



**ESTUDOS DE CASO E DESENVOLVIMENTO DE  
TECNOLOGIAS COM EMPREGO DE DADOS DO  
PROGRAMA NACIONAL DE BOIAS (PNBOIA)**

**CASE STUDIES AND TECHNOLOGY  
DEVELOPMENT USING DATA COLLECTED BY  
BRAZILIAN NAVY BUOY PROGRAM**

**Cdr. Márcio Borges**



## **PROGRAMA NACIONAL DE BOIAS NATIONAL BUOY PROGRAM**

**Collect and disseminate meteorological and oceanographic data using a network of moored buoy and drifters, benefiting the following sectors: meteorological and oceanographic modeling, validation of satellite data, weather forecast, offshore activities, safety of navigation and safety of human life at sea**



# PNBOIA

## SPECIFIC OBJECTIVES

- a) Expand and maintain a network of moored buoys, drifters and ARGO floats; and
- b) Operate a data transmission and dissemination system.



DBCPC  
Data Buoy Cooperation Panel



ISABP  
International South Atlantic Buoy Program



Fundação Universidade  
Federal do Rio Grande







# SENSORS



TWO ANEMOMETERS (WIND)

SOLAR RADIATION

HUMIDITY AND AIR  
TEMPERATURE

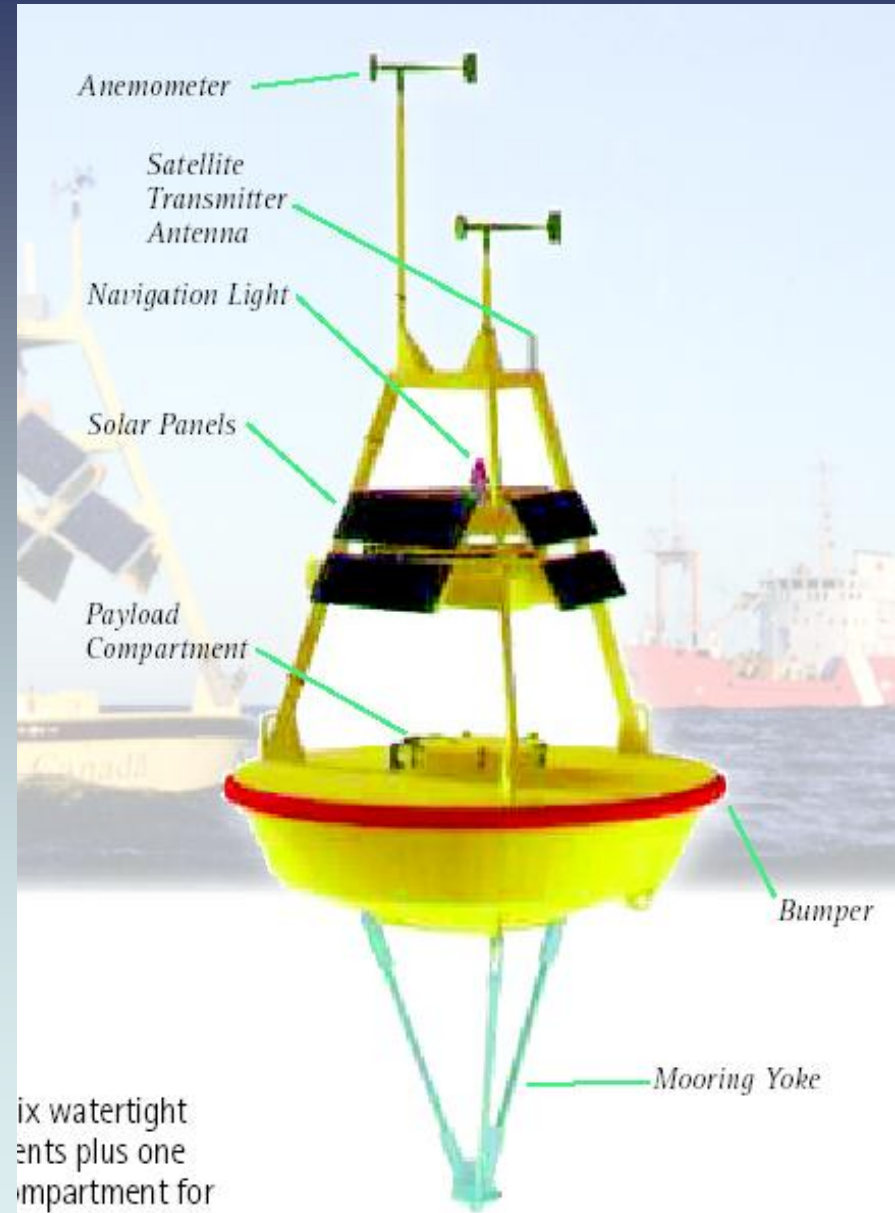
ATMOSPHERIC PRESSURE

OCEAN CURRENTS

DIRECTION AND WAVE  
HEIGHT

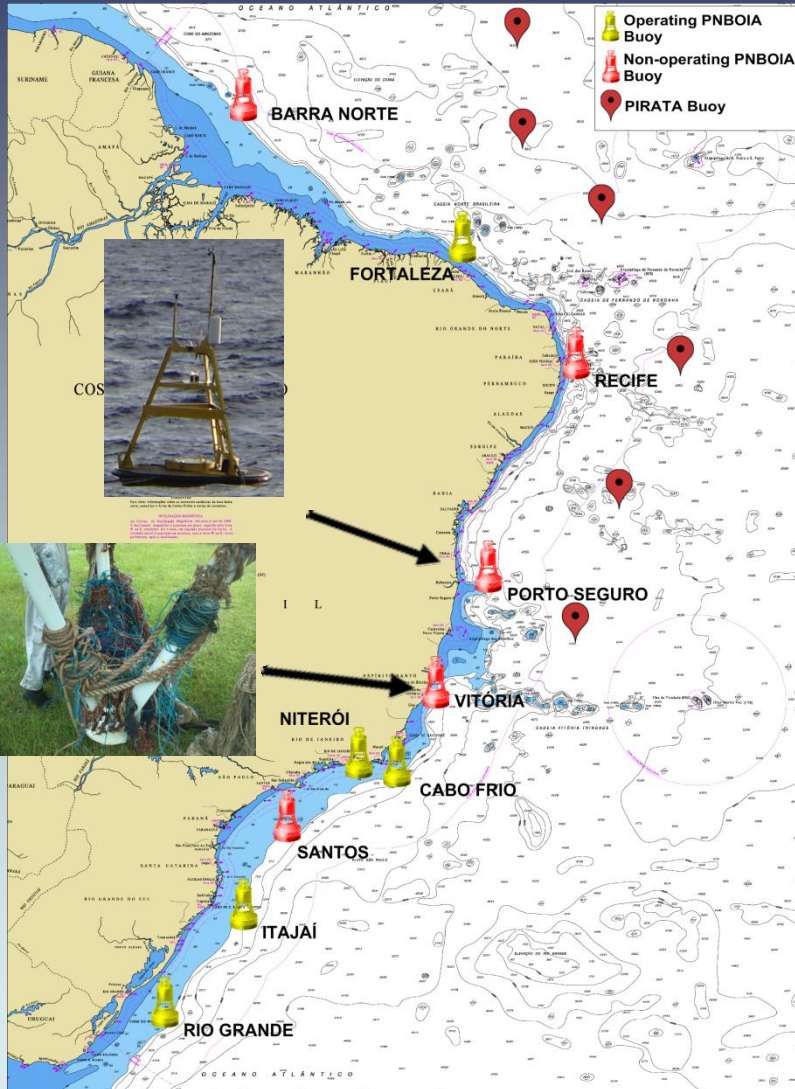
WATER TEMPERATURE

AIS





# OPERATIONAL PROGRAM



## > Moored buoys

10 along the coast  
Deploy depth: 200 meters

## > Drifters

Maintain a 5°x5° grid

## YESTERDAY

- **ACTIVES: 5 BUOYS**
- **PLANNING FOR 2017: 1 MORE BUOY**



# OPERATIONAL PROGRAM

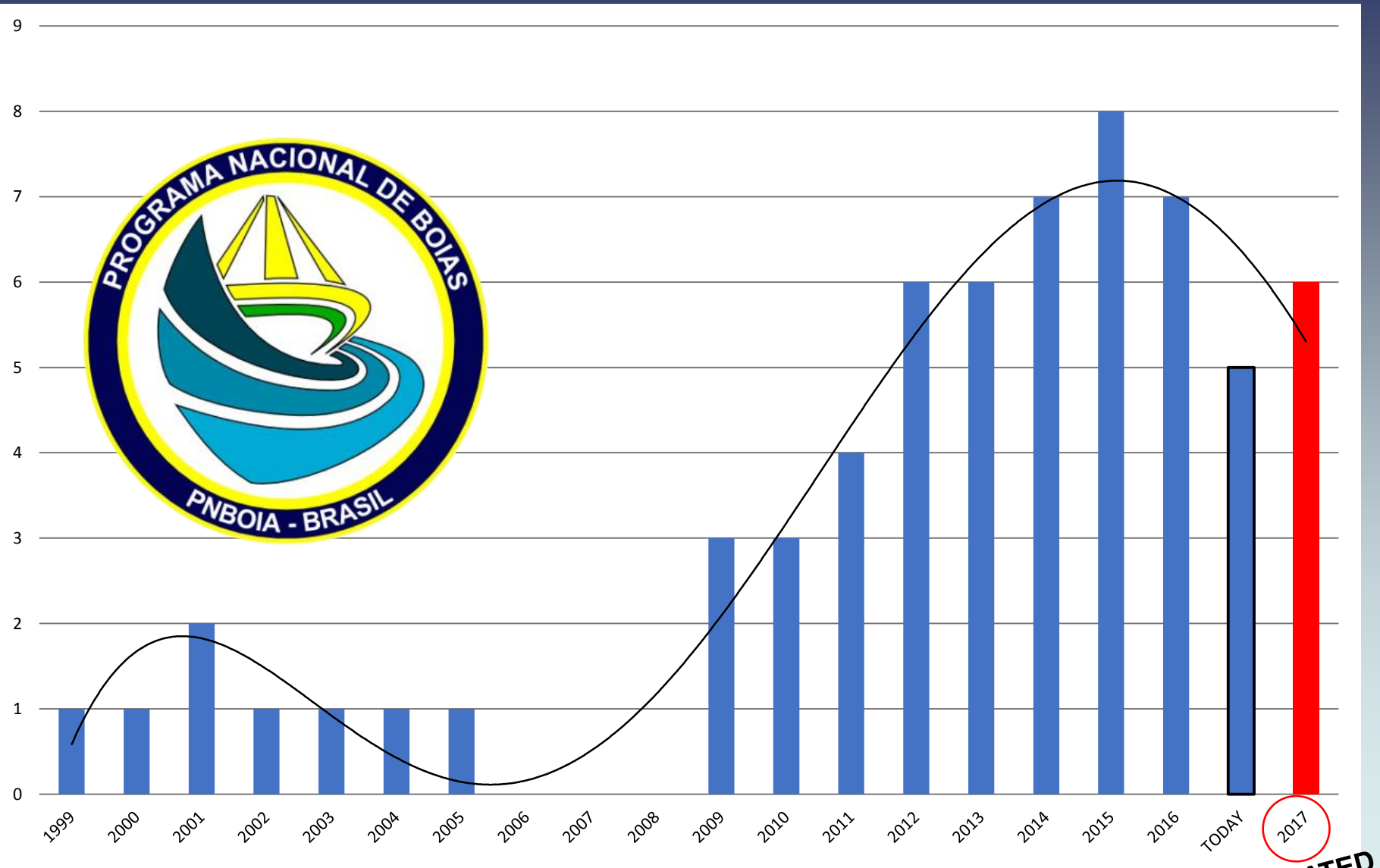


## TODAY

- **ACTIVES: 4 BUOYS**
- **PLANNING FOR 2017: 1 MORE BUOY**



# PROGRAM HISTORY



**ESTIMATED**





# DATA ACCESS



ALL DATA ARE FREE FOR EVERYONE:

- GTS and Internet
- Hourly transmission
- Almost real time data QC



DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO  
CENTRO DE HIDROGRAFIA DA MARINHA  
Serviço Meteorológico Marinho



INSTITUCIONAL | INFORMAÇÕES GERAIS | PREVISÃO DO TEMPO | REFERÊNCIA | SITES INTERESSANTES

## Dados Observacionais

### Estações Meteorológicas

MARINHA DO BRASIL			
ESTAÇÕES METEOROLÓGICAS CONVENCIONAIS			
Nº	NOME	LATITUDE	LONGITUDE
82096	Canivete	00° 30,88' N	050° 25,40' W
82143	Salinópolis	00° 37,01' S	047° 21,03' W
82595	Calcanhar	05° 09,61' S	035° 29,24' W
83499	Abrolhos	17° 57,87' S	038° 41,73' W
83650	Ilha da Trindade	20° 30,52' S	029° 18,52' W
83700	São Tomé	22° 02,52' S	041° 03,17' W
83759	São Pedro D'Aldeia	22° 48,96' S	042° 05,52' W
83117	Ilha Rasa	23° 03,81' S	043° 08,77' W
83825	Ilha do Mel	25° 29,71' S	048° 19,58' W
83925	Santa Marta	28° 36,27' S	048° 48,82' W
83970	Mostardas	31° 14,88' S	050° 54,47' W
83998	Chuí	33° 44,50' S	053° 22,35' W



Programa Nacional de Boias (PNBOIA)



"CLIQUE AQUI" para acessar os dados qualificados até 15JUL2017.

