Spectral Variational Multi-Scale methods for two-dimensional convection-diffusion problems

T. Chacón Rebollo,* S. Fernández-García* and M. Gómez-Mármol†

Keywords: Variational Multi-Scale, advection-diffusion, stabilization, spectral approximation

Mathematics Subject Classification (2010): 65L60, 65J10, 65M70

In this work, we consider two-dimensional convection-diffusion problems and apply the variational multi-scale (VMS) method with spectral approximation of the sub-scales. This method was developed in [1] for one-dimensional elliptic problems. In the two-dimensional case considered here, the domain is the unit square and the problem has Dirichlet boundary conditions.

In order to apply the spectral VMS method, we need to compute the eigenpairs of the convection-diffusion operator. We take first a mesh of squares and second a mesh of isosceles right triangles and compute the eigenpairs of the Laplace operator in such two-dimensional domains, in order to obtain later those of the convection-diffusion operator. After that, the stabilization coefficients are computed in an off-line phase.

Finally, we present some numerical tests to compare the results of the spectral VMS method with those obtained using different stabilization coefficients, such as, for instance, those computed through orthogonal subscales [2].

Acknowledgements

References

[1] T. Chacón Rebollo, B. M. Dia, *A variational multi-scale method with spectral approximation of the sub-scales: Application to the 1D advection-diffusion equations*. Comput. Methods Appl. Mech. Engrg. **285** (2015), 406–426.

[2] R. Codina, *Stabilization of incompressibility and advection through orthogonal sub-scales in finite element methods*, Comput. Methods Appl. Mech. Engrg. **190** (2000) 1579–1599.

*Dpto. EDAN & IMUS, University of Seville, Campus de Reina Mercedes, 41012 Sevilla (Spain). Email: chacon@us.es, soledad@us.es
†Dpto. EDAN, University of Seville, Campus de Reina Mercedes, 41012 Sevilla (Spain). Email: macarena@us.es