Development of an Annual Meteorological Dataset using WRF

David Brown

Iowa DNR

Ad-Hoc Meteorological Modelers Meeting

6/26/2009

Overview

- Multi-state Collaboration
  - Develop modeling protocol
    - Modeling domain, vertical structure, benchmark, etc
  - Conduct sensitivity analysis
    - Summer and winter episodes
      - July 28–Aug 16
      - Dec 5–24
    - PBL, land surface, cloud microphysics
  - Perform annual WRF simulation
  - Basic model performance evaluation
    - Southeast hiring contractor to assist with eval

Purpose

- WRF ARW v3.1
  - 2007 & 2008 annual simulations planned
  - Other years possible
- Support state SIP development
  - 2006 $PM_{2.5}$ NAAQS
  - 2008 Ozone NAAQS
  - Possibly 1997 Ozone NAAQS and Regional Haze
    - Serious designations and 2012 review, respectively

Modeling Group

- Project Manager
  - Michael Kiss, VA DEQ
- Project Technical Coordinators
  - Maudood Khan, GA EPD
  - Gopal Sistla, NY DEC

Modeling Group

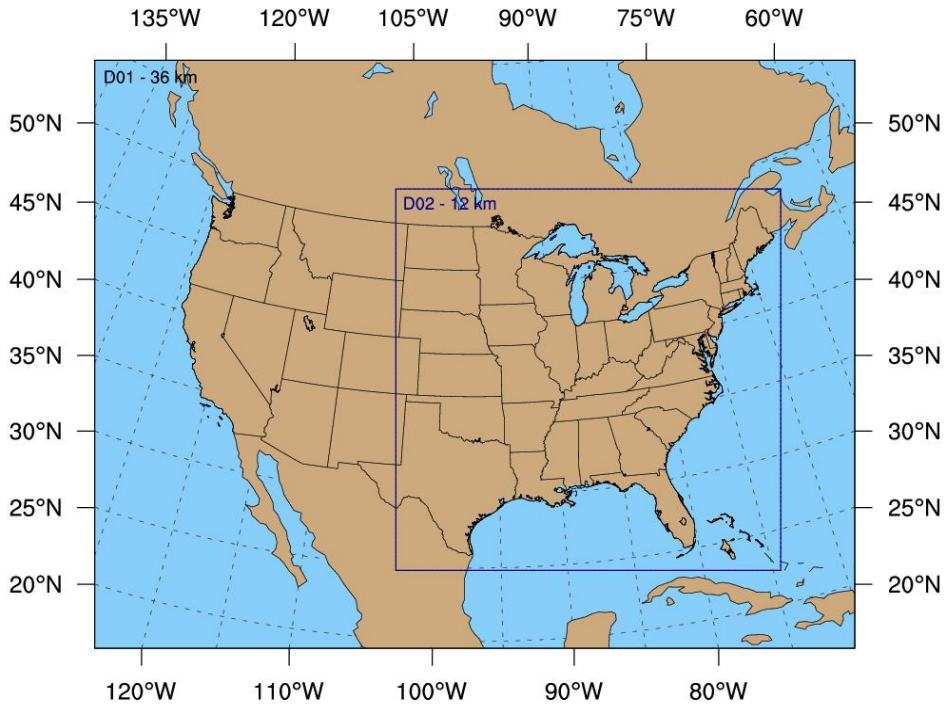
- Modeling Centers
  - David Brown & Matthew Johnson, IA DNR
  - Maudood Khan & Jim Boylan, GA EPD
  - George Bridgers & Nick Witcraft, NC DENR
  - Da-Lin Zhang & Jeff Stehr, UMD

Modeling Group

- Technical Support
  - Bret Anderson, EPA Region VII
  - Debra Baker, MDE
  - Winston Hao, NY DEC
  - Michael Ku, NY DEC
  - Jin-Sheng Lin, VA DEQ
  - Jeff Underhill, NH DES
  - Michael Woodman, MDE

Horizontal Domains

- Lambert Conformal projection
  - Centered at 40 °N, 97 °W
  - True latitudes: 33 °N, 45 °N
- 36 km course domain
  - 165x129
- 12 km nested domain
  - LL i,j: 66,18
  - 250x250

