

# Sea Level Monitoring in Mexico

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**Report presented by the Universidad Nacional Autónoma de México (UNAM)**

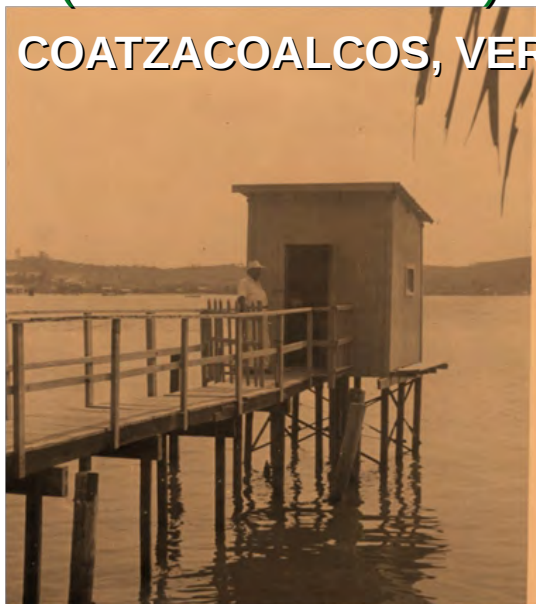
**Aknowledgments:** API BCS (La Paz), API Puerto Vallarta, Lazaro Cárdenas, Puerto Chiapas, Progreso y Coatzacoalcos, API FONATUR Zihuatanejo y Huatulco, Municipio de Zihuatanejo y Agencia Municipal Puerto Angel, Club de Yates de Acapulco, UMAR Puerto Angel, SCT Puertos, Escuela de la Marina Mercante Veracruz, API Tab, API Camp, API QROO, Coordinación de la Investigación Científica UNAM, Base B.O. Puma y Justo Sierra, Ciencias del Mar y Limnología UNAM, Universidad de La Rochelle, GLOSS, Univ. of Hawaii, IOCARIBE

**XIV Session of the GLOSS Group of Experts: 19-23 October 2015**

# UNAM BEGAN MEASURING IN THE 40'S AND CREATE THE SERVICE IN THE 50'S (Fotos from the 50's)



SALINA CRUZ, OAX.



COATZACOALCOS, VER.



ACAPULCO, GRO.



TUXPAN, VER.



ISLA SOCORRO, COL.



ENSENADA, B.C.



ISLA SOCORRO, NAY.

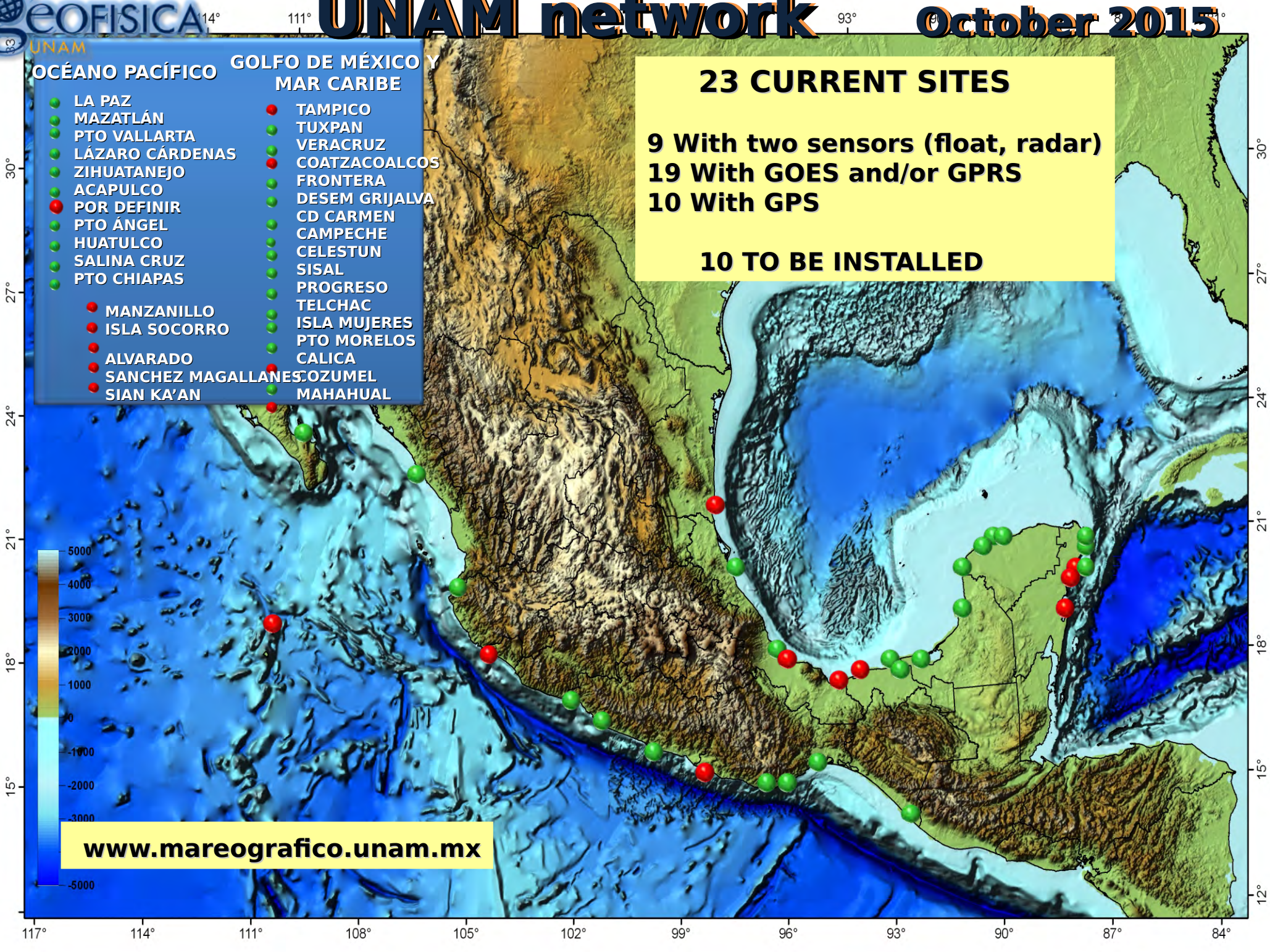
# Sea level networks in Mexico

- **UNAM** With stations in most of the country except in the northwest.
- **SEMAR** (Mexican Navy). They have sites in most of the Country.
- **CICESE**. Academic institution with stations mainly in the northwest part of the country, including Baja California and islands in the Pacific Ocean.
- **IMT**. Governmental institution that support the Transport ministry. Have tide gauges in major ports.

# National tsunami warning system

## Sistema Nacional de Alerta de Tsunamis (SINAT)

- It was consolidated in the last two years
- Participant institutions: Federal Civil protection (Secretaría de Gobernación), CENAPRED, SEMAR, UNAM, CICESE, IMT
- Was consolidated in 2015 with the first budget ongoing with the purpose to upgrade the instrumentation of the sea level networks of UNAM, SEMAR and IMT
- There is a place at SEMAR (CAT) where permanent personal work in the Center



OCEANO PACÍFICO GOLFO DE MÉXICO Y MAR CARIBE

- LA PAZ
- MAZATLÁN
- PTO VALLARTA
- LÁZARO CÁRDENAS
- ZIHUATANEJO
- ACAPULCO
- POR DEFINIR
- PTO ÁNGEL
- HUATULCO
- SALINA CRUZ
- PTO CHIAPAS
- MANZANILLO
- ISLA SOCORRO
- ALVARADO
- SANCHEZ MAGALLANES
- SIAN KA'AN
- TAMPICO
- TUXPAN
- VERACRUZ
- COATZACOALCOS
- FRONTERA
- DESEM GRIJALVA
- CD CARMEN
- CAMPECHE
- CELESTUN
- SISAL
- PROGRESO
- TELCHAC
- ISLA MUJERES
- PTO MORELOS
- CALICA
- OZUMEL
- MAHAUAL

**23 CURRENT SITES**

**9 With two sensors (float, radar)**

**19 With GOES and/or GPRS**

**10 With GPS**

**10 TO BE INSTALLED**

[www.mareografico.unam.mx](http://www.mareografico.unam.mx)

