Sustainability in Aviation, Government of Canada Perspective

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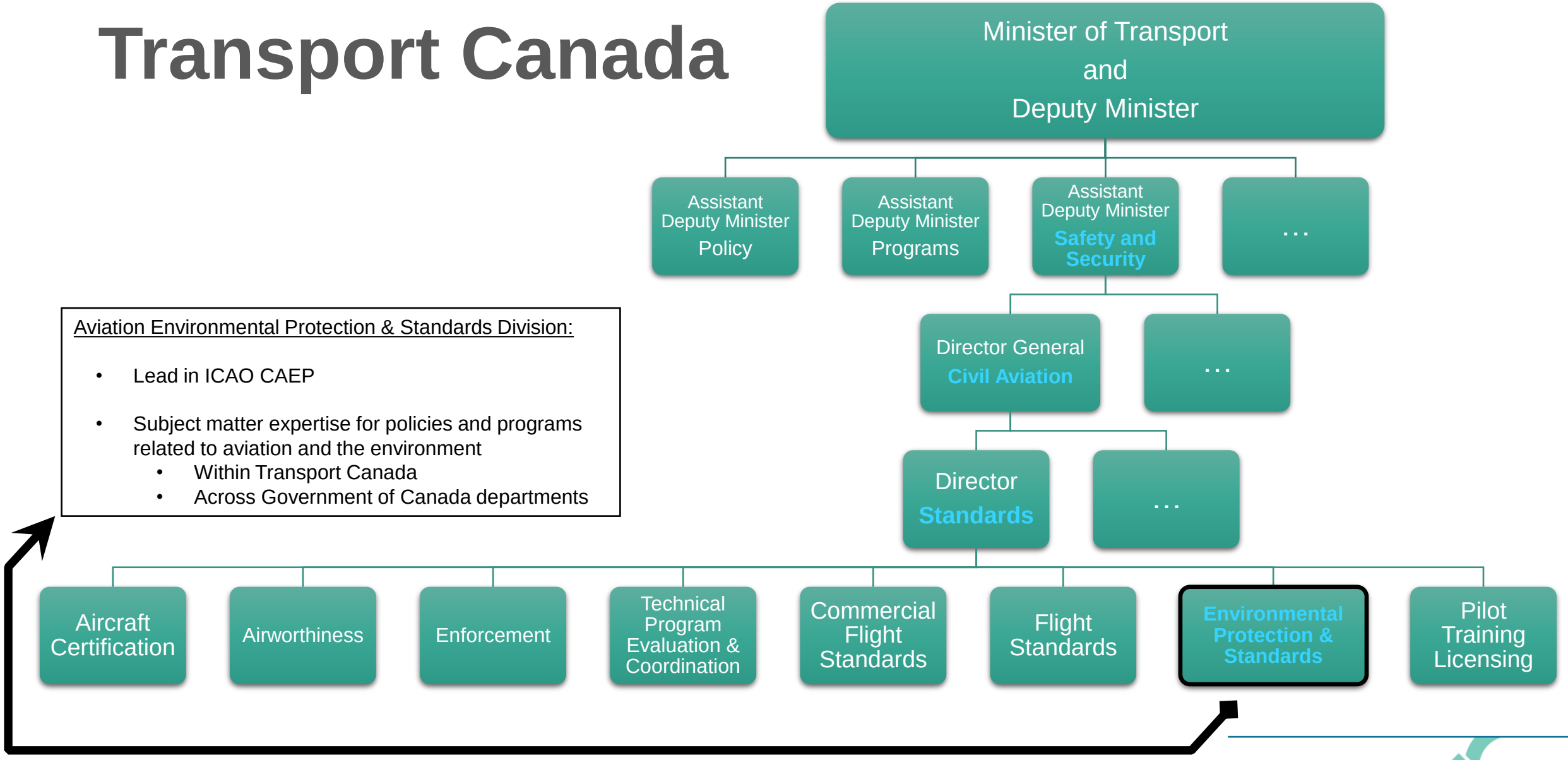
Outline

- Describe role of TC & other Federal Government Departments
- Review previous work and announcements
- Present new efforts and priority areas
- Describe opportunities for engagement

