2nd MEETING OF THE IHO TIDAL AND WATER LEVEL GROUP

27 - 29 APRIL 2010, STAVANGER, NORWAY

CHILEAN SEA LEVEL NETWORK

NEW CHALLENGES AFTER TSUNAMI FEBRUARY 27TH-2010

Juan Fierro C.

Lecture Overview

- Tsunami, Offshore Maule, Chile
- Current Status of Sea Level Stations
- Data transmission
- Forthcoming upgrade
- Future Plans

Tsunami, Offshore Maule, Chile

Introduction

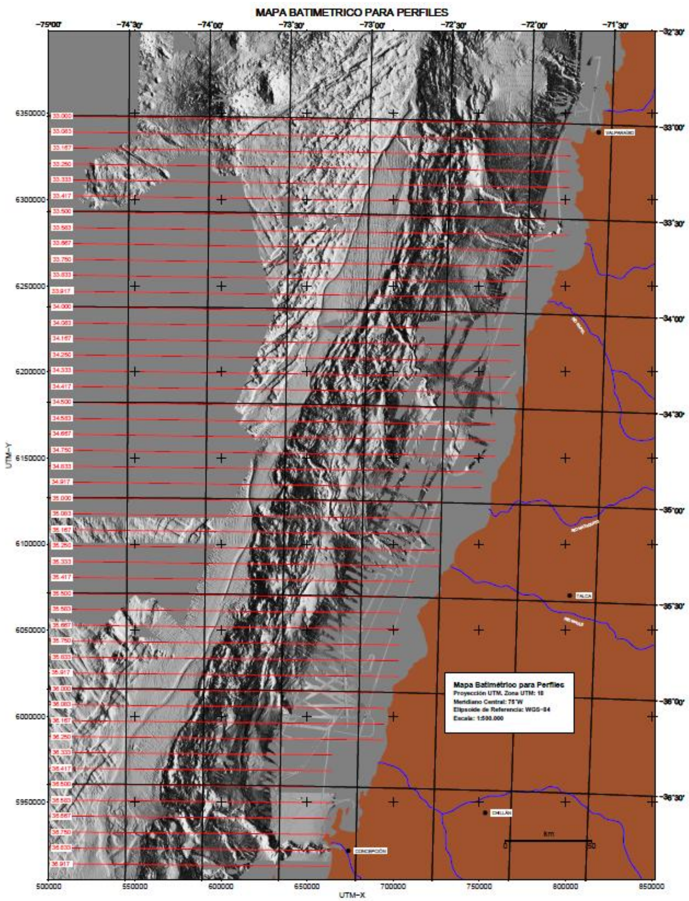
- At 3:34 local time, February 27th, a devastating earthquake M 8.8 struck Chile

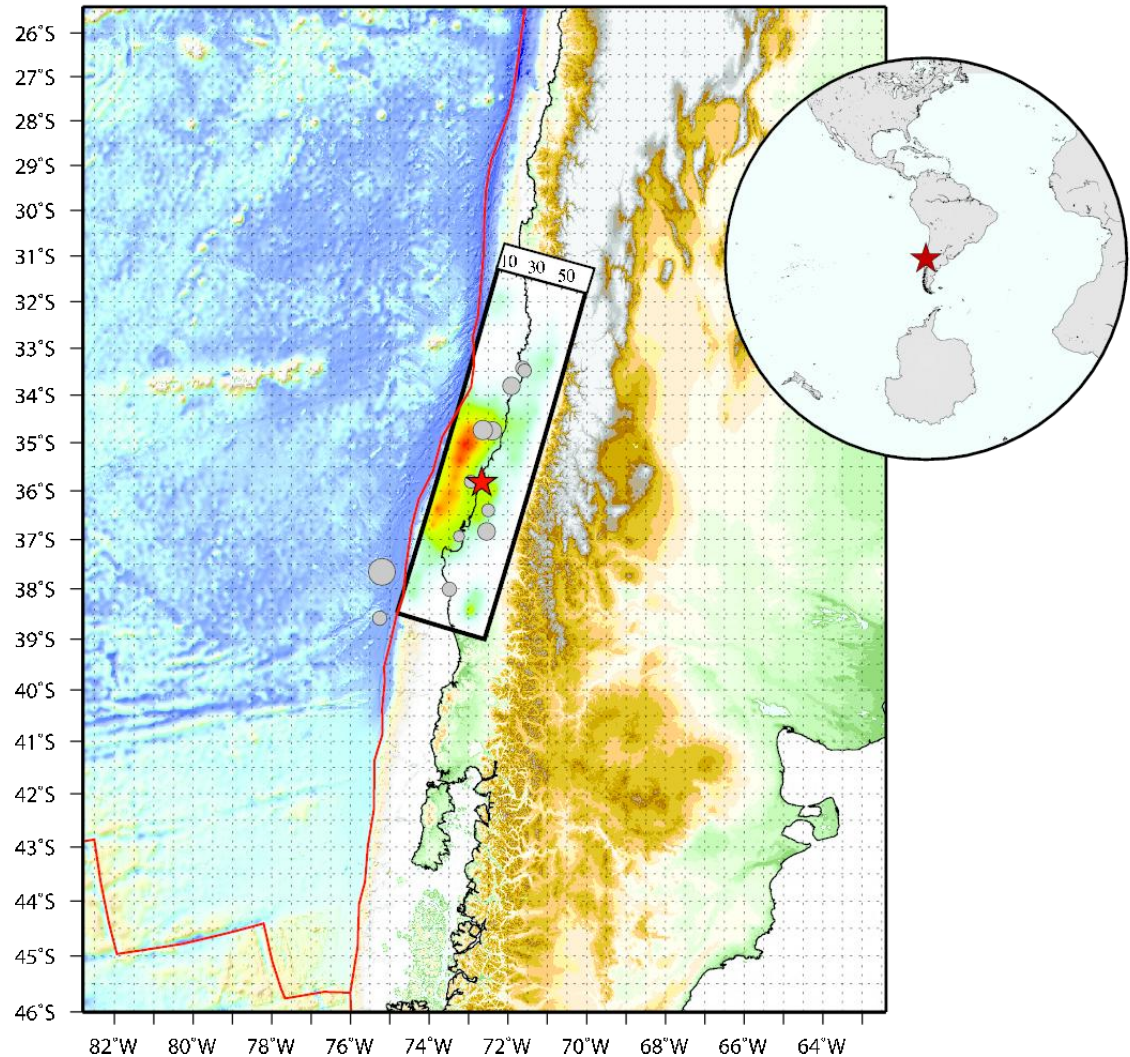
- The earthquake also triggered a tsunami which crossed into the Pacific Ocean

