ASCENT 21
Improving Climate Policy Analysis Tools

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Motivation and Objectives

Aviation emissions contribute to global climate change by affecting the radiative balance of the earth's atmosphere. While aircraft emit about 2% of anthropogenic carbon dioxide (CO_2), other short-lived climate forcers from aviation such as sulfates, water vapor, and nitrates also impact the energy balance of the earth. Contrails and aviation induced cirrus cloudiness may be the most significant short-lived climate forcers but are also among the most uncertain.

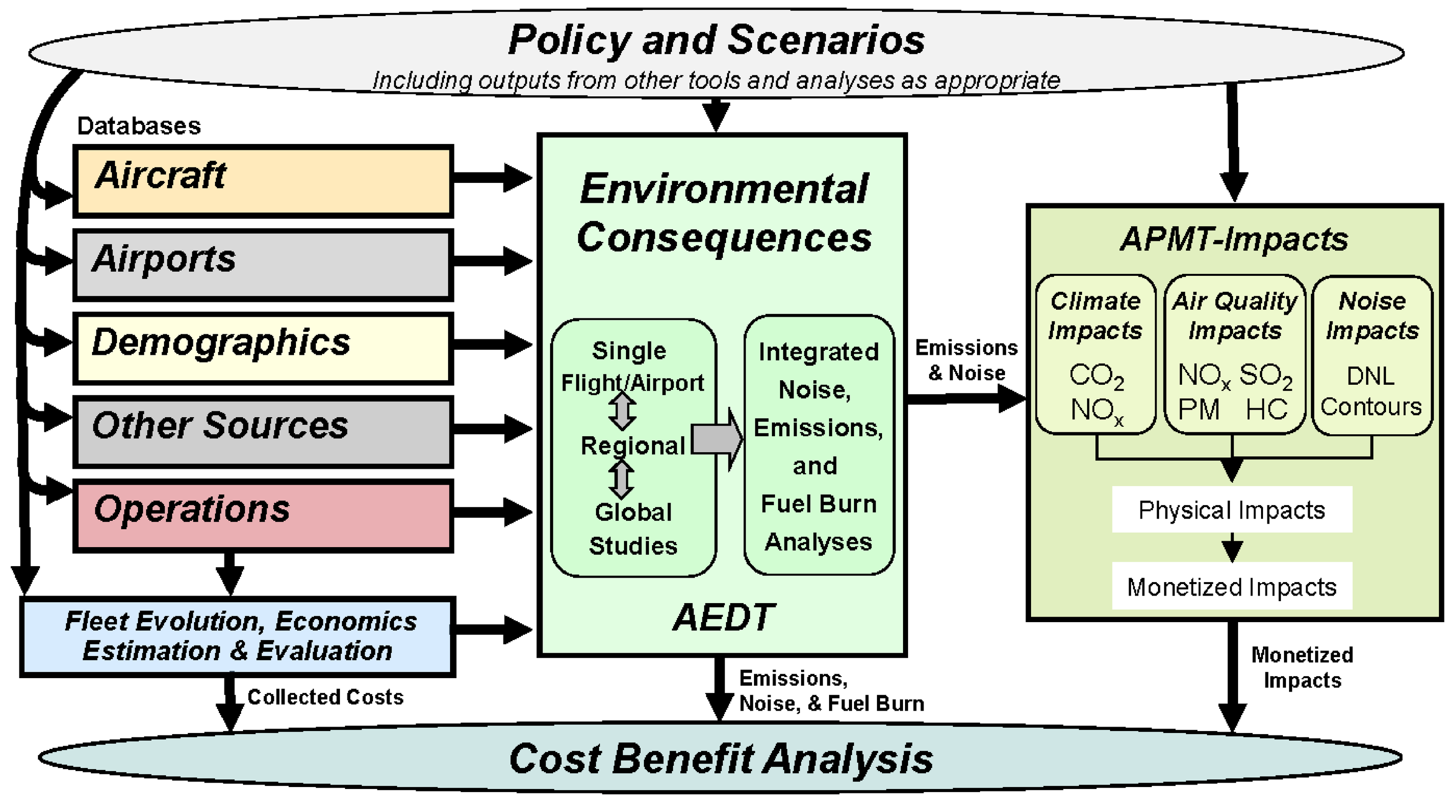
Global airline traffic is forecasted to grow at 5% while emissions from other sources are expected to decrease; thus, aviation's contribution to climate change is expected to grow both absolutely and relatively. Concurrently, industry, governments, and international organizations have set ambitious targets for reducing or mitigating aviation's environmental impact

Following this overall objective, the goals of this project are (1) to continue the development of a rapid reduced-order **climate model for policy analysis** consistent with the latest literature and scientific understanding and (2) contribute to the development and use of a more complex models appropriate at finer spatial and temporal scales, with a focus on **contrail model development**.

