

SEA LEVEL MEASUREMENTS IN MEXICO

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Summary

The Servicio Mareográfico Nacional (National Sea Level Service of Mexico), operated by the *Instituto de Geofísica* of the *Universidad Nacional Autónoma de México* (UNAM), has more than 50 years of operation in Mexico. In some sites the sea level time series cover more than 90% of this period. During this period earthquakes, storm surges, El Niño and La Niña events, and the sea level trends have been registered. This period coincides with that of stronger impact to climate by human activities. The coverage of the network has changed along the time, currently has 15 stations, 6 in the Gulf of Mexico and the Caribbean Sea and 9 in the Pacific Ocean.

There are another two Sea Level networks in Mexico, one operated by the *Centro de Investigación Científica y de Educación Superior de Ensenada* (CICESE), and the other operated by the Secretaría de Marina (SEMAR). In addition, the *Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada* (CICATA), in collaboration with the Texas A & M University and UNAM, recently modernized three sites in the Mexican state of Tamaulipas, over the west Gulf of Mexico. The three networks, UNAM's, CICESE's and SEMAR's, are coordinated and collaborate by a peer committee named REDMMAR.

CICESE's sea level network covers the northwest region of the country, in the Pacific Ocean. It combines traditional stations with state-of-the-art ones. They have around 15 years of experience and technical.

UNAM will substitute the old instruments in 6 sites during 2007 and in 10 sites during 2008 with equipment that fulfill the GLOSS requirements for sea level data. In addition, applications to obtain budget for modern equipment able to monitor meteorological variables, sea temperature and salinity, as well as other complementary sensors (GPS, pressure sensor), are carried out in national and international institutions.

Background

The *Servicio Mareográfico Nacional* was created in 1952 which is operated by the *Instituto de Geofísica* of 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.

Current situation

UNAM

UNAM network has 15 stations (Table 1, Fig. 1), although some of them are not working currently, some of these sites have been monitoring the sea level for more than 50 years.

Each station has a sea level measurement instrument, a shelter, well and float, a table, tide ruler, bucket, thermometer for water, and air thermometer.

- Five stations have Stevens tide gauges ~15 years old. Each with plotter, analog-digital converter, and datalogger.
- Ten stations have older tide gauges ~40 years. Each has plotter, clock, pulley and float.

Table 1. UNAM Sea level network.

Stations	Working	Collaboration	Location	Type
1.- Ensenada, B.C.	NO	CICESE	API	Estándar
2.- La Paz, B.C.S.	YES	CICIMAR	API	Stevens
3.- Guaymas, Son.	YES	CIBNOR	Base Naval	Estándar
4.- Mazatlán, Sin.	NO	ICML	ICML	Estándar
5.- Puerto Vallarta, Jal.	NO	API	API	Estándar
6.- Lázaro Cárdenas, Mich.	NO	API	API	Stevens
7.- Acapulco, Gro.	YES	Club de Yates	Club de Yates	Stevens
8.- Salina Cruz, Oax.	NO	API	API	Stevens
9.- Puerto Madero, Chis.	NO	Non	Muelle Fiscal	Estándar
10.- Tuxpan, Ver.	NO	CFE	Partida de la SeMar	Estándar
11.- Veracruz, Ver.	NO	Esc. Marina M.	Esc. Marina Mercante	Estándar
12.- Coatzacoalcos, Ver.	NO	API	API	Estándar
13.- Cd. del Carmen, Camp.	NO	Non	Muelle Fiscal	Estándar
14.- Pto Progreso, Yuc.	NO	CINVESTAV	API	Estándar
15.- Pto Morelos, Q. Roo.	YES	ICML	ICML	Stevens

