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# Changes in Tropical Cyclone activity for the western North Pacific during the last decades, derived from a regional model simulation.

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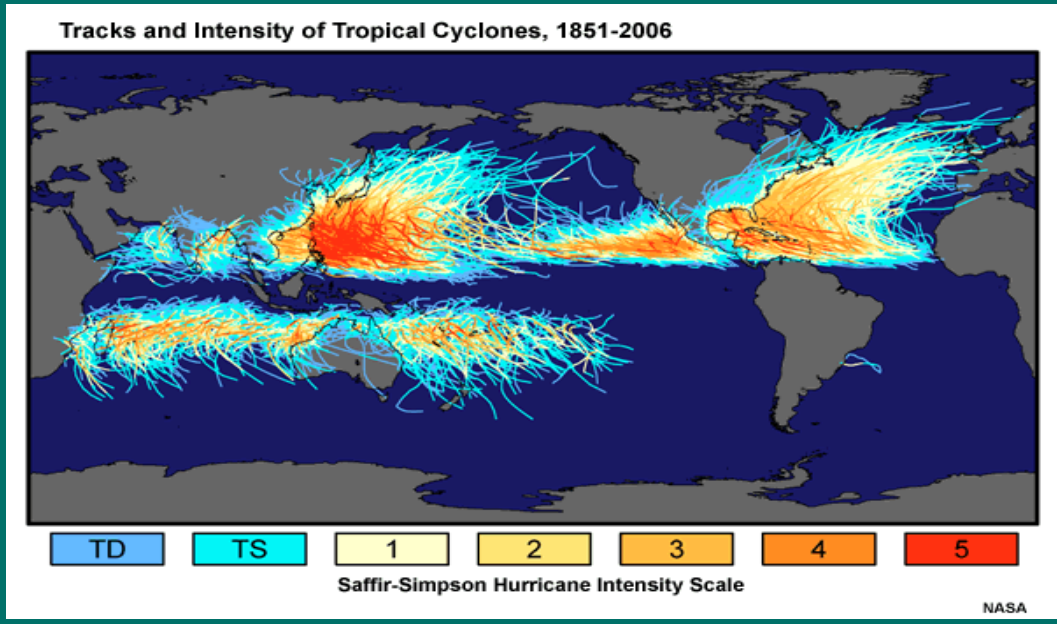
# Motivation

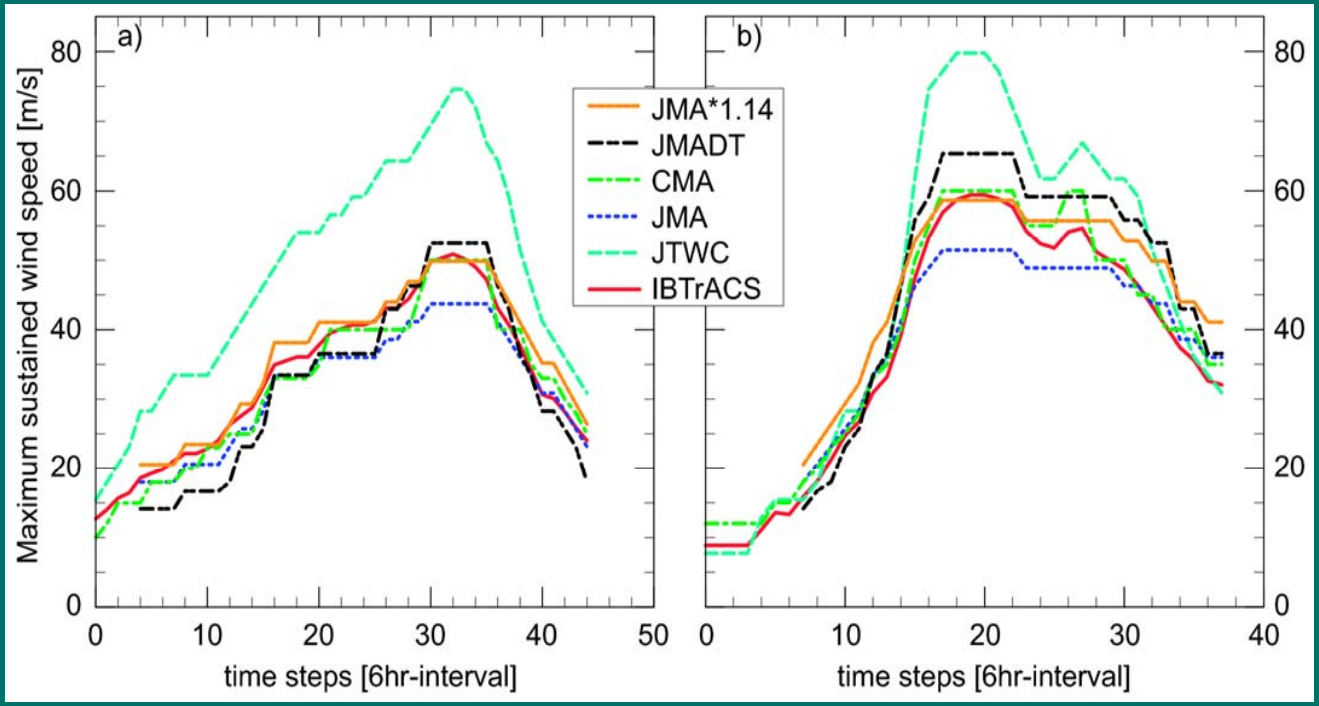
Increasing potential destructiveness/activity of tropical cyclones (TCs) in the past 30 years… (Emanuel, 2005)

- **North Atlantic: YES**
- **western North Pacific** (WNP)**: ?**
  - **ambiguous trends of TC activity**
  - **not correlated with average SST**



## 1. Reliability of TC trends derived from observations (BTD)

• different and changing over time operational practices for TC intensity estimation
( e.g.: 1 / 2 / 10 minute maximum sustained wind speed)

