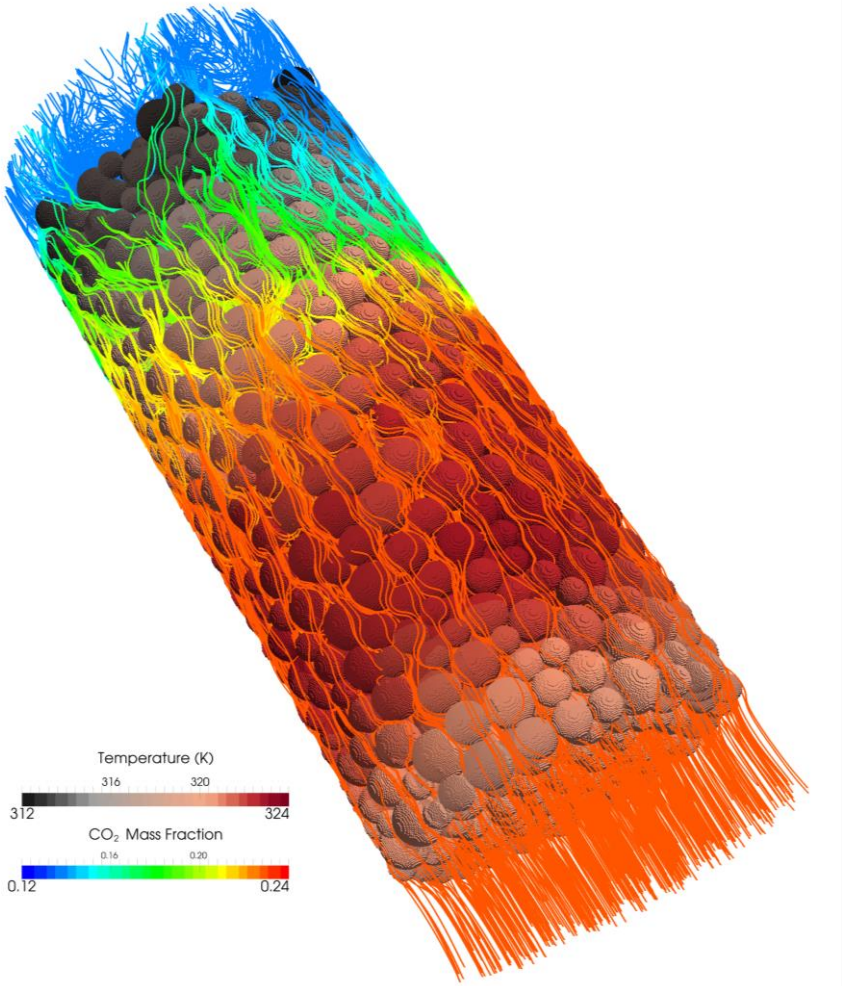
# OpenFOAM® Basic Training

# Tutorial Seven

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CFD an introduction

Cover picture from:

- Bahram Haddadi, The image presented on the cover page has been prepared using the Vienna Scientific Cluster (VSC).

# pisoFoam – pitzDaily (turbulence, transient)

## Simulation

Use the pisoFoam solver, run a backward facing step case for 0.2 s with different turbulence models:

- Smagorinsky (LES)
- oneEqEddy (LES)
- kEpsilon (RAS)

## Objectives

- Understanding turbulence models
- Understanding the difference between transient and steady state simulation
- Finding appropriate turbulent model

## Post processing

Display the results of U and the turbulent viscosity in two separate contour plots at three different time steps. Compare with steady state simulation (example 6).

## Step by step simulation

### *Copy tutorial*

Copy the tutorial from the following directory to your working directory:

```
~/OpenFOAM/OpenFOAM-
2.3.0/tutorials/incompressible/pisoFoam/les

/pitzDaily
```

### *0 directory*

Set the turbulence model initial and boundary values.

*Note: For different turbulent models, different constant files should be modified (check example 6).*

### *constant directory*

As mentioned in example 6, in turbulenceProperties the turbulent model type has to be set.

```
// * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * //

simulationType  LESModel;

// ********************************************************************************** //
```

For setting a turbulence model, if RAS models are being used, in the constant directory there is RASProperties file and we should modify it, but if LES models are used LESProperties file should be found and modified.

```
// * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * //

LESModel        oneEqEddy;

delta           cubeRootVol;

printCoeffs     on;

cubeRootVolCoeffs
{
    deltaCoeff      1;
}

PrandtlCoeffs
{
    delta           cubeRootVol;
    cubeRootVolCoeffs
    {
        deltaCoeff      1;
    }

    smoothCoeffs
    {
        delta           cubeRootVol;
        cubeRootVolCoeffs
        {
            deltaCoeff      1;
        }

        maxDeltaRatio   1.1;
    }

    Cdelta          0.158;
```

```
}

vanDriestCoeffs
{
    delta           cubeRootVol;
    cubeRootVolCoeffs
    {
        deltaCoeff      1;
    }

    smoothCoeffs
    {
        delta           cubeRootVol;
        cubeRootVolCoeffs
        {
            deltaCoeff      1;
        }

        maxDeltaRatio   1.1;
    }

    Aplus           26;
    Cdelta          0.158;
}

smoothCoeffs
{
    delta           cubeRootVol;
    cubeRootVolCoeffs
    {
        deltaCoeff      1;
    }

    maxDeltaRatio   1.1;
}

// ************************************************************************* //
```

