GLOSS National Report for Spain

REDMAR Sea Level Network (Puertos del Estado)

Report prepared by: Begoña Pérez Gómez

Figure 1: REDMAR sea level stations (Spanish Harbours Authority: Puertos del Estado) in operation in 2013 (http://www.puertos.es)

The original network, established in 1992, has been upgraded during last years from SRD Acoustic sensors to MIROS radar sensors. New stations have also been installed in the Balearic Islands (Palma de Mallorca, Alcudia, Formentera, Mahón), North of Africa and Alboran Sea (Melilla, Motril and Almería), Gibraltar Strait (Tarifa and Algeciras), Galicia (Ferrol, Marín), Catalonia (Tarragona) and Canary Islands (Hierro, La Palma and Arrecife). In 2012 and 2013 two additional stations have been incorporated to the network: Langosteira (nearby Coruña harbor) and Carboneras (North of Almería, in the Mediterranean coast).

All the stations (36) consist of a MIROS radar system that provides 2Hz raw data and transmits 1-min averages in real time (via ADSL, GPRS or Internet) to Puertos del Estado (http://www.puertos.es). These sensors provide also agitation information each 20 minutes (significant wave height and mean period). The old stations based on acoustic sensors and/or pressure sensors have all been dismantled. Granadilla and Arinaga stations, originally part of the network and based on two Aanderaa pressure sensors, are not integrated in REDMAR nowadays; nevertheless the harbours maintain their operation for local applications.

All these stations are integrated in the Nivmar Sea Level Forecast System, run by Puertos del Estado, in the IBIROOS Data Portal (IBI In-situ Tac, developed within Myocean project) and practically all are also contributing to the IOC Sea Level Data Facility with 1-min data. Automatic quality control is performed in near-real time for application in operational

oceanography (more details can be found in: “Use of tide gauge data in operational oceanography and sea level hazard warning systems”, Pérez et al, 2013, Journal of Operational Oceanography, in press).

In order to guarantee the use of data for long-term studies, a detailed inter-comparison was performed for each upgraded station, between the old acoustic/pressure systems and the new radar systems, after about one year of simultaneous operation. The upgrade has been done gradually during last years and sometimes the new stations are located at other quay in the harbor with different sea level variability in high frequencies. The study pretends to guarantee the quality of long-term sea level measurements, combining old and new tide gauges at each harbor. High precision leveling and connection between stations and the national geodetic network was performed with funding from Puertos del Estado and each individual harbor, and the technical collaboration of the National Geographic Institute. For those harbours where another station from IEO or IGN exists, the high-precision leveling of Puertos del Estado has taken this station into account. The main results of this study include the impact of this upgrade of the network in harmonic constants and mean sea levels time series provided to PSMSL. More details can be found in: “Overlapping sea level time series measured using different technologies: an example from the REDMAR Spanish network”, Pérez et al, 2013, Natural Hazards and Earth System Sciences, in press.

Only one REDMAR station has a CGPS very close to the tide gauge and leveled to the TGBM: Ibiza in the Balearic Islands. The data are being sent by Puertos del Estado to the TIGA project.

Finally, there is plan of adding meteorological parameters (atmospheric pressure and wind) to the REDMAR sea level network. At this moment both parameters are included in Tarragona, Algeciras, Almería, Carboneras and Vigo stations and there is also atmospheric pressure at Tarifa station. Atmospheric pressure is recorded with 1-min sampling for detection of meteo-tsunamis.

