Forecasting

FORECAST WORKSHEET - A NEW APPROACH

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1. INTRODUCTION. One of the most perplexing problems forecasters face today is how to effectively use the myriad of available information in preparing forecasts. Even if time was abundant, the task would be difficult because forecasting aids are mixtures of products from different models, techniques, and data bases; valid for different times or time intervals; and presented in many different ways. Simply put, forecasters are given numerous bits and pieces of data that never fit together perfectly; yet, they must assemble all the various parts, interpret implications of each bit of information, resolve all inconsistencies, and put everything together as an operationally sound forecast.

Through years of experience, forecasters generally learn to do most of these things in their head and still derive a fairly clear picture of what's happening. However, new forecasters usually don't have that ability and frequently develop the bad habit of relying too heavily on only a few centralized aids and ignoring the rest. This has become a critical problem in many units because there is no real "pro" around to teach good habits or procedures, and it's getting worse as the experience level declines.

In an attempt to resolve this problem, we conducted a study which focused primarily on methods for improving use of centralized guidance. The study began with an evaluation of worksheets used by 7WW units and guidance available for developing them. Our search lead to a thorough review of worksheets, and their effectiveness. This technical note describes our findings and recommendations.

1.1. Common Weaknesses in Worksheets. Several different publications furnish guidelines for designing worksheets, but the primary source available to all units is AWS TR 218, Preparation of Terminal Forecast Worksheets. It contains an excellent description of the objective of worksheets and features they should contain. This guidance also promotes two serious deficiencies which thwart the objective: Insufficient detail and poor organization.

1.1.1. Insufficient Detail. This deficiency refers to inadequate information concerning WHEN major changes in key predictors will take place and how SIGNIFICANT those changes will be. Substantial changes in predictors such as temperature, stability, moisture, vorticity, etc., frequently occur during a 24-hour period, but very few worksheets require more than one entry for each element. Furthermore, the significance or magnitude of change is usually missing because oversimplified entries, such as "increasing/decreasing" or "yes/no", are used. Many aids available to forecasters give predictions of various elements in 6 or 12-hour intervals, but such detail is rarely recorded on worksheets. Omission of this essential guidance encourages forecasters to overlook a detailed analysis of timing and significance of major changes that should be considered.

1.1.2. Poor Organization. The other major deficiency arises because little thought is given to arranging the data in a format that helps digest the information recorded. Entries are usually scattered all over the page, different types of entries are made for the same element (e.g. moisture indicated by dewpoint, temperature/dewpoint, dewpoint spread, or relative humidity), and when valid times are recorded, they often vary. This lack of organization makes most worksheets distasteful to use and of limited value in deriving conclusions.

1.2. Guidelines for Designing Worksheets. The following features were used as guidelines for designing a better format for worksheets. The objective was to eliminate the two problems cited above and to improve use of available information. These features include the best of those listed in AWSTR 218 plus others believed necessary to achieve the objective:

a. Provide a logical step-by-step process for preparing forecasts.

b. Aid review and collating essential information.

c. Promote evaluation of data as it is received rather than just prior to forecast deadlines.

d. Depict data in a format that is easily derived, rapidly entered, and quickly digested.

e. Minimize rechecks of data evaluated earlier.

f. Minimize oversight by focusing attention on key predictors.

g. Provide continuity and consistency in time and space.

h. Provide detailed information on timing and significance of expected changes in predictors.

i. Flag times for intensifying local met watch or use of local forecast studies.

j. Provide a record of rationale used in producing forecasts.

k. Aid identification of procedural problems and development of improved techniques through forecast reviews, case studies, and technical studies.

2. DESCRIPTION. This section describes the new format for displaying data on forecast worksheets. Emphasis is on format only since it is impossible to design a standard worksheet that satisfies the needs of all units. Figure 1 shows a basic worksheet designed for Scott AFB, IL. This format is not really new; in fact, it is very similar to the standard time cross-section with two exceptions. First, all information beyond the first time group is a forecast. Second, symbols instead of numerical values or graphical plots are used to give a visual display of the magnitude or "importance" of various predictors. The time cross-section format was chosen because it provides a logical method for evaluating interactive changes which take place in the atmosphere.

