

U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL WEATHER SERVICE  
OFFICE OF SYSTEMS DEVELOPMENT  
TECHNIQUES DEVELOPMENT LABORATORY

TDL OFFICE NOTE 87-2

COMBINING FORECAST PERIODS IN COMPUTER  
WORDED FORECASTS

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June 1987

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## 1. INTRODUCTION

A common practice in writing operational public weather forecasts is to combine forecast periods when the weather for those periods is similar. This is illustrated in the following example where periods 2, 3, and 4 are combined in the second of the two forecasts:

.TONIGHT.. MOSTLY CLOUDY WITH A CHANCE OF RAIN. LOW IN THE MID 30S. EAST WINDS 10 TO 15 MPH. CHANCE OF RAIN 30 PERCENT.  
.TUESDAY...SUNNY AND COLD, HIGH NEAR 40. NORTHWEST WINDS 10 TO 20 MPH.  
.TUESDAY NIGHT...CLEAR, LOW IN THE LOWER 20S. NORTHWEST WINDS 10 TO 15 MPH.  
.WEDNESDAY...SUNNY AND CONTINUED COLD, HIGH NEAR 40. NORTHWEST WINDS 10 TO 20 MPH.

.TONIGHT...MOSTLY CLOUDY WITH A CHANCE OF RAIN. LOW IN THE MID 30S. EAST WINDS 10 TO 15 MPH. CHANCE OF RAIN 30 PERCENT.  
.TUESDAY THROUGH WEDNESDAY...CLEAR AND COLD, HIGHS BOTH DAYS NEAR 40, LOW TUESDAY NIGHT IN THE MID 30S. NORTHWEST WINDS 10 TO 20 MPH.

As shown in this example, the reasons for combining forecast periods are for brevity and to avoid repetition.

It follows that the operational computer worded forecast (CWF) program (Glahn, 1978; Heffernan and Glahn, 1979; National Weather Service, 1983a and 1983b) should also have the capability of combining forecast periods. The purpose of this paper is to document the criteria that are used in the CWF to decide whether or not forecast periods can combine. It is another in the series of continuing improvements that have been made to the CWF program (Bermowitz et al., 1980; Bermowitz and Miller, 1984; Bermowitz, 1986).

## 2. METHODOLOGY

There are at least two ways to determine if forecast periods can combine. The first is to compute the differences in the digital forecasts between periods for each weather element. These digital forecasts are used to construct the phrases that comprise the CWF (Glahn, 1978). If these differences exceed some threshold value for, at least, one weather element, then those periods would not combine. For example, if the difference in maximum temperature between today and tomorrow exceeds, say 5°F, then the three periods--today, tonight, and tomorrow--would not be permitted to combine. It's also possible to have an additional set of smaller thresholds and not permit combining when differences in, say two or three, of the weather elements exceed these smaller threshold values. For those periods which can be combined, some kind of average of the digital forecasts for each element can be computed. These averages would then be used to generate phrases for the combination.

The second way to determine if forecast periods can combine is to compare the phrases for each weather element after they have been constructed. If a major difference in phrases for any one element occurs between periods, then these periods would not combine. A major difference for clouds, for example, could be "sunny" in one period and "cloudy" in another period. Also, combining would be precluded when multiple small or moderate differences in phrases in one or more elements occur. A small difference for clouds could be "mostly sunny" in one period and "partly cloudy" in another period; a moderate difference could be "partly cloudy" and "cloudy."

The second method, a comparison of the resulting phrases for each weather element, was selected for use in the CWF. It was felt that it would probably be more accurate to determine which periods combine from the phrases rather than from differences in the digital forecasts, since the interrelationships among the digital forecasts have already been taken into account when the phrases were constructed for each period. For example, deciding on a phrase for precipitation type for a given forecast period requires algorithms that not only make use of the probability of frozen precipitation, but temperature and categorical forecasts of precipitation type as well. Therefore, just a comparison of differences in digital forecasts of the same element between periods to threshold values may not be completely revealing with respect to combining for precipitation type as would the phrases themselves.

As previously discussed, combining will not occur if one major difference in phrases between periods occurs for any one element. Furthermore, exceeding two moderate or five small differences in phrases summed over all elements--precipitation, temperature, clouds, and wind--will preclude combining on the 0000 GMT cycle where computer worded forecasts are prepared for three periods. The 1, 2, and 5 difference criteria were selected after experimenting with several values. For the 1200 GMT cycle, where forecasts are made for four periods, the selected difference criteria are 1, 3, and 7. Provided the 2, 5 (3, 7 for 1200 GMT) criteria are not exceeded, a combination phrase is selected for each small or moderate difference in phrases. As an example, "mostly sunny" and "partly cloudy," classified as a small difference, would result in "partly cloudy" for the combined periods.

