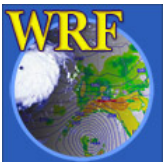

WRF-NMM

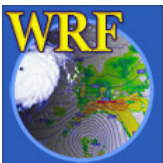
Standard Initialization (SI)

Matthew Pyle
8 August 2006

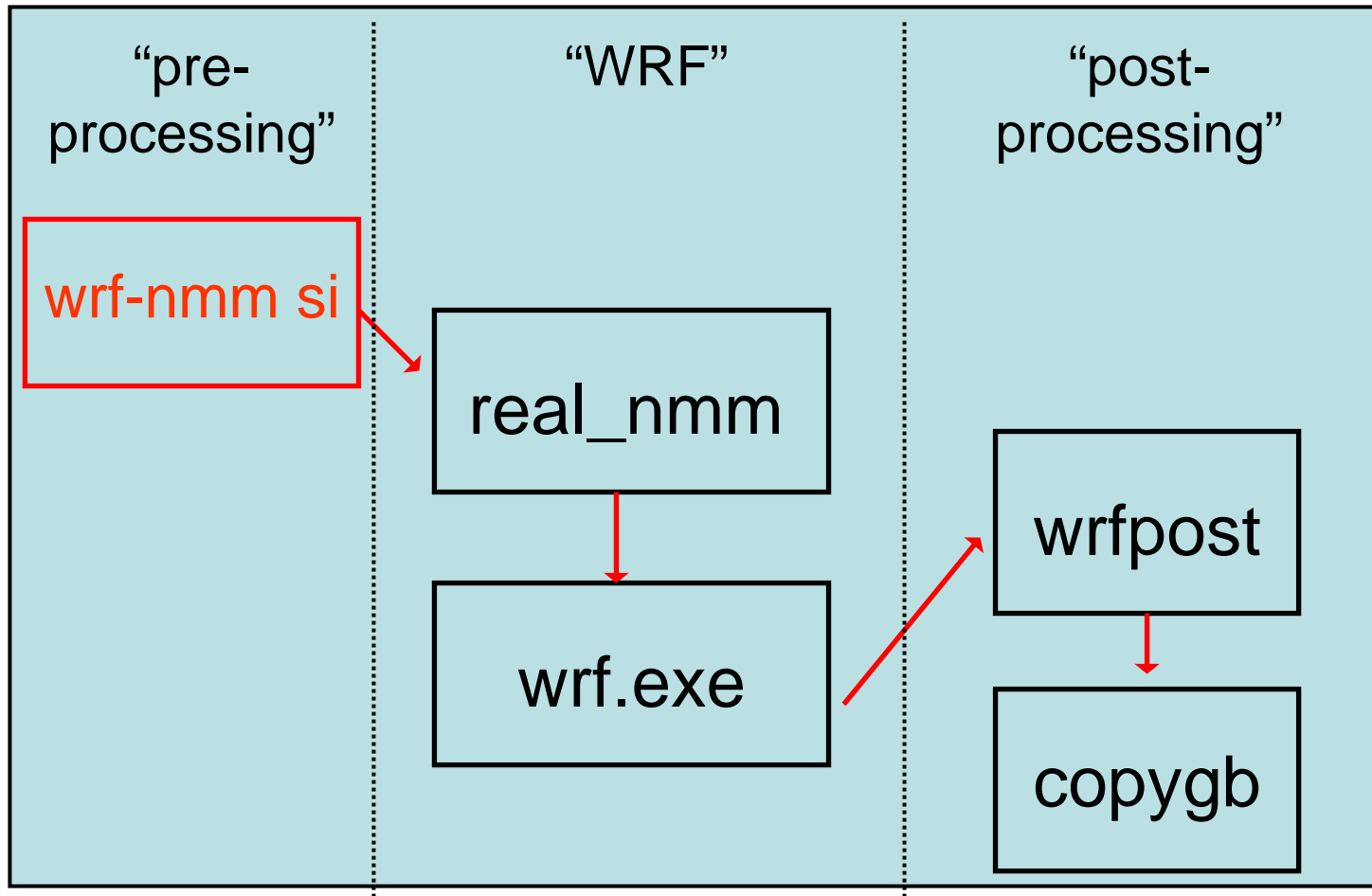


Outline

- Overview of the WRF-NMM Standard Initialization (SI) package.
- More detailed look at individual SI program components.
- SI software requirements, SI utility programs (briefly).

