OSIP Business Case Analysis for
Gridded MOS

3.2.1 Executive Summary

To support the transition to a digital era through the creation of the National Digital Forecast Database (NDFD), National Weather Service (NWS) forecasters must produce accurate forecasts on a high-resolution grid in an optimal manner, using guidance available on a grid at a resolution comparable to that used in the Weather Forecast Office (WFO) forecasts. The Meteorological Development Laboratory (MDL) of the NWS's Office of Science and Technology (OST), and this Integrated Working Team, is proposing the development of a new generation of statistical guidance valid on grids with the resolution of the NDFD. Support for the project has also come from the Interactive Forecast Preparation System (IFPS) Science Steering Team (ISST) which acknowledges that the MDL Gridded Model Output Statistics (MOS) activity would eliminate some of the model bias and would improve the centralized guidance. Other alternative solutions considered, but not selected, include maintaining the status quo by providing only the station-based MOS guidance, and implementing a statistically-based model post-processing system locally at each WFO and NCEP center.

3.2.2 Project/Investment Description

The proposed project will produce the MOS guidance on a high-resolution 5 km grid, compatible with the current NDFD grid, with a level of accuracy comparable to that of the station-oriented MOS guidance. Nothing in this solution precludes the generation of the statistical guidance on a finer grid, if it becomes a requirement. The table below describes the elements in the gridded MOS system, to be produced twice a day at 0000 and 1200 UTC based on output from the Global Spectral numerical prediction model.

Type															
	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192
Max	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z
Min	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z	00Z	12Z

Type	**Forecast Projections**
Temperature	Every 3 h from 6 to 192 hours
Dew Point	Every 3 h from 6 to 192 hours
Relative humidity	Every 3 h from 6 to 192 hours
Wind direction	Every 3 h from 6 to 192 hours
Wind speed	Every 3 h from 6 to 192 hours
Wind gusts	Every 3 h from 6 to 192 hours
Sky cover	Every 3 h from 6 to 192 hours
Precipitation type	Every 3 h from 6 to 192 hours
Probability of precipitation – 6 h period	Every 6 h from 12 to 192 hours
Probability of precipitation – 12 h period	Every 6 h from 18 to 192 hours
Probability of thunderstorms – 3 h period	Every 3 h from 9 to 84 hours
Probability of thunderstorms – 6 h period	Every 6 h from 12 to 192 hours
Probability of thunderstorms – 12 h period	Every 6 h from 18 to 192 hours
Quantitative precipitation – 6 h period	Every 6 h from 12 to 156 hours
Quantitative precipitation – 12 h period	Every 6 h from 18 to 156 hours
Snowfall amount – 24 h period	Every 12 h from 36 to 132 hours

3.2.3 Alternatives and Analysis

3.2.3.1 Alternatives Description

1. **Maintain the Status Quo –** This approach is to continue the station-based MOS guidance only. The major drawback of this approach is a continued lack of forecast guidance valid at the grid resolution required by the forecasters. Maintaining the status quo has a cost, however, since it does not reduce the workload of the forecasters in the field, it does not help the issue of coordination among the WFO's, and, in fact, it requires additional tools and techniques to make the best use of the station-based guidance in the current digital forecast paradigm. This approach was not selected.

2. **Develop a centrally-produced gridded statistical system, i.e., gridded MOS -** This approach will generate and disseminate MOS guidance, produced centrally on NOAA's Central Computing System (CCS) at NCEP, on grids with the resolution of the NDFD. If available human resources to develop and sustain the MOS guidance remain adequate, this approach is a low-risk activity. Prototype products have already been developed over the western third of the contiguous U. S., and are currently being evaluated. The Systems Engineering Center (SEC) of OST has been involved during the development, and has already successfully decoded many of the prototype grids, as we coordinate the implementation for the AWIPS system. A centrally produced system also has the advantage of providing gridded MOS products to our customers and partners in the private sector. This approach is the recommended solution.

3. **Develop a gridded statistical system, and implement it locally at each forecast office –** This approach requires the implementation of a MOS system at each forecast office. The current centrally-produced GFS-based MOS system contains 4.3 million equations to produce over 30 million forecasts (combining stations, projections, cycles, meteorological variables) in one 24-hr period. Excluding the MOS developmental software, the current operational MOS software consists of over 200,000 lines of FORTRAN code, in approximately 700 modules; and more than 20,000 lines of UNIX commands in over 100 scripts, developed and optimized to run on IBM AIX POWER4 Clusters (SPs). On average, 30 minutes of computing time on the CCS is required for each cycle to produce the full suite of MOS products. This system of software and equations, along with quality-controlled observations, specially formatted direct numerical model output, and station climatologies would need to be ported to each WFO. In addition, the statistically post-processed guidance would still need to be available to the NCEP centers, and to other external customers. Even if the guidance was produced locally at each office, it would also need to be generated and maintained on the CCS. This approach is not recommended.

