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The effects of ENSO-types and SAM on the large-scale southern blockings

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Estrutura da apresentação

1. Introdução

- a. O que é bloqueio
- b. O que é ENSO
- c. El Niño: Canonical x Modoki
- d. Modo Anular Sul (Southern Annular Mode , SAM)

2. Objetivo Principal do Artigo

3. Dados e Metodologia

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- b. Setores de Bloqueio
- c. Índice SAM Diário
- d. Índice ENSO Mensal

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Objetivo Principal do Artigo

É prover uma análise observacional sobre os efeitos combinados dos tipos de ENSO e os padrões de SAM sobre as atividades de bloqueio.

O que é Bloqueio Atmosférico?

1. É um regime setorial do clima de natureza não linear gerando persistência de eventos extremos sobre os continentes;
2. O bloqueio pode ser descrito como uma onda planetária quase estacionária de grande amplitude entre a variabilidade de baixa frequência (padrões de teleconexão) e alta frequência (vórtices);
3. Impactos socioeconômicos.

O que é o ENSO

É a flutuação periódica na temperatura da superfície do mar e da pressão do ar sobre a atmosfera ao longo do Pacífico equatorial.

El Niño: Canonical x Modoki

1. É caracterizado por anomalias da temperatura da superfície do mar na região da língua fria; e
2. É caracterizado por anomalias da temperatura da superfície do mar confinada próxima à região das linhas de dados.

Modo Anular Sul (Southern Annular Mode, SAM)

É o padrão de variabilidade climática de larga escala nos extratropicais no hemisfério sul.

1. Apresentam forte relação com o ENSO
2. Podem intensificar ou enfraquecer a ocorrência de bloqueios devido a junção com o El Niño.

Dados e Método: Índice de Bloqueio 2D

1. National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR)
2. Geopotencial 500 hPa (Z500)
3. 1979-2010 (32 anos)
4. médias diárias
5. $0.5^\circ \times 0.5^\circ$
6. Blocking Index: é adaptado da versão de Tibaldi et al. (1994)

Dados e Método: Setores de Bloqueio

Table 1. Blocking sectors, acronyms, regional domains and longitudinal boundaries.

Sectors	Acronym	Regional domains	Longitudinal boundaries
East Indian Ocean	SE Indian	Indian Ocean and AUS	90° – 150°E
Southwest Pacific Ocean	SW Pacific	NZ and Southwest Pacific	150°E – 140°W
Southeast Pacific Ocean	SE Pacific	Southeast Pacific and Western Coast of SSA	140° – 80°W
Southwest Atlantic Ocean	SW Atlantic	SSA and Southwest Atlantic	80° – 30°W

AUS, Australian, NZ, New Zealand and SSA, Southern Southern America.

Dados e Método: Índice SAM Diário

1. National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR)
2. Anomalia do Geopotencial 700 hPa (Z700)
 - a. obtida pela função Ortogonal Empírica
 - i. através da remoção do ciclo anual computando o primeiro harmônico pela transformação discreta de Fourier
3. 1979-2010 (32 anos)
4. médias diárias
5. $2.5^\circ \times 2.5^\circ$

