Some examples illustrating how to use the relevant namelists to set the numerical methods for solving the equations

Click here to come back to the previous page

Context : Heat driven incompressible flow

- Numerical scheme for solving the governing equations of velocity and temperature
  - Time discretization : semi-implicit formulation with the 2nd order Backward Differentiation formula (BDF2)
  - Viscous and conduction fluxes (2nd order centered scheme selected by default with BDF2)
  - convective flux for momentum equation : 2nd order centered scheme, conservative form
  - advective flux for temperature equation : 2nd order centered scheme, conservative form
  - Solving Poisson's equation : see the following examples

Example 1 : Partial diagonalization method

Only one namelist is required : “Numerical_Methods”. You first find the old version and then the new one. The both versions are strictly equivalent.
The old version :

```
    &Numerical_Methods  Numerical_Scheme= 1,
                        Convective_Flux_Discretization_Type           = 1 ,
                        Temperature_Advective_Flux_Discretization_Type = 1 ,
                        Numerical_Method_Poisson_Equation   = 3    /
```

The corresponding new version :

```
  &Numerical_Methods  NS_NumericalMethod= "BDF2-SchemeO2",
                      MomentumConvection_Scheme="Centered-O2-Conservative" ,
                      TemperatureAdvection_Scheme="Centered-O2-Conservative"
,
                      Poisson_NumericalMethod="Home-PartialDiagonalization"
/
```

Example 2 : An iterative method coupled with a multigrid procedure using a "in-house" development

Suitable setting :

- A SOR solver with a relaxation coefficient of 1.7, using a red-black alogorithm in a MPI-parallel context.
- The nV-cycle multigrid procedure is composed of 5 grid levels, with a maximum number of cycles n= 10.
- The number of SOR iterations is :
  - 5 on the restriction step (going from finnest to the coarsest grid)
  - 20 on the coarsest grid
  - 15 on the prolongation step (going from coarsest to the finnest grid)
- The stopping criterion based on the residu of the computation is 1E-08

As the fluid is incompressible, the matrix coefficients of the Poisson's equation are constant.
As a “homemade” method is used, two ways are possible :

- Using the namelist “Numerical_Methods” only (old version).
- Using the namelists “Numerical_Methods” and “HomeData_PoissonSolver” (new version)

Using the namelist "Numerical_Methods" only (old version)

```
    &Numerical_Methods  Numerical_Scheme= 1,
                        Convective_Flux_Discretization_Type           = 1 ,
                        Temperature_Advective_Flux_Discretization_Type = 1 ,
                        Numerical_Method_Poisson_Equation   = 1
                        Iterative_Method_Selection          = 3   ,
                        Number_max_Grid = 5                         ,
                        Number_max_Cycle= 10                       ,
                        Number_Iteration= 15,
                        Number_Iteration_FineToCoarseGrid= 5,
                        Number_Iteration_CoarsestGrid    = 15,
                        Number_Iteration_CoarseToFineGrid= 10,
                        Relaxation_Coefficient           = 1.70 ,
                        Convergence_Criterion            = 1.D-08 /
```

Using the namelists "Numerical_Methods" and "HomeData_PoissonSolver" (new version)

```
    &Numerical_Methods  NS_NumericalMethod= "BDF2-SchemeO2",
                        MomentumConvection_Scheme="Centered-O2-Conservative"
,
                        TemperatureAdvection_Scheme="Centered-O2-
Conservative" ,
                        Poisson_NumericalMethod="Home-SORMultigrid-
ConstantMatrixCoef"/
    &HomeData_PoissonSolver   SolverName="SOR",
                              Number_max_Grid = 5                         ,
                              Number_max_Cycle= 10                       ,
```

```
                                Number_Iteration= 15,
                                Number_Iteration_FineToCoarseGrid= 5,
                                Number_Iteration_CoarsestGrid    = 15,
                                Number_Iteration_CoarseToFineGrid= 10,
                                Relaxation_Coefficient           = 1.70 ,
                                Convergence_Criterion            = 1.D-08 /
```

Example 3 : An iterative method coupled with a multigrid procedure using the HYPRE library

Suitable setting :

- Selection of the PFMG method using a SOR relaxation method for non symmetrical matrix (even though the Poisson's operator could be symmetric in this context)
- The number of iterations is :
  - The maximum iteration number is 20
  - 5 relaxation sweeps before coarse-grid correction
  - 10 relaxation sweeps after coarse-grid correction
- The tolerance convergence is 1E-08

Using the namelists "Numerical_Methods" and "HypreData_PoissonSolver" (new version only)

```
    &Numerical_Methods  NS_NumericalMethod= "BDF2-SchemeO2",
                        MomentumConvection_Scheme="Centered-O2-Conservative"
,
                        TemperatureAdvection_Scheme="Centered-O2-
Conservative" ,
                        Poisson_NumericalMethod="Home-Multigrid-
ConstantMatrixCoef"/
    &HypreData_PoissonSolver  SolverName="SOR-Redblack-Nonsym",
                              Number_Iteration                 = 20 ,
                              Number_Iteration_FineToCoarseGrid= 5,
                              Number_Iteration_CoarseToFineGrid= 10,
                              Convergence_Criterion            = 1.D-08 /
```

Click here to come back to the previous page