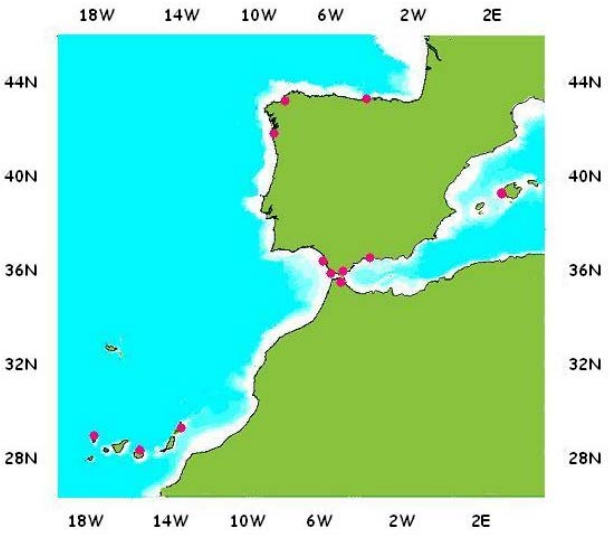
Station	Coordinates	Sensor type	Data Since
BILBAO3	43º21’26” N 03º03’00” W	Radar-Miros	1992-
SANTANDER2	43º27’45” N 03º47’22” W	Radar-Miros	1992-
GIJÓN2	43º33’33” N 05º41’50” W	Radar-Miros	1995-
FERROL1	43º27’46” N 08º 19’32” W	Radar-Miros	2006-
FERROL2	43º28’34” N 08º14’54” W	Radar-Miros	2006-
LA CORUÑA2	43º21’31” N 08º23’17” W	Radar-Miros	1992-
LANGOSTEIRA	43º20’47” N 08º31’48”W	Radar-Miros	2013
MARÍN (PONTEVEDRA)	42º24’22”N 08º41’28”W	Radar-Miros	2009-
VILAGARCÍA2	42º35’58” N 08º46’12” W	Radar-Miros	1997-
VIGO2	42º14’35” N 08º43’33” W	Radar Miros	1992-
HUELVA5 (Mazagón)	37º08’00” N 06º49’56” W	Radar-Miros	1995-
SEVILLA2 (Sluice)	37º19’57” N 05º59’41” W	Radar-Vega	2012-

SEVILLA (BONANZA2)	**36°48'14" N 06°20'10" W**	**Radar-Miros**	**1992-**
MÁLAGA3	**36°42'42" N 04°25'02" W**	**Radar Miros**	**1992-**
TARIFA	**36°00'23''N 05°36'13''W**	**Radar Miros**	**2009-**
ALGECIRAS	**36°10'37''N 05°23'54''W**	**Radar Miros**	**2009-**
MOTRIL2	**36°43'13" N 03°31'25"W**	**Radar-Miros**	**2004-**
ALMERÍA	**36°49'48" N 02°28'42"W**	**Radar-Miros**	**2006-**
CARBONERAS	**36°58'27"N 01°53'59"W**	**Radar-Miros**	**2013-**
VALENCIA3	**39°26'31"N 00°18'40"W**	**Radar Miros**	**1993-**
SAGUNTO	**39°38'02" N 00°12'22"E**	**Radar-Miros**	**2007-**
GANDÍA	**38°59'44" N 00°09'06"W**	**Radar-Miros**	**2007-**
BARCELONA2	**41°20'30"N 02°09'49" E**	**Radar-Miros**	**1992-**
TARRAGONA	**41°04'48"N 01°12'36"E**	**Radar-Miros**	**2011-**
IBIZA2	**38°54'36"N 01°26'36"E**	**Radar-Miros**	**2003-**
PALMA	**39°33'37''N 02°38'15''E**	**Radar-Miros**	**2009-**
ALCUDIA	**39°50'05''N 03°08'21''E**	**Radar-Miros**	**2009-**
FORMENTERA	**38°44'05''N 01°25'08'' E**	**Radar-Miros**	**2009-**
MAHÓN	**39°53'35''N 04°16'14'' E**	**Radar-Miros**	**2009-**
MELILLA	**35°17'26" N 02°55'42" W**	**Radar-Miros**	**2007-**
TENERIFE2	**28°28'42" N 16°14'25" W**	**Radar- Miros**	**1992-**
HIERRO2 (LA ESTACA)	**27°47'03" N 17°54'03"W**	**Radar- Miros**	**2001-**
S. CRUZ DE LA PALMA	**28°40'40" N 17°46'04"W**	**Radar-Miros**	**2006-**
LA GOMERA (SAN SEBASTIAN)	**28°05'16"N 17°06'29"W**	**Radar-Miros**	**2006-**
ARINAGA	**27°50'49"N 15°24'05"W**	**Pressure Aanderaa**	**2004-**
FUERTEVENTURA2 (EL ROSARIO)	**28°29'33"N 13°51'30"W**	**Radar-Miros**	**2004-**
LAS PALMAS2	**28°08'26"N 15°24'43"W**	**Radar-Miros**	**1992-**
LANZAROTE (ARRECIFE)	**28°58'03"N 13°31'49"W**	**Radar-Miros**	**2008-**

Table 1: coordinates of REDMAR stations today in operation: the start date correspond to the start date of the station, based on an acoustic/pressure sensor, not the radar one that is the only one in operation nowadays. The exception is Sevilla, where the link between tide gauges was not possible: original time series based on SRD sensor ends in 2008. Nowadays a Vega radar is installed and operational at the new sluice of the harbour.