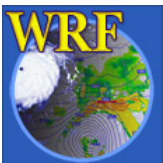


WRF-NMM Modeling System Flowchart

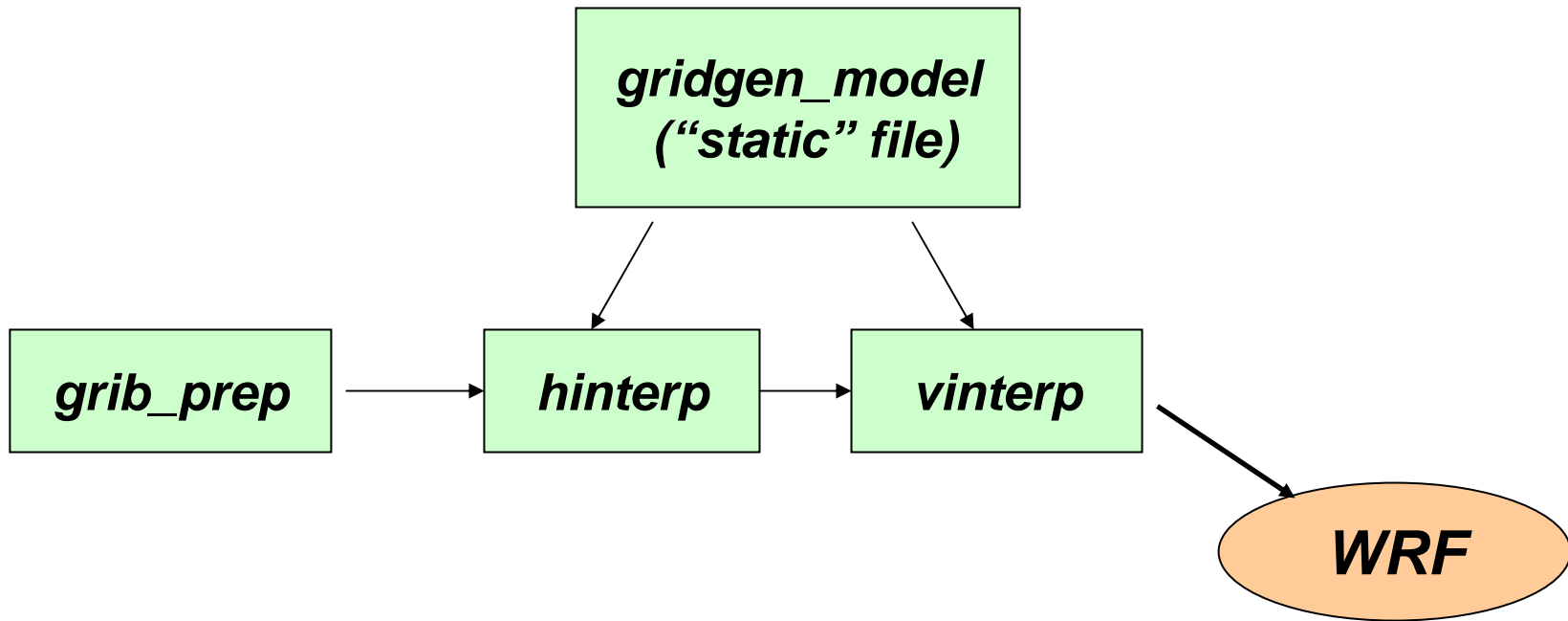


SI Program Overview

- Prepares input for WRF simulations using actual (not idealized) meteorological data:
 - Defines a mesoscale WRF domain and creates associated lat/lon, topography, landuse, soil type and other static (non time-varying) land state data.
 - Provides time-varying meteorological data (including soil information) on these domains.

