FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT

Improving Climate Policy Analysis Tools

Project 21

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April 26-27, 2015
Alexandria, VA

ASCENT
AVIATION SUSTAINABILITY CENTER

Motivation

- Aviation accounts for 2% of global CO_2 emissions and up to 5% of global radiative forcing.
- Aviation is projected to grow at about 5% per annum globally.
- Fast, efficient, and up-to-date tools are needed to model the expected impact of aviation on the climate for a variety of future technology and operational scenarios.
- This work looks to improve modeling techniques for long- and short-lived aviation emission species on the global climate to support climate and policy analyses leading to sustainable aviation growth.

Objectives

- Long-term
  - Contribute to the development and application in the aviation context of a more complex model appropriate at finer spatial and temporal scales
  - Improved understanding of climate feedbacks and emissions species interactions over time
  - Alternative fuel projections and modeling capability in policy analysis
- Near term
  - to continue the development of a rapid reduced-order climate model for policy analysis consistent with the latest literature and scientific understanding
  - Improved communication of a greater depth of climate information and trade-offs across researchers and policymakers

Outcomes and Practical Applications

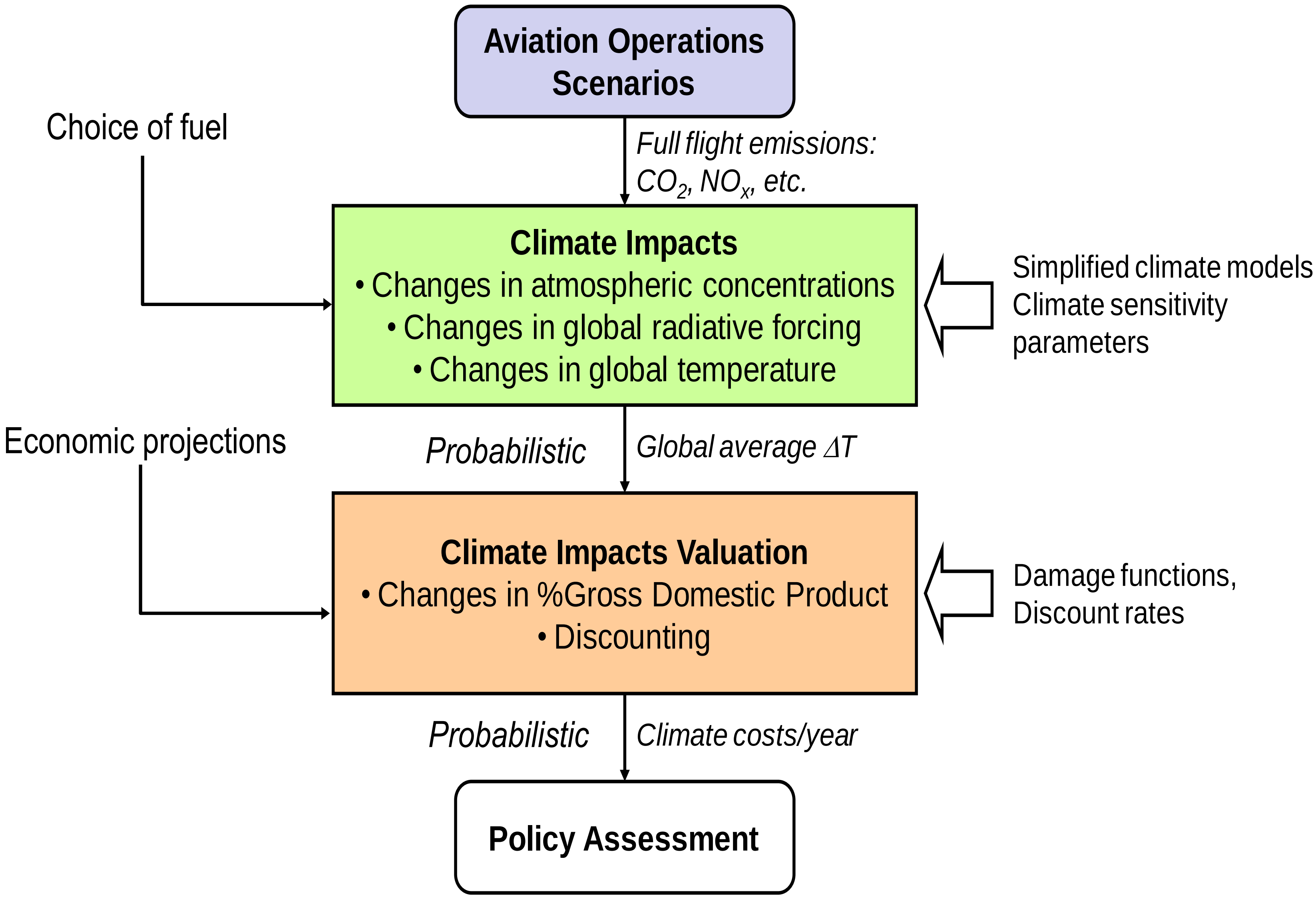
- Outcomes
  - APMT-Impacts Climate Code
    - Continued use and support for FAA domestic and international policy analyses
    - Alternative fuel and well-to-tank modeling of climate impacts
    - Comparison and harmonization with other environmental tools used in domestic regulatory impact assessment
  - Climate system response to short-lived climate forcers
    - Fine-scale modeling of global contrail coverage
    - Climate projections considering 'novel' short-lived climate forcers (e.g. nitrates, indirect cloud effects)
    - Interactions and feedbacks between emission species, radiative forcing, and temperature change to inform policy tools

