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Bumblebees meet fully developed turbulence: high resolution numerical simulations THOMAS ENGELS, M2P2-CNRS, Aix-Marseille University, Marseille, France & Institut für Strömungsmechanik und Technische Akustik (ISTA), TU Berlin, Germany, DMITRY KOLOMENSKIY, Biomechanical Engineering Laboratory, Chiba University, Chiba, Japan, KAI SCHNEIDER, M2P2-CNRS & CMI Aix-Marseille University, Marseille, France, JOERN SESTERHENN, Institut für Strömungsmechanik und Technische Akustik (ISTA), TU Berlin, Germany, FRITZ-OLAF LEHMANN, Department of Animal Physiology, Institute of Biological Sciences, University of Rostock, Rostock, Germany — Numerical experiments of a tethered bumblebee in a wind tunnel with turbulent inflow of different intensity are performed at realistic Reynolds numbers on massively parallel computers. Ensemble averaging of different flow realizations shows that the mean forces (lift and drag, or horizontal and vertical), the moments (roll, pitch and yaw), and power, are robust and are not modified significantly by the turbulent inflow. Phase averaging of the vorticity field illustrates that in all cases the leading edge vortex is indeed persistent (in the average sense) as it is the case for laminar inflow, which explains the above findings. However, as expected, the corresponding standard deviations do increase with the turbulence intensity. In particular the roll moment shows the strongest increase of standard deviation. Considering that the moment of inertia of the bumblebee is the smallest around this axis yields a possible explanation for the experimentally observed flight instability around the roll axis under turbulent flow conditions.

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