Sea level changes at Tenerife Island (NE Tropical Atlantic) since 1927

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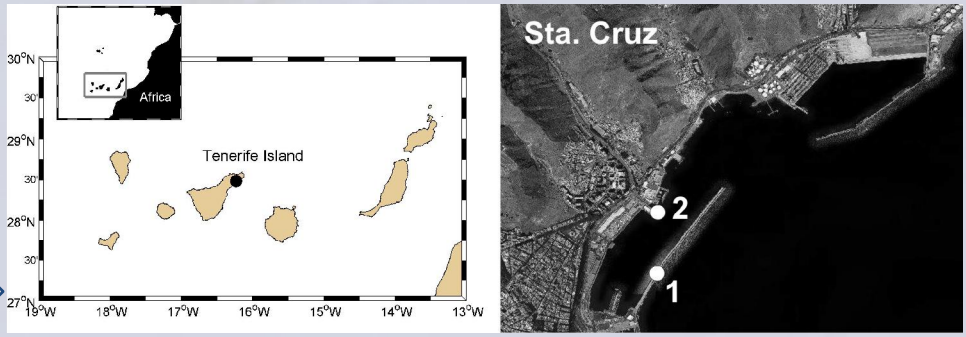
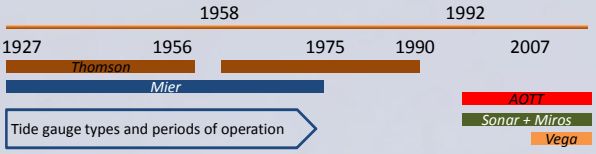
Hourly sea level observations measured by five tide gauges at Santa Cruz harbor (Tenerife Island), in the Northeastern Tropical Atlantic, have been merged to build a consistent and almost continuous sea level record starting in 1927. Datum continuity was ensured using high precision leveling information. The time series underwent a detailed quality control in order to remove outliers, time drifts, and datum shifts. The resulting sea level record was then used to describe the low frequency (interannual to decadal) sea level variability at Tenerife.



Left: Location of Tenerife Island and Santa Cruz harbor (black dot)
Right: View of Santa Cruz and location of the tide gauges

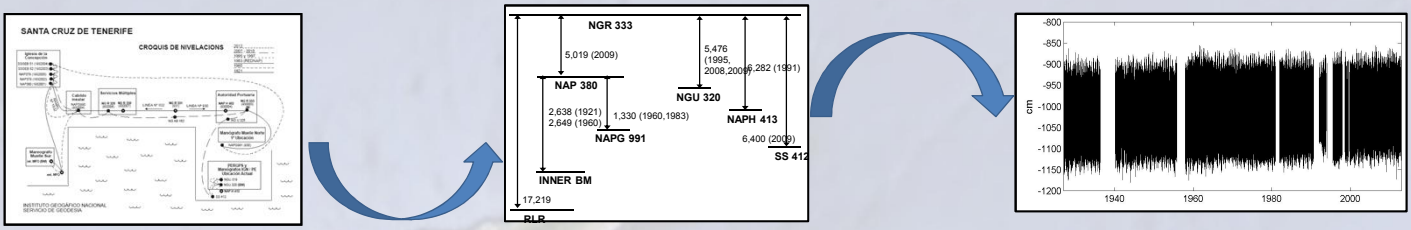
The tide gauges



Tide gauge types and periods of operation

Sea level observations were obtained from five tide gauge records. Hourly sea level data for 1927-1990 from *Thomson* tide gauge correspond to hand written observations from tidal charts that were digitized and converted into electronic format. The same applies to *AOTT* until 1997. These rescued observations were calibrated based on the "tide gauge constant", i.e. the difference between non calibrated values and the actual distance of sea level to the benchmark. For the rest of the more recent observations, data were acquired as a digital output and no calibration was needed.

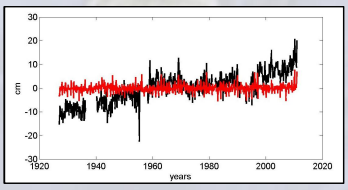
Datum continuity: a single long sea level record



High precision leveling information (left figure) was used to link the benchmarks of the different instruments and compute accurately their relative heights (middle figure)

All sea level observations were referred to the common benchmark NGR333, which was considered as the most adequate due to its stability and location close to the modern tide gauge. The result was a **consistent hourly sea level record for the period 1927–2012** (right figure).

The atmospheric contribution

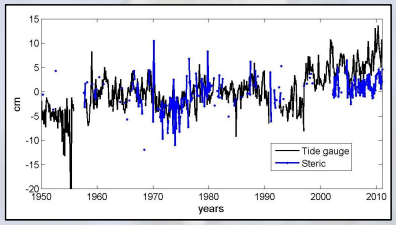


Monthly sea level (black) and barotropic contribution (red)

The barotropic response of sea level to the combined effect of atmospheric pressure and wind was calculated using a multiple regression adjustment. This contribution accounts for 9% of the non-seasonal monthly variance

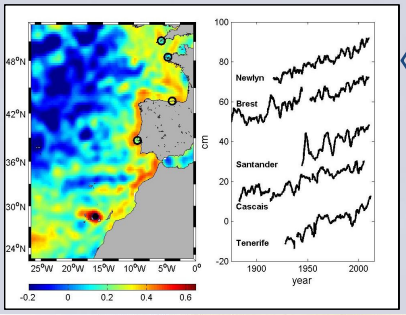
Monthly sea level (black) and steric contribution (blue) since 1950

The steric contribution



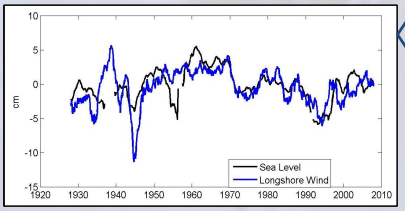
Steric sea level computed from individual hydrographic profiles shows a good correspondance with observed sea level. For the common period 1950–2011 the atmospherically corrected sea level trend was 1.5±0.1 mm/yr, while the steric sea level trend was 0.8±0.1 mm/yr.

Regional sea level



Left: Correlations between Tenerife time series and sea level anomalies from altimetry and other tide gauge records.
Right: Tide gauge records smoothed using 2 year running average.

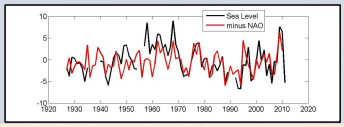
Correlations of 0.4–0.5 were found over the continental shelf. This coherent signal along the continental coast was consistent with a response of sea level to the integrated longshore winds along the coast. Therefore, the correlations suggest that sea level is related to steric variability driven by longshore winds.



Detrended and smoothed (2 year running mean) sea level at Tenerife (black) and integrated longshore wind at 28ºN (blue)

Changes in steric sea level associated with longshore wind forcing of the thermocline are dominant at decadal scales. The correlation is 0.8 when only the period from 1958 onward was considered.

Such large scale impact is also reflected in the relation of winter sea level at Tenerife and the winter NAO index with a correlation of 0.56.



Highlights

- A new hourly sea level record starting in 1927 has been constructed using observations from five different tide gauge records, all of them located at Santa Cruz harbor in Tenerife Island.
- Interannual and decadal sea level variability at Tenerife is mostly of steric origin, which in turn is controlled by longshore winds linked to large scale atmospheric forcing.
- The signal was present at Tenerife despite being a few hundreds of kilometers off the continental coast, therefore suggesting that the waves generated by longshore winds may propagate from the eastern boundary through the open ocean to the western boundary.