

# **GLOBAL TRENDS IN THE OCCURRENCE AND CHARACTERISTICS OF BLOCKING ANTICYCLONES USING SEN INNOVATIVE TREND ANALYSIS**

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# INTRODUCTION

- **BLOCKING ANTICYCLONES HAS BEEN STUDIED DUE TO ITS IMPORTANT CONTRIBUTIONS TO ATMOSPHERIC PHENOMENA LIKE DROUGHTS, HEAVY PRECIPITATION, HEAT WAVES, AND COLD SPELLS. THESE EXTREMES HAVE AN ADVERSE EFFECT ON DAILY LIFE.**
- **INTERDECADAL VARIABILITY AND LONG-TERM TRENDS OF ATMOSPHERIC BLOCKING FOR BOTH HEMISPHERES ALSO STUDIED BY RESEARCHERS. STUDIES COVERING THE PERIOD OF LATE 20<sup>TH</sup> CENTURY FOR NH BLOCKING EVENTS SHOWED THAT LONG-TERM TRENDS DEPEND ON THE SEASON AND REGION. HOWEVER, LUPO ET AL. (2019), SHOWED THAT BLOCKING OCCURRENCES HAVE DECREASED DUE TO MINIMUM IN LATE 20<sup>TH</sup> CENTURY, BUT AN INCREASE IN BLOCK OCCURRENCE SINCE THE BEGINNING OF 21<sup>ST</sup> CENTURY.**

# INTRODUCTION

- IN THE SH, WIEDENMANN ET AL. (2002) SHOWED THAT OCCURRENCE AND DURATION OF BLOCKING DECREASED STRONGLY DURING THE LAST PART OF 20<sup>TH</sup> CENTURY. OLIVERIA ET AL. (2014) FOUND NO STATISTICALLY SIGNIFICANT TREND IN WHOLE SH. LUPO ET AL. (2019) DEMONSTRATED THAT BLOCKING OCCURRENCE AND DURATION HAS INCREASED SIGNIFICANTLY AT THE START OF THE 21<sup>ST</sup> CENTURY.
- THE SEN INNOVATIVE TREND ANALYSIS METHOD (ITA) (ŞEN, 2012) IS A TECHNIQUE BY WHICH THE TREND IS DETECTED VISUALLY. IT IS A WIDELY USED METHOD IN ENVIRONMENTAL SCIENCES. ŞEN AND AKSU (2021) USED ITA TO DETECT TREND IN MAXIMUM PRECIPITATION IN İSTANBUL, TURKEY. CUI ET AL. (2019) INVESTIGATED THE TREND OF ANNUAL AND SEASONAL AIR TEMPERATURE AND RAINFALL IN YANGTZE RIVER BASIN IN CHINA.

# MOTIVATION AND GOALS

- THIS STUDY IS UNIQUE IN THAT IT USES THE ITA IN ORDER TO DETECT TRENDS IN BLOCKING OCCURRENCE, DURATION AND BLOCKING INTENSITY IN BOTH THE NH AND SH.
- THE GOAL OF THIS WORK IS TO APPLY ITA FOR BLOCKING CHARACTER IN ORDER TO DETERMINE WHETHER ITA SUPPORTS THESE PREVIOUSLY PUBLISHED RESULTS. ADDITIONALLY, THE ITA ANALYSIS CAN PROVIDE MORE INFORMATION ABOUT TRENDS THAN THE TRENDS INFERRED IN LUPO ET AL. (2019)

# DATA

- THE BLOCKING DATA USED HERE ARE ARCHIVED AT THE UNIVERSITY OF MISSOURI BLOCKING ARCHIVE (2021 – [HTTP://WEATHER.MISSOURI.EDU/GCC](http://weather.missouri.edu/gcc)).
- THE VARIABLES USED IN STUDY INCLUDES THE BLOCKING INTENSITY, BLOCKING DURATION AND ANNUAL BLOCKING NUMBERS. THE STUDY COVERS THE PERIOD FROM 1968 TO 2019 (NH) AND 1970 – 2019 (SH).
- THE TREND IN BLOCKING PARAMETERS WAS INVESTIGATED FOR THE ENTIRE HEMISPHERE AND THEN FOR DIFFERENT PREFERRED BLOCKING REGIONS FOR BOTH HEMISPHERES. IN NH THE PREFERRED BLOCKING REGIONS ARE: ATLANTIC ( $80^{\circ}$  W– $40^{\circ}$  E), PACIFIC (LB:  $140^{\circ}$  E– $100^{\circ}$  W) AND CONTINENTAL ( $100^{\circ}$  – $80^{\circ}$  W AND  $40^{\circ}$ – $140^{\circ}$  E). THE SH THE PREFERRED REGIONS ARE: ATLANTIC ( $60^{\circ}$  W– $30^{\circ}$  E), PACIFIC ( $130^{\circ}$  E– $60^{\circ}$  W) AND INDIAN ( $30^{\circ}$  –  $130^{\circ}$  E).