- Practical applications
  - Codes and frameworks used in domestic and international policy analysis (e.g. CAEP/10 CO_2)
  - Improved modeling of environmental costs of alternative fuel policies and analyses

Schedule and Status

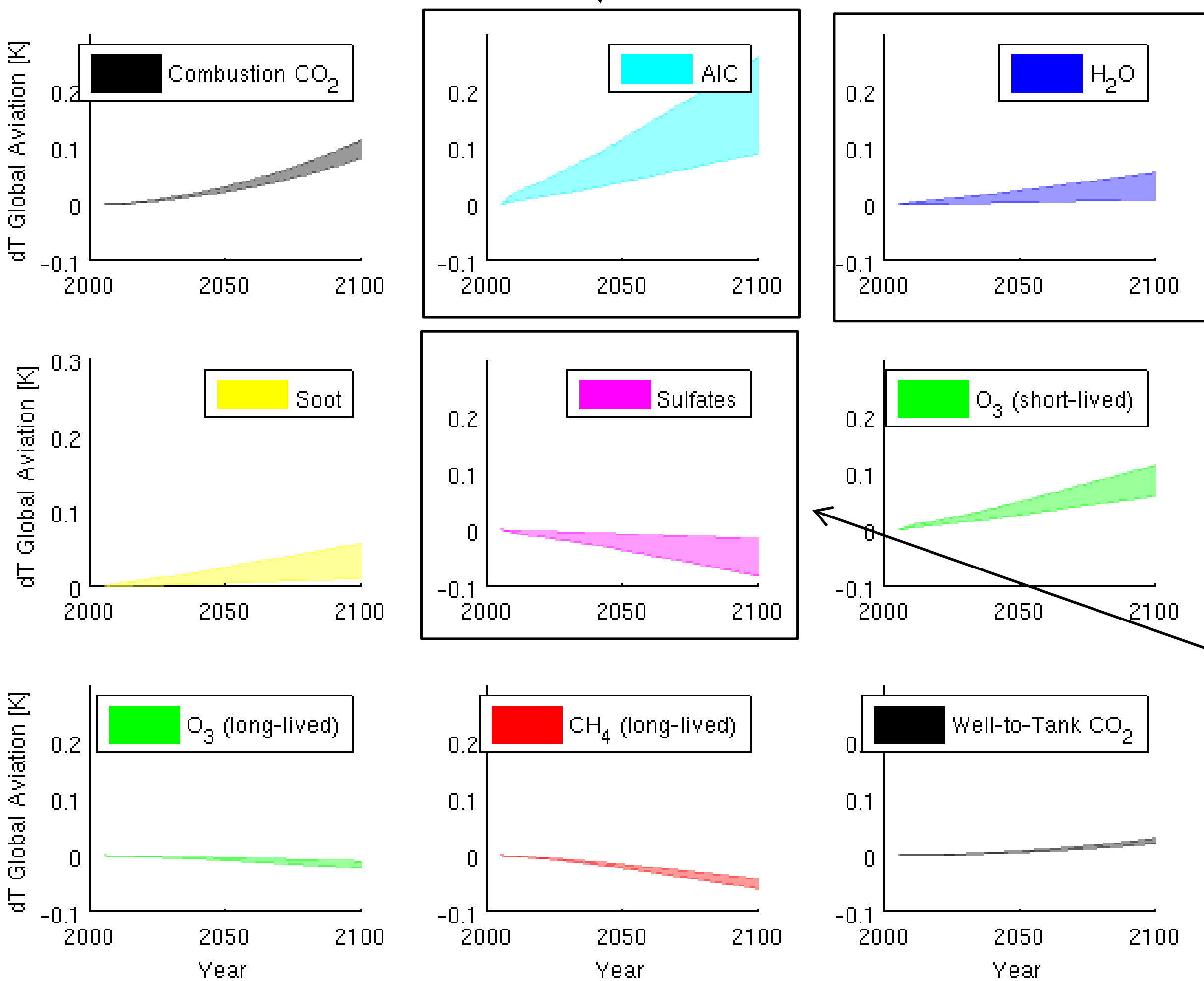
Task	Status
Expand alternative fuel modeling capability in APMT-Impacts Climate	Completed
Transfer of APMT-I v23 to Other Research Teams	Completed
Conduct scoping analysis for APMT-Impacts Climate v24	Completed
Contrail and SLCF non-linearity projections for policy tools	Ongoing
Climate assessment for CAEP/10 CO_2 Analysis	Completed
APMT-Impacts Climate v24 Requirements Analysis and Requirements Document	Ongoing
Global contrail model development and comparison	Ongoing

Recent Accomplishments: APMTv24 Scoping Analysis (1 of 2)



Recent Accomplishments: APMT v24 Scoping Analysis (2 of 2)

Current model considers only direct impacts of aviation on clouds through linear contrails and aviation induced cirrus

