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SEPARATED FLOW PREDICITION AROUND A 6:1 PROLATE SPHEROID USING REYNOLDS STRESS MODELS

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The objective of the present study is to apply Reynolds stress models (RSM) to the prediction of three-dimensional separated flows around a 6:1 prolate spheroid at high-angle of attack. Four Reynolds stress models were tested: the MCL model proposed by Batten *et al* [1], the Jakirlic and Hanjalic (JH) model [2] with a quadratic formulation of the pressure strain term, the hybrid SSG/LRR-ω model developed by Eisfeld [3], and the fourth model is a recent model develpoed by Gerolymos *et al* known as the $GLVY$ model [4]. The objectives are to evaluate the applicability of RSM to practical high-Reynolds, separated flows, and to investigate the influence of dissipation modelling on the quality of the results.

Despite its simple geometry, the flow around a prolate spheroid at incidence exhibits complex flow features, such as cross-flow separation, streamline curvature, the formation and evolution of free-vortex sheets, and stream-wise vortices. At high incidence angles, the flow separates from the leeward side of the prolate spheroid and rolls up into coherent longitudinal vortices. A pair of primary vortices that are usually accompanied by at least one pair of secondary vortices. The vortical structure on the lee side presents a serious challenge for accurate flow predictions.

Numerical simulations of the flow about a 6:1 prolate spheroid at a Mach number of $M_\infty = 0.2$, an angle of incidence of $\alpha = 20^\circ$, and a Reynolds number of $Re_\infty = 4.2 \times 10^6$ are conducted in accordance with exprimental flow conditions [5]. Figure (1) shows the comparison of the boundary layer velocity profiles, $\widetilde{U}_b, \widetilde{V}_b$, and $\widetilde{W}_b$, at six radial rakes at station $x/L = 0.772$ using the SSG/LRR-ω model. An excellent agreement is achieved between the computed and the experimental results (the final paper would include results obtained from the three other Reynolds stress models).

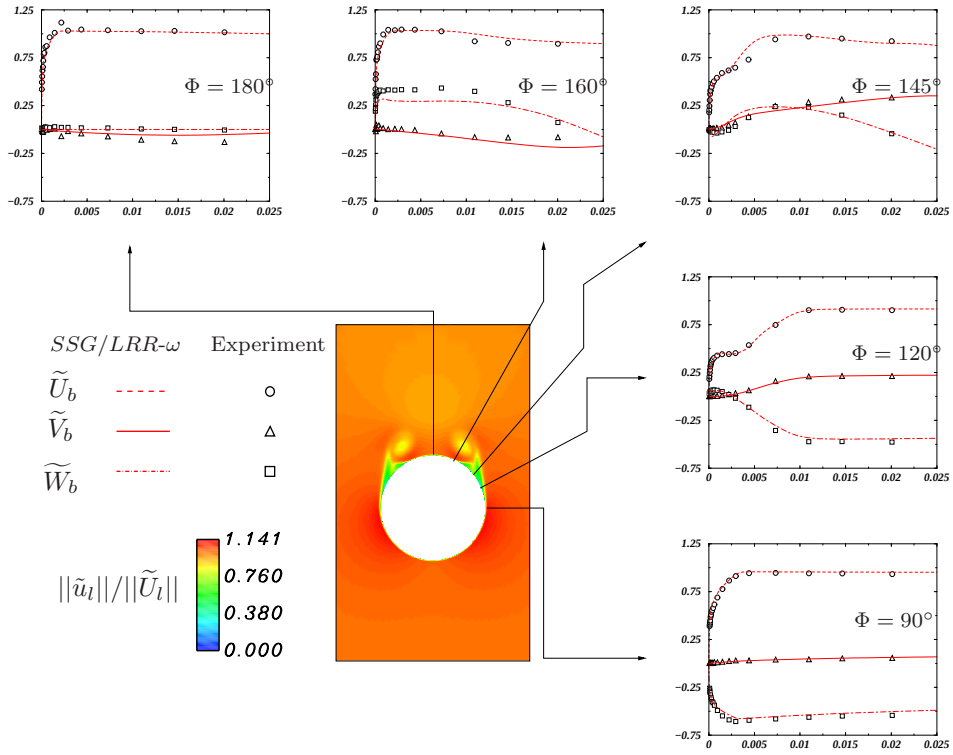

Figure 1: Comparison between computed and measured normalized velocity profiles in the body surface coordinate system at station $x/L = 0.772$ for six circumferential angles using the SSG/LRR-ω.

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