his experiments, few had the necessary expertise in making torsion balances.

Not every historian believes that Heering has proven Coulomb to have been guilty of data manipulation. Maria Trumpler, a Yale historian of science who has worked extensively on the history of electrical experimentation, says there is a fundamental problem with any historical reconstruction: "The only test to see if you have in fact reconstructed what [the original researchers] have done is if you get the data they get." There is no way to know if Heering was really true to the conditions under which Coulomb carried out his experiment, she says. "Did he dress in the same clothes? Did he wear the same kind of powdered wig?" Riess says he and Heering took these factors into account, even though he admits that it was not possible to reproduce the original conditions exactly. "We have thought of what Coulomb could have done to avoid a charge on his body," says Riess. "He could have been perfectly grounded but that would have been very complicated. Or he could have been naked. But he didn't report taking any of these precautions."

MIT historian of science Jed Buchwald also has doubts. There are other methods that Coulomb might have used to counteract the effects of a charged observer, he says, without mentioning them in the treatise. For example, Coulomb may have moved away from the apparatus after imparting the initial charge and read the angle of deflection using a telescope, a well known technique at the time.

Buchwald, a highly respected historian who is familiar with Riess' and Heering's work, says he regards them as reliable researchers. "If they say they saw this effect [of the oscillations], then they saw it." Buchwald is certain of his final decision, however: "I do not believe for one second that Coulomb had 20 pages of numbers and that he kept calculating through until he found three that worked." Coulomb was too good a scientist for that, he says.

Riess and Heering agree that Coulomb was a great scientist. They are quick to point out that at the time, other electricity researchers would measure the strength of an electric charge by giving themselves a shock with it and seeing how far they could feel it go up their arms. In comparison, Coulomb's work is refreshingly quantitative. At least in principle, it was possible to use the torsion balance to make reproducible measurements.

Trumpler adds that even if Riess' and Heering's claim is correct, Coulomb should be applauded for coming up with the right result: "If we assume that in this case the data were not sufficient to determine the theory, then we have to acknowledge that Coulomb had tremendous insight." Furthermore, says Trumpler, the eagerness of many modern scientists to obtain "zillions" of reliable data points may have lessened the emphasis on scientific intuition. "The ability to have a profound insight about the nature of how things work based on just a few data points," says Trumpler, "is becoming a lost art."

–Steven Dickman

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ENVIRONMENT

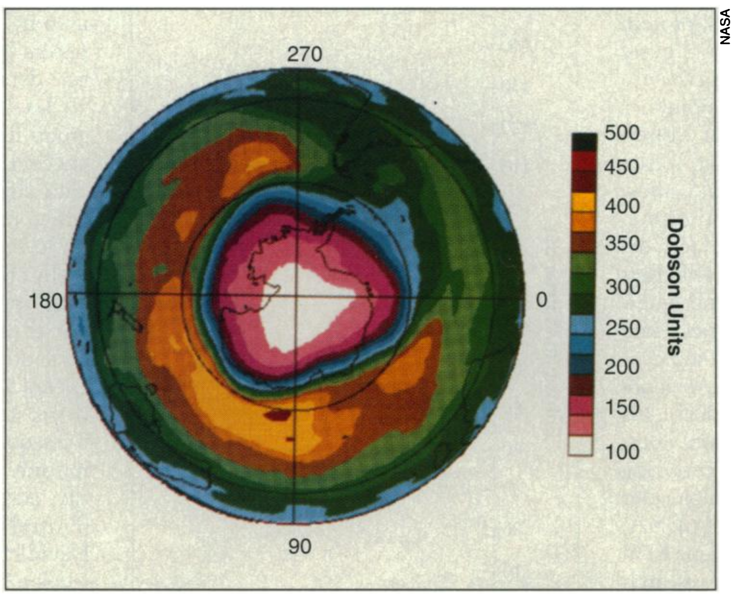
The Ozone Hole Reaches a New Low

Most scientists thought the ozone hole couldn't get much deeper. But the annual thinning of the ozone layer over Antarctica has broken another record. Balloon and satellite measurements during this year's Southern Hemisphere spring reveal 15% less ozone over Antarctica than during last year's thinning, leaving the protective ozone shield at less than one-third its normal thickness.

Announced last week, the additional losses are a surprise because in recent years the depletion of ozone has been almost complete at the altitudes where conditions normally favor its destruction by chlorine from manmade chlorofluorocarbons (CFCs). Only if favorable conditions, including extreme cold and the presence of the fine particles that trigger the ozone depleting reactions, had spread to other altitudes could more ozone disappear. And that's just what scientists think may have happened, thanks to lingering debris from the 1991 eruption of Mount Pinatubo and perhaps unusual cold at high altitudes.

The erosion of Antarctic ozone appeared on schedule, says David Hofmann of the National Oceanic and Atmospheric Administration in Boulder, but by early October it had extended well beyond the region where ozone loss had tended to be complete: a 1- to 2-kilometer-thick layer centered at an altitude of 17 kilometers. Instead, balloon-borne instruments showed total depletion from 14 to 19 kilometers. All told, just 90 Dobson units (DU) of ozone were left in the Antarctic stratosphere this spring, compared to 105 DU last year, which in turn was 5 to 10 DU below preceding years. (At other seasons, Antarctic ozone levels are about 280 to 300 DU.)

Something similar, but not as dramatic, happened last year, when heavy ozone depletion was seen for the first time at altitudes below 14 kilometers, says Hofmann. Since the high-altitude ice clouds that activate ozone-destroying chlorine are centered at an altitude of around 17 kilometers, researchers concluded that something else had to be taking their place at lower altitudes. The best candidate seemed to be the haze of sulfuric acid particles lofted by Pinatubo's eruption. And that same, lingering haze is probably to blame for this year's low-altitude losses, Hofmann says.



Empty sky. On 6 October the TOMS instrument aboard the Russian meteorological satellite Meteor-3 found unprecedented ozone losses *(white)* within the ozone hole *(blue, magenta, and white).*

Volcanic haze doesn't explain the enhanced losses seen between 18 and 23 kilometers, however; there is no significant Pinatubo debris above 18 kilometers over Antarctica. Hofmann wants to look at more data, but he suspects that colder-than-normal temperatures at high altitudes might have encouraged the formation of more ice cloud particles, laying the groundwork for more ozone loss.

For the time being, researchers are assuming that this year's record losses don't mean that they have to rethink their understanding of Antarctic ozone depletion. Next year's hole should tell: Providing stratospheric temperatures are normal and most of the Pinatubo debris has settled out, the hole should be back to "normal."

–Richard A. Kerr