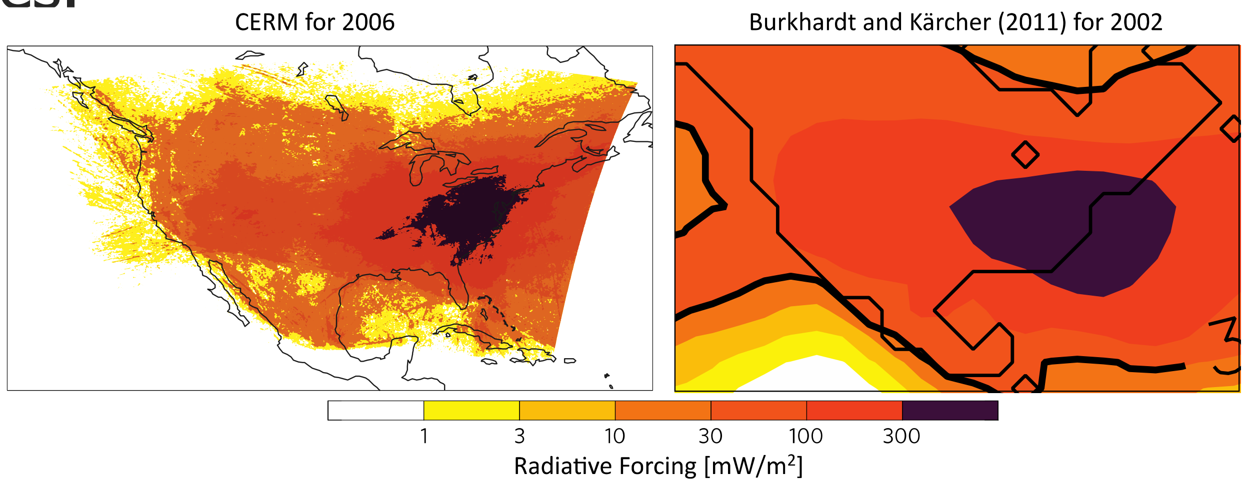


Current model only considers direct tropospheric water vapor, but NOx-induced changes in stratospheric water vapor may be important

Aviation-attributable nitrates may provide additional aerosol related climate change

Recent Accomplishments: Improved Global Contrail Modeling (1/3)

- Global contrail modeling is needed to improve climate policy analysis tools, e.g. APMT-Impact
- MIT Contrail Evolution and Radiation Model (CERM) has the finest resolution of existing contrail models for continental United States.



- To improve climate projection estimates and the FAA Tools, a global contrail model is needed; however, tradeoffs exist across model scale, resolution, computational intensity, and fidelity.

Recent Accomplishments: Improved Global Contrail Modeling (2/3)