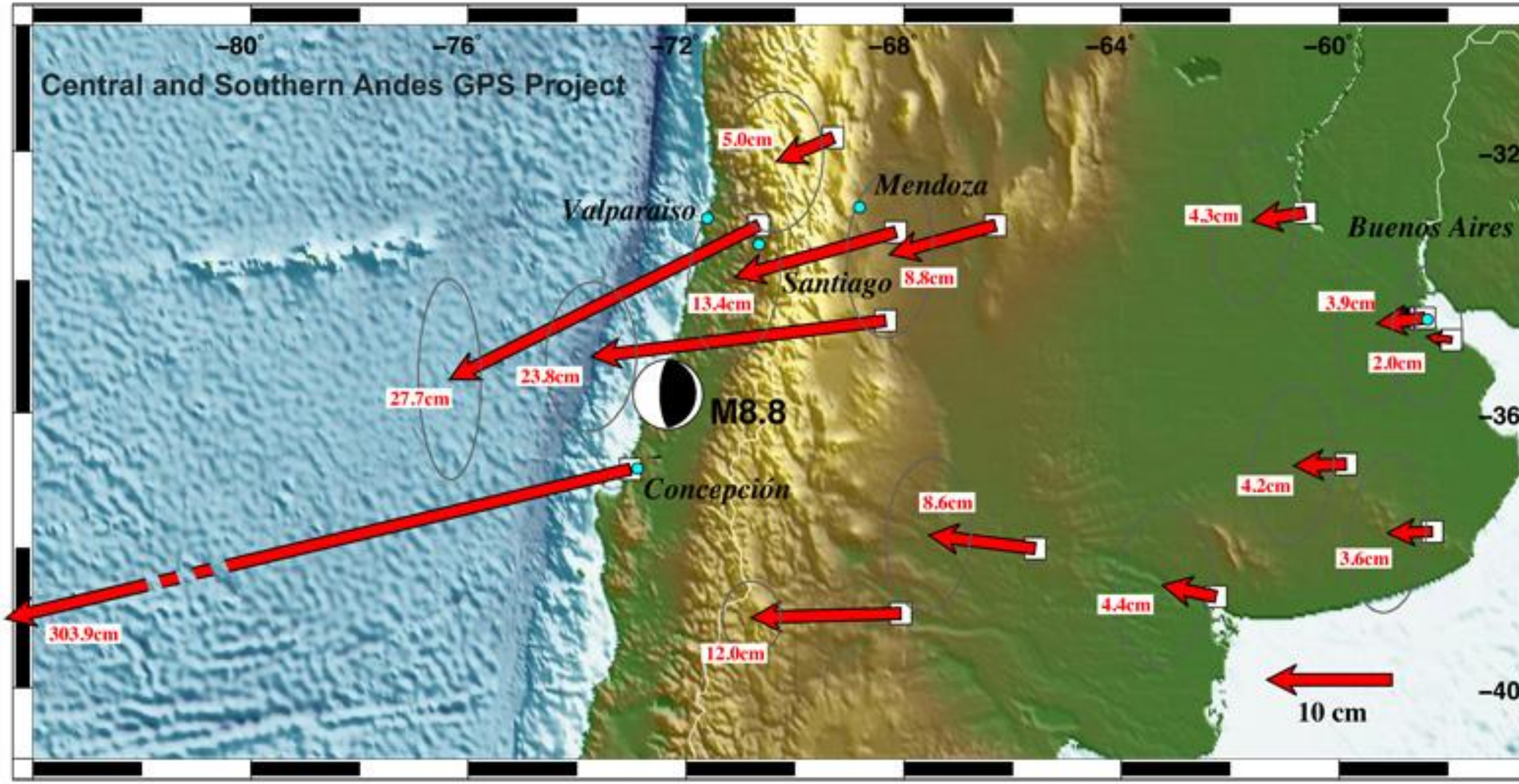
- Historic world earthquake listed by magnitude
  - 1960 05 22 Valdivia, Chile – M 9.5
  - 1964 03 28 Prince William Sound, Alaska – M 9.2
  - 2004 12 26 Sumatra – Andaman Island – M 9.1
  - 1952 11 04 Kamchatka – M 9.0
  - 1868 08 13 Arica, Chile – M 9.0
  - 1700 01 26 Cascadia Subduction Zone – M 9.0
  - 2010 02 27 Offshore Maule, Chile – M 8.8

- Sea level stations contribute strongly as tsunami detection systems with potential warning time from minutes to hours, depending on proximity of source location

Introduction



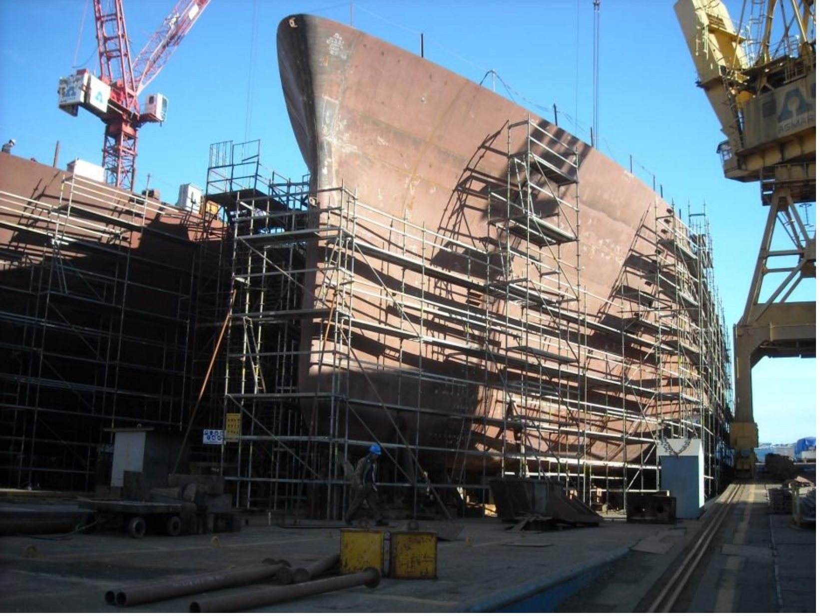




Central and Southern Andes GPS Project
−80°
−76°
−72°
−68°
−64°
−60°
−32°
−36°
−40°
Valparaiso
Mendoza
Santiago
Buenos Aires
Concepción
M8.8
5.0cm
4.3cm
8.8cm
13.4cm
3.9cm
2.0cm
23.8cm
27.7cm
4.2cm
8.6cm
3.6cm
4.4cm
303.9cm
12.0cm
10 cm

Valparaíso
Juan Fernández
Santiago
Rancagua
Constitución
Talca
Cobquecura
Talcahuano
Concepción
Chillán
Temuco

Los expertos dicen que en el caso de otros megasismos, como el de Sumatra, ha habido fuertes réplicas.



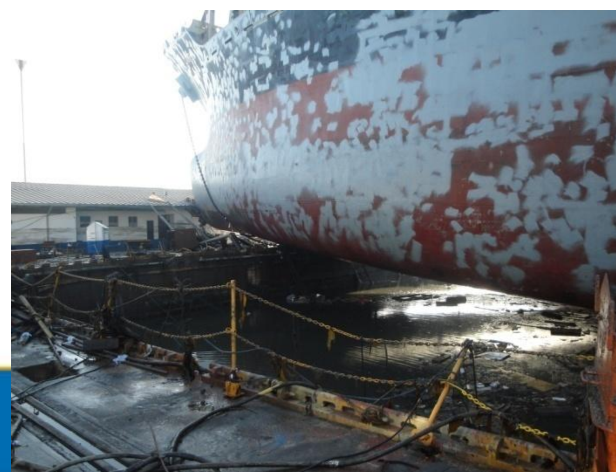
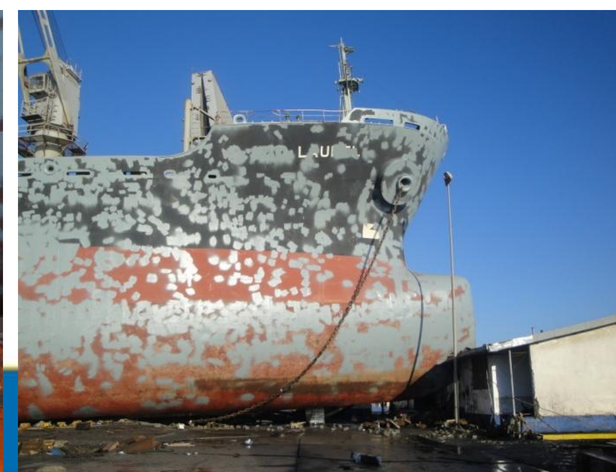

