

McDonald, Coursey, and Carter
reply: Our intent was to provide an overview of the types of instruments used to detect and identify illicit radioactive sources, and we hope we were successful in providing some information about the basic operational principles used in those instruments. The article was not intended to address the operational activities aimed at interdicting the transport of radioactive or other dangerous materials across all of our borders.

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More Notes on Global Warming

I was puzzled when I read the exchange of letters on global warming in the January 2005 issue of *PHYSICS TODAY* (page 13). George Smith suggested that the recent carbon dioxide increase could be the result of a century of global warming—in particular, by the degassing of the ocean. Spencer Weart answered (correctly, but see below) that scientists with the Intergovernmental Panel on Climate Change (IPCC) have calculated the budget between the carbon input with the sinks in different reservoirs of the carbon cycle: ocean, forest, soil, and so forth.

Besides technicalities implying that the global CO₂ budget still has second-order uncertainties, I'm surprised Weart didn't cite first-order proofs demonstrating that the recent CO₂ increase cannot be due to ocean warming. Those killing proofs are well-known in the climatology community—for example, in the IPCC—but it is crucial to emphasize them again for a wider audience.

The recent CO₂ increase—280 to 380 parts per million by volume between 1800 and 2005—is accompanied by three phenomena that completely rule out ocean warming as the main cause:

► Parallel decline of the ¹⁴C/¹²C ratio of atmospheric CO₂. Strictly speaking, this is the “Suess effect,” first observed, and correctly interpreted, by Hans Suess of the University of California, San Diego, in the early 1950s. The Suess effect occurs because fossil fuels do not contain ¹⁴C



Albert Einstein to Max Born¹

Translated by Irene Born Newton-John
 Commentary by Max Born [1882–1970]¹

Hedi [Born, Max's wife] had sent her play, A Child of America, to Einstein, asking his opinion.² Einstein's son-in-law, who had married the eldest of his stepdaughters, Ilse, was the then well-known and respected author and critic, Rudolf Kayser.

4 December 1926

Dear Born,

You will have to be a little patient. My son-in-law is certain to read the play, and I will write to you. But the poor man has to economize with his strength, as his heart is in poor condition. I have reminded him again to give an opinion on the play as soon as possible. I liked the beginning of the play very much, and I think its impact will not be lost on him.

Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the “Old One.” I, at any rate, am convinced that He is not playing at dice. Waves in three-dimensional space whose velocity is regulated by potential energy (for example, rubber bands) . . . I am working very hard at deducing the equations of motion of material points regarded as singularities, given the differential equation of general relativity.

With best wishes,

Yours,
 A. Einstein

Einstein's verdict on quantum mechanics came as a hard blow to me. He rejected it not for any definite reason, but rather by referring to an “inner voice.” This rejection plays an important part in later letters. It was based on a basic difference of philosophical attitude, which separated Einstein from the younger generation to which I felt that I belonged, although I was only a few years younger than Einstein.

References

1. M. Born, *The Born–Einstein Letters 1916–1955: Freindship, Politics and Physics in Uncertain Times*, Macmillan, New York (2005), p. 88. Original letter © The Hebrew University of Jerusalem, Israel.
2. For discussion of the relationship between Einstein and Max and Hedi Born, see N. T. Greenspan, *The End of the Uncertain World: The Life and Science of Max Born*, Basic Books, New York (2005).

precisely because they are fossil—much older than 10 half-lives of ¹⁴C.

► Parallel decline of the ¹³C/¹²C ratio of atmospheric CO₂. This phenomenon is linked to the fact that fossil fuels, forests, and soil carbon come from photosynthetic carbon, which is strongly depleted in ¹³C.

► Parallel decline in the oxygen concentration of the atmosphere, which is the inescapable signature of an oxidation of carbon. If ocean warming were responsible for the CO₂ increase, we should also observe an increase in atmospheric O₂.

Nonspecialists will not easily be impressed by model calculations and

complex budgets that contain often large uncertainties. Moreover, I have seen dishonest skeptics using “old hat” arguments such as ocean CO₂ outgassing to refute the responsibility of human activities in the recent CO₂ increase and the forthcoming large global warming.

One crucial note about the global budget of inputs and outputs that Weart should have stated: Known CO₂ emissions from fossil fuels and deforestation largely exceed (by about a factor of two) what remains in the atmosphere. Hence, if warming were the cause of the CO₂ increase, how would we account for the

hundreds of gigatons of carbon generated by human activity?

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I was surprised by Spencer Weart's comments on my previous letter. I had explained that when floating sea ice melts, the sea level would actually go down and not up, as the general public has been led to believe. I further stated that the Vostok and Dome-C ice cores from Antarctica show that the main Antarctic ice mass has not melted in the past 730 000 years. That evidence would seem to remove most of the planet's ice as a possible factor in coastal flooding in the event of global warming.

Instead of addressing those statements, Weart chose to introduce a completely different situation, namely what happens when the ocean's mean temperature rises—something I never mentioned.

Of course, warming the ocean could raise the sea level due to expansion, as evidently happens during El Niño events, but no one suggests that ocean warming could raise ocean levels by tens of meters and flood low-lying areas. Increased evaporation has apparently lowered ocean levels in some warmed areas.

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Weart replies: A notable feature of climate science is that most of its issues, unlike most questions in physics, involve evidence and arguments that are scattered among many specialties. People in one specialty are rarely familiar with the details of evidence from another, and the public grasps still less. A letter in this space of a few centimeters must miss a lot, and both letter writers are correct that I failed to go into details of serious concern—for example, I mentioned carbon isotopes only in passing. I thank Edouard Bard for rightly pointing out that the Suess effect was historically the most important demonstration that human activity is rapidly adding CO₂ to the atmosphere. His letter offers this and other good ways to answer some questions raised by uninformed people who can grasp physics arguments.

George Smith's concerns are among many issues in the study of sea-level rise, a subject that scientists have discussed for half a cen-

tury without reaching consensus on all points. Still, nearly all students of the topic have come to agree that the rise in the next couple of centuries will almost certainly be greater than zero, with a significant component due to thermal expansion; the expansion, in fact, is the surest thing in the whole business. Experts have also long agreed, as Smith rightly says, that the main Antarctic ice dome will not play a significant role in the next few centuries. Still under discussion is a possible large component of future sea-level rise caused

by the slow collapse of other ice sheets—West Antarctica and Greenland. In the last five years, new field evidence has caused some experts to change their opinion of such a collapse from “highly unlikely, scarcely worth worrying about,” to “possible, worth seriously worrying about.” (For history and references, see <http://www.aip.org/history/climate/floods.htm>, end of page.)

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