3.2.3.2 Alternatives Analysis

1. Status Quo

Pros	**Cons**
Requires no additional development resources at MDL	Does not reduce the workload on the forecasters, who are required to produce gridded forecasts
Current verification system already exists	Does not meet the needs of users requiring digital

	data
Low-risk – tried and true statistical technique	Current station-based MOS does not have adequate spatial resolution
Uses minimal resources on the CCS	Continued problems in the River Forecast System (NWSRFS) getting unbiased gridded temperature forecasts into the hydrologic models
NWS forecasters are familiar with the guidance, no need for additional training modules	
24/7 support provided by NCEP and Gateway staff	

2. Centrally-Produced Gridded MOS

Pros	**Cons**
Expected to improved forecast efficiency	Pulls resources away from the traditional station-based MOS development
Enables more consistency between the WFOs	Requires additional spatial analysis technique and software
Provides gridded guidance in digital format	Requires new gridded verification techniques
A centrally-produced system lends itself better to a quick response to problems, simpler than local systems to maintain, one central point for failure	Adds traffic to the SBN
Low-risk - Developers experienced with employing statistical techniques are enhancing familiar processes with additional data to produce gridded guidance	Does not allow local customization of individual forecast guidance equations
Provides guidance at desired spatial resolution	Requires training resources to learn to use the guidance
24/7 support provided by NCEP and Gateway staff	
Uses minimal additional resources on the CCS	
Unbiased gridded forecast guidance fields would be available for hydrologic and other AWIPS applications	
QC of observations is done centrally, not duplicated at each office	
Software can remain optimized for the current CCS operating system, no need to maintain different versions for different computing platforms	

3. Locally-Produced Gridded Statistical Forecast Guidance

Pros	**Cons**
Saves bandwidth on the SBN	Difficult to maintain
Allows local customization	Multiple points for failure
Provides guidance in digital format	Uses resources to maintain and support local operations rather than improve the guidance
Provides guidance at desired spatial resolution	Requires storage to maintain observations and model output in additional format for MOS system
	Duplicates effort since the creation of a centrally produced product for external customers and NCEP centers is still required
	Requires additional time to QC the observations
	Additional local configuration management is

	undesirable
	Requires an applications release – no quick fixes for errors
	Code would have to be ported from a UNIX platform to a LINUX platform. The code is not platform independent, estimated to require 6 person-months for check-out
	Requires additional local gridded verification process
	Required resources to learn how to install, customize, maintain, and use guidance

3.2.3.3 Solution Selection

We are proposing a centrally-produced gridded statistical system based on the MOS technique as our selection. This approach is a highly developed technique that has been shown to produce good guidance at observation sites. MDL's objective in this solution is to generate gridded guidance with accuracy comparable to that of the station-oriented guidance. Dissemination of these grids to the NWS forecaster would provide a consistent nationwide forecast in a more accessible and adaptable gridded format. In adapting the MOS approach to provide gridded guidance, MDL is using high-resolution geophysical datasets, as well as available mesonet observational data, in addition to the traditional numerical model output, and METAR observations. MDL has completed a risk-reduction effort by creating gridded prototype MOS products for the western U. S. This solution will provide statistically-based forecasts in a spatially coherent gridded form, while also incorporating probabilistic information.

Resources required:

- The fully-staffed Statistical Modeling Branch of MDL consists of 11 full-time federal employees and 1 contractor. Costs for the Branch are approximately $1.1 million annually, and are obtained via the NOAA planning, programming, and budget execution process. The branch is currently staffed at 9 FTE's and 1 contractor.
- 1.5 person-months (i.e.: approx. 6 weeks) from OST/SEC for AWIPS development.
- .5 person-months (approx. 2 weeks) from Global Systems Division (formerly FSL) for GFE AWIPS development.
- Costs less than $1/day to run on the CCS (estimate provided from NCEP), based on node usage and CPU time.
- Minimal bandwidth required, less than 250K/grid (See Request for Change DRG 9332 - Addition of GFS-based gridded MOS guidance for the CONUS for more details http://www.weather.gov/mdl/synop/gmos/gmos_drg.pdf).
- Training module – A 30-minute PowerPoint presentation can be created from already existing gridded MOS briefing material, approximately 1 person-week required to address the science of gridded MOS.
- Additional resources will be needed to provide adequate training on the tools and interfaces within AWIPS, this is currently being evaluated.
- No changes are requested to the existing enterprise architecture.

Development Schedule Highlights (For a more detailed and complete schedule, see the Program Plan)

- February 28, 2006 – Development of operational maximum/minimum temperature, temperature, dew point, wind direction, wind speed, probability of thunderstorms, probability of precipitation, probability of precipitation amount, and snowfall amount forecast equations for the CONUS.
- May 31, 2006 – Complete modifications to software and processes used by NCEP's HPC to ingest gridded MOS guidance.
- June 30, 2006 – Implementation for deployment of max/min temperature, temperature, dewpoint, relative humidity, wind speed, wind direction, thunderstorm probabilities, and probability of precipitations on high resolution grids covering the CONUS.
- July 31, 2006 – Development of appropriate training materials for WFO forecasters.
- August 31, 2006 – Development of sky cover and wind gust forecast guidance equations for the CONUS.
- September 30, 2006 – Development of operational precipitation type forecast equations for CONUS.
- Fall 2006 – (Actual date to be determined) Gridded MOS system deployed within AWIPS OB7, if not sooner in an applications release.

3.2.4 Enterprise Architecture (EA)

[Identify how the proposed system conforms to the NWS EA and capital planning and investment control processes in this section. Describe the relationship between the investment and the business, data, application, and the technology layers of the EA.]

The proposed solution does not require any additional investment in the existing enterprise architecture.

3.2.5 Security and Privacy

[Describe the security and privacy processes and planning efforts for this proposal in this section. All investments should demonstrate up-to-date security plans and be fully certified and accredited before becoming operational. Include the current and projected security costs, security performance gaps, and how such funding will close the performance gaps. The NWS must demonstrate that they have fully considered privacy in the context of this investment. The NWS must comply with Section 208 of the E-government Act and, in appropriate circumstances, conduct a privacy impact assessment that evaluates the privacy risks, alternatives, and protective measures implemented at each stage of the information life cycle.]

We are not requesting any system changes with our proposed solution. Existing machines and communication networks, already fully certified and accredited will be employed.