By Lesley M. M. Blume

- Published July 20, 2023Updated July 21, 2023, 9:05 a.m. ET

In July 1945, as J. Robert Oppenheimer and the other researchers of the Manhattan Project prepared to test their brand-new atomic bomb in a New Mexico desert, they knew relatively little about how that mega-weapon would behave.

On July 16, when the plutonium-implosion device was set off atop a hundred-foot metal tower in a test code-named "Trinity," the resultant blast was much stronger than anticipated. The irradiated mushroom cloud also went many times higher into the atmosphere than expected: some 50,000 to 70,000 feet. Where it would ultimately go was anyone's guess.

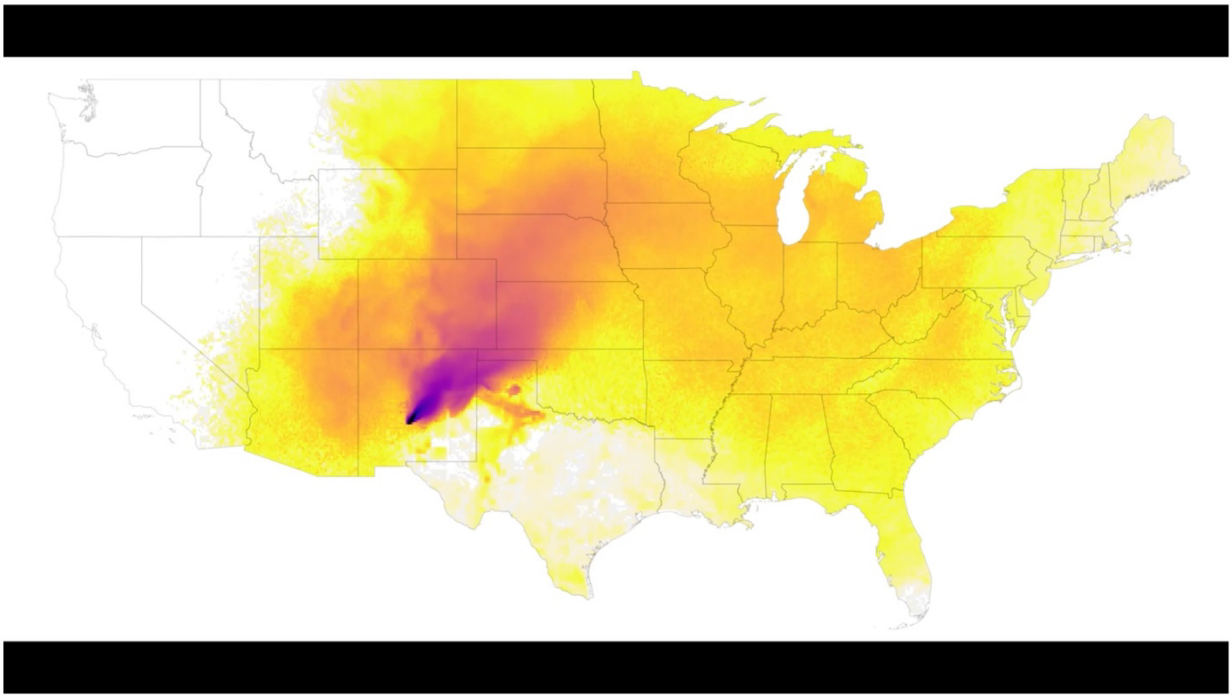
A new study, released on Thursday ahead of submission to a scientific journal for peer review, shows that the cloud and its fallout went farther than anyone in the Manhattan Project had imagined in 1945. Using state-of-the-art modeling software and recently uncovered historical weather data, the study's authors say that radioactive fallout from the Trinity test reached 46 states, Canada and Mexico within 10 days of detonation.

“It’s a huge finding and, at the same time, it shouldn’t surprise anyone,” said the study’s lead author, Sébastien Philippe, a researcher and scientist at Princeton University’s Program on Science and Global Security.

The study also reanalyzed fallout from all 93 aboveground U.S. atomic tests in Nevada and created a map depicting composite deposition of radioactive material across the contiguous U.S. (The team also hopes to study U.S. tests over the Pacific Ocean in the future).

How much of Trinity’s fallout still remain at original deposition sites across the country is difficult to calculate, said Susan Alzner, an author of the study and the co-founder of shift7, an organization that coordinated the study’s research. The study documents deposition as it originally hit the ground in 1945.

“It’s a frozen-in-time image,” she said.
Video



Estimated radionuclide deposition density for the first 10 days after detonation of the Trinity test on July 16, 1945, at 5:29 a.m. local time. Sébastien Philippe, Susan Alzner, Gilbert P. Compo, Mason Grimshaw, Megan Smith

The findings could be cited by advocates aiming to increase the number of people eligible for compensation by the federal government for potential exposure to radiation from atmospheric nuclear explosions.

