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Role of wing color and seasonal changes in ambient temperature and solar irradiation on predicted flight efficiency of the Albatross

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Abstract

Drag reduction of the wings of migrating birds is crucial to their flight efficiency. Wing color impacts absorption of solar irradiation which may affect drag but there is little known in this area. To this end, the drag reduction induced by the thermal effect of the wing color of migrating birds with unpowered flight modes is presented in this study. Considering this natural phenomenon in the albatross as an example of migrating birds, and applying an energy balance for this biological system, a thermal analysis is performed on the wings during the summer and winter to obtain different ranges of air density, viscosity, and wing surface temperature brought about from a range of ambient temperatures and climatic conditions seen in different seasons and to study their effects. The exact shape of the albatross wing is used and nine different wing colors are considered in order to gain a better understanding of the effect different colors' absorptivities make on the change in aerodynamic performances. The thermal effect is found to be more important during the summer than during the winter due to the higher values of solar irradiation and a maximum drag reduction of 7.8% is found in summer changing the wing color from light white to dark black. The obtained results show that albatrosses with darker colored wings are more efficient (constant lift to drag ratio and drag reduction) and have better endurance due to this drag reduction.

Keywords: Drag reduction, thermal effect, wing color, migrating birds, albatross

1- Introduction

Natural avian flight has different flight modes which are divided into powered and unpowered flights. The large birds, such as vultures, albatrosses, pelicans, and storks are applying unpowered flight modes (gliding and soaring) to fly (Muijres et al., 2012;