

Aviation and Climate Change

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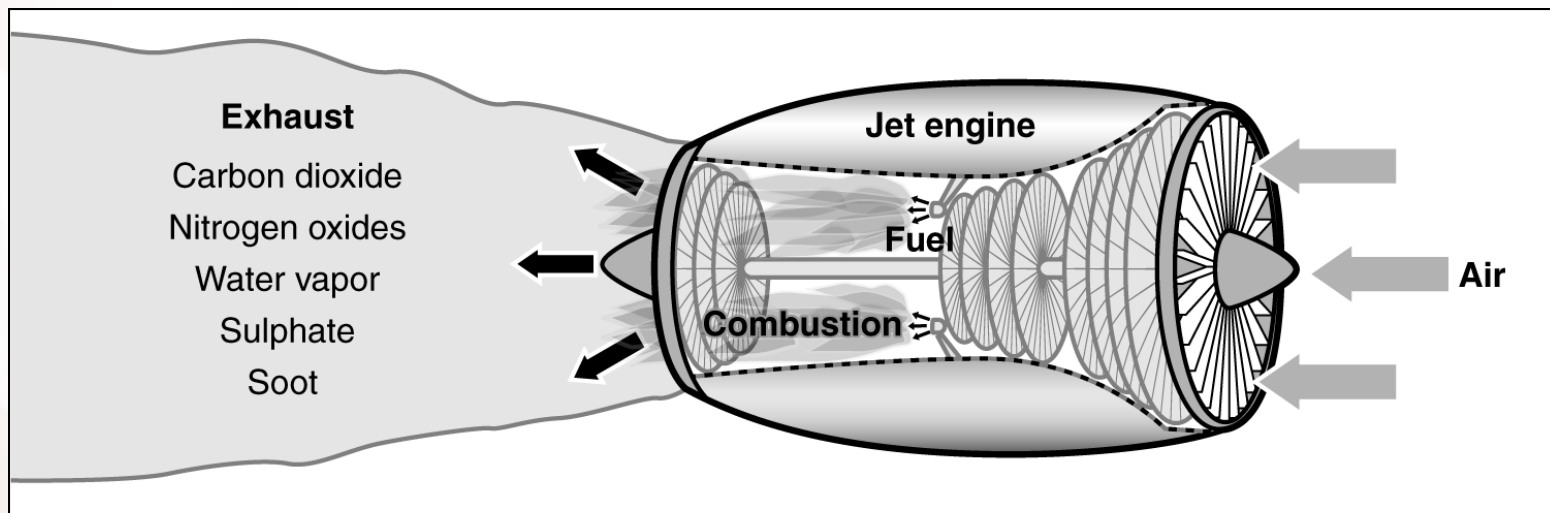
Aviation and Climate Change Report

- Aviation and Climate Change: Aircraft Emissions Expected to Grow, but Technological and Operational Improvements and Government Policies Can Help Control Emissions (GAO-09-554)
- www.gao.gov/new.items/d09554.pdf

Report Objectives

- Aviation's current and estimated future contribution to greenhouse gas and other climate change emissions.
 - Existing and potential future technological and operational improvements to reduce commercial aircraft emissions.
 - Options for the U.S. and other governments to help address commercial aviation emissions and the advantages and disadvantages of each.
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Current Aviation Emissions



Source: GAO.

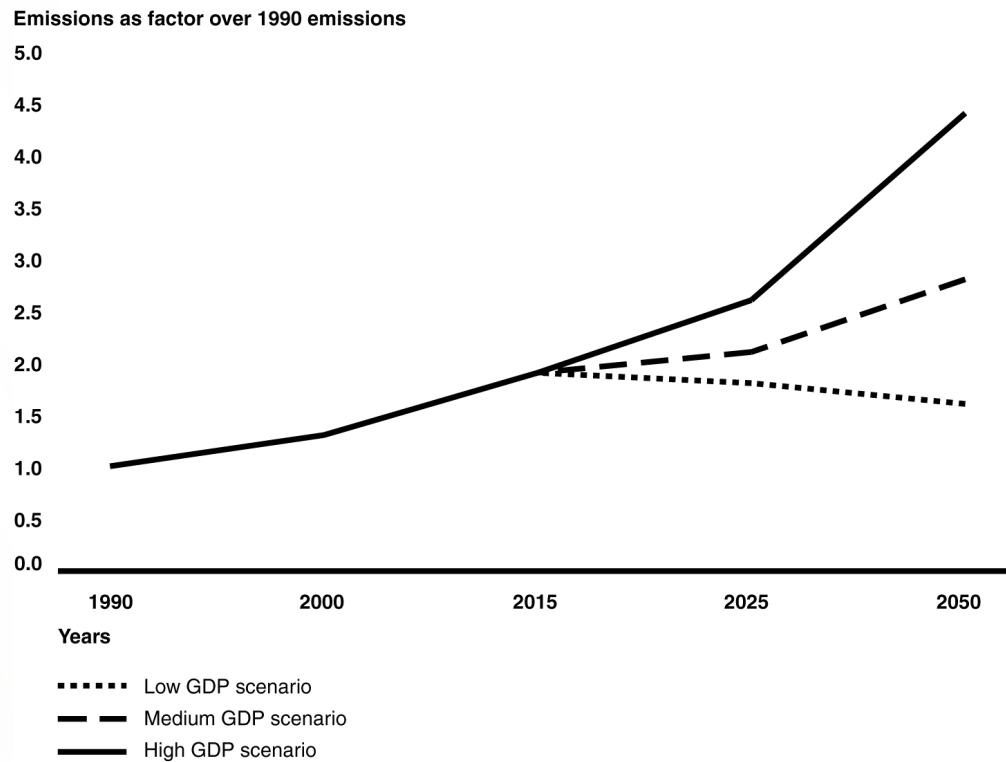
Current Aviation Emissions

- According to IPCC, global aviation CO₂ emissions represent about 2 percent of total of all human-generated emissions
- According to EPA, U.S. aviation CO₂ emissions represent about 3 percent of total of all human-generated emissions .
- IPCC estimates all global aviation climate change emissions represent 3 percent of total of all human-generated emissions.