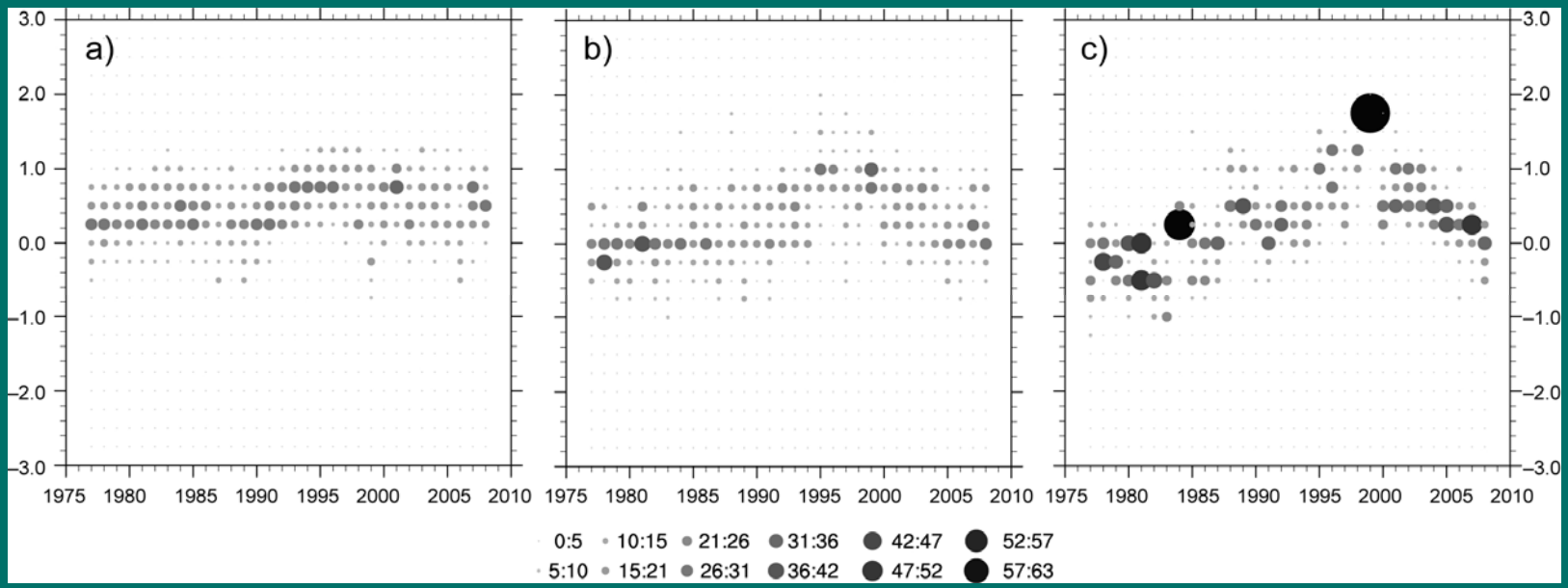



Barcikowska et al., 2012

**Wind speed time series for two TC events: a) Isa (1997), b) Dianmu (2004) for original BTD sets: JMA, CMA, JTWC, IBTrACS and modified BTD sets: JMA*1.14, (JMA multiplied by a factor), JMADT (JMA using the Dvorak conversion table).**

## 1. Reliability of TC trends derived from observations (BTD)

•extensive and not regular usage of satellite sources



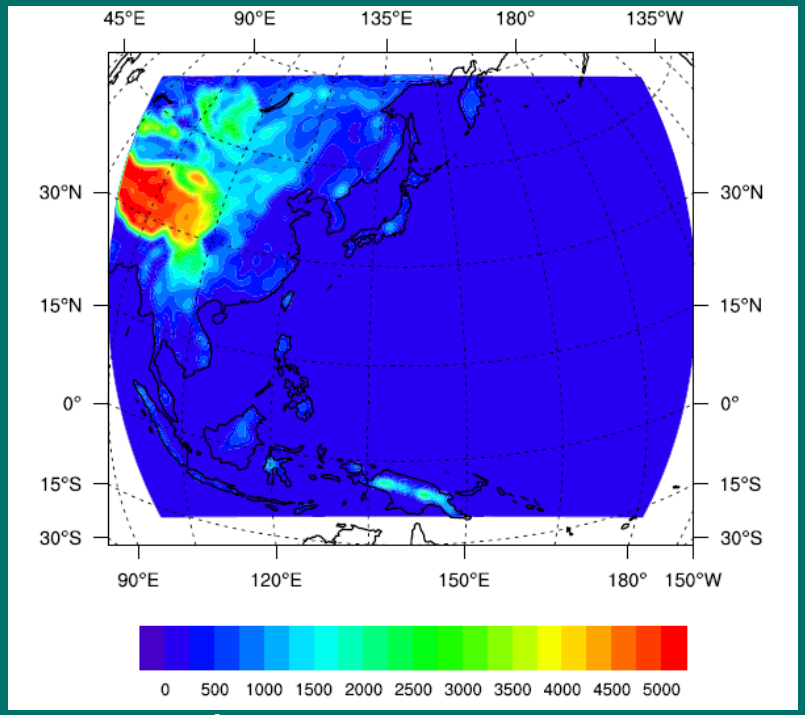

Barcikowska et al., 2012

**Distribution of CI-number differences for JTWC- JMADT assigned to intensity categories: a) TD, TS, 1, b) 2-3, c) 4-5. The circles indicate the percentage of the yearly occurrence number.**

