12.1 CREATING A NATIONAL DIGITAL FORECAST DATABASE OF OFFICIAL NATIONAL WEATHER SERVICE FORECASTS

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1. INTRODUCTION

For years, National Weather Service (NWS) forecasters have prepared and disseminated official forecasts as text. Although advances in observing systems, numerical models, and computer workstations have greatly improved both the quantity and quality of weather information available to NWS forecasters, the information the NWS provides to our users has continued to be limited by how fast forecasters can type. Perhaps the best known NWS text product is the public zone forecast (Fig. 1). For years, the Zone Forecast Product (ZFP) has served as the flagship in a fleet of text products tailored to meet the specific needs of the public, fire weather, and marine user communities. The zone product describes forecast weather over county-sized areas for 12-h and 24-h periods of time. It is routinely issued and updated two to four times per day.

With the implementation of the Interactive Forecast Preparation System (IFPS) at forecast offices nationwide (Ruth 2002), the NWS now has an unprecedented opportunity to increase both the resolution and timeliness of its forecasts. Instead of manually typing a myriad of text products tailored for specific user communities, forecasters rely on interactive interpretation and editing techniques to prepare forecasts of weather elements in a common digital database. The database contains weather forecasts on at least a 5-km grid from the current hour until 7 days into the future. The database is updated as soon as new model information or changing conditions dictate. From the database, IFPS software automatically composes and formats the legacy text suite of products. More importantly, the high-resolution forecast itself can now be provided to our customers and partners in digital form–a strategic goal of the NWS for 2003 (NWS 1999). In order to meet this goal, the Meteorological Development Laboratory (MDL) is leading the development of a seamless mosaic of NWS digital forecasts, called the National Digital Forecast Database (NDFD).

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CAZ017-072330-
SOUTHERN SACRAMENTO VALLEY-
INCLUDING SACRAMENTO
330 AM PDT MON OCT 07 2002

.TODAY...SUNNY. HIGHS 93 TO 98. NORTH WINDS 5 TO 15 MPH SHIFTING TO THE NORTHWEST.

.TONIGHT...CLEAR. LOWS 55 TO 60. LIGHT WINDS.

.TUESDAY...SUNNY. HIGHS 92 TO 97. NORTH WINDS 5 TO 15 MPH SHIFTING TO THE SOUTHWEST.

.TUESDAY NIGHT...CLEAR. LOWS 49 TO 54.

.WEDNESDAY...PARTLY CLOUDY IN THE MORNING THEN CLEARING. HIGHS 82 TO 87.

.THURSDAY...DRY. LOWS 45 TO 55. HIGHS IN THE 70S.

.FRIDAY...DRY. LOWS 45 TO 55. HIGHS 65 TO 75.

.SATURDAY...DRY. LOWS 45 TO 55. HIGHS IN THE 70S.

.SUNDAY...DRY. LOWS 45 TO 55. HIGHS 75 TO 85.

Figure 1. A Public Zone Forecast Product.

2. THE DIGITAL AGE

Most NWS text products are prepared and disseminated for direct use by human readers. Although text can be parsed as input to computer applications to a limited extent, it is far more effective for computers to exchange meteorological data directly in digital (or numeric) form. World Meteorological Organization standards for the exchange and storage of meteorological data are BUFR (Binary Universal Form Representation) and GRIB (Grid in Binary). Digital products will be both transmitted to and disseminated from the NDFD in these forms. Standard NWS decoders and encoders for these forms are available at www.nws.noaa.gov/mdl/iwt/.

By making NWS high-resolution digital forecasts available in a form designed for computers, we increase the usefulness of NWS weather forecasts to our customers and partners. These data not only provide input for applications to generate NWS text, tabular, voice, and graphical products, but are expected to drive many custom applications developed outside the NWS. Some

examples are:

- Decision support systems that fit the forecast to the problem.
- Weather information along a path.
- Text generation in more than one language.
- Forecasts for vehicles and hand-held devices with Global Positioning Systems.
- Controls for smart appliances (e.g., heating, cooling, irrigation).
- Graphics for mass media.

As computer applications and smart appliances with a need for accurate high-resolution weather forecasts become ubiquitous, the importance of an always current digital database will grow. With the national implementation of IFPS nearly complete, central development resources previously devoted to the production of legacy text products at Weather Forecast Offices (WFO) can now focus instead on the production of a new suite of high-resolution text and graphical products based on the NDFD.

Fig. 2 shows a high-resolution temperature forecast made by the NWS WFO in Sacramento, California. This represents one of many types of exciting new high-resolution products that can be generated both by the NWS and by our customers and partners from NWS digital data provided them from the NDFD.

