Developing Sub-Domain Verification Methods Based Upon GIS Tools

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Objectives

- Develop tools and methods to validate high resolution WRF models for Soldiers in tactical echelons.
- Employ a geographic information system (GIS) to conduct spatial and temporal verification/validation of WRF using high resolution digital elevation models.
- Identify sub-domains within the model domain for more comprehensive analyses of WRF forecasts.

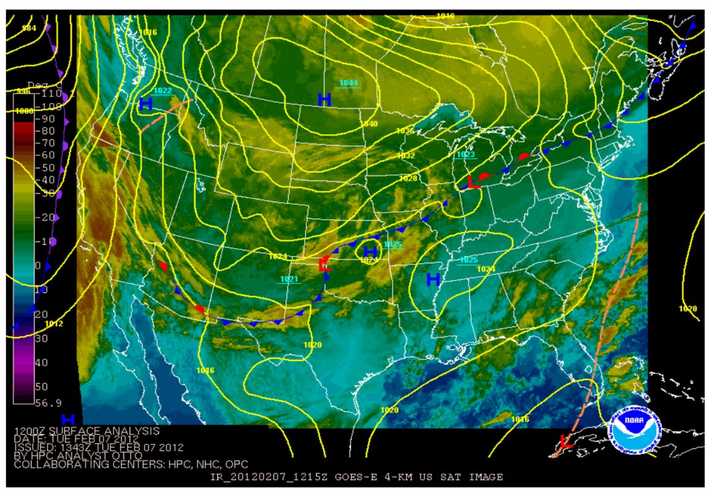
Challenges

- Existing approaches for forecast verification, while useful for ascertaining the predictive validity of the model over a given domain, can obscure the ability of the model to handle sub-domain phenomenon of interest that are important at meso-gamma or “terra incognita” scales (≈ 0.5-1.5km).
- Although GIS methods have proven useful in other fields, their use in NWP verification is still in its infancy. Our challenge is to develop GIS forecast verification and model validation strategies, and establish their value to the NWP community.

WRF Validation Case Study using GIS

- WRF nested domains with resolutions of 9 kilometers, 3 kilometers and 1 kilometer.
- Sub-domains were created according to elevation and horizontal distance from the coast.
- USGS digital elevation data with a resolution of 1/3 arc second.
- Coastline layer from the US Census Bureau TIGER website.

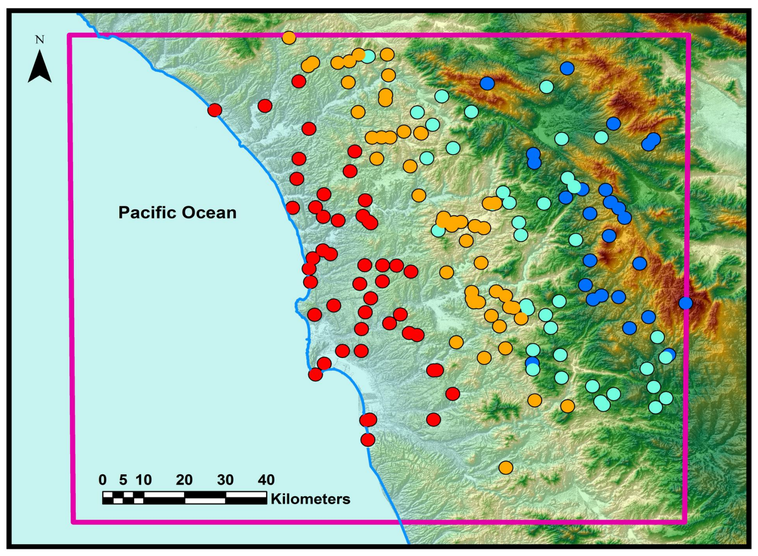
Synoptic Conditions on February 7, 2012



Surface troughing along the California coast, out ahead of an approaching strong Pacific upper level disturbance/trough, caused an extended and widespread period of precipitation over the region. Much of southern California experienced strong diffluent flow at upper levels as the day progressed, as well as mainly an east to southeast surface flow regime (although more southerly along or just off shore later in the day).

One Kilometer Study Area Location

This southern California location was selected because of its varied terrain, and availability of ground observations.



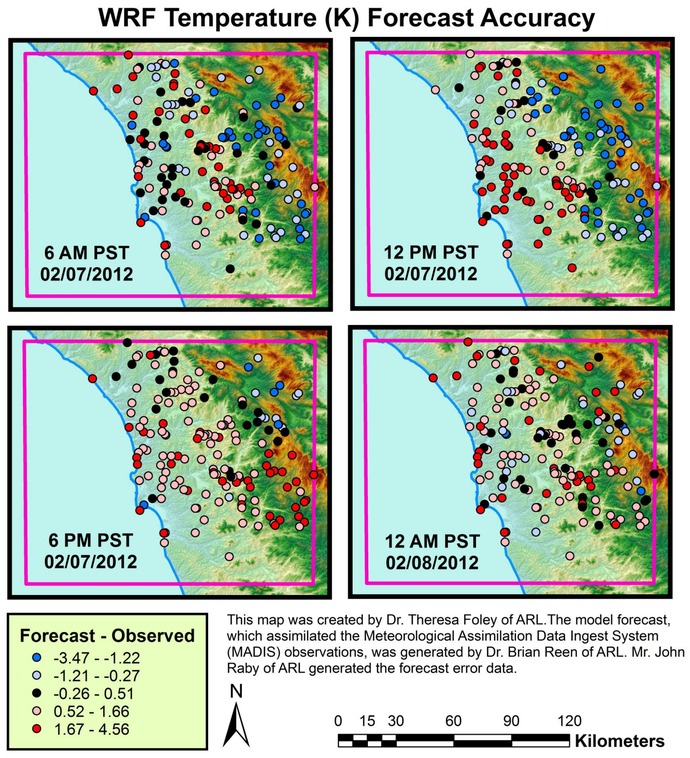
Legend
- Elevation < 500 Meters
- Elevation 500-1000 meters
- Elevation >= 1000
- Distance <= 25 Km from Coastline

