

Influência da Maré Meteorológica no Nível do Mar

Ricardo de Camargo

Departamento de Ciências Atmosféricas

IAG-USP



Agradecimentos

Ao IEAPM/CHM/MB pela iniciativa do OMARSAT desde 1995 e pelo convite

Aos ensinamentos que tive com:

Almte Alberto dos Santos Franco

Prof.Dr. Afranio Rubens de Mesquita

Prof.Dr. Joseph Harari

Dr. Carlos Augusto Sampaio França

Prof.Dr. Eduardo Marone

Nível do Mar

Projeto de pesquisas:

MARÉS E NÍVEL MÉDIO DO MAR NA COSTA DO BRASIL (NIVEMAR)

Responsável: Almte. Alberto dos Santos Franco

São Paulo, 15 de abril de 1985

ENTIDADES ENVOLVIDAS

Instituto Oceanográfico da Universidade de São Paulo (IOUSP)
Diretoria de Hidrografia e Navegação da Marinha do Brasil (DHN)
Instituto de Pesquisas Tecnológicas do Estado de São Paulo
S/A I.P.T.

VIII - EQUIPE DE PESQUISADORES E PESSOAL TÉCNICO-CIENTÍFICO

Responsável pelo projeto (e coordenador dos trabalhos no IPT-USP):
Almte. Alberto dos Santos Franco

Coordenadores dos trabalhos no IOUSP:
Prof. Dr. Afrânio Rubens de Mesquita
Dr. Joseph Harari

Coordenadores dos trabalhos na DHN:
CC Domingos Sérgio Meirelles
CT Araken José da Silva Veloso
Prof. Marco Antonio de C

Colaborador:
Bel. Carlos Augusto de S



The image shows a green identification card for Ricardo de Camargo. On the left is a black and white portrait of a young man with dark, curly hair. To the right of the portrait is a circular seal of the University of São Paulo. The text on the card is as follows:

UNIVERSIDADE DE SÃO PAULO	
INSTITUTO OCEANOGRÁFICO	
NOME:	Ricardo de Camargo
DEPTO:	Oceanografia Física
Nº USP:	8314318
ALUNO	

LOCAL		Lat.		Long.	
1	Santana	00°	0,2'S	51°	0,6'W
2	Belem	01	30	48	30
3	Itaqui (Maranhão)	02	36	44	18
4	Luiz Correia (PI)	02	54	41	42
5	Fortaleza	03	42	32	30
6	Fern. de Noronha	03	48	32	24
7	Natal	05	48	35	12
8	Cabedelo	07	06	34	54
9	Recife	08	02	34	54
10	Maceió	09	36	35	42
11	Itaparica	13	00	38	34
12	Ilhéus	14	48	39	00
13	Vitória	20	18	40	18
14	Trindade	20	30	29	18
15	Cabo Frio	23	00	42	00
16	Ilha Fiscal	22	48	43	12
17	Ubatuba	23	24	45	06
18	Santos	23	54	46	24
19	Cananéia	25	06	47	54
20	Paranaguá	25	30	48	30
21	S. Francisco do Sul	26	18	48	36
22	Itajaí	26	54	48	42
23	Imbituba	28	18	48	42
24	Rio Grande	32	06	52	06

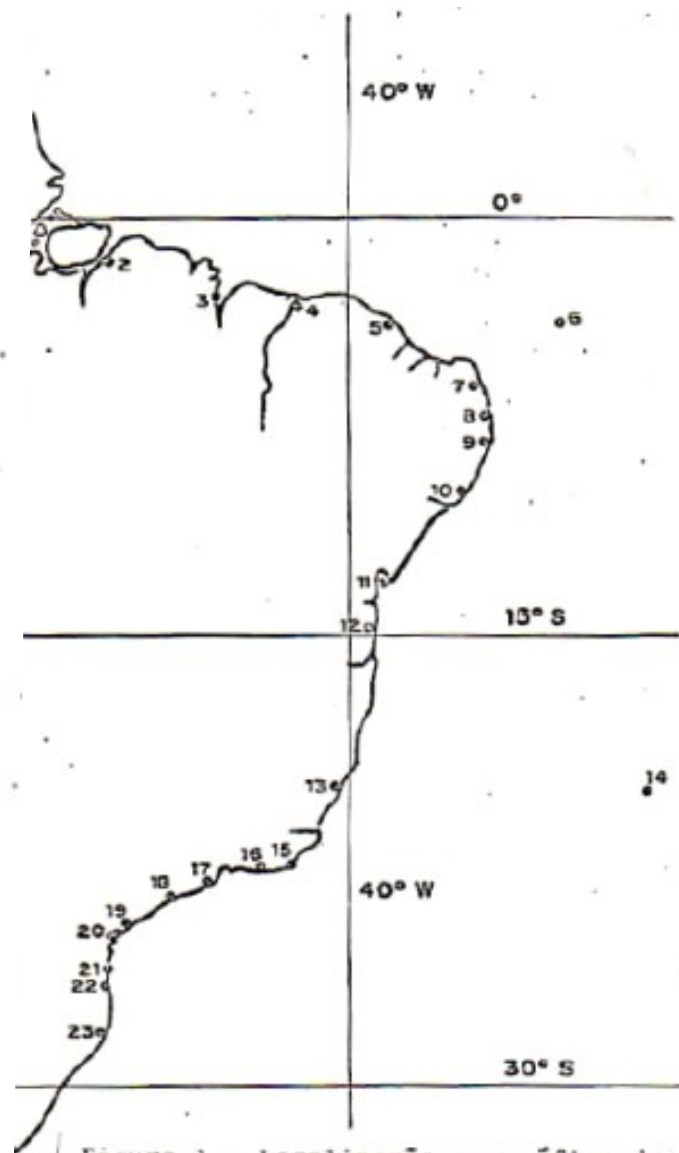


Figura 1 - Localização geográfica das 24 estações maregráficas permanentes prioritárias a corrigir os dados de maré.

Tabela 1 - Localização das 24 estações maregráficas permanentes prioritárias a corrigir os dados de maré.

LOCAL

Nº ANOS DE TENDÊNCIA DO NÍVEL
PSMSL - All Regions (⊕ brazilian stations)

SÉC

B

F

R

S

C

R

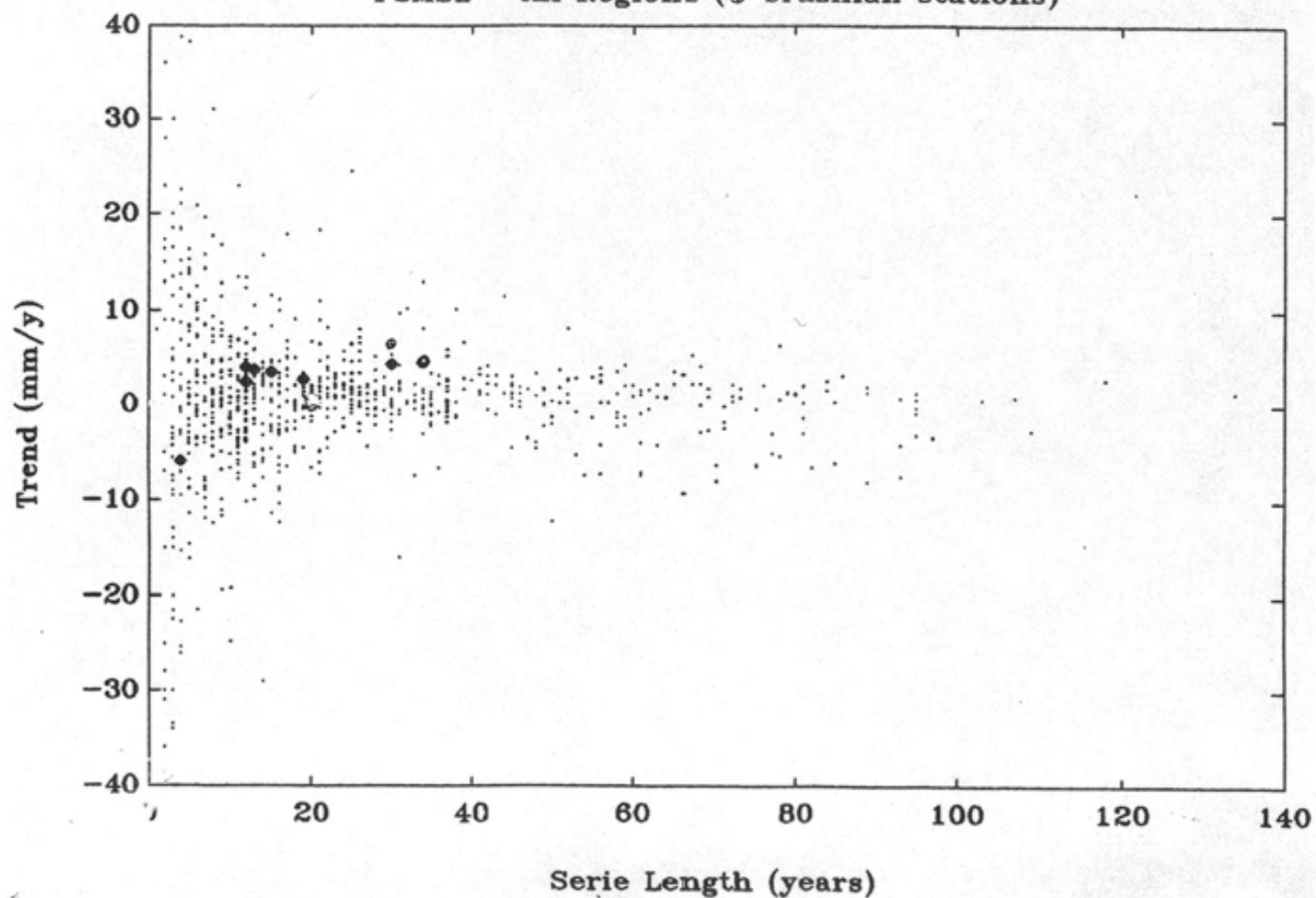
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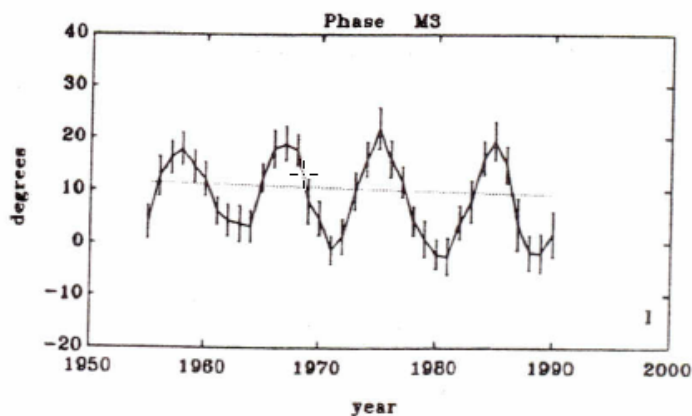
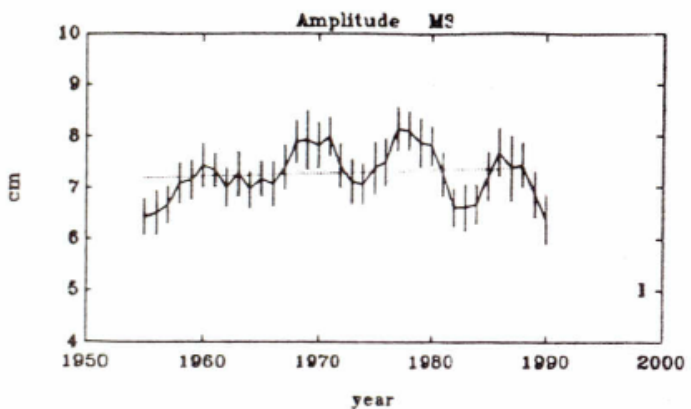
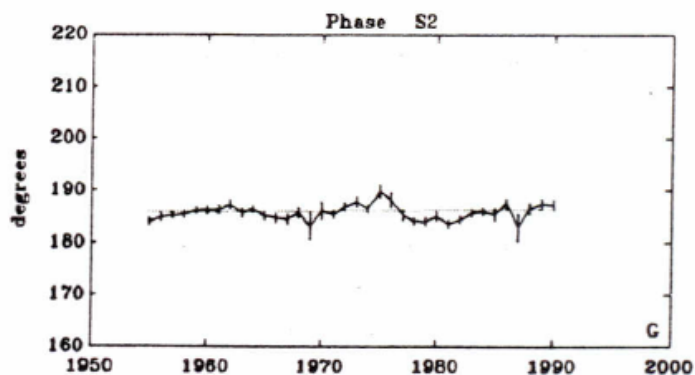
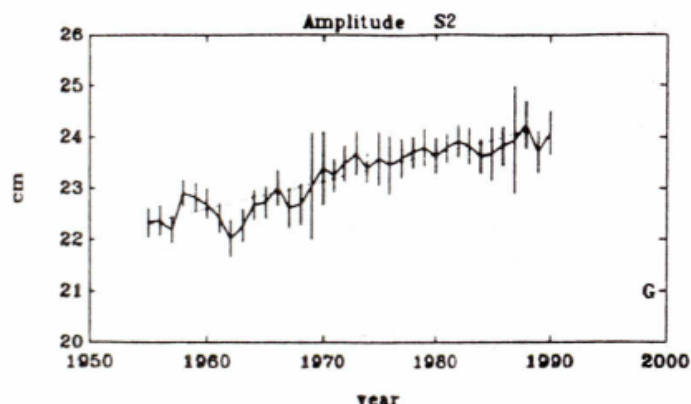
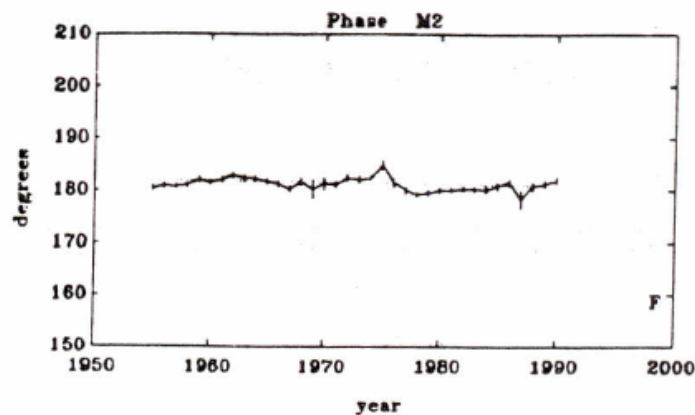
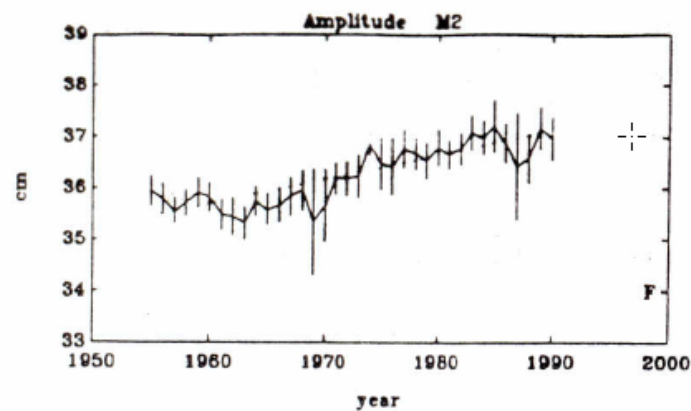
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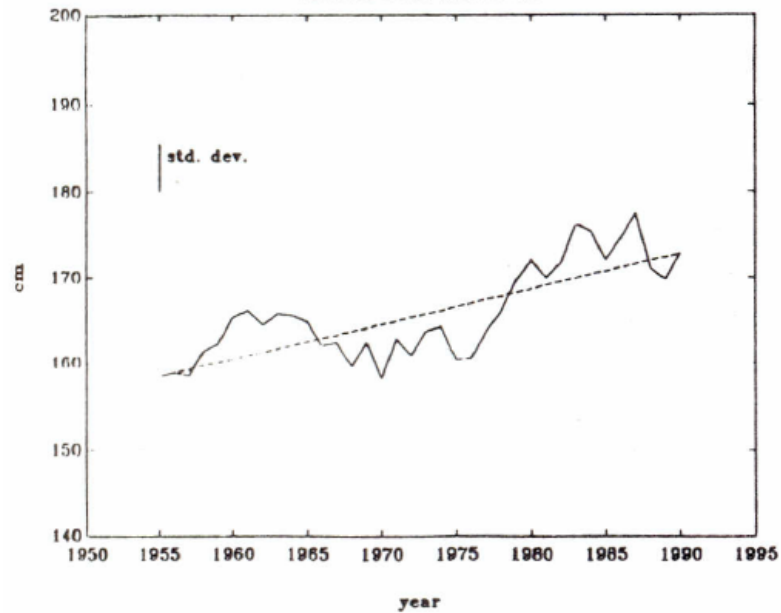


Cananéia, Brazil,

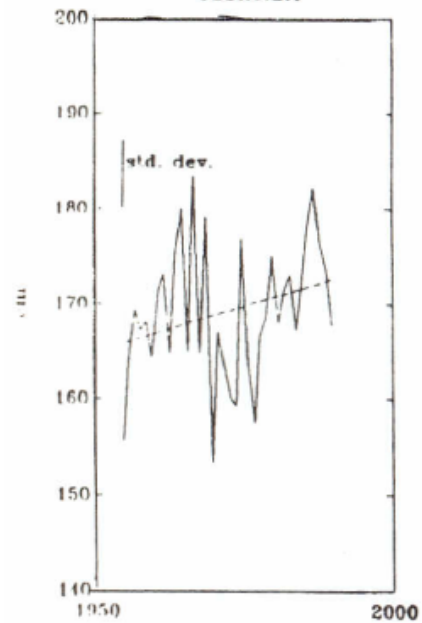
Estação FRANÇA

Analysis of Cananéia
variability of the
of the principal
with a rate of
approximately 4 cm
series of each
trends, which
in the summer
as changes in

