MM5 Modeling

Thailand Application

Where to get information

- NCAR MM5 Community Model home page:

 http://www.mmm.ucar.edu/mm5/

- PSU/NCAR Mesoscale Modeling System Tutorial Class Notes and User's Guide" MM5 Modeling Systemp Version 3

 http://www.mmm.ucar.edu/mm5/documents/MM5_tut_Web_notes/tutorialTOC.htm

- Learn by following the on-line tutorial:

 http://www.mmm.ucar.edu/mm5/mm5v3/tutorial/teachyourself.html

ADDITIONAL SUPPORT

- Go to user support:
  - http://www.mmm.ucar.edu/mm5/support/meso user.html
  - http://www.mmm.ucar.edu/mm5/support/policy .html

  Fill out the user registration form to get access to mm5-news and mm5-users mailing lists

- Contract Support: **EarthTech, Inc.**
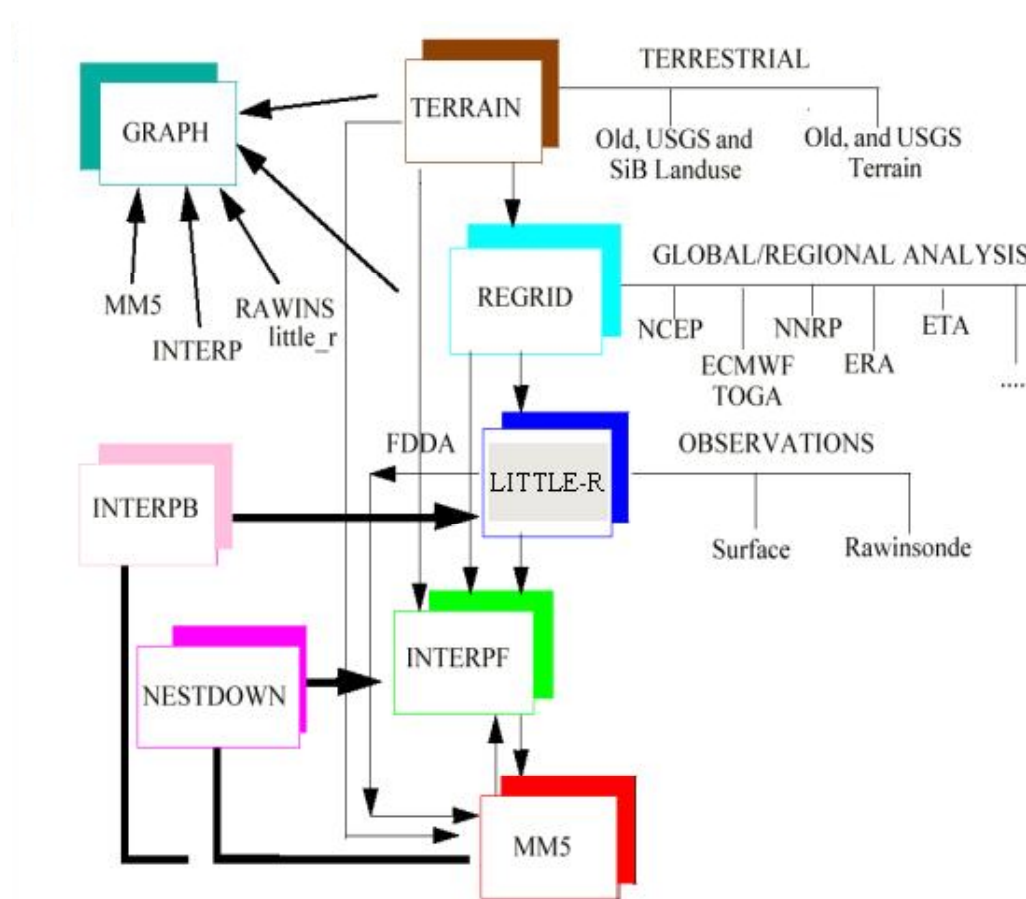 - Customized MM5 simulation

THAILAND APPLICATION

- Note: the option selection for this application is an example of how to run MM5 over Thailand but it is NOT THE ONLY WAY!

