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Contrails prediction and routes optimization by machine learning and operational research

ENAC LAB - OPTIM TEAM

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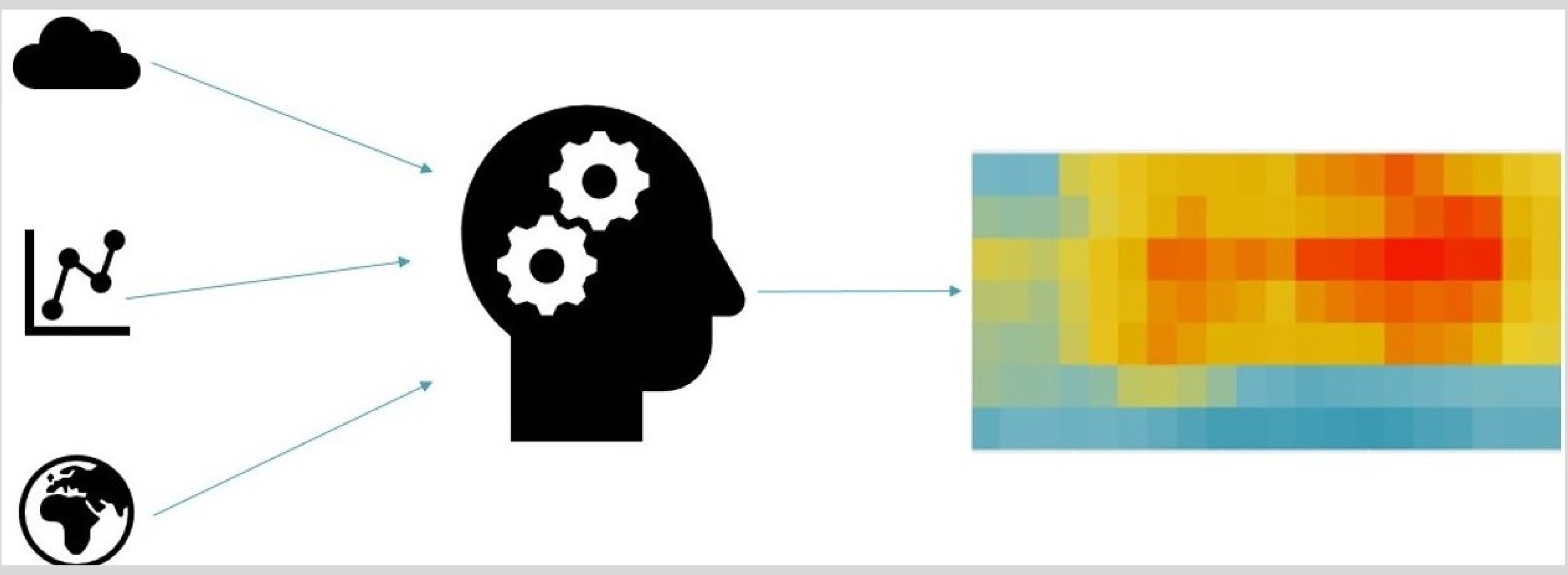
Context

- Contrails are formed at altitude at the back of the aircraft by condensation of water vapors from the engines [1,2].
- They may disappear or persist for several hours [3]. They can form cirrus clouds which contribute to the greenhouse effect, by preventing the Earth from cooling down at night [4,5,6].
- Interest in the environmental impact of factors other than CO_2 is growing, as shown by an EASA report on non-CO_2 effects [7].

Contrails prediction

Objective : build a meta model of a complex (and time consuming) meteorological model

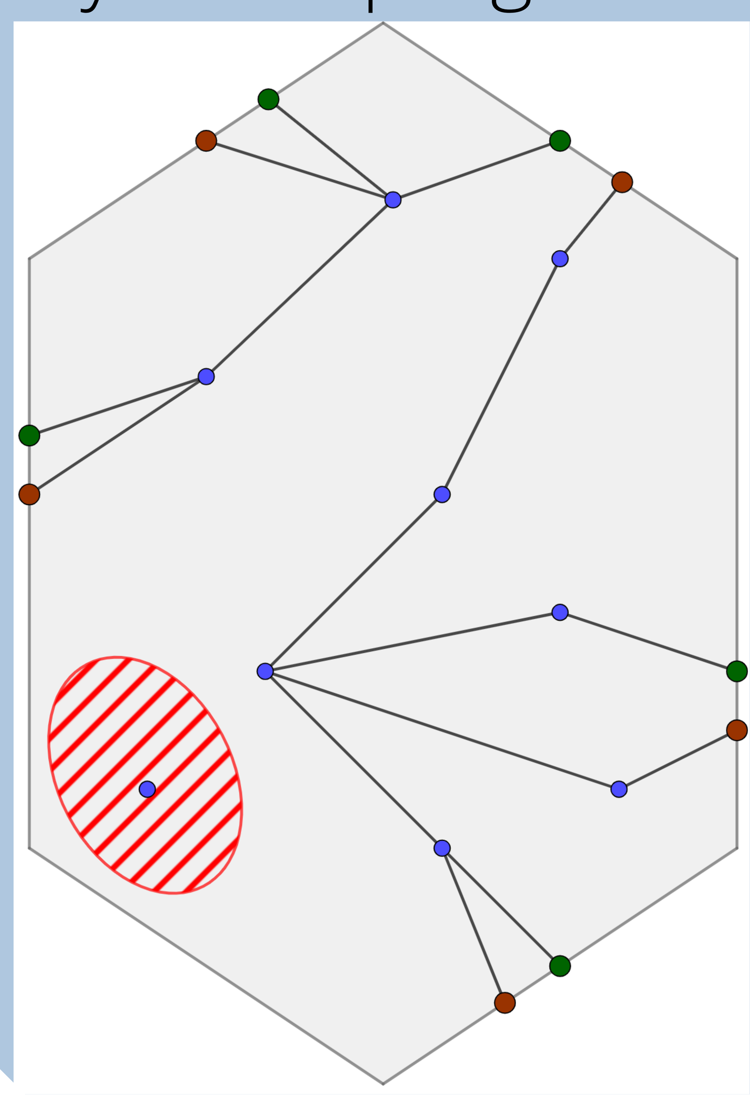


Objectives

- Develop methodologies for predicting contrail formation.
- Develop tools for traffic flow planning in order to minimize the environmental impact of contrails, the emission of CO_2 and other pollutants resulting from the combustion of kerosene (NO_x, etc...) on a French scale.
- Develop tools for planning traffic flows with the same objective on a European scale.

Flows optimization

- Free route airspace context
- Dynamic programming approach



Multi objective optimization :
- CO_2, contrails, NO_x...
- Congestion

Operational constraints:
- Equity
- Delays

References

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[4] S. Marquart, M. Ponater, F. Mager, and R. Sausen, "Future development of contrail cover, optical depth, and radiative forcing: Impacts of increasing air traffic and climate change," Journal of Climate, vol. 16, no. 17, pp. 2890–2904, 2003.

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