

The banner features a green and blue background with stylized mountains, a sun, an airplane, and a globe. The text is positioned in the upper right quadrant.

ICAO Symposium on Non-CO₂ Aviation Emissions

16 — 18 September 2024
Montréal, Canada



Jane Hupe

Deputy Director Environment

International Civil Aviation Organization (ICAO)

Scene Setting by ICAO

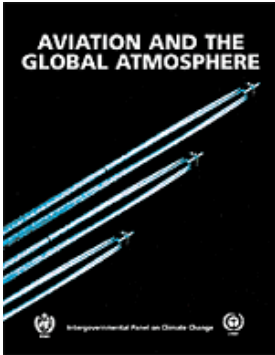


ICAO Symposium on Non-CO₂ Aviation Emissions

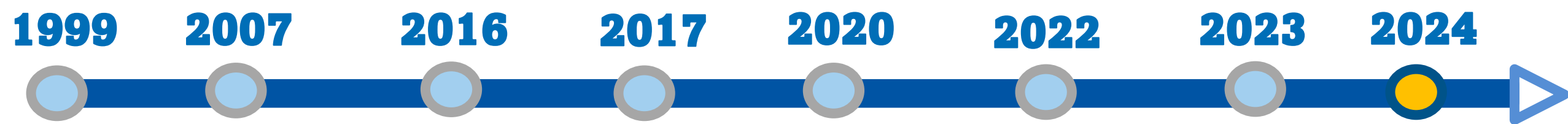
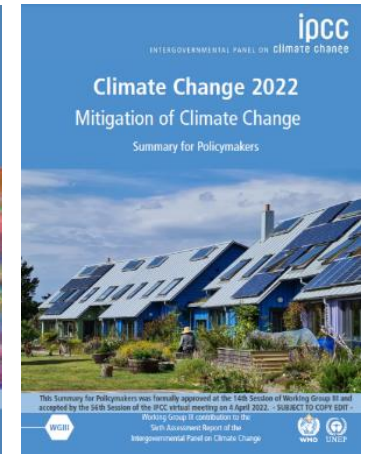
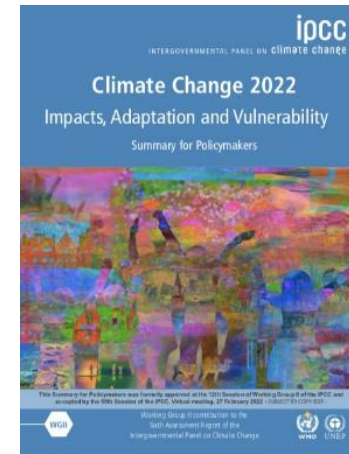
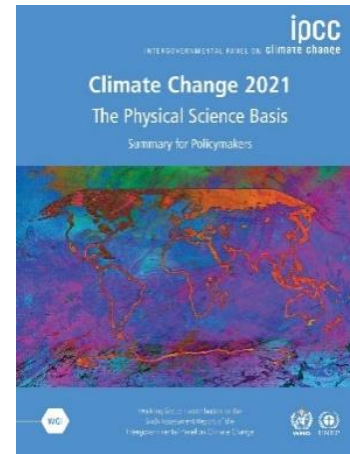
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Montréal, Canada

ICAO Work on Non-CO₂ Aviation Emissions

Aviation and the Global Atmosphere: A Special Report of the Intergovernmental Panel on Climate Change (IPCC)



IPCC 1999 Report Supplement: White Paper On Climate Change Aviation Impacts On Climate: State Of The Science



CAEP ISG Environmental Impact Seminar



CAEP ISG Aviation Noise Impacts Workshop

CAEP ISG Workshop on NO_x, nvPM, non-CO₂, fuel composition

Report to CAEP: Allowed Emission Of CO₂ For Limiting Global Mean Temperature Increases To 1.5 Or 2°C