On the 0000 GMT cycle, possible combinations of periods are 1, 2, 3; 1, 2; and 2, 3. For 1200 GMT, 1, 2, 3, 4; 1, 2, 3; 2, 3, 4; 1, 2; 2, 3; and 3, 4 are possible combinations. In addition, under certain circumstances the two daylight periods (1, 3 on the 0000 GMT cycle and 2, 4 on the 1200 GMT cycle) can combine. These circumstances are primarily ones that are experienced in warm weather conditions when daytime convective activity predominates, so that the forecast would contain a phrase such as "showers likely both days" or "chance of showers and thunderstorms both afternoons." It should be pointed out that National Weather Service (NWS) policy does not allow the first period to combine with any other periods (National Weather Service, 1984). The CWF program follows this policy in operation, but contains the code and a switch to allow the first period to combine with the other should NWS policy change. Future discussion in this paper will assume that the first period can combine with other periods.

Not surprisingly, it's possible for there to be two or more combinations in the same CWF. For example, on the 1200 GMT cycle, periods 2, 3, 4; 2, 3; and 3, 4 could combine. When this happens, as one would expect, the group that combines the most periods--in this case 2, 3, 4--is selected. If it comes down

to a choice between two groups, each with the same number of forecast periods--for example, 2, 3 and 3, 4--the combination that has the fewest moderate differences in phrases is selected. If the number of moderate differences for both groups are the same, then the group with the fewest small differences is chosen. Finally, if the number of small differences for both groups are equal, the combination selected is the one with the forecast period furthest out in time, in this case 3, 4. The reasoning here is that the further out in time a forecast goes, the less detail is required because of reduced predictability. One other possibility exists which occurs when periods 1, 2; 2, 3; and 3, 4 are possible combinations in the same 1200 GMT CWF. Since, in this case, it's possible to have two non-overlapping combinations, 1, 2 and 3, 4 are both selected.

It should be pointed out that combining of forecast periods with similar forecasts is an option in the CWF program. Each forecast office can decide whether or not this option will be used. Discussion will now focus on the decisions that either allow or preclude combining of periods for phrases of each of the four weather elements--precipitation, temperature, cloud, and wind.

### 3. PRECIPITATION

The precipitation phrase used in the CWF consists of three parts. One part is an expression of the PoP (e.g., "chance of," "likely," or no phrase if the PoP is sufficiently low), another the type (and amount under certain conditions) of precipitation (e.g., showers, snow, rain), and the third an expression of the beginning or ending time of precipitation, if any, over a 12-h period.

With regard to PoP, combining of periods could occur only if the same phrase to express PoP is used in those periods, or if the phrases "chance of" with a PoP of less than 35 percent is used in one period and "slight chance of" is used in the other period. For the latter, the phrase for the combination would be "chance of" if the average PoP for the combined periods is at least 25 percent; otherwise, "slight chance of" would be used. Use of any phrase that indicates precipitation beginning or ending during a 12-h period precludes combining of that period with another.

Different phrases of precipitation type that could allow periods to combine are summarized in Table 1. The resulting phrases for the combinations are also included. A precipitation type phrase will combine with itself into the same phrase for the combination; therefore, these are not shown in the table. In addition, there are precipitation type phrases that will not combine with any others. Among these are phrases that describe precipitation changing from one form to another (e.g., frozen to liquid). Others are "snow, sleet, or freezing rain," and "drizzle."

Phrases of quantitative precipitation and snow amount also play a role in the combining process. Since snow amount forecasts are available only in the first period, any phrase that indicates an accumulation (e.g., "snow accumulating 1 to 3 inches") would preclude combining of period 1 with any other periods. Similarly, an expression of heavy precipitation (e.g., "heavy at times") in one period and not in another would keep these periods from combining, with one exception. This occurs when heavy precipitation is forecast in non-adjacent forecast periods, say the first and third, but not the second period. In this case, if precipitation is forecast to occur in the second period, then it will

be assumed that heavy precipitation is possible in this period, too, so that "heavy at times" would appear in the combined forecast for all three periods. This represents some smoothing of the forecast but is reasonable, since "heavy at times" over a three-period forecast implies intervals of heavy precipitation sometime over the 36-h period.

#### 4. TEMPERATURE

If periods can combine at the conclusion of the checks on the precipitation phrases, then the temperature statements are checked to determine if these same periods can be combined for temperature. The temperature phrase consists of two parts, a descriptor such as "cold" (which is sometimes omitted) and a statement such as "high in mid 30's."