- Run was performed on 5 days – May 31, 2002 hour 0 to June 6, 2002 hour 0

- Platform used for example is a DEC_ALPHA - 4100/8400 Series (Compaq)

- Data for this period are available on the DVD – note: the example files are finishing with ".thai". It is recommended to start again with files created when UNTAR is done and follow the instruction to create executable and namelist.input file (some files are platform specific. ".thai" files may not work on your platform)

Get the PROGRAMS for this Application

- Create a directory MM5V3
- GO TO ftp://ftp.ucar.edu/mesouser/MM5V3/
- DOWNLOAD The PROGRAM we need for this application:
  - TERRAIN.TAR.gz
  - REGRID.TAR.gz
  - INTERPF.TAR.gz
  - MM5.TAR.gz
  - GRAPH.TAR.gz
- Unzipped (gunzip XXX.TAR.gz), UNTAR (tar –xvf XXX.TAR) each inside MM5V3, a directory for each program will be created.

MM5 Modeling system flow Chart

RUNNING TERRAIN
DOMAIN CONFIGURATION; CREATE TERRESTRIAL FIELDS

- GOTO TERRAIN directory
- If NCARG graphic is used, make sure NCARG_ROOT linked to the right library
- Type **make terrain.deck**: two files are created terrain.deck and terrain.deck.intel
- Edit "terrain.deck" (application example: terrain.deck.thai)

RUN TERRAIN (Cont'd)

- FTPDATA is set to .False.
- IIMX=201; JJMX=201 (max of any domain)
- ITRH=1500, JTRH=1500 (max of source data)
- PHIC=12.6 (Central latitude of coarse domain, positive for North)
- XLONC=100.0 (Central longitude of coarse domain, positive for East)
- IEXP = .F. (no expansion of coarse domain)
- IPROJ='LAMCON' Lambert conformal projection
- TRUELAT1=30; TRUELAT2=5 (for LCC projection, positive for North)

RUN TERRAIN (Cont'd)

- MAXNES=4 (4 domains are used)
- NESTIX (31, 34, 37, 49) - I(y)-direction dimension of each domain
- NESTJX (34, 34, 52, 46) - J(x)-direction dimension of each domain
- DIS (81, 27, 9, 3) - grid distance for each domains in km (3:1 ratio between mother/daughter domain; because two-way nesting chosen)
  - Domain 1: grid resolution, dis_1= 81 km
 - Domain 2: grid resolution, dis_2=dis_1/3 = 27 km …

RUN TERRAIN (Cont'd)

- NUMNC (1,1,2,3) - mother domain's ID
- NESTI (1, 11, 11, 12) - I location in its mother domain LLC
- NESTJ (1, 12, 10, 29) - J location in its mother domain LLC
- NTYPE (3,4,5,6) - Source terrain height and land-use data type
  - If type=6, better than ftp, put the 30second terrain data you need in a special directory.
  - To get the data: ftp edcftp.cr.usgs.gov; user anonymous; psswd=your e-mail (goto: cd /pub/data/gtopo30/global)
- NSTYP (2,2,2,2) - nest type; 2=two-way nesting

RUN TERRAIN (Cont'd)

- IFTER=.TRUE. (create terrain file for the next steps+ map, if FALSE create only maps, used to set up the domain)
- LSMDATA=.FALSE. (true if LSM option for more detailed soil is used)
- IEXTRA=.FALSE. (true for LSM)
- VEGTYPE=1 (use 24-category USGS global dataset)
- RUN **terrain.deck>& log &**
- Use **idt TER.PLT** to see the terrain/landuse

