Parallel MODFLOW 6

Jarno Verkaik

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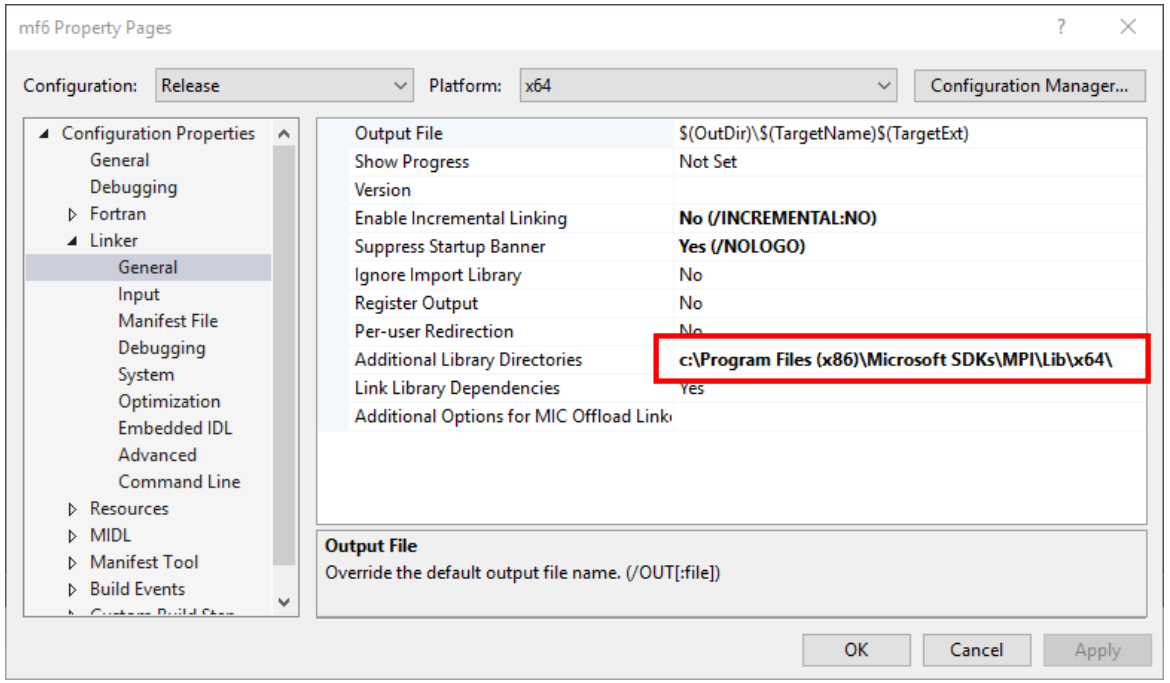
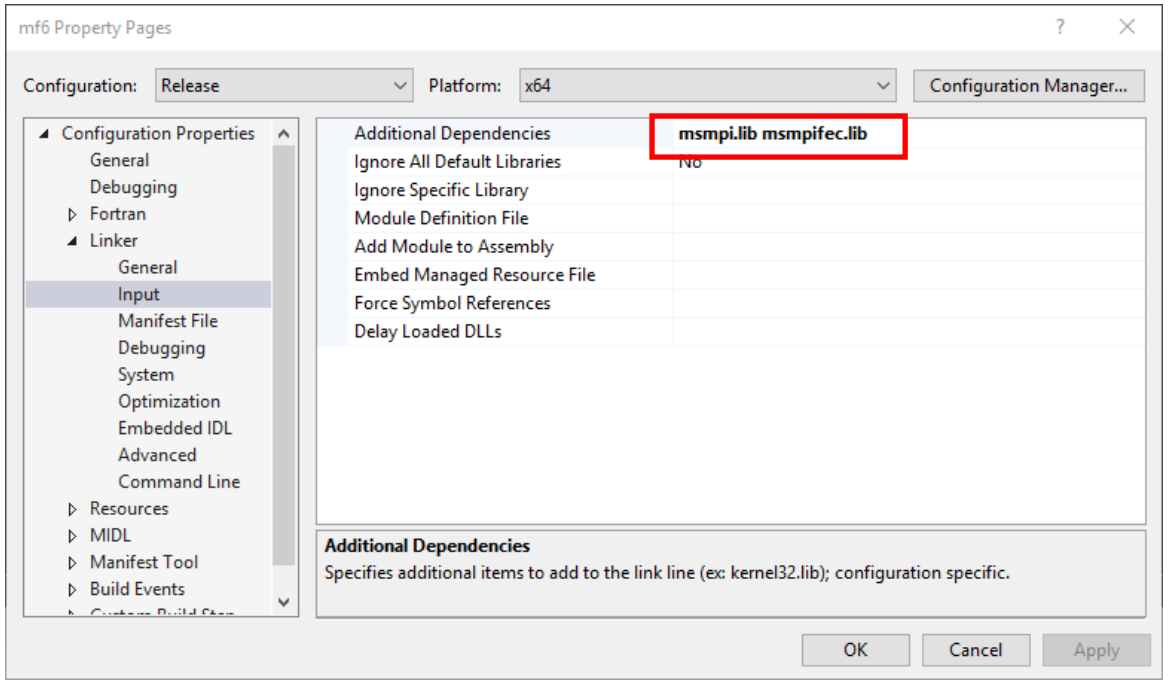
Compiling and linking

