Role of Brazil Current warming in amplifying 2008 Santa Catarina extreme precipitation event

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Introduction

(1) Most extreme disaster by landslide in Santa Catarina;

(2) More than 80.000 people removed from their homes and 2 million people affected (34% from the total population in Santa Catarina);

(3) Before the event, were more than three months of heavy rainfall;

(4) Between 22 and 23 November rained twice as expected for the month.

Introduction

As chuvas de novembro de 2008 em Santa Catarina: um estudo de caso visando à melhoria do monitoramento e da previsão de eventos extremos

ESTUDO DA PRECIPITAÇÃO MÁXIMA DIÁRIA PARA BLUMENAU-SC E O EVENTO DE NOVEMBRO DE 2008

Ademar Cordero[1], Dirceu Luis Severo[2]; Hélio dos Santos Silva[3]; Mário Tachini[4] & Péricles Alves Medeiros[5]

Indústria das enchentes: Impasses e desafios dos desastres socioambientais no Vale do Itajaí*

Caio Floriano dos Santos**
Carmen Susana Tornquist e Maria Paula Casagrande Marimon***

Chuvas Intensas em Santa Catarina: Análise Sinótica de um Evento Extremo e Simulação Numérica com o Modelo Atmosférico WRF
Heavy Rain in Santa Catarina: Synoptic Analysis of an Extreme Event and Numerical Simulation Using WRF Model

Vinícius Albuquerque de Almeida & Edilson Marton

APLICAÇÃO DE IMAGENS SAR ORBITAIS EM DESASTRES NATURAIS: MAPEAMENTO DAS INUNDAÇÕES DE 2008 NO VALE DO ITAJAÍ, SC

Application of Orbital SAR Images in Natural Disasters – 2008 Flood Mapping

Introduction

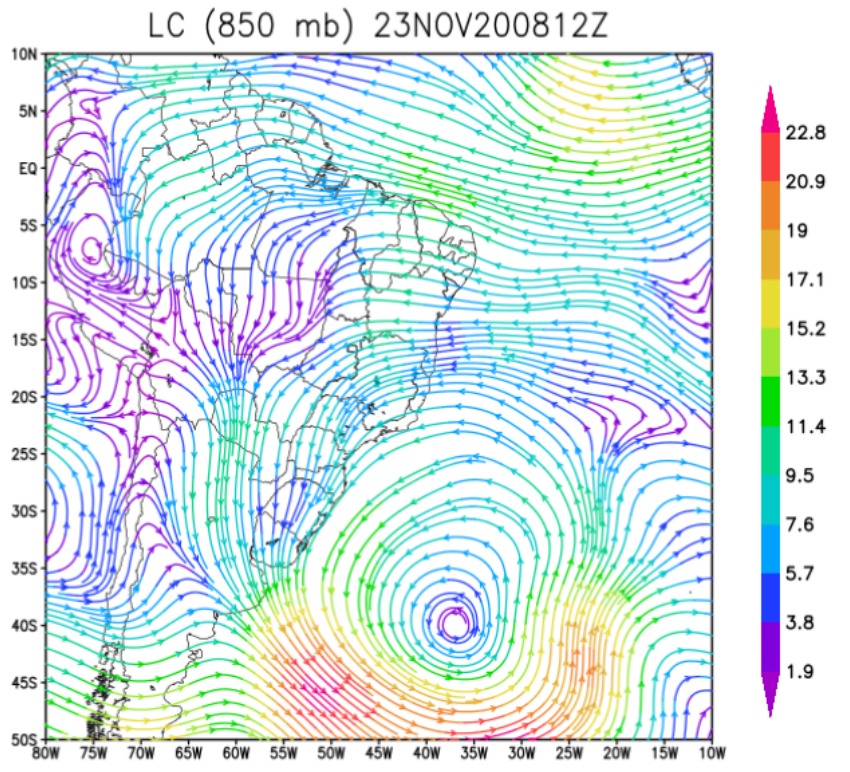


Figure 1: Streamlines (m/s) at 850 mb extracted from CFS reanalysis for 23 November 2008 12Z Courtesy of Cabrera (2018).

