C1.1 Ringleb flow

1. Code description

XFlow is a high-order discontinuous finite element library written in ANSI C, intended to be run on Linux-type platforms. XFlow supports DG and HDG discretizations and a variety of equation sets, including compressible Euler, Navier-Stokes, and RANS with the Spalart-Allmaras model. High-order is achieved compactly within elements using various high-order bases on triangles, tetrahedra, quadrilaterals, and hexahedra. Parallel runs are supported using domain partitioning and MPI communication. Visual post-processing is performed with an in-house plotter. Output-based adaptivity is available using discrete adjoints.

2. Case summary

The steady runs were performed using:

- DG discretization
- Wall and exact boundary conditions
- 9 orders of magnitude L_1 residual convergence
- Element-line preconditioned Newton-GMRES solver

The runs were performed on a 24-core desktop with Intel(R) Xeon(R) CPUs and 64GB shared memory. On one core of this machine, one TauBench unit is equivalent to 9.66 seconds of compute time.

3. Meshes

The meshes used were nearly the same as the ones posted on the workshop website. The primary difference is that the nodes on the wall boundaries were snapped to the exact geometry via projection to the appropriate k value. For the wall-BC cases, all elements were curved using an order Q equal to one plus the solution approximation order ($Q = p + 1$). For the exact BC cases, elements were curved to $Q = 2$.

4. Results

The output convergence plots for the entropy norm output are shown below.
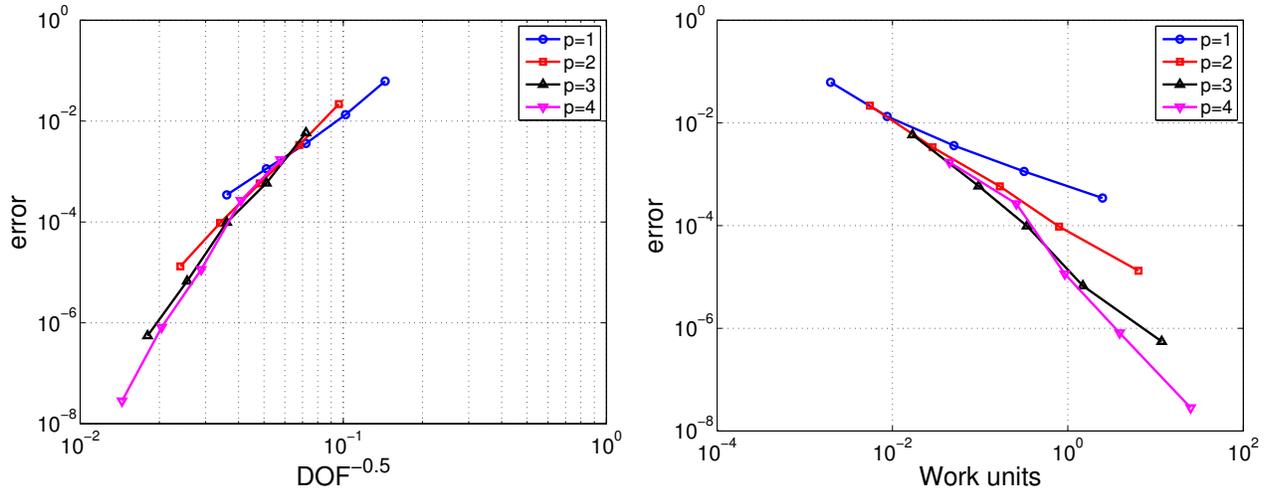
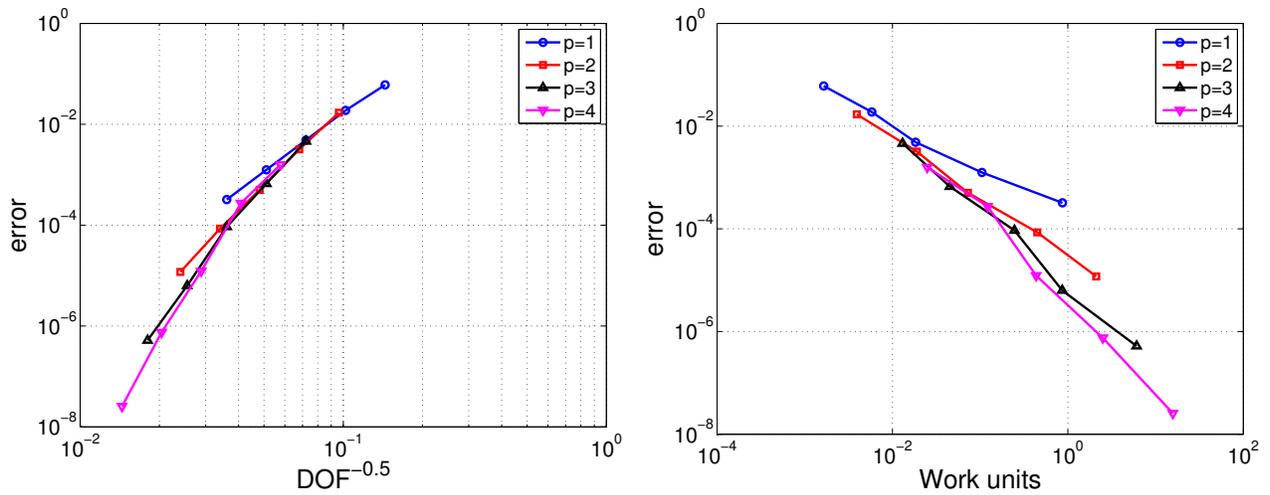Figure 1: Wall BCs: Output convergence with degrees of freedom and work units.

Figure 2: Exact BCs: Output convergence with degrees of freedom and work units.