MM5

How to run it?

Wei Wang

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
- Examples

How to compile and run MM5?

(page 8-21)

- 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

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 compile options 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

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)

How to compile MM5? (cont.)

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

How to run MM5? (page 8-21,22)

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

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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… (8-29 – 8-35)

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

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Basic runs (page 8-22)

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

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

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Restart runs (page 8-22)

- 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 file

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One-way Run (page 8-22)

> 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 8-22,23)

- 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

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Input files (cont)

- If it is restart run:
  Model output `SAVE_DOMAINx` files from previous run, renamed 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 or linked in the *Run/* directory

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Output files (pages 8-23 – 8-26)

- History files (if *IFTAPE* = 1)
  `MMOUT_DOMAINx` – 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.

List of variables in MM5 output file on page 8-23 – 8-26

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Input options (page 8-30)

- 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 8-31)

- *IBOUDY* = 3
  Recommended boundary condition for coarse domain
- *IBOUDY* = 2
  Boundary condition for the nest
- *IBOUDY* = 0
  Coarse domain lateral boundary condition. Use it if you absolutely have to

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Nest initialization option (*IOVERW*) (page 8-32)

- *IOVERW* = 0
  - Nest initialized completely from coarse domain MMINPUT file
  - 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 8-29, 8-30)

- 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 save at every save time in a file (*SAVFRQ*), or the last save time in a file (*SVLAST* = T) in order to save disk space

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Output options (cont)

- To output time series: set
  IFTSOUT = T and
  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 (8-27,28)

- 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 (page 8-31)

- *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 – *make sure that you have real SST*
  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 8-31)

- *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 8-31)

- *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 nesting (pages 8-32,33)

- *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 default MM5 code handles 4 levels of nesting only. Code may be modified to add more levels of nesting (details available on the FAQ page)

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Useful namelists for nesting (pages 8-33)

- 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

Useful namelists for sensitivity test (pages 8-31)

- *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

Useful namelists to control model constants (page 8-33)

- *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)

Namelists for using Noah LSM

- 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

Tip: see Appendix C for more information

FDDA runs

- Compilation options in *configure.user* file
  Set either or both *FDDAGD* and *FDDAOB* = 1
- Runtime options for analysis or grid nudging (page 8-34, 35):
  - *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,
```


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 8-20 or 13-20, 21

Namelist for FDDA

- 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

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

Namelist for FDDA (cont)

- Runtime options for dynamic initialization:
  - *IDYNIN*: whether to do 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.

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.

Miscellaneous topics

- What are in MM5 output file (page 8-23)
- Fortran units used in MM5 (page 8-26)
- What is in MM5 tar file (page 8-36)
- Common errors (page 8-35)
- configure.user (page 8-37)
- configure.user.linux (page 8-49)
- mm5.deck (page 8-51)
- MM5 directory listing (8-59)