CABO DE HORNOS


CABO DE HORNOS
15/02/2010 15:17

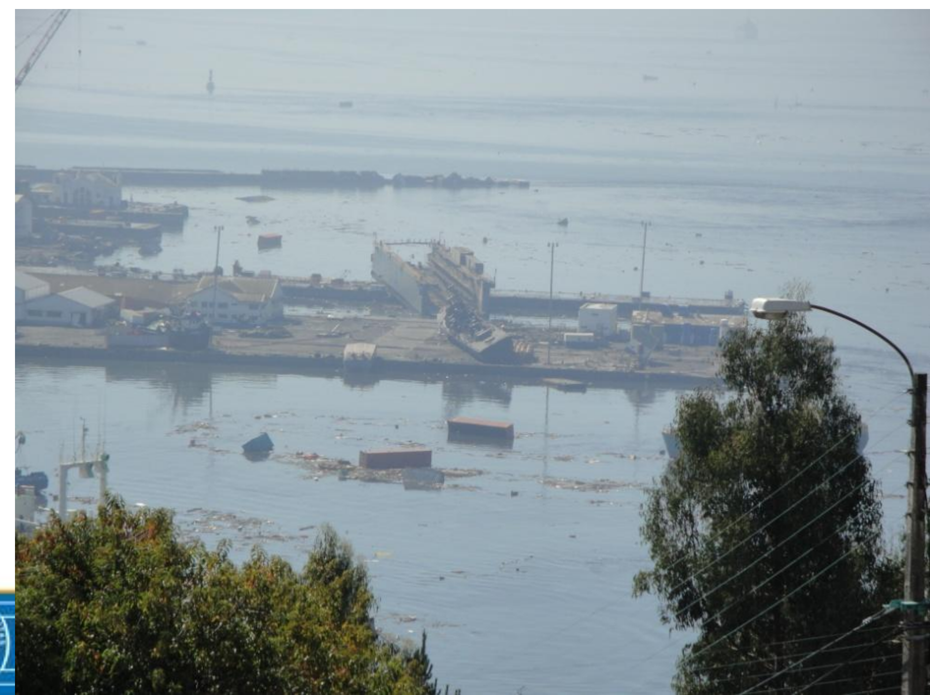

AGS 61
CABO DE HORNOS



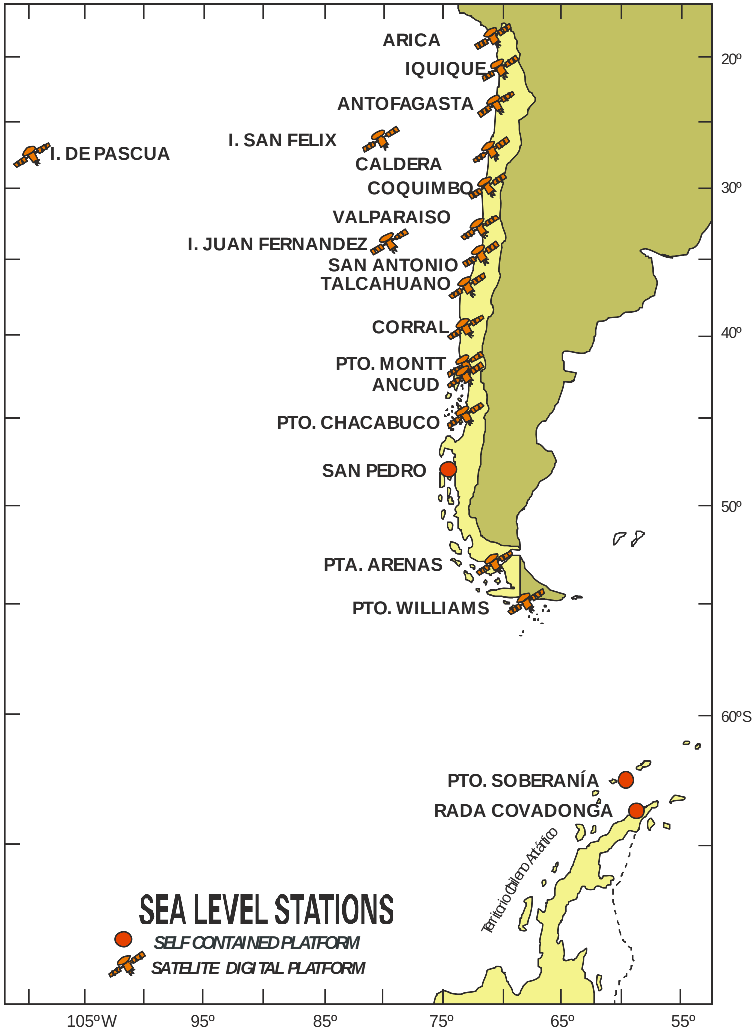
CCNI

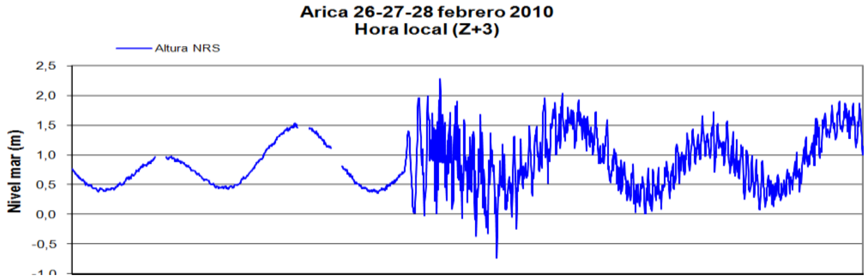


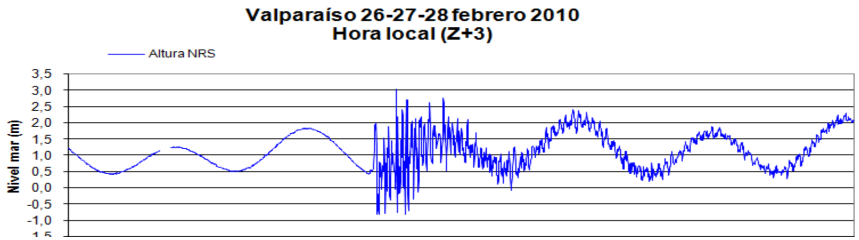



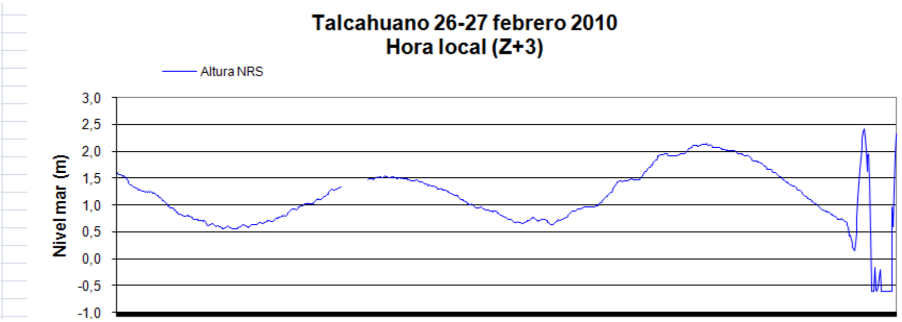
Chilean Sea Level Network
Some damage

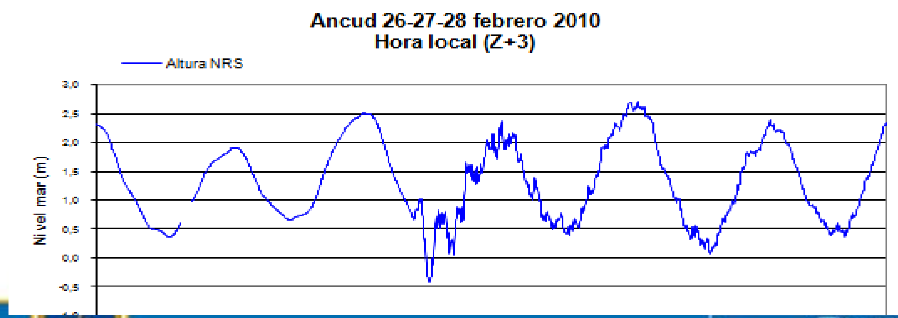


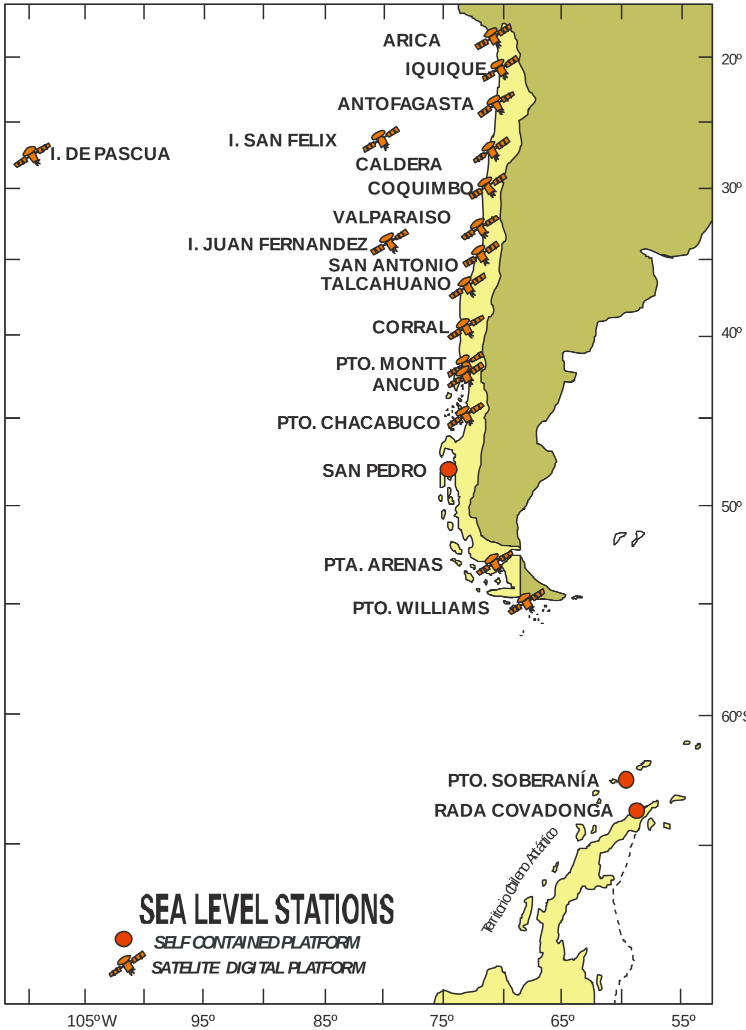
Chilean Sea Level Network: Data Feb 27th