Dados e Método: Índice SAM Diário

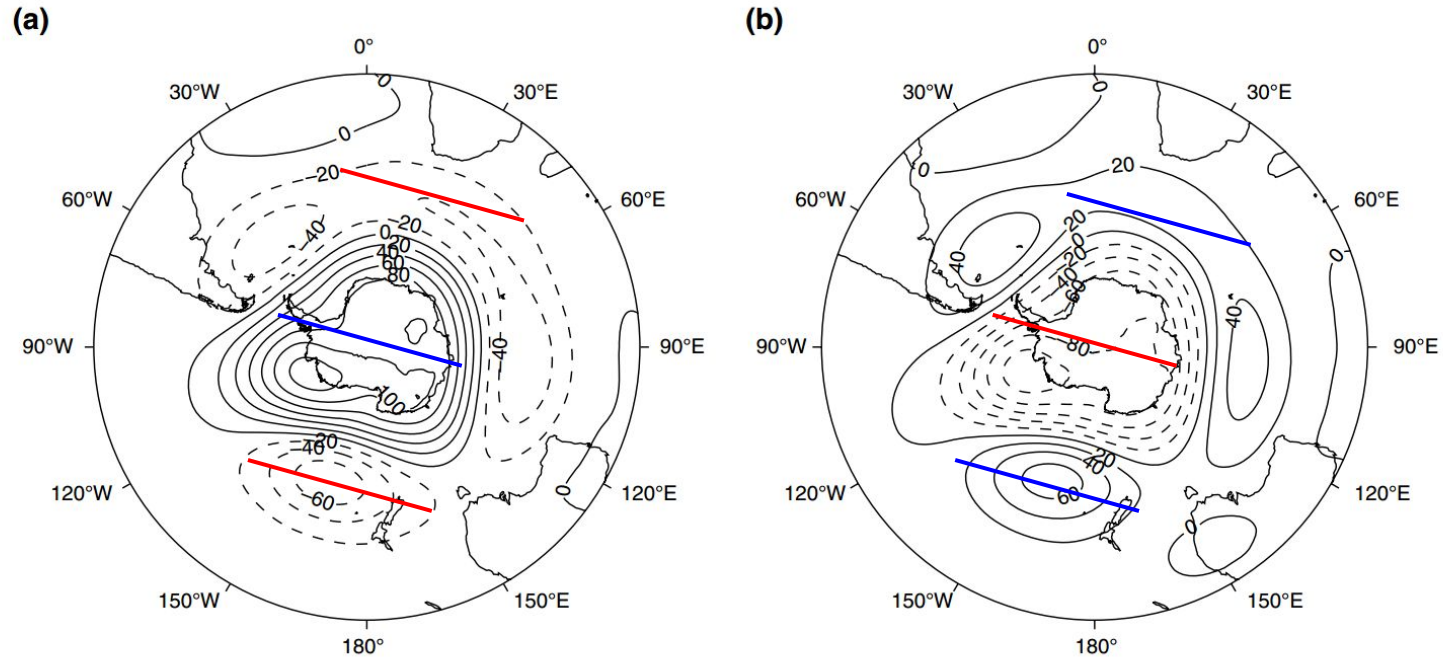


Figure 1. Composites of Z700 anomalies on leading EOF for time coefficients that exceed 0.5 STD level (STD is the standard deviation). The annual cycle was removed. Solid (dashed) lines represent positive (negative) geopotential anomalies for (a) SAM- and (b) SAM+. Units: gpm.

Dados e Método: Índice ENSO Mensal

1. National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR)
2. Anomalias da temperatura da superfície do mar (SST)
3. 1979-2010 (32 anos)
4. médias mensais
5. $0.5^\circ \times 0.5^\circ$
6. Blocking Index: é adaptado da versão de Tibaldi et al. (1994)
7. Áreas de estudos:
 - a. Sudeste do Índico,
 - b. Sudoeste e sudeste do Pacífico, e
 - c. Sudoeste do Atlântico

Dados e Método: Índice ENSO Mensal

64%

Table 2. The results of the EOF analyses according to the method proposed by North *et al.* (1982).

EOF (<i>k</i>)	SST anomalies		Z700 anomalies	
	$\lambda \pm \delta\lambda$	Var	$\lambda \pm \delta\lambda$	Var
1	153.53 ± 107.44	35.29	1209.84 ± 76.67	10.36
2	46.09 ± 13.08	12.00	861.76 ± 54.61	7.38
3	33.01 ± 15.20	8.60	833.06 ± 52.79	7.13
4	17.81 ± 3.79	4.64	652.57 ± 41.35	5.59
5	14.02 ± 14.02	3.65	589.08 ± 37.33	5.04

The EOF order (*k*), the distance between the eigenvalues [eigenvalues (λ) ± sampling error ($\delta\lambda$)] and the accumulated percentage of the explained variance (Var) by the first five EOFs for SST and Z700 anomalies are shown.

Canonical: El Niño (2A) e La Niña (2B)

Modoki: El Niño (2C) e La Niña (2D)

