

# INTERPB

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## 11

INTERPB

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## 11.1 Purpose

The INTERPB program handles the data transformation required to go from the mesoscale model on  $\sigma$  coordinates back to pressure levels. This program only handles vertical interpolation and a few diagnostics. The output from this program is suitable for input to REGRIDDER (to re-grid a model forecast), LITTLE\_R (for pressure-level re-analysis), INTERPF (for pressure to  $\sigma$  interpolation for generating model input) and GRAPH (for visualization and diagnostic computation). In practice, much of the post-analysis performed with MM5 data is done interactively with diagnostic and visualization tools that can handle simple vertical coordinate transformations on-the-fly.

The INTERPB program can run on the following platforms: Compaq/Alpha, Cray, DEC, HP, IBM, SGI, Sun, PCs running Linux (Fedora with PGI or Intel compilers), and MAC (OSX with xlf).

## 11.2 INTERPB Procedure

- input model input or model output data (INTERPF, NESTDOWN, MM5)
- compute total pressure on dot and cross points
- compute RH and Z on  $\sigma$  levels
- compute 2D fields on both staggerings: surface pressure, sea level pressure, latitude, longitude, “computationally expedient” surface pressure
- extrapolate below ground and above top  $\sigma$  surface
  - variables:  $u$  and  $v$ , temperature, moisture, height, pressure, and ELSE
  - options: extrapolate or constant
- interpolate to selected pressure levels
  - options: linear in pressure, linear in  $\ln$  pressure, linear in  $p^k$
- output interpolated data

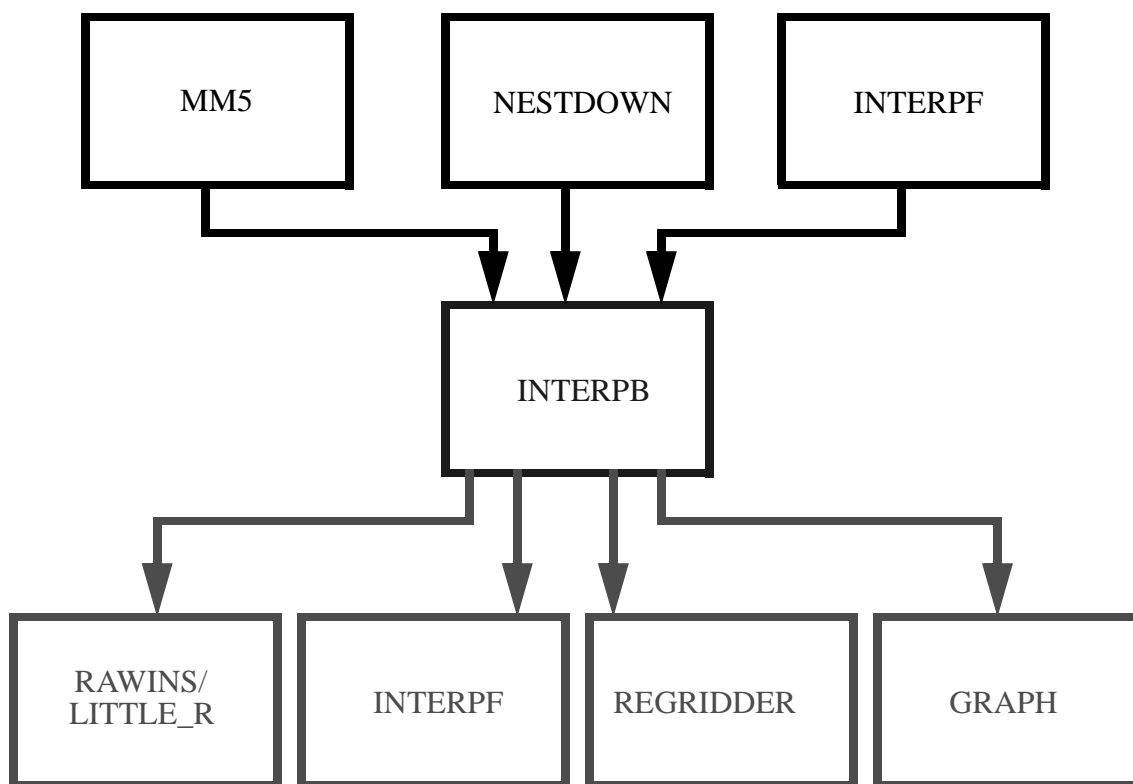


Fig. 11.1 All INTERPB jobs involve ingesting  $\sigma$ -level model output. This data is interpolated to requested isobaric surfaces by INTERPB. The output from INTERPB is suitable for use by the MM5 programs LITTLE\_R, INTERPF, REGRIDDER, and GRAPH.

