Paul J. Crutzen

Amsterdam, Netherlands, 3 December 1933 - Mainz, Germany, 28 January 2021

Nomination 25 June 1996

Field Chemistry

Title Professor, Nobel laureate in Chemistry, 1995

Most important awards, prizes and academies

Awards: Leo Szilard Award for "Physics in the Public's Interest" of the American Physical Society (1985); Tyler Prize for Environmental Achievement (1989); Volvo Environment Prize (1991); Deutscher Umweltpreis of the Federal "Um weltstiftung" (1994); Max-Planck-Forschungspreis (with Dr. M. Molina)(1994); Nobel Prize in Chemistry (with Dr. M. Molina and F.S. Rowland)(1995). *Academies*: Fellow, American Geophysical Union (1986); Foreign Honorary Member, American Academy of Arts and Sciences (1986); Founding Member, Academia Europaea (1988); Coresponding Member, Royal Netherlands Academy of Art and Sciences (1990); Foreign Member, Royal Swedish Academy of Sciences (1992); Foreign Associate, US National Academy of Sciences (1994). *Honorary Degrees*: York University, Canada (1986); Université Catholique de Louvain-la-Neuve, Belgium (1992); University of East Anglia, Norwich, UK (1994); Aristotle University of Thessaloniki, Greece (1996); Oregon State University, USA (1997); Tel Aviv University, Israel (1997); Université de Liège (1997); University of San José, Costa Rica (1997); University of Chile, Chile (1997); Université de Bourgogne, Dijon, France (1997); University of Athens, Greece (1998); University of Xanthi, Greece (2001); Nova Gorica Polytechnic, Slovenia (2002); University of Hull, UK (2002).

Summary of scientific research

The research of Paul J. Crutzen has been mainly concerned with the photochemistry of the atmosphere, in particular the role of ozone both in the stratosphere and troposphere. In 1970 Crutzen hypothesized that ozone production by the action of solar ultraviolet radiation on molecular oxygen (O2) could be mainly balanced by ozone destruction processes, involving NO and NO2 as catalysts. These catalysts in turn result from the oxidation of N2O, a product of the microbiological nitrogen conversion in soils and waters. In 1971, together with Prof. Harold Johnston of the University of California, Berkeley, he pointed out that NO emissions from large fleets of supersonic aircraft could cause substantial ozone losses in the stratosphere. In the years 1972-74 Crutzen proposed that NO and NO2 could catalyze ozone production in the background troposphere by reactions occurring in the CO and CH4oxidation chains. Additional photochemical reactions leading to ozone loss were likewise identified. These gross ozone production and destruction terms are each substantially larger than the downward flux of ozone from the stratosphere, which until then had been considered the main source of tropospheric ozone. In 1979-1980 Crutzen and co-workers drew attention to the great importance of the tropics in atmospheric chemistry. In particular, some measurement campaigns in Brazil clearly showed that biomass burning in the tropics was a major source of air pollutants, on a par with or in some cases larger than industrial pollution in the developed world. In 1982 Crutzen, together with Prof. John Birks of the University of Colorado, drew attention to the risk of strong cooling occurring at the earth surface as a consequence of huge loadings of the atmosphere with black aerosol particles resulting from the many fires which would break out as a consequence of a nuclear war ('nuclear winter'). This study and additional studies by R. Turco, B. Toon, T. Ackerman, J. Pollack and C. Sagan and by the Scientific Committee on Problems of the Environment (SCOPE) showed that more people could die from the indirect consequences of a nuclear war than from the direct impacts of the nuclear explosions. In 1986, together with Dr. F. Arnold of the Max-Planck-Institute of Nuclear Physics in Heidelberg, Crutzen showed that nitric acid and water vapour could co-condense in the stratosphere, an important contributing process in a chain of events leading to rapid ozone depletion at high latitudes during late winter and spring (the so-called Antarctic 'ozone hole'). His most recent research is concerned with the role of clouds in atmospheric chemistry as well as photochemical reactions taking place in the marine boundary layer, involving catalysis by halogen radicals, derived from seasalt and photolysis of reactive organohalogen gases produced by marine organisms. In addition, his current research mainly deals with the chemical and climatic effects of the heavy air pollution which is found over Asia and other regions in the developing world: the so-called ABC (Atmospheric Brown Clouds) phenomenon.

Main publications

Crutzen, P.J., The influence of nitrogen oxides on the atmospheric ozone content, *Quart. J. Roy. Meteor. Soc.*, 96, pp. 320-5 (1970); Crutzen, P.J., Ozone production rates in an oxygen-hydrogen-nitrogen oxide atmosphere, *J. Geophys. Res.*, 76, pp. 1490-7 (1971); Crutzen, P.J., A discussion of the chemistry of some minor constituents in the stratosphere and troposphere, *Pure App. Geophys.*, 106-8, pp. 1385-99 (1973); Fishman, J. and Crutzen, P.J., The origin of ozone in the troposphere, *Nature*, 274, pp. 855-8 (1978); Crutzen, P.J., Heidt, L.E., Krasnec, J.P., Pollock, W.H. and Seiler, W., Biomass burning as a source of atmospheric gases CO, H2, N2O, NO CH3Cl and COS, *Nature*, 282, pp. 253-6 (1979); Crutzen, P.J. and Birks, J.W., The atmosphere after a nuclear war: Twilight at noon,*Ambio*, 2&3, pp. 114-25 (1982); Crutzen, P.J., Delany, A.C., Greenberg, J., Haagenson, P., Heidt, L., Lueb, R., Pollock, W., Seiler, W., Wartburg, A. and Zimmermann, P., Tropospheric chemical composition measurements in Brazil during the dry season, *J. Atmos. Chem.*, 2, pp. 233-56 (1985); Crutzen, P.J. and Arnold, F., Nitric acid cloud formation in the cold Antarctic stratosphere: A major cause for the springtime "ozone hole", *Nature*, 324, pp. 651-5 (1986); Crutzen, P.J. and Andreae, M.O., Biomass burning in the tropics: Impact on atmospheric chemistry and biogeochemical cycles, *Science*, 250, pp. 1669-78 (1990); Lelieveld, J. and Crutzen, P.J., Influence of cloud and photochemical processes on tropospheric ozone, *Nature*, 343, pp. 227-33 (1990); Vogt, R. and Crutzen, P.J., Sander, R., A mechanism for halogen release from sea salt aerosol in the remote marine boundary layer, *Nature*, 382, pp. 327-30 (1996); Crutzen, P.J. *et al*., High spatial and temporal resolution measurements of primary organics and their oxidation products over the tropical forests of Surinam, *Atmos. Environ.*, 37, pp. 1161-5 (2000); Lelieveld, J. and Crutzen, P.J. *et al.*, The Indian Ocean Experiment: Widespread Pollution from South and Southeast Asia, *Science*, 291, pp. 1031-6 (2001); Ramanathan, V., Crutzen, P.J., Kiehl, J.T. and Rosenfeld, D., Aerosols, Climate and the Global Environment: A Hazy Future for the Blue Planet?, *Science*, 294 pp. 2041-236 (2001); Crutzen, P.J. and Ramanathan, V., The Parasol Effect on Climate, *Science*, 302, pp. 1679-80 (2003); von Glasow, R., Lawrence, M.G., Sander, R. and Crutzen, P.J., Modeling the chemical effects of ship exhaust in the cloud-free marine boundary layer, *Atmos. Chem. Phys.*, 3, pp. 233-50 (2003); Ramanathan, V. and Crutzen, P.J., New Directions: Atmospheric Brown "Clouds", *Atmos. Environ.*, 37, pp. 4033-5 (2003).