Multidecadal variability of tropical cyclone translation speed over the western North Pacific

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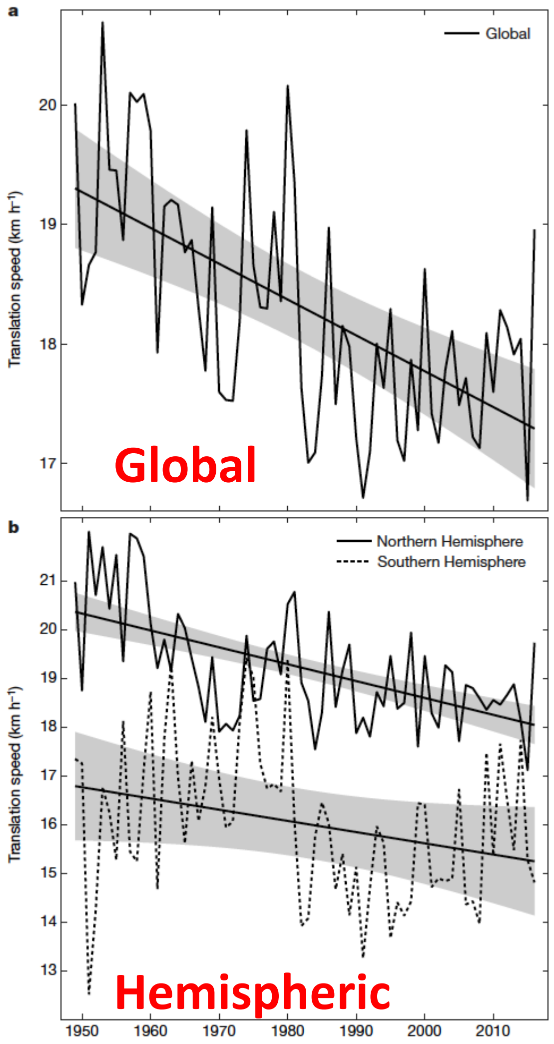
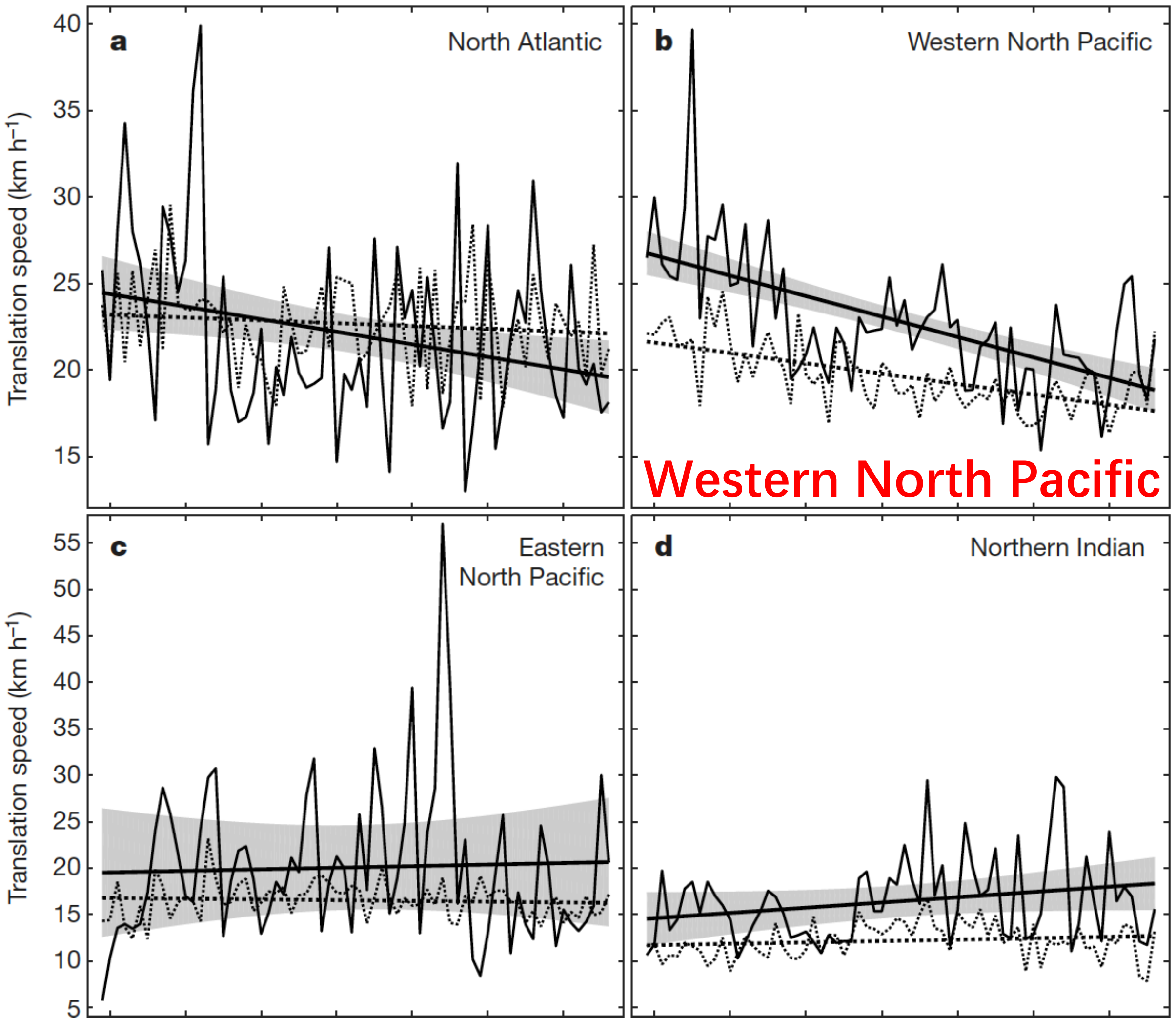
Background and Motivation

Long-term changes in the TC translation speeds





(Kossin 2018)

Background and Motivation

- TC slowdown trend is due to data inhomogeneity (e.g., Moon et al. 2019; Lanzante 2019)
- TCs over extratropics slow down in the future warming scenario (e.g. Zhang et al. 2020)
- TC translation speed (TCS) may also increase in the future (e.g. Hassanzadeh et al.2020; Yamaguchi et al. 2020)
- ENSO-induced zonal displacement of TC genesis positions strongly modulates the interannual variability of the WNP TCS (Wang et al. 2020)
- AMO is also suggested to be linked to the slowdown trend of TCS over the North Atlantic (Guo et al. 2021)

Question：

How does the WNP TCS changes on low-frequency time-scale?
What is the role of internal modes like AMO and PDO?