Current Status of Sea Level Stations

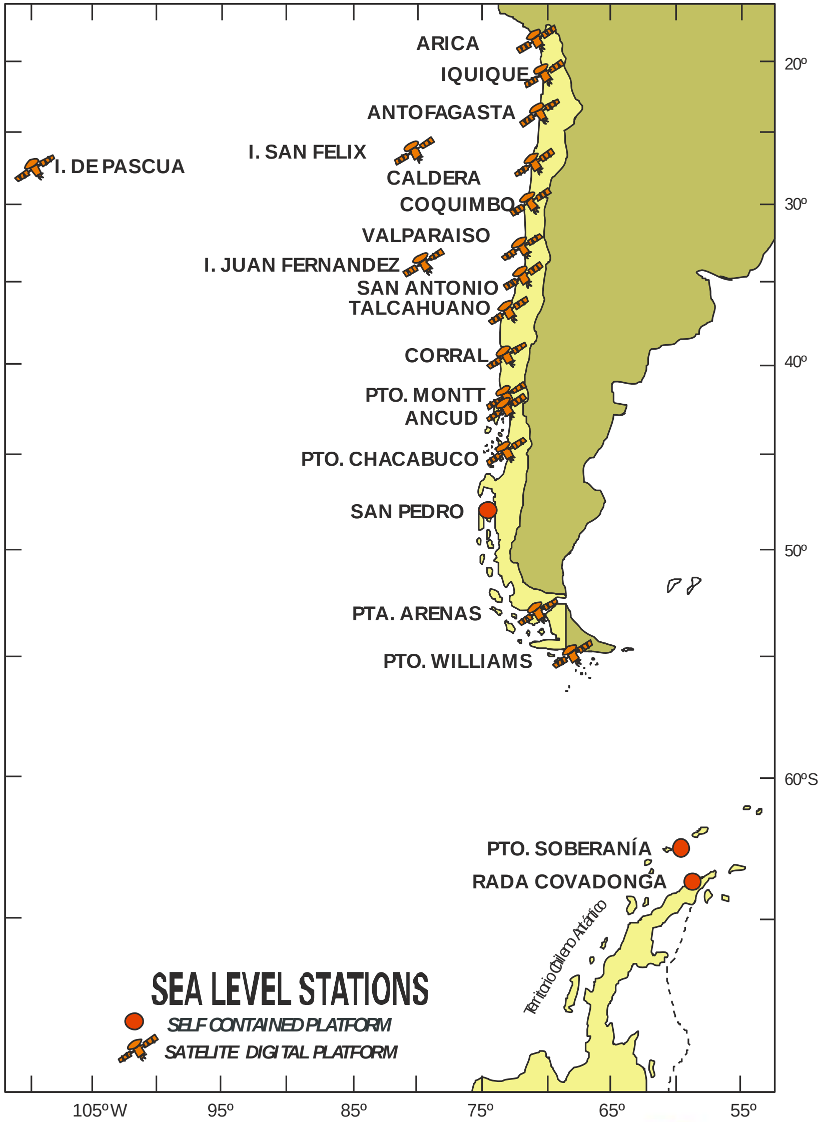
Chilean Sea Level Network

• **17 Stations with satellite transmission:**

Sea Level : c/2min
Water Temperature : c/1 hr
Air Temperature : c/1 hr
Atmospheric pressure : c/1 hr