# SEMAR network

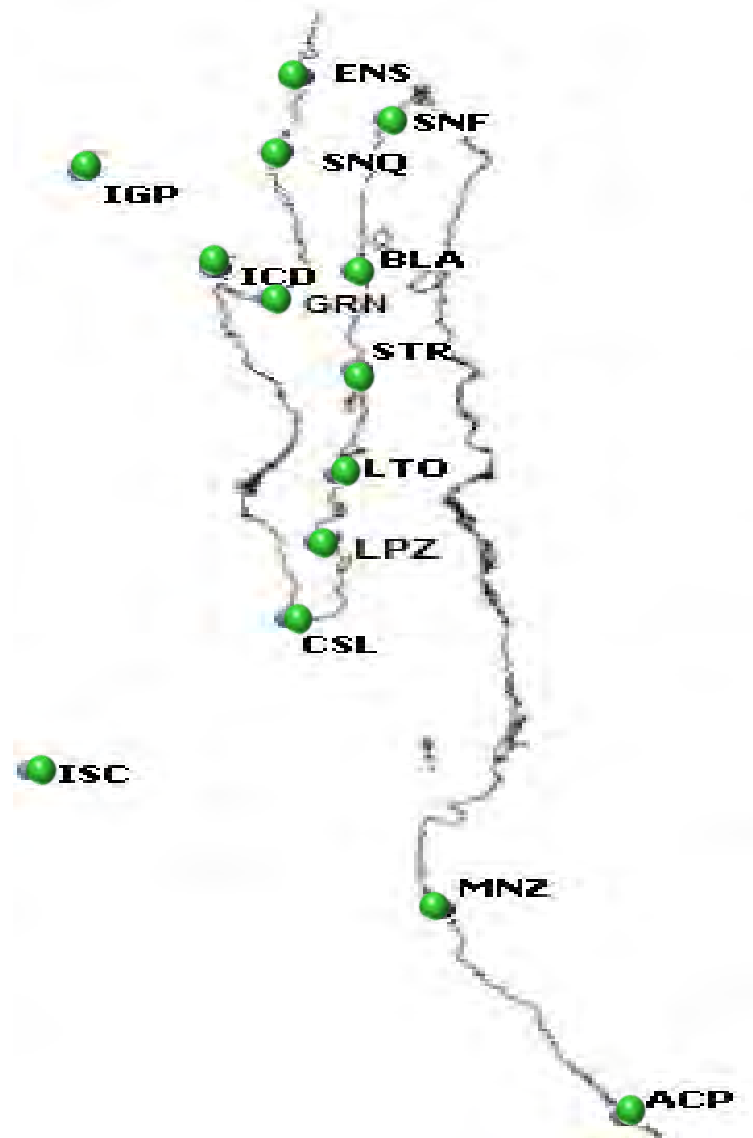
42 sites; 29 with transmission



# CICESE network

## 14 sites

[redmar.cicese.mx](http://redmar.cicese.mx)



# UNAM sea level network program

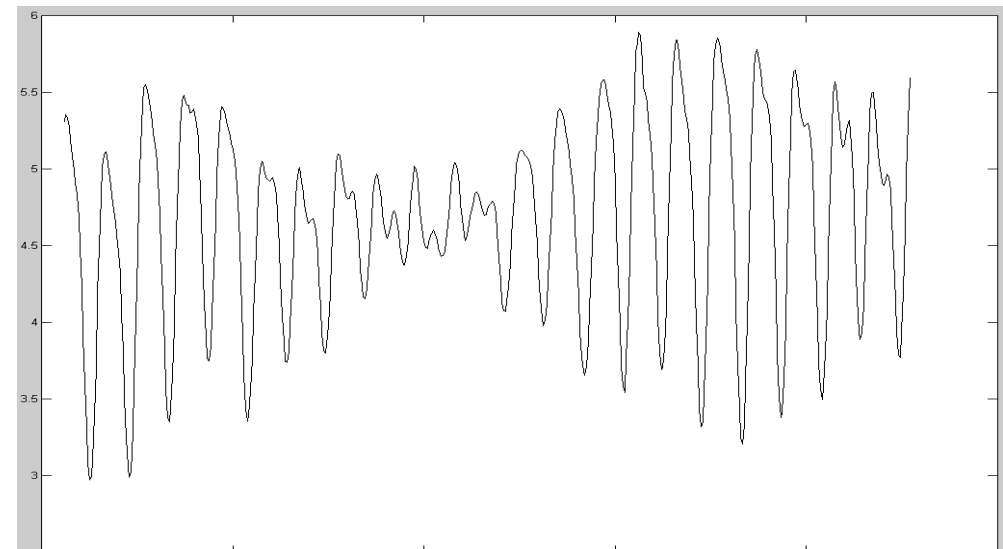
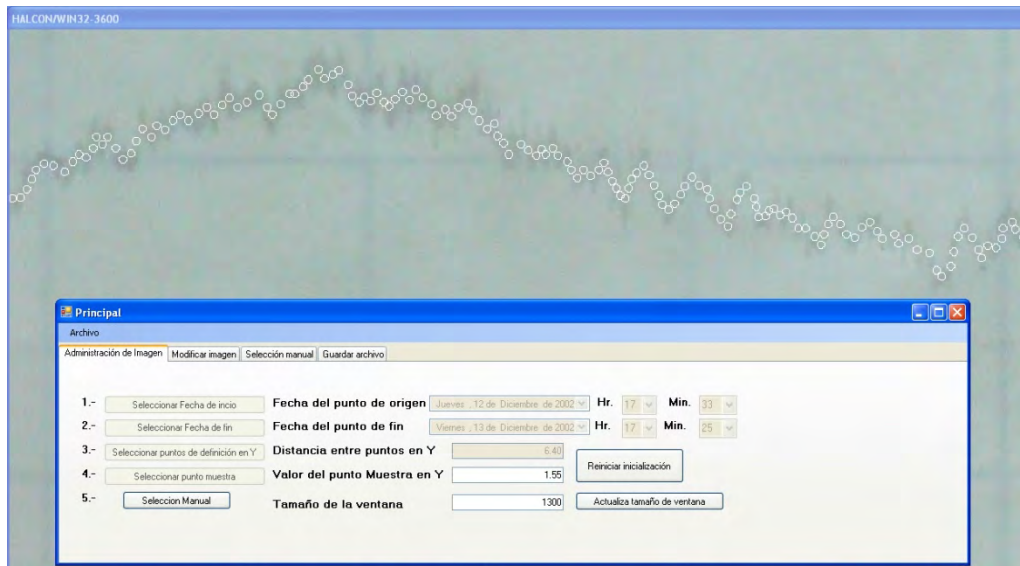
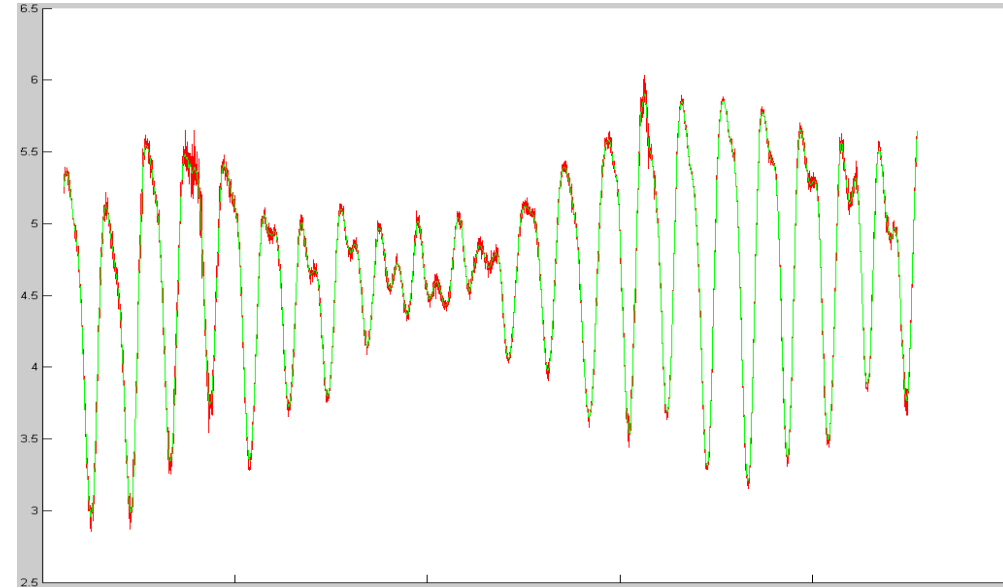
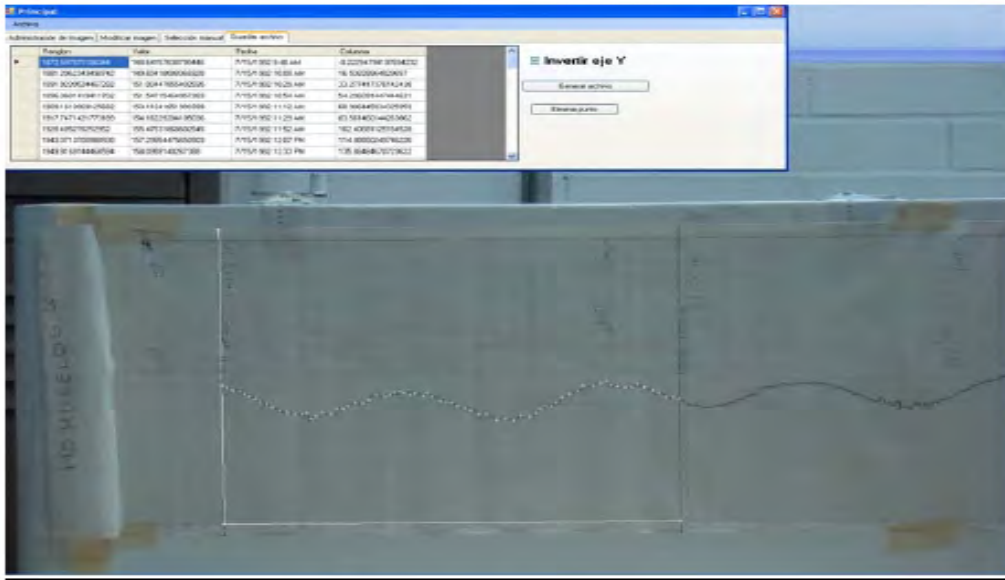
- Rehabilitate the network (currently 22)
- Organize the data base and the web site
- Digitize archived mareograms
- Collaborate with national and international institutions