MARINHA DO BRASIL		
BOIAS METEOCEANOGRÁFICAS		
DADOS	METADADOS	LATITUDE
Fortaleza		03° 12,82' S
Recife		08° 09,22' S
Porto Seguro		16° 00,05' S
Vitória		19° 55,34' S
Cabo Frio		23° 37,79' S
Niterói		22° 55,21' S
Santos		25° 26,10' S





# DATA ACCESS

ALL DATA ARE FREE FOR EVERYONE:

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- Almost real time data QC

**GOOS-BRASIL**

PIRATA PNBOIA GLOSS BRASIL ARGO ANTARES REDE ONDAS MOVAR

## PNBOIA

Programa Nacional de Boias

Selecione uma boia na lista abaixo ou no mapa para ver mais informações.

### Boias fixas

Fortaleza (nov-2016 a set-2017)	
Rio Grande3 (set-2017 a set-2017)	
Niterói (ago-2017 a set-2017)	
Cabo Frio 2 (jul-2016 a set-2017)	
Santa Catarina2 (fev-2017 a set-2017)	
Santos2 (jun-2017 a ago-2017)	
Vitória (nov-2015 a ago-2017)	
Rio Grande2 (jan-2017 a jun-2017)	
Santos (mar-2011 a abr-2017)	
Guanabara2 (jan-2017 a mar-2017)	
Porto Seguro (jul-2012 a jan-2017)	
Rio Grande (fev-2012 a jan-2017)	
Santa Catarina (mar-2011 a nov-2016)	
Guanabara (abr-2012 a out-2016)	
Recife (nov-2012 a abr-2016)	
Cabo Frio (mar-2012 a set-2013)	

Novos dados validados pela Marinha do Brasil  
abr-2009 a jul-2017

Map showing buoy locations in Brazil and surrounding regions (Venezuela, Colombia, Guyana, Suriname, French Guiana, Argentina, Paraguay, Chile, Uruguay). Major cities like Caracas, Bogotá, Quito, Lima, Asunción, Buenos Aires, Montevideo, and São Paulo are marked. States of Brazil are labeled. A scale bar indicates 500 km.



# SMM



## PNBOIA SUPPORTS MARINE METEOROLOGICAL SERVICE



- BRAZIL (Decree 70.092 of 1972)  
"Supervision, orientation, research and development of activities related to **marine meteorology**"
- INTERNATIONAL (International Convention for the Safety of Life at Sea and Decree No. 92610 of 1986)  
"Producing and disseminating **meteorological forecasts** and analyzes for the maritime area of responsibility of Brazil (METAREA V)"

**IT IS ONLY POSSIBLE WITH OPERATIONAL  
DATA COLLECTION AT SEA**



# PNBOIA



**Before PNBOIA, operational data collection at sea was incipient in Brazil**





# SMM



## PNBOIA SUPPORTS MARINE METEOROLOGICAL SERVICE



- DATA FOR VALIDATION OF NUMERICAL MODELS
- DATA TO SUPPORT METEOROLOGISTS
- DATA FOR SYNOTIC CHARTS

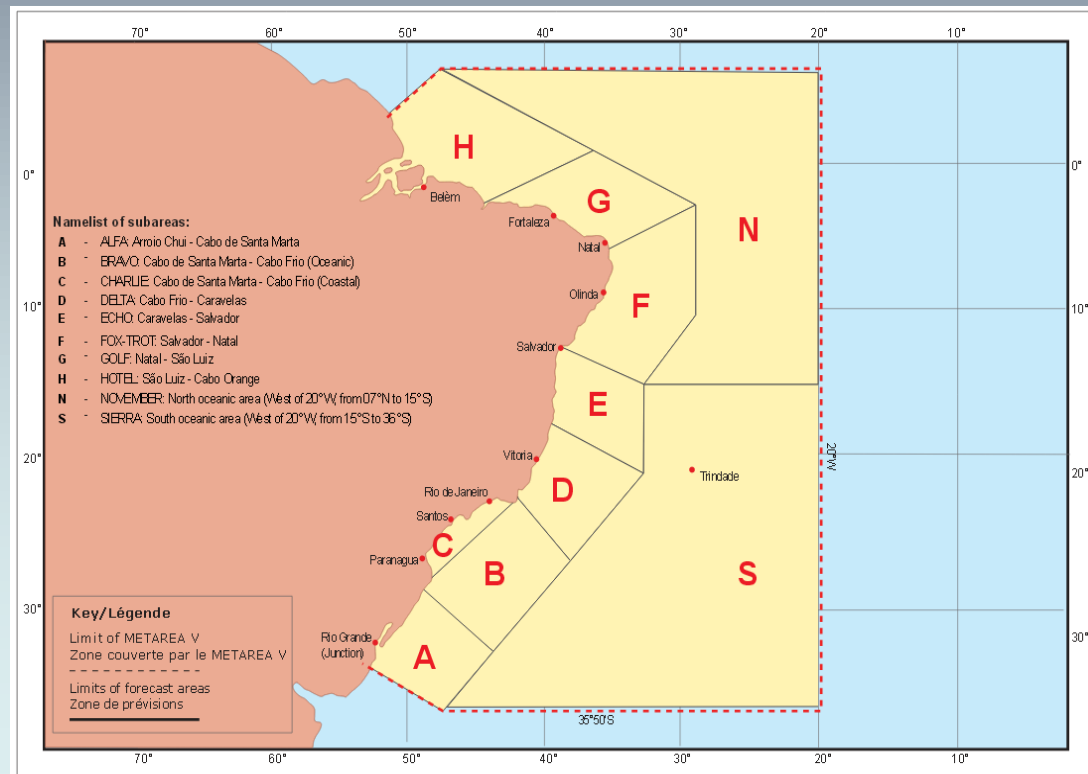


# SMM



## VALIDATION OF SEVERE WEATHER WARNING

- NORMAN 19: "It is a message issued as far in advance as possible when there is forecast of ...":
  - Rough Sea: Waves greater than 3 meters;
- It is a work in progress:
  - Start by Area ALFA;
  - Year 2015;
  - Rough Sea Warning.





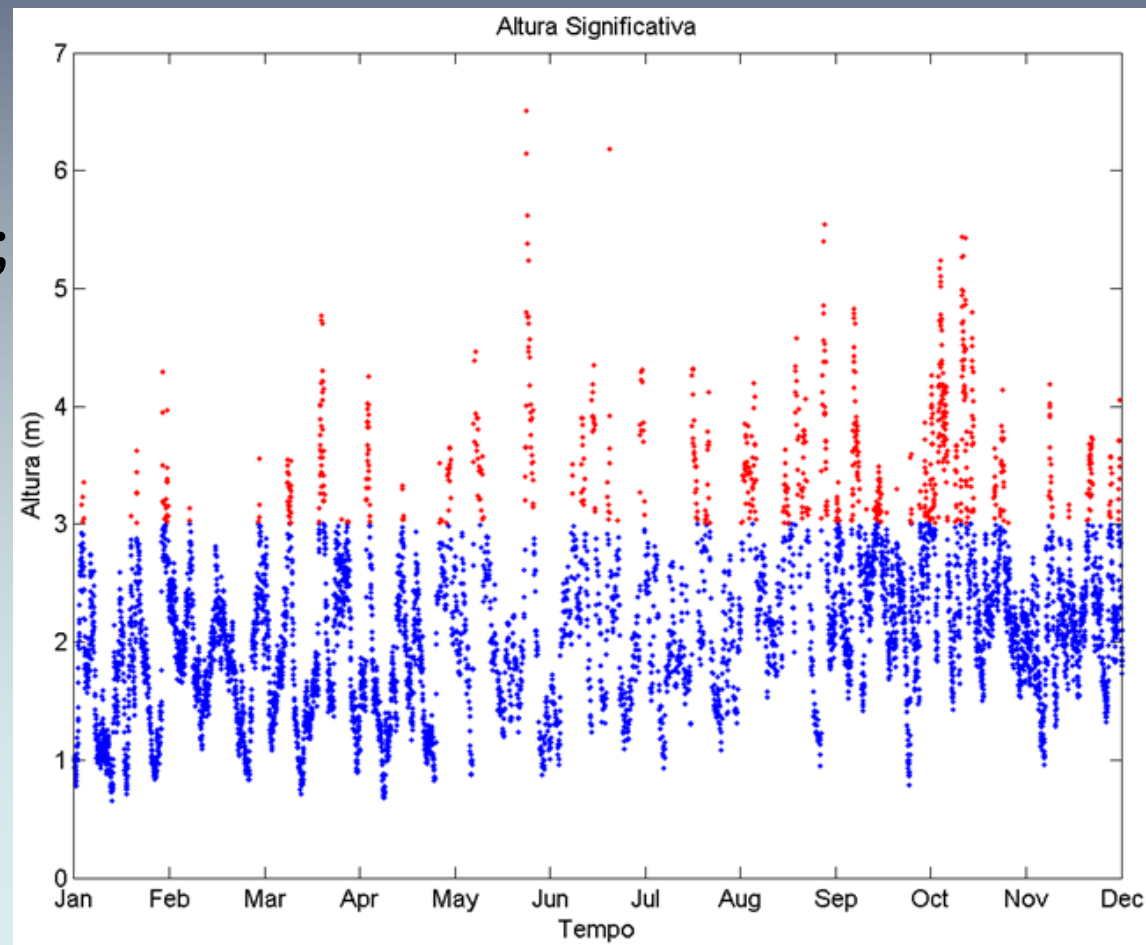
# SMM



## VALIDATION OF SEVERE WEATHER WARNING

### 2015 - Area ALFA

- A total of 187 Rough Sea Warning were issued;
- RIO GRANDE Buoy = 109 days of  $H_s > 3m$ ;
- Warning days: 103 dias
- 95% correct







