Subgrid stress tensor modeling in homogeneous isotropic turbulence using 3D convolutional neural network - A teaser

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General scope of our work

- The intrinsic multi-scale nature of Turbulent flows imposes most of the time a computational modeling, but constants or hypotheses made restrain model's accuracy to peculiar cases
- In the same time artificial intelligence (AI) algorithms seem to be usable to design a model solely based on available fields such as filtered quantity in a LES approach

What we propose

- AI model based on 3D-convolutions being able to predict SGS tensor components τ_{ij} in a HIT from the *diced* filtered velocity field $\overline{u}_i$; where :
  - The cube length is given by the Kraichnan Spectral Eddy Viscosity
  - The AI is trained on a simulation with $Re_\lambda = 90$ and tested on ones which Re_λ is up to 240 without significant accuracy loss at tensorial, vectorial and scalar levels

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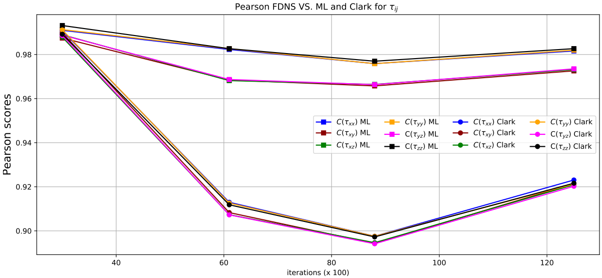
Some results

Scores	τ_{xx}	τ_{xy}	τ_{xz}	τ_{yy}	τ_{yz}	τ_{zz}
Pearson	0.98 / 0.92	0.97 / 0.92	0.97 / 0.92	0.98 / 0.92	0.97 / 0.92	0.98 / 0.92
1 - $\mathcal{R}^2$	0.04 / 0.33	0.05 / 0.16	0.05 / 0.16	0.04 / 0.34	0.05 / 0.16	0.04 / 0.34
E_r	0.15 / 0.43	0.23 / 0.40	0.23 / 0.40	0.15 / 0.43	0.23 / 0.40	0.15 / 0.43

Table of correlation comparisons between τ_{ij}^{FDNS} vs τ_{ij}^{ML} and τ_{ij}^{FDNS} vs τ_{ij}^{Clark}



Pearson correlations through iterations (and turbulent regimes

- For 3D comparisons, scores on other level, 3D-Unet Architecture and features and more - see you at the poster presentation :)