Transport Canada



Aviation Environmental Protection & Standards Division:

- Lead in ICAO CAEP
- Subject matter expertise for policies and programs related to aviation and the environment
  - Within Transport Canada
  - Across Government of Canada departments

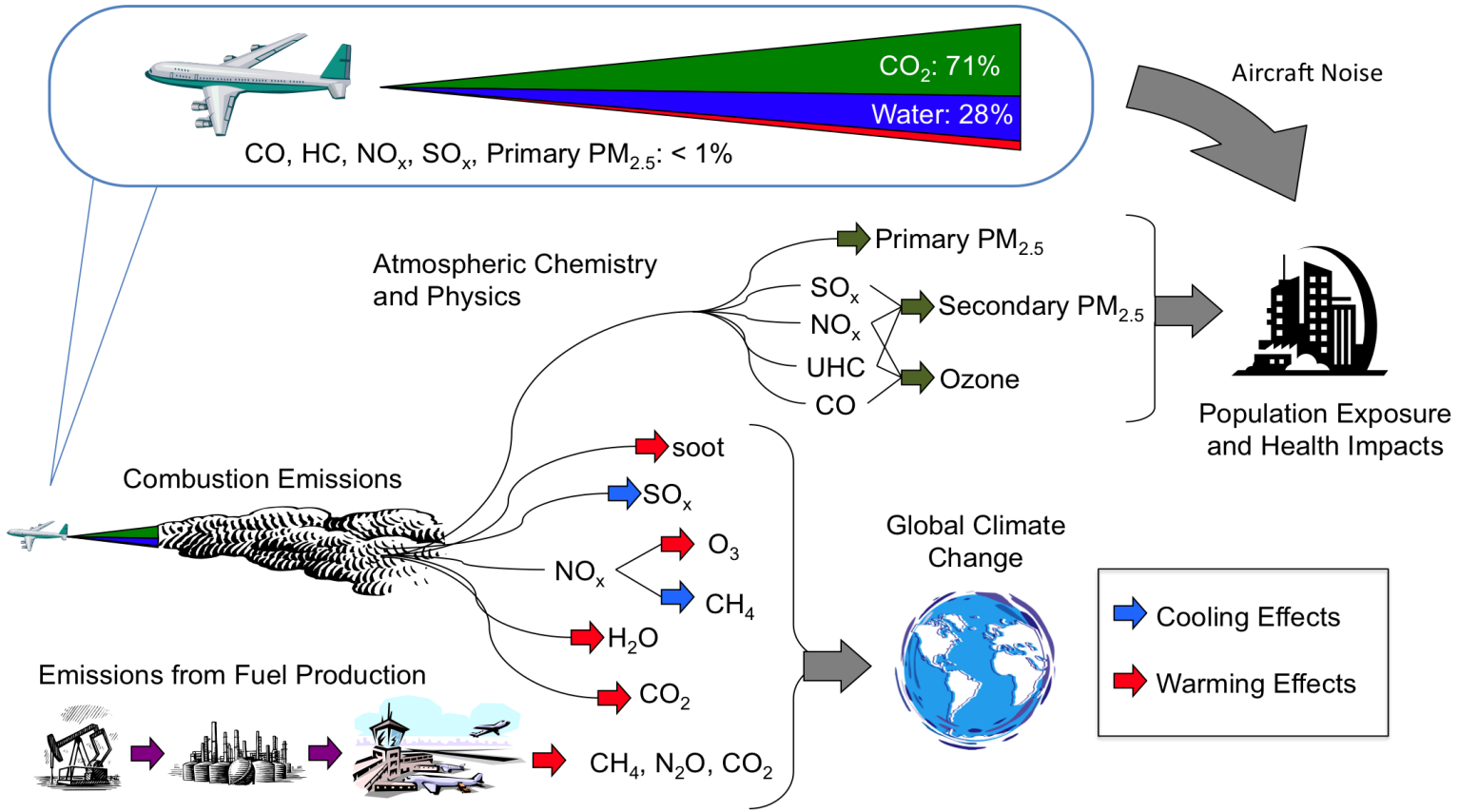
Canadian Aviation Regulations

- Canada has a policy of harmonization with the international standards and recommended practices developed and adopted by the International Civil Aviation Organization (ICAO).