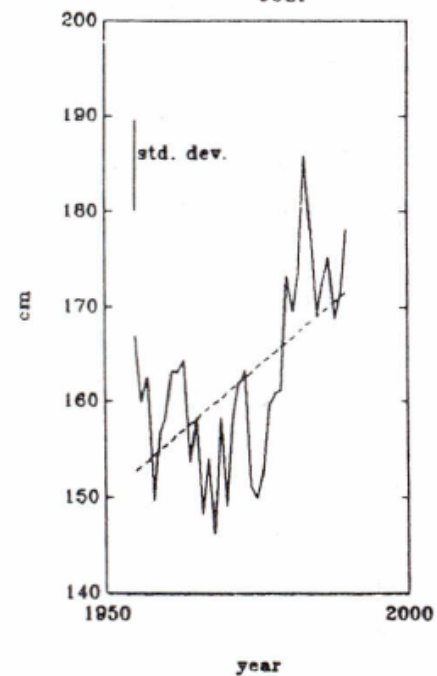
ANNUAL MEAN SEA LEVEL



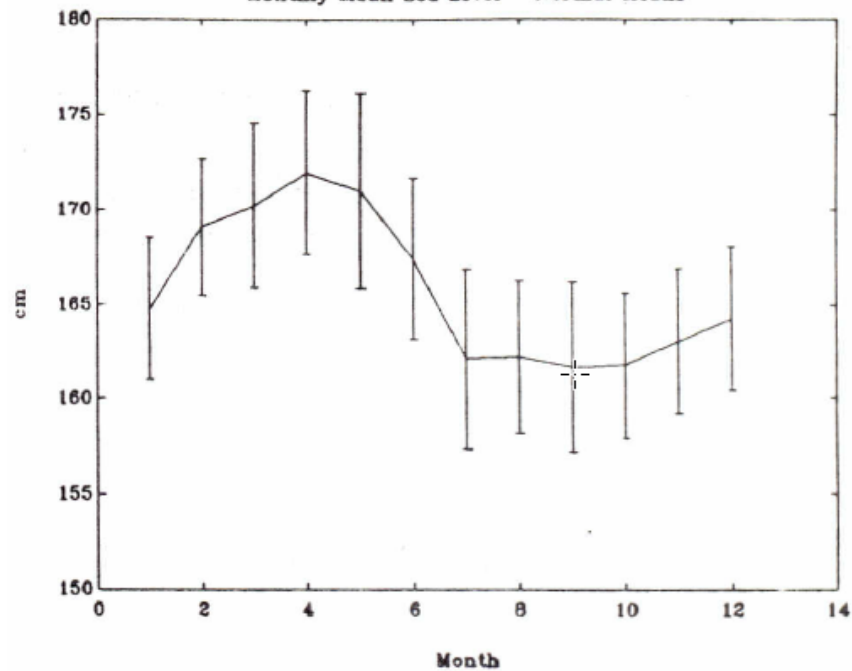
FEBRUARY



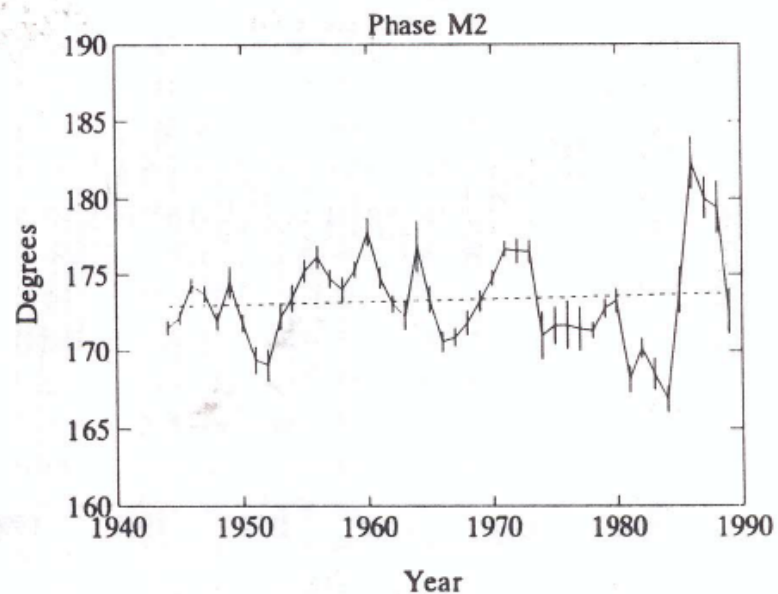
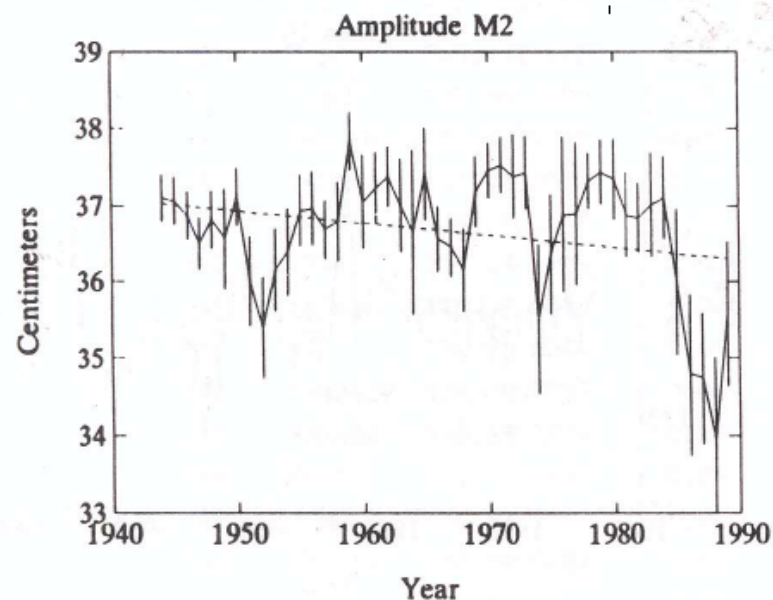
JULY



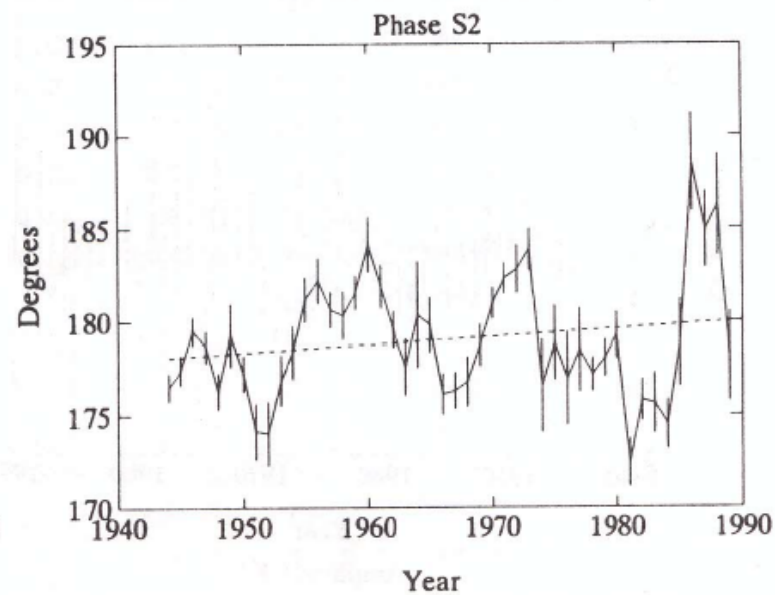
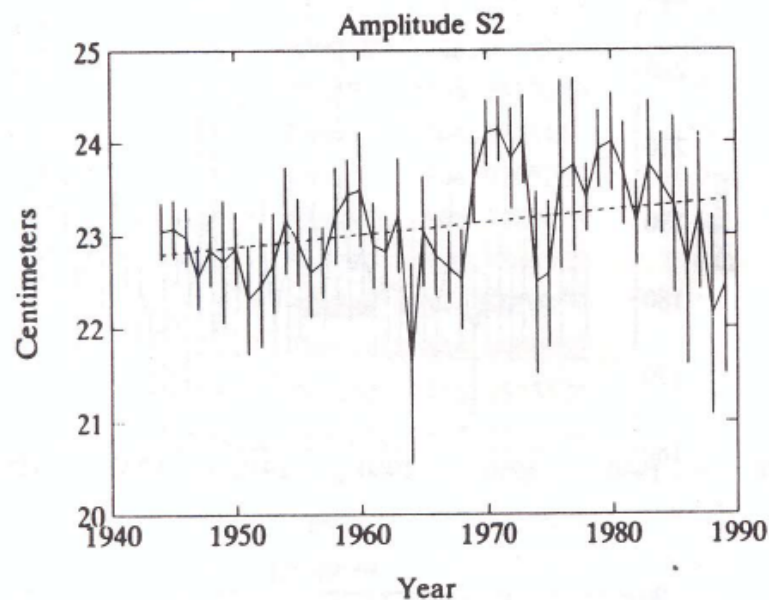
Monthly Mean Sea Level - Normal Means



Ti



the evolution of the tidal components and the mean sea level; these computations allowed to form the following time series: annual values of amplitudes and phases of



Annual Mean Sea Level

Summer Conditions

Winter Conditions

Monthly Mean Sea Level - Normal Means

Centimeters

Centimeters

Centimeters

Centimeters

Month

170

165

160

155

150

145

140

135

130

125

120

1940

170

165

160

155

150

145

140

135

130

125

120

1940

170

165

160

155

150

145

140

135

130

125

120

1940

170

165

160

155

150

145

140

135

130

125

120

0

2

4

6

8

10

12

Permanent Service for Mean Sea Level (PSMSL)

Global Sea Level Observing System (GLOSS)



Afro America GLOSS news

ISSN 1983-0319



[GLOSS África](#)

Link para Informações sobre o GLOSS no continente africano

[GLOSS](#)

Global Sea Level Observing System

[GLOSS Chile](#)

Link para Informações sobre o GLOSS no Chile

Apresentação:

O Afro-America Gloss News é uma publicação que pretende estimular e difundir notícias referentes às atividades de instituições e pesquisadores das Ciências do Mar dedicados a estudos das variações do Nível do Mar. O alvo principal são as comunidades de fala Castelhana e Portuguesa da África e América, mas contribuições em outras línguas e outros Continentes são também bemvindas.

Presentación:

El Afro-America Gloss News es una publicación que pretende estimular y difundir noticias referentes a las actividades de instituciones e investigadores de Ciencias del Mar que trabajan con problemas relativos a variaciones del Nivel del Mar. Está dirigida principalmente a las comunidades de habla Castellana y Portuguesa de África y América, mas contribuciones relevantes y noticias en otras lenguas y de otras regiones son bienvenidas.

1106	5.4	SEX	1209	5.6	DOM	0651	1.3	SEG	0639	1.9	SEG	0628	1.3	TER	1206	5.2	QUI	0838	1.5	SEX	0739	2.0
1739	1.4		1819	1.4		1258	5.5		1253	5.2		1239	5.5		1824	1.8		1508	5.5		1349	4.0
2334	5.4					1928	1.2		1915	1.9		1906	1.2					2121	1.2		2017	
0606	1.4	29	0034	5.3	14	0145	5.3	29	0132	4.8	14	0126	5.3	29	0045	4.8	14	0349	5.5	29	0238	4.0
1208	5.4	SAB	0645	1.5	SEG	0758	1.4	TER	0749	2.2	TER	0736	1.5	QUA	0656	2.2	SEX	0954	1.4	SAB	0858	2.0
1847	1.4		1258	5.3		1421	5.4		1358			1402	5.4		1311	4.9		1613	5.7		1508	4.0
			1911	1.6		2043	1.2		2039			2019	1.3		1945	2.0		2228	1.0		2132	1.0
0043	5.3	30	0126	5.1	15	0306	5.3					0251	5.3	30	0200	4.6	15	0449	5.8	30	0354	5.0
0715	1.4	DOM	0743	1.8	TER	0911	1.4					0854	1.5	QUI	0821	2.3	SAB	1058	1.0	DOM	1006	1.0
1326	5.3		1353	5.2		1541	5.6					1524	5.5		1430	4.8		1709	6.0		1624	5.0
1958	1.4		2023	1.8		2158	1.1					2141	1.2		2106	2.0		2323	0.7		2236	1.0
		31	0230	4.9										31	0323	4.7						
		SEG	0856	2.0										SEX	0941	2.1						
			1454	5.1											1551	4.9						

Nome da Estação :		CAETÉ - PA			
Localização :		Na Baía de Caeté – trapiche da cidade			
Organ. Responsável :		DHN			
Latitude :		00° 58,0' S	Longitude : 46 ° 42,6' W		
Período Analisado :		28/05/83 a 28/06/83	Nº de Componentes : 78		
Análise Harmônica :		Método Almirante Santos Franco			
Classificação :		Maré Semidiurna			
Estabelecimento do Porto: (HWF&C)		VII H 22 min	Nível Médio (Zo):		275 cm acima do NR.
Médias das Preamares de Sizígia (MHWS) :		500 cm acima do NR.	Média das Preamares de Quadratura (MHWN) :		398 cm acima do NR.
Média das Baixa-mares de Sizígia (MLWS) :		50 cm acima do NR.	Média das Baixa-mares de Quadratura (MLWN) :		152 cm acima do NR.
CONSTANTES HARMÔNICAS SELECIONADAS					
Componentes	Semi-amplitude (H) cm	Fase (g) graus (°)	Componentes	Semi-amplitude (H) cm	Fase (g) graus (°)
As	-	-	MU ₂	7,8	330
Ssa	-	-	N ₂	36,6	212
Mm	4,9	082	NU ₂	7,0	212
Mf	-	-	M ₂	173,8	211
MTM	2,7	320	L ₂	14,0	164
Msf	8,3	279	T ₂	3,0	246
Q ₁	1,2	232	S ₂	50,8	248
O ₁	9,2	251	K ₂	13,8	250
M ₁	2,0	158	MO ₃	2,5	038
P ₁	2,6	265	M ₃	2,3	338
K ₁	7,7	266	MK ₃	5,2	009
J ₁	1,7	008	MN ₄	11,0	346
OO ₁	2,1	190	M ₄	29,0	349
MNS ₂	0,8	076	SN ₄	6,8	227
2N ₂	4,8	213	MS ₄	15,3	024
Referências de Nível: RN-1 fixada na quina da casa do Sr. Lula. RN-2 implantad junto ao Mastro da Bandeira da escola local					

ABSTRA

coast from
distributed
(C), against
correlation
series (12C
adjusted to
Recife, Car

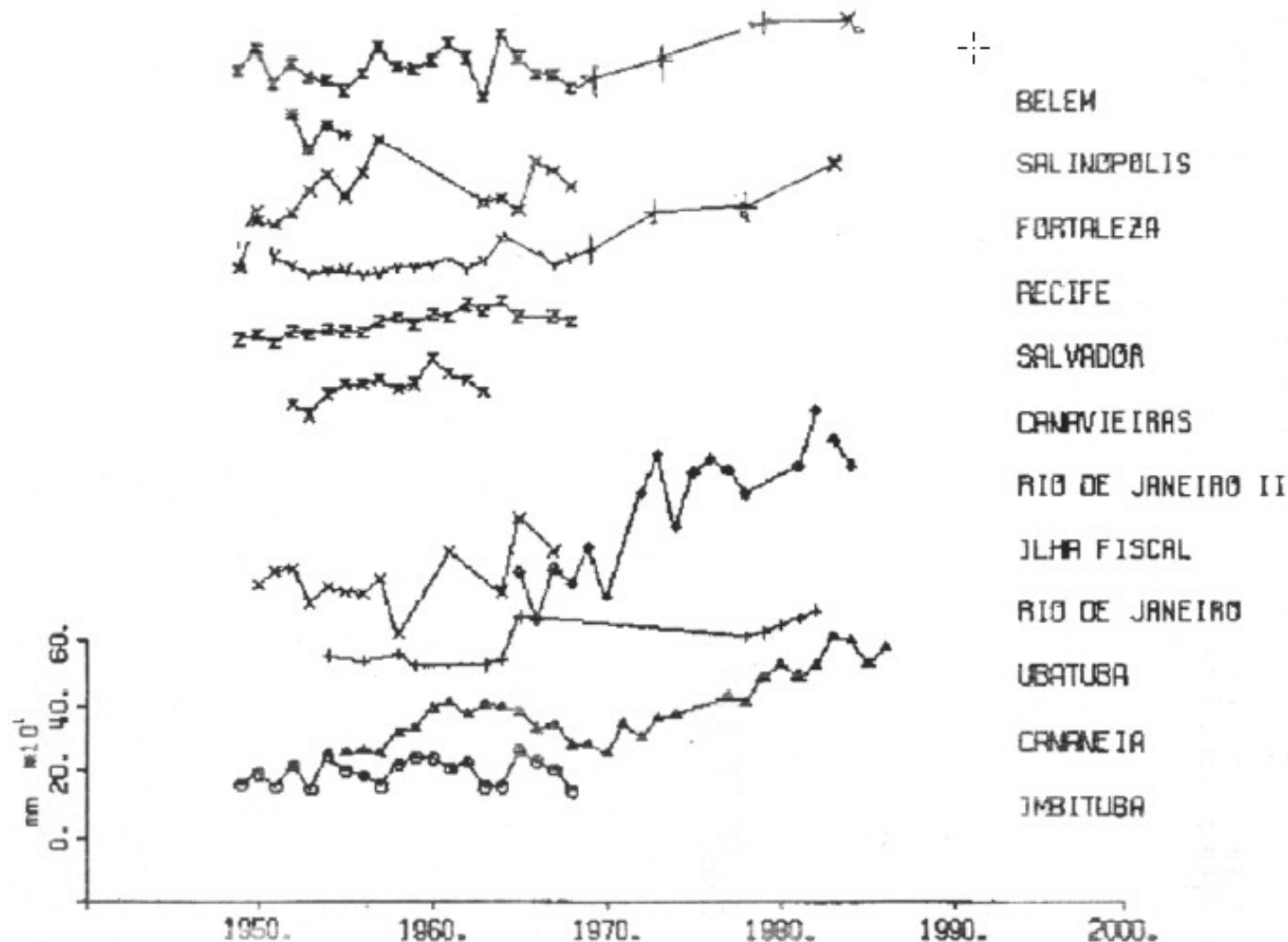


Figure 2 – Brazilian sea level data for various ports. Annual means (mm). The series were separated in order to have them all in the same graph. Zero of the years axis has to be displaced and put in the starting year of each series in order to estimated its trend value (Mesquita & Harari, 2011).

the Brazilian
sidering data
a level trends
corresponding
or the longest
American data
m, Fortaleza.
I plot, with all

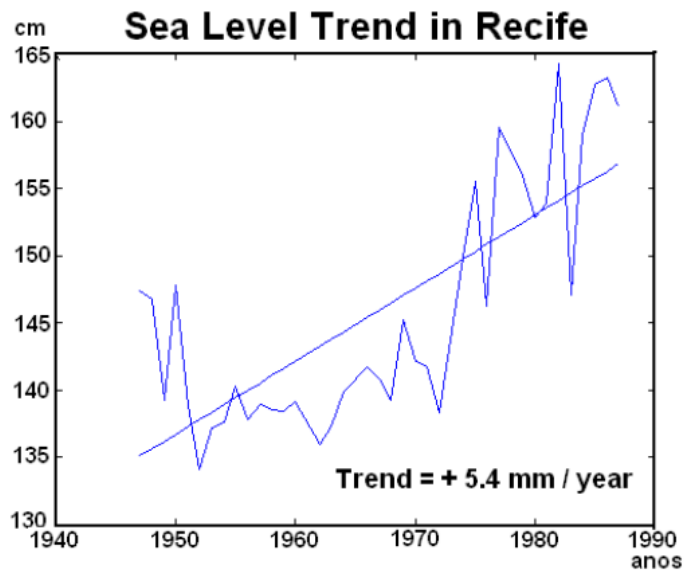


Figure 1 – Mean sea level in Recife.

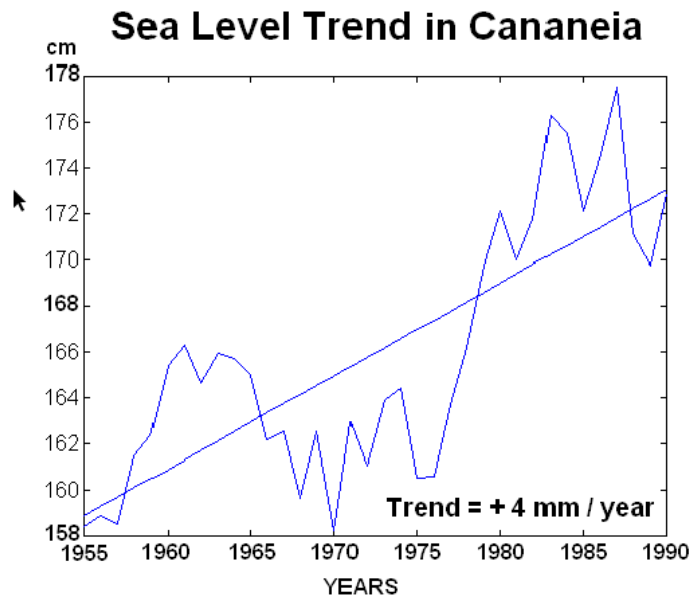


Figure 3 – Mean sea level in Cananeia.

3, Belém, Cananeia and Santos.

ude ade)	S ₂ phase (°/decade)
10	2.600
90	1.000
	0.160

(1954-1990)
Santos
(1944-1989)

around the world, the mean

Keywords: Brazilian coast,

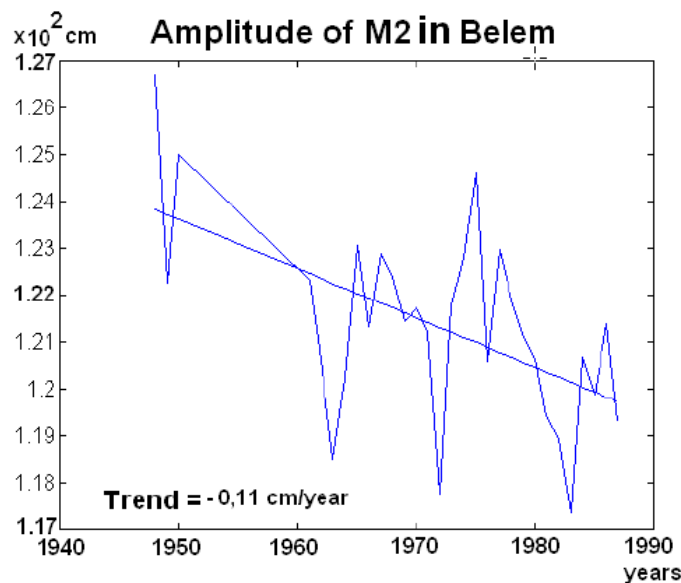


Figure 2 – Values of M₂ amplitude in Belém, from the annual records analysis.