### 11.3 Sea Level Pressure Computation

*Please note that the “X” used in the following computations, and throughout this chapter, signifies an arithmetic multiplication, not a cross product.*

1. Find two surrounding  $\sigma$  levels 100 hPa above the surface, compute T at this level

$$T = \frac{T_{\sigma_A} \ln \frac{P_{\sigma_B}}{P} + T_{\sigma_B} \ln \frac{P}{P_{\sigma_A}}}{\ln \frac{P_{\sigma_B}}{P_{\sigma_A}}} \quad (11.1)$$

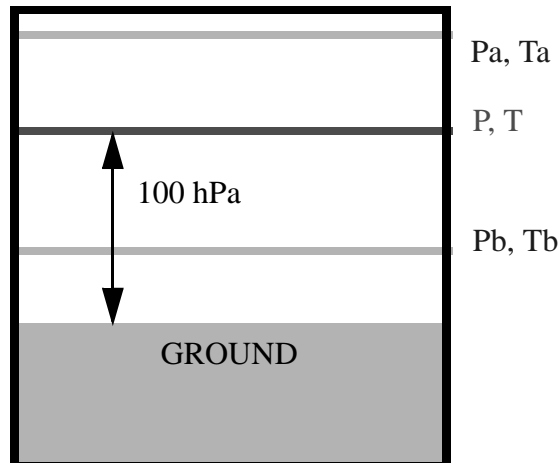


Fig.11.2 To minimize the diurnal effects on the sea-level pressure computation, a pressure and temperature 100 hPa above the surface is used to compute a “surface” pressure and “surface” temperature.

2. Find  $T_s$  (surface temperature),  $T_m$  (mean temperature in layer above ground),  $Z$  at level 100 hPa above surface, and  $T_{slv}$  (sea level temperature)

$$T_S = T \left( \frac{P_{SFC}}{P} \right)^{\frac{R\gamma_s}{g}} \quad (11.2)$$

$$T_m = \frac{T_S + T}{2} \quad (11.3)$$

$$Z = Z_{SFC} - \frac{R}{g} \ln \frac{P}{P_{SFC}} \times T_m \quad (11.4)$$

$$T_{SLV} = T + \gamma_s Z \quad (11.5)$$

3. Then sea level pressure is calculated as

$$P_{SLV} = P_{SFC} \exp \left[ \frac{(g)Z_{SFC}}{R \frac{(T_S + T_{SLV})}{2}} \right] \quad (11.6)$$

## 11.4 Vertical Interpolation/Extrapolation

Extrapolation is required near the surface when

$$p_{ij}^* \sigma_k = KX + P_{TOP} + P'_{ijk} < P_{int-bot} \quad (11.7)$$

where  $P_{int-bot}$  is typically 1000 hPa. This is handled in a subroutine specifically to allow pipelining of expensive inner loops for the vertical interpolation scheme. Extrapolation is required near the top of the model when

$$p_{ij}^* \sigma_k = 1 + P_{TOP} + P'_{ijk} > P_{int-top} \quad (11.8)$$

where  $P_{int-top}$  is typically  $P_{TOP}$ . Every column of  $\sigma$  level data has a fictitious level inserted in the column, below the 1000 hPa level (the chosen value is 1001 hPa).

