EFFECTS OF PROPERTIES OF DISCRETE SPATIAL FILTERS ON EDDY VISCOSITY MODELS WITH TEST FILTERING

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Some LES models require explicitly filtering flow variables. Most of the theory of LES is constructed upon the assumption that the used filters approach, up to some degree, a convolution filter. But explicitly using convolution filters would lead to $N \times N$ operations where N is the number of unknowns (or degrees of freedom), i.e., unacceptable computing costs. Thus, in practice, less costly filter approximations are used. But these approximations usually break relevant global properties of the convolution filters when meshes are irregular or when filtering is adaptative.

In our previous work [4], we listed the properties of the convolution filter and provided constraints ensuring that explicit filters on the literature based on Sagaut and Grohens [3] and Vreman [5] verify them. Then, we studied the consequences of respecting or violating these properties by means of specifically designed tests and filtering a 2D isentropic vortex and a singularity field. It was found that some non-conservative filters increased the vortex circulation. It was also found that applying filters with positive-semidefinite matrices on fields defined in non-uniform meshes can augment the number of maxima and minima, but this could be resolved using filters with positive diagonal dominant matrices (see Figure 1).

The mentioned results invite to revisit the effect that not preserving the properties of the convolution filter has on the turbulence models in which filtering is explicitly performed. We present here the current state of our research regarding this on eddy-viscosity models using test filtering. So we plan to compare the turbulent stresses computed with the dynamical procedure [1] and the variational multiscale methodology [2] when test filters verify or not the properties in [4].

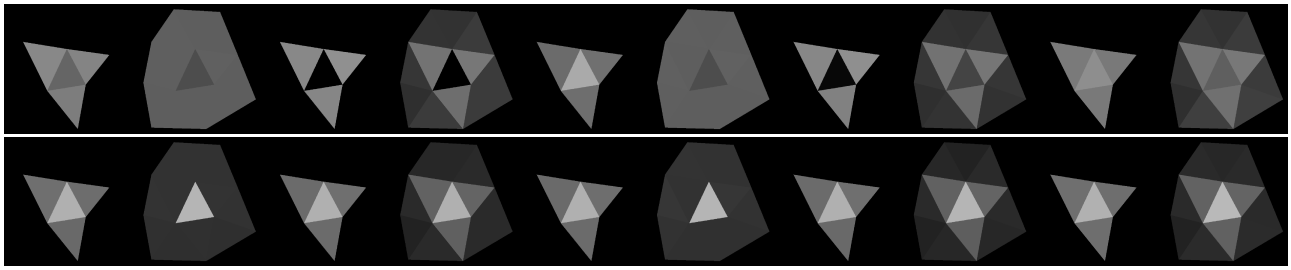

Figure 1. Filtered singularity on unstructured mesh, brighter gray shades are higher values. Top: Filters with positive semidefinite matrices. Bottom: Filters with positive Diagonal dominant matrices.

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