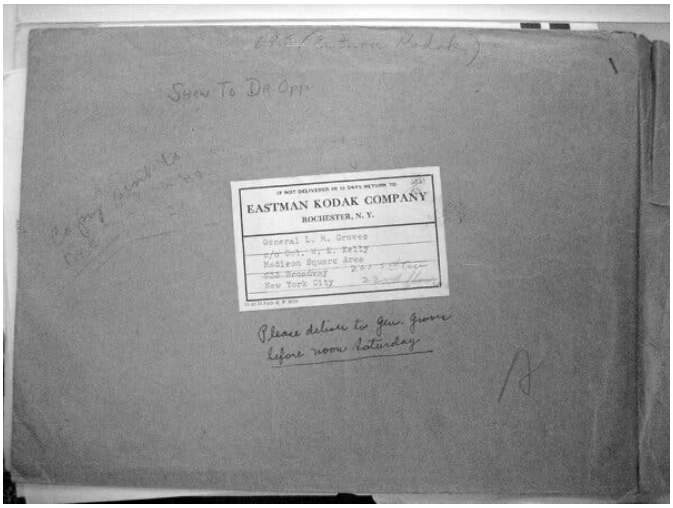
The drift of the Trinity cloud was monitored by Manhattan Project physicists and doctors, but they underestimated its reach.

“They were aware that there were radioactive hazards, but they were thinking about acute risk in the areas around the immediate detonation site,” Alex Wellerstein, a nuclear historian at the Stevens Institute of Technology in New Jersey, said. They had little understanding, he said, about how the radioactive materials could embed in ecosystems, near and far. “They were not really thinking about effects of low doses on large populations, which is exactly what the fallout problem is.”

At the time, Dr. Stafford L. Warren, a Manhattan Project physician specializing in nuclear medicine, reported to Lt. Gen. Leslie Groves, leader of the Manhattan Project, that the Trinity cloud “remained towering over the northeast corner of the site for several hours.” Soon, he added, “various levels were seen to move in different directions.” Dr. Warren assured General Groves that an assessment of the fallout’s reach could be undertaken later on horseback.

In the decades that followed, a lack of crucial data has bedeviled assessments and attempted studies of the Trinity test’s fallout. The U.S. had no national monitoring stations in place in 1945 to track the fallout, Dr. Philippe said. Plus, essential historical weather and atmospheric data was available only from 1948 onward. Remodeling fallout from tests in Nevada — starting in 1951 — was easier, but Trinity remained frustratingly difficult to reanalyze.

“The data sets for the Nevada tests and the available data that we could possibly find for Trinity were not comparable,” Ms. Alzner said. “You couldn’t put them on the same map. We decided to keep pushing.”



“Show to Dr. Opp”: An envelope sent to General Groves contained contaminated film scans from Rochester, N.Y., an early indicator that the fallout from the Trinity test was spreading nationwide. Credit...National Archives and Records Administration

Mr. Oppenheimer and General Groves.Credit...U.S. Army Corps of Engineers

The fogged film. Credit...National Archives and Records Administration

Determined to fill in the gaps, the team started the study about 18 months ago. Dr. Philippe has extensive background in modeling fallout and was an author of a similar project in 2021 that documented the effects from French nuclear tests.

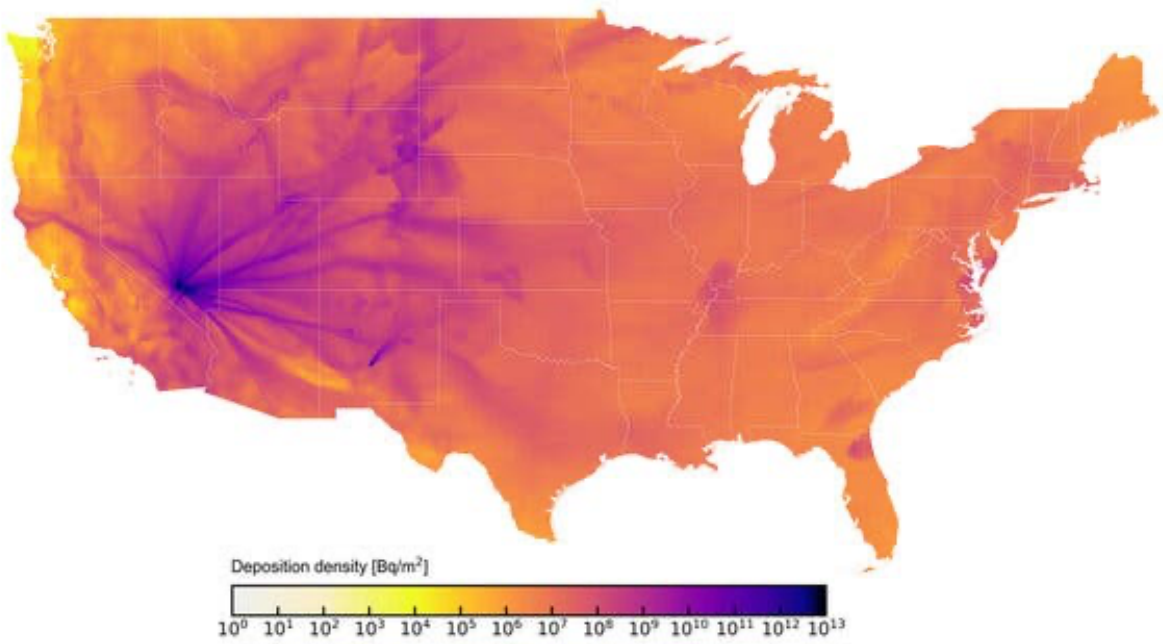
A breakthrough came in March, when Ms. Alzner and Megan Smith, another co-founder of shift7 and a former United States chief technology officer in the Obama administration, contacted the National Oceanic and Atmospheric Administration. There, Gilbert P. Compo, a senior research scientist at the University of Colorado and the NOAA Physical Sciences Laboratory, told the team that the European Centre for Medium-Range Weather Forecasts had only a week earlier released historical data that charted weather patterns extending 30,000 feet or higher above Earth's surface.

