

TEMPERATURE & EXPANSION

Unit 19 Dr. John P.

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Seas Are Rising at Fastest Rate in Last 28 Centuries



Juan Carlos Sanchez paddled a kayak with his shoes on a flooded street in Miami Beach last year.

INTRODUCTION: Function of this application is to show with a $\Delta F^\circ = -1/3$ degree (5/27 deg. $\Delta C = -0.185^\circ$) oceans drop 3 inches. The 11.1 table below show researchers use the top 2000 meters of ocean as volume which expands or contracts with temperature change. β is coefficient of volume expansion. $\Delta V = \beta V \Delta t$, $V = (\text{Vol. of top layer of oceans}) = A \cdot 2000 \text{ m.}$, $A = 4\pi r^2$, $r = 6353 \text{ km}$ Where $\Delta V = \Delta h A$, where $\Delta h = \text{change in ocean depth.}$

$$\Delta h (A) = \beta (2000) A (\Delta t)$$

QUESTIONS: (a) $\beta = 0.000214/^\circ\text{C}$ for water, find Δh drop of oceans depth(m.)? (b) convert Δh in meters to inches? **HINTS:** 39.37 inch/m.,

ANSWERS: (a) 0.07918 m., (b) 3.1 inch

COMMENT: Quite amazing! The article says with $\Delta F = -1/3^\circ\text{F}$, $\Delta h = 3 \text{ inch}$, close

The worsening of tidal flooding in American coastal communities is largely a consequence of greenhouse gases from human activity, and the problem will grow far worse in coming decades, scientists reported Monday. Those **emissions, primarily from the burning of fossil fuels, are causing the ocean to rise at the fastest rate since at least the founding of ancient Rome**, the scientists said. They added that in the absence of human emissions, the ocean surface would be rising less rapidly and might even be falling. The increasingly routine tidal flooding is making life miserable in places like Miami Beach; Charleston, S.C.; and Norfolk, Va., even on sunny days. The ocean is extremely sensitive to small fluctuations in the Earth's temperature. The researchers found that **(((when the average global temperature fell by a third of a degree Fahrenheit in the Middle Ages, for instance, the surface of the ocean dropped by about three inches)))** in 400 years. When the climate warmed slightly, that trend reversed. "Physics tells us that sea-level change and temperature change should go hand-in-hand," Dr. Kopp said. "This new geological record confirms it." **In the 19th century, as the Industrial Revolution took hold, the ocean began to rise briskly, climbing about eight inches since 1880.** That sounds small, but it has caused extensive erosion worldwide, costing billions. Due largely to human emissions, global temperatures have jumped about 1.8 degrees Fahrenheit since the 19th century. The sea is rising at what appears to be an accelerating pace, lately reaching a rate of about a foot per century.

Table 11.1: Summary of observations of interior ocean temperature changes and steric sea level rise during the 20th century.

Reference	Dates of data	Location, section or region	Depth range (m)	Temperature change (C/century)	Steric rise (mm/yr) (and heat uptake)
North Atlantic Ocean					
Read and Gould (1992)	1962-1991	55 N, 40-10 W	50-3000	-0.3	
Joyce and Robbins (1996)	1922-1995	Ocean Station S 32.17 N, 64.50 W	1500-2500	0.5	0.9 (0.7 W/m ²)
Joyce et al. (1999)	1958, 1985, 1997	20 N-35 N 52 W and 66 W		0.57	1.0
Parilla et al. (1994), Bryden et al. (1996)	1957, 1981, 1992	24 N	800-2500	Peak of 1 at 1100 m	0.9 (1 W/m ²)
Roemmich and Wunsch (1984)	1959, 1981	36 N	700-3000	Peak of 0.8 at 1500 m	0.9
Arhan et al. (1998)	1957, 1993	8 N	1000-2500	Peak of 0.45 at 1700 m	0.6
Antonov (1993)	1957-1983	40 N 70 N	0-500	Cooling	
			800-2500	0.4	

Contribution [mm/year]	1961-2003	1993-2003
Thermal Expansion	0.42±0.12	1.6±0.5
Glaciers & Ice Caps	0.50±0.18	0.77±0.22
Greenland	0.05±0.12	0.12±0.07
Antarctica	0.14±0.41	0.21±0.35
Sum	1.1±0.5	2.8±0.7
Direct Observations	1.8±0.5	3.1±0.7

Table 1: Individual contributions to global mean sea level rise for the periods 1961-2003, and 1993-2003 (Source: IPCC 2007,