WSI's Operational Implementation of the WRF model

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1. Introduction

WSI Corporation has developed a real-time modeling system that uses the Weather Research and Forecast modeling system (WRF) as the forecast engine. Operational WRF simulations over the continental United States (CONUS) began in April 2004. Since then, European and North Atlantic domains have been added (Fig 1). Additional configuration details can be found in Hutchinson et. al. (2004). Output forecasts are used by WSI's energy and aviation forecasting groups and provided to media outlets for use in generating broadcast quality graphics.

WRF was chosen as the forecast model for the operational system due to its superior performance in predicting convectively-driven precipitation, as compared to other available mesoscale models. A comprehensive study was undertaken to evaluate several models (WRF, MM5, ARPS and workstation Eta) and various configurations of each of those models. The configurations consisted of different combinations of parameterization options for convection, cloud microphysics, etc. Results from that study can be found in Sousounis et. al. (2004).

2. Model configuration

i. CONUS domain

The CONUS domain is run every 3 hours out to 51 hours with 12-km grid-point spacing. Forecast data is output every 30 minutes. Selection of initialization and boundary condition data sources was driven primarily by frequency and timeliness. Because NCEP's rapid update cycle (RUC) analyses are available every hour approximately 40 minutes after the hour (except for 00 and 12 UTC analyses that are available approximately 1 hr 5 min after analysis time), the RUC was chosen as the initialization data source. In order to provide boundary condition data for model runs that will begin at time of receipt of the RUC analyses, forecast data from the most recently available NCEP Eta run is used for boundary condition data. Because the "Noah" land surface model (LSM) within WRF requires soil data from specific levels not provided by the RUC model, but provided by the Eta model, soil moisture and temperature are also initialized using Eta forecast data.

Forecasts are complete approximately 2 hour 10 minutes after initialization time, except for the 00 and 12 UTC initialized forecasts that complete about 2 hours and 30 minutes after initialization time (since receipt of RUC 00 and 12 UTC analyses is delayed).

i. European domain

The European domain is run every 6 hours out to 48 hours with 14-km grid spacing. Analyses and forecasts from NCEP's Global Forecast System (GFS) are used for initial and boundary conditions.

ii. Atlantic domain

The Atlantic domain is run every 6 hours out to 48 hours with 36-km grid spacing. Analyses and forecasts from NCEP's Global Forecast System (GFS) are used for initial and boundary conditions.

2. Media Products

Output from the CONUS simulations is delivered to television broadcast customers under the brand

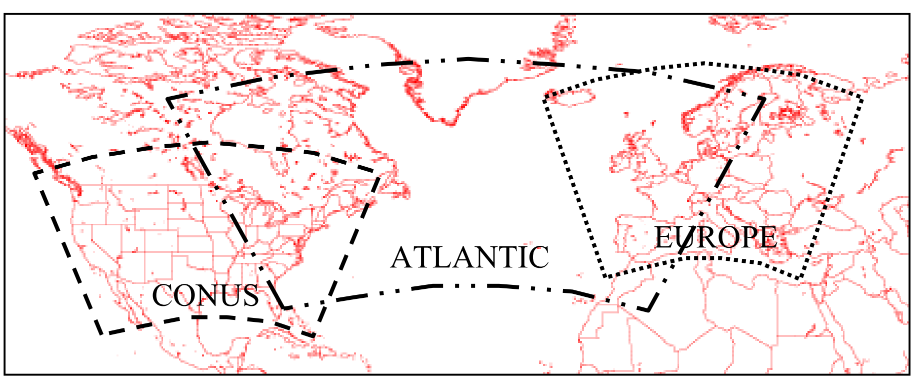

Fig. 1. Domains over which the WRF is run operationally.

name *Rapid Precision Mesoscale (RPM)*™ model. CONUS simulations are run centrally at WSI and selected output data is distributed to customers via the internet. At the customer site, the data is ingested into a WxProducer™ system. The data can then be accessed by the customer within WSI's suite of graphics generation systems. Customers use applications such as WxProducer™, True View Interactive (TVI)™ or ShowEffects™ to produce broadcast quality graphics.

