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A non-statistical regularization approach and a tensor product decomposition method applied to complex flow data

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Handling high-dimensional data sets like they occur e.g. in turbulent flows or in multiscale behaviour of certain types in Geosciences are one of the big challenges in numerical analysis and scientific computing. A suitable solution is to represent those large data sets in an appropriate compact form. In this context, tensor product decomposition methods currently emerge as an important tool. One reason is that these methods often enable one to attack high-dimensional problems successfully, another that they allow for very compact representations of large data sets.

We follow the novel Tensor-Train (TT) decomposition method to support the development of improved understanding of the multiscale behavior and the development of compact storage schemes for solutions of such problems. One long-term goal of the project is the construction of a self-consistent closure for Large Eddy Simulations (LES) of turbulent flows that explicitly exploits the tensor product approach's capability of capturing self-similar structures.

Secondly, we focus on a mixed deterministic-stochastic subgrid scale modelling strategy currently under development for application in Finite Volume Large Eddy Simulation (LES) codes. Advanced methods of time series analysis for the databased construction of stochastic models with inherently non-stationary statistical properties and concepts of information theory based on a modified Akaike information criterion and on the Bayesian information criterion for the model discrimination are used to construct surrogate models for the non-resolved flux fluctuations. Vector-valued auto-regressive models with external influences form the basis for the modelling approach [1], [2], [4].

Here, we present the reconstruction capabilities of the two modeling approaches tested against 3D turbulent channel flow data computed by direct numerical simulation (DNS) for an incompressible, isothermal fluid at Reynolds number $Re_\tau = 590$ (computed by [3]).

<u>References</u>

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