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INVESTIGATION OF EARLY NATURAL TRANSITION USING THE SA-γ-$\tilde{Re}_{\theta t}$ TURBULENCE MODEL

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Transition from laminar to turbulent flow has a strong influence on the aerodynamic coefficients. Therefore, modelization of such flow is important to optimize aircraft performance. In the present work, the Spalart-Allmaras (SA) turbulence model [1] is coupled with the γ-$\tilde{Re}_{\theta t}$ local correlation-based transition model [2, 3] and implemented in the unstructured finite volumes RANS code CHAMPS [4], a solver developed at Polytechnique Montreal. The model's transition positions are examined on 2D cases such as the Schubauer and Klebanov flat plate [5], NACA0012 [6], S809 [7] and NLF0416 [8] airfoils and compared to experimental data.

The results show that the prediction of the transition location is accurate when the type of transition is separation-induced. But when the transition type is natural, there is often an offset with the experimental data and the trend is that the location is too far upstream. In this context, an investigation is carried out to find out the cause of the early natural transition. In particular, the F_{onset} equation of the transition model is examined. This equation is used in the model to trigger the intermittency production and therefore the transition process when the transition criteria, F_{onset1}, exceeds the local value of 1.

The analysis of the flow just before the transition led to postulate a possible cause: a high increase of the viscosity ratio (RT) before the transition criteria is met is causing the transition process to begin too early. According to Langtry [2] in the original model, the purpose of RT when used in the F_{onset} equation is to prevent the transition process to stall. Therefore, it should not trigger the transition process. The solution proposed in this work is to reduce the influence of RT on the triggering of the transition process by calibrating the parameters in the F_{onset} equation. Results with this fix show that the natural transition position is more inline with the experimental data. Most importantly, the separation-induced transition positions that were in agreement with the experimental data are barely affected. But, in some few cases where the natural transition was already too far downstream, this calibration pushes even more the transition downstream. One hypothesis is that this late transition is caused by another effect and further investigation is underway to find a solution.

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