# CASE STUDY

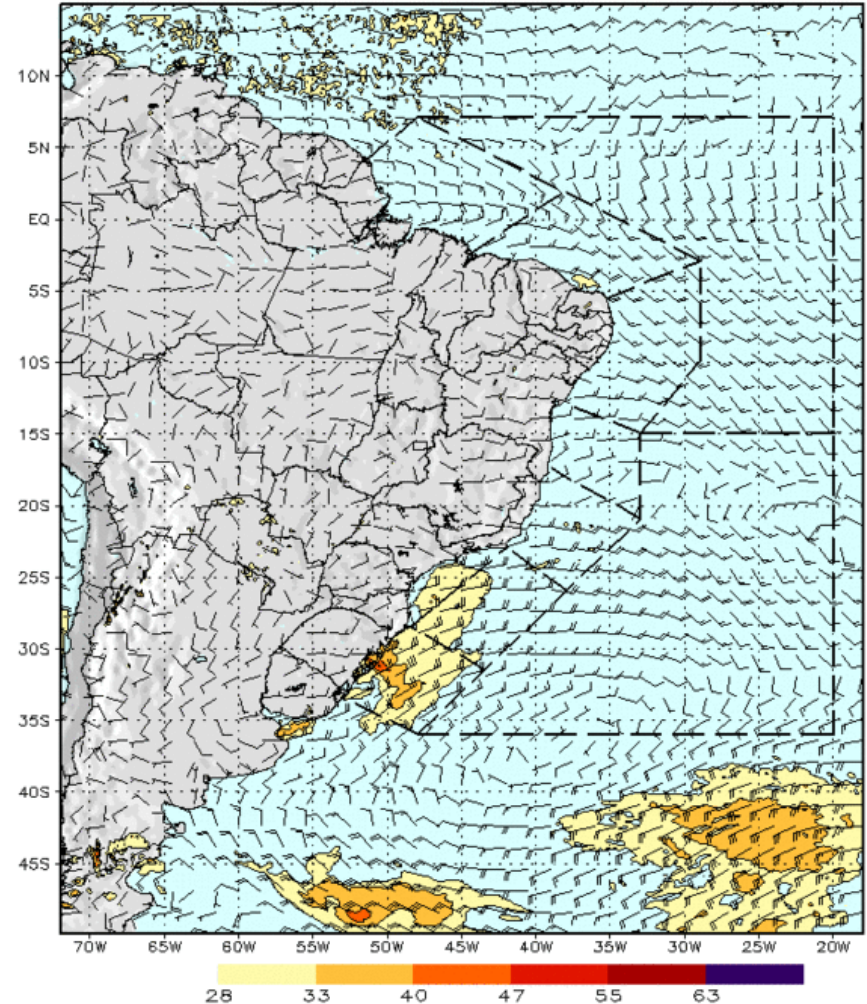


## OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST

COSMO (regional model)

- Extratropical Cyclone in the South Atlantic
- 25 m / s of wind
- Direction on the coast: S / SW
- 995 hPa (Low Pressure)

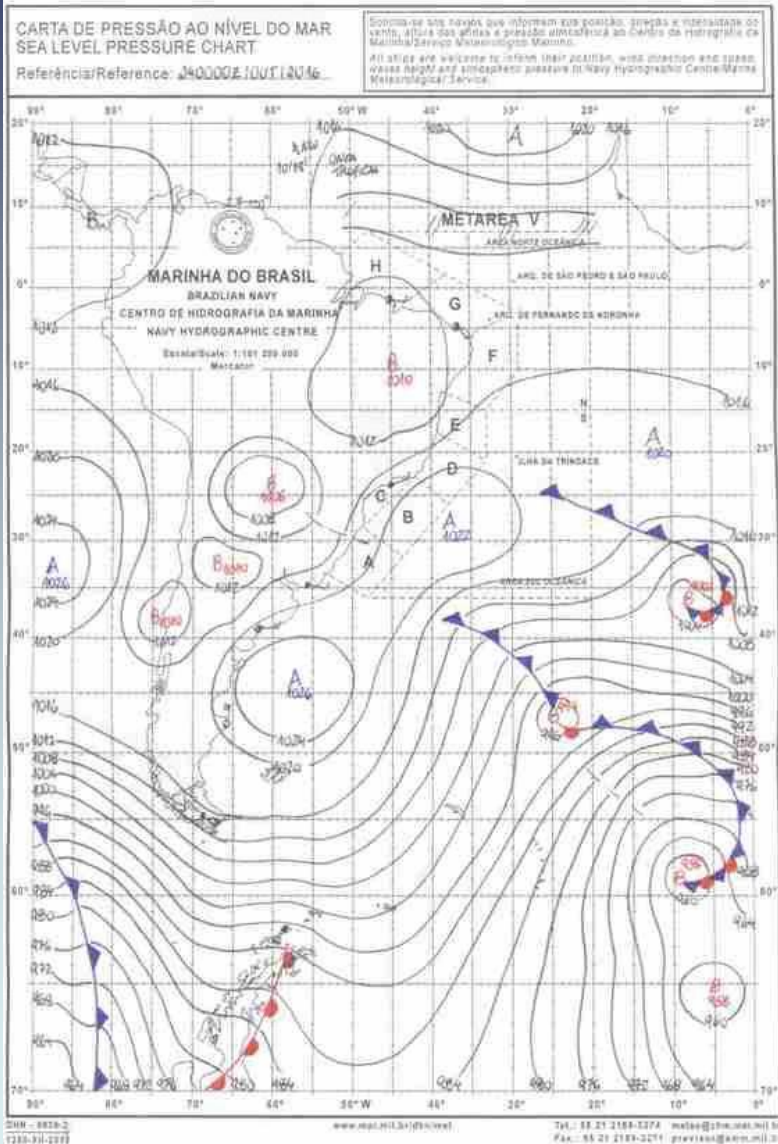
Modelo COSMO/CHM – Vento Maximo 10m(nos)  
Ref:00Z26OUT2016(Qua) +PROG003h/Vai:03Z26OUT2016(Qua)





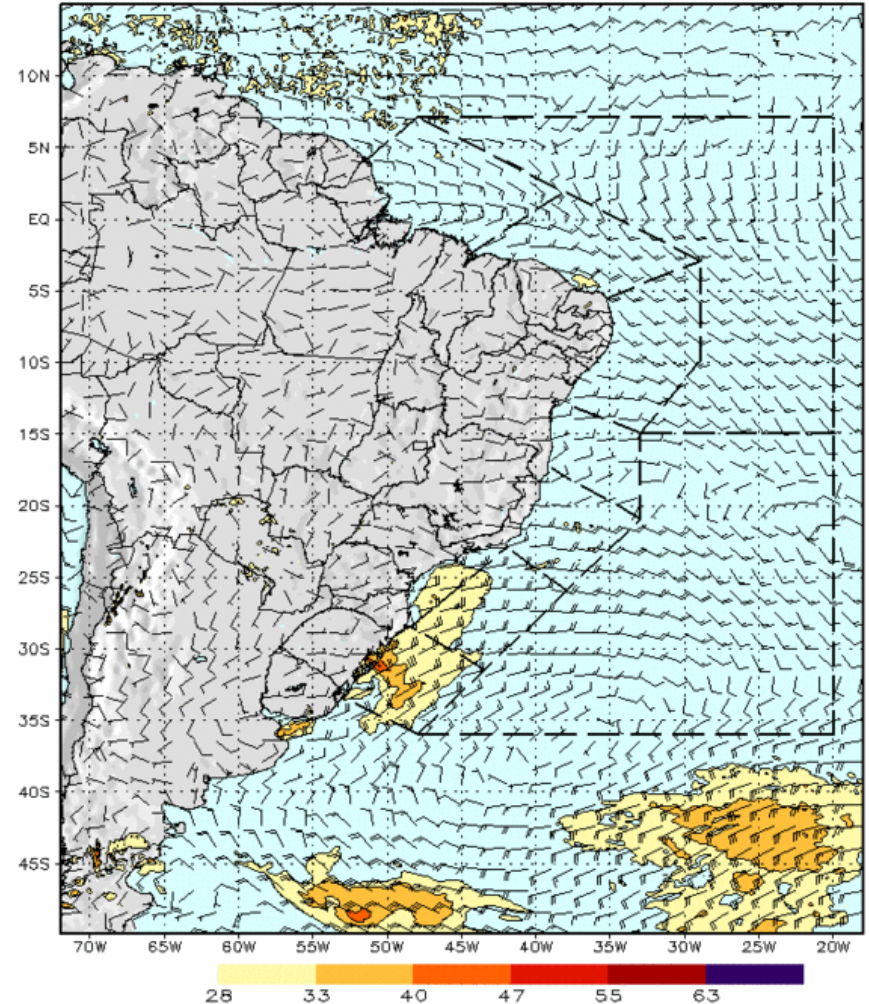
# CASE STUDY

## OCTOBER 2016: THE LARGEST WAVE ALREADY ZILIAN COAST



e

Modelo COSMO/CHM - Vento Maximo 10m(nos)  
Ref:00Z260UT2016(Qua) +PROG003h/Vai:03Z260UT2016(Qua)





# CASE STUDY

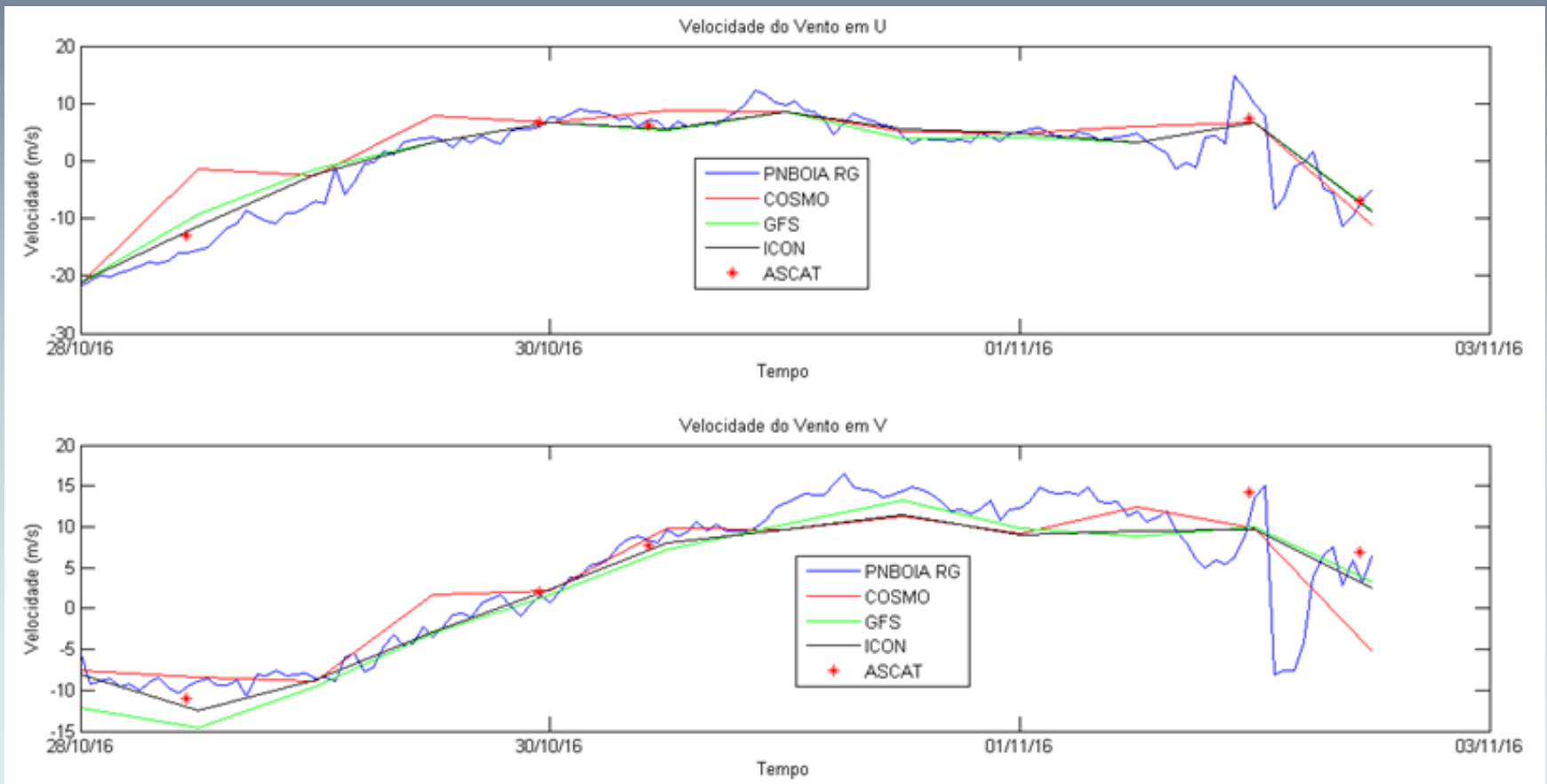
## OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST

