
International Hydrography Organization (IHO)

Directorate of Hydrography and Navigation (DHN)

Navy Hydrographic Center (CHM)

# 1st Tidal and Water Level Working Group Meeting

Niterói, Brazil. March 30 – April 01, 2009

# NATIONAL PRESENTATIONS

# BRAZIL

Lt Cdr Rosuita Helena Roso, M.Sc.

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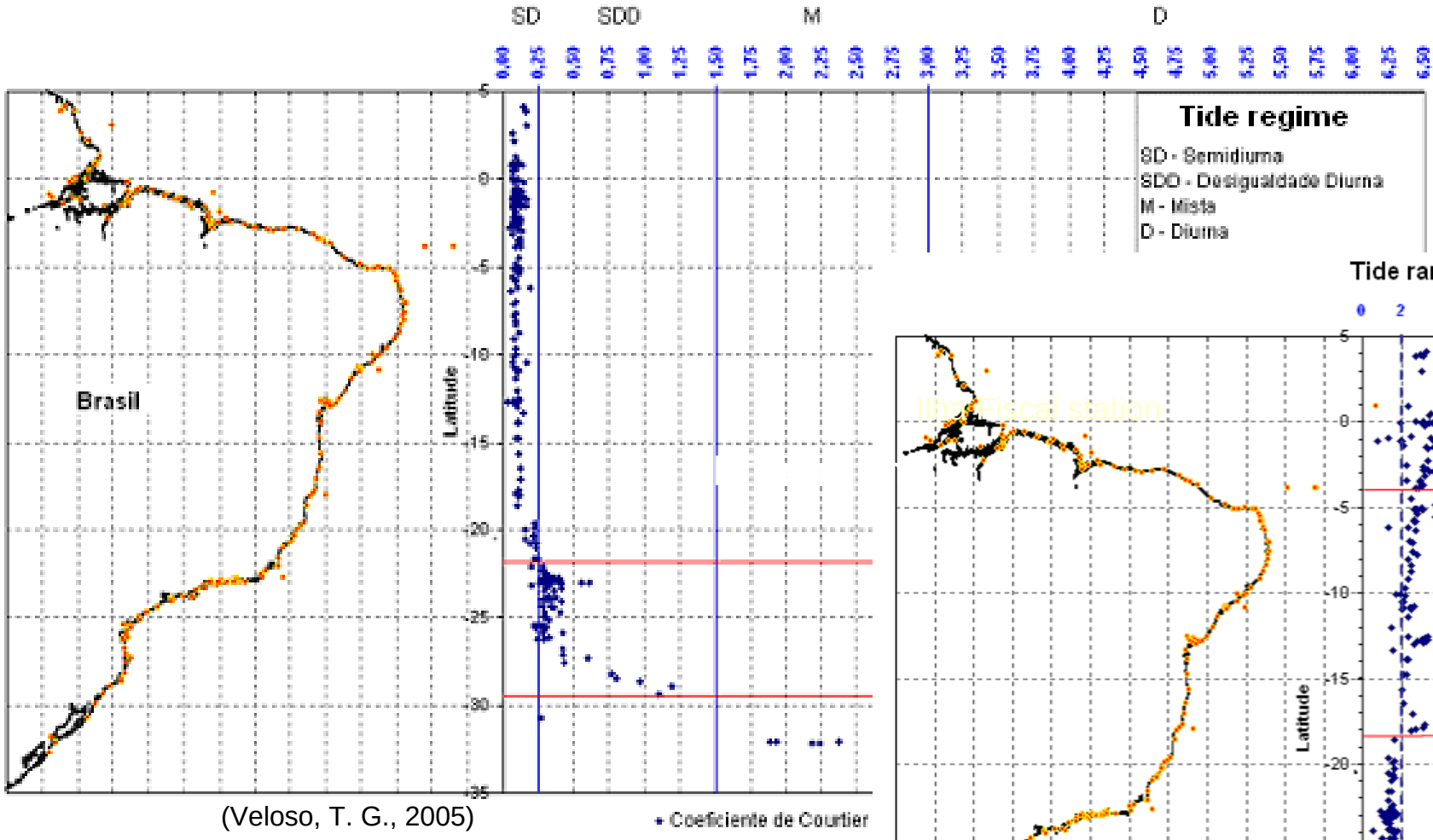
**TIDES SECTION**

# An overview of tides in Brazil…




(Veloso, T. G., 2005)

Tide bore in Brazil…Pororoca

# Projects underway at the Hydrographic Center related to Tides

I. To establish LAT as the Brazilian CD:

I.1. Revitalization of the tidal stations network

I.2. Upgrade of the Tides System software

II. Modeling tides (Lt Maria Fernanda, M.Sc.)

III. GPS applied for soundings reduction (Lt Cdr Ramos, M.Sc.)

V. Digital tidal currents charts (Lt Cdr Marcelo, M. Sc.)

Brazilian Chart Datum

For maritime areas

CD = MLWS (Courtier - Balay criterium)

Differences between LAT and MLWS can be significant

In order to perform the IHO Technical Resolutions
it's needed to adopt LAT as the national CD….

# Problems must be solved ahead !!

## I. Lack of data for that purpose:

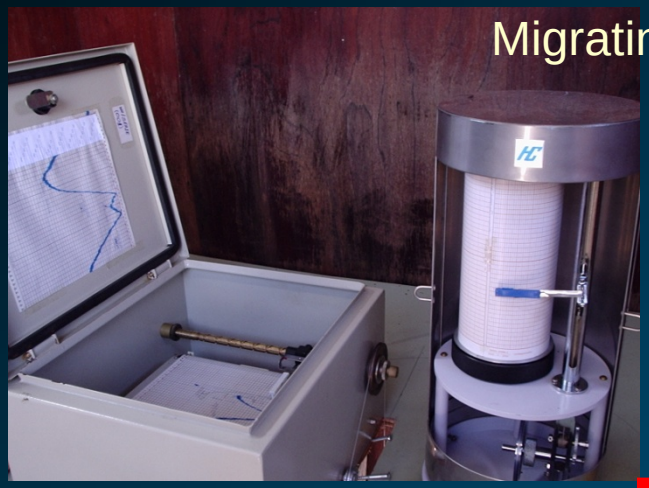
- most of the data is outdated
- short periods of observation for most of the stations
- no common “epoch” for all stations

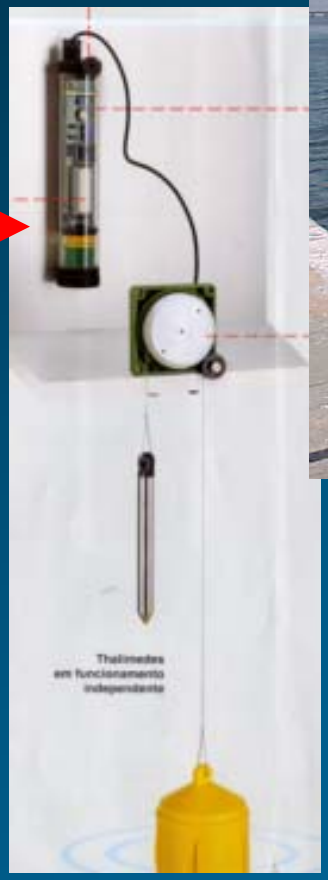
Low cooperation from other national Institutions