# METHODS

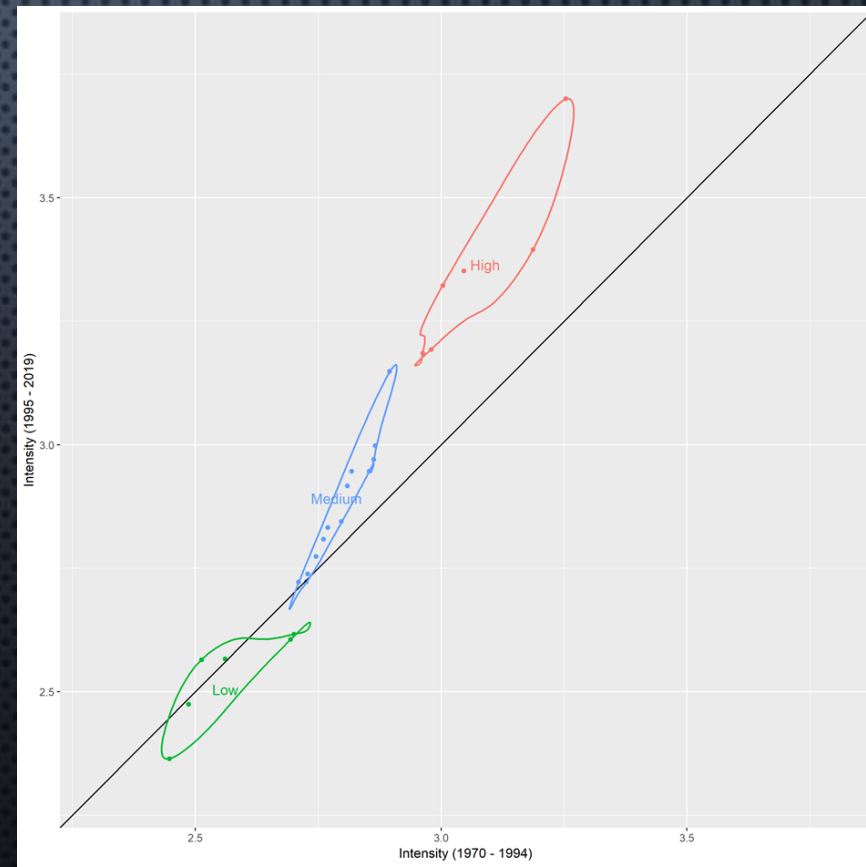
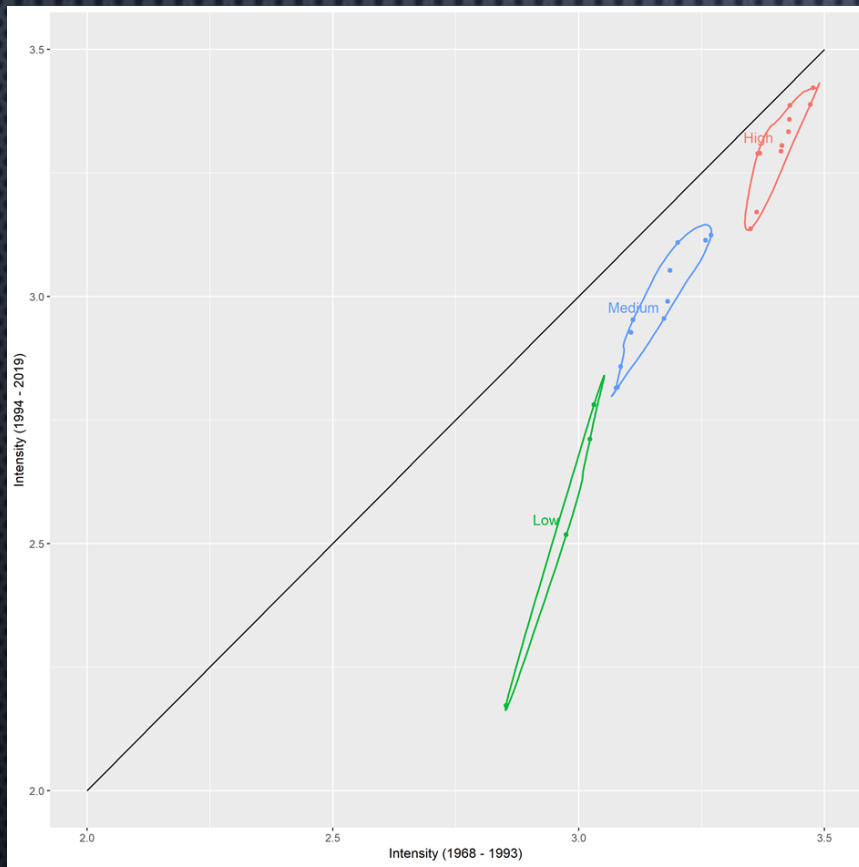
- THE ŞEN INNOVATIVE TREND ANALYSIS METHOD (ŞEN, 2012) WHICH IS A NON-PARAMETRIC TREND TEST AND WAS USED HERE.
- THIS METHOD IS COMPOSED OF SEVERAL STEPS: 1) DATA ARE SEPARATED INTO TWO EQUAL HALVES, 2) DATA ARE SORTED IN ASCENDING ORDER FOR BOTH HALVES, 3) PLOT THE SCATTER OF THESE ORDERED DATA IN CARTESIAN COORDINATE SYSTEM WITH THE ADDITION OF THE 1:1 (TREND FREE) LINE.

