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JOB OFFER – POST-DOCTORAL

Contrail modelling in a simplified climate model

OFFER INFORMATION

Reference: GLOBC-2026-MP-01
Team: GLOBC

Location: 42 Avenue Gaspard Coriolis – 31057 Toulouse
Contact person: Maxime Perini – Daniel Cariolle

Period: 1 year - from: 01/04/2026
Salary: 40 K€/year (gross)
Level of education required: PhD

Key words: Contrail, Numerical simulation, Climate modeling

CERFACS

Cerfacs is a private research, development, transfer and training center for modeling, simulation and high-performance computing. Cerfacs designs, develops and proposes innovative software methods and solutions to meet the needs of its partners in the aeronautics, space, climate, environment and energy sectors. Cerfacs trains students, researchers and engineers in simulation and high-performance computing.
Cerfacs works closely with its seven partners: Airbus, Cnes, EDF, Météo France, Onera, Safran et TotalEnergies.

HOSTING TEAM - GLOBC

The GlobC Team is currently comprised of 11 researchers and 14 early career researchers, and benefits from the support of a team of 6 highly-skilled research engineers with strong expertise on climate and environmental models, high-performance computing (HPC), simulation workflows and data management. We conduct cutting edge research spanning from climate variability and prediction, oceanography and polar science, air-sea interaction, climate change detection and attribution and its impacts, to extreme events such as heat waves, intense precipitation events and droughts as well as environmental risks such as atmospheric pollutant dispersion, wildland fires and floods. We use a wide range of numerical models from large-eddy simulation to global Earth system models and associated algorithms (data assimilation, uncertainty quantification, machine learning, code coupling) to tackle our science challenges.

CONTEXT

In the context of global warming, the impact of aviation on the environment has received increasing attention in recent years due to the increase in air traffic of around 4 to 5% per year. This indicates a doubling in passenger numbers by the years 2030-2040 in comparison with the 2000s.

The Intergovernmental Panel on Climate Change (IPCC) has clearly demonstrated that the gases and particles emitted by aircraft engines contribute to the increase in the greenhouse effect by altering both the global radiation balance (e.g. CO_2 emissions, water vapor and the formation of condensation trails) and the chemical balance of the atmosphere (e.g. the chemistry of nitrogen oxides and ozone, and the effects of methane). The most recent study to be published by Lee et al (2021) has provided quantitative data on the various processes involved. The two primary factors contributing to radiative forcing in the context of aviation are CO_2 emissions and the effects of induced cloud cover, namely contrails cirrus. The third most significant contribution is that of nitrogen oxide emissions, which result in an increase in ozone, thereby contributing to the greenhouse effect, a phenomenon that is partly offset by the decrease in methane.

To contain the gaseous and particulate emissions associated with the increase in traffic, the aviation industry and airlines are studying technical improvements in aircraft design, the use of alternative fuel, and ways of managing air traffic.

References :
Lee et al., The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018, 2021
IPCC, Climate Change 2013: the physical science basis, contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change, 2013

MISSION

The objective of this post-doctoral fellowship is to contribute to the development of a simplified climate model for aviation. This model will encompass the main forcings previously mentioned and will be designed to meet the requirements of the industrial partners of the project (Airbus, Safran and Total Energie). The intended purpose of the model is to serve as a straightforward and effective tool for assessing the impact of different scenarios for future fleets.
The simplified model will incorporate multiple modules for calculating radiative forcing as a function of the various components. To propose and calibrate a module for the radiative forcing of condensation trails, climate model simulations, including condensation trail modelling, will be carried out. Initially, the objective of these simulations is to validate, or correct, the linearity and additivity assumptions generally made in this type of model (cf. FAiR model, AirClim) and necessary for attribution studies such as those envisaged at the end of this project. Secondly, a sensitivity study will be carried out to account for the change in architecture/fuel on the radiative forcing of contrails.
ARPEGE-Climat model, the atmospheric component of the CNRM-CM6.1 general circulation model, will be used in order to carry out this work. A number of air traffic emission inventories will be analysed for a range of socio-economic scenarios (SSP2-4.5 and SSP3-7.0, for instance) and across several time periods.
The contrail parameterization is currently undergoing a process of refinement with a view to improving the accuracy of predictions by taking into account the variations in properties (e.g. ice crystal size and lifetime) that are observed when contrails are formed by different combinations of architecture and fuel. The outputs from high-resolution simulations (LES) of engine outlet contrail configuration, carried out by the AAM team (advanced aerodynamics and multiphysics), will be used to fuel this reflection.

References :
Millar et al., A modified impulse-response representation of the global near-surface air temperature and atmospheric concentration response to carbon dioxide emissions, 2017
Grewe and Stenke, AirClim: an efficient tool for climate evaluation of aircraft Technology, 2008

DESIRED PROFILE

- PhD defended less than 3 years ago.
- You have in-depth knowledge atmospheric physics and numerical simulation
- You are independent, creative, and capable of proposing innovative solutions
- You have good communication skills and can work effectively within a multidisciplinary team
- Some experience in climate modeling is a plus

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To apply, please send your CV and covering letter to maxime.perini@cerfacs.fr , applications are open until 31/01/2025.

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