### ATMOSPHERIC MODELS X RIO GRANDE BUOY (PNBOIA)

S/SW Wind

Veloc=23 m/s

Gust=29 m/s





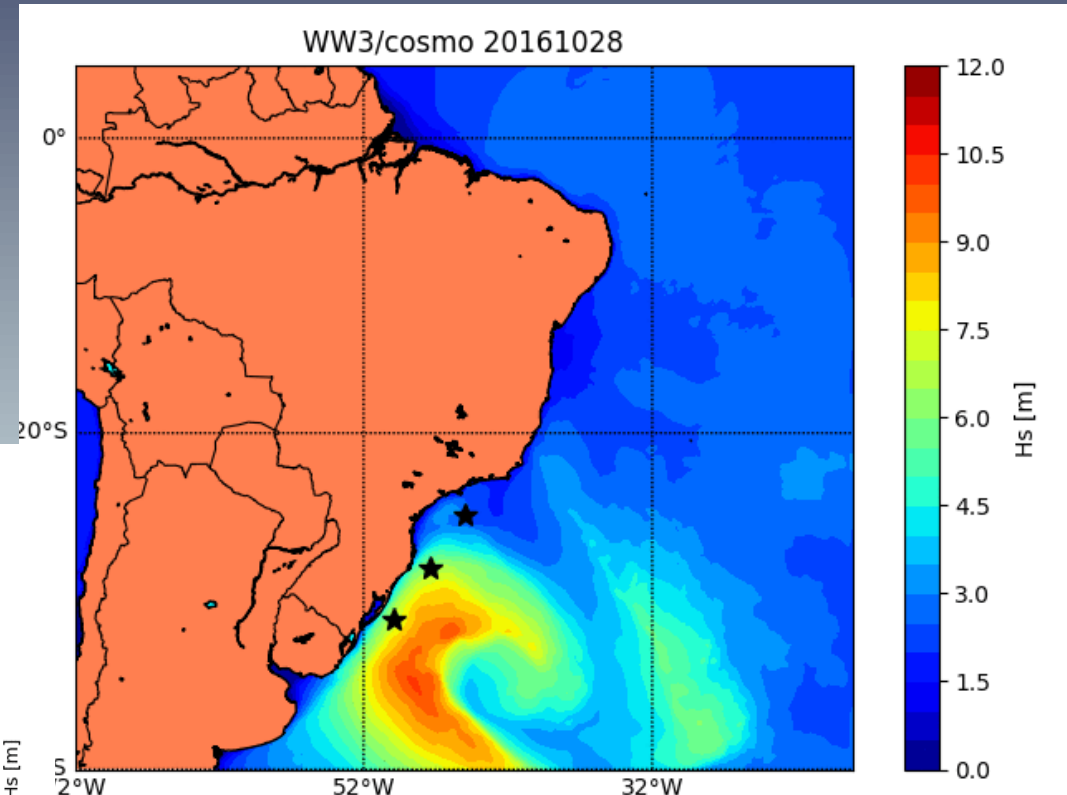
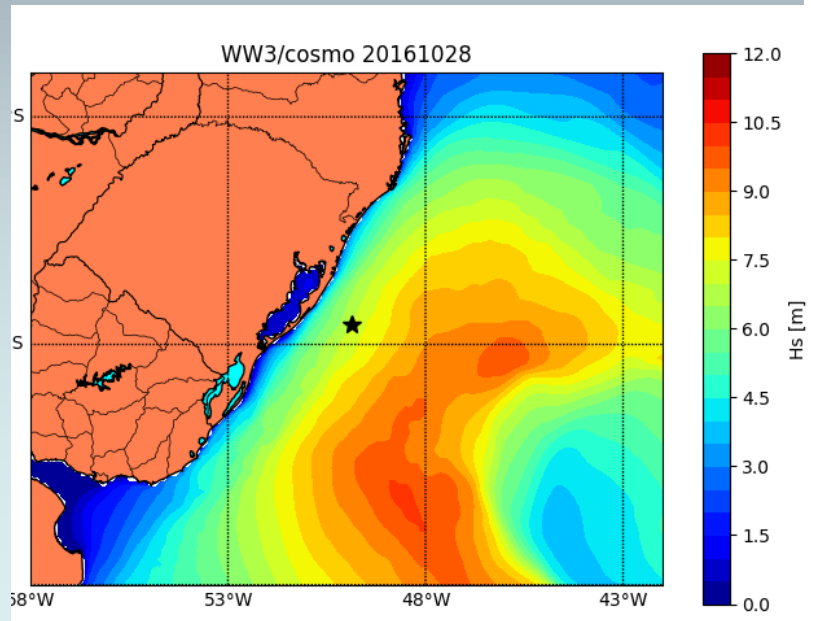


# CASE STUDY

## OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST

WWIII (COSMO)

- S/SW Waves
- $H_s = 9$  m in the ocean
- $H_s = 3$  m at coast
- $T_s = 15$  s





# CASE STUDY



**OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST**

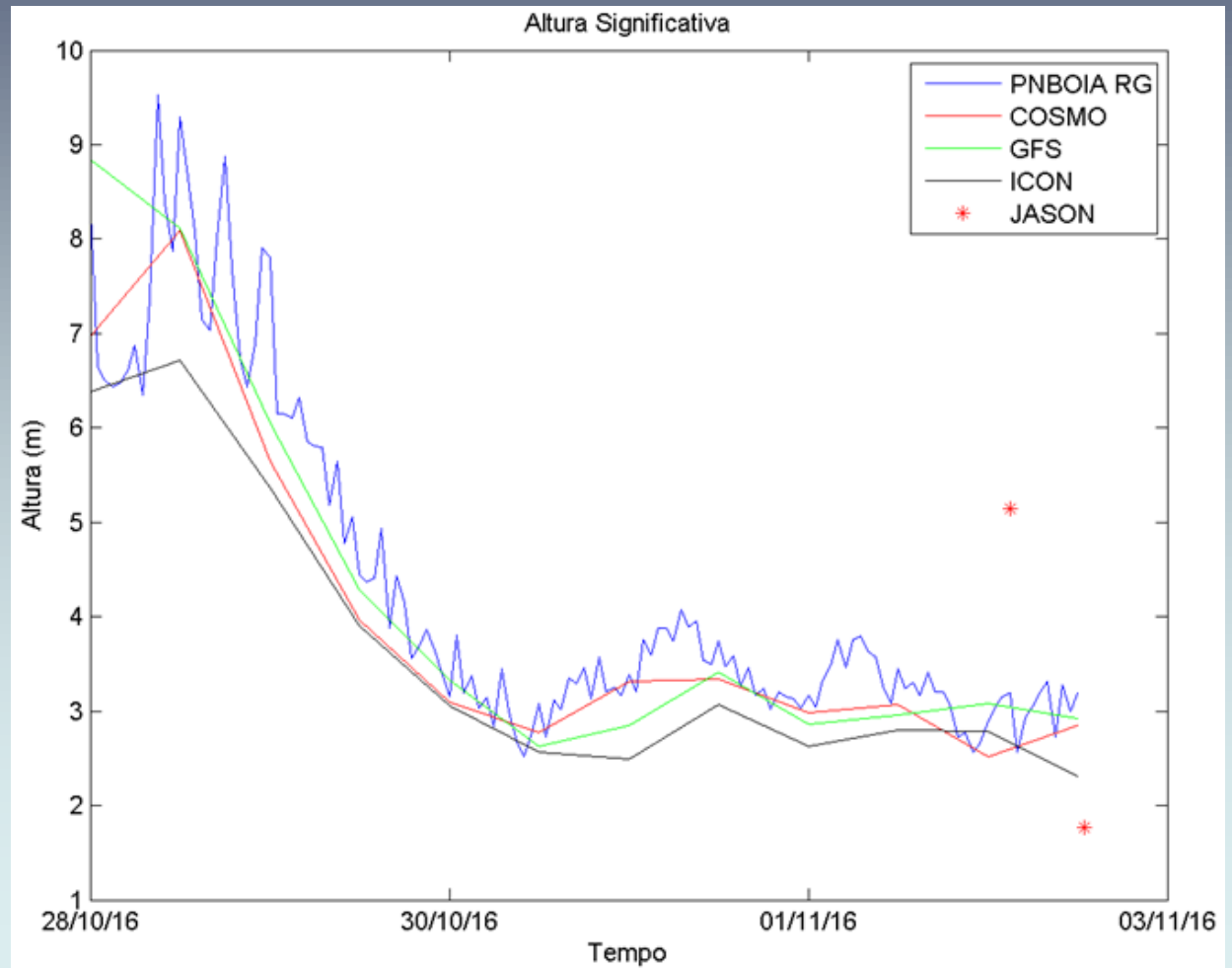
**SINGLE RECORD: RIO GRANDE BUOY (PNBOIA)**

$H_s=9.53$  m

$H_{max}=14.79$  m

$T_s=17$  s

Mean Direction=SW





# CASE STUDY



## OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST

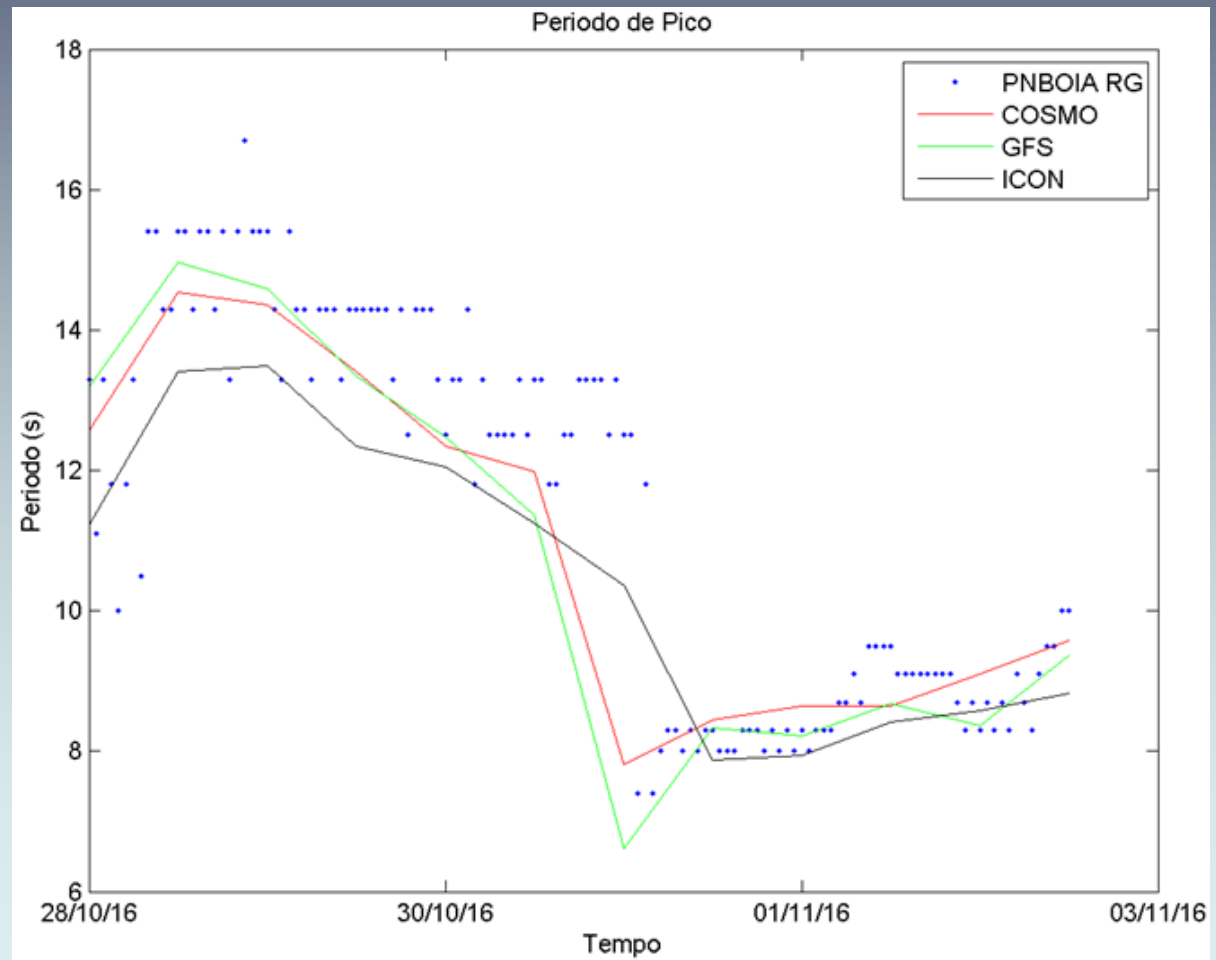
### SINGLE RECORD: RIO GRANDE BUOY (PNBOIA)