The first item checked is the difference between the maximum (and minimum for the 1200 GMT cycle) temperatures. If this difference exceeds 5°F (this difference can be set for each forecast site), then the periods will not combine. Other phrases that will preclude combining are related to unusual traces of the 3-hourly temperatures such as nighttime warming or daytime cooling. In addition, descriptors that indicate a change in temperature from the previous day's maximum or previous night's minimum--such as colder, moderating temperatures, much warmer--will not allow the period with that phrase to combine with any other period. An exception to this is when two adjacent periods under consideration both have similar phrases describing the temperature change; these periods may combine. The use of "humid" in one period and not another will also keep periods from combining.

As with precipitation, when periods combine a descriptor for each combination must be determined. For the 0000 GMT cycle, the descriptor that is selected when all three periods combine for temperature is the one that appears in the first daytime period. This is done for two reasons. First, in the CWF program, descriptors appear more often for daytime periods than they do for nighttime periods. Second, period 1 is at least as likely as period 3 to contain a descriptor. While this depends on the choice of complexity constants which control the detail in the forecast (see Glahn, 1978), generally, the constants are selected to provide more detail in the earlier periods in accordance with field practice.

When all three periods combine for temperature, it's obvious that periods 1 and 2 also combine for this element. Therefore, the descriptor for periods 1, 2, and 3 would also be used for the 1, 2 combination.<sup>1</sup> When periods 1-3 do not combine, Table 2 is used in addition to the checks discussed in the second paragraph of this section to determine if periods 1 and 2 can combine. This table consists of daytime-period temperature descriptors that can be combined with descriptors for the following nighttime period and the resulting descriptors of the 1, 2 combination. If a matching pair is not available in Table 2, then the periods will not combine. As was the case with the precipitation phrases, a temperature descriptor will always combine with itself; therefore, these are not shown in Table 2.

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<sup>1</sup>One could inquire about the need for a descriptor for periods 1 and 2 when 1, 2, and 3 have combined for temperature. However, it's possible that after checking clouds or winds, periods 1, 2, and 3 will no longer combine, but 1 and 2 will.

Table 3 serves the same function for periods 2 and 3 as Table 2 does for periods 1 and 2, namely, to determine whether periods 2 and 3 can combine. As with the 1, 2 combination, this check is in addition to those previously performed. Table 3 consists of nighttime-period temperature descriptors that can be combined with descriptors from the following daytime period and the resulting descriptors of the 2, 3 combination. Again, if a matching pair is not available in the table, periods 2 and 3 will not combine.

The rules for combining periods on the 1200 GMT cycle based on the temperature descriptors are analogous to those for 0000 GMT. When periods 1, 2, 3, and 4 combine (the difference between maximum temperatures and the difference between minimum temperatures are both 5°F or less, and phrases that preclude combining are not prevalent), the descriptor that is used for this combination is the one that appears in the second period--that is, the first daytime period. The selection of the descriptor for the first daytime period instead of the first nighttime period is made because, as mentioned earlier, descriptors appear more often for daytime periods than for nighttime periods in the CWF program. Since all four periods combine for temperature, so do periods 1, 2, 3 and periods 1, 2. Therefore, the same descriptor would be used for these two combinations.

If periods 1-4 do not combine, but periods 1-3 do (as determined from 5°F or less difference in minimum temperatures and lack of non-combining phrases), then the descriptor used for the 1-3 combination is also used for the 1, 2 combination. This descriptor is obtained from Table 3. When 1-3 do not combine for temperature, Table 3 is examined in addition to the checks discussed in second paragraph of this section to determine if periods 1 and 2 can combine and to obtain the descriptor for the combination.

The method to determine if periods 2, 3, and 4 can combine and the descriptor for this potential combination is the same as that used for the 1, 2, 3 combination for the 0000 GMT cycle. Also, whether or not periods 2 and 3 as well as 3 and 4 can combine and potential descriptors for each combination are determined in the same way as was done for the 1, 2 and 2, 3 combinations, respectively, for 0000 GMT.

## 5. CLOUDS

Periods that combine for precipitation and temperature are next checked to determine if they can also be combined for clouds. Cloud phrases for a particular period are determined from the digital forecasts of cloud categories (1 is clear, 2 is scattered, 3 is broken, and 4 is overcast) at the beginning, middle, and end of each forecast period (see Heffernan and Glahn, 1979 for details). It should be pointed out that a particular cloud phrase can result from rather different combinations of categorical forecasts. This occurs because the phrase selection also depends on the choice of complexity constant which controls the detail desired in the forecast (see Glahn, 1978) and the forecast period (less detail for the later forecast periods). So, for example, "partly cloudy" is used for a nighttime-period categorical 2, 1, 2 combination as well as for a 4, 2, 2 combination for a period when little detail is desired. Because of this, special rules had to be devised when the combining of cloud phrases was considered.