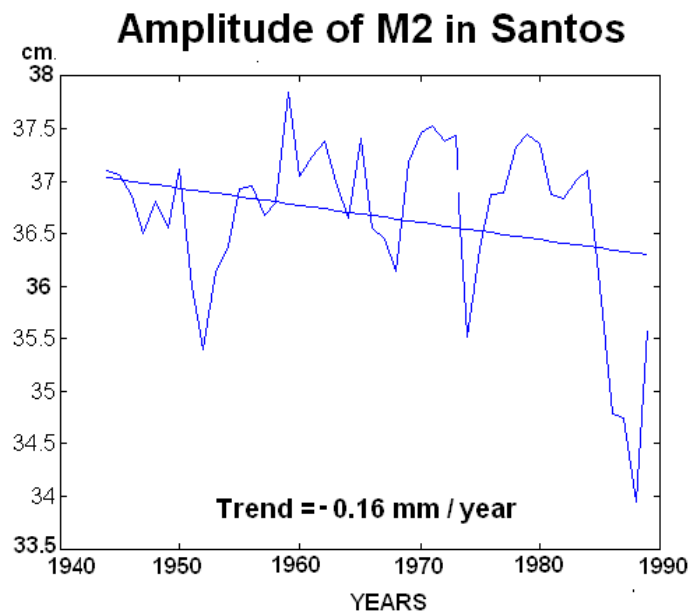
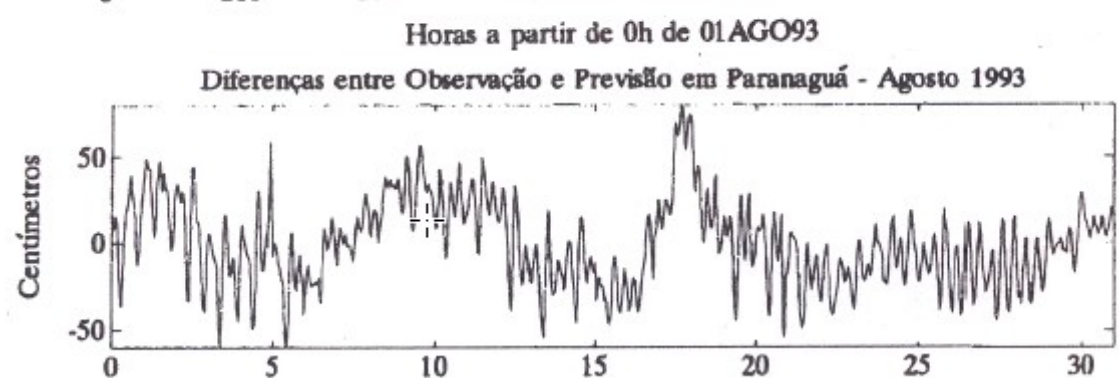
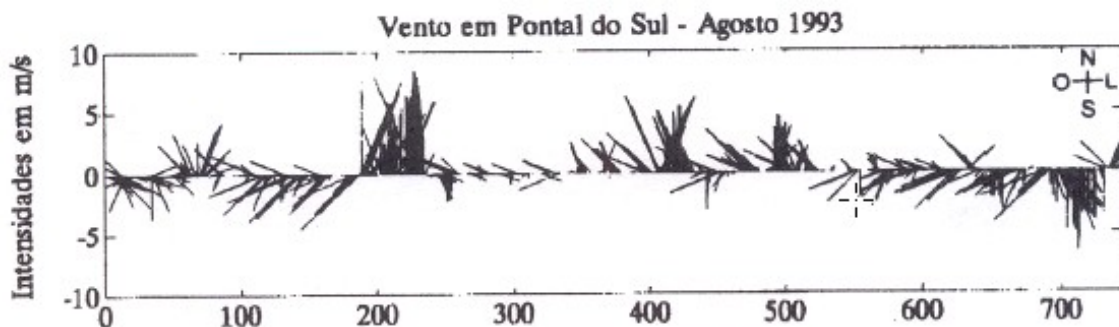
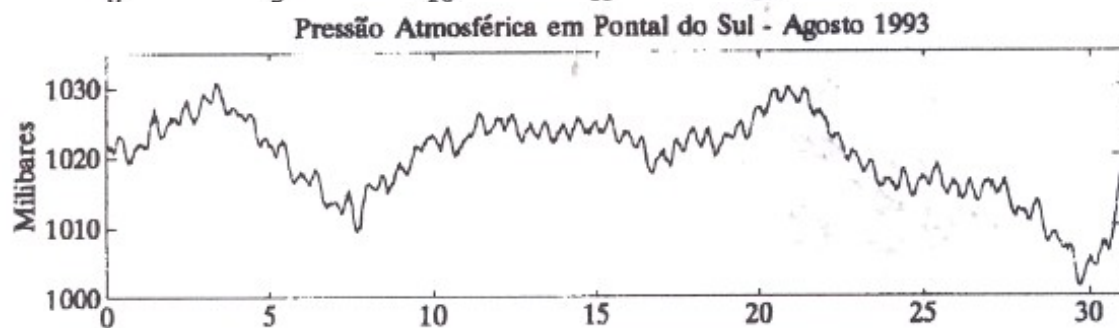
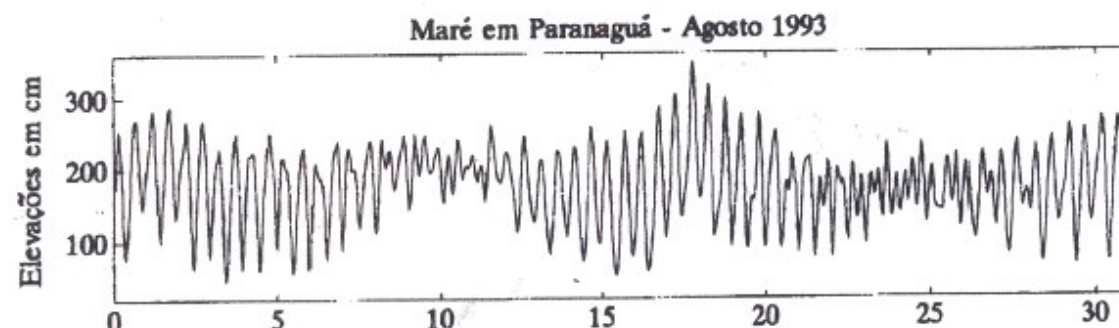


Figure 4 – Values of M₂ amplitude in Santos, from the annual records analysis.

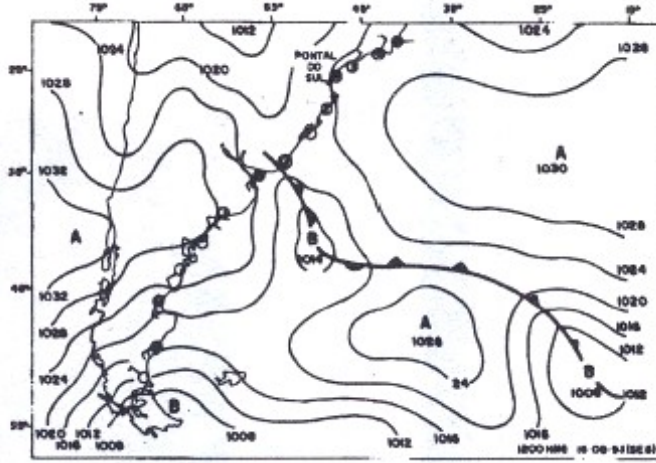
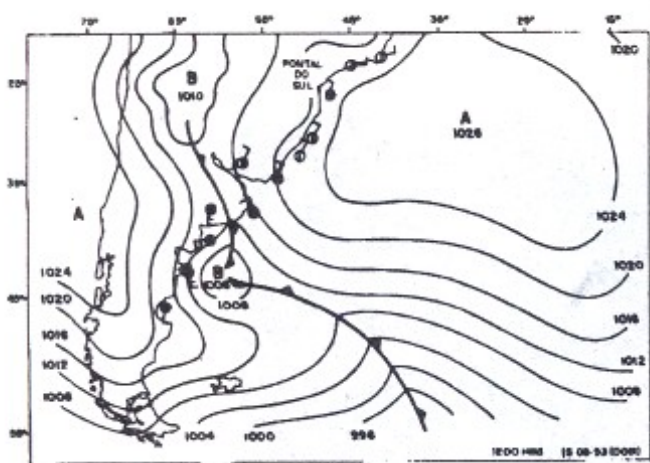
Influência meteorológica no nível do mar

MARÉS I PAI

ESTADO DO E 1993

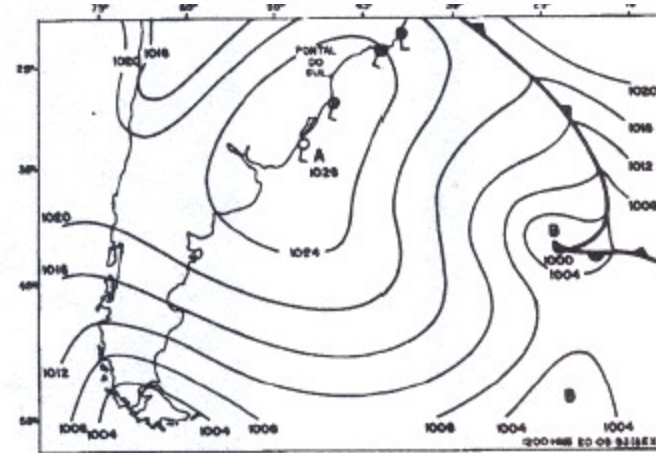
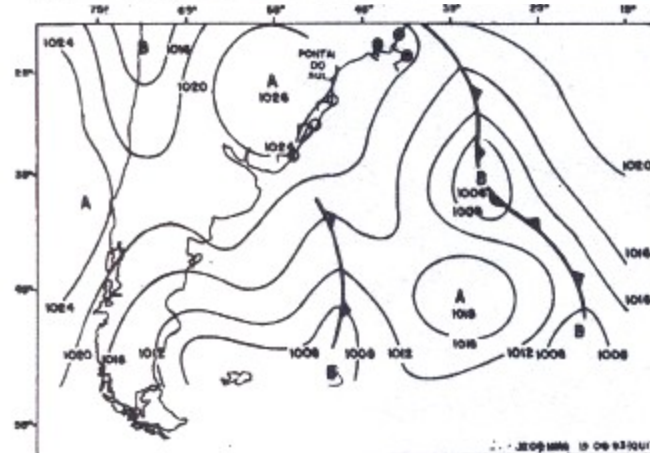
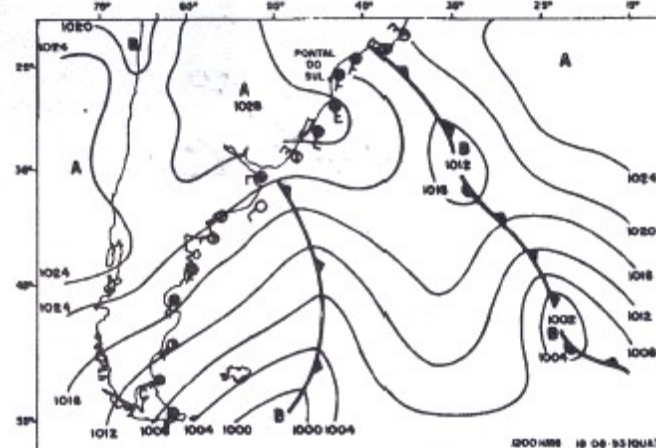
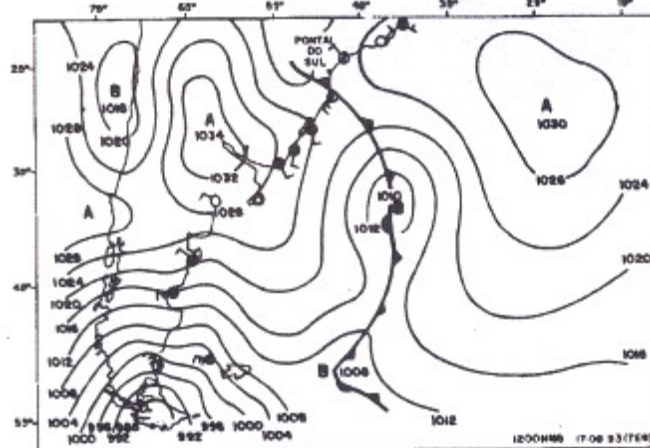


ardo MARONE*
de CAMARGO*

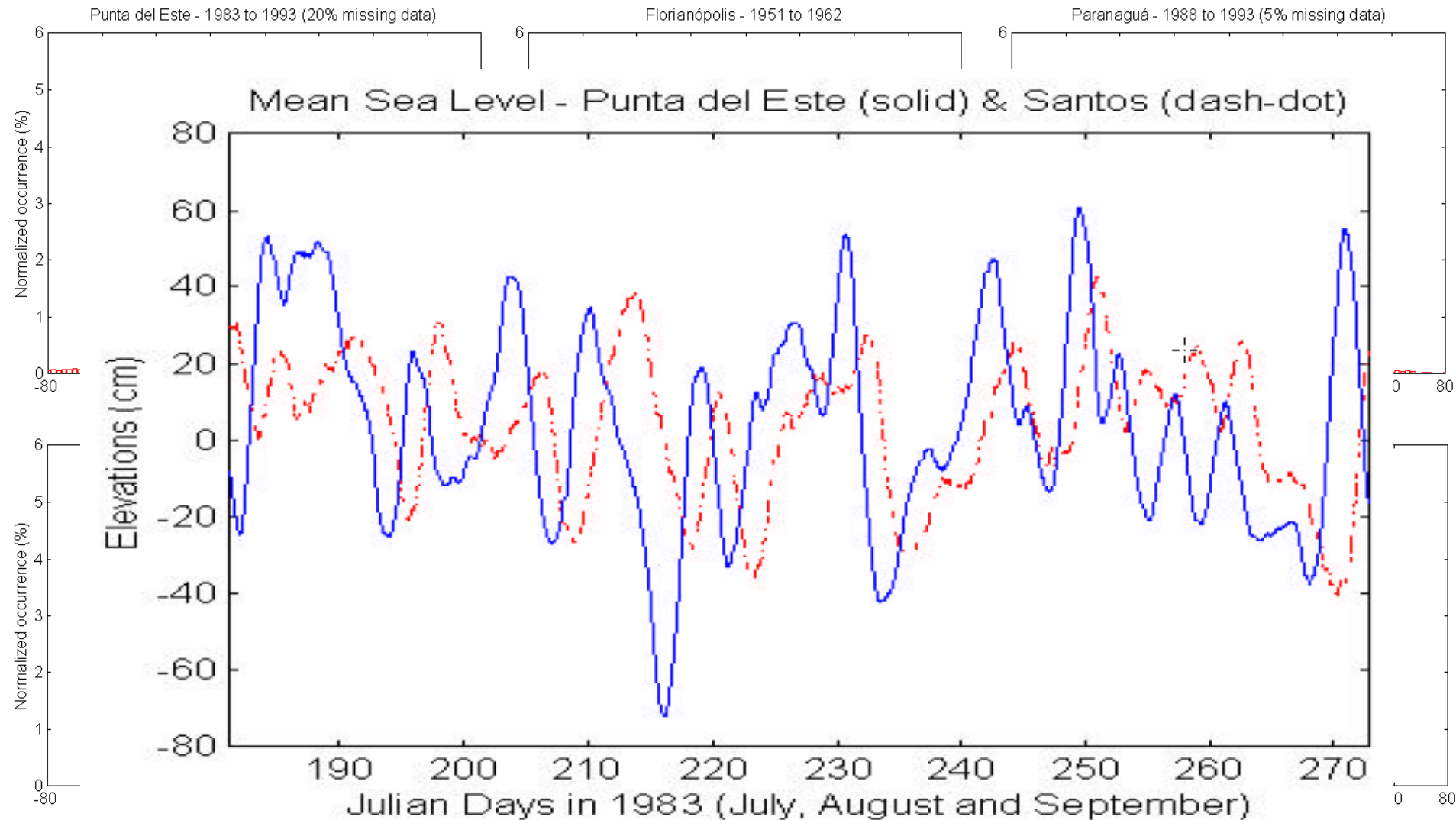


Meteoromarinha

15 a 20 de Agosto
1993



CAMARGO, R., HARARI, J. & CARUZZO, A. 1999 Basic Statistics of Storm Surges over the South-Western Atlantic Ocean. Afro-America GLOSS News



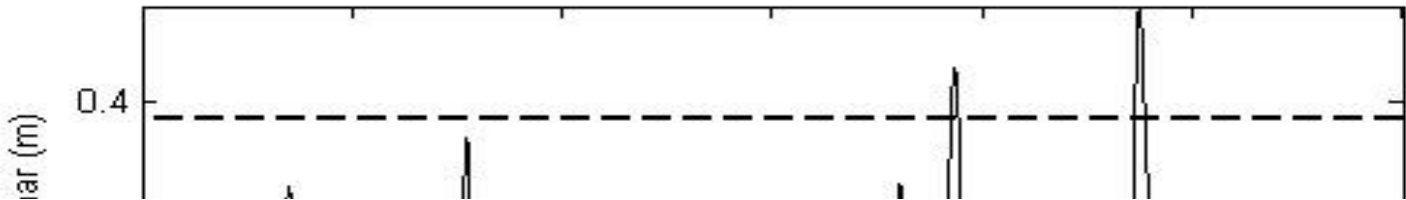
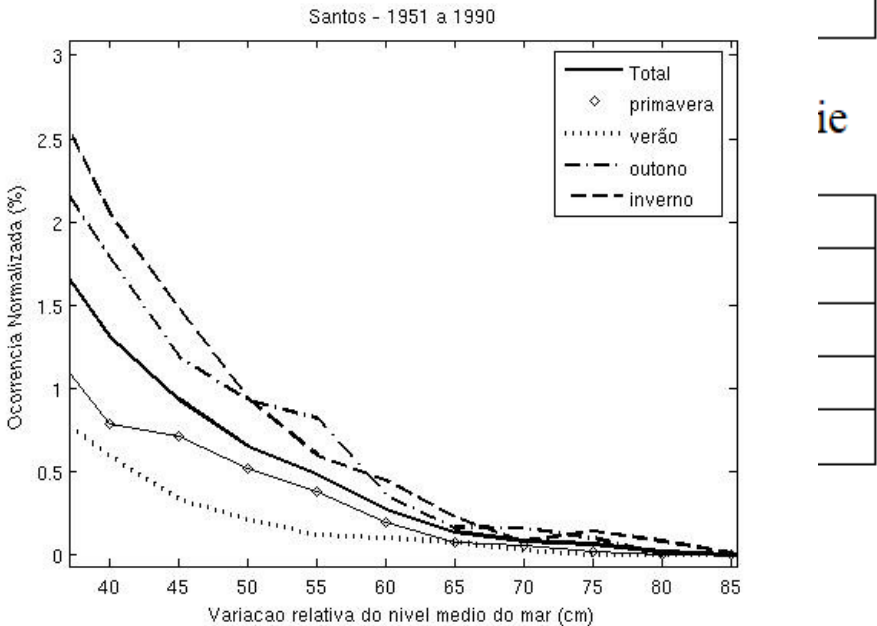
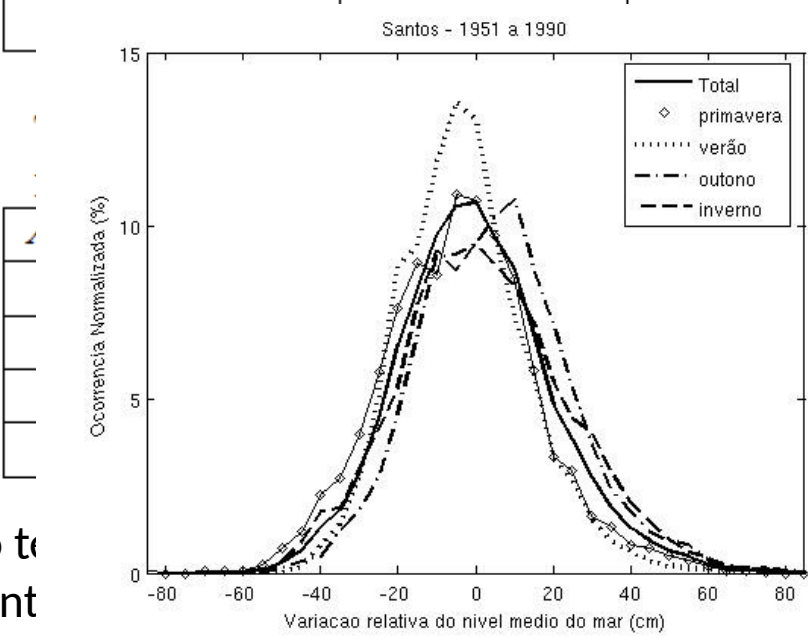
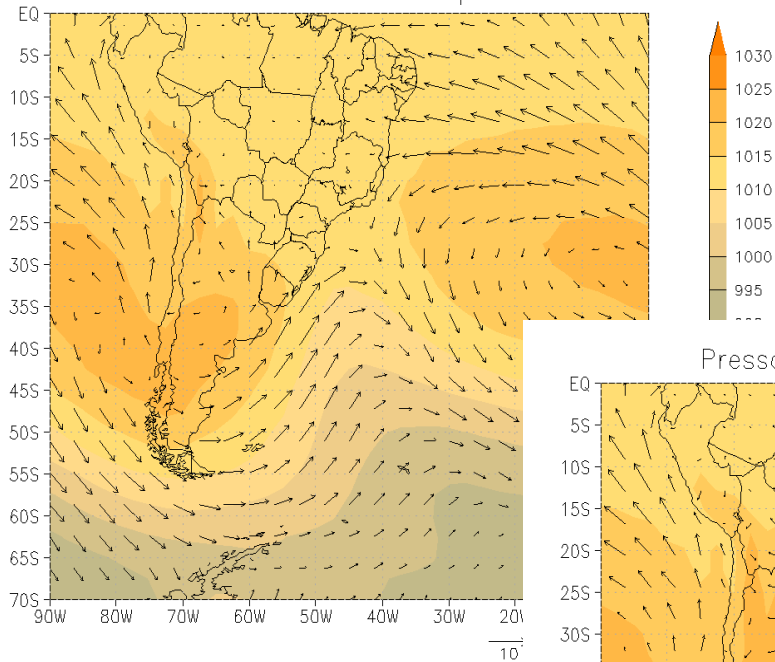


Tabela 1 – Quantificação dos eventos superiores a +2 desvios padrão, considerando a série filtrada de valores diários de elevação do nível do mar.