"For the first time, we had the most accurate hourly reconstruction of the weather back to 1940, around the world," said Dr. Compo, who became a co-author on the study. "Every single event that puts something in the air, no matter what it is, can now be tracked, by the hour."

Using the new data and software built by NOAA, Dr. Philippe then reanalyzed Trinity's fallout. And while the study's authors acknowledge limitations and uncertainties within their calculations, they maintain that "our estimates likely remain conservatively low."

"It's a very comprehensive, well-executed study," said M. V. Ramana, professor and Simons chair in disarmament, global and human security at the University of British Columbia, who was not involved in the study. Dr. Ramana was unsurprised by the study's findings about Trinity. "I expected that the old estimates were understating what was actually deposited," he said.

The results show that New Mexico was heavily affected by Trinity's fallout. Computations by Dr. Philippe and his colleagues show the cloud's trajectory primarily spreading up over northeast New Mexico and a part of the cloud circling to the south and west of ground zero over the next few days. The researchers wrote that there are "locations in New Mexico where radionuclide deposition reached levels on par with Nevada."



A map depicting composite deposition of radioactive material across the contiguous U.S. from the Trinity test in New Mexico and from 93 atmospheric tests in Nevada.
Credit...Sébastien Philippe, Susan Alzner, Gilbert P. Compo, Mason Grimshaw, Megan Smith

Trinity's fallout, Dr. Philippe says, accounts for 87 percent of total deposition found across New Mexico, which also received deposition from Nevada's aboveground tests. The study also found that Socorro County — where the Trinity test took place — has the fifth highest deposition per county of all counties in the United States.

Trinity test "downwinders" — a term describing people who have lived near nuclear test sites and may have been exposed to deadly radioactive fallout — have never been eligible for compensation under the 1990 Radiation Exposure Compensation Act (RECA). It has provided over $2.5 billion in payments to nuclear workers in much of the Western U.S. and to downwinders who were located near the Nevada test site and may have developed cancer or other diseases as a result of radiation exposure.

"Despite the Trinity test taking place in New Mexico, many New Mexicans were left out of the original RECA legislation and nobody has ever been able to explain why," said Senator Ben Ray Luján, a New Mexico Democrat. He has

helped lead efforts in Congress to expand and extend the legislation, currently due to sunset in 2024.

Census data from 1940 shows that as many as 500,000 people were living within a 150-mile radius of the test site. Some families lived as close as 12 miles away, according to the Tularosa Basin Downwinders Consortium. Yet no civilians were warned about the test ahead of time, and they weren't evacuated before or after the test.

“This new information about the Trinity bomb is monumental and a long time coming,” Tina Cordova, a co-founder of the consortium, said. “We’ve been waiting for an affirmation of the histories told by generations of people from Tularosa who witnessed the Trinity bomb and talked about how the ash fell from the sky for days afterward.”

The study also documents significant deposition in Nevada, Utah, Wyoming, Colorado, Arizona and Idaho, as well as dozens of federally-recognized tribal lands, potentially strengthening the case for people seeking expanded compensation in those areas.

Although Dr. Wellerstein said that he approaches such reanalyses of historical fallout with a certain amount of uncertainty, partly because of the age of the data, he said there is value in such studies by keeping nuclear history and its legacy in the public discourse.

“The extent to which America nuked itself is not completely appreciated still, to this day, by most Americans, especially younger Americans,” he said.

https://www.nytimes.com/2023/07/20/science/trinity-nuclear-test-atomic-bomb-oppenheimer.html?action=click&module=Well&pgtype=Homepage&section=Science