SEA LEVEL MEASUREMENTS IN MEXICO
Report to the XI GLOSS group of experts
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Elaborated by: Jorge Zavala-Hidalgo[1] and Cuahutemoc Nava[2]

1. Instituto de Geofísica
Universidad Nacional Autónoma de México
Circuito exterior s/n
04510 México, D.F.
México
Tel. +52 55 5622 4048, + 52 55 5622 4104
jzavala@atmosfera.unam.mx, mareografico@geofisica.unam.mx
http://www.mareografico.unam.mx

2. Departamento de Oceanografía Física
Centro de Investigación Científica y Educación Superior de Ensenada
Km 107 Carretera Tijuana-Ensenada,
Ensenada, Baja California
México
Tel +52 646 175-05-00 ex 24068

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Summary

There are several institutions in Mexico that measure sea level: a network operated by the *Universidad Nacional Autónoma de México* (UNAM), another by the *Centro de Investigación Científica y de Educación Superior de Ensenada* (CICESE), and another one operated by the *Secretaría de Marina* (SEMAR). In addition, the *Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada* (CICATA) has been operating stations in the state of Tamaulipas. The three networks, UNAM's, CICESE's and SEMAR's, collaborate between each other and are coordinated by a peer committee named REDMMAR.

Systematic sea level measurements by UNAM begun in Mexico in the 50's covering more than 30 sites with around 16 permanent sites. In the 90's the support to the network and the coverage decreased. These data are in the GLOSS databases. In the 80's CICESE developed a network covering the northwestern part of the country in the Pacific Ocean. The SEMAR network covers all the Mexican coasts.

In the last two years at UNAM, 9 stations were rehabilitated with float sensors; 30% of ~900 months of archived mareograms were digitized and the database and website were modernized. The CICESE's sea level network combines traditional stations with state-of-the-art ones. SEMAR has 30 stations in their network.

UNAM program for 2009-2010 includes the rehabilitation and/or inclusion in the network of 15 sites, five in the Pacific Ocean and the rest in the Gulf of Mexico; the conclusion of the digitalization of archived mareograms and their inclusion in the database, and the third stage of the modernization of the website. In addition, a priority is the consolidation of the collaboration with CICESE looking for the integration of a national sea level network.

Background

The *Servicio Mareográfico Nacional* was created in 1952, which is operated by the *Instituto de Geofísica* of the UNAM. It began sea level measurements in seven sites in Mexico: four in the Pacific Ocean (La Paz, Guaymas, Acapulco, and Salina Cruz) and three in the Gulf of Mexico (Veracruz, Coatzacoalcos, and Progreso). Five years later, eleven stations were operating; later, during the period of 1979-1983, there were 14 sites operating simultaneously, eight in the Pacific Ocean and six in the Gulf of Mexico.

CICESE is a research center with a strong physical oceanography department. CICESE developed a regional network in the 80's and 90's with 16 sites. They have a strong collaboration with GLOSS.

Current situation

UNAM

The UNAM network has 9 stations currently working (Table 1, Fig. 1). They are equipped with float sensors (Thalimedes/OTT) and transmit the information via Internet or GPRS modems. Veracruz has also meteorological sensors, radar (kalesto) and pressure sensors. Acapulco, Lázaro Cárdenas and Salina Cruz have permanent GPS sensors.

Table 1. *UNAM Sea level working stations.*

Station	Site Owner/ collaboration	Sensor type	Sensor brand	Data Transmission	Year/GPS
La Paz, B.C.S.	API	Float	Thalimedes/OTT	Internet	2008
Mazatlán, Sin.	UNAM	Float	Thalimedes/OTT	Internet	2008
Lázaro Cárdenas, Mich.	Club de Yates	Float	Thalimedes/OTT	GPRS	2008/YES
Acapulco, Gro.	API	Float	Thalimedes/OTT	GPRS	2007/YES
Salina Cruz,	API	Float	Thalimedes/OTT	GPRS	2008/YES

Oax.					
Puerto Madero, Chis.	API	Float	Thalimedes/OTT	GPRS	2008
Tuxpan, Ver.	UNAM	Float	Thalimedes/OTT	GPRS	2009
Veracruz, Ver.	ENN	Float and radar	Thalimedes/OTT Kalesto	GPRS	2008
Pto Morelos, Q. Roo.	UNAM	Float	Thalimedes/OTT	Internet	2007/2009

API – Administración Portuaria Intgral; ENN - Escuela Náutica Naval

Stations programmed for rehabilitation during 2009 and 2010.

