International Association of Meteorology and Atmospheric Sciences (IAMAS)

International Ozone Commission

President
Dr. Sophie Godin-Beekmann
Tel: +33 1 80 28 54 99
Fax: +33 1 80 28 53 30
sophie.godin-beekmann@latmos.ipsl.fr

Secretary
Dr. Irina Petropavlovskikh
Tel. +1 303 497 62 79
Fax; +1 303 497 55 90
Irina.petro@noaa.gov

Vice President
Dr. Paul Newman
Tel: +1 301 614 59 85
Fax: +1 301 614 59 03
paul.a.newman@nasa.gov

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Press Release: The International Ozone Commission, on the 35th anniversary of the Montreal Protocol, reports new milestones in documenting ozone layer recovery

September 16th is the International Day for the Preservation of the Ozone Layer, celebrating the 35th signing anniversary of the 1987 Montreal Protocol treaty on Substances that Deplete the Ozone Layer. We would like to report success in the reduction of the ozone-depleting substances (ODSs) in the stratosphere by about 25 % since their peak in the late 1990s, which sets the ozone layer on the path of recovery by 2060.

The theme of the International Day for the Preservation of the Ozone Layer on 16 September 2022 is: "Global Cooperation Protecting Life on Earth". Many controlled ozone-depleting substances warm the Earth, so the Montreal Protocol has avoided some climate change. The Kigali Amendment to the Montreal Protocol is set to deliver even stronger climate benefits, by phasing down hydrofluorocarbons (HFCs). While HFCs don't directly damage the ozone layer, some of these compounds are powerful greenhouse gases. Controlling their use is expected to avoid 0.3- 0.5°C of global temperature rise by the end of the century (Velders et al., 2022, https://doi.org/10.5194/acp-22-6087-2022).

The necessity for ongoing observations and associated research was emphasized by the significant Antarctic and Arctic ozone depletion events in the 2020-2022 period (i.e. 2022 Antarctic ozone depletion already started) and the unexpected increases in CFC-11 emissions noted during the 2013-2018 period, which appear to have become much smaller subsequently.

The 2021 Antarctic ozone hole was the 13th largest since the start of the NASA satellite observational record in 1979, with an area of 23.34 million km^2 and a minimum total ozone column of only 92 Dobson units (DU). The meteorological conditions that lead to the large size and depth of the 2021 Antarctic ozone were similar to those recorded in 2020, including near- or below-average temperatures in the lower stratosphere during austral winter and spring. The ozone hole has recurred every year since the early 1980s and is caused by high levels of human-produced ODSs. Concentrations of ODSs are still high enough to cause severe spring-time ozone

destruction. However, the continued gradual decline of ODSs overall is contributing to a slow improvement of Antarctic ozone levels during springtime.

The devastating Australian wildfires of December 2019 and January 2020 generated unusually large Pyrocumulonimbus (PyroCb) activity that injected smoke and trace gases into the stratosphere, which warmed by 1°C for roughly six months. The PyroCb injections combined with solar heating of this highly-absorbing smoke led to stratospheric perturbations that persisted for 3 months and rose to 35 km altitude. Strong ozone depletion of more than 50 DU was observed in air masses affected by this perturbation. The impact of the Australian bush fires and injected smoke aerosols on the 2020 ozone hole is still being explored. The recent eruption of the Hunga Tonga volcano in January 2022 injected observationally unprecedented amounts of water vapor up to the mesosphere, with this water vapor perturbation likely to last for months - affecting ozone chemistry.

The ozone layer is on the mend because of the Montreal Protocol. Studies published in IO3C sponsored ACP/AMT special issue (https://acp.copernicus.org/articles/special_issue1194.html) discuss ozone recovery in the stratosphere and total content, analyze processes leading to recovery, and report on the importance of tracking the emissions of the CFC replacements. In addition, new research shows that the Montreal Protocol avoided significant UV damage to plants that would have reduced the uptake of carbon by plants (Young et al., 2022, https://doi.org/10.5194/acp-22-6087-2022.). The authors reported that without the Montreal Protocol, an additional 115–235 parts per million of atmospheric carbon dioxide would have been released into the atmosphere by 2100, leading to "additional warming of global-mean surface temperature by 0.50–1.0 degrees".

The Quadrennial Ozone Symposium (QOS) was virtually held from October 3rd to 9th, 2021. This every 4-year meeting is the primary assemblage of the international ozone research community. The IO3C-sponsored QOS was hosted by scientists from the Republic of Korea, and organized by the local committee from the Yonsei University in Seoul. The large participation of early career scientists (56) and researchers from developing countries (22) at the symposium showed the continuing interest in the excellent science of the scientific ozone community.

Our ability to follow significant ozone events is crucially dependent on satellite, balloon, and ground-based observing systems. Maintenance and continuation of ozone and ancillary observations are vital for improving our understanding of interactions between tropospheric pollution, climate change, and ozone depletion, identifying drivers of stratospheric and tropospheric ozone changes, and developing research tools for detecting potential future impacts on the ozone layer.

Ozone Commission website: http://www.io3c.org/