Data and Methods

Datasets:

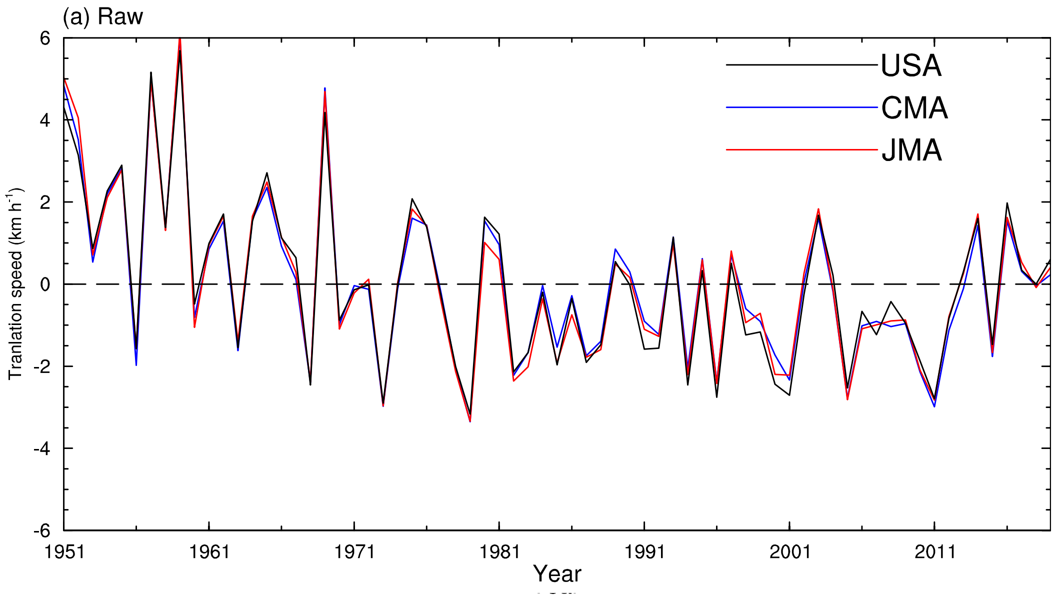
- TC data: IBTrACS version 4, agencies include: USA, CMA, and JMA
- Atmospheric variables: NCEP-1 and JRA-55
- SST data: NOAA's Extended Reconstructed SST reanalysis dataset, version 5 (ERSSTv5)
- AMO and PDO indices are from NOAA

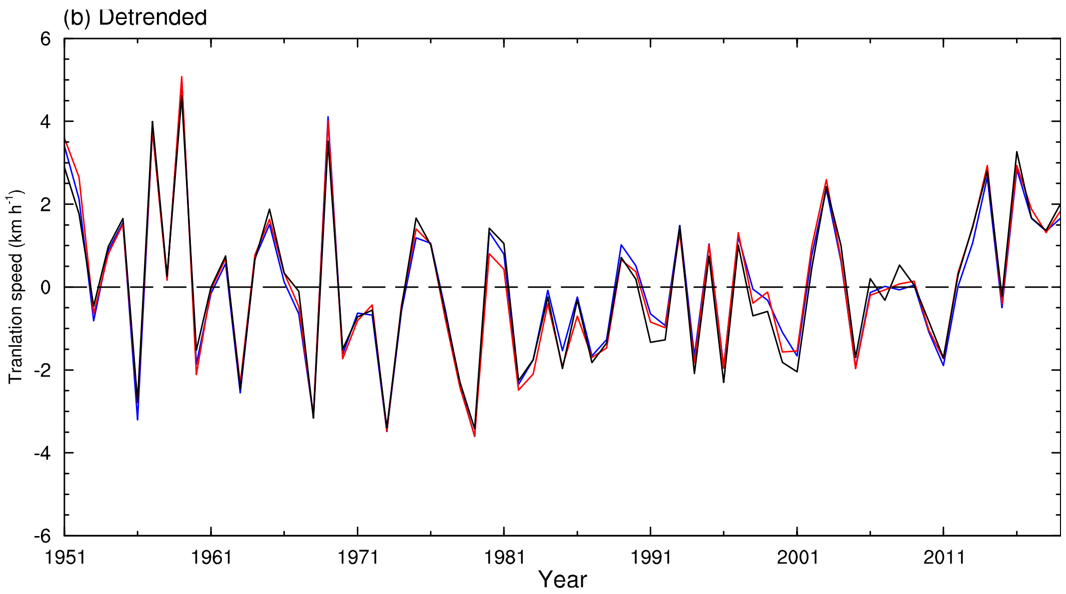
Methods:

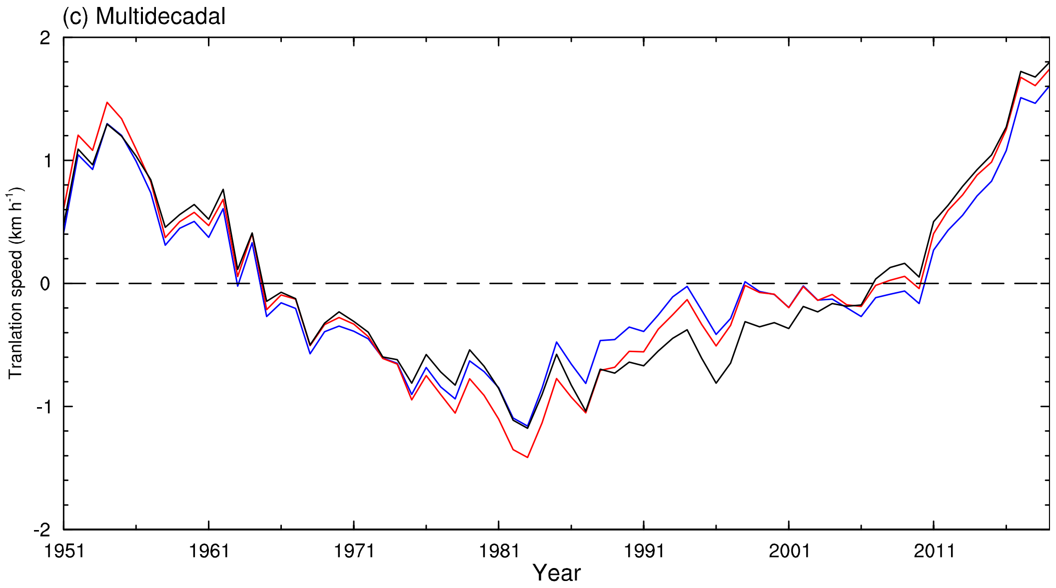
- The effective degree of freedom of the low-frequency component of each variable

$$\frac{1}{N^{eff}} \approx \frac{1}{N} + \frac{2}{N}\sum_{j=1}^{N}\frac{N-j}{N}\rho_{xx}(j)\rho_{yy}(j)$$