## II. Necessity of an effective software to process a large amount of data

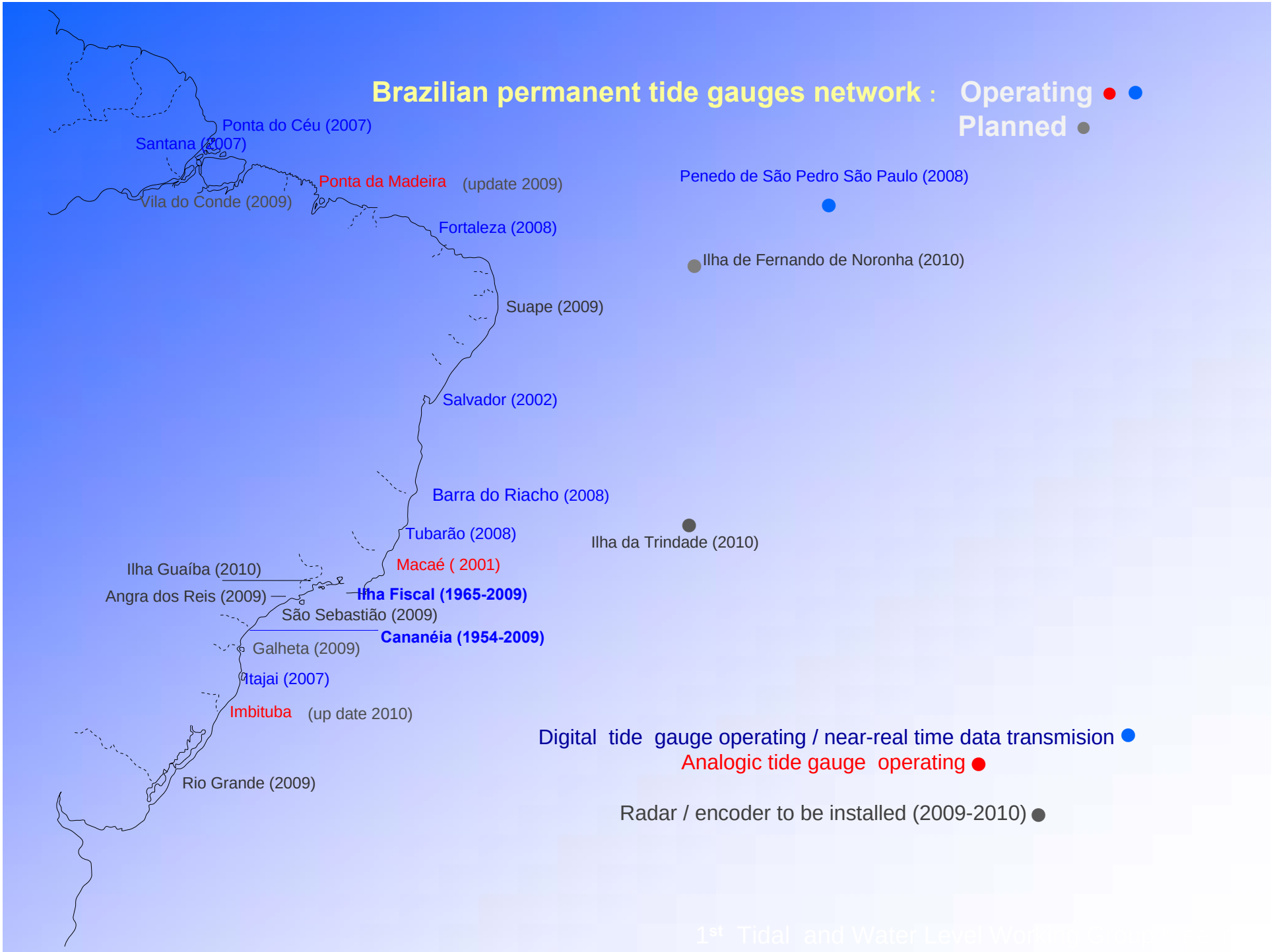
# I.1. Project to revitalize the tidal stations network

Migrating to digital sensors with automatic data transmission (radar, encoder, pressure)





**2002 GLOSS**
**2008** : IBGE/ CHM/ INPE / CVRD


Brazilian permanent tide gauges network : Operating
Planned
Ponta do Céu (2007)
Santana (2007)
Ponta da Madeira (update 2009)
Vila do Conde (2009)
Fortaleza (2008)
Penedo de São Pedro São Paulo (2008)
Ilha de Fernando de Noronha (2010)
Suape (2009)
Salvador (2002)
Barra do Riacho (2008)
Tubarão (2008)
Ilha da Trindade (2010)
Macaé ( 2001)
Ilha Guaíba (2010)
Angra dos Reis (2009)
Ilha Fiscal (1965-2009)
São Sebastião (2009)
Cananéia (1954-2009)
Galheta (2009)
Itajai (2007)
Imbituba (up date 2010)
Rio Grande (2009)
Digital tide gauge operating / near-real time data transmision
Analogic tide gauge operating
Radar / encoder to be installed (2009-2010)

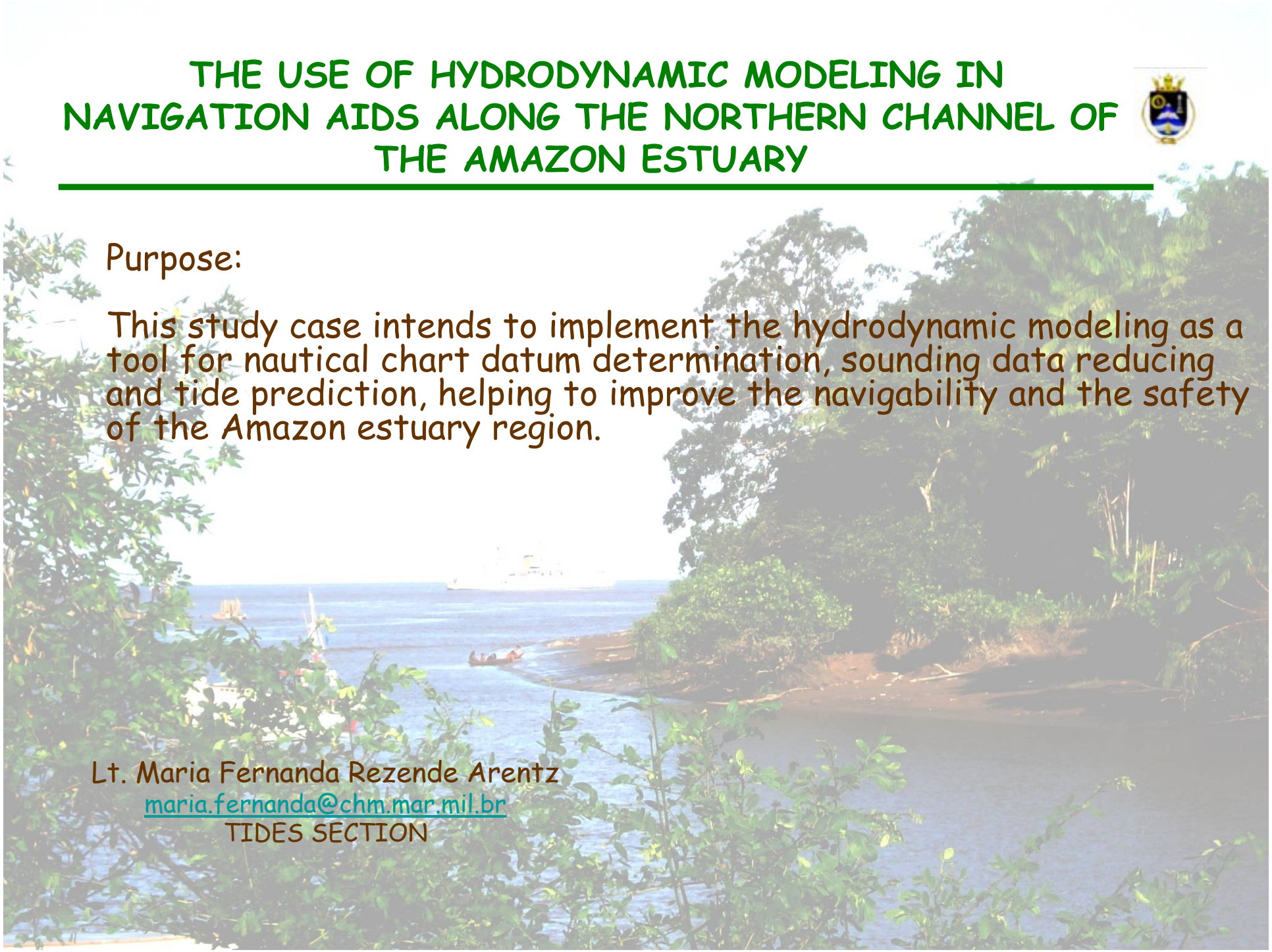
## I.2. Project for upgrading Tides System software

Tides System (Franco,1971)

In 2008 50% of the upgrade was done

- Tide data and HC bank
- "near-automatic" data processing (filters, gap filling, spikes correction, quality flag,etc)
- Harmonic Analysis (Franco (1971))
- Cross Analysis
- Predictions
- National Tide Tables / Implement Digital National Tide Tables
- Mean Sea Level analysis
- Long series analysis
- Extremes analysis

# THE USE OF HYDRODYNAMIC MODELING IN NAVIGATION AIDS ALONG THE NORTHERN CHANNEL OF THE AMAZON ESTUARY



Purpose:

This study case intends to implement the hydrodynamic modeling as a tool for nautical chart datum determination, sounding data reducing and tide prediction, helping to improve the navigability and the safety of the Amazon estuary region.