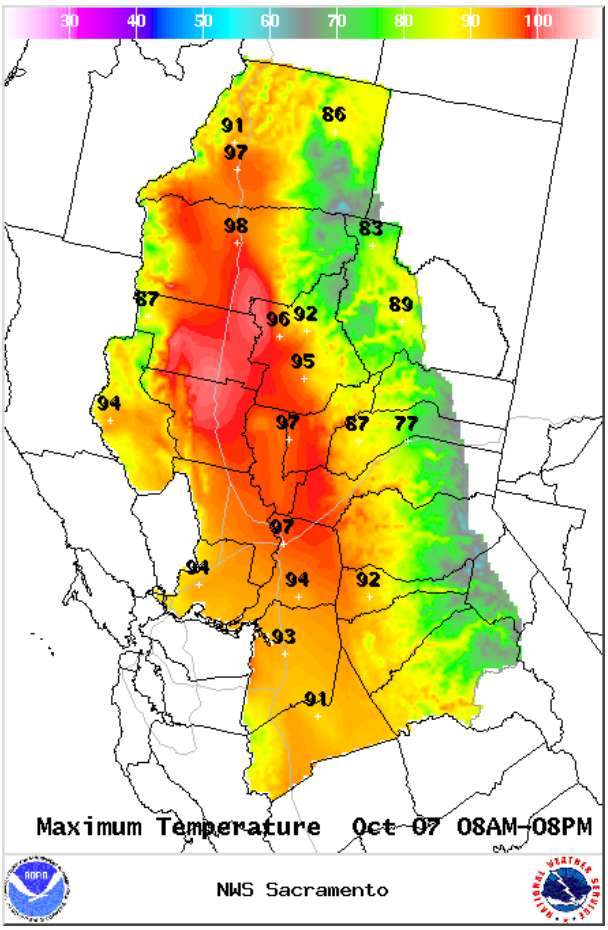

Figure 2. A high-resolution temperature forecast image produced from digital forecast data.

3. EVENT-BASED COLLABORATIVE FORECASTS

As the specificity of NWS forecasts increases, the frequency of updates must also increase to keep high-resolution digital forecasts current. In the early days of interactive forecast preparation (Ruth and Peroutka 1993), forecasters most often started with a "first-guess" model initialization and made modifications with the goal of having a complete database from which to generate forecast products at a scheduled time. In the NDFD era, field offices now maintain a continuous watch on a current and coordinated digital database from one to seven days. Changes are made when either observed weather or new model guidance differs from it. For purposes of NDFD, this constitutes an "an event." New text products can be produced from the digital database as often as desired.

In order to support this new forecast paradigm, NCEP service centers, and in particular, the Hydrometeorological Prediction Center (HPC), are taking a lead role. As new model guidance arrives, experts at HPC review that guidance against the current NDFD. If significant changes are necessary, they coordinate among the effected offices by recommending deltas to the current forecast. These deltas are sent to Weather Forecast Offices either in the form of graphics or digital guidance. In addition, HPC forecasters have now begun to actively participate in local "chat sessions" among WFOs as the weather situation dictates. Although there is always the occasion when the "lone ranger" forecaster is going to be right, on average, most forecasters seem to benefit from interoffice collaboration (Maximuk 2003).

4. THE DIGITAL PRODUCT

As of October 2002, more than 60 WFOs were submitting their forecast elements to the NDFD on 5-km grids. Plans call for the database to expand to over 40 elements on a 2.5-km grid over the next couple of years. WFO forecast elements in the NDFD at the time of this writing are shown in Table 1.

The Conterminous United States (CONUS), 16 CONUS tiles, and eventually four Outside the CONUS (OCONUS) grids are being made available for FTP downloads in GRIB, Version 2. We are also prototyping interactive web services that will allow users to query the NDFD (Boyer and Ruth 2003). In addition, we plan to post selected NDFD forecasts and graphics on NWS web pages. Information on the current status of NDFD is available at www.weather.gov/ndfd.

Table 1. NDFD Elements

NDFD Element Name	Temporal Frequency Days 1-3	Temporal Frequency Days 4-7
Daytime Maximum Temperature	24 hours	24 hours
Nighttime Minimum Temperature	24 hours	24 hours
Probability of Precipitation (12-h)	12 hours	12 hours
Quantitative Precipitation Forecast	6 hours	n/a
Sky Cover	3 hours	6 hours
Snowfall Amount	6 hours	n/a
Surface Temperature	3 hours	6 hours
Dewpoint Temperature	3 hours	6 hours
Wind Direction	3 hours	6 hours
Wind Speed	3 hours	6 hours
Weather	3 hours	6 hours
Free Air Wind Direction	12 hours	n/a
Free Air Wind Speed	12 hours	n/a
Wave Height	12 hours	n/a

5. THE FUTURE

Fig. 3 is a temperature image of the CONUS produced from the NDFD. In addition to forecast information, the image provides an indication of the number of WFOs contributing forecasts to the NDFD at the time of this writing, the current state of collaboration among them, as well as some IFPS software problems that remain to be addressed (e.g., grids over California). In the fall of 2002, we are making a subset of these forecasts available to NWS partners via FTP on an experimental basis. These only include forecasts from those WFOs with the most collaboration experience. MDL's objective is to make mosaics for the entire CONUS experimentally available to support an IFPS operational readiness demonstration this summer. Digital forecasts from offices outside the CONUS should be available by year's end.