The high-fidelity and high temporal resolution of the WRF output gives on-camera meteorologists the ability to provide viewers with detailed depictions of forecasts. One example is with loops of satellite and radar composites derived from WRF output (a static image from a typical loop is shown in Fig. 2). Fig. 2. shows a 36 hour forecast initialized at 12 UTC 18 July 2005. Within the domain, meteorological features are clearly visible. Just north of Minnesota, a squall line is evident. Scattered convection is evident in the central Plains states. Hurricane Emily is nearing the coast of Mexico. The depictions of such features provide the on-camera meteorologist with tools to realistically describe and present forecast information to the viewing public.

3. Post-processing

Several post-processing routines for generating isobaric output, severe weather, winter weather and aviation products have been implemented. Winter weather products include a snowfall algorithm described by Dube (2003), precipitation type algorithms based on work by Baldwin et. al. (1994) and Bourgouin (2000). Severe weather products include an internally developed lightning intensity algorithm, a hail size algorithm based on algorithms presented by Brimelow et. al. (2002) and Moore and Pino (1990), and the Nimrod convective gust algorithm (Hand, 2000). Algorithms useful for aviation forecasting include a cloud ceiling and visibility algorithm based on work by Stoelinga and Warner (1999) and Kuchera et. al. (2004), and a turbulence algorithm based on work by Sharman et. al. (2002). The products are currently being evaluated. However, the ceiling and visibility algorithms have proven to be especially beneficial to WSI's aviation forecasters. Fig. 3. shows ceiling height for a 36 hour forecast.

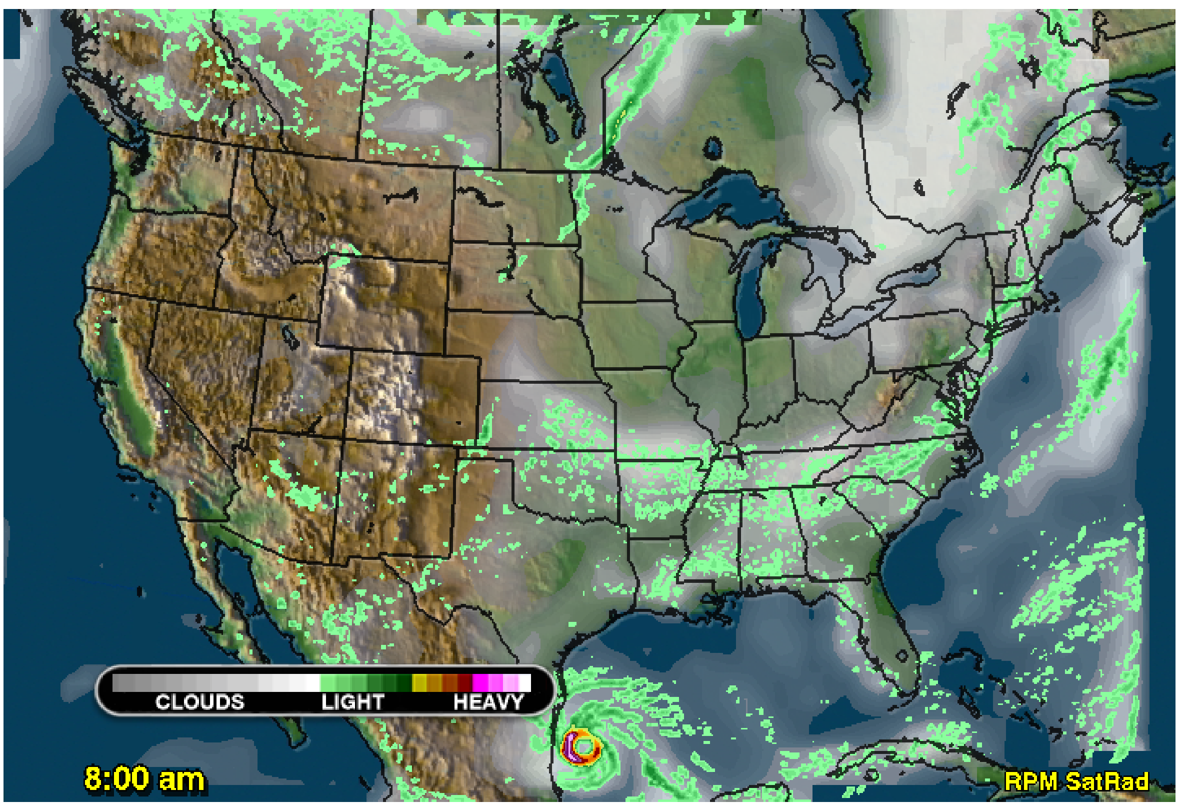

Fig. 2. 36 hour forecast of simulated satellite and radar valid 00UTC 20 July 2005. Radar is simulated by using the standard NWS Z-R relationship to derive dBz values from liquid precipitation accumulation. Satellite radiances are simulated by integrating relative humidity throughout a vertical column.