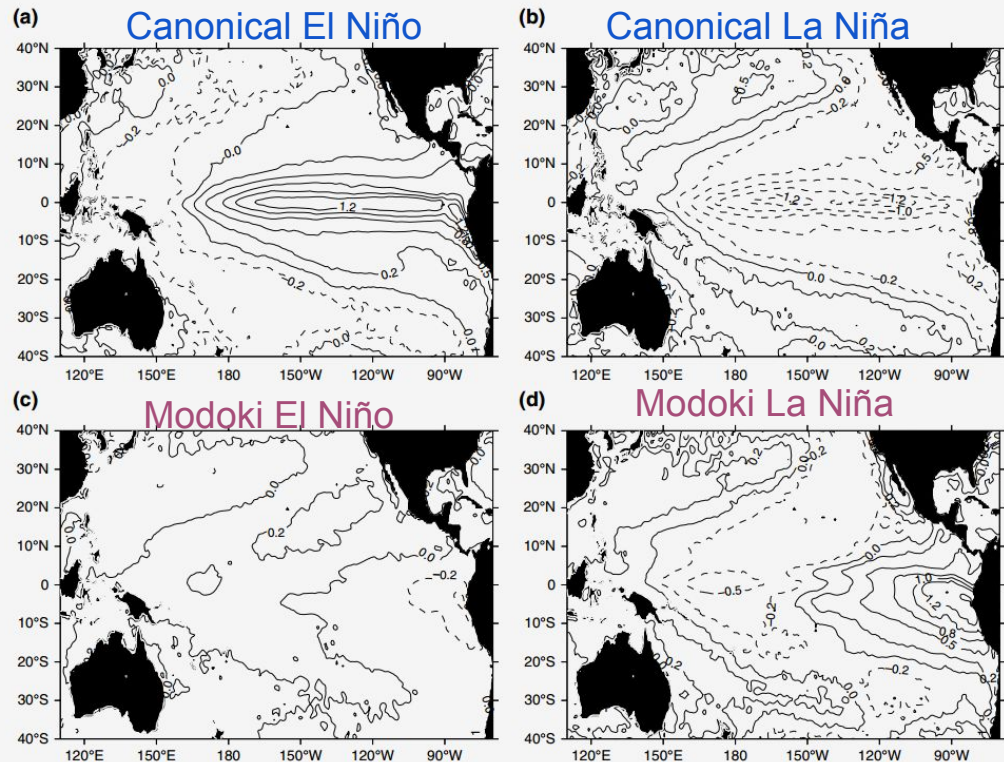


Figure 2. Composites of SST anomalies based on the first two EOF modes for time coefficients that exceed 1.0 STD level (STD is the standard deviation). The annual cycle was removed. Solid (dashed) lines represent positive (negative) SST anomalies for the canonical (a) El Niño and (b) La Niña and for the (c) El Niño and (d) La Niña Modoki. Units: °C.

Influência sazonal Estatística: ENSO x SAM

Table 3. Statistical properties of all independent ENSO episodes in month quantities for southern warm and southern cool seasons.

ENSO-type	Warm season	Cool season	Annual
Canonical El Niño	56	35	91
Canonical La Niña	52	36	88
El Niño Modoki	41	46	87
La Niña Modoki	27	24	51
ENSO-neutral	43	59	102

All quantities that exceed the median location are shown in bold. Units: month.

Table 4. Seasonal statistics for the total number of SAM episodes, the total number of days of SAM and the median lifetime of SAM episodes, in order, during the southern warm and southern cool seasons.

Statistical properties of the Southern Annular Mode									
Warm season									
ENSO-type	SAMw			SAM-			SAM+		
	Episodes	Days	Median lifetime	Episodes	Days	Median lifetime	Episodes	Days	Median lifetime
ENSO-neutral	75	429	4.0	43	507	7.0	47	343	6.0
Canonical El Niño	99	601	4.0	66	691	6.0	54	379 ○	5.0
El Niño Modoki	76	432	4.0	39	362 ○	5.0	48	426 ●	6.0
Canonical La Niña	107	569	4.0	44	386 ○	5.0	74	605 ●	6.0
La Niña Modoki	62	296	4.0	29	245 ○	6.0	33	271 ●	4.0
Total	419	2327		221	2191		256	2024	
Cool season									
ENSO-neutral	113	614	4.0	65	604	5.0	67	566	6.0
Canonical El Niño	69	423 ●	6.0	31	272 ○	6.0	48	370	6.0
El Niño Modoki	83	458	4.0	41	408 ○	6.0	64	524 ●	5.5
Canonical La Niña	65	340	4.0	31	276 ○	6.0	51	475 ●	8.0
La Niña Modoki	55	280 ●	4.0	24	124 ○	4.0	41	320 ●	5.0
Total	385	2115		192	1684		271	2255	

●, Number of days of SAM-phase 'increase' at $p < 0.05$; ○, number of days of SAM-phase 'decrease' at $p < 0.05$; values in bold represent significant differences at $p < 0.05$ significance level between a particular SAM-phase that occurs during a particular ENSO-type and that same observed during the ENSO-neutral. Black (white) balls represent a significant increase (decrease) at $p < 0.05$ in the number of days of a particular SAM-phase in relation to ENSO-neutral episodes.

