World Ozone Day

"Montreal Protocol@35: Global Cooperation Protecting Life on Earth"

Date & Time: 20th September 3:00-5:40 pm

Start Time: 3:00 pm

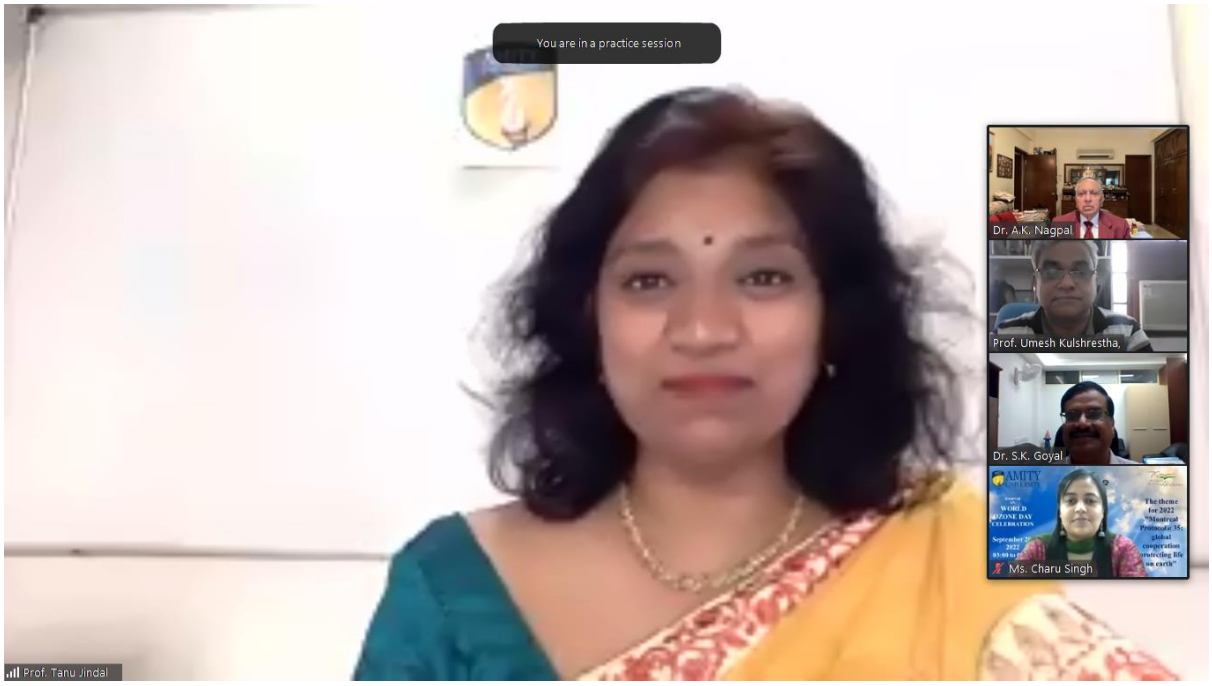
End Time: 5:40 pm

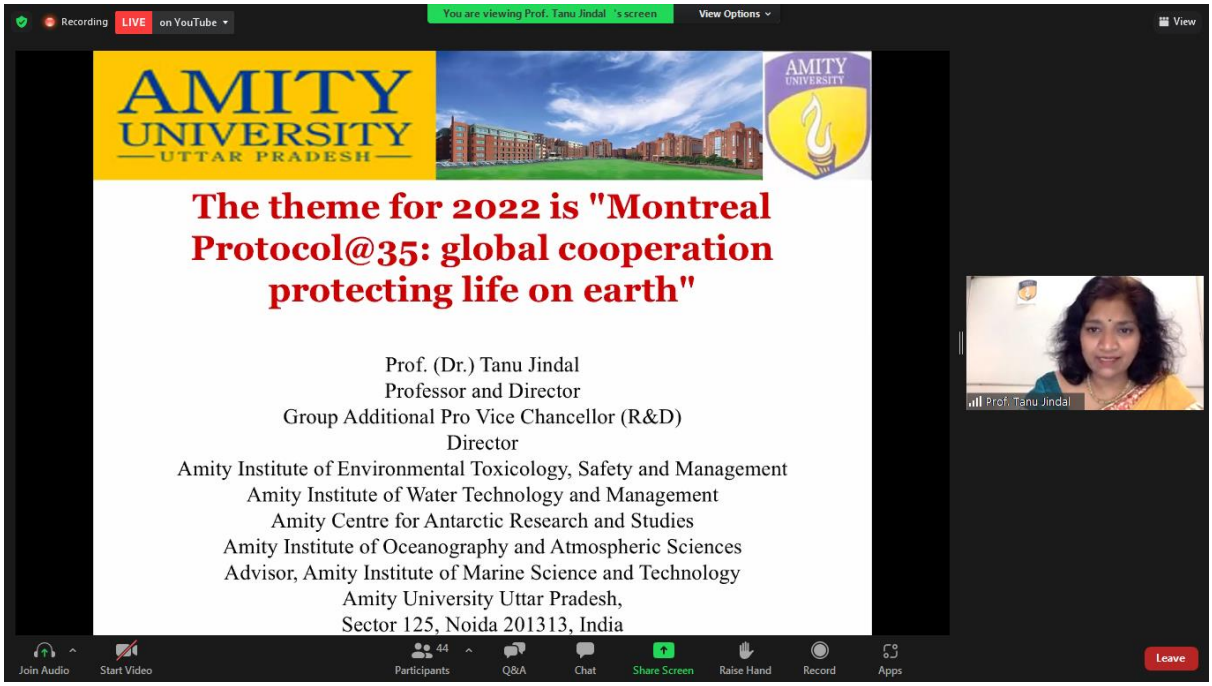
The international webinar was organized on the World Ozone Day. The webinar began at 3:00 pm.

Introduction to the theme by Prof. Tanu Jindal

Prof. Tanu Jindal, Director of Amity Institute of Environmental Toxicology, Safety and Management, Amity University, Noida. She welcomed the dignitaries and introduced this year's theme for World Ozone Day. Prof. Tanu Jindal gave a welcome speech with highlight the theme. She discussed her research paper, books, patents, and projects. She said that ozone day is a very important day in terms of UV radiation and the ozone hole. She also discussed the toxic impact of ozone on human health and the environment. She said that UV-induced allergy occurs in 5-20 % of the population often after the first summer exposure to UV radiation. Malignant melanoma, non-melanocytic skin cancer, sunburn, and chronic sun damage are the effects of the skin due to exposure to UV radiation. Acute photokeratitis, cancer of the cornea, lens opacity, uveal melanoma, and macular degeneration are the effects on the eye. The growth of the plants is reduced, and acidity increases in aquatic ecosystems. There are many possible solutions such as reducing the production of those chemicals that cause the destruction of ozone, proper recycling, staying out of the sun, and carbon sequestration.

"Protect ozone layer save earth to bring worth for the new birth"


You are in a practice session
Dr. A.K. Nagpal
Prof. Umesh Kulshrestha,
Dr. S.K. Goyal
Ms. Charu Singh
Prof. Tanu Jindal


Recording LIVE on YouTube
You are viewing Prof. Tanu Jindal 's screen
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The theme for 2022 is "Montreal Protocol@35: global cooperation protecting life on earth"
Prof. (Dr.) Tanu Jindal
Professor and Director
Group Additional Pro Vice Chancellor (R&D)
Director
Amity Institute of Environmental Toxicology, Safety and Management
Amity Institute of Water Technology and Management
Amity Centre for Antarctic Research and Studies
Amity Institute of Oceanography and Atmospheric Sciences
Advisor, Amity Institute of Marine Science and Technology
Amity University Uttar Pradesh,
Sector 125, Noida 201313, India
Prof. Tanu Jindal
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Q&A
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GWCC CLUSTER GROUP

Group-1 High-resolution climate models Exploratory studies on climate change, Weather extremes, and climate variability

1.Dr. Pushan Dutta (AUK)
Dr. PVS Raju (AUR)

2.Dr. Sayantika Mukherjee (AUK

3.Dr. Abhinav Sahay (AUP

4.Dr. Abdul Amir Khan (AUH)

5.Dr. Kushagra Rajendra

Group-2: Biotic and Abiotic Stress tolerance for microbes for sustainable Environment

1.Dr. Amit C Kharkwal (AIMT, AUUP

2.Dr. Kuldeep Dwivedi (AUMP)

3.Dr. Richa Sinha (AUJ)
Dr. Smriti Shukla (AUUP)

4.Dr. Richa Dave Nagar (AUUP)

5.Dr. Richa Sinha (AUJ)

Group-3: Biofuel, Bioplastics, Biosurfactants, etc for ecofriendly products

1.Prof. Dr. Indu Shekhar Thakur (JNU)
Dr. Neeraj Kumar

2.Dr. Abhishek Chauhan (AUUP)

3.Dr. Anuj Ranjan (AUUP)

Group-4: Bioremediation, Absorption based technologies for the removal of pollutants from water

1.Dr. Umesh Kumar (AUP

2.Dr. Amrita Saha (AUK)

3.Dr. Kuldeep Dwivedi (AUMP

4.Dr. Anamika Srivastava (AIES, AUUP)

5.Dr. Manoj C. Garg, (AIES, AUUP)

6.Dr. Kartikeya Shukla (AIES, AUUP)

Group-5: Air pollution (air pollution dispersion modelling and air pollution indexing) Noise Pollution

1.Dr. Rajshree Sarkar (AUK

2.Dr. Shubhansh Tiwari (AUH)

3.Dr. Nilesh Deorao Wagh (AUM)

4.Dr. Amrit Kumar (AUH)

Group-6 Solid waste, Heavy metal toxicity and removal, plants

1.Dr. Ashutosh Tripathi (AIES, AUUP)

2.Dr. Ambrina Sardar Khan (AIES, AUUP)

3.Dr. Priyanka Singh (ASET, AUUP)

4.Dr. Renu Dhupper (AIES, AUUP)

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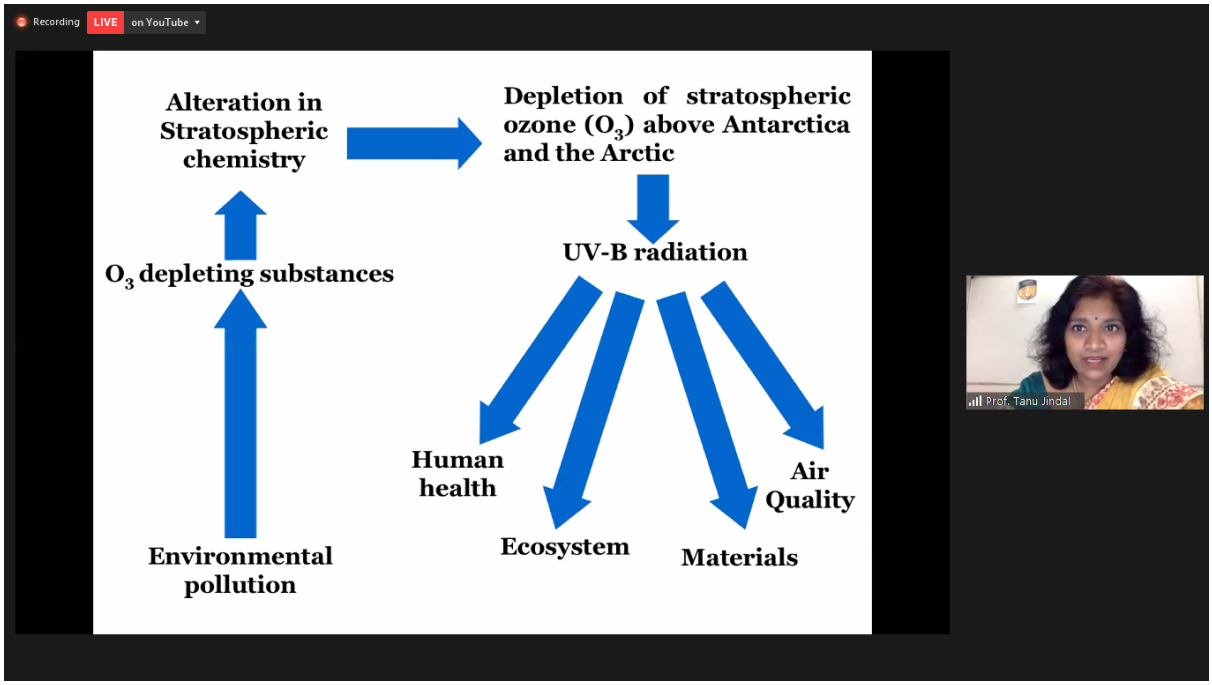
AMITY GLOBAL RESEARCH HUB (AGRH), NEW YORK-LONG ISLAND CAMPUS

Amity is in the process of exponential growth in the field of Education and Research. **Dr. Ashok K. Chauhan,** Founder President and Chairman of Amity Group of Institutions & Industries **has envisioned to develop all Amity Universities as Research & Innovation Driven University. To achieve his vision to make India not only a Knowledge Superpower but also a General Superpower by 2030**.

Dr. Atul Chauhan, President Ritnand Balved Education Foundation; CEO-AKC Group of Companies and Chancellor Amity University Uttar Pradesh has promoted Research & Innovation in all Amity Institutions.

Dr. Aseem Chauhan, Additional President, Ritnand Balved Education Foundation; CEO, Amity Capital Ventures and Chancellor, Amity University Haryana **has established an 'Amity Global Research Hub' (AGRH) at Amity New York-Long Island Campus.**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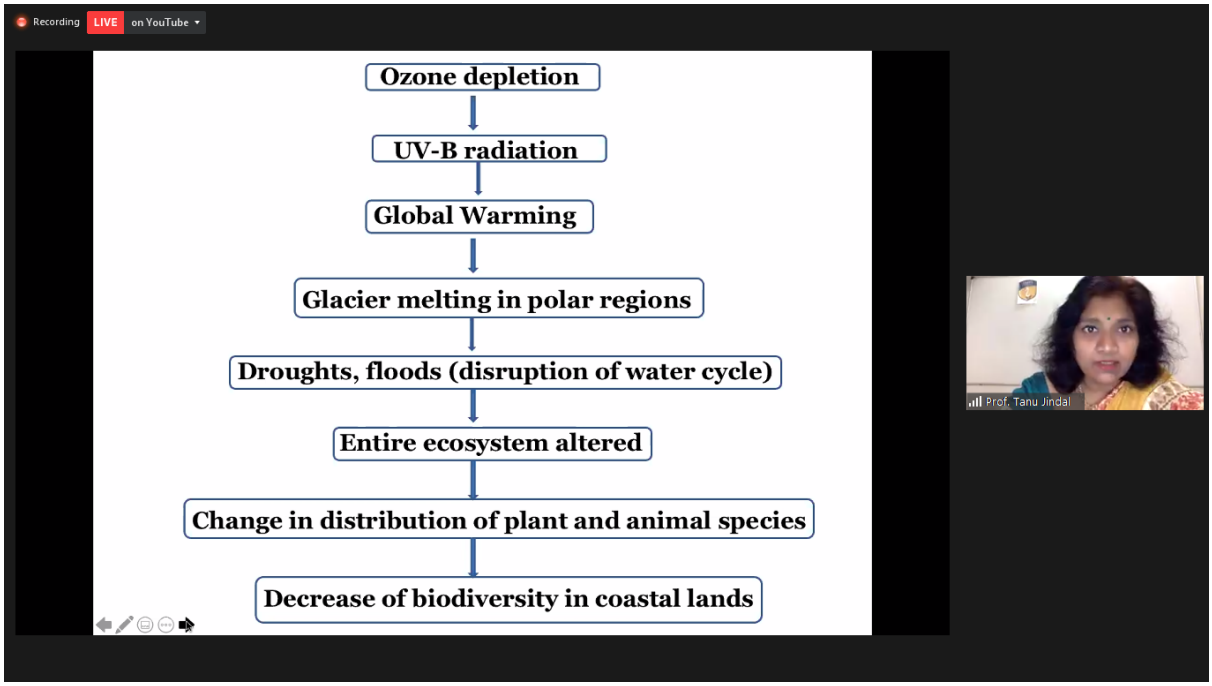
Alteration in Stratospheric chemistry
Depletion of stratospheric ozone (O_3) above Antarctica and the Arctic
UV-B radiation
O_3 depleting substances
Environmental pollution
Human health
Ecosystem
Materials
Air Quality
Prof. Tanu Jindal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Ozone depletion
UV-B radiation
Global Warming
Glacier melting in polar regions
Droughts, floods (disruption of water cycle)
Entire ecosystem altered
Change in distribution of plant and animal species
Decrease of biodiversity in coastal lands
Prof. Tanu Jindal

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- **UV-induced allergy**

-Occurs in 5-20% of the population often after first spring/summer exposure to UV radiation

-Increased photosensitivity of the skin (temp., dust - deserts)

-Higher temperatures may lead to more skin cancers For the same UV exposure, for every 10°C increase, there is an estimated 3-6% increase in skin cancers

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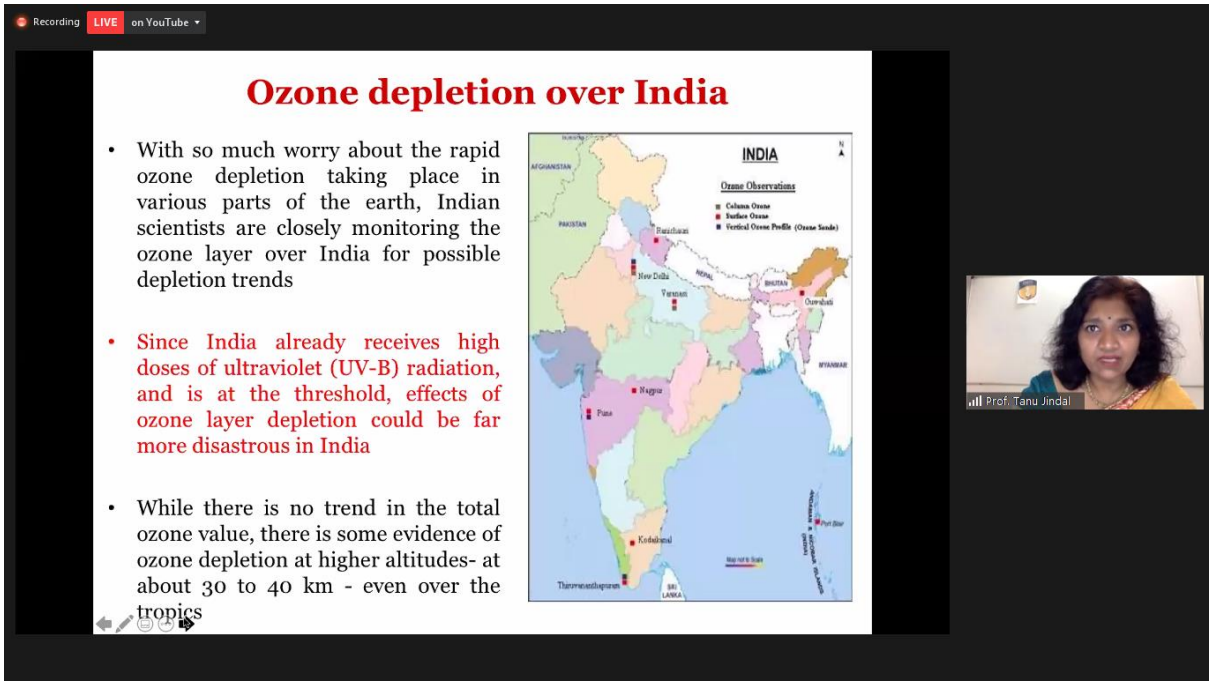
- **Effects on the eye**

- Acute photokeratitis and photoconjunctivitis
- Climatic droplet keratopathy
- Pterygium
- Cancer of the cornea and conjunctiva
- Lens opacity (cataract) – cortical, posterior subcapsular
- Uveal melanoma
- Acute solar retinopathy
- Macular degeneration

Malignant melanoma of the eye

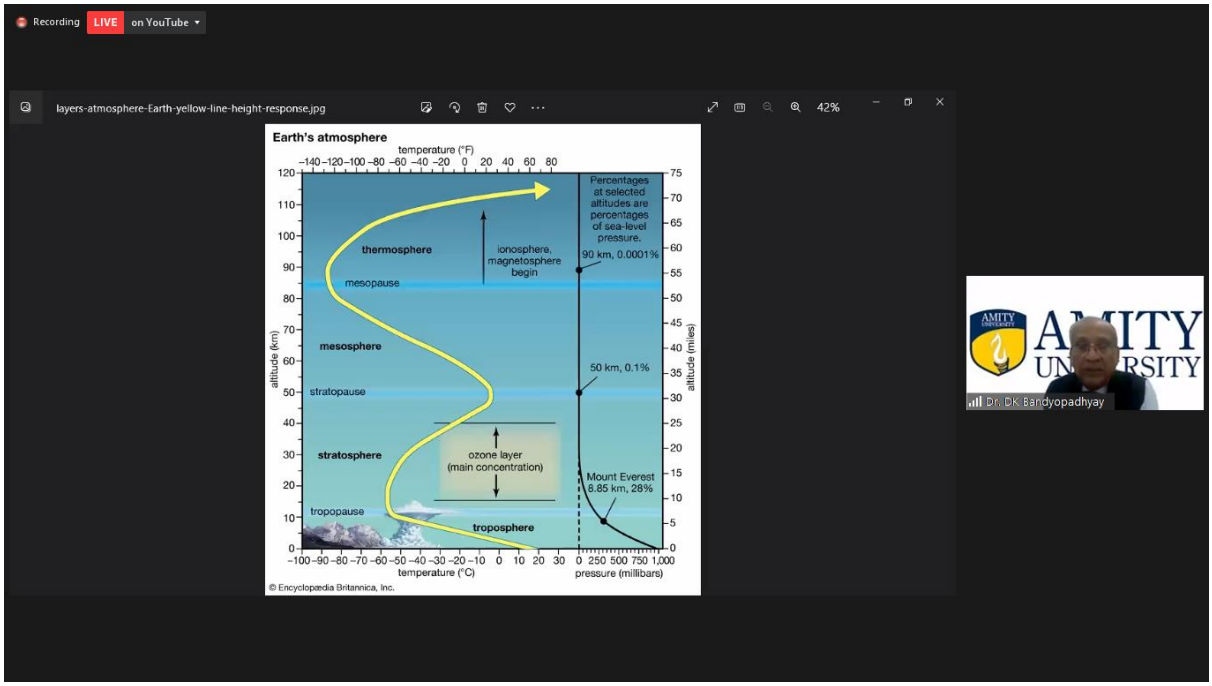
Macular degeneration of the eye



Address by Dr. D.K Bandyopadhyay

Dr. D.K Bandyopadhyay, Chief Advisor FPO, and Chairman, Amity Law School, Amity University, Noida. He also welcomed all the dignitaries. He addressed the theme of the ozone day. World Ozone Day is the most important day as per the Montreal Protocol. It is the international treaty which was adopted on 16 September 1987. Initially, it was signed by 46

countries but now it has nearly 200 countries. This treaty regulates the use of chemicals which were dangerous to ozone. CFC was the main responsible compounds for the depletion of ozone. So, many developed countries have taken the decision to ban the use of CFC. People should take the precautions from the UV radiations. Most of the remaining ozone occurs in the troposphere and the layer of the atmosphere is extent from earth to the stratosphere. The harmful UV rays can cause the skin disease.



Presentations were given by-

1- **Dr. Mukesh Sharma,** Professor, Department of Civil Engineering, IIT Kanpur.

2- **Dr. Vijay Kumar Soni,** Head, Environmental Monitoring and Research Center (EMRC), Delhi.

3- **Dr. S. K. Goyal,** Chief Scientist & Head CSIR-NEERI, Delhi.

4- **Prof. Manju Mohan,** Head, Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi.

5- **Prof. Umesh Kulshrestha,** Deputy Director, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi.

6- **Prof. Qing-Bin Lu,** Professor, University of Waterloo, Ontario, Canada.

Speaker-wise discussion points (as per programme flow):

1. **Dr. Mukesh Sharma- "Ozone: Basic to its stratospheric resurrection"**

1.1. Ozone is a highly reactive gas composed of three oxygen atoms.

1.2. It is both a natural and man-made product that occurs in the Earth's upper atmosphere (stratosphere) and lower atmosphere (troposphere).

1.3.It works a lot like sunscreen, blocking out harmful UV rays from the sun.

1.4.The ozone layer is getting depleted due to anthropogenic pollution forming an ozone hole.

1.5.Since the 1970's the ozone hole has been increasing in size over Antarctica.

1.6.For the first time, in September of 2000, the ozone hole became so large it actually left populated areas of Southern Chile fully exposed to the effects of the Sun's UV rays.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Azadi Ka Amrit Mahotsav
nidm
Resilient India - Disaster Free India
He is a renowned professor in department of civil engineering IIT Kanpur. He has completed PhD in civil engineering from University of Waterloo, Ontario, Canada, and MTech in civil engineering from IIT Kanpur. Dr. Sharma holds honorary positions like Vice President of Indian Air Pollution Control Association, Delhi. He has also served in Central Pollution Control Board, delhi for >10 years. He has received many awards and recognition such as Fellow of National Academy of Engineering (FNAE) 2014, Kong Ha Award in Air Quality from Clean Air Asia (a UN supported foundation) 2012, Hiyoshi Environmental Award by Hiyoshi Corporation, Japan, Excellence in Research and Technology Development, 2012, etc. He has published more than 86 papers in reputed journals.
Dr. Mukesh Sharma
Professor
Department of Civil Engineering, IIT Kanpur
Ms. Charu Singh


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Dr. DK Bandyopadhyay
Ms. Jayati Arora
Ms. Charu Singh
Prof. Tanu Jindal
Dr. Mukesh Sharma

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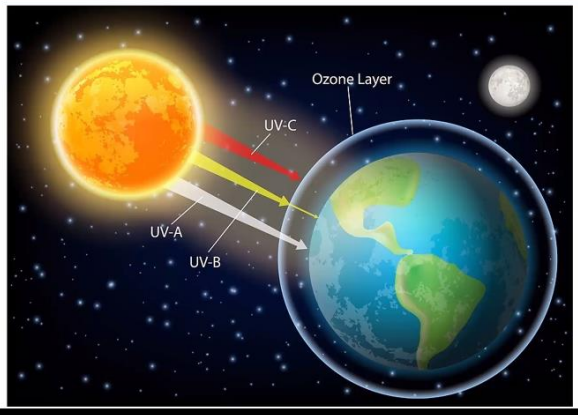
- The ozone layer is a protective layer of gas molecules located within the stratosphere.
- It Acts as an umbrella or shield of the earth to protect it from incoming harmful UV rays from sun.



