

The banner features a green and blue background with stylized elements: a sun in the top left, a white airplane flying over a green globe with yellow arrows indicating emissions, and another white airplane flying over a blue globe with green leaves in the bottom right.

# ICAO Symposium on Non-CO<sub>2</sub> Aviation Emissions

16 — 18 September 2024  
Montréal, Canada

## Pervez Canteenwalla

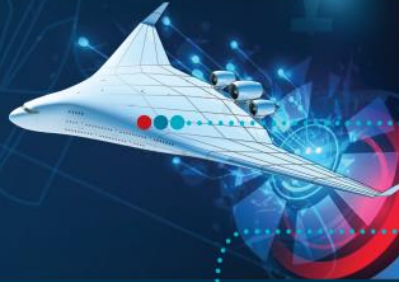
Program Lead – Low Emission Aviation  
National Research Council Canada – NRC

---



Speaker

Session 4: Partnerships to act on (Part I) **Research and  
Monitoring**



# ICAO Symposium on Non-CO2 Aviation Emissions

**Pervez Canteenwalla**  
Program Lead – Low Emission Aviation  
16-18 September 2024



# WHAT WE DO



**WE ADVANCE  
SCIENTIFIC  
AND TECHNICAL  
KNOWLEDGE**

**WE SUPPORT  
GOVERNMENT  
POLICY  
OBJECTIVES**

**WE SUPPORT  
BUSINESS  
INNOVATION**



# Sustainable Aviation Fuel (SAF)

Examples from over a decade of experience and partnerships

## Ground-test emissions

AAFEX II  
(50-100%,  
both HEFA-SPK and FT-SPK)



AVIATOR  
(32% HEFA-SPK blends)



ECLIF 2 / ND-MAX  
(17-49% HEFA-SPK blends)



ECLIF 3  
(100% HEFA-SPK and blends)



Boeing EcoDemonstrators  
(100% HEFA-SPK and blends)



2011

2023



World's 1<sup>st</sup> Flight on  
100% SAF  
(100% CHJ)



NASA ACCESS II Flights  
(50% HEFA-SPK blend)



1<sup>st</sup> Flight with SAF using  
Synthetic Aromatics  
(17% SAK, 83% HEFA-SPK)



Air Canada  
Enroute Emissions  
(43% HEFA-SPK blend)



High-blend SAF Campaigns  
(92%-100%, both  
ATJ-SPK and HEFA-SPK)

## Flight test emissions and contrails

## Collaboration between Transport Canada and NRC: From Innovation to Regulation

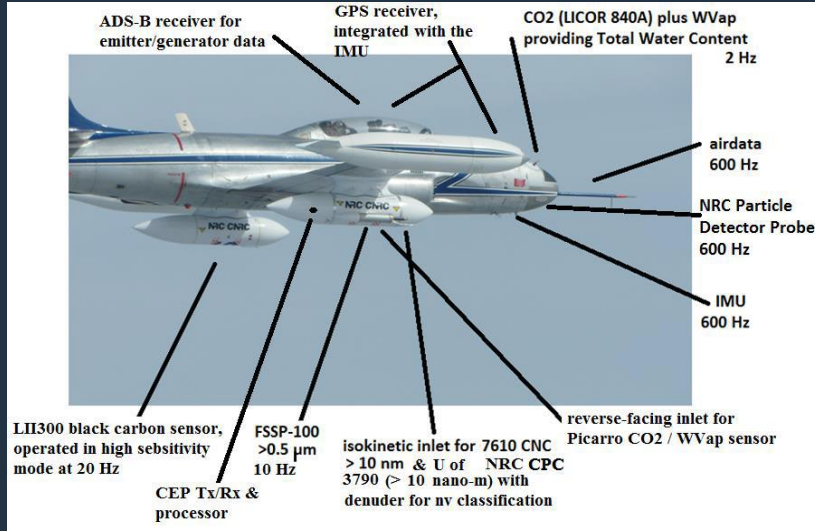
### A Government of Canada Success Story

Capabilities in the measurement of Black Carbon (BC) have led to a new global regulation for nonvolatile particulate matter (nvPM) emissions from civil aviation aircraft engines with a thrust >26.7 kN

- NRC patents → Artium LII 300 Instrument
- Basic science → knowledge about properties of BC nanoparticles
- Applied research → development and understanding of nvPM sampling and measurement method on aircraft engine emissions
- Technical standards development
- Regulatory development
- Quality system – new calibration service for BC and nvPM mass concentration instruments

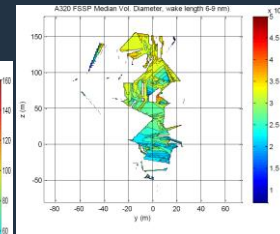
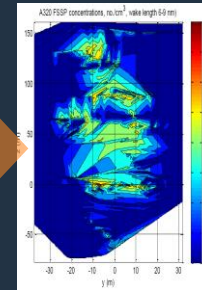


## NRC High Altitude Atmospheric Research Capability



### NRC philosophy & technique

- Suite of sensors to measure: nvPM, vPM, NO<sub>x</sub>, CO<sub>2</sub>, and ice particles
- Measure emissions & contrail plumes holistically, using ~9 traverses (6-7 lateral, 3-2 vertical)
  - Autonomous (no CO<sub>2</sub> accuracy dependency)
  - Emission Index values calculated by lateral, then vertical integrands
- Measure all regimes of the contrail (upper jet wake (UJW) contrail, stem (linkage) & lower wake vortex regimes of the contrail)



# Objectives of Future Research

Further scientific study by the *international scientific community* is required to better understand the non-CO<sub>2</sub> climate effects and reduce the uncertainties. To fully characterize 100% SAF and Jet A1 contrails (and hydrogen in the future), NRC may undertake the following activities:

Contrail / cloud / emissions physics

Engine technology effects

Fuel effects

Renew High Altitude Atmospheric Research Capability

In-flight engine exit plane measurements

Development of ground facility for simulating contrails

- Characterize the cirrus transition process (0-60 minute aged contrails)
- Contrail gaseous/PM species classification and microchemistry
- Measure smaller (<1 μm) ice particles directly
- Effect of fuel hydrogen content on nvPM emissions (mass and number)
- New fuels impacts upon contrail development
- Engine combustor operational regimes
- Altitude scaling of nvPM emissions



# Thank you

Pervez Canteenwalla • Program Lead, Low Emission Aviation Program • [pervez.canteenwalla@nrc-cnrc.gc.ca](mailto:pervez.canteenwalla@nrc-cnrc.gc.ca)

[nrc.canada.ca](http://nrc.canada.ca) • [info@nrc-cnrc.gc.ca](mailto:info@nrc-cnrc.gc.ca)