**Limited reliability for inhomogeneous observational data sets (BTD) for WN Pacific to derive TC climate statistics**

## 2. Alternative TC climatology - downscaling TC activity in 1948-2011

- NCEP-NCAR reanalysis -> 200 km (too coarse)
- CCLM regional model -> 55 km



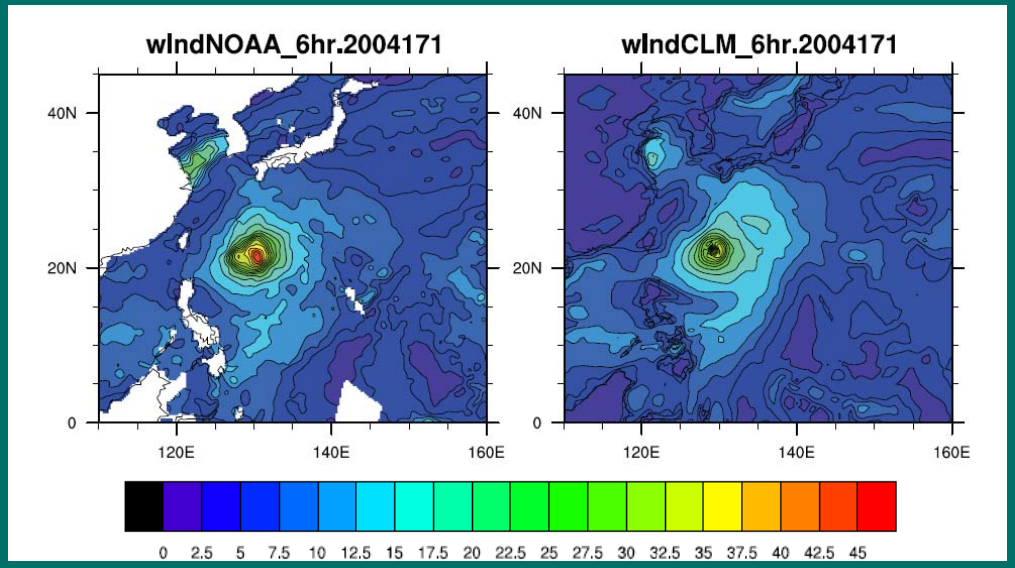

**Regional climate model:**

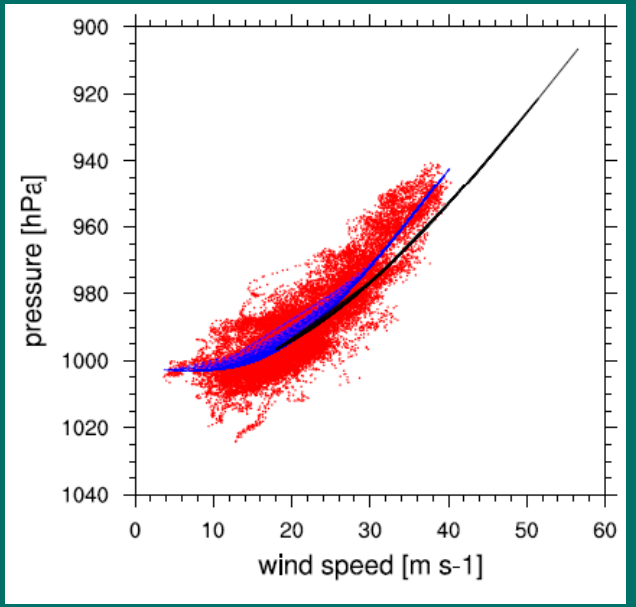
- COSMO – CLM
(**C**limate **L**imited-area **M**odel)
- WN Pacific and SE Asia domain,
- nonhydrostatic mode,
- convection: Tiedke scheme,
- spectral nudging technique (Feser and Barcikowska, 2012)

**To determine the trends of TC activity and their link to environmental large-scale pattern, the long term, homogenous time series are needed.**

## 2. Definition of extreme event in CCLM

**CCLM is capable to** downscale the meso-scale features of TCs, **BUT**

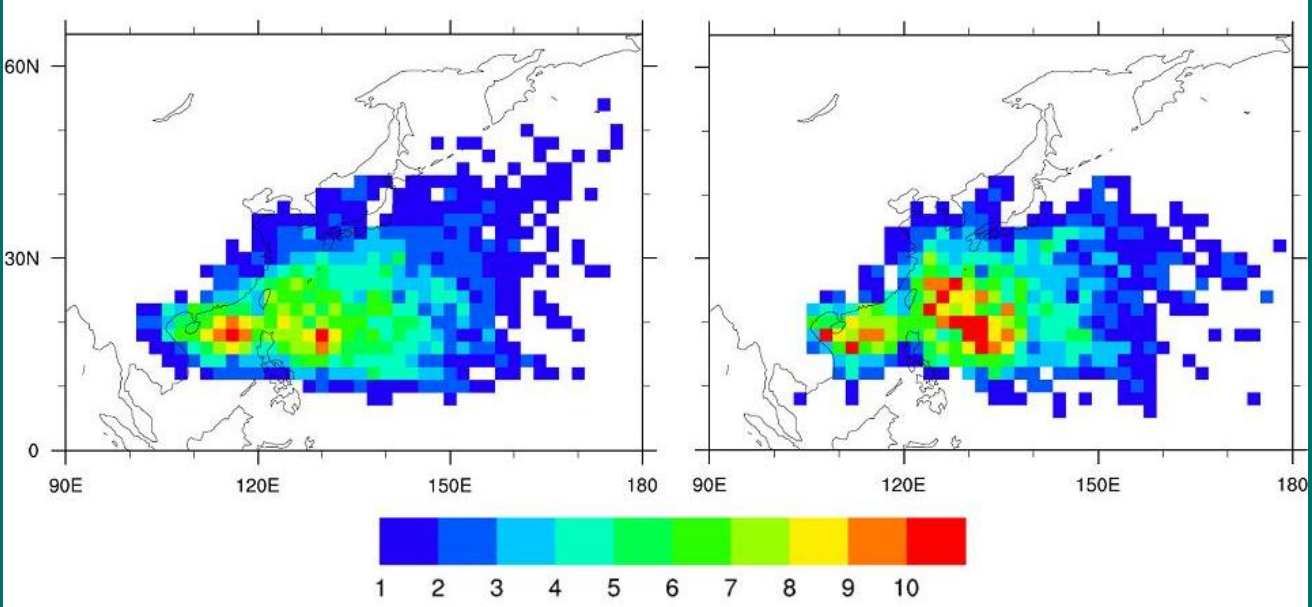



TCs intensity is underestimated:

- TCs can not exceed 40 m/s (3 cat of intensity (SSHS))
- Enhanced precipitation

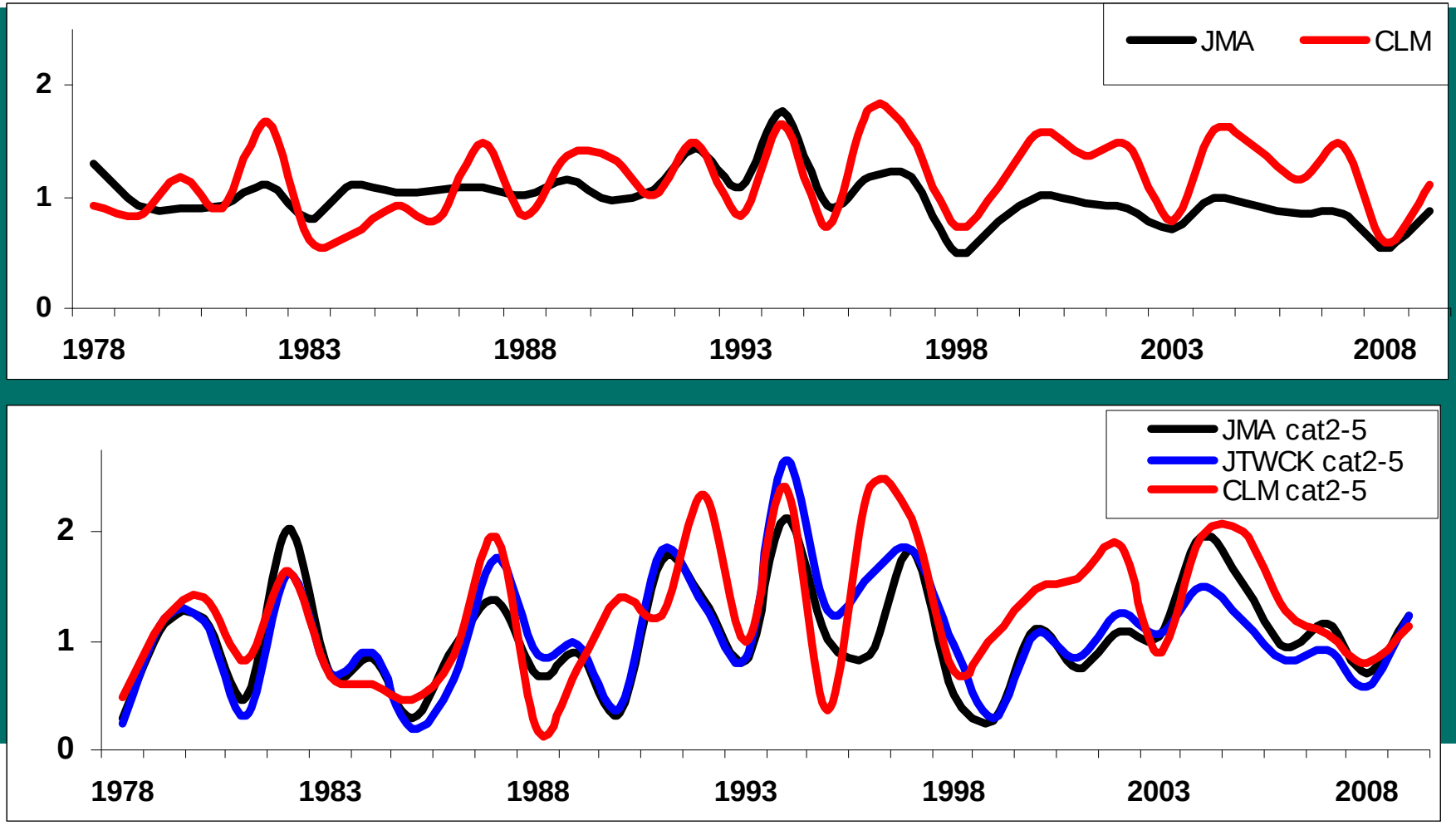
# 3. Comparison of TC in CCLM and observations: 1978-2011