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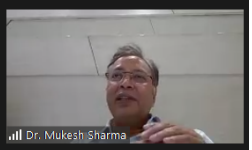
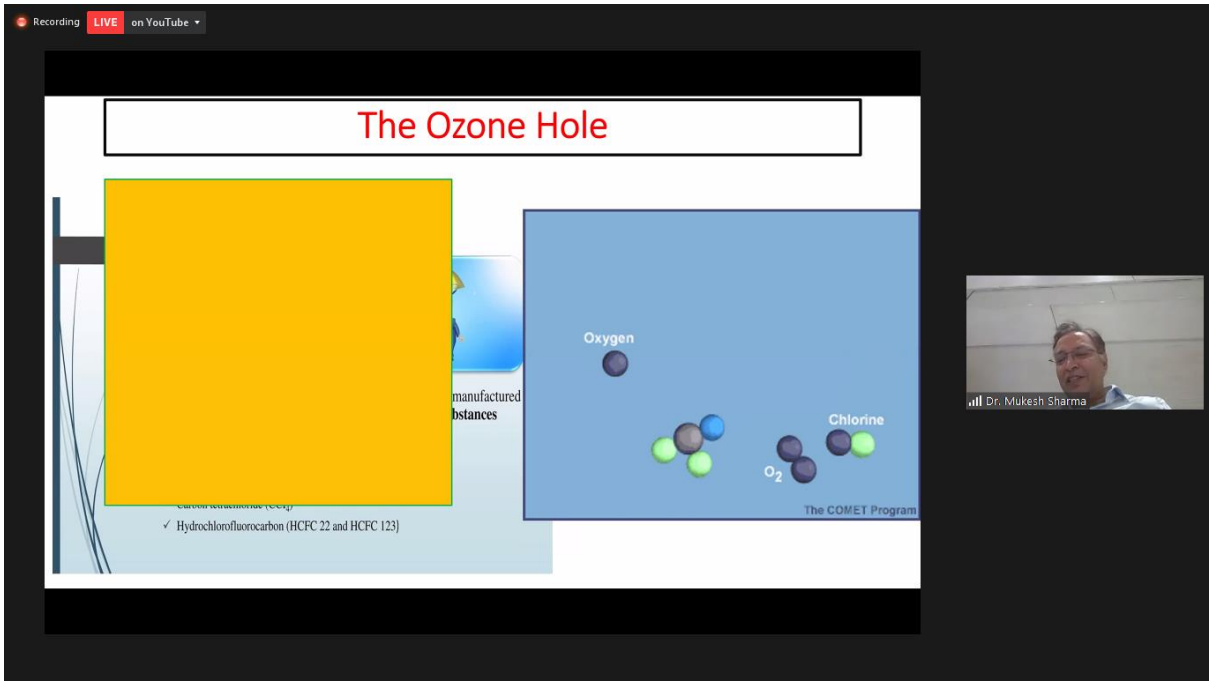
The Ozone Hole

Causes of Ozone Depletion

- Natural Factors
  - ✓ Seasons
  - ✓ Weather Conditions
  - ✓ Solar Cycle
- Anthropogenic
  - Ozone layer is being destroyed by a group of manufactured chemicals that are called **ODS** or **Ozone-Depleting Substances**
    - ✓ Chlorofluorocarbons (CFC 11, CFC 12, CFC 13)
    - ✓ Methyl bromide (CH_3Br)
    - ✓ Halons (halon-1211, halon-1301, halon-2402)
    - ✓ Carbon tetrachloride (CCl_4)
    - ✓ Hydrochlorofluorocarbon (HCFC 22 and HCFC 123)

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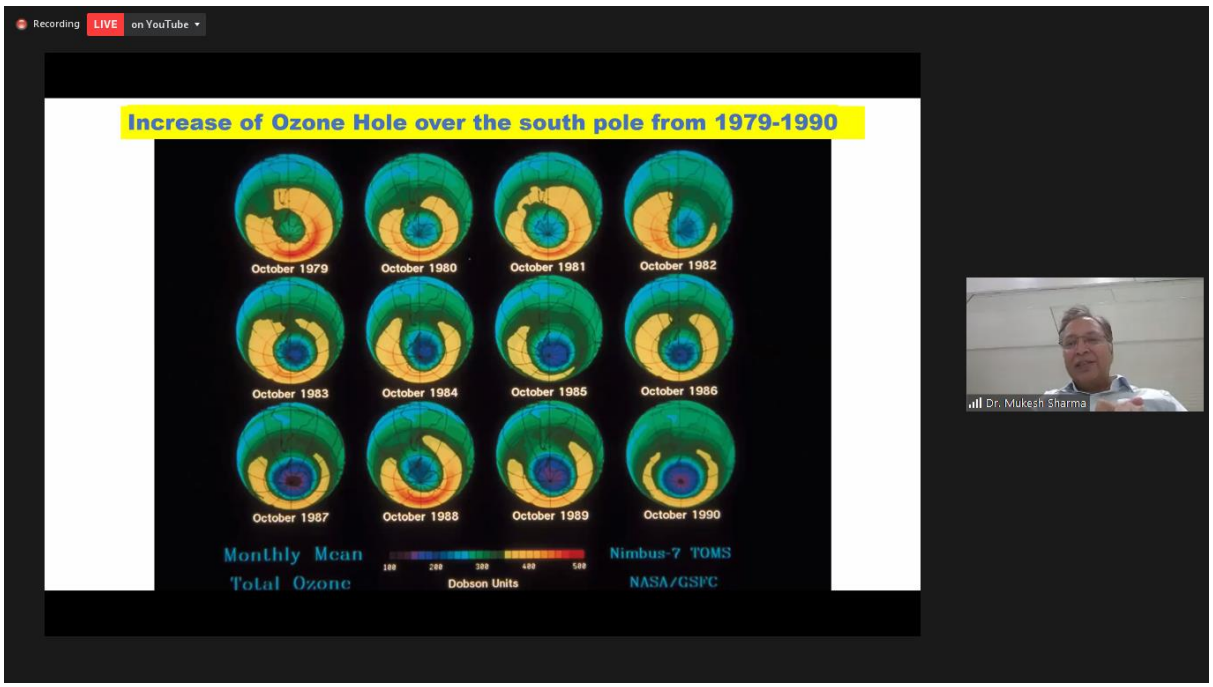
The Ozone Hole
manufactured
bstances
Hydrochlorofluorocarbon (HCFC 22 and HCFC 123)
Oxygen
Chlorine
O_2
The COMET Program
Dr. Mukesh Sharma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Increase of Ozone Hole over the south pole from 1979-1990
October 1979
October 1980
October 1981
October 1982
October 1983
October 1984
October 1985
October 1986
October 1987
October 1988
October 1989
October 1990
Monthly Mean
Total Ozone
100
200
300
400
500
Dobson Units
Nimbus-7 TOMS
NASA/GSFC
Dr. Mukesh Sharma


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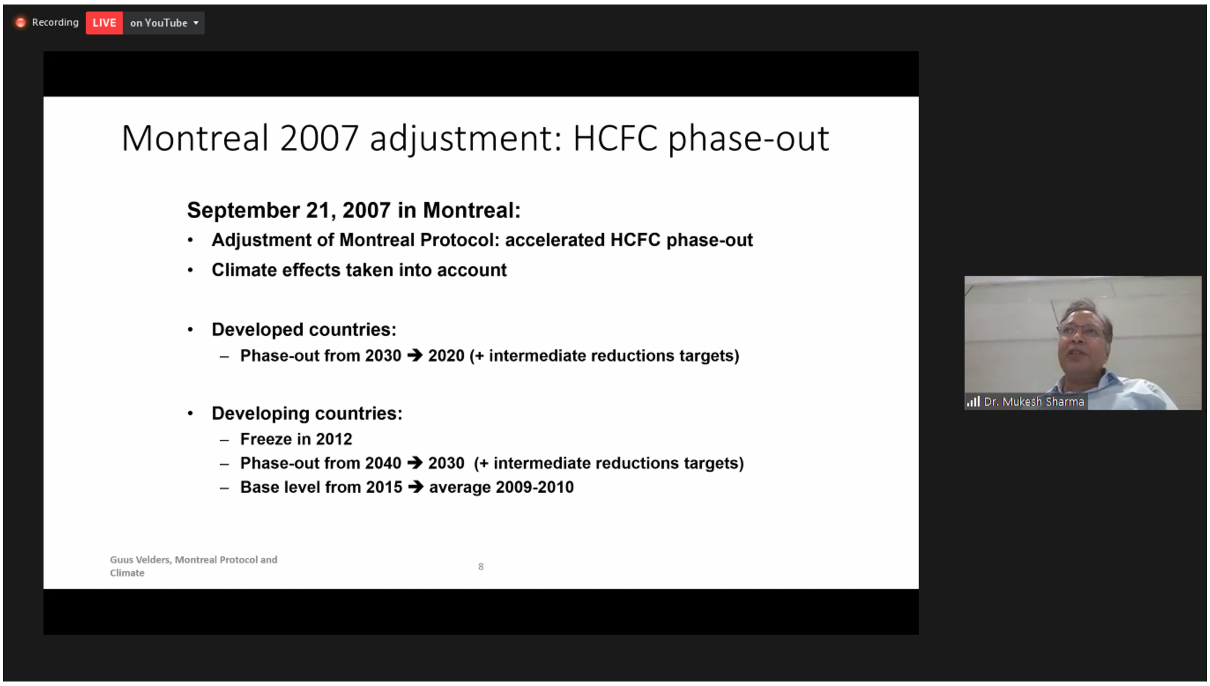
on YouTube
The Montreal Protocol -1987
Canadian Montreal Protocol
Signing Delegation
1987
NEW YORK, THURSDAY, SEPTEMBER 17, 1987
in 564 Counts
oll Abuse Case
DOZENS OF NATIONS REACH AGREEMENT TO PROTECT OZONE
24 Sign and Others Back Pact to Reduce Chemicals That Damage Earth's Shield
By PHILIP SHABECOFF
Senator Arlen Specter
CFC
Now banned
HCFC
Being phased out
Dr. Mukesh Sharma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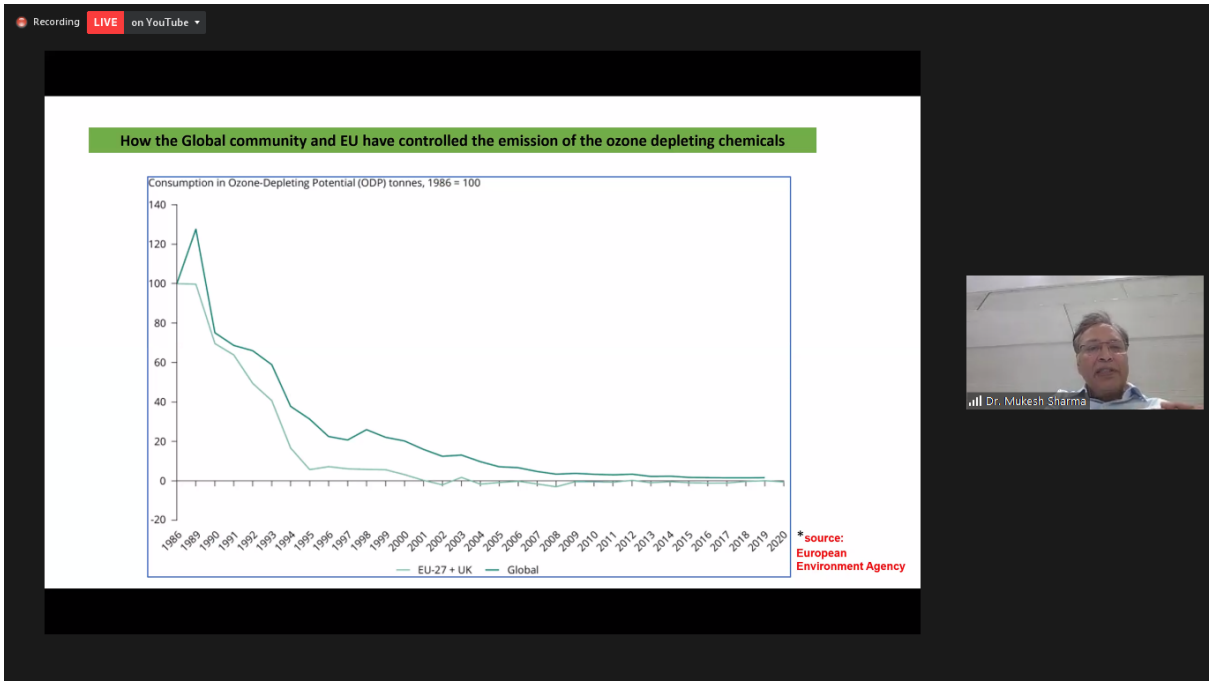
Montreal 2007 adjustment: HCFC phase-out
September 21, 2007 in Montreal:
• Adjustment of Montreal Protocol: accelerated HCFC phase-out
• Climate effects taken into account
• Developed countries:
– Phase-out from 2030 → 2020 (+ intermediate reductions targets)
• Developing countries:
– Freeze in 2012
– Phase-out from 2040 → 2030 (+ intermediate reductions targets)
– Base level from 2015 → average 2009-2010
Guus Velders, Montreal Protocol and Climate
8
Dr. Mukesh Sharma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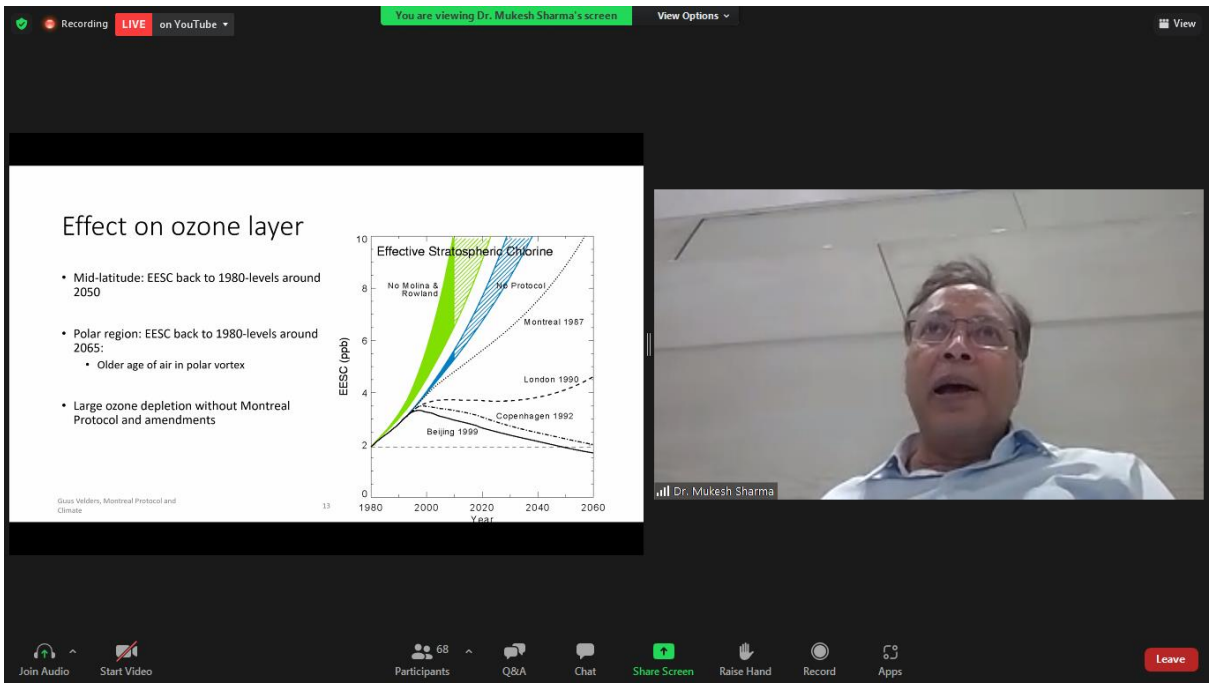
How the Global community and EU have controlled the emission of the ozone depleting chemicals
Consumption in Ozone-Depleting Potential (ODP) tonnes, 1986 = 100
140
120
100
80
60
40
20
0
-20
1986 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
EU-27 + UK
Global
*source: European Environment Agency
Dr. Mukesh Sharma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Effect on ozone layer
• Mid-latitude: EESC back to 1980-levels around 2050
• Polar region: EESC back to 1980-levels around 2065:
• Older age of air in polar vortex
• Large ozone depletion without Montreal Protocol and amendments
Effective Stratospheric Chlorine
No Montreal Protocol
Montreal 1987
London 1990
Copenhagen 1992
Beijing 1999
EESC (ppb)
Year
1980 2000 2020 2040 2060
Dr. Mukesh Sharma
Join Audio
Start Video
Participants
68
Q&A
Chat
Share Screen
Raise Hand
Record
Apps
Leave

2. Dr. Vijay Kumar Soni-"Ozone Layer Hole in a Changing Climate"

2.1. Ozone or trioxygen is an allotrope of oxygen that is much less stable than the diatomic allotrope.

2.2.Oxygen is a colourless, odourless gas at ambient concentrations.

2.3.At high concentration, it is a pale blue gas, slightly soluble in water and much more soluble in inert non-polar solvents. At -112 ^{o}C temperature, it condenses to form a dark blue liquid.

2.4. Ozone is present in low concentrations throughout the Earth's atmosphere. In total, ozone makes up only 0.6 ppm of the atmosphere.

2.5.Ozone is a major product of air pollution and globally its abundance is unknown.

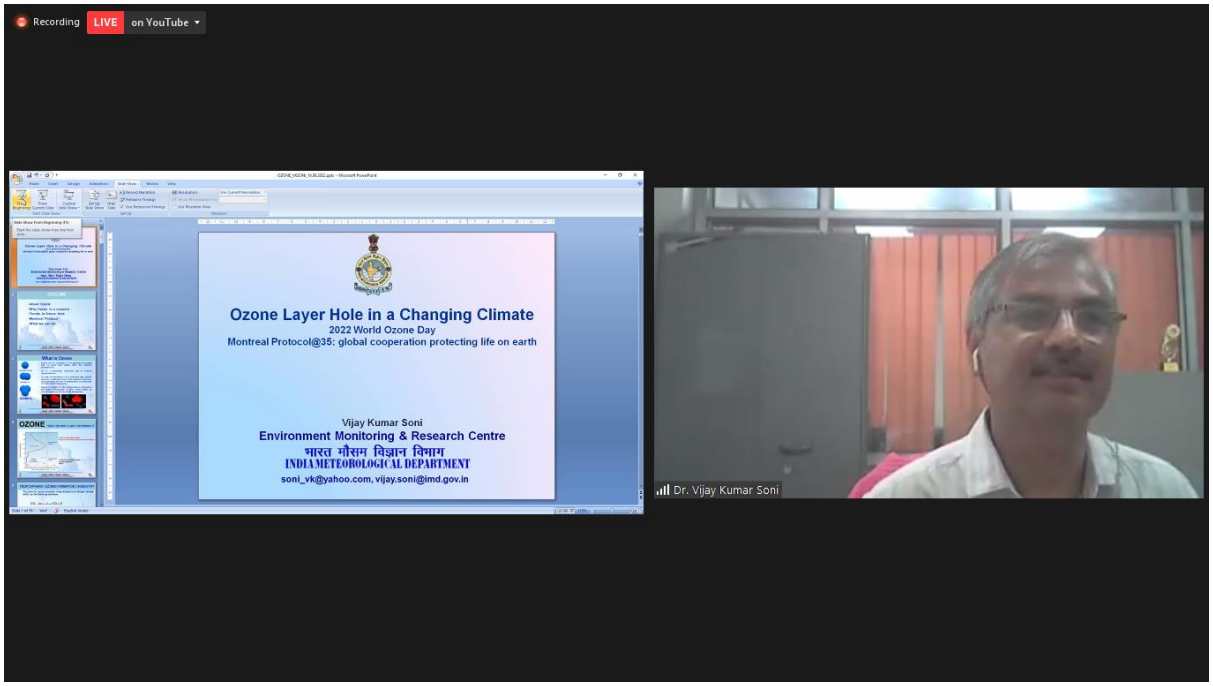
2.6.Ozone at the earth's surface plays a key role in the chemical cycling of many other trace gases in the atmosphere.

2.7.Knowing the amount of ozone helps assess the degree to which it is an environmental problem.

2.8. The clearest sign, so far, are ozone increases over the last 20 years in the upper stratosphere, and a decrease in the severity of the Antarctic ozone hole in September.

2.9.It is certain that the significant ozone decline from the 1960s to the 1990s has levelled off.

2.10. The worldwide ban of ozone-depleting substances (ODS)by the Montreal Protocol and its amendments has been successful.



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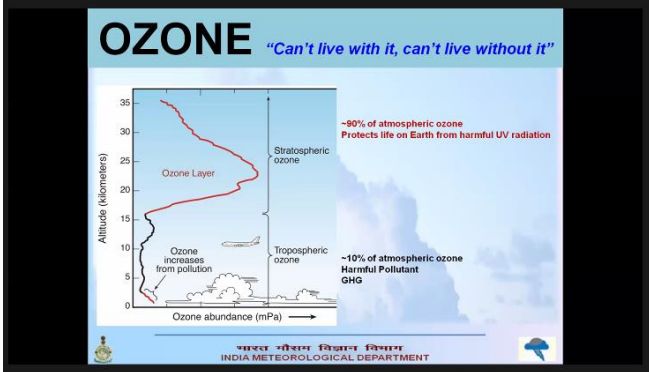

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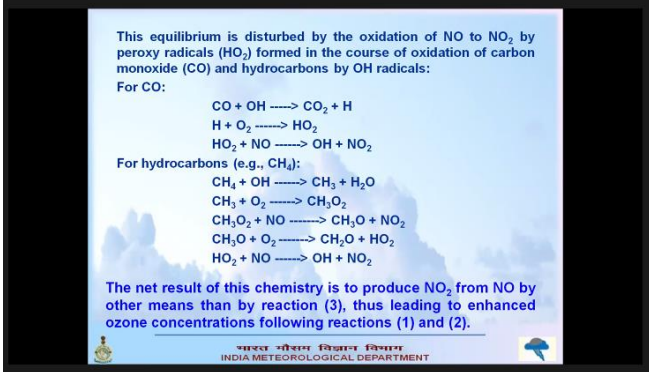

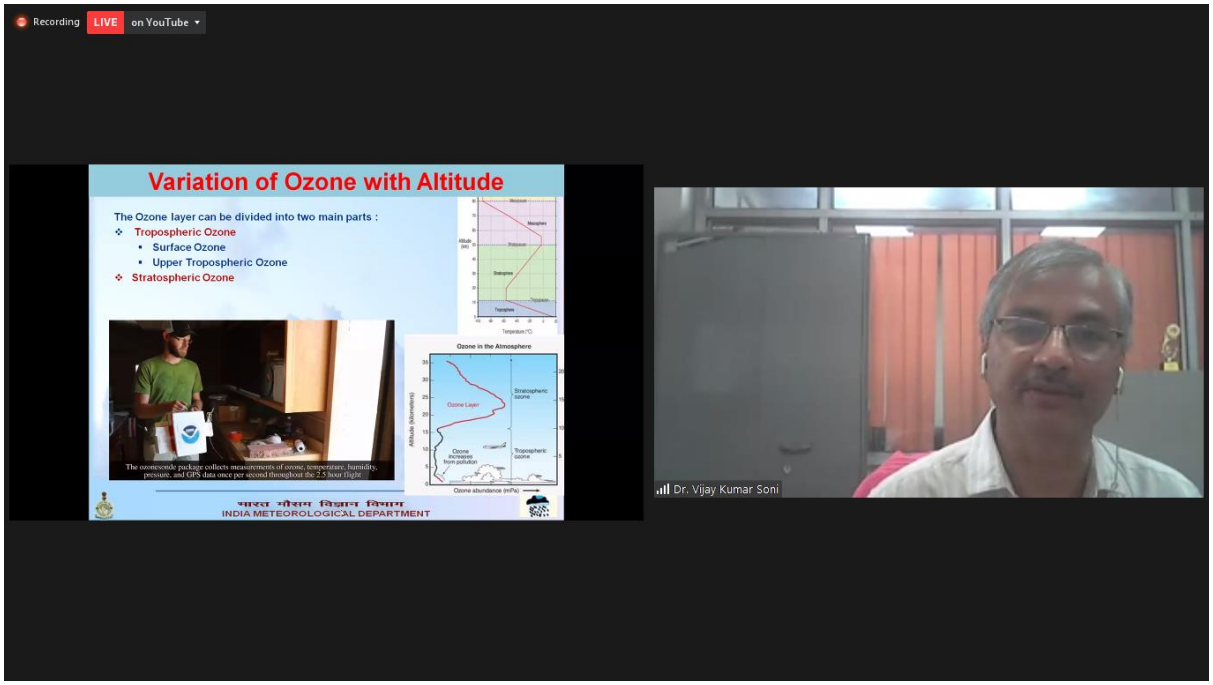
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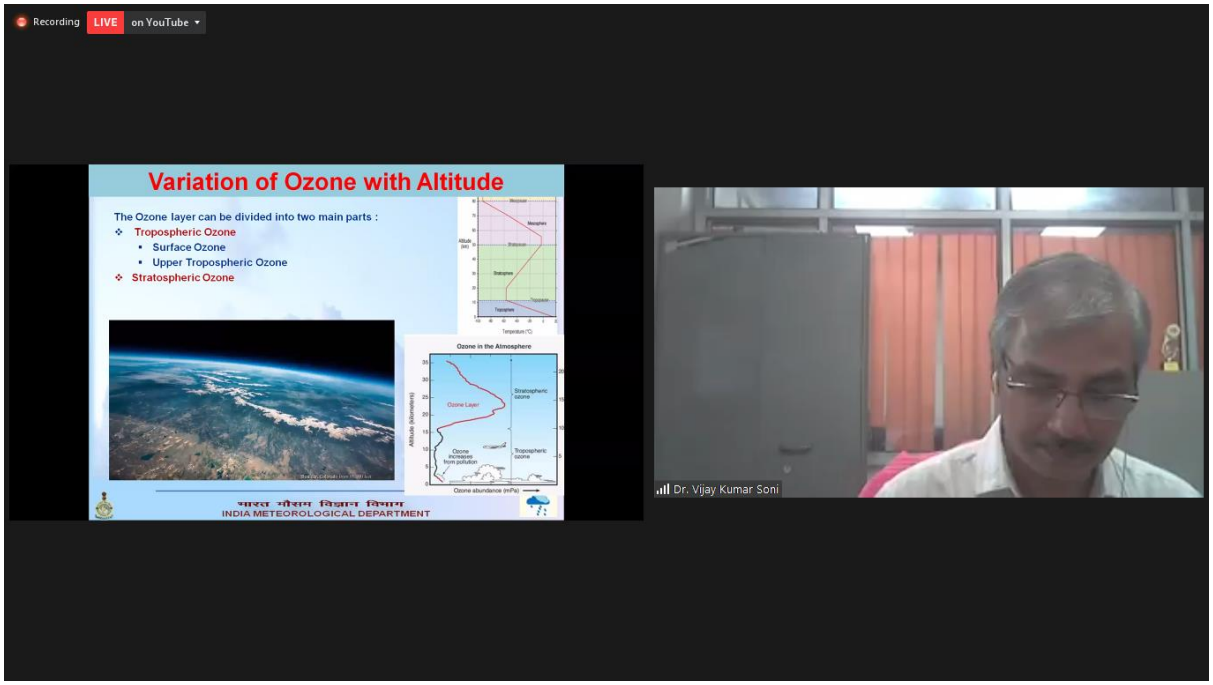
Variation of Ozone with Altitude
The Ozone layer can be divided into two main parts :
Tropospheric Ozone
Surface Ozone
Upper Tropospheric Ozone
Stratospheric Ozone
The ozonesonde package collects measurements of ozone, temperature, humidity, pressure, and GPS data once per second throughout the 2.5 hour flight
Ozone in the Atmosphere
Ozone Layer
Stratospheric ozone
Tropospheric ozone
Ozone increases from pollution
Ozone abundance (mPa)
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni