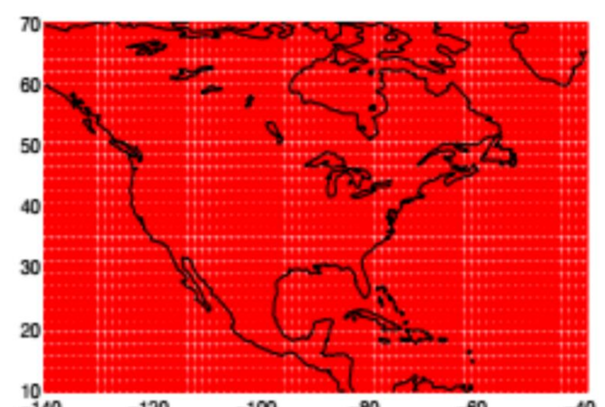
This project looks to develop, test, validate, and eventually utilize scientifically justified policy-relevant tools that are needed to assess domestic and international operational, technological, and environmental policies and goals.

Methods and Materials

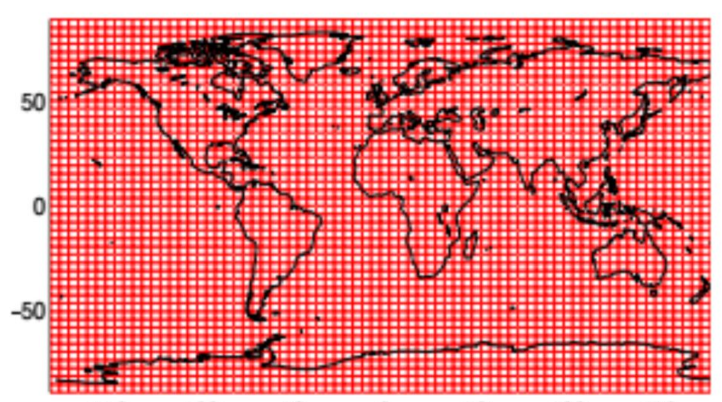
APMT-Impacts Climate, a reduced-order integrated climate model for aviation, is part of the Aviation Environmental Portfolio Management Tools Suite and is used in environmental assessment and policy analysis, often in a Cost Benefit Assessment context.



Current contrail and contrail-cirrus radiative forcing assessment is associated with low confidence (IPCC 2013). **Contrail Evolution and Radiation Model (CERM)** is a parameterized 3D model to simulate contrails and contrail cirrus. We have developed a global version of the model from the initial North American domain to support future assessments of uncertainty in contrail and contrail cirrus radiative forcing and associated climate impacts.



