CONTENTS

1 INTRODUCTION

- 1.1 Introduction to MM5 Modeling System 1-3
- 1.2 The MM5 Model Horizontal and Vertical Grid 1-5
- 1.3 Nesting 1-8
- 1.4 Nonhydrostatic Dynamics Versus Hydrostatic Dynamics 1-9
- 1.5 Reference State in the Nonhydrostatic Model 1-9
- 1.6 Four-Dimensional Data Assimilation 1-10
- 1.7 Land-Use Categories 1-11
- 1.8 Map Projections and Map-Scale Factors 1-11
- 1.9 Data Required to Run the Modeling System 1-11

2 Getting Started

- 2.1 Purpose 3
- 2.2 Program portability 3
- 2.3 Prerequisite 4
- 2.4 Where to obtain program tar files? 4
- 2.5 What are contained in a tar file? 6
- 2.6 Steps to run MM5 modeling system programs 6
- 2.7 Functions of Job Decks or Scripts 7
- 2.8 What to Modify in a Job Deck/Script? 7
- 2.9 How to build the executable and run the program? 9
- 2.10 Output Files 10
- 2.11 Representation of date in MM5 modeling system programs 10
- 2.12 Where to Find Data at NCAR? 10

3 MAKE UTILITY

- 3.1 The UNIX make Utility 3-3
- 3.2 make Functionality 3-3
- 3.3 The Makefile 3-4
- 3.4 Sample make Syntax 3-5
- 3.5 Macros 3-5
- 3.6 Internal Macros 3-5
- 3.7 Default Suffixes and Rules 3-6
- 3.8 Sample Program Dependency Chart 3-7
- 3.9 Sample Program Components for make Example 3-8
- 3.10 makefile Examples for the Sample Program 3-9
- 3.11 Configure.make File 3-10
- 3.12 An Example of configure.make File 3-11
- 3.13 An Example of Top-level Makefile 3-12
- 3.14 An Example of Low-level Makefile 3-12

MM5 Tutorial

4 TERRAIN

- 4.1 Purpose 4-3
- 4.2 Data Format 4-5
- 4.3 Mesoscale domain information 4-12
- 4.4 Interpolation 4-14
- 4.5 Adjustment 4-15
- 4.6 Fudging function 4-17
- 4.7 Script Variables 4-20
- 4.8 Parameter statement 4-20
- 4.9 Namelist Options 4-20
- 4.10 TERRAIN Didn't Work: What Went Wrong? 4-22
- 4.11 TERRAIN Files and Unit Numbers 4-24
- 4.12 TERRAIN tar File 4-25
- 4.13 Terrain Miscellanea 4-25
- 4.14 terrain.deck 4-26

5 REGRID

- 5.1 Purpose 3
- 5.2 Structure 3
- 5.3 A schematic 4
- 5.4 Input to pregrid 4
- 5.5 Input to regridder 4
- 5.6 Output from regridder 5
- 5.7 Intermediate Data Format 5
- 5.8 Pregrid VTables 7
- 5.9 Pregrid program functioning 8
- 5.10 Handy pregrid utility programs 8
- 5.11 How to run REGRID 9
- 5.12 pregrid.csh 9
- 5.13 The regridder Namelist options 12
- 5.14 REGRID tar File 13

6 RAWINS

- 6.1 Purpose 6-3
- 6.2 Source of Observations 6-3
- 6.3 Objective Analysis in RAWINS 6-4
- 6.4 Quality Control for Observations 6-6
- 6.5 Bogus Options 6-7
- 6.6 Script Variables 6-7
- 6.7 Parameters 6-8
- 6.8 Namelist Variables 6-9
- 6.9 Check Your Output 6-10
- 6.10 RAWINS didn't Work! What Went Wrong? 6-10
- 6.11 What is Missing from RAWINS? 6-11