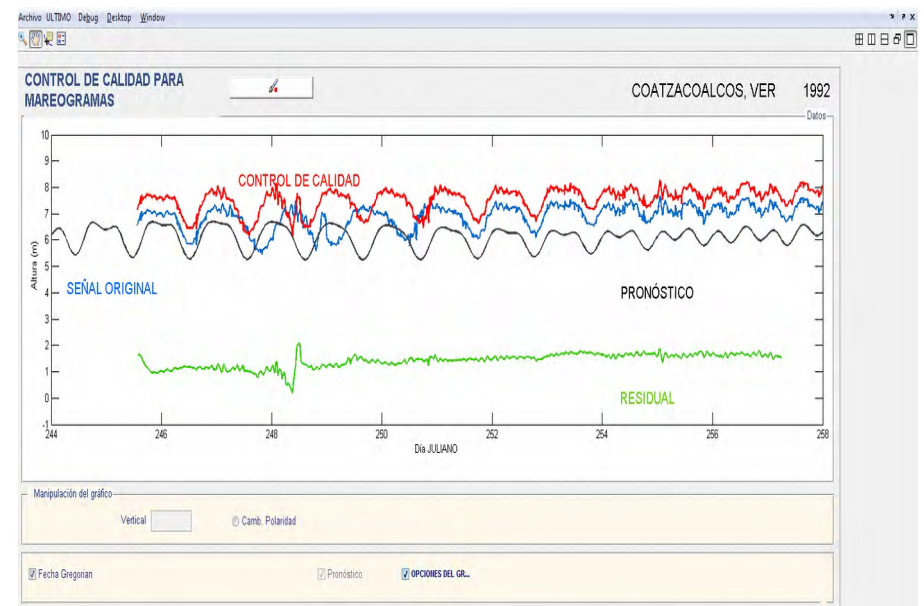
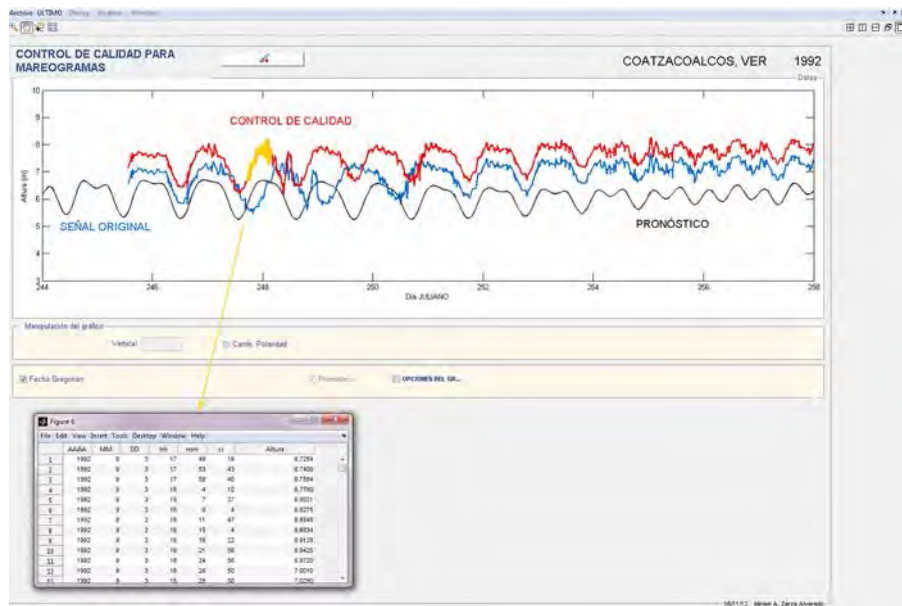


# Digitalization process

## Software was developed for this purpose

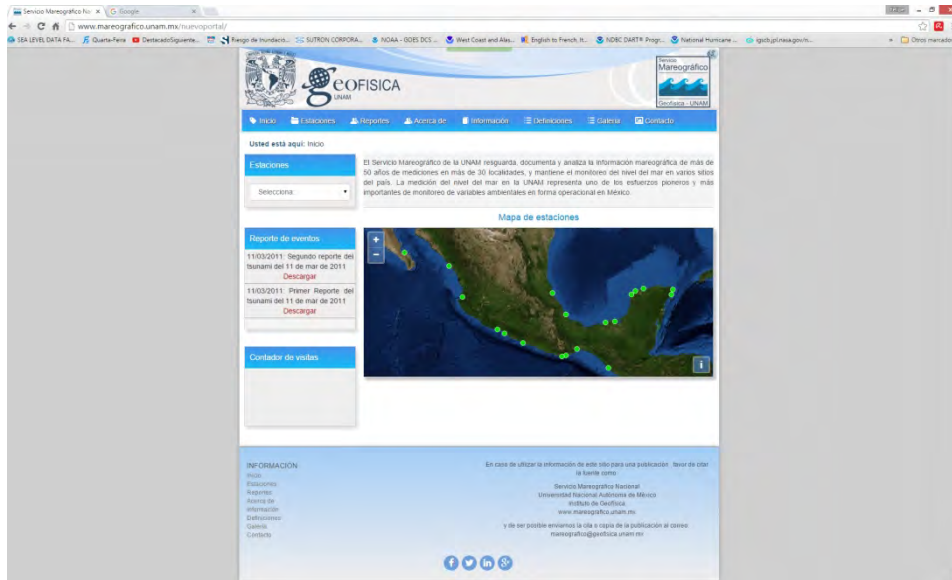


# DATA PROCESSING AND DATA QC



# Database and new website

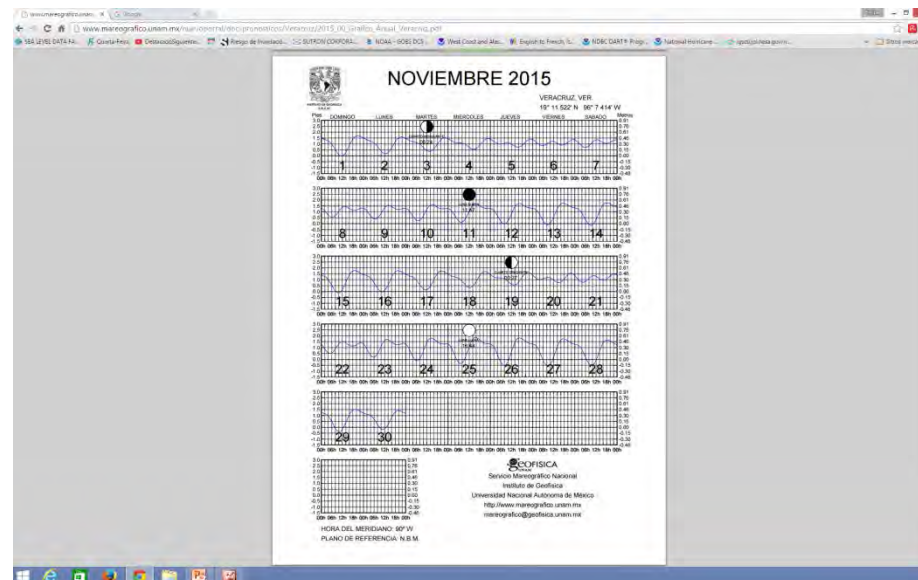
[www.mareografico.unam.mx/nuevoportal](http://www.mareografico.unam.mx/nuevoportal)



The screenshot shows the home page of the website. At the top, there is a navigation menu with links for Inicio, Estaciones, Reportes, Acerca de, Información, Defecciones, Galería, and Contacto. Below the menu, a main heading reads "Usted está aquí: Inicio". A sidebar on the left contains sections for "Estaciones" (with a dropdown menu), "Reporte de eventos" (listing two tsunami reports from March 11, 2011), and "Contador de visitas". The main content area features a "Mapa de estaciones" with a map of Mexico and the Gulf of Mexico showing station locations. At the bottom, there is an "INFORMACION" section with contact details for the Servicio Mareográfico Nacional at UNAM.



This screenshot displays a detailed view of a tide gauge station. The page title is "VERACRUZ". It features a large line graph titled "Nivel del mar (Fosador)" showing tide levels in meters over time. The graph has a y-axis from 1.4 to 1.8 and an x-axis with markers at 06:10, 09:00, 03:10, 06:00, and 08:10. To the left of the graph, technical data is provided: "Veracruz", "Status", "Latitud 19° 11.50' N", "Longitud 96° 7.40' W", "Ultimo dato de nivel", "Fecha", "Voz", and "Dirección". Below the graph, there are buttons for "5 días", "15 días", and "30 días", along with "Descargar imagen" and "Descargar datos". The bottom section contains "INFORMACION" about the station and a disclaimer in Spanish.