Acima de +2 d.p.	Primavera	Verão	Outono	Inverno	Total
1951 - 1960	16	12	48	28	104
1961 - 1970	13	16	49	41	119
1971 - 1980	19	26	53	36	134

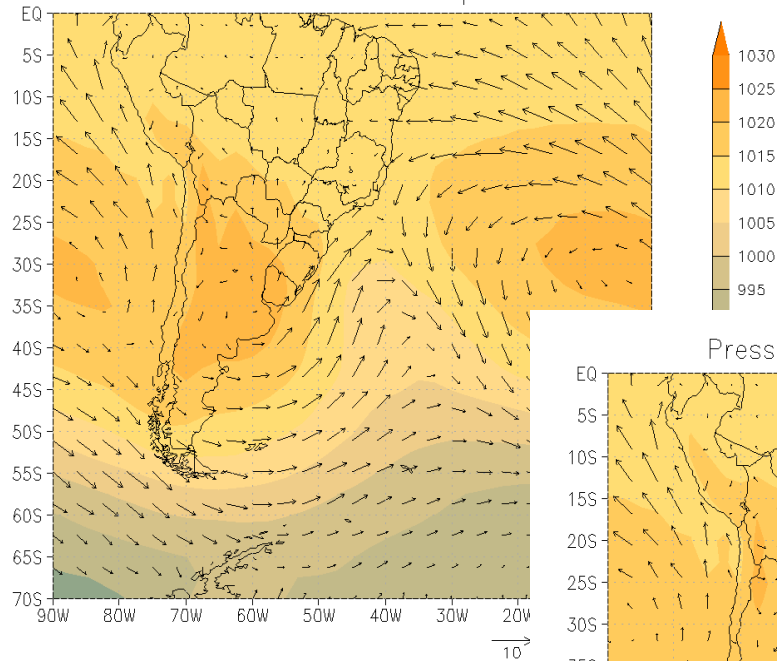


Pressao e Vento em Superficie



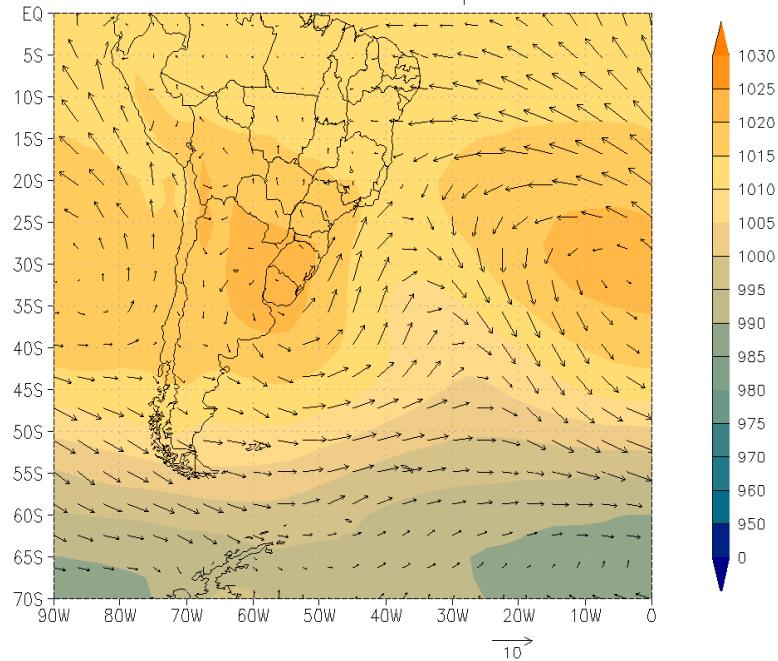
2 dias antes

Pressao e Vento em Superficie



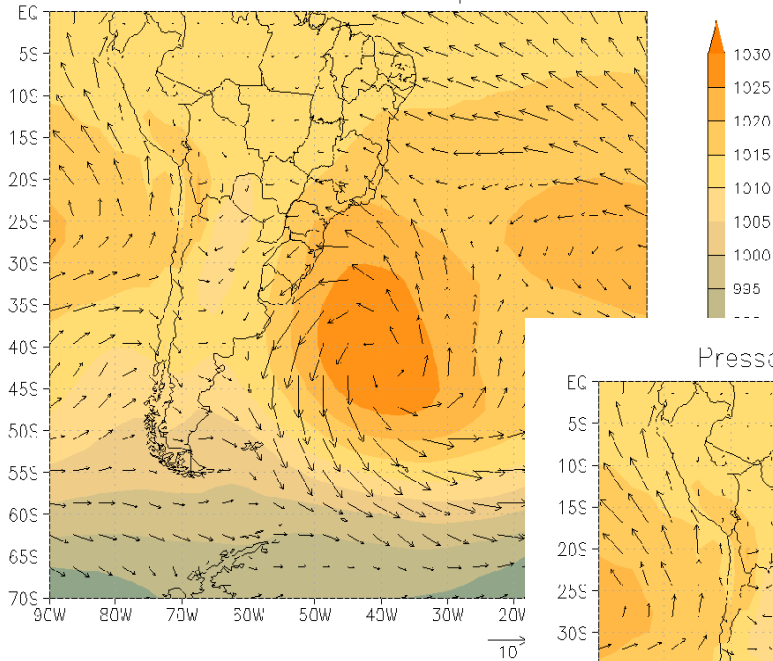
1 dia antes

Pressao e Vento em Superficie



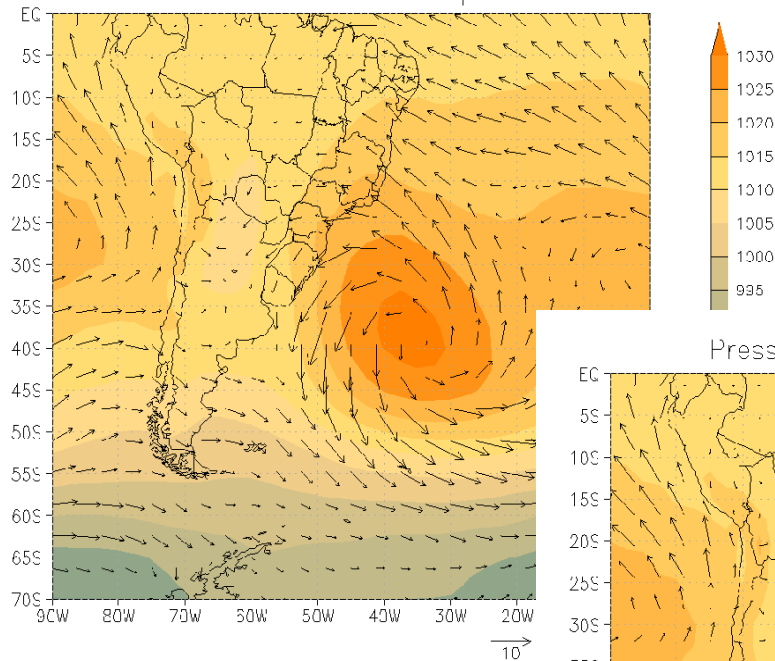
Eventos positivos > 3 std

Pressao e Vento em Superficie



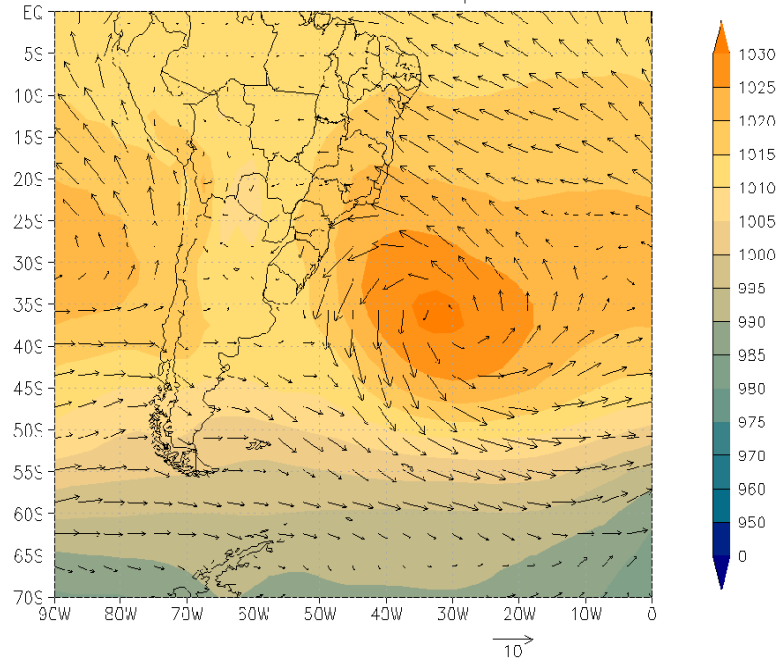
2 dias antes

Pressao e Vento em Superficie



1 dia antes

Pressao e Vento em Superficie



MODELAGEM NUMÉRICA

Quatro simulações para combinar diferentes forçantes

Ventos e Fluxos (sal e calor) (sempre considerados)

Marés (com e sem)

Pressão ao Nível do Mar (com e sem)

Experimento 1: vento, fluxos, maré e pressão

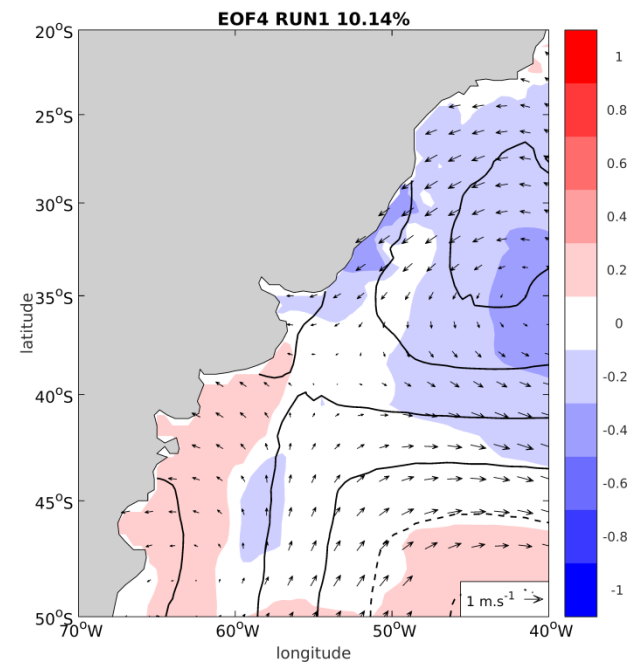
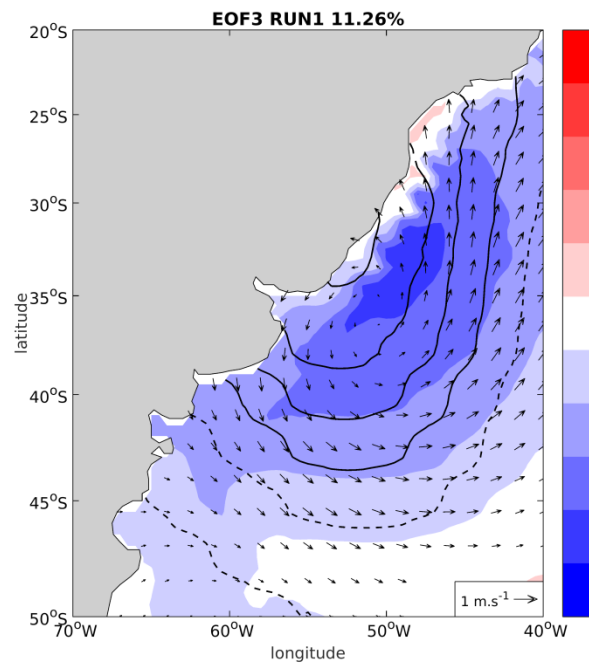
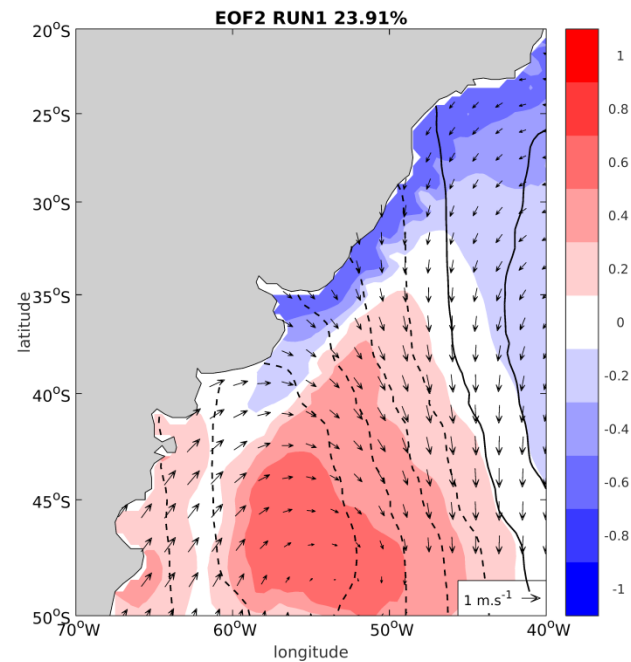
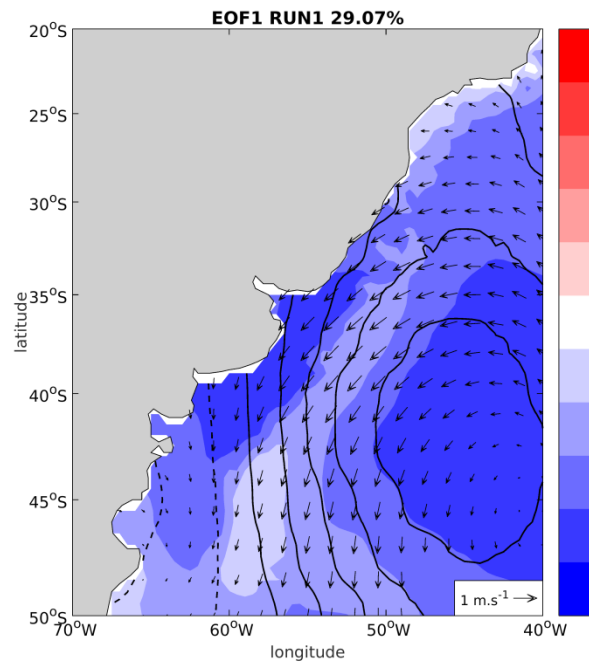
Experimento 2: vento, fluxos e maré

Experimento 3: vento, fluxos e pressão

Experimento 4: vento e fluxos

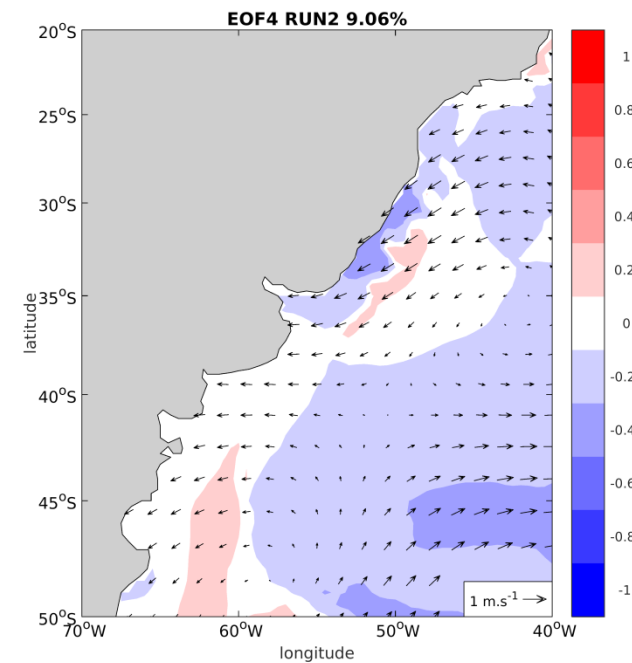
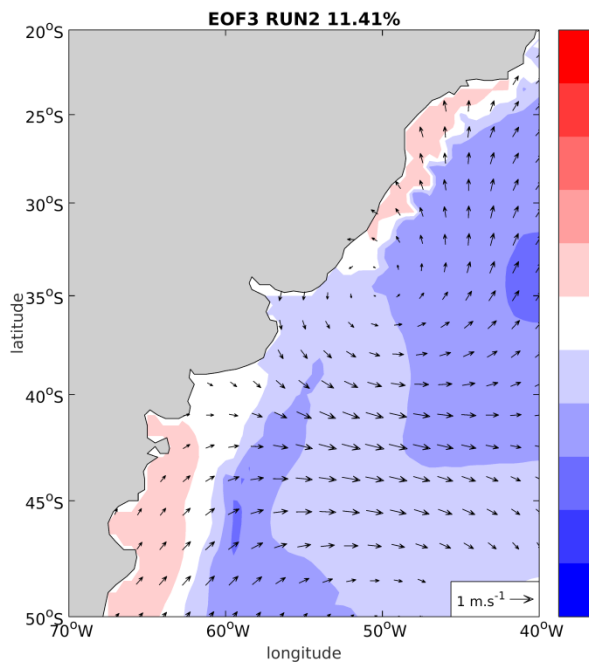
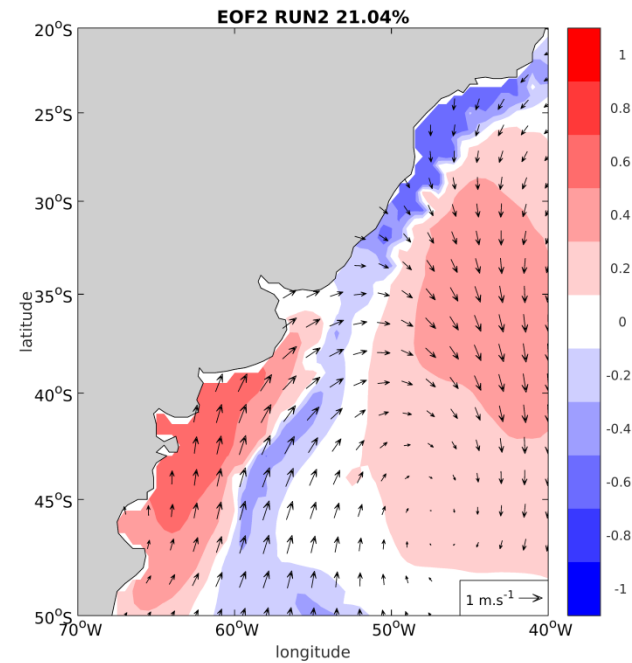
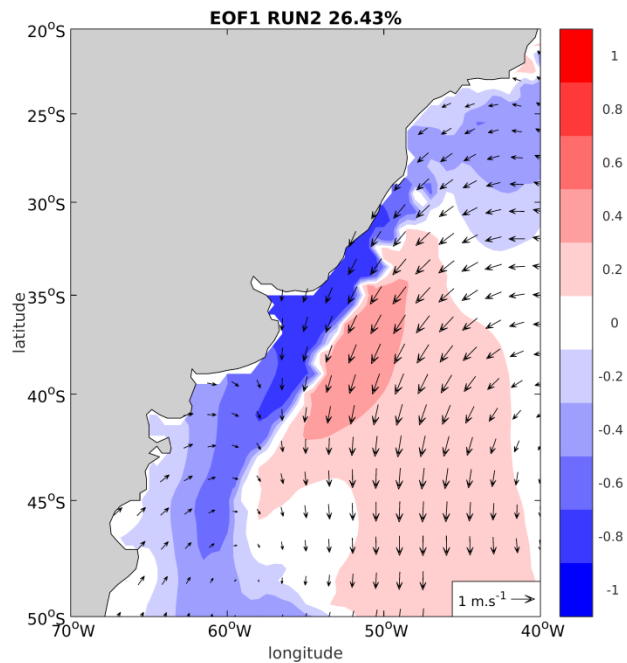
ASPECTOS DE GERAÇÃO