### *Running simulation*

```
>blockMesh

>pisoFoam
```

### *Exporting simulation*

The simulation results are as follows:

For the kEpsilon model after 0.1 s the results are similar to the steady state simulation. Therefore, it can be assumed it has reached the steady state. Other models do not have a steady situation and are fluctuating all the time, so they require averaging for obtaining steady state results.

kEpsilon and other RAS models use averaging to obtain the turbulence values, but LES does not include any averaging by default. Therefore, LES simulations should use a higher grid resolution (smaller cells) and smaller time steps (for reasonable Co number). Contour plots or other LES results should be presented time averaged over reasonable number of time steps (not done in this example).

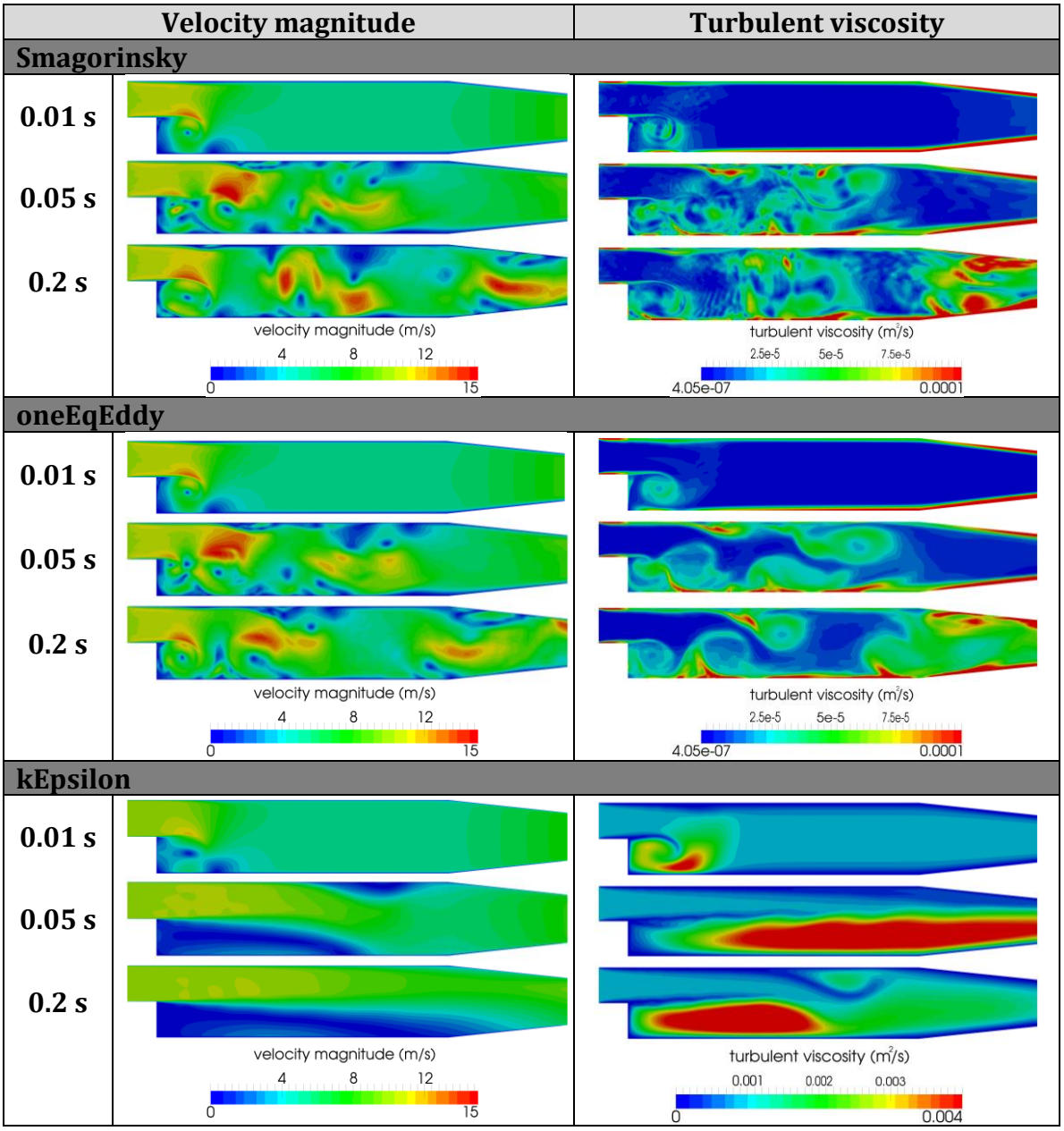


**Figure 7.1** Comparison of different turbulent models for transient simulation.