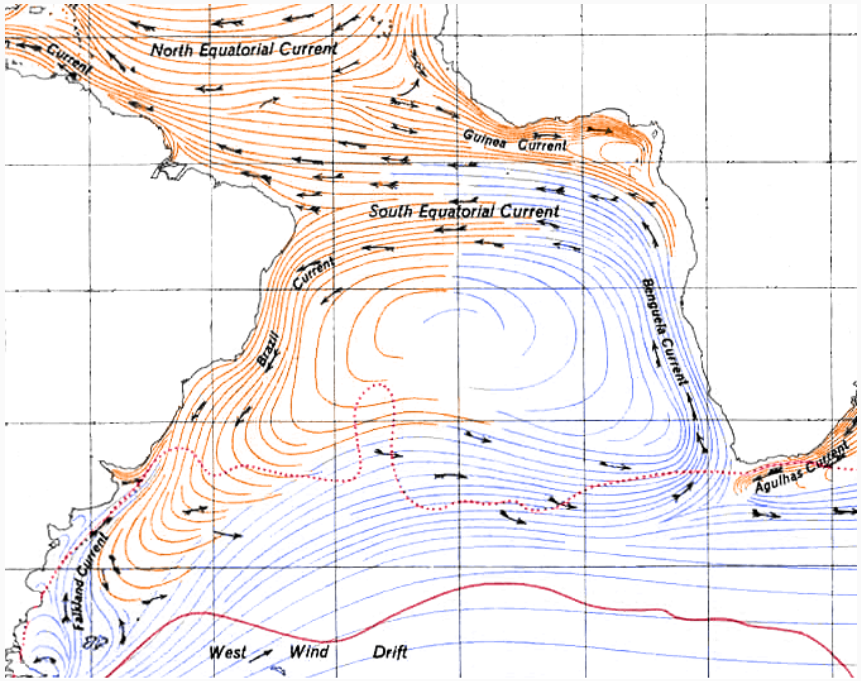


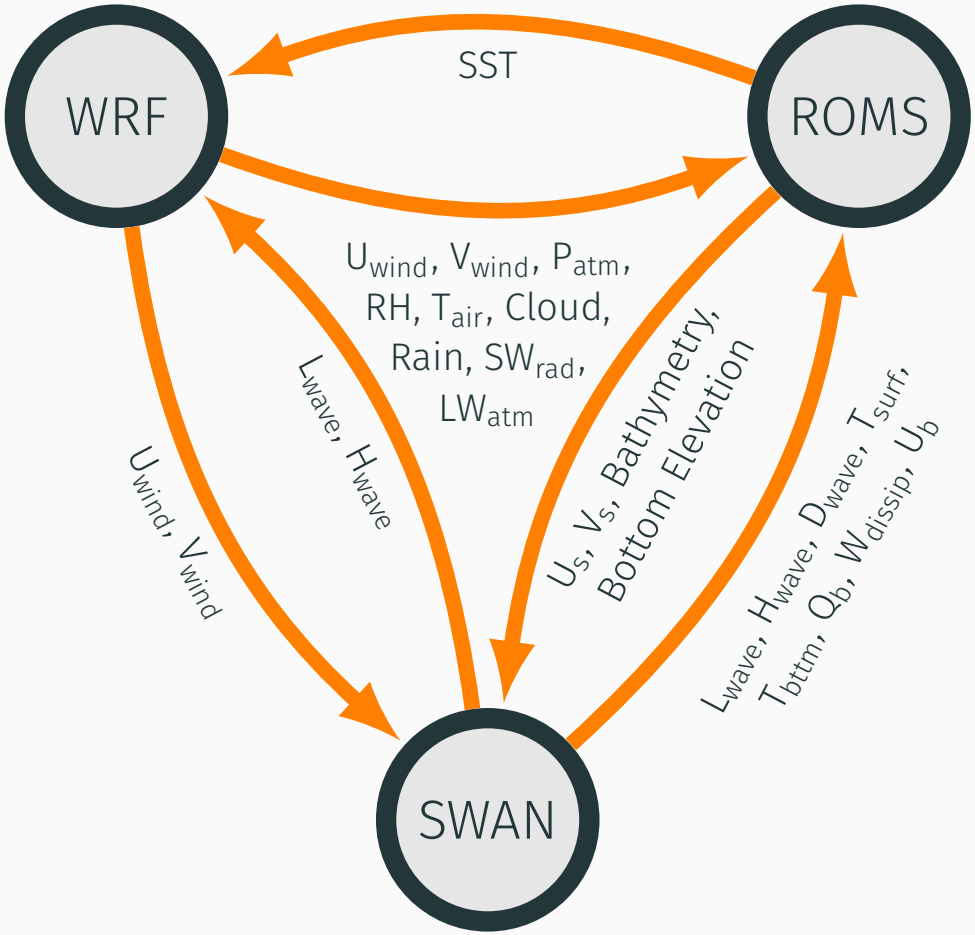
Figure 2: Schematic representation of the circulation in the southwestern Atlantic region. Modified from US Force. (1942)

Aim

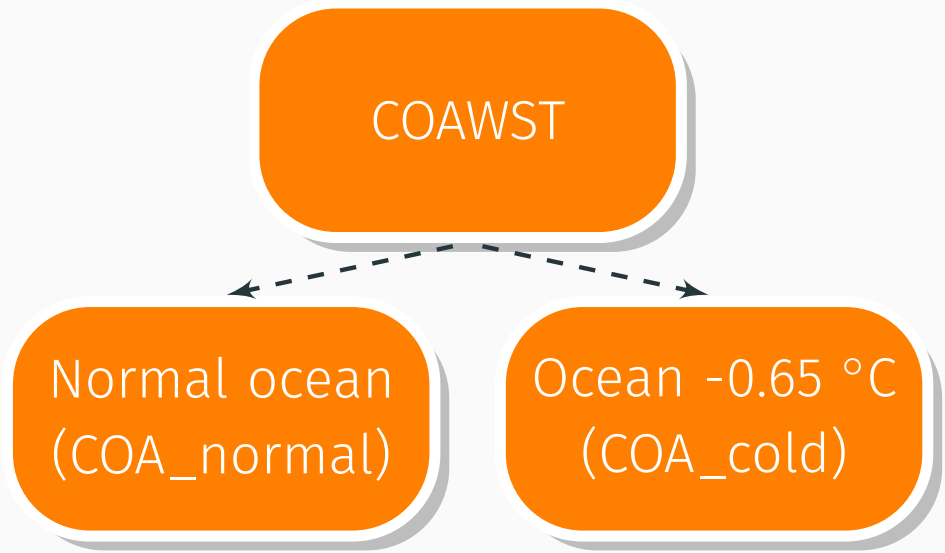
Question	Knowing that there was the influence of the South Atlantic Subtropical High, with easterly winds from the ocean, did the Southwest Atlantic Ocean potentiated the extreme precipitation event of November 2008 in Santa Catarina?
Aim	Investigate the behavior of the Sea Surface Temperature and the Heat Fluxes during the event.

