# MM5

How to run it?

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## Topics of Discussion

- How to compile and run MM5
- Namelist setup for typical runs
- Input and output files
- Input and output options
- More namelist options
- Miscellaneous topics

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## How to compile and run MM5?

(page 8-22)

- Step 1:
  Choose compilation options in `configure.user` file and compile the code
- Step 2:
  Modify runtime options in `mm5.deck` and execute the program

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## How to compile MM5?

- After download, uncompress, and untar the MM5 program tar file, cd to the *MM5* directory
- Edit `configure.user` file to select the compile option for your computer:
  - section 3: single processor or OpenMP
  - section 7: MPP options for multi-nodes, clusters

  and edit sections 5 and 6 for your case:
  - section 5: domain sizes, FDDA
  - section 6: physics options

Remember modifying anything in `configure.user` requires RECOMPILATION

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## How to compile MM5? (cont.)

- Domain sizes:
  *MIX, MJX, MKX* – translated to parameter statements in MM5 source code
- Physics options:
  - *IMPHYS* – microphysics options (1 – 8)
  - *ICUPA* – cumulus convection options (1 – 8)
  - *IBLTYP* – planetary boundary layer (0 – 7)
  - *ISOIL* – soil model options (0 – 3)
  - *FRAD* – atmospheric radiation options (0 – 4)
  - *IPOLAR* – polar physics modifications (0 or 1)
  - *ISHALLO* – shallow convection (0 or 1) – not well tested.

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## How to compile MM5? (cont.)

- Type
  `make`
  or
  `make >& make.out &`
  to compile

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## How to run MM5? (pages 8-22,23)

- Use *mm5.deck* to run MM5
- To create a *mm5.deck*, type
  `make mm5.deck`
- Edit *mm5.deck* for run-time / namelist options

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## Alternative way to run MM5

- Edit *configure.user* file as usual.
- Create *mmlif* file:
  - Create *mm5.deck* first
  - Run it for a few time steps, then kill it
  - cd to *Run/* directory, *mmlif* should be there
- May change *mmlif* for various options (if it is an option specified in *configure.user* file, make sure that it is compiled)
- Type *mm5.exe* to run directly

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## A note on namelist

- When there is a single value, it usually applies to all domains. e.g.
  *IFUPR*
- When there are 10 values in a row, each value corresponds to each domain
  *IMPHYS* = 4,5,5,0,0,0,0,0,0,0,
  *ISFFLX* = 1,1,1,0,0,0,0,0,0,0,
- Special case:
  *FRAD* = 2,1,3,4,0, - only the first one is used

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## Complete list of namelist variables… (pages 8-30 – 8-36)

- There are 5 namelists:
  - *OPARAM* (time control, input and output options)
  - *LPARAM* (physics options)
  - *NPARAM* (nest options)
  - *PPARAM* (changeable parameters)
  - *FPARAM* (FDDA options)

(There are a total of 111 namelist variables in 3.7)

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## Basic runs (page 8-23)

- Modify the following in *mm5.deck* for your case:
  - *TIMAX, TISTEP,TAPFRQ*
  - *NESTIX, NESTJX*, domain sizes

  If there is a nest:
  - *NESTI, NESTJ*, nest starting location in its mother domain
  - *NUMNC*: nest mother domain ID
  - *IOVERW*: nest initialization option

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## Restart runs (page 8-23)

- In addition to those defined for a standard run, set
  *IFREST = .TRUE.*
  *IXTIMR = 720.* (it appears at the end of *mm5.print.out* file from the previous run)
- Make sure times are available in BDYOUT_DOMAIN1 file

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## One-way Run (page 8-23)

> Treat it the same way as it is a standard run.