Lt. Maria Fernanda Rezende Arentz
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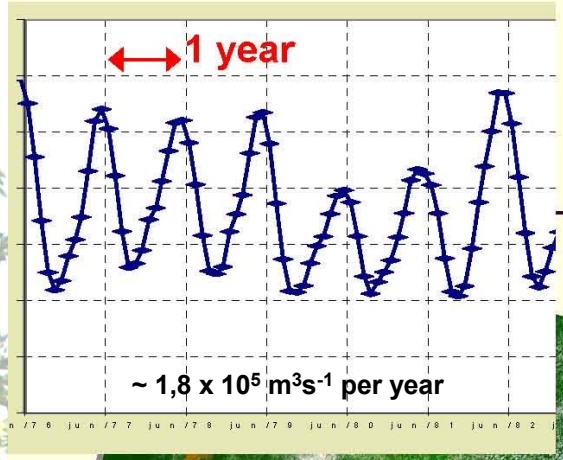
TIDES SECTION

**Specific purposes:**

- make sensitivity tests in the hydrodynamic model (MH) connected to bathymetric mesh changes;
- set new national CD and LAT for the channel region, following the recommendations of the IHO (2008) and check the spatial variability of these datums;
- Reduce the bathymetric data collected by the Sirius Ship in 2006, with the results of the hydrodynamic modeling;
- Assess the capacity of MH in reproducing the astronomical tide as a new tool for prediction