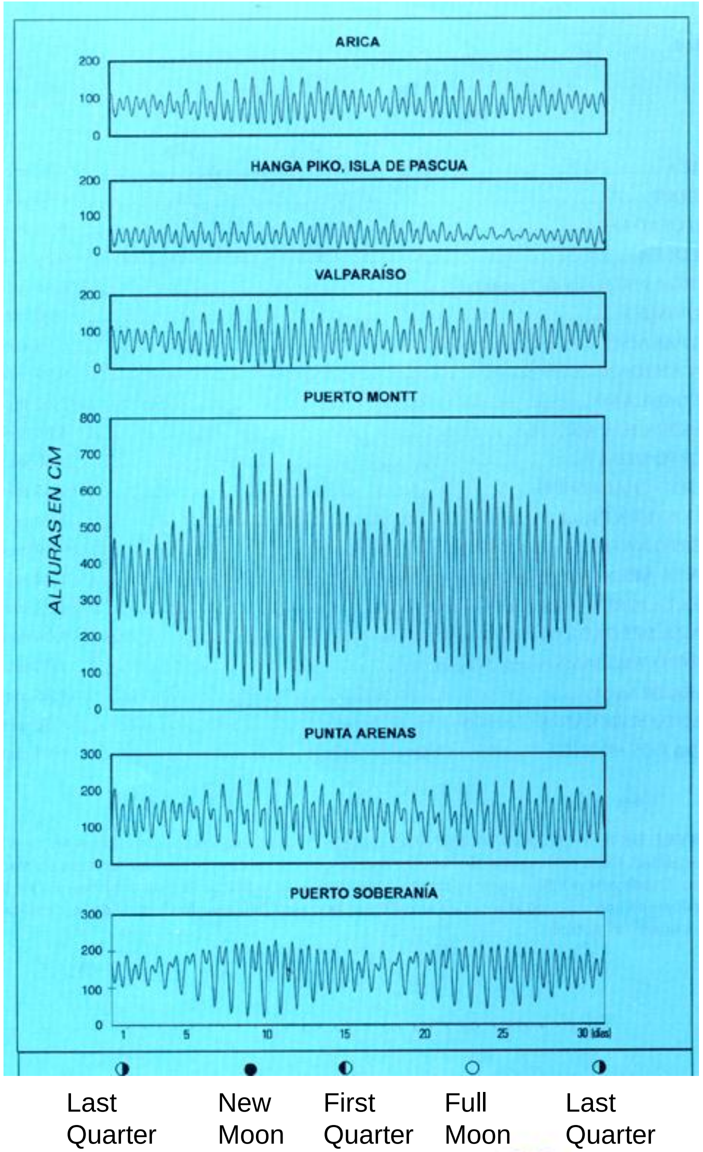
• **3 Self contained platforms:**

San Pedro
Pto. Soberanía
Rada Covadonga

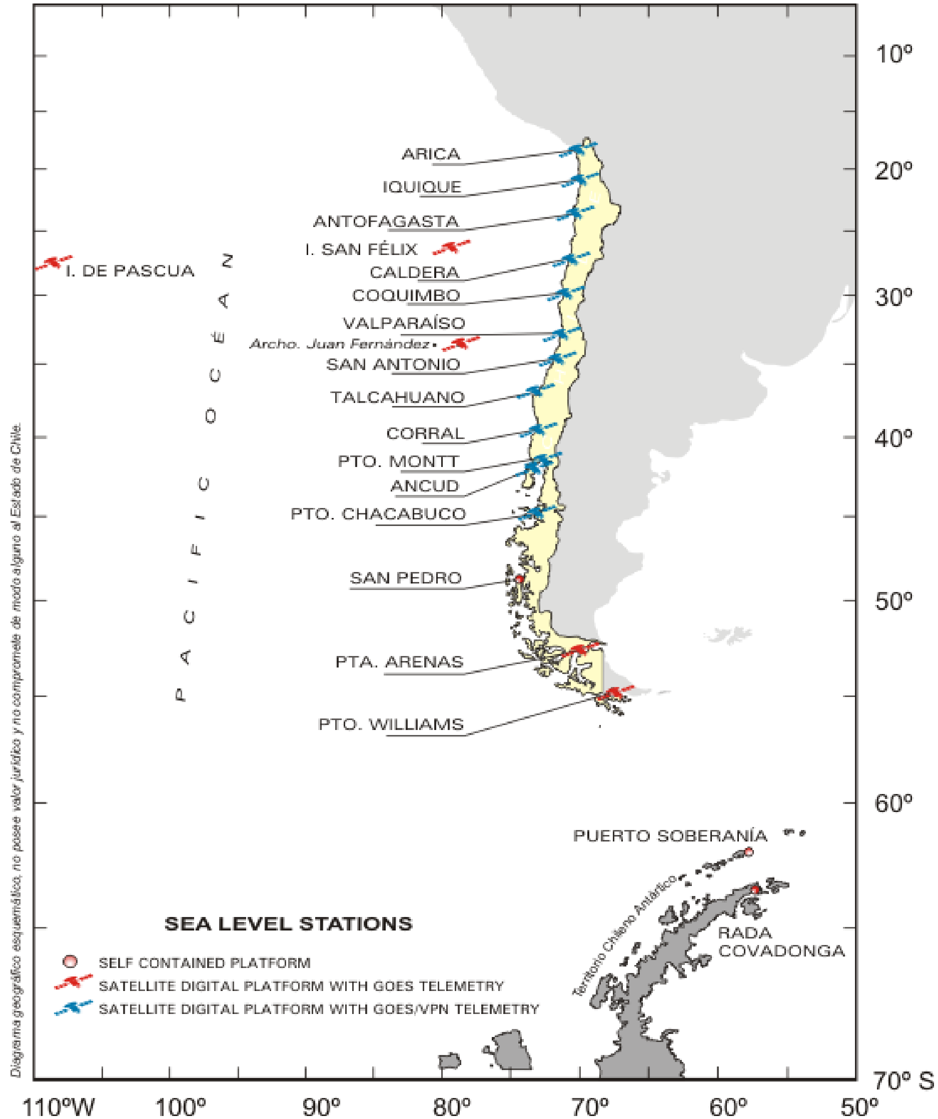


Chilean Sea Level Network

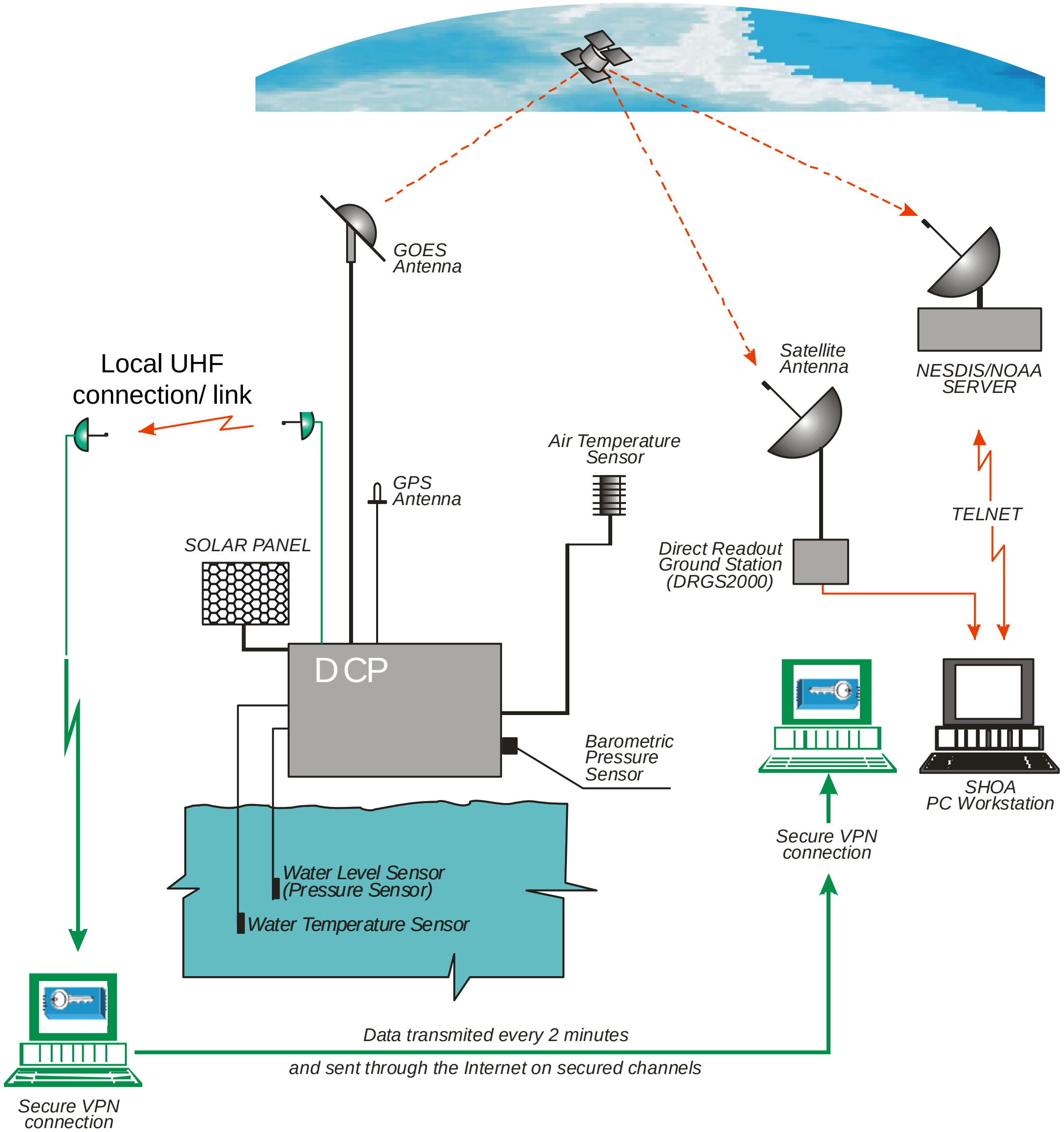
Station	Lat. °S	Long. °W	Installation Year
Arica	18° 29'	070° 19'	1950
Iquique	20° 13'	070° 10'	1958
Antofagasta	23° 39'	070° 25'	1945
I. San Félix	26° 16'	080° 07'	1984
Caldera	27° 04'	070° 50'	1950
I. De Pascua	27° 09'	109° 27'	1957
Coquimbo	29° 56'	071° 21'	1960
Valparaíso	33° 02'	071° 38'	1941
San Antonio	33° 35'	071° 38'	1985
I.R. Crusoe	33° 37'	078° 50'	1981
Talcahuano	36° 41'	073° 06'	1949
Corral	39° 52'	073° 26'	1961
Puerto Montt	41° 29'	072° 58'	1942
Ancud	41° 52'	073° 51'	1999
Pto. Chacabuco	45° 28'	072° 50'	1993
I.San Pedro	47° 43'	074° 54'	1995
Punta Arenas	53° 10'	070° 54'	1942
Puerto Williams	54° 56'	067° 37'	1964
Pto. Soberanía	62° 29'	059° 38'	1983
Rada Covadonga	63° 19'	057° 55'	2006



Chilean Sea Level Network
Current Telemetry Options



Information flow across Chilean Sea Level network



Data Transmission

Telemetry Options

- Radio link → Short distances (e.g. harbour operations)

- Virtual Private Network → Countrywide links

- Mobile Phone Link → Long-distance communication

- Mobile Satellite links → Remote areas

Satellite Systems: GOES-E, GOES-W (USA)

Main Characteristics

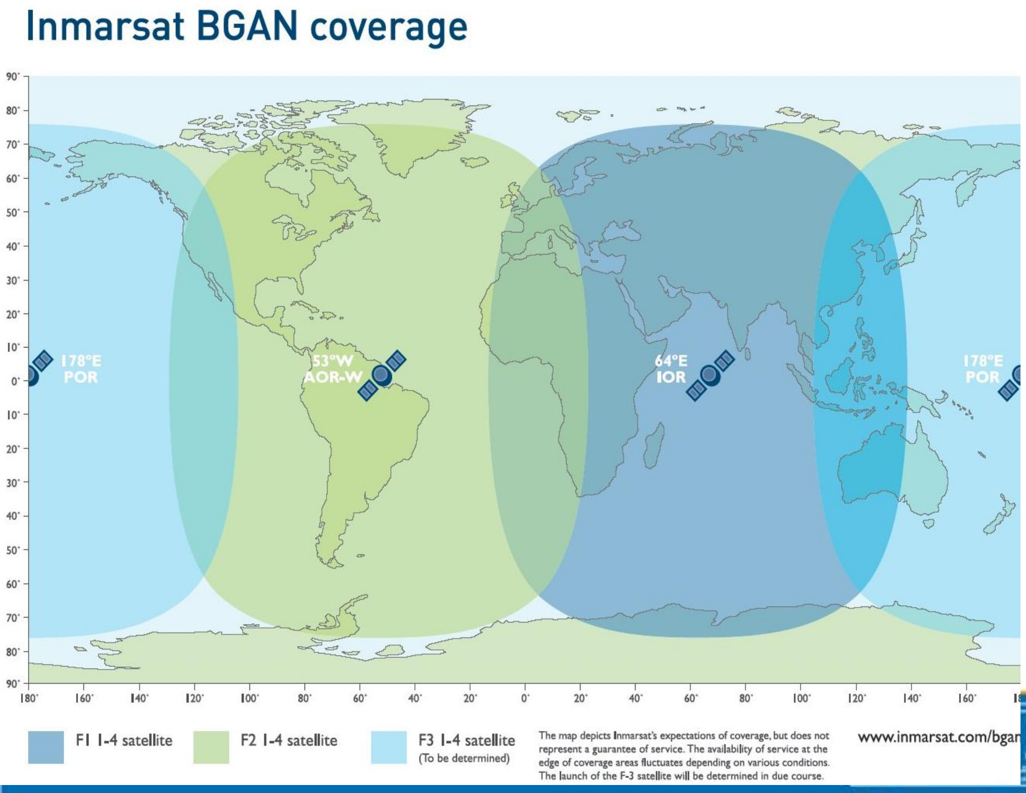
- Under responsibility of the National Oceanic and Atmospheric Administration (NOAA) through the National Environmental Satellite, Data, and Information Service (NESDIS).
- NASA launched the first GOES for NOAA in 1975 and followed it with another in 1977.
- Two meteorological satellites in geostationary orbit over the equator. Each satellite views almost a third of the Earth's surface. Coverage extends approximately from 20 W longitude to 165 E longitude.
- Latitude cover limited to about 75°.