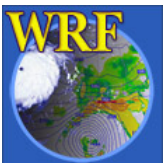


SI Program Overview



Functions of SI Program Components

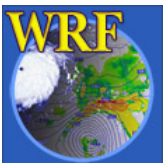
- *gridgen_model*
- *grib_prep*
- *hinterp*
- *vinterp*



gridgen_model

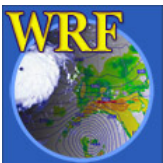
gridgen_model

- Takes a user-defined WRF grid specification, and creates the associated fields needed for the WRF-NMM SI and WRF model:
 - latitude and longitude for both the mass and wind points of the NMM's e-grid.
 - topography, land/sea mask, landuse (vegetation) and soil categories.
 - albedo and greenness fraction (monthly values stored for later time-interpolation to model cycle time).



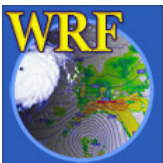
gridgen_model

- Input static data: (on regular lat / lon grid)
 - 30" USGS topography
 - 30" landuse (based on USGS Version 2 Land Cover data, 24 classes)
 - 30" top (0 – 30 cm) and bottom (30 – 100 cm) soil texture data (created from 30" STATSGO data over North America and 5' UN data elsewhere, 16 classes)



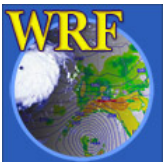
gridgen_model

- Input static data (cont.):
 - 10' monthly vegetation fraction data and monthly albedo data, 10' maximum snow albedo data (NCEP).
 - 1 degree deep soil temperature (based on average ECMWF data).
 - 10' terrain slope data (NCEP) – not currently used.



gridgen_model

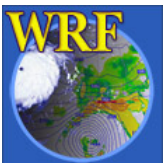
- Input static data (cont.):
 - Need to be downloaded before you run the *gridgen_model* program.
 - Occupy a big chunk of disk space (several GB if download the entire globe).
 - All 30" datasets are stored in 10 x 10 degree tiles, and are tarred into files that contain 1/4 of the globe (e.g. 0 – 180 E, 0 – 90 N in one tar file).



gridgen_model

- Define the domain (in SI namelist file) by specifying:
 - grid dimensions (xdim, ydim)
 - grid center (MOAD_KNOWN_LAT/LON)
 - grid spacing (MOAD_DELTA_X/Y) in degrees
 - number and distribution of vertical levels (LEVELS)

Details on the namelist later today....



gridgen_model

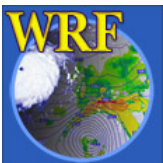
- Topography processing:
 - Five-point smoothing is performed:
 - near the lateral boundaries
 - at localized peaks in the domain interior. Controlled by simple code modifications described in the user manual.
 - The namelist controls used by the ARW WRF-SI (SILAVWT_PARA_WRF & TOPTWVL_PARA_WRF) for topography smoothing **DO NOT APPLY** in the WRF-NMM SI.



gridgen_model

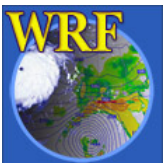
Running *gridgen_model*:

- Will be done through the Graphical User Interface (GUI) in this tutorial, which greatly simplifies the mechanics of defining a domain.
- *gridgen_model* only needs to be run once for a given domain. The resulting “static” file only contains fixed or climatologically varying data – no real-time component.



gridgen_model

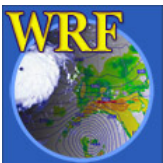
- Output:
 - *static.wrfsi.rotlat*
 - Used by *hinterp* and *vinterp*
 - In netCDF, but not WRF I/O API conforming
 - Other outputs:
 - localize_domain.log in the “log” directory
 - ASCII and binary output of gridded lat/lon and terrain data (e.g. *topography.dat**)