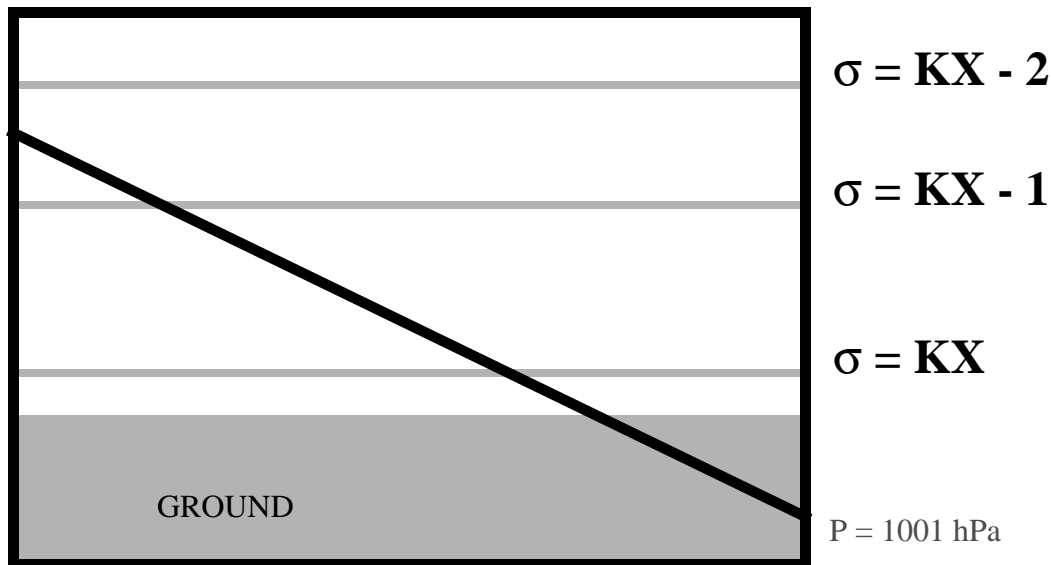


Fig. 11.3 Extrapolation is required on INTERPB jobs when the requested pressure is below the lowest  $\sigma$  level. A fictitious level is generated (1001 hPa) so that the 1000 hPa level is always available without extrapolation.

### 11.4.1 Interpolation (non-hydrostatic)

Similar to the front-end interpolation, the back-end interpolation is handled as either linear in pressure, linear in  $\ln$  pressure, linear in  $p^k$ . The vertical interpolation on the back-end may not be entirely contained within the bounds of valid data, resulting in extrapolation. The non-hydrostatic pressure from the forecast data is given as

$$P_{\sigma_{ijk}} = p_{ij}^* \sigma_k + P_{top} + P'_{ijk} \quad (11.9)$$

- $P_{\sigma_{ijk}}$  : 3-D pressure at each (i,j,k) of the  $\sigma$ -level variable
- $p_{ij}^*$  : 2-D field of reference surface pressure minus a constant ( $P_{top}$ )
- $\sigma_k$  : 1-D vertical coordinate
- $P_{top}$  : reference pressure at model lid
- $P'_{ijk}$  : 3-D pressure perturbation from reference state

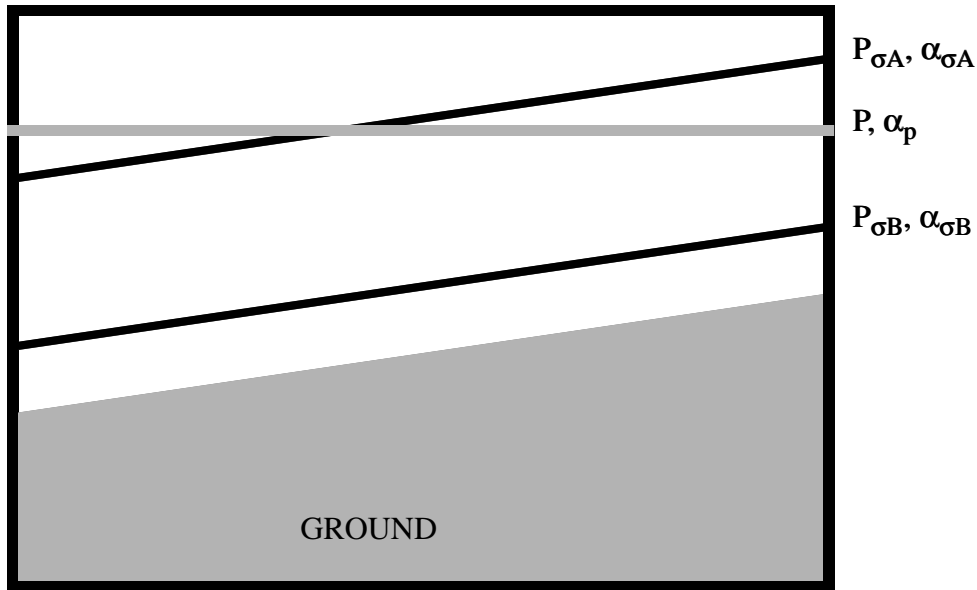


Fig. 11.4 For INTERPB jobs, most of the data placed on the isobaric surface is interpolated between the nearest two surrounding  $\sigma$  levels.

