A CERTIFIED REDUCED BASIS METHOD FOR THE PARAMETRIZED UNSTEADY BOUSSINESQ EQUATIONS

Dr. David J. Knezevic*

*Massachusetts Institute of Technology
77 Massachusetts Avenue, Cambridge, MA 02139, USA
e-mail: dknez@mit.edu

ABSTRACT

We present a computational framework for certified reduced basis approximation of the parametrized unsteady Boussinesq equations. This framework involves several essential ingredients, namely, (i) Galerkin projection onto a low-dimensional space associated with a smooth parametric manifold — to provide dimension reduction; (ii) an efficient POD-Greedy sampling method for identification of "optimal" and numerically stable approximations — to yield rapid convergence; (iii) accurate (Online) calculation of the solution-dependent stability factor by the Successive Constraint Method — to quantify the growth of perturbations/residuals in time; (iv) rigorous *a posteriori* bounds for the errors in the reduced basis approximation and associated outputs — to provide *certainty* in our predictions; and (v) an Offline-Online computational decomposition strategy for our reduced basis approximation and associated error bound — to minimize marginal cost and hence achieve high performance in the real-time and many-query contexts.

The method is applied to a transient natural convection problem and numerical results indicate that the reduced basis approximation converges rapidly. Furthermore, the (inexpensive) rigorous *a posteriori* error bounds remain practicable for parameter domains and final times of physical interest.

REFERENCES

[1] D.J. Knezevic, N.C. Nguyen, and A.T. Patera, Reduced basis approximation and *a posteriori* error estimation for the parametrized unsteady Boussinesq equations, *Submitted to M3AS, November 2009.*