Satellite Systems: INMARSAT/BGAN

- The two latest generation satellites, the Inmarsat-4s (I-4s), were launched in 2005. Together, they provide coverage to around 85 per cent of the world's landmass and 98 per cent of the world's population.

- Following the successful launch of its third I-4 satellite on 18 August 2008, Inmarsat has repositioned the I-4 constellation in order to optimise the network and deliver global coverage , except for the extreme polar regions.

- Broadband speed of 492 kbits/s is available with a static IP address.



- Connection is by LAN, USB or Bluetooth; there is not serial port connection.

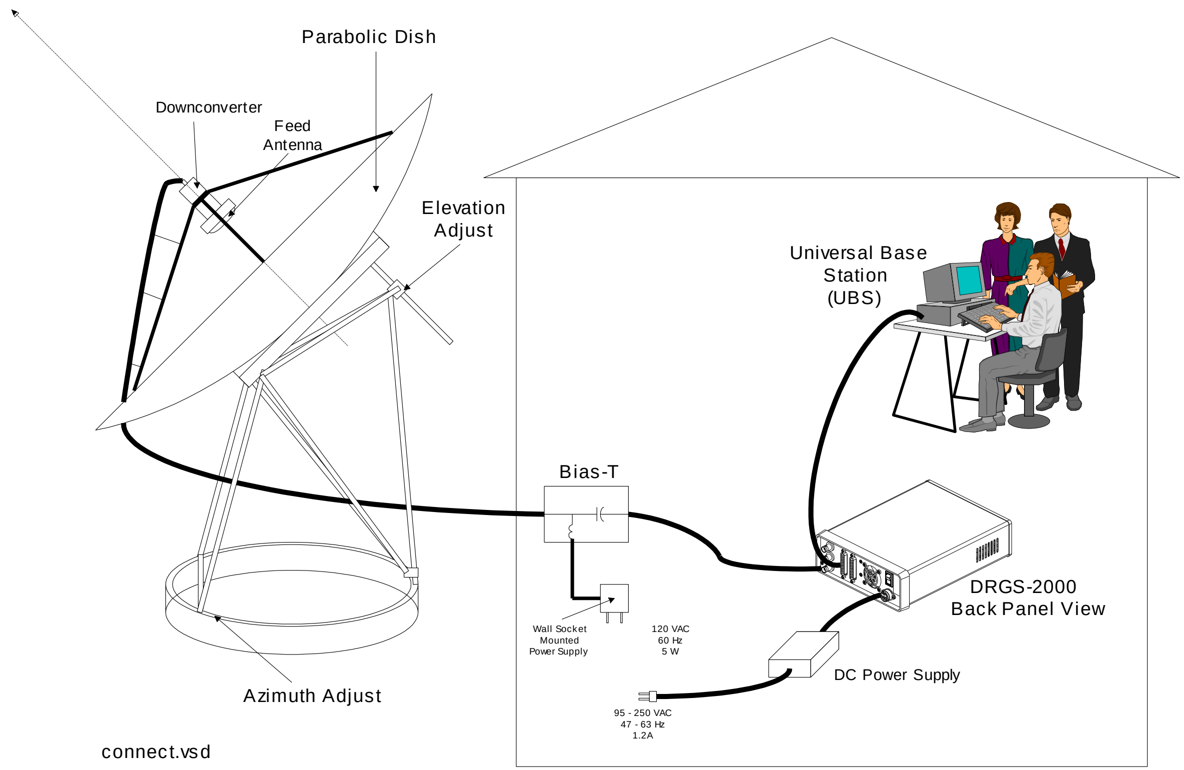
- Instruments interfaced to this terminal unit will need a network connection.

- Capable of operating in remote areas and is optimized for low-power operation.

- BGAN´s biggest advantage over fixd-line broadband is its independence of local telephone infrastructure.

Direct Readout Ground Station (DRGS)

Provides ability to directly receive data from GOES satellites without being dependent on secondary links



UBS2000

- Software developed by VAISALA
- Collect data from a large number of met and oce sensors
- Displays data in a variety of forms, including graphs, tables, wind roses, status, etc
- Ingests Data from
  - GOES Direct Readout Ground Station
  - Interrogated Radio
  - Telephone Modem

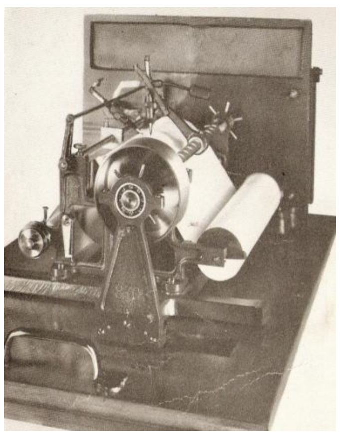
Forthcoming Upgrade

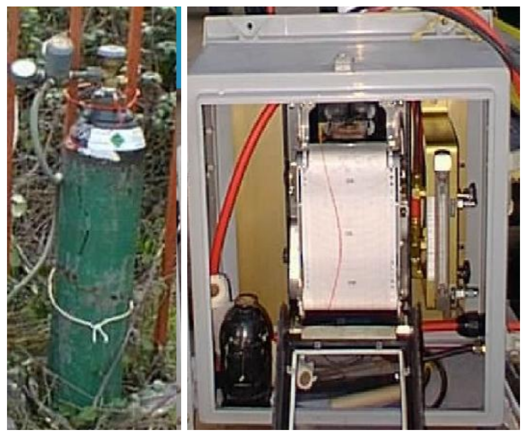
Chilean Sea Level Network
Hardware Upgrade process