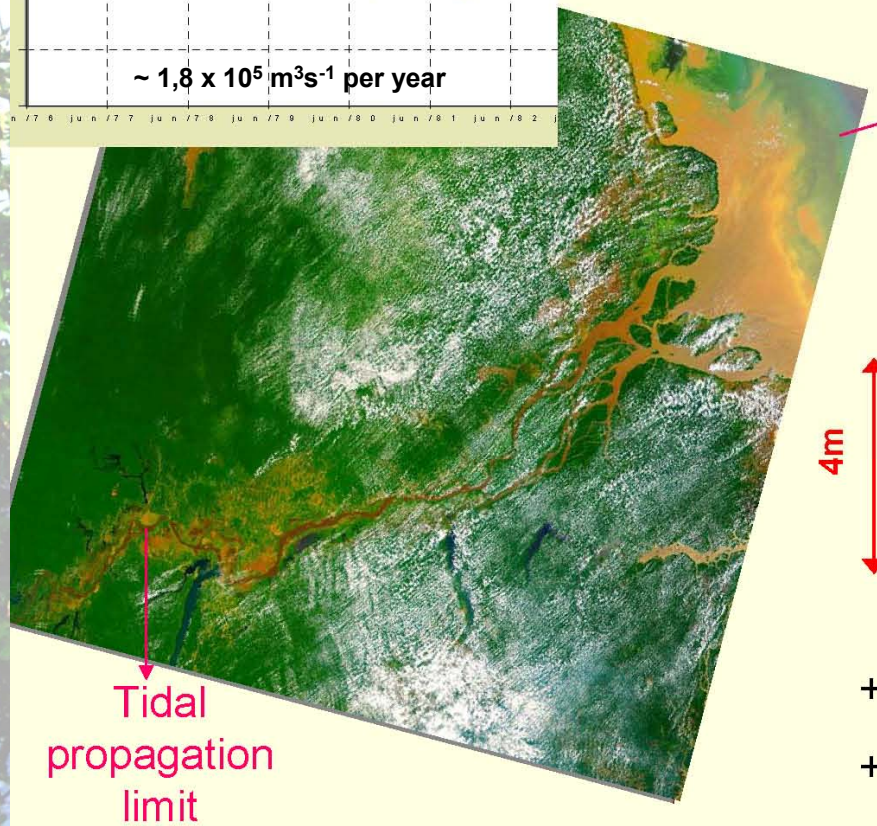
## RIVER DISCHARGE




## Physical characteristics / numerical modeling

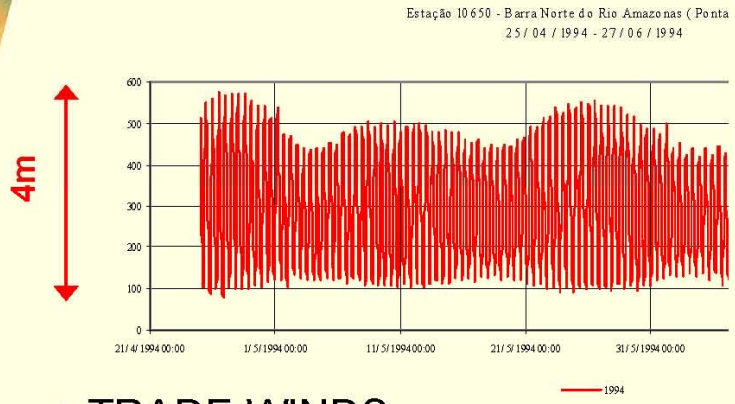
# Amazon estuary

Mixing process



Tidal propagation limit

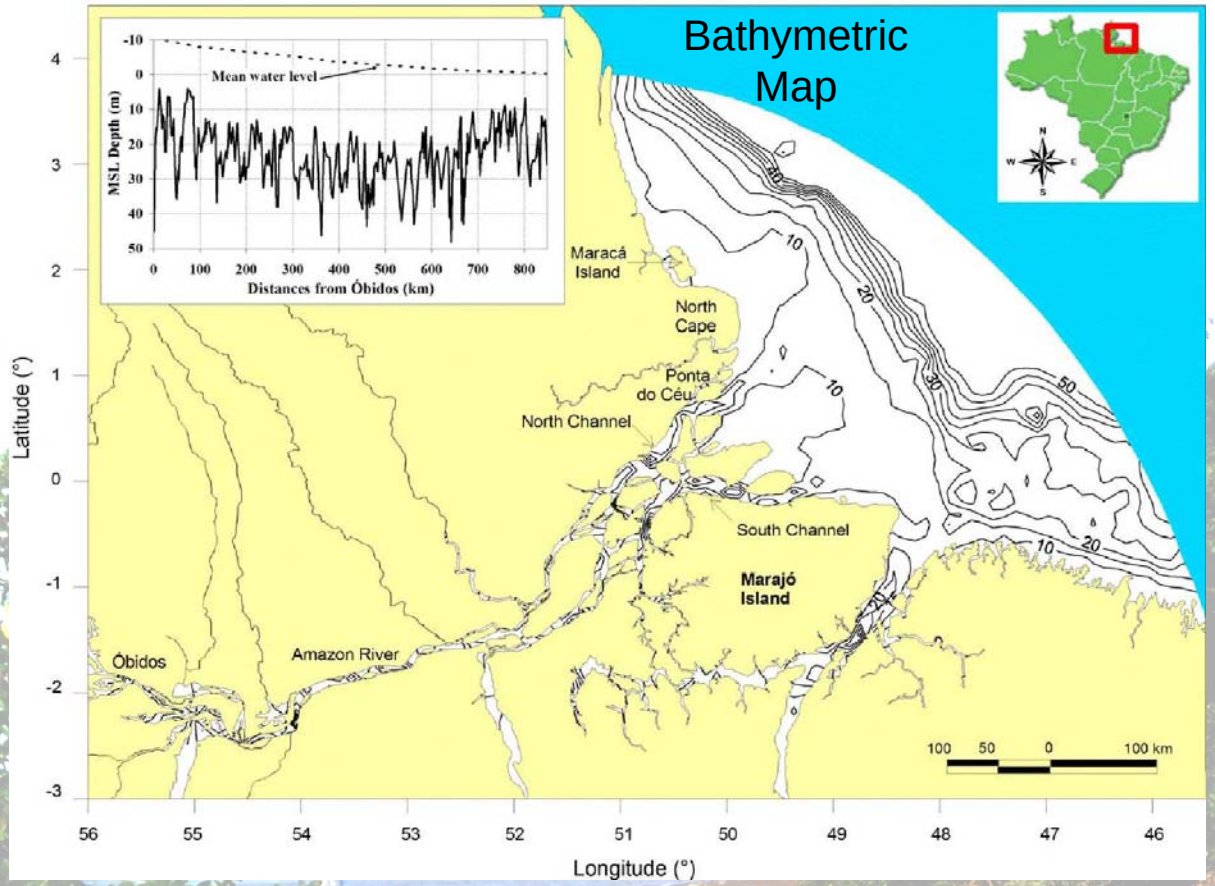
## MACRO-TIDE SYSTEM




+ TRADE WINDS

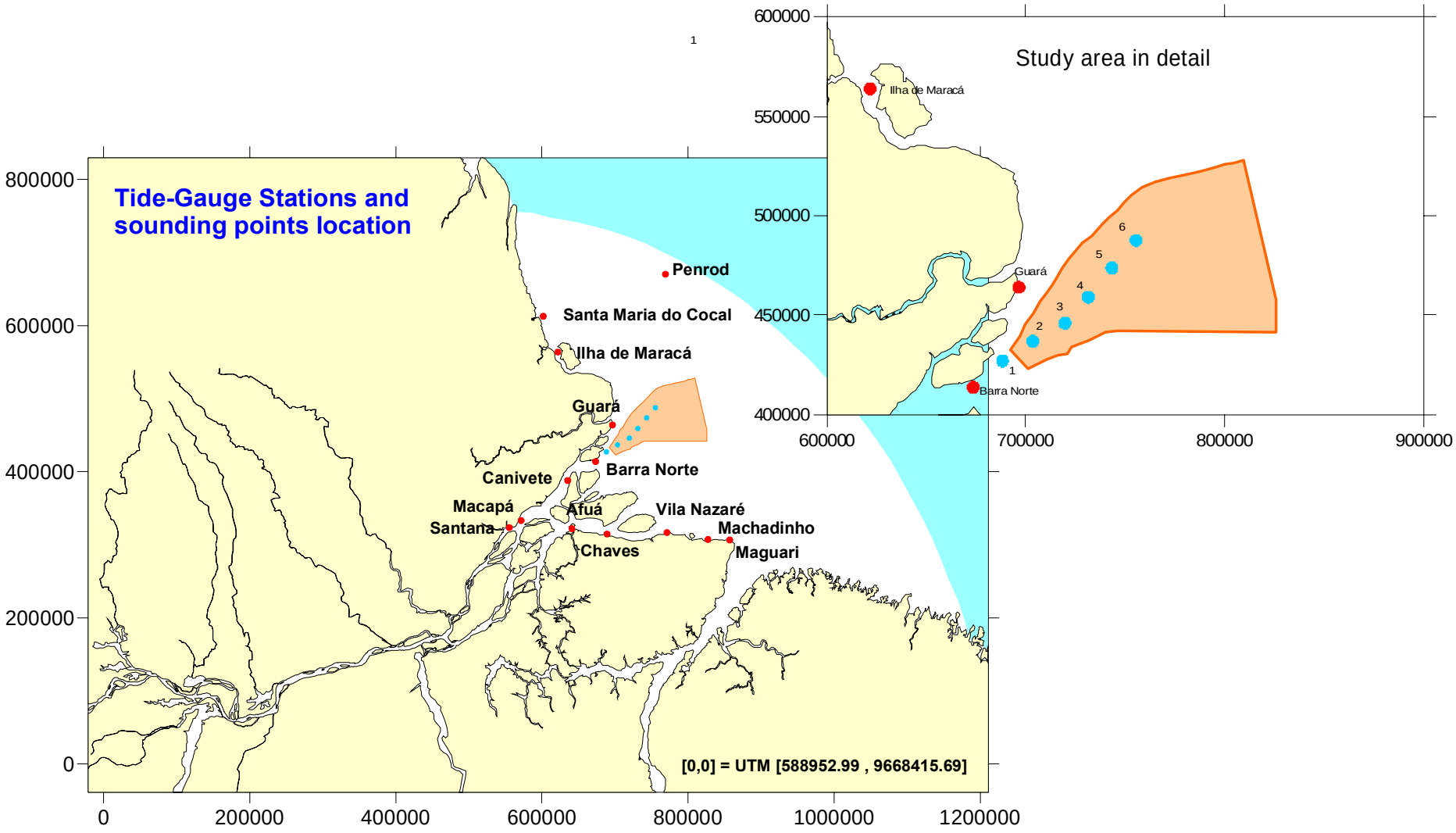
+ NBC

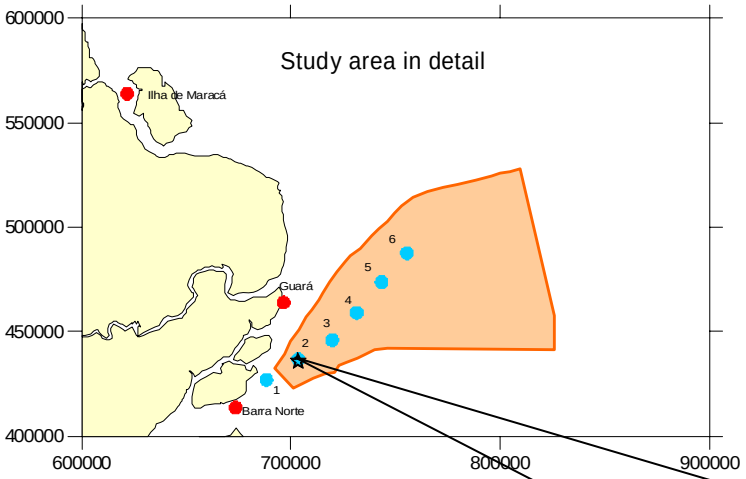
+ WAVES (local & remote)