- Source: https://github.com/verkaik/modflow6-parallel.git
- Windows: install Microsoft MPI (or MPI-CH)
- Visual Studio:





Compiling and linking

- Linux: e.g. mpiifort using OpenMPI or MicroSoft MPI (see e.g. module load avail)
- Generate makefile with makegen.py:

jverkaik@int2:~/codes/mf6/compile

```
    plt.savefig(f)

if __name__ == "__main__":

    ###########################################################
    bindir   = "/home/jverkaik/codes/mf6/compile/bin/"
    program  = "mf6"
    f90flags = "-O3 -fpp -DMPI_PARALLEL -assume buffered_io"
    f90      = "mpiifort"
    srcInDir  = ["/home/jverkaik/codes/mf6/modflow6-parallel/src/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Exchange/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Model/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Model/Geometry/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Model/GroundWaterFlow/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Model/ModelUtilities/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Solution/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Solution/SparseMatrixSolver/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Timing/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Utilities/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Utilities/Memory/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Utilities/Observation/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Utilities/OutputControl/",
                 "/home/jverkaik/codes/mf6/modflow6-parallel/src/Utilities/TimeSeries/"]

    srcExcl = []
    srcOutDir = "./src/"
    srcExt    = ['.f','.F','.for','.FOR','.f90','.F90','.fpp']
    hdrExt    = ['.inc','.h','.fi','.gin','.com']
    overwrite = True
                                                          126,18        37%
```

Preparing model (mfsim.nam)

1. Set number of cores in mfsim.nam:

```
BEGIN OPTIONS
  MEMORY_PRINT_OPTION SUMMARY
  DOMAIN_DECOMPOSITION 9
END OPTIONS
```

2. Assign each GWF model uniquely to a processor core:

```
BEGIN MODELS
  GWF6 .\m1_1\m1_1.nam m1_1 1
  GWF6 .\m1_2\m1_2.nam m1_2 2
  GWF6 .\m1_3\m1_3.nam m1_3 3
  GWF6 .\m2_1\m2_1.nam m2_1 4
  GWF6 .\m2_2\m2_2.nam m2_2 5
  GWF6 .\m2_3\m2_3.nam m2_3 6
  GWF6 .\m3_1\m3_1.nam m3_1 7
  GWF6 .\m3_2\m3_2.nam m3_2 8
  GWF6 .\m3_3\m3_3.nam m3_3 9
END MODELS
```

Running model

- Linux: use batch script, e.g. slurm
- Windows: using MicroSoft MPI

```
set mpi="c:\Program Files\Microsoft MPI\Bin\mpiexec.exe"
set exe="c:\Users\verkaik_jo\data\codes\git\modflow6-parallel-11-02-21\bin\mf6.exe"
set np=9
set nam="my_mfsim.nam"

%mpi% -np %np% %exe% -s %nam%
```


Number of cores

More advanced options

- Coarse grid correction preconditioner (also supported for serial run):

In mfsim.nam:

```
BEGIN SOLUTIONGROUP 1
  IMS6_CGC structest.ims FILEIN solmodels.asc.wrp
END SOLUTIONGROUP
```

solmodels.asc.wrp:

```
BEGIN MODELS
  OPEN/CLOSE solmodels.asc
END MODELS
```

solmodels.asc:

m1_1	1
m1_2	2
m1_3	3
m2_1	4
m2_2	5
m2_3	6
m3_1	7
m3_2	8
m3_3	9

Assign to processor core

More advanced options

- Block Jacobi preconditioner:
  - Default for parallel, also supported for serial
  - For testing parallel vs. serial to check if linear solver convergence matches
  - Enable this option in IMS-file:

```
BEGIN NONLINEAR
  OUTER_HCLOSE 1E-08
  OUTER_MAXIMUM 2
  LINEAR_SOLVER_BJPC
END NONLINEAR
```

- IMS option for viewing linear convergence:

```
BEGIN OPTIONS
  PRINT_OPTION ALLITER
END OPTIONS
```

More advanced options

- Direct acces binary read for reducing number of (transient) files:

```
BEGIN OPTIONS
END OPTIONS

BEGIN GRIDDATA
  ICELLTYPE
    CONSTANT 0
  K
    OPEN/CLOSE ..\..\models\run_input\m00001\m00001.bin (BINARY) 241778817 253446421
  K33
    OPEN/CLOSE ..\..\models\run_input\m00001\m00001.bin (BINARY) 253446421 265114025
END GRIDDATA
```

Start position in bytes

End position in bytes

1 file for all binary bulk data

Begin = position 1

More advanced options

- Mover is supported (no additional input is required).
- Multiple solutions are supported in parallel, where each solution corresponds to a MPI communicator group