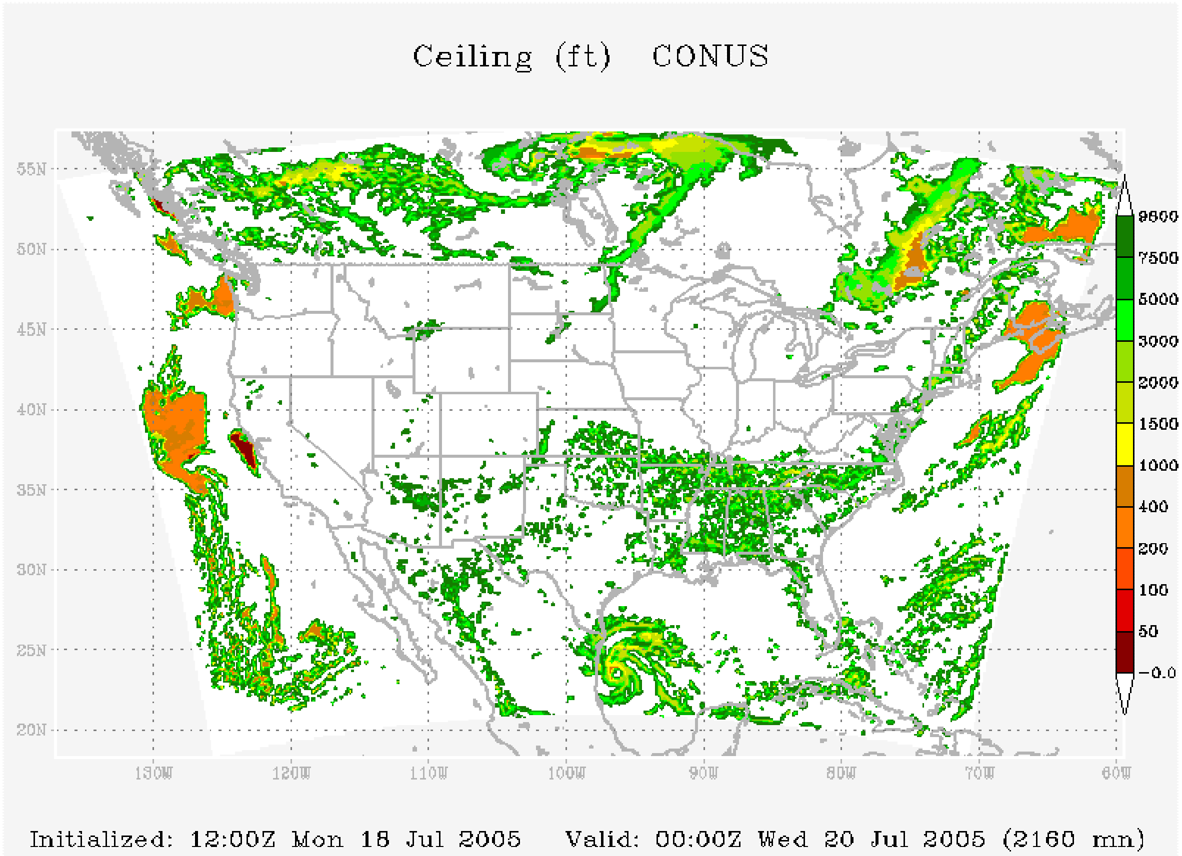

Fig. 3. As in Fig. 2. except for ceiling height (ft).

4. Summary

WSI Corporation has developed a real-time, national modeling system that uses the Weather Research and Forecast modeling system as the forecast engine. WRF is proving that it can generate physically realistic fine-scale structure not seen in the standard output resolutions of other operational forecast models.

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