2D flow around a heated square-cylinder - $Re_{h}= 50$, $Ra= 5\; 10^6$

A heated square-cylinder is placed in a channel flow

Author : Y. Fraigneau CNRS-LIMSI (yann.fraigneau@lisn.fr)
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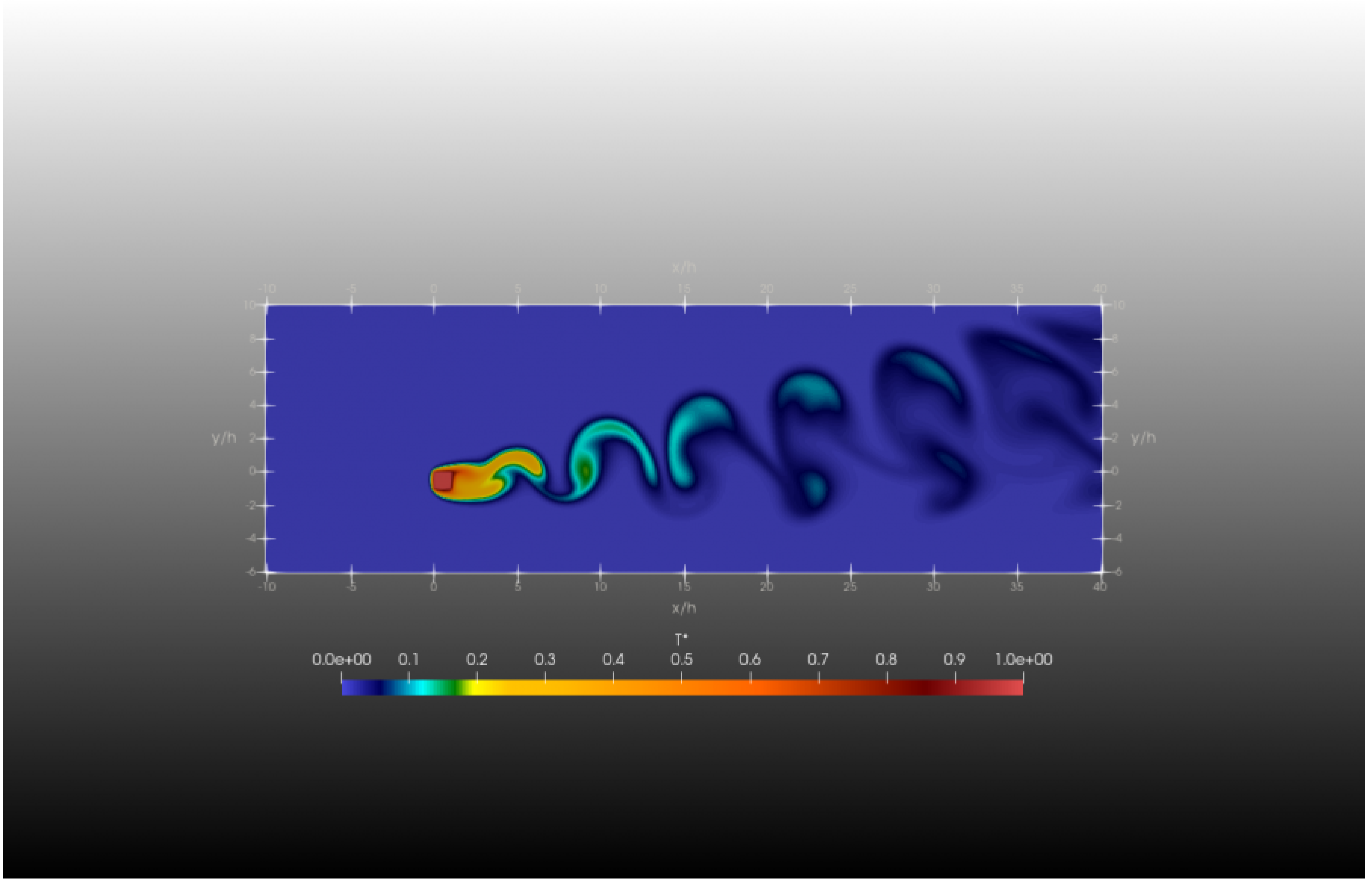
Simulation type : DNS (Sunfluidh code)
Location : /DATABASE_2DFLOW_AROUND_HEATED_SQUARECYLINDER_DNS
Status : Free access
Data size : ~ 3 Gb