Table 4 summarizes the different cloud phrases that can be combined and the resulting phrase for the combination along with any special conditions that may apply. Perhaps the most obvious thing in Table 4 is that "partly cloudy" can combine with phrases ranging from "sunny" to "cloudy." This results from the fact that "partly cloudy" is the phrase of choice for a wide range of digital forecast combinations for reasons given in the previous paragraph. Generally, "partly cloudy" combines with phrases of nearly cloudless conditions when "partly cloudy" itself is made up of numerically low categorical forecasts. The results of these combinations of phrases depend mostly on the digital forecasts that comprise "partly cloudy" and range from "mostly clear" to "partly cloudy."

At the other end of the spectrum, "partly cloudy" can combine with phrases representing cloudy conditions when it consists of numerically high categorical forecasts. The phrase for the combination is either "mostly cloudy" or "partly cloudy" and depends on whether the sum of the categorical forecasts that comprise the phrases for both forecast periods is less than 14 (partly cloudy) or greater than or equal to 14 (cloudy). The value of 14 as a cutoff was subjectively determined from tests and works reasonably well in day-to-day operations. Combining of "partly cloudy" with phrases of cloudy conditions will not occur when the difference in the sum of the digital forecasts that comprise "partly cloudy" and the sum of the digital forecasts that comprise the cloudy phrase is greater than 1. However, when precipitation is occurring in both forecast periods, this latter test is not used. The reason for this is that if periods have combined in the precipitation section and precipitation is occurring for this combination, clouds are not as important with respect to combining when compared to a non-precipitation case. Therefore, by easing the cloud tests, clouds phrases are more apt to combine, thereby allowing the periods to combine.

## 6. WIND

Wind is the final element checked to determine whether or not periods can combine. Only those periods that have combined for precipitation, temperature, and clouds are checked for wind. Wind is considered the least important weather element with respect to combining of forecast periods. By this is meant that wind phrases should not preclude combining of forecast periods when periods have combined for all other weather elements, provided none of the wind speeds exceed a certain threshold value. This threshold, for example 15 mph, can be set at each forecast site. If periods combine for all weather elements except wind, and all speeds are at or below the threshold, then a wind phrase will not appear in the worded forecast for the combination. However, wind phrases for speeds less than reasonably set threshold values (e.g., "light northwest winds") will usually combine.

Wind phrases for the CWF are constructed from one or two wind speeds and one or two wind directions for each forecast period. These wind directions and speeds are prepared from the digital wind speeds and directions at the beginning, middle, and end of each forecast period (Heffernan and Glahn, 1979). Each of the two speeds may be an average value from digital forecasts at two or three projections and each is rounded to the nearest 5 mph. The two directions, which may also be average values, are given to 8 points of the compass. These wind directions and speeds are used with the wind phrases when decisions about combining phrases are made.

Table 5 contains only those wind phrases that can combine along with the phrase numbers used in the CWF program. Table 5 is provided so that phrase numbers rather than lengthy phrases can be used in Table 6. Table 6 summarizes the wind phrases that can be combined and the resulting phrase for the combination as well as special conditions that may apply.

Several things should be pointed out in Table 6. First, wind phrases that combine with themselves are provided. This contrasts to the tables for the other weather elements where phrases which combine with themselves are not shown. The reason is that a wind phrase may or may not combine with itself. For example, phrases such as 1, 4, or 11 that express an intraperiod change of the wind vector cannot combine with themselves.

Second, the order that a pair of combining phrases in adjacent periods occurs is important; that is, the reverse order may not combine. This contrasts to say, cloud phrases, where the order doesn't matter. For example, phrase 3, "strong \_\_\_ winds \_\_\_ to \_\_\_ mph" may, under certain conditions, combine with phrase 4, "strong \_\_\_ winds \_\_\_ to \_\_\_ mph, diminishing to \_\_\_ mph by evening" into "strong \_\_\_ winds \_\_\_ to \_\_\_ mph, diminishing to \_\_\_ mph by (day of the week) evening" when 3 precedes 4. However, when 4 precedes 3, these phrases will not combine since there is no relatively concise way to express the wind forecast over the two periods while maintaining the intraperiod detail contained in 4.

Third, some of the possible combinations of phrases may, at first glance, seem inappropriate--for example, "light and variable winds" (phrase 17) and "breezy" (phrase 24). However, as with the other weather elements, phrase selection depends in part on the choice of control constants (see Glahn, 1978), in this case, the ones that define the ranges of speed for each of the speed categories. Therefore, although it is quite unlikely that the control constants would be established in such a way that would allow the speeds of phrases 17 and 24 to be close enough so that they could combine, this possibility should be taken into account. In any case, the test that would allow these phrases to combine requires that the difference between the maximum and minimum speeds in the two periods be less than or equal to 10 mph.

