Impact on contrails coverage when flying with hybrid electric aircraft

Yin, F.; Grewe, V.; Gierens, K.

Publication date
2020

Document Version
Final published version

Citation (APA)
Yin, F., Grewe, V., & Gierens, K. (2020). *Impact on contrails coverage when flying with hybrid electric aircraft*. 71-71. Abstract from 3rd ECATS conference.

IMPACT ON CONTRAILS COVERAGE WHEN FLYING WITH HYBRID ELECTRIC AIRCRAFT

F. Yin[1], V. Grewe[2] & K. Gierens[2]

[1] *Faculty of Aerospace Engineering, Delft University of Technology, the Netherlands, F.yin@tudelft.nl*
[2] *Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany*

Abstract Aviation is responsible for approximately 5% of global warming and is expected to increase substantially in the future. In the face of the continuing expansion of air traffic, mitigation of the aviation's climate impact becomes challenging, but imperative. Among various mitigation options, hybrid electric aircraft (HEA) has drawn intensive attention due to its large potential in reducing the greenhouse gas emissions. The non-CO_2 effects (especially the contrails) of the HEA on the climate change, however, remains ambiguous. As the first step to understand the climate impact of HEA, this research aims to investigate the impact on the formation of persistent contrails when flying with HEA. The simulation is performed using the Earth System model (EMAC) coupled with a CONTRAIL submodel, where the Schmidt Appleman Criterion (SAC) is adapted to estimate changes in the potential contrail coverage (PCC) globally. The analysis shows that the HEA forms contrails at relatively lower temperature than conventional aircraft. At the same altitude, the reduction in contrails formation is mainly observed in the tropical regions where the temperature is warmer. With a smaller fraction of electric power in use, the contrail coverage remains nearly unchanged. As the degree of hybridization increases further to 90%, an exponential reduction in the contrail formation is expected with a maximum value of about 40%.

Keywords: Contrail formation; hybrid electric aircraft; degrees of hybridization; seasonal effects; regional effects

INTRODUCTION

Aviation is responsible for approximately 5% of the anthropogenic causes to global warming and is expected to increase substantially in the future. In the face of the continuing expansion of air traffic, mitigation of the aviation's climate impact becomes challenging, but imperative. Among various mitigation options, hybrid electric aircraft (HEA) is drawing intensive attention due to its large potential in reducing the greenhouse gas emissions. Regional/narrow body aircraft are the most promising candidates for this technology (Gladin et al, 2017). On longer-range flights, the additional weight of the electric propulsion system makes it difficult to achieve any substantial fuel saving. Multiple studies have shown that the hybrid electric configuration can reduce the fuel burn in regional flights by around 7-10% with the envisaged 2030-2035 technology in comparison to conventional propulsion system (Gladin et al, 2017; Ang et al, 2019).

The climate impact of HEA, however, remains ambiguous, as the climate impact of aviation includes both CO_2 and non-CO_2 effects from NO_x, H_2O and contrails. The non-CO_2 effects depend not only on the emission quantity but also the geographical location, altitude, time and the local weather condition. Furthermore, among those non-CO_2 effects, the contrails climate impact is more than 50% (Lee et al, 2009, Grewe et al, 2017). As the first step towards understanding of the climate impact of HEA, this research aims to investigate the impact on the formation of persistent contrails when flying with HEA. A parallel hybrid configuration is considered.

The paper is organized as follows: section 2 describes the modelling approach to estimate the potential contrails coverage (PCC) of HEA; section 3 presents the results; finally the conclusions are drawn in section 4.