Recording
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Variation of Ozone with Altitude
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भारत मौसम विज्ञान विभाग
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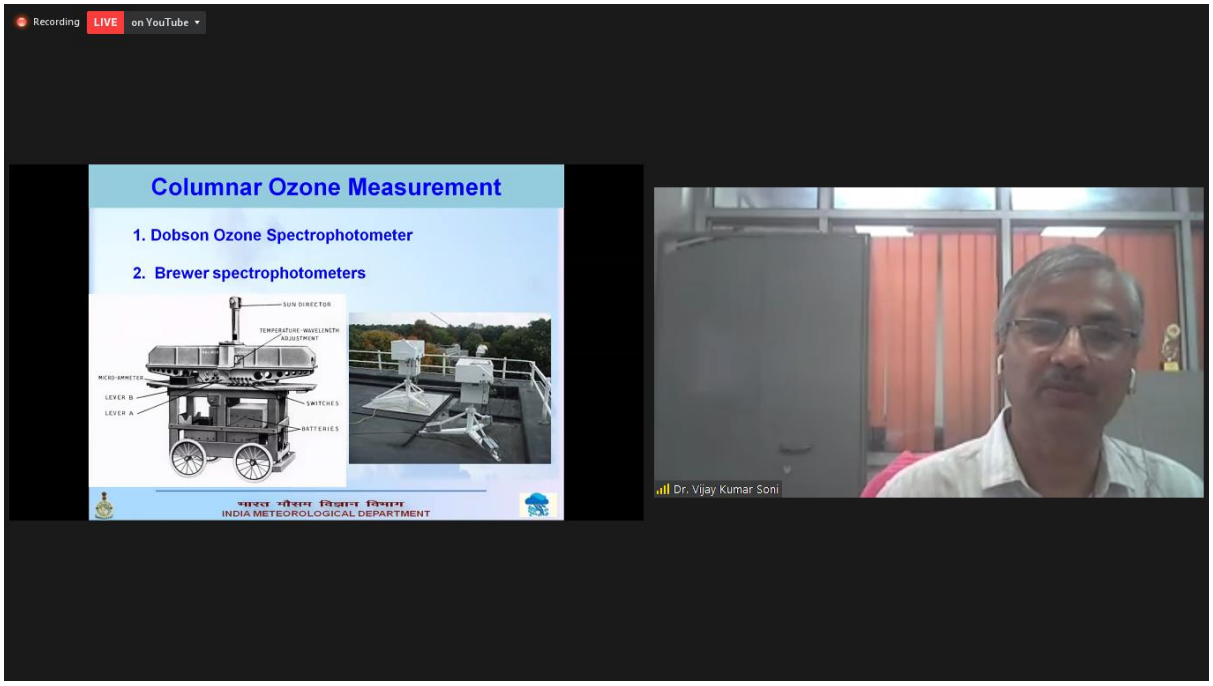
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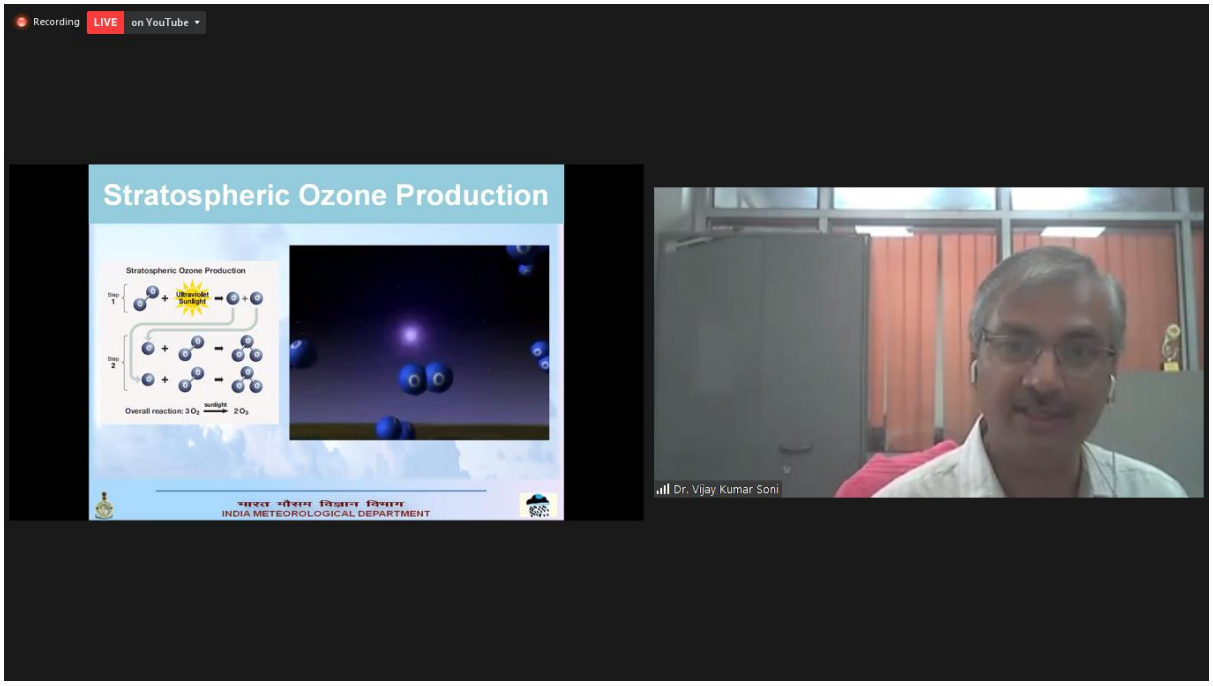
Columnar Ozone Measurement
1. Dobson Ozone Spectrophotometer
2. Brewer spectrophotometers
SUN DIRECTOR
TEMPERATURE-WAVELENGTH ADJUSTMENT
MICRO-AMMETER
LEVER B
LEVER A
SWITCHES
BATTERIES
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni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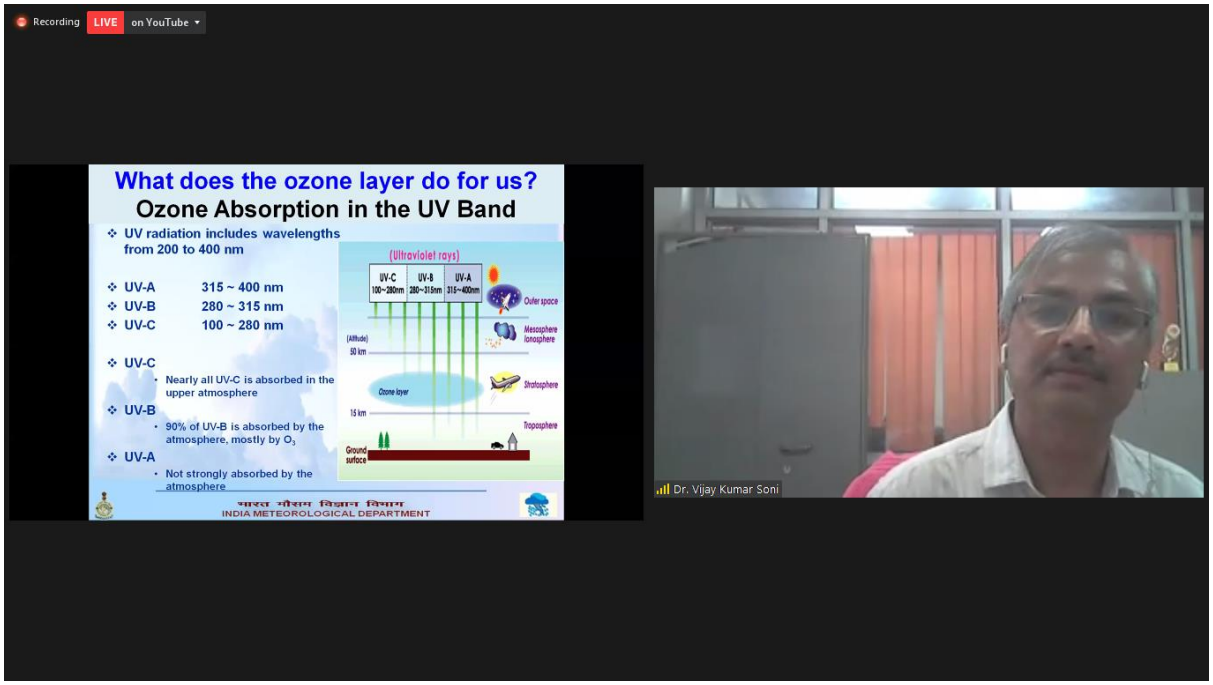
Stratospheric Ozone Production
Stratospheric Ozone Production
Step 1
Ultraviolet Sunlight
Step 2
Overall reaction: 3O2 sunlight 2O3
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni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What does the ozone layer do for us?
Ozone Absorption in the UV Band
UV radiation includes wavelengths from 200 to 400 nm
UV-A 315 ~ 400 nm
UV-B 280 ~ 315 nm
UV-C 100 ~ 280 nm
UV-C
Nearly all UV-C is absorbed in the upper atmosphere
UV-B
90% of UV-B is absorbed by the atmosphere, mostly by O_3
UV-A
Not strongly absorbed by the atmosphere
(Ultraviolet rays)
UV-C 100~280nm
UV-B 280~315nm
UV-A 315~400nm
Outer space
Mesosphere Ionosphere
(Altitude) 50 km
Ozone layer
Stratosphere
15 km
Troposphere
Ground surface
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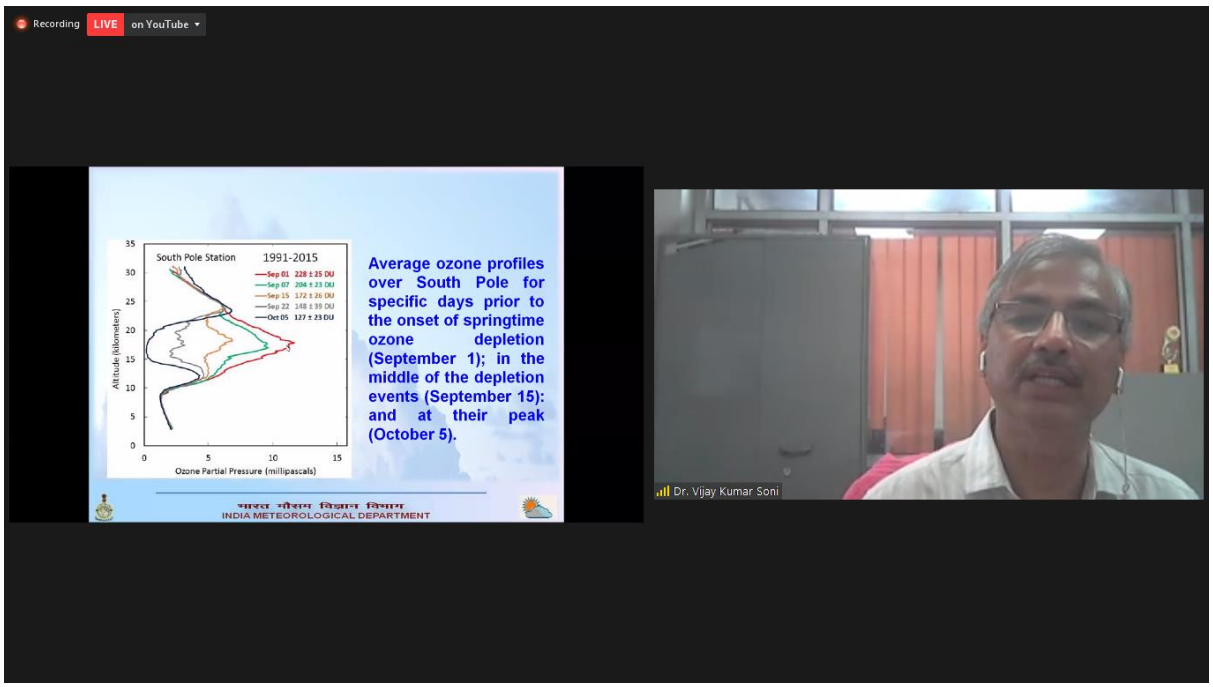
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South Pole Station 1991-2015
Sep 01 228 ± 25 DU
Sep 07 204 ± 23 DU
Sep 15 172 ± 26 DU
Sep 22 148 ± 39 DU
Oct 05 127 ± 23 DU
Altitude (kilometers)
Ozone Partial Pressure (millipascals)
Average ozone profiles over South Pole for specific days prior to the onset of springtime ozone depletion (September 1); in the middle of the depletion events (September 15): and at their peak (October 5).
भारत मौसम विज्ञान विभाग
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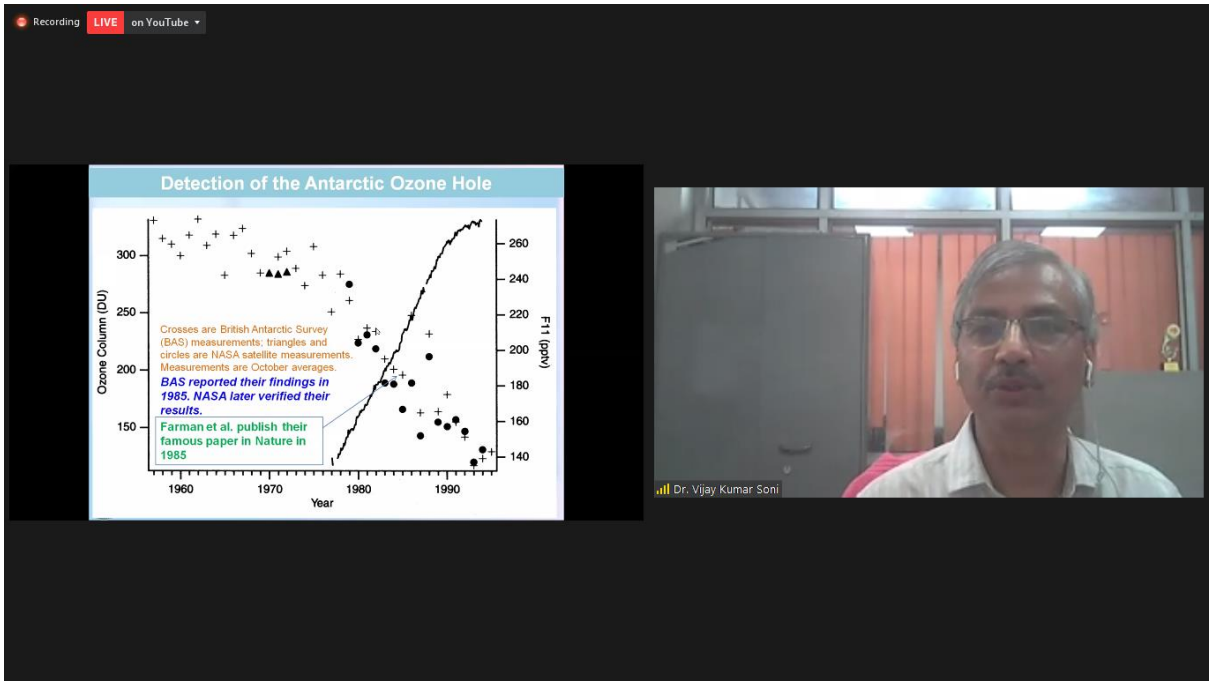
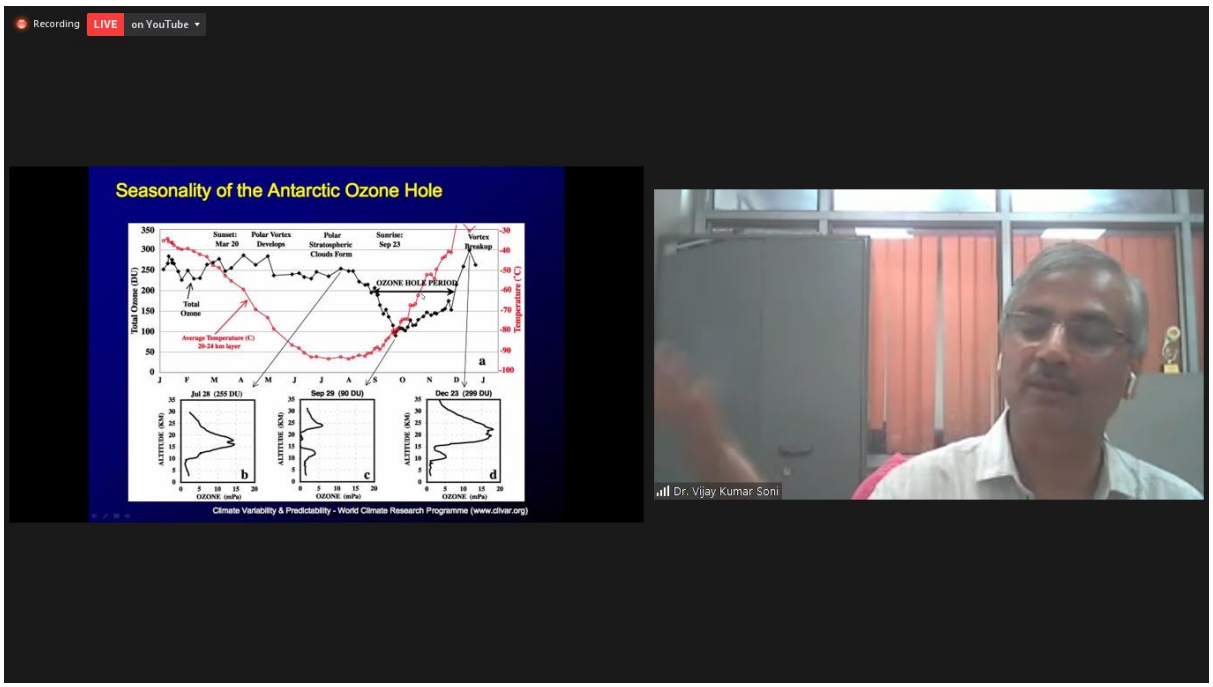
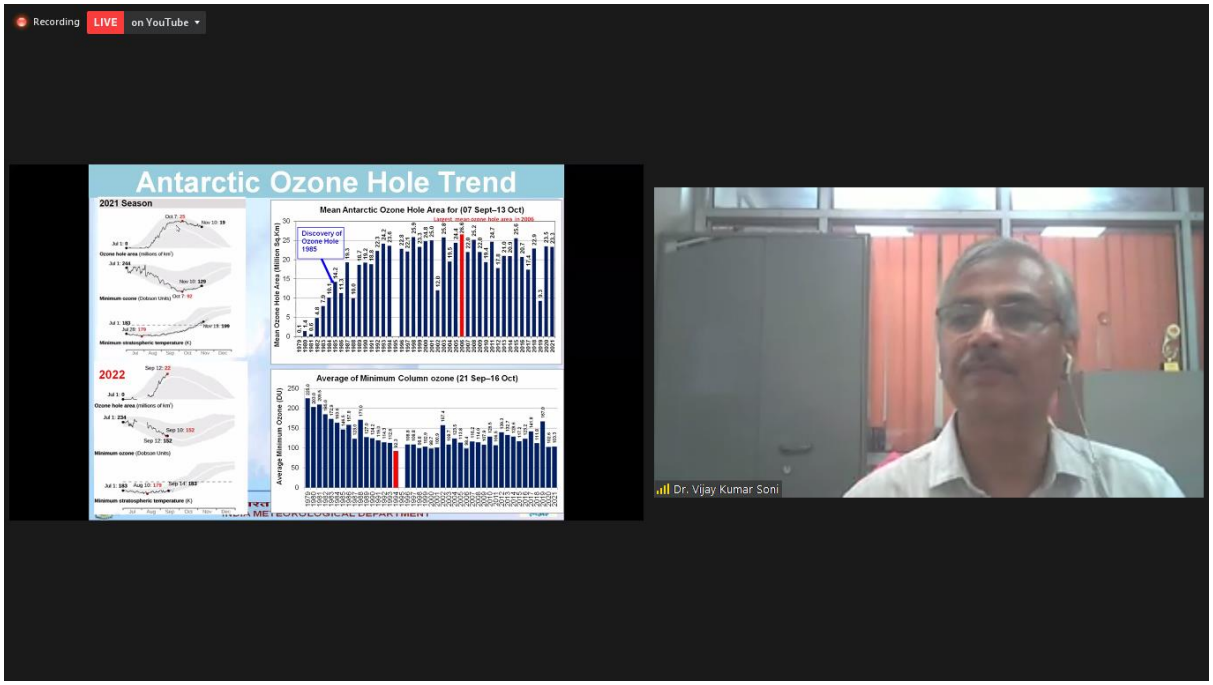
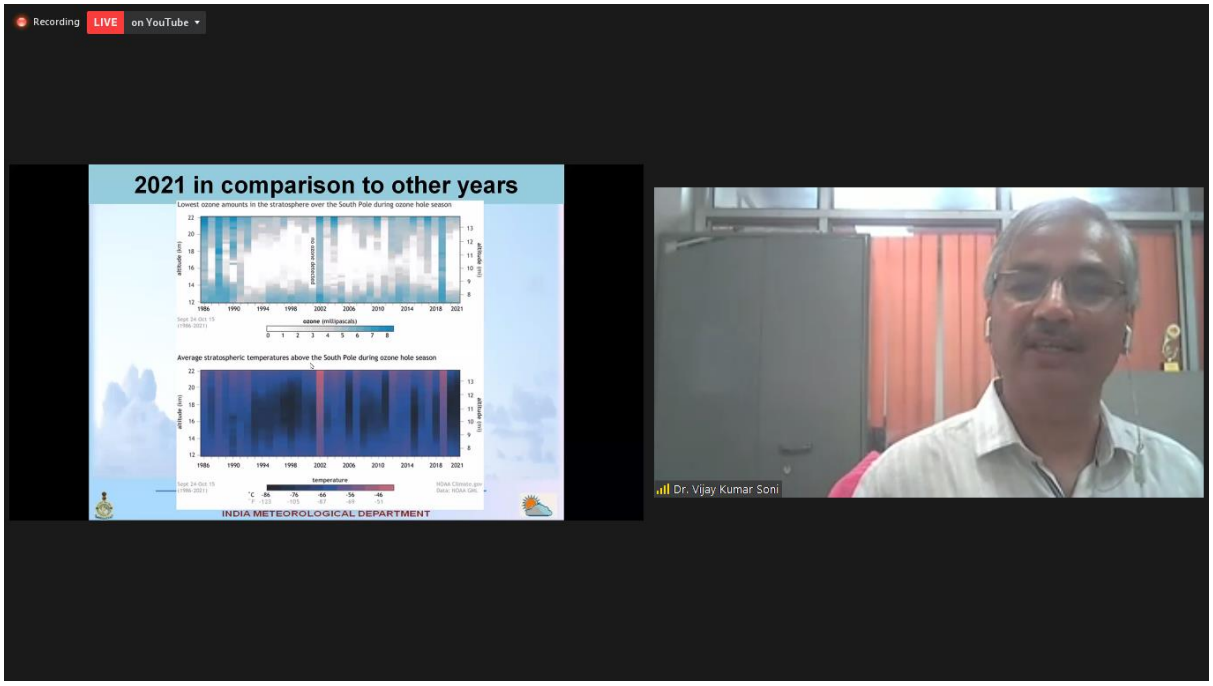
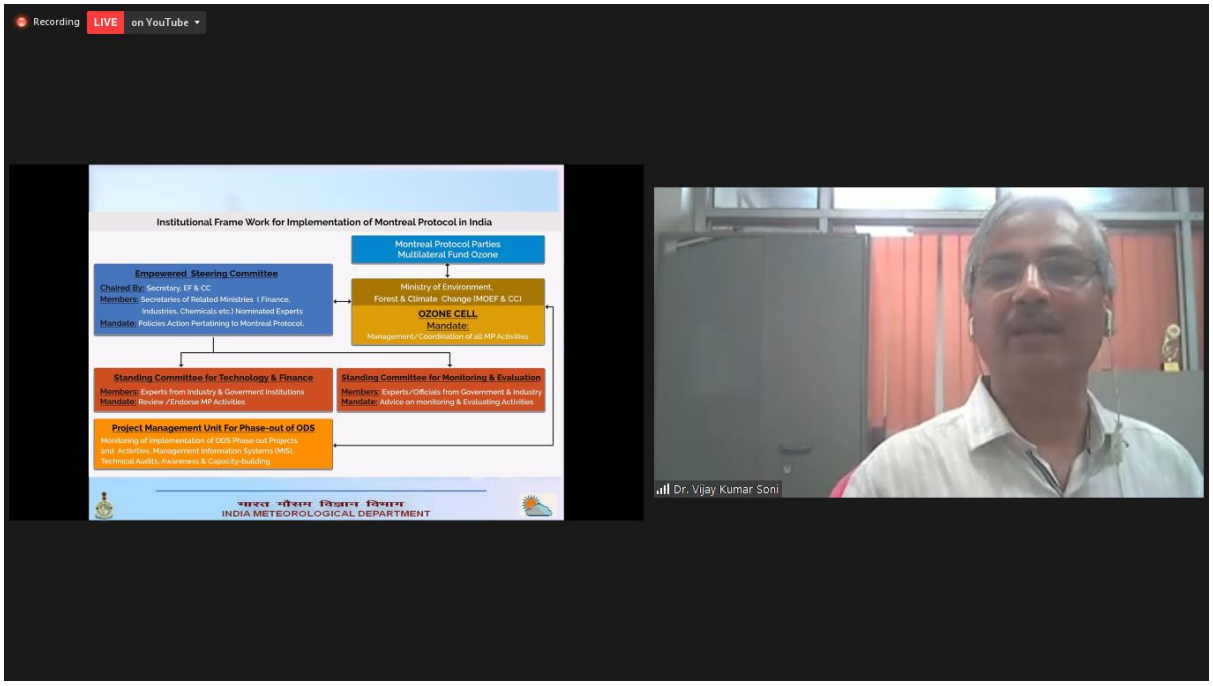
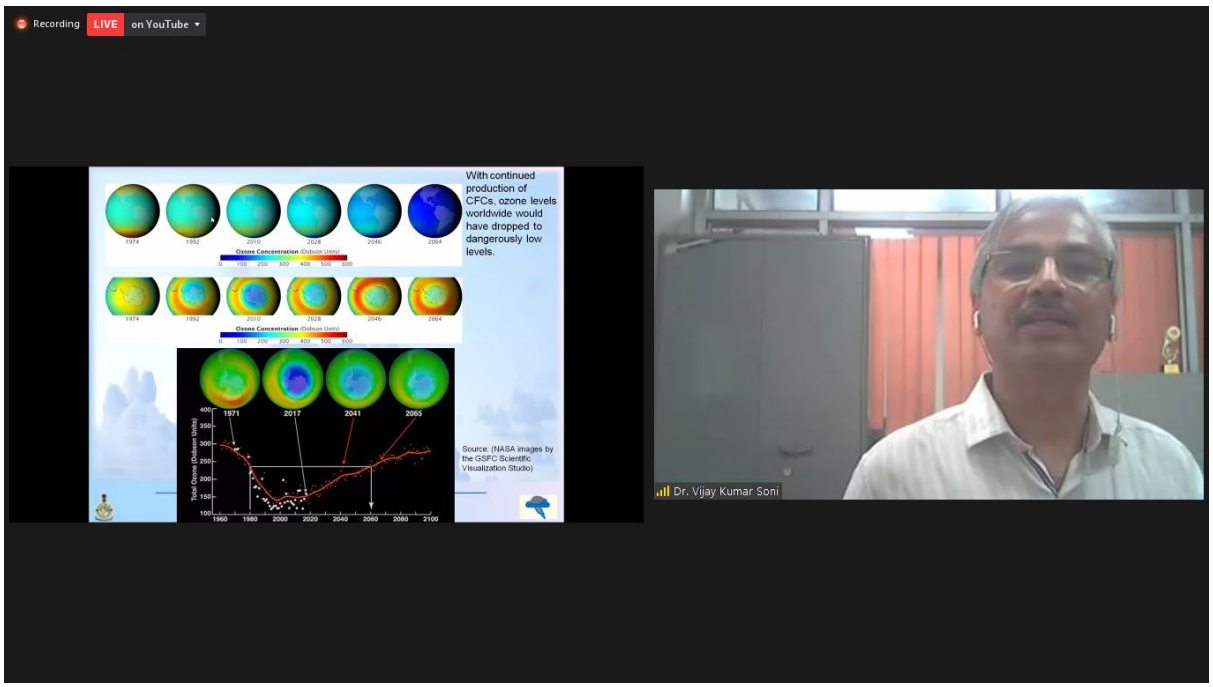

Recording
LIVE
on YouTube
Detection of the Antarctic Ozone Hole
Ozone Column (DU)
F11 (pptv)
Year
Crosses are British Antarctic Survey (BAS) measurements: triangles and circles are NASA satellite measurements. Measurements are October averages.
BAS reported their findings in 1985. NASA later verified their results.
Farman et al. publish their famous paper in Nature in 1985
Dr. Vijay Kumar Soni

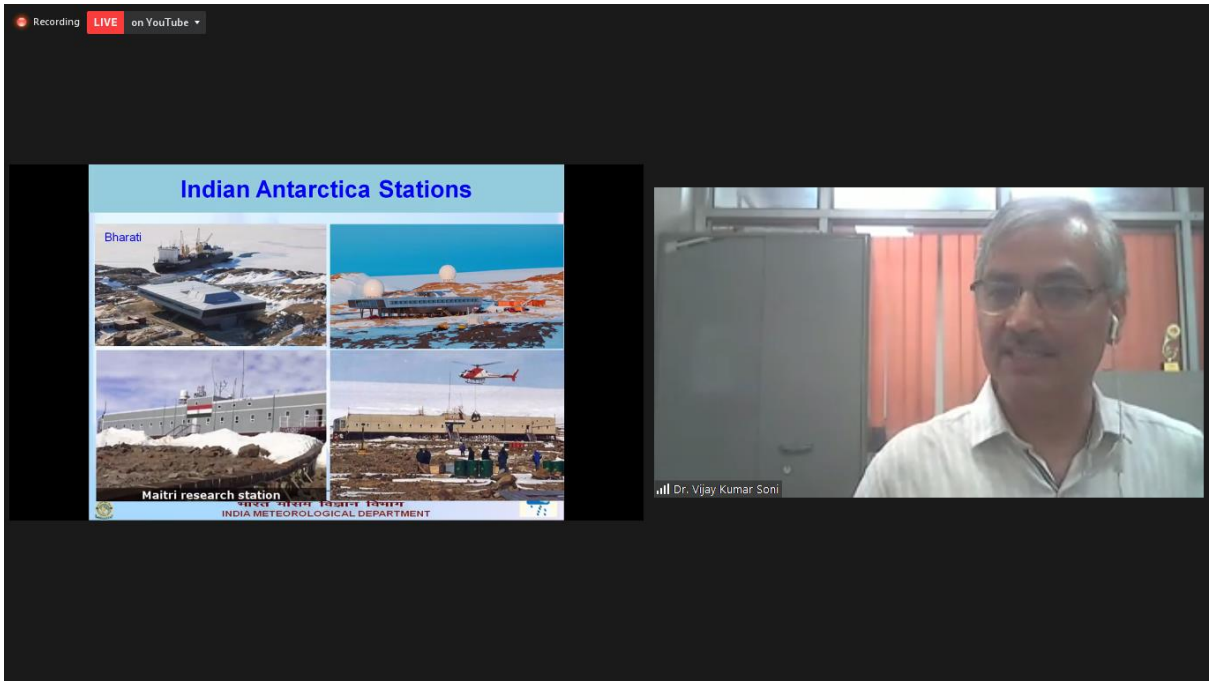

Recording
LIVE
on YouTube
Seasonality of the Antarctic Ozone Hole
Total Ozone (DU)
Temperature (°C)
Sunset: Mar 20
Polar Vortex Develops
Polar Stratospheric Clouds Form
Sunrise: Sep 23
Vortex Breakup
OZONE HOLE PERIOD
Total Ozone
Average Temperature (C) 20-24 km layer
Jul 28 (255 DU)
Sep 29 (90 DU)
Dec 23 (299 DU)
ALTITUDE (KM)
OZONE (mPa)
Climate Variability & Predictability - World Climate Research Programme (www.clivar.org)
Dr. Vijay Kumar Soni

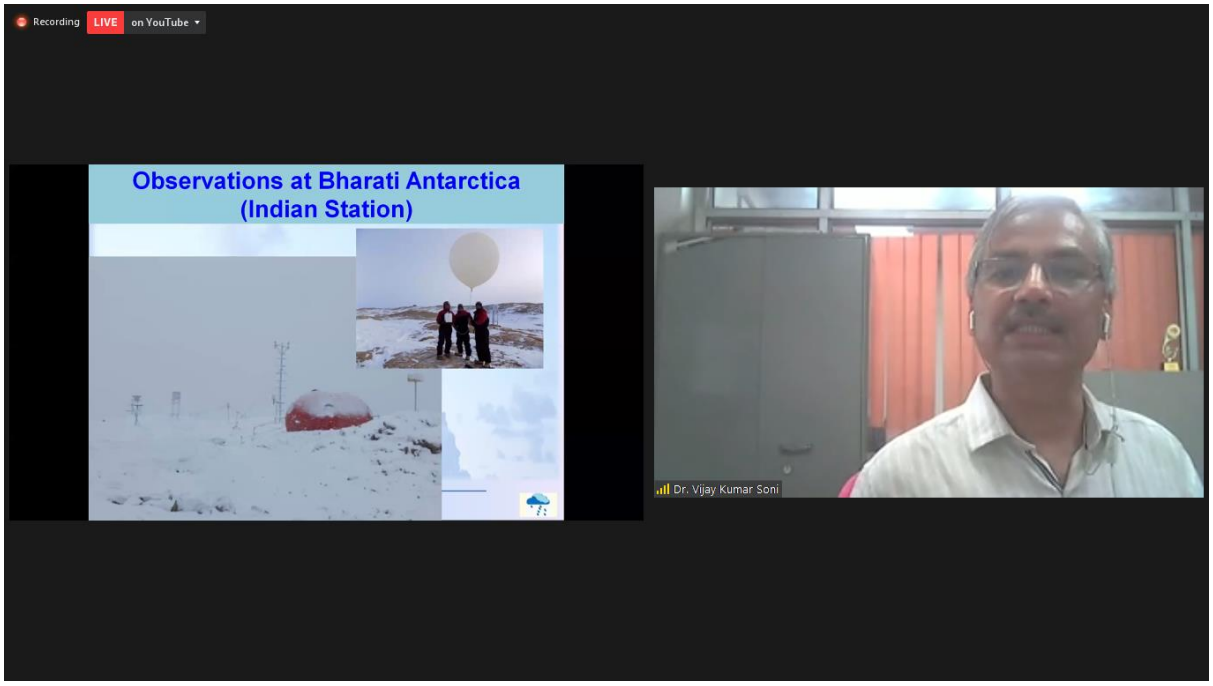

Recording
LIVE
on YouTube
Antarctic Ozone Hole Trend
2021 Season
2022
Mean Antarctic Ozone Hole Area for (07 Sept–13 Oct)
Discovery of Ozone Hole 1985
Mean Ozone Hole Area (Million Sq.km)
Average of Minimum Column ozone (21 Sep–16 Oct)
Average Minimum Ozone (DU)
METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni

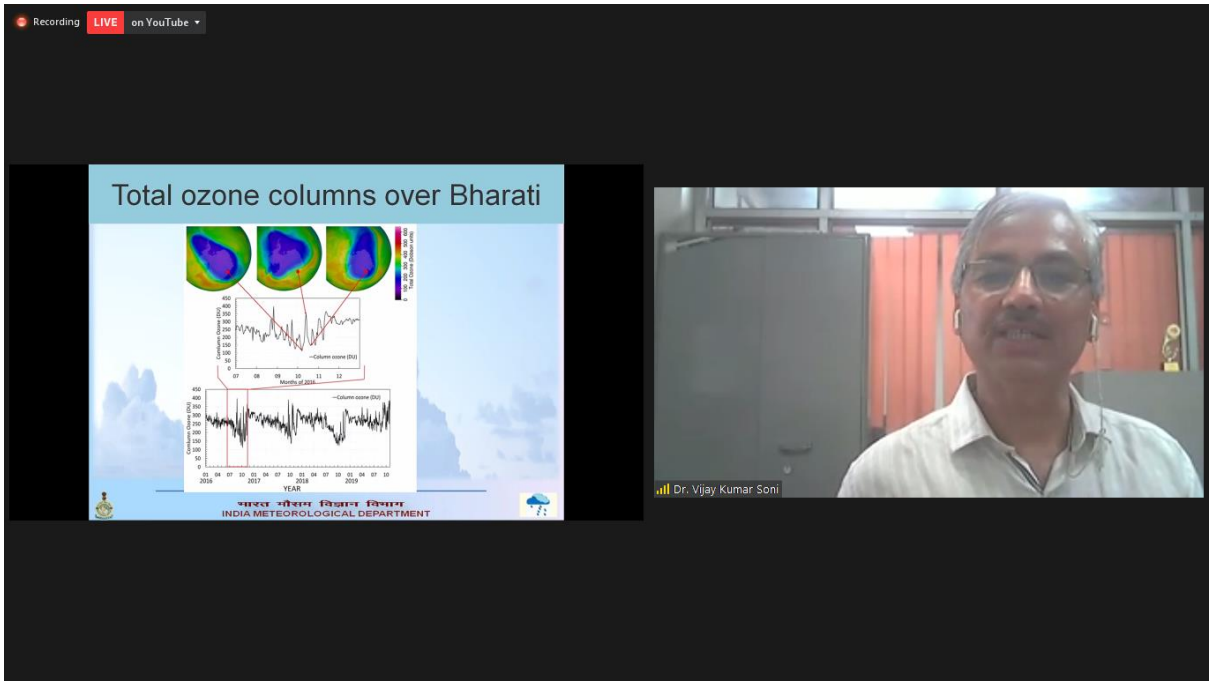

Recording
LIVE
on YouTube
2021 in comparison to other years
Lowest ozone amounts in the stratosphere over the South Pole during ozone hole season
altitude (km)
pressure (hPa)
ozone (millipascals)
Average stratospheric temperatures above the South Pole during ozone hole season
temperature
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni


Recording
LIVE
on YouTube
Institutional Frame Work for Implementation of Montreal Protocol in India
Montreal Protocol Parties
Multilateral Fund Ozone
Empowered Steering Committee
Chaired By: Secretary, EF & CC
Members: Secretaries of Related Ministries (Finance, Industries, Chemicals etc.) Nominated Experts
Mandate: Policies Action Pertaining to Montreal Protocol.
Ministry of Environment, Forest & Climate Change (MOEF & CC)
OZONE CELL
Mandate:
Management/Coordination of all MP Activities
Standing Committee for Technology & Finance
Members: Experts from Industry & Goverment Institutions
Mandate: Review /Endorse MP Activities
Standing Committee for Monitoring & Evaluation
Members: Experts/Officials from Government & Industry
Mandate: Advice on monitoring & Evaluating Activities
Project Management Unit For Phase-out of ODS
Monitoring of implementation of ODS Phase out Projects and Activities, Management Information Systems (MIS), Technical Audits, Awareness & Capacity-building
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni


Recording
LIVE
on YouTube
With continued production of CFCs, ozone levels worldwide would have dropped to dangerously low levels.
1974
1992
2010
2028
2046
2064
Ozone Concentration (Dobson Units)
1971
2017
2041
2065
Total Ozone (Dobson Units)
Source: (NASA images by the GSFC Scientific Visualization Studio)
Dr. Vijay Kumar Soni


Recording
LIVE
on YouTube
Indian Antarctica Stations
Bharati
Maitri research station
INDIA METEOROLOGICAL DEPARTMENT
Dr. Vijay Kumar Soni


Recording
LIVE
on YouTube
Observations at Bharati Antarctica
(Indian Station)
Dr. Vijay Kumar Soni



3. Dr. S. K. Goyal- "Ozone Layer: Protect the Protector"

3.1. In 1985, using satellites, balloons, and surface stations, a team of researchers discovered a balding patch of ozone in the upper stratosphere, the size of the United States, over Antarctica.