MM5 domains for Thailand
LCC coordinates centered on 12.6N, 100E
Standard Parallels: 5N and 30N
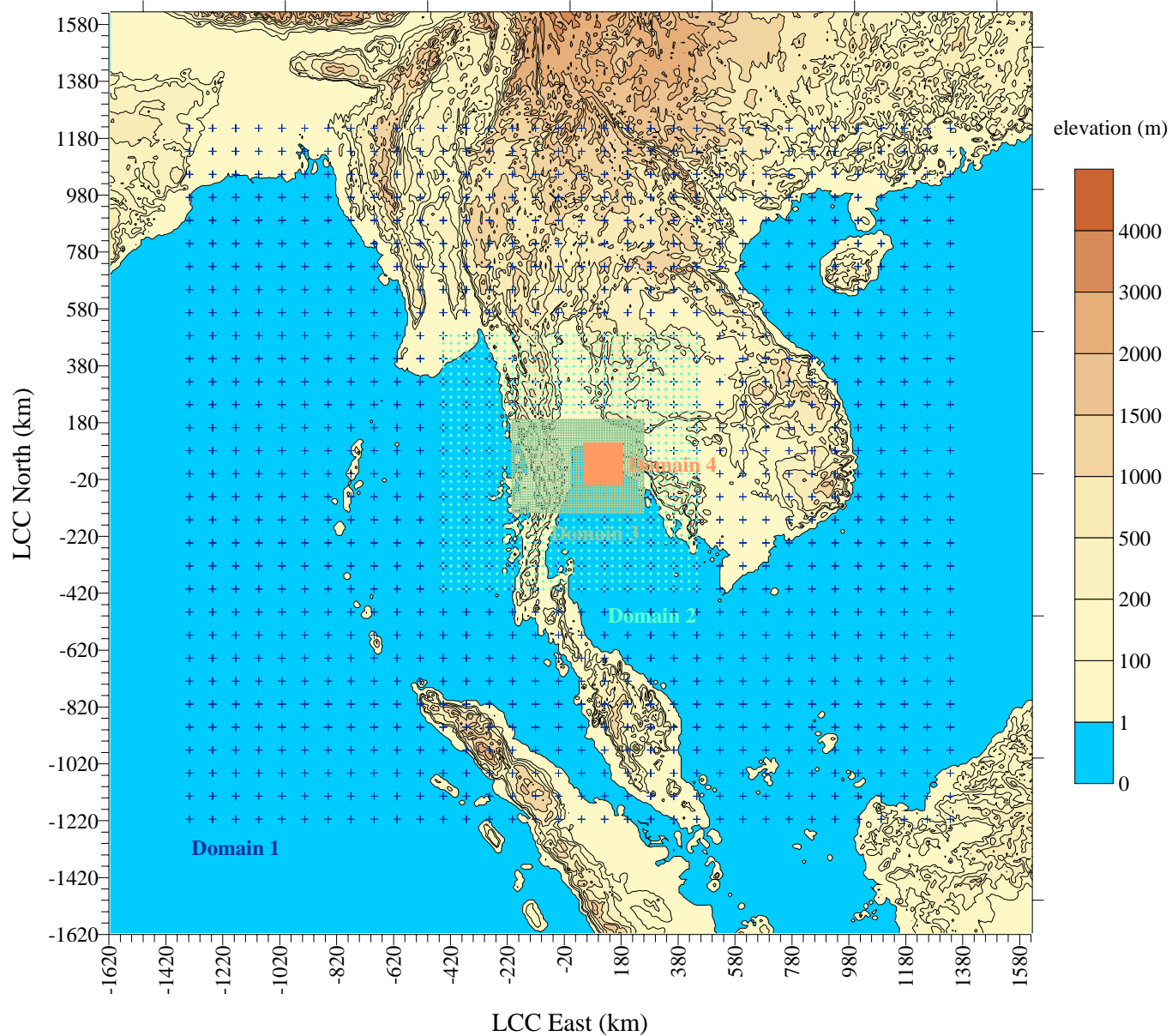
D1: 2673 km x 2430 km (34 x 31 - DX = 81 km)