1.- San Carlos, B.C.S.	9.- Cd. Carmen, Camp.
2.- Topolobampo, Son.	10.- Campeche, Camp.
3.- Puerto Vallarta, Jal.	11.- Celestun, Yuc.
4.- Zihuatanejo, Gro.	12.- Progreso, Yuc.
5.- Puerto Angel, Oax.	13.- Cozumel, Q. R.
6.- Alvarado, Ver.	14.- Isla Mujeres, Q. R.
7.- Coatzacoalcos, Ver.	15.- Chetumal, Q. R.
8.- Dos Bocas, Tab.	

Figure 1. UNAM Sea level Network. Red dots are sites rehabilitated and working, yellow dots are sites planned to be rehabilitated in 2009-2010. With blue are the sites operated by CICATA.

CICESE Sea Level Network

The CICESE sea level network is intented to cover mainly the northwestern coast of Mexico. There are 7 stations currently working (Table 2, Fig. 2). They are equipped with float sensors (with Handar encoders), pressure sensors (Druck) or radar (OTT Kalesto) or some combination of these, and are transmitting sea level data in cuasi real time via GOES (mostly).

By the end of 2009 there will be 4 more tide stations in operation, two of them using Gumstix hardware as data loggers and transmitting sea level data to CICESE facilities in real time over internet (TCP/IP).

Raw data can be accesed in near "real time" from CICESE web site http://redmar.cicese.mx.

Most tide gauges has been acquired trough federal funds from Mexico (CONACYT) and some others gauges where provided by UHSLC.
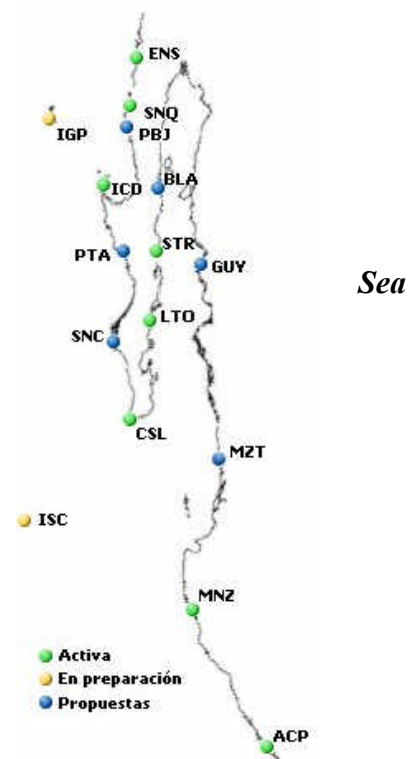

Fig 2. CICESE Sea Level Network

Table 2. *CICESE Sea level network*

Station	Data-logger	Prim. Sensor (type)	Prim. Sensor (brand)	Dt (min)	Second. Sensor (type)	Second. Sensor (brand)	Dt (min)	Telemetry	DTx
Ensenada	555C	float	436-B	6				GOES	3 h
I. Cedros	555C	float	436-B	6				GOES	3 h
Santa Rosalía	555C	float	436-B	6				GOES *	3 h
Loreto	555C	float	436-B	6				GOES *	3 h
Cabo San Lucas	555C	float	436-A	2	float	436-A	15	GOES	15 min
Manzanillo	Sutron	radar	Vega	1	pressure	Druck	6	GOES	5 hou
Acapulco	Sutron	radar	Vega	1	pressure	Druck	1	GOES	5 min
Socorro*	555C	radar	Ott	1	pressure	Druck	1	GOES	5 min
Guadalupe*	555C	radar	Ott	1	pressure	Druck	1	GOES	5 min
San Felipe*	Gumstix	radar	Ott	1				internet	1 min
San Quintín*	Gumstix	float	436-B	1				internet	1