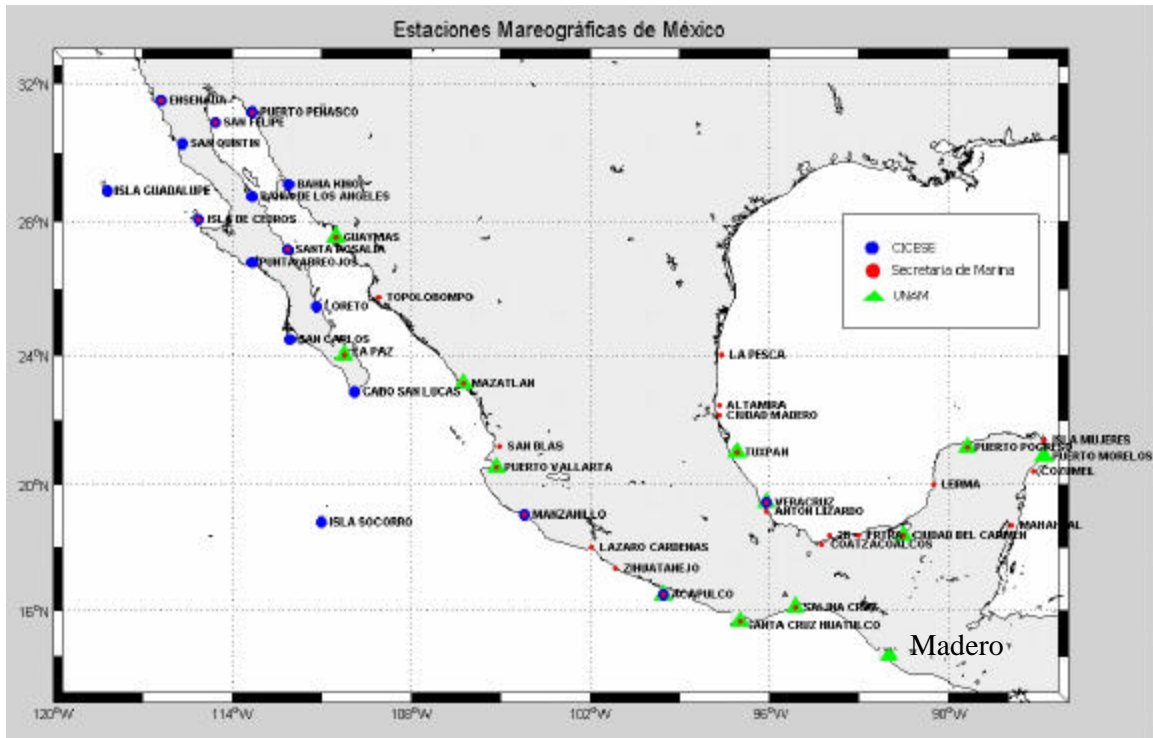


Figure 1. Mexican sea level stations. Networks from UNAM, CICESE and SEMAR are included.

CICESE

Table 2. CICESE Sea level network

EST	Datalogger	Sea level Sensor (type)	Sea level Sensor (brand)	Dt (min)	Secondary Sensor (type)	Secondary Sensor (brand)	Dt (min)	Telemetry	DTx
ENS	555C	Float	436-B	6				GOES	3 h
SNQ	555C-1	Float	436-B	6				PC	3 months
ICD	555C	Float	436-B	6				GOES	3 h
STR	555C-1	Float	436-B	6				PC, Tel	3 months 1 day
LTO	555C-1	Float	436-B	6				PC, Tel	3 months 1 day
CSL	540	Float	436-A	2	Float	436-A	15	GOES	15 min
MNZ	555C	Acoustic	Aquatrak	6	Pressure	Druck	6	GOES	1 h
ISC	555C	Radar	Ott	15	Pressure	Druck	1	GOES	15 min
IGP	555C	Radar	Ott	15	Pressure	Druck	1	GOES	15 min
SNC	555C-1	Float	436-B	6					
BLA	555C-1	Float	436-B	6					
PBJ	555C-1	Float	436-B	6					
PTA	555C-1	Float	436-B	6					
GUY	555C-1	Float	436-B	6					
MZT	555C-1	Float	436-B	6					

Database

UNAM has an important and long term database, available at <http://www.mareografico.unam.mx>. The database currently does not have all the data that have been collected. It covers until the early 90's and some stations until the early 2000s. In the last four years, several paper mareograms have been digitized, although many still have to be digitized and validated. The information of the mareograms that still have to be digitized corresponds to the last 17 years.