Drivers for New Regulations / Measures

- Human Health Concerns (respiratory illness, noise exposure, other)
- Environmental Concerns (climate change, ozone depletion, acid rain, soil and water contamination, hazardous materials, other)
- Political Concerns
    - governments (environmentally responsible) and
    - manufacturers (branding)
- Other United Nations Bodies (UNEP, WHO, WMO, etc)
- State interests (Canada, US, EU, Brazil, Indonesia, etc)
- Special interests (NGOs, ENGOs, industry associations, others)

Aviation Environmental Protection Considerations



**Jim Hileman, MIT, FAA, Boeing*

Sustainability in Aviation – Factors and Tools

FACTORS

- Social, economic, env. benefits and costs
- Noise, CO_2, NO_x, PM, UHC, and non-CO_2 emissions (SO_x , CH_4, H_2O)
- Human health & env. impacts, design constraints, costs, and.. **SAFETY**

TOOLS

- Regulatory measures
- Operational measures
- Market-based measures
- Promotional measures
  - Technology development
  - Low Carbon fuels
  - Sustainability criteria
  - LCA & Env. assessment
- Others?

Key considerations
Interdependencies and Tradeoffs

- Noise
  - *Local vs. Regional (beyond 10nm) and Global (future SST, Business Jets)*
- Emissions
  - *Local (Air Quality – NOx, PM, SOx, other) vs. Global (Climate Change – CO_2, Ozone Layer Depletion / other)*
  - *↑ Efficiency vs. impacts (noise, PM, NOx, CO, other)*
  - *Altitude (Cruise NOx, PM and other vs. other phases of flight)*
  - *Flight levels and Routing (contrail and cirrus cloud formation)*

  Caution re: risk of unintended consequences from focus on the wrong emissions parameter or consequence (health vs. env.)
- Other
  - *Effectiveness of Policy vs. Operational vs. Market-based Measures*
  - *International vs. Regional vs. Domestic Concerns*

**Cost-benefit is always a key consideration*

SAFETY

Metrics and Tools

METRICS

- Sig. aircraft noise contained within the airport fence
- Climate stabilized?
- Air quality & health?
- Carbon footprint?
- ISO, GRI, other?
- Others?

TOOLS

- New aircraft, new designs (C-Series, B787, Q400, blended wing?)
- New engine concepts (geared TF, open rotor)
- New operations (free flight, speed ↑↓, formation flying)
- Reduced carbon intensity (fuels, MBM's, incentives)