Data and methods

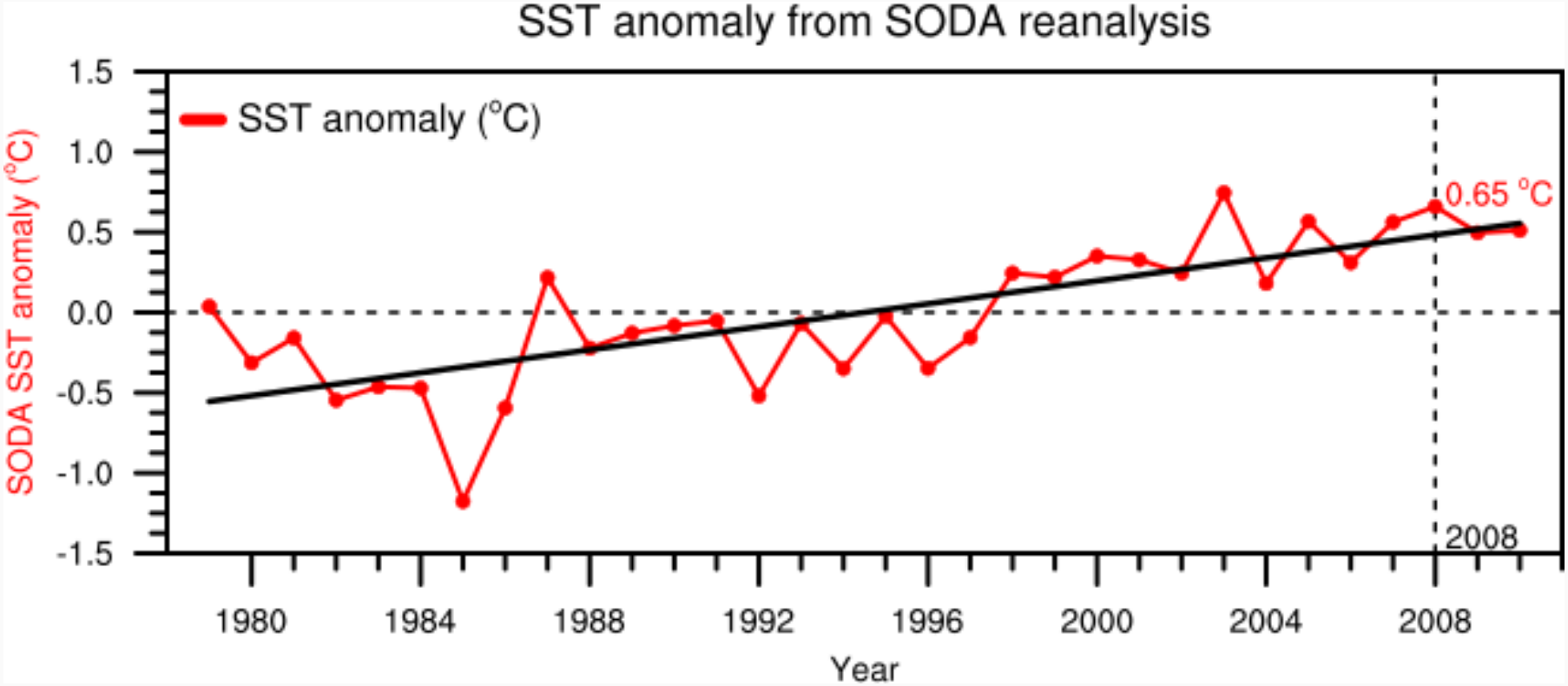
Coupled Ocean Atmosphere Wave Sediment Transport modeling system (COAWST)



Two simulations were performed:



Data and methods



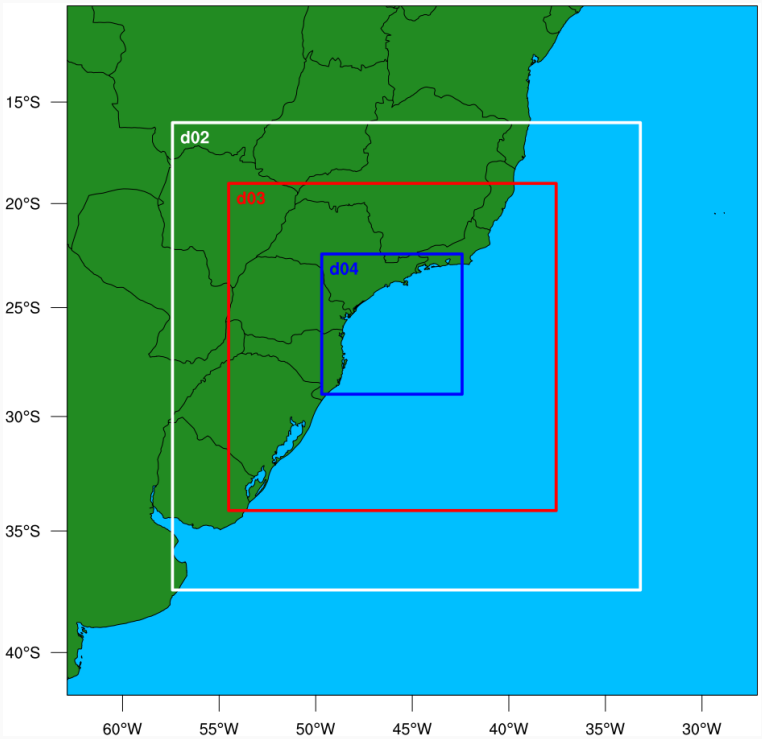
SST anomaly (Red; °C) and SST anomaly linear trend (Black) SODA reanalysis from 1980 to 2011.

