Accepted Manuscript

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Takashi Misaka, Shigeru Obayashi

PII: S1270-9638(16)30652-6
DOI: http://dx.doi.org/10.1016/j.ast.2017.08.038
Reference: AESCTE 4180

To appear in: *Aerospace Science and Technology*

Received date: 14 September 2016
Revised date: 20 August 2017
Accepted date: 23 August 2017

Please cite this article in press as: T. Misaka, S. Obayashi, Numerical study on jet-wake vortex interaction of aircraft configuration, *Aerosp. Sci. Technol.* (2017), http://dx.doi.org/10.1016/j.ast.2017.08.038

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ACCEPTED MANUSCRIPT

Numerical Study on Jet-Wake Vortex Interaction of Aircraft Configuration

Takashi Misaka
Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Sendai 980-8577, Japan

Shigeru Obayashi
Institute of Fluid Science, Tohoku University, Sendai 980-8577, Japan

The interaction of aircraft exhaust jet and wake vortex generated from a realistic aircraft configuration was numerically studied from the early phase until the complete roll-up. For numerical simulation we employed an unstructured mesh Reynolds-averaged Navier-Stokes (RANS) solver for the flow around an aircraft model, while a Cartesian mesh large-eddy simulation solver implemented on the framework of the building-cube method (BCM) was used for the simulation of the mid- to far-field wake. We especially investigated the feasibility of a coupling approach of the steady RANS solver and the Cartesian LES solver in the simulation of the jet-wake vortex interaction, where unsteady velocity fluctuations are stochastically reproduced based on RANS turbulence variables. The results showed that a multi-level Cartesian mesh of the BCM was effective to capture the evolution of aircraft wake including exhaust jet. The velocity profiles of a wake vortex are compared with several vortex models, which reveals that the velocity profiles fit with different vortex models depending on the vortex ages. The normalized temperature of exhaust jet is compared with the experiment, which confirms that the temperature information is appropriately transferred from the near- to the far-field simulation.

Keywords: *Aircraft wake vortex, Jet-wake vortex interaction, Large eddy simulation*

I. Introduction

Wake vortices generated by a flying aircraft pose a potential risk to following aircraft due to the strong and coherent vortical flow structure, thus it limits the capacity of airports.[1] In addition, it is pointed out that condensation trails (contrails) originated from the interaction of jet exhaust, wake vortices and the environmental atmosphere may trigger the formation of cirrus clouds (contrail cirrus) which would have an influence on the climate.[2,3] Although large-eddy simulation (LES) or direct numerical simulation (DNS) of a vortex pair provide detailed insights into the wake vortex evolution and decay in various environmental

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