Main thematic area: Economics/*Science*/Technology
Cost: £/*££*/£££

Understanding initial dispersion of engine emissions:

- **modelling the dispersion of aircraft engine efflux in proximity to airports in an atmospheric boundary layer wind tunnel**
- **prediction of the mixing of engine exhaust gases**
- **jet vortex interaction**

Background
This project examines the nature of the aircraft engine efflux, in terms of its gaseous and particle emissions. With three discrete components to the work, it will examine aircraft emissions at all stages of operation – ground idle, taxi, take-off, climb, cruise and landing – in order to analyse and model the way emissions disperse and enable an in-depth analysis of pollutant levels.

Mixing engine exhaust gases
To produce accurate models for pollutant dispersal, part of the study will focus on building a precise picture of aircraft plumes during cruise (high altitude pollution) and for landing and take-off cycles (for local air quality assessments). Efflux from a jet engine is a very complex flow of hot fast gas and cold, slower moving gas. It is non-uniform, highly turbulent and has various velocity scales and chemical reactions. Using computational fluid dynamics (CFD) – a process whereby numerical methods and algorithms are used to calculate and analyse fluid and gas flows – the project will construct an accurate model of the flow immediately down stream of the exit of engine and of the mixing process. It will result in a much better understanding of how the efflux from a jet engine turns into a mixed plume; and of the composition of the plume itself.

Jet vortex interaction
During take-off and landing the wings of an aircraft produce lift which in turn generates powerful trailing vortices. These vortices interact with the exhaust plumes from the engines and the way that jet efflux disperses is altered as a result. At present there is limited understanding of this phenomenon. Another element of this project will investigate the interaction between vortices and exhaust plumes.

Lead: Cranfield University
Duration: 12 months
Partner: Cambridge
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Researchers will develop a CFD model that is able to predict the combined jet/vortex flowfield for distances of a kilometre or more behind the aircraft.

Modelling engine efflux in a wind tunnel
The final element of the project will develop a sub-scale model of efflux dispersion in an atmospheric boundary layer wind tunnel. This simulates the conditions of an aircraft engine in flight so that the plume can be analysed in the context of atmospheric wind and upwind conditions. Very few data are available relating to the use of this technique for simulating aircraft engine exhaust plumes. This study will make it possible to assess key factors influencing plume trajectory and concentration levels in a number of simulated wind conditions and for a range of aircraft operations.

Benefits
Understanding the factors that determine pollutant concentration levels around airports is a key objective. The three elements of this study will all contribute to a better understanding of the behaviour of aircraft engine efflux and thus how aircraft technology affects the atmosphere.

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