TC translation speed over the WNP



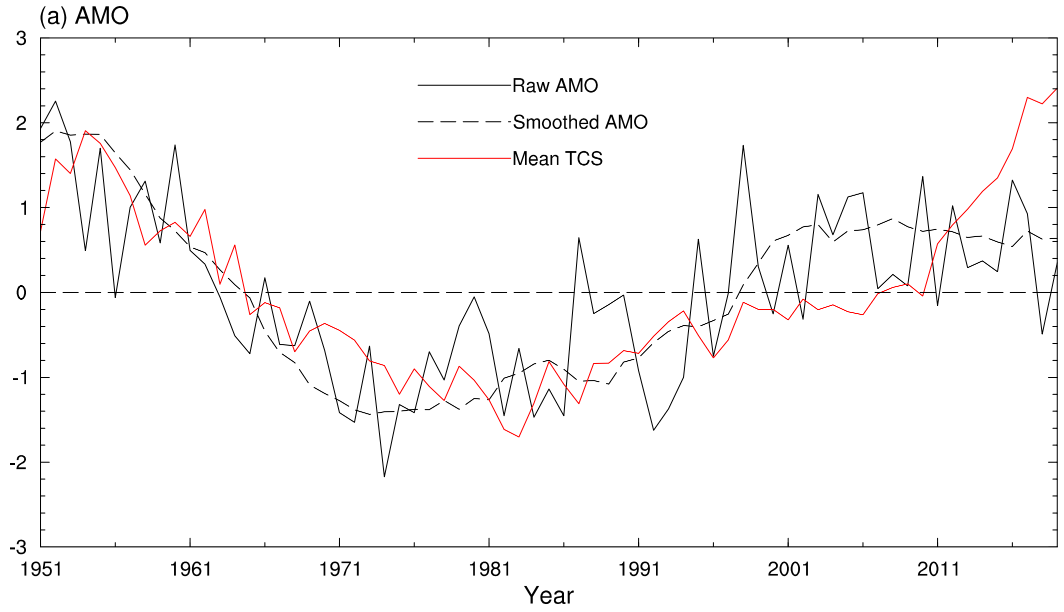




- Three agencies consistently show multidecadal variation of the WNP TCS

Relationship with AMO and PDO

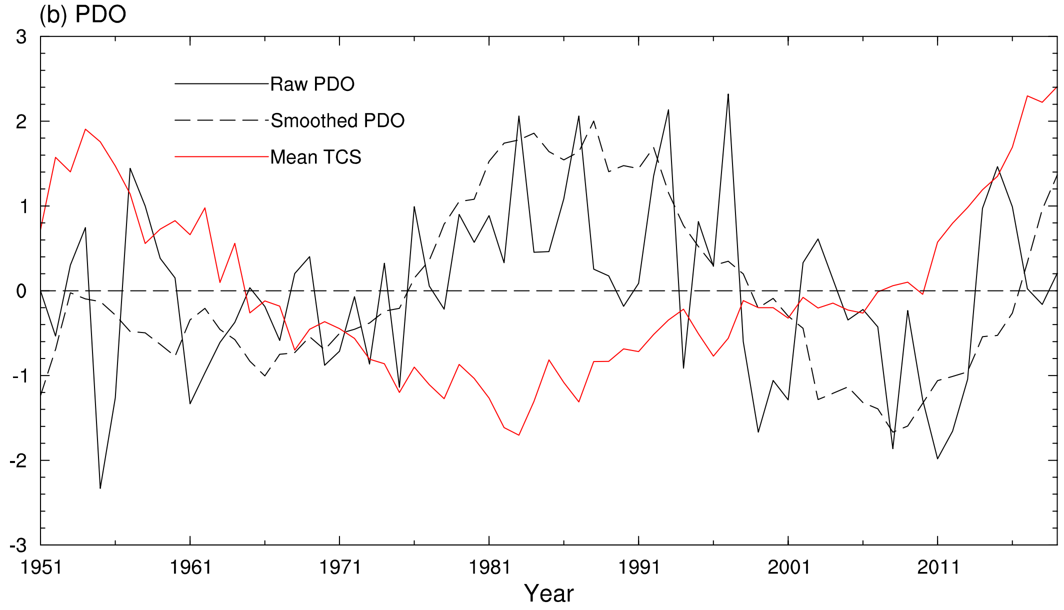
TCS & AMO



Correlation: 0.79~0.82

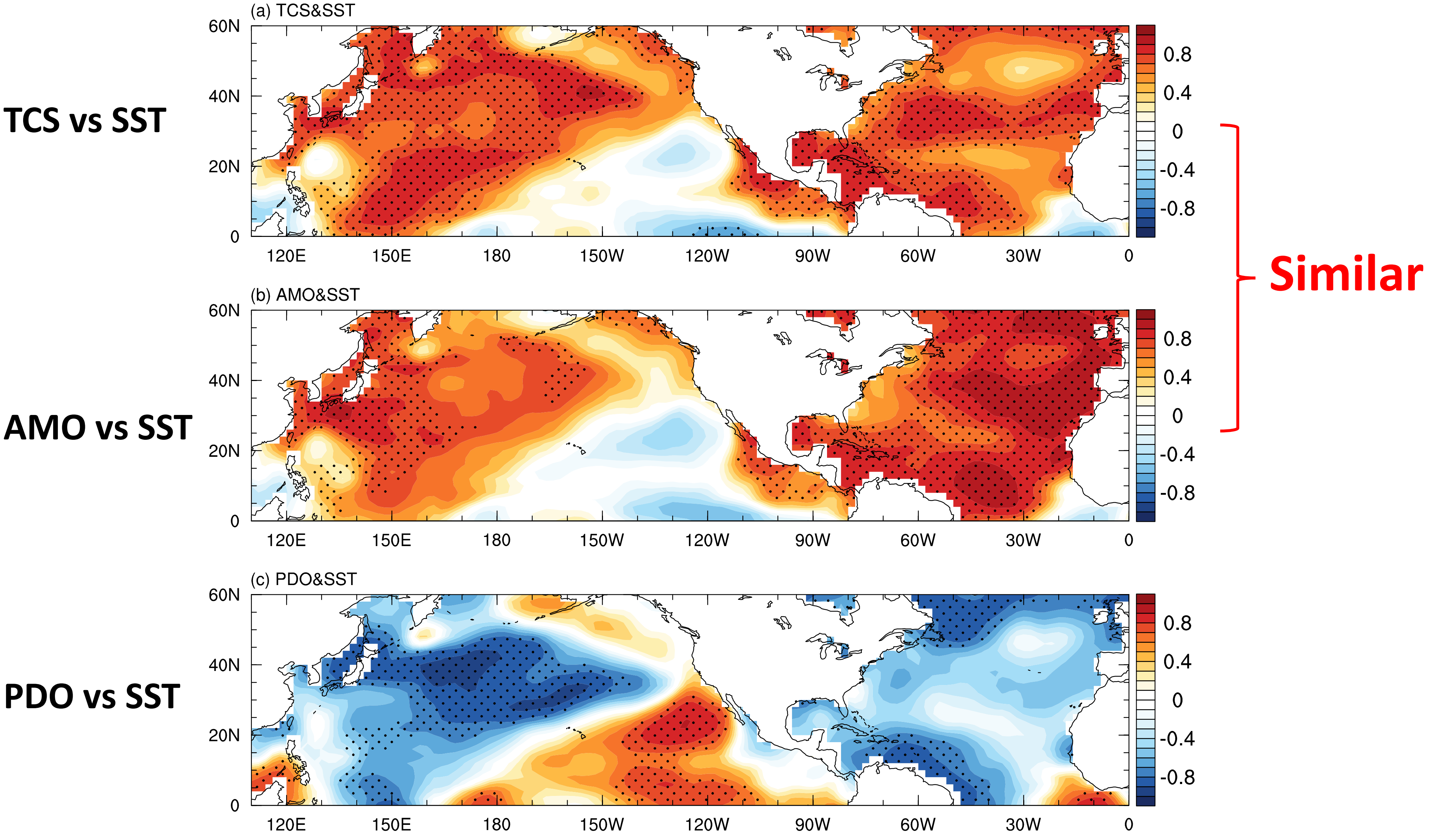
(P<0.05)