The screenshot shows a monthly report for "NOVIEMBRE 2015" from the "VERACRUZ, VER" station. The report includes a table with columns for "Día", "Ondas", "Mareas", "Resacas", "Jalisco", and "Suroeste". Below the table are 31 individual tide graphs, one for each day of the month, showing the tidal cycle. At the bottom, there is contact information for the "Servicio Mareográfico Nacional" and "Instituto de Geofísica" at UNAM, including the website URL and email address. The report also specifies the "HORA DEL MERIDIANO" and the "PLANO DE REFERENCIA".

# COLABORATION WITH GLOSS, IOC, PSMSL, IOCARIBE, PTWC

SEA LEVEL STATION MONITORING FACILITY

Stations monitored by Universidad Nacional Autónoma de México ( Mexico )  
 Status at 2013-10-23 06:32 GMT : 17 stations listed ordered by delay

Show:  only active  only GLOSS  only GTS  only FTP  only Webservice  only BGAN  only Email  
 all known stations

Info:  general  contacts  performance

Code	GLOSS ID	Country	Location	Connection	DCP ID	Last observation level	Time in GMT	Delay	Transmit Interval	View
zihu2		Mexico	Zihuatanejo, Gro	SOMX10	0102D23E	3.19	2013-07-10 09:36	165d	5'	[open]
talc		Mexico	Telchac	ftp		1.37	2013-10-21 13:34	2d	10'	[open]
tuxp		Mexico	Tuxpan	ftp		2.62	01:28	5h	10'	[open]
made		Mexico	Puerto Madero, Chis.	ftp		0.53	05:00	2h	10'	[open]
laza		Mexico	Lazaro Cardenas	ftp		5.39	05:44	48	10'	[open]
vera2	212	Mexico	Veracruz, Ver.	SOMX10	0102A4AE	1.78	05:55	37'	15'	[open]
acya	267	Mexico	Acapulco Club de Yates	ftp		1.37	06:00	32'	10'	[open]
sali		Mexico	Salina Cruz, Oax.	ftp		0.61	06:06	26'	10'	[open]
maza		Mexico	Mazatlan	ftp		2.51	06:06	26'	10'	[open]
vera	212	Mexico	Veracruz, Ver.	ftp		1.83	06:06	26'	10'	[open]
frt		Mexico	Frontera	ftp		2.21	-maintenance	26'	10'	[open]
imuj		Mexico	Isla Mujeres, Q. R.	ftp		2.45	06:06	26'	10'	[open]
puermo		Mexico	Puerto Morelos, Q. R.	ftp		0.71	06:10	22'	10'	[open]
lapaz		Mexico	La Paz	ftp		2.22	06:12	20'	10'	[open]
clst		Mexico	Celestun, Yuc.	ftp		1.88	06:14	18'	10'	[open]
sali2		Mexico	Salina Cruz, Oax.	SOMX10	0103703C	0.71	06:16	16'	5'	[open]
prog2	213	Mexico	Progreso, Yuc	SOMX10	01029134	0.01	06:29	3'	15'	[open]

Site developed and maintained by VLIZ for UNESCO/IOC [contact]

The data presented under this service has not undergone any quality control and data is provided as received. IOC, VLIZ and data suppliers accept no liability for any errors and/or delays in data or for interpretations, transactions, or any other use carried out on the basis thereof.

## IOC - UNESCO Website

SEA LEVEL STATION MONITORING FACILITY

Station: Acapulco Club de Yates at GMT

Station metadata

- Code: acya
- Country: Mexico
- Location: Acapulco Club de Yates
- Status: Operational
- Local: Universidad Nacional Autónoma de México ( Mexico )
- Contact: Universidad Nacional Autónoma de México ( Mexico )
- Other Contact: [goto handbook]
- GLOSS ID: 267 [goto handbook]
- Latitude: 16.53799
- Longitude: -99.90298
- Connection: FTP box

Sensor 1

- Type of sensor: ft
- Sampling rate (min): 1

Sealevel at Acapulco Club de Yates station - (1.64 m)

Graph showing sea level data (ft) from 06:00 Oct 22 to 06:00 Oct 23. The y-axis ranges from -0.6 to 0.6 ft. The data shows a clear tidal cycle with peaks around 12:00 and troughs around 18:00.

From 2013-10-22 06:41 to 2013-10-23 06:41 @IOC-VLIZ

Period: 12h, day, 7 days, 30 days

Signals:  Remove outliers,  Remove spikes

Data:  Relative levels= signal - average over selected period,  Absolute levels= as received,  Offset signals= relative signals + offset

Tip: use left icons to zoom & scroll

Site developed and maintained by VLIZ for UNESCO/IOC [contact]

The data presented under this service has not undergone any quality control and data is provided as received. IOC, VLIZ and data suppliers accept no liability for any errors and/or delays in data or for interpretations, transactions, or any other use carried out on the basis thereof.

# UNAM Gulf of Mexico and Caribbean sea Stations



TUXPAN, VER.



VERACRUZ, VER. (GOES)



FRONTERA, TAB.



DESEMB. GRIJALVA, TAB.



CD. CARMEN, CAMP.



CAMPECHE, CAMP.



CELESTÚN, YUC.



SISAL, YUC.



PROGRESO, YUC. (GOES)



TELCHAC, YUC.



ISLA MUJERES, Q. ROO



PTO. MORELOS, Q. ROO . (GOES)



COZUMEL, Q. ROO

02.04.2010 17:58

# UNAM Pacific Ocean Stations



LA PAZ, B.C.S.



MAZATLÁN, SIN. (GOES)



PTO. VALLARTA, JAL. (GOES)



LAZARO CARDENAS, MICH. (GOES)



ZIHUATANEJO, GRO. (GOES)



ACAPULCO, GRO. (GOES)



PUERTO ÁNGEL, OAX.. (GOES)



HUATULCO, OAX. (GOES)



SALINA CRUZ, OAX. (GOES)



PTO. CHIAPAS, CHIS. (GOES)