Frequência Anual: 1 Bloqueio x Bloqueio de larga Escala

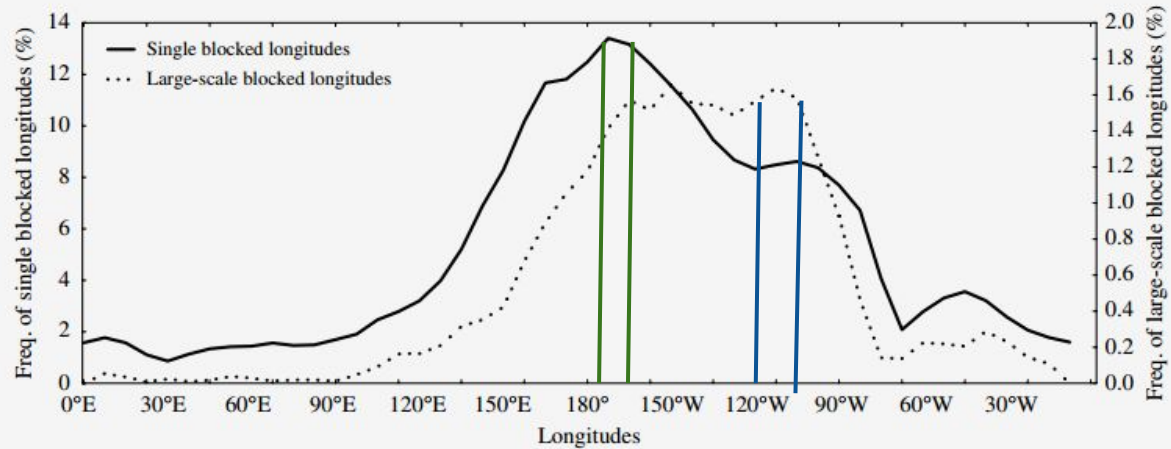


Figure 3. The annual frequency for single blocked longitudes (solid line – left vertical axis) and large-scale blocked longitudes (dotted line – right vertical axis) from 1979 to 2010.

Estatística Anual e sazonal: 1 Bloqueio x Bloqueio de larga Escala

Table 5. Annual and seasonal statistical of the blocking patterns for the total number of blocked days, the total number of days of blocking and the total number of blocking events, in sequence.

Season	SE Indian			SW Pacific			SE Pacific			SW Atlantic			Southern Hemisphere												
Warm	73	/	12	/	4	692	/	312	/	78	328	/	112	/	28	93	/	28	/	6	1186	/	464	/	116
Cold	220	/	60	/	21	1165	/	570	/	208	1041	/	549	/	136	365	/	56	/	13	2791	/	1235	/	262
Yearly	293	/	72	/	25	1857	/	882	/	286	1369	/	661	/	164	458	/	84	/	19	3977	/	1699	/	378
Average	9.2	/	2.3	/	0.8	58.0	/	27.6	/	8.9	42.8	/	20.7	/	5.1	14.3	/	2.6	/	0.6	124.3	/	53.1	/	11.8

The last line shows the average per year.

