

## Origin of 2011 Shift in the Seasonal Mean State

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#### Abstract

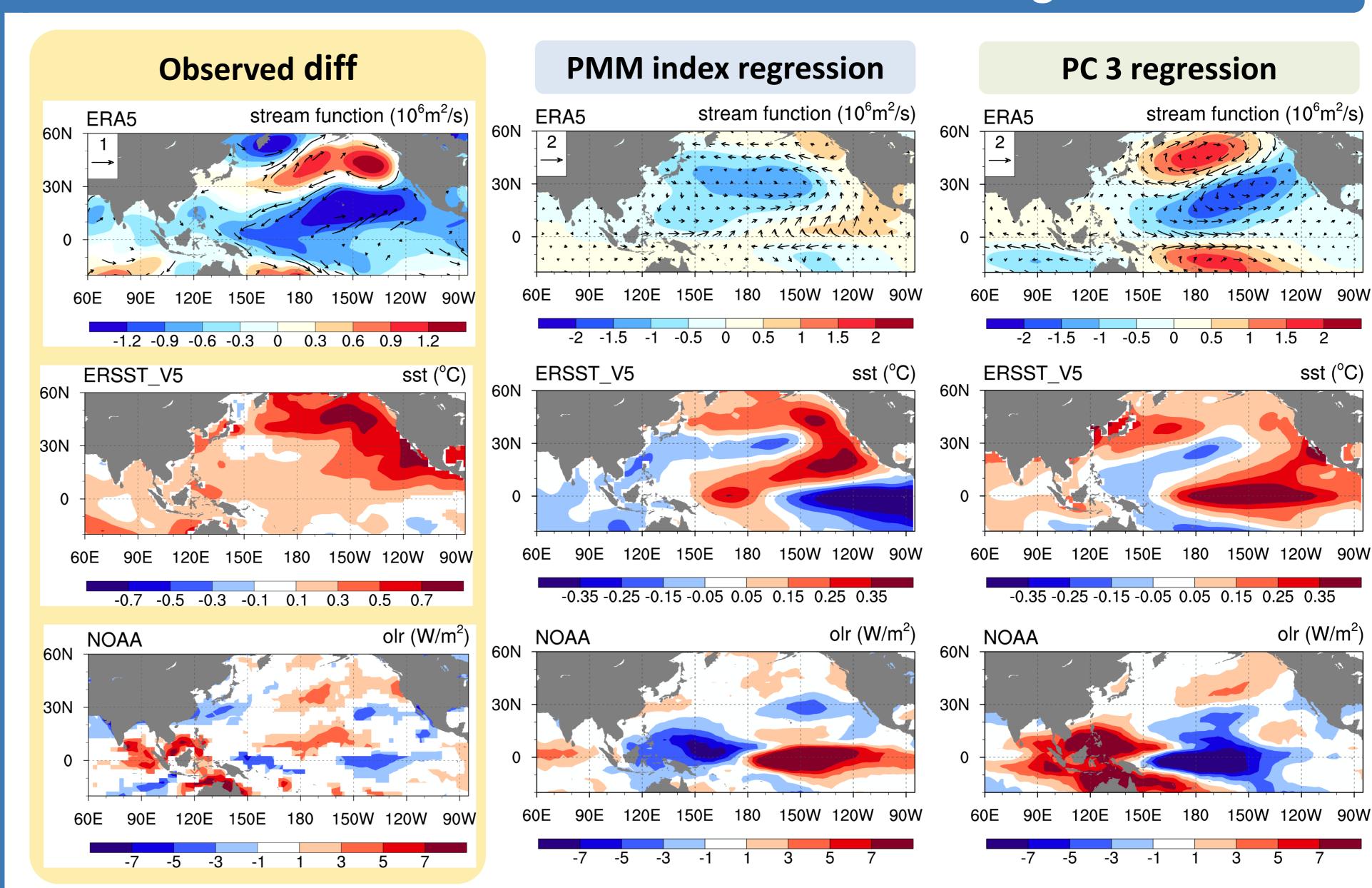
We explore the cause of 2011 shift in Madden-Julian Oscillation variance during Dec.-Feb. from 1979 to 2023. The results are as follows:

- Known factors and long-term results do not fully explain the shift. Explanations involving Pacific Meridional Mode (PMM)
  and typical atmospheric patterns from stream function EOF have been excluded.
- 2. Mechanistic simulations show the observed SST shift could be a responsible forcing but its origin needs further study.

