

# FLUIDS

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## Lessons From Underwater Miami



**INTRODUCTION:** The goal of this application is to verify the oceans would rise 260 ft. if Greenland & Antarctica ( $2.85 \times 10^6 \text{ km}^3$  &  $26.5 \times 10^6 \text{ km}^3$  of ice respectively from Wikipedia) melted. The density of ice  $\rho_{\text{ICE}} = 934 \text{ kg./m}^3$ .  $\rho_{\text{WATER}} = 1000 \text{ kg./m}^3$  71% of earth's surface is ocean. Radius of earth is  $6.371 \times 10^6 \text{ m}$ . Area of a sphere =  $4\pi r^2$  Let  $h$  = depth oceans rise due to melting of Greenland & Antarctica.  $A_{\text{OCEANS}} = 0.71 A_{\text{earth}}$ , Thus, the volume of ocean increase due to the melting of Greenland & Antarctica =

$$h A_{\text{OCEANS}} = V_{\text{ice melted now liquid}}$$

**QUESTIONS:** SEE BELOW

IN Miami's fashionable financial district, a slab of limestone juts out of the ground beneath the elevated tracks of the commuter rail line, across the street from a new apartment building. The pockmarked rocks sit about 25 feet above sea level. But 120,000 years ago, this limestone outcrop was part of a white sandy shoal beneath a sea that covered the lower third of Florida. "If one wants to see evidence of a higher sea, downtown Miami is a good place," said Daniel Muhs, a United States Geological Service geologist who has studied these rocks from the **Eemian Interglacial Period, which began about 130,000 years ago and ended 15,000 years later.** Using computer models, the Intergovernmental Panel on Climate Change estimated in 2013 that with continued high emissions, **seas will rise by about one and a half feet to three feet by the end of the century.** The team predicts in a worst-case scenario, up to five to six feet of sea level rise by the end of the century, roughly double what the [climate change](#) panel has projected. Dr. Hansen's team predicts, more ominously, "several meters" of sea level rise over the next 50 to 150 years. (One meter equals about 3.3 feet.) The mechanism for warming in the Eemian was different than today: Rather than greenhouse gases, **the wobble of the planet was responsible, exposing the Northern Hemisphere to more sunshine.** It's not a perfect match to our situation, but the consequences might be the same.

And sea rise during the Eemian has nothing on earlier periods. Millions of years ago, **during epochs when it was 3 to 4 degrees Celsius (5.4 to 7.2 degrees Fahrenheit) warmer than it is today, sea levels were 50 to 80 feet higher.** When it was moderately warmer than that, there was no ice at the poles whatsoever. "So a simple way that I look at this is that we know that **with pretty good confidence that roughly 4 to 5 degrees Celsius warming is what it took to get us to, say, 40 million years ago, (((when Antarctica was completely melted and Greenland was completely melted)))**. Dr. White, the Colorado geologist, said. **(((“In rough numbers that was about 80 meters of sea level rise,” or about 260 feet)))**. **World leaders hope to limit warming to 2 degrees Celsius by the end of the century.**

**QUESTIONS:** (a) Find combined all ice in Greenland & Antarctica to  $\text{km}^3$ ?, (b) Convert all the ice in Greenland & Antarctica to  $\text{m}^3 = V_{\text{ICE}}$ ?, (c) Find volume of ice which is now water? NOTE:  $m_{\text{ICE}} = m_{\text{ICE WATER}}$ ,  $\rho_{\text{ICE}} V_{\text{ICE}} = \rho_{\text{ICE WATER}} V_{\text{WATER}}$ . Thus,  $V_{\text{WATER}} = (\rho_{\text{ICE}} / \rho_{\text{ICE WATER}}) V_{\text{ICE}} = (934/1000) V_{\text{ICE}} = 0.934 V_{\text{ICE}}$   
(d) Find area of all the oceans in  $\text{m}^2$ ? (e) Find height ( $h$ ) oceans would rise if Greenland & Antarctica melted?  
(f) Convert  $h$  in meters to feet?

**HINTS:** 3.37 ft./m.,  $h A_{\text{OCEANS}} = V_{\text{ice melted now liquid}}$ , Area of sphere =  $4 \pi r^2$

**ANSWERS:** (a)  $29.35 \times 10^6 \text{ km}^3$ , (b)  $29.35 \times 10^{15} \text{ m}^3$ , (c)  $27.412 \times 10^{15} \text{ m}^3$ , (d)  $362.15 \times 10^{12} \text{ m}^2$ , (e)  $\sim 75.7 \text{ m}$ .  
(f)  $\sim 255 \text{ ft}$ . **COMMENT:** The article states oceans would rise 260 ft. Your calculations got 255 ft. CLOSE!