N° de dias de
bloqueio

N° total de
bloqueios

N° total de dias
de bloqueio

Frequência sazonal de Bloqueios 2D

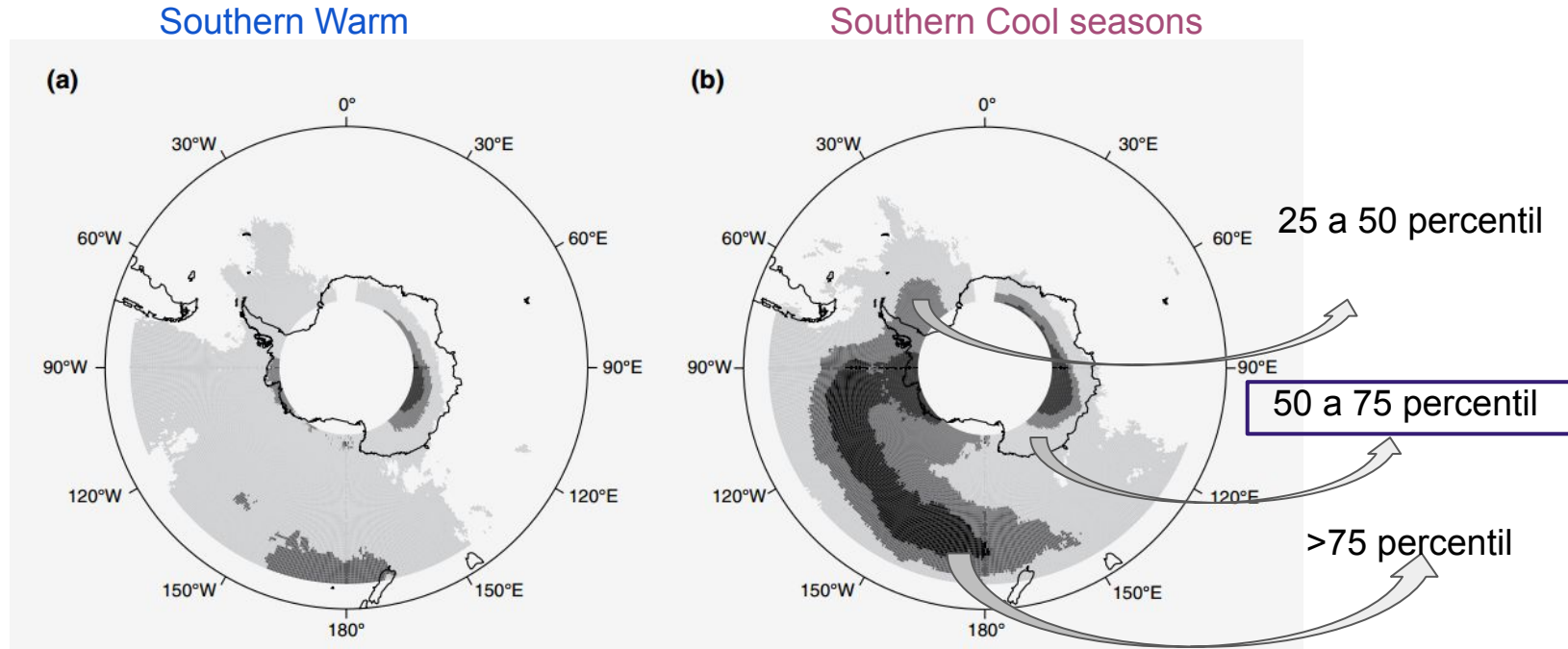


Figure 5. Seasonal BI frequencies in the 2D version of the index between 45° and 75° S during the (a) southern warm and the (b) southern cool seasons. BI frequencies ≥ 25 th and < 50 th percentiles of the $2D_{fmax}$ are shown as light gray areas. BI frequencies ≥ 50 th and < 75 th percentiles are shown as dark gray areas. BI frequencies ≥ 75 th percentiles are shown as black areas. The BI frequencies less than 0.6% (outliers) were not shown.