# Shelters construction and instrument installation

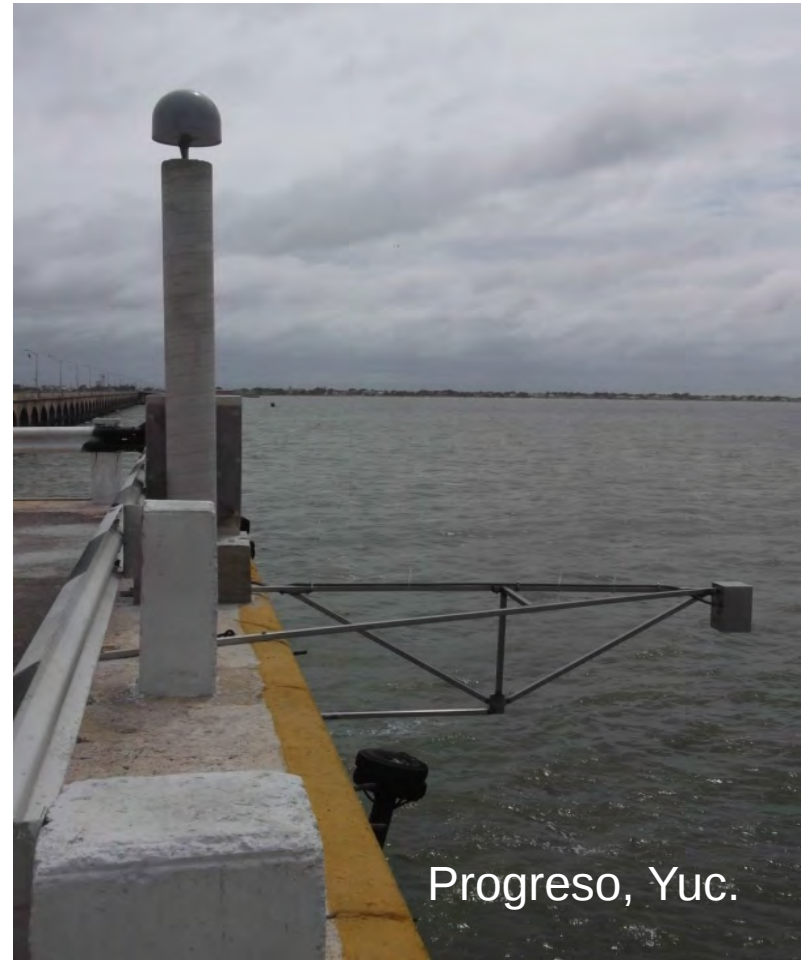






# UNAM Equipment in each station

TIDE STATION	FLT	PRS	RAD	GPS	MET	DATALOGGER	BATERIA	PANEL SOLAR	PCU-12	GOES	CELULAR
Acapulco, Gro.	■			■		■	■		■	■	■
Celestún, Yuc.	■		■			■	■	■			■
Cd. del Carmen, Camp.			■				■				■
Desembocadura Río Grijalva, Tab.	■						■	■			
Frontera, Tab.	■						■	■			■
Huatulco, Oax.			■	■		■	■		■	■	
Isla Cozumel, Q. Roo		■									
Isla Mujeres, Q. Roo.	■						■	■			■
Lázaro Cárdenas, Mich.	■		■	■		■	■		■	■	■
Lerma, Camp.	■										■
Mazatlán, Sin.	■		■	■		■	■		■	■	■
Pichilingue, B.C.S.	■										
Progreso, Yuc.			■	■		■	■		■	■	
Puerto Ángel, Oax.	■		■	■		■	■	■	■	■	■
Puerto Chiapas, Chis.	■		■	■		■	■		■	■	■
Puerto Morelos, Q. Roo.	■		■		■	■	■		■	■	
Puerto Vallarta, Jal.	■		■	■		■	■		■	■	■
Salina Cruz, Oax.	■		■	■		■	■	■	■	■	
Sisal, Yuc.			■			■	■				■
Telchac, Yuc.	■						■	■			■
Tuxpan, Ver.			■		■	■	■		■	■	■
Veracruz, Ver.	■	■	■	■	■	■	■		■	■	■
Zihuatanejo, Gro.	■		■			■	■	■	■	■	■