CERM N.A. Domain



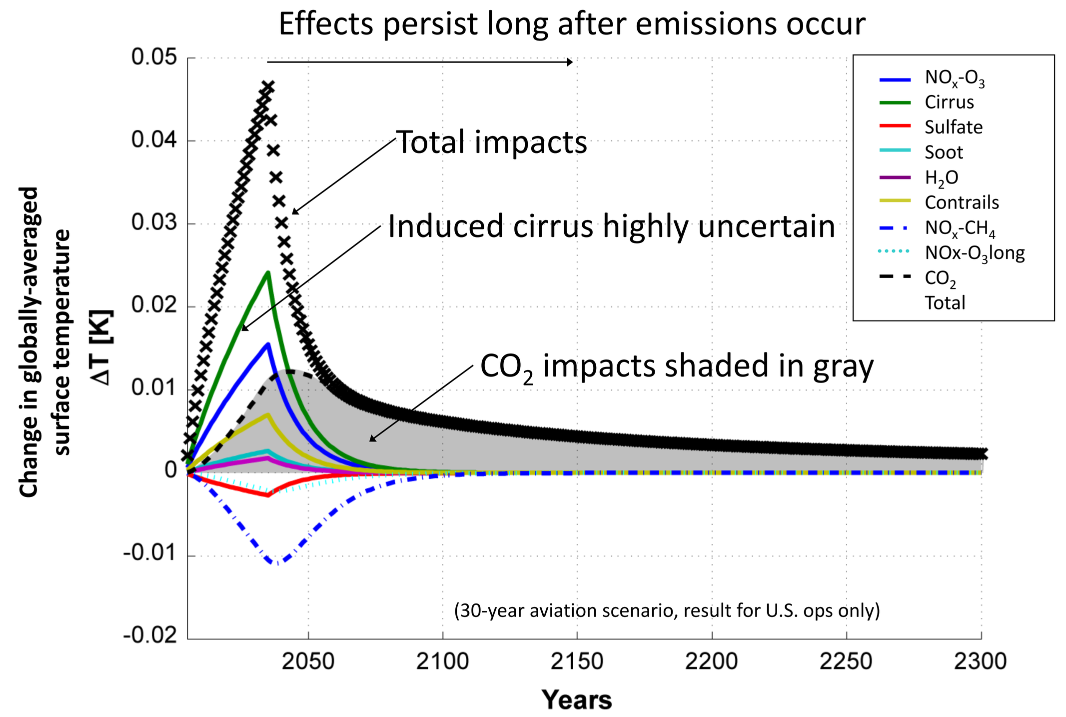
CERM Global Domain

Summary

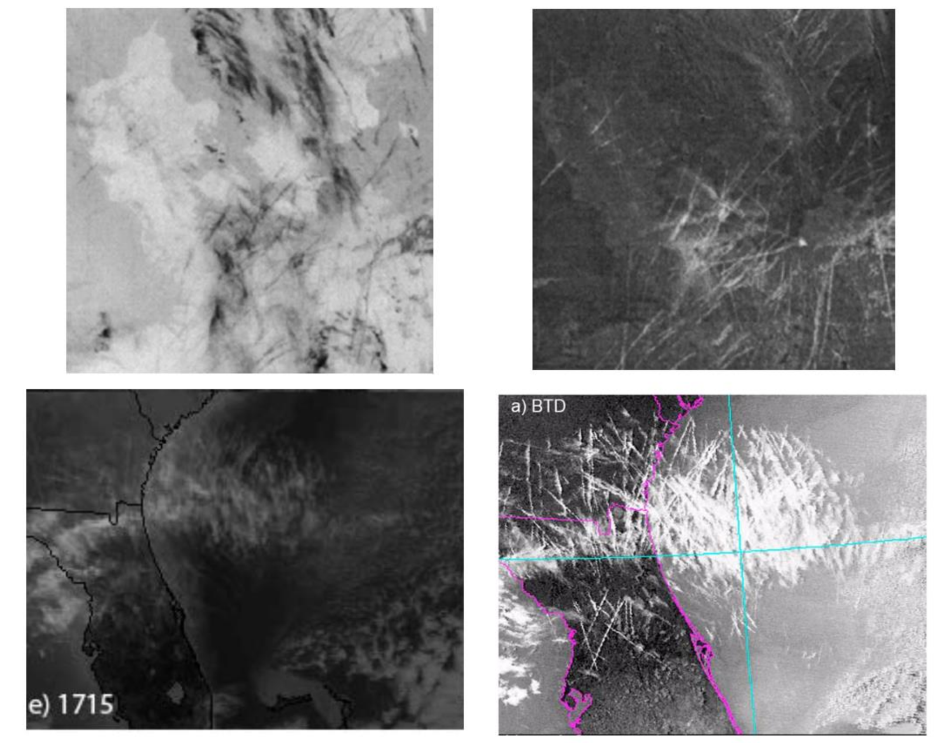
Aviation's impact on the climate is complex and growing. Tools are needed to both understand the physical and chemical mechanisms of climate change and to assess the environmental impact of technological, operational, and policy changes to the commercial aviation sector.

This project aims to develop two tools: a global version of a parameterized 3D contrail and contrail cirrus model and a reduced-order climate model for policy assessment.

In addition to CO_2, aircraft emit water vapor, NOX, sulfur, black carbon, and other short-lived climate forcers and climate-forcer precursors. The cumulative impact of these forcers may be of equal importance to carbon emissions for near-term warming.