**TC spatial densities (accumulated TC occurrence per grid point; normalized by the mean spatial density fields) for BTD (left) and CCLM (right) in period 1978-2011.**

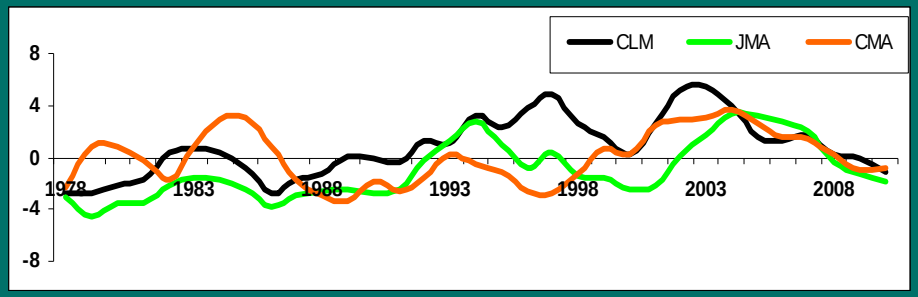
- higher ratio of TC occurrences in the main development region (10°-30°N,120°-150°E)
- TC tracks are shorter, rarely exceed subtropical latitudes

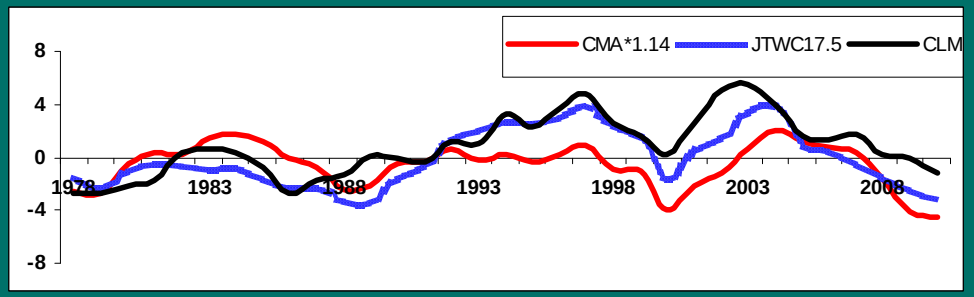
# 3. Comparison of TC in CCLM and observations: 1978-2011