2.1. Selection of Times. The data to be recorded begins with the latest (0000Z or 1200Z) available analysis package. This starting point was chosen because accurate predictions of future conditions are directly related to the extent of knowledge about the initial state. Subsequent data consists of progs of key predictors in six-hour increments spanning the valid period of the forecast. Times listed are geared to the normal valid times of most centralized progs and forecast aids. For some parameters, centralized guidance will be available only in 12-hour increments; in these cases, intermediate entries must be interpolated.

2.2 Selection of Predictors. When making a forecast, the first step is to identify major synoptic scale features, such as ridges, troughs, fronts, jets, etc., that will be influencing terminal weather. Next, various sources of data are studied to develop conclusions about the significance of moisture, temperature advection, stability, vorticity advection and other key predictors that will prevail throughout the forecast period. Predictors shown in Figure 1 are the ones most frequently used to make general forecasts of ceiling and visibility. Others could be added, but these were chosen to illustrate the principle involved.

2.3. Symbol Definitions. Symobls, rather than raw values, were chosen as the means for depicting the significance of most key predictors. This was done because their influence can be adequately described by such terms as strong, moderate, weak, or neutral. These are the same terms we routinely use in verbal and written explanations of why certain conditions occurred or were forecast. Table 1 shows the symbols and corresponding verbal equivalents. Also shown are typical ranges of values for each symbol; this subject will be discussed later.

Carefully note the subtle but very important order in which the symbols and terms appear. The intent is to define the predictors such that "N" represents the threshold between non weather-producing (= or -) and weather-producing (+ or ‡) influences. In effect, the symbols visually portray the "importance" role or SIGNIFICANCE of each predictor. The symbol which best represents conditions expected at each time would be

Table 1. Symbol Definitions

	SYMBOLS				
PREDICTOR	=	-	N	+	‡
Vorticity Advection (Units per 12hrs)	Strong NVA ($\geq$ 5)	Moderate NVA (2-4)	Weak/Neutral ($\pm$ 1)	Moderate PVA (2-4)	Strong PVA ($\geq$ 5)
Cold Advection (^{o}C Per 6-Hrs)	Strong Warm ($\geq$ 3^{o}C)	Moderate Warm (1-2^{o}C)	Weak/Neutral (0^{o}C)	Moderate Cold (1-2^{o}C)	Strong Cold ($\geq$ 3^{o}C)
Warm Advection	Strong Cold	Moderate Cold	Weak/Neutral	Moderate Warm	Strong Warm
Moisture (RH%)	Very Dry ($\leq$ 65%)	Moderately Dry ($>$65 $<$ 78%)	Slightly Moist ($\geq$78 $<$ 82%)	Moderately Moist ($\geq$ 82 $<$ 90%)	Very Moist ($\geq$ 90%)