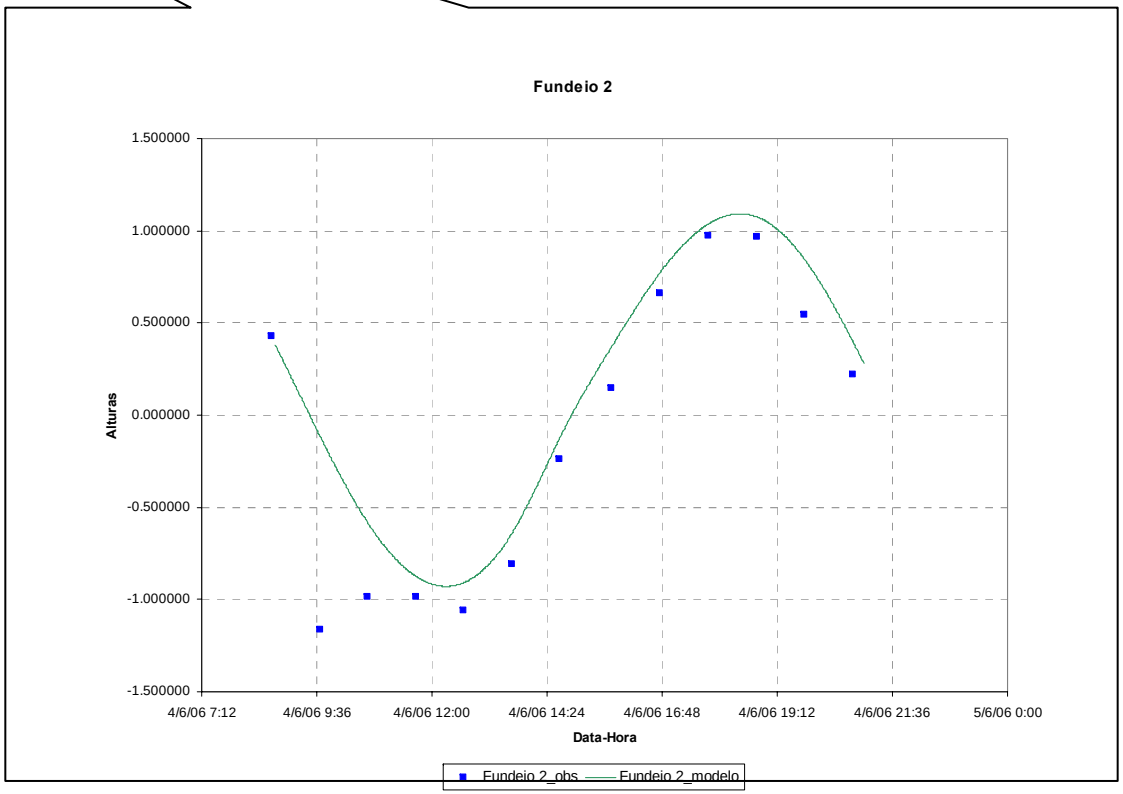

Motivation: There is an intrinsic difficulty to establish the reference level and to apply sounding reductions, due to the region's great dimensions, the variability and magnitude of the tides and river discharge which influences water levels and tidal amplitudes.

A numerical model has been implemented and has shown good agreement with the observed tides.

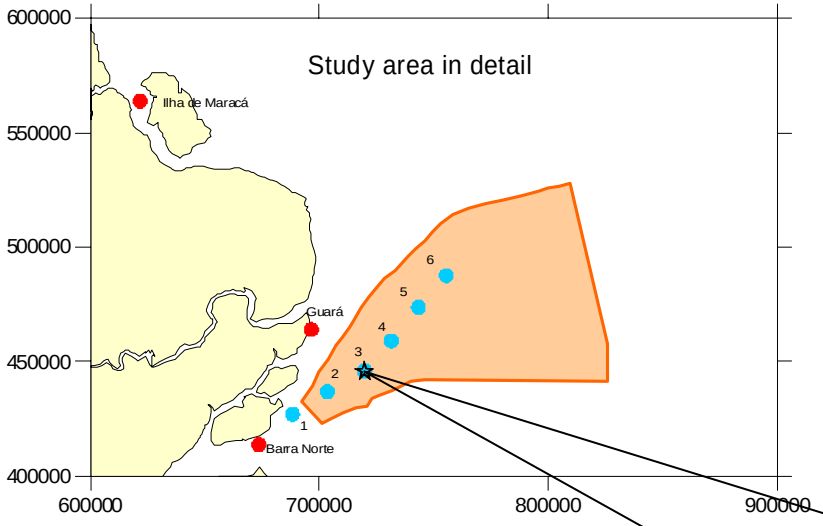



Study area in detail
Ilha de Maracá
Guará
Barra Norte
1
2
3
4
5
6
600000
550000
500000
450000
400000
600000
700000
800000
900000

# POINT # 2


Fundeio 2
1.500000
1.000000
0.500000
0.000000
-0.500000
-1.000000
-1.500000
Alturas
4/6/06 7:12
4/6/06 9:36
4/6/06 12:00
4/6/06 14:24
4/6/06 16:48
4/6/06 19:12
4/6/06 21:36
5/6/06 0:00
Data-Hora
Fundeio 2_obs
Fundeio 2_modelo

1


Study area in detail
Ilha de Maracá
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1
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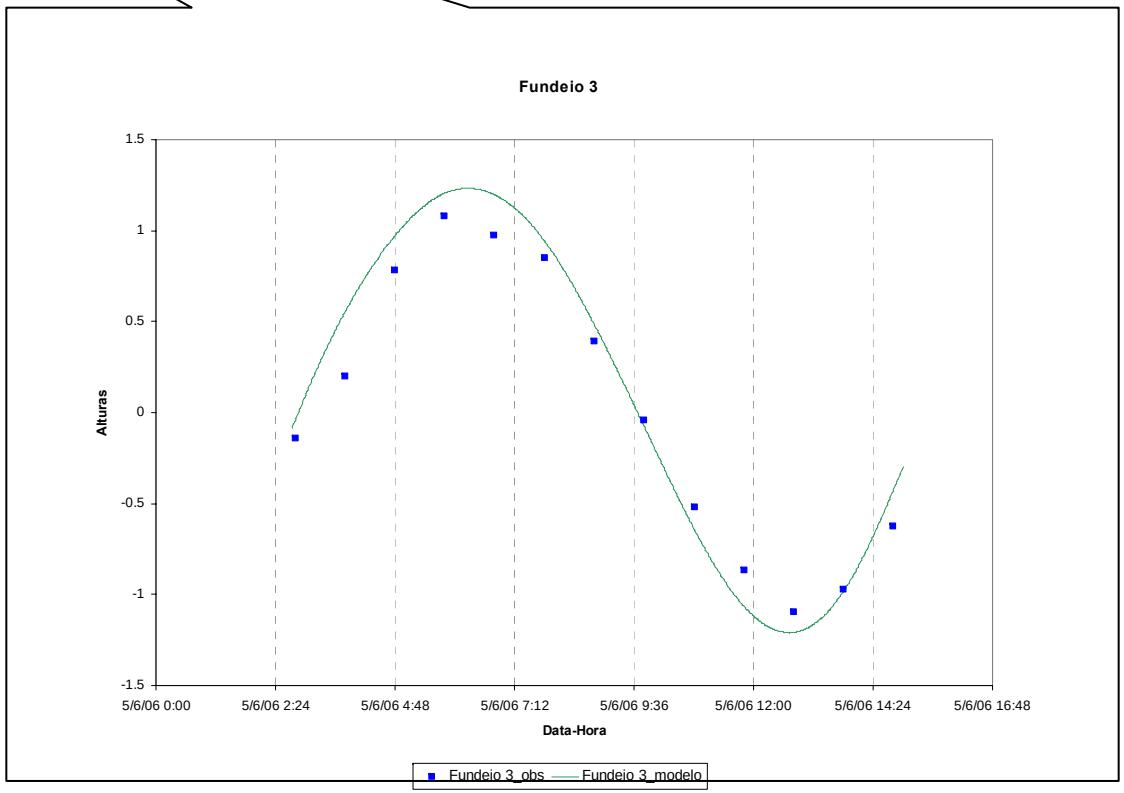
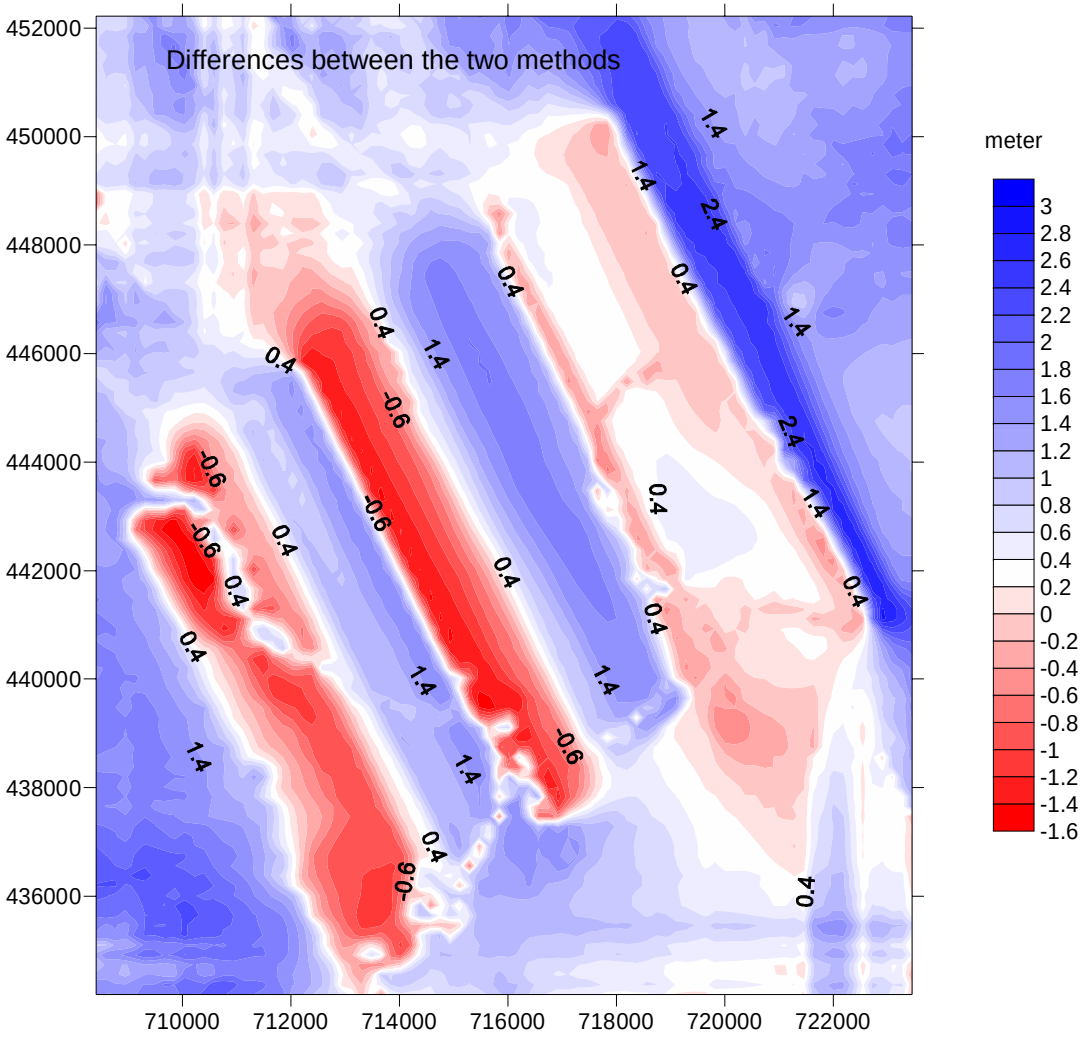
900000

