Homework - Lecture 7

Task 1

Using the Lee-Zaki DNS dataset[1] and Paraview, you are asked to:

- Plot the Reynolds stresses and the turbulent kinetic energy (TKE) in function of y^+ and the distance normal to the wall (refer to figure 1). Discuss the main observations.
- Plot the laminar stress, turbulent stress, and total stress in function of y^+ (refer to figure 2). Discuss the main observations.
- Plot u^+ in function of y^+ (refer to figure 3). Discuss the main observations.
- Plot the wall shear stresses and determine the transition point.
- Write down all the equations used to do the plots.

You must use the following Lee-Zaki dataset (which is ready to use with Paraview):

`http://www3.dicca.unige.it/guerrero/turbulence2020/datasets/lee_zaki.zip`

You must save Paraview's state file and send it to me so I can reproduce your results.

Optional tasks

If you want to go for the extra mile, you can try to complete the following tasks,

- Plot the turbulent kinetic energy budget. You only need to plot the production and dissipation terms (refer to figure 4).

[1] `http://turbulence.pha.jhu.edu/Transition_bl.aspx`

- Plot the Reynolds stress budget for R_{uu}. You only need to plot the production and dissipation terms.
- Plot the Reynolds stress budget for R_{uv}. You only need to plot the production and dissipation terms.
- Plot the viscous diffusion term and pressure transport terms of R_{uu} and R_{uv}.

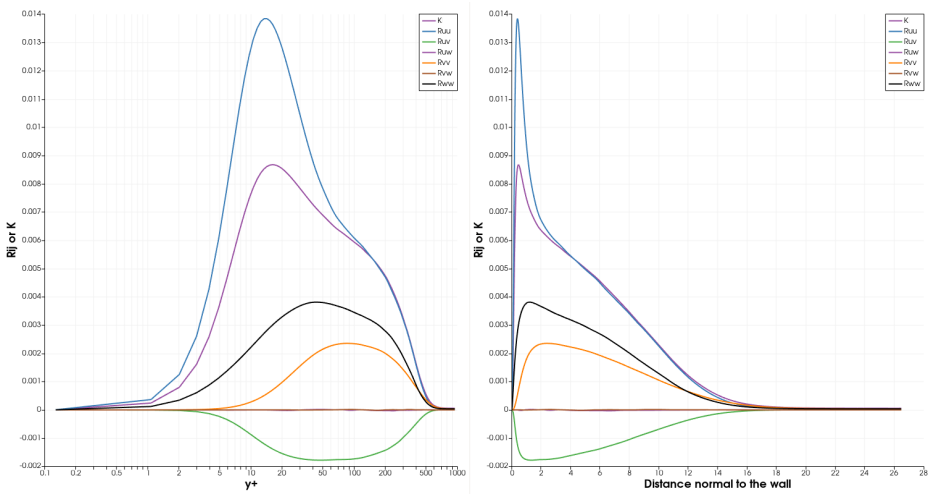

Figure 1: Left image: Plot of Reynolds stresses and TKE in function of y^+. Right image: Plot of Reynolds stresses and TKE in function of distance normal to the wall.

Task 2

Using the data available at the following link,

`http://www3.dicca.unige.it/guerrero/turbulence2020/homework7/data_l7.zip`

you are asked to:

- Compute the mean value and standard deviation of the C_D and C_L time signals (file coeffs.csv).

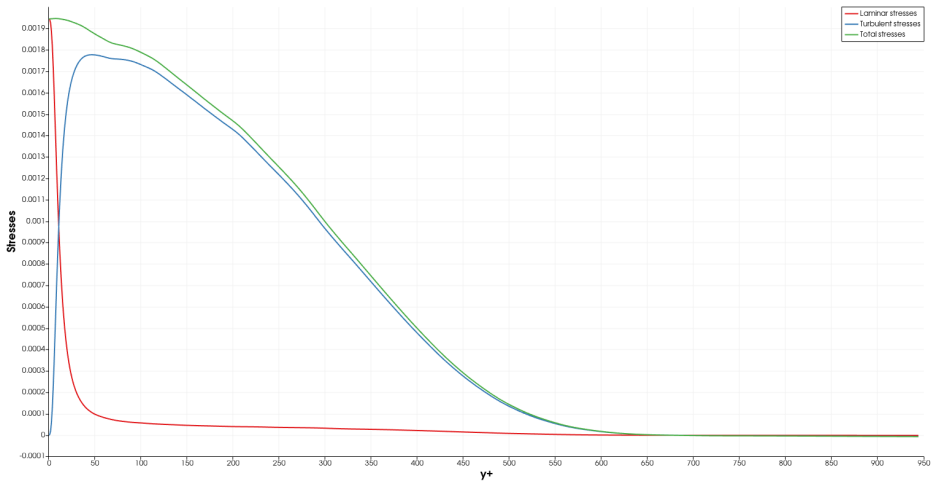

Figure 2: Laminar stress, turbulent stress, and total stress in function of y^+.

