Sonic-boom Evaluation in Realistic Atmospheres: Introduction of the SEIRA Project

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ABSTRACT

The project SEIRA (Sonic-boom Evaluation In Realistic Atmospheres) has been kicked-off in June 2020. We simulate a lot of supersonic flights in the chemistry-climate model EMAC and obtain realistic atmospheric conditions corresponding to the flights. Sonic boom impact is evaluated under those conditions, and then a surrogate model for the sonic boom impact is constructed from a data set of flight conditions, atmospheric conditions and sonic boom impact.

1. Introduction

Sonic boom mitigation remains a key issue for a commercial supersonic aircraft. Concorde experience has shown that sonic boom impact is significantly affected by local atmospheric conditions, such as temperature, winds, and relative humidity; that is, the impact changes every flight because of atmospheric conditions changing from moment to moment. We believe that sonic boom evaluation and exploration of further mitigation methods are needed, by assuming pragmatic supersonic aircraft operations.

The aim of the SEIRA project is twofold: to examine relations between sonic boom impact and atmospheric conditions, and to develop a surrogate model for sonic boom evaluation. The model is an essential technology for application studies, such as a boom-optimized aircraft routing, which probably enables further reduction in sonic boom impact.

2. Methodology

A large number of supersonic flights are simulated for a representative city-pair in the chemistry-climate model EMAC (version 2.54) [1,2] coupled with the air traffic simulation model AirTraf (version 2.0) [3,4], and meteorological data of the flights are obtained. With those data, sonic boom evaluations are carried out by using a validated sonic boom simulation code [5]. Furthermore, a surrogate model for sonic boom impact is constructed from a data set of flight conditions, atmospheric conditions and sonic boom impact, and its validation is performed.

3. Preliminary Test and Outlook

The simulation setup consists of the following: the Concorde departs from Heathrow airport (LHR) at 08:30:00 (UTC) on December 1st, 2008 and flies to John F. Kennedy (JFK) airport along the great circle route at M = 2.0 at 17.3 km. Figure 1 shows the temperature and wind vectors obtained from the EMAC model. We anticipate that sonic boom waveforms change as a result of local atmospheric variables in the lower stratosphere and troposphere. Many sonic boom simulations are carried out for different days, and relations between sonic boom impact and atmospheric conditions are investigated further.

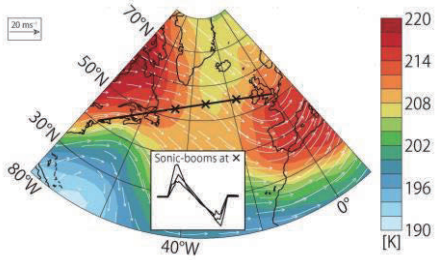

Fig. 1 Temperature (contours) and wind vectors at 75 hPa (~ 17.3 km) at 10:00:00 (UTC) on Dec. 1st, 2008. The thick solid line shows the great circle (LHR-JFK).

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