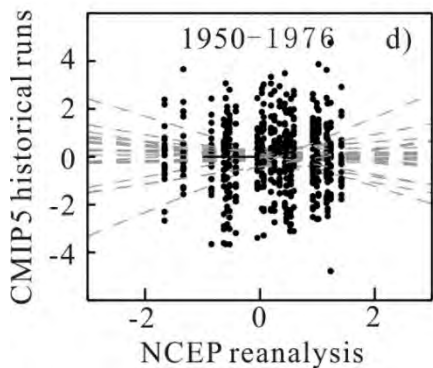
- ◆ During 2000-2014, the correlation between filtered easterlies in area 'A', northeasterlies in area 'B', and OLR anomalies over the WNP is 0.75, 0.73, and -0.74, respectively.
- ◆ During the other two PDO phases, negative phase of 1950–76 and positive phase of 1977–99, the correlation was much lower, with increasing tendency from 1950–76 to 1977–99



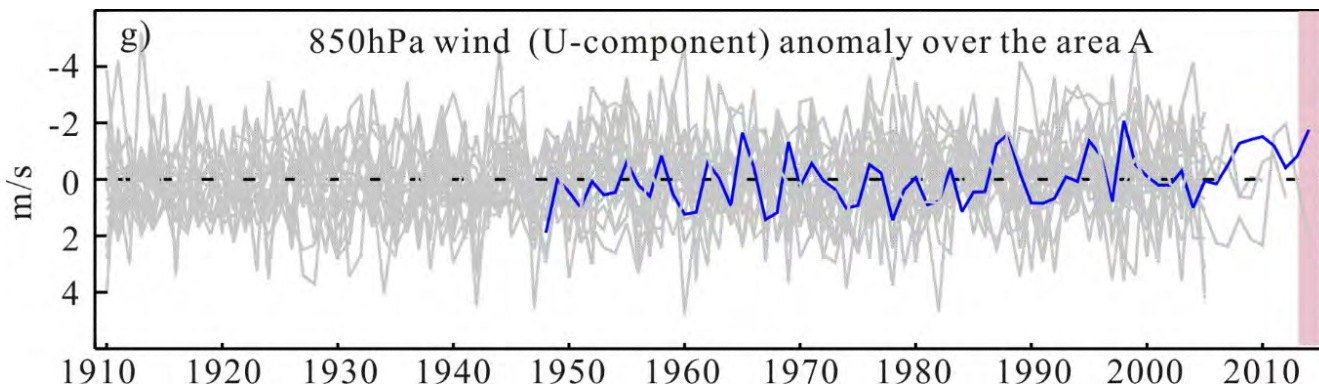


A CMIP5 model historical run simulate an opposite pattern of 850-hPa easterly anomaly compared to the reanalysis data: westerly anomaly in the WNP and easterly anomaly in the ENP

850hPa wind (U-component) anomaly over the area A



None of the twenty CMIP5 models can reproduce zonal wind for all three periods.



Summary

- The year 2014 was the first since 1949 that no TC formed in the WNP during August, which is climatologically a peak TC month.
- It is found that ISO played an important role in inhibiting TC genesis in August 2014 by inducing anomalous easterlies, which led to decreased moisture and vorticity, and increased divergence.
- The strength of the modulation of TC frequency by the ISO over the WNP during August has been increasing since 1948 under three PDO phases with the strongest during the recent negative PDO phase.
- The inability of CMIP5 models to replicate the easterly anomaly pattern might be partly due to the inconsistency of PDO phase transition and the variation of EASM with observations. we currently cannot determine whether the significant easterly trend as well as the observed TC activity is part of natural climate variability or climate change induced by anthropogenic forcing.
- In the future, application of downscaling techniques in atmospheric general circulation models may be needed to diminish the biases in the tropical areas.

Thank You!