Feb 27th

Near Real Time | Real Time

1941 — 1970 — 1999 — 2010





dry purged recording tide gauge

Data collecting platforms

A reinforced upgrade

-Improving telemetry

-New platforms and sensors

Mechanical devices ← | → Digital equipments

VAISALA HydroMet SYSTEM MAWS110
Medium Sized Systems

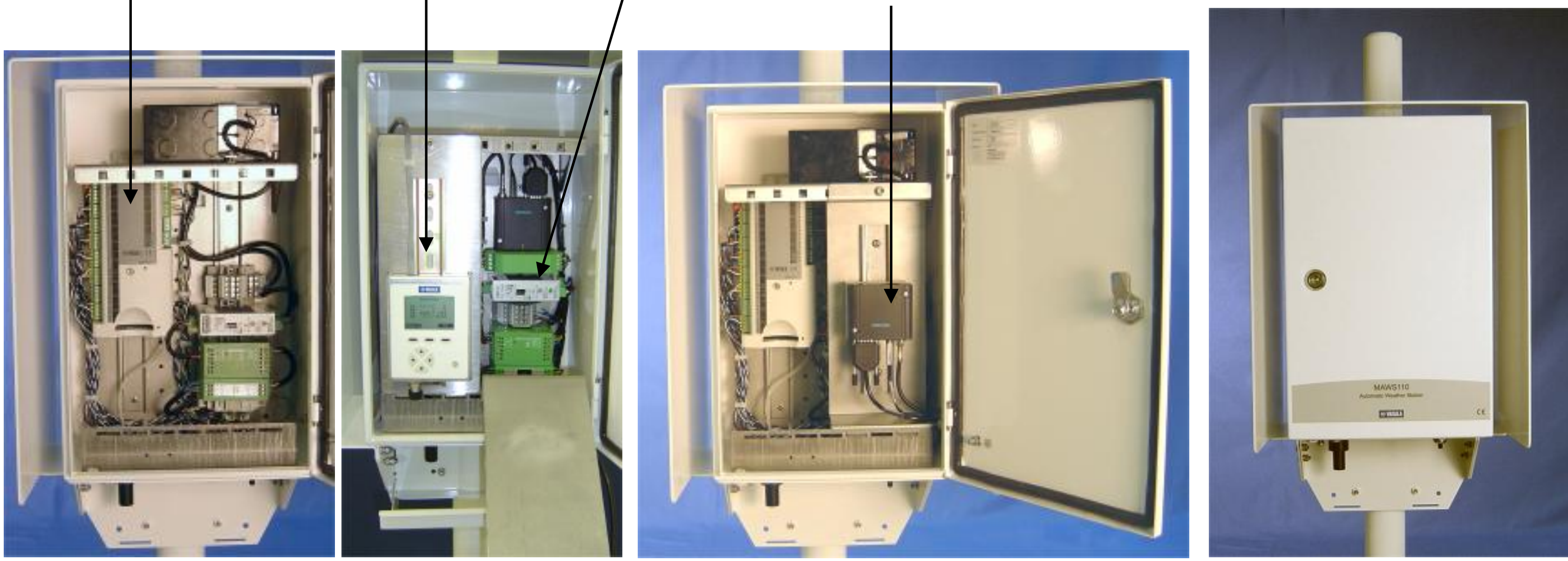
QML201 Logger

QMD202 Display and
Keyboard Unit

Mains power supply
Battery Charger
Surge arrestor(s)

PSTN modem
GSM/GPRS modem
TCP/IP module

MAWS110



VAISALA HydroMet SYSTEM MAWS

Wireless Telemetry

- **GSM** (900, 1800, 1900 MHz) **CELLULAR NETWORKS, incl. SMS and GPRS**
- **CDMA (circuit- & packet-switched)**
- **UHF RADIO MODEMS (380 - 470 MHz)**
- **VHF RADIO MODEMS**
- **SPREAD SPECTRUM RADIO MODEM**
- **SATELLITE SERVICES:**
  - **ORBCOMM (Worldwide)**
  - **Inmarsat – C and BGAN (Worldwide)**
  - **Iridium (Worldwide)**
  - **AutoTrac (Brazil, Argentina..)**
  - **VSAT (Worldwide)**
  - **GOES - 100, 300 & 1200 bps (Americas)**
  - **GMS (Japan, Australia)**
  - **METEOSAT (Europe, Near-East)**
  - **ARGOS/SCD (Worldwide)**

Submersible Water Level Sensor
PR-36XW/H

- **PR-36XW FOR MEASURING HYDROSTATIC LEVEL IN RIVERS, LAKES AND RESERVOIRS**
- **MEASURING RANGE 0 - 40 m** (USER SETTABLE)
- **PR-36XW/H WITH HASTELLOY DIAPHRAGM FOR SEA WATER APPLICATIONS**
- **SPECIFICATIONS:**

OUTPUT SIGNAL:	4-20 mA, 2-WIRE
ACCURACY:	0.1 % of F.S.
MATERIAL:	STAINLESS STEEL, POLYURETHANE CABLE

OPERATING TEMP. : - 40 ° ... +60° C

Radar Water Level Sensor QHR102

- CONTACT FREE WATER LEVEL MEASUREMENTS(26GHz TECHNOLOGY)
  - INSENSITIVE TO MUD, DRIFT WOOD, LEAVES, ETC
  - MINIMUM CONSTRUCTION WORK
  - INSENSITIVE TO FOG, AIR TEMPERATURE FLUCTUATION

- ➢ MEASURING RANGE 0 - 35 M
- ➢ ACCURACY: ± 1 MM
- ➢ OPERATING TEMP: - 20 TO +70° C
- ➢ LOW POWER CONSUMPTION

Schedule of upgrade

Present Situation

17 DCP model 555C

Sensors:

Sea Level, water temp, air temp, atm pressure

Transmitting data by:

GOES (all)

Secure VPN (12)

Future Situation

First Step (2010)

15 DCP model MAWS110

Sensors: Sea Level, sea level (radar), water temp, air temp, atm pressure, humidity

Transmitting data by:

GOES and VPN (10)

GOES (1)

BGAN and GPRS (3)

6 DCP model 555C

Sensors: Sea Level, water temp, air temp, atm pressure

Transmitting data by:

GOES and VPN (3)

GOES (3)

BGAN (4)

Second Step (2011)

31 DCP model MAWS110

Sensors: Sea Level, sea level (radar), water temp, air temp, atm pressure, humidity

Transmitting data by:

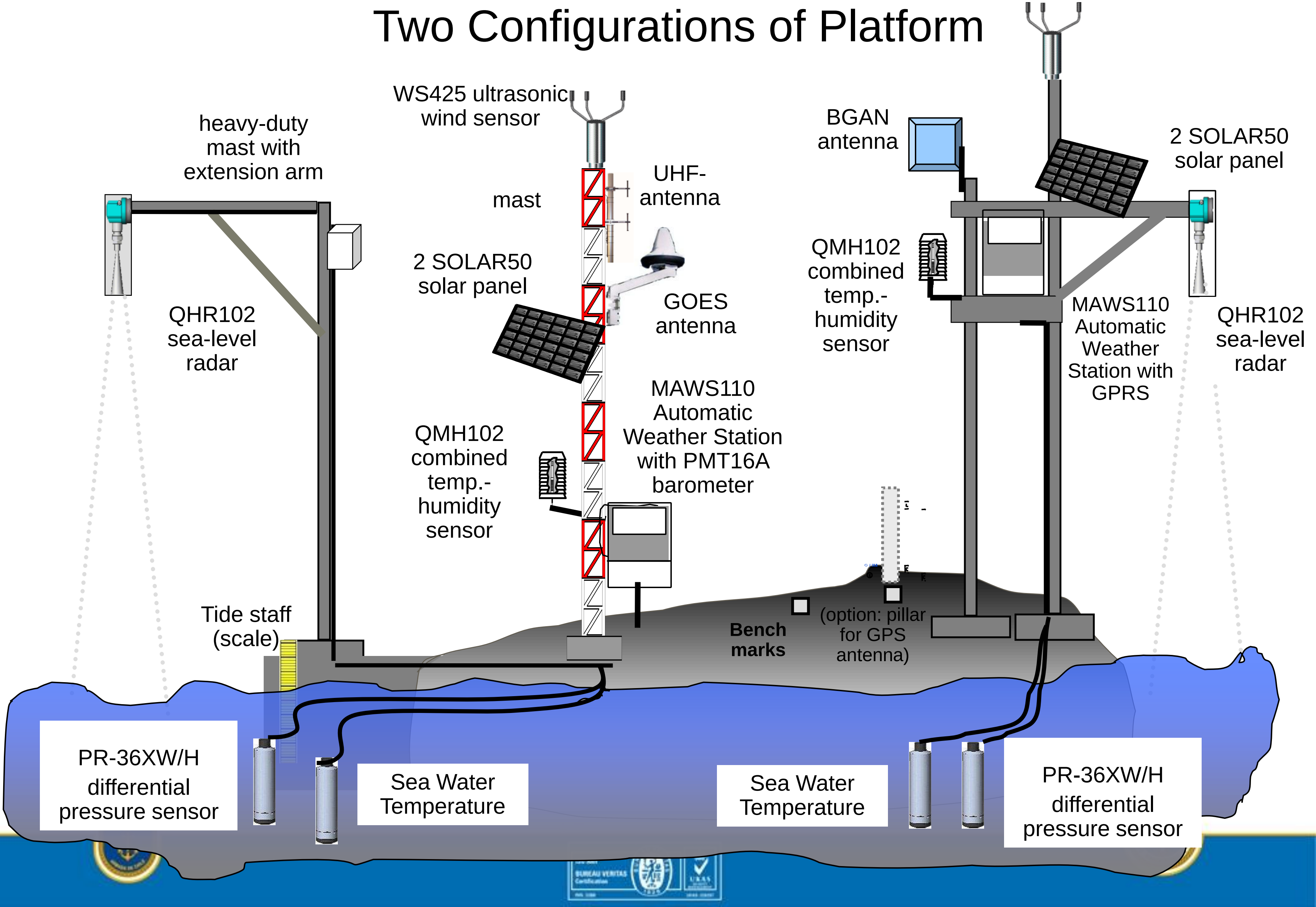
GOES and VPN (13)

