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Direct Numerical Simulations of the flow over a dimpled flat plate NIKOLAOS BERATLIS, KYLE SQUIRES, Arizona State University, ELIAS BALARAS, The George Washinton University — Golf balls use dimples to reduce the drag by as much as 50 percent when compared to a smooth sphere in the subcritical regime. Recent experiments and computations indicate that dimples introduce perturbations that drive high momentum fluid towards the wall, thus delaying separation and reducing drag. The nature of these perturbations and how they are affected by the Reynolds number, boundary layer thickness, and dimple shape is not well understood. In the present study we will report a series of DNS of the flow past a dimpled flat plate. A stability map with the important parameters that control the onset of the perturbations (Reynolds number, ratio of dimple depth to boundary layer thickness, etc) will be presented. We will show that dimples induce perturbations that lead to turbulent-like boundary layers at relatively low Reynolds numbers, where the flow would otherwise remain laminar. The origin of these perturbations is a thin shear layer forming over a dimple, which becomes unstable and generates vortices. These undergo complex three-dimensional instabilities transforming themselves into structures that resemble hairpin-like vortices typically found in turbulent wall bounded flows. They are very effective in mixing the flow and already within one dimple diameter downstream of the dimple the flow attains characteristics of low Reynolds number turbulence.

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