> Name the *MMINPUT, BDYOUT* and LOWBDY files generated from program *NESTDOWN* to

*MMINPUT_DOMAIN1*

*BDYOUT_DOMAIN1*

*LOWBDY_DOMAIN1*

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## Input Files (pages 8-24)

- For standard run:
  Input files from *INTERPF*:
  - MMINPUT_DOMAIN1,
  - BDYOUT_DOMAIN1
  - LOWBDY_DOMAIN1
  - TERRAIN_DOMAINx (if using *IOVERW=2*)

*Additional input files required for FDDA runs (see later)*

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## Input files (cont)

- If it is restart run:
  Model output SAVE_DOMAINx files from previous run, rename them to RESTART_DOMAINx

*What is a restart run?*

- *Split a long run into several smaller runs*
- *Continue a run if the model blows up*

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## Input files (cont)

- Other input files (provided):
  - LANDUSE.TBL
  - BUCKET.TBL (*IMOIAV* = 1, 2 only)
  - RRTM_DATA (*FRAD* = 4 only)
  - VEGPARM.TBL (*ISOIL* = 2)
  - SOILPARM.TBL (*ISOIL* = 2)
  - GENPARM.TBL (*ISOIL* = 2)

Note that MM5 job expects all the input files either located in or linked to the *Run/* directory

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## Output files (pages 8-24,27)

- History files (if *IFTAPE* = 1)
  MMOUT_DOMAINx – where x is domain no.
- Restart files (if *IFSAVE* = T)
  SAVE_DOMAINx
- time series output (if *IFTSOUT* = T)
  fort.26 for domain 1
  fort.27 for domain 2, etc.

Variables in MM5 history file and time series output are listed on page 8-24 – 8-27

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## Input options (page 8-31)

- MM5 can skip input files and start at any times which is available in MMINPUT file (*IFSKIP* and *CDATEST*)
  For example, for an MMINPUT file that contains the following times:
  2004_01_04:12:00:00
  2004_01_05:00:00:00 ← model may start from here
  2004_01_05:12:00:00
  2004_01_06:00:00:00

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## Lateral BC options (page 8-32)

- *IBOUDY* = 3
  Boundary condition option for coarse domain
- *IBOUDY* = 0
  Coarse domain lateral boundary condition. Use it if you absolutely have to
- *IBOUDY* = 2
  Boundary condition for the nest (do not change)

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## Nest initialization option (*IOVERW*) (page 8-34)

- *IOVERW* = 0
  - Nest initialized completely from coarse domain MMINPUT file, inc. terrain etc.
  - Nest can start any time, and move
  - Required input files are
    `MMINPUT_DOMAIN1`
    `LOWBDY_DOMAIN1` (always required)
    `BDYOUT_DOMAIN1` (always required)

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## Nest initialization option (*IOVERW*) (cont)

- *IOVERW* = 1
  - Nest initialized from MMINPUT files for each of the nest domains
  - Nest can only start at initial time
  - Required input files are
    `MMINPUT_DOMAIN1, 2, 3, …`
    `LOWBDY_DOMAIN1` (always required)
    `LOWBDY_DOMAIN2, 3, …` (optional)
    `BDYOUT_DOMAIN1` (always required)

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## Nest initialization option (*IOVERW*) (cont)

- *IOVERW* = 2 (recommended)
  - Nest initialized from coarse domain MMINPUT file and TERRAIN files for each of the nest domains
  - Nest can start at any time
  - Required input files are
    `MMINPUT_DOMAIN1`
    `TERRAIN_DOMAIN2, 3, …`
    `LOWBDY_DOMAIN1` (always required)
    `LOWBDY_DOMAIN2, 3, …` (optional)
    `BDYOUT_DOMAIN1` (always required)

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## Output options (page 8-31)

- For history files (*IFTAPE* = T):
  MM5 can output at different times for different domains (*INCTAP* option)
  For example, if
  - *MAXNES*= 3
  - *TAPFRQ* = 60.,
  - *INCTAP* = 6,3,1,…. then

  domain 3 will be output at every 60 min
  domain 2 will be output at every 60 x 3 or 180 min
  domain 1 will be output at every 60 x 6 or 360 min

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## Output options (cont)

- For history files:
  MM5 can split output into several pieces by using *BUFFRQ*
  For example, if TIMAX = 1440.
  - *TAPFRQ* = 60.,
  - *BUFFRQ* = 360., then

  output will be split into 5 pieces:
  `MMOUT_DOMAIN1_00`: hour 0
  `MMOUT_DOMAIN1_01`: hour 1 – 6
  `MMOUT_DOMAIN1_02`: hour 7 – 12
  `MMOUT_DOMAIN1_03`: hour 13 – 18
  `MMOUT_DOMAIN1_04`: hour 19 – 24

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## Output options (cont)