Spanish Institute of Oceanography Sea Level Network (IEO)

Report prepared by: María Jesús García



Cod.	Nombre	Posición	Periodo
002	Santander	Lat: 43° 28' N Lon: 03° 48' W	1943 - ongoing
005	A Coruna	Lat: 43° 22 'N Lon: 08° 24' W	1943 - ongoing
006	Vigo	Lat: 42° 14' N Lon: 08° 44' W	1943 - ongoing
008	Cádiz	Lat:36° 32' N Lon: 06° 17' W	1945 - ongoing
009	Tarifa	Lat:36° 00' N Lon:05° 36' W	1943 - 1961 1963 - 1989 1991 - ongoing
019	Ceuta	Lat:35° 54' N Lon:05° 19' W	1943 - ongoing
010	Algeciras	Lat:36° 07' N Lon:05° 26' W	1943 - 1955
011	Málaga	Lat:36° 43' N Lon:04° 25' W	1943 - 1959 1961 - ongoing
014	Palma de Mallorca	Lat:39° 33' N Lon:02° 38' E	1963 - 1982 1989 - 1993 1996 - ongoing
015	Arrecife	Lat:28° 57' N Lon:13° 34' W	1949 - 1975 1980 - ongoing
016	Puerto de la Luz	Lat:28° 08' N Lon:15° 25' W	1949 - 1956 1971 - 1989 1991 - ongoing
017	Santa Cruz de la Palma	Lat:28° 41' N Lon:17° 33' W	1949 - 1989 1997 - ongoing

Figure 2: map and coordinates of IEO Tide Gauge Network, including period of data available (extracted from: http://indamar.ieo.es/mareas/mareas.htm).

The network is composed of float gauges, but now additional radar systems have been installed at Santander, Algeciras and Tarifa stations. Data are automatically downloaded via modem once per day and displayed at http://indamar.ieo.es/mareas/mareas.htm. Plans exist to upgrade all the network to radar sensors, but IEO is still waiting for funding. All Spanish GLOSS stations belong to this network.

Update 2013:

New radar sensor have been installed in the stations of Palma de Mallorca, Cadiz and Puerto de la Luz. The c3 stations provide data at 1 minute interval. Data from each station is transmitted to the data Center by automatically telephone call ones a days and loaded in the IEO server. http://indamar.ieo.es and the data of the 3 GLOSS stations are automatically integrated in the SEA LEVEL STATION MONITORING FACILITY (IOC) http://www.ioc-sealevelmonitoring.org/index.php

Fort he historical data, the complete data set of monthly mean sea level are already sin the PSMSL up to 2012 and the high frequency data of the three GLOSS stations are sending to the Joint Archive for Sea Level, JASL (Puerto de la Luz up to 2010, Ceuta up to 2010 and Coruña up to 2012). Concerning to the graphical recorder, the

mareogrames have been scanned and many of them are already loaded in the IEO server for viewing and downloading. http://indamar.ieo.es/mareas/mareogramas.htm

Concerning to the GPS installed at the stations of Puerto de la Luz, the data have been sent to the TIGA archiving Data Center in France from the beginning of April 2003 up to January 2011 with some gaps that correspond to periods where the GPS was not operative.

National Geographic Institute Sea Level Network (IGN)

Report prepared by: María Angeles Fraile/Bernat Puyol

The National Geographic Institute tide gauge network consists of nine stations. All are equipped with radar sensors recording data every minute. Also collect data every ten minutes with float and angle encoder gauges except in Puerto de la Cruz (TN02) and Los Cristianos (TN03).

The location of the stations and the available data period is reflected in the table. ALAC1, ACOR1, TN01, TN02 and TN03 also have GPS Permanent Stations near the tide gauge.