- Contrail formation and persistence is a function of operational performance parameters and ambient conditions, but ambient temperature and relative humidity can vary drastically over short spatial and temporal scales.
- However, model resolution is limited by computational tractability and data availability.
- Thus, we developed Probability Density Functions (PDFs) to model sub-grid scale variations in ambient conditions.
- PDF approach improves model performance over comparable coarse scale models significantly.

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Recent Accomplishments: Improved Global Contrail Modeling (3/3)

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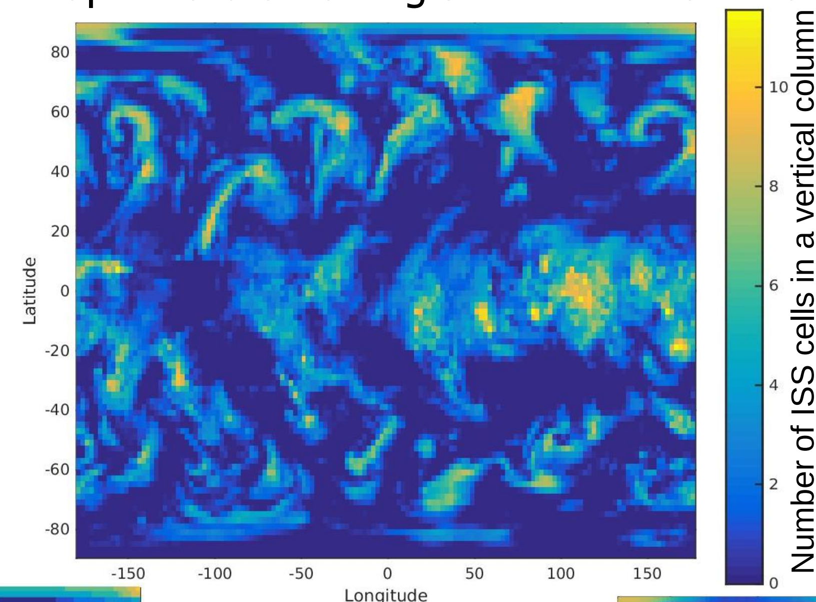
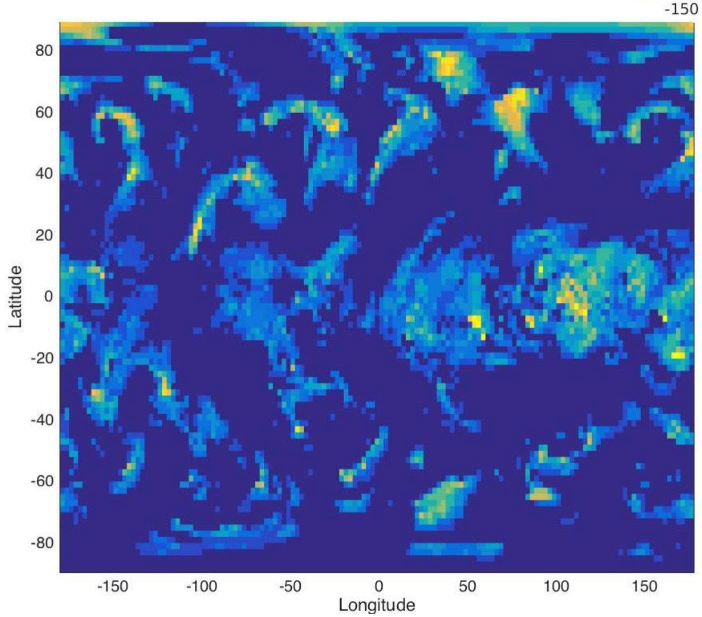
Ice Super Saturated Regions: Benchmark Data