- Plot the C_D and C_L time signal, together with the mean value and standard deviation.
- Using the C_D and C_L time signals, compute the shedding frequency.
- Using the data in the file vel.csv (instantaneous velocity data), compute the turbulent spectrum and superimpose the $-5/3$ curve. Detrend your the data if it is deemed necessary.
- Discuss the main observations.
- Answer the following question:
  - Do you think this simulation is statistically steady?
  - Is the time-step of the simulation constant?
  - Are there anomalies in the time signal?

General guidelines

- Be technical and concise when written your report.
- You can write your report in English or Italian.

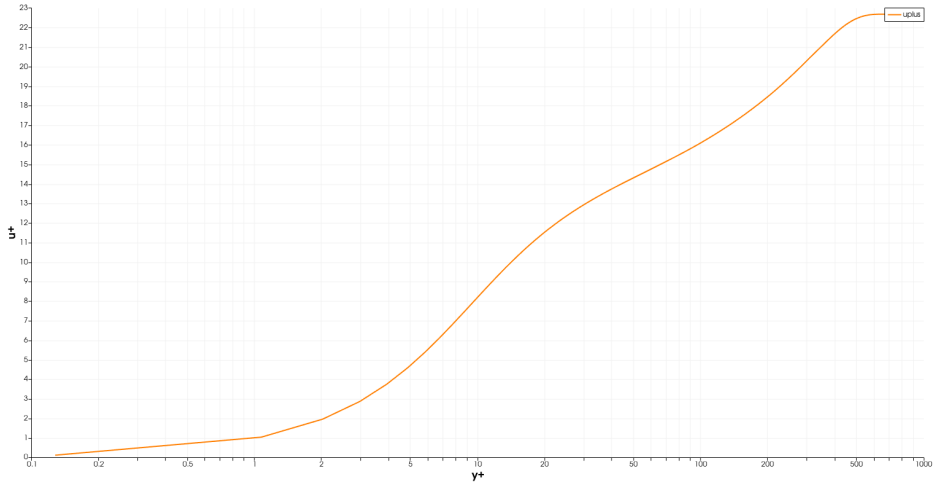

Figure 3: u^+ in function of y^+.

- Do not hesitate to contact me if you have any questions.

Deadline

The deadline to submit your homework is 3 June 2020. You can send it to my email: joel.guerrero@unige.it

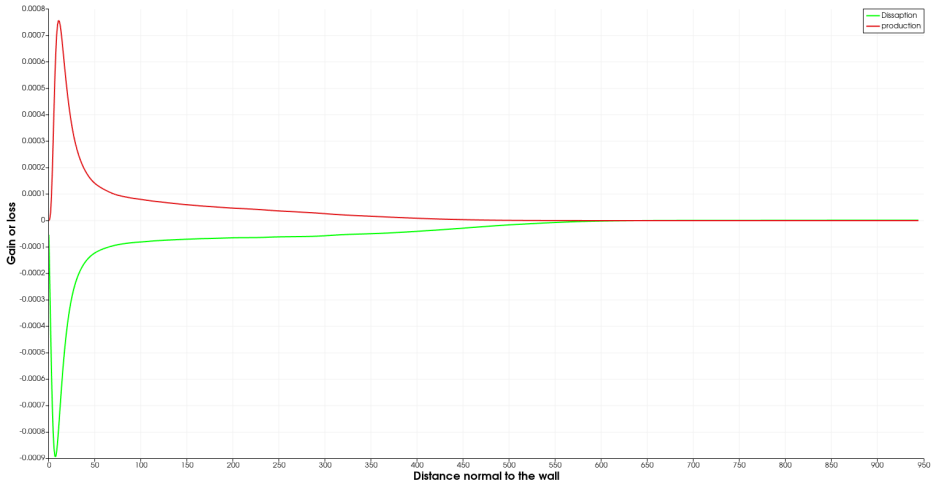

Figure 4: Turbulent kinetic energy budget.