Frequência de bloqueios durante o inverno ENSO neutro

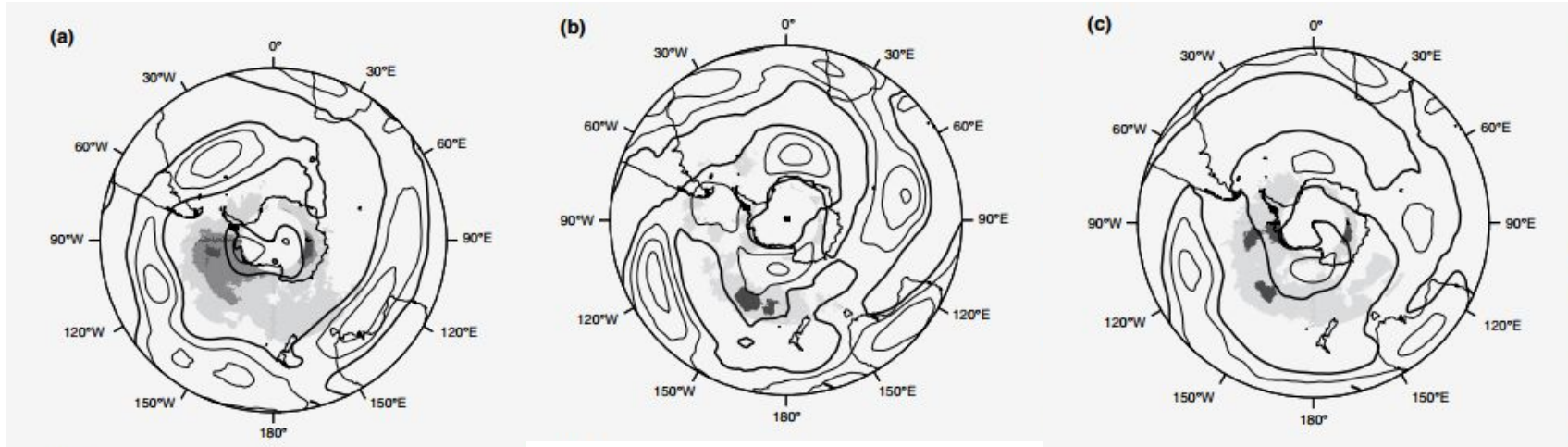


Figure 6. BI frequencies for the southern cool season during the ENSO-neutral episodes, when combined with (a) SAM-, (b) SAM+ and (c) SAMw with overlapping fields of u_{200LF} composites during blocking events that last at least 3 days. As in Figure 5, the BI frequencies are shown as interquartile ranges of the $2D_{fmax}$ distribution. Units: % for BI and $m s^{-1}$ for u_{200LF} .

Bloqueios considerando El Niño e SAM

Table 7. Significant changes in the number of days of blocking over the SW and SE Pacific sectors according to each ENSO-type when combined with the SAM patterns in the southern warm and southern cool seasons.

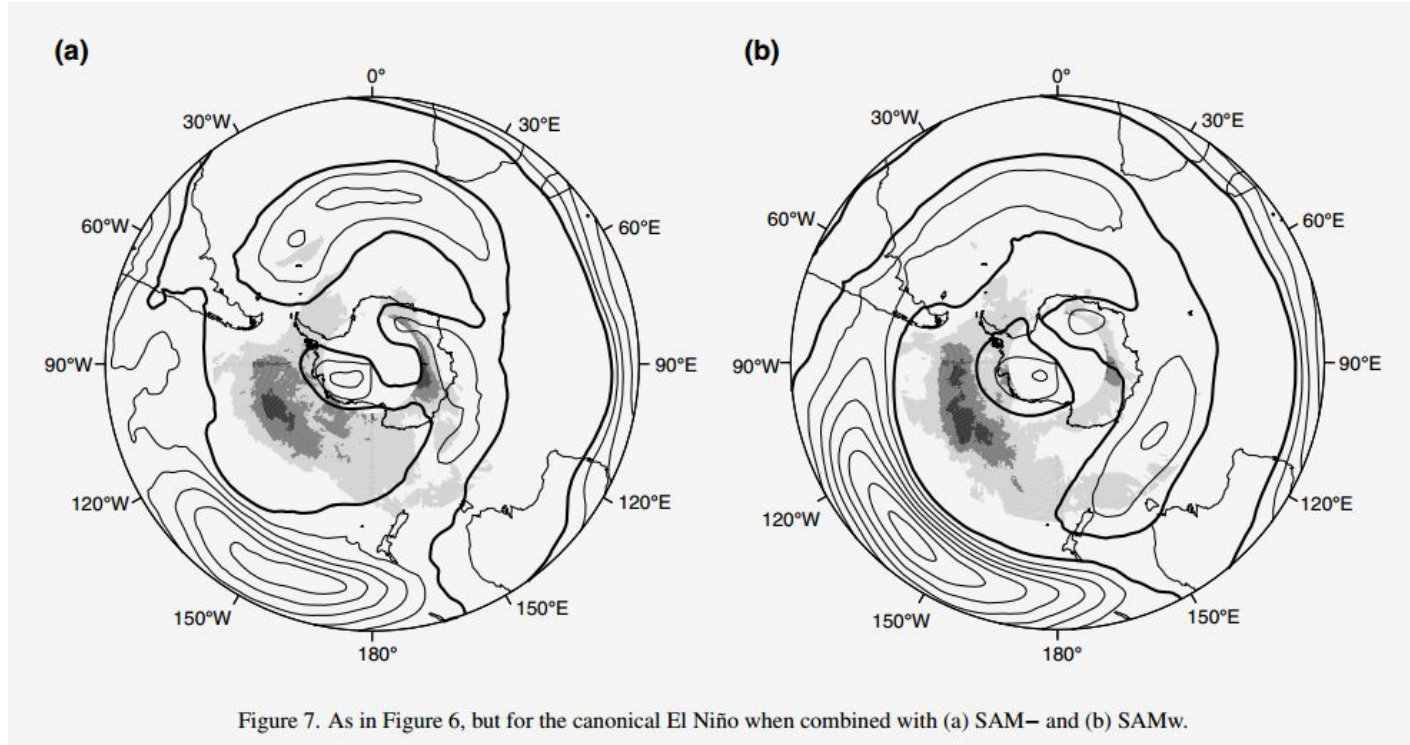
Types of ENSO	Phases of ENSO	SW Pacific						SE Pacific						Southern Hemisphere							
		Warm season			Cool season			Warm season			Cool season			Warm season			Cool season				
		SAM	-	+	w	-	+	w	-	+	w	-	+	w	-	+	w	-	+	w	
Canonical Modoki	El Niño							●			●	○		●	●		●	○		●	●
Canonical Modoki	LaNiña																			○	○

●, Number of days of blocking 'increase' at $p < 0.05$; ○, number of days of blocking 'decrease' at $p < 0.05$; black (white) balls represent that the number of days of blocking increases (decreases) at $p < 0.05$ in relation to ENSO-neutral episodes.