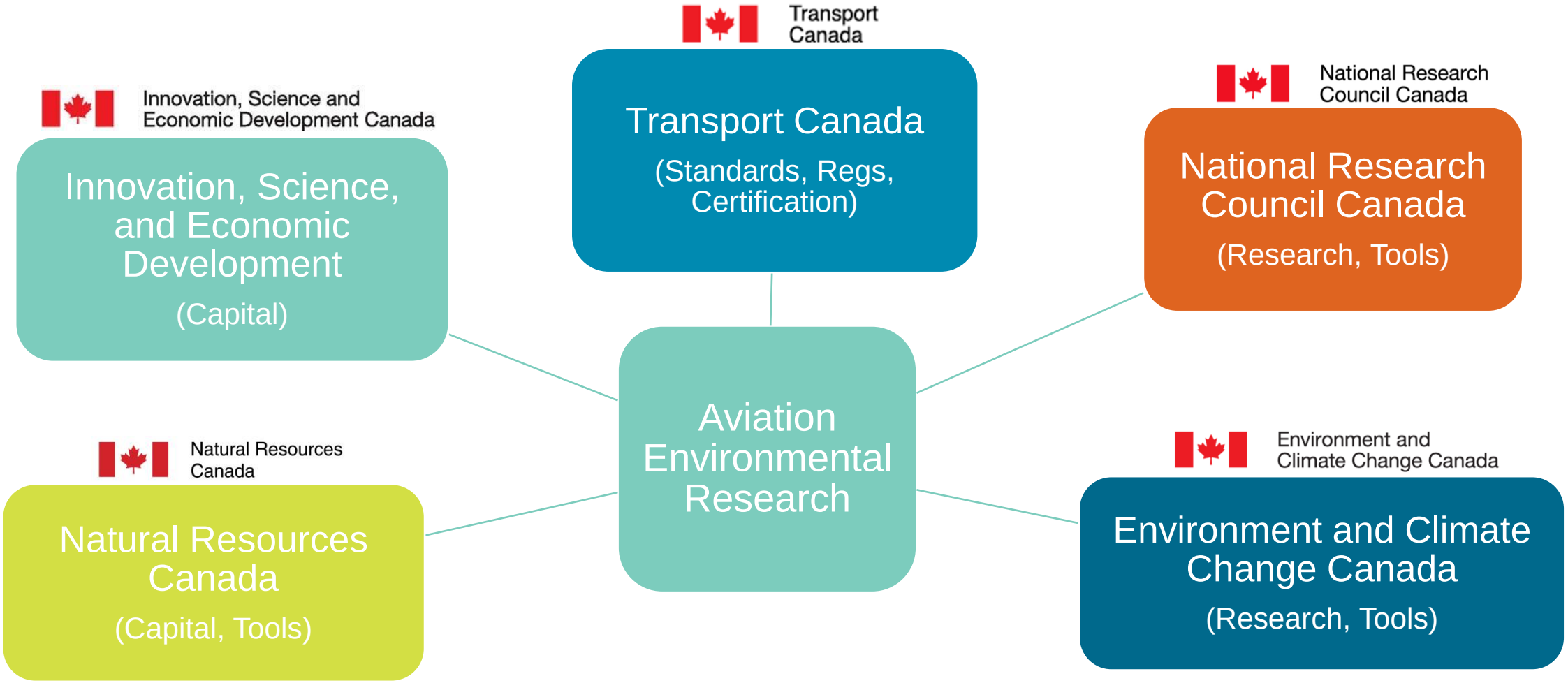
Aviation Sustainability - Stakeholders

- Governments (Canada / US / EU, ICAO, other UN)
- Manufacturers
- Operators
- Airports
- Air Navigation Service Providers
- Citizens (local, regional, global)
- Users
- Special Interest Groups
- Others?

Government of Canada Commitments and Announcements

- Commitment to NET-ZERO by 2050
- $1.75 B targeted for aerospace (Net Zero Accelerator)
- $1.5 B Clean Fuel Fund
- $228 M Low carbon fuel procurement for the Federal Safety and Security fleet (air and marine)
- *NRCan Biofuels initiative *announced in Budget 2023*