ii MM5 Tutorial

6.12 6.13	RAWINS Files and Unit Numbers 6-11 RAWINS tar File 6-12		
6.14	NBOGUS example 6-13		
6.15	rawins.csh 6-15		
INT	ERP		
,			
7.1	Purpose 7-3		
7.2	Standard Front-end Job 7-3		
7.3	Surface Pressure Computation 7-5		
7.4	Hydrostatic Vertical Interpolation 7-5		
7.5	Integrated Mean Divergence Removal 7-6		
7.6	Base State Computation 7-7		
7.7	Initialization of Nonhydrostatic Model 7-8		
7.8	Shell Variables 7-9		
7.9	Parameter Statements 7-9		
7.10	FORTRAN Namelist Input File 7-11		
7.11	Standard Back-end Job 7-15		
7.12	Sea Level Pressure Computation 7-16		
7.13	Back-end Interpolation/Extrapolation 7-18		
7.14	Non-standard Back-end: 1-way Nest 7-20		
7.15	Non-standard Back-end: First-guess (Forecast Re-analysis) 7-24		
7.16	INTERP didn't Work! What Went Wrong? 7-27		
7.17	File I/O 7-27		
7.18	INTERP tar File 7-29		
7.19	interp.deck 7-30		
GRA	NPH		
8.1	Purpose 8-3		
8.2	Typical GRAPH Jobs 8-4		
8.3	Plotting Table File: g_plots.tbl 8-5		
8.4	Default Option Settings File: g_defaults.nml 8-6		
8.5	Map Options File: g_map.tbl 8-7		
8.6	Plot Color Options File: g_color.tbl 8-9		
8.7	Running GRAPH Interactively 8-11		
8.8	Available 2-D Horizontal Fields 8-14		
8.9	Available Cross-Section Only Fields 8-15		
8.10	Available 3-D Fields (as 2-D Horizontal or Cross-Section) 8-16		
8.11	Some Hints for Running GRAPH 8-18		
8.12	Sample Graph Plot File 8-19		
8.13	Graph tar file 8-20		
8.14	Script file to run Graph job 8-20		

9 MM5

7

8

MM5 Tutorial iii

10

11

12

12.5 12.6

9-10 Failure 9-25
ailure 9-25
ailure 9-25
ailure 9-25
ailure 9-25
Cailure 9-25
ailure 9-25
Failure 9-25
Pailure 9-25
ot 11.2
at 11-3
utput 11-11
arpar 11 11
11-21
m 11-30

iv MM5 Tutorial

Model Simulation 12-4

1	12.7	Viewing Model Output 12-5		
13	CVS	\mathbf{S}		
1 1 1	13.1 13.2 13.3 13.4 13.5	What is CVS? 13-3 How to Use CVS? 13-3 Use CVS to Keep Up to Date with Mesouser's Changes 13-4 Use CVS to Track Both New Releases and Your Changes 13-6 Where to Obtain CVS on the Internet? 13-9		
14	MM	5 Version 3		
1 1 1 1	14.1 14.2 14.3 14.4 14.5 14.6 14.7	8		
Appendix 1 Derivation of Basic MM5 Equations				
I I	A.1 A.2 A.3 A.4 A.5	Derivation of Thermodynamic Equation A-1 Derivation of Pressure Tendency Equation A-1 Forms of the Vertical Momentum Equation A-2 Coordinate Transformation A-3 Derivation of Relation A-3		
Appe	endix	2 MM5 Model Code		
Appe	endix	3 little_r		
((((C.1 C.2 C.3 C.4 C.5 C.6 C.7	Purpose C-1 InputData C-1 OutputData C-9 Quality Control Techniques C-10 Objective Analysis Techniques C-13 little_r Didn't Work, What Went Wrong? C-14 How to Run little_r C-15 Structure and Methods C-16		
Appe	endix	4 Cray Job Decks		
I	D.1 D.2 D.3	Purpose D-1 Prerequisite D-1 Functions of Job Decks D-2		

MM5 Tutorial

What to Modify in a Job Deck? D-2

D.4

- D.5 What is in the Remainder of a Job Deck? D-9
- D.6 terrain.deck D-11
- D.7 regrid.deck D-19
- D.8 rawins.deck D-24
- D.9 interp.deck D-34
- D.10 For Cray batch jobs: D-43
- D.11 graph.deck D-54

Appendix 5 Some FDDA Definitions

References

vi MM5 Tutorial

MM5 Tutorial vii