D2: 891 km x 891 km (34 x 34 - DX = 27 km)
D3: 459 km x 324 km (52 x 37 - DX = 9 km)
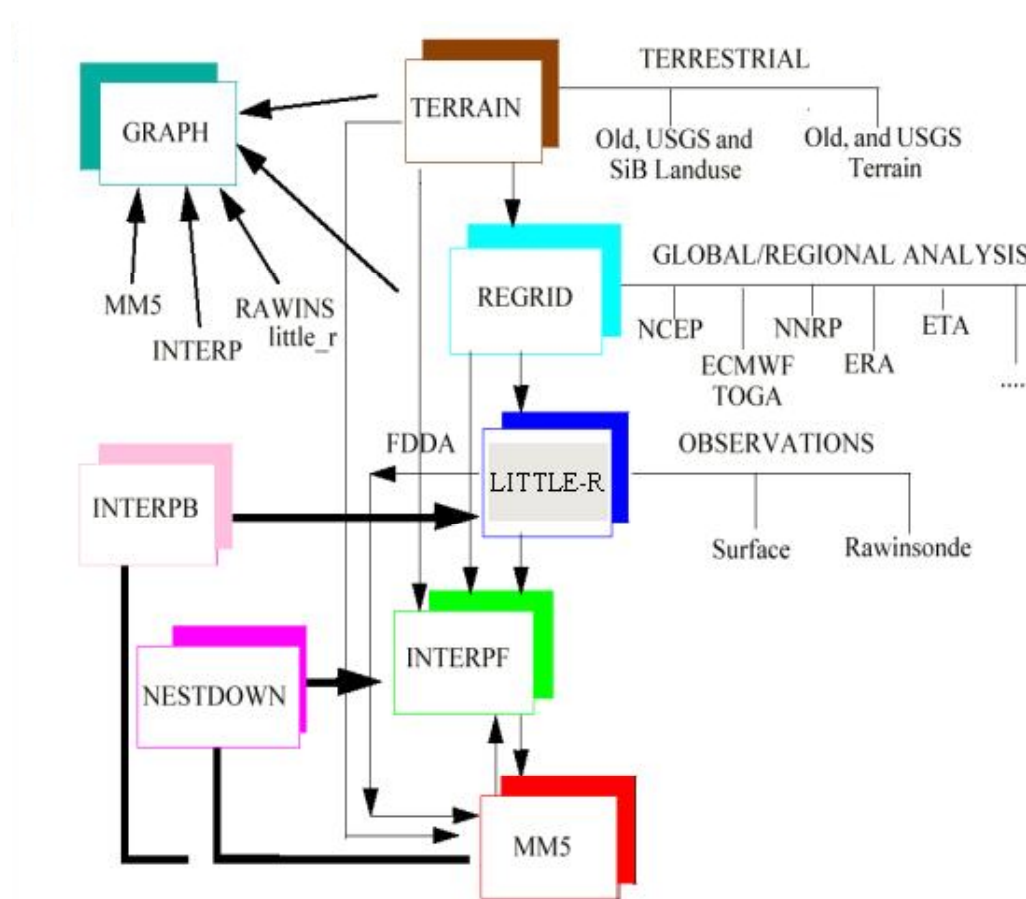D4: 135 km x 144 km (46 x 49 - DX = 3 km)