This map was created by Dr. Theresa Foley of ARL. The model forecast, which assimilated Meteorological Assimilation Data Ingest System (MADIS) observations, was generated by Dr. Brian Reen of ARL. Mr. John Raby of ARL generated the forecast error data.

USGS terrain data has a resolution of 1/3 arc second (~10m).

Spatial and Temporal Variation of WRF Performance with Temperature and Relative Humidity

WRF Temperature (K) Forecast Accuracy



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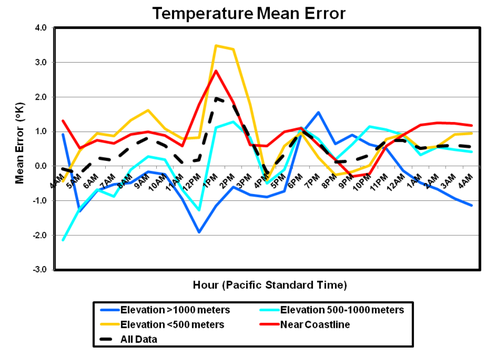
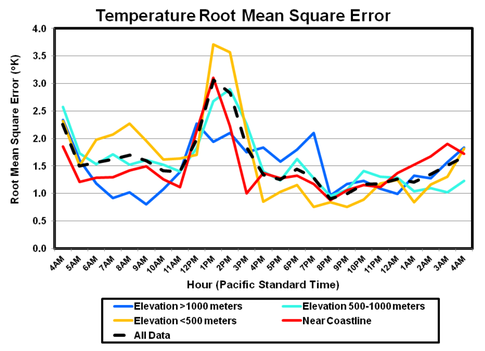
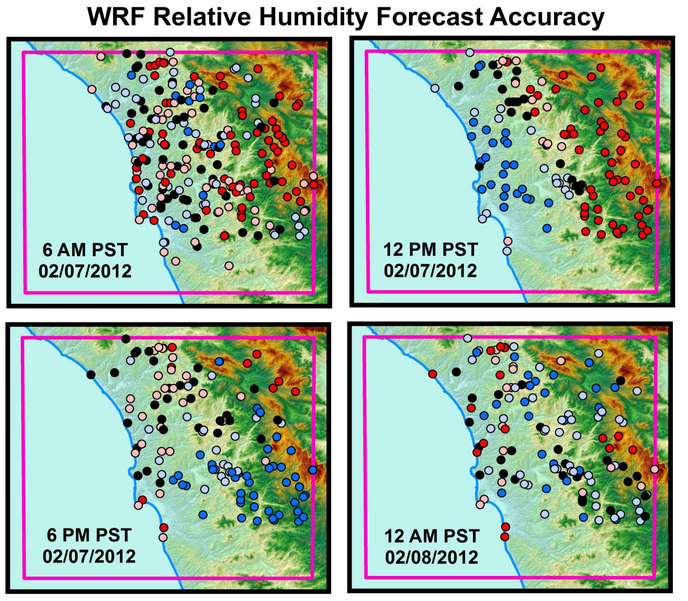




WRF Relative Humidity Forecast Accuracy



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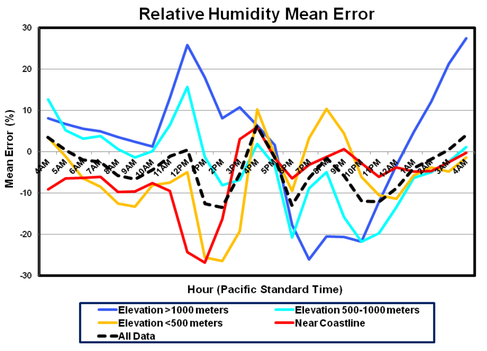

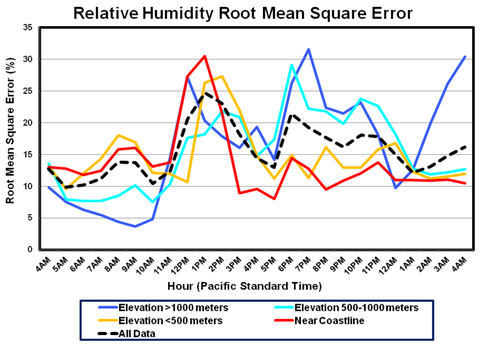

Future Work

- Analyze four more case study days around the same time.
- Incorporate land use and soil moisture data into the analysis.
- Develop different criteria for partitioning the domain into sub-domains, using methods such as k-means clustering and multivariate regression.
- Use GIS analysis to identify areas of WRF where model performance may need improvement.

References

Agnew, M.S., Palutikof, J.P., 2000. GIS-based construction of baseline climatologies for the Mediterranean using terrain variables. Climate Research 14 (2) 115-127.

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