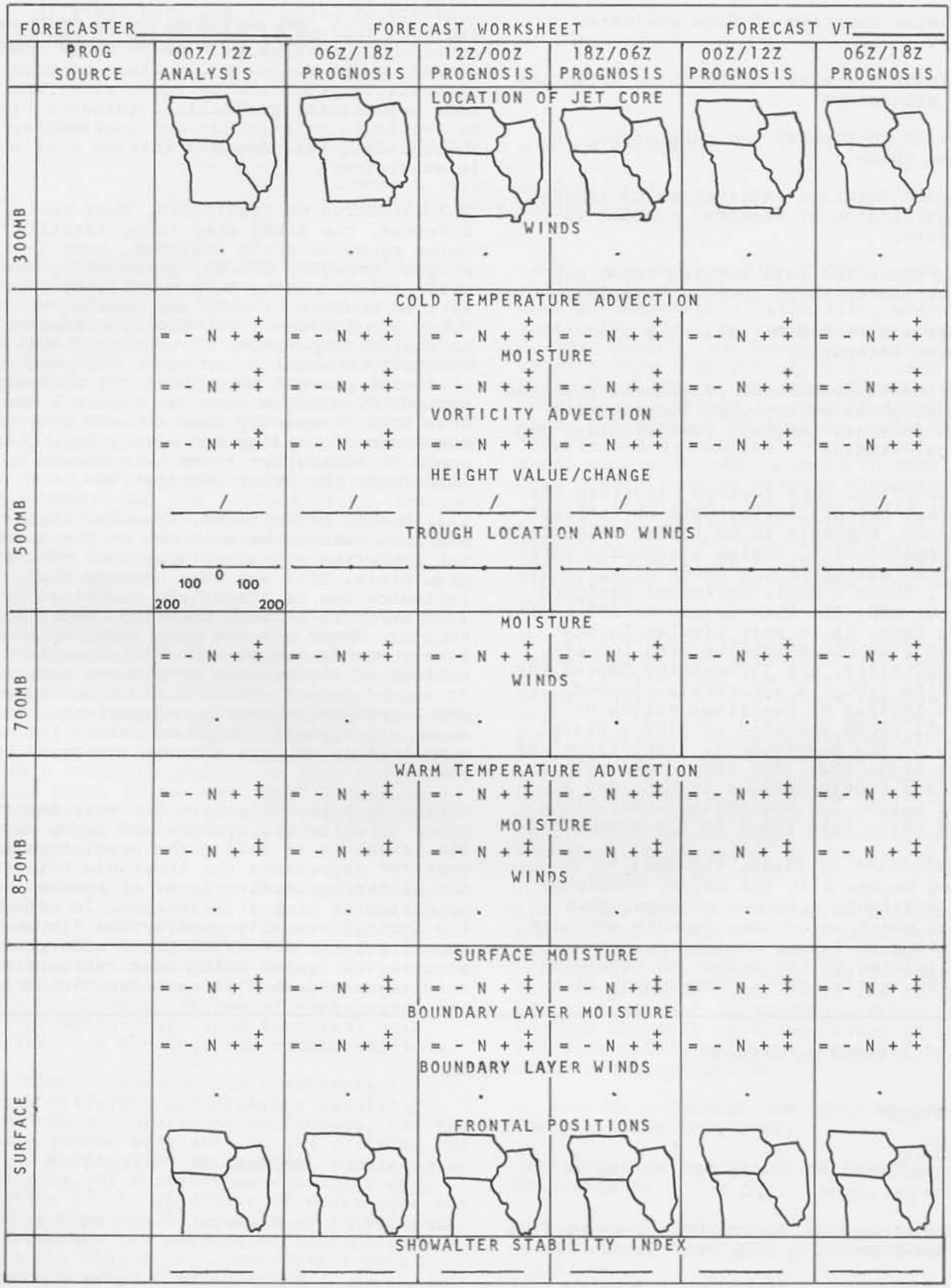

Figure 1. Basic Worksheet for Scott AFB, IL.

marked by placing a circle or square around it. This allows the forecaster to scan all the data and quickly determine the combined effect on future weather conditions. Thus, a worksheet on which all the double-plus symbols (‡) are marked implies that it's going to be a hectic shift. Conversely, all double-minus symbols (=) probably means that there will be time to catch up on those additional duties and technical training. Since the atmosphere rarely lines everything up so perfectly, most situations will be represented by a mix of symbols ranging from one extreme to the other.

The ranges of numbers assigned to each symbol are merely "ball park" figures to get everyone thinking alike and to provide uniform meanings for the symbols. In some cases, these values may need adjustment for individual locations. Don't get "wrapped around the axle" and waste time in trying to calculate precise values of temperature and vorticity advection. For most applications, visual inspection of the angle between the contours and isopleth gradient will usually suffice for estimating the strength of advection. This will be easy after a little practice. The same goes for other predictors; use symbols unless actual values are needed for objective rules or other specific reasons.