EXP1



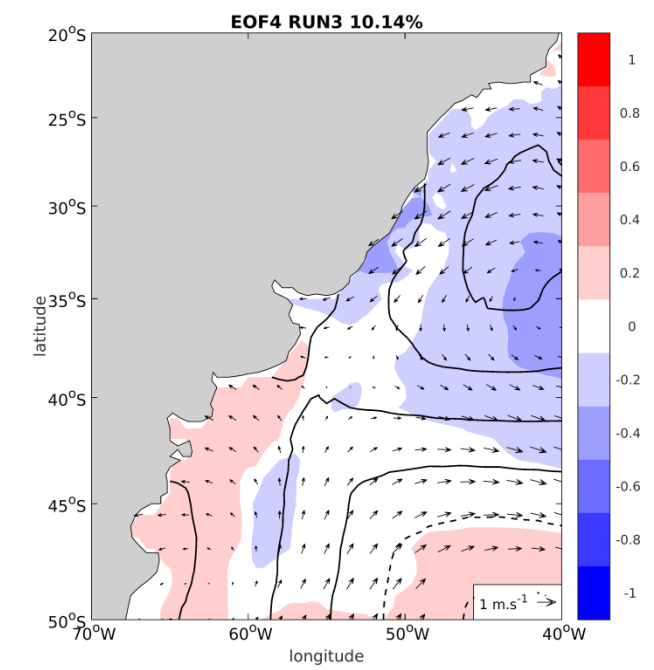
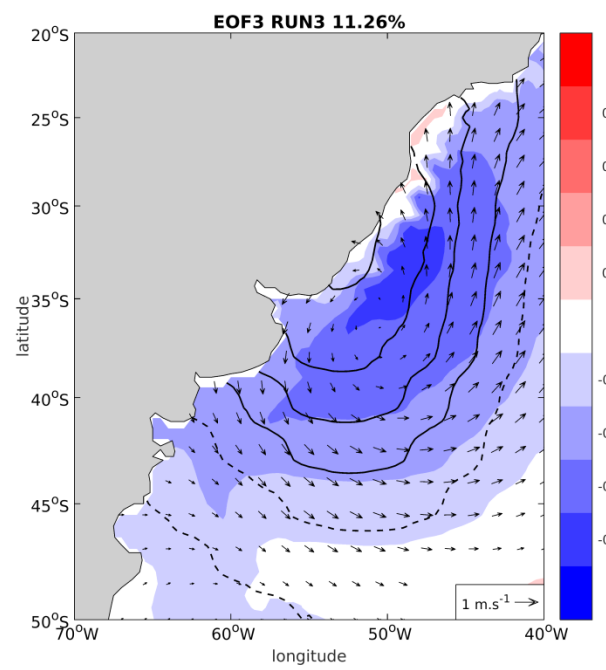
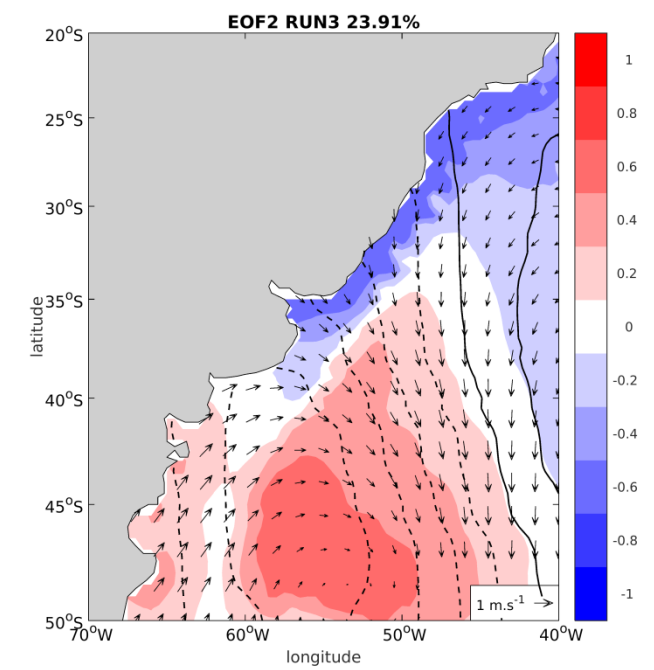
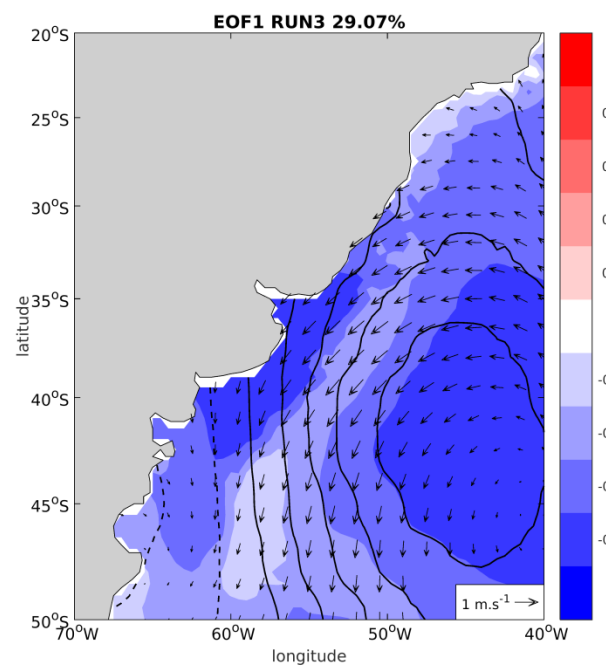
ASPECTOS DE GERAÇÃO

EXP2



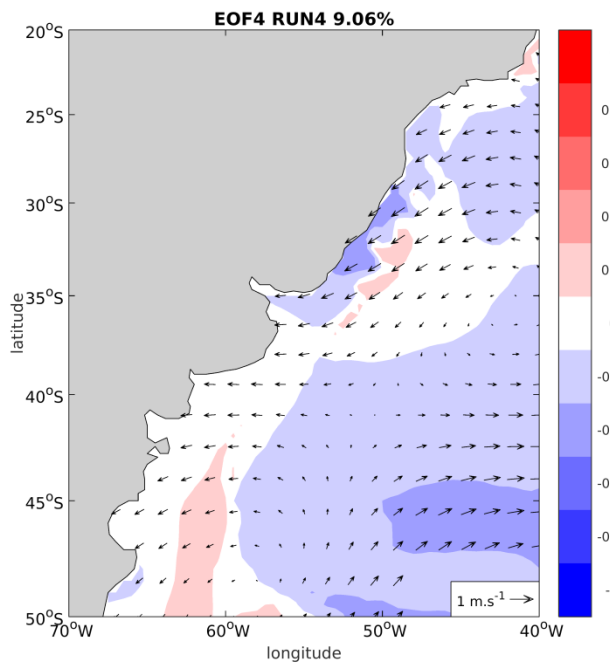
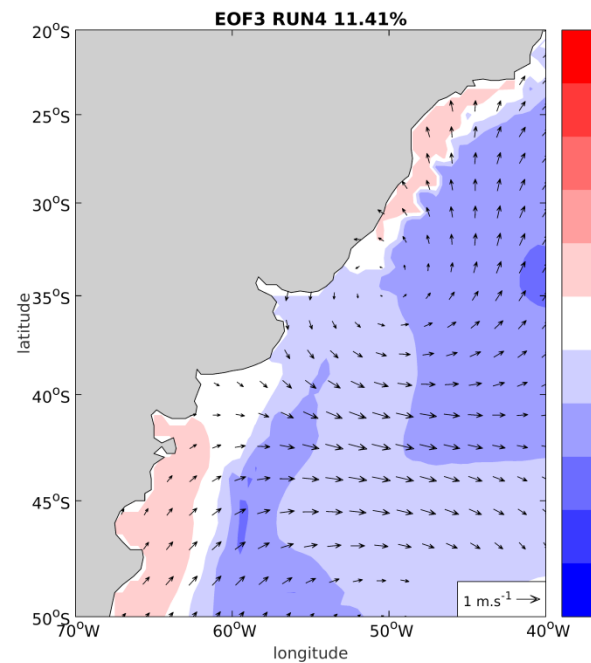
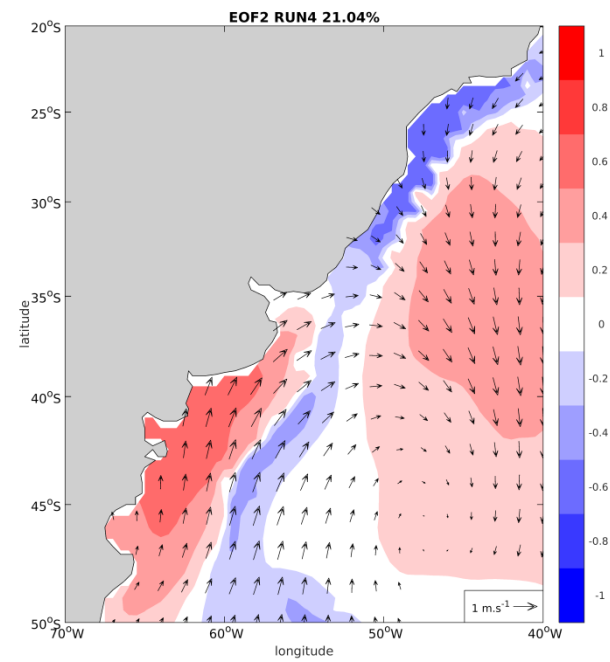
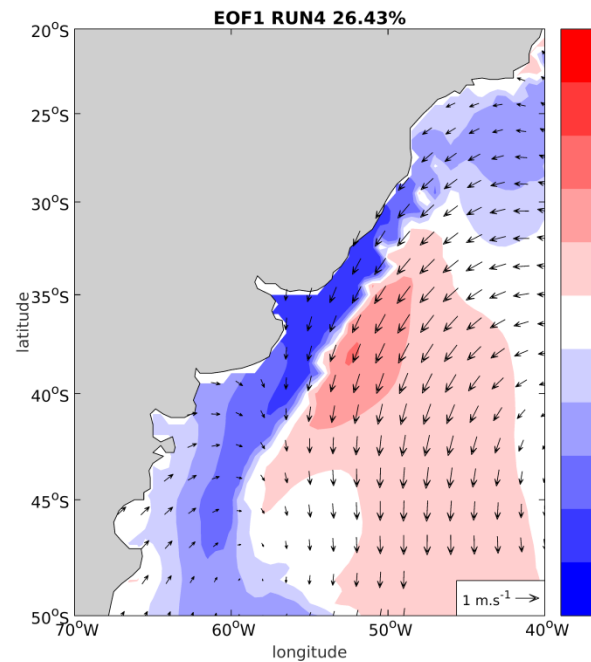
ASPECTOS DE GERAÇÃO

