Quick presentation of the time and space mesh adaptation and discussion about Naca0018

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A word about the time and space mesh adaptation

The goal is to minimize the error according to $\mathcal{M} : t \to \mathcal{M}(t)$ and $\tau : t \to \tau(t)$. under the constraint

$$\mathcal{C}\left(\mathcal{M},\tau,n_{\text{step}}\right) = \int_0^T \mathcal{C}_{\text{spatial}}\left(\mathcal{M}(t)\right)\left(\tau(t)\right)^{-1} dt.$$

The error analysis writes :

$$\mathcal{E}(\mathcal{M},\tau) = \mathcal{E}_{\text{time}}(\mathcal{M},\tau) + \mathcal{E}_{\text{space}}(\mathcal{M},\tau),$$

with

$$\mathcal{E}_{\text{time}}(\mathcal{M},\tau) = \int_0^T \int_\Omega \left(K_t\,\tau^\alpha \left|\frac{\partial^\alpha W}{\partial t^\alpha}\right|\right)^p d\mathbf{x}dt,$$

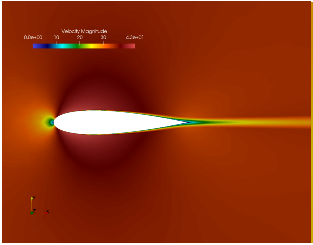
and

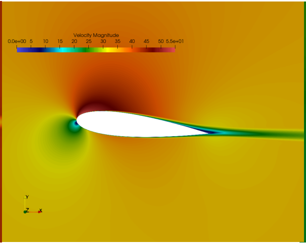
$$\mathcal{E}_{\text{space}}(\mathcal{M},\tau) = \int_0^T \int_\Omega \left(Tr(\mathcal{M}^{\frac{1}{2}}(\mathbf{x},t)\mathbf{H}_{\text{Feature}}(\mathbf{x},t)\mathcal{M}^{\frac{1}{2}}(\mathbf{x},t))\right)^p d\mathbf{x}dt.$$

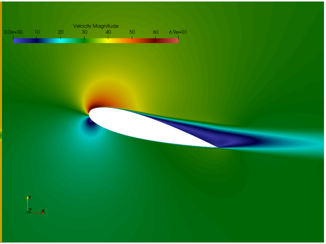
with

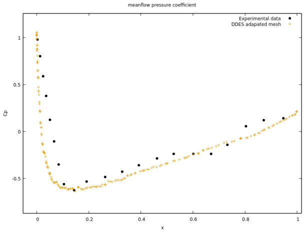
$$\mathbf{H}_{\text{feature}} = |H_{u_t} + H_u|.$$

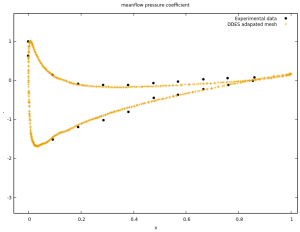
AOA 0° | **AOA 6°** | **AOA 15°**

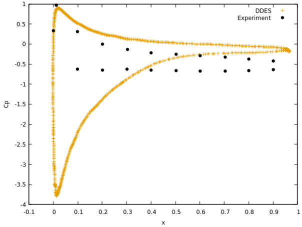






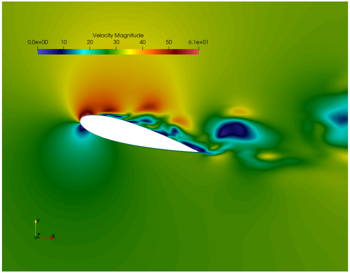






⚠ DDES calculations give a steady flow.

A VMS computation gives an unsteady flow !



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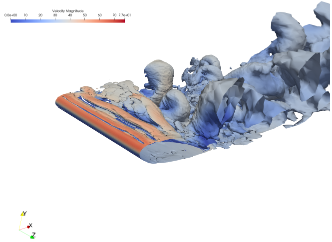
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Figure – Velocity field in cross-section on left and Q-criterion iso-surface.

- Implementation of a new subgrid length-scale subgrid length-scale from the article *An Enhanced Version of DES with Rapid Transition from RANS to LES in Separated Flows*, M. L. Shur, P. R. Spalart, M. Kh. Strelets, A. K. Travin.

$$\Delta = \tilde{\Delta}_{\omega} F_{KH}(< VTM >).$$

- Implementation of a IDDES.

Influence of the subgrid length-scale (for the DES model)

$\Delta = |Cell|^{\frac{1}{3}}$ $\Delta = \frac{1}{3}\,|Cell|^{\frac{1}{3}}$ $\Delta = \frac{1}{9}\,|Cell|^{\frac{1}{3}}$

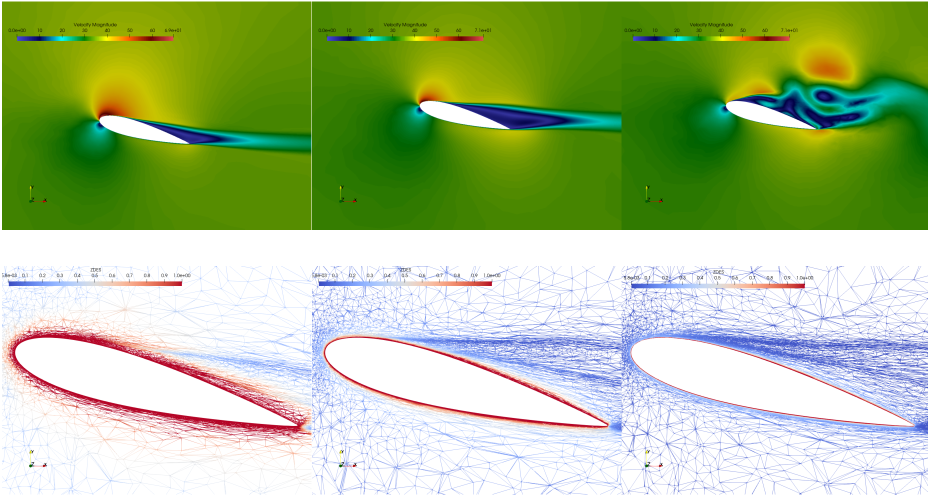

Figure – Velocity field in cross-section at the top and and vizualisation of RANS areas (in red) and LES areas (in blue) for different subgrid length-scale definitions.