3.2. The ozone hole is defined as the area having less than 220 Dobson units (DU) of ozone in the overhead column (i.e., between the ground and space).

3.3. Composed of elements chlorine, fluorine, and carbon.

3.4. CFC was developed in 1903 by DuPont.

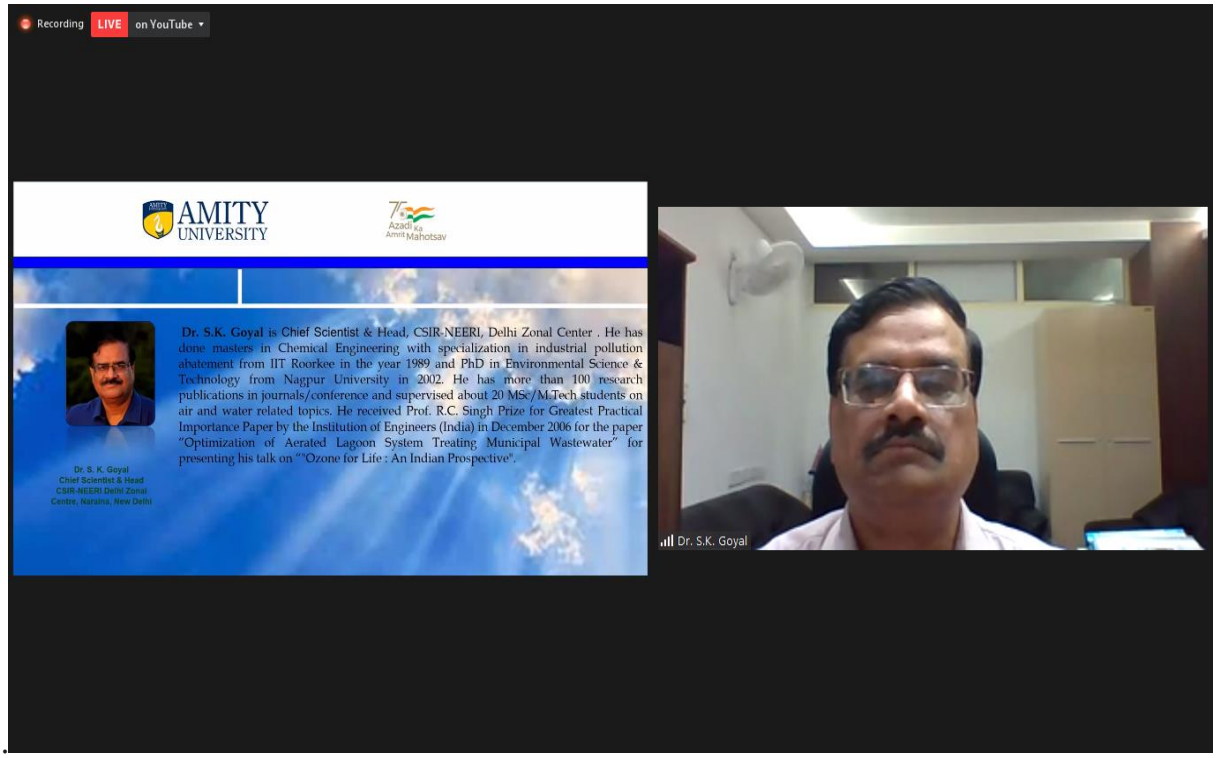
3.5. CFCs were welcomed by industries: low toxicity, chemical stability, and cheap.

3.6. CFCs are used as refrigerants, blowing agents, for making flexible foam, cleaning agents, propellants.

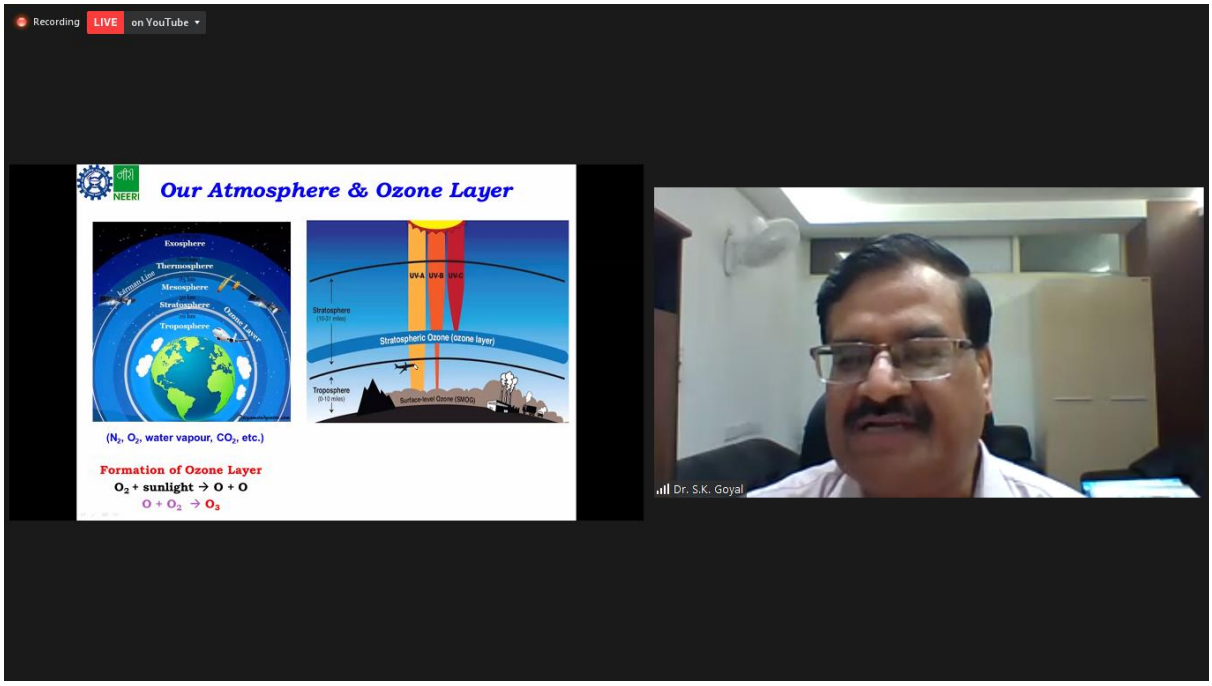
3.7. A panel of experts was formed to investigate substances responsible for hole formation.

3.8. Established policies that prevent future use of certain types of chemicals.

3.9.


Recording
LIVE
on YouTube
AMITY UNIVERSITY
Azadi Ka Amrit Mahotsav
Dr. S.K. Goyal is Chief Scientist & Head, CSIR-NEERI, Delhi Zonal Center . He has done masters in Chemical Engineering with specialization in industrial pollution abatement from IIT Roorkee in the year 1989 and PhD in Environmental Science & Technology from Nagpur University in 2002. He has more than 100 research publications in journals/conference and supervised about 20 MSc/M.Tech students on air and water related topics. He received Prof. R.C. Singh Prize for Greatest Practical Importance Paper by the Institution of Engineers (India) in December 2006 for the paper "Optimization of Aerated Lagoon System Treating Municipal Wastewater" for presenting his talk on ""Ozone for Life : An Indian Prospective".
Dr. S. K. Goyal
Chief Scientist & Head
CSIR-NEERI Delhi Zonal Centre, Naraina, New Delhi
Dr. S.K. Goyal


Recording
LIVE
on YouTube
"Webinar on Ozone Day Celebration 2022"
Ozone Layer: Protect the Protector
Ozone Layer
UV-C
UV-A
UV-B
Organized by
Amity University, Noida
September 20, 2022
(3-5 pm)
NEERI
Dr. S. K. Goyal
Chief Scientist & Head,
CSIR-NEERI Delhi Zonal Centre,
Naraina, New Delhi
Dr. S.K. Goyal


Recording
LIVE
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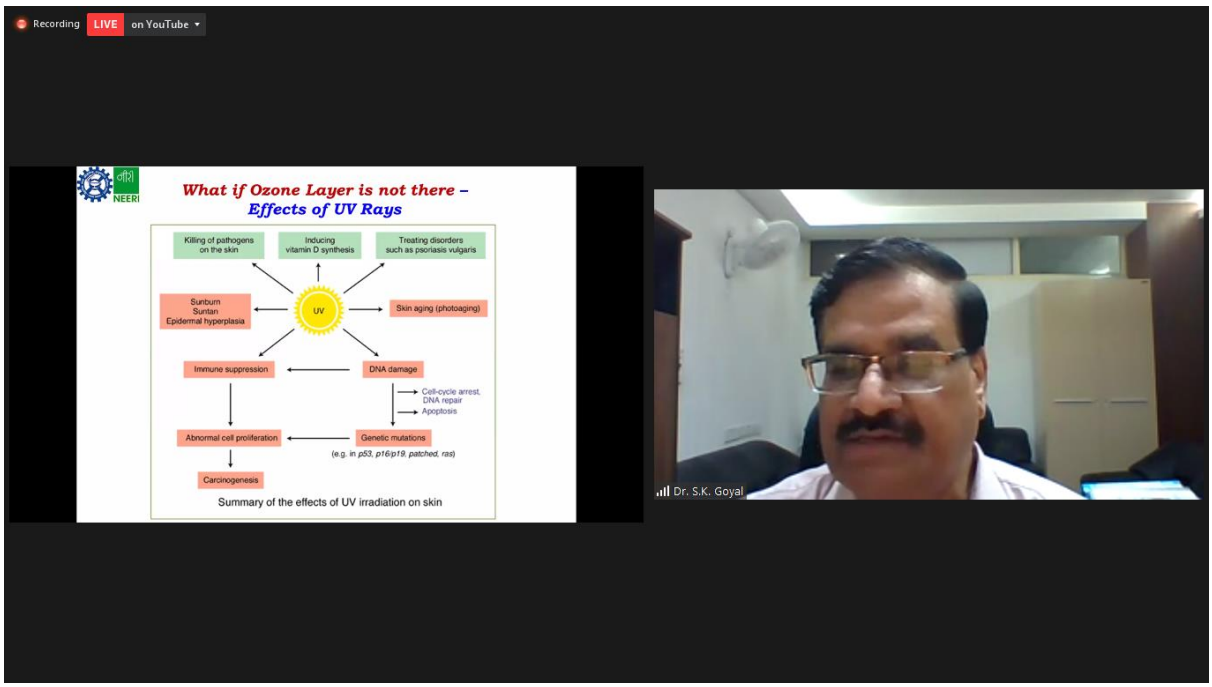
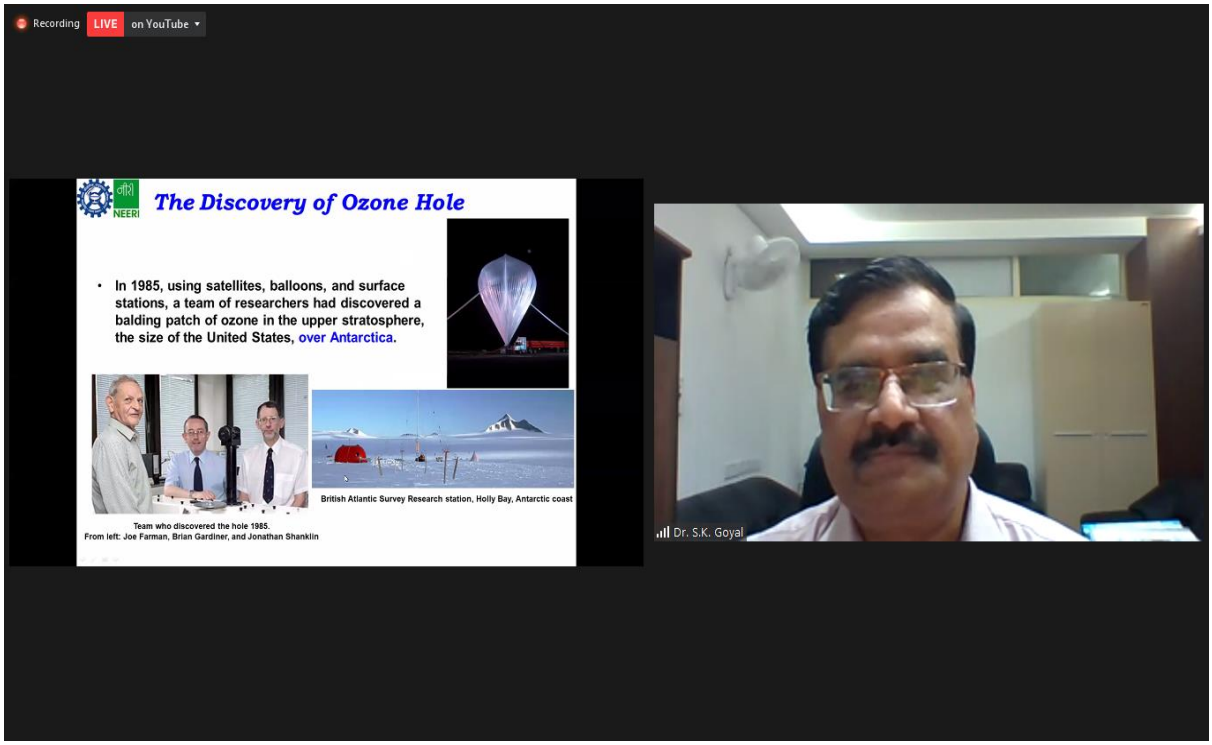
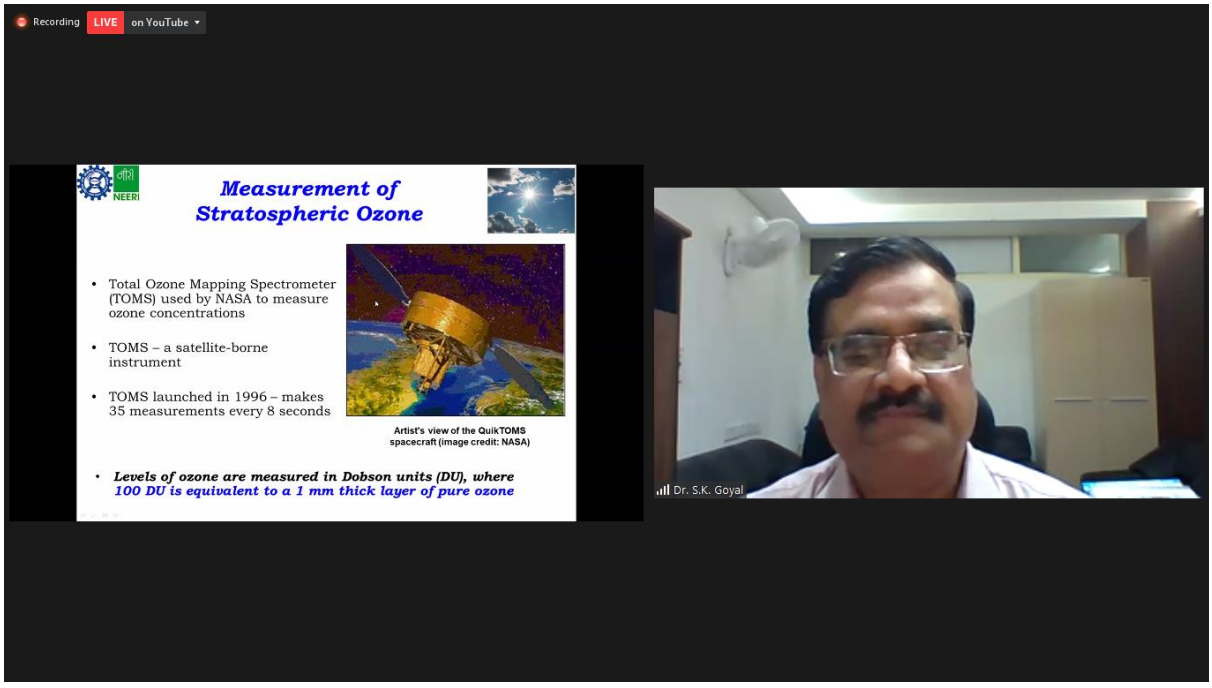
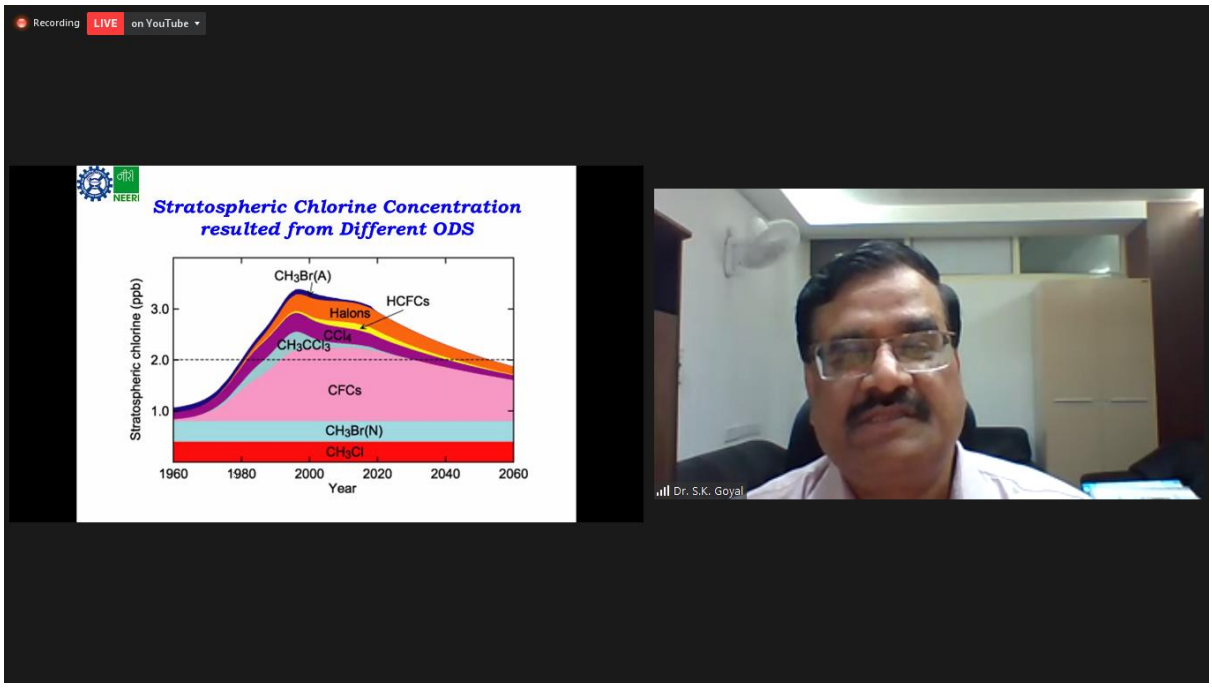
Our Atmosphere & Ozone Layer
Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere
Ozone Layer
Stratosphere
Stratospheric Ozone (ozone layer)
Troposphere
Surface-level Ozone (SMOG)
(N_2, O_2, water vapour, CO_2, etc.)
Formation of Ozone Layer
O_2 + sunlight → O + O
O + O_2 → O_3
Dr. S.K. Goyal


Recording
LIVE
on YouTube
What if Ozone Layer is not there –
Effects of UV Rays
Killing of pathogens on the skin
Inducing vitamin D synthesis
Treating disorders such as psoriasis vulgaris
Sunburn
Suntan
Epidermal hyperplasia
UV
Skin aging (photoaging)
Immune suppression
DNA damage
Cell-cycle arrest, DNA repair
Apoptosis
Abnormal cell proliferation
Genetic mutations
(e.g. in p53, p16/p19, patched, ras)
Carcinogenesis
Summary of the effects of UV irradiation on skin
Dr. S.K. Goyal


Recording
LIVE
on YouTube
NEERI
The Discovery of Ozone Hole
In 1985, using satellites, balloons, and surface stations, a team of researchers had discovered a balding patch of ozone in the upper stratosphere, the size of the United States, over Antarctica.
British Atlantic Survey Research station, Holly Bay, Antarctic coast
Team who discovered the hole 1985.
From left: Joe Farman, Brian Gardiner, and Jonathan Shanklin
Dr. S.K. Goyal


Recording
LIVE
on YouTube
NEERI
Measurement of Stratospheric Ozone
Total Ozone Mapping Spectrometer (TOMS) used by NASA to measure ozone concentrations
TOMS – a satellite-borne instrument
TOMS launched in 1996 – makes 35 measurements every 8 seconds
Artist's view of the QuikTOMS spacecraft (image credit: NASA)
Levels of ozone are measured in Dobson units (DU), where 100 DU is equivalent to a 1 mm thick layer of pure ozone
Dr. S.K. Goyal


Recording
LIVE
on YouTube
NEERI
Mechanism of Ozone Depletion
Ozone layer absorbs 93 % of the harmful, high frequency Ultra-violet radiations.
CFC
UV Radiation
UV Radiation
1 - CFCs released
2 - CFCs rise into ozone layer
3 - UV releases Cl from CFCs
4 - Cl destroys ozone
5 - Depleted ozone -> more UV
6 - More UV -> more skin cancer
Cl atoms from CFCs attack the ozone, taking away ozone and forming chlorine monoxide (ClO), which then combines with another oxygen atom to form a new oxygen molecule and a chlorine atom.
$O_3 + Cl \rightarrow O_2 + ClO$
$ClO + O \rightarrow Cl + O_2$
The chlorine atom is free to destroy up to 100,000 ozone molecules
Dr. S.K. Goyal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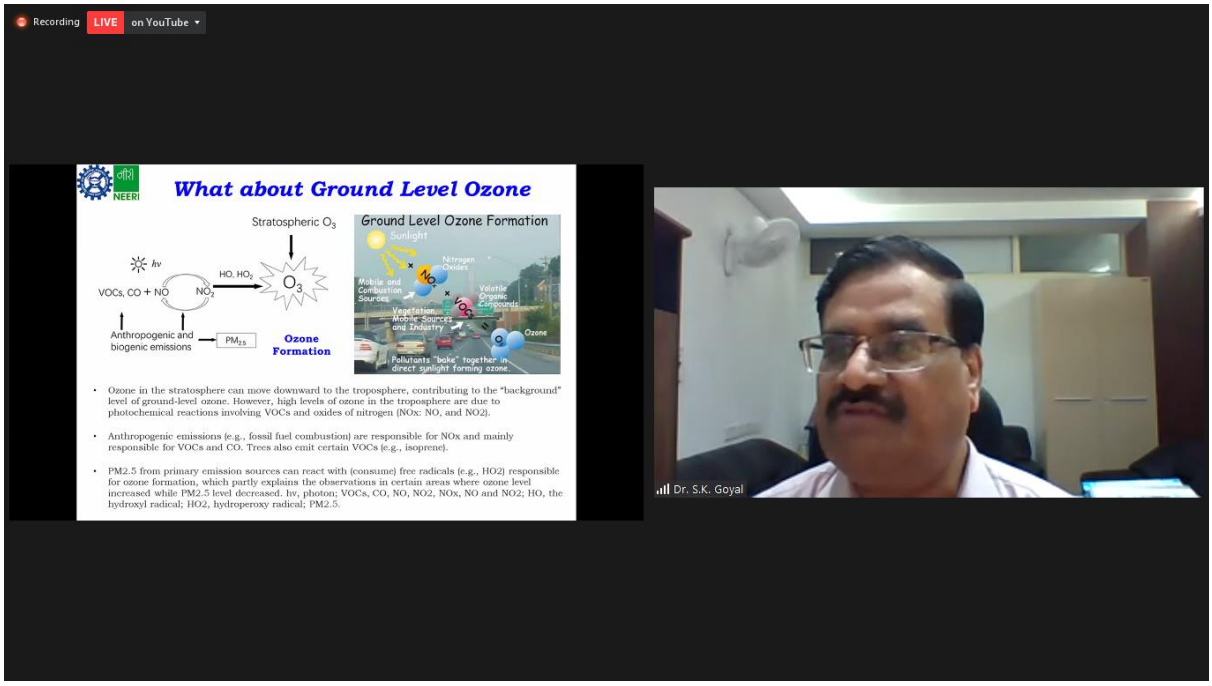
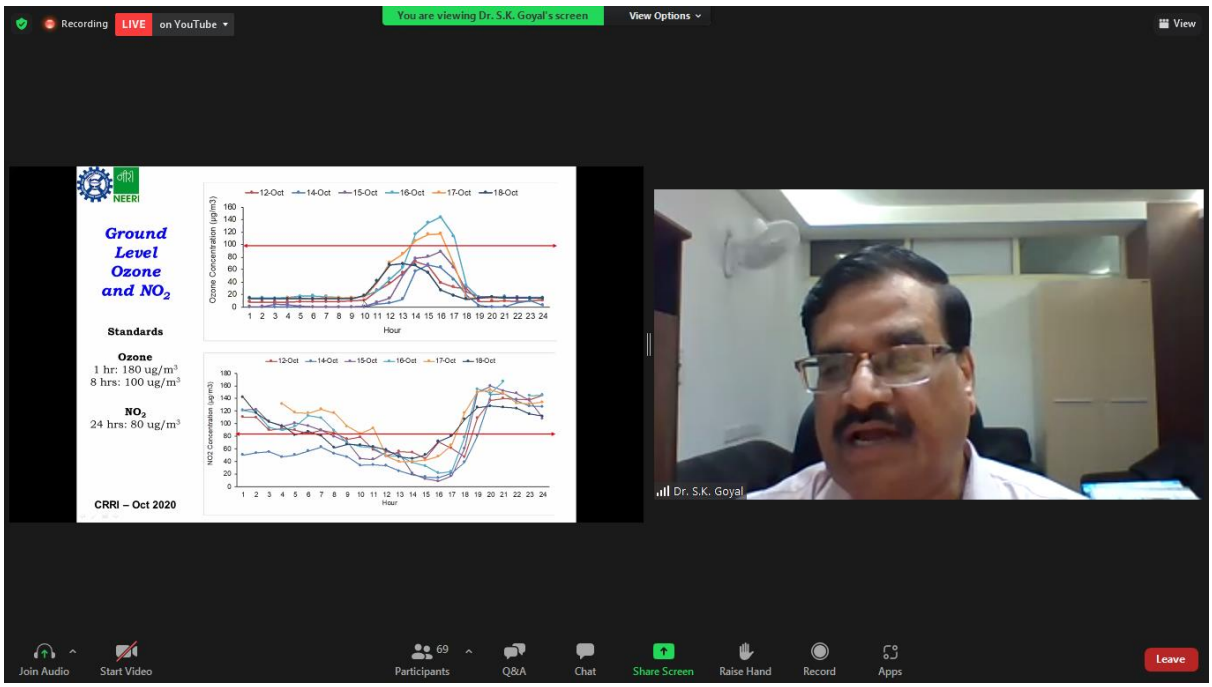
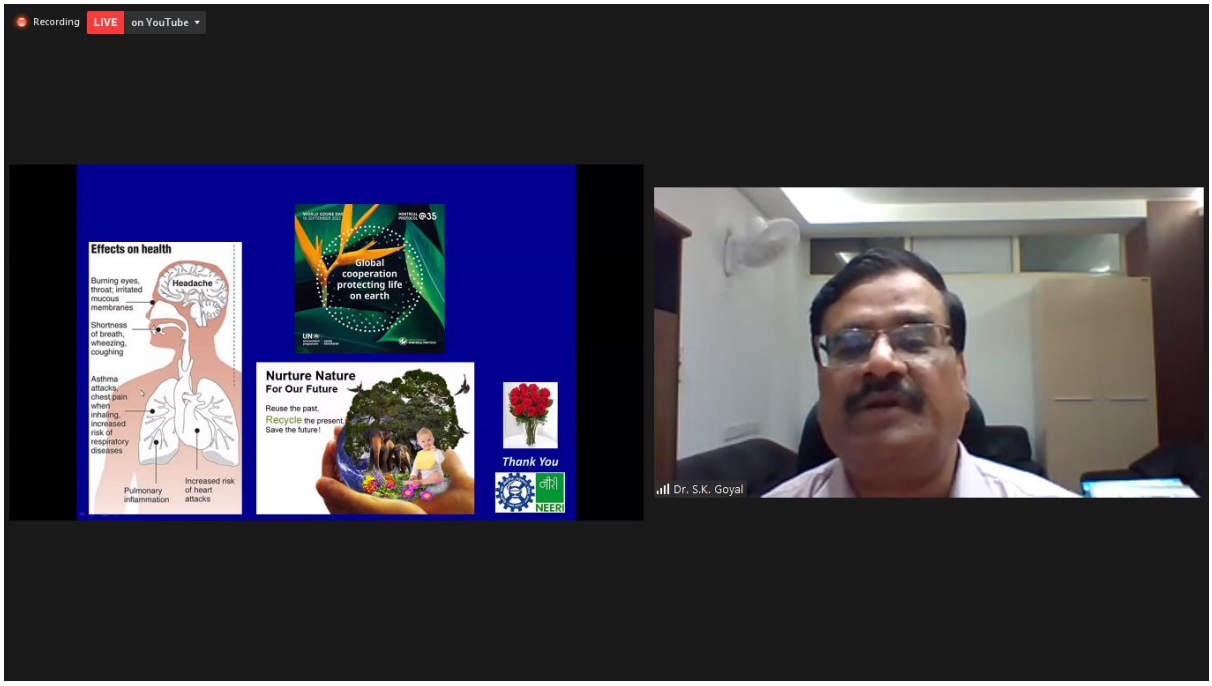
LIVE
on YouTube
NEERI
Stratospheric Chlorine Concentration resulted from Different ODS
Stratospheric chlorine (ppb)
3.0
2.0
1.0
CH3Br(A)
HCFCs
Halons
CCl4
CH3CCl3
CFCs
CH3Br(N)
CH3Cl
1960
1980
2000
2020
2040
2060
Year
Dr. S.K. Goyal


