Real-Time Analysis of Weather Prediction Accuracy

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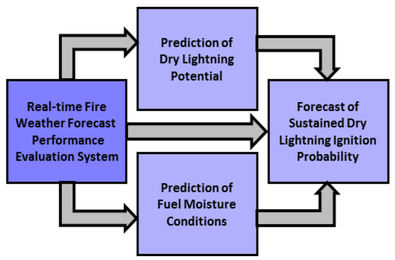
AIRFIRE

INTRODUCTION

Currently, fire weather forecasters, fire planners, and decision makers do not have easy access to information needed to verify the accuracy of, or communicate the level of confidence in, fire weather forecasts and fire prediction products that depend on fire weather forecasts. The Joint Fire Science Program (JFSP) funded us to develop a system that produces intuitive, easily understandable meteorological model performance assessments and provides end-users with real-time information about meteorological model bias, model reliability, and overall performance of fire weather forecasts used in predictions of ignition risk potential.

The system is extensible to parameters important for emissions, dispersion and transport, dry and wet deposition, chemical reactions, and air pollutant concentrations.

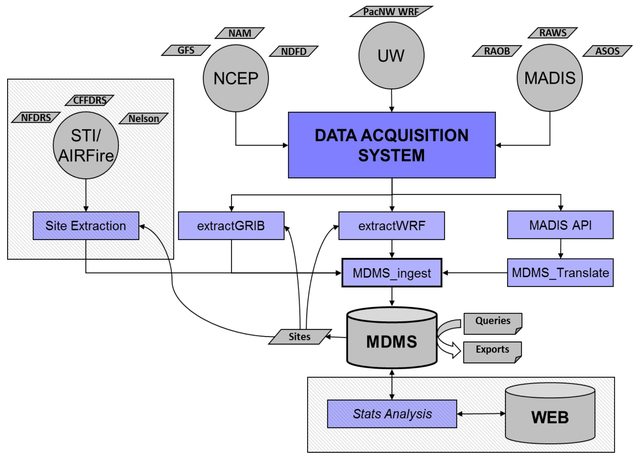


The forecast performance evaluation system described here provides information on fire weather predictions and uncertainty important to fire ignition risk. It routinely acquires observed and forecast meteorological data, and provides real-time evaluation/verification and uncertainty estimates of the model-predicted fire weather variables (both surface and aloft) that will be used in the fire ignition risk predictions.

Spatially and temporally integrated results of the real-time comparison of predicted and observed fire weather parameters will be used as an indicator of model performance.

DATA ACQUISITION AND FORECAST EVALUATION SYSTEM

System Overview



Data Acquisition System

A data acquisition system (DAS) was developed to provide a single program for managing and coordinating continuous remote file transfer protocol (FTP) and local data transfers from multiple sources. This system offers:

- Customizable data transfer jobs
- Integrated job scheduling
- Logging capability for tracking system failures
- Command-line options for manually spawning one-time transfers
- Python (version 2.6); leverages queue and threading modules from the Python standard library

Data Sources

Data Sources[1]	T_{sfc}	RH_{sfc}	E	Prec.	u_{sfc}	T_{aloft}	$T_{dp,aloft}$
Observed							
ASOS	✓	✓		✓	✓		
RAWS	✓	✓	✓	✓	✓		
RTMA	✓	✓		✓	✓		
RAOB						✓	✓
Forecast							
UW WRF	✓	✓	✓	✓	✓	✓	✓
NDFD	✓	✓		✓	✓		
NAM	✓	✓	✓	✓	✓	✓	✓
GFS	✓	✓	✓	✓	✓	✓	✓

[1] Data sources for seven meteorological parameters: surface air temperature (T_{sfc}); surface relative humidity (RH_{sfc}); solar radiation (E); precipitation (Prec.); surface wind velocity (u_{sfc}); aloft temperature (T_{aloft}); and aloft dew point temperature ($T_{dp,aloft}$)

ASOS: Automated Surface Observing System
RAWS: Remote Automated Weather Station
RTMA: Real Time Mesoscale Analysis
RAOB: Radiosonde Observation
UW WRF: University of Washington—Weather Research and Forecasting model
NDFD: National Digital Forecast Database
NAM: North American Model
GFS: Global Forecast System