- For restart files (*IFSAVE* = T)
  MM5 allows you to store all save times in the save file at interval specified by *SAVFRQ*, or the last save time in the save file (*SVLAST* = T) to save disk space

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## Output options (cont)

- To output time series: set
  *IFTSOUT* = T and specify
  *TSLAT, TSLON*: the latitude/longitude locations
- Output has 13 'surface' variables from the model at every model time step
  *e.g.* 2 m T, Qv, 10 m u,v (earth-coordinate), surface fluxes (see page 8-26 for a listing)

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## Physics options (pages 8-28,30)

- Standard ones (as defined in *configure.user*)
  *IMPHYS*: for microphysics
  *ICUPA*: for cumulus convection
  *IBLTYP*: for planetary boundary layer
  *ISOIL*: for land surface
  *IFRAD*: for atmospheric radiation
  *IPOLAR*: for activating polar physics

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## Other useful namelists options (pages 8-32,33)

- *IFUPR*: upper radiative boundary condition (good for < 50 km grid)
- *ISSTVAR*: whether SST/sea ice/snow cover is going to be updated during a long simulation (> 3-5 days) – *make sure that you have real SST from pregrid*
  0: no;
  1: yes, fields will be updated during a simulation at the interval available in the `LOWBDY_DOMAINx` files

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## Other useful namelists options (page 8-33)

- *IMOIAV*: how bucket soil moisture model is initialized (if not using a land-surface model)
  0: do not use bucket soil moisture model
  1: use table values from `LANDUSE.TBL`
  2: use soil moisture field in MMINPUT
- *IFSNOW*: how snow cover data are considered
  0: not considered;
  1: considered, but constant during the run
  2: can be updated with simple snow model

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## Other useful namelists options (page 8-33)

- *ISFMTHD*: methods for calculating 2 m / 10 m temperature and wind diagnostics (*IBLTYP* = 2, 5 only)
  0: old method;
  1: new method for stable conditions
- *IZ0TOPT*: thermal roughness length option (*IBLTYP* = 2, 5 only)
  0: default (old) scheme;
  1: Garratt formulation;
  2: Zilitinkevich formulation

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## Useful namelists for sensitivity test (pages 8-33)

- *IFDRY*=1: excluding latent heating (must also set ICUPA = 1)
- *ISFPAR*=0: reset landuse with land and water only
- *ISFFLX*=0: may turn of surface fluxes

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## Useful namelists to control model constants (page 8-35)

- *SOILFAC* = 1. – 2.: makes soil time step in 5-layer soil model more conservative
- *CZO,OZO*: constants in Charnock relation for water roughness length used in IBLTYP = 2,5,6. Default values: CZO=0.032, and OZO = 0.1 mm
- *CKH*: factor to control background diffusion. Default value is 1., which gives the same b.d. as versions before 3.5 if one uses 3DX as the time step
- If *ISFPAR* = 0, one may set values for *ZZLND, ZZWTR, ALBLND,THILND* and *XMAVA*
- *CONF*: criterion for super saturation removal (< 1 and for *IMPHYS* = 1 only)

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## Namelists for using Noah LSM (pages 8-29, 8-33,34)

- Set *ISOIL* = 2 in *configure.user* file
- Additional options to decide whether to use climatological albedo fields:
  - *RDMAXALB*: true or false
  - *RDBRDALB*: true or false
- Options to specify input soil layers, if they are different from what Noah uses:
  - *ISTLYR*: soil temp layers
  - *ISMLYR*: soil moisture layers

*Tip: see Appendix C for more information*

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## Useful namelists for nesting (pages 8-34,35)

- *LEVIDN* (nest level)
- *NUMNC* (mother domain ID)
- *XSTNES, XENNES*: beginning and ending nest times (doesn't apply to domain 1)
- *IFEED*: nest feedback option. Recommended option: 3

*Note that the default MM5 code handles 6 levels of nesting. Code may be modified to add more levels of nesting (details available on the FAQ page)*

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## Useful namelists for nesting (cont)

- Moving nest options for the most inner domain:
  - *IMOVE*: whether this nest will move
  - *IMOVCO*: move counter
  - *IMOVEI*: no of grids moved in y-direction
  - *IMOVEJ*: no of grids moved in x-direction
  - *IMOVET*: time of nest moves

