Analysis of the mean sea level from a 50 years tide gauge record and GPS observations at Cananéia (São Paulo-Brazil)

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1. Introduction

A preliminary comparison of the results obtained from GPS observations at Cananéia, an estuary city (= -25° 1'12.9", = -47° 55'29.9", h = 6.06m; ITRF2000), and the results obtained from the application of the program VAV on the ocean tide (OT) data from the tide gauge of the same site is presented. The main objective is to estimate the absolute variation of the mean sea level.

The Cananéia Base was founded in 1954, and it's supported by the Oceanographic Institute of the University of São Paulo, Brazil. This station is part of GLOSS (Global Sea Level Observing System) under number 194. A tide gauge AOTT is in operation since then. In 2002, a pillar was built to install a GPS antenna near the tide gauge. Up to now, except for some gaps due to operational problems, a time series of 30 months of dual frequency GPS data is available. Spirit leveling is carried out frequently between the tide gauge and GPS pillar.

2. Processing and analysis of GPS data

Figure 1: Cananéia GPS site.

The processing of GPS data was made by AUSPOS, an online GPS processing service. It uses International GNSS Service (IGS) products, Precise Orbits and Coordinate Solutions (IGS-SSC), to compute precise coordinates in ITRF2000 anywhere on Earth. This service uses some models to correct the displacements due to some effects. However, no corrections for the ocean tide and atmosphere loading are applied, which may cause vertical displacements of several centimeters. It's a free service and designed to process only dual frequency GPS phase data. For more information, see http://www.ga.gov.au/geodesy/sgc/wwwgps/.

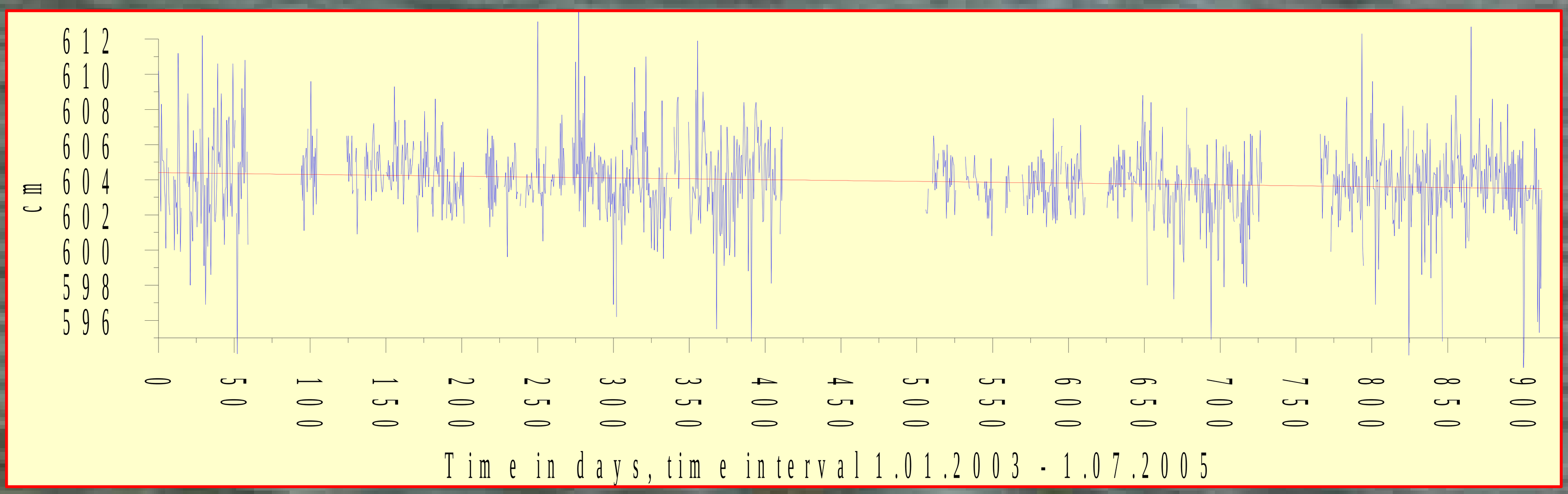

Figure 2: Geometric height after eliminating of some discrepancies.

Figure 2 shows the time series of the geometric height derived from GPS data after eliminating some discrepancies. The estimated velocity of the vertical Earth crust movement (presently sinking) through a linear regression is b_1 = -0.38 ± 0.11 cm/year.

3. Analysis of ocean data

The computation of the MSL variations require the evaluation of all the periodic components i.e., regular tides deriving directly from the tidal potential, shallow water components, radiation tides, and other geophysical effects, such as the ocean pole tide. It is necessary to identify all of them in order to have a complete model for the Least Squares adjustment. An automatic research algorithm allowed to find all the radiation tides with period larger than one year.

