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A NEW APPROACH TO LOCAL MODELING

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1. INTRODUCTION

Locally run atmospheric models have been available to National Weather Service Forecast Offices for several years and have provided a source of flexibility in available model solutions. These local models are frequently run in an automated fashion but with limited or no forecaster interaction. The Weather Forecast Office (WFO) in Tulsa, Oklahoma, has developed a system to change that paradigm. A graphical user interface (GUI) has been created to allow forecasters to access and interact with the local model to produce a wide variety of short range model output, using forecaster-selectable settings. Forecasters can create a sort of ensemble of model forecasts using different physics and/or dynamics parameter settings. Development of a weather event centric verification database is underway to aid forecasters in selecting the most appropriate modeling schemes to best bracket the potential solutions. These tailored model solutions are expected to have positive impacts on the quality of hazardous weather information issued by WFO Tulsa, OK.

2. WRF-ARW MODEL

The atmospheric model used at WFO Tulsa is the Weather Research and Forecast (WRF) model with the Advanced Research WRF (ARW) dynamical core, hereafter referred to as the local model. It is provided and supported by the SOO Science and Training Resource Center at COMET (http://strc.comet.ucar.edu). The model is run on a PC with a Dual Quad Core Intel® Xeon® E5310 processor at 1.60GHz with a RedHat Enterprise 5.0 operating system. The model domain is on a 10km grid of 82x83 gridpoints centered on the WFO Tulsa County Warning Forecast Area (CWFA). Generally each hour of model time takes about 1 minute of CPU time to run and input and output processing takes another 4-6 minutes (ex. a 6 hour run takes around 12 minutes). This is fast enough to allow forecasters to run a short range simulation several times within the zero hour forecast window and export the various solutions into in the Advanced Weather Interactive Processing System (AWIPS) for comparison.

3. GRAPHICAL USER INTERFACE

Initialize: ● laps ○ nam ○ gfs ○ ruc

Bndry Cond.: ● wrf ○ gfs ○ ruc

or

Archive: ○ NARR

None	Cumulus Param
WSM 5	Microphysics
2	MP_ZERO_OUT
1.e-8	MP_ZERO_THRESH
Mellor-Yamada-Janjic	Planetary Bdry Lyr
RRTM	LW Radiation
Dudhia	SW Radiation
Runge-Kutta 3rd ord...	Time integration
Simple	Diffusion
Average	Damping

Model Init (UTC)

2009	Year
May	Month
20	Day
15	Cycle
00	FcstHr

Length: 12

Your model run : 20090520 15 Z

Awips output model : wrf_arw
○ ● 2 ○ 3 ○ 4 ○ 5

05:20:2009 11:16:12 CDT
HOURLY CRONJOB IS RUNNING!!

No manual run available until it is done...check after the top of the hour!

this space is empty

Figure 1: Screen capture of the model graphical user interface.

Figure 1 illustrates the user-friendly interface developed locally at WFO Tulsa, OK to allow forecasters to easily interact with the local model settings and view the associated output in AWIPS. The available options include: initialization and boundary conditions, model start and length of run, and physics and dynamics parameterization schemes. Additionally, a status window allows the forecaster to watch the status of the model run and then write the model

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output to AWIPS for ease of comparison to other data sets.

The first step within the local model GUI is to select the sources of initial and boundary conditions. The default option for boundary conditions is to use the Local Analysis and Prediction System (LAPS; FSL 2004) initial conditions nested within a previous run of the local model on a larger regional scale. Other options allow using the North American Regional Reanalysis (NARR, Mesinger et al. 2006) archived datasets or operational NCEP North American Mesoscale (NAM) or NCEP Global Forecast System (GFS) model input.

The model start time and length of the run are then selected, followed by various physics and dynamics parameterization scheme choices. The ability to alter both physics and dynamics schemes in near real-time offers the largest variance in model output, with the cumulous parameterization, microphysics and planetary boundary layer (PBL) schemes the most popular settings to alter. The cumulous parameterization selections include: Kain-Fritch, Betts-Miller, Grell-Devenyi and Arawkawa. PBL parameterization selections include: Yonsei, Mellor-Yamada-Janjic and NCEP. The microphysics schemes are: Kessler, Lin, New Ferrier and Thompson. Finally, the AWIPS output selection sets the model output name for ingest and writing to the AWIPS database (wrfarw1, wrfarw2, etc). Buttons and a status window provide model status and the ability to write the model output to AWIPS, with options for viewing the model log file and restarting the automated hourly run scheduled within AWIPS.

4. FORECASTER METHODOLOGY AND TRAINING

Ideally, forecasters should be able to identify critical forecast elements along with the critical time period, and then select the model physics, dynamics, and initializations which will best predict those critical elements. An ensemble approach can then be obtained by running the local model multiple times with differing schemes and/or initializations. The goal would be for this ensemble approach to provide insight allowing a forecaster to add or eliminate forecast scenarios.

