



IDENTIFICATION OF VORTEX STRUCTURES IN TRANSITIONAL FREE-CONVECTION BOUNDARY LAYER USING DATA OF TEMPORAL DIRECT NUMERICAL SIMULATION

A.G. ABRAMOV¹, E.M.SMIRNOV^{1,c}, V.D.GORYACHEV²

¹Department of Aerodynamics, St.-Petersburg State Polytechnic University, St.-Petersburg, 195251, Russia

²Department of Mathematics, Tver State Technical University. 170026, Tver, Russia

^cCorresponding author: Tel.: +78122972419; Fax: +78125526621; E-mail: aero@phmf.spbstu.ru

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ABSTRACT: As shown in [1,2], the temporal approach for direct numerical simulations (DNS) of transitional and turbulent free-convection boundary layer at a hot vertical plate can provide valuable information for getting more insights into peculiarities of this type of flows and associated heat transfer phenomena. The present contribution deals with graphic post-processing of DNS data [2] obtained for time-developing air free convection assuming periodicity conditions in both the direction parallel to the heated plate (Fig.1, left). The flow visualization is performed with the in-house computer program HDVIS being under development to provide the user with advanced tools for visual analysis of data after 3D steady/unsteady flow simulation [3]. A special attention is paid to 3D vortex structures that occur first at the non-linear stage of 2D laminar flow destruction and clearly manifest themselves up to the end stage of laminar-turbulent transition in the layer. Different visualization techniques oriented on creation of static scenes and animation are used to clarify flow features associated with formation and evolution of the vortex structures. In particular, these structures visualized with isosurfaces of Q-criterion (Fig. 1, color plots) has a hairpin form, with the “hairpin” head oriented upstream, in contrast to the case of forced-convection boundary layer where hairpin vortices are directed downstream. Effects of the vortex structures on unsteady local heat transfer are analyzed via superposition of maps created for temperature and heat flux with those for flow kinematics.

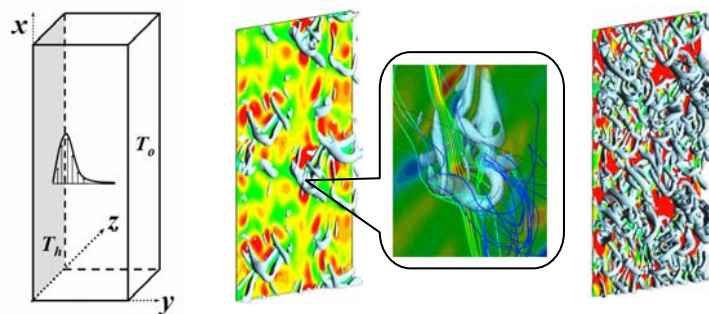


Fig. 1 Computational domain for Temporal DNS of free convection flow. Visualization of vortex structures and their effect on local heat transfer for different stages of laminar-turbulent transition

References

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