Over the next several years, we expect to increase the temporal and spatial resolution of the NDFD, introduce additional forecast elements including those that provide probabilistic information, include objects (in BUFR) that define meteorological features and areas, extend NDFD grids into the vertical, and provide web services that provide interactive access to NDFD. At the same time, we are building a system to digitally verify forecasts for all elements and times we issue–something impractical when NWS products were prepared as typewritten text.

As advances in numerical weather prediction continue, NWS forecasters will continue to transition from looking at model guidance, to working with model guidance; from thinking in words, to thinking in numbers; and from data entry and drawing, to interacting with high level functions that retain the full resolution of the model guidance (Ruth 2000). The purpose of the National Digital Forecast Database is to provide these human value-added forecasts in a form that offers high-resolution and maximum flexibility to our customers and partners.

6. REFERENCES

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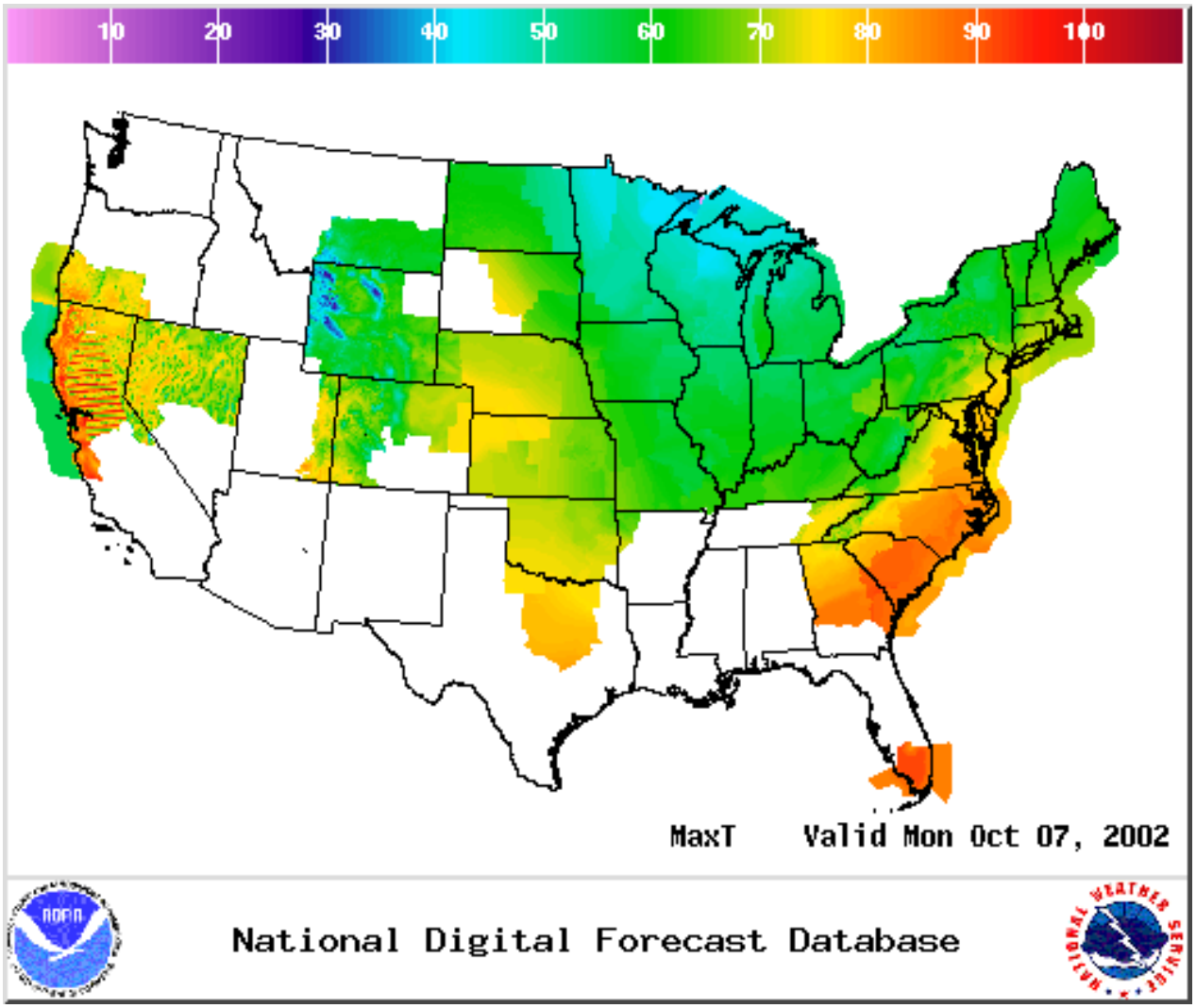

Figure 3. Temperature image of CONUS produced from emerging NDFD