Recording
LIVE
on YouTube
What about Ground Level Ozone
Stratospheric O_3
hv
HO, HO_2
VOCs, CO + NO
NO_2
O_3
Anthropogenic and biogenic emissions
$PM_{2.5}$
Ozone Formation
Ground Level Ozone Formation
Sunlight
Nitrogen Oxides
Mobile and Combustion Sources
Volatile Organic Compounds
Vegetation, Mobile Sources and Industry
Ozone
Pollutants "bake" together in direct sunlight forming ozone.
Ozone in the stratosphere can move downward to the troposphere, contributing to the "background" level of ground-level ozone. However, high levels of ozone in the troposphere are due to photochemical reactions involving VOCs and oxides of nitrogen (NOx: NO, and NO2).
Anthropogenic emissions (e.g., fossil fuel combustion) are responsible for NOx and mainly responsible for VOCs and CO. Trees also emit certain VOCs (e.g., isoprene).
PM2.5 from primary emission sources can react with (consume) free radicals (e.g., HO2) responsible for ozone formation, which partly explains the observations in certain areas where ozone level increased while PM2.5 level decreased. hv, photon; VOCs, CO, NO, NO2, NOx, NO and NO2; HO, the hydroxyl radical; HO2, hydroperoxy radical; PM2.5.
Dr. S.K. Goyal


Recording
LIVE
on YouTube
You are viewing Dr. S.K. Goyal's screen
View Options
View
Ground Level Ozone and NO_2
Standards
Ozone
1 hr: 180 ug/m³
8 hrs: 100 ug/m³
NO_2
24 hrs: 80 ug/m³
CRRI – Oct 2020
12-Oct 14-Oct 15-Oct 16-Oct 17-Oct 18-Oct
Ozone Concentration (µg/m3)
Hour
NO2 Concentration (µg/m3)
Dr. S.K. Goyal
Join Audio
Start Video
69
Participants
Q&A
Chat
Share Screen
Raise Hand
Record
Apps
Leave



4. **Prof. Manju Mohan- "For Life on Earth Protect the Ozone Layer and Prevent Climate Change"**

4.1 197 countries agreed to the Montreal Protocol.

4.2 To protect the ozone layer by taking measures to control total global production and consumption of substances that deplete it.

4.3 Stratospheric ozone is present in high altitudes in the atmosphere and protects life on earth from damaging UV radiation from the sun.

4.4 Tropospheric ozone forms near the ground from pollutants in presence of sunlight. It is the primary component of smog.

4.5 Human activities such as driving cars and generating electricity are major sources of tropospheric ozone.

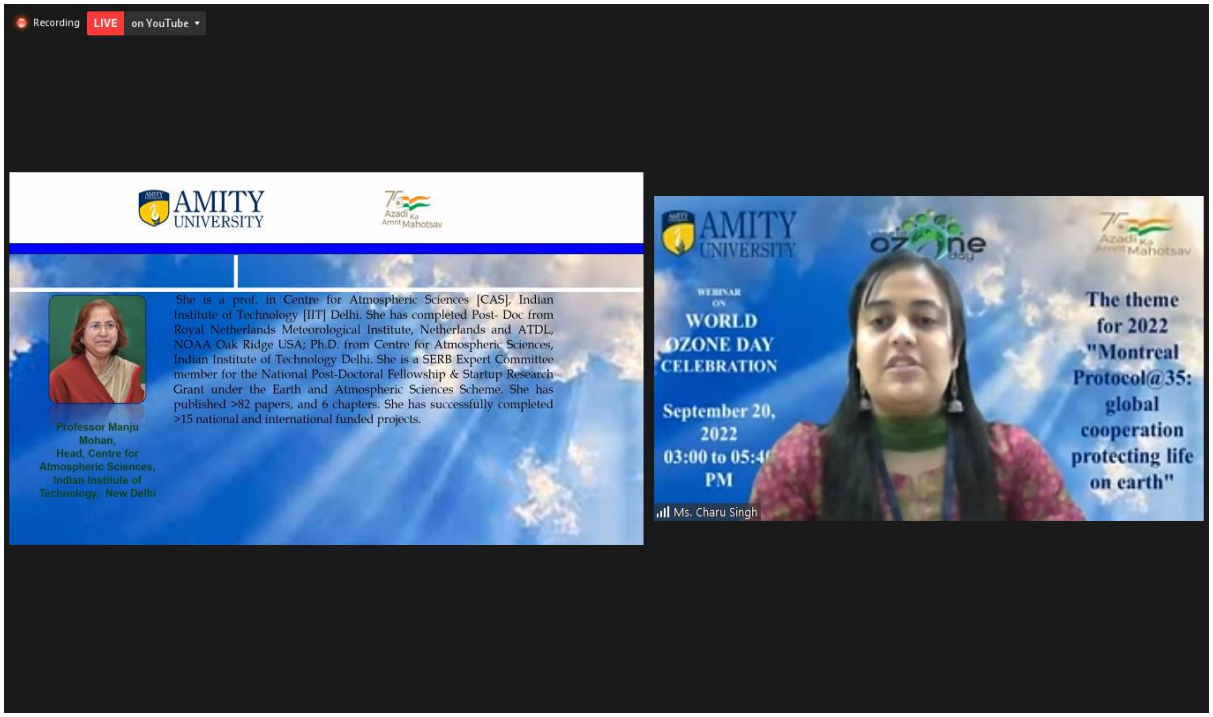
4.6 Arctic stratosphere has cooled in recent years, and a strong correlation is found between this cooling and increased O_3 depletion.

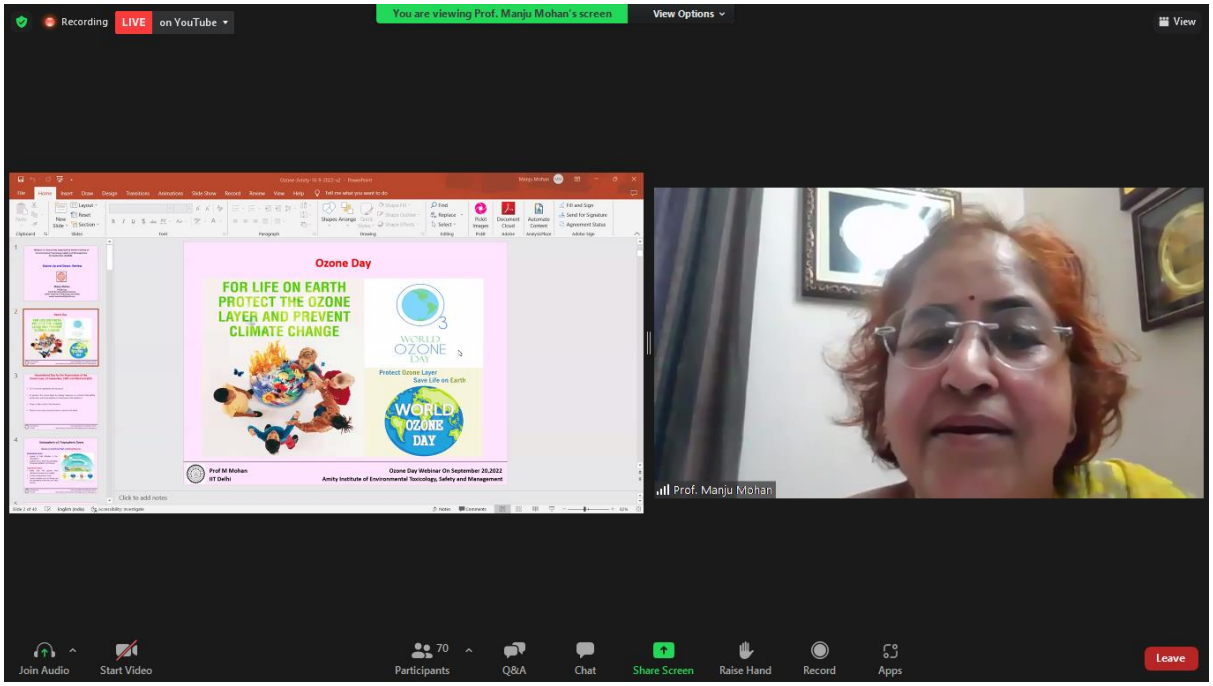
4.7 A growth of hydrofluorocarbons (HFCs) in air conditioning and refrigeration systems is seen as a result of CFCs phase-out.

4.8 Photochemical production of ozone is a highly nonlinear system.

4.9 High VOC/NO_x ratios are less sensitive to changes in VOC concentrations.

4.10 O_3 increases with increasing VOC concentrations and decreases with increasing NO_x concentrations.





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Stratospheric v/s Tropospheric Ozone

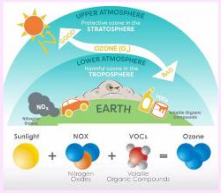
Ozone is Good Up High and Bad Nearby

Stratospheric Ozone

- present in high altitudes in the atmosphere
- protects life on earth from damaging Ultraviolet radiation from the sun.

Tropospheric Ozone

- forms near the ground from pollutants in presence of sunlight.
- primary component of smog
- human activities such as driving cars and generating electricity are major sources



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IIT Delhi

Ozone Day Webinar On September 20,2022
Amity Institute of Environmental Toxicology, Safety and Management

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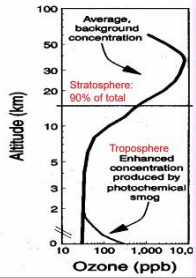
The many faces of atmospheric ozone: Radiation and Chemistry both plays an important role



In stratosphere: UV shield

In middle/upper troposphere: greenhouse gas

In lower/middle troposphere: precursor of OH, main atmospheric oxidant

In surface air: toxic to humans and vegetation

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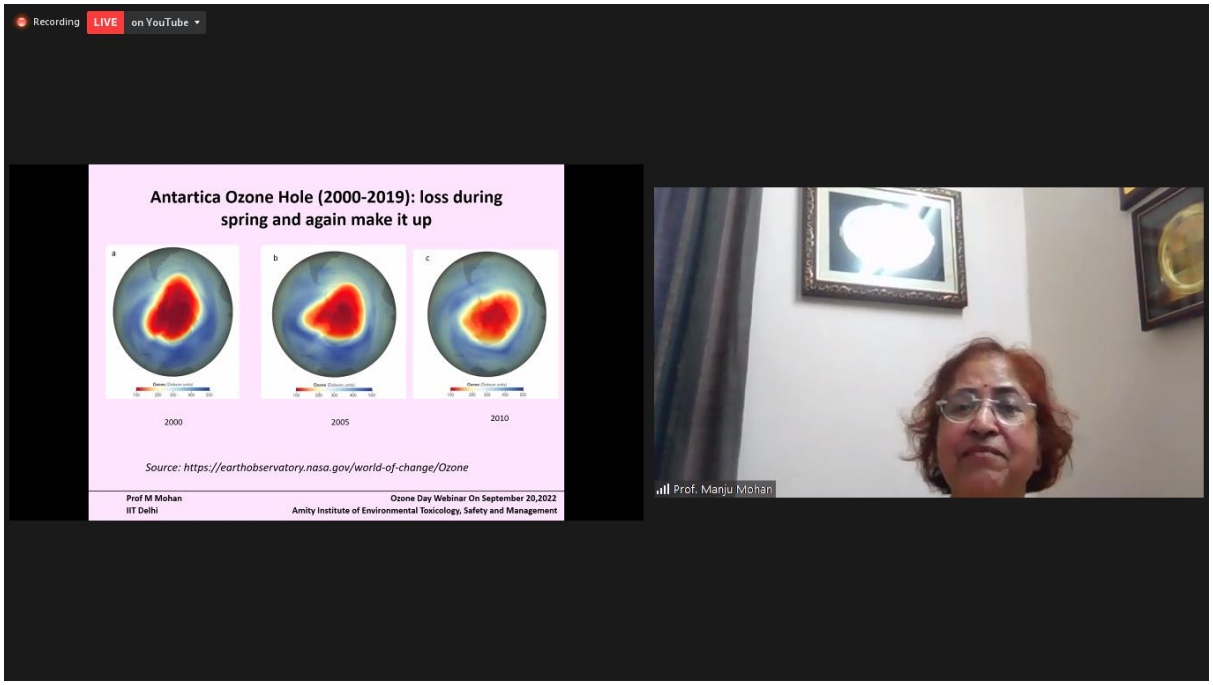
Recording
LIVE
on YouTube
Antartica Ozone Hole (2000-2019): loss during spring and again make it up
2000
2005
2010
Source: https://earthobservatory.nasa.gov/world-of-change/Ozone
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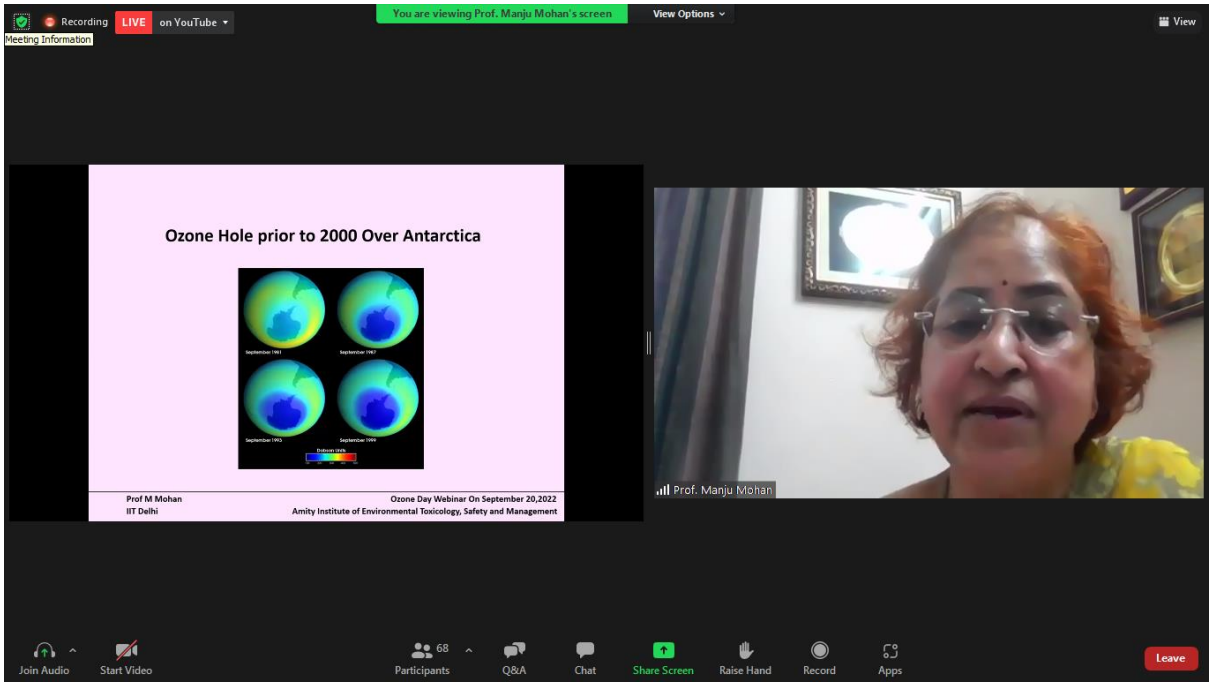
Amity Institute of Environmental Toxicology, Safety and Management
Prof. Manju Mohan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Meeting Information
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View Options
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Ozone Hole prior to 2000 Over Antarctica
Prof M Mohan
IIT Delhi
Ozone Day Webinar On September 20,2022
Amity Institute of Environmental Toxicology, Safety and Management
Prof. Manju Mohan
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68
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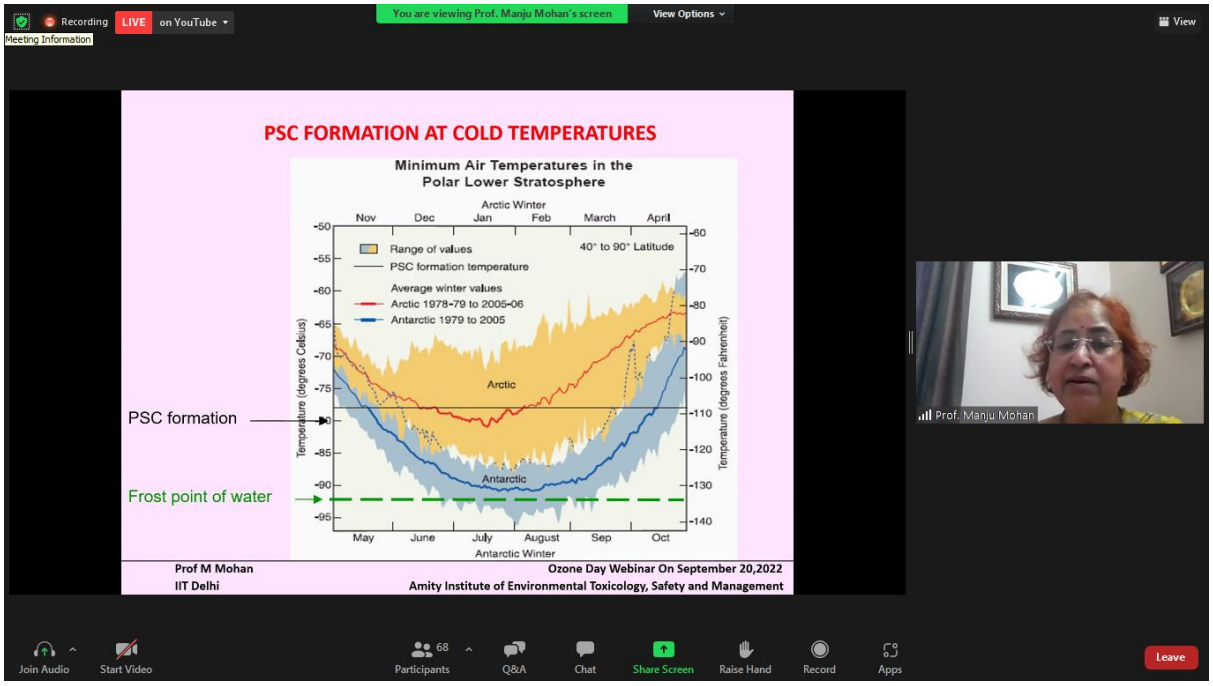
Apps
Leave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View Options
View
PSC FORMATION AT COLD TEMPERATURES
Minimum Air Temperatures in the Polar Lower Stratosphere
Arctic Winter
Nov Dec Jan Feb March April
Range of values
PSC formation temperature
Average winter values
Arctic 1978-79 to 2005-06
Antarctic 1979 to 2005
40° to 90° Latitude
Arctic
Antarctic
Temperature (degrees Celsius)
Temperature (degrees Fahrenheit)
PSC formation
Frost point of water
May June July August Sep Oct
Antarctic Winter
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Prof. Manju Mohan
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Participants
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Q&A
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Apps
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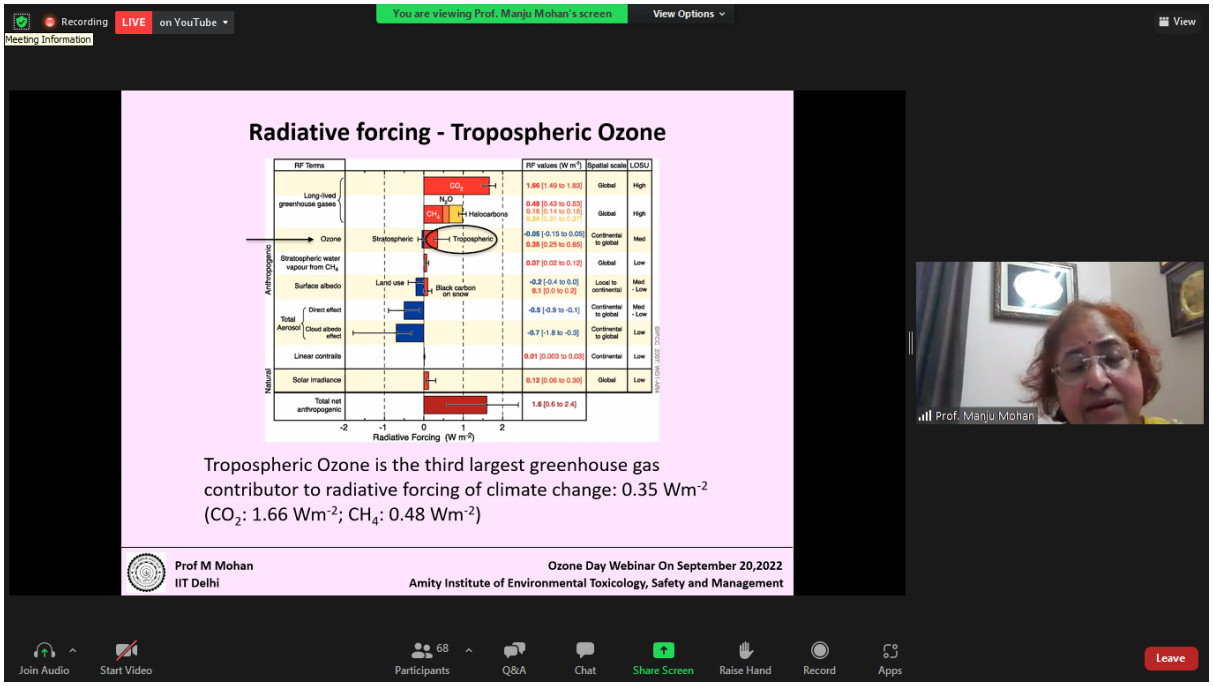
Recording LIVE on YouTube
Meeting Information
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View Options
View
Radiative forcing - Tropospheric Ozone
RF Terms
RF values (W m-2)
Spatial scale
LOSU
Long-lived greenhouse gases
Ozone
Stratospheric water vapour from CH4
Surface albedo
Total Aerosol
Direct effect
Cloud albedo effect
Linear contrails
Solar irradiance
Total net anthropogenic
Anthropogenic
Natural
Halocarbons
Stratospheric
Tropospheric
Land use
Black carbon on snow
Radiative Forcing (W m-2)
Tropospheric Ozone is the third largest greenhouse gas contributor to radiative forcing of climate change: 0.35 Wm-2 (CO2: 1.66 Wm-2; CH4: 0.48 Wm-2)
Prof M Mohan
IIT Delhi
Ozone Day Webinar On September 20,2022
Amity Institute of Environmental Toxicology, Safety and Management
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Participants
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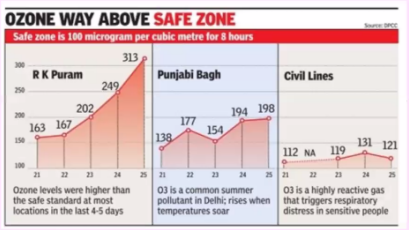
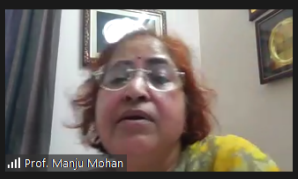
Ozone Pollution Worsens as Daily Temperatures Increases

Heat pulls city out of comfort ozone



Source: TOI, 26 May, 2016



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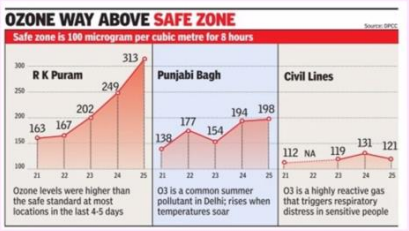
Ozone Pollution Worsens as Daily Temperatures Increases

Heat pulls city out of comfort ozone



Source: TOI, 26 May, 2016

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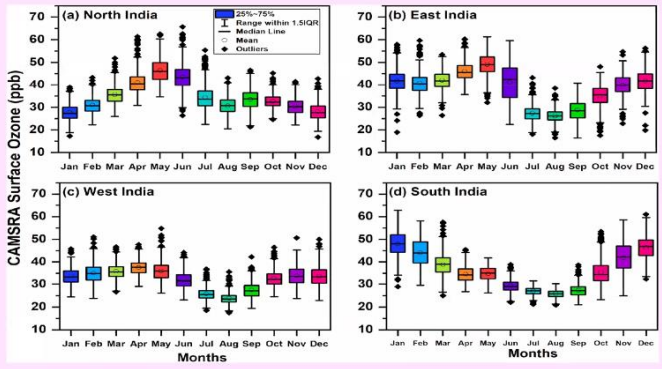
Box-Whisker plot of surface ozone for different regions considered in the analysis



Kunchala et al. 2021, Environmental Science and Pollution Research

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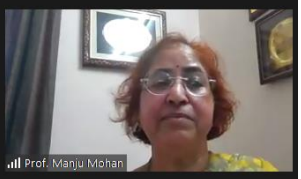

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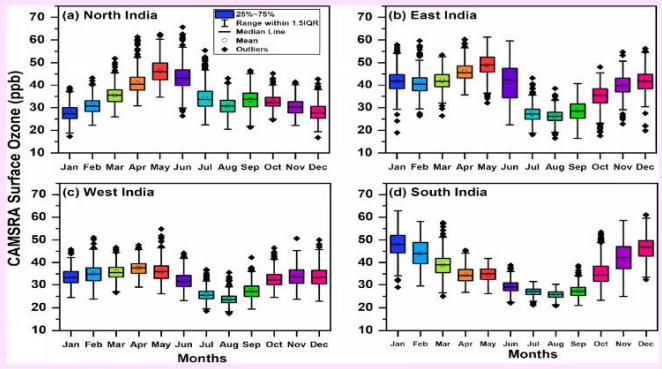
Box-Whisker plot of surface ozone for different regions considered in the analysis



Kunchala et al. 2021, Environmental Science and Pollution Research

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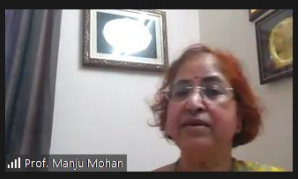
	BEFORE COVID-19	DURING COVID-19
India		
Kangra valley in Dharmsala, India		

Source: https://www.insider.com/before-after-photos-show-less-air-pollution-during-pandemic-lockdown



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CITY	BEFORE vs. DURING LOCKDOWN' 2020					MARCH-APRIL 2019 vs. MARCH APRIL 2020				
	$PM_{2.5}$	PM_{10}	NO_2	CO	O_3	$PM_{2.5}$	PM_{10}	NO_2	CO	O_3
Delhi	–41%	–52%	–50%	–29%	7%	–45%	–52%	–48%	–41%	–14%
Mumbai	–33%	–47%	–75%	–46%	8%	DNA*	DNA*	DNA*	DNA*	DNA*
Chennai	–14%	DNA*	–32%	–25%	3%	–39%	DNA	–43%	–23%	73%
Bangalore	–22%	–34%	–60%	–16%	–11%	–47%	–40%	–56%	–15%	–21%
Kolkata	–23%	–34%	–60%	–29%	17%	–27%	–32%	–66%	–16%	87%

* DNA: Data Not Available.

> 60% 40%-60% 20%-40% < 20%

Decline in air pollutants

> 60% 40%-60% 20%-40% < 20%

Increase in air pollutants

Percentage decline or increase in criteria air pollutants concentrations in five megacities of India during lockdown (25th March to 6th April 2020) and before lockdown (10th to 20th March 2020) period.