$H_s=9.53$  m

$H_{max}=14.79$  m

$T_s=17$  s

Mean Direction=SW







# CASE STUDY

**OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST**

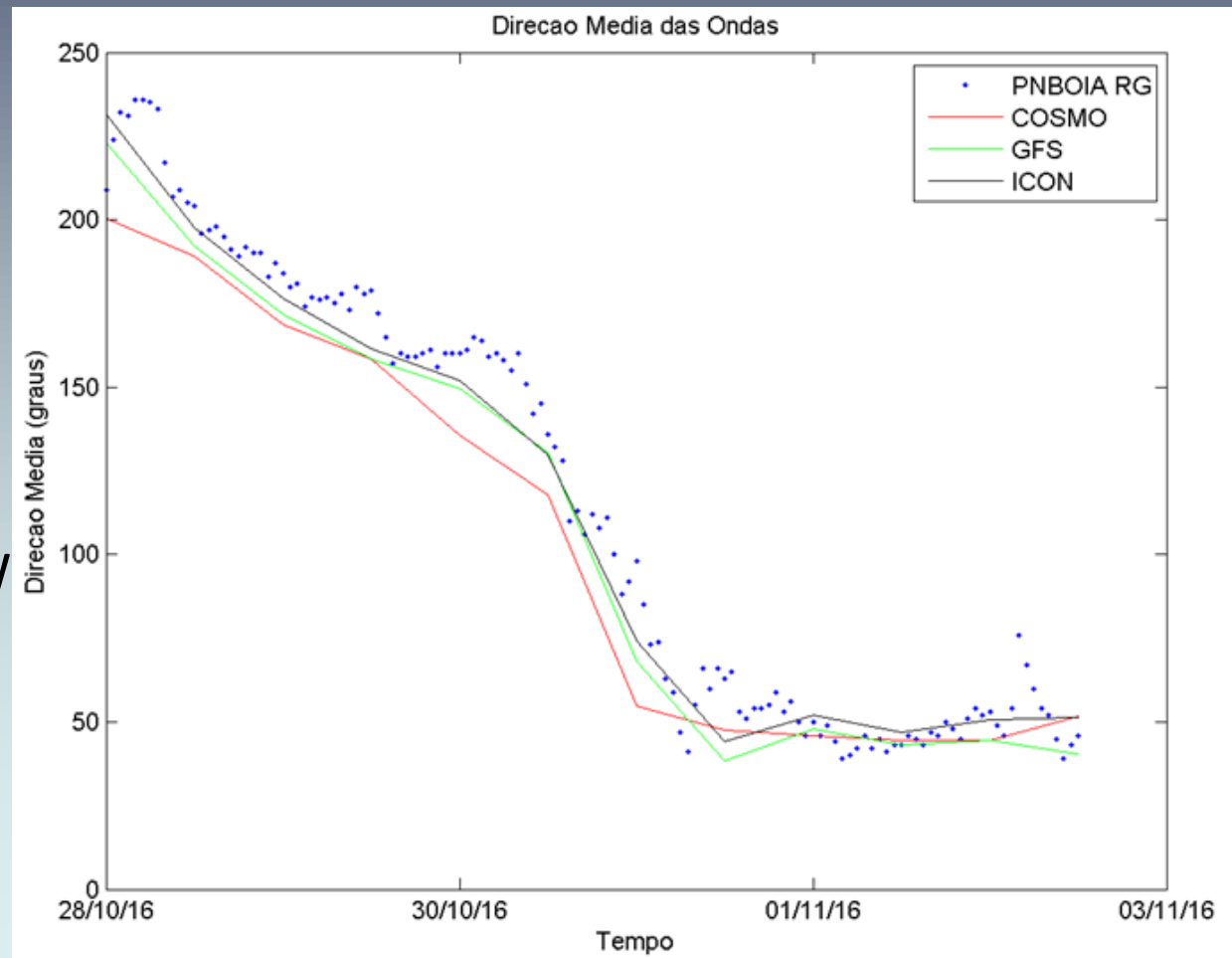
**SINGLE RECORD: RIO GRANDE BUOY (PNBOIA)**

$H_s=9.53$  m

$H_{max}=14.79$  m

$T_s=17$  s

Mean Direction=SW

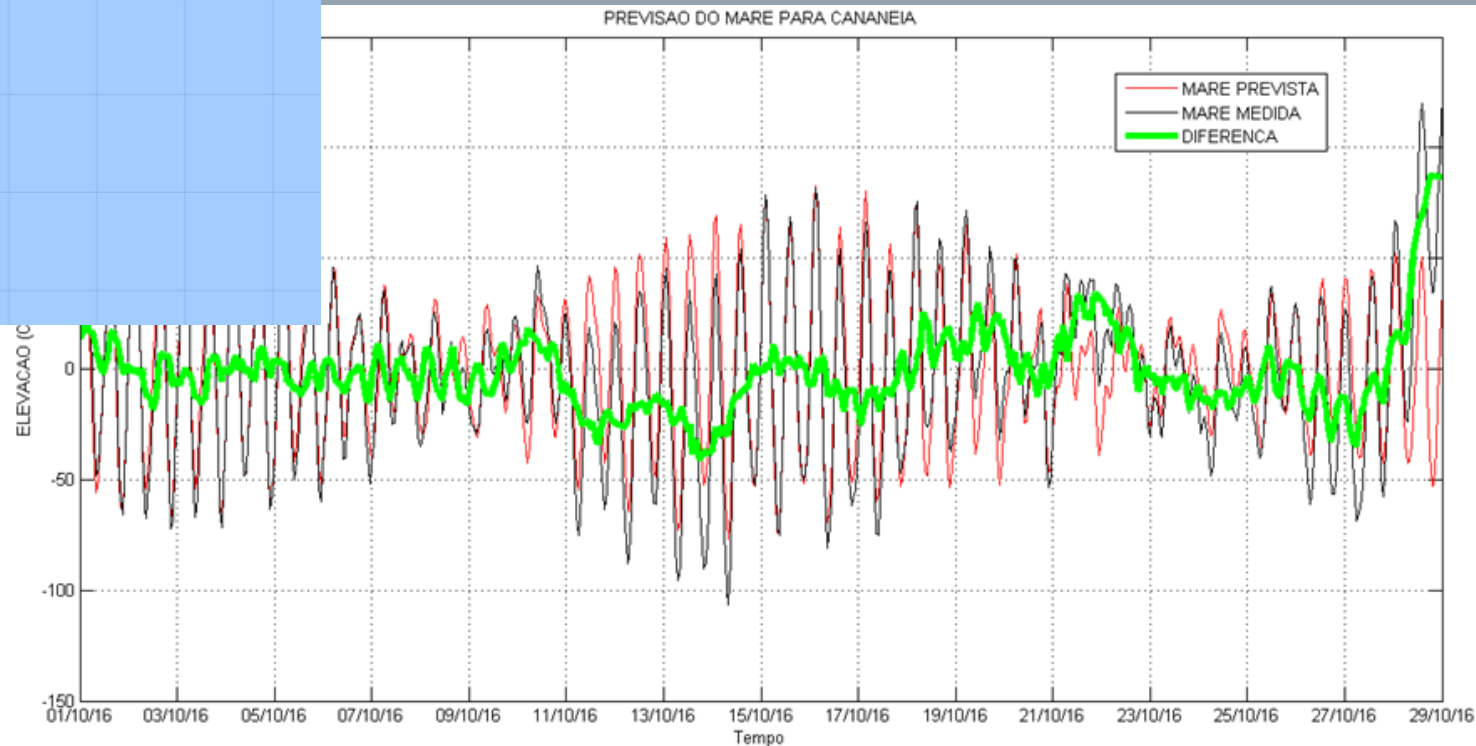
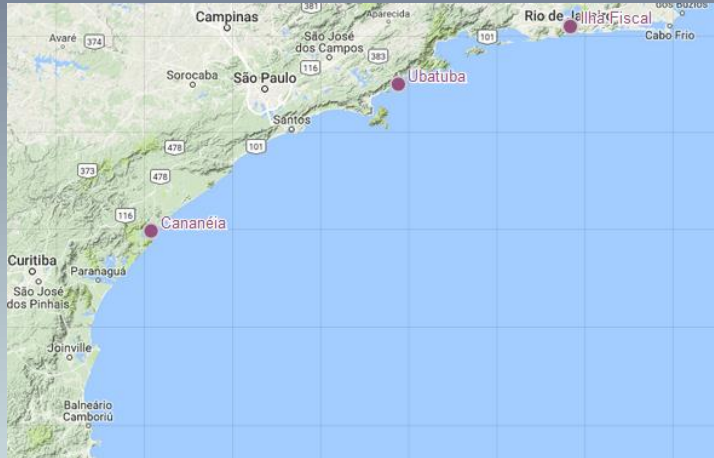




# CASE STUDY

**OCTOBER 2016: THE LARGEST WAVE ALREADY REGISTERED ON THE BRAZILIAN COAST**

**STORM SURGE: GLOSS STATION OF CANANEIA  
1 METER OF DIFERENÇA**





# CASE STUDY

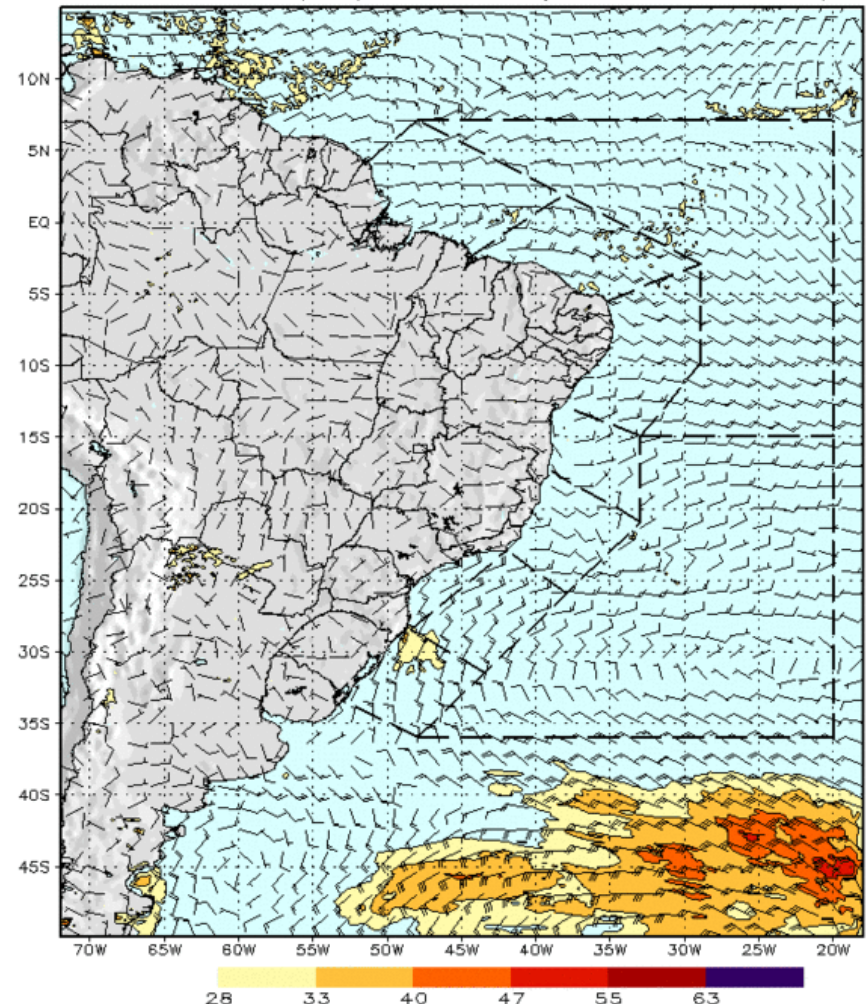


## DECEMBER 2016: TROPICAL STORM EÇAÍ

COSMO (regional model)

- Extratropical Cyclone in the South Atlantic
- 30 m / s of wind
- Direction on the coast: S / SW
- 992 hPa (Low Pressure)