El Niño Canonical

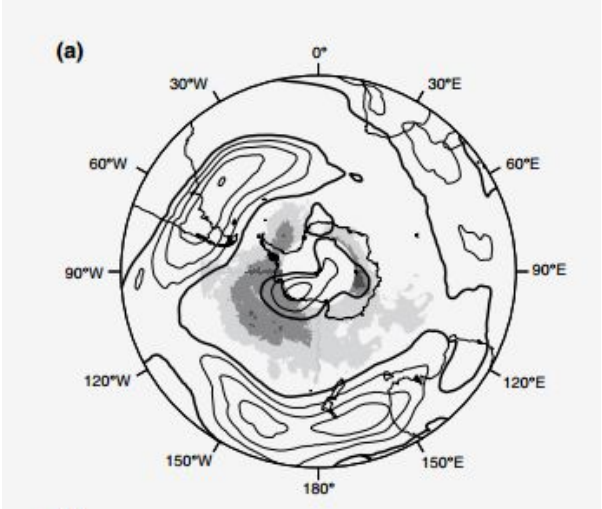
SAM -

SAMw

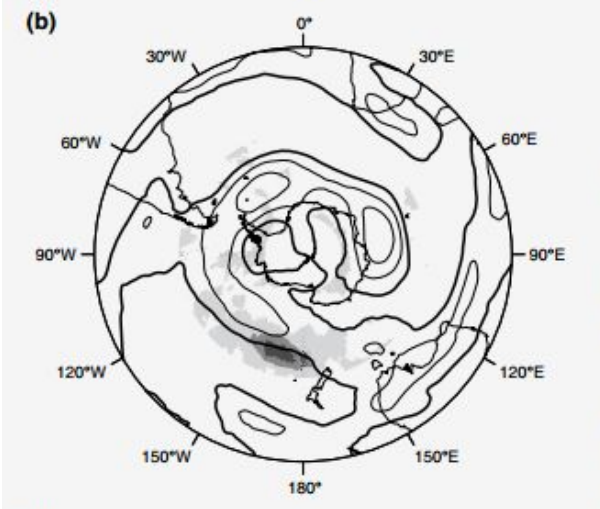


El Niño Modoki

SAM -



SAM +



SAMw

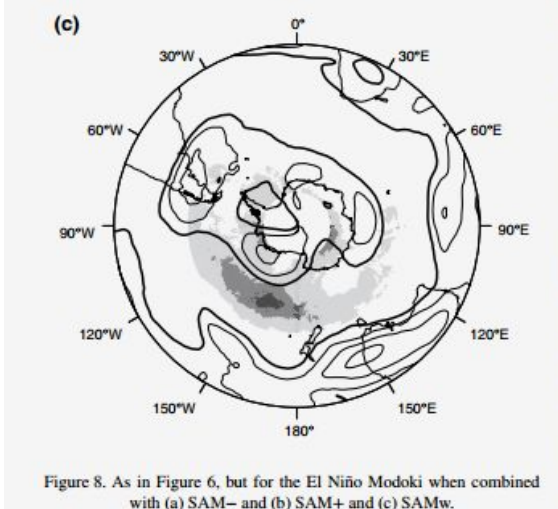


Figure 8. As in Figure 6, but for the El Niño Modoki when combined with (a) SAM- and (b) SAM+ and (c) SAMw.