## 7. SUMMARY

The technique used to combine forecast periods with similar forecasts in the CWF has been discussed. This technique compares phrases of each element between periods and determines whether or not they can combine. Combining of forecast periods is an option in the CWF program; that is, it can be used at one forecast site and not at another.

The criteria that are used to decide whether or not forecast periods can combine have also been documented. Needless to say, these criteria are highly subjective and, consequently, open to question. However, twice daily operational execution of the CWF with this combining feature for almost two years has indicated that the method and selected criteria work quite well.

## 8. ACKNOWLEDGMENT

My thanks are extended to Karen Yip for typing this paper.

## 9. REFERENCES

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Table 1. Different precipitation type phrases that can combine with the resulting combination phrase shown in the third column. Identical phrases in two periods will combine into the same phrase and are not shown.

Precipitation Type Phrase	Precipitation Type Phrase	Phrase for the Combination
Snow	Wet snow	Snow
Snow or snow and rain mixed	Snow or snow mixed with rain	Snow or snow mixed with rain
Rain or rain and snow mixed	Rain or rain mixed with snow	Rain or rain mixed with snow
Freezing rain or sleet	Sleet or freezing rain	Sleet or freezing rain
Rain, sleet, or freezing rain	Sleet, freezing rain, or rain	Rain, sleet, or freezing rain
Rain	Showers	Either rain or showers <sup>1</sup>
Thunderstorms	Thundershowers	Thundershowers
Showers and thunder- storms	Thunderstorms	Showers and thunder- storms
Showers and thunder- storms	Thundershowers	Showers and thunder- storms
Showers and thunder- storms	Rain and thunder- storms	Either rain and thunder- storms or showers and thunderstorms <sup>1</sup>

<sup>1</sup>"Rain" and "showers" can combine, provided the difference in their probabilities is less than or equal to 10 percent for at least one forecast period. The choice of "rain" or "showers" for the combined phrase is determined as follows: compare the average probability for showers to the average probability for rain for the periods in question, and select the highest one. If the probabilities are the same, select "rain." Use the same method for determining whether or not "rain and thunderstorms" can combine with "showers and thunderstorms."

Table 2. Daytime-period temperature descriptors that can be combined with descriptors from the following nighttime period with the resulting combination phrase shown in the third column. Identical phrases in the two periods will combine into the same phrase and are not shown.

Daytime-Period Temperature Descriptor	Nighttime-Period Temperature Descriptor	Phrase for the Combination	Daytime-Period Temperature Descriptor	Nighttime-Period Temperature Descriptor	Phrase for the Combination
Continued chilly	Cool	Continued cool	Cold	Cool	Cold
Continued chilly	None	None	Cold	Very cool	Cold
Moderate temperatures	None	None	Cold	Very cold	Cold
Comfortable temperatures	Warm	None	Cold	Bitter cold	Cold
Comfortable temperatures	Mild	None	Continued cold	Cool	Continued cold
Comfortable temperatures	None	None	Continued cold	Very cool	Continued cold
Unusually cool	Cool	Cool	Continued cold	Cold	Continued cold
Unusually cool	Very cool	Unusually cool	Continued cold	Very cold	Continued cold
Unusually cool	Cold	Unusually cool	Continued cold	Bitter cold	Continued cold
Unseasonably cool	Cool	Cool	Very cold	Cold	Very cold
Unseasonably cool	Very cool	Unseasonably cool	Very cold	Bitter cold	Very cold
Unseasonably cool	Cold	Unseasonably cool	Continued very cold	Cold	Continued very cold
Continued cool	Cool	Continued cool	Continued very cold	Very cold	Continued very cold
Continued cool	Very cool	Continued cool	Continued very cold	Bitter cold	Continued very cold
Very cool	Cool	Very cool	Bitter cold	Cold	Bitter cold
Very cool	Cold	Very cool	Bitter cold	Very cold	Bitter cold
Little change in temperature	Cool	None	Very hot	Hot	Hot
Little change in temperature	Mild	None	Continued hot	Hot	Continued hot
Little change in temperature	None	None	Very warm	Hot	Very warm
Cool	Very cool	Cool	Very warm	Warm	Very warm
Seasonable temperatures	Cool	None	Pleasant temperatures	Mild	None
Seasonable temperatures	Mild	None	Pleasant temperatures	None	None
Seasonable temperatures	None	None	Continued mild	Warm	Continued mild
Chilly	Cool	Chilly	Continued mild	Mild	Continued mild
Chilly	Very cool	Chilly	Warm	Hot	Warm
Chilly	Cold	Chilly	Mild	Warm	Mild
Chilly	None	None	None	Cool	None
Continued very hot	Hot	Continued hot	None	Mild	None

Table 3. Nighttime-period temperature descriptors that can be combined with descriptors from the following daytime period with the resulting combination phrase shown in the third column. Identical phrases in the two periods will combine into the same phrase and are not shown.