TCS & PDO

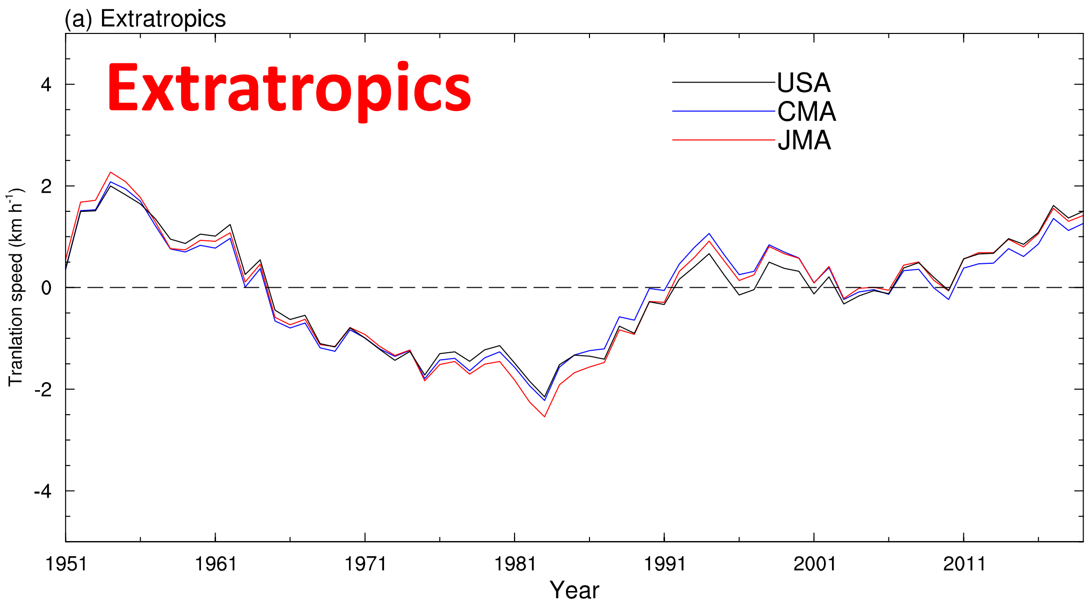


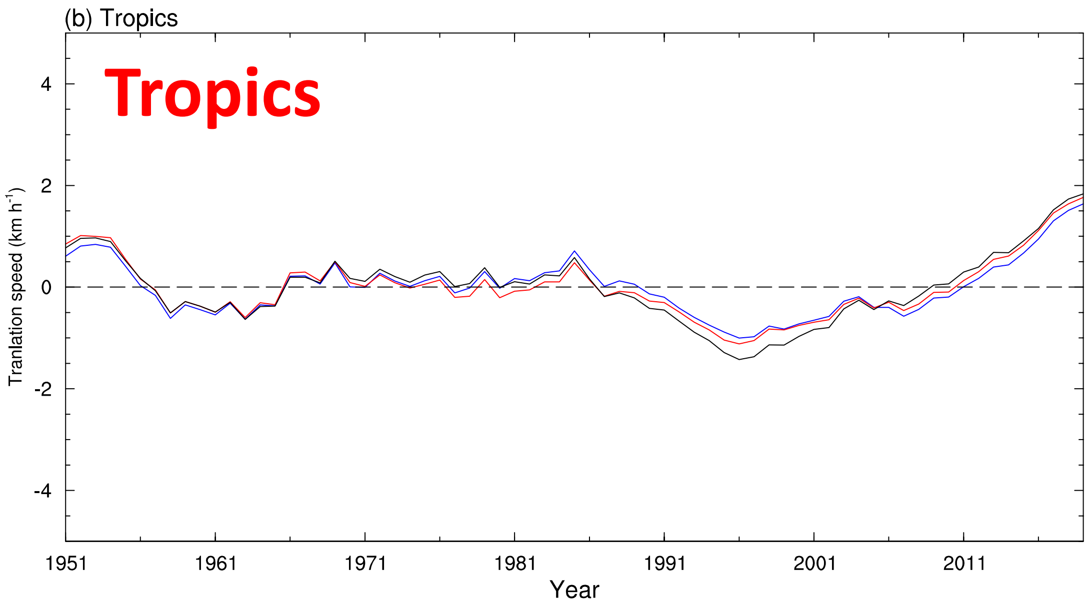
Correlation: -0.31~-0.39

Regressed SST anomalies



Tropical and extratropical TCS



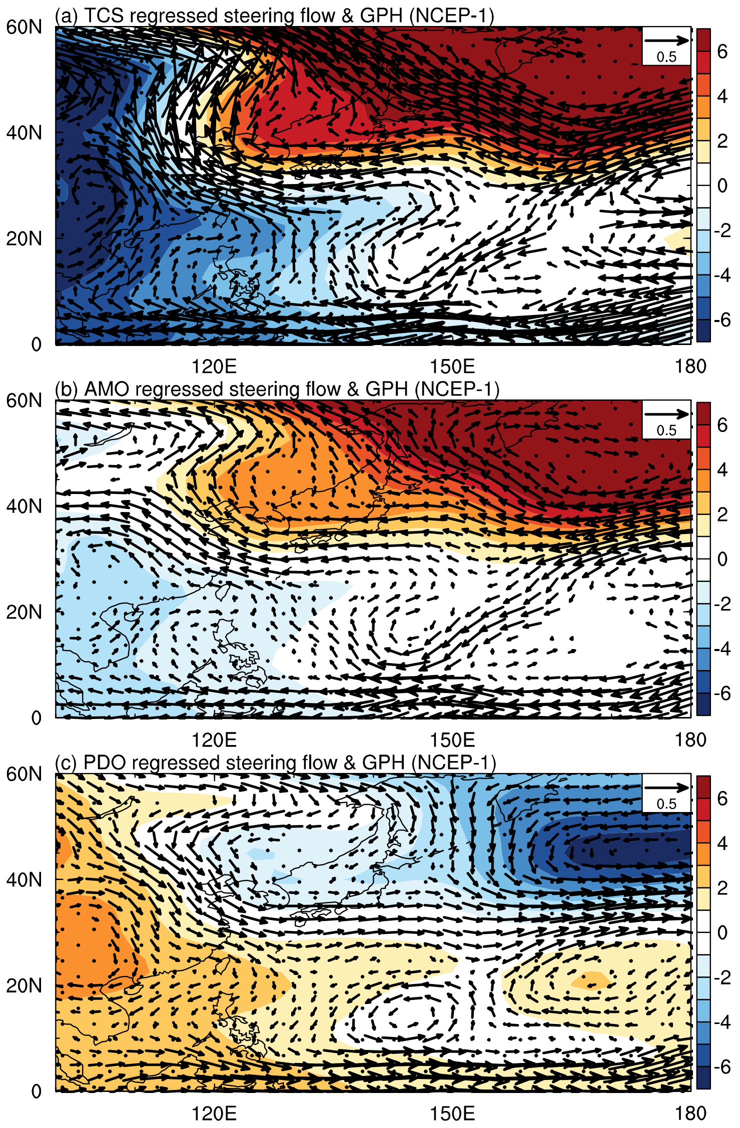


Large-scale steering flow and geopotential height