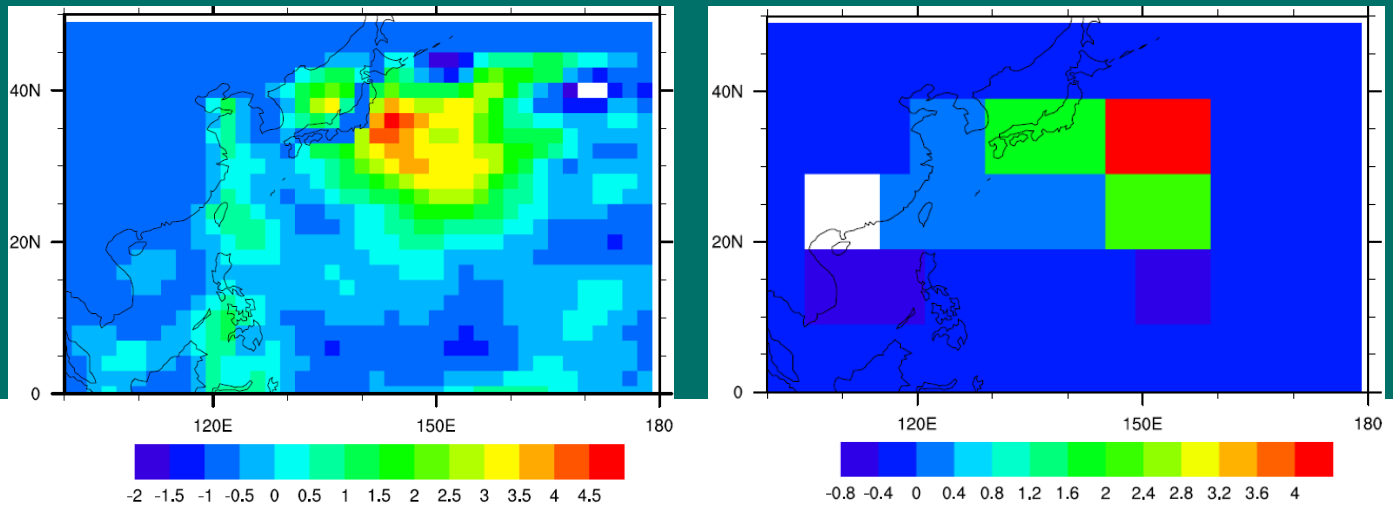

**Yearly TC days number variability in CCLM and observations**

# 3. Comparison of TC in CCLM and observations: 1978-2011



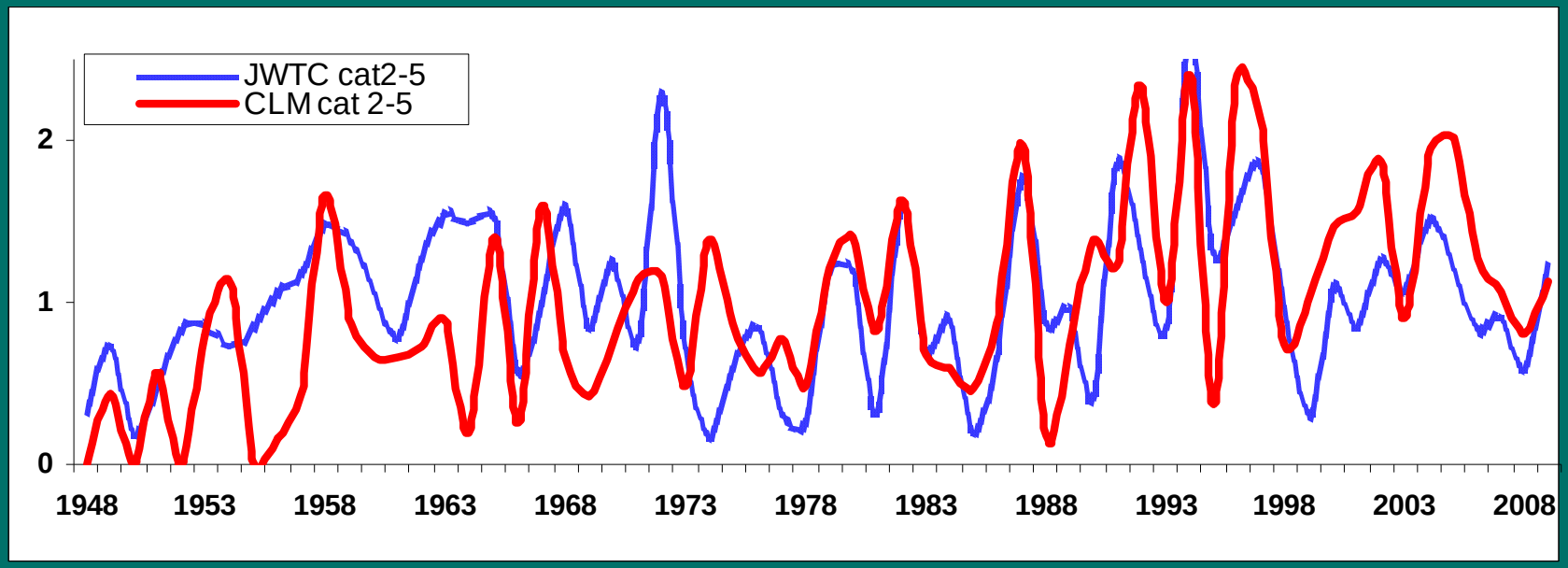




Time series of CCA (canonical correlation analysis) pattern (SST vs TC) for CLM and observations




First CCA pattern for TC spatial density and SST time series in CCLM

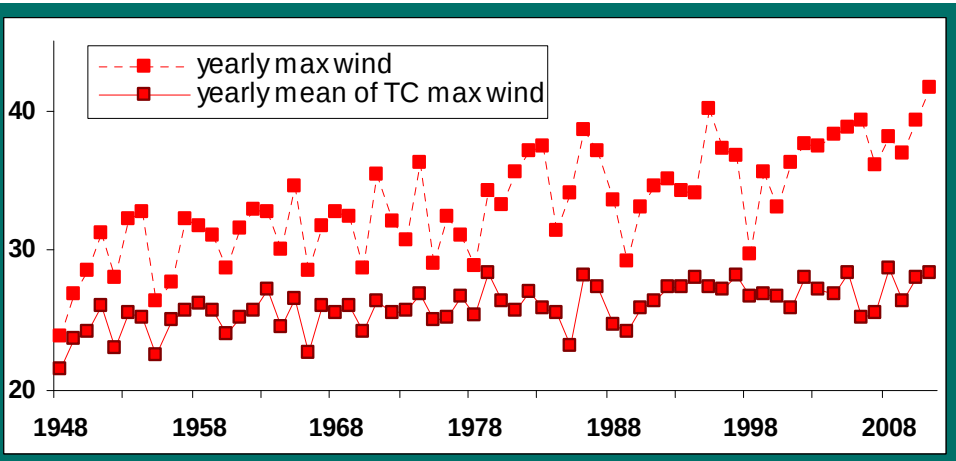
# 4. A long-term TC climatology over 1948-2011

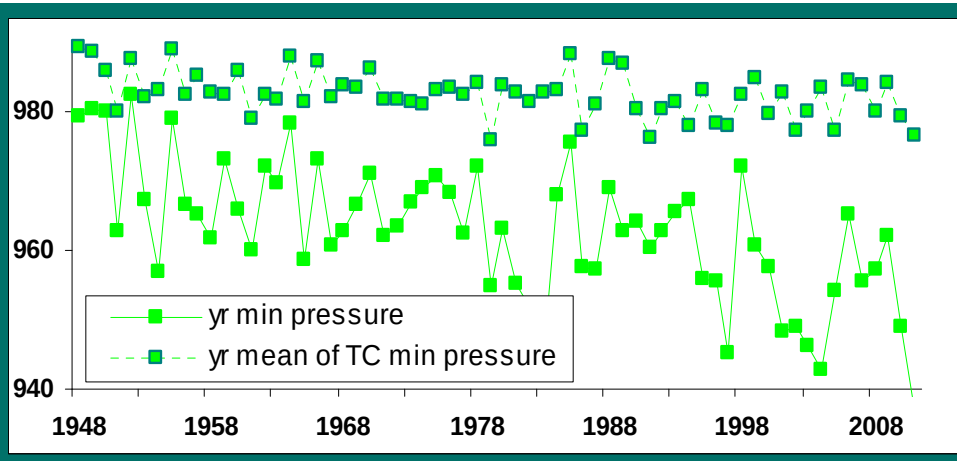



**Annual numbers TC days normalized by their mean values for the period 1948-2011, in CCLM for all TCs (red) and only the intense ones (blue).**

