Florida Institute of Technology Report:

Florida's Changing Sea Level

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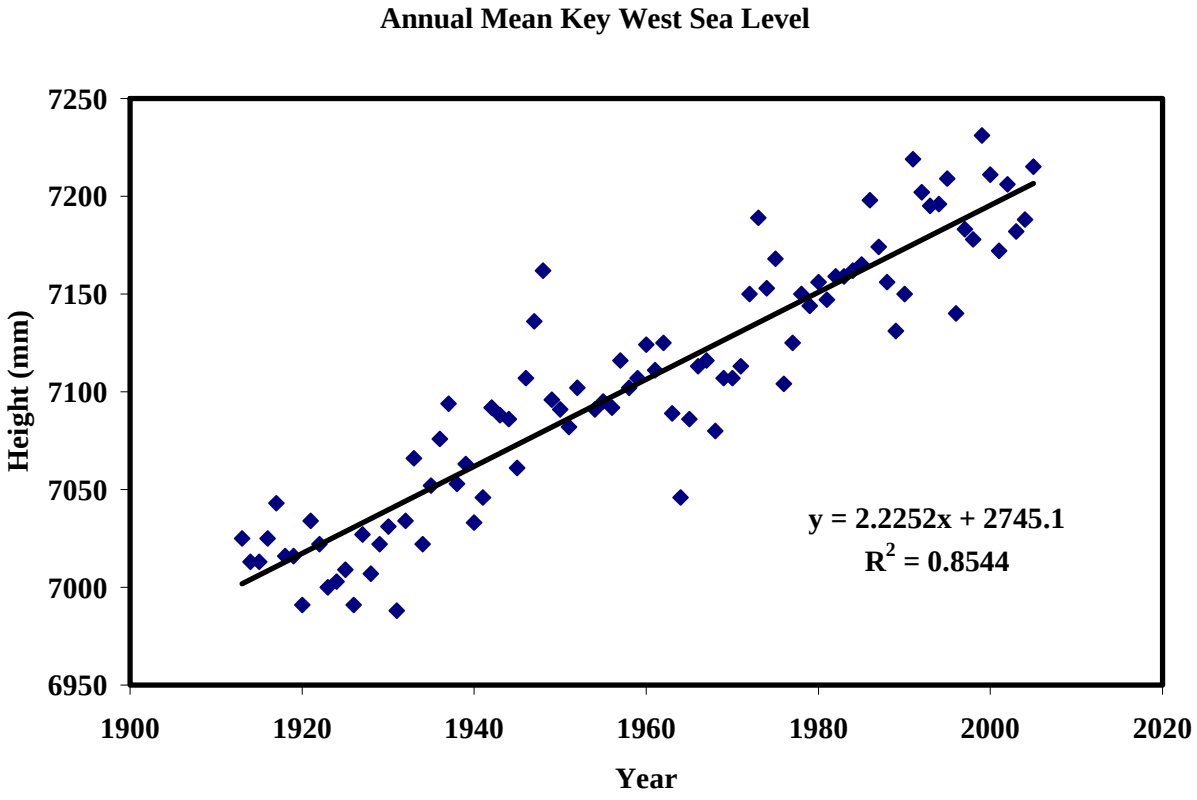
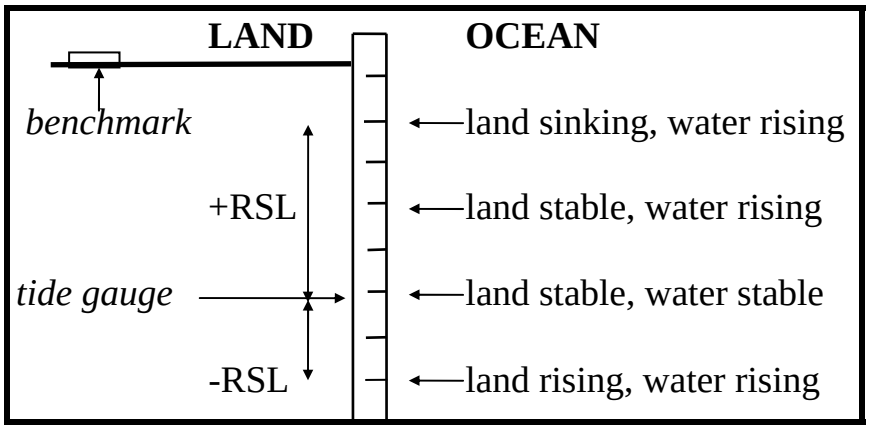
(The opinions expressed by the author in this article are not necessarily those of FSBPA)