EXP3

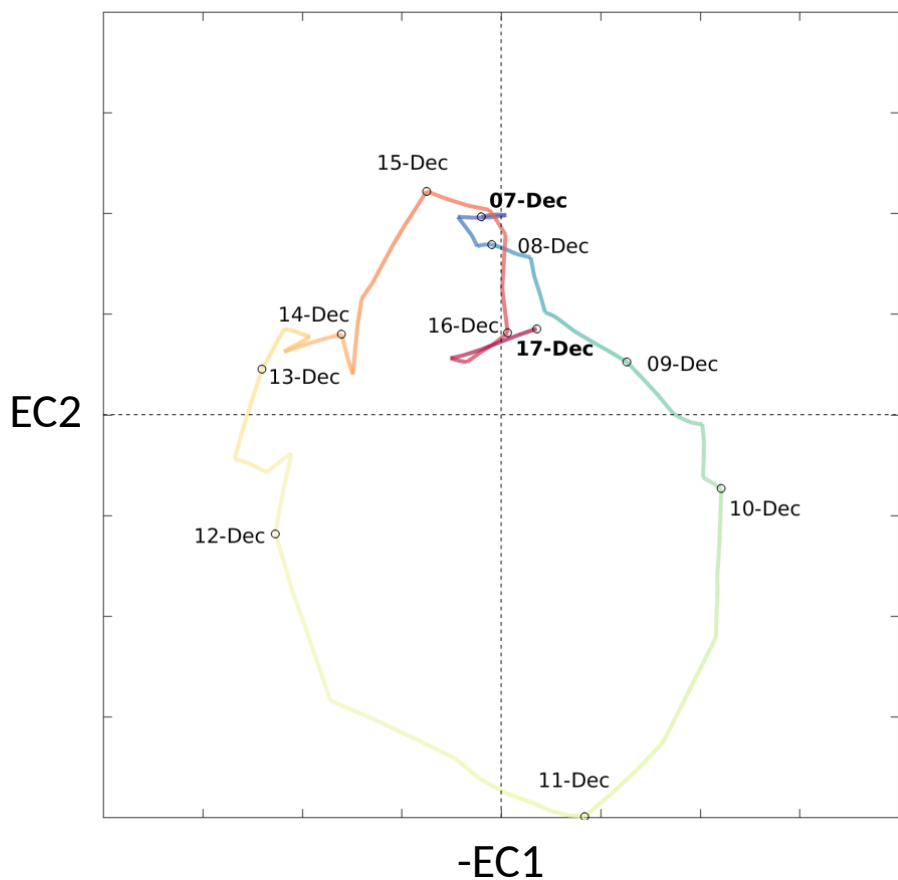


ASPECTOS DE GERAÇÃO

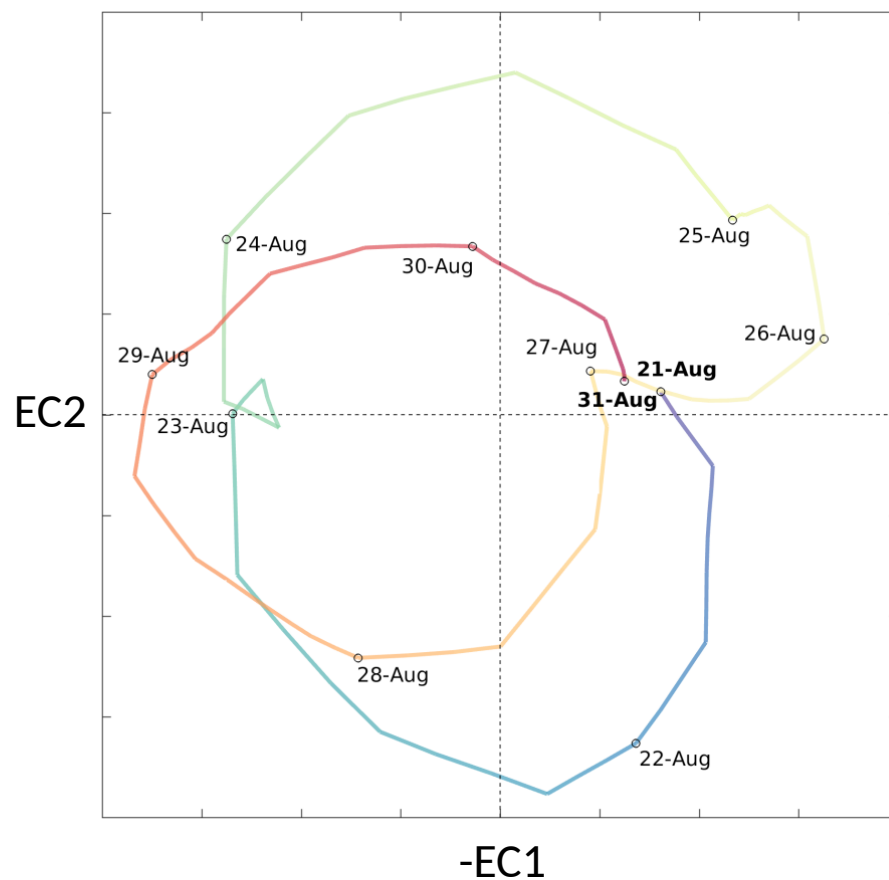
EXP4



EVOLUÇÃO DOS MODOS

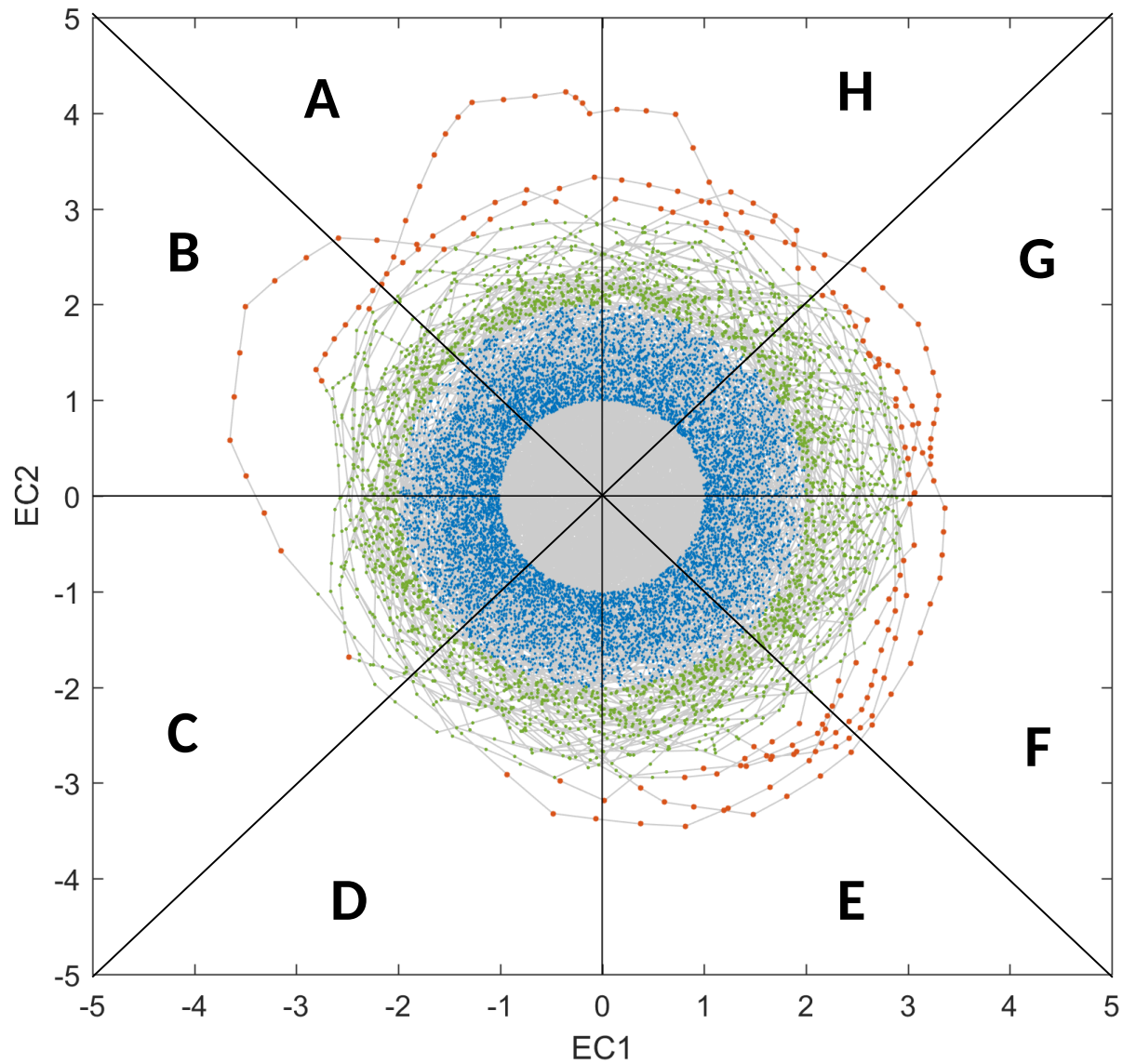


07 a 17 de Dezembro, 1960



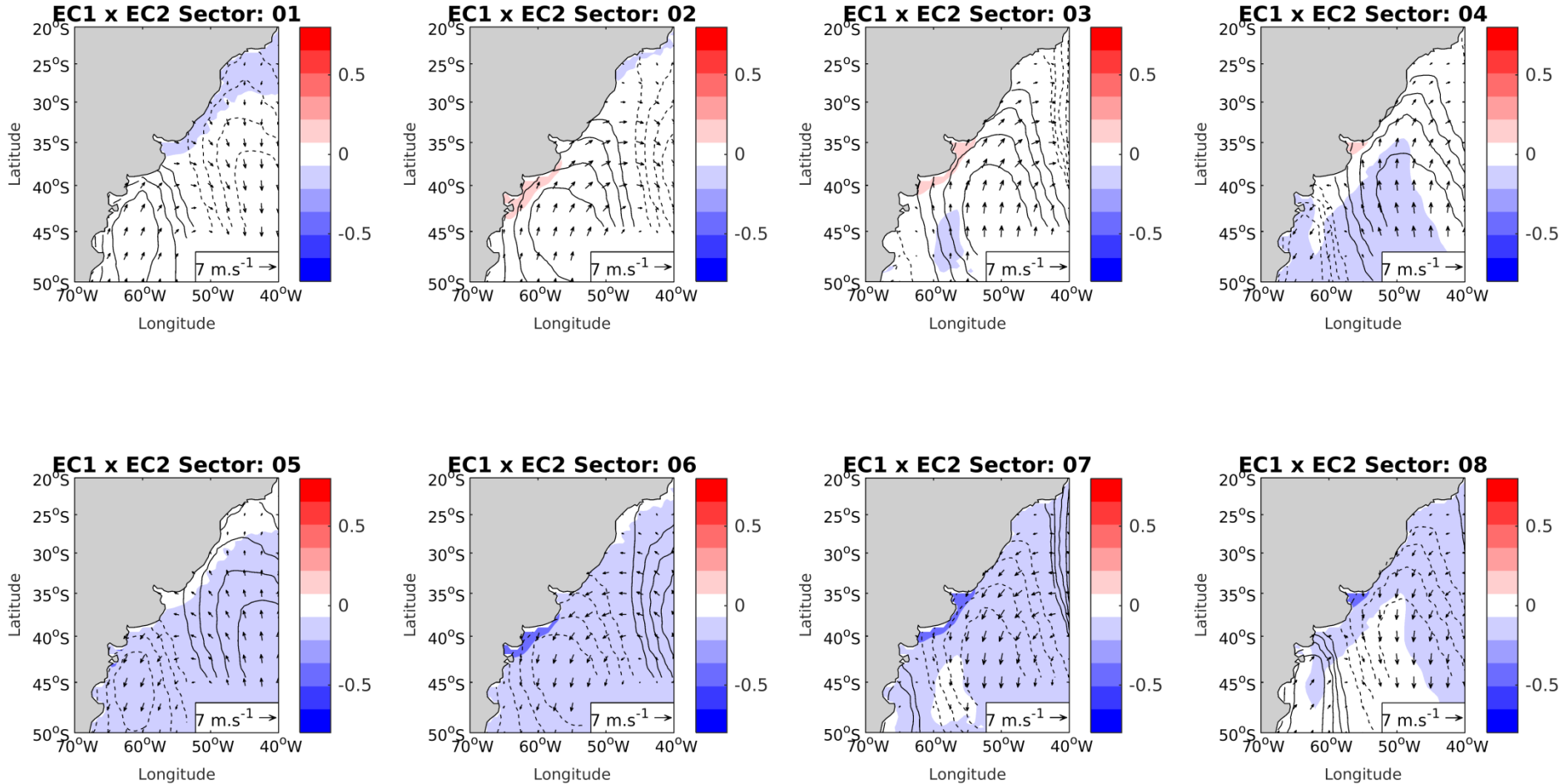
21 a 31 de Agosto, 1988

ASPECTOS DE PROPAGAÇÃO



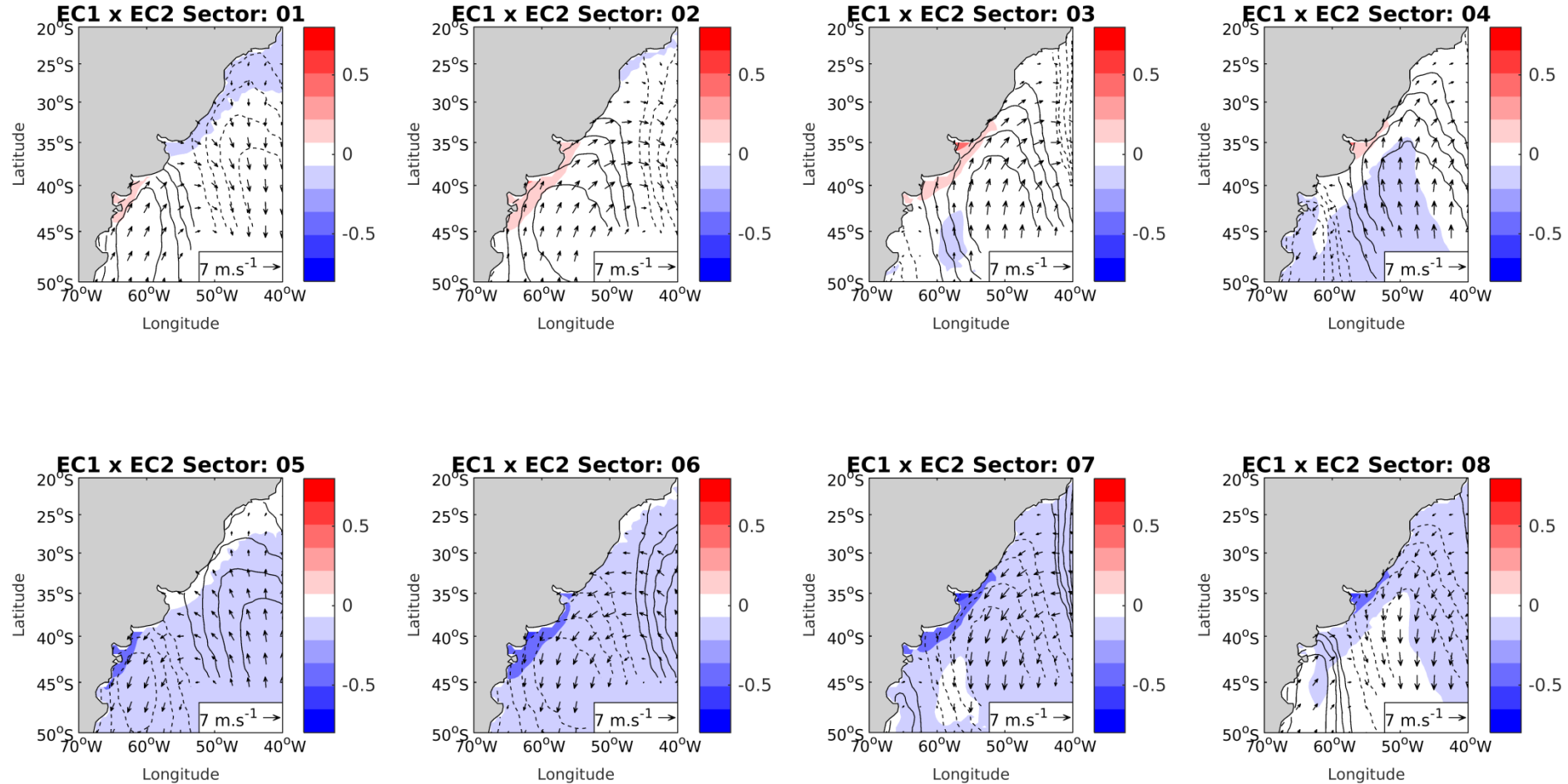
COMPOSITES EXP1 TODOS OS PONTOS

Eta+Wind Composites - RUN1



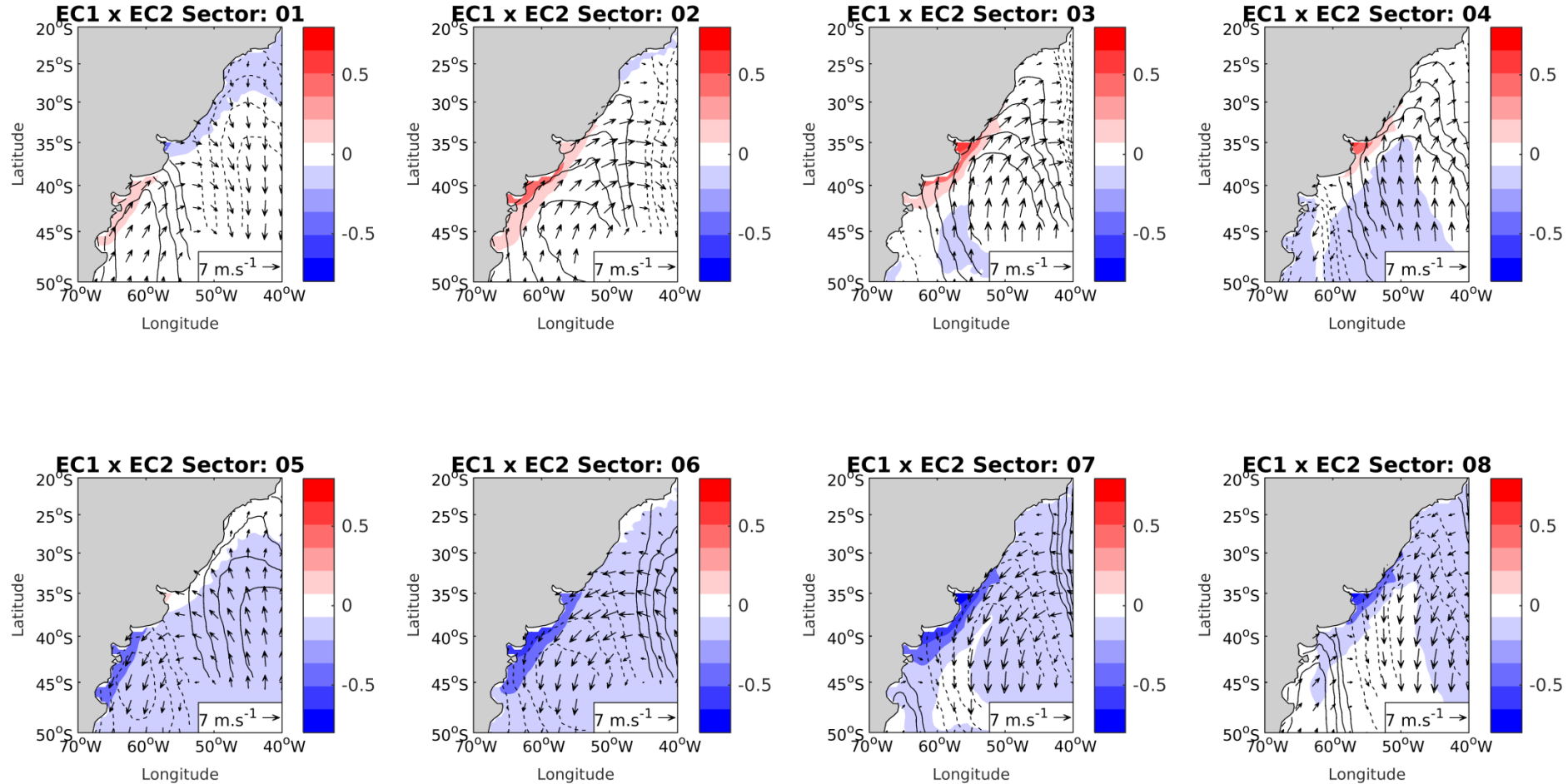
COMPOSITES EXP1 1std

Eta+Wind Composites - RUN1



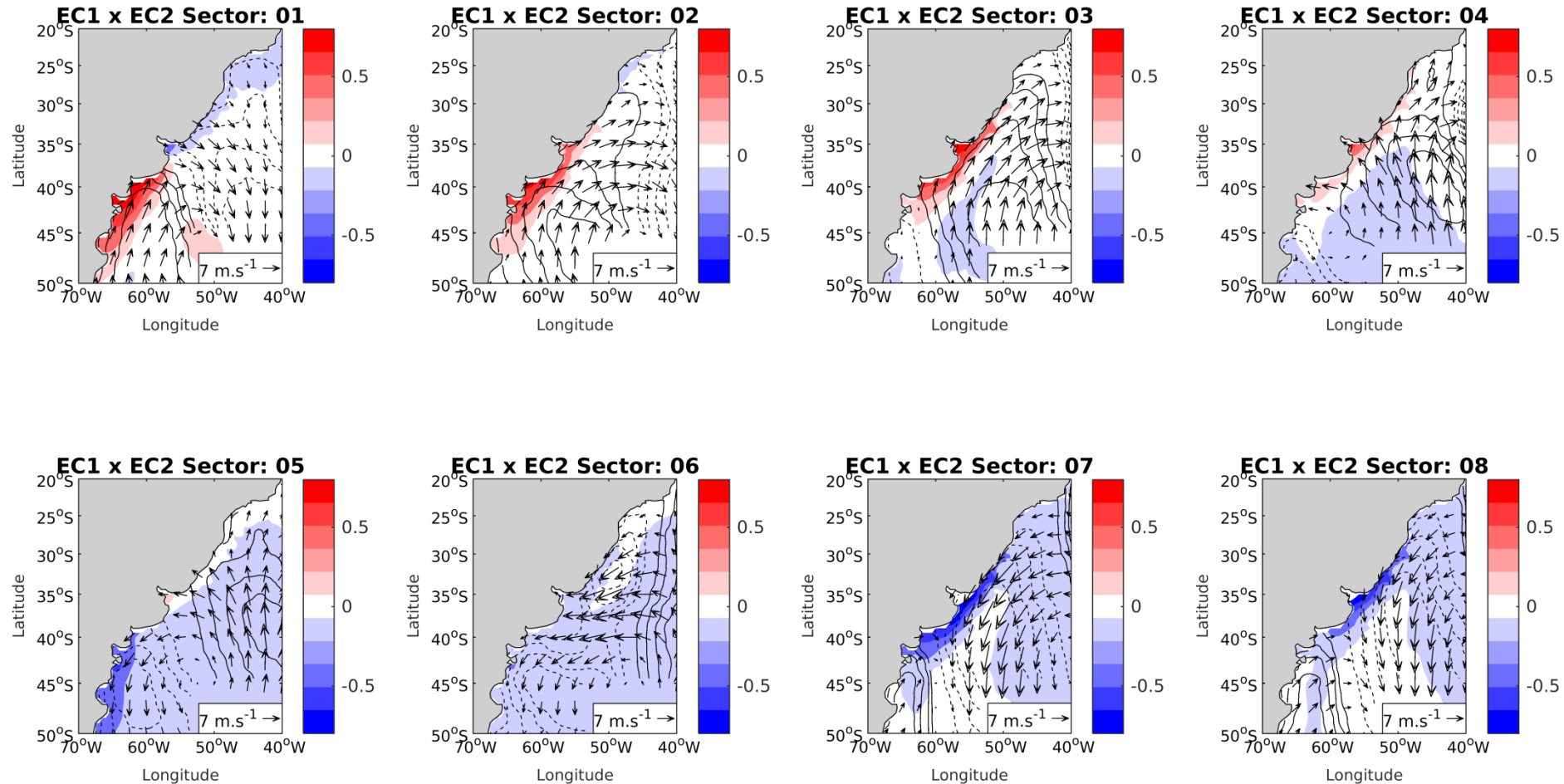
COMPOSITES EXP1 2std

Eta+Wind Composites - RUN1



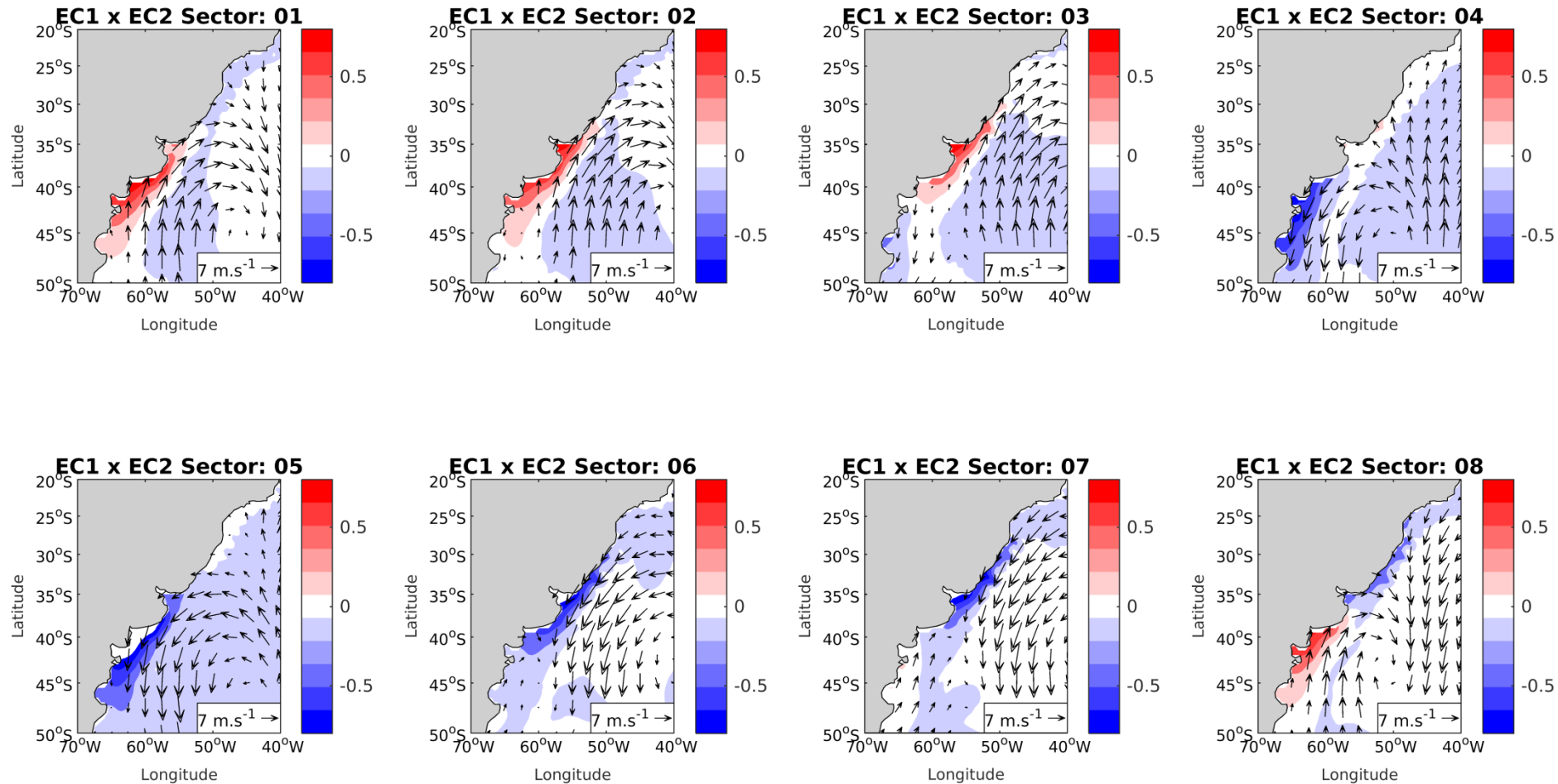