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**Fig.1** In the Maritime Continent region, a significant regime shift in MJO variance (from OLR) was detected in 2011 (1979-2023, DJF). Source: Li-Chiang Jiang.

## Result 1: Observations do not match PMM or long-term modes

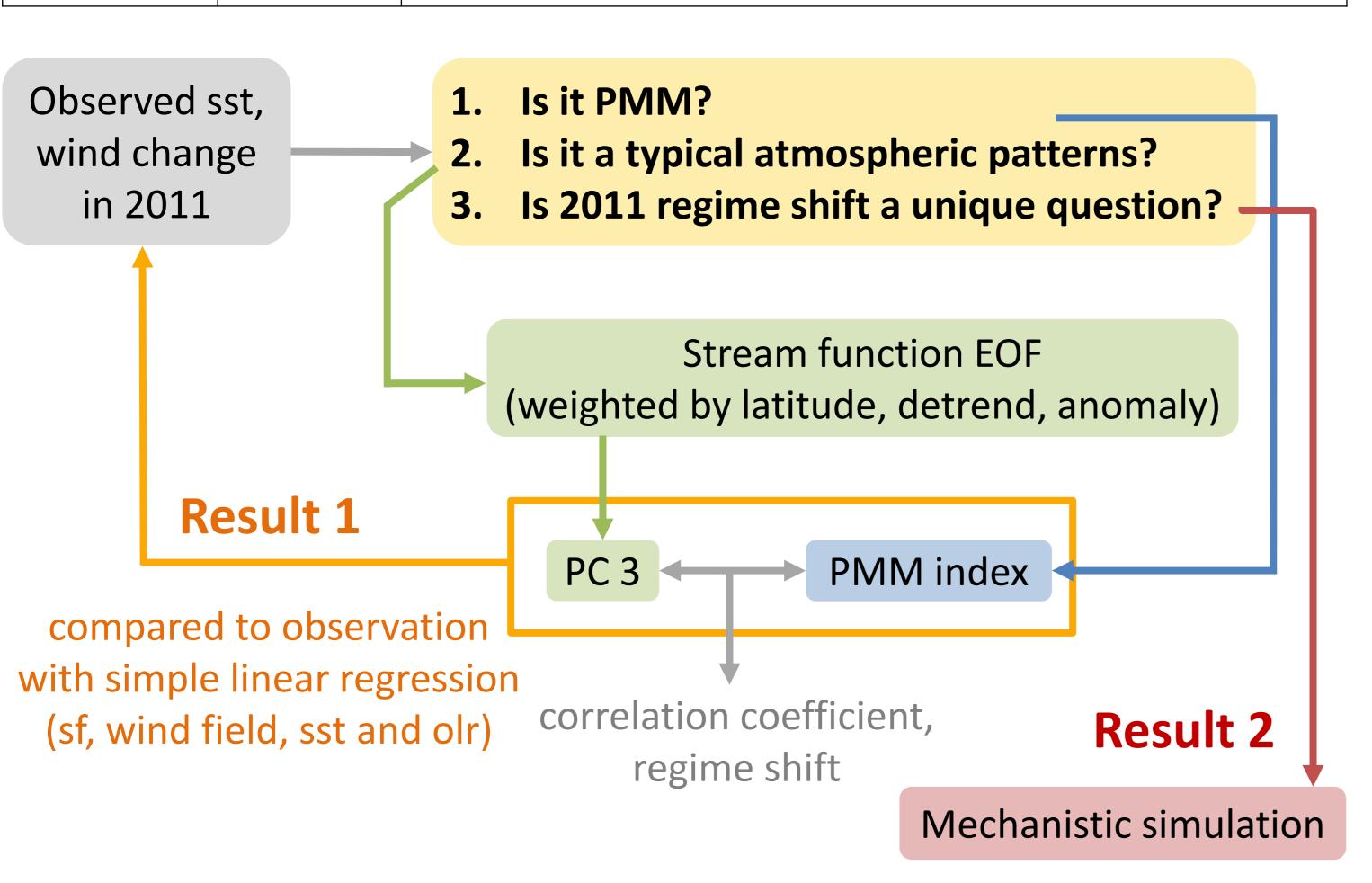


**Fig.2** Observed DJF average differences (2011 ±12 years), compared