6 MONTHS INTERNSHIP FOR 2024

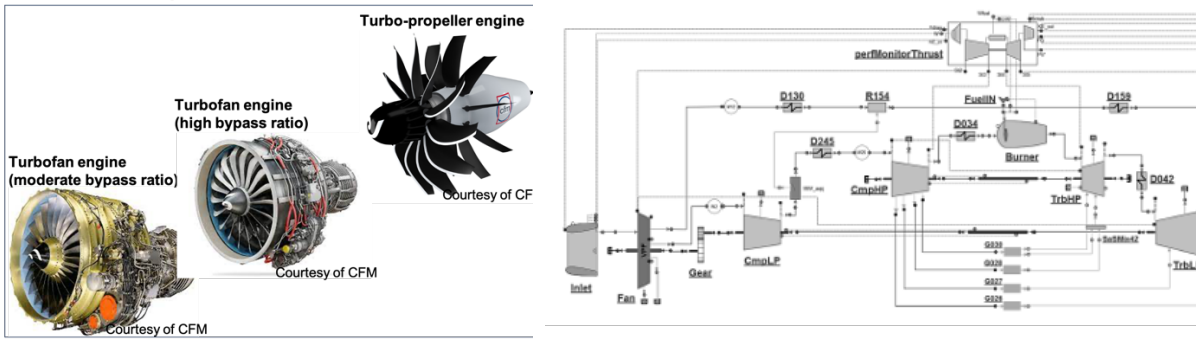
Impact of climate change: sensitivity of an aircraft engine performance to extreme temperatures in take-off conditions

Aviation contributes to global warming both directly through greenhouse gas emissions and indirectly through non-CO2 effects, such as contrails and NOx emissions [1]. While the aviation sector progressively improved its energetic efficiency per km.passenger, climate change started to impact the ability of aircrafts to operate safely and efficiently (modification of the wind regimes, more frequent clear air turbulence and heat waves for example). A research program called "Impact of Climate Change on Aviation" (ICCA), led by CERFACS, ONERA, METEO-FRANCE, ENAC and ISAE-SUPAERO started in 2019 to evaluate and quantify the different physical effects of global warming on aviation. Among these effects, the growing influence of heat waves during landing and take-off operations is of paramount importance.

The main objective of the current internship position is to quantify the sensitivity of different engine architectures, in terms of operability and performance, to extreme temperature conditions. This work would come in partnership of a PhD project led by Suzanne Salles in the Dpt. Aerodynamics, Energetics and Propulsion at ISAE-SUPAERO and in the Global Change team at CERFACS which focuses on the impact of extreme heat and humidity on take-off performance of an aircraft. The internship project relies on:

- the identification of future climatic conditions for different airports around the world, thanks to climate models (among which CNRM-CM6, a fully coupled atmosphere-ocean general circulation model developed by CNRM/CERFACS),
- the atmospheric data (temperature, humidity) are then used to define day by day meteorological conditions and evaluate the performance response thanks to a performance model of the aircraft. Within the performance model, a 0D thermodynamic model of the engine computes thrust as an output,
- Finally, the uncertainties and sensitivities associated with input atmospheric variables are quantified and propagated with a dedicated methodology.

The main objective of this internship will be to better characterize the sensitivity of the response of different engine architectures to such heat waves, ranging from moderate bypass ratio turbofan (CFM56) to turbo propeller architecture (future RISE engine). The engine performance will be estimated with a 0D model of the thermodynamic cycle obtained with the PRopulsion Object Oriented SImulation Software, PROOSIS (see Fig. 1b). For each engine modeled, an analysis of the output's performance sensitivity to atmospheric variables and engine parameters could then be considered.



(a) (b)

Fig. 1 (a) Overview of different engine architectures and (b) simplified thermodynamic model of an engine with PROOSIS [2]

Application and profile

Last year of an engineering school or Master program, ideally, you have a background in fluid mechanics and aircraft engine performance. Good programming skills (Python) and knowledge of energy/climate issues is an asset. Good communication skills and capability to work in a multidisciplinary environment is necessary.

Please send your application to suzanne.salles@isae-supaero.fr, sophie.ricci@cerfacs.fr and nicolas.gourdain@isae-supaero.fr, before December, 22th, 2023.

Short Bibliography

[1] S. Delbecq, J. Fontane, N. Gourdain, T. Planès, F. Simatos. (2023). Sustainable aviation in the context of the Paris Agreement: A review of prospective scenarios and their technological mitigation levers, Progress in Aerospace Sciences, Volume 141, 2023

[2] A. Joksimovic, S. Duplaa, Y. Bousquet and N. Tantot. (2019). Performance prediction methodology and analysis of a variable pitch fan turbofan engine. *Aeronautics and Aerospace Open Access J.*, 2(6), pp. 394-402

[3] A. Gossard, S. Salles, B. Roiron, S. Ricci, N. Gourdain, E. Sanchez and V. Gallardo. (2022). Impact of global warming on aircraft aerodynamics and engine thrust at take-off conditions, 56th 3AF International Conference on Applied Aerodynamics, FP107-AERO2022, Toulouse, France