Canadian Aviation Environmental Work

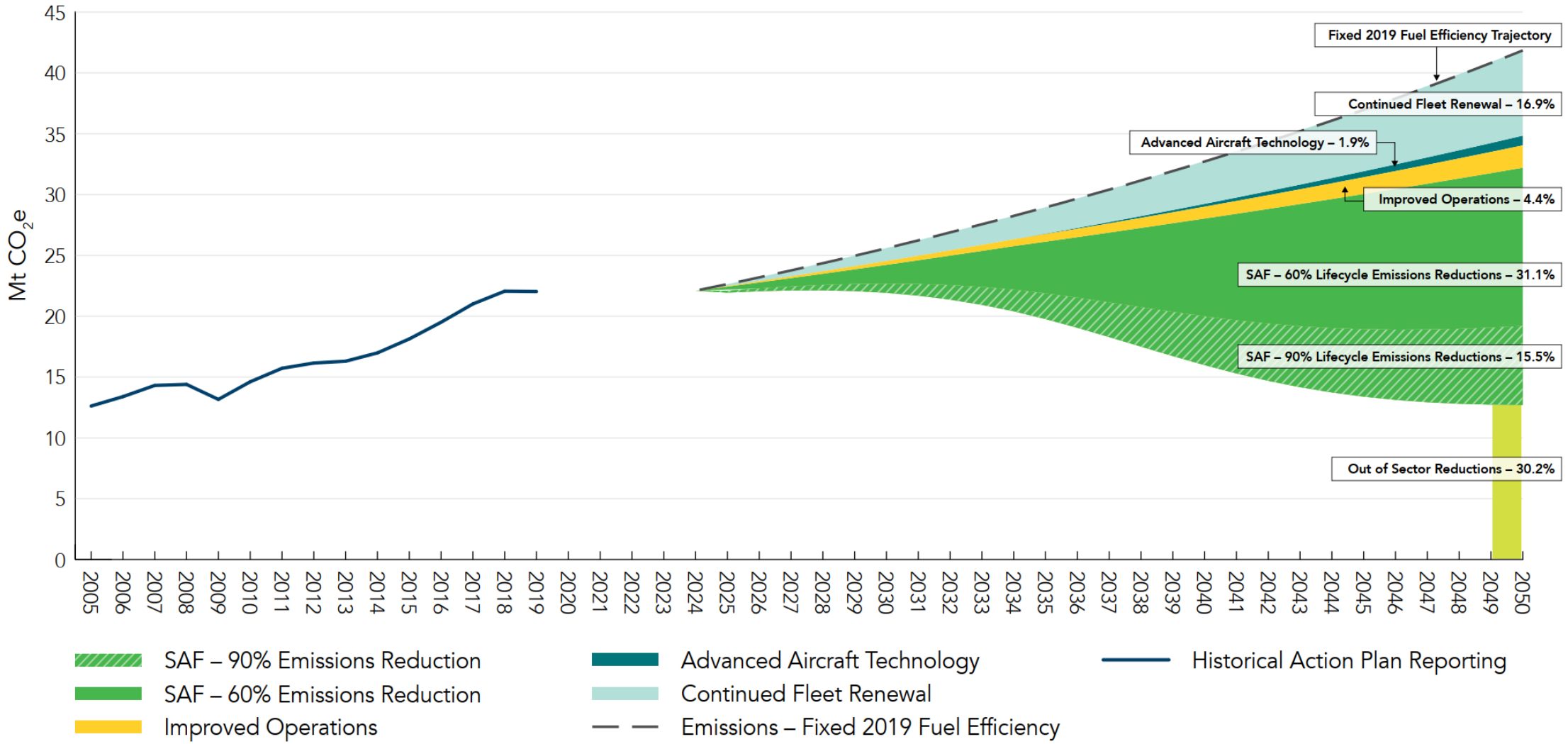


Canada's Aviation Climate Action Plan

- Signed in September 2022
- Government / industry initiative building on previous Action Plan
- Whole of government approach
- Aligns with commitments within Canada's Emission Reduction Plan
- Highlights key decarbonization pathways and near-term measures
- 2050 vision: Net-zero aircraft emissions
- 2030 aspirational goal: 10 percent SAF use

https://tc.canada.ca/en/corporate-services/policies/canada-s-aviation-climate-action-plan

THE PATHWAYS TO ACHIEVE NET-ZERO BY 2050



Combination of measures is needed – <u>no silver bullet</u>

Aircraft and Engine Design

- Participation in ASCENT
- Participation at ICAO in WG1, WG3 (with Canadian OEMs)
- Examples:
  - Pratt & Whitney Canada (PWC) Geared Turbofan
  - PWC and De Havilland Canada (DHC) Dash 8 hybrid-electric demonstrator
  - Bombardier ecoJet
  - Harbour Air electric Beaver (DHC-2)

NRC Work on Particulate Matter

Overall intent is for NRC to provide research and technical support to Transport Canada (TC) for emissions from civil aviation (standards, regulatory work)

Focus is on emissions of particulate matter (PM), with a specific focus on nonvolatile particulate matter (nvPM)

NRC supports TC through active participation in:

- SAE E-31 Aircraft Engine Gas and Particulate Emissions Measurement Technical Committee
- ICAO/CAEP Working Group 3 (WG3) Emissions, Technical

Research efforts are discussed at SAE E-31 and WG3

- Ongoing laboratory research to support improved measurements of nvPM mass concentration
- Participation in international field measurement campaigns

NRC nvPM Activities in 2022-2023

- **Field measurement campaigns**
  - ecoDemonstrator (fieldwork performed Q3 2022)
  - CERMS ILC (fieldwork performed Q2 2023)