* to be reactivated in 2009

SEMAR Sea level network

The SEMAR network has 33 stations based on pressure sensors (Fig. 2). Currently SEMAR is working in the replacement of their equipment. Five of the SEMAR stations have satellite transmission.
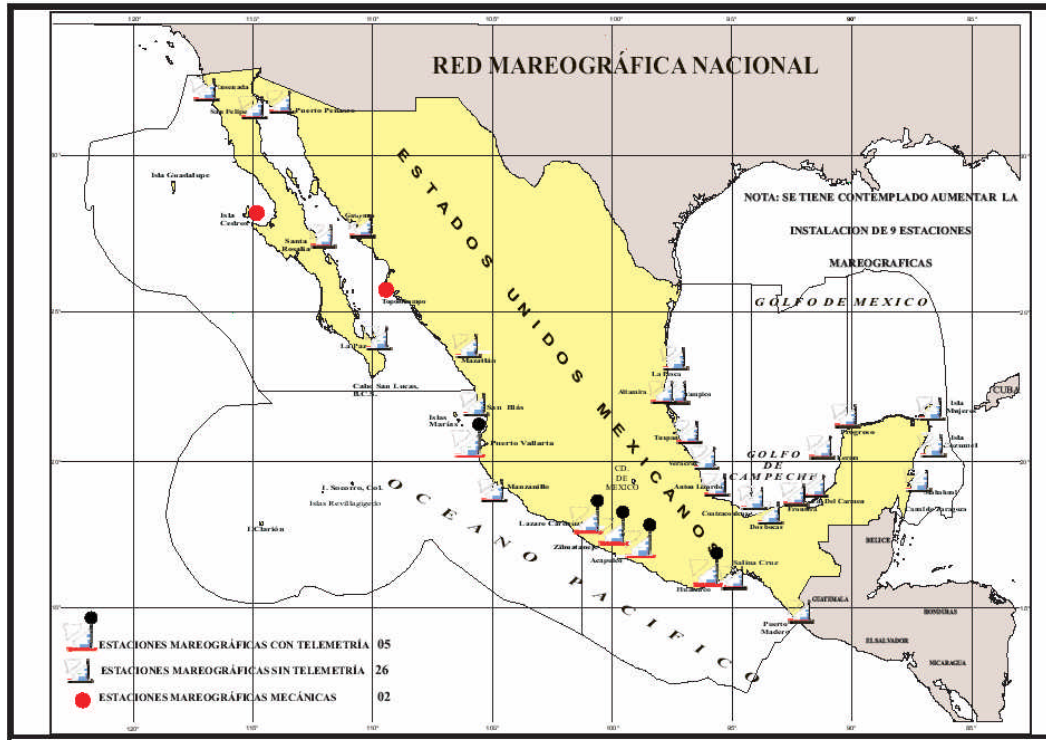

Figure 2. SEMAR network: mechanical tide gauges (red dots) and tide gauges with satellite transmission (black dots).

Database

UNAM has an important and long term database, available at the website http://www.mareografico.unam.mx (Fig. 3). Currently the database does not have all the data that have been collected, covering until the early 90's and some stations until the early 2000's. Recently digitized information has not been included yet. It will be included this semester.