CAEP ISG Workshop on non-CO₂ effects

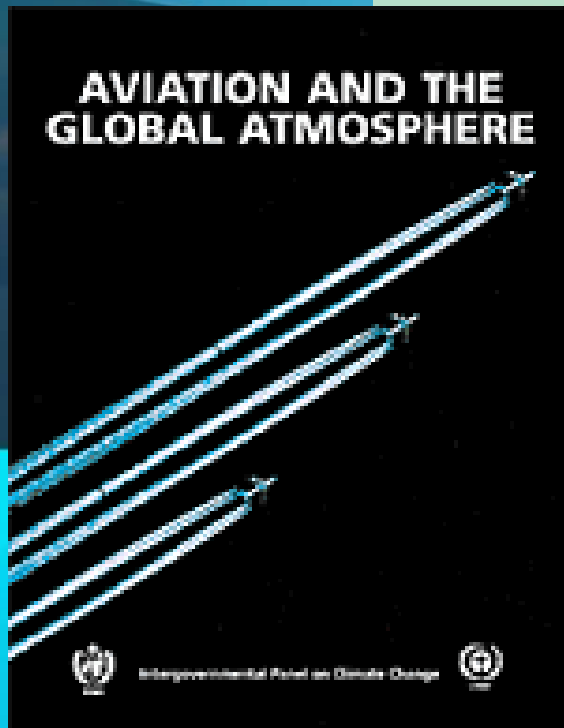


ICAO Symposium on Non-CO₂ Aviation Emissions





What are non-CO₂ aviation emissions?



IPCC-1999

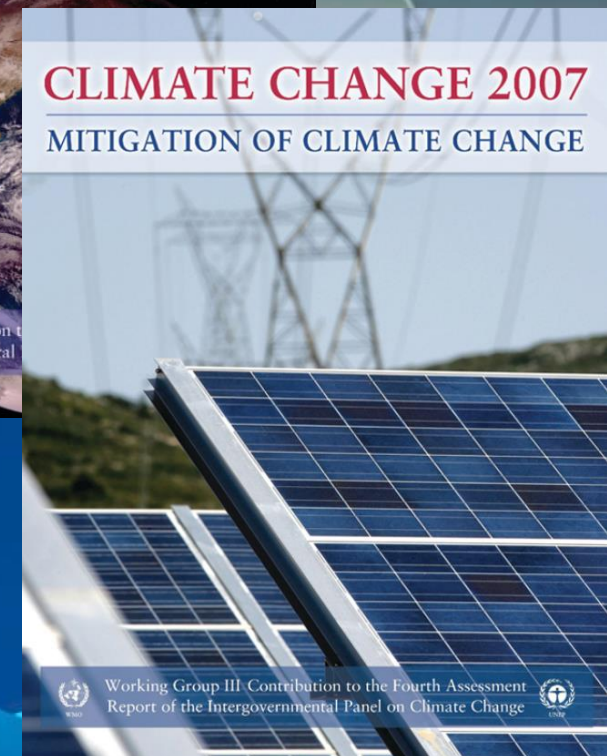
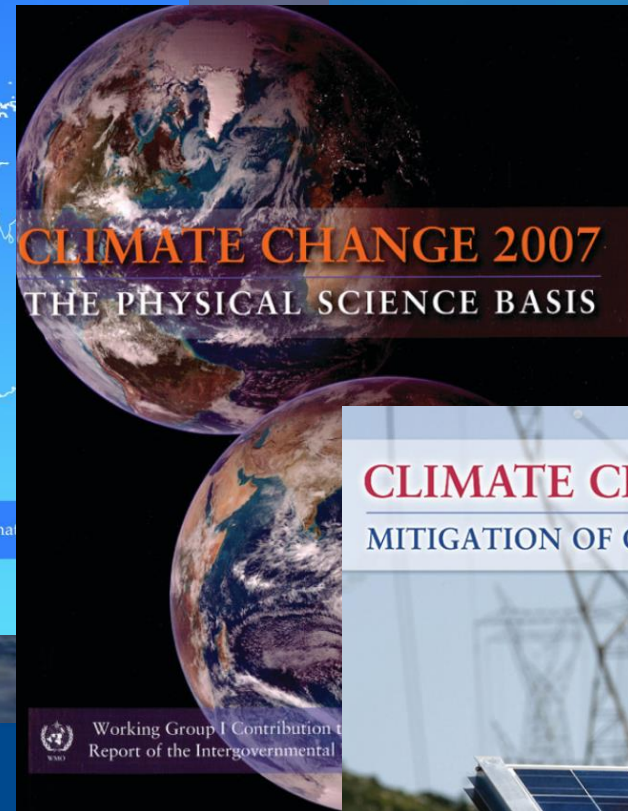
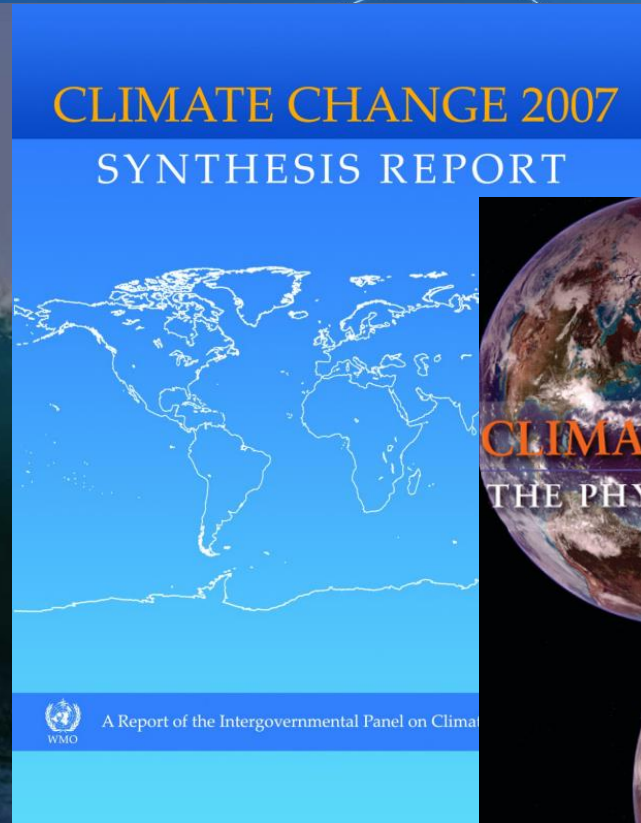
Aviation is estimated to contribute about 3.5% of the total anthropogenic **positive radiative forcing** (= warming effect on the climate).