This idealized approach highlights two primary training objections. First is the ability to identify the critical forecast elements within the time of interest. An example would be to focus on surface dew point forecasts to best identify dryline placement in anticipation of thunderstorm initiation and degree of potential instability. This training objective is largely influenced by forecast experience; however, case studies focusing on defining the critical forecast element(s) and timeframe(s) are being developed to further hone forecaster skills. The second training objective is the ability to select the most appropriate modeling scheme(s) for the identified weather element(s) within the timeframe(s) of choice. The goal for this objective is to provide an overview of the advantages / disadvantages of the available schemes and initialization choices within the model GUI, and to develop a representative flowchart to aid the forecasters' decision. Additionally, a verification dataset is being developed based on potential weather scenarios and the associated critical weather element. These statistics will also be made available to forecasters to guide them through the many modeling choices the GUI offers.

The ability to easily compose various model solutions is expected to offer not only enhancements to locally produced gridded forecasts contained within the National Digital Forecast Database, but also to enhance decision support for our partners during high impact events. These events might include hazardous spill mitigation, wild fires, large venue events and others. In these events, the critical weather elements and associated timeframe can be relayed from the event site to the forecasters who will assimilate that data with the local model. The forecasters will then interpret various model output and the relayed observational data. Finally, forecasters will communicate the potential scenarios back to the decision makers. This type of interaction can be repeated prior to, and throughout an event producing both real-time and / or contingency forecasts.

5. EXAMPLE USING VARIOUS MODEL SCHEMES

Figure 2 is an example of utilizing various schemes within the local model to produce potential scenarios involving convective initiation along an approaching dryline. Three different 6-hour forecasts with altered cumulus parameterizations were made using the local model with output made available to the forecaster within 40 minutes. All other variables were unchanged for the three model runs. Shown is a snapshot of the modeled surface dew points and derived composite radar reflectivity centered over the western periphery of WFO Tulsa's CWFA. Additionally, a brief note is made on the appearance of each model solution. Finally, the 21 UTC KINX 0.5˚ reflectivity is shown for verification.

6. FORECAST ELEMENT VERIFICATION

WFO Tulsa believes that the ability to both determine the critical forecast element(s) and the appropriate model scheme(s) will be key in how successful the forecaster adjusted modeling efforts will be. An important component will be a verification dataset that is defined by the forecast element and/or weather scenario in question. For example, dryline placement and associated convective initiation could define a verification scenario. Utilizing the NARR dataset, the model can be run using various schemes on defined events with both subjective and objective verification made available to forecasters. Currently, verification scenarios include arctic frontal timing, dryline behavior, stratus formation, and Arkansas River Valley wind behavior. The goal is to produce a flowchart to guide forecaster decisions on the modeling schemes most likely to perform best once the forecast element and / or scenario is defined. Figure 3 and Table 1 illustrate preliminary verification efforts for a dryline event observed 10 April 2009.

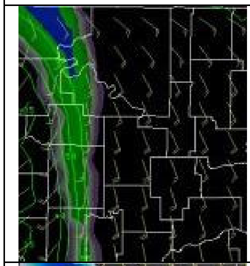
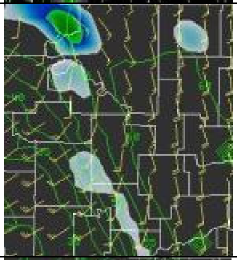
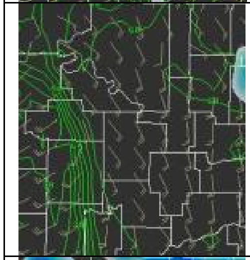
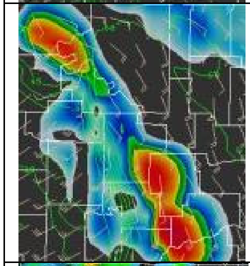
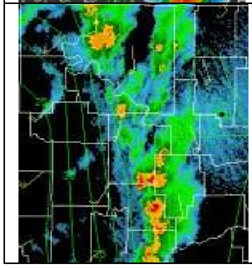
Comp Reflectivity, Surface Wind and Dwpts valid at 21 UTC	**Model: Cumulous Pararm Fcst Hour**	**Notes**
	Operational NCEP NAM (WRF) 3 Hour Fcst	Slower moving dryline east. Solid band of weak looking convection
	Local WRF-ARW w/ Kain-Fritch 6 hr Fcst	Similar to Nam with dryline. Weak broken convection
	Local WRF-ARW w/ Grell-Devenvi 6 hr Fcst	Much tighter dew point gradient. No convection
	Local WRF-ARW w/ Betts-Miller 6 hr Fcst	Stronger line of convection and faster eastward movment.
	21 UTC KINX 0.5° Reflectivity	Location and intensity most similar to solution with Betts-Miller scheme.

Figure 2: Model comparison utilizing differing cumulus parameterization schemes.