Variabilidade Interanual de Larga Escala dos

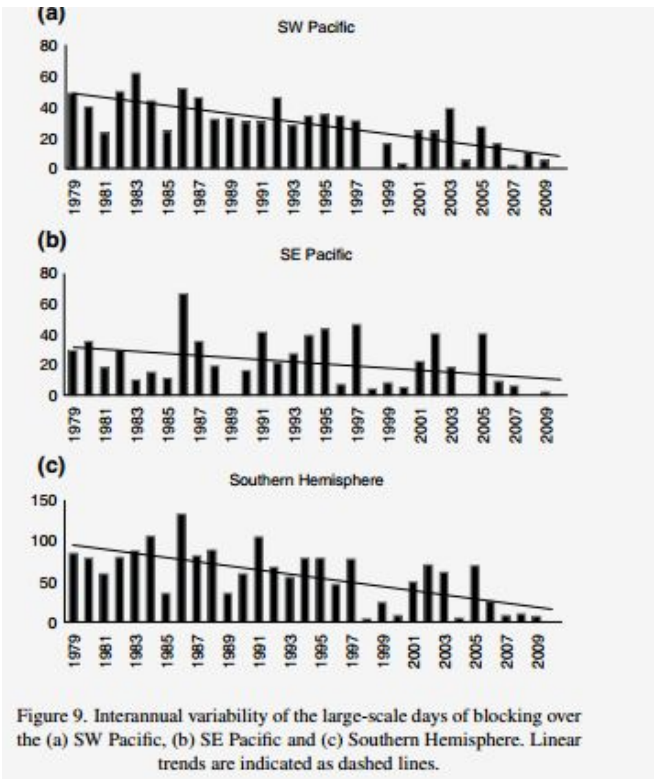


Figure 9. Interannual variability of the large-scale days of blocking over the (a) SW Pacific, (b) SE Pacific and (c) Southern Hemisphere. Linear trends are indicated as dashed lines.

La Niña + SAM: Canonical x Modoki

SAM -

SAM +

SAM -

SAM +

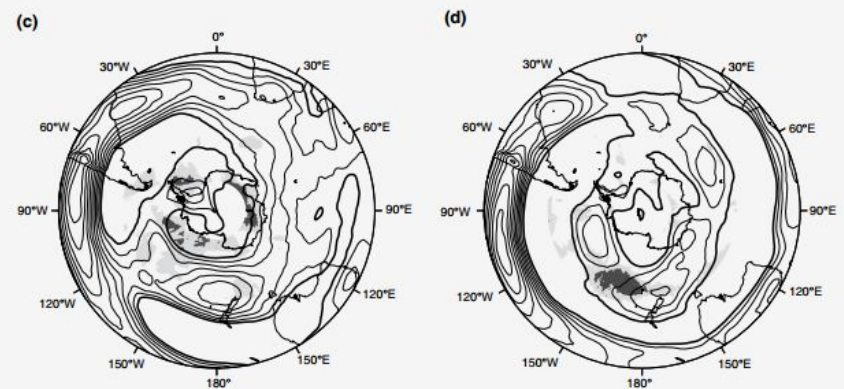
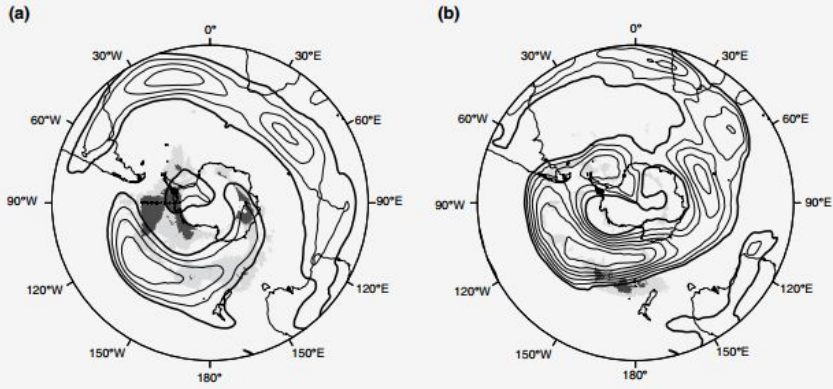


Figure 10. As in Figure 6, but for the two types of La Niña when combined with the SAM patterns as follow: the canonical La Niña that occurs with (a) SAM- and (b) SAM+ and La Niña Modoki that occurs with (c) SAM- and (d) SAM+.

Conclusão

1. Os bloqueios são mais frequentes durante o inverno no sul do Pacífico
2. O Pacífico é a região mais afetada pelos bloqueios
 - a. diferentes fontes de calor
 - b. mecanismos físicos
 - c. evolução temporal
3. ENSO + SAM+ : aumenta os bloqueios exceto no El Niño Canonical
4. El Niño Modoki + ENSO: são mecanismos favoráveis a formação de bloqueios
5. A morfologia dos jatos subtropicais mais próximos aos polos podem ajudar nos bloqueios
6. Os dois tipos de La Niña + SAM+ tendem a fortalecer o fluxo inferior de longo termo dos bloqueios ao sul.

Obrigada a todos!