Remaining scientific uncertainties.

AR4 Climate Change 2007: Synthesis Report

This Synthesis Report is based on the assessment carried out by the three Working Groups of the Intergovernmental Panel on Climate Change (IPCC) during the AR4 cycle.

- **Aviation is estimated to contribute about 3% of the total anthropogenic radiative forcing.**
- **Low level of scientific understanding on aviation contrails and cirrus.**

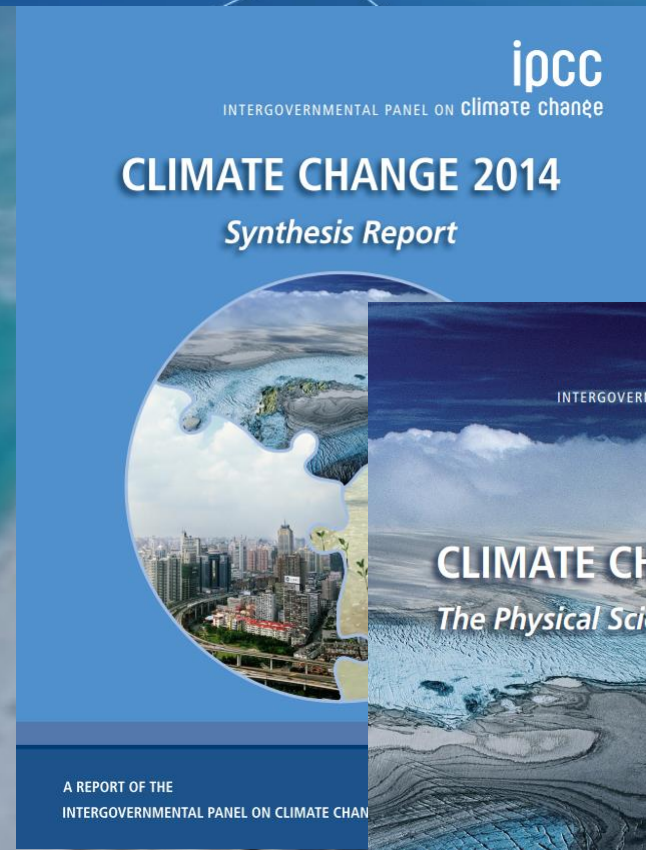


AR5 Synthesis Report: Climate Change 2014

The Synthesis Report (SYR) of the IPCC Fifth Assessment Report (AR5) provides an overview of the state of knowledge concerning the science of climate change, emphasizing new results since the publication of the IPCC Fourth Assessment Report (AR4) in 2007.