The local model data is ingested into the National Weather Service's Graphical Forecast Editor (GFE; Forecast Systems Laboratory 2001) which, when combined with an observed analysis, allows for rapid objective verification of the model output. Figures 4, 5 and 6 were produced in GFE and show examples of forecast dew point bias calculations from the different boundary layer schemes.

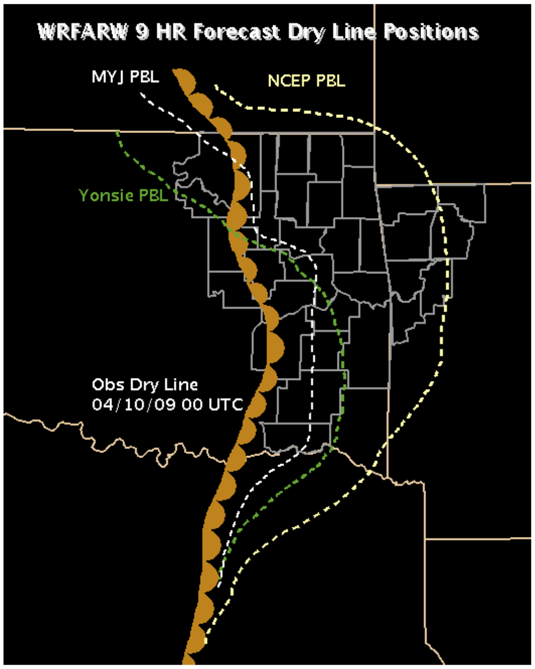


Figure 3: Subjective verification of dryline placement with differing PBL schemes on 10 April 2009.

PBL	bias (F)	absErr (F)
Yonsie	-1.1	7.0
MYJ	0.4	6.4
NCEP	-18.1	18.5

Table 1: Objective dew point verification on 10 April 2009 for the WFO Tulsa, OK grid domain in GFE.

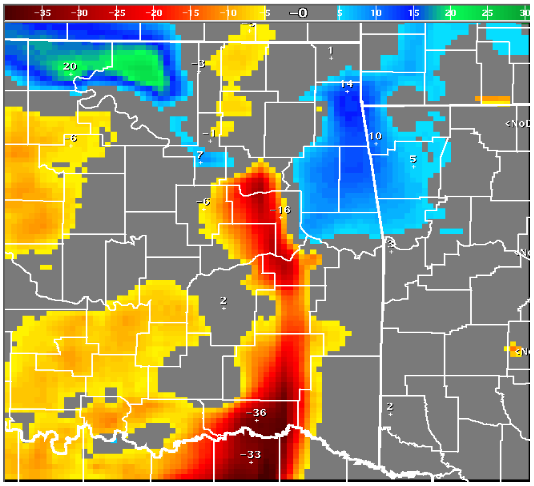


Figure 4: 10 April 2009 Yonsie PBL 9 hour forecast dew point bias.

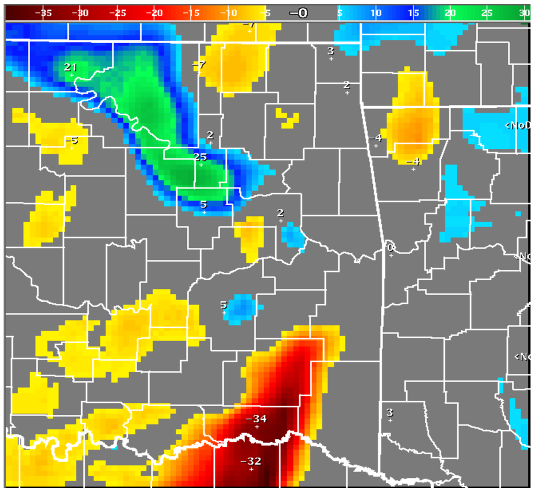


Figure 5: 10 April 1009 MYJ PBL 9 hour forecast dew point bias.

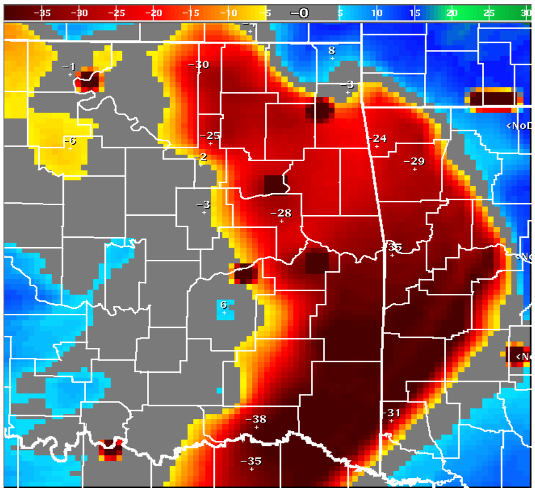


Figure 6: 10 April 209 NCEP PBL 9 hour dew point forecast bias.

7. REFERENCES

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