- **Analysis of prior field measurement campaigns**
  - ECLIF III (fieldwork performed Q2 and Q4 2021)
  - AVIATOR (fieldwork performed Q3 2021 and Q1 2022)
  - RAPTOR (fieldwork performed Q4 2021)
  - SAMPLE IV (fieldwork performed Q4 2021)

- **Flame Spray Pyrolysis to produce aviation-like nvPM**

Alternative Aviation Fuels

- **Our focus: a combination of …**
  - Safety of fuel and aircraft
  - Improving fuel efficiency
  - Improving environmental outcomes
  - Support to other Federal Departments (eg NRCan SAF Challenge, Clean Fuels Fund, Biofuels Initiative)

- **Type of work we do**
  - Provide scientific support to assess the emission characteristics of alternative fuels
  - Collaborate with partners to test various alternative fuels
  - Bring together and integrate information in order to achieve the goals outlined in the Action Plan to Reduce Greenhouse Gas Emissions from Aviation.
  - Participate in aviation specific technical groups such as ASCENT, CAAFI, ICAO Fuels Task Group, others

Canadian SAF Flights

Bombardier Aerospace

- Q400 world's first turboprop aircraft to fly on biofuel

Porter Airlines

- First revenue flight in Canada on biofuel from Montreal to Ottawa
- Flew ICAO Secretary General on bio-fuelled flight from Montreal to Toronto en-route Rio+20 conference

Air Canada

- Flew ICAO Secretary General on bio-fuelled flight from Toronto to Mexico en-route Rio+20 conference

Royal Canadian Air Force

- Canadian Hercules C-130

National Research Council Canada

- World's first "unblended" 100% biofuel flight

World's First 100% Unblended Biojet Flight

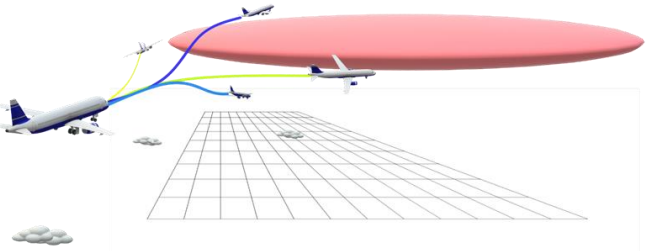
Hydrogen study at Canadian Airports

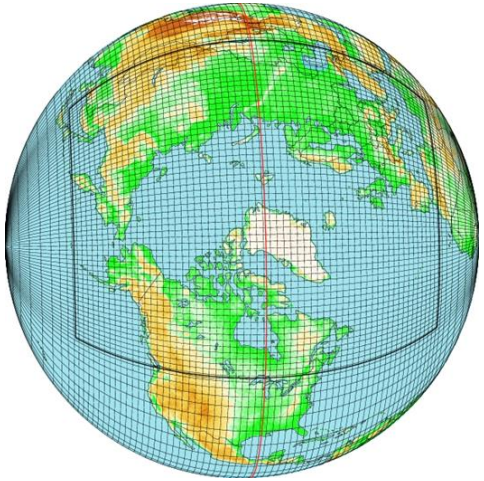
- Research 2022/2023 – **A benefit-cost analysis of hydrogen adoption in Canada's airports** – The project estimates the amount of hydrogen that would be needed in the year 2050 to serve multiple energy services at Canada’s busiest airports.

- Research 2023/2024 – **Optimizing hydrogen microgrids for adoption at Canada’s airports** – This project will develop an energy system optimization model for a hydrogen-backed microgrid deployed at Canadian airports.

Atmospheric Science

- Engine emissions sampling at altitude including contrail measurement (NRC)
- Aviation Impact Modelling (York U.)
- Weather prediction for contrail avoidance (ECCC)
- ASCENT
- Participation in ICAO ISG, WG2