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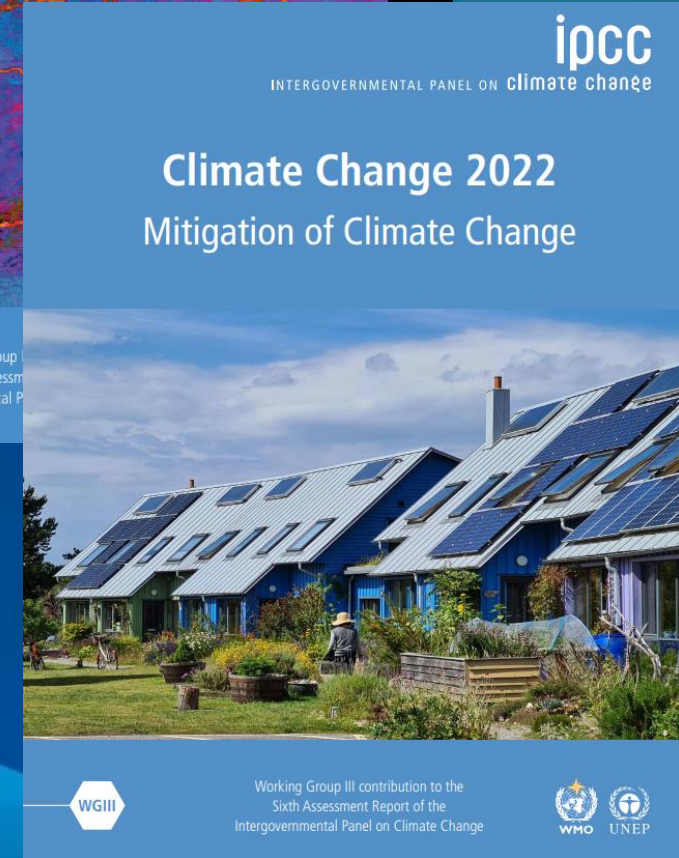
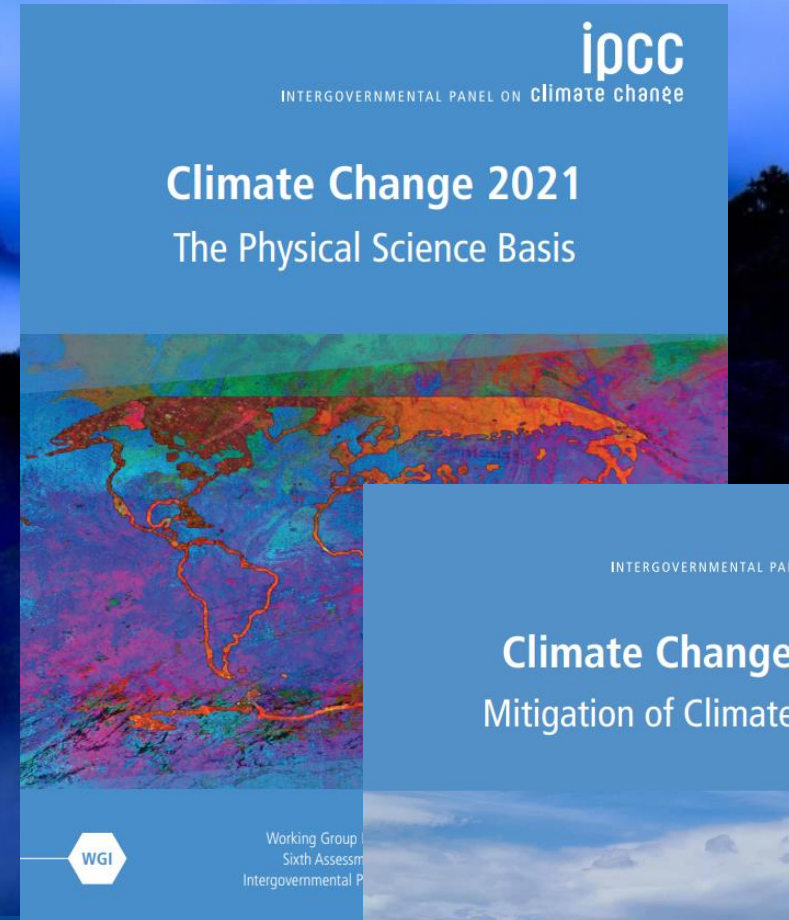
- **AR5 provided a best estimate for contrails and contrail induced cirrus.**
- **Since AR4, the evidence for contrail-induced cirrus increased due to observational studies**

AR6 Synthesis Report: Climate Change 2023

The IPCC finalized the Synthesis Report for the Sixth Assessment Report during the Panel's 58th Session held in Interlaken, Switzerland from 13 - 19 March 2023.