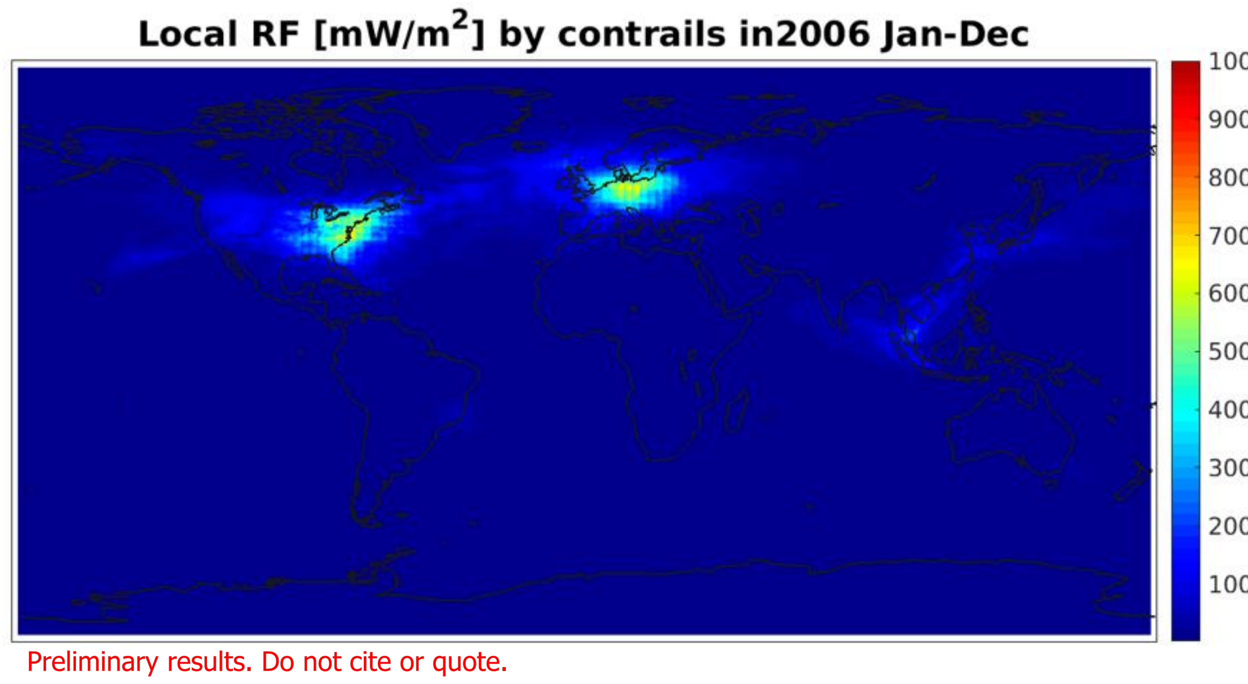
The radiative forcing of contrail and contrail cirrus is especially uncertain. To improve the understanding contrail and contrail cirrus to better inform policy decisions, global models are needed that integrate meteorology, aircraft operations, radiative transfer, and complex local chemistry and physics. Comprehensive comparisons between satellite observations and model simulations can be used to validate these models.



Contrail Satellite Observations
(Minnis et al. 2013; Mannstein et al. 1999)

Results

A preliminary estimate of global direct aviation induced cloudiness radiative forcing by the CERM model is 47 mW/m². This is in line with (but higher) than the mean estimate of cloudiness impacts from previous assessments, and is 1.6x greater than the current estimate of radiative forcing from aviation CO_2.



Preliminary results. Do not cite or quote.

In addition, local radiative forcing can approach the order of 1 W/m², particularly over the eastern United States and western Europe. Contrail impacts remain mostly negligible in the southern hemisphere. There is significant uncertainty in the direct and indirect impact of contrails, and quantifying this uncertainty is an area of future work.

APMT-Impacts Climate has been comprehensively compared to the US Government Interagency Working Group Social Cost of Carbon (IAWG SCC) climate monetization methodology. Notably, however, the IAWG SCC method does not monetize aviation short-lived climate forcers, which may have a significant, policy-relevant impact.

	Discount Rate and Statistic			
Year	5% Average	3% Average	2.5% Average	3% 95th percentile
2015	$11	$36	$56	$105
2020	$12	$42	$62	$123
2025	$14	$46	$68	$138
2030	$16	$50	$73	$152
2035	$18	$55	$78	$168
2040	$21	$60	$84	$183
2045	$23	$64	$89	$197
2050	$26	$69	$95	$212

IAWG SCC Values

Conclusions and Next Steps

Aviation's impact on the climate is significant, complex, and uncertain. Continued improved understanding of the climate effects of aviation induced cloudiness and contrail cirrus are necessary for informing policy decision-making. Fast, reliable, and appropriate models are needed to assess technological, operational, and policy decisions that impact the environment.

Next steps include:

- Comparison of modeled contrail coverage with NASA satellite data
- Projections of future contrail impacts considering changes in global demand for air transport and future fleet
- Continued development of aviation and the environment policy assessment tools.

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