`grib_prep`

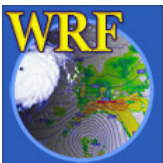
grib_prep

- Processes GRIB data from a source model (e.g., NAM, GFS) and writes data to an intermediate binary format.
 - Interpolates data to missing times if necessary.
 - Creates required data from related fields (e.g., generates RH from specific humidity).



grib_prep

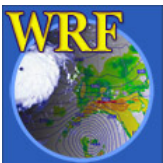
- GRIB data are the primary data supported:
 - NCEP: NAM (Eta), GFS (AVN), AWIP (NAM data in AWIP format), NNRP (global reanalysis), RUC
 - ECWMF: TOGA, others
 - AFWA: AGRMET soil model data
- For the supported GRIB data, provided Vtables define which fields will be extracted.



grib_prep

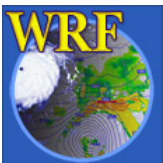
- Sample Vtable file (e.g., Vtable.GFS), partial contents:

GRIB Code	Level Code	Level 1	Level 2	REGRID Name	REGRID Units	REGRID Description
11	100	*		T	K	Temperature
33	100	*		U	m s ^{-1}	U
34	100	*		V	m s ^{-1}	V
52	100	*		RH	%	Relative Humidity
7	100	*		HGT	m	Height
81	1	0		LANDSEA	0/1 Flag	Land/Sea flag



grib_prep

- Other GRIB data containing the requisite fields likely will work after a new Vtable is added (closely mimic an existing Vtable in terms of content and format).
- For non-GRIB data sources, it ***may*** be possible to rewrite the data to the intermediate format (output from *grib_prep*) that is read by the *hinterp* code.

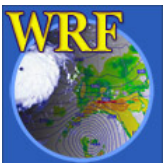


grib_prep

- Output:
 - One file per time per data source type
 - File names: e.g. if GFS and SST data and Vtables are used:

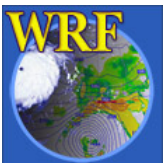
GFS:2005-07-10_00

SST:2005-07-10_00



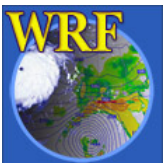
grib_prep

- One key idea to keep in mind is that the *grib_prep* output is not specific to a particular WRF domain.
- Output from a single *grib_prep* job can be used to initialize multiple WRF domains - assuming all domains physically are contained within the source model data.



grib_prep

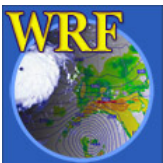
- How does one get GRIB data?
 - Responsibility of user.
 - Some free data are available from NCAR and NCEP. See <http://www.mmm.ucar.edu/wrf/users/>
 - > *Download (pulldown menu)*
 - Some NCEP data for the previous year
 - also, a link to NCEP FTP server (real-time data)



interp

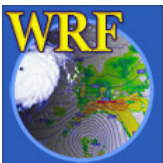
hinterp

- Horizontally interpolates atmospheric fields (typically on isobaric levels) and surface/soil fields from the source model to the target WRF grid.
- Horizontal interpolation methodology is controlled by WRF-NMM SI namelist options:
 - 3 options supported: nearest neighbor, 4-pt bilinear, and 16-pt bicubic.
 - Technique set separately for atmospheric fields (HINTERP_METHOD) and for land-surface fields (LSM_HINTERP_METHOD).



hinterp

- The program supports the use of multiple data sources through namelist options:
 - **INIT_ROOT**: data used for atmospheric initial conditions.
 - **LBC_ROOT**: data used for lateral boundary conditions.
 - **LSM_ROOT**: data used for land surface initial conditions.
 - **CONSTANTS_FULL_NAME**: constant fields (e.g. SST).



hinterp

- Output files:

Meteorological data (binary):