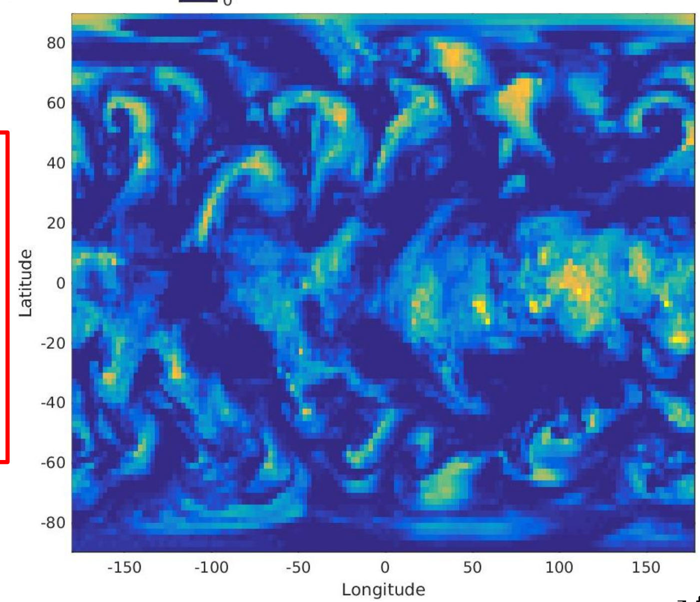


Conventional Modeling Approach



PDF approach better predicts where contrails could be expected to form.

PDF Modeling Approach



Interfaces and Communications

- External
  - Interfaces with ACCRI researchers and project managers
  - v23 review performed by UIUC (2014-2015)
    - UIUC performing additional comparisons (2015-2016)
  - Collaboration with MIT Joint Program on the Science and Policy of Global Change
- Within ASCENT
  - Code transfer to and support of ASCENT Project 14 in the CAEP CO_2 standard analysis
  - Alternative fuel emissions harmonization with ASCENT Project 24A
  - Well-to-tank assumptions for lifecycle CO_2 and long-lived greenhouse gas species with ASCENT Project 32

Summary

- Summary statement
  - Aviation's impact on climate change is significant and heterogeneous in space and time. Reduced-order assessment tools are necessary to understand the costs and benefits of operational or policy changes. A framework that accounts for interactions, changes in background concentrations, and spatial nonlinearities may be necessary to capture policy-relevant changes on a regional scale.
- Next steps?
  - Investigation of fuel impacts on SLCFs
  - APMT-Impacts Climate v24 Developmental Code
  - Comparison of model results with other US Government Policy Tools
- Key challenges/barriers
  - Availability of robust research on local and regional climate impacts.
  - As we include greater spatial/temporal disaggregation, the amount of information to communicate increases exponentially.

References

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Contributors

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