Source: Jain, S., & Sharma, T. (2020). Aerosol and Air Quality Research. https://doi.org/10.4209/aaqr.2020.04.0171

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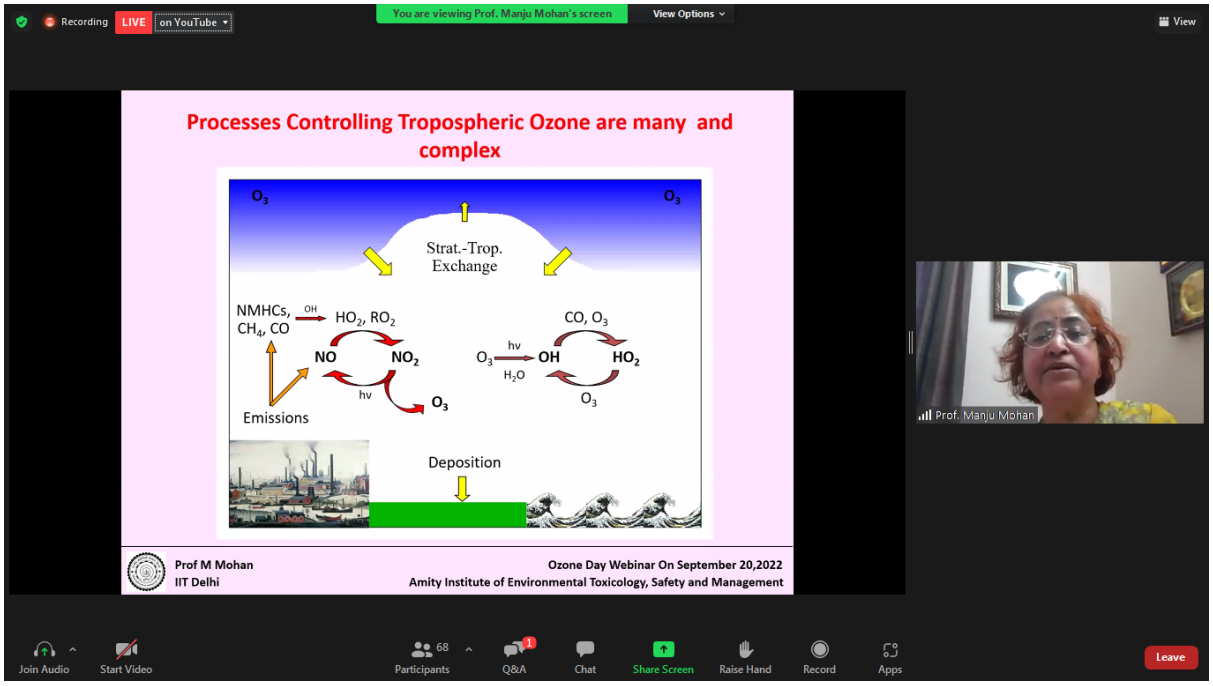
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Processes Controlling Tropospheric Ozone are many and complex
O_3
O_2
Strat.-Trop. Exchange
NMHCs, CH_4, CO
OH
HO_2, RO_2
NO
NO_2
hv
O_3
Emissions
CO, O_3
hv
O_3
H_2O
OH
HO_2
O_3
Deposition
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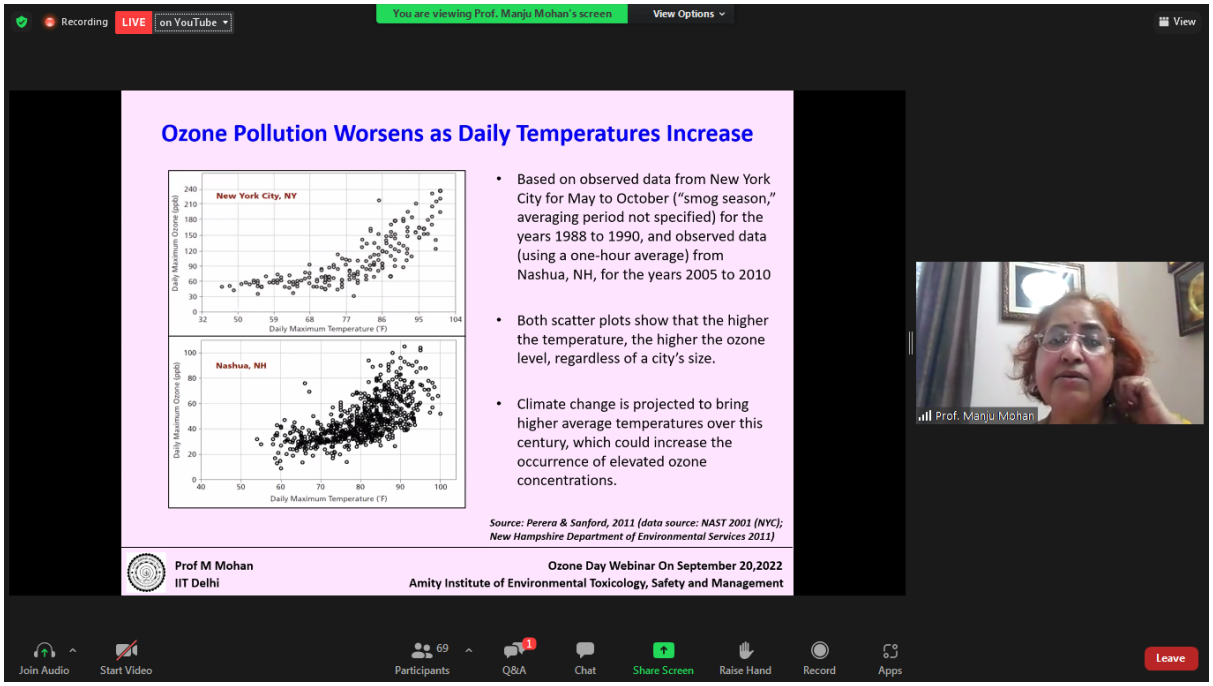
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Ozone Pollution Worsens as Daily Temperatures Increase
New York City, NY
Daily Maximum Ozone (ppb)
Daily Maximum Temperature (F)
Nashua, NH
Daily Maximum Ozone (ppb)
Daily Maximum Temperature (F)
• Based on observed data from New York City for May to October ("smog season," averaging period not specified) for the years 1988 to 1990, and observed data (using a one-hour average) from Nashua, NH, for the years 2005 to 2010
• Both scatter plots show that the higher the temperature, the higher the ozone level, regardless of a city's size.
• Climate change is projected to bring higher average temperatures over this century, which could increase the occurrence of elevated ozone concentrations.
Source: Perera & Sanford, 2011 (data source: NAST 2001 (NYC); New Hampshire Department of Environmental Services 2011)
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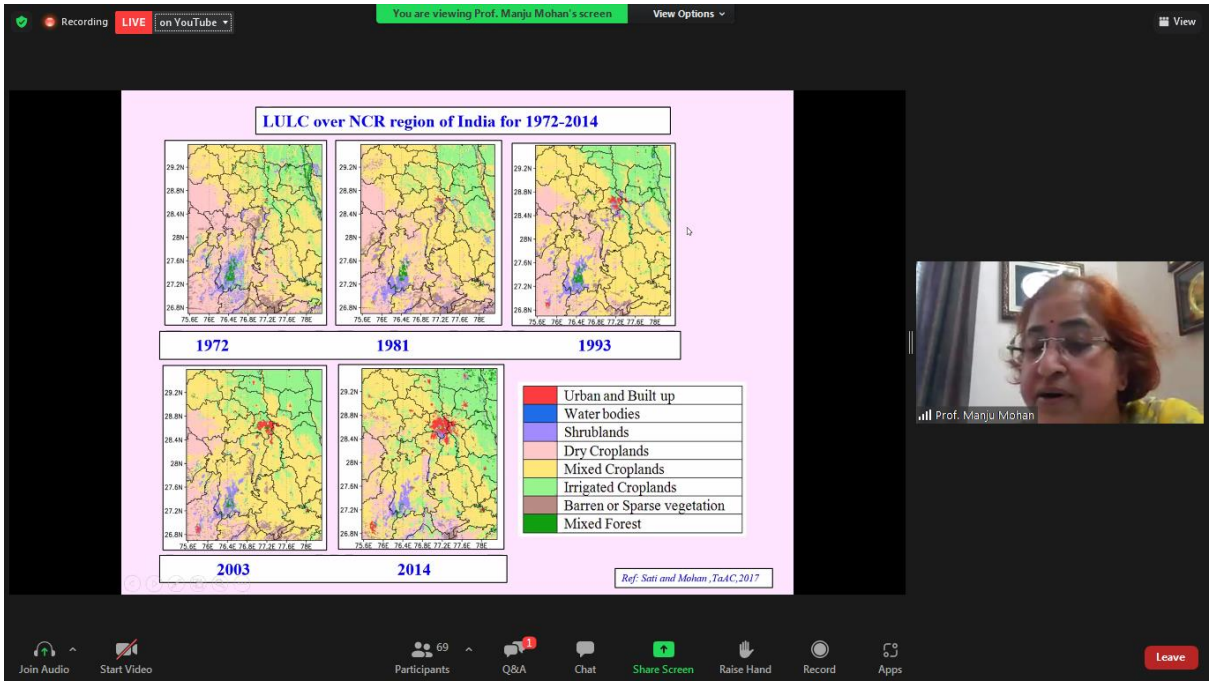
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LULC over NCR region of India for 1972-2014
1972
1981
1993
2003
2014
Urban and Built up
Water bodies
Shrublands
Dry Croplands
Mixed Croplands
Irrigated Croplands
Barren or Sparse vegetation
Mixed Forest
Ref: Sati and Mohan ,TaAC,2017
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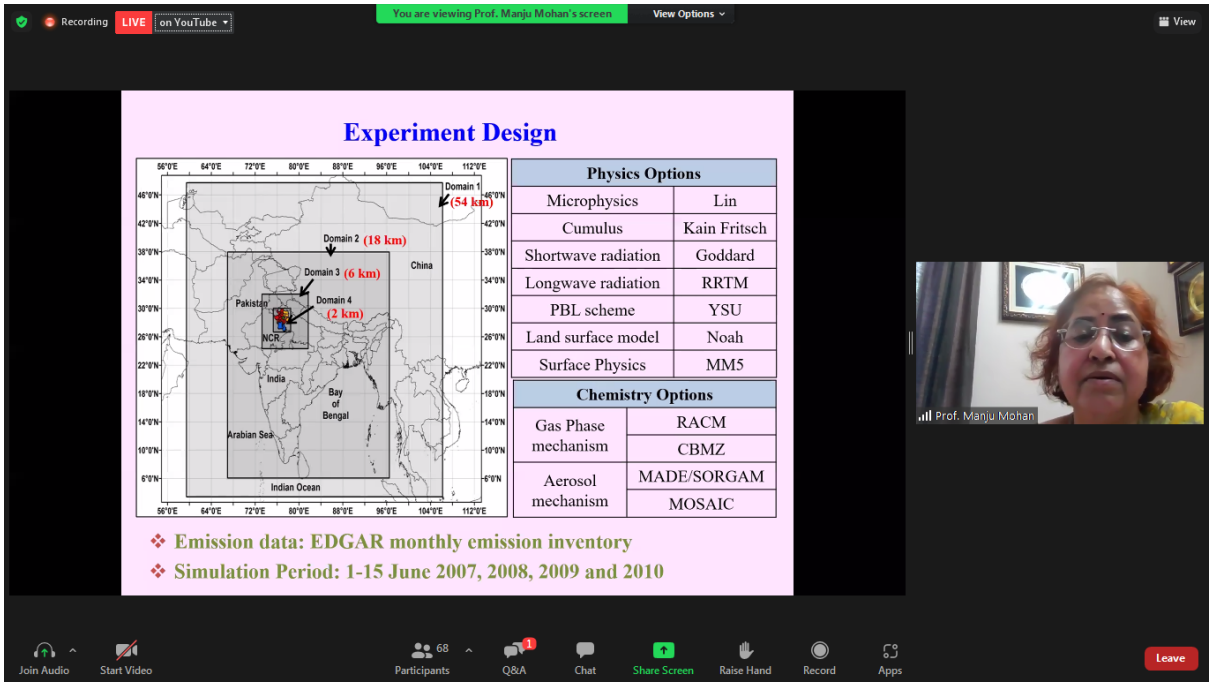
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Experiment Design
Domain 1 (54 km)
Domain 2 (18 km)
Domain 3 (6 km)
Domain 4 (2 km)
China
Pakistan
NCR
India
Bay of Bengal
Arabian Sea
Indian Ocean
Physics Options
Microphysics | Lin
Cumulus | Kain Fritsch
Shortwave radiation | Goddard
Longwave radiation | RRTM
PBL scheme | YSU
Land surface model | Noah
Surface Physics | MM5
Chemistry Options
Gas Phase mechanism | RACM
CBMZ
Aerosol mechanism | MADE/SORGAM
MOSAIC
Emission data: EDGAR monthly emission inventory
Simulation Period: 1-15 June 2007, 2008, 2009 and 2010
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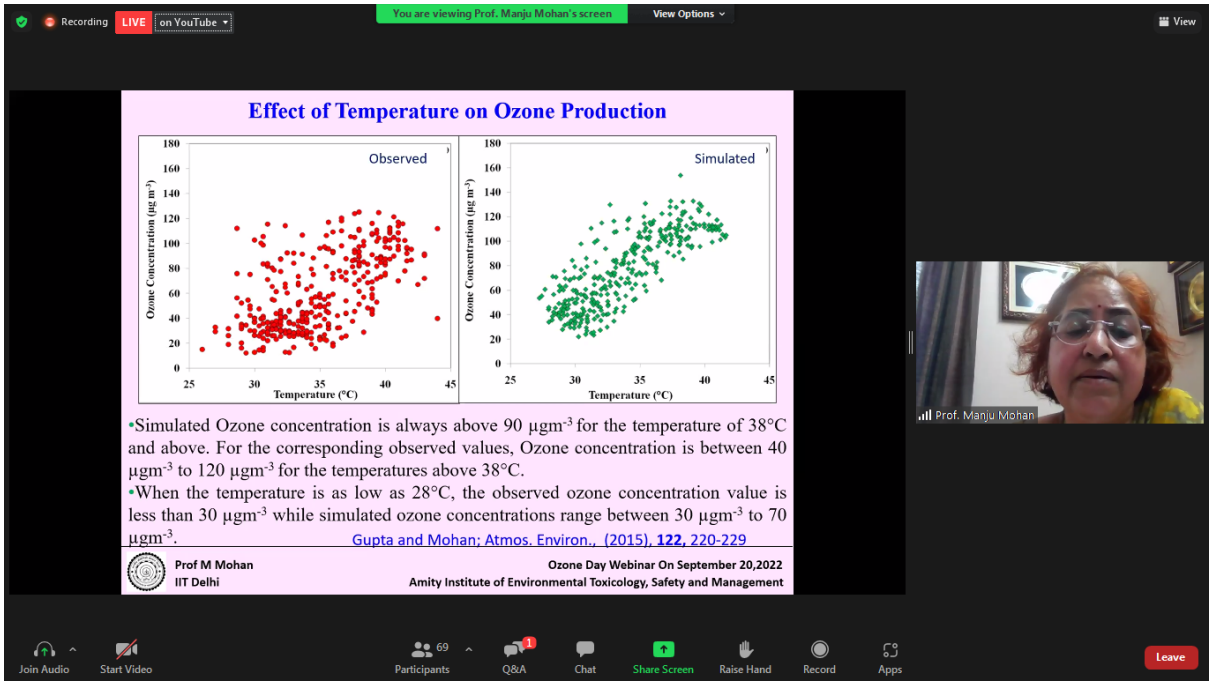
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Effect of Temperature on Ozone Production
Observed
Simulated
Ozone Concentration (µg m-3)
Temperature (°C)
•Simulated Ozone concentration is always above 90 µgm-3 for the temperature of 38°C and above. For the corresponding observed values, Ozone concentration is between 40 µgm-3 to 120 µgm-3 for the temperatures above 38°C.
•When the temperature is as low as 28°C, the observed ozone concentration value is less than 30 µgm-3 while simulated ozone concentrations range between 30 µgm-3 to 70 µgm-3.
Gupta and Mohan; Atmos. Environ., (2015), 122, 220-229
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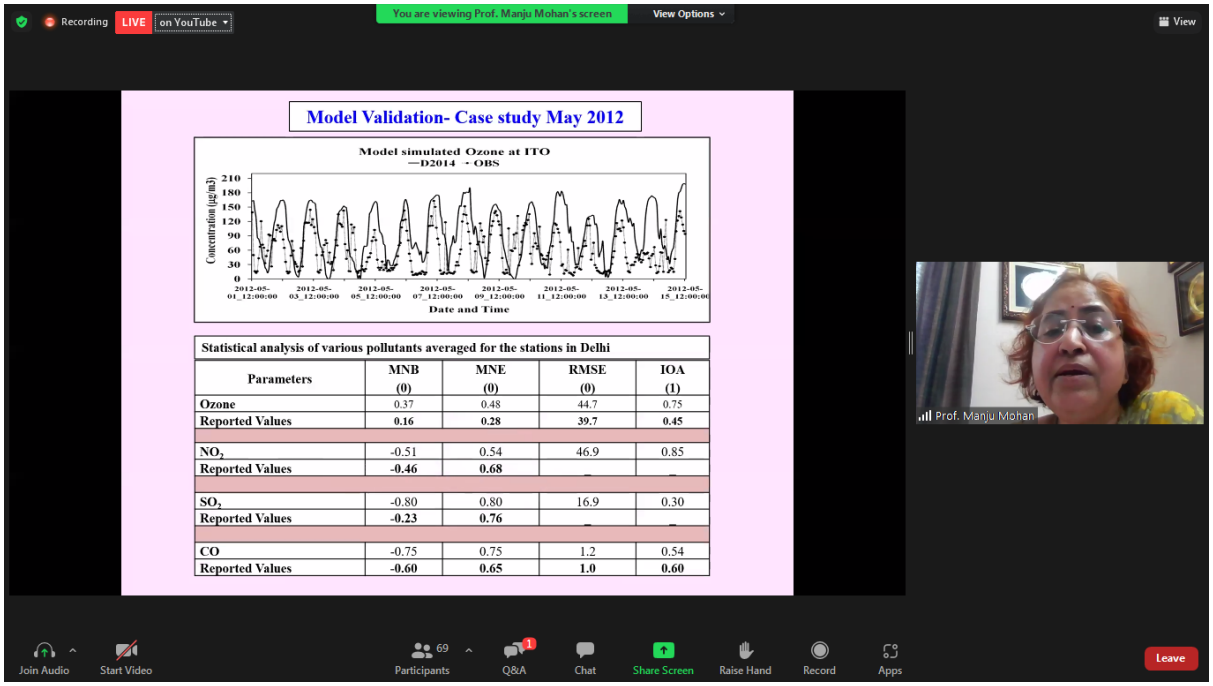
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Model Validation- Case study May 2012
Model simulated Ozone at ITO
—D2014 - OBS
Concentration (µg/m3)
Date and Time
Statistical analysis of various pollutants averaged for the stations in Delhi
Parameters | MNB (0) | MNE (0) | RMSE (0) | IOA (1)
Ozone | 0.37 | 0.48 | 44.7 | 0.75
Reported Values | 0.16 | 0.28 | 39.7 | 0.45
NO2 | -0.51 | 0.54 | 46.9 | 0.85
Reported Values | -0.46 | 0.68 | _ | _
SO2 | -0.80 | 0.80 | 16.9 | 0.30
Reported Values | -0.23 | 0.76 | _ | _
CO | -0.75 | 0.75 | 1.2 | 0.54
Reported Values | -0.60 | 0.65 | 1.0 | 0.60
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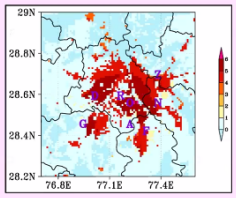
Changes in the UHI intensities between D2014-D1972

Surface UHI

Night Time 1:30 IST



Increase (K)	Area (sq Km)
6+	9
5-6	667
4-5	794
3-4	68
1-3	80

- For nocturnal SHI most of the area experience an increase of 4-5 °C followed closely by 5-6 °C rise.

Mohan et al., 2021; Urban Climate

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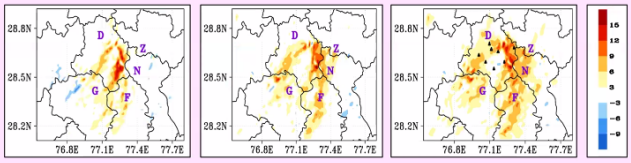
Changes in Ozone concentration

D1993-D1972 | D2003-D1972 | D2014-D1972



The nocturnal ozone concentration at surface shows considerable increase (40%) with increase in urban expansion

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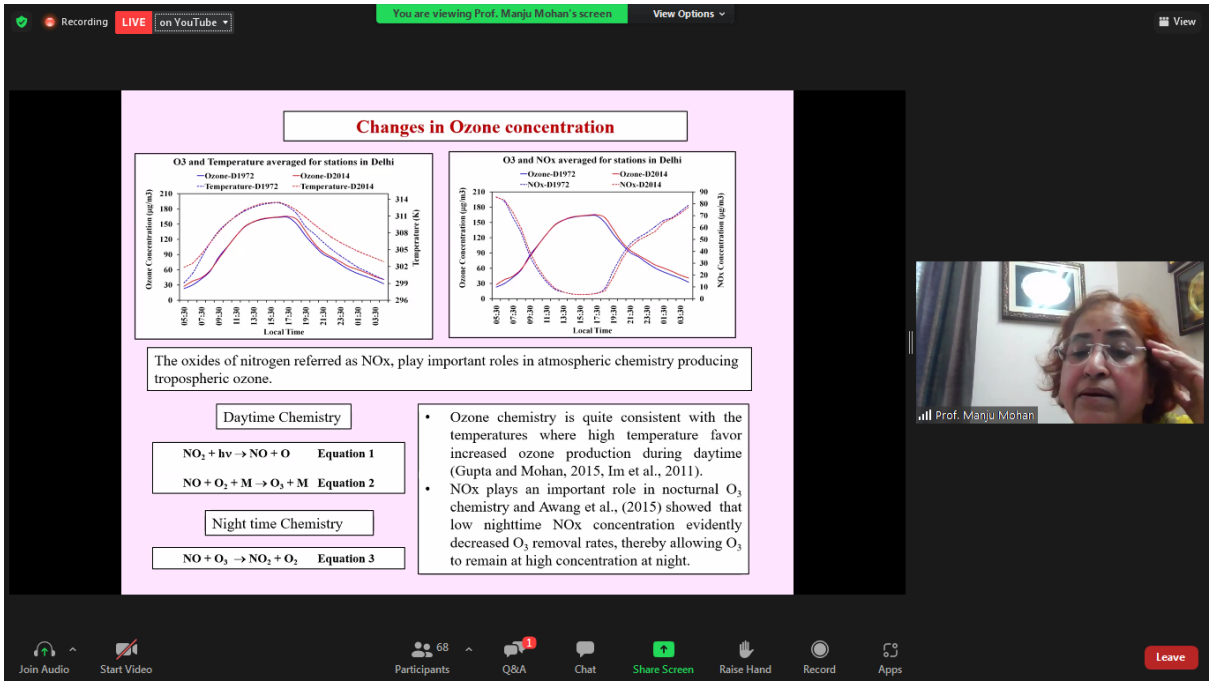


5. Prof. Umesh Kulshrestha- "How Continuous O_3 Monitoring without Chlorine Measurements is Incomplete"

5.1. There is 95 % certainty that human activities are responsible for global warming.

5.2.Carbon dioxide is at an unprecedented level not seen for at least the last 8000,000 years.

5.3.Sea level is set to continue to rise at a faster rate than over the past 40 years.

5.4.Over the last two decades, the Greenland and Antarctic ice sheets have been melting and glaciers have been recorded in most parts of the world.

5.5.The ban on the burning of plastic wastes and other polymers reduced emissions of chlorine species.

5.6.In addition, NO emission was very less due to shut down of industries, flights, automobiles, etc.

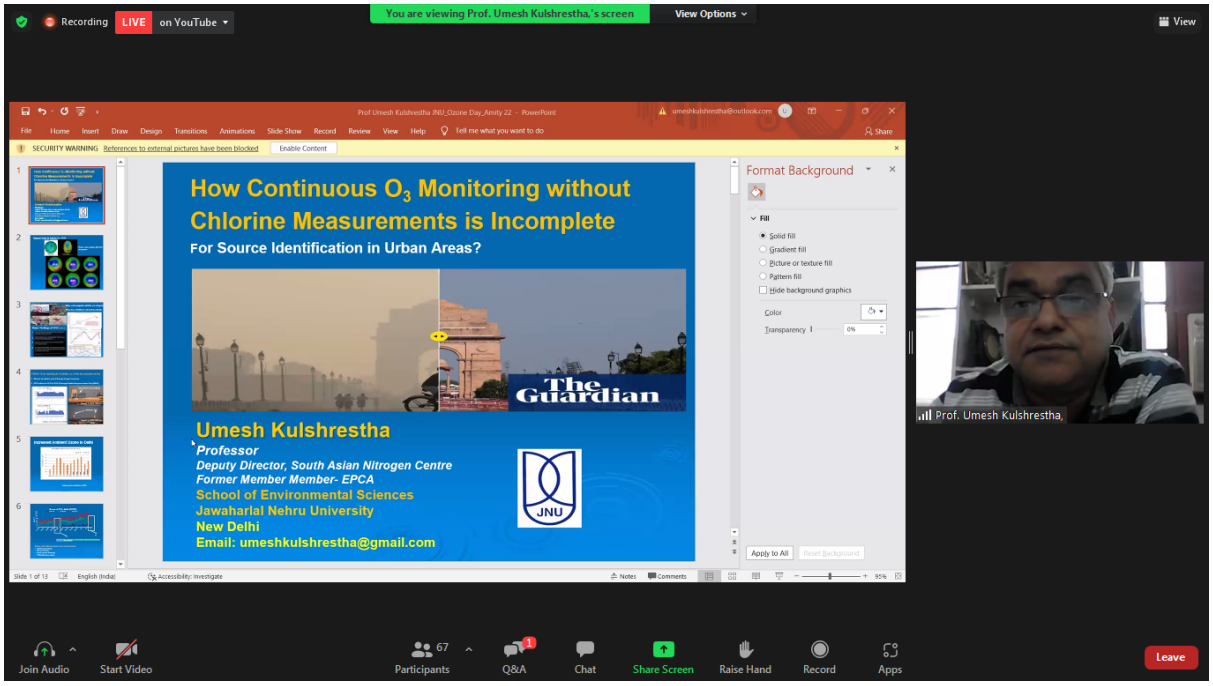
5.7.Regular monitoring of O_3 is required.

5.8.Monitoring of HCl and Cl_2 is required.

5.9.Role of sanitizer studied is needed.