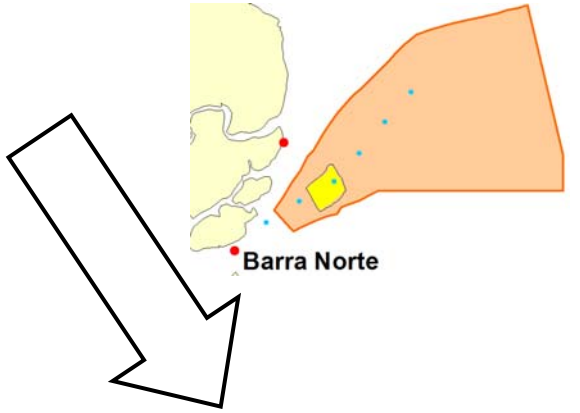
# POINT # 3

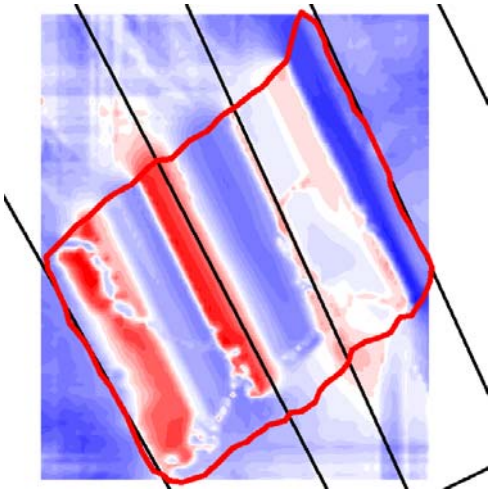

Fundeio 3
Alturas
1.5
1
0.5
0
-0.5
-1
-1.5
5/6/06 0:00
5/6/06 2:24
5/6/06 4:48
5/6/06 7:12
5/6/06 9:36
5/6/06 12:00
5/6/06 14:24
5/6/06 16:48
Data-Hora
Fundeio 3_obs
Fundeio 3_modelo

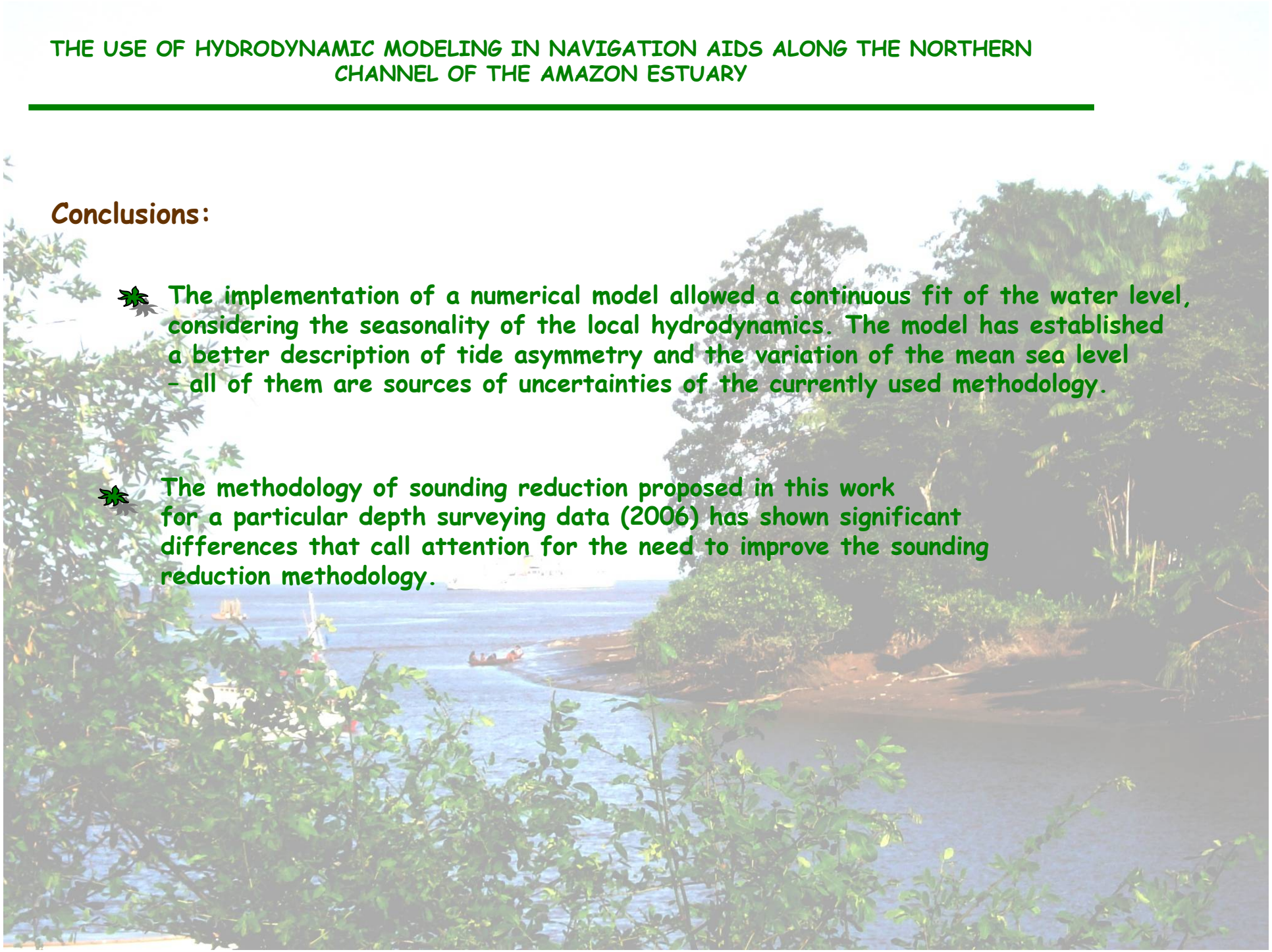
## Differences in the depth obtained according to the two sounding reduction methodologies.