COMPOSITES EXP1 3std

Eta+Wind Composites - RUN1



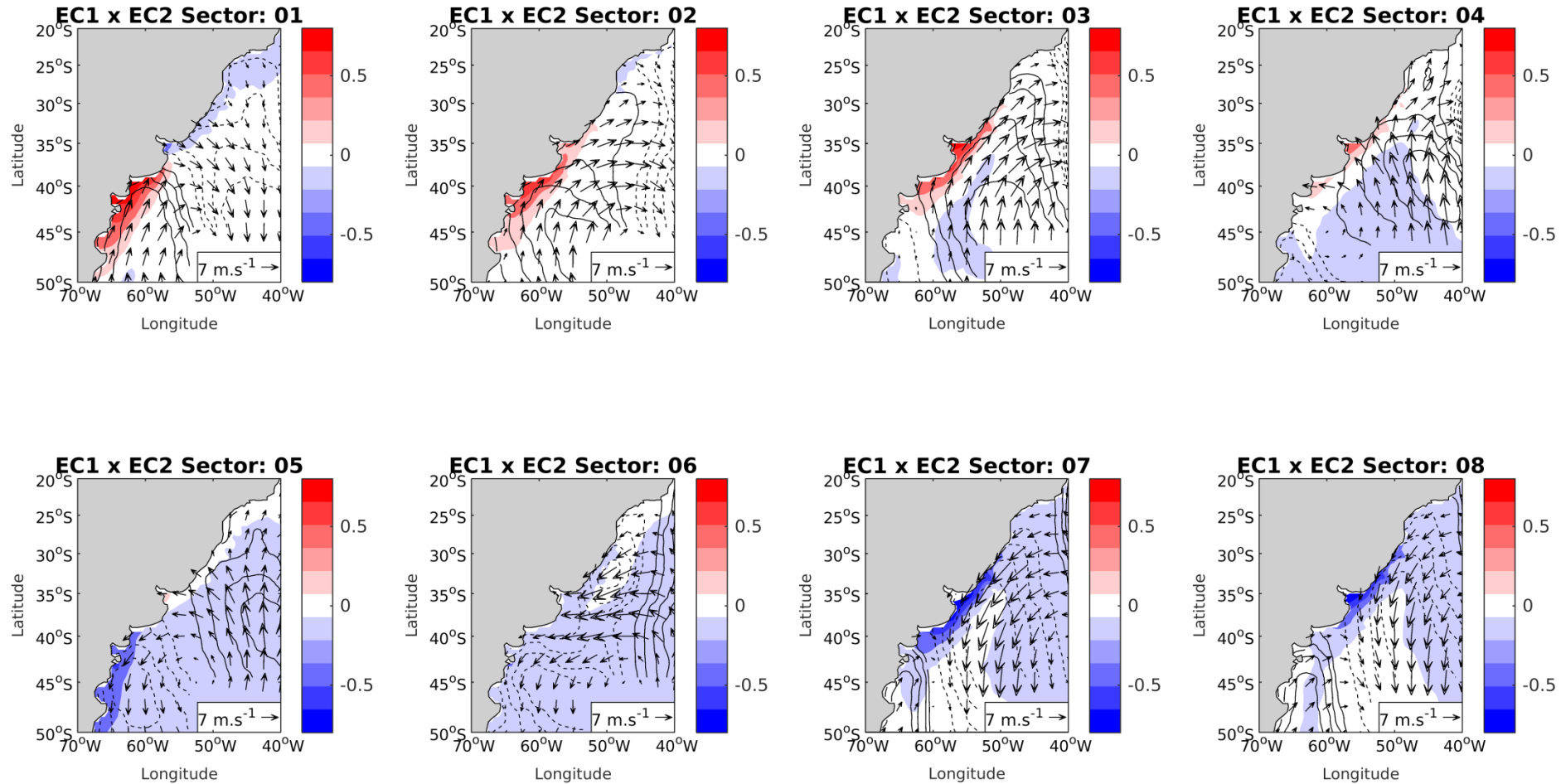
COMPOSITES EXP2 3std

Eta+Wind Composites - RUN2



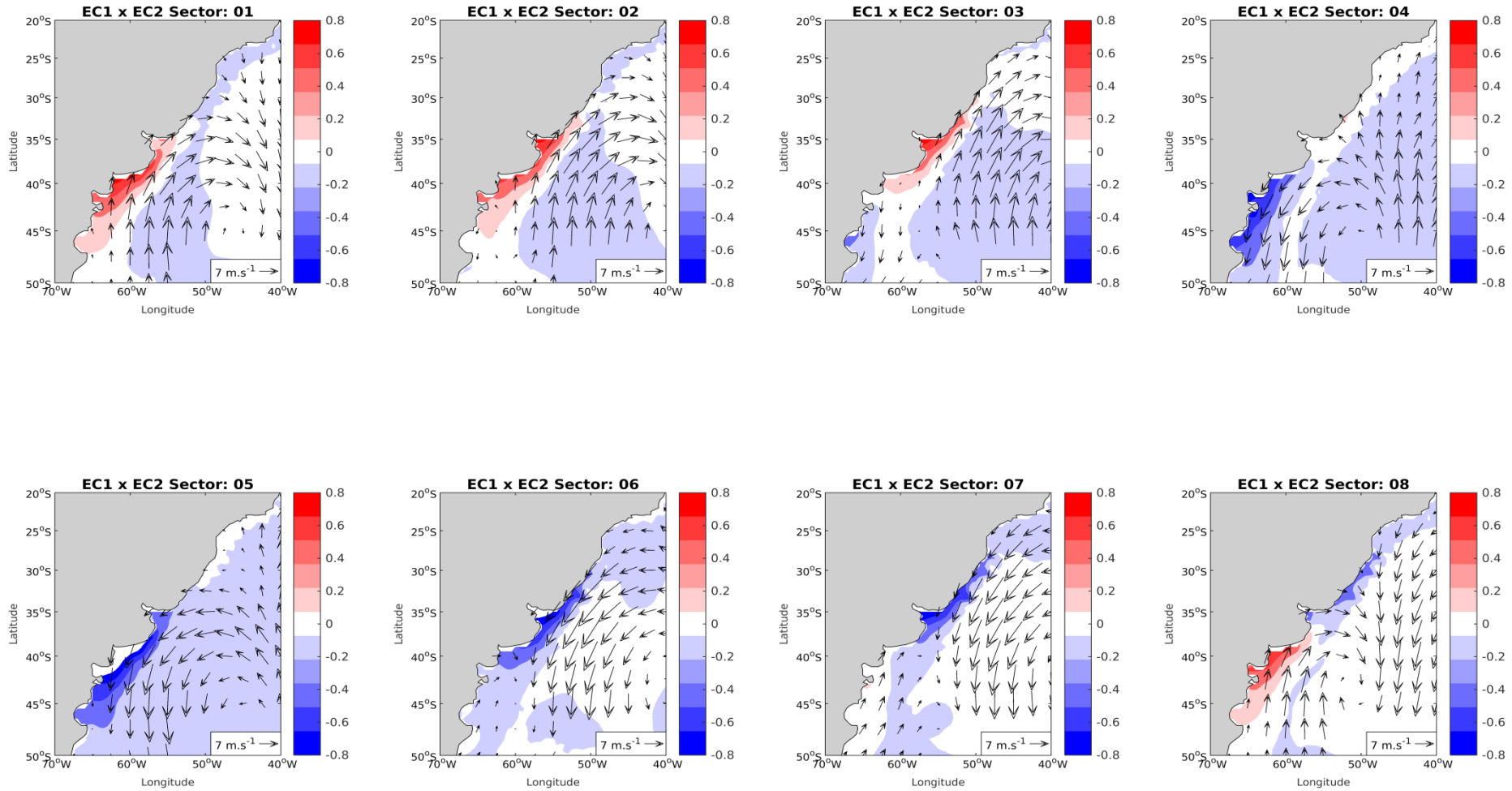
COMPOSITES EXP3 3std

Eta+Wind Composites - RUN3

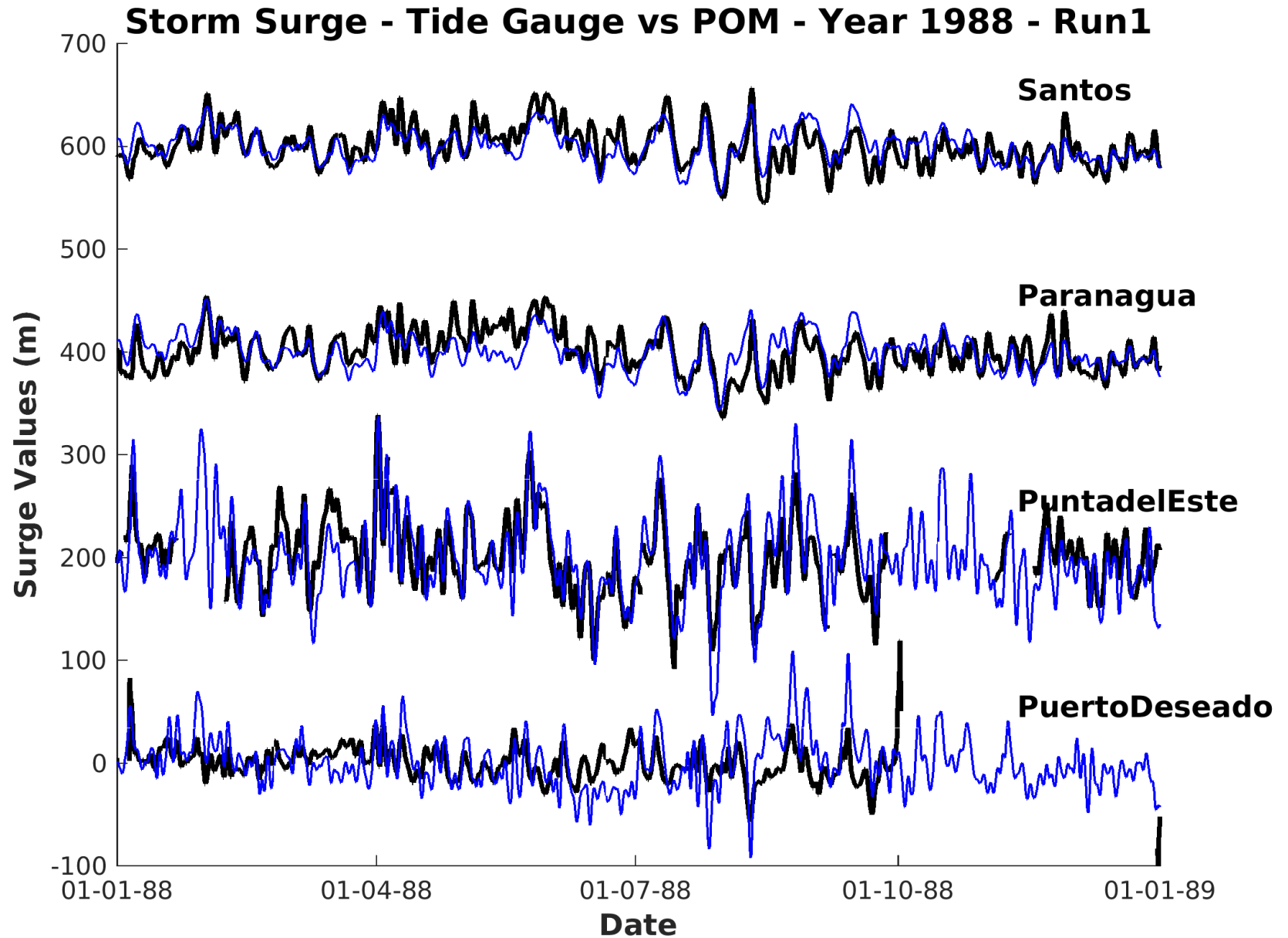


COMPOSITES EXP4 3std

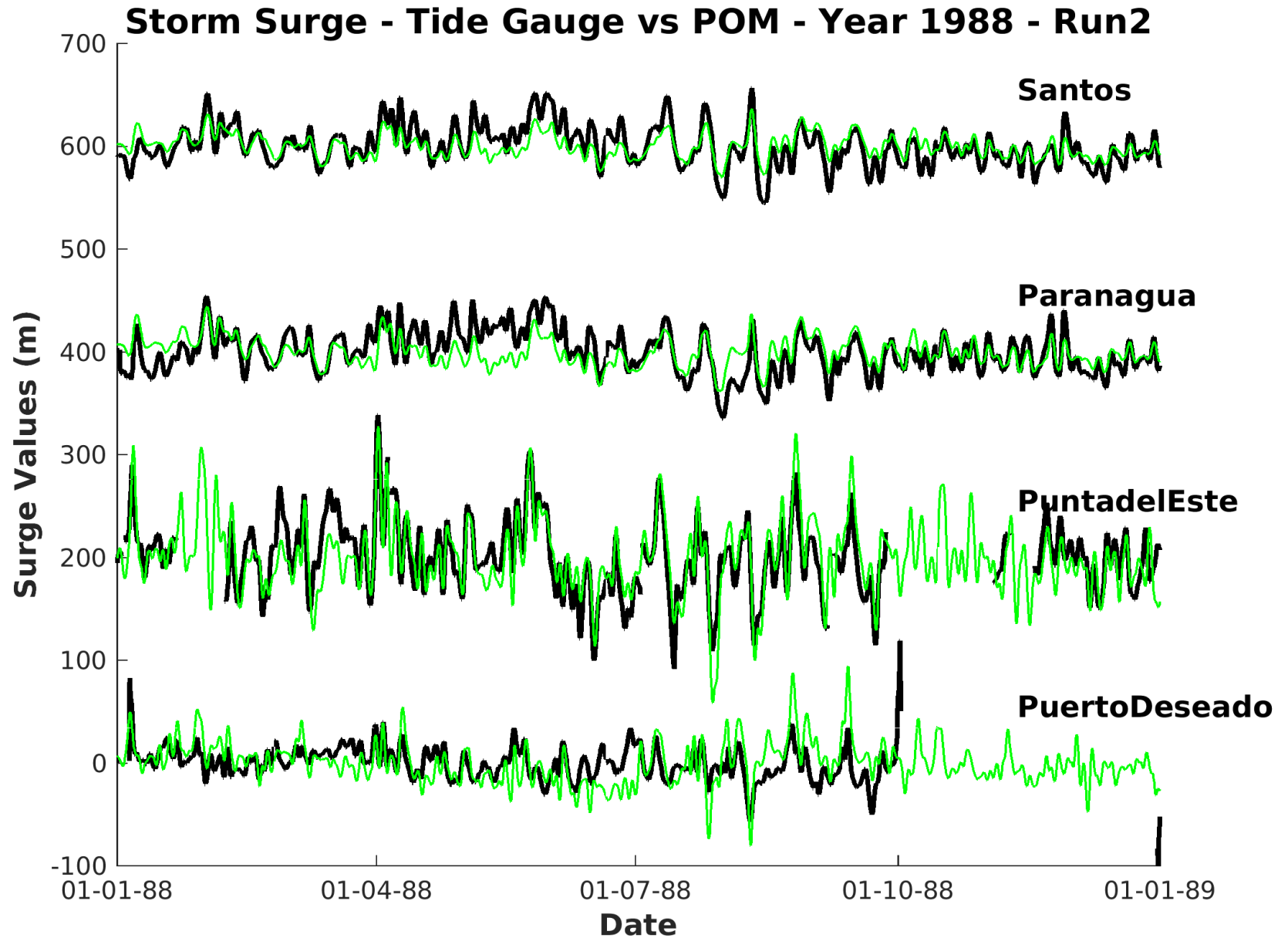
Eta+Wind Composites - RUN4



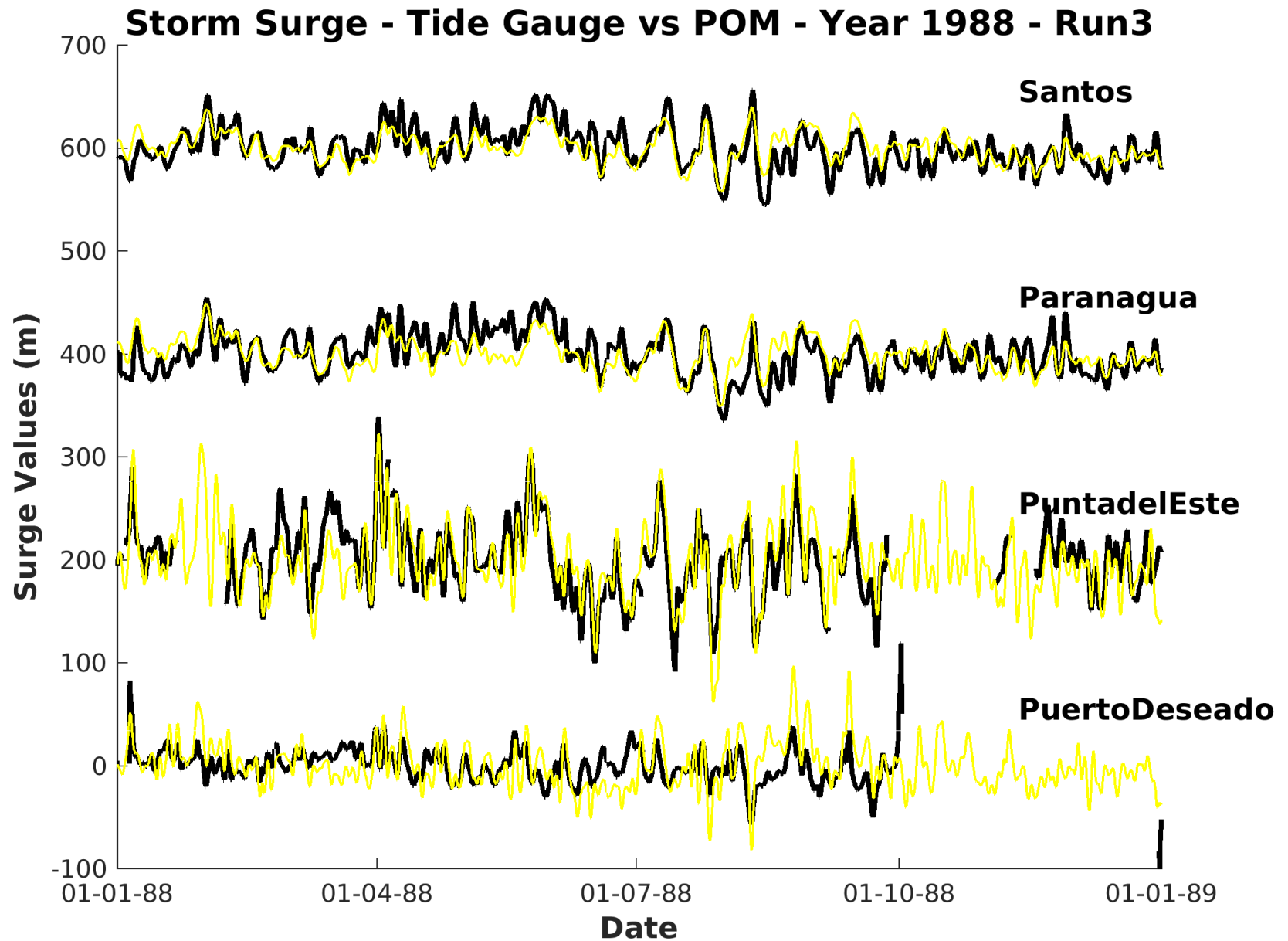
SEPARAÇÃO DE FATORES



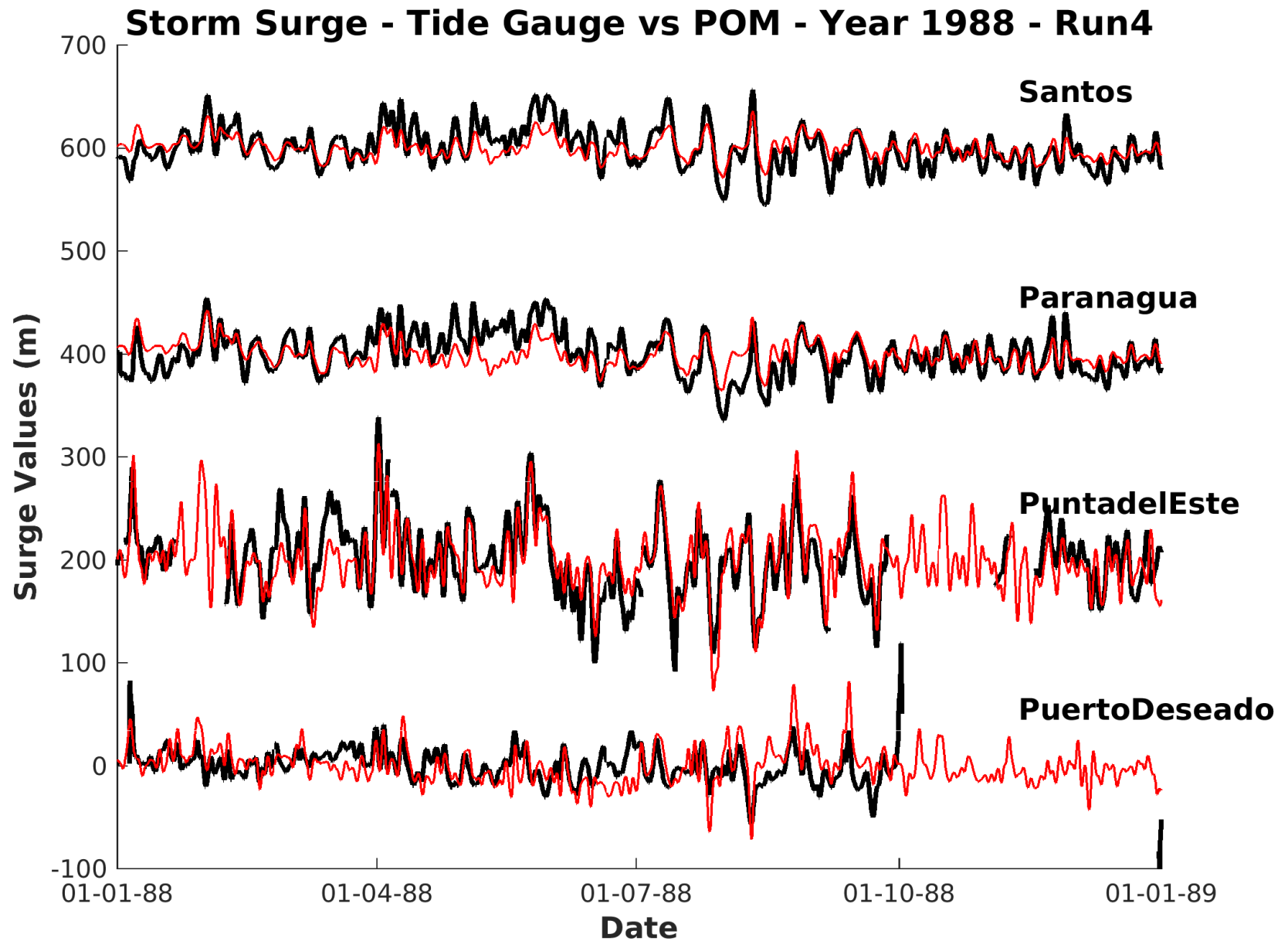
SEPARAÇÃO DE FATORES



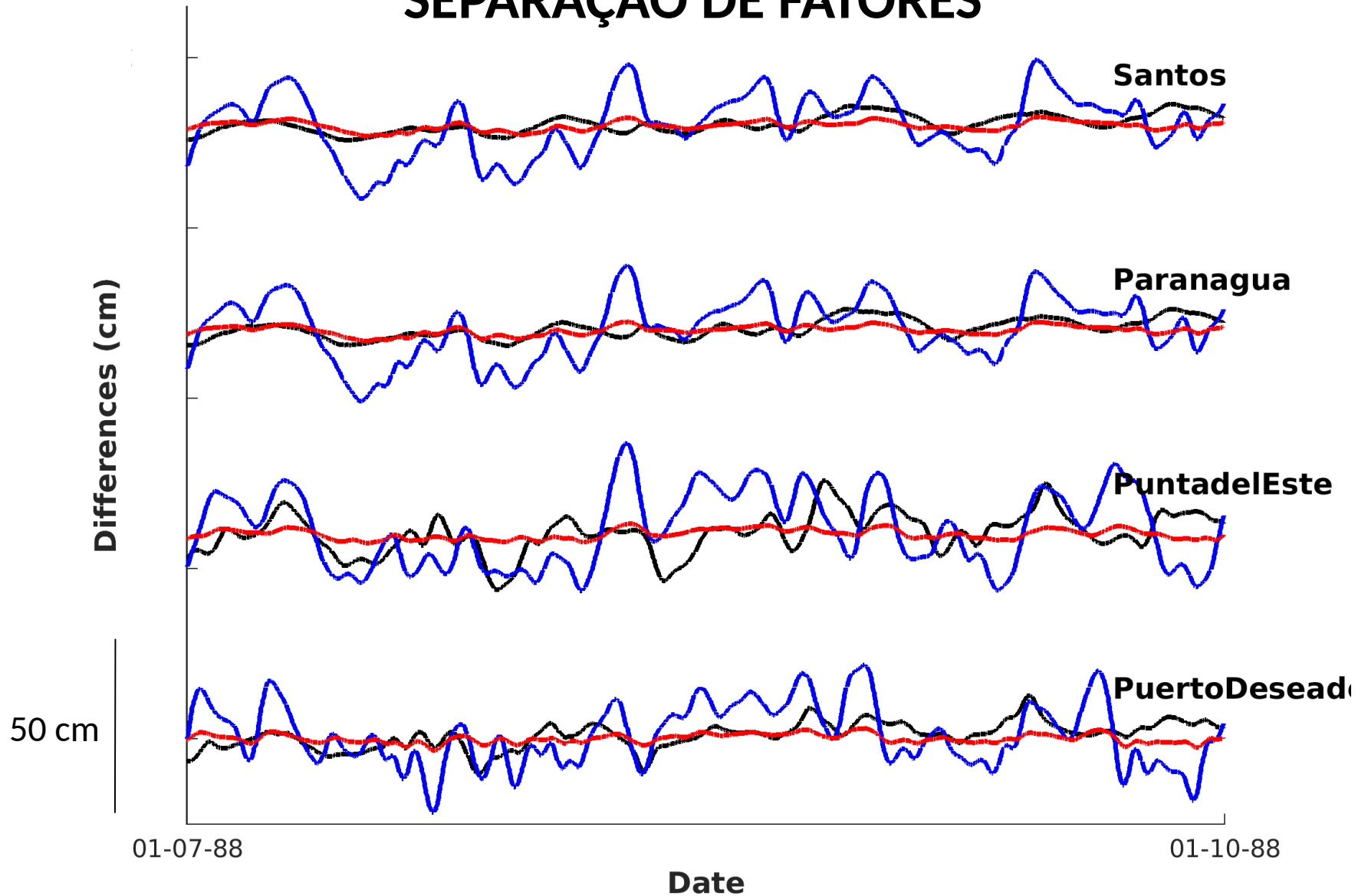
SEPARAÇÃO DE FATORES



SEPARAÇÃO DE FATORES



SEPARAÇÃO DE FATORES



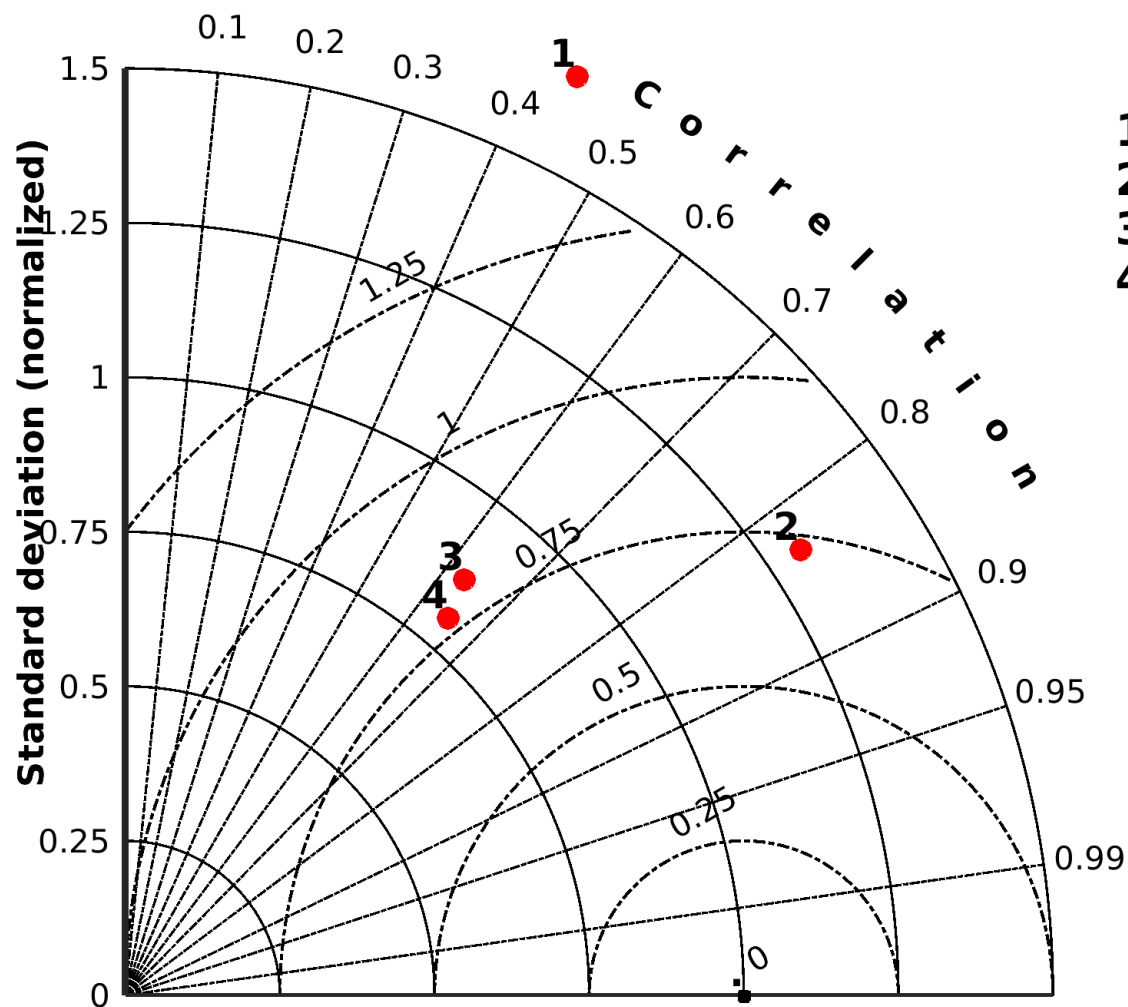