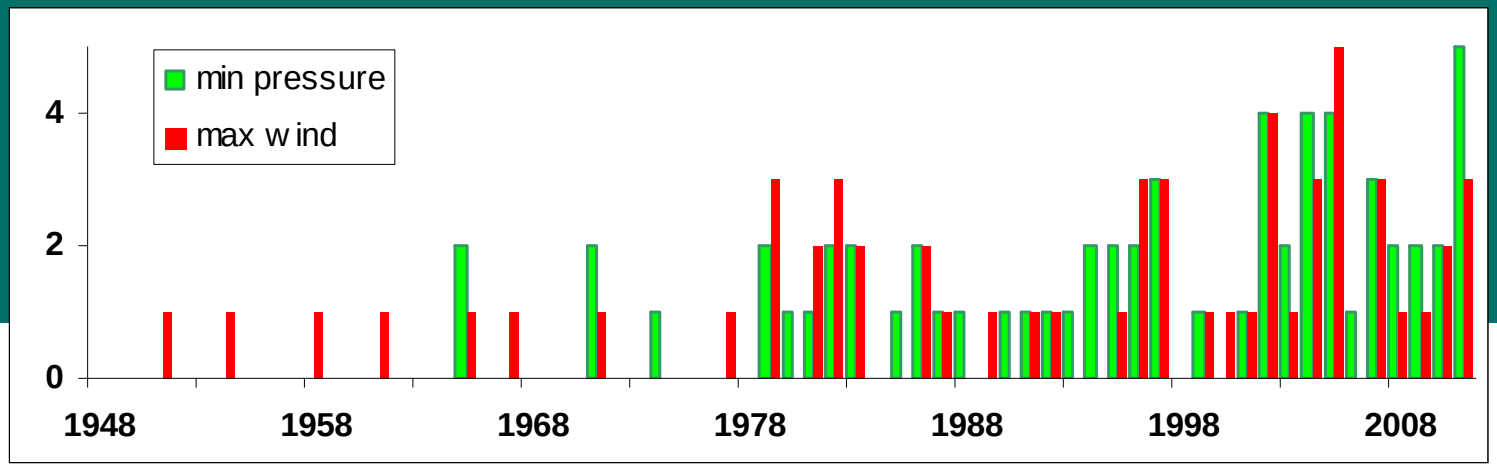
# 4. A long-term TC climatology over 1948-2011

## Increasing TC intensity



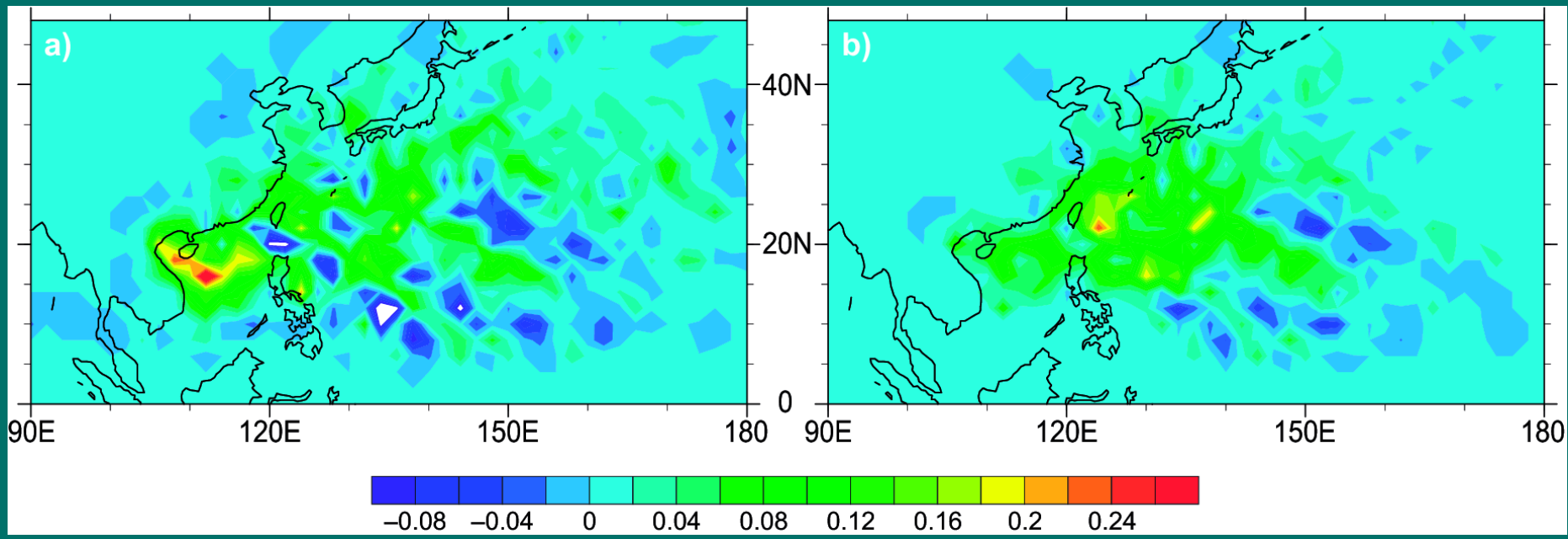




**Annual max of TC intensity (max wind and min pressure), annual mean of TC max intensity.**




**Number of TCs reaching intensity treshold (50 prcntile of annual max of TC intensity).**

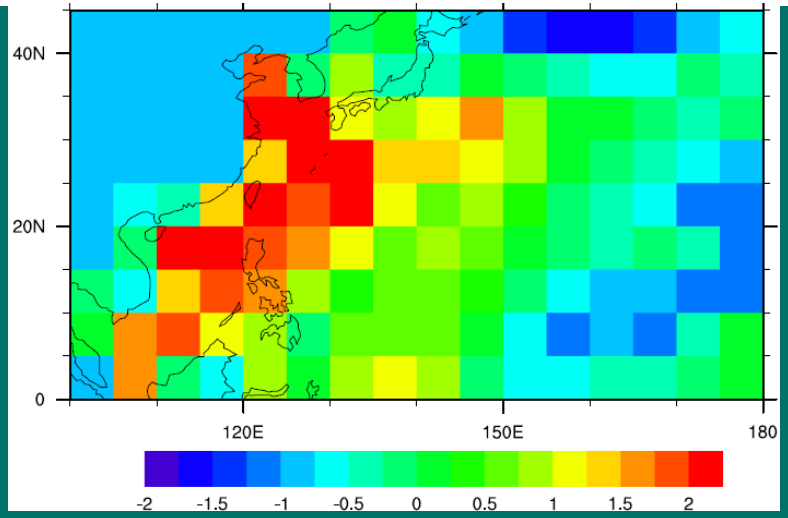
# 4. A long-term TC climatology over 1948-2011