Nighttime-Period Temperature Descriptor	Daytime-Period Temperature Descriptor	Phrase for the Combination	Nighttime-Period Temperature Descriptor	Daytime-Period Temperature Descriptor	Phrase for the Combination
Cool	Continued chilly	Cool	Very cool	Continued cold	Continued cold
Cool	Moderate temperatures	None	Very cool	Cool	Cool
Cool	Comfortable temperatures	None	Cold	Very cool	Very cool
Cool	Unusually cool	Unusually cool	Cold	Continued cold	Continued cold
Cool	Moderate temperatures	None	Cold	Very cold	Very cold
Cool	Comfortable temperatures	None	Cold	Continued very cold	Continued very cold
Cool	Very cool	Very cool	Cold	Bitter cold	Bitter cold
Cool	Little change in temperature	None	Very cold	Cold	Cold
Cool	Seasonable temperatures	None	Very cold	Continued cold	Continued cold
Cool	Chilly	Cool	Very cold	Continued very cold	Continued very cold
Cool	Pleasant temperatures	None	Very cold	Bitter cold	Bitter cold
Cool	None	None	Mild	Moderate temperatures	None
Very cool	Unusually cool	Very cool	Mild	Comfortable temperatures	None
Very cool	Unseasonably cool	Very cool	Mild	Little change in temperature	None
Very cool	Continued cool	Continued cool	Mild	Seasonable temperatures	None
Very cool	Cold	Cold	Mild	Pleasant temperatures	None
Mild	Continued mild	Continued mild	Cooler	Somewhat cooler	Cooler
Mild	Warm	Mild	Cooler	Lower temperatures	Cooler
Mild	None	None	Cooler	Slightly cooler	Cooler
Warm	Moderate temperatures	None	Colder	Bitter cold	Colder
Warm	Comfortable temperatures	None	Colder	Becoming colder	Colder
Warm	Little change in temperature	None	Much colder	Turning much colder	Much colder
Warm	Seasonable temperatures	None	None	Continued chilly	None
Warm	Very warm	Warm	None	Moderate temperatures	None
Warm	Continued hot	Continued hot	None	Comfortable temperatures	None
Warm	Continued mild	Continued mild	None	Continued cool	Continued cool
Warm	Mild	Mild	None	Continued cold	Continued cold
Warm	None	None	None	Continued very cold	Continued very cold
Hot	Continued very hot	Continued hot	None	Little change in temperature	None
Hot	Very hot	Hot	None	Seasonable temperatures	None
Hot	Continued hot	Continued hot	None	Chilly	None
Hot	Very warm	Very warm	None	Pleasant temperatures	None

Table 4. Different cloud phrases that can combine with the resulting combination phrase shown in third column. Identical phrases in two periods will combine into the same phrase and are not shown.