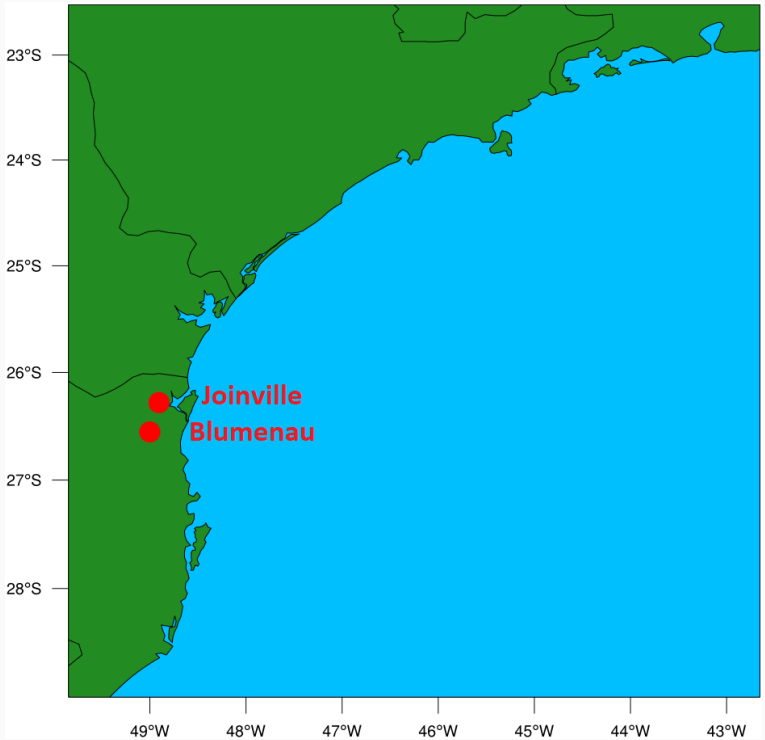
The methodology to calculate the SST warming was based from the previous work of Meredith et al. (2015).

Data and methods

Table 1: Modeling setup.

	WRF	ROMS
Spatial resolution	60 km, 12 km, 2.5km and 0.5 km	~9 km
Inputs	NCEP FNL analyses	SODA 3.3.1 reanalysis
Integration period	10 to 25 November 2008	10 to 25 November 2008