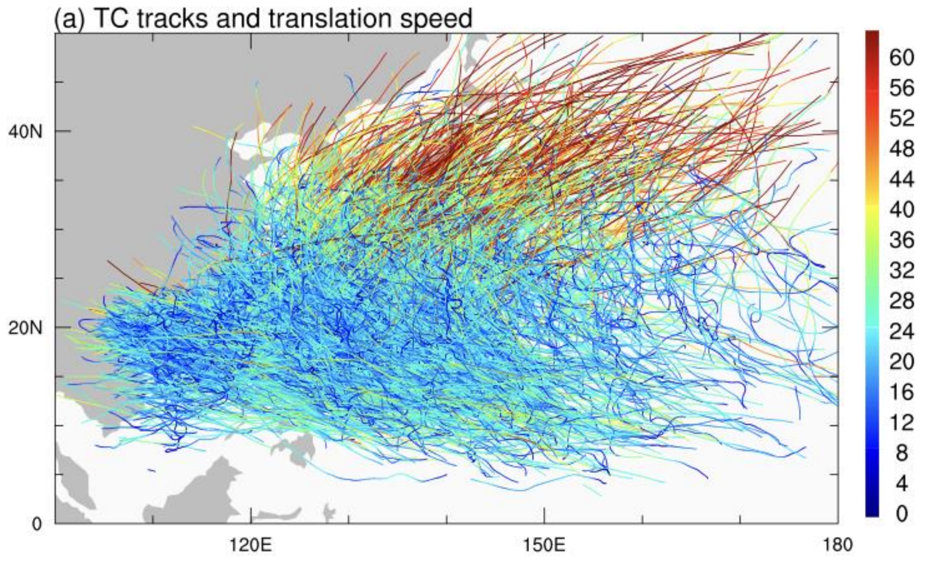
TCS

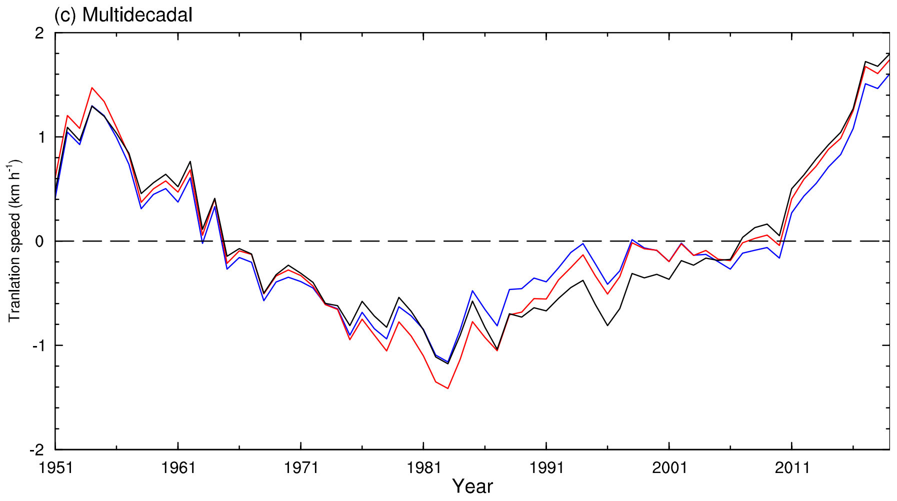
AMO

PDO

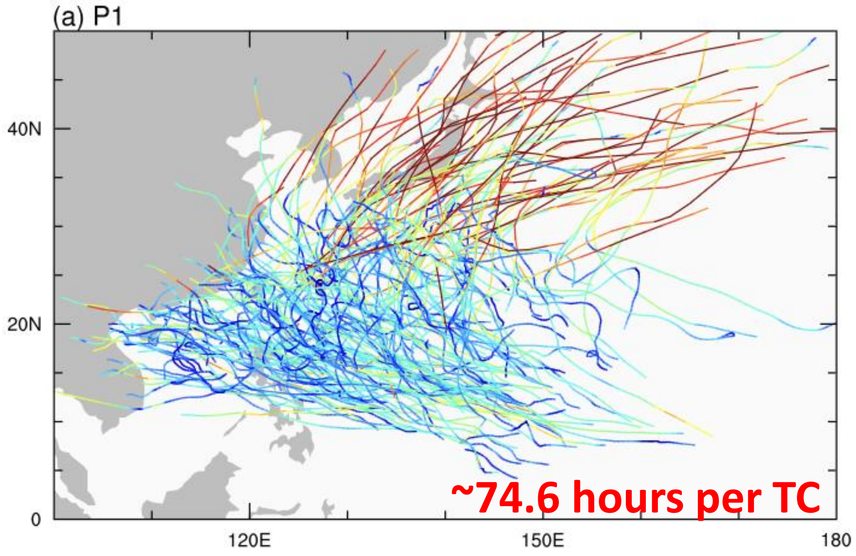


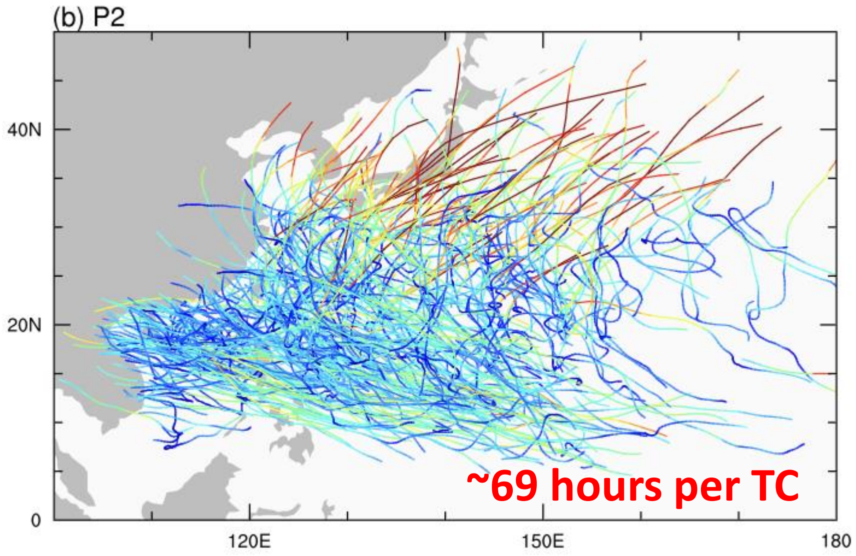
AMO+

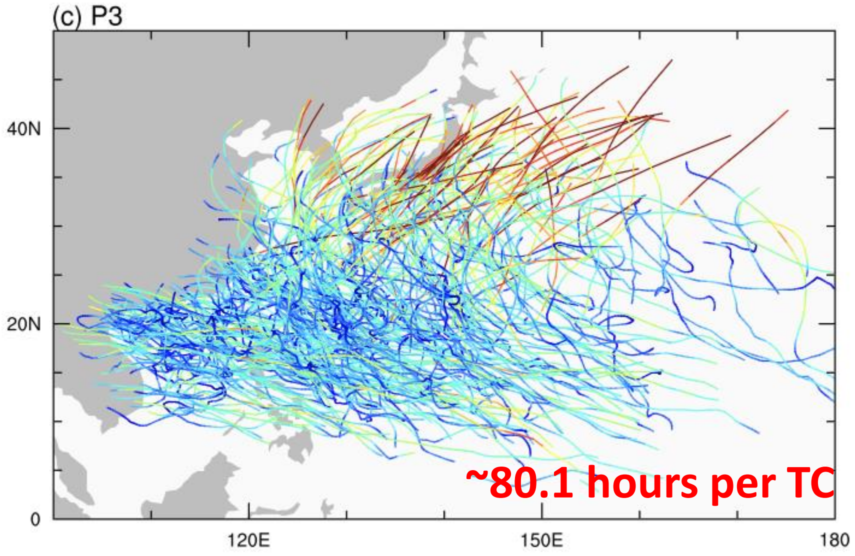