Estación	Localización			Sistema de medida		Datos			Designación PSMSL
	Longitud	Latitud	Situación	Nombre	Tipo	intervalo	periodo		
ALAC1	00° 28' 40" W	38° 20' 18"N	ALICANTE	THOMSON I	Registrador mecánico		1927	1969	220/051 ALICANTE I
			Muelle de Levante	OTT R20	Registrador mecánico	1 h	1979	mar-08	
			Escollera	OTT Thalimedes	Codificador angular	1' promedio 10'	ago-99	mar-00	
				OTT Thales	Codificador angular	1' promedio 10'	mar-00	mar-09	
				OTT Thales	Codificador angular	10'	abr-09	-	
				VEGA Radar	Sensor rádar	1'	feb-10	-	
ALAC2	00° 28' 53" W	38° 20' 20"N	ALICANTE	THOMSON III	Registrador mecánico	1 h	1957	1973	220/052 ALICANTE II
			Muelle de Levante	OTT R20	Registrador mecánico	1 h	feb-76	mar-96	
			Bocana	OTT OWK16	Codificador angular	1' promedio 10'	jul-96	may-98	
				OTT Thalimedes	Codificador angular	1' promedio 10'	oct-98	ene-99	
				OTT OWK16	Codificador angular	1' promedio 10'	mar-00	mar-10	
				Barometro		1' promedio 10'	mar-00	may-10	
				OTT OWK16	Codificador angular	10'	oct-10	-	
				VEGA Radar	Sensor rádar	1'	oct-10	-	
				Barometro		10'	oct-10	-	
ALME2	02° 29' W	36° 50' N	ALMERIA	SEBA Alpha	Registrador mecánico	1 h	1986	-	220/042 ALMERIA II
			Dique Sur	OTT Thalimedes	Codificador angular	1' promedio 10'	feb-00	nov-03	
			Dársena pesquera	OTT OWK16	Codificador angular	1' promedio 10'	nov-03	mar-09	
				OTT OWK16	Codificador angular	10'	abr-09	-	
				VEGA Radar	Sensor rádar	1'	oct-10	-	
MURC2	00° 58' 24"W	37° 35' 46"N	CARTAGENA	AOTT R20			abr-05	feb-10	
			Muelle Santa Lucía	OTT OWK16	Codificador angular	1' promedio 10'	abr-05	mar-09	
			Caseta Bombas	OTT OWK16	Codificador angular	10'	abr-09	nov-09	
				VEGA Radar	Sensor rádar	1'	feb-10	-	
				OTT OWK16	Codificador angular	10'	feb-10	-	
ACOR1	08° 23' 17" W	43° 21' 31" N	LA CORUÑA	Mier	Registrador mecánico		ene-50		200/031 LA CORUÑA II
			Muelle Calvo Sotelo	Thomson	Registrador mecánico		ene-50	jun-78	
				AOTT 20.030	Registrador mecánico		sep-78	-	
				OTT Thales	Codificador angular	1' promedio 10'	may-97	abr-98	
				OTT Thalimedes 1	Codificador angular	1' promedio 10'	may-98	may-99	
				OTT Thalimedes 2	Codificador angular	1' promedio 10'	oct-99	jul-05	
				OTT OWK16	Codificador angular	1' promedio 10'	abr-05	nov-08	
				OTT OWK16	Codificador angular	1'	nov-08	oct-11	
				OTT OWK16	Codificador angular	10'	oct-11	-	
				VEGA Radar	Sensor Rádar	1'	oct-11	-	
TN013	16° 14' 28"W	28° 28' 38" N	SANTA CRUZ DE TENERIFE	AOTT 20.030	Registrador mecánico	1 h	ene-92	-	370/031 SANTA CRUZ DE TENERIFE II
			Dársena Anaga	OTT Hydrus	Codificador angular	1' promedio 10'	jul-97	-	
			Muelle Norte	SEBA Radar	Sensor rádar	5'	may-07	nov-08	
				SEBA Radar	Sensor rádar	1'	nov-08	-	
TN021	16° 33' 2"W	28° 25' 6"N	PUERTO DE LA CRUZ	SEBA Radar	Sensor rádar	5'	oct-08	mar-09	
				SEBA Radar	Sensor rádar	1'	mar-09	-	
TN033	16° 43' 5"W	28° 2' 49"N	LOS CRISTIANOS	VEGA Radar	Sensor rádar	1'	mar-09	-	
FUER1	13° 51' 33" W	28° 29' 48" N	PUERTO DEL ROSARIO	AOTT 20.030	Registrador mecánico		feb-99	abr-02	
			Muelle deportivo	OTT Thalimedes	Codificador angular	promedio 10'	sep-99	abr-02	
				OTT OWK16	Codificador angular	promedio 10'	oct-05	mar-09	
				OTT OWK16	Codificador angular	1'	mar-09	-	

Table 2: stations of the National Geographic Institute