## Numerical Modeling x Discrete Tidal Zoning





## Conclusions:

- The implementation of a numerical model allowed a continuous fit of the water level, considering the seasonality of the local hydrodynamics. The model has established a better description of tide asymmetry and the variation of the mean sea level – all of them are sources of uncertainties of the currently used methodology.

- The methodology of sounding reduction proposed in this work for a particular depth surveying data (2006) has shown significant differences that call attention for the need to improve the sounding reduction methodology.

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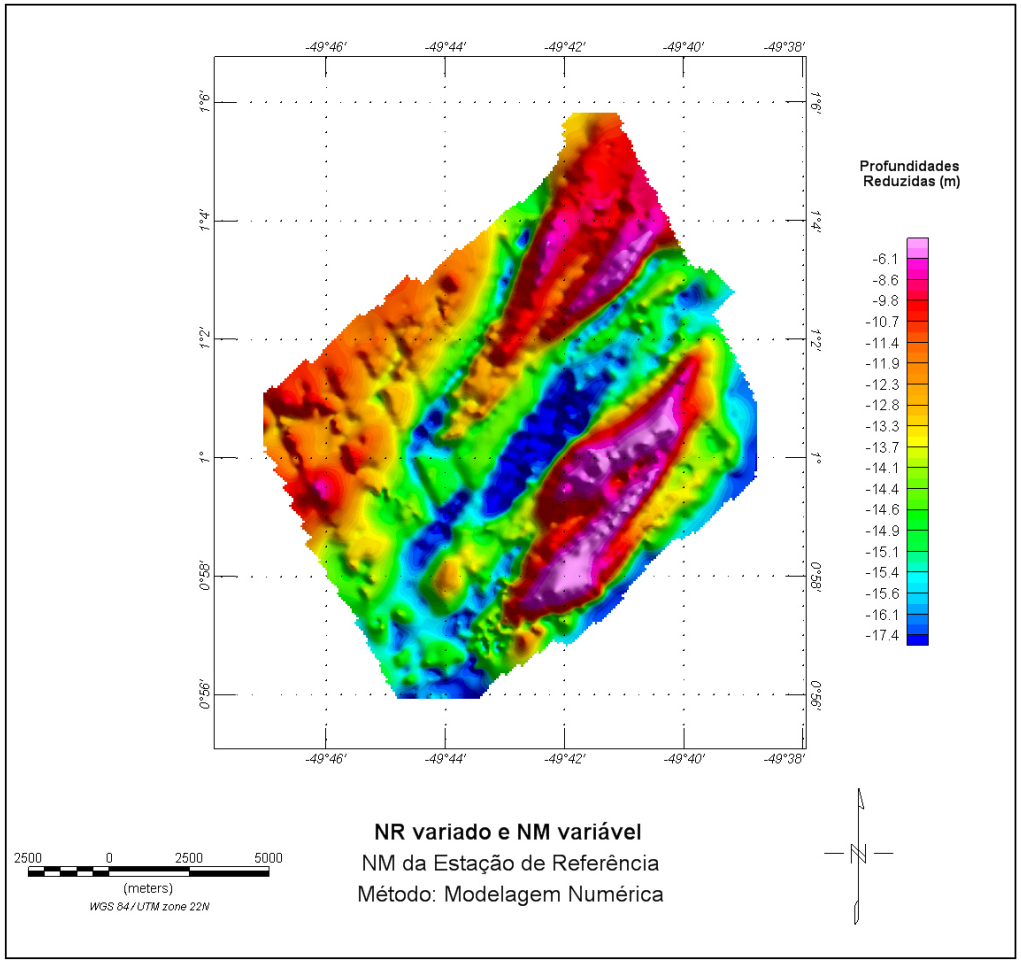

# GPS apllyed for Tides

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**GEODESY SECTION**

# Projects underway : GPS Tides

Evaluation the application of RTG/RTK Tides in hydrographic surveys, in accordance with IHO S-44 standards.

- Application of precise Differential GPS techniques to obtain tides corrections directly from their ellipsoid height trends.

- GPS Positioning Systems:
  - -C-Nav 2050M RTG
  - - Trimble 7400 RTK
  - - NovAtel DL-V3

- Real time measurement removes the need to:
  - -Measure tidal height
  - - Measure heave and squat

## GPS Tides application in the hydrographic surveys

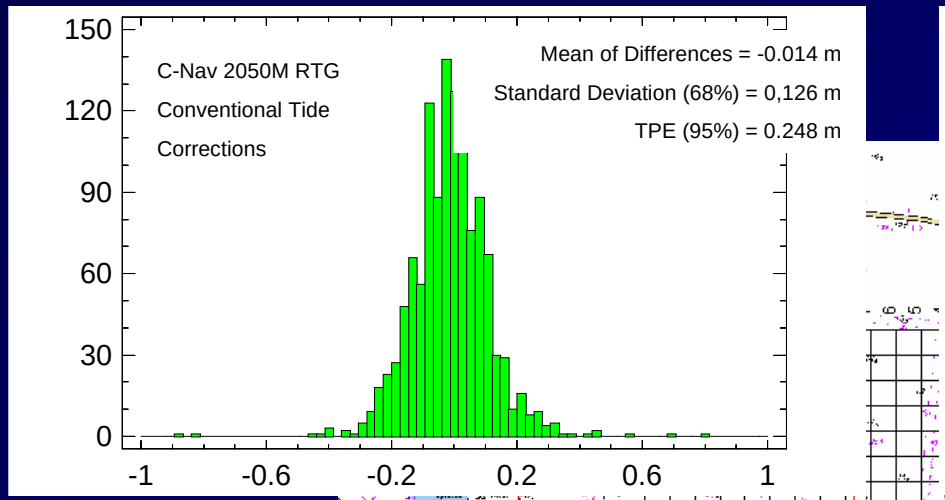
Operations

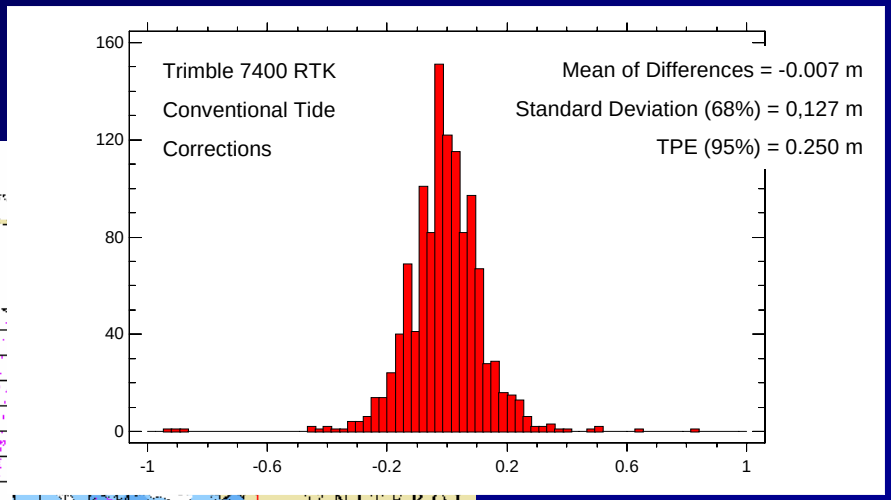
- Determination of the height of Chart Datum relative to WGS-84 ellipsoid (SEP – Vertical Separation);
- GPS antenna height above vessel reference point;
- SEP value was considered constant for entire survey area.

