

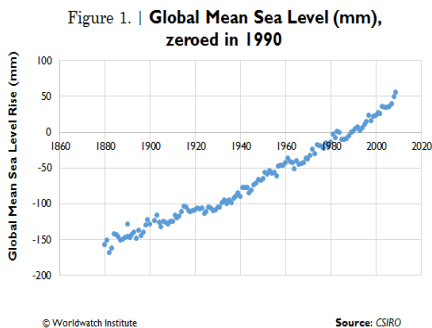
HEAT, TEMPERATURE, EXPANSION

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As Rising Seas Erode Shorelines, Tasmania Shows What Can Be Lost

ISLE OF THE DEAD, Tasmania — The [island](#) on which he lies is being chewed away by the sea. The roots of trees that have stood for decades now dangle perilously over a fast-eroding shore. A few miles away, a seaside [coal mine](#) once worked by the convicts is under similar assault by the waves.



A sea-level benchmark, bottom right, on Isle of the Dead in Tasmania. Carved into the stone in 1841, the benchmark has been compared to modern measurements to show that the sea level in Tasmania is rising.

The ocean is rising in large part, of course, because people the world over have burned so much coal, pumping planet-warming carbon dioxide into the air. Convict ancestry was once a badge of shame in Australia, but now it is bragged about, and Port Arthur, a 19th-century prison that received some of the most incorrigible criminals in the British Empire, has become one of the country's premier tourist attractions. **Most of the excess heat trapped by human emissions of greenhouse gases is absorbed by the ocean, and the water expands as it warms, accounting for much of the rise in the sea over the past century.**

(((It has gone up about eight inches since 1880))) which sounds small, but has been enough in some places to cause extensive erosion, forcing governments to spend billions to cope. **The problem is worse in places where the land is also sinking, as in Venice and along much of the East Coast of the United States.** Over the long term, the rise of the sea appears to be accelerating because of runaway growth in greenhouse emissions, and scientists fear much bigger effects this century, perhaps so large they could ultimately force the abandonment of entire coastlines.

Source: Volkov, D. L., S.-K. Lee, F. W. Landerer, and R. Lumpkin (2017), Decade-long deep-ocean warming detected in the subtropical South Pacific, *Geophys. Res. Lett.*, 44, 927–936, doi:[10.1002/2016GL071661](https://doi.org/10.1002/2016GL071661).

Our planet has been warming at unprecedented rates, largely due to greenhouse gases trapping heat in our atmosphere. There's more heat entering the atmosphere than Our planet has been warming at unprecedented rates, largely due to greenhouse gases trapping heat in our atmosphere. There's more heat leaving, and the ocean plays a critical role in absorbing some of this extra energy. If it weren't for the ocean, the atmosphere would be warming much faster than its current pace. But where in the ocean is this heat going, and does it matter? **It is certain that the upper ocean (sea surface down to a ((depth of 2000 meters) has been warming by taking up heat from the atmosphere,** but whether or not this heat is making it down to the deep ocean is up for debate

INTRODUCTION: Goal with this application is to find ocean temperature rise since 1880 causing the oceans to rise about 8 inches (20.32 cm., 0.2032 m. = Δh) . $\Delta V = \beta V \Delta t$ where β = coefficient of volumetric expansion for water = $0.00015/C^\circ$, $V = A h$ = volume of water in oceans (71% of earth surface = A) where h = depth of ocean affected by surface temperature changes = 2000 m. (see research at left). $\Delta V = A \Delta h$ = (area of oceans) (change in depth)

Thus: $A \Delta h = \beta A h \Delta t$, Thus

$$\Delta h = \beta h \Delta t$$

QUESTIONS: Find temperature rise Δt of oceans causing ocean rise of ~ 0.2032 m. (~ 8 inches) since 1880?

ANSWER: $\Delta t = \sim 0.68 C^\circ$

COMMENT: Since 1880 NASA/EPA measured surface t change = $0.8 C^\circ$