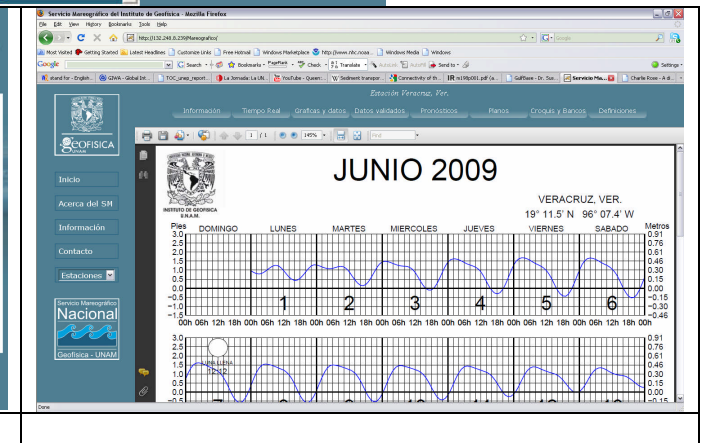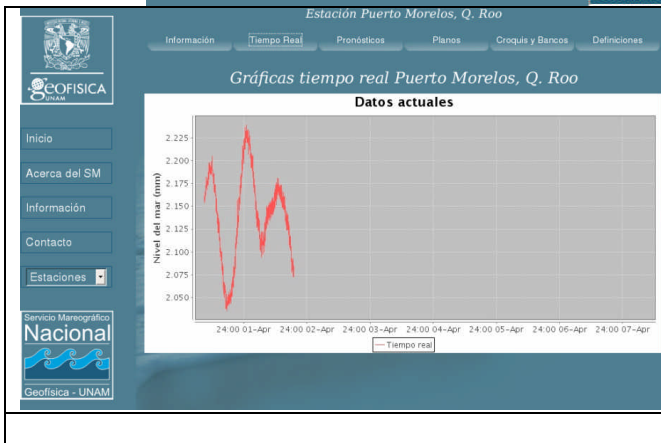**Figure 3**. UNAM website (http://www.mareografico.unam.mx), including the database, forecasts, quasi-real time data, and general information about tides and sea level measurements.

Digitalization

In the last two years, software and a methodology to digitize mareograms were developed (Fig. 4). 328 mareograms have been digitized, equivalent to 3283 photographs. These mareograms are approximately 30% of the archived data.
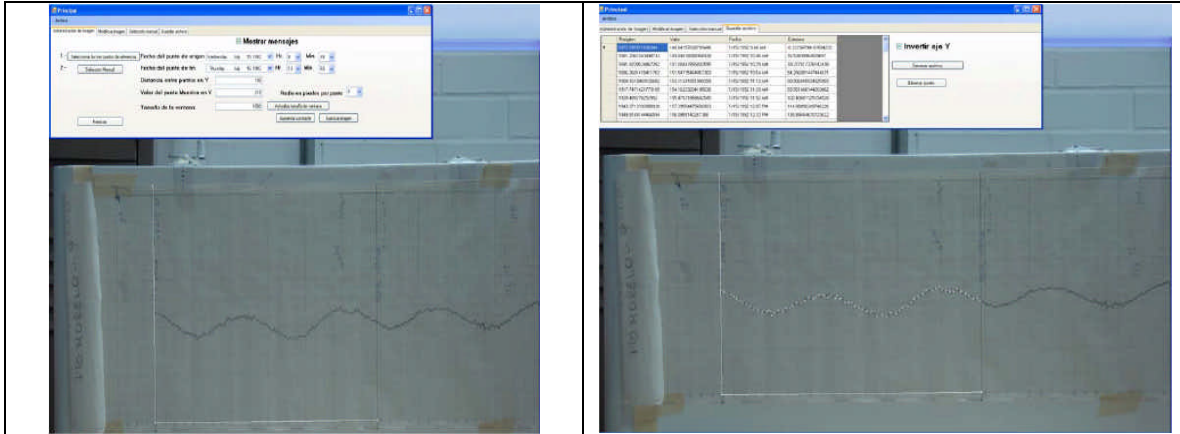

Figure 4. Digitalization software.

UNAM Projected activities

- 2009
  - Rehabilitation of eight stations. The sensors are float based.
  - Conclusion of the digitalization of archived data.
  - Continue with the elaboration of proposals for getting budget for the modernization of the network, including atmospheric and complementary sensors.
  - Training.
- 2010
  - Rehabilitation of seven stations. The sensors are float based.
  - Continue with the elaboration of proposals for getting budget for the modernization of the network, including atmospheric and complementary sensors.
  - Training.