TC residence time over the extratropics

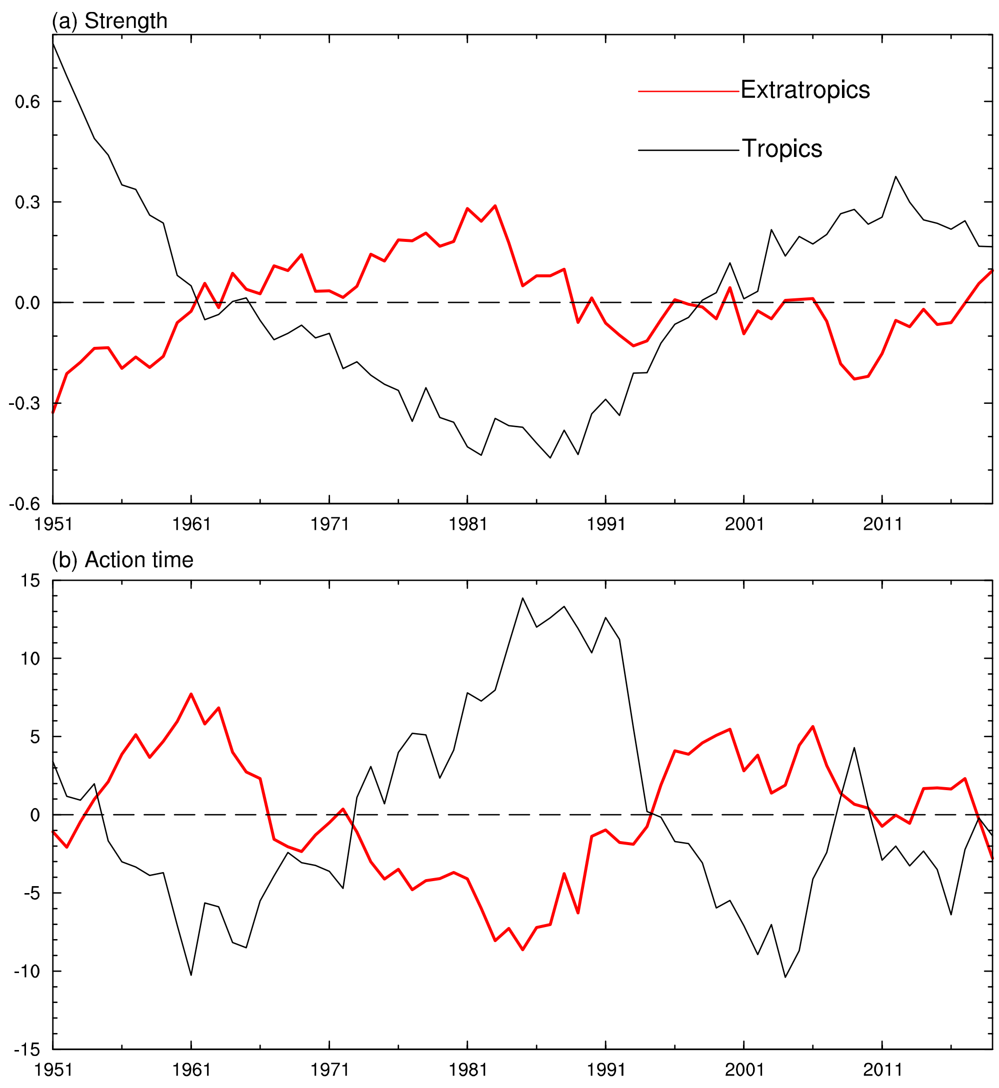


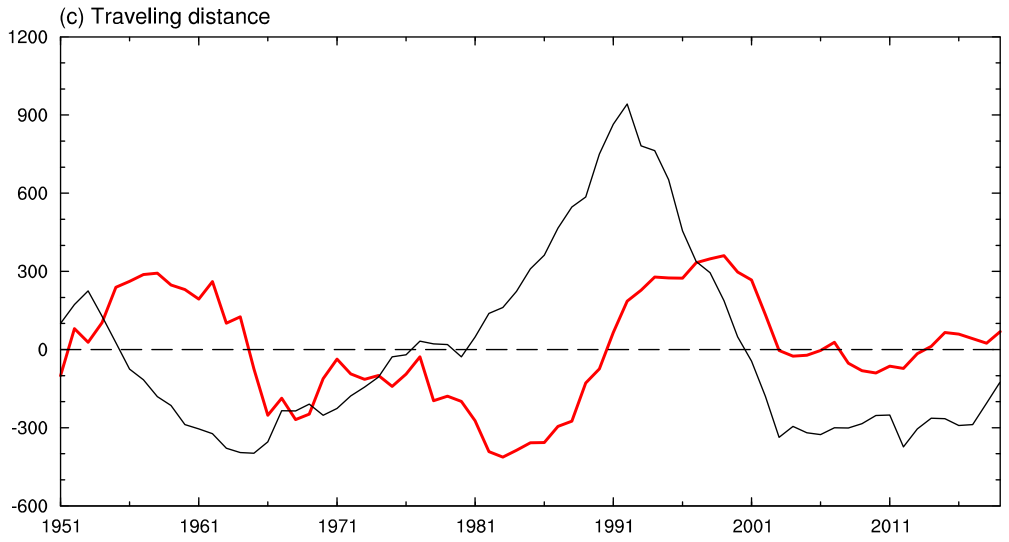




- P1 and P3 (AMO+) has longer lifetime staying in the extratropics than P2 (AMO-)
- Longer time been accelerated by westerly during P1 and P3