[READ THE REPORT](#)

[CORE WRITING TEAM](#)



- **Contrails and aviation-induced cirrus yield the largest individual positive ERF followed by CO₂ and NO_x emissions (Lee et al. 2021).**
- **Low level of confidence.**



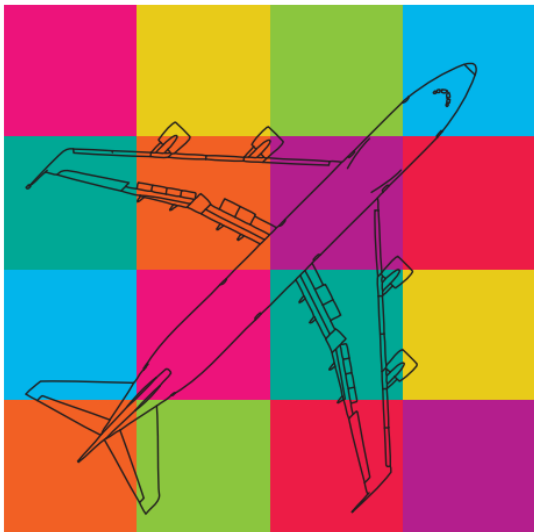
What is ICAO's role on non-CO₂ aviation emissions?



ICAO CAEP Impact and Science Group - ISG

ON BOARD

A SUSTAINABLE FUTURE



ICAO

2016 ENVIRONMENTAL REPORT

WHITE PAPER ON CLIMATE CHANGE AVIATION IMPACTS ON CLIMATE: STATE OF THE SCIENCE

BY D. W. FAHEY, NOAA EARTH SYSTEM RESEARCH
LABORATORY, BOULDER, COLORADO, UNITED STATES

S. L. BAUGHUM, BOEING COMPANY, SEATTLE,
WASHINGTON, UNITED STATES

J. S. FUGLESTVEDT, CICERO, OSLO, NORWAY

M. GUPTA, FEDERAL AVIATION ADMINISTRATION,
WASHINGTON, DC, UNITED STATES

D. S. LEE, MANCHESTER METROPOLITAN UNIVERSITY,
MANCHESTER, UNITED KINGDOM

R. SAUSEN, DEUTSCHES ZENTRUM FÜR LUFT- UND
RAUMFAHRT (DLR), INSTITUT FÜR PHYSIK DER
ATMOSPHERE, OBERPFAFFENHOFEN, GERMANY

P. F. J. VAN VELTHOVEN, ROYAL NETHERLANDS METEORO-
LOGICAL INSTITUTE (KNMI), DE BILT, THE NETHERLANDS

*This White Paper represents the summary of the scientific literature review undertaken by researchers and internationally recognized experts. It does not represent a consensus view of ICAO.

Summary

Aircraft emit gases and aerosol that change the composition of the atmosphere, cause increases in cloudiness through contrail formation and spreading, and modify natural clouds. At present, these changes together are estimated to cause a net positive forcing of Earth's climate system, which contributes to surface warming and other responses. There is substantial understanding of the components of aviation climate forcing, particularly CO₂. Important uncertainties remain in quantifying some of the aviation non-CO₂ climate terms and in the underlying physical processes. This paper presents a summary of recent progress in the state of the science since the 2012 ICAO/CAEP/ISG paper, especially related to contrails and induced cloudiness, contrail avoidance, and aerosol and NO_x effects. The number and diversity of newly available studies has created a need to re-evaluate best estimates of aviation climate forcings. Our understanding and confidence in aviation climate forcings would be enhanced by a new international scientific assessment.