Modelo COSMO/CHM – Vento Maximo 10m(nos)  
Ref:00Z03DEZ2016(Sab) +PROG003h/Val:03Z03DEZ2016(Sab)

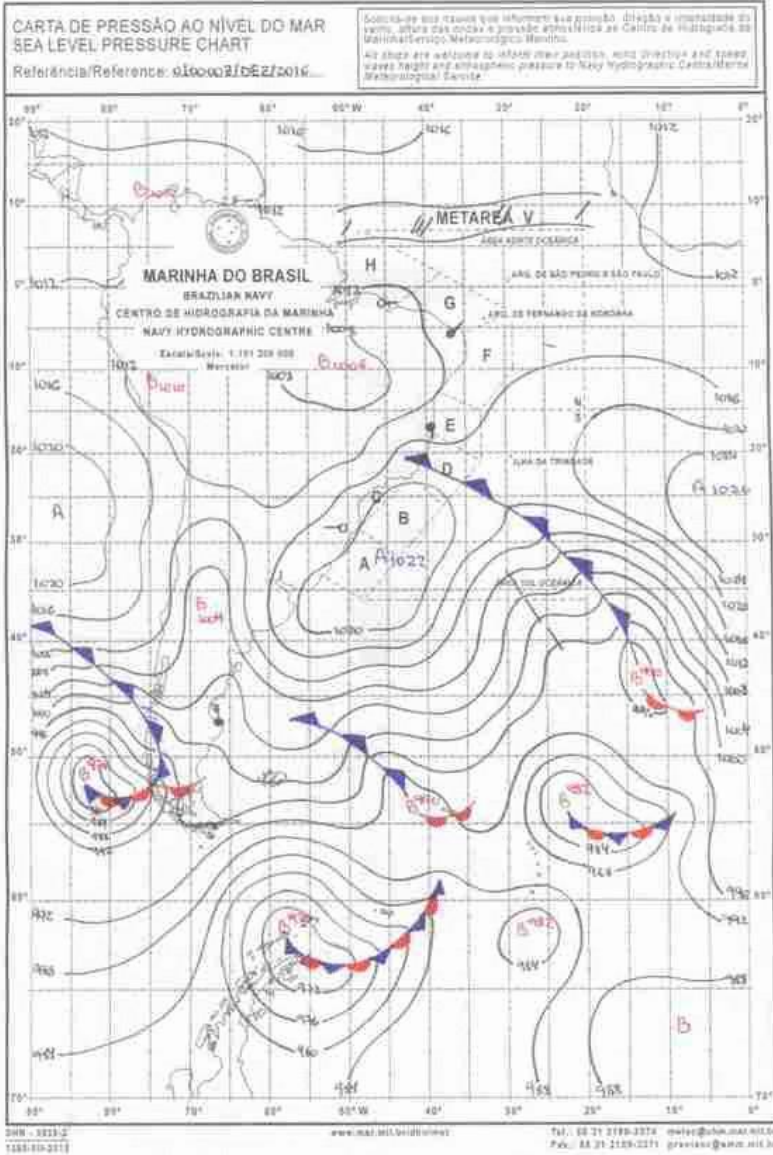




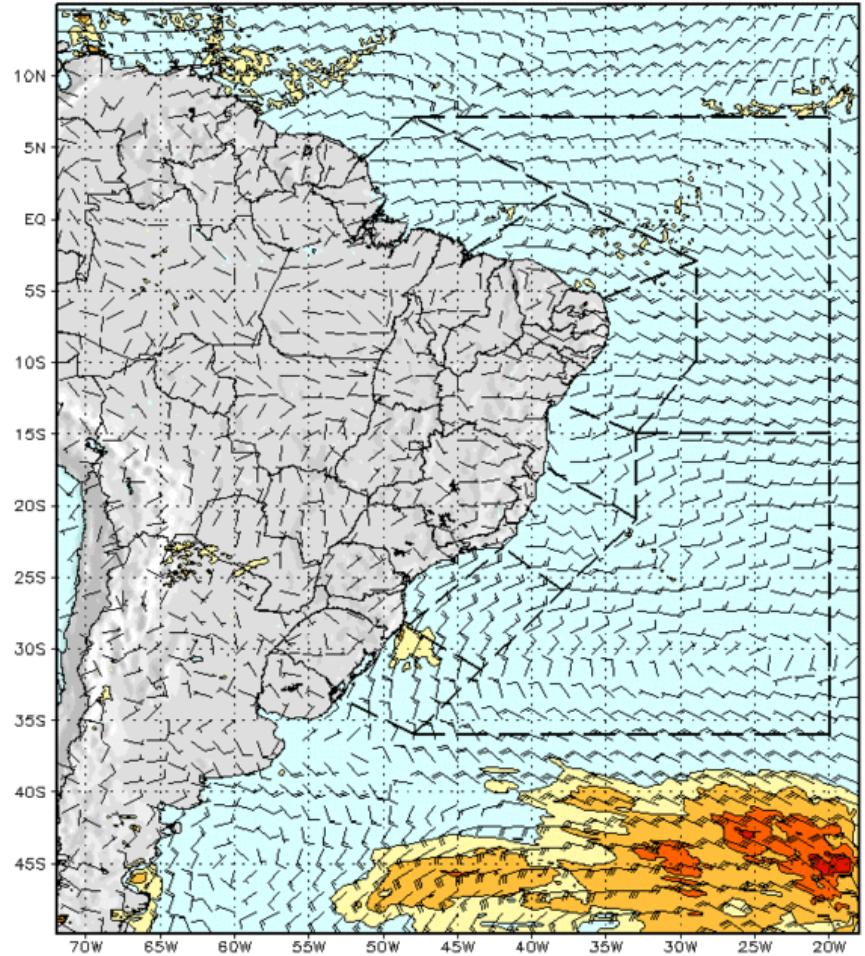


# CASE STUDY

## AL STORM EÇA



Modelo COSMO/CHM – Vento Maximo 10m(nos)  
 Ref:00Z03DEZ2016(Sab) +PROG003h/Vai:03Z03DEZ2016(Sab)





# CASE STUDY



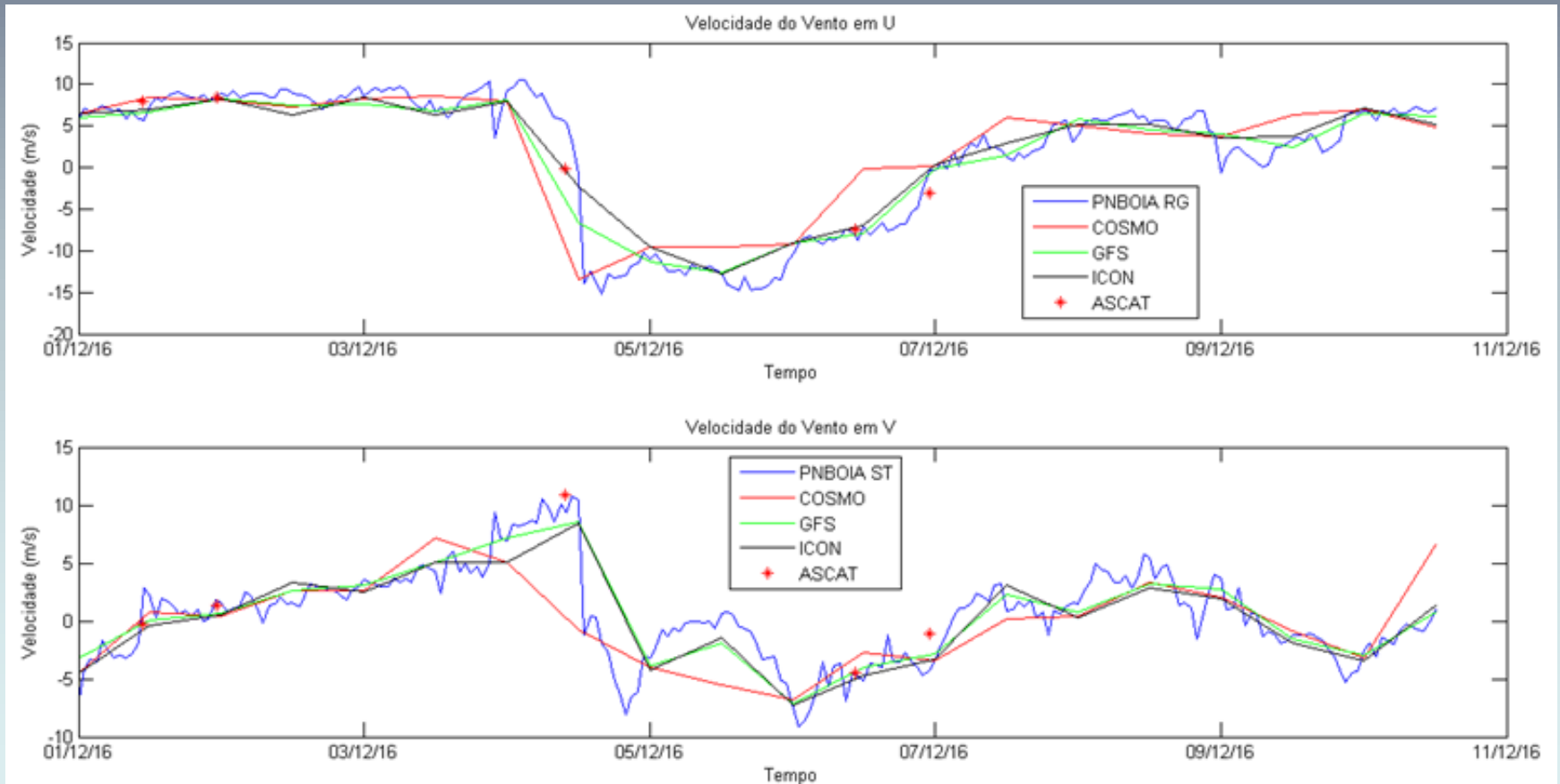
## DECEMBER 2016: TROPICAL STORM EÇAI

### ATMOSPHERIC MODELS X SANTOS BUOY (PNBOIA)

S/SW Wind

Wspd=15 m/s

Gust=20 m/s





# CASE STUDY

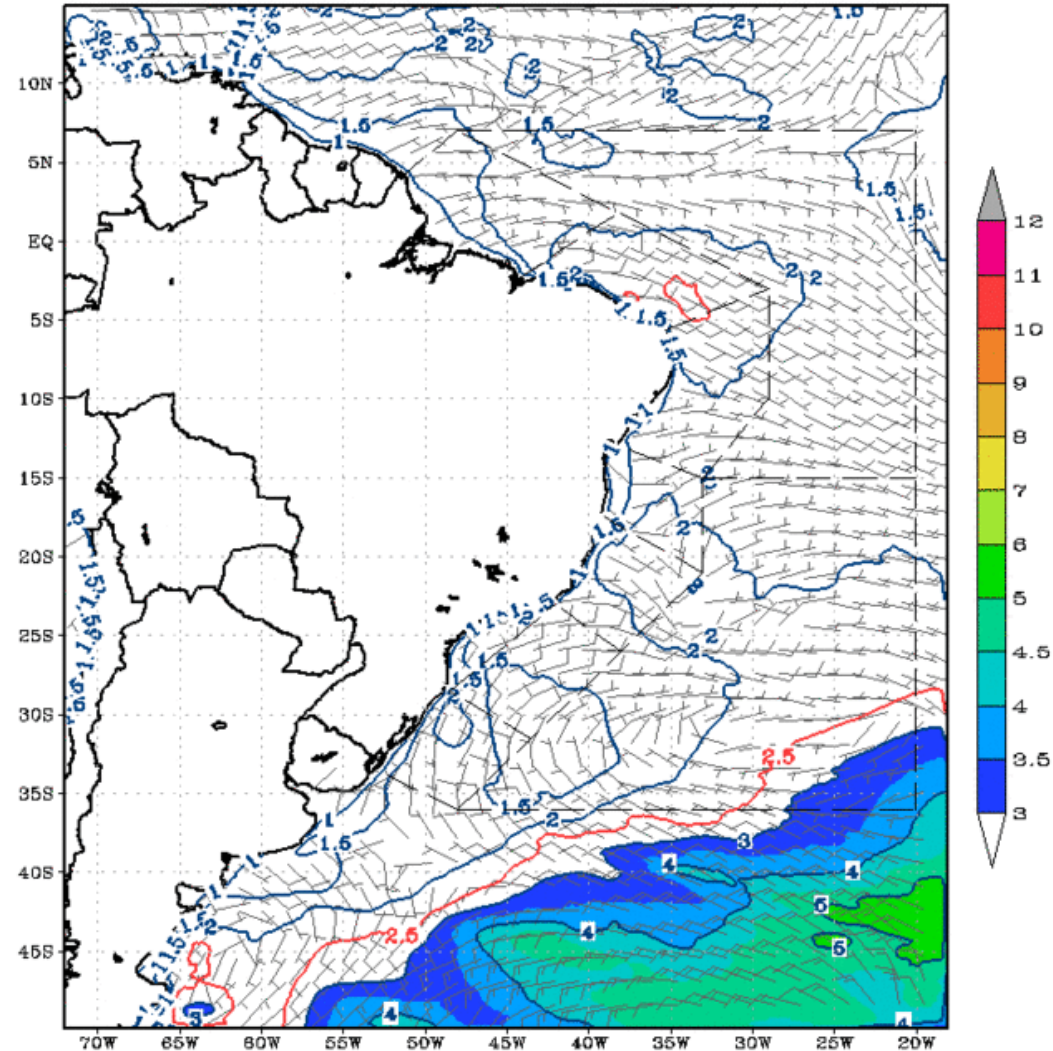


## DECEMBER 2016: TROPICAL STORM EÇAÍ

### WWIII (COSMO)

- S/SW Waves
- $H_s = 9$  m in the ocean
- $H_s = 5$  m at buoy
- $T_s = 11$  seconds