# METHODS

- THE ORDERED DATA IN FIRST HALF IS LOCATED ON THE ABSCISSA AND SECOND HALF IS LOCATED ON THE ORDINATE.
- THE NON – PARAMETRIC MANN – KENDALL TAU TEST WHICH IS A WIDELY USED TREND TEST IN ATMOSPHERIC SCIENCES IS ALSO APPLIED IN ORDER TO DETECT TREND (KENDALL, 1975).

# RESULTS

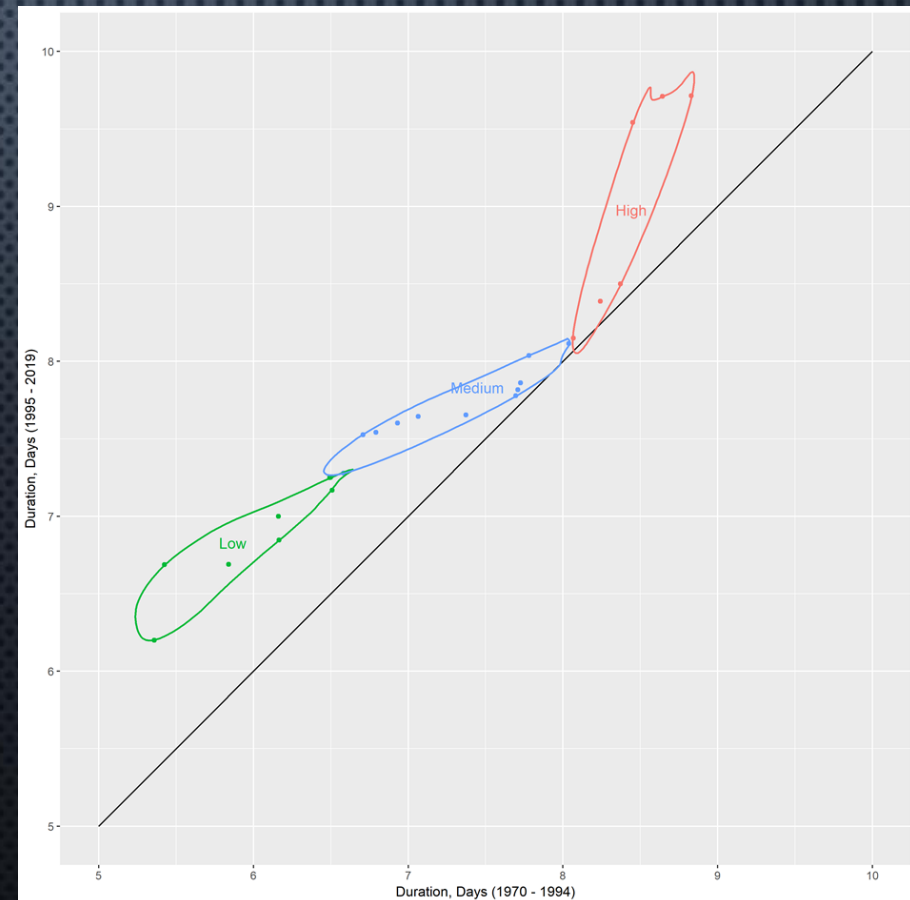
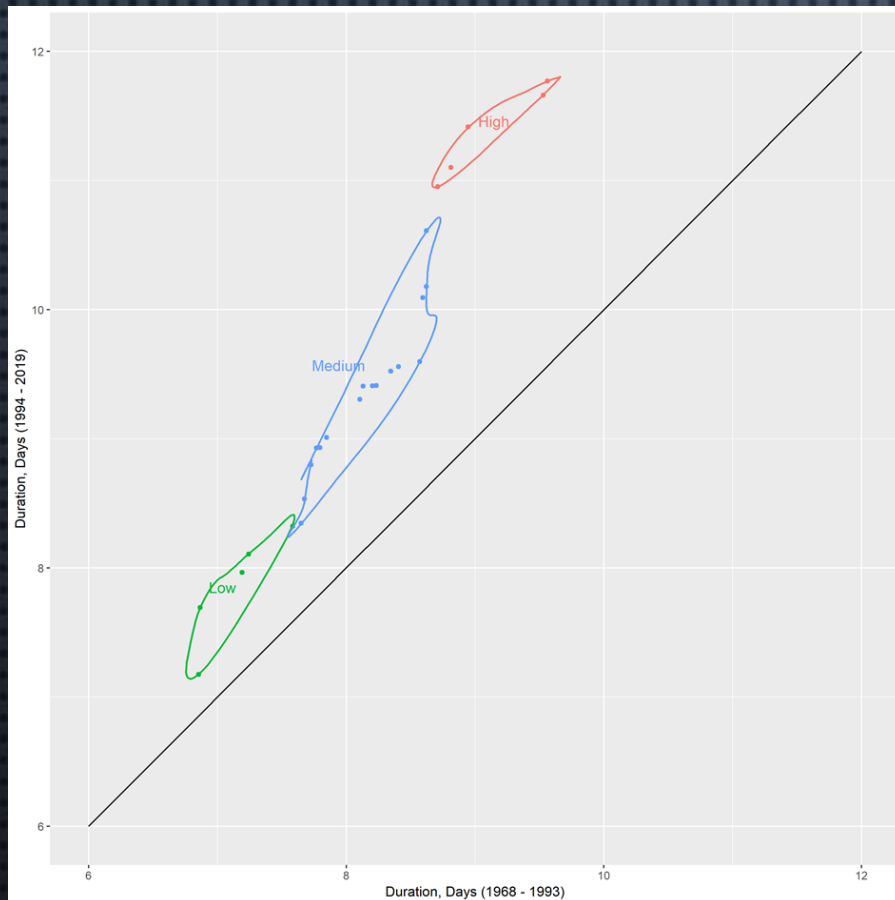
- FOR THE NH (LEFT) AND SH (RIGHT) INTENSITY: GREEN (WEAK BLOCKS), BLUE (MODERATE BLOCKS), RED (STRONG BLOCKS).