*Tip: Move less frequent, and with large overlap*

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## FDDA runs

- Compilation options in *configure.user* file
  Set either or both *FDDAGD* and *FDDAOB* = 1
- Runtime options for analysis or grid nudging (page 8-35, 36):
  - *FDASTA, FDAEND*: start and end of FDDA time
  - *I4D*: whether to use FDDA option
  - *DIFTIM*: analysis time intervals
- Two rows: upper row for 3D analysis nudging, and lower row for surface analysis nudging. e.g.

```
I4D = 1,0,0,0,0,0,0,0,0,0,
      0,0,0,0,0,0,0,0,0,0,
```

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## FDDA runs (cont) – Additional input files

- For analysis nudging:
  - standard MMINPUT files
  - `SFCFDDA_DOMAINx` from *RAWINS/LITTLE_R* programs
- For observation nudging:
  - `MM5OBS_DOMAINx` generated by user

*Tip: file format described on pages 8-21 or 13-20*

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## Namelist for FDDA (pages 8-35,36)

- Runtime options for analysis nudging:
  - *IWIND, GV*: whether to nudging wind, and weighting coefficient for wind nudging
  - *ITEMP, GT*: whether to nudging temp, and weighting coefficient for temp nudging
  - *IMOIS, GQ*: whether to nudging moisture, and weighting coefficient for moisture nudging
  - *INONBL*: whether to exclude boundary layer nudging when using only 3D analysis

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## Namelist for FDDA (cont)

- Runtime options for observation nudging:
  - *I4DI*: whether to do obs nudging
  - *ISWIND, GIV*: whether to nudging wind, and weighting for wind nudging
  - *ISTEMP, GIT*: whether to nudging temp, and weighting for temp nudging
  - *ISMOIS, GIQ*: whether to nudging moisture, and weighting for moisture nudging
  - *RINXY*: radius of influence
  - *TWINDO*: time window in minutes
  - *NPFI*: time frequency to computer weighting

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## Namelist for FDDA (cont)

- Runtime options for dynamic initialization:
  - *IDYNIN*: whether to use this option
  - *DTRAMP*: time window in minutes to ramp nudging terms. +: means ramping is done after *FDAEND* time; -: means ramping is done before *FDAEND* time.


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## A note on time specification in the MM5 namelist

- All time variables used in the namelist are defined in *minutes.* e.g. *TIMAX, TAPFRQ, SAVFRQ, IXTIMR, IMOVET, FDASTA, FDAEND,* etc..

(except for *TISTEP*, which is defined in *seconds*).

- All of these times are specified with respect to domain 1's starting time, regardless it is an original run or a restart run.

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## New namelist variables in 3.7

- *IFRSFA* – used for restart and FDDA runs
- *ITPDIF* = 2 (and *TDKORR*) – more accurate (and *expensive*) diffusion scheme
- *LEVSLP* – topography slope effect
- *OROSHAW* – terrain shadow effect
  - May be used for high resolution runs
- *ITADVM*, *IQADVM*

*Tip: Use default options unless you see problems*

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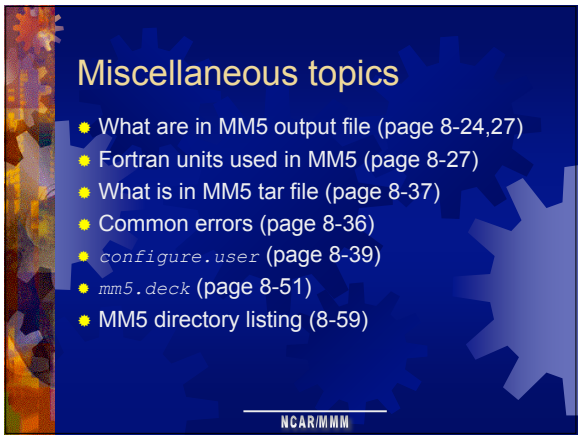
Miscellaneous topics
What are in MM5 output file (page 8-24,27)
Fortran units used in MM5 (page 8-27)
What is in MM5 tar file (page 8-37)
Common errors (page 8-36)
configure.user (page 8-39)
mm5.deck (page 8-51)
MM5 directory listing (8-59)
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