$$\alpha_P = \frac{\alpha_{\sigma_A} (P_{\sigma_B} - P) + \alpha_{\sigma_B} (P - P_{\sigma_A})}{P_{\sigma_B} - P_{\sigma_A}} \quad (11.10)$$

## 11.5 Parameter Statements

And again, no domain-specific FORTRAN PARAMETER statements.

## 11.6 FORTRAN Namelist Input File

Most of the available options for the INTERPB code are handled through the namelist input file. Since this is a FORTRAN namelist (a FORTRAN 90 standard), syntax is very strict. There are three namelist records for INTERPB. There are no default values, the entire namelist must be correctly modified for each program execution.

**Table 11.1: INTERPB namelist values: RECORD0.**

Namelist Record	Namelist Variable	Description
RECORD0	INPUT_FILE	CHARACTER string, $\sigma$ -level input file (from MM5, INTERPF, or NESTDOWN), complete with directory structure

**Table 11.2: INTERPB namelist values: RECORD1.**

Namelist Record	Namelist Variable	Description
RECORD1	START_YEAR	starting time, 4 digit INTEGER of the year
RECORD1	START_MONTH	starting time, 2 digit INTEGER of the month
RECORD1	START_DAY	starting time, 2 digit INTEGER of the day
RECORD1	START_HOUR	starting time, 2 digit INTEGER of the hour
RECORD1	END_YEAR	ending time, 4 digit INTEGER of the year
RECORD1	END_MONTH	ending time, 2 digit INTEGER of the month
RECORD1	END_DAY	ending time, 2 digit INTEGER of the day
RECORD1	END_HOUR	ending time, 2 digit INTEGER of the hour
RECORD1	INTERVAL	time interval in seconds between analysis/forecast periods

**Table 11.3: INTERPB namelist values: RECORD2.**

Namelist Record	Namelist Variable	Description
RECORD2	pressure_bu_no_sfc_Pa	array of REALs, pressure (Pa) from 100000 up to (but not necessarily including) $P_{TOP}$ , the surface pressure is <i>NOT</i> included

**Table 11.4: INTERPB namelist values: RECORD3.**

Namelist Record	Namelist Variable	Description
RECORD3	print_info	LOGICAL: TRUE = send extra printout to the standard out; FALSE = nah, don't do that

The entries in the RECORD4 namelist record (described in the following three tables) are optional. Default values for each variable have been established to remain internally consistent with other interpolation assumptions made through out the modeling system. This record is not available from the standard namelist.input file in the INTERPB directory, but is located in the ./INTERPB/.hidden/namelist.input file. This record is to allow the user access to differing methods for the vertical interpolation and the extrapolations which are performed above or below the model half  $\sigma$  levels.

**Table 11.5: INTERPB namelist values: RECORD4**

Namelist Record	Namelist Variable	Description
RECORD4	uv_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for $u$ and $v$
RECORD4	t_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for temperature
RECORD4	moist_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for all moisture species
RECORD4	height_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for height

**Table 11.5: INTERPB namelist values: RECORD4**

Namelist Record	Namelist Variable	Description
RECORD4	p_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for pressure
RECORD4	else_interp_method	CHARACTER, “linear in p”, linear in log p”, or “linear in p**kappa” for everything else

**Table 11.6: INTERPB namelist values: RECORD4**

Namelist Record	Namelist Variable	Description
RECORD4	uv_extrap_up	CHARACTER, "constant" or "extrapolate" for $u$ and $v$
RECORD4	t_extrap_up	CHARACTER, "constant" or "extrapolate" for temperature
RECORD4	moist_extrap_up	CHARACTER, "constant" or "extrapolate" for all moisture species
RECORD4	height_extrap_up	CHARACTER, "constant" or "extrapolate" for height
RECORD4	p_extrap_up	CHARACTER, "constant" or "extrapolate" for pressure
RECORD4	else_extrap_up	CHARACTER, "constant" or "extrapolate" for everything else