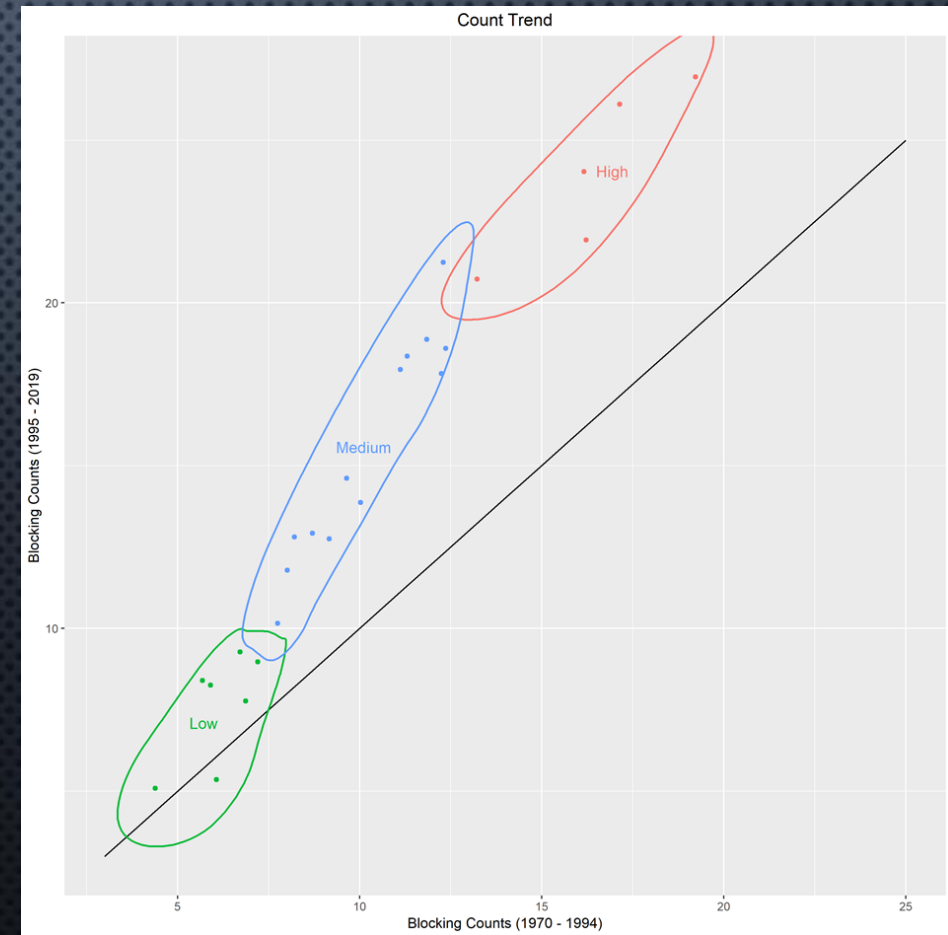
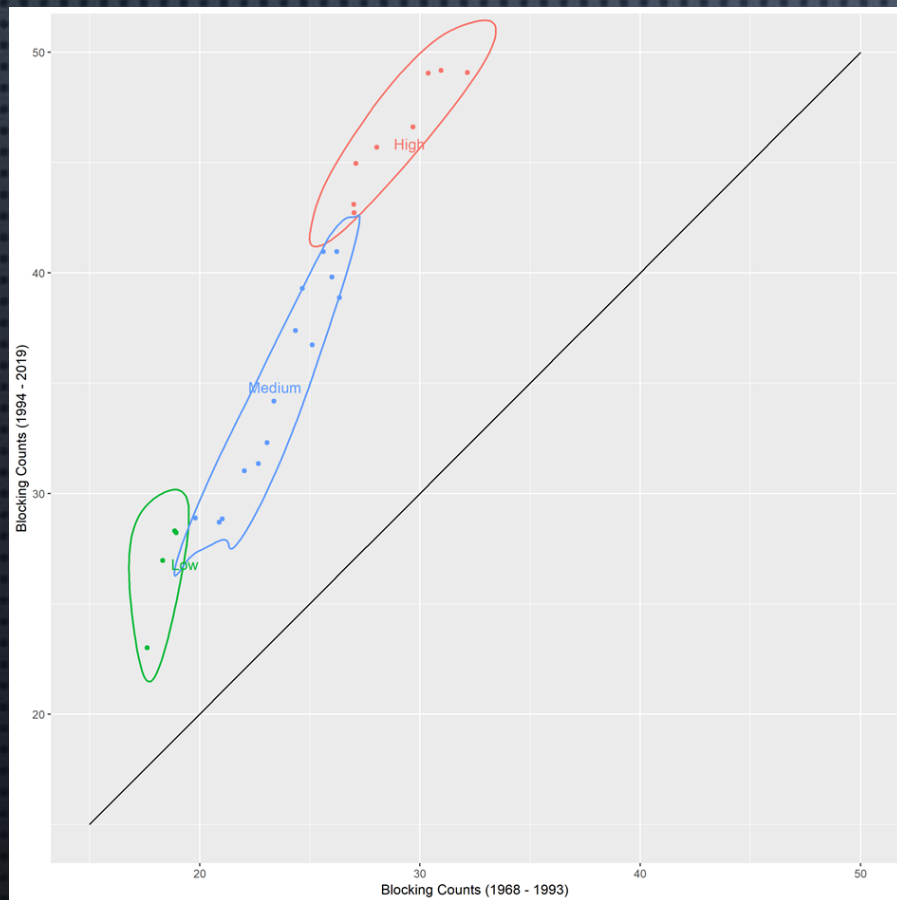
# RESULTS