Results

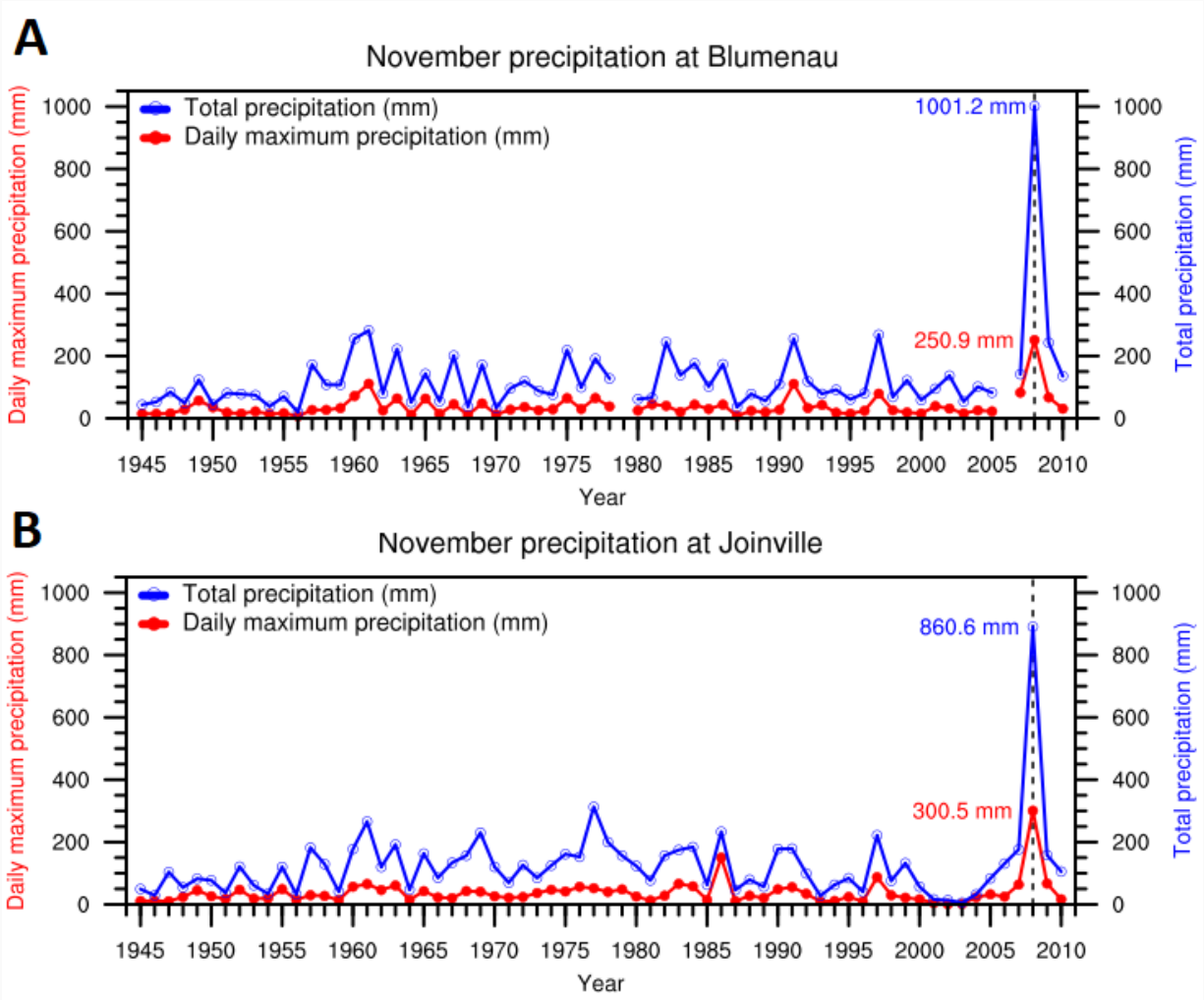


Figure A: Blumenau: November accumulated precipitation (Blue) and Daily maximum precipitation for November (Red).

Figure B: Joinville: November accumulated precipitation (Blue) and Daily maximum precipitation for November (Red).

Results

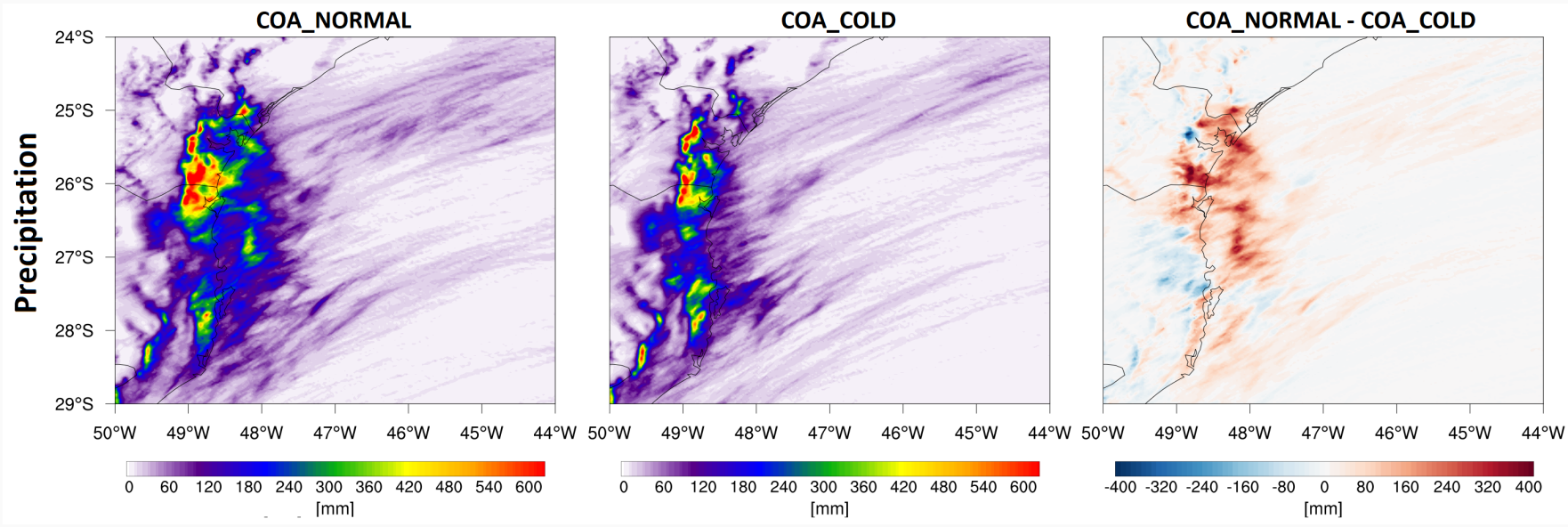
Table 2: Daily precipitation (mm).

Day	Blumenau	COAnormal	COAcold
18/11	0.2	0.0	0.0
19/11	30.8	27.1	17.7
20/11	13.9	9.2	6.4
21/11	38	22.5	11.6
22/11	43.3	29.8	17.23
23/11	243.5	228.7	176.8
24/11	250.9	213.6	162.6
25/11	10.5	6.7	5.5
Total	**631.1**	**537.6**	**397.83**