MM5.DAT Domain 4 gridded

elevation (m)
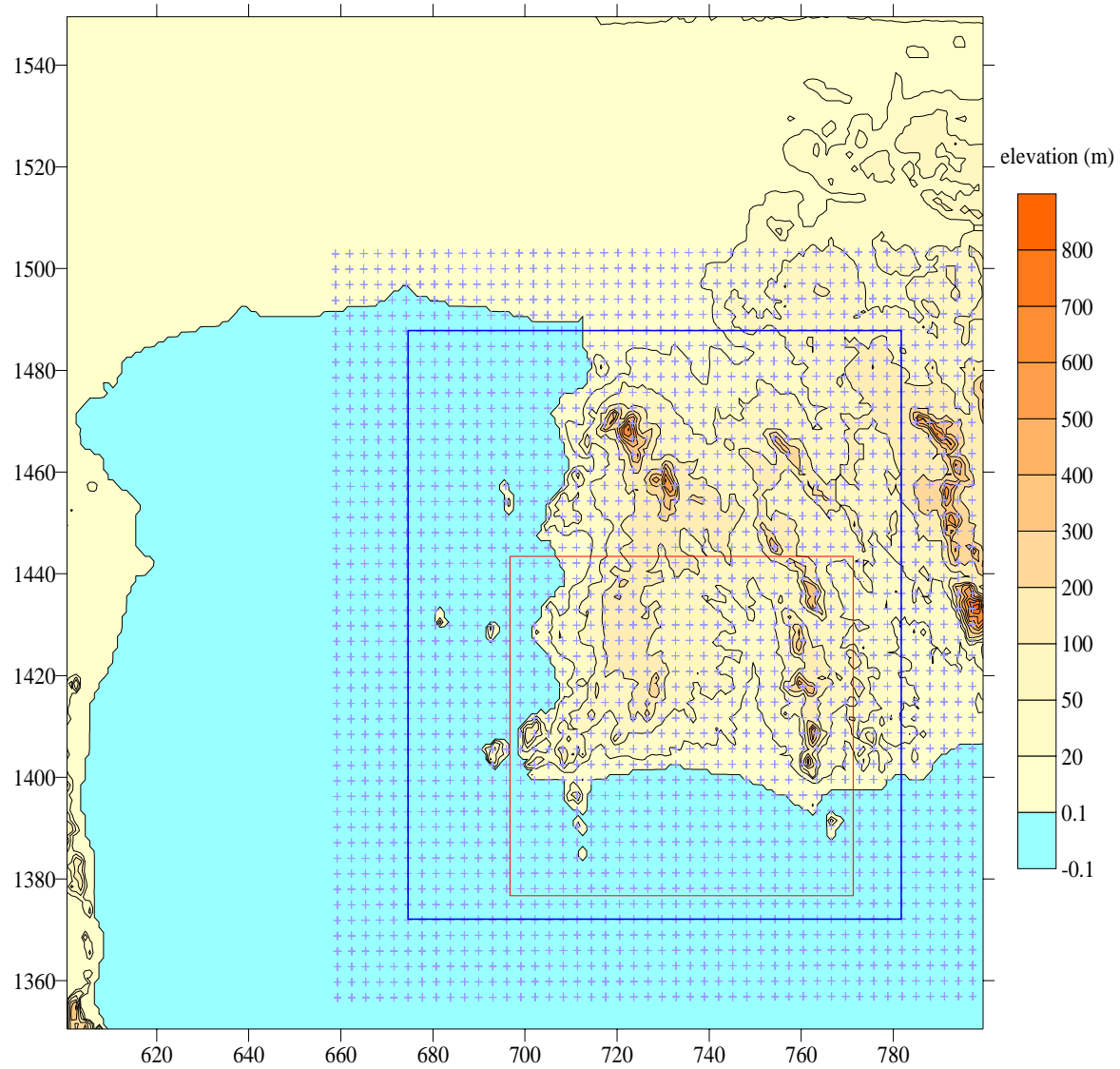
MM5-D4 gridpoints Final
(3km resolution)
I=2,46 (nx=46)
j=2,49 (ny=49)