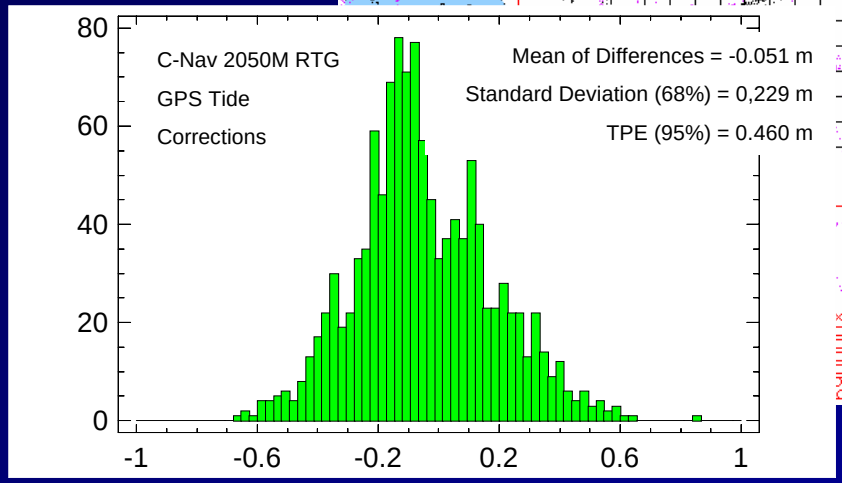
Vertical Separation Model - interpolation process by which the SEP is estimated everywhere in a chart.

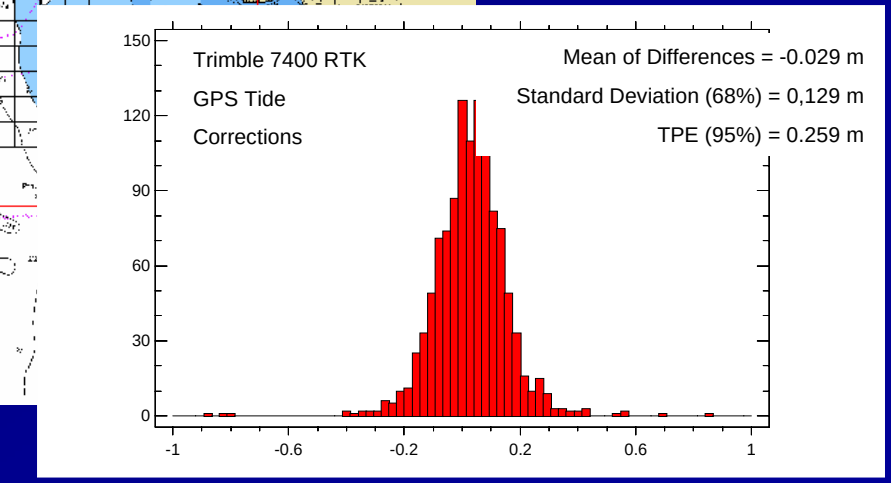
- Hydrodynamic model
- Data from coastal tidal stations
- Global Tide Models / Geoidal Models.

# GPS Tides – 2006 Tests

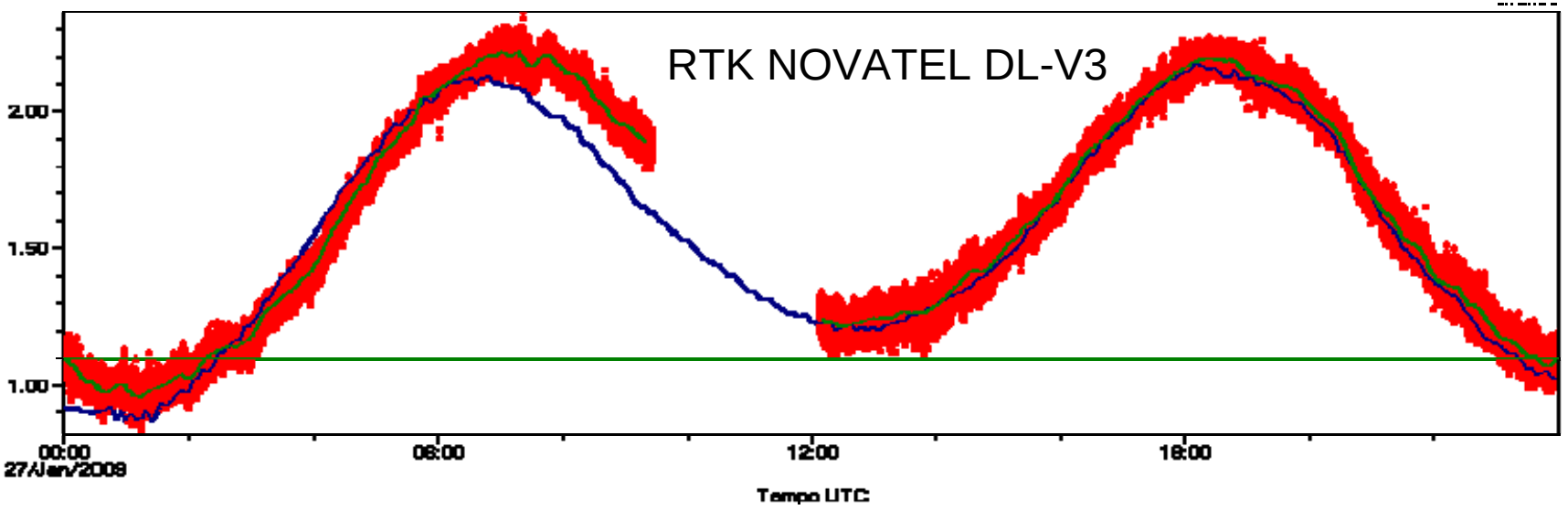


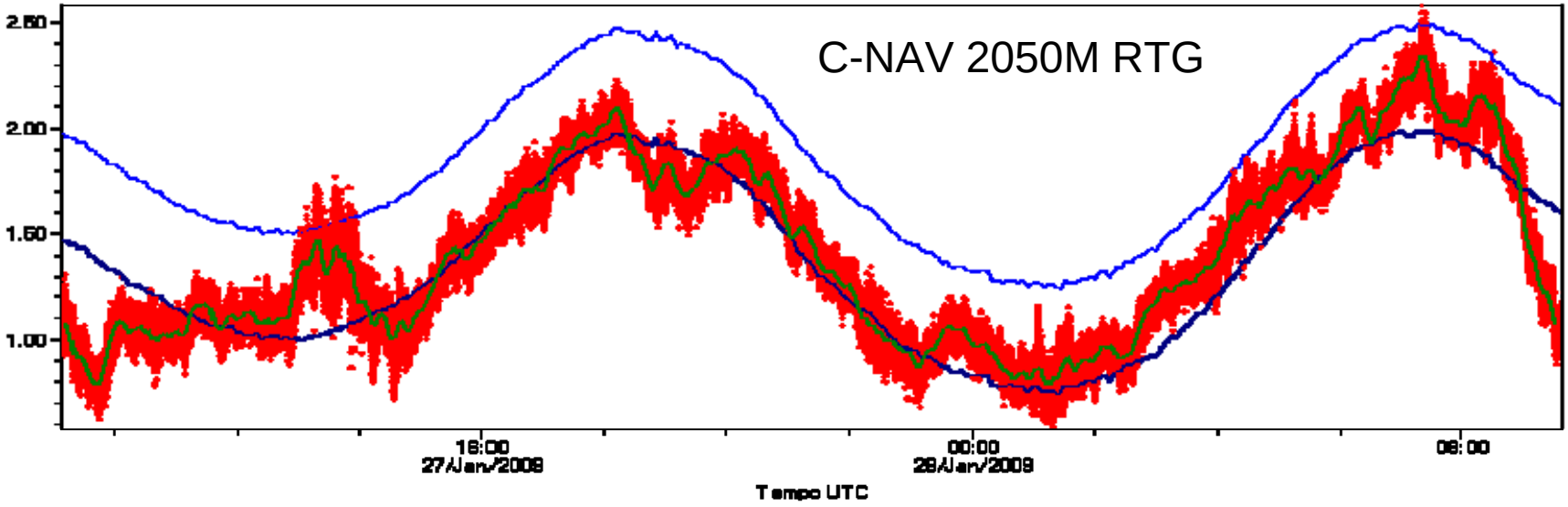



# GPS Tides – 2008 Preliminary Tests



# Thanks!

Cdr **Marcelo** Fricks , Lt Cdr **Rosuita** Helena Roso, Lt Cdr Alexandre Moreria **Ramos**, Lt **Maria Fernanda** Rezende Arentz
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