Cloud Phrase	Cloud Phrase	Phrase for the Combination	Cloud Phrase	Cloud Phrase	Phrase for the Combination
Clear	Mostly clear	Mostly clear	Partly cloudy <sup>3</sup>	Becoming cloudy	Partly cloudy <sup>5</sup>
Clear	Sunny	Clear	Partly cloudy <sup>3</sup>	Becoming cloudy	Mostly cloudy <sup>6</sup>
Clear	Mostly sunny <sup>1</sup>	Mostly clear	Partly cloudy <sup>3</sup>	Becoming overcast	Partly cloudy <sup>5</sup>
Clear	Partly cloudy <sup>1</sup>	Mostly clear	Partly cloudy <sup>3</sup>	Becoming overcast	Mostly cloudy <sup>6</sup>
Mostly clear	Sunny	Mostly clear	Partly cloudy <sup>3</sup>	Cloudy	Mostly cloudy <sup>7</sup>
Mostly clear	Mostly sunny <sup>1,2</sup>	Mostly clear	Partly cloudy <sup>3</sup>	Overcast	Mostly cloudy <sup>7</sup>
Mostly clear	Partly cloudy <sup>1,2</sup>	Mostly clear	Partly cloudy <sup>3</sup>	Variable cloudiness	Variable cloudiness <sup>7</sup>
Mostly clear	Partly cloudy <sup>1</sup>	Partly cloudy	Partly cloudy <sup>3</sup>	Variable cloudiness	Partly cloudy <sup>8</sup>
Sunny	Mostly sunny <sup>1,2</sup>	Mostly sunny	Mostly cloudy <sup>9</sup>	Cloudy	Mostly cloudy
Sunny	Partly cloudy <sup>1,2</sup>	Mostly clear	Mostly cloudy <sup>10</sup>	Cloudy	Cloudy
Sunny	Partly cloudy <sup>1</sup>	Partly cloudy	Mostly cloudy <sup>9</sup>	Overcast	Mostly cloudy
Mostly sunny <sup>3</sup>	Partly cloudy <sup>3,4</sup>	Partly cloudy <sup>5</sup>	Mostly cloudy <sup>10</sup>	Overcast	Cloudy
Partly cloudy <sup>3</sup>	Mostly cloudy	Partly cloudy <sup>5</sup>	Mostly cloudy	Variable cloudiness	Mostly cloudy <sup>7</sup>
Partly cloudy <sup>3</sup>	Mostly cloudy	Mostly cloudy <sup>6</sup>	Mostly cloudy	Variable cloudiness <sup>2</sup>	Variable cloudiness <sup>8</sup>
Partly cloudy <sup>3</sup>	Becoming mostly cloudy	Partly cloudy <sup>5</sup>	Mostly cloudy	Variable cloudiness	Mostly cloudy <sup>8</sup>
Partly cloudy <sup>3</sup>	Becoming mostly cloudy	Mostly cloudy <sup>6</sup>	Cloudy	Variable cloudiness	Mostly cloudy <sup>7</sup>
Cloudy	Overcast	Cloudy	Variable cloudiness <sup>2</sup>	Becoming cloudy	Variable cloudiness <sup>8</sup>
Overcast	Variable cloudiness	Mostly cloudy <sup>7</sup>	Variable cloudiness	Becoming cloudy	Mostly cloudy <sup>8</sup>
Variable cloudiness	Becoming mostly cloudy	Mostly cloudy <sup>7</sup>	Variable cloudiness	Becoming overcast	Mostly cloudy <sup>7</sup>
Variable cloudiness <sup>2</sup>	Becoming mostly cloudy	Variable cloudiness <sup>8</sup>	Variable cloudiness <sup>2</sup>	Becoming overcast	Variable cloudiness <sup>8</sup>
Variable cloudiness	Becoming mostly cloudy	Mostly cloudy <sup>8</sup>	Variable cloudiness	Becoming overcast	Mostly cloudy <sup>8</sup>
Variable cloudiness	Becoming cloudy	Mostly cloudy <sup>7</sup>			

<sup>1</sup>None of the digital forecasts that comprise "partly cloudy" can exceed category 2 (scattered clouds).  
<sup>2</sup>One of the digital forecasts that comprise this phrase is category 1 (clear).  
<sup>3</sup>One of the digital forecasts that comprise "partly cloudy" is greater than category 2.  
<sup>4</sup>None of the digital forecasts that comprise "partly cloudy" can be category 4 (overcast).  
<sup>5</sup>For this combined phrase to occur, the sum of the three digital forecasts that comprise "partly cloudy" plus the sum of the three that comprise "mostly cloudy" is less than 14, and the difference in these two sums is less than or equal to 1. If precipitation is forecast to occur in both periods of the combination, the latter test is not used.  
<sup>6</sup>Same as footnote 5 except the two sums are greater than or equal to 14.  
<sup>7</sup>Precipitation is forecast to occur in both periods of the combination.  
<sup>8</sup>No precipitation is forecast to occur in either period of the combination and the difference of the sum of the three digital forecasts that comprise the phrase in column 1 and the three that comprise the phrase in column 2 is less than or equal to 1.  
<sup>9</sup>One of the three digital forecasts that comprise "mostly cloudy" is less than category 3 (broken clouds)  
<sup>10</sup>the sum of these three digital forecasts is less than 10.  
<sup>11</sup>All of the three digital forecasts that comprise "mostly cloudy" are greater than or equal to category 3 and the sum of these three digital forecasts is at least 10.

Table 5. Wind phrases and associated phrase numbers that are used in Table 6. Underlining within the phrases indicates places where wind directions or speeds are required.