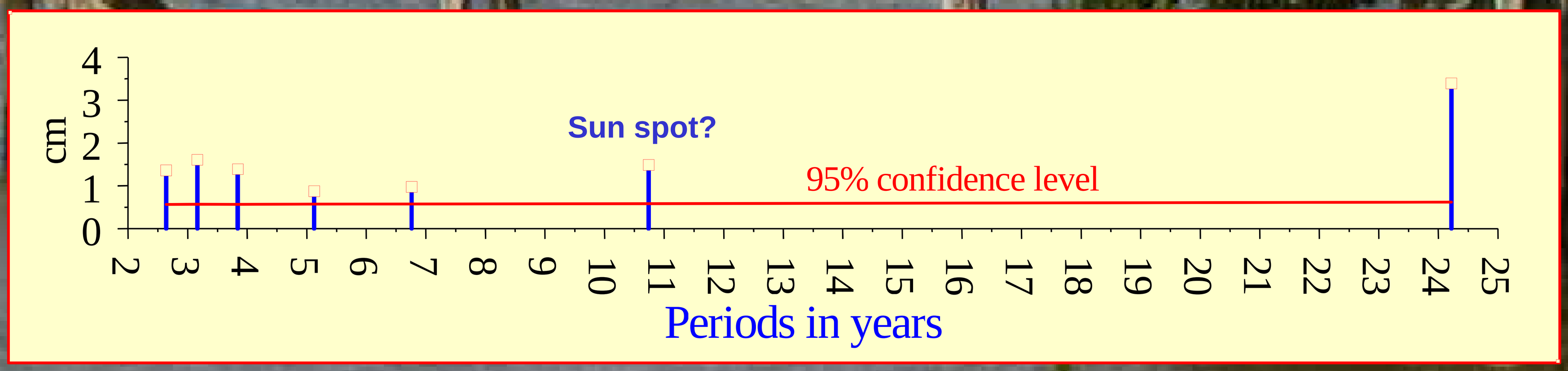

Figure 3: Amplitude of all very long period components

Their contribution is far from being negligible: (15cm peak to peak).