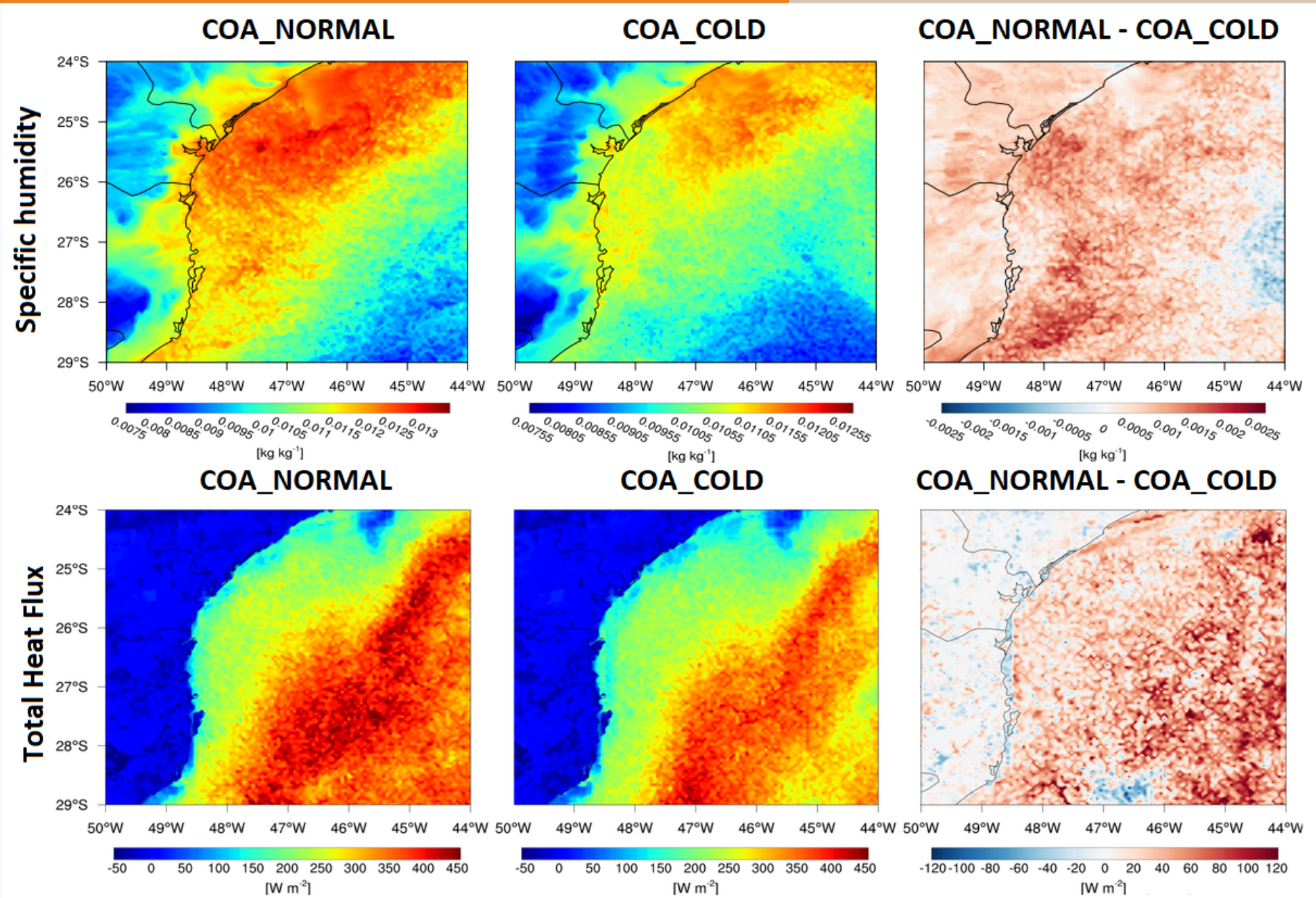
COAcold: -139.77 mm less than COAnormal

Day	Joinville	COAnormal	COAcold
18/11	0.0	0.0	0.0
19/11	34.8	29.7	20.1
20/11	15.5	14.1	7.8
21/11	56.3	38.2	27.2
22/11	30.5	21.2	16.23
23/11	300.5	271.3	234.2
24/11	135.4	122.8	112.0
25/11	29.3	26.7	18.3
Total	**602.3**	**524**	**435.83**