5.10. Role and interference of atmospheric dust to be investigated.

5.11. Policies are needed to support more research.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How Continuous O_3 Monitoring without Chlorine Measurements is Incomplete
For Source Identification in Urban Areas?
The Guardian
Umesh Kulshrestha
Professor
Deputy Director, South Asian Nitrogen Centre
Former Member Member- EPCA
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi
Email: umeshkulshrestha@gmail.com
JNU
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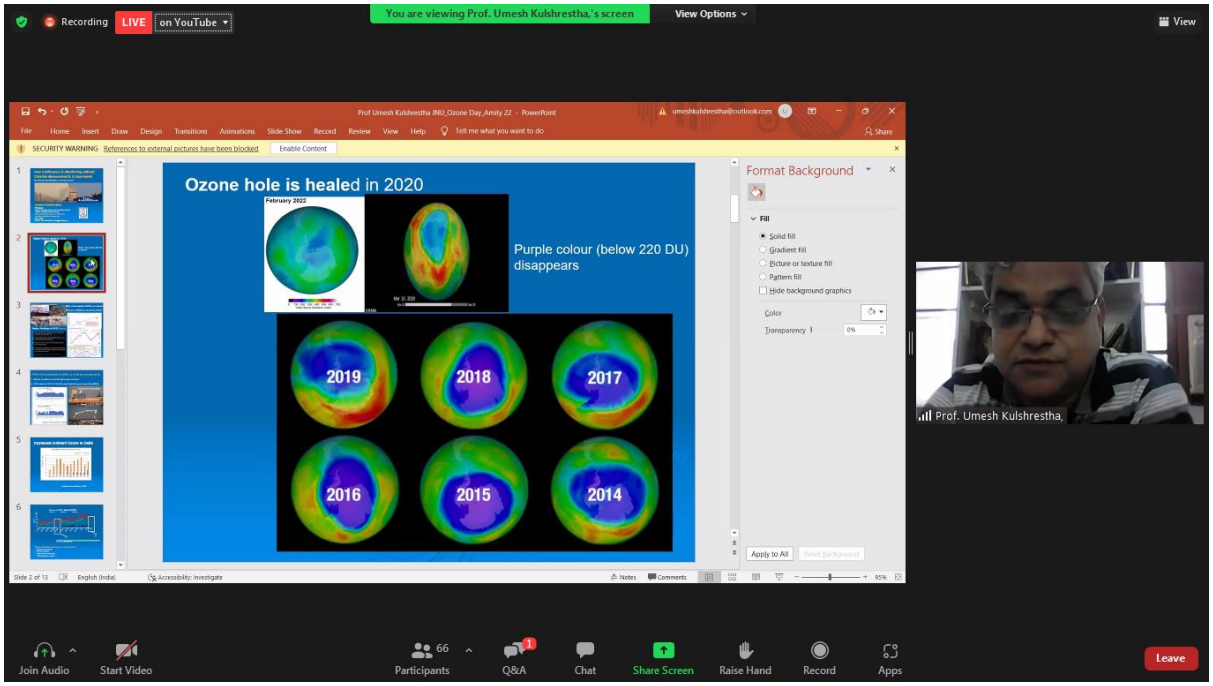
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Ozone hole is healed in 2020
February 2022
Purple colour (below 220 DU) disappears
2019
2018
2017
2016
2015
2014
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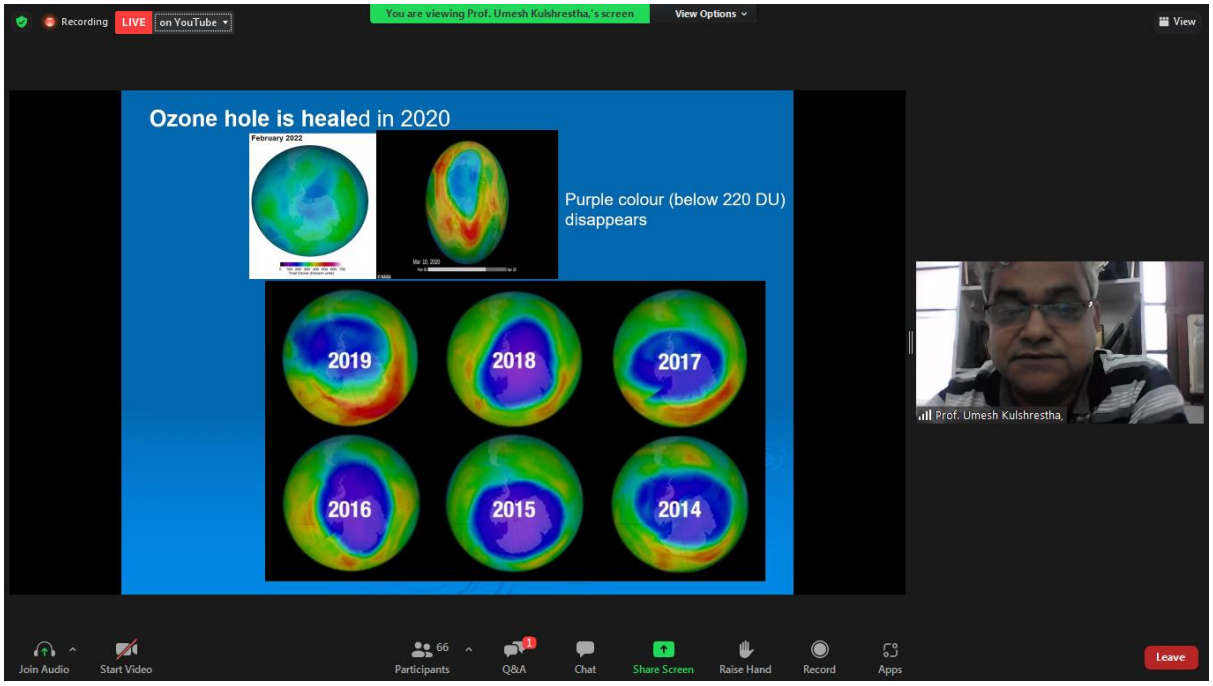
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Ozone hole is healed in 2020
February 2022
Purple colour (below 220 DU) disappears
2019
2018
2017
2016
2015
2014
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COVID 19 Lockdown Scenario
Industries
Transport
Major anthropogenic activities are stopped
Emissions of CO2 are reduced drastically
Mauna Loa CO2 (annual cycle & ENSO removed)
March 2020
As of March 2020, little or no atmospheric evidence yet of reduced global CO2 emissions from COVID-19 Economic Slowdown
March 2019
March 2020
Major Findings of IPCC (2013)
1 There is 95 percent certainty that human activities are responsible for global warming
2 Carbon dioxide is at an "unprecedented" level not seen for at least the last 800,000 years
3 Sea level is set to continue to rise at a faster rate than over the past 40 years
4 Over the last two decades, the Greenland and Antarctic ice sheets have been melting and glaciers have receded in most parts of the world
Carbon Dioxide Variations
The Industrial Revolution Has Caused A Dramatic Rise in CO2
Ice Age Cycles
Thousands of Years Ago
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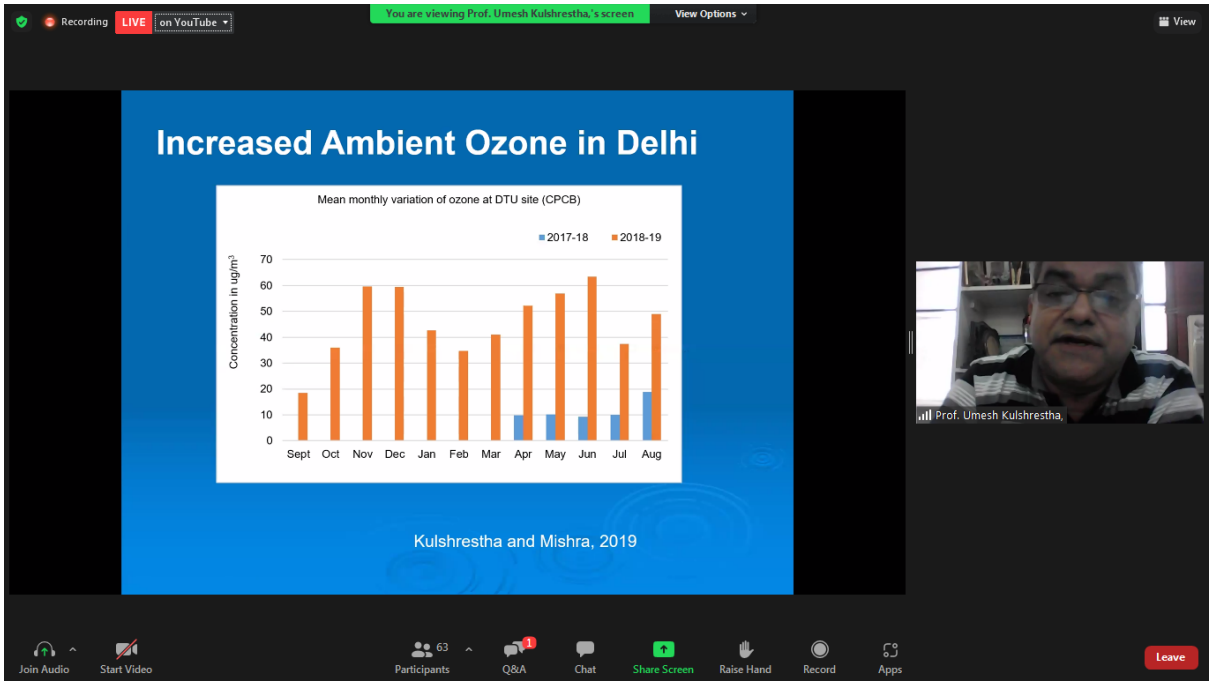
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Increased Ambient Ozone in Delhi
Mean monthly variation of ozone at DTU site (CPCB)
2017-18
2018-19
Concentration in ug/m3
70
60
50
40
30
20
10
0
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Kulshrestha and Mishra, 2019
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Ozone at DTU, Delhi (CPCB)
Year-18
Year-19
Year-20
140
120
100
80
60
40
20
0
μg m-3
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar
05-Apr
12-Apr
19-Apr
26-Apr
03-...
10-...
17-...
??
??
From CPCB (https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing)
Data retrieved on 16/09/2020
Effects of the following factors to be studied further:
• HCl/Cl2 quenching
• NO quenching
• Black carbon dimming
• VOCs/Sanitizer effect
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Ozone at DTU, Delhi (CPCB)
Year-18
Year-19
Year-20
μg m-3
140
120
100
80
60
40
20
0
01-Mar
08-Mar
15-Mar
22-Mar
29-Mar
05-Apr
12-Apr
19-Apr
26-Apr
??
??
From CPCB (https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing)
Data retrieved on 16/09/2020
Effects of the following factors to be studied further:
• HCl/Cl2 quenching
• NO quenching
• Black carbon dimming
• VOCs/Sanitizer effect
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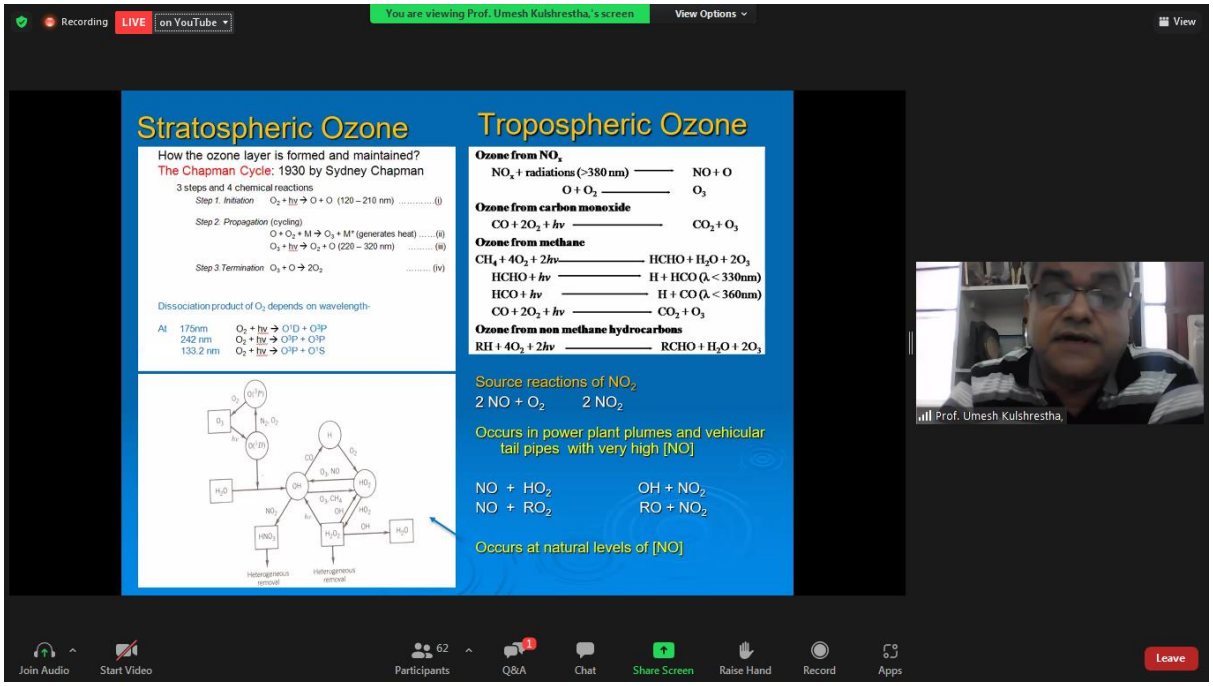
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Stratospheric Ozone
How the ozone layer is formed and maintained?
The Chapman Cycle: 1930 by Sydney Chapman
3 steps and 4 chemical reactions
Step 1. Initiation O2 + hν → O + O (120 – 210 nm) .....(i)
Step 2. Propagation (cycling)
O + O2 + M → O3 + M* (generates heat) .....(ii)
O3 + hν → O2 + O (220 – 320 nm) .....(iii)
Step 3.Termination O3 + O → 2O2 .....(iv)
Dissociation product of O2 depends on wavelength-
At 175nm O2 + hν → O1D + O3P
242 nm O2 + hν → O3P + O3P
133.2 nm O2 + hν → O3P + O1S
Tropospheric Ozone
Ozone from NOx
NOx + radiations (>380 nm) ——— NO + O
O + O2 ——— O3
Ozone from carbon monoxide
CO + 2O2 + hν ——— CO2 + O3
Ozone from methane
CH4 + 4O2 + 2hν ——— HCHO + H2O + 2O3
HCHO + hν ——— H + HCO (λ < 330nm)
HCO + hν ——— H + CO (λ < 360nm)
CO + 2O2 + hν ——— CO2 + O3
Ozone from non methane hydrocarbons
RH + 4O2 + 2hν ——— RCHO + H2O + 2O3
Source reactions of NO2
2 NO + O2 2 NO2
Occurs in power plant plumes and vehicular tail pipes with very high [NO]
NO + HO2 OH + NO2
NO + RO2 RO + NO2
Occurs at natural levels of [NO]
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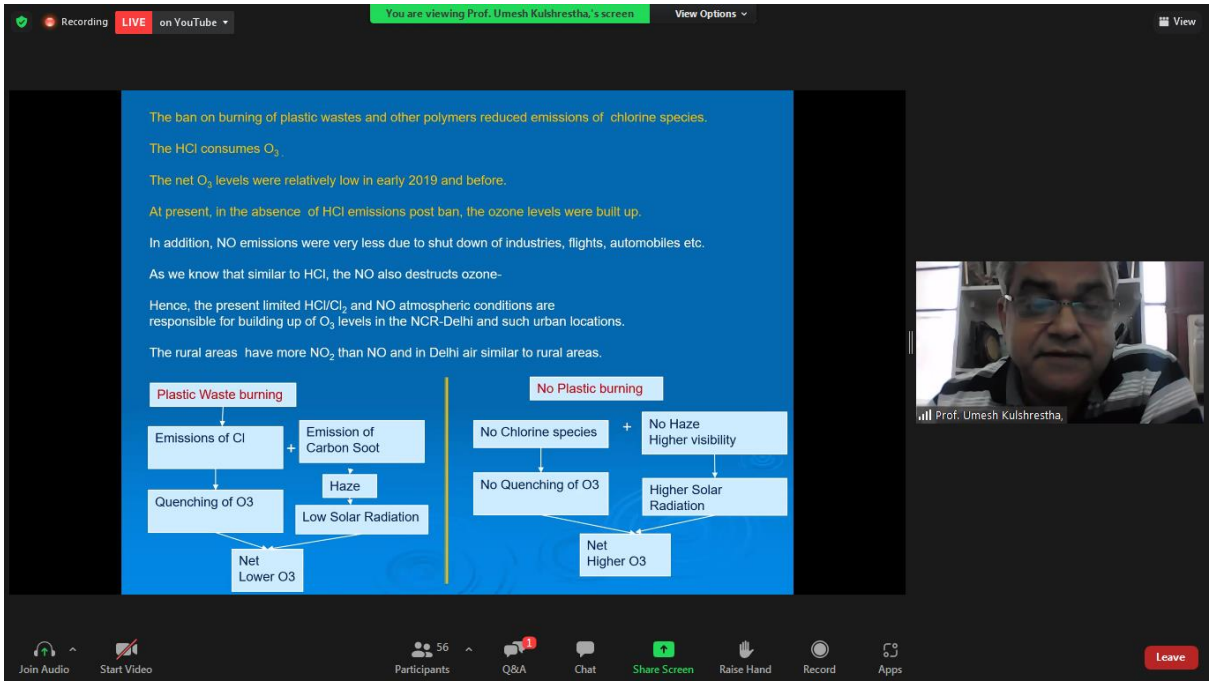


6. Prof. Qing-Bin Lu- "Success and New Implications of the Montreal Protocol"

6.1. The Montreal Protocol is the most successful international treaty.

6.2.CFCs are not only major ozone-depleting gases but powerful greenhouse gases.

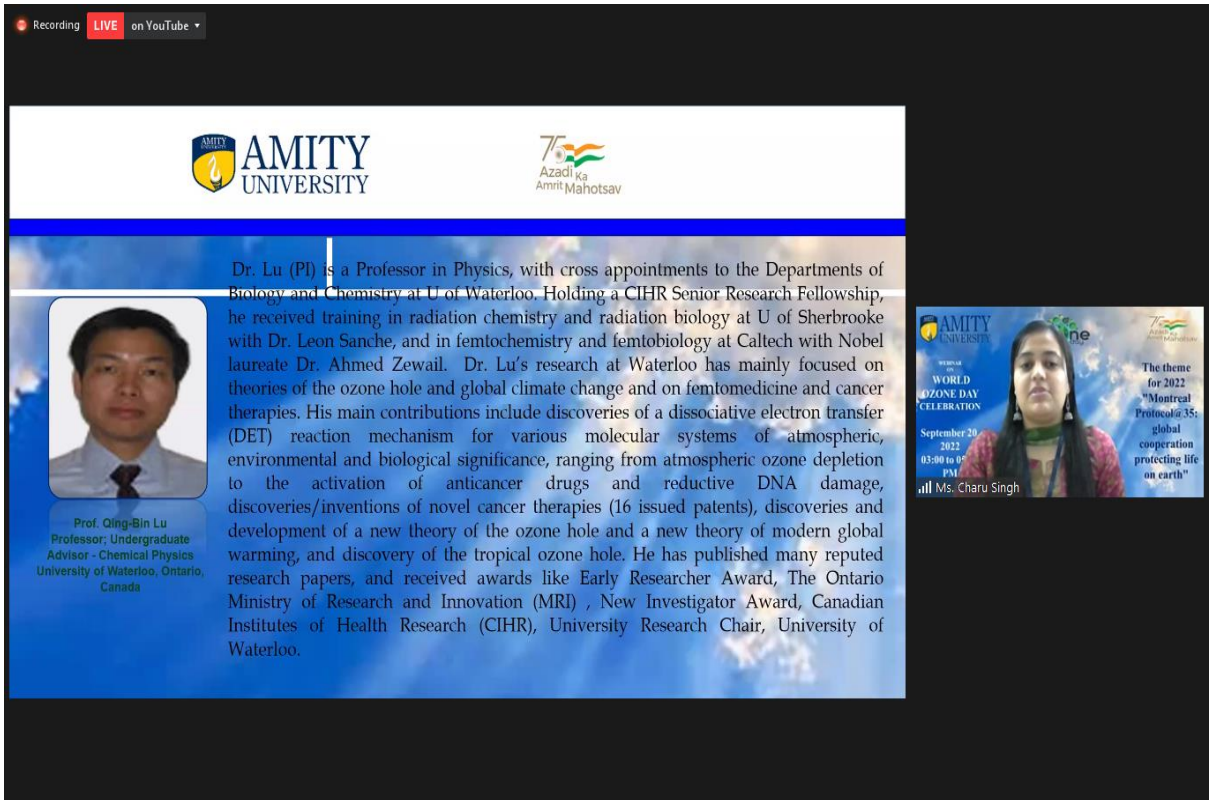
6.3.CFCs played a major role in global warming.

6.4.Cosmic-Ray theory of the ozone hole was given in 1998.

6.5.Cosmic rays could be a major contributor to ozone destruction over Antarctica.

6.6.Photolysis by UV photons, dissociative electron attachment by free electrons, and dissociative electron transfer reaction are the possible pathways for the destruction of CFCs in the atmosphere.

6.7.CFC theory of global warming was given in 2009.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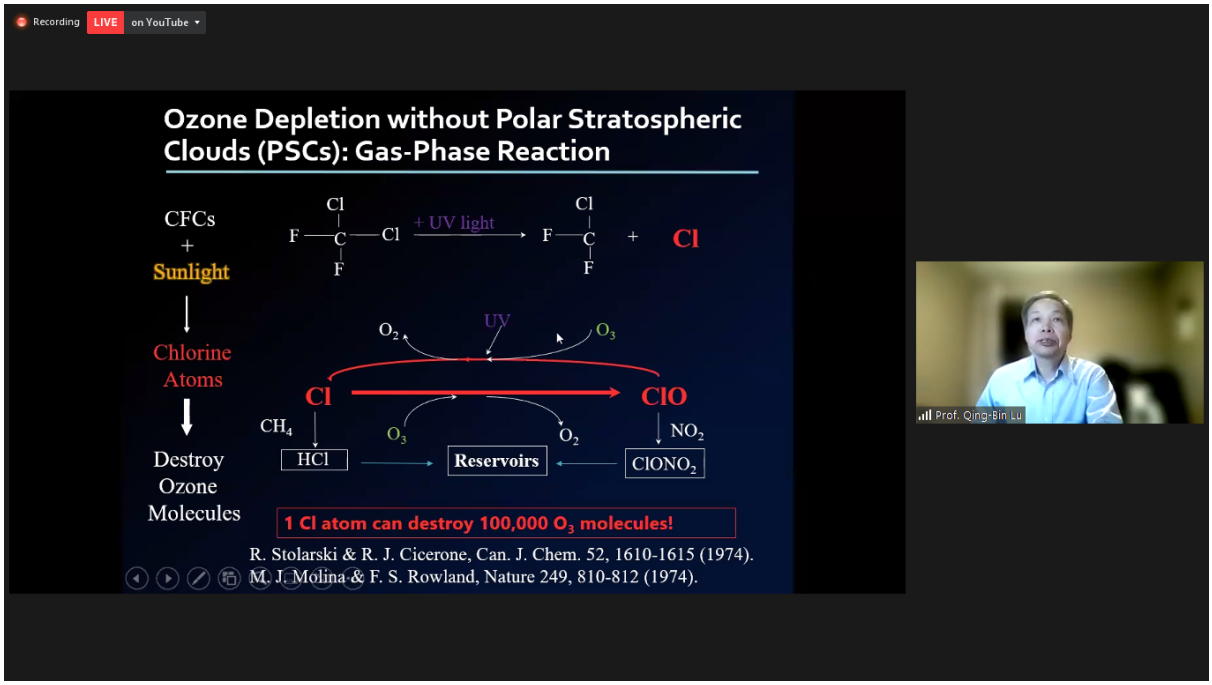
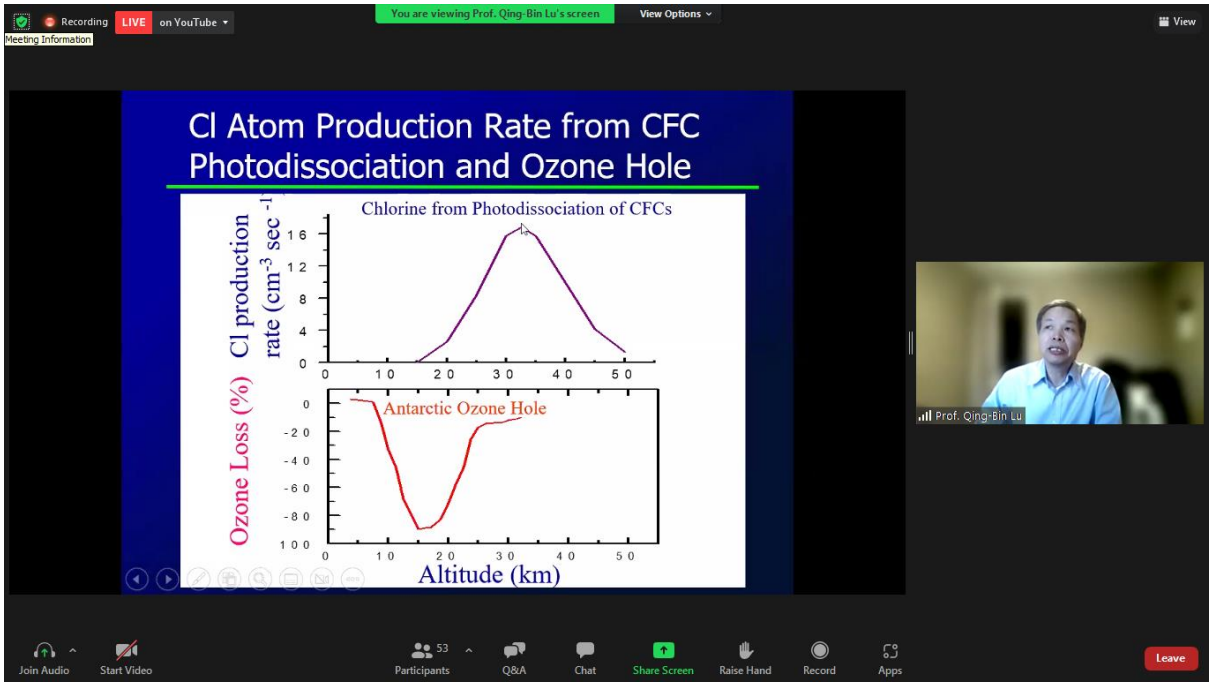
AMITY UNIVERSITY
Azadi Ka Amrit Mahotsav
Dr. Lu (PI) is a Professor in Physics, with cross appointments to the Departments of Biology and Chemistry at U of Waterloo. Holding a CIHR Senior Research Fellowship, he received training in radiation chemistry and radiation biology at U of Sherbrooke with Dr. Leon Sanche, and in femtochemistry and femtobiology at Caltech with Nobel laureate Dr. Ahmed Zewail. Dr. Lu's research at Waterloo has mainly focused on theories of the ozone hole and global climate change and on femtomedicine and cancer therapies. His main contributions include discoveries of a dissociative electron transfer (DET) reaction mechanism for various molecular systems of atmospheric, environmental and biological significance, ranging from atmospheric ozone depletion to the activation of anticancer drugs and reductive DNA damage, discoveries/inventions of novel cancer therapies (16 issued patents), discoveries and development of a new theory of the ozone hole and a new theory of modern global warming, and discovery of the tropical ozone hole. He has published many reputed research papers, and received awards like Early Researcher Award, The Ontario Ministry of Research and Innovation (MRI) , New Investigator Award, Canadian Institutes of Health Research (CIHR), University Research Chair, University of Waterloo.
Prof. Qing-Bin Lu
Professor; Undergraduate Advisor - Chemical Physics
University of Waterloo, Ontario, Canada
WORLD OZONE DAY CELEBRATION
The theme for 2022 "Montreal Protocol@ 35: global cooperation protecting life on earth"
Ms. Charu Singh


Recording
LIVE
on YouTube
Ms. Jayati Arora
Prof. Tanu Jindal
Prof. Qing-Bin Lu
Ms. Charu Singh
Prof. Qing-Bin Lu