# Checking old bench marks and installing new ones



# More benchmarks (Veracruz)



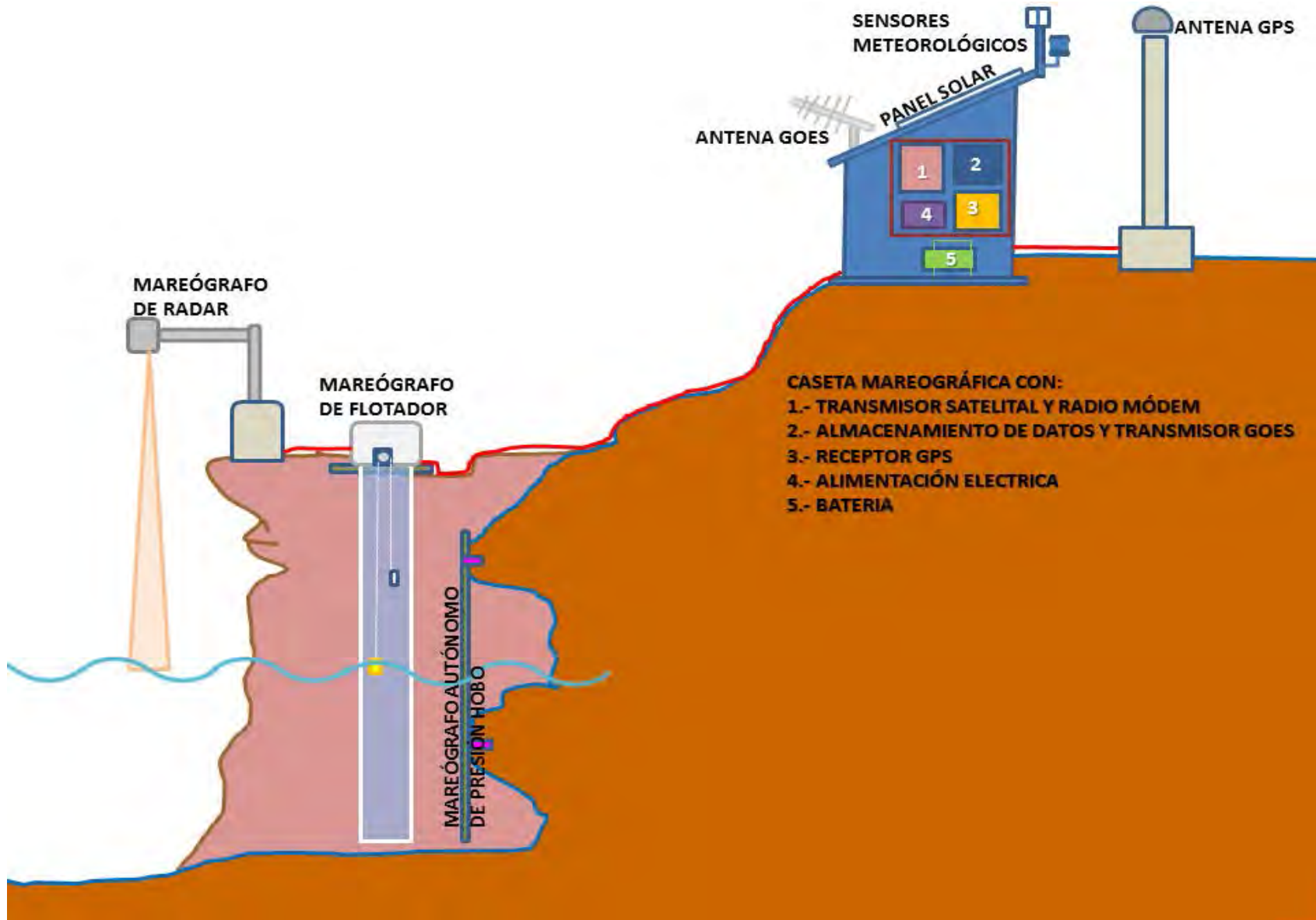
# Leveling and georeferencing



# Sites to be installed in the near future

## ISLA SOCORRO, COL.

In collaboration with SEMAR and UHSLC



# ISLA SOCORRO, COL.



# MANZANILLO, COL.

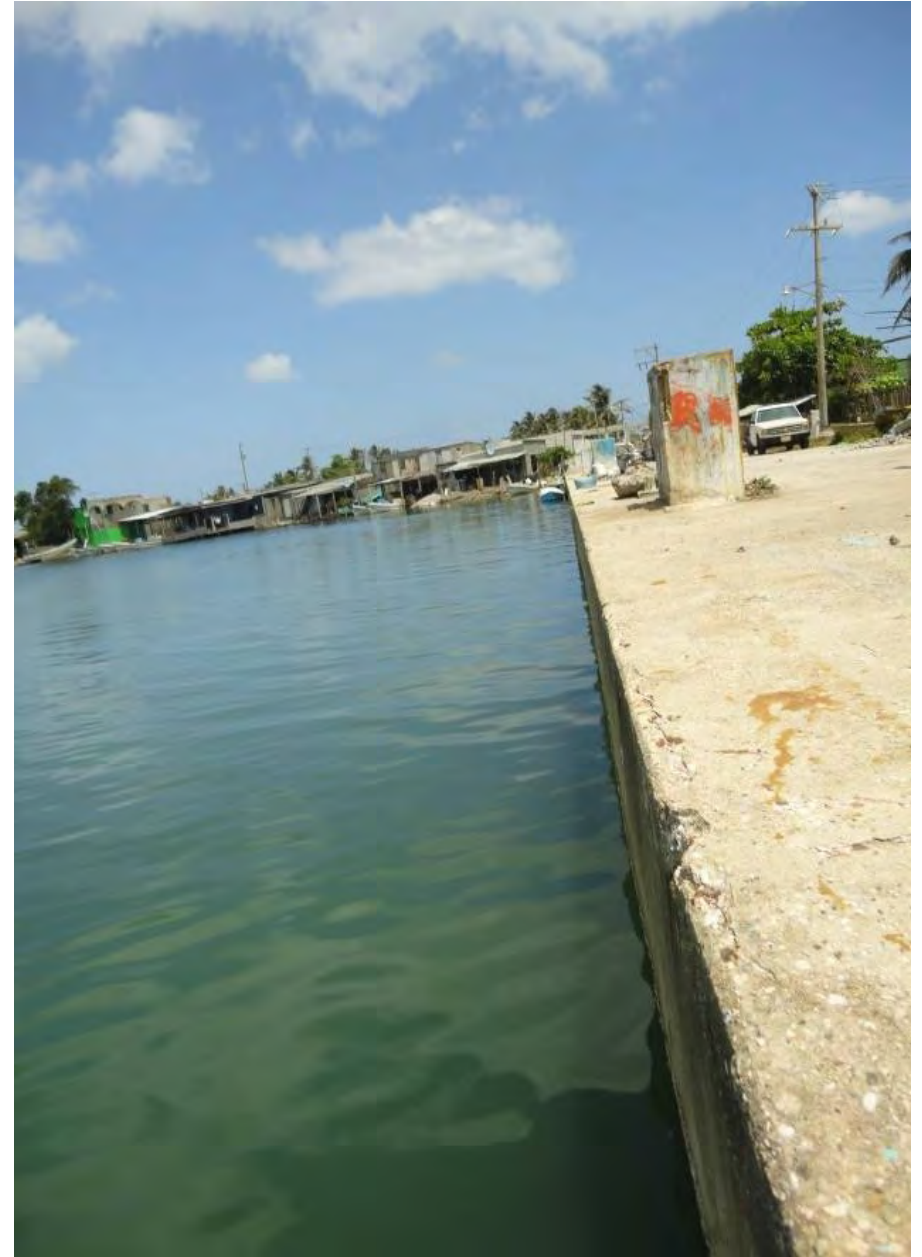
## API Manzanillo and UHSLC





# SÁNCHEZ MAGALLANES, TAB.

In collaboration with INECC-API Tabasco



# ALVARADO, VER.

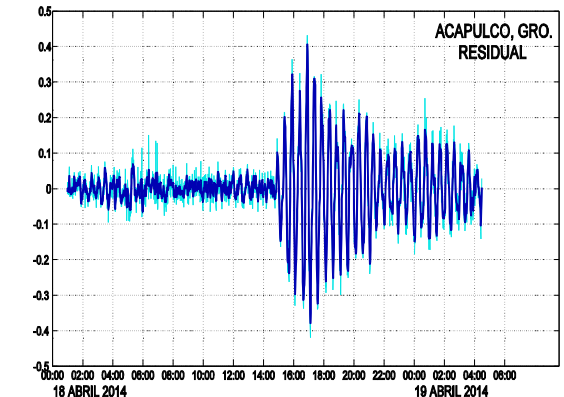
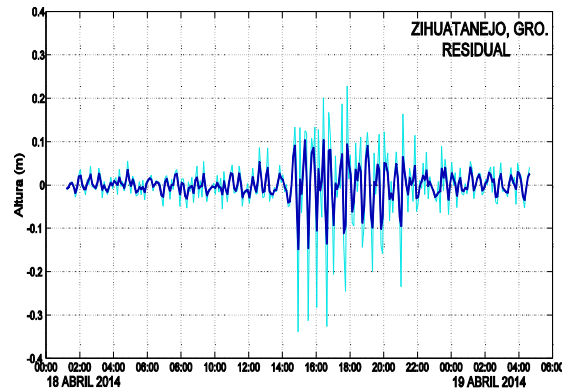
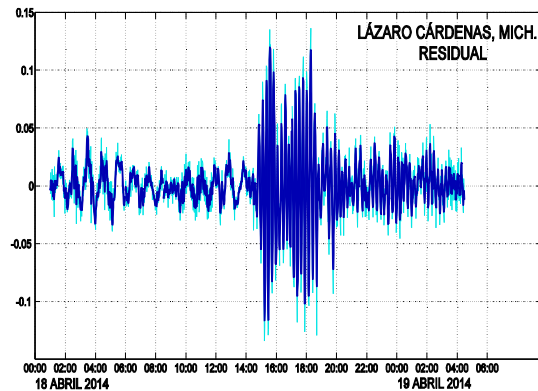
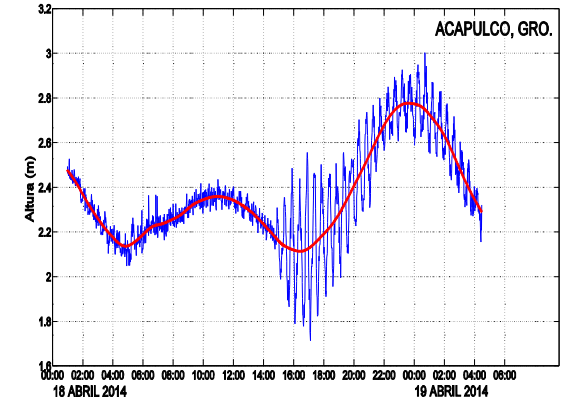
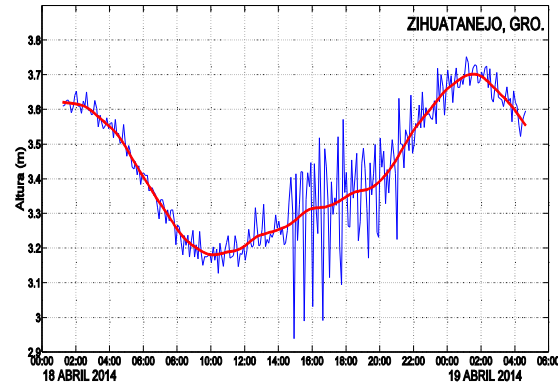
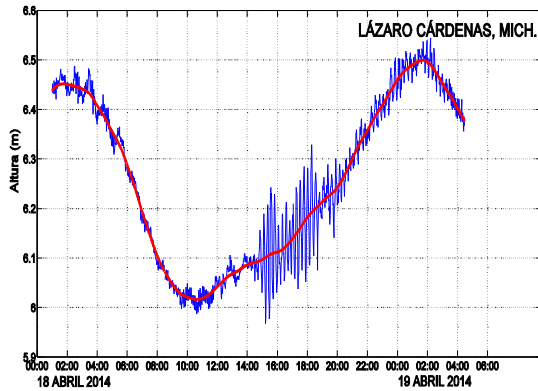
In collaboration with INECC-Municipio Alvarado



**PUNTA HERRERO, RESERVA DE LA BIOSFERA DE SIAN  
KA'AN, Q. ROO  
In collaboration with SEMAR**



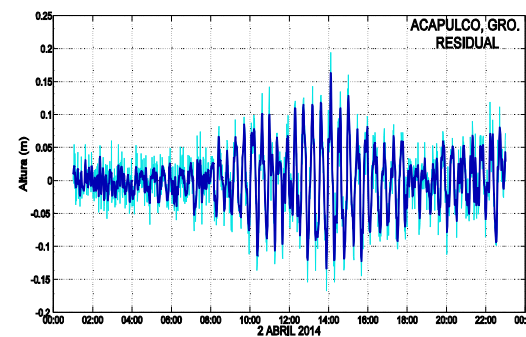
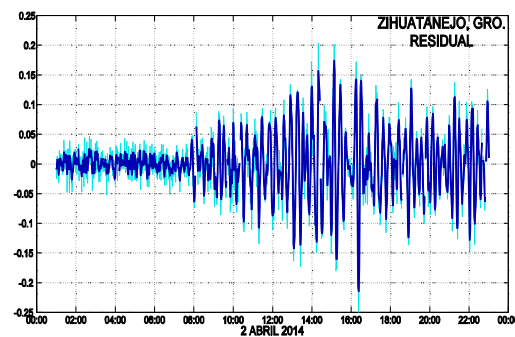
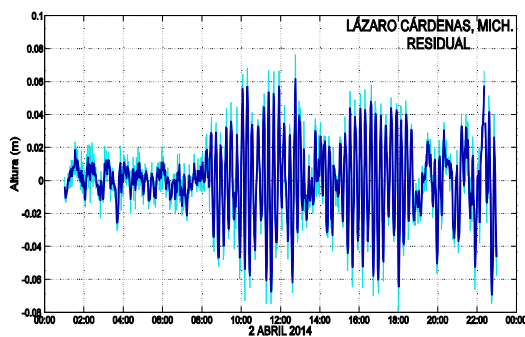
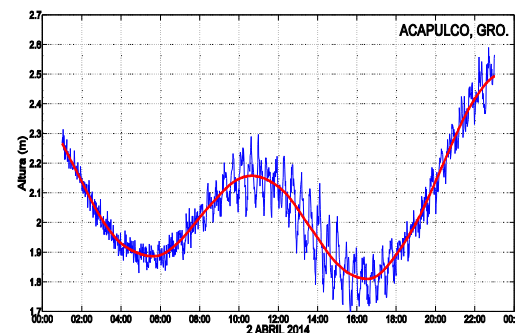
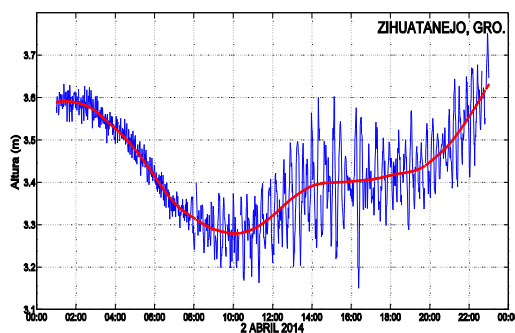
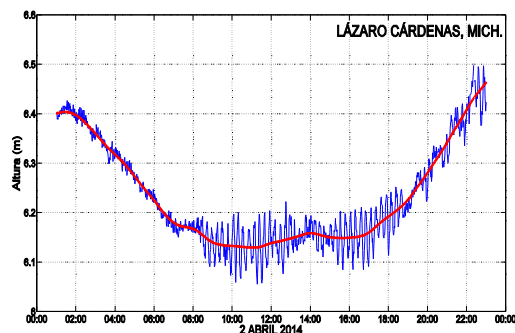
# Data from the local Tsunami of Petatlán, Guerrero; 2014-04-18



18-abr-14	HORA DE ARRIBO (GMT)	HORA DE ARRIBO (LOCAL)	ALTURA MAXIMA (m)	ALTURA MINIMA (m)	RANGO MÁXIMO (m)	PERÍODO DEL TSUNAMI (min)
LÁZARO CÁRDENAS, MICH.	14:43	09:43	0.135	-0.134	0.27	15
ZIHUATANEJO, GRO.	14:32	09:32	0.329	-0.394	0.72	15
ACAPULCO, GRO.	14:50	09:50	0.432	-0.420	0.85	30

