REDUCTION OF ENVIRONMENTAL EFFECTS OF CIVIL AIRCRAFT THROUGH MULTI-OBJECTIVE FLIGHT PLAN OPTIMISATION

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ABSTRACT

Aircraft emission targets worldwide and their climatic effects have put pressure in government agencies, aircraft manufacturers and airlines to reduce water vapour, carbon dioxide (CO2) and oxides of nitrogen (NOx) resulting from aircraft emissions. The difficulty of reducing emissions including water vapour, carbon dioxide (CO2) and oxides of nitrogen (NOx) is mainly due to the fact that a commercial aircraft is usually designed for a particular optimal cruise altitude but may be requested or required to operate and deviate at different altitude and speeds to archive a desired or commanded flight plan, resulting in increased emissions. This is a multi- disciplinary problem with multiple trade-offs such as optimising engine efficiency, minimising fuel burnt and emissions while maintaining aircraft separation and air safety. There are possible attempts to solve such problem by designing new wing/aircraft shape, new efficient engine, ATM technology, or modifying the aircraft flight plan. This paper presents the coupling of an advanced optimisation technique with mathematical models and algorithms for aircraft emission reduction through flight plan optimisation. Two multi-objective design optimisations are conducted to find the best set of flight plans for current aircraft considering a discretised altitude and Mach number without modifying aircraft shape or engine type. The objective of the first optimisation is to maximise range of aircraft while minimising NOx with constant mission fuel weight. The second optimisation considers minimisation of mission fuel weight and NOx with fixed aircraft range. Numerical results show that the method is able to capture a set of useful trade-offs between aircraft range and NOx, and mission fuel consumption and NOx. In addition, alternative cruise operating conditions including Mach and altitude that produce minimum NOx andCO2 (minimum mission fuel weight) are suggested.

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