Usable part of MM5 domain 4
(i.e. away from border effects)

MTP MM5 Domain
provided (3km resolution)

MM5 Modeling system flow Chart

RUNNING REGRID
CREATE FIRST-GUESS METEOROLOGICAL FIELDS ON MM5 GRID

- Get initial conditions (analyses) with at least 12-hour intervals. In this example,
  - FNL data are used for 3D dataset (wind, temperature, pressure,..) download from http://dss.ucar.edu/datasets/ds083.2/data (available every 6 hours)
  - RTG_SST_0.5 for 2D sea surface temperature, download from http://polar.ncep.noaa.gov/sst/Welcome.html (available every day)

- Type make>& make.out & - pregrid and regridder directories are created

RUNNING REGRID (Cont'd)

REGRID is run in two steps: PREGRID and REGRIDDER
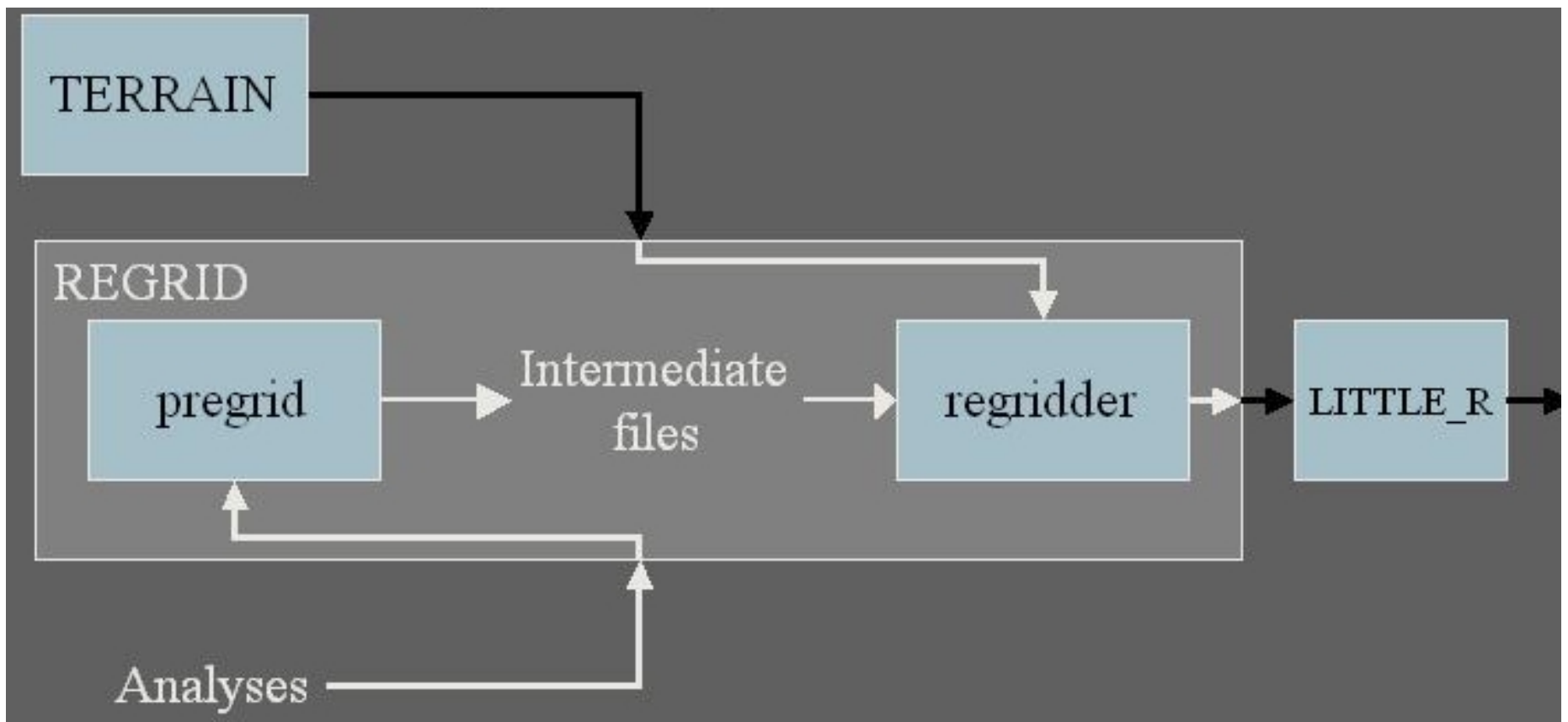
RUNNING REGRID (Cont'd)
PREGRID

- GOTO pregrid directory
- Copy Pregrid.csh in two files:
  - once for 3D FNL dataset (pregrid_press.csh)
  - once for 2D SST dataset (pregrid_sst.csh)

Application example: pregrid_press.csh.thai and pregrid_sst.csh.thai

RUNNING REGRID (Cont'd)
## PREGRID

In each file:

- Specified the type of data: GRIB
- Specified the starting date: May 31, 2005 at h0
- Specified the ending date: June 6, 2005 at h0
- Time step: 21600 seconds (6 hours)
- Specified right Vtable (if GRIB format used) – here Vtable.AVN for 3D_FNL and Vtable.GDASST (not present in grib.misc directory when REGRID is untar)

- RUN **pregrid_sst.csh>& log_sst &**
- RUN **pregrid_press.csh>& log_press &**
- OUTPUT:

  – FILE:2002-05-31_00 for 3D data (1 for each time step)
  – SST_FILE:2002-05-31_00 for 2D SST (1 for each time step)

RUNNING REGRID (Cont'd) REGRIDDER

- GOTO regridder directory
- Edit namelist.input (application example namelist.input.thai)
  - Edit the starting and ending date
  - Enter root for intermediate files (../pregrid/FILE for 3D data and ../pregrid/SST_FILE for 2D sst)
  - Enter path and file for TERRAIN data file (../../TERRAIN/TERRAIN_DOMAIN1)
- Run in this example only for DOMAIN1 (IOVERW=2, only terrain for each domain is used)
- RUN **regridder>& log &**
- FILE REGRID_DOMAIN1 is created