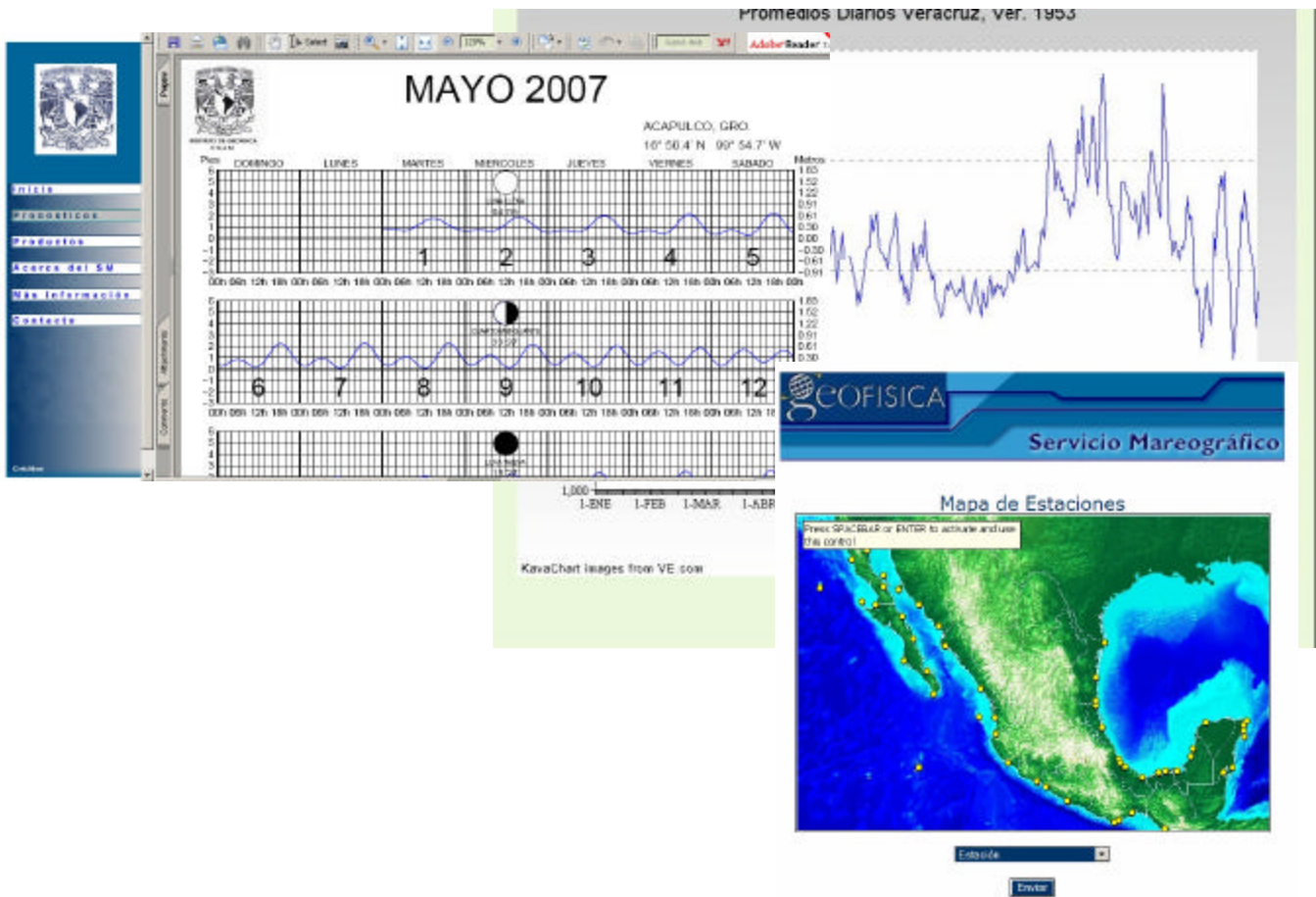


Figure 6. Components of the UNAM website (<http://www.mareografico.unam.mx>).

Examples of data series collected by UNAM.

