Ralph J. Cicerone

(1943–2016)

Atmospheric scientist who defended the environment.

Ralph Cicerone was an authority on climate change who shaped science and environmental policy worldwide, including at the helm of the US National Academy of Sciences. Early in the 1970s, he and atmospheric chemist Richard Stolarski showed that chlorine could damage Earth's protective ozone layer. Soon, others — who later received the Nobel Prize in Chemistry for their work — found that widely used industrial chemicals released chlorine into the stratosphere, creating a hole in the ozone layer that let dangerous ultraviolet radiation reach Earth's surface.

Cicerone, who died on 5 November, dedicated his life to understanding the impact of humans on the environment and working to mitigate it. In the late 1970s and 1980s, he and other scientists visited government leaders across the United States, building support for a ban on chlorofluorocarbons that eventually garnered federal attention. This was crucial for the creation of the Montreal Protocol, the global treaty banning chlorofluorocarbons, which went into force in 1989. The modelling and predictions that led to the Montreal Protocol have largely been confirmed over the subsequent 30 years, and the ozone layer is now slowly recovering. In later years, Cicerone oversaw the production of several influential reports on the human causes of global warming. He was chosen for these tricky jobs in part because he was known for unselfishly sharing ideas and credit, and for his abilities to work through differing views without polarizing people, always focused on evidence.

Cicerone was born in 1943 in rural Pennsylvania. His father, an insurance salesman who had not been to college, left mathematics problems for Ralph to solve while he met with clients in the evenings. Influenced by the space race and its focus on technical education, Cicerone received his PhD in electrical engineering at the University of Illinois at Urbana–Champaign in 1970. He focused on the physics of the ionosphere, the layer of free electrons and ions that starts some 60 kilometres above Earth and is important for propagating radio waves. He and Stolarski studied this region as postdocs at the University of Michigan at Ann Arbor, where they became intrigued by the effects of supersonic aircraft exhaust much closer to Earth. This

led to their work on chlorine's effects on ozone in the stratosphere.

In 1980, after faculty positions at Michigan and the Scripps Institution of Oceanography in La Jolla, California, Cicerone became director of the atmospheric chemistry division at the National Center for Atmospheric

Research in Boulder, Colorado. He moved to the University of California (UC), Irvine, in 1989 to establish the first interdisciplinary academic group studying global climate change, heading a diverse group of chemists, physicists, biologists and engineers. Cicerone — who had no experience of academic leadership — was chosen for the political skills he had demonstrated when advocating for the ban on chlorofluorocarbons with one of us (M.M.) and UC Irvine professor and future Nobel laureate F. Sherwood Rowland. Cicerone served as chancellor of UC Irvine from 1998 to 2005, when he became the 21st president of the National Academy of Sciences (NAS). He retired in June this year.

Cicerone led a key NAS study of climate change requested by President George W. Bush in 2001. The study panel included climate sceptics, but the report was unanimous and unequivocal that greenhouse gases were building up in the atmosphere because of human activities and causing temperatures to rise. Under his leadership, the NAS also produced a comprehensive, authoritative set of reports in 2011 titled *America's Climate Choices*. These called for reductions in greenhouse-gas emissions and identified strategies.

Engaging the public was another priority of Cicerone's. One result was the Science and Entertainment Exchange, an NAS programme that helps the entertainment

industry to liaise with technical experts to portray science more accurately. Another was a 2008 NAS book called *Science, Evolution, and Creationism*, an accessible account of the evidence for evolution. In 2014, he guided the publication of *Climate Change: Evidence and Causes*, co-produced with the UK Royal Society, and which offered a remarkably readable resource for policy-makers, educators and the public.

Cicerone presided over the restoration and renovation of the 1924 NAS building in downtown Washington DC. And he led the creation of a US\$500-million Gulf of Mexico research programme following the Deepwater Horizon explosion and oil spill. He also had a leading role in convening an international summit to explore issues raised by new genetic tools, such as CRISPR–Cas9, and their potential to transform plants, animals and humans.

Ralph was captain of the baseball team as an undergraduate at the Massachusetts Institute of Technology in Cambridge. As chancellor of UC Irvine, he revived baseball as an officially recognized sport on campus; the university's baseball stadium is named in his honour. He is also famous for sinking 28 consecutive free throws in a basketball competition with UC Irvine students.

On walks across campus, Ralph often stopped to chat with students. His dedication to helping less-advantaged ones to succeed was legendary. His fundamental premise was that every individual should have opportunity, and that the biggest enabler of all is higher education. An early leader in recruiting diverse faculty members, he went out of his way to mentor younger staff and was especially supportive of women.

Ralph's dedication to evidence, the environment, public policy and inclusive excellence established a legacy that will last for many generations. He is a model for what a scientist can be. ■

Mario Molina is a chemist at UC San Diego, who shared the 1995 Nobel Prize in Chemistry for his work on the environmental impact of chlorofluorocarbons. He met Ralph Cicerone in 1975 and they remained close. **Kenneth Janda** is dean of physical sciences at UC Irvine and worked with Cicerone from 1992. e-mails: mjmolina@ucsd.edu; kcjanda@uci.edu