# Tsunami Lejano Iquique, Chile

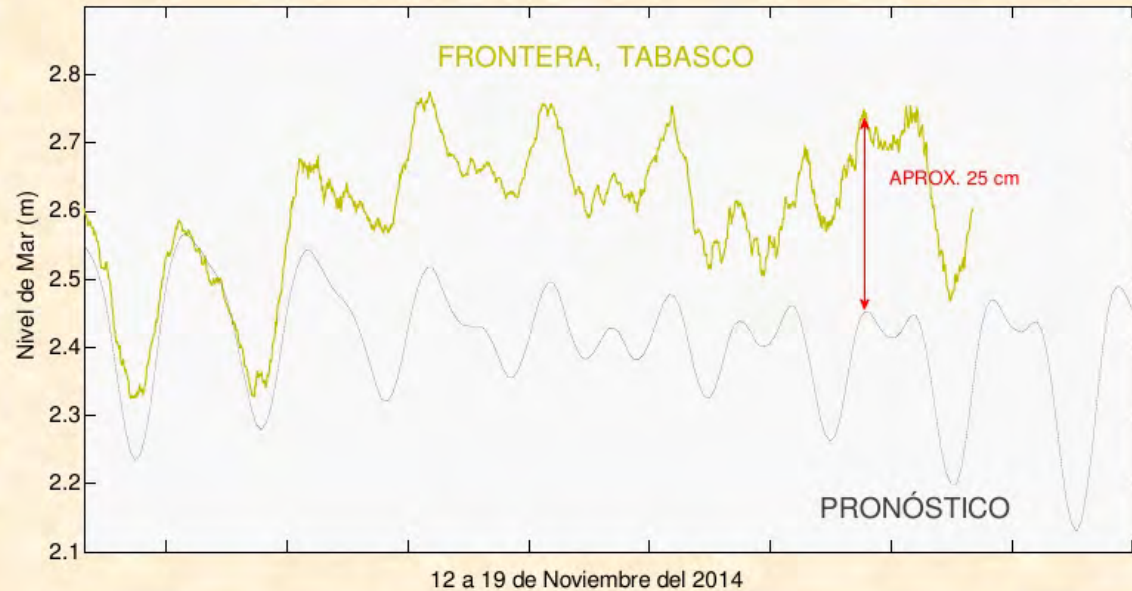
## 2014-04-02



02-abr-14	HORA DE ARRIBO (GMT)	HORA DE ARRIBO (LOCAL)	ALTURA MÁXIMA (m)	ALTURA MÍNIMA (m)	RANGO MÁXIMO (m)	PERÍODO (MINUTOS)
LÁZARO CÁRDENAS, MICH.	08:23	02:23	0.07646	-0.0748	0.15	15
ZIHUATANEJO, GRO.	07:50	01:50	0.201	-0.1731	0.37	15
ACAPULCO, GRO.	08:08	02:08	0.2042	-0.1676	0.37	25
PUERTO ÁNGEL, OAX.	NO SE APRECIA	NO SE APRECIA	NO SE APRECIA	NO SE APRECIA	NO SE APRECIA	NO SE APRECIA
HUATULCO, OAX.	07:11	01:11	0.1394	-0.1213	0.26	10
SALINA CRUZ, OAX.	08:28	02:28	0.1805	-0.1816	0.36	18

# Meteorological events have been registered

18 de Noviembre de 2014



Las lluvias son provocadas por el frente frío número 12. (@jdedios85)

## Lluvias en Tabasco dejan inundaciones de hasta 50 cm

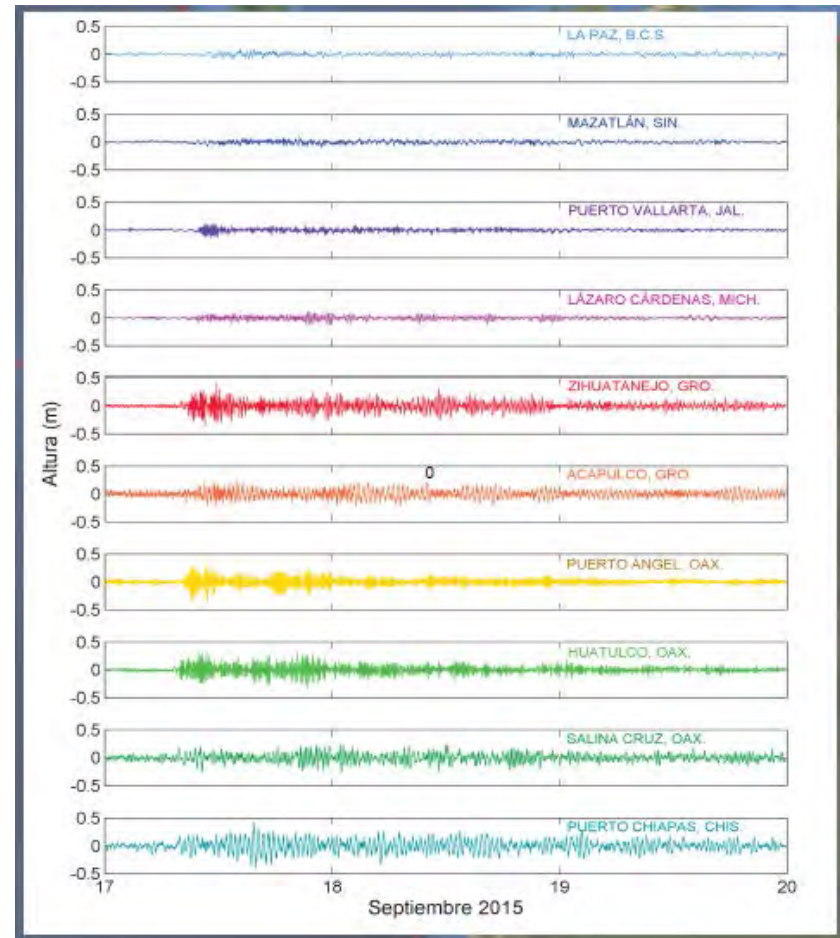
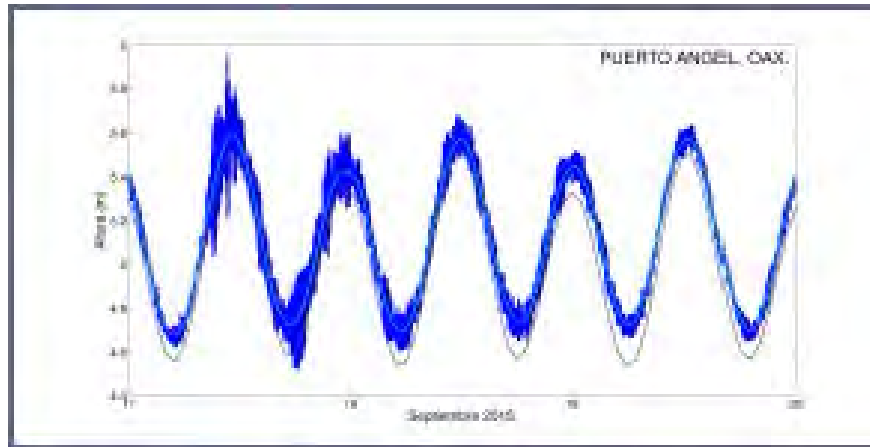
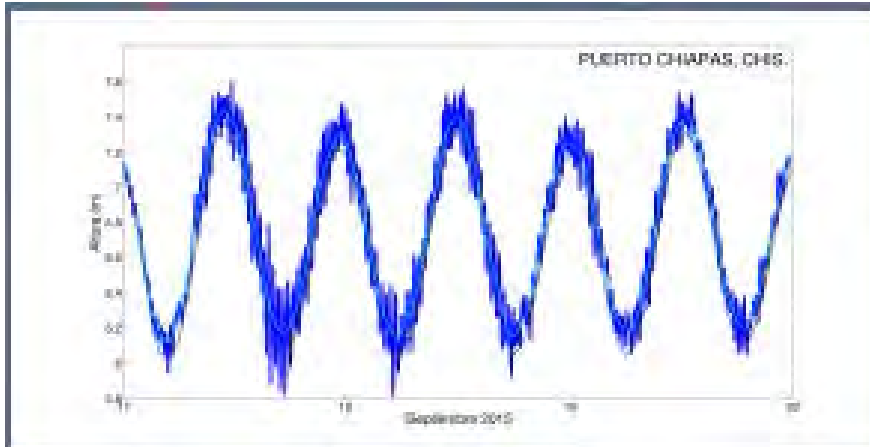
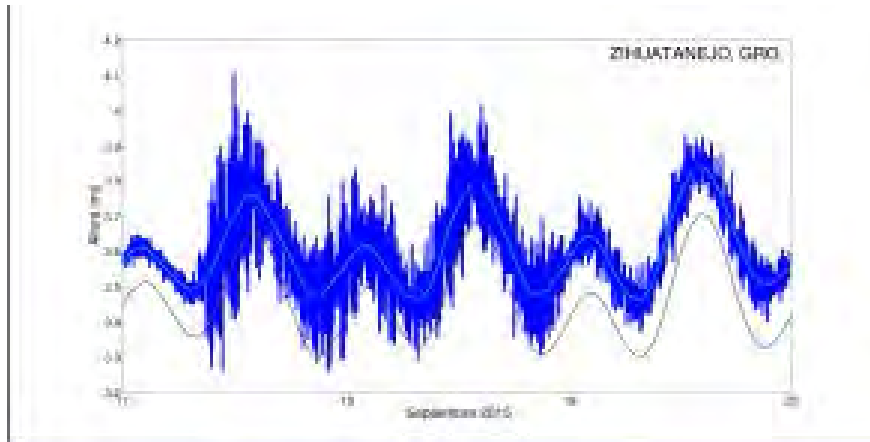
Tras dos días de lluvias las autoridades decidieron suspender las clases; las precipitaciones son causadas por el frente frío número 12.

