11.1 Purpose

(Note: This program is not yet available.)

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 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 and PC running Linux.

11.2 INTERPB Procedure

- input MM5 data
- compute sea level pressure
- compute RH and Z on $\sigma$ levels
- extrapolate below ground
  - wind and moisture fields: underground value defined as lowest $\sigma$ surface value
  - temperature: -6.5 K/km lapse rate from lowest $\sigma$ level
  - height: linear in $ln$ pressure from sea level to terrain elevation
- interpolate to selected pressure levels
  - wind and moisture fields: linear in pressure
  - potential temperature, height: linear in $ln$ pressure
- output interpolated data
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 σ levels 100 hPa above the surface, compute T at this level

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

$$T_s = T \left( \frac{P_{SFC}}{P} \right)^{\gamma_s}$$  \hspace{1cm} (11.2)

$$T_m = \frac{T_S + T}{2}$$  \hspace{1cm} (11.3)

$$Z = TER - \frac{R}{g} \ln \frac{P}{P_{SFC}} \times T_m$$  \hspace{1cm} (11.4)

$$T_{slv} = T + \gamma_s Z$$  \hspace{1cm} (11.5)

3. Then sea level pressure is calculated as
11.4 Vertical Interpolation/Extrapolation

Extrapolation is required near the surface when

\[ p_{ij}^* \sigma_k = KX + P_{TOP} + P'_{ijk} < P_{int-bot} \]  \hspace{1cm} (11.7)

where Pint-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

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

where Pint-top is typically Ptop. Every column of σ level data has a fictitious level inserted in the column, below the 1000 hPa level (the chosen value is 1001 hPa). This is the technique used to allow removal of an IF test in a deeply nested FORTRAN loop.

Fig. 11.3 Extrapolation is required on INTERPB jobs when the requested pressure is below the lowest σ 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 $p^\kappa$. 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

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

- $P_{\sigma_{ijk}}$: 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.

$$ \alpha_P = \frac{\alpha_{\sigma_A} (P_{\sigma_B} - P) + \alpha_{\sigma_B} (P - P_{\sigma_A})}{P_{\sigma_B} - P_{\sigma_A}} \tag{11.10} $$
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>
<thead>
<tr>
<th>Namelist Record</th>
<th>Namelist Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECORD0</td>
<td>INPUT_FILE</td>
<td>CHARACTER string, coarse grid input file from MM5, complete with directory structure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Namelist Record</th>
<th>Namelist Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECORD1</td>
<td>START_YEAR</td>
<td>starting time, 4 digit INTEGER of the year</td>
</tr>
<tr>
<td>RECORD1</td>
<td>START_MONTH</td>
<td>starting time, 2 digit INTEGER of the month</td>
</tr>
<tr>
<td>RECORD1</td>
<td>START_DAY</td>
<td>starting time, 2 digit INTEGER of the day</td>
</tr>
<tr>
<td>RECORD1</td>
<td>START_HOUR</td>
<td>starting time, 2 digit INTEGER of the hour</td>
</tr>
<tr>
<td>RECORD1</td>
<td>END_YEAR</td>
<td>ending time, 4 digit INTEGER of the year</td>
</tr>
<tr>
<td>RECORD1</td>
<td>END_MONTH</td>
<td>ending time, 2 digit INTEGER of the month</td>
</tr>
<tr>
<td>RECORD1</td>
<td>END_DAY</td>
<td>ending time, 2 digit INTEGER of the day</td>
</tr>
<tr>
<td>RECORD1</td>
<td>END_HOUR</td>
<td>ending time, 2 digit INTEGER of the hour</td>
</tr>
<tr>
<td>RECORD1</td>
<td>INTERVAL</td>
<td>time interval in seconds between analysis/forecast periods</td>
</tr>
</tbody>
</table>
11.7 How to Run INTERPB

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

   Anonymous ftp:

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

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

3) Type ‘make machine_name’ to create an executable for your platform, where machine_name
   is: cray, dec, ibm, hp, sgi, sun..

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

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

INTERPB expects the following input file: MMOUT_DOMAINn, where n is the domain identifier of the input data. This is specified in the namelist.input file.

INTERPB outputs the file: INTERPB_DOMAINn, where n is the domain identifier of the input data. 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>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>namelist.input</td>
<td>namelist file containing run-time options</td>
</tr>
<tr>
<td>MMOUT_DOMAINn</td>
<td>model output file on s coordinates, where n is the domain identifier</td>
</tr>
</tbody>
</table>

Table 11.5: INTERPB program output files.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERPB_DOMAINn</td>
<td>pressure-level file suitable for input to LITTLE_R, INTERPF and GRAPH, where n is the domain identifier</td>
</tr>
</tbody>
</table>

11.10 INTERPB tar File

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

- CHANGES: Description of changes to the Graph program
- 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