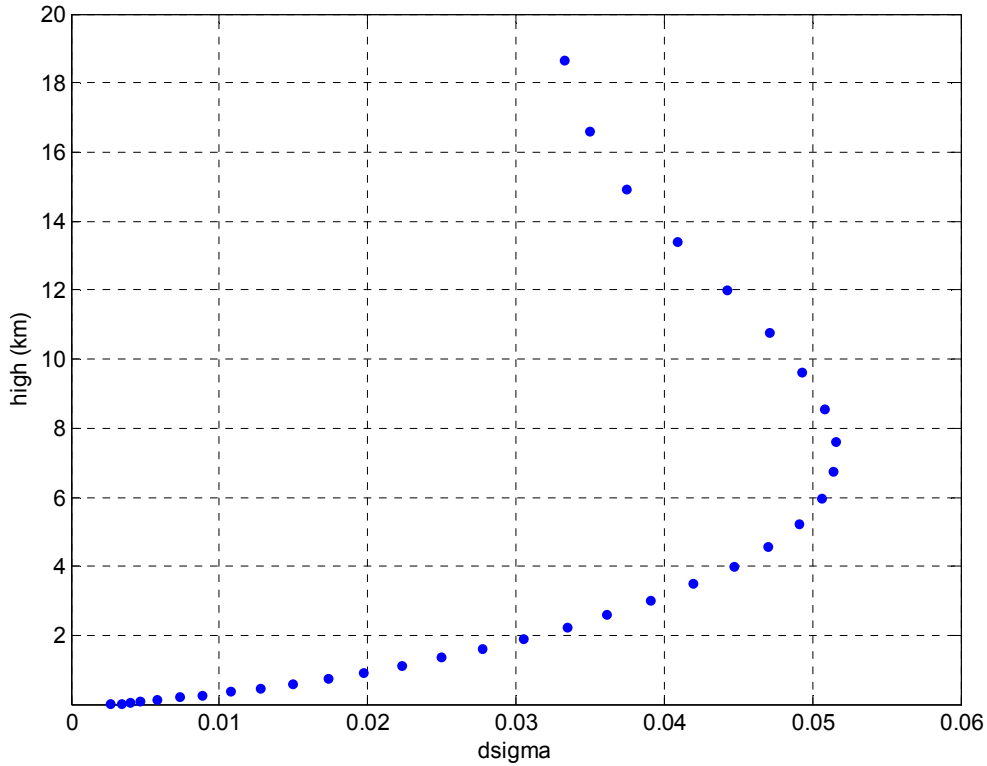


Vertical Structure

- 35 vertical levels
- Model top at 50 mb
- Second sigma level at 20 m
- Increased resolution in boundary layer and near tropopause

Vertical Structure

Level	Sigma	Height (m)	Pressure (mb)	Depth (m)
35	0.0000	18663	50	2034
34	0.0332	16629	82	1715
33	0.0682	14914	115	1515
32	0.1056	13399	150	1375
31	0.1465	12024	189	1255
30	0.1907	10769	231	1145
29	0.2378	9624	276	1045
28	0.2871	8579	323	955
27	0.3379	7624	371	870
26	0.3895	6754	420	790
25	0.4409	5964	469	715
24	0.4915	5249	517	645
23	0.5406	4604	564	580
22	0.5876	4024	608	520
21	0.6323	3504	651	465
20	0.6742	3039	690	415
19	0.7133	2624	728	370
18	0.7494	2254	762	330
17	0.7828	1924	794	293
16	0.8133	1631	823	259
15	0.8410	1372	849	228
14	0.8659	1144	873	200
13	0.8882	944	894	174
12	0.9079	770	913	150
11	0.9252	620	929	128
10	0.9401	492	943	108
9	0.9528	384	955	90
8	0.9635	294	965	74
7	0.9723	220	974	60
6	0.9796	160	981	48
5	0.9854	112	986	38
4	0.9900	74	991	30
3	0.9940	44	994	24
2	0.9974	20	998	20
1	1.0000	0	1000	0



Temporal Structure

- 5.5 day blocks
- 12 hour spin-up time

Input Data

- Initial and Boundary Conditions
  - NCEP Eta/NAM analysis
    - 40 km Eta 212 grid
- FDDA
  - NCEP ADP global upper air observations
    - T,q,u,v
  - NCEP ADP global surface observations
    - u,v

Preliminary Sensitivity Analysis

- July 28–August 16
- December 5–December 24

Planetary Boundary Layer (PBL) and Land Surface Model (LSM)				
Physics Option	Sensitivity 1		Sensitivity 2	
	NAMELIST Value	Description	NAMELIST Value	Description
sf_surface_physics	7	PX	2	NOAH
bl_pbl_physics	7	ACM2	1 or 2	YSU or MYJ

Cloud Microphysics						
Physics Option	Sensitivity 3		Sensitivity 4		Sensitivity 5	
	NAMELIST Value	Description	NAMELIST Value	Description	NAMELIST Value	Description
mp_physics	6	WSM6	4	WSM5	2 or 8 or 10	Lin or Thompson or Morrison

Performance Evaluation

Metrics	Formulation
Bias	$B = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(P_j^i - O_j^i\right)$
Gross Error	$E = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left\lvert P_j^i - O_j^i\right\rvert$
Root Mean Square Error	$RMSE = \left[\frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(P_j^i - O_j^i\right)^2\right]^{1/2}$
Systematic Root Mean Square Error	$RMSE_S = \left[\frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(\hat{P}_j^i - O_j^i\right)^2\right]^{1/2}$
Unsystematic Root Mean Square Error	$RMSE_u = \left[\frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(P_j^i - \hat{P}_j^i\right)^2\right]^{1/2}$
Index of Agreement	$IOA = 1 - \left[\frac{IJ.RMSE^2}{\sum_{j=1}^{J}\sum_{i=1}^{I}\left\lvert P_j^i - M_o\right\rvert + \left\lvert O_j^i - M_o\right\rvert}\right]$

Project Timeline and Deliverables

Task I.D.	Milestone/Deliverable	Responsible Party	Deadline
Task 1	Protocol Development	WRF Committee	June 30, 2009
Task 2	Benchmark Modeling	Modeling Centers	July 15, 2009
Task 3	Sensitivity Analysis Modeling	Modeling Centers	August 31, 2009
Task 4	Basic Model Performance Evaluation	WRF Committee	Aug-Nov 2009
Task 5	Detailed Model Performance Evaluation	SESARM Contractor	Sep-Dec 2009
Task 6	Production Modeling Runs	Modeling Centers	Sep-Nov 2009
Task 6	Modeling Report	WRF Committee & SESARM Contractor	Dec 2009
Task 7	Data Archival/Transfer	Modeling Centers & SESARM Contractor	Dec 2009
Task 8	Quality Assurance Plan	WRF Committee	July 2009
Task 9	Monthly Calls	WRF Committee	As Scheduled
Task 10	Project Management	WRF Committee	Jun 2009-Jan 2010