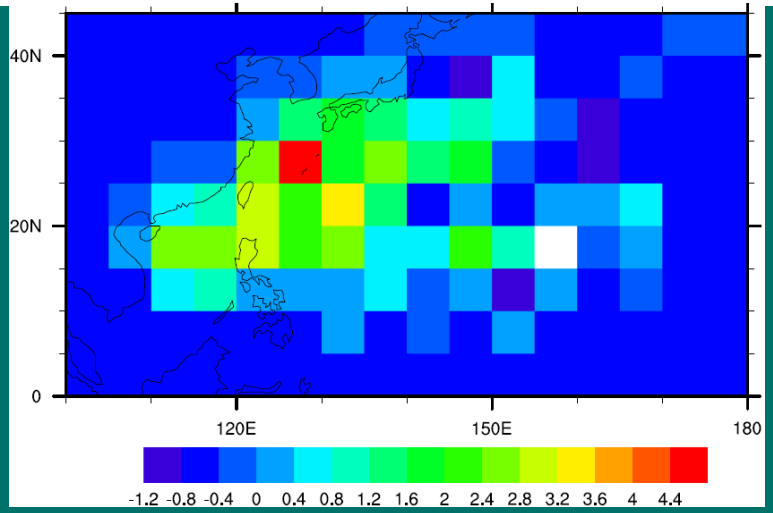



**Spatial fields of trend for annual TC days estimated with a linear regression using a least squares fit derived for every 2° x 2° grid box for a) all TCs and b) intense TCs; for the period 1948-2011.**

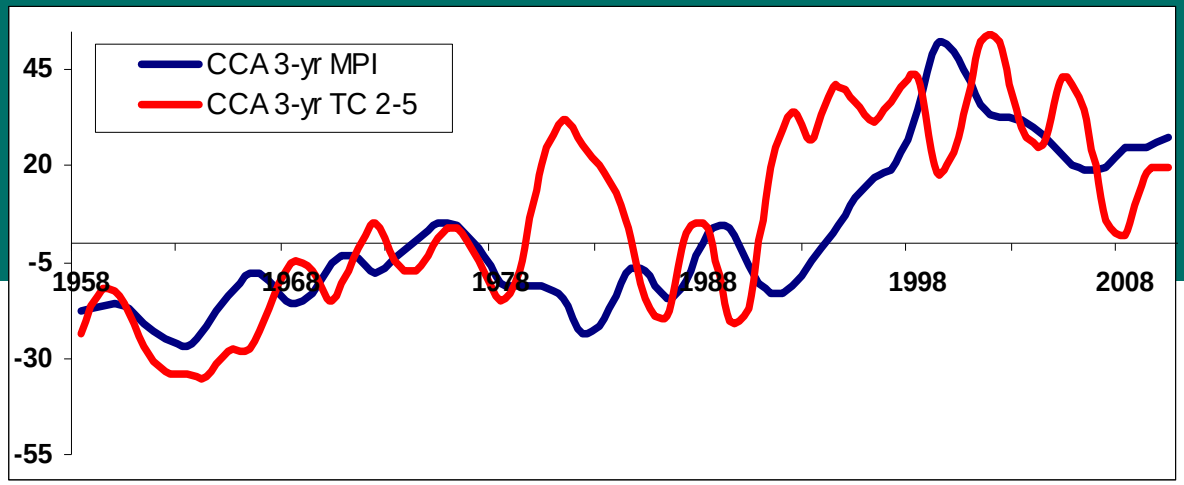
# 4. TC relationship with large-scale environmental patterns - Canonical Correlation Analysis

**Increasing favourable conditions for TC genesis lead to increased TC activity along the coast of SE Asia in the last decades.**