GOES (5)

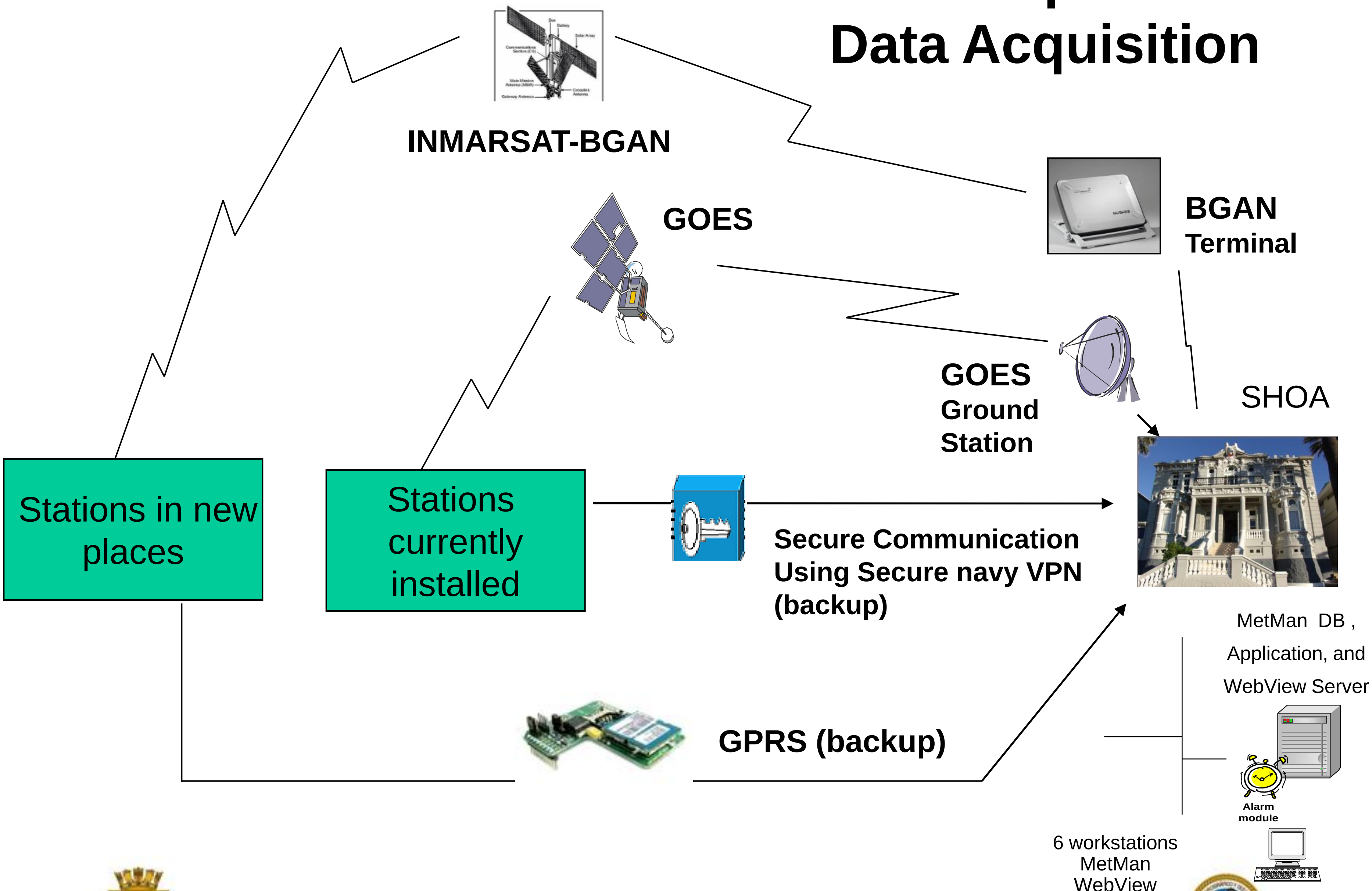
BGAN and GPRS (13)

Tide Station for Tsunami Monitoring

Two Configurations of Platform

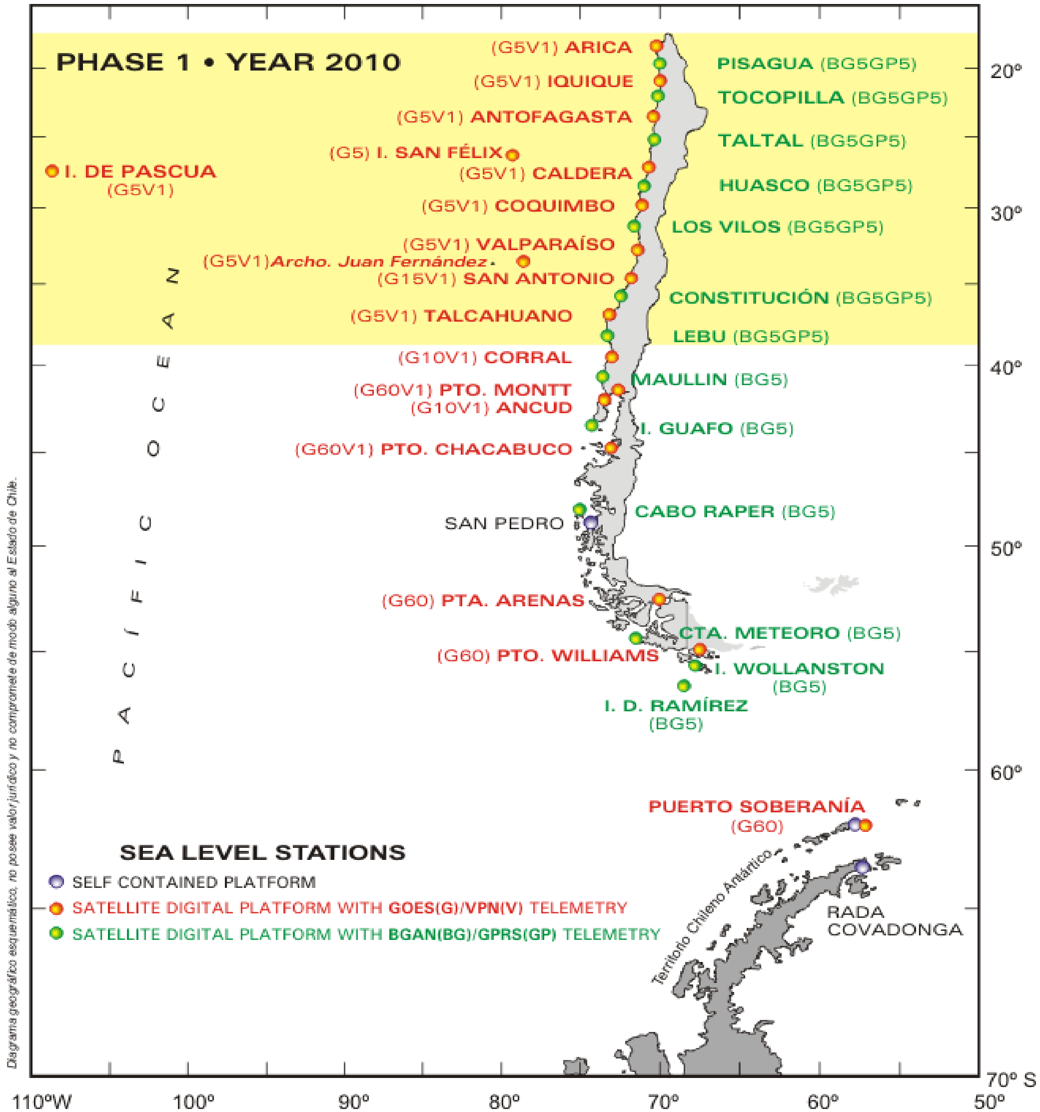


SHOA Operational Data Acquisition



Chilean Sea Level Network

Future Telemetry Options and Data Transmission Frequency



FUTURE PLANS

- Implementation of alternative systems for real time data transmission using several telemetry options (GOES, BGAN, GPRS and a Wide Area Network) basically as a contribution to the National Tsunami Alarm System operation.
- A new configuration considering VEGA radar sensor as a secondary sea level sensor mantaining a Differential Pressure Transducer as the primary sensor and ancillary sensors.
- By the end of May 2010, to initiate the replacement of VAISALA DCP model 555C by the new MAWS 110 model in stations already operating and densify the chilean sea level network with new stations.
- To Improve the data reception system at SHOA, suitable to several telemetry options transmitting at high frequency rates.

THANKS