Relative humidity (RH), rather than dewpoint depression, was chosen as the standard for describing moisture content. It was selected primarily for two major reasons. First, generally reliable progs of relative humidity for several layers in the lower atmosphere are available in FOUS KWBC bulletins. Secondly, comparisons of the amount of saturation between levels of the atmosphere are easier when relative humidity is used because dewpoint depression varies with temperature for a given degree of saturation (RH). However, use of relative humidity does not eliminate a complication that arises when dealing with clouds composed of ice crystals. Figure 2 graphically shows the significance of this problem and variations in dewpoint depressions. Note especially the large differences in relative humidities with respect to ice and with respect to water for equivalent dewpoint depressions (all with respect to water). For example, a dewpoint depression of 3 degrees C at an ambient temperature of 0 degrees C equates to a relative humidity of 80 percent with respect to both water and ice. However, at air temperatures of -30 degrees C, the 3 degrees C dewpoint depression equates to 75 percent RH with respect to water and 98 percent RH with respect to ice.

Figure 2 can be used to quickly convert progs of dewpoint depression to relative humdities. Dashed lines were added to illustrate saturation differences between water and ice when forecasting clouds composed of ice crystals. Air containing a mixture of water droplets and ice crystals will likely have a relative humidity somewhere between the two pure states; relative humidities in pure ice clouds are indicated by the dashed portion of the dewpoint depression lines. Note that dewpoint, dewpoint depression, and relative humidities used operationally are normally given with respect to water. This is the relative humidity that should be recorded on worksheets - account for the ice versus water differences mentally.

2.4 Data Sources. Figures 3a and 3b are two examples of worksheets completed for Scott AFB, IL. Normally worksheets should be prepared each time a scheduled forecast is issued, but the 03/1200Z Oct 79 worksheet was omitted here for brevity. This section only discusses data sources in general; a later section gives a more complete discussion of the two examples shown.

CONUS forecasters normally have several possible data sources to help complete most prog entries. Sources used in these two examples are shown under the column labeled "Prog Sources". Unfortunately, entries for most predictors must be gleaned from more than one centralized aid to obtain a complete picture for the entire 24-hour period. In some cases, the data are in terms of pressure layers or heights versus pressure surfaces. Other aids depict temperature, moisture, and winds in terms of heights or pressure layers rather than standard pressure surfaces. In addition, moisture is quantified in four different ways (relative humidity, dew point depression, temperature/dew point, and quantitative precipitation). For these situations, the data must be converted to some common standard and mentally interpolated or extrapolated to the desired level before a representative symbol can be assigned. When none of the centralized aids are representative of expected conditions, they should be modified based on all available clues.

In practice, units should establish local policy as to which predictor sources should be studied by listing them directly on their local worksheet in a format similar to the example. The source used should be indicated by placing a check in the parenthesis to the right of the source listed. For situations in which the forecaster modifies centralized guidance, the source labeled "Personal" would also be checked along with any other sources used. When the centralized guidance is modified, cross out (X) the prog entry and place a square box around the prog entry which best reflects your personal belief of what will happen. Modifications should be based on reanalyses of centralized products, local analyses, satellite data, upstream observations, discussion bulletins, or any other met watch information which indicates that the centralized guidance is unrepresentative.

DEW POINT — RELATIVE HUMIDITY CONVERSION CHART

NOTE: ADAPTED FROM AWSTR 105-72. DASHED LINES WERE ADDED TO REFLECT APPROXIMATE RELATIVE HUMIDITIES WITH RESPECT TO ICE FOR CORRESPONDING DEW POINT DEPRESSIONS WITH RESPECT TO WATER.