A video is available here

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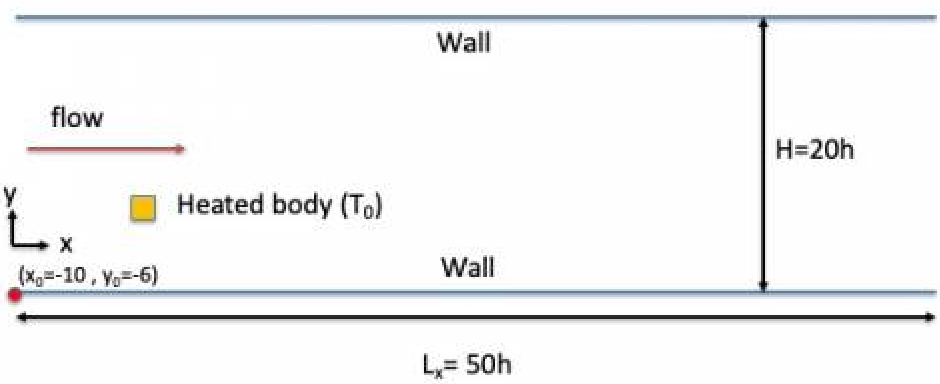
Simulation settings

2D sketch



Referential : cartesian geometry

1. axes :
    - x(i) : downstream direction
    - y(j) : normal direction
2. origin : lower left corner of the computational domain
    - $x_0= 10h$
    - $y_0= -6h$

Reference scales

- Density : mass density of the fluid (ρ_0)
- Lengths : cylinder size (h) and $H_u= 10h$ the distance between the domain's top and the square-cylinder's top.
- Velocity : velocity at inlet (U_0)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- thermal diffusivity : (κ_0)
- Reynolds number : $Re_H= \frac{\rho_0.U_0.h}{\mu_0}= 50$
- Rayleigh number : $Ra= \frac{\rho_0.\beta.g\Delta T.H_u^3}{\mu_0 \kappa_0}= 5\;10^6$

Non-dimensionalised data

- velocity : $U^*=\frac{U}{U_0}$
- density : $\rho^*= \rho/\rho_0= 1$
- coordinates : $x*=\frac{x}{h}$, $y^*=\frac{y}{h}$
- temperature : $T^*=\frac{T-T_c}{T_h-T_c}$ (T_h and T_c are respectively the temperature imposed at the cylender's walls and the temperature at the inlet and channel's walls)

Computational domain

1. **Domain scope**
    1. computational domain size (channel flow)
        - Downstream direction(x) : $L_x^*= 50.0$ (upward part $L_u= -10$, downward part $L_d=40$)
        - Normal direction (y) : $H*= 20.0$
    2. heated square cylinder
        - size: $h^*= 1$
        - wall temperature T_h^*= 1

1. **Boundary conditions**
    - Inlet : imposed pressure uniform velocity ($U_0=1$)
    - Outlet : Orlansky type
    - Bottom and top conditions : walls at (T_c^*=0)
2. **Spatial resolution**
    - mesh size : $512 \times 256 $ (131.072 cells)
    - About cell-size
        - $\Delta x*$: from 0.03125 to 0.723 (downstream direction)
        - $\Delta y*$: from 0.03125 to 0.187 (normal direction)

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Data features

- **Time series**
    - Physical quantities : velocity components along x and y directions (u,v) and pressure (p)
    - 1 probe
    - Time step= $\approx 6 \,10^{-2}$ time unit (irregular time step)
    - Time range : 250 time units
    - Location : Xi= 20.0 , Xj=2.0
    - File name (per physical quantity): x_ins_00000.d with x= u,v,t
- **3D snapshots**
    - Instantaneous fields : velocity components in x, y and z directions (U,V), the pressure (P) and the phase function related to the body motion (TRACE)
    - Recording rate : 1 time unit
    - Time range from from 20.0 to 250.0 time units

- File name : res_xxxxx_yyyyyyy.d
  - MPI subdomain ID: from 0 to 3 (case with MPI domain decomposition)
  - Time ID : from 0 to 250

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Database organisation

Data size : ~ 3 Gb
Main directory : /vol/DATABASE_MECA/DATABASE_2DFLOW_HEATED_SQUARRECYLINDER_DNS

Directories & files

```
  /DATASETUP       : ASCII files
                     input data file for sunfluidh : input3d.dat (and
input3d.dat_mpi4 for the case with MPI domain decomposition)
  /GRID            : ASCII files
                     input data file         : data_meshgen.d
                     grid files for sunfluidh: maillx.d, mailly.d, maillz.d
(sequential case)
                                               mesh.tar (archive containing
grid files for a domain decomposition with 4 MPI processes)
  /SNAPSHOTS       : snapshots binary files res_xxxxx_yyyyyyy.d
  /SNAPSHOTS_MPI4  : snapshots ressulting from a domain decomposition with 4
MPI processes
  /TIMESERIES      : ASCII files
                     u_ins_00000.d , v_ins_00000.d and t_ins_00000.d
(timeseries of the velocity components and temperature from probe)
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