Tide effect

SLP effect

Non linear effect Tide/SLP

Storm Surge - Tide Gauge vs POMrun1

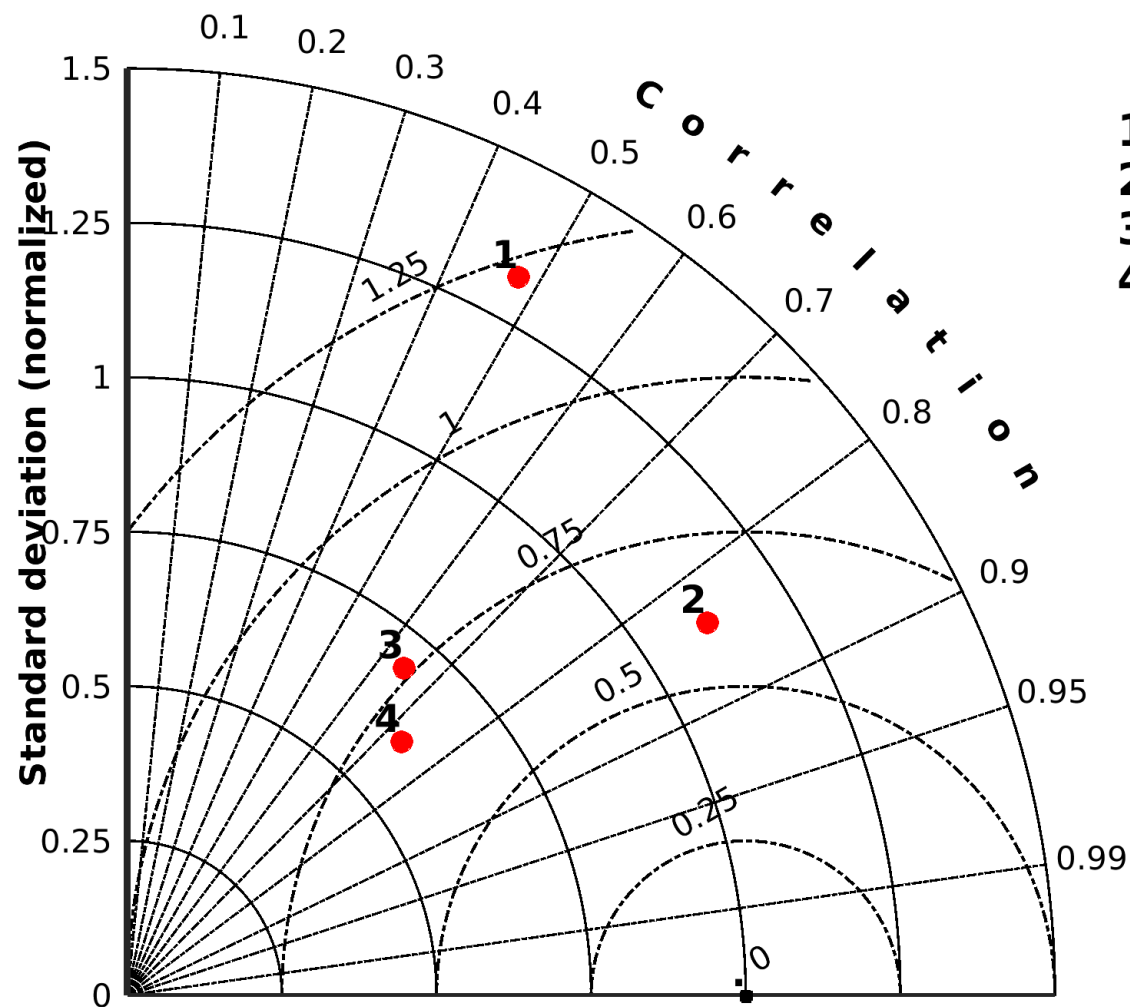
Only 1988



1 PuertoDeseac
2 PuntadelEste
3 Paranagua
4 Santos

Storm Surge - Tide Gauge vs POMrun2

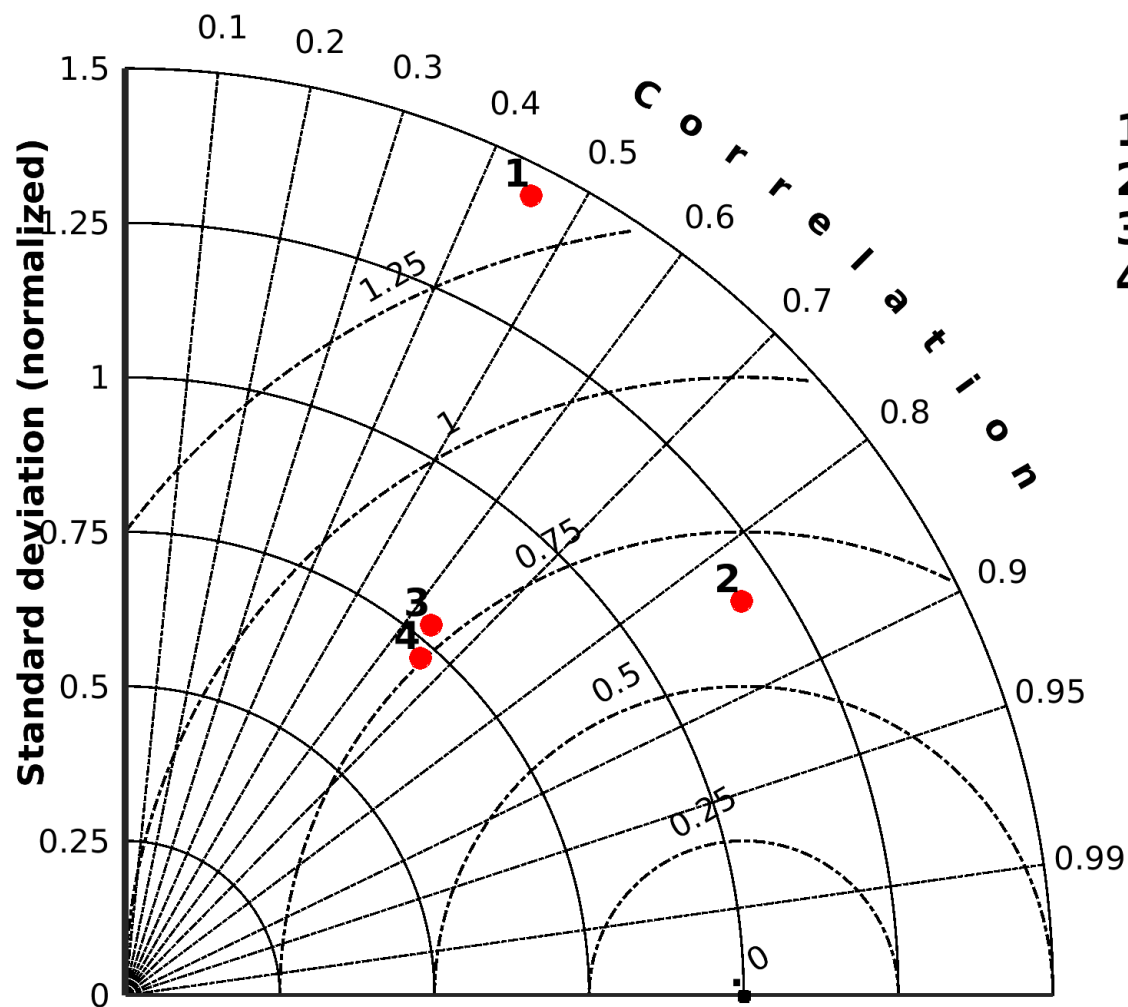
Only 1988



- 1 PuertoDeseado
- 2 PuntadelEste
- 3 Paranagua
- 4 Santos

Storm Surge - Tide Gauge vs POMrun3

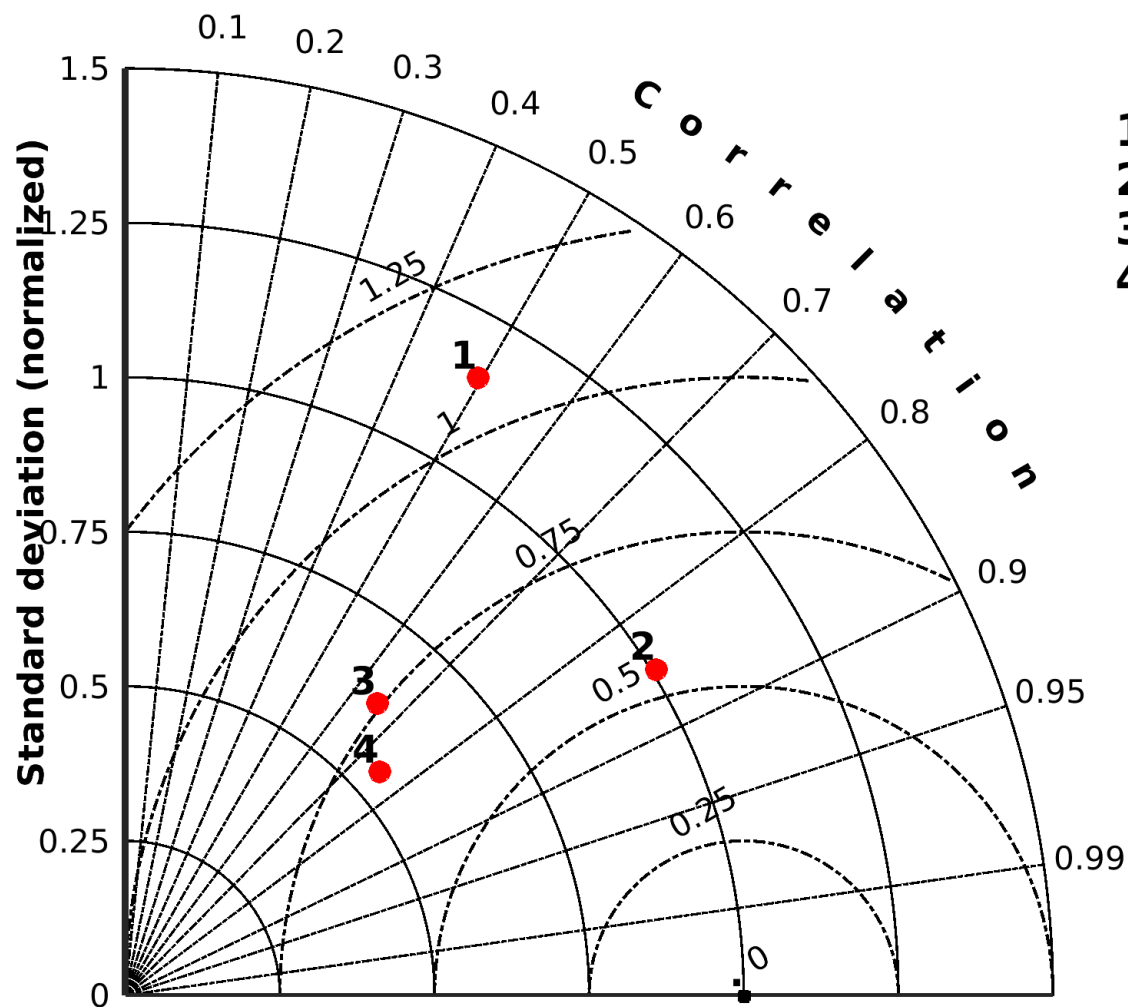
Only 1988



- 1 PuertoDeseac
- 2 PuntadelEste
- 3 Paranagua
- 4 Santos

Storm Surge - Tide Gauge vs POMrun4

Only 1988



Obrigado pela atenção!

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