Phrase Number	Phrase
1	Strong ___ winds ___ to ___ mph, becoming ___ to ___ mph by evening.
2	Strong ___ winds ___ to ___ mph, shifting to ___ by evening.
3	Strong ___ winds ___ to ___ mph.
4	Strong ___ winds ___ to ___ mph, diminishing to ___ mph by evening.
5	Strong ___ winds ___ to ___ mph, shifting to ___ mph by evening.
9	___ winds ___ mph.
10	Winds ___ mph.
11	___ winds ___ mph in the morning, diminishing by evening.
12	Winds ___ mph in the morning, diminishing by evening.
13	___ winds ___ mph in the afternoon.
14	Winds ___ mph in the afternoon.
15	Light ___ winds.
16	Light winds.
17	Light and variable winds.
19	Windy
20	Windy <sup>1</sup>
21	Windy <sup>2</sup>
22	Very light winds.
24	Breezy
25	Breezy <sup>1</sup>
26	Breezy <sup>2</sup>
27	___ winds ___ mph in the afternoon and early evening.
28	Winds <sup>3</sup> ___ mph in the afternoon and early evening.
125	Blank
281	Strong ___ winds ___ to ___ mph, becoming ___ to ___ mph by morning.
282	Strong ___ winds ___ to ___ mph, shifting to ___ by morning.
284	Strong ___ winds ___ to ___ mph, diminishing to ___ mph by morning.
285	Strong ___ winds ___ to ___ mph, shifting to ___ mph by morning.
291	___ winds ___ mph in the early evening, diminishing by morning.
292	Winds ___ mph in the early evening, diminishing by morning.
293	___ winds ___ mph after midnight.
294	Winds ___ mph after midnight.

<sup>1</sup>Phrase is applicable for the first part of a 12-h forecast period, e.g., "windy in the morning."

<sup>2</sup>Phrase is applicable for the second part of a 12-h forecast period, e.g., "windy in the afternoon."

<sup>3</sup>For wind speeds less than a certain threshold or for later forecast periods, a forecast site may not want to use a wind phrase.

Table 6. Wind phrases—represented by their phrase numbers—in adjacent forecast periods that can combine with the combination shown in the third column. See Table 5 for the phrases.

Wind Phrase for the First of Two Forecast Periods	Wind Phrase for the Second of Two Forecast Periods	Phrase for the Combination	Wind Phrase for the First of Two Forecast Periods	Wind Phrase for the Second of Two Forecast Periods	Phrase for the Combination
3	3	1	15	125	7,10
3	4	2,3	15-17,22	125	6,9
3	19	1	16,17	9-14,24-26,291-294	6
3	19	5	16	15-17,22	6
3	20	2,3	16	125	10
3	125 <sup>4</sup>	1	17	15,16	16
3	284	2,3	17	17,22	16
9	9-17,24-26,125,291-294	6,7	17	125	17
9	9-17,24-26,125,291-294	6	17,22	125	10
10	9-17,24-26,125,291-294	6	22	15,16	11
11	9,10,15-17,24,26,125,291-294	6,7	22	17	16
11	9,10,15-17,24,26,125,291-294	6	22	22	17
12	9,10,15-17,24-26,125,291-294	6	22	125	22
13	9,10,15-17,24-26,293,294,125	6,7	24	24	10
13	291,292	6,7	24-26	9-17,25,26,291-294,125	24
13,14	9,10,15-17,24-26,125,293,294	6	24-26	9-17,25,26,291-294,125	6
13,14	291,292	6	19-21	1-5,19-21,281-285	12
15	9-14,24-26,291,293,294	6,7	19-21	125	13
15	9-14,24-26,291,293,294	6	27	9-16,24-26,125	6,7
15	15	8	27,28	9-16,24-26,125	6
15	16,17,22,125	6,7,9	125	125	14
15	125	6,7,9	291,293	9-17,24-26,125	6,7
			291-294	9-17,24-26,125	6

<sup>1</sup> Only one of the total of four wind directions for the two periods can be different from the others, and by no more than one point of the compass. In addition, the maximum wind speeds in each period must be the same.

<sup>2</sup> The four wind directions from both periods must be the same and the difference in maximum wind speed between each period must be less than or equal to 5 mph.

<sup>3</sup> The day of the week is inserted prior to "evening" or "morning."

<sup>4</sup> Even though this phrase is a blank, wind directions and speeds exist for the forecast period.

<sup>5</sup> At least one of the tests listed under footnote 1 fails.

<sup>6</sup> The difference between the maximum and minimum wind speeds in the two forecast periods must be less than or equal to 10 mph.

<sup>7</sup> Only one of the total of four wind directions for the two forecast periods can be different from the others and by no more than one point of the compass.

<sup>8</sup> The wind directions in both periods must be the same.

<sup>9</sup> At least one wind speed in the second forecast period must be greater than 10 mph.

<sup>10</sup> Both wind speeds in the second forecast period are less than or equal to 10 mph.

<sup>11</sup> At least one wind speed in the second forecast period must be equal to 10 mph.

<sup>12</sup> Both wind speeds in the second forecast period must be greater than or equal to 15 mph and less than or equal to 20 mph.

<sup>13</sup> At least one wind speed in the second forecast period must be greater than 20 mph.

<sup>14</sup> Wind speeds must all be less than or equal to a threshold value for combining to occur.