with PMM index and PC3 regression on 925mb stream function, wind field, SST, and OLR.

Total corr: 0.17

### Data & Methods

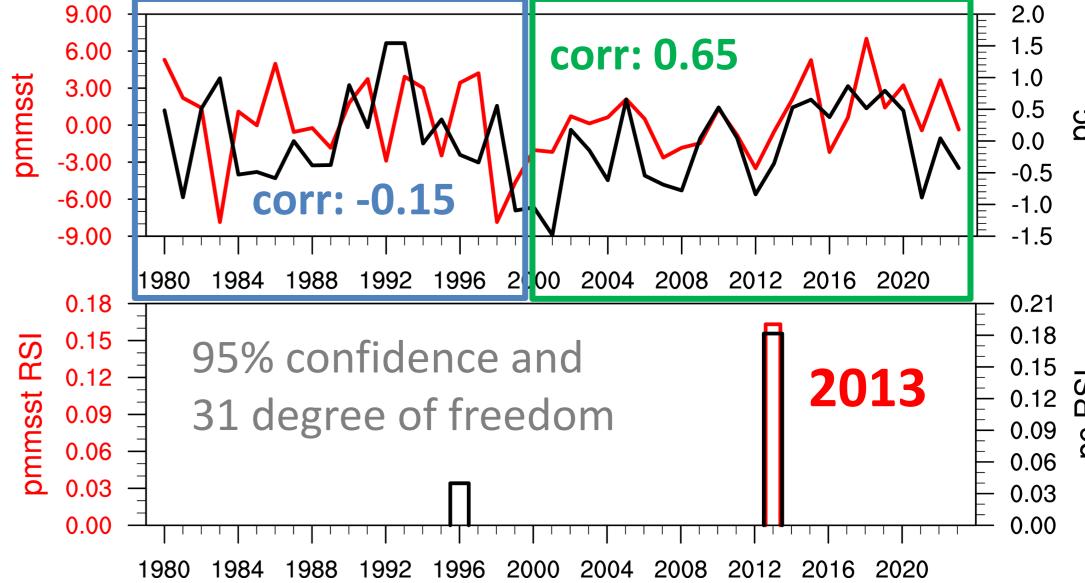
Data		ERA5	ERSST_V5	NOAA	
Type		Reanalysis	Observation	Observation	Index
Variables		SF, UV wind	SST	OLR	PMM SST
Resolution	Spatial	0.25° x 0.25°	2° x 2°	2.5° x 2.5°	X
	Temporal	1979 to 2023 Monthly (DJF)			