Recording LIVE on YouTube
Ozone Depletion without Polar Stratospheric Clouds (PSCs): Gas-Phase Reaction
CFCs + Sunlight
Chlorine Atoms
Destroy Ozone Molecules
+ UV light
Cl
UV
ClO
HCl
Reservoirs
ClONO2
1 Cl atom can destroy 100,000 O3 molecules!
R. Stolarski & R. J. Cicerone, Can. J. Chem. 52, 1610-1615 (1974).
M. J. Molina & F. S. Rowland, Nature 249, 810-812 (1974).
Prof. Qing-Bin Lu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Meeting Information
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Cl Atom Production Rate from CFC Photodissociation and Ozone Hole
Chlorine from Photodissociation of CFCs
Cl production rate (cm-3 sec-1)
Antarctic Ozone Hole
Ozone Loss (%)
Altitude (km)
Prof. Qing-Bin Lu
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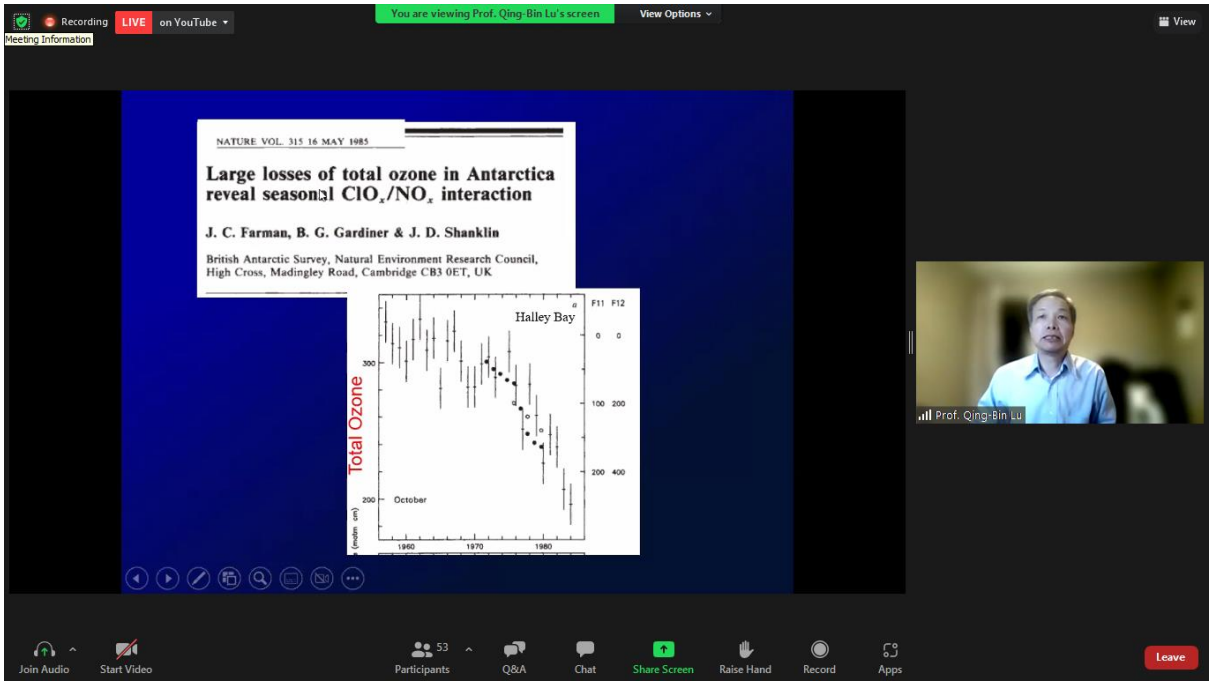
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NATURE VOL. 315 16 MAY 1985
Large losses of total ozone in Antarctica reveal seasonal ClO$_x$/NO$_x$ interaction
J. C. Farman, B. G. Gardiner & J. D. Shanklin
British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK
Halley Bay
Total Ozone
October
1960
1970
1980
Prof. Qing-Bin Lu
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Participants
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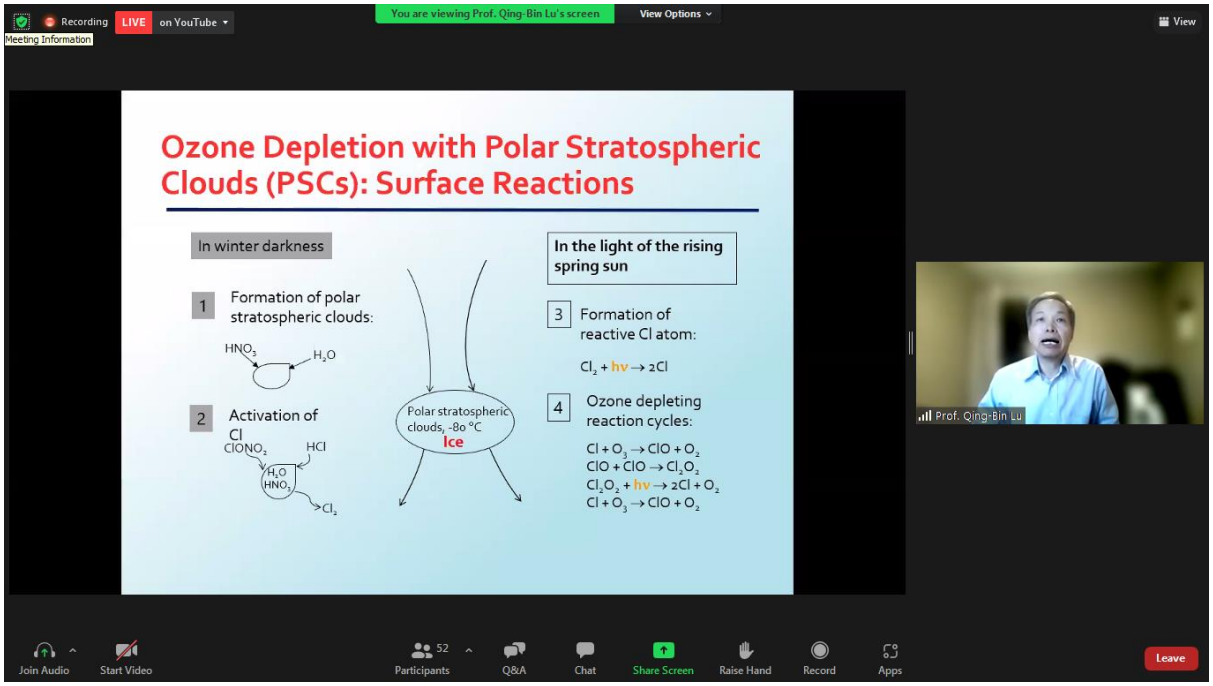
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Ozone Depletion with Polar Stratospheric Clouds (PSCs): Surface Reactions
In winter darkness
1 Formation of polar stratospheric clouds:
HNO3
H2O
2 Activation of Cl
ClONO2
HCl
H2O
HNO3
Cl2
Polar stratospheric clouds, -80 °C
Ice
In the light of the rising spring sun
3 Formation of reactive Cl atom:
Cl2 + hν → 2Cl
4 Ozone depleting reaction cycles:
Cl + O3 → ClO + O2
ClO + ClO → Cl2O2
Cl2O2 + hν → 2Cl + O2
Cl + O3 → ClO + O2
Prof. Qing-Bin Lu
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Participants
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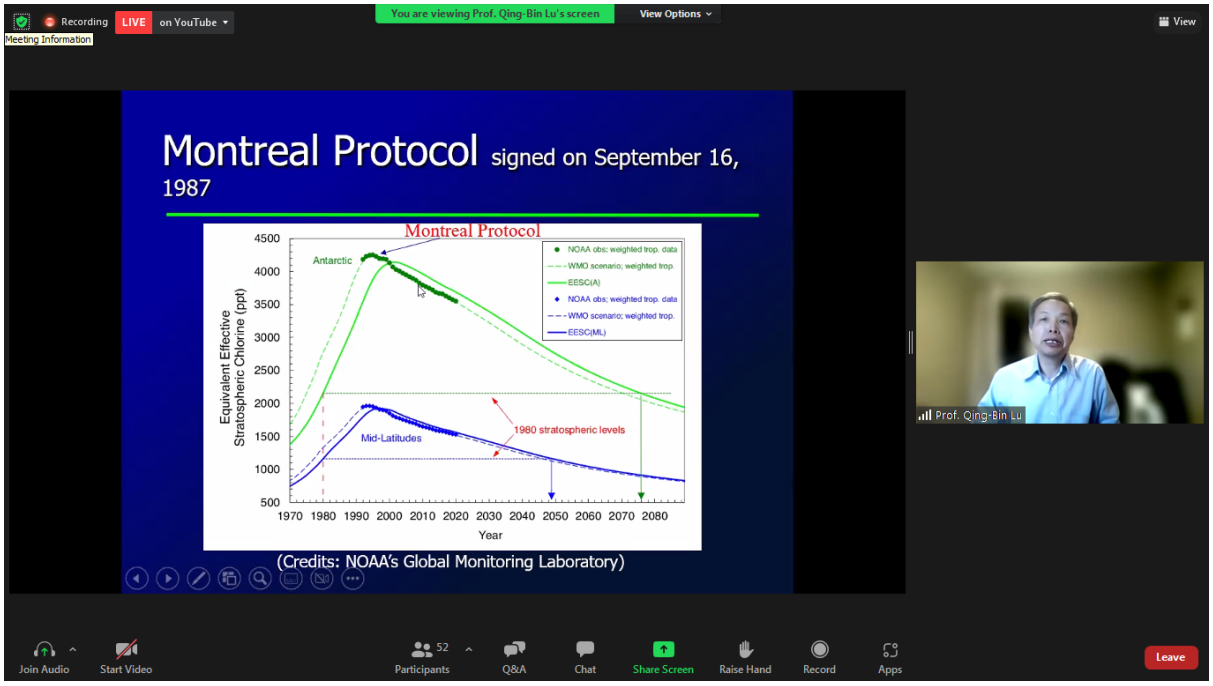
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Montreal Protocol signed on September 16, 1987
Montreal Protocol
Antarctic
Mid-Latitudes
1980 stratospheric levels
Equivalent Effective Stratospheric Chlorine (ppt)
Year
(Credits: NOAA's Global Monitoring Laboratory)
Prof. Qing-Bin Lu
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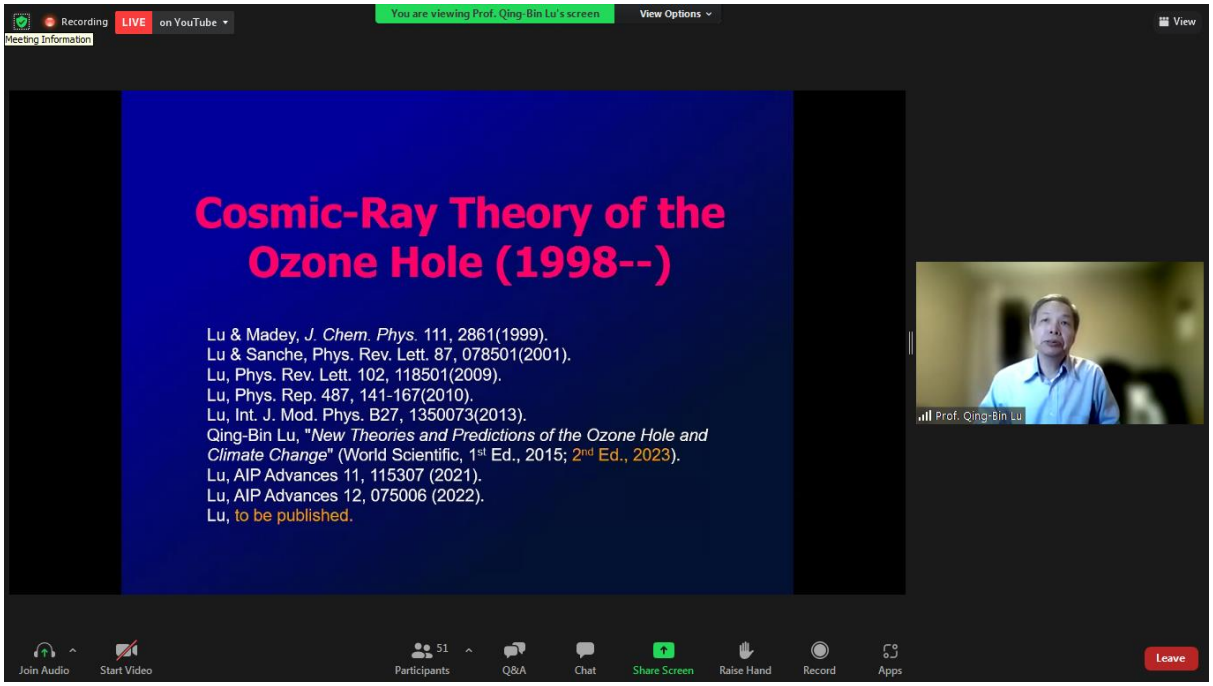
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Cosmic-Ray Theory of the Ozone Hole (1998--)
Lu & Madey, J. Chem. Phys. 111, 2861(1999).
Lu & Sanche, Phys. Rev. Lett. 87, 078501(2001).
Lu, Phys. Rev. Lett. 102, 118501(2009).
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Lu, Int. J. Mod. Phys. B27, 1350073(2013).
Qing-Bin Lu, "New Theories and Predictions of the Ozone Hole and Climate Change" (World Scientific, 1st Ed., 2015; 2nd Ed., 2023).
Lu, AIP Advances 11, 115307 (2021).
Lu, AIP Advances 12, 075006 (2022).
Lu, to be published.
Prof. Qing-Bin Lu
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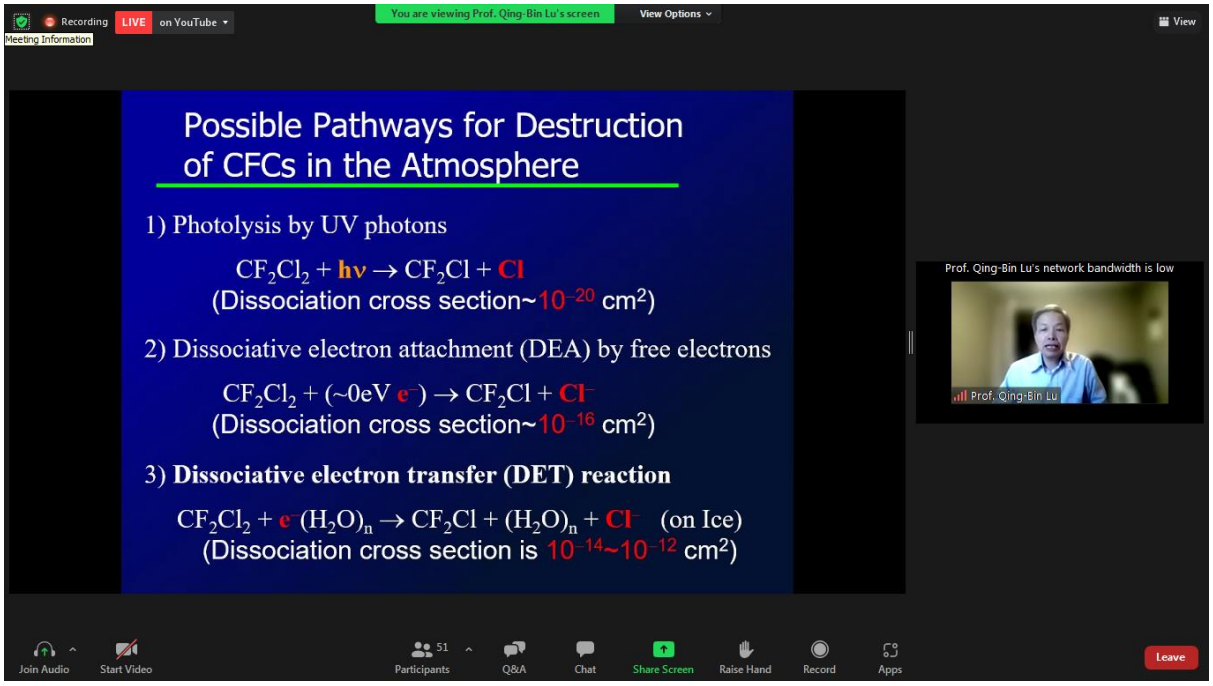
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Possible Pathways for Destruction of CFCs in the Atmosphere
1) Photolysis by UV photons
$CF_2Cl_2 + h\nu \rightarrow CF_2Cl + Cl$
(Dissociation cross section~10^{-20} cm^2)
2) Dissociative electron attachment (DEA) by free electrons
$CF_2Cl_2 + (\sim 0eV\ e^-) \rightarrow CF_2Cl + Cl^-$
(Dissociation cross section~10^{-16} cm^2)
3) Dissociative electron transfer (DET) reaction
$CF_2Cl_2 + e^-(H_2O)_n \rightarrow CF_2Cl + (H_2O)_n + Cl^-$ (on Ice)
(Dissociation cross section is 10^{-14}~10^{-12} cm^2)
Prof. Qing-Bin Lu's network bandwidth is low
Prof. Qing-Bin Lu
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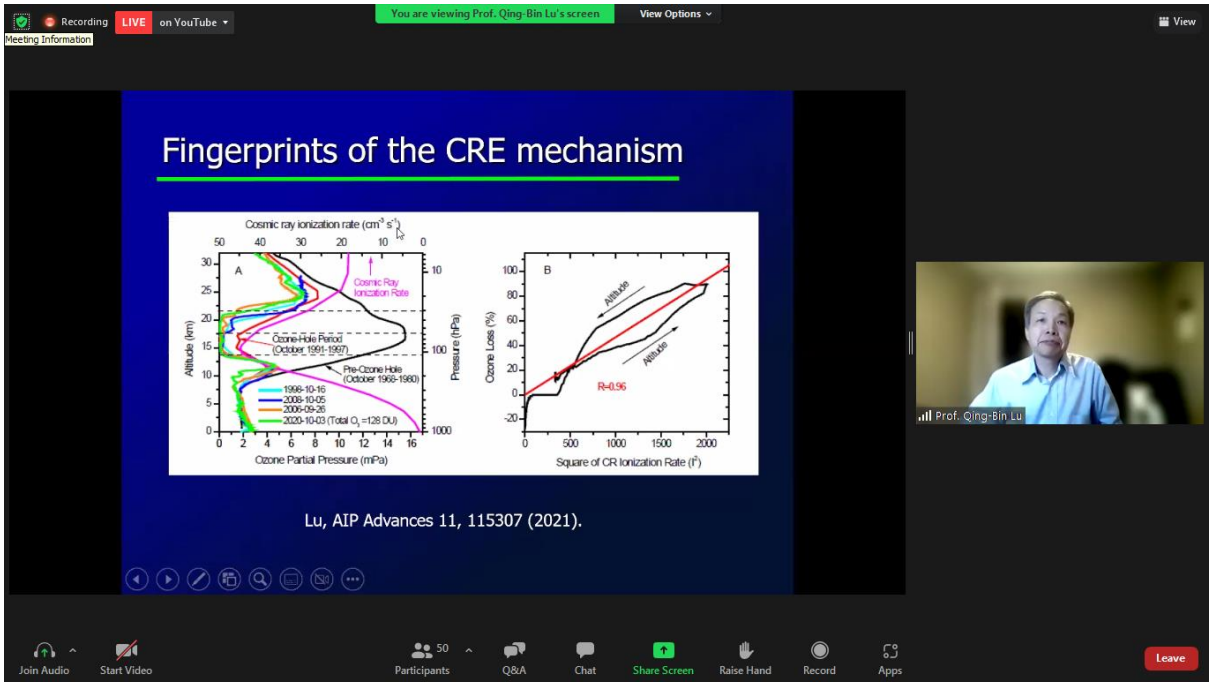
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Fingerprints of the CRE mechanism
Cosmic ray ionization rate (cm^3 s^{-1})
A
Cosmic Ray Ionization Rate
Ozone-Hole Period (October 1991-1997)
Pre-Ozone Hole (October 1968-1980)
1968-10-16
2006-10-05
2006-09-26
2020-10-03 (Total O_3=128 DU)
Altitude (km)
Pressure (hPa)
Ozone Partial Pressure (mPa)
B
Ozone Loss (%)
Altitude
Altitude
R=0.96
Square of CR Ionization Rate (I^2)
Lu, AIP Advances 11, 115307 (2021).
Prof. Qing-Bin Lu
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Participants
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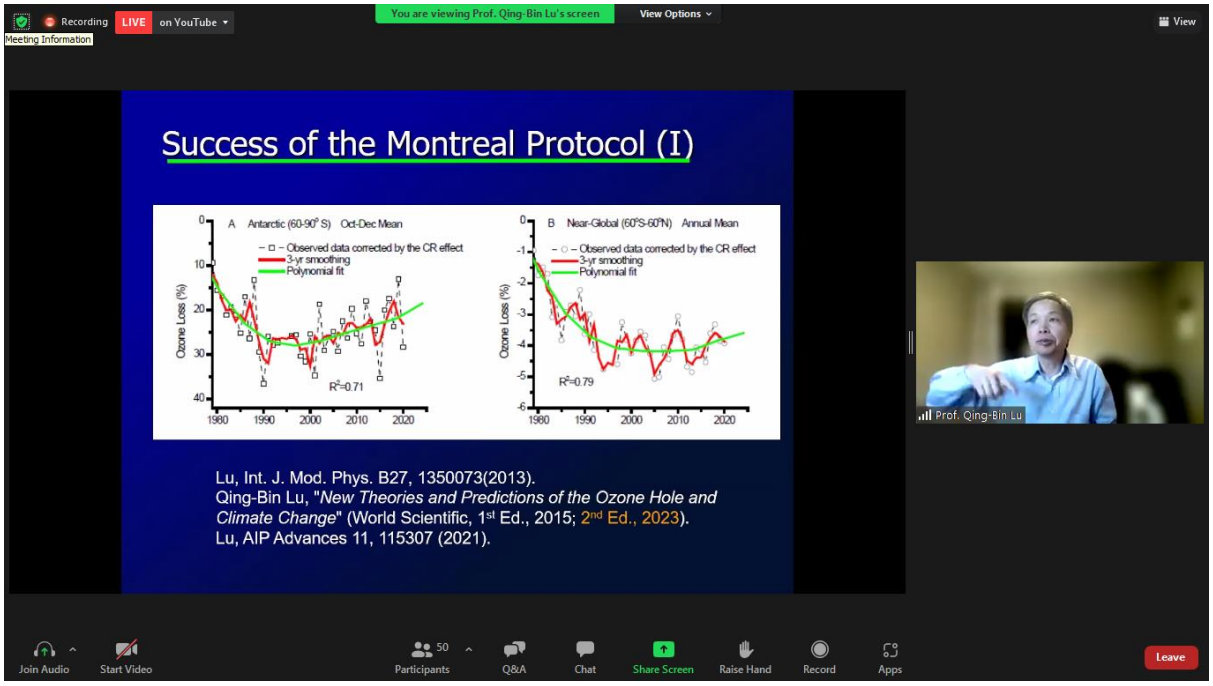
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Success of the Montreal Protocol (I)
A Antarctic (60-90° S) Oct-Dec Mean
Observed data corrected by the CR effect
3-yr smoothing
Polynomial fit
Ozone Loss (%)
R²=0.71
B Near-Global (60°S-60°N) Annual Mean
Observed data corrected by the CR effect
3-yr smoothing
Polynomial fit
Ozone Loss (%)
R²=0.79
Lu, Int. J. Mod. Phys. B27, 1350073(2013).
Qing-Bin Lu, "New Theories and Predictions of the Ozone Hole and Climate Change" (World Scientific, 1st Ed., 2015; 2nd Ed., 2023).
Lu, AIP Advances 11, 115307 (2021).
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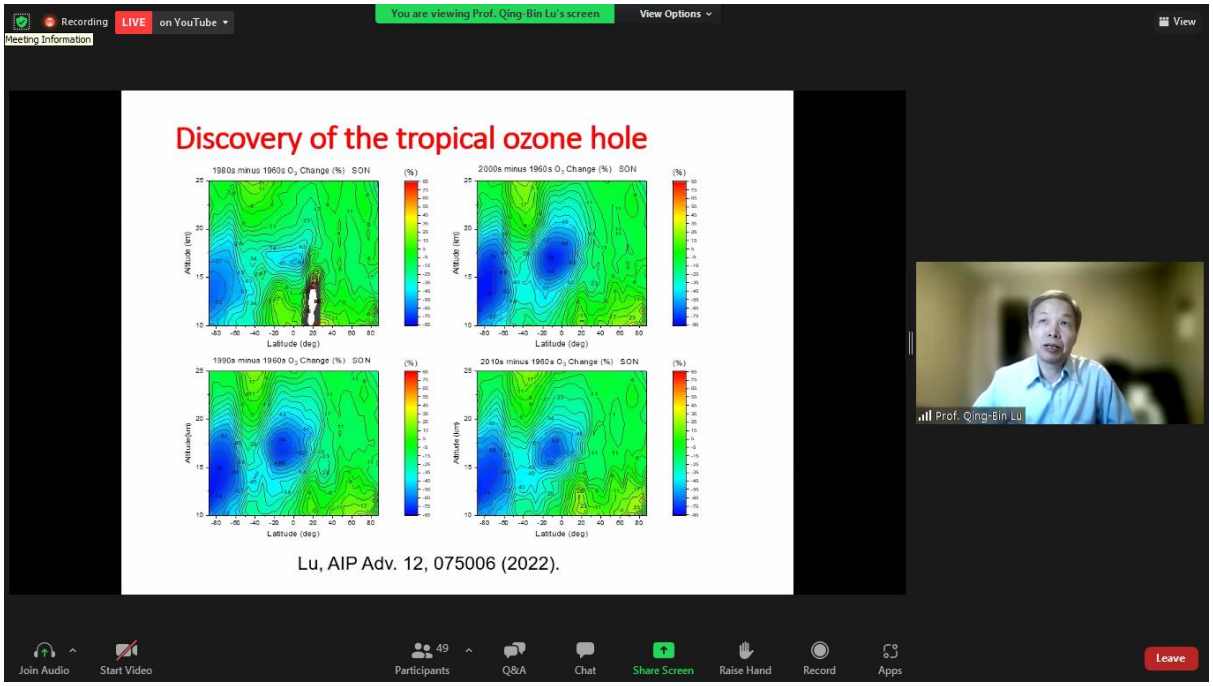
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Discovery of the tropical ozone hole
1980s minus 1960s O3 Change (%) SON
2000s minus 1960s O3 Change (%) SON
1990s minus 1960s O3 Change (%) SON
2010s minus 1960s O3 Change (%) SON
Altitude (km)
Latitude (deg)
Lu, AIP Adv. 12, 075006 (2022).
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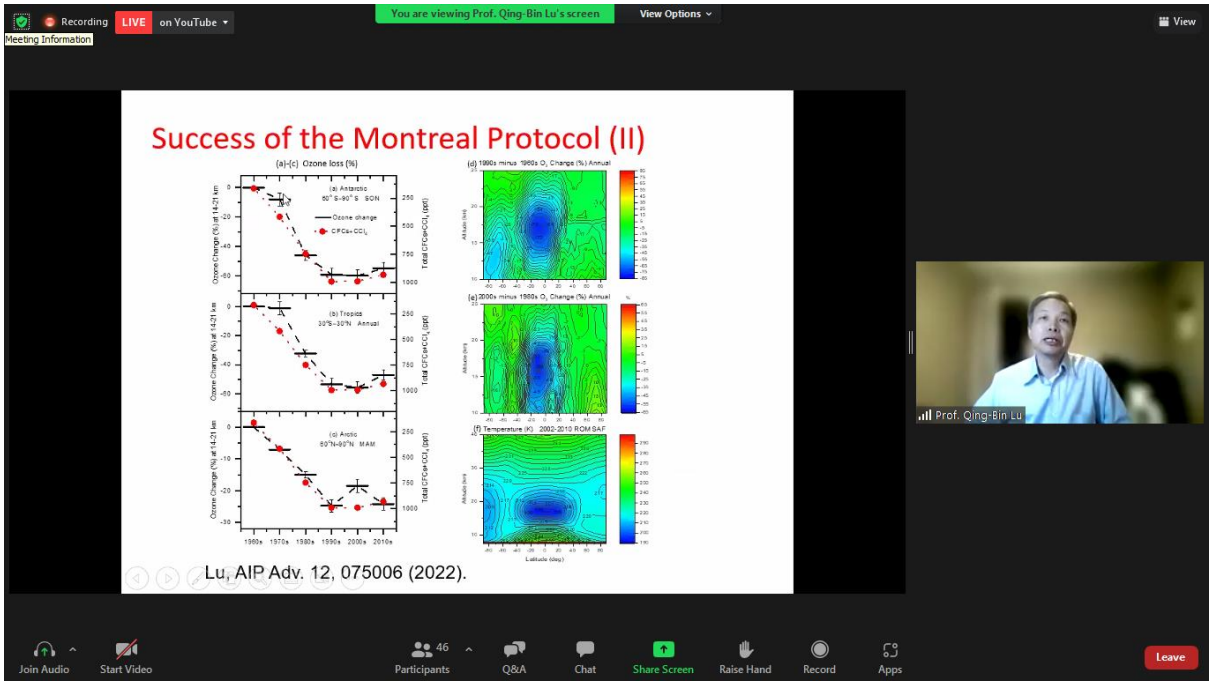
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Success of the Montreal Protocol (II)
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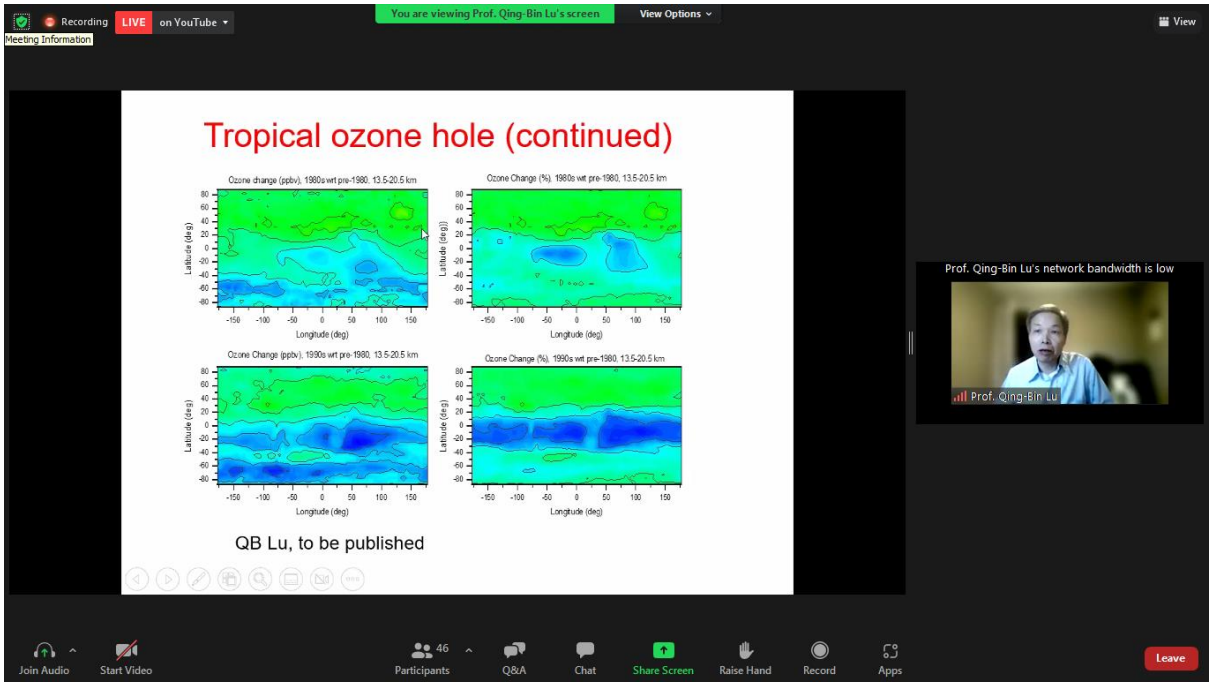
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Tropical ozone hole (continued)
QB Lu, to be published
Prof. Qing-Bin Lu's network bandwidth is low
Prof. Qing-Bin Lu
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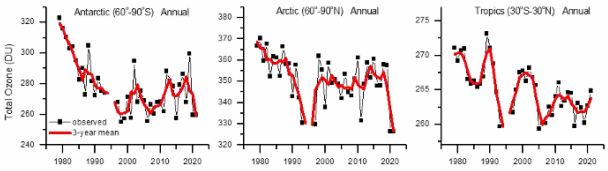
Why do we worry about the tropical ozone hole?



As satellite data show, the annual average total ozone value over the tropics was around 262 DU over the last decade, while it was 275 DU over Antarctica and 288 over the global!

QB Lu, to be published

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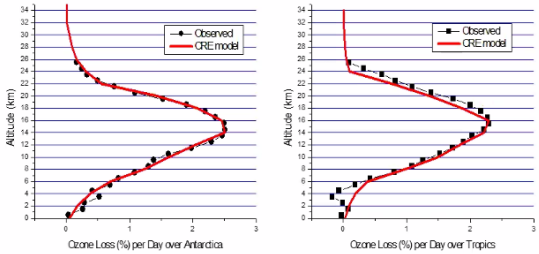
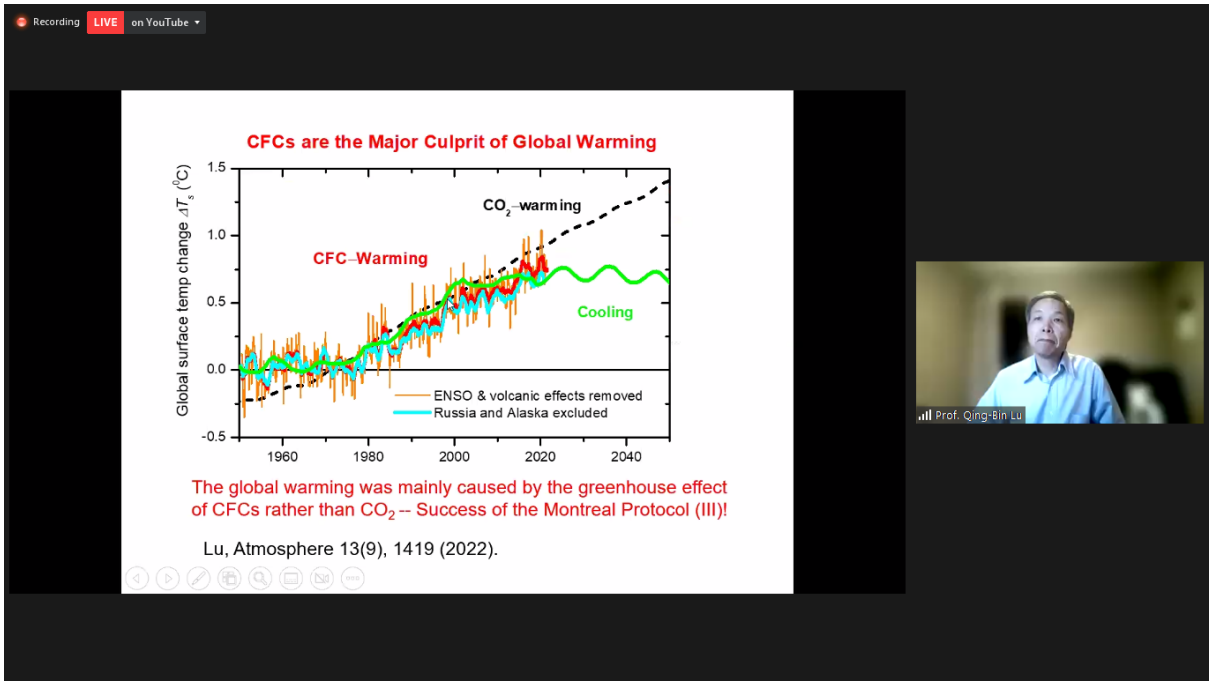
Observation and Theoretical calculations of global ozone depletion



QB Lu, to be published



Vote of thanks

The vote of thanks was given by Ms. Prangya Rath.