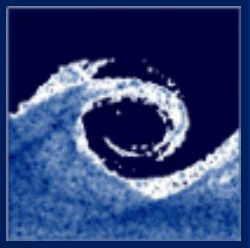
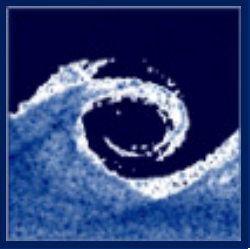


Experiments and Simulations

Lecture 11

Balogh Miklós

April 21, 2015



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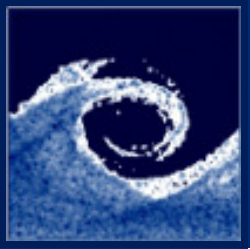
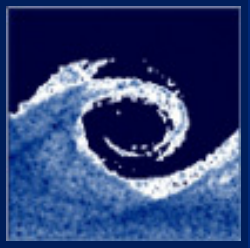


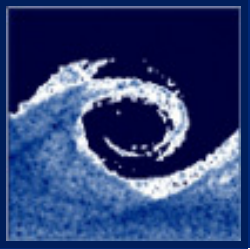
Boundary Conditions

- Inlet BC-s
  - Given analitical profiles
  - Arbitrary input parameters
  - Should be implemented as a new function
  - See e.g.:
    - laminarPipe BC (Lecture 9)
    - Turbulent BC-s for atmospheric flows (in src/.../derivedFvPatchFields)
- Wall BC-s
  - Wall functions for turbulent quantities (ν_t, k, ϵ, ω)
  - Arbitrary input parameters
  - Should be implemented as a new function
  - See WF-s for atmospheric flows (Balogh et al., 2012)
- Special
  - Non-reflective BC-s (wave transmissive, sponge)
  - Sponge could be implemented (via source terms)



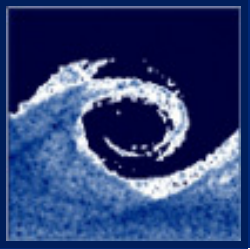
Boundary Conditions from Experimental Data

- Experiments
  - Measured quantities: U, V, W, u', v', w'...
  - Derived quantities: TI
- Simulations
  - Inlet quantities: U, V, W, k, ϵ, ω
  - Should be derived based on the theory
- Derivation
  - Turbulent kinetic energy: $k = 1.5\overline{U}^2 I^2$
  - Its dissipation rate: $\epsilon = C_\mu^{0.75} k^{1.5}/l$
  - Specific dissipation rate: $\omega = \epsilon/k$
  - Mixing length estimation: $l = 0.07L$, e.g. $l = 0.07 d_{eqv}$ for fully developed flows in pipes and channels



Mapping Boundary Conditions from Experimental Data

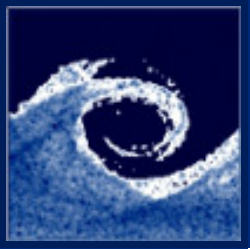
- Mapping functionality
  - Using timeVaryingMappedFixedValue BC
  - Coordinates: constant/boundaryData/points
  - Quantities: constant/boundaryData/0/...
- Mapping values at the inlet-wall join (e.g. for channels)
  - U: fixedValue (0 0 0)
  - k: kqRwallFunction (zeroGradient)
  - ϵ: epsilonWallFunction (theory)
- Set mapped fields
  - point cloud with the corresponding quantities
  - always 3 dimensional
- Example experimental data



Mapping fields - points

Listing 1: constant/boundaryData/points

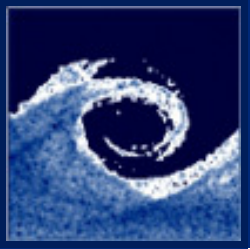
```
1  FoamFile
2  {
3      version     2.0;
4      format      ascii;
5      class       vectorField;
6      object      points;
7  }
8  //*****************************************************************//
9  (
10     // minz coordinates
11           (  0    1.016   -1)
12           (  0   1.0033   -1)
13           (  0  0.99695   -1)
14           (  0   0.9906   -1)
15           ...
16
17     // maxz coordinates
18           (  0    1.016    1)
19           (  0   1.0033    1)
20           (  0  0.99695    1)
21           (  0   0.9906    1)
22           ...
23 )
```



Mapping fields - listed fields

Listing 2: constant/boundaryData/inlet/0/k

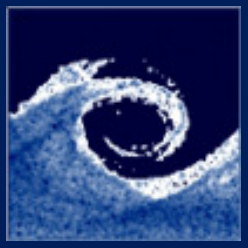
```
1  FoamFile
2  {
3      version     2.0;
4      format      ascii;
5      class       scalarField;
6      object      k;
7  }
8  //*************************************************************//
9  (
10 // Average
11 0
12
13 // Data on points
14 58
15 (
16
17     // data for minz coordinates
18     61.8027985067
19     63.5482090058
20     60.8383454386
21     51.3919900459
22     ...
23 )
```



Mapping fields - boundary definition

Listing 3: timeVaryingMappedFixedValue

```
1  boundaryField
2  {
3      // For k, epsilon (scalar-fields)
4      inlet
5      {
6          type              timeVaryingMappedFixedValue;
7          setAverage        0;
8          offset            0;
9      }
10     ...
11     // For U (vector-fields)
12     inlet
13     {
14         type              timeVaryingMappedFixedValue;
15         setAverage        off;
16         offset            (0 0 0);
17     }
18     ...
19 }
```



Topics of re-take exam

- The topics of the former mid-term exam (Lecture 1-7)
  - Introduction to OpenFOAM
  - Solving simple fluid flow problems
  - Software components
  - Stationary and transient flows
  - Turbulent and compressible flows
  - Multiphase and reactive flows
- Additional topics
  - Lecture 9 – laminar pipe flow
  - Lecture 10 – advanced post-processing
  - Lecture 11 – current topics