MM5 Modeling system flow Chart
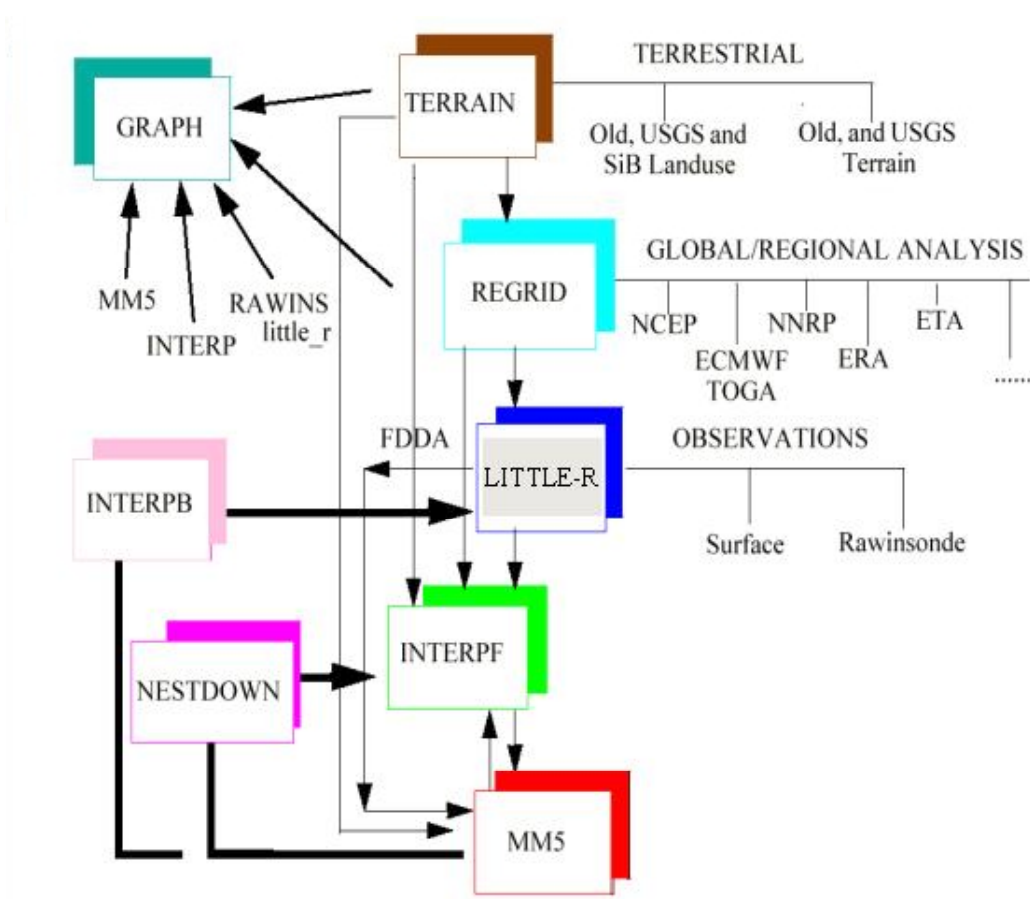
RUNNING INTERPF
INTERPOLATE PRESSURE LEVEL DATA
TO MODEL COORDINATE

- GO TO INTERPF directory
- Compile INTERPF: **make>& make.out &**
- Edit Namelist.input (namelist.input.thai for application example), update with the right information
  - Starting/ending date
  - 32 half-sigma levels (33 sigma levels, 0 and 1 included)
- RUN **interpf>& log &**
- Check that the following files are created:
  - BDYOUT_DOMAIN1
  - LOWBDY_DOMAIN1
  - MMINPUT_DOMAIN1

Use all domains Low Boundary

- The option to use low boundaries specific for every domain is possible. Important if SST or SNOW cover data has a much higher resolution than Domain 1
  - go back to regridder directory and create REGRID_DOMAIN2, REGRID_DOMAIN3, REGRID_DOMAIN4 by changing TERRAIN input in namelist.input and running regridder once for each domain
  - Then, goto INTERPF and run interpf once for each domain by changing the input file at the top of the namelist.input
  - When running MM5 – don't forget to copy LOWBDY for each domain in the Run directory. If not there, it will not be used but the run will not stop (it is optional)

RUNNING MM5 (1- create MM5 executable)

- GO TO MM5

- Edit **configure.user** (application example configure.user.thai)
  - Uncomment the right platform
  - Select FDDA option and maximum size arrays
  - Choose the physics options

- Compile MM5 by typing: **make>& make.out &** (mm5.exe should be created in the Run directory)

MM5 – PHYSICS OPTION

- IMPHYS=4 – simple ice (Explicit Moisture Scheme- No look-up tables for moist physics MPHYSTBL=0)
- ICUPA=3 - Grell Cumulus Scheme for domain 1, 2
- ICUPA=1 - no Cumulus Scheme for domain 3, 4, grid size is small enough to resolve updraft and downdrafts, less than 5-10km
- IBLTYP=6 –Gayno-Seaman Scheme for Planetary Boundary Layer
- FRAD=2 – Cloud Scheme for Radiation Cooling of Atmosphere (always same scheme for all domains)
- ISOIL=1 – Force Restore for Surface Scheme
- No Shallow Convection options

