# The sea level at Port-aux-Français, Kerguelen Island, from 1949 to the present

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## Historic observations

We know that all throughout the twentieth century, there were expeditions to Kerguelen Island for many different purposes: exploration of the archipelago, local fisheries and establishment of human colonies. However, extensive scientific work really began at Kerguelen when a permanent base was established at Port-aux-Français in 1950. The first well-documented sea level observations at Kerguelen come from the French National Hydrographical and Oceanographic Service (hereafter SHOM). The first important hydrographic survey by SHOM took place at Kerguelen at the end of 1949 remained at Port-aux-Français from 23 November 1949 until 31 January 1950. During this period, a tide pole was installed and referenced to a South African penny embedded on the rock (Fig. 1). This penny is still the fundamental benchmark for Kerguelen and defines the hydrographic data or zero level (3.07 m below this benchmark). The sea level measured at that time is considered as the first reliable MSL estimate at Port-aux-Français (referred to as SHM0 in Table 1). At the beginning of the 1960s, a significant campaign was undertaken by the French National Geographic Institute (hereafter IGN), and remained at Kerguelen for a number of years (1961–1965) in order to establish the first complete and precise map of the island (Guichard 1966). One of the essential objectives of this campaign was to accurately estimate the MSL to establish the height reference for the island. IGN operated a new tide pole only a few metres from the original one and install a float gauge. Then from April to December 1962, tide pole readings were compared to simultaneous float gauge records. The mean difference of these two records is <1 cm. This second estimate of the MSL is conseidered as the reference for our study. After this record, there was a 30-year data gap at Port-aux-Français. The scientific interest to measure in situ sea level in that region was rekindled with the World Ocean Circulation Experiment (WOCE) and the emergence of ambitious satellite altimetry programs during the 1980s. The particular interest on in situ tidal measurements at islands and in the deep ocean led to a valuable collaboration between Christian Le Provost's team at Grenoble and the Proudman Oceanographic Laboratory of Liverpool, where the latter had long-standing experience in bottom pressure record (BPR) deployment. These common efforts to study the Southern Ocean using BPR technology found their expression as national networks by the creation of the Antarctic Circumpolar Levels from Altimetry and Islands Measurements network (see Spencer et al. 1993) for the UK and the Réseau d'Observation Subantarctique et Antarctique du niveau de la MEr (ROSAME) network for France.

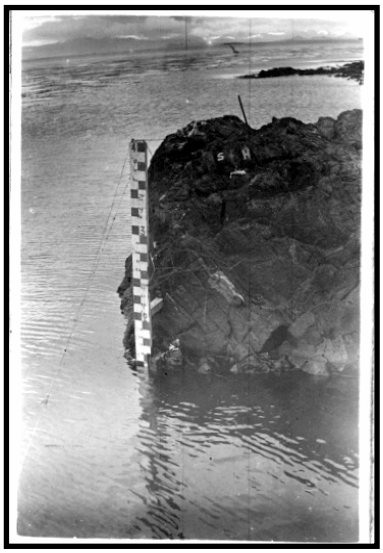
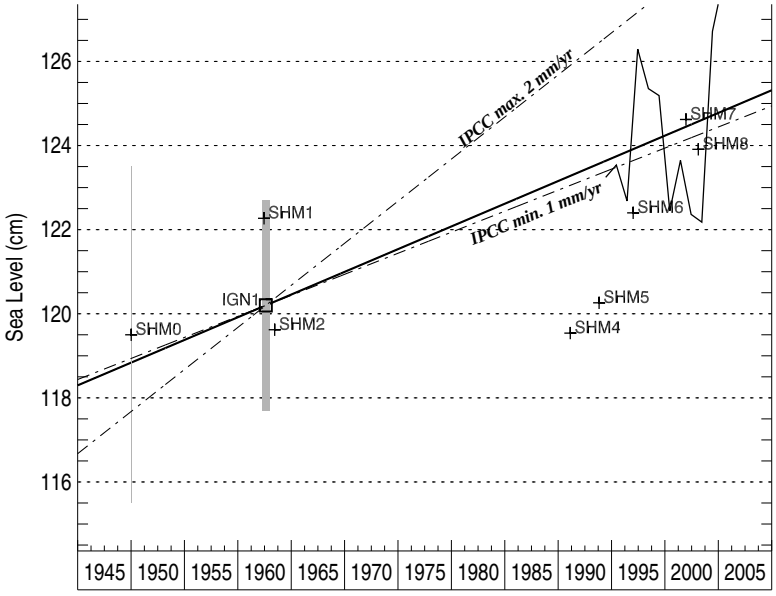


Photo of the first tide pole installed at Port-au-Français by the SHOM in December 1949




Relative sea level trend at Port-aux-Français, Kerguelen Island, since 1949. The sea level is expressed in centimetres above the reference. The eight crosses, named SHM0–SHM8, correspond to the MSL computed over the period indicated in Table 1. The bold square IGN1 indicates the MSL measured in 1962 in order to establish the zero data for Kerguelen. This level is the reference for the estimate of the sea level trend. The grey rectangular box illustrates the uncertainty of the MSL estimate at this time. The width of the box shows the duration of the observation, and its height provides an estimate of the uncertainty based on annual and interannual variabilities (annual=±4 cm; interannual=±1.9 cm). The black curve on the right represents the annual means of the ROSAME permanent tide gauge for the 1994–2004 period. The two dash–dotted lines indicate the upper and lower estimates of the rate of global average sea level rise (Church et al. 2001). The central black line is our estimate of the relative sea level trend at Kerguelen

This Figure provides the height of Mean Sea Level from all available data sets. A simple trend estimate of sea level (relative to land at Kerguelen) from historical data provided only by the SHOM data set (i.e., daily means of SHM1, SHM2, SHM4, SHM5, SHM6, SHM7 and SHM8) leads to a relative sea level trend of 0.5±0.2 mm/year. This pre-liminary estimate is dubious partly because of the lack of information on the early data sets SHM1/2. Merging the SHOM data set and ROSAME annual means leads to a revised relative sea level trend estimate of 0.3±0.2 mm/year. Because of the low confidence in some of the SHM data sets and because of the high annual and interannual variabilities observed at Kerguelen, we have chosen to compute the sea level trend from the two most accurate and representative MSL data sources. The first one is the MSL (120.2 cm), established in 1962, which is used to define the zero data for Kerguelen (from a year of tide pole readings with tide gauge comparisons). The other reliable value is the MSL (centred in 1999), derived from 11 years of data available from the ROSAME Kerguelen tide gauge (124.3 cm). The relative sea level trend for this 38-year period is 1.1 mm/year. As expected, the main source of uncertainty is linked to high interannual sea level variability. This oceanic variability prevents us from giving an accurate estimation of sea level trend derived from 'short' individual tide gauge records. If we assume an error of one standard deviation of interannual variability (1.9 cm) in sea level difference, the uncertainty on the sea level trend for the same 38-year period is about 0.7 mm year−1.

For more information see the related paper:

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