Modelo WWS/COSMO - Alt.Ondas(m)/Vento(10m) - WWS/COSMO Model - Wave Height(m)/Wind(10m)  
00Z03DEC2016 (Sat) Analise







# CASE STUDY



## DECEMBER 2016: TROPICAL STORM EÇAÍ

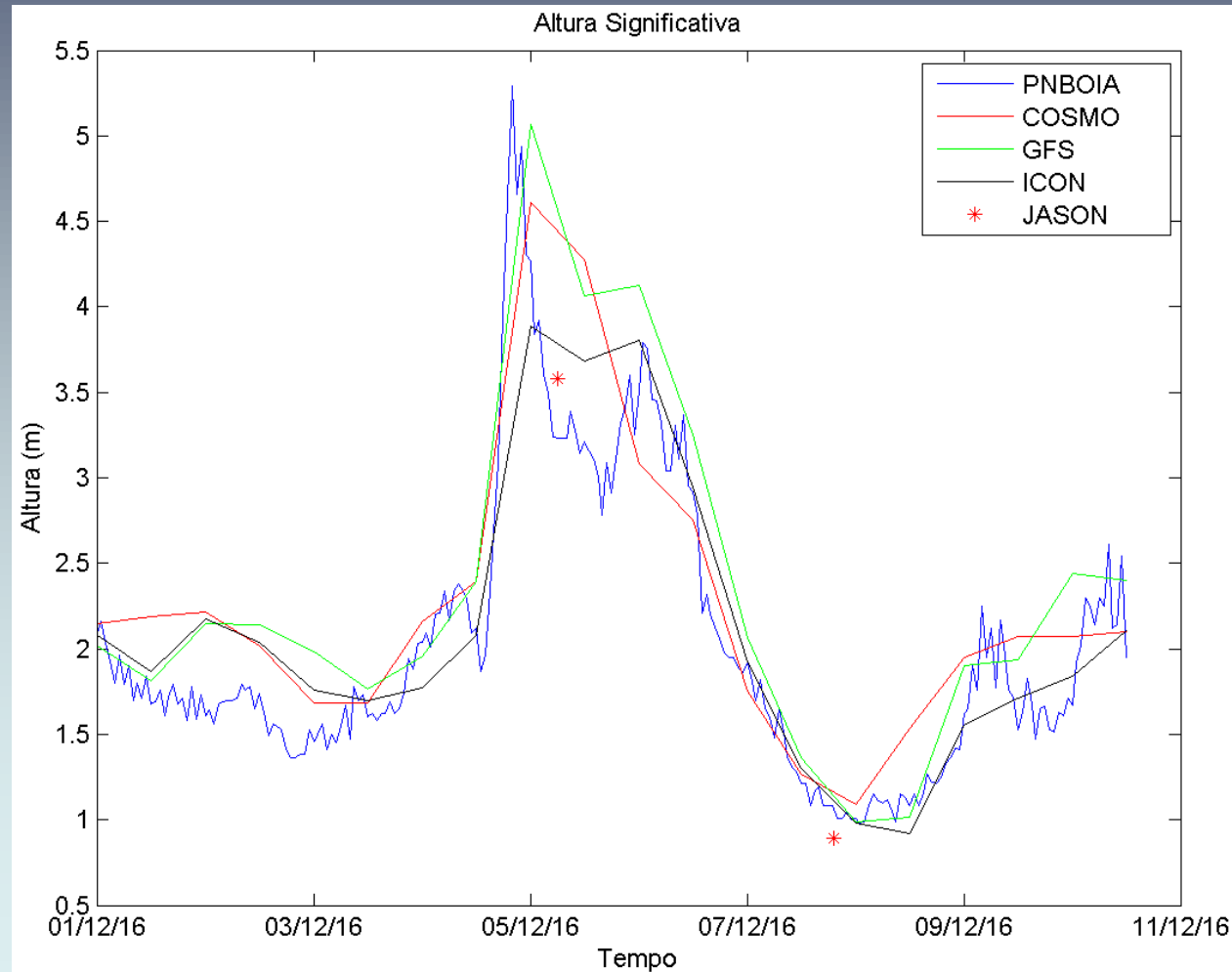
### SANTOS BUOY (PNBOIA)

$H_s=5,23$  m

$H_{max}=8,76$  m

$T_s=13$  s

Mean Direction=SW





# CASE STUDY



## DECEMBER 2016: TROPICAL STORM EÇAÍ

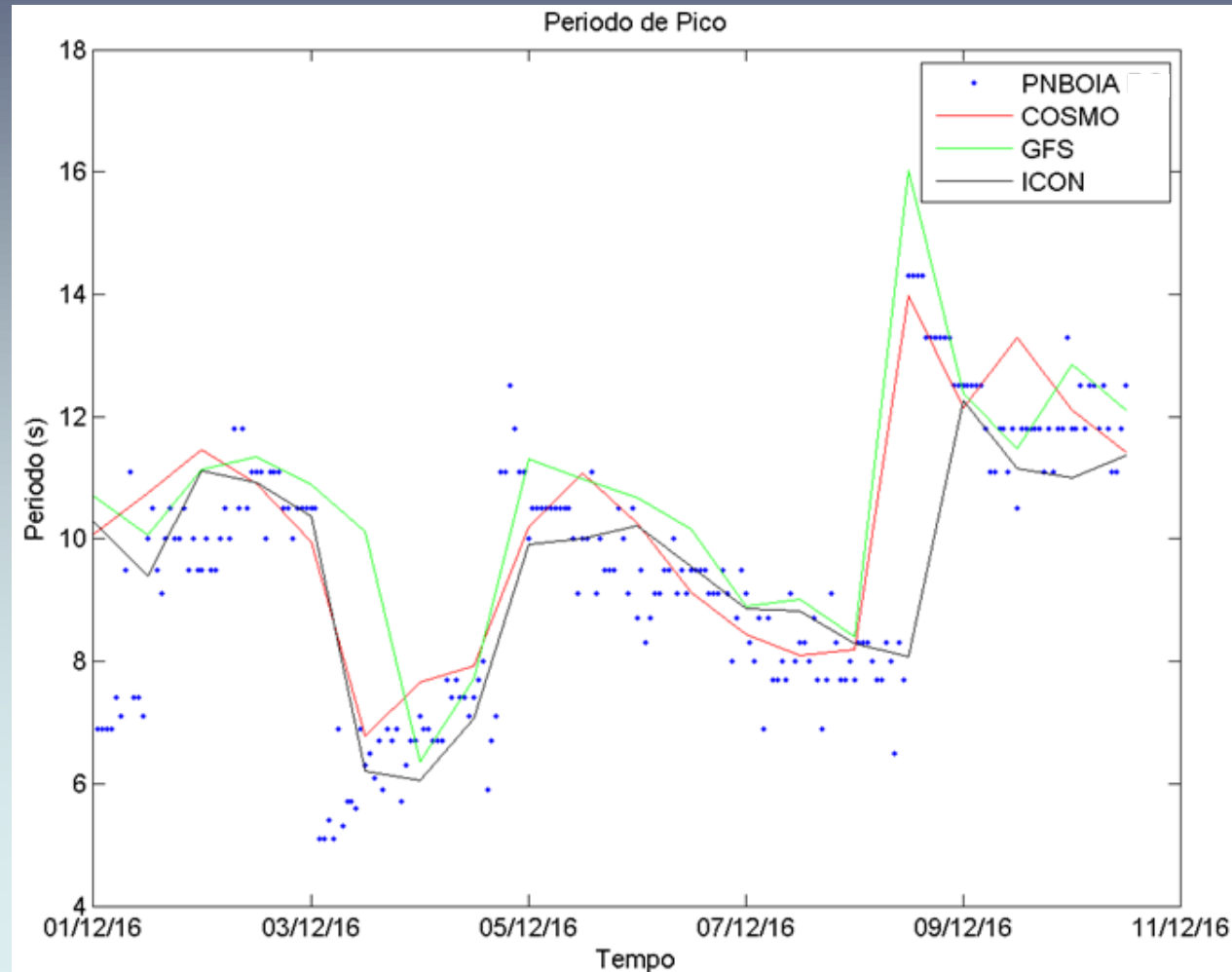
### SANTOS BUOY (PNBOIA)

$H_s=5,23$  m

$H_{max}=8,76$  m

$T_s=13$  s

Mean Direction=SW





# CASE STUDY



## DECEMBER 2016: TROPICAL STORM EÇAÍ

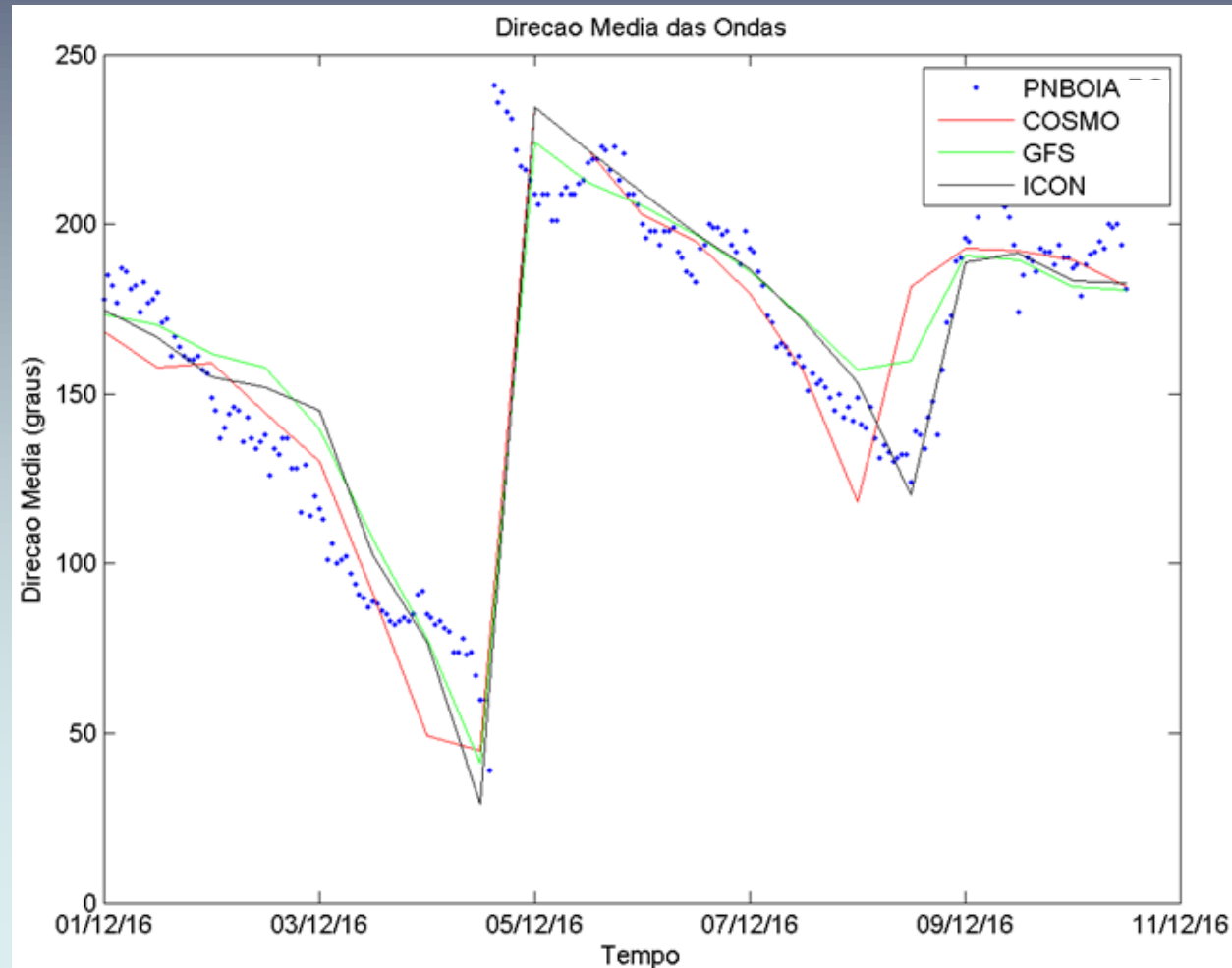
### SANTOS BUOY (PNBOIA)