**Keep track of
the latest
progress in the
state of the
science on the
climate impact
of non-CO₂
aviation
emissions.**

CAEP/13 Programme for ISG

Contrail Impacts and Aviation Induced Cloudiness

**Workshop in November 2023 with
the internationally recognized
contrail science experts.**



CAEP/13 Programme for Working Group 2

Operational Opportunities to Reduce Non-CO₂ Effects On Climate Change



ICAO Work on Local Air Quality

ON BOARD

A SUSTAINABLE FUTURE



ICAO

2016 ENVIRONMENTAL REPORT

WHITE PAPER ON AIR QUALITY AVIATION IMPACTS ON AIR QUALITY: STATE OF THE SCIENCE

R. MIAKE-LYE, AERODYNE RESEARCH, INC.,
BILLERICA MASSACHUSETTS, UNITED STATES

J.I. HILEMAN, US FEDERAL AVIATION ADMINISTRATION,
WASHINGTON, DC, UNITED STATES

P. MADDEN, ROLLS ROYCE, DERBY, UNITED KINGDOM

E. FLEUTI, ZÜRICH AIRPORT, ZÜRICH, SWITZERLAND

B. T. BREM, EMPA, SWISS FEDERAL LABORATORIES FOR
MATERIALS SCIENCE AND TECHNOLOGY DÜBENDORF,
SWITZERLAND

S. ARUNACHALAM, UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, NORTH CAROLINA, UNITED STATES

T. ROETGER, INTERNATIONAL AIR TRANSPORT
ASSOCIATION, GENEVA, SWITZERLAND

O. PENANHOAT, SNECMA, SAFRAN GROUP,
MOISSY CRAMAYEL, FRANCE

* This White Paper represents the summary of the scientific literature review undertaken by researchers and internationally-recognized experts. It does not represent a consensus view of ICAO.

Summary

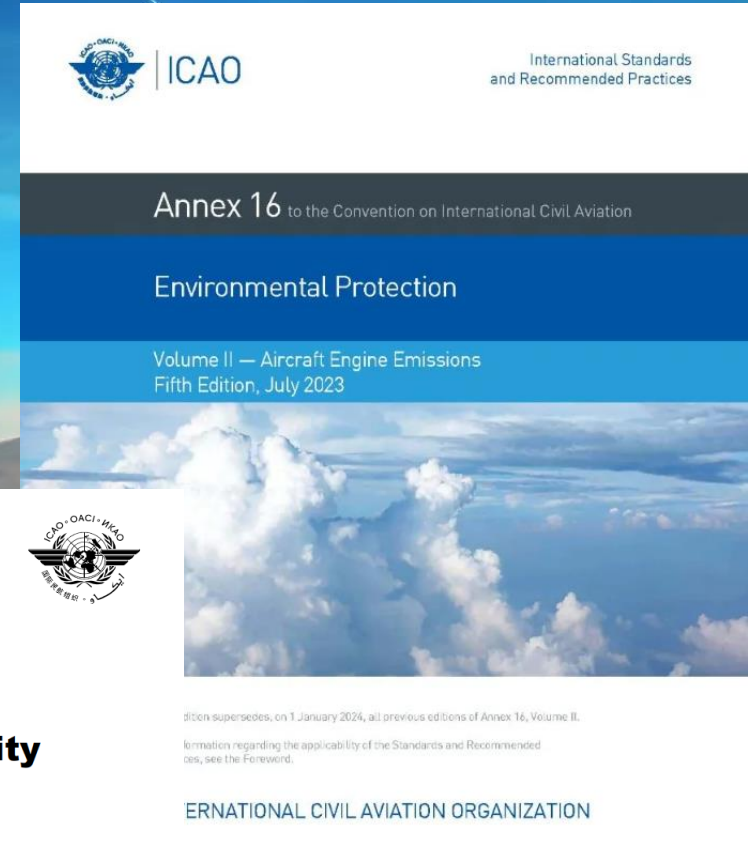
Aircraft produce emissions that react in the atmosphere to form pollutants that impact air quality. These emissions have long been regulated through standards for aircraft engines for oxides of nitrogen (NO_x), carbon monoxide (CO), unburned hydrocarbons (UHC), and smoke, via a Smoke Number (SN). New standards are being developed for non-volatile particulate matter (nvPM). Much is understood about how these and other emissions affect air quality in airports and in the regions around them. Ongoing research efforts are extending that understanding through better measurements and modelling. Work on PM is directed at developing the new nvPM standard, and increasing the available data on aircraft engine PM emissions. Alternative fuels have the potential to reduce PM emissions significantly. Emissions inventories are developed to calculate the contributions of all emissions to the ambient burden of pollutant concentrations that, in turn, are used to estimate the impacts on air quality and human health. Aircraft emissions at cruise altitude can also propagate back to affect local and regional air quality, and estimates of this contribution and the associated uncertainties have been calculated.