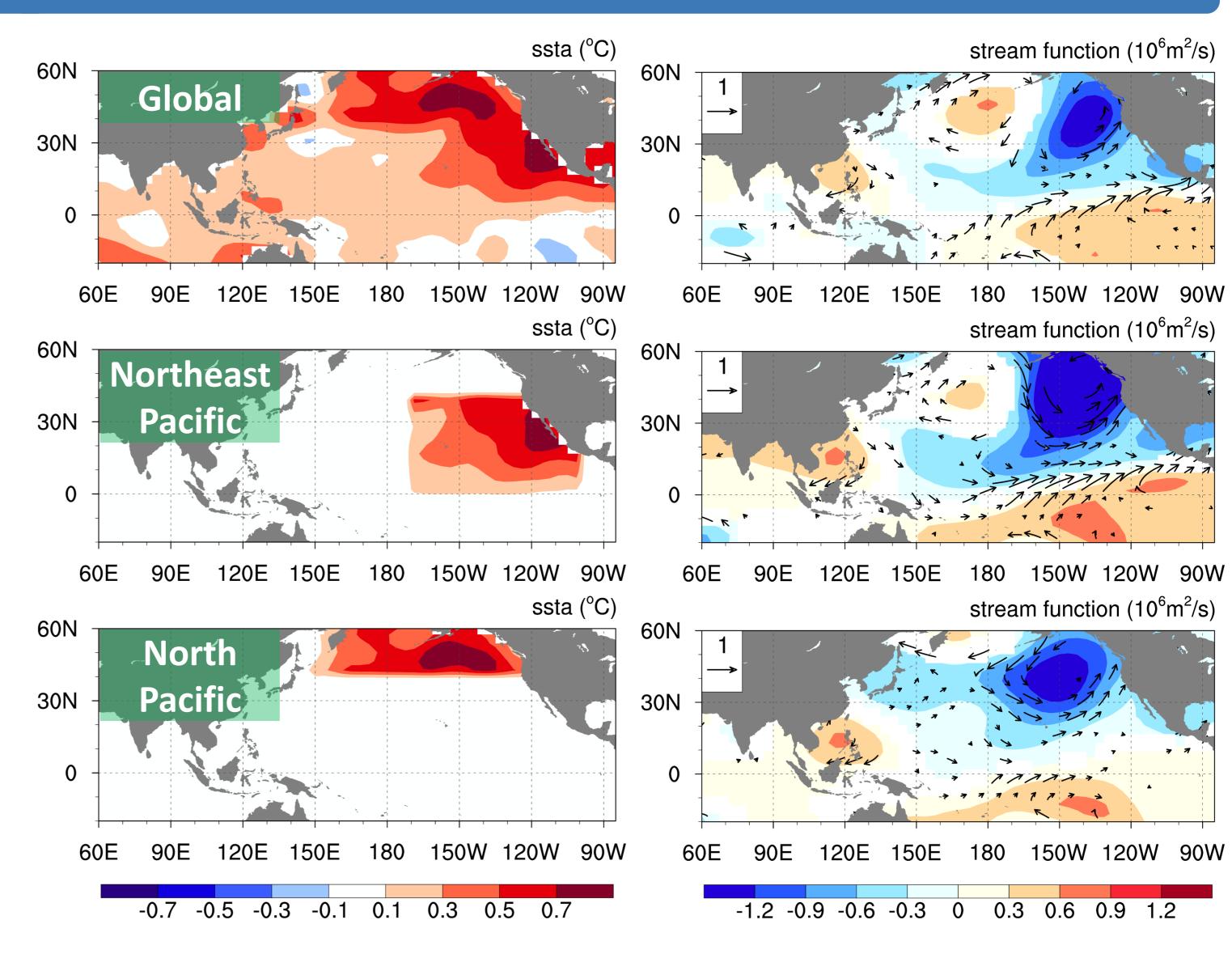
## experimental design

RUN	Time	SSTA region	
Control	1999-2011 DJF average	global	
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Northeast Pacific (positive)	DJF average differences (2011 ±12 years)	ON-40N, 100W-170W	
North Pacific (positive)	(ZUII IIZ years)	40N-60N, 120E-120W	

Fig.3 Correlation between the DJF mean PMM index and PC3, and regime shifts from 1979 to 2023 by sequential algorithm (S. N. Rodionov, 2004)



## Result 2: Mechanistic simulations



**Fig.4** Using SST anomalies from different regions for atmospheric simulations with SPEEDY model, the 925mb stream function and wind field are evaluated at a 90% confidence level.