Applying Parareal to Fluid Problems

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The usecase of parallelization in time begins when runtime reductions by spatial parallelization techniques are coming to an end. This talk addresses the Parareal algorithm, which splits the temporal domain into multiple parts and solves a given problem on each part iteratively and in parallel. It is well-known to be efficient for a restricted set of problems only, e.g. the Heat equation. When it comes to wave equations or applications in fluid mechanics the algorithm's convergence rate deteriorates or even stalls. The additional (massive) computational effort following Parallel-In-Time algorithms then ceases to justify its cost. To overcome some of these deficiencies either very problem-specific coarse solvers are needed to be developed or the iteration scheme of Parareal is sought to be modified. The latter option proved itself as very efficient for linear PDEs. Decomposition of the linear system matrix allows for a component-wise update scheme that converges in very few iterations, even for oscillatory problems. This talk dives into the modification to Parareal and its application to a range of PDEs, from linear to selected inhomogeneous and non-linear models.