- FOR THE NH (LEFT) AND SH (RIGHT) PERSISTENCE: GREEN (LESS PERSISTENT BLOCKS), BLUE (TYPICAL BLOCKS), RED (MORE PERSISTENT BLOCKS)



# RESULTS

- FOR THE NH (LEFT) OCCURRENCE: GREEN (LESS BLOCKING), BLUE (TYPICAL BLOCKING YEAR), RED (MORE BLOCKING)



# RESULTS

- THE STATISTICAL TESTING RESULTS: NH (TOP) AND SH (BOTTOM), BOLD → P = 0.10, \* → P = 0.05, AND \*\* → P = 0.01

	Northern Hem.	Atlantic Region	Pacific Region	Continental Region
Blocking Intensity	-0.15	-0.14	0.005	<b>-0.18</b>
Blocking Number	<b>0.52**</b>	<b>0.33**</b>	<b>0.45**</b>	<b>0.49**</b>
Blocking Duration	<b>0.37**</b>	<b>0.37**</b>	<b>0.34**</b>	<b>0.25**</b>

	Southern Hem.	Atlantic Region	Pacific Region	Indian Region
Blocking Intensity	0.04	0.07	0.11	0.001
Blocking Number	<b>0.34**</b>	0.17	<b>0.34**</b>	0.15
Blocking Duration	<b>0.17</b>	<b>0.22*</b>	<b>0.20*</b>	0.07

# SUMMARY

- THIS STUDY EXAMINED THE TREND ANALYSIS OF ATMOSPHERIC BLOCKING CHARACTERISTICS BY USING ŞEN'S INNOVATIVE TREND ANALYSIS METHOD FOR BOTH NORTHERN (1968 - 2019) AND SOUTHERN HEMISPHERES (1970 – 2019). . ŞEN'S INNOVATIVE TREND ANALYSIS METHOD IS NON-PARAMETRIC TREND TEST WHICH IS PERFORMED VISUALLY.
- THE BLOCKING DATA ARCHIVED IN UNIVERSITY OF MISSOURI INCLUDES BLOCKING OCCURRENCE, BLOCKING DURATION, BLOCKING SIZE, ONSET LONGITUDE, BLOCKING INTENSITY, PREFERRED LOCATION.
- THE NCEP – NCAR RE-ANALYSIS 500 hPa GEOPOTENTIAL HEIGHT DATA IS USED TO DETECT BLOCKING IN THIS DATASET. BI IS THE CHARACTERISTIC THAT IS FIRSTLY USED BY THIS RESEARCH GROUP.

# CONCLUSIONS

- THE SEN ITA CONFIRMS THE LONG TERM TRENDS FOUND IN LUPO ET AL. (2019). HOWEVER, THERE ARE SOME RESULTS CITED BELOW THAT COULD NOT BE GAINED FROM TRADITIONAL ANALYSIS OF VARIANCE TECHNIQUES.
- IN THE NH, THE DECREASE IN BI IS LARGEST AMONG WEAK BLOCKING EVENTS, WHILE THE INCREASE IN BLOCK FREQUENCY IS OCCURRING MOST STRONGLY AMONG YEARS WITH FEWER BLOCKING EVENTS.
- FURTHER, THE DECREASE IN BI AMONG WEAK EVENTS AND INCREASE IN BLOCK PERSISTENCE IS MOST PREVALENT IN THE ATLANTIC OCEAN REGION.

# CONCLUSIONS

- IN THE SH, THE LARGEST INCREASE IN BI IS AMONG MODERATE BLOCKING EVENTS, AND THE LARGEST INCREASE IN FREQUENCY IS AMONG TYPICAL YEARS.
- EXAMINING INDIVIDUAL REGIONS, THE BI IS INCREASING AMONG MODERATE AND STRONG BLOCKING EVENTS, WHILE PERSISTENCE INCREASES ARE FOUND AMONG THE MOST PERSISTENT OF PACIFIC REGION BLOCKING, AND INCREASES IN BLOCKING OCCURRENCE ARE NOTED AMONG TYPICAL YEARS IN BOTH THE ATLANTIC AND PACIFIC OCEAN REGION.

# THE END

- QUESTIONS?
- COMMENTS?
- CRITICISMS?
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