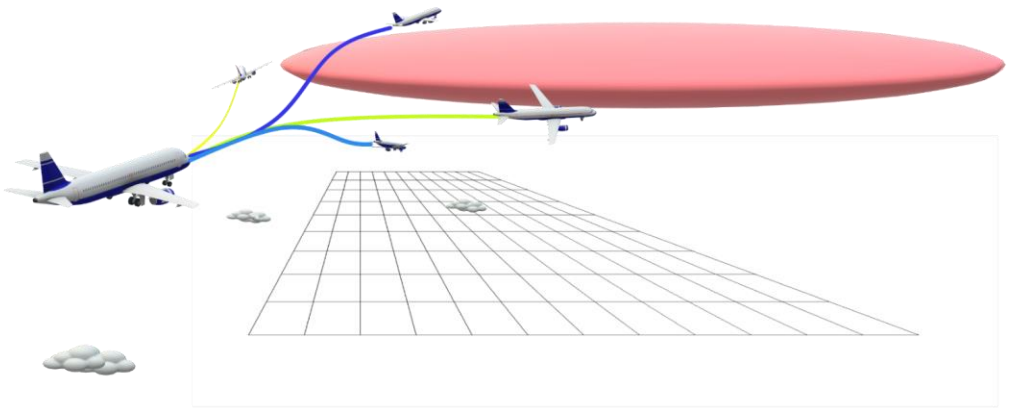


ECCC - Contrail Avoidance Tool (CoAT)

Model

Base Model:

- Well developed model used at **Environment and Climate Change Canada**
- **Physically based** numerical weather prediction model
- Used for generating **daily forecasts** and to issue weather related warnings



CoAT (developed within the framework of the base model)

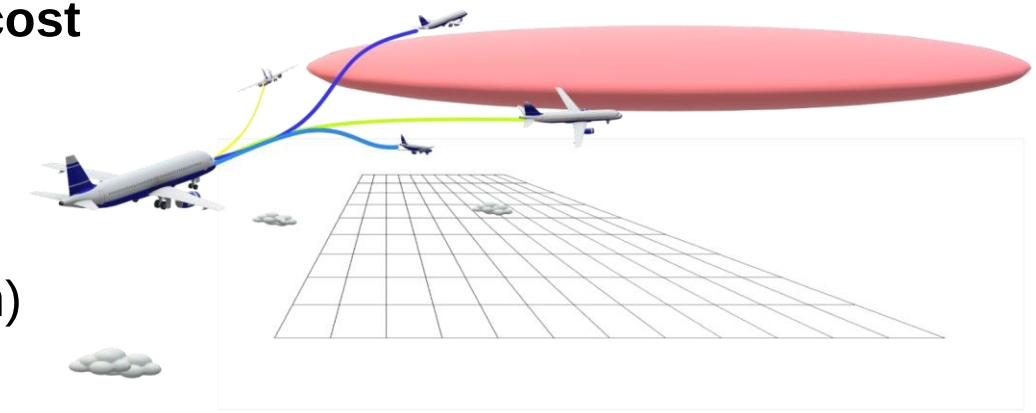
- Predict regions for contrail formation

ECCC - Contrail Avoidance Tool (CoAT)

Application

Mitigation strategies

- Forecasts can be used by flight planners for flight mitigation strategies
- Flight planners can then asses new flight paths and the **cost** for **diverting aircraft**



Research studies

- Climate impact of using alternate fuels (SAF or Hydrogen)

CoAT support

- Environment and Climate Change Canada – led
- Transport Canada as cost-share partner

Jet Emissions and Contrails Research

- Scope of Work
  - In-flight measurement of contrail-related emissions and properties
  - Test different SAF blends using NRC's Falcon 20 aircraft
  - Sampling using equipment in NRC's T33 chaser aircraft
  - Data for validation of ECCC's CoAT work

- Status
  - T33 aircraft grounded at the moment (ejection seats are past their certified time)
  - Searching for funding/partnership options

Working with Stakeholders
Aircraft Noise & Emissions Committee

GOVERNMENT

- Transport Canada
  - Safety and Security
  - Policy
  - Programs
  - Legal Services
- Environment Canada
- Health Canada
- Foreign Affairs Canada
- National Research Council

INDUSTRY

- Aerospace Industries Association of Canada
- Air Transport Association of Canada
- National Airlines Council of Canada
- Canadian Airports Council
- Canadian Business Aviation Association
- NAV CANADA

Emerging Issues

- Supporting domestic SAF production (10% by 2030)
- Clean technology development
- Contrail avoidance
- Hydrogen fuel
- Aircraft noise exposure tools and metrics
- Noise exposure from RPAS
- Advanced Air Mobility

Contact List

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Thank You