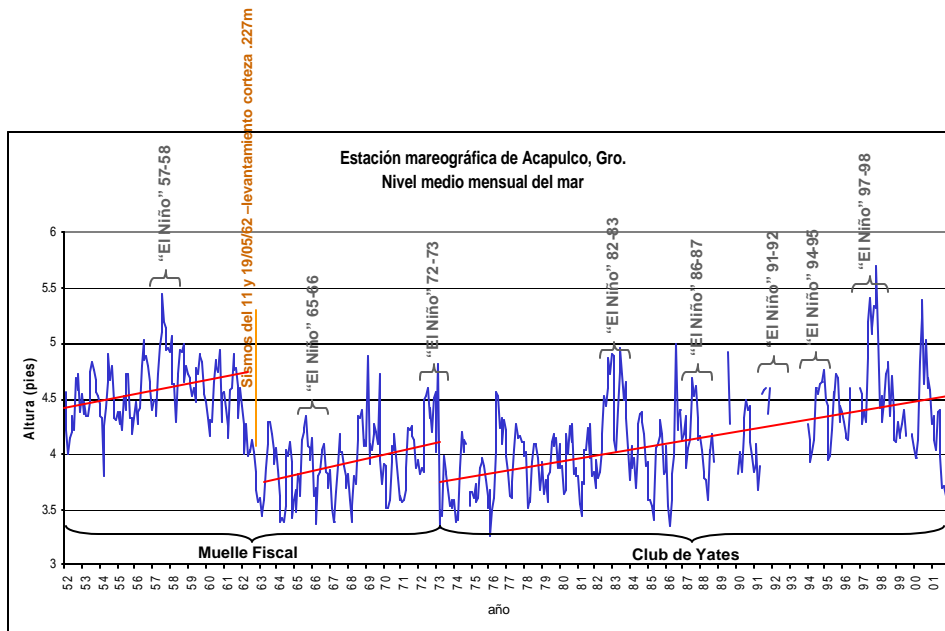


Figure 7. Time series of Acapulco from 1952 to 2001. Highlighted are El Niño events, which have a strong signal in Acapulco, and the 0.22 m jump due to the earthquake of 1962.

Cambio en el nivel medio del mar en Veracruz, Ver. (1953-2001)
0.18 cm/año

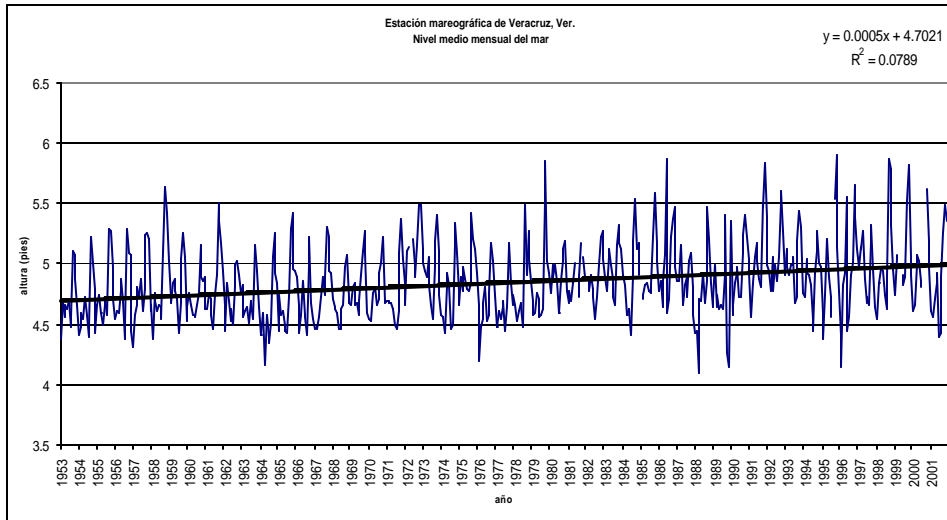


Figure 8. Time series of Veracruz from 1953 to 2001. In this site, a $0.18 \text{ cm year}^{-1}$ trend is observed for the period.

Projected activities

UNAM

- 2007
 - Substitution of tide gauge sensors in six sites (Acapulco, Veracruz, Puerto Morelos, Mazatlán, Progreso). The new equipment has an integrated datalogger. The sensors are float based.
 - Inclusion of the data collected from the new sensors in real time (every three hours).
 - Continue with the elaboration of proposals for getting budget for the modernization of the network, including atmospheric and complementary sensors, and digitalization of old mareograms.
 - Training.
- 2008
 - Substitution of tide gauge sensors in 10 sites (Tuxpan, Coatzacoalcos, Cd. Carmen, Salina Cruz, Puerto Madero, Puerto Vallarta, La Paz, Guaymas, and two more sites to be determined later).
 - Continue with the elaboration of proposals for getting budget for the modernization of the network, including atmospheric and complementary sensors, and digitalization of old mareograms.
 - Training.

CICESE

- 2007
 - Substitution of 6 equipments in the northwest of the country.
 - Installation of an automatic station in Manzanillo.
 - Installation of an automatic station in Acapulco.