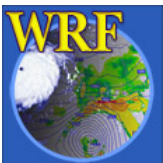
hinterp.d01.2005-07-10_00:00:00

hinterp.d01.2005-07-10_03:00:00

hinterp.d01.2005-07-10_06:00:00

Metadata file, used by vinterp:

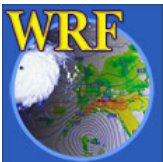
hinterp.global.metadata



vinterp

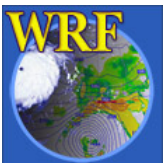
vinterp

- Vertically interpolate 3-D atmospheric data (already processed by *hinterp*) to the NMM sigma-pressure hybrid coordinate.
- Incorporate the static data generated by *gridgen_model*.
- Write netCDF output files (WRF I/O API conforming) for use by *real_nmm* executable.



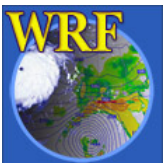
vinterp

- The number of vertical levels and their relative thickness is defined by the namelist variable LEVELS.
- Once the hybrid vertical coordinate is defined (discussed in detail in a later talk), vertical interpolation is performed differently for different fields.



vinterp

- Vertical interpolation of wind components (u,v) is performed by fitting cubic splines to the input data.
- Temperature now directly interpolated from input temperatures using a linear-in-log(p) approach. Earlier versions derived temperature from layer thicknesses.
- Moisture (as specific humidity) is interpolated using a log-in-log(p) approach.



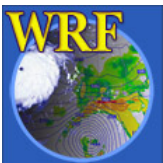
vinterp

- Output files (netCDF):

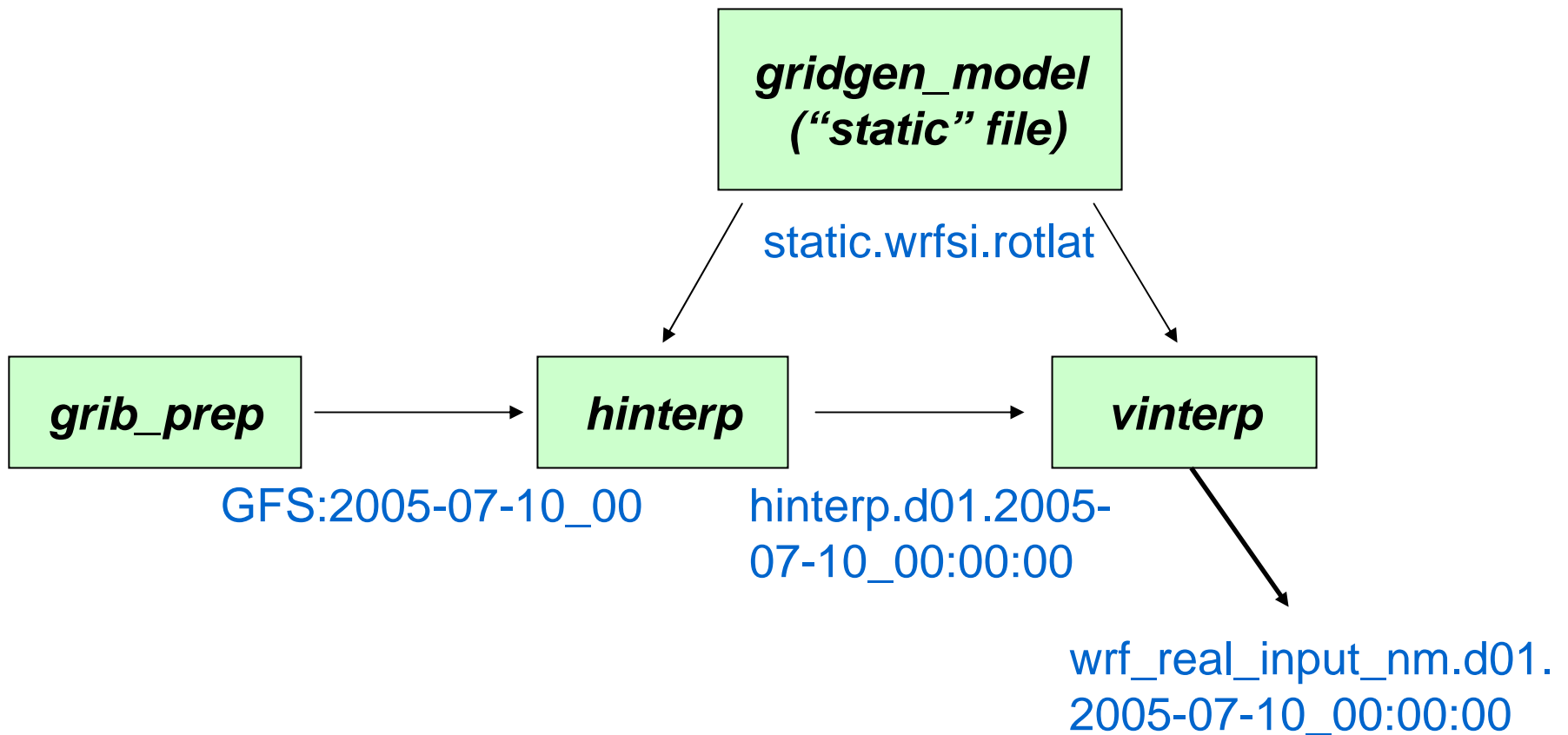
wrf_real_input_nm.d01.2005-07-10_00:00:00