Database Platform

The Model Data Management System (MDMS) was developed in **PostgreSQL** to

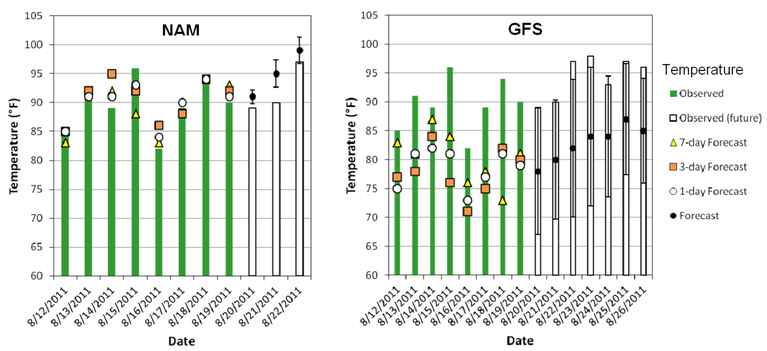
- facilitate efficient storage and retrieval of modeled and observed meteorological data;
- store site-specific data using a minimized data table for optimal storage and retrieval; and
- accommodate the unique challenges posed by model data sets with multiple daily cycles.

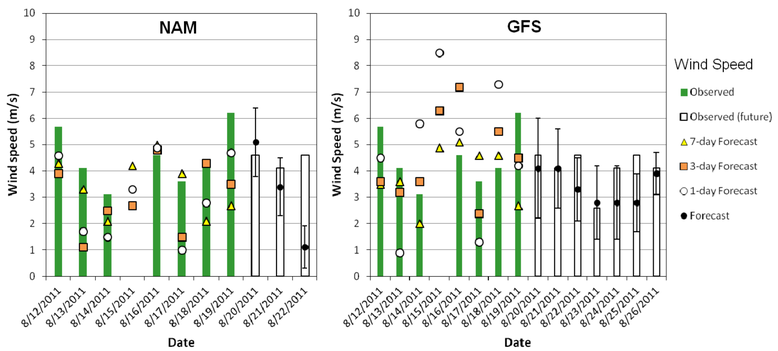
A Java-based automated ingest system was built into the MDMS to import modeled and observed data in real time as they are acquired and processed.

Forecast Analysis and Evaluation

Various analysis methods to establish confidence levels for the meteorological models considered are being investigated, including inter-comparison and evaluation methods such as time-series analysis, standard model performance metrics, and skill scores. A retrospective evaluation of the meteorological predictions provides a basis for quantifying the reliability of meteorological forecasts for fire weather purposes. Currently underway, this evaluation will complement the daily real-time comparisons.

EXAMPLE RESULTS





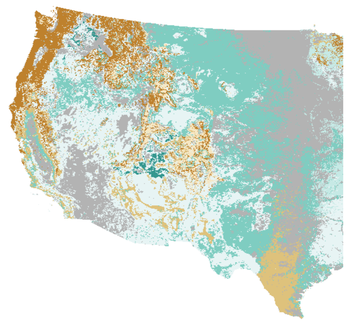
The DAS underwent an initial testing phase with data from MADIS[1] (ASOS and RAWS surface data) and NCEP[2] (NAM 12-km 0000 UTC and 1200 UTC 3-hourly forecasts; and GFS 1.0 degree 0000 UTC and 1200 UTC 3-hourly forecasts). The data, including temperature, relative humidity, wind speed, wind direction, solar radiation, fuel moisture, and precipitation, were ingested by the MDMS. Queries were developed to retrieve data from the MDMS for initial investigation of model performance evaluation analyses.

[1] Meteorological Assimilation Data Ingest System
[2] National Centers for Environmental Prediction

The above examples are for NAM and GFS forecasts for Boise, Idaho, over an 11-day time period. They demonstrate the performance of the model by comparison of the observed temperature (green bars) to the one-day (open circles), two-day (orange squares) and three-day (yellow triangles) forecasts on 8/19/2011 and the previous seven days. They also show the performance of forecasts (solid black circles) for the next three days. The error bars on the three "future" day forecasts indicate the mean error for the forecast based on the model performance over the previous seven days.

FUTURE WORK

- Continue testing the DAS, including additional observation and model data sources.
- Continue investigating forecast performance analysis methods.
- Develop prototype analysis tools and products, which will be integrated into a web-based information display system.
- Implement the full sustained ignition probability forecasting system.
- Investigate how uncertainties in the weather predictions propagate through to the sustained fire ignition predictions.
- Develop spatial plots of the resulting sustained ignition probability.
- Develop a "dashboard" type summary of confidence in the predictions suitable for use by land managers.



Example Spatial Plot

Forecast Source	Forecast Length (days)						
	1	2	3	4	5	6	7
UW-WRF							
NAM							
GFS							
NDFD							
Persistence							

No Forecast Available
High Confidence
Medium Confidence
Low Confidence
No Confidence

Example Confidence Dashboard

ACKNOWLEDGMENTS

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Joint Fire Science Program

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