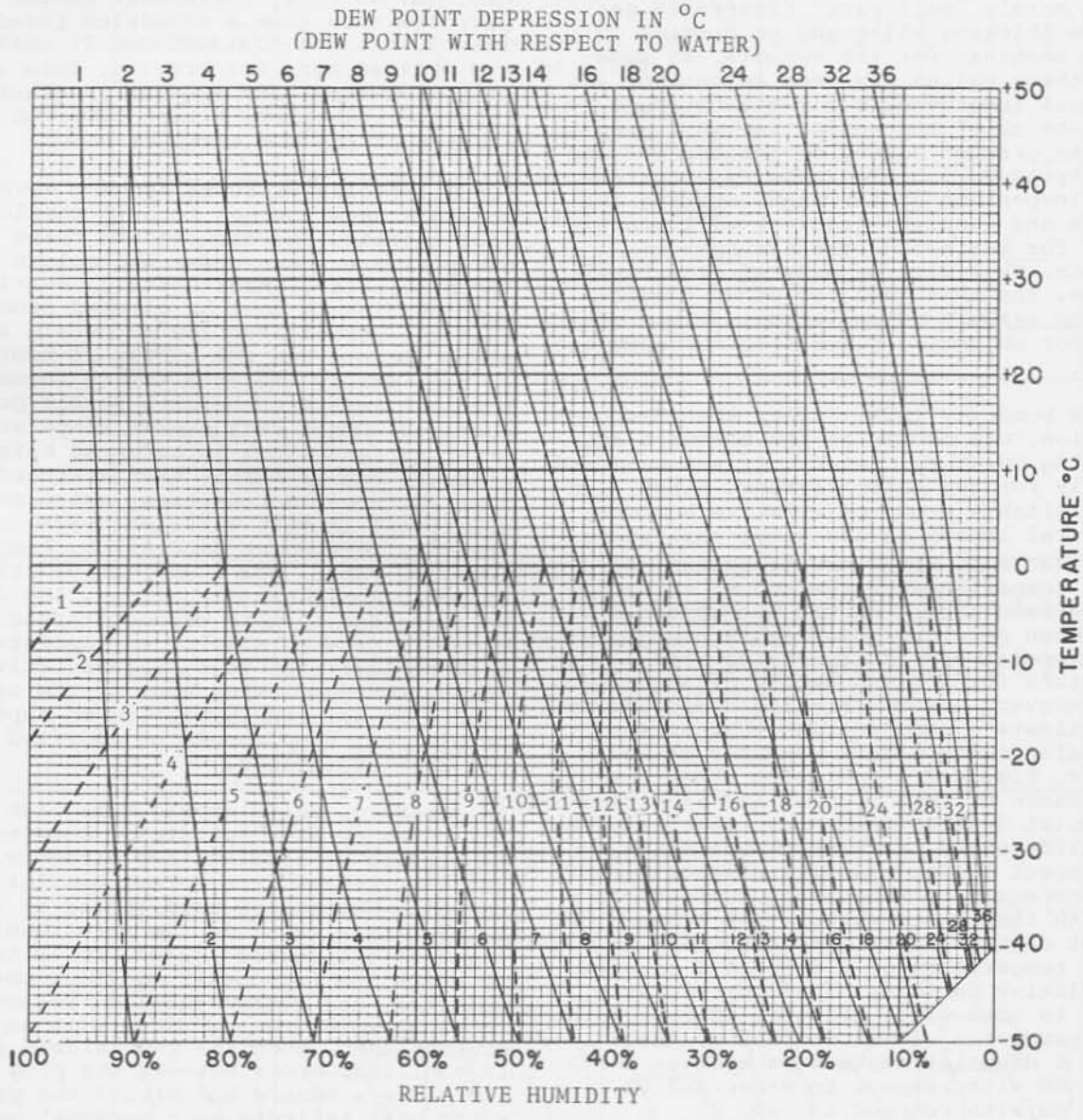

Figure 2. Dew Point - Relative Humidity Conversion Chart.