**CCA patterns for 3-yr MPI (CCA MPI) and 3-yr intense TCs (CCA TC), sharing a correlation of 68%.**

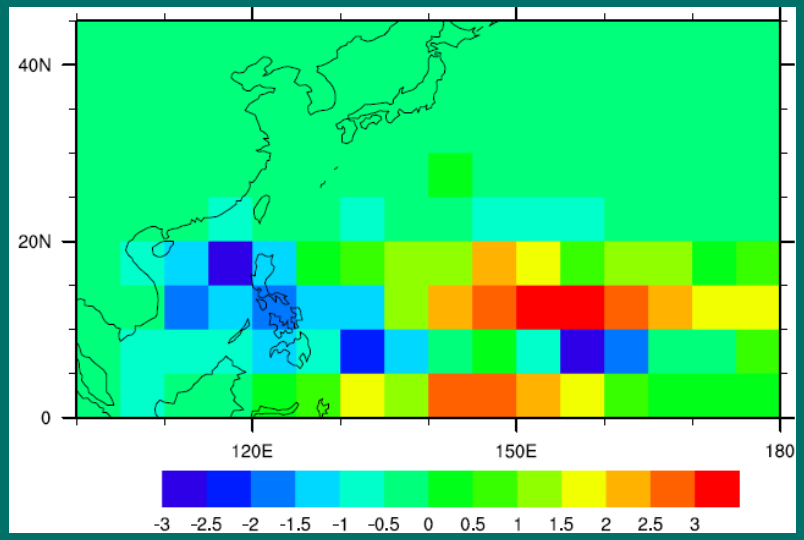


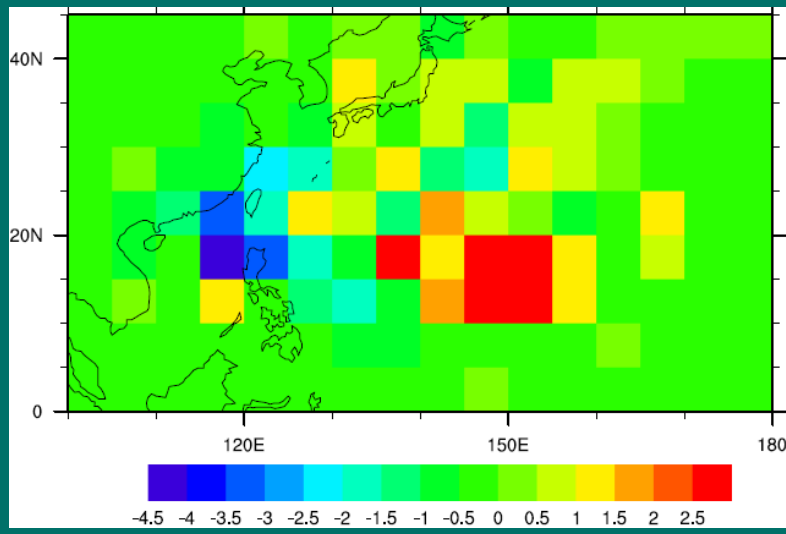

CCA time series, r=0.65

CCA TC explains 0.71 of TC variability

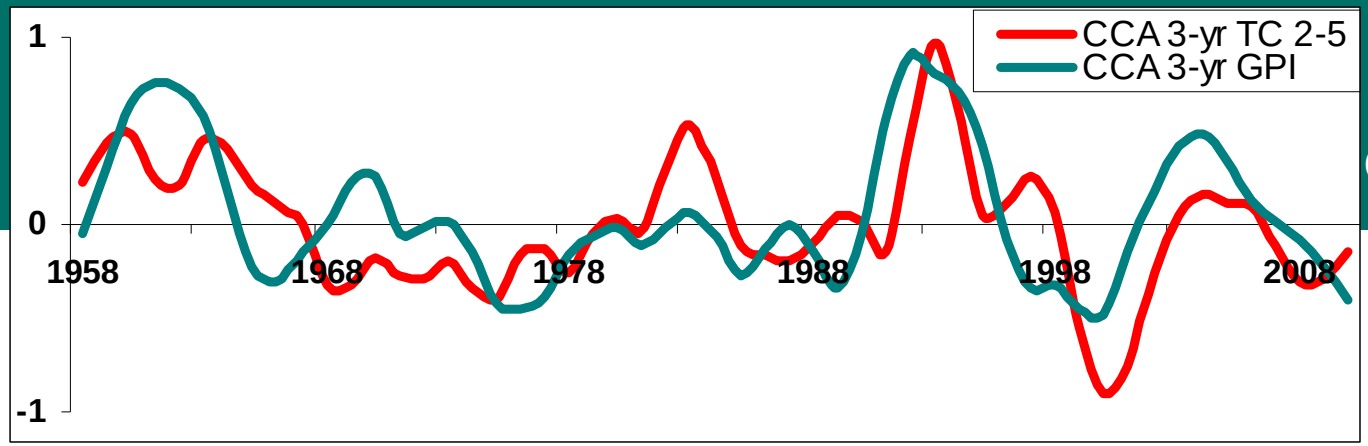
# 4. A long-term TC climatology over 1948-2011

CCA: GPI vs TC anomalies



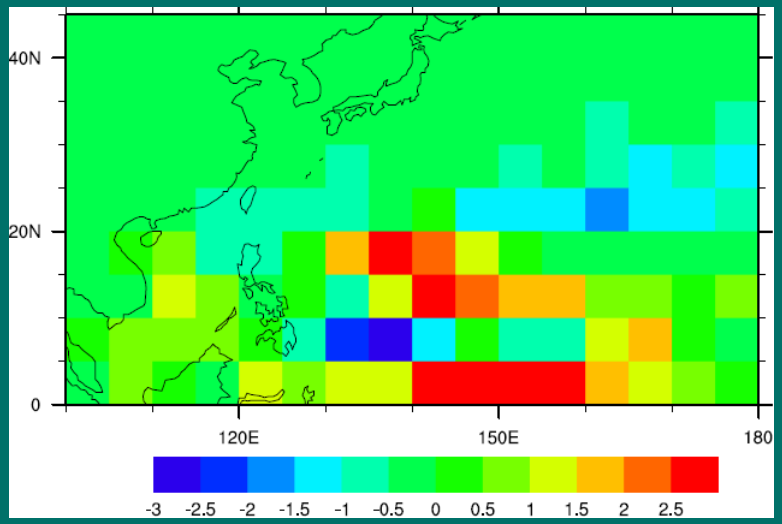

**CCA patterns for 10-yr GPI (CCA GPI) and 10-yr intense TCs (CCA TC), sharing a correlation of 68%.**

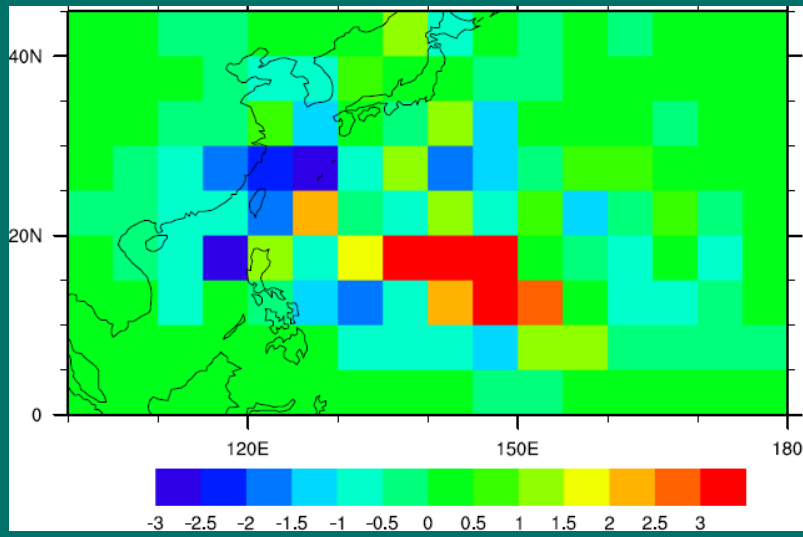



CCA time series, r=0.6

# 4. A long-term TC climatology over 1948-2011

CCA: GPI vs TC anomalies

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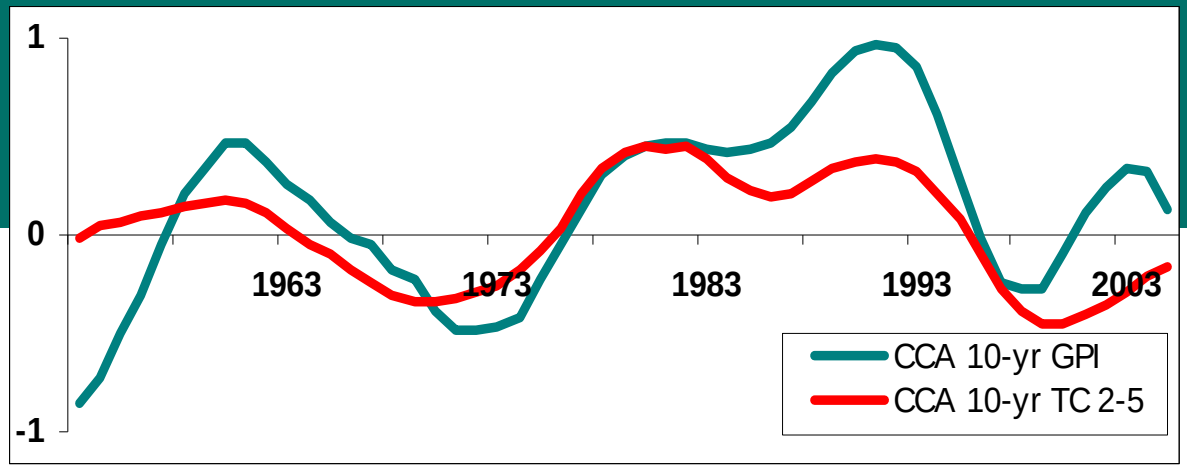


CCA time series, r=0.68

## SUMMARY

- Observations of TCs in WN Pacific are of limited reliability to derive TC statistics for the last decades
- CCLM is capable to derive long-term homogenous TC climatology
- TC activity over WN Pacific and SE Asia show

  upward tendencies and shift towards north-west
- Increasing TC activity is related to GPI, mean SST, ENSO
- HIgh TC activity in 90s is related to ENSO
- HIgh TC activity in 2000s is related to increased mean SST


Thank you!
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