- **Understand and address impacts on local and regional air quality and human health**
- **Regulation of emissions through standard for aircraft engines**
- **Challenge of PM, need for a new nvPM Standard**
- **Ongoing research through better measurements and modelling**

Local Air Quality Technology Standards

Annex 16, Volume II – Engine Emissions

- **Hydrocarbons, NO_x, carbon monoxide.**
- **New nvPM Standard adopted in 2020**





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**Learn more about the Programme
of the ICAO Symposium on Non-
CO₂ Aviation Emissions**



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&
The way
forward**





ICAO



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 **IFAR** | INTERNATIONAL FORUM
FOR AVIATION RESEARCH

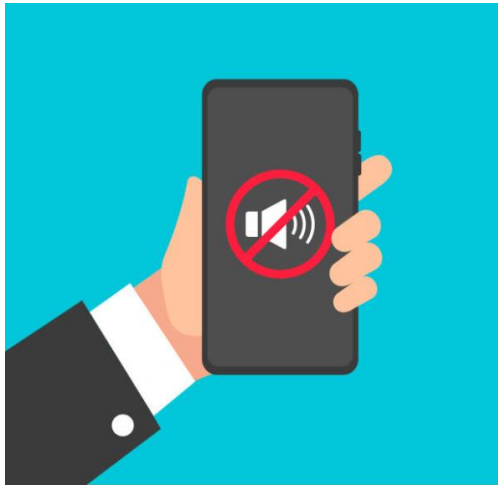
Thank You



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Logistics



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ICAO80th

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Montréal, Canada

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Upcoming session See all

On-Site Registration and Badge Collection

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AGENDA

Agenda My agenda My meetings

Sep 12 **Sep 16** Sep 17 Sep 18

07:30 **On-Site Registration and Badge Collection**
10:30 Lower Atrium Entrance

09:00 **Welcome and Opening**
09:25 Salvatore Sciacchitano, Mohamed Rahms and 1 other
Main Stage - Assembly Hall - ICAO HQ

09:25 **Setting the Scene by ICAO**
09:40 Jane Hupe
Main Stage - Assembly Hall - ICAO HQ

09:40 **Session 1: Scientific Knowledge – Historical overview & State-of-the-art**
10:45 Neil Dickson, David Lee and 4 others
Main Stage - Assembly Hall - ICAO HQ

10:45 **Coffee Break - Sponsored by Ministry of Infrastructure and Water Management of the Netherlands**
11:15 Exhibition Area

11:15 **Session 2: Enhancing Scientific Knowledge – Part I: NOx and Particulate Matter.**
12:15 Raymond Speth, Rick Miake-Lye and 2 others
Main Stage - Assembly Hall - ICAO HQ

12:30 **Lunch Break - Sponsored by Ministry of Infrastructure and Water Management of the Netherlands**
14:00

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Write a post...

Questions & Answers



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slido.com



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Logistics

The ICAO TV logo is displayed in white text on a dark blue background. A blue play button icon is positioned between the words 'ICAO' and 'TV'. Below the logo is a white rectangular button with the text 'SUBSCRIBE TODAY' in dark blue.

The event will be recorded and streamed on ICAO TV.

A carousel of three video thumbnails for the ICAO Symposium on Non-CO2 Aviation Emissions. Each thumbnail features the event title and a white airplane flying over a globe. A grey 'OFF AIR' button is in the bottom right corner of each thumbnail. The thumbnails are labeled: 'Day 1 : Morning session', 'Day 1 : Afternoon session', and 'Day 2 : Morning session'. A right-pointing arrow is visible on the right side of the carousel.

The banner features a stylized illustration of a white airplane flying over a green landscape with rolling hills and a blue sky. A globe is visible in the background, and a sun is partially shown in the top left corner. The text is centered in white on a green background.

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Monkeypox Health Information

- World Health Organization (WHO) guidelines regarding public gatherings in light of the current monkeypox outbreak
- No necessity to postpone or cancel scheduled meetings, based on a thorough risk assessment of currently available information
- Revised risk mitigation strategies in line with the United Nations Medical Directors' Risk Mitigation Plan for Mpox
- Refer to actions by participants on the Symposium website

Thank You