En tanto, calles y avenidas de esta ciudad registraron encharcamientos de hasta 50 centímetros por la cantidad de lluvia acumulada durante la madrugada, como en la colonia Municipal, la avenida México, Tierra Colorada, entre otras zonas.

Asimismo, el vocero estatal de la Comisión Nacional del Agua (Conagua), Héctor Pérez Ruiz, precisó que el acumulado de lluvias de las últimas 24 horas fueron de 220.6 milímetros en la zona de la colonia Miguel Hidalgo, en Villahermosa.

Comentó que el pronóstico de precipitaciones para las siguientes 24 horas es de fuertes a intensas, a causa del frente frío número 12 que se encuentra en la región.

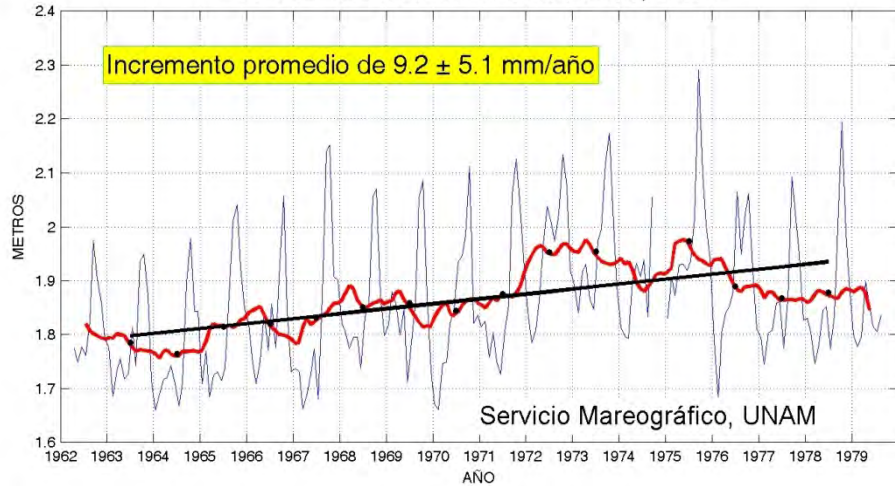
# CHILE TSUNAMI (2015-09-16)



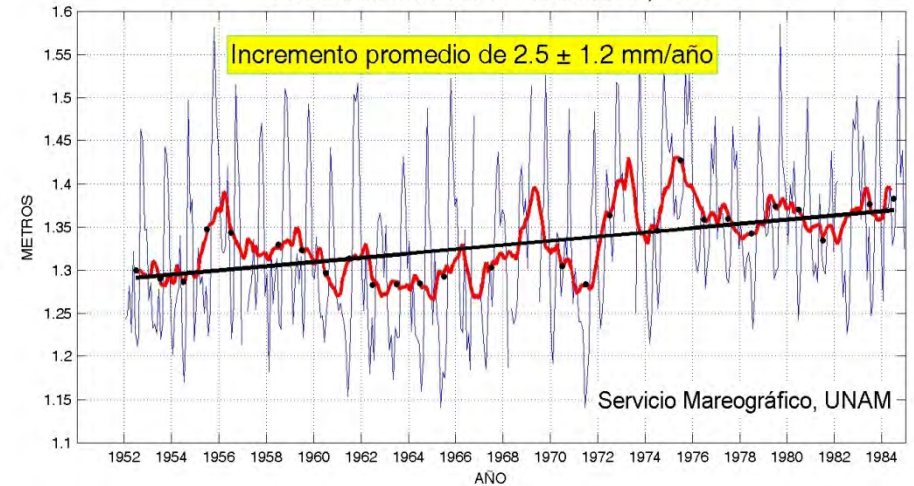
ESTACIÓN	HORA DE ARRIBO (GMT)	RANGO MÁXIMO (cm)	PERÍODO (min)
LA PAZ, B.C.S.	10:30	16	21
MAZATLÁN, SIN.	10:33	7	13
PUERTO VALLARTA, JAL.	09:53	25	8
LÁZARO CÁRDENAS, MICH.	09:10	24	15
ZIHUATANEJO, GRO.	08:50	66	6
ACAPULCO, GRO.	08:32	47	29
PUERTO ANGELO, OAX.	08:21	75	5
HUATULCO, OAX.	07:56	59	9
SALINA CRUZ, OAX.	08:10	51	16
PUERTO CHIAPAS, CHIS.	07:23	85	30

# Sea level trends

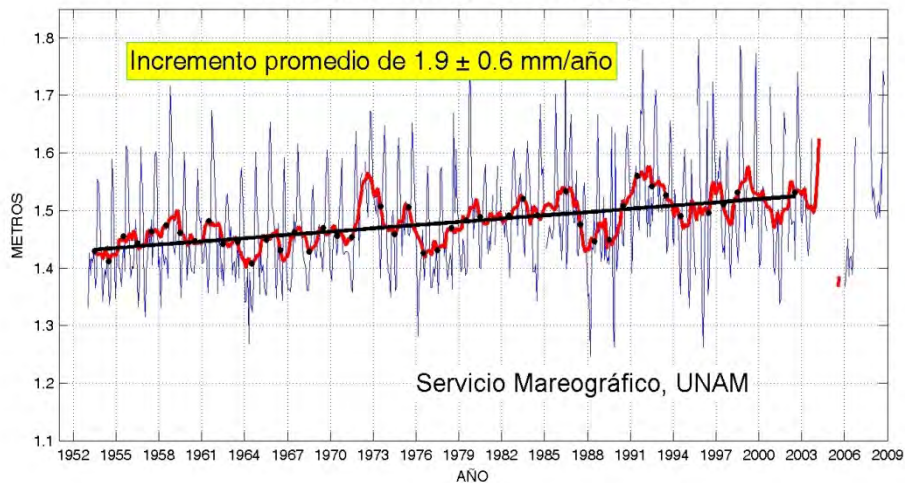
NIVEL DEL MAR EN CD MADERO, TAM.



NIVEL DEL MAR EN PROGRESO, YUC.



NIVEL DEL MAR EN VERACRUZ, VER.



Sitio	Tendencia (mm/year)	Período	No. de años en el cálculo
Alvarado, Ver.	1.9 ± 2.3	1955-1981	19
Cd. del Carmen, Camp.	3.4 ± 1.0	1956-1990	26
Cd. Madero, Tamps.	9.2 ± 5.1	1962-1979	15
Coatzacoalcos, Ver.	2.9 ± 1.5	1952-1988	22
Progreso, Yuc.	2.5 ± 1.2	1952-1984	27
Veracruz, Ver.	1.9 ± 0.6	1952-2003	43
Tuxpan, Ver.	2.8 ± 2.3	1958-1989	16

Sitio	Tendencia (mm año <sup>-1</sup> )	Período	No. de años en el cálculo
Acapulco, Gro.	-2.4 ± 3.2	1952-1999	36
Ensenada, B.C.	2.7 ± 1.7	1956-1992	30
La Paz, B.C.S.	1.0 ± 2.2	1952-1991	20
Manzanillo, Col.	3.3 ± 2.5	1954-1988	25
Mazatlán, Sin.	1.9 ± 3.3	1953-1992	19
Puerto Angel, Oax.	1.7 ± 11.7	1967-1990	7
Salina Cruz, Oax.	1.1 ± 1.7	1952-1992	26
San Carlos, B.C.S.	16.1 ± 13.2	1968-1987	8
Topolobampo, Sin.	3.0 ± 4.3	1952-1992	19
Guaymas, Son.	4.2 ± 1.7	1951-1991	25



# NEXT

- New sites Socorro, Manzanillo, Sanchez Magallanes, Alvarado and Sian Ka'an
- Include datalogger, radars, GOES transmitters, meteorological sensors in most of the sites
- Improve communications (make them robust)
- Improve data processing and data QC (quality and time)
- Improve leveling
- Improve our website ([www.mareografico.unam.mx](http://www.mareografico.unam.mx))
- Conclude the digitizing of archived mareograms
- Continue the national and international collaboration