**Table 11.7: INTERPB namelist values: RECORD4**

Namelist Record	Namelist Variable	Description
RECORD4	uv_extrap_low	CHARACTER, "constant" or "extrapolate" for $u$ and $v$

**Table 11.7: INTERPB namelist values: RECORD4**

Namelist Record	Namelist Variable	Description
RECORD4	t_extrap_low	CHARACTER, "constant" or "extrapolate" for temperature
RECORD4	moist_extrap_low	CHARACTER, "constant" or "extrapolate" for all moisture species
RECORD4	height_extrap_low	CHARACTER, "constant" or "extrapolate" for height
RECORD4	p_extrap_low	CHARACTER, "constant" or "extrapolate" for pressure
RECORD4	else_extrap_low	CHARACTER, "constant" or "extrapolate" for everything else

## 11.7 How to Run INTERPB

1) Obtain the source code tar file from one of the following places:

Anonymous ftp:  
<ftp://ftp.ucar.edu/mesouser/MM5V3/INTERPB.TAR.gz>

On NCAR MSS:  
 MESOUSER/MM5V3/INTERPB.TAR.gz

2) gunzip and untar the INTERPB.TAR.gz file.

3) Type 'make' to create an executable for your platform. Users may choose to run the interpb program with the available job deck on the NCAR IBMs. This file, interpb.deck.ibm, is located on the NCAR IBM blackforest machine at ~mesouser/MM5V3/IBM. As with other job decks for the IBMs, the proper NQS instructions are included at the top, and most of the namelist options are handled through shell variables. Files are read from and written to the NCAR MSS.

4) Edit the namelist.input file to select the run-time options.

5) Run the executable directly by typing 'interpb >& interpb.log'.

INTERPB expects an input file (such as MMOUT\_DOMAIN $n$  or MMINPUT\_DOMAIN $n$ , where  $n$  is the domain identifier of the input data) to be provided. This is specified in the namelist.input file.

INTERPB outputs the files: MMOUTP\_DOMAIN $n$ , REGRID\_DOMAIN $n$ , and FILE\_MMOUTP:*blah*, where  $n$  is the domain identifier of the input data and *blah* is the date string typical of the intermediate format files. The user has no control over the output file naming convention.

## 11.8 INTERPB didn't Work! What Went Wrong?

- Most of the errors from INTERPB that do not end with a "segmentation fault", "core dump", or "floating point error" are accompanied with a simple print statement. Though the message itself may not contain enough substance to correct the problem, it will lead you to the section of the code that failed, which should provide more diagnostic information. The last statement that INTERPB prints during a controlled failed run is the diagnostic error.
- To see if INTERPB completed successfully, first check to see if the "STOP 99999" statement appears. Also check to see that INTERPB processed each of the requested times from the namelist.
- When INTERPB runs into an interpolation error that it did not expect (i.e. forced to do an extrapolation when none should be required), INTERPB will stop and print out the offending (I,J,K) and pressure values.

## 11.9 File I/O

The interpolation program has input and output files that are ingested and created during an INTERPB run. The gridded input file and the output file are unformatted FORTRAN I/O (binary, sequential access). One of the input files is a human-readable namelist formatted file of run-time options.

The following tables are for the input and output units.

**Table 11.8: INTERPB program input files.**

File Name	Description
namelist.input	namelist file containing run-time options
MMOUT_DOMAIN $n$	model output file on $s$ coordinates, where $n$ is the domain identifier

**Table 11.9: INTERPB program output files.**

File Name	Description
MMOUTP_DOMAIN $n$ , REGRID_DOMAIN $n$	pressure-level file suitable for input to LITTLE_R, INTERPF and GRAPH, where $n$ is the domain identifier (MMOUTP has all model output 3d fields, REGRID has only the traditional 3d arrays: wind, temperature, moisture, height)
FILE_MMOUTP: <i>blah</i>	intermediate format file, suitable for input to the REGRIDDER program (as it would come from PREGRID), where <i>blah</i> is the 13-character date string

## 11.10 INTERPB tar File

The INTERPB.tar file contains the following files and directories:

.hidden/	Special namelist.input file with interpolation and extrapolation options
Makefile	Makefile to create INTERPB executable
README	General information about the INTERPB directory
namelist.input	Namelist file containing run-time options
src/	INTERPB source code