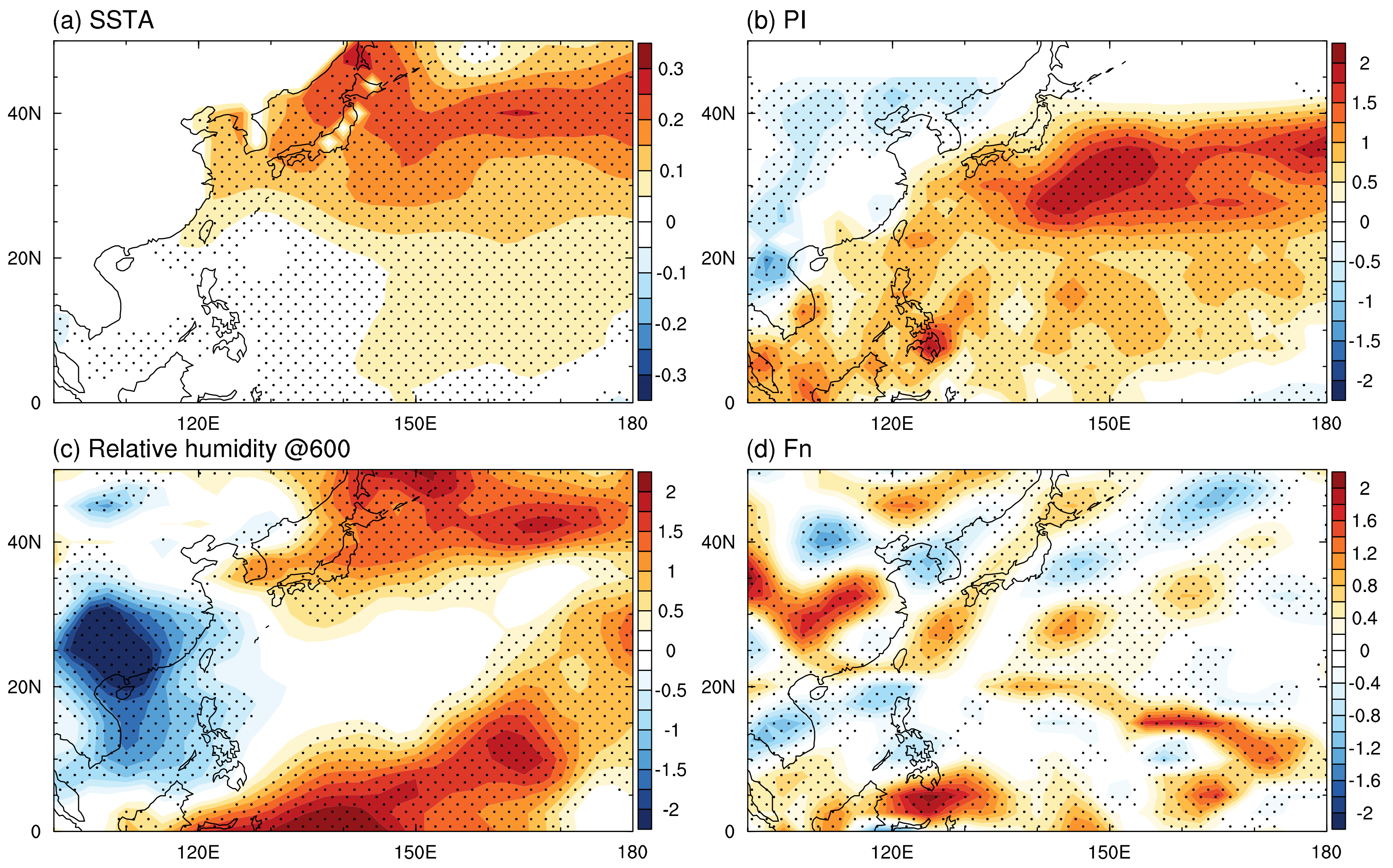
Large-scale steering flow effect



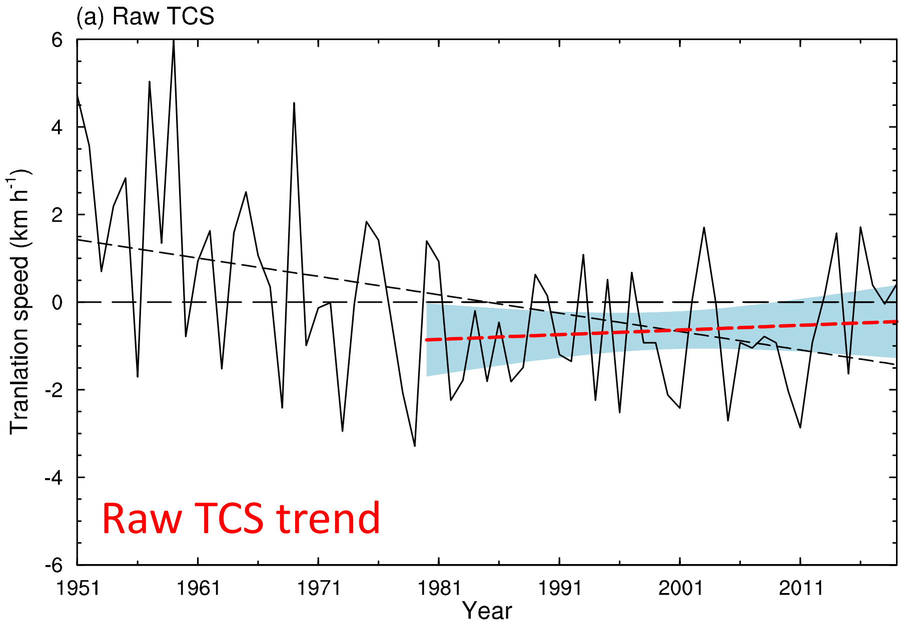


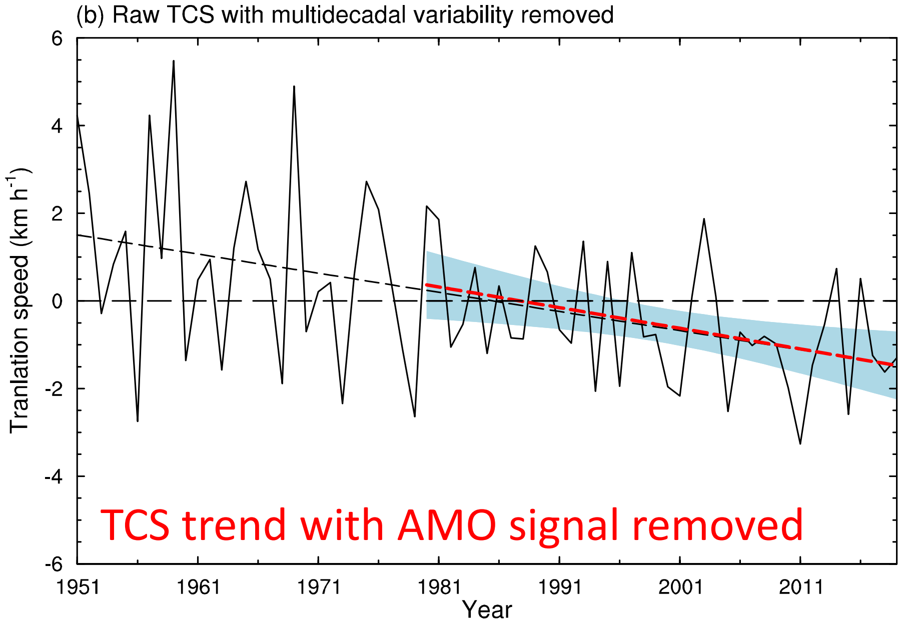
- Steering flow strength shows out-phase relationship with TCS
- Action time and traveling distance show in-phase relationship with TCS

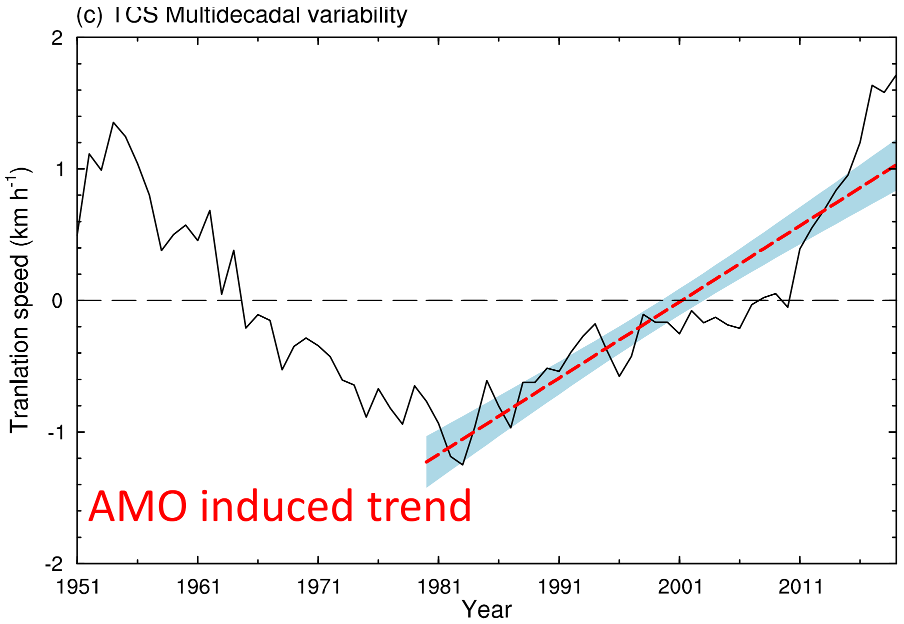
Large-scale environmental conditions related to AMO+



Influence on the TCS slowdown trend consistency







- AMO induced significant increasing trend of TCS since 1980
- This trend offsets the TCS trends since 1950s, leading to the inconsistent slowdown trends during different subperiods

Summary

- Low frequency variation of the basin mean TCS over the WNP has significant multidecadal variability, which is dominant by TCs over the extratropics.
- AMO positive phase provides favorable conditions for the TCs entering the extratropics, increasing TC lifetime and resulting in more opportunities for TCs to be accelerated to a high translation speed by the midlatitude westerly steering flow.
- The TCS multidecadal variability offsets the long-term decreasing trend of the WNP TCS since the 1980s because of its phase shift during this period.

Thank you !

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