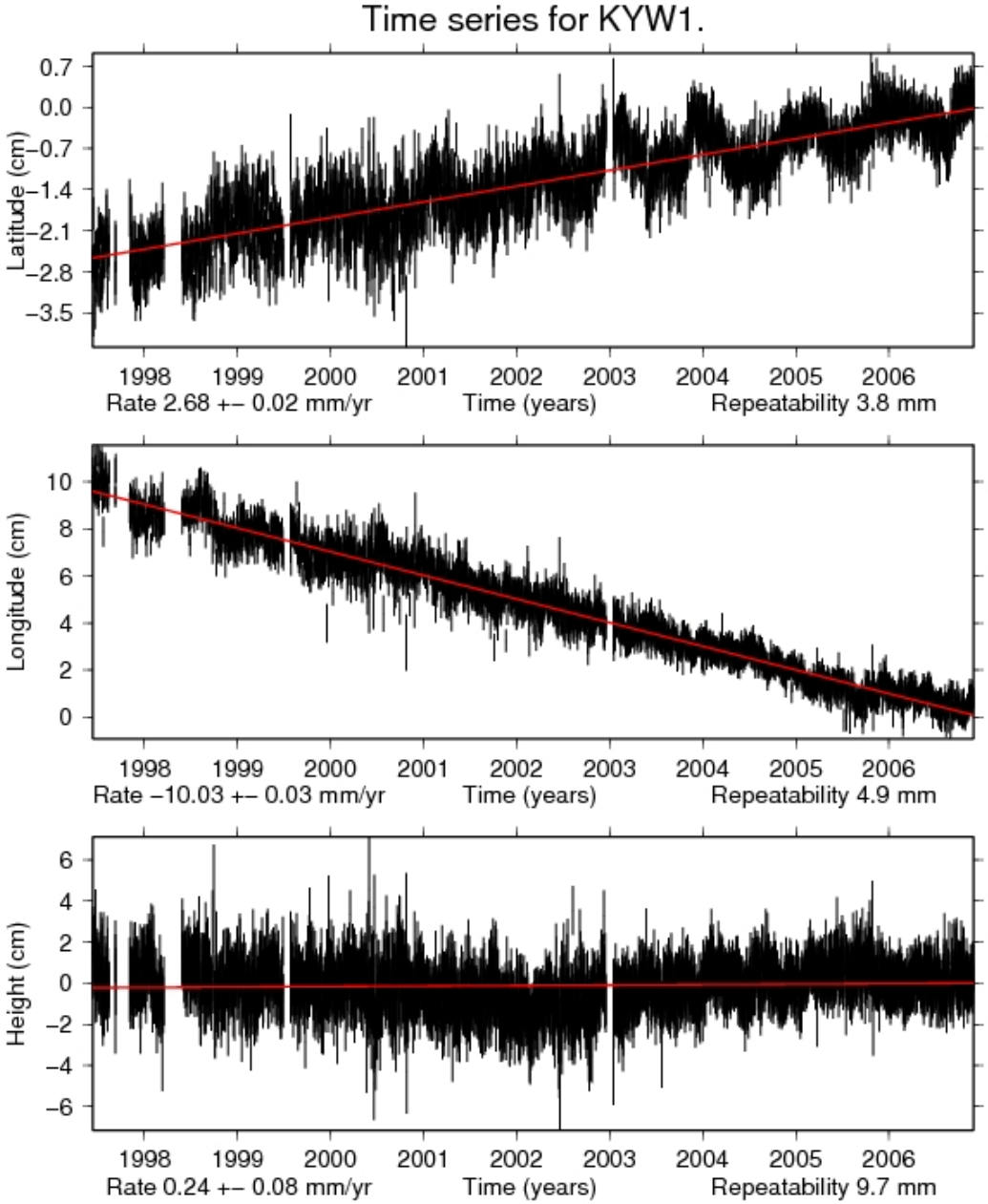
Key West has the distinction of being the Western Hemisphere's longest sea level record. It dates back to 1846, and although it has several multi-year gaps, it shows a long-term trend of rising sea level of about +2 mm per year. Records such as those at Key West are a measure of the ocean's surface relative to fixed survey points on land called benchmarks, and is titled relative sea level (RSL). Changing sea level is a study of the inter-annual trends calculated by a linear least-squares fit to monthly or annual means as shown below for Key West (data from the Permanent Service for Mean Sea Level).