wrf_real_input_nm.d01.2005-07-10_03:00:00

wrf_real_input_nm.d01.2005-07-10_06:00:00

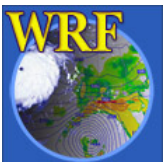


SI Program Overview



SI Program Overview

- As alluded to earlier, the SI also includes a Graphical User Interface (GUI) that provides an easy way to configure domains and run the individual SI programs.
 - To be discussed in Paula McCaslin’s “GUI Applications” talk later today.



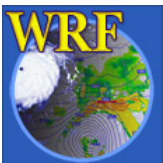
Utility Programs / Examining Output

- *siscan*: reads and lists contents and grid dimensions of the *hinterp.d01.yyyy-mm-dd_hh:mm:ss* file.
- Examination of interpolation log files best way to unravel major errors:
 - *YYYYmmddhh.hinterp*
 - *YYYYmmddhh.vinterp*



Utility Programs / Examining Output

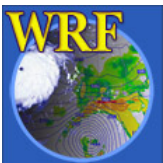
- The final (netCDF) output from SI can be visualized and examined fairly easily:
 - ‘*ncBrowse*’ is a basic but useful tool for visualizing output. Plots arrays of data – no maps. Google it to find where to download.
 - The netCDF utility program ‘*ncdump*’ will generate ASCII output to examine.
- If you have other tools for netCDF, by all means give them a shot (I’m a netCDF simpleton).



SI Software

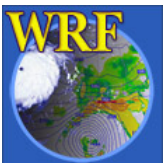
SI homepage has links for the static datasets, and has up-to-date public releases of the WRF-NMM SI code release:

<http://wrfsi.noaa.gov/>



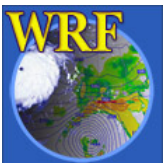
WPS: The future

- NCAR/MMM has been overhauling and redesigning the wrfsi; this replacement package will be known as the WRF Preprocessing System (WPS for short).
- The objective of WPS is to simplify the preprocessing system, and to completely integrate it into the WRF system. The current wrfsi system is somewhat less integrated, as will be explained later today.



WPS: The future

- WPS now becoming available for the WRF-ARW, while the needed integration work for the WRF-NMM remains to be done over the next several months.
- Don't let the future of WPS prevent your use of the current NMM wrfsi in the present. WPS will change many details of the preprocessing software, but the resulting model forecasts should be little changed by the switch from wrfsi to WPS.



Acknowledgement

Major thanks to [Wei Wang](#), for providing an excellent starting point for this talk with her ARW SI tutorial slides.