COAcold -88.17 mm less than COAnormal

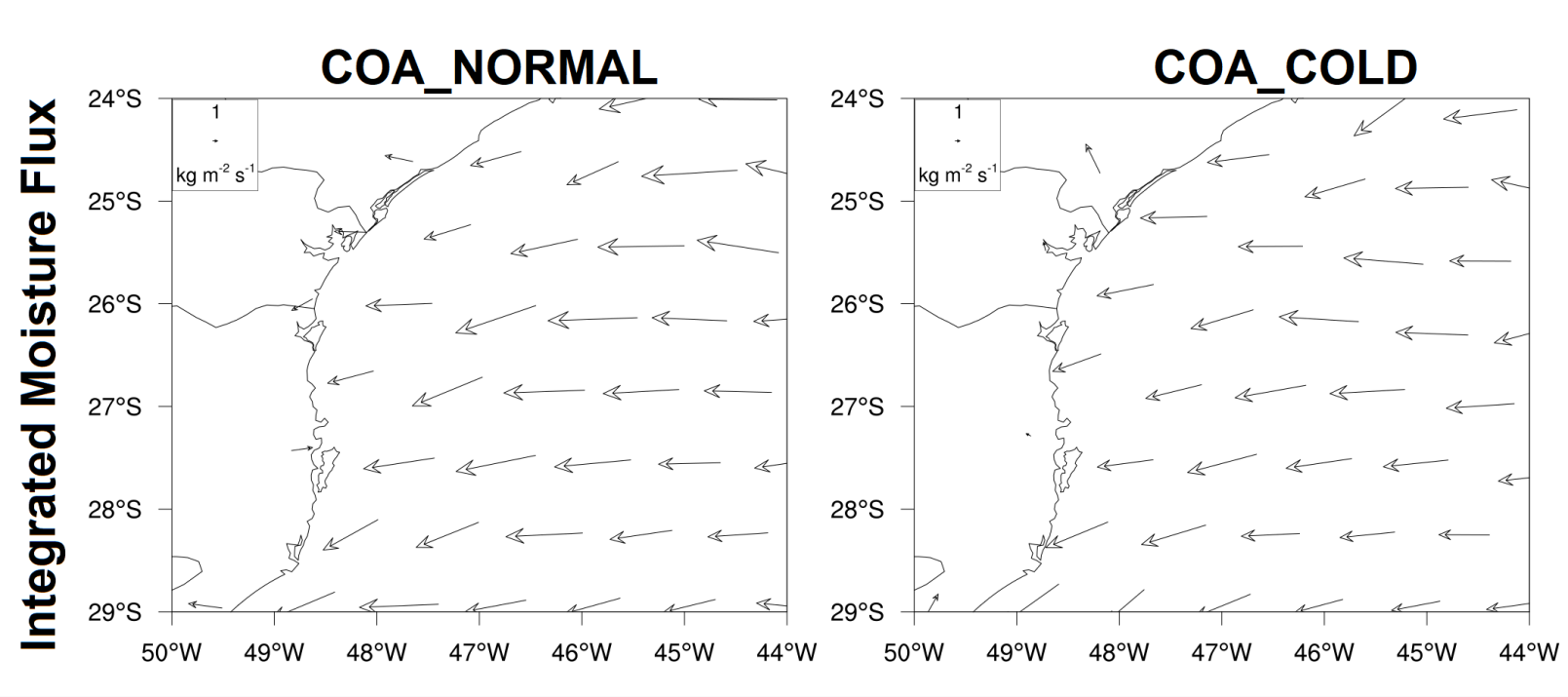


Results


COA_NORMAL
COA_COLD
COA_NORMAL - COA_COLD
Specific humidity
Total Heat Flux
24°S
25°S
26°S
27°S
28°S
29°S
50°W
49°W
48°W
47°W
46°W
45°W
44°W
0.0075 0.008 0.0085 0.009 0.0095 0.01 0.0105 0.011 0.0115 0.012 0.0125 0.013
0.00755 0.00805 0.00855 0.00905 0.00955 0.01005 0.01055 0.01105 0.01155 0.01205 0.01255
-0.0025 -0.002 -0.0015 -0.001 -0.0005 0 0.0005 0.001 0.0015 0.002 0.0025
[kg kg-1]
-50 0 50 100 150 200 250 300 350 400 450
-120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120
[W m-2]

Results

$$IMF = q\vec{V}_H$$



Results

Return period estimated using the the work of Back (2002). Were the intensity equation for precipitations higher than 120 minutes is given by:

$$I = \frac{542.5 RP^{0.1764}}{(t+22.3)^{0.7909}}$$

Were I is the average maximum precipitation (mm/h), RP is the return period (years) and t is the duration of the precipitation (minutes).

Table 2: Characteristic values of rainfall series for durations up 1 to 3 days and the return period of the event.

	1	2	3
11/2008 Precipitation (mm)	250.9	494.4	537.7
Precipitation maximum, excluding 2008 (mm)	159.5	240.8	253.1
Return period (years)	1122	1685	6253

These values demonstrated that the pluviometric caused in November 2008 in the region of Blumenau presented an exceptionality when analyzed by time intervals of days.

Final remarks and summary

(1) During the event, the South Atlantic Subtropical High alligned the winds from the Atlantic Ocean to the continent;

(2) It was found that the ocean was 0.65°C hotter than the expected to be;

(3) With a -0.65 °C temperature in the ocean, the precipitation at the continent was 27% lower in the COA_cold than in the COA_normal;

(4) The difference between COA_normal and COA_cold heat fluxes was more than 120 W m^{-2}. The winds from the South Atlantic Subtropical High carried over the moisture to the continent. This moisture encontered a mountain chain and precipited over the east side of Santa Catarina;

(5) The return period for this event is >1000 years, indicating that the event was very intense.

Thank you!

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Data and methods

Table 3: WRF parameterization schemes.

Parameterization	Scheme
Cumulus	Kain-Fritsch
Clouds	WSM6
Shortwave radiation	CAM SW
Longwave radiation	RRTM LW
Planetary boundary layer	Yonsei University
Land surface physics	Unified Noah LSM
Surface layer	MM5 Similarity

Table 4: ROMS parameterization schemes.

Parameterization	Scheme
Momentum	Horizontal harmonic viscosity
Tracers	3^{rd} order upstream horizontal advection and 4^{th} order centered horizontal advection
Pressure gradient	Spline Jacobian density
Wave roughness formulation	Taylor and Yelland relation
Horizontal mixing of momentum	Constant sigma surfaces
Horizontal mixing tracers	Geopotencial surface

Data and methods

Table 5: WRF input data parameters from NCEP FNL Operational Model Global Tropospheric Analyses.