Future Aviation Emissions

- IPCC forecasts global aviation emissions to 2050 in three scenarios.
 - Major difference between scenarios is rate of economic growth.
- Under IPCC's medium growth scenario, 2050 CO₂ emissions estimated to be 2.8 times higher than 1990 emissions.

Future Aviation Emissions



Source: IPCC.

Note: This forecast assumes fuel efficiency improvements made by airlines.

Future Aviation Emissions

- IPCC forecasts that global aviation CO₂ emissions in 2050 will be about 3 percent of all CO₂ emissions and all aviation emissions will be about 5 percent of total.
- Recent economic slowdown has resulted in downward revisions of many aviation traffic and emissions forecasts.
 - In 2005, FAA forecasted a 60 percent growth in commercial aviation CO₂ emissions from 2001 to 2025; in 2009 FAA cut forecast in half.

Future Aviation Emissions

- IPCC forecast rests on key assumptions including:
 - Ideal air traffic management system
 - Capacity keeping up with demand
 - Fuel efficiency improvements
 - Forecast projections inherently uncertain. If key assumptions not realized, actual emissions may differ greatly.
 - If other sources reduce emissions to greater extent than aviation, aviation's share may be greater than forecasted 3 percent.
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Improvements to Reduce Emissions

- Technological Options
 - Aircraft
 - Aircraft Engines
 - Operational Options
 - Air Traffic Management
 - Alternative Fuels
 - Government Options
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Technical Improvements to Reduce Emissions

- Aircraft efficiency has continuously improved over time.
- Future improvements include advanced engines—such as geared turbofan—as well as advanced aircraft technologies—such as blended-wing body and composite materials.
- Experts we surveyed cited potential for high development costs and potentially long time frames for commercialization.

Operational Improvements to Reduce Emissions

- Increased efficiency in operations, such as increasing load factors, has already contributed to emissions reductions
 - Experts we surveyed cited limited potential future reductions from increasing load factors and other measures already used.
 - Experts we surveyed cited a number of potential options in the future
 - However, surveyed experts cited technical and consumer acceptance challenges to their use.
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ATM Improvements to Reduce Emissions

- Air traffic management technologies and improvements have potential to reduce emissions
 - RNP
 - ADS-B
 - CDA
 - Efforts in the US (NextGen) and Europe (SESAR)
 - Some experts we met with expressed concern that some estimates for ATM-related emissions reductions are overly optimistic
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Alternative Fuel Improvements to Reduce Emissions

- Biofuels have potential to reduce life-cycle CO₂ emissions.
- A number of biofuels show potential and have been tested in flight
 - Algae
 - Jatropha
- However, challenges exist with biofuel use for aviation
 - Environmental concerns
 - Production and supply concerns
- Non-oil based sources seem to have limited use for commercial aviation

Challenges to Improvements to Reduce Emissions

- Fuel prices will drive development and adoption of improvements to fuel efficiency
- Economic downturn and economic stress of airlines limiting investments in emissions reducing investments and aircraft purchases.
- Given forecasted market growth, absolute reductions in emissions will be difficult despite technological and other improvements.

Market Based Government Options to Reduce Emissions

- By pricing emissions, these options would provide incentives for adoption of improvements to reduce emissions
- Cap and Trade Schemes
 - Some industry support for global schemes, but also concerns.
- Emissions taxes
 - Provides greater certainty of price of emissions and more economically efficient than cap and trade
- Subsidies
 - Generally inefficient compared to other options.

Other Government Options to Reduce Emissions

- Emissions Standards
 - Technology or performance based
 - Certain standards already imposed on industry
 - Not as efficient as market-based measures
- Research and Development
 - Experts we surveyed with cited importance of long term fundamental research in encouraging options to reduce emissions
 - FAA and NASA both conduct research related to emissions reductions
 - NASA research has emissions-related goals for commercial aviation, but research budget has declined.

Related GAO Reports

- [Biofuels: Potential Effects and Challenges of Required Increases in Production and Use; GAO-09-446](#)
 - [Climate Change: Expert Opinion on the Economics of Policy Options to Address Climate Change, GAO-08-605](#)
 - [International Climate Change Programs: Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism, GAO-09-151](#)
 - [Aviation and the Environment: FAA's and NASA's Research and Development Plans for Noise Reduction Are Aligned, but the Prospects of Achieving Noise Reduction Goals Are Uncertain, GAO-08-384](#)
 - [Aviation and the Environment: NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate, GAO-08-706T](#)
 - [Aviation and the Environment: Initial Voluntary Airport Low Emissions Program Projects Reduce Emissions, and FAA Plans to Assess the Program's Overall Performance as Participation Increases GAO-09-37](#)
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Questions?