Explicit Moisture Scheme (Simple Ice)

- Also known as Dudhia scheme
- Adaptation of Hsie scheme (Warm rain, Original MM4 method of treating clouds and rain as separate 3d fields) to allow ice processes
- Cloud and ice share one array, rain and snow share another. No additional memory.
- Ice sedimentation
- No supercooled water
- Immediate snow melt at melting layer

Cumulus Scheme (Grell scheme)

- Rate of destabilization closure (quasi-equilibrium)
- Single updraft and downdraft properties
- Mass-flux type scheme with compensating subsidence
- Suitable for most grid sizes down to 5 km

Planetary Boundary Layer Scheme (Gayno-Seaman PBL)

- Predict TKE
- Allows for cloud-topped PBL processes by using liquid water potential temperature and total water as its mixing variables

Radiation Scheme (Cloud Radiation)

- Also known as Dudhia scheme
- Provides atmospheric radiative effects due to modeled clouds
- Provides surface longwave and shortwave fluxes itself (does not call Surface Radiation scheme)
- LEVSLP and OROSHAW switches allow for slope and shadow effects on surface solar flux using this option. New in Version 3.7 from G. Zaengl.

Surface Schemes (Force Restore (Blackadar))

- Ground temperature prediction
- 2-layer model with a constant-temperature substrate
- Substrate (reservoir) temperature is specified in INTERPF as a diurnal average surface temperature
- Tuned to represent diurnal cycle best

RUNNING MM5 (cont'd)

- make mm5.deck, Create a deck to run MM5 (Application example: mm5.deck.thai)

- GOTO "Run" directory and link or copy all input data file necessary: Output of regridder and TERRAIN

- Edit mm5.deck and update:
  - TIMAX=7920 minutes – 132 hours - (5 days + 12hours)
  - TISTEP= 162 (coarse model DT in second)
  - SAVFRQ=2880 Save data time step
  - NEST OPTIONS (update LEVIDN, NUMNC, NESTIX, NESTJX, NESTI, NESTJ,XSTNES, XENNES, IOVERW)
  - FDDA OPTIONS (only for Domain 1, only 3D nudging, surface nudging is not used – Observation nudging is not used)

RUNNING MM5 (cont'd)

- Run MM5 in MM5 directory:
  - **mm5.deck> & log &**
- MMOUT_DOMAIN1, MMOUT_DOMAIN2,… should be created in Run directory
- Check file mm5.print.out to check that everything ran well

RUNNING CALMM5

put MM5 output in 3D.DAT format ready for CALMET

- Edit calmm5.par with the right maximum size
- Compile calmm5 **f90 calmm5.f –o calmm5.exe**
- Edit calmm5.inp and change the information (application example calmm5.inp.thai)
- Run calmm5 **calmm5.exe calmm5.inp**
- A 3D.DAT file MM5_THAI.m3d is created, which can be used to run CALMET

SENSITIVITY TESTS

- Grid resolution of domain 4 (3km versus 2km)
- Two-way nesting versus One-way nesting
- SST (in the testing FNL performed better than RTG_SST. Modis demands more preparation)
  - FNL SST (1 degree resolution) using only 0Z (once a day, despite available 4 times a day)
  - RTG_SST (0.5 degree resolution) tends to be biased towards day time, so sea breeze not triggered by MM5 when this dataset is used.
  - Modis (4km –for Future Application)

SENSITIVITY TESTS (Cont'd)

- ## Cumulus Scheme (Grell versus Kain-Fritsh)
  - D1-D2 Grell and D3-D4 explicit is the best association for test done on 4 days in October 2002 (convection studied)

- ## Boundary Layer (Gayno-Seaman versus MRF)
  - Gayno-Seaman boundary layer improved dramatically MM5's ability to represent the sea-breeze circulation

- ## FDDA or NOT – 3D FDDA and/or surface FDDA
  - 3D FDDA every 6 hours seems the way to go – surface FDDA didn't improve much the results

SENSITIVITY TESTS (Cont'd)

- Number of vertical layers
  - 24 or 32 layers similar results with 32 layers better in July
  - 50 layers worsen dramatically the results
- Coarser domain location center
- Size and Dimension of intermediate domains
  - Location of boundary domain over ocean versus land for domain 3