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Certified Reduced Basis Approximation for the Coupling of Viscous and Inviscid Parametrized Flow Models

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We present a model order reduction approach for parametrized laminar flow problems including viscous boundary layers. The viscous effects are captured by a Navier-Stokes model in the vicinity of the boundary layer, whereas a potential model is used in the outer region [4]. By this, we provide an accurate model avoiding the usage of the Kutta condition for potential flows as well as an expensive numerical solution of a global Navier-Stokes model. The domain decomposition approach is combined with the reduced basis method, which takes account of the parametrized nature of the heterogeneous coupled system.

We avoid the more involved ansatz of posing localized, decoupled problems on the subdomains [2] and instead consider a monolithic approach for this problem [3]. For this, we can apply recent elements of the reduced basis methodology for non-coercive and nonlinear partial differential equations [1, 5]. The accuracy of the reduced order model is ensured by computable a-posteriori error bounds. Numerical experiments are conducted with a parametrized flow around a NACA airfoil, including geometry variations. A considerable reduction of the computational times is obtained. Different methods to approximate the inf-sup constant of the global Fréchet-derivative are compared.

References

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