Spatial resolution	1°x 1°
Temporal resolution	Every 6 hours
Pressure levels	26 levels from 1000 to 10 hPa
Running period	Continuing from July 1999

Table 6: ROMS input data parameters from Simple Ocean Data Assimilation

Spatial resolution	0.5°x 0.5°
Temporal resolution	Every 5 days
Levels	40
Running period	From 1980 to 2015

Introduction

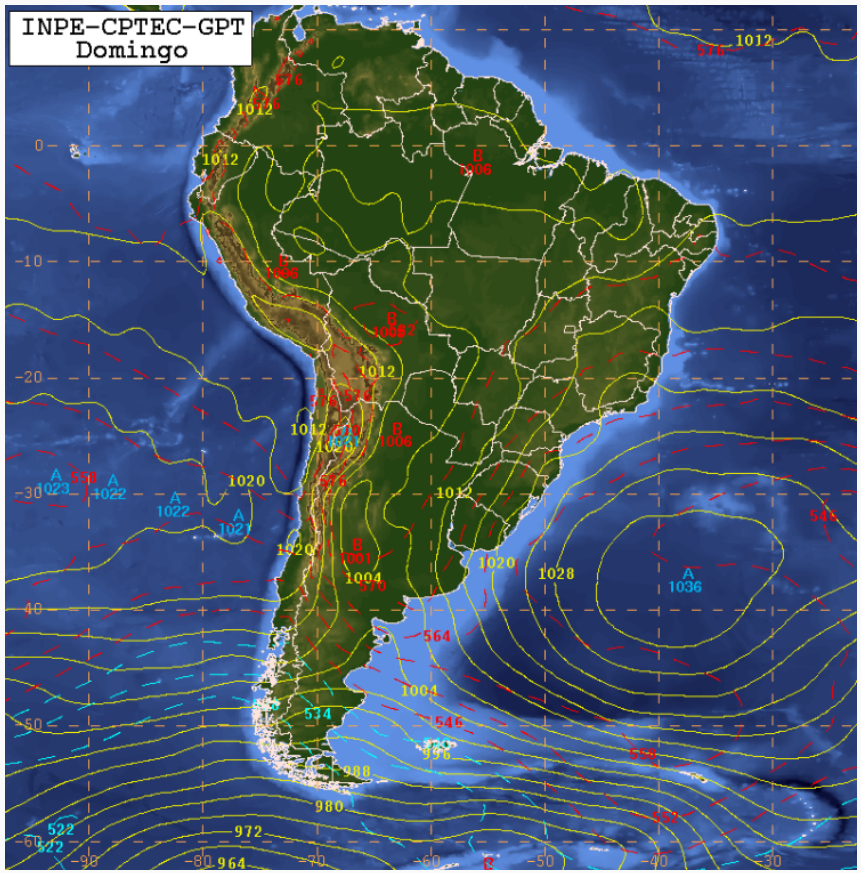

Figure 3: Synoptic chart at the surface for 23 November 2008 at 12Z
INPE (2018).

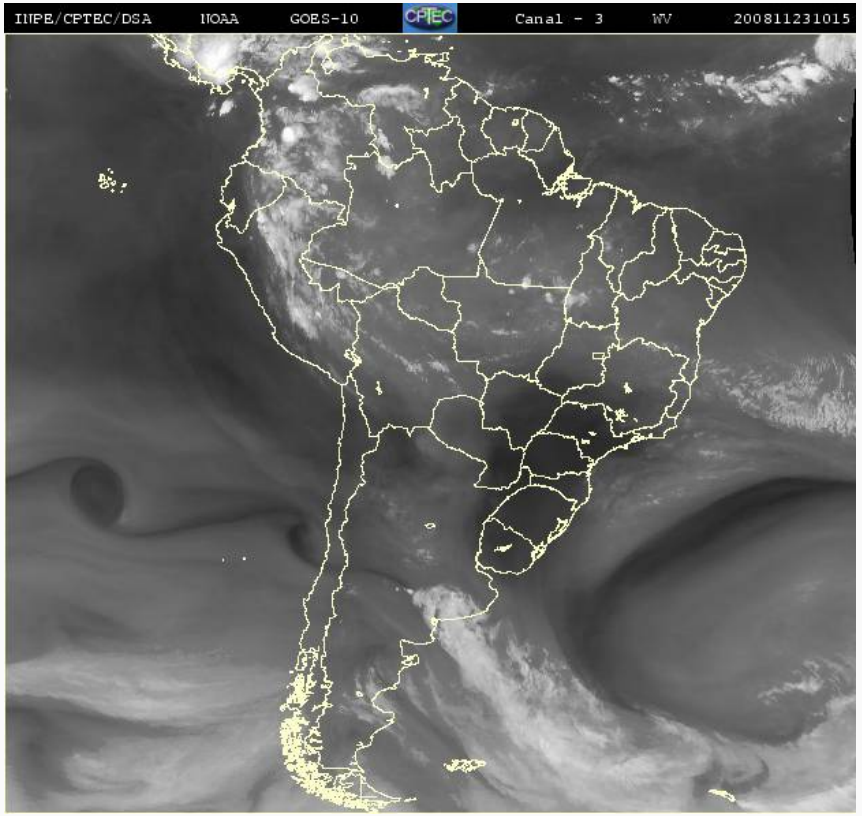

Figure 4: Water vapour from GOES-10 for 23 November 2008 at 12Z .
INPE (2010)