$H_s=5,23$  m

$H_{max}=8,76$  m

$T_s=13$  s

Mean Direction=SW







# DATA QC



## ALMOST REAL TIME DATA QC

DATA ARE MARKED WITH HARD AND SOFT FLAGS;

REFERENCES:

- QARTOD
- NDBC
- LOCAL FLAGS



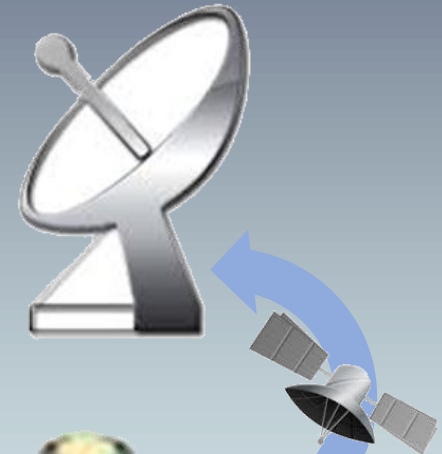
INTERNET:  
FINAL USER

### DATA QC

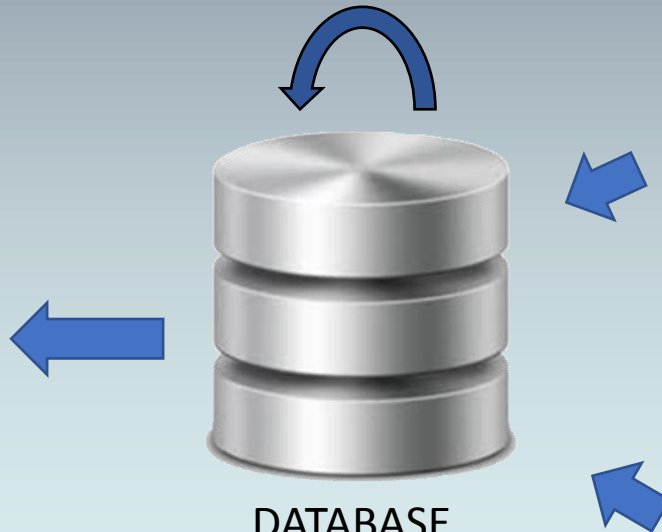


DATABASE

### SATELLITE TRANSMISSION



BUOY MEMORY  
CARD

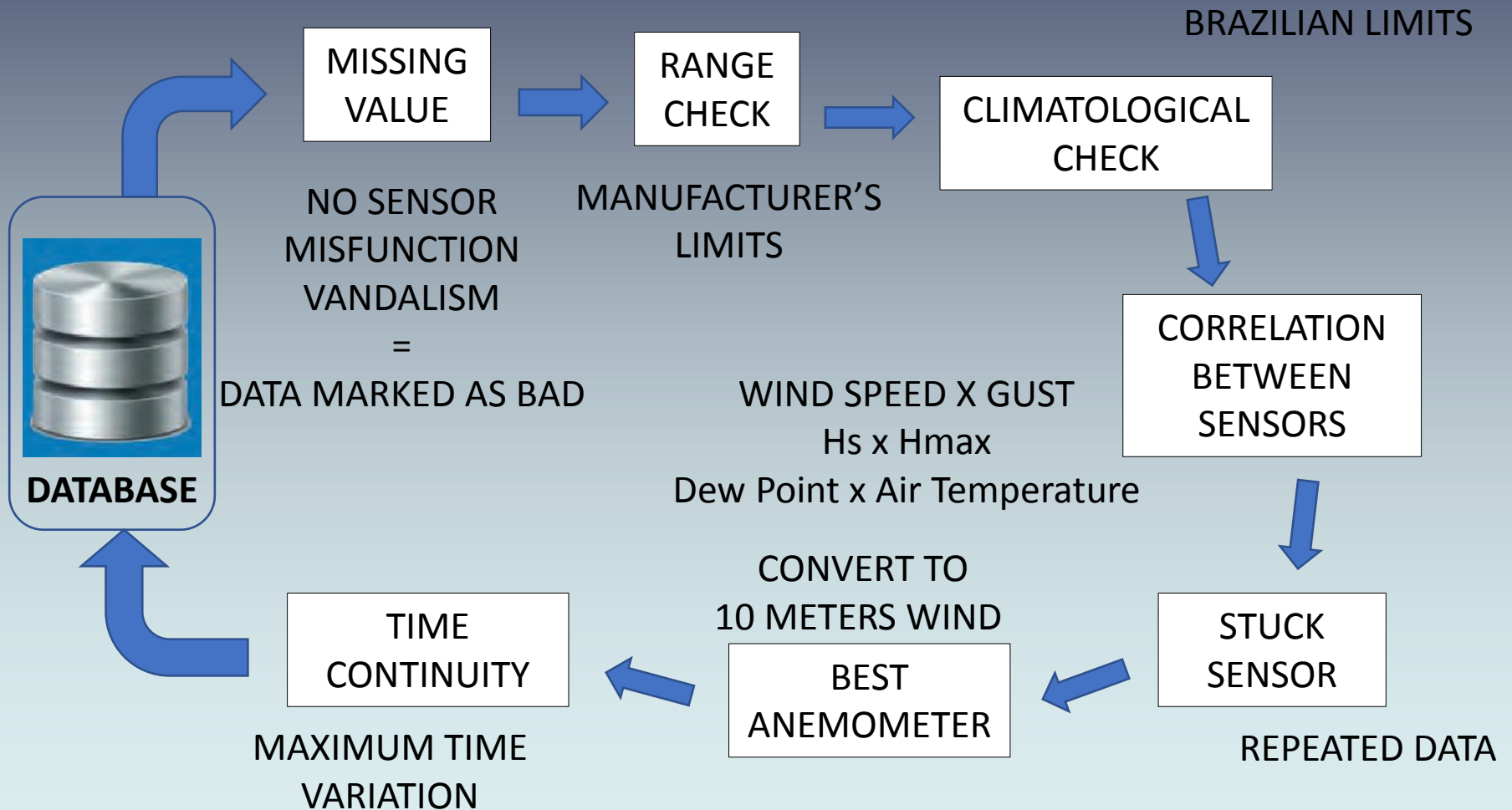




# DATA QC



## ALMOST REAL TIME DATA QC





# FUTURE PERSPECTIVES



- R & D Projects;

- Deep-Gliders: new frontier of knowledge;
- Acquire ARGO floats annually;

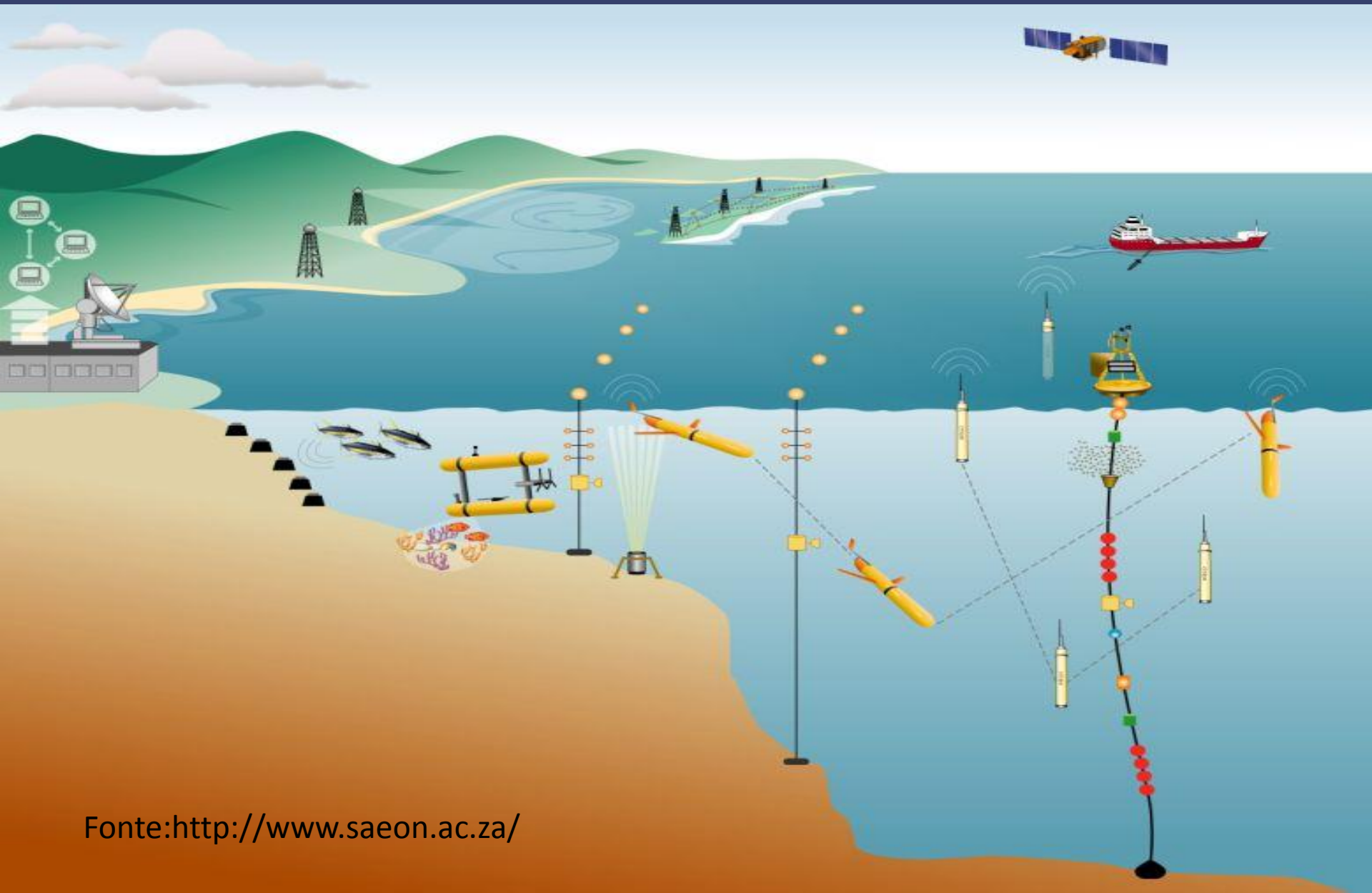


- Operate BMO-BR buoys;
- Manual data QC;
- Support the development of national industry (BMO-BR, mooring line, mooring floats).





# FUTURE PERSPECTIVES



Fonte: <http://www.saeon.ac.za/>



**“Restará sempre  
muito o que fazer...”**



**There will be always so  
much to do...**