

## Master-level training position at CERFACS/ISAE-SUPAERO

### Impact of global warming on air transportation: aircraft engines

#### Context and objective

Air transportation contributes to global warming both directly through greenhouse gas emissions and indirectly through soot and contrails [1]. However, global warming also impacts the ability of aircraft to operate safely and efficiently (modification of low and high altitude winds, increase of turbulence, lower air density, etc.). Dozens of flights are already canceled each year due to hot weather. To better understand how global warming will affect air transportation, a research program (ICCA - Impact of Global Warming on Aircraft), led by CERFACS, METEO-FRANCE, ENAC and ISAE-SUPAERO has started in 2019. In the framework of this research program, the main objective of the training position is to study the impact of global warming on the operability and performance of aircraft engines. The method will rely on the use of uncertainty quantification applied with climate and engines models. The engine behavior will be modelled in a simplified fashion using a modeling tool (e.g. PROOSIS - Propulsion Object Oriented Simulation Software) [2]. Climatic data and components variables will be considered as the uncertain parameters. A first part of the work will be to characterize the sources of uncertainties (like the statistical distribution of uncertain variables that can be dependents or independents). Then a stochastic analysis will be led using a set of numerical simulations of growing complexity considering different scenarios. Finally, the last part of the work will consider a global sensitivity analysis using the library OpenTURNS ([www.openturns.org](http://www.openturns.org)) and the wrapper BATMAN developed at CERFACS.

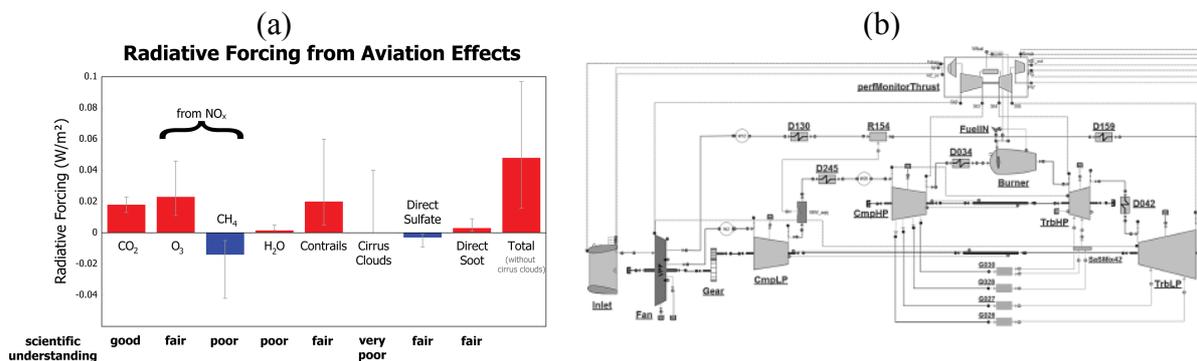


Fig. 1 (a) Radiative forcing from aviation effects (IPCC report) and (b) simplified model of a turboprop with PROOSIS [2]

#### Application and profile

Ideally, you have a background in fluid mechanics and/or applied mathematics (probability and statistics) and good programming skills (Python). A good knowledge of aircraft design methods and numerical simulation are important assets, as well as good communication skills.

Please send your application to [Sophie.Ricci@cerfacs.fr](mailto:Sophie.Ricci@cerfacs.fr) and [Nicolas.Gourdain@isae-supaero.fr](mailto:Nicolas.Gourdain@isae-supaero.fr), before November, 30<sup>th</sup> 2019.

#### Short Bibliography

- [1] B. Owen, D. S. Lee and L. Lim. (2010). Flying into the future: aviation emissions scenarios to 2050. *J. of Env. Science and Technology*, 44(7), pp. 2255-2260
- [2] A. Joksimovic, S. Duplaa, Y. Bousquet and N. Tantot. (2019). Performance prediction methodology and analysis of a variable pitch fan turboprop engine. *Aeronautics and Aerospace Open Access J.*, 2(6), pp. 394-402