RSL is a combination of several factors including the rise or fall of the sea surface due to variations in salinity and/or temperature, vertical land motion, and changes in currents, winds, barometric pressure, bottom topography, long-period tides, *etc*. If the land is sinking, RSL will appear to be rising even if the water level isn't changing height due to the other factors; similarly if the land is rising RSL will fall all other things being equal as shown in the drawing below.



Geodetic technology, such as the Global Positioning System (GPS) is setting the stage to directly measure the land motion, and thus remove one of the largest uncertainties in separating absolute sea level change from RSL. Vertical and horizontal land motion is being monitored by permanent GPS receivers in a network called CORS, the Continuously Operating Reference Stations. An example of a CORS dataset for Key West is shown below (KYW1 data from NASA's Jet Propulsion Laboratory).



The general effects of continental drift can be seen in the changing latitude and longitude (Key West and indeed much of Florida is moving west-northwest at a rate of about 10.4 mm/yr. Vertical motion at Key West is seen to be about +0.24 mm/yr, *i.e.* Key West is rising slightly. From a survey of CORS data (see table below), for the very short time periods of a decade or less and for only five stations, Florida may be sinking at a rate of about –0.5 ± 1.6 mm/yr. This very

preliminary value of –0.5 mm/yr with its very large uncertainty of ± 1.6 mm/yr, should be viewed very cautiously, but a sinking Florida is in general agreement with geophysical models of Earth's changing shape due to post-glacial rebound from the last ice age.

CORS Site	Symbol	Years	Rate (mm/yr)	Repeatability
Mobile Point AL	MOB1	1997-2006	–2.29±0.07	9.4 mm
Mac Dill AFB FL	MCD1	2001-2006	+1.71±0.16	8.3 mm
Key West FL	KYW1	1997-2006	+0.24±0.08	9.7 mm
Miami FL	MIA3	1998-2006	–0.17±0.09	8.8 mm
Cape Canaveral FL	CCV3	1999-2006	–1.94±0.09	10.4 mm

For most scientific, engineering, and ecosystem management purposes it is relative sea level that is of socioeconomic importance. RSL around Florida is rising but not at uniform rates. For example, St. Petersburg and Cedar Key have the two geographically closest long-term records, and yet they are the most different in RSL values. This is summarized in the table below.

Site	Years	Rate (mm/yr)	Uncertainty
Pensacola	1923-1999	2.2	± 0.2 mm/yr
Cedar Key	1914-1999	1.9	± 0.1 mm/yr
St. Petersburg	1947-1999	2.5	± 0.2 mm/yr
Key West	1913-2005	2.2	± 0.4 mm/yr
Miami Beach	1931-1981	2.4	± 0.2 mm/yr
Mayport	1928-1999	2.4	± 0.2 mm/yr
Fernandina Beach	1897-1999	2.2	± 0.1 mm/yr

The ensemble mean and standard deviation of these seven multi-decadal RSLs for Florida is +2.3 ± 0.2 mm/year, or about +9 inches per century. The ± uncertainty for each site is individually much less than the rate (Key West is 2.2 ± 0.4 mm/year for example), and thus the statistical certainty of the rate of sea level rise is very high. At the current ensemble rate it will take over 430 years for RSL to rise 1 meter around Florida.

In their 2007 report, the Intergovernmental Panel on Climate Change (IPCC) suggest that global sea level between 1900 and 2000 has risen 16 cm. If this 16 cm per century applies to Florida waters, then the difference between 23 cm per century from Florida RSL is 8 cm per century. The CORS data suggest 5 cm per century, a value not much different and consistent with the notion that Florida is sinking.

Absolute sea level rise around Florida (the difference between RSL and land motion) is much less certain because of the shortness and repeatability (precision) of the CORS records. However these very preliminary data paint a general picture for Florida and that is sea level has been rising steadily for at least 160 years, and will most likely continue to do so into the future. Whether or not the rate of rise changes in a changing climate is not known from these data.

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