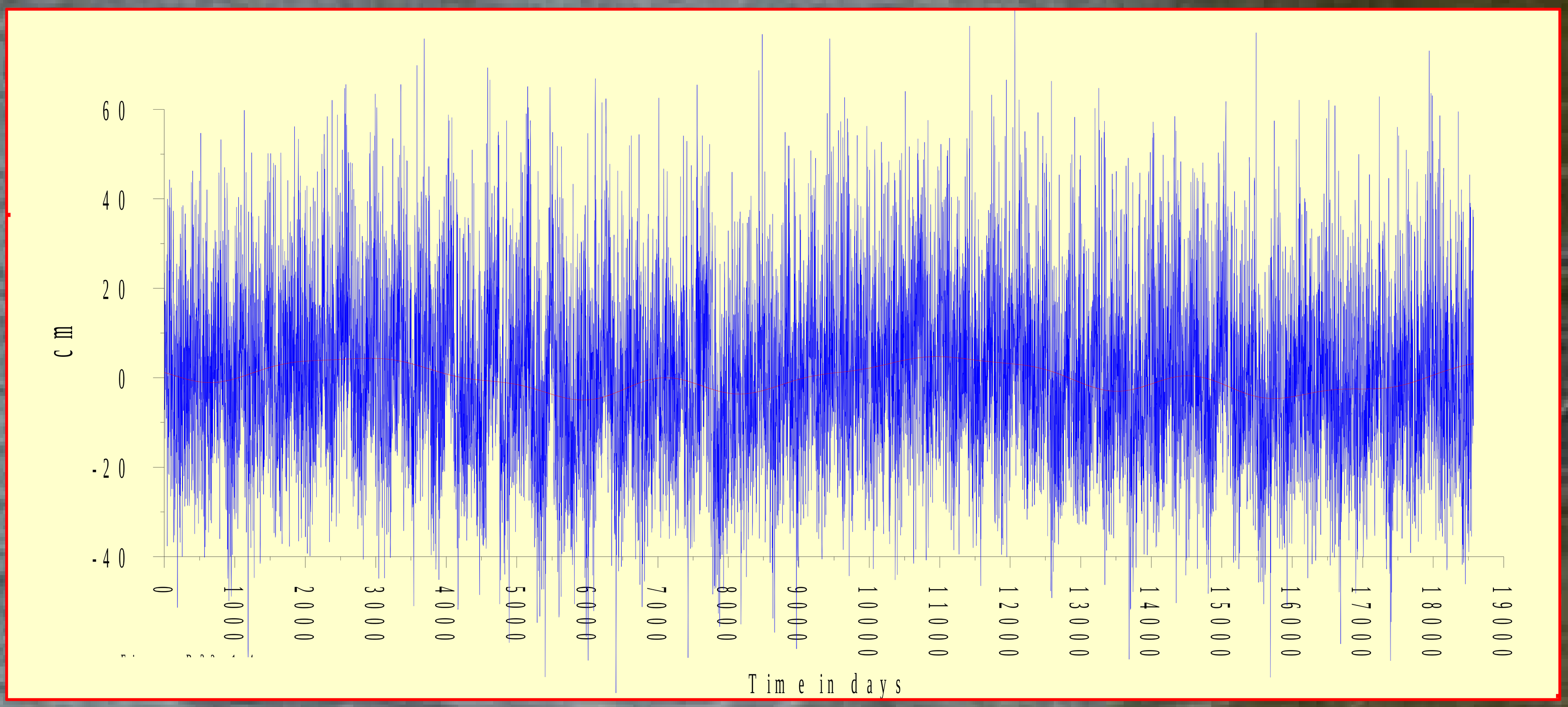

Figure 4: Comparison between the effect of the long period constituents (red curve) with the data (blue curve), after subtraction of the linear trend in the MSL variations.

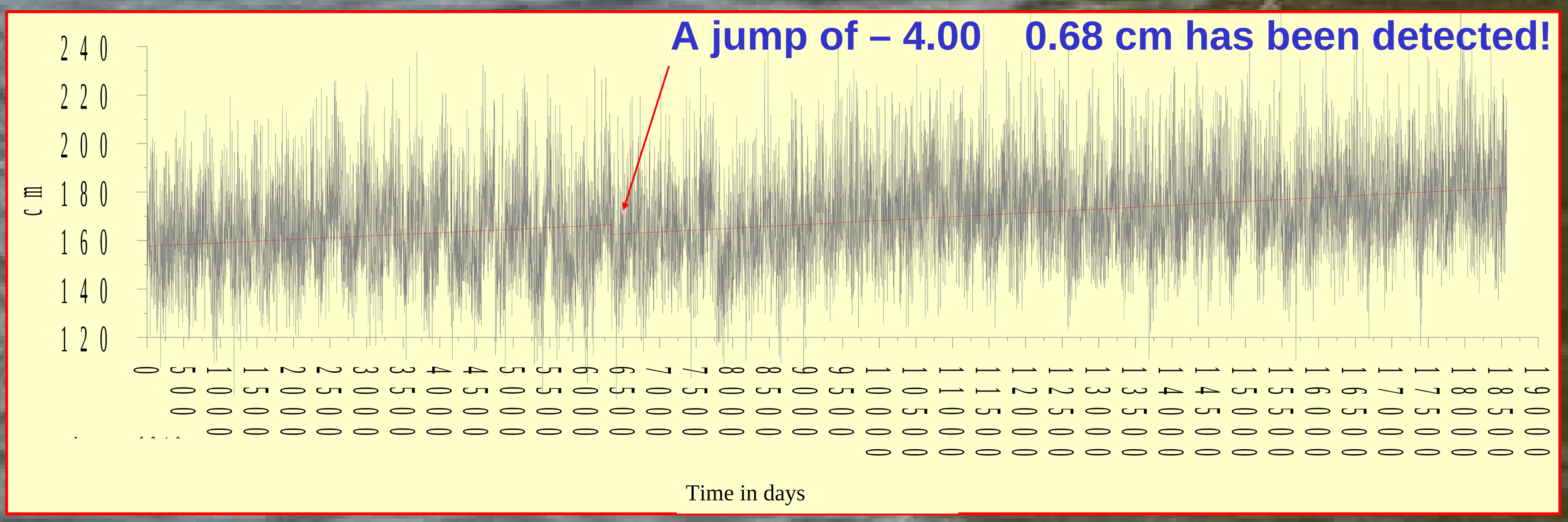

Figure 5: The mean sea level during 50 years (26.02.1954 – 31.12.2004).

After correction of the jump, which corresponds to interpolated data, we get the following representation for the MSL: $L(T)=a_0+a_1T$

- a_0 = 171.279 ± 0.094 cm at the central epoch 01h 31.01.1979, and;
- a_1 = 0.5666 ± 0.0070 cm/year (velocity of the of MSL rise).

4. Conclusions

The absolute value of the regression coefficient b_1 is not significantly different from the MSL rise velocity estimated by the program VAV. This means that the established rise of the sea level is most likely due to the sinking of the Earth crust. Of course, this conclusion needs to be confirmed by the accumulation of a larger quantity of GPS data.