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forecasting

WEATHER COMMUNICATION PROBLEMS

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Through innovative programming, the predictions made by numerical atmospheric models can be directly converted into the familiar terms and phrases human weather forecasters have used for years. However, there is evidence that these terms are not uniformly interpreted by the public, and little research has been done to determine the scope of the problem or the nature of possible solutions. Mogil (1979) reports results of a study that assessed public reaction to the terms used in severe-weather forecasts. However, there has been no comprehensive study of the routine weather forecasting terminology; there is no official glossary for meteorologists to use. In fact, the National Weather Service Operations Manual states: "No attempt should be undertaken at either the national or regional level to produce a glossary of public weather forecasting terms." Instead, "Accepted American usage terms presented in accepted weather observational handbooks and glossaries of professional meteorologists' societies, coupled with forecast writer professionalism and common sense, will form the basis for the selection of public forecasting terms." An advantage of this "hands-off" approach is that it allows the forecaster to use any combination of words to get his message across without need to conform to rigid rules. Since the weather varies so much, there is good reason for allowing flexibility. However, once the forecaster has composed the message, what assurance is there that users will interpret the forecast in the intended manner? If forecasters cannot agree on a set of definitions, what guidelines shall forecast recipients use? Certainly, meteorologists object strenuously when their forecasts are "misinterpreted" or "distorted" by radio announcers and others. Recently, there has been renewed interest in updating the GLOSSARY OF METEOROLOGY (published by the American Meteorological Society). Now may be a good time to see if the vocabulary in our routine forecasts is really adequate. At the very least, forecasters should be able to refer to studies showing how a variety of forecast terms and phrases are interpreted by users in each region. With such information, the forecaster will be better able to choose words and phrases that convey the intended weather message to the recipients.

How shall we approach the forecast wording problem? Do we try to establish a working vocabulary and then educate the public? Or, do we use terms that are well understood and use them in our forecasts in a consistent manner? Perhaps the best aproach will be to completely study the impact of our current vocabulary and then make improvements where there are shortcomings. If a systematic study is completed, forecasters may gain enough confidence in its findings to use the results in providing better forecasts.

A variety of forecast wording problems may be identified. For example, there is no general agreement on the precise meanings of the words and phrases denoting times of day. In a survey by the author in 1970, such commonly used terms as late afternoon, evening, early morning, etc. were subject to wide variations in interpretation. The survey results are displayed in Table 1. In each case, four calculations were made: (1) mean starting time, (2) standard deviation for starting time, (3) mean ending time, and (4) standard deviation for the ending time.

describing the upcoming day's sky condition, there is no assurance the forecast recipients will interpret the forecast in the intended manner. To illustrate some of the problems in this area, consider Table 2. It

Table entries give mean starting and ending times associated with each term or phrase, standard deviations for each time, and sample sizes. Respondents were asked to convert each descriptive term to a range of clock times. Values are the nearest 5 minutes.

Term or Phrase	Mean Starting Time (Hrs.& Mins.)	Std.Dev. Starting Time (Hrs.& Mins.)	Mean Ending Time (Hrs.& Mins.)	Std.Dev. Ending Time (Hrs.& Mins.)	Sample Size
Early Morning	4:45 AM	1:55	8:55 AM	1:50	73
Mid Morning	8:20 AM	1:35	10:50 AM	1:10	65
Late Morning	9:30 AM	0:55	11:55 AM	0:35	60
Mid Afternoon	1:35 PM	0:55	4:05 PM	0:55	71
Late Afternoon	3:20 PM	0:40	5:35 PM	0:40	71
Late in the Day	3:20 PM	1:20	6:00 PM	1:10	60
Early Tonight	6:10 PM	0:55	8:55 PM	1:20	70
Evening	5:55 PM	0:50	10:30 PM	1:35	120
Late Evening	8:10 PM	1:25	11:30 PM	1:40	73
Late Tonight	10:20 PM	1:10	2:00 AM	1:40	67
Early Tomorrow Morn	5:00 AM	1:50	8:10 AM	1:40	70

Table 1

CLOCK TIMES ASSOCIATED WITH TERMS AND PHRASES DESCRIBING PARTS OF THE DAY.

In considering why people have differing interpretations of the terms describing parts of the day, two factors come to mind. First, the terms change because of the seasons. In winter, sunset occurs before 5 PM in the northern United States; in summer it is light well past 8 PM. The meanings of late afternoon, evening, and tonight must be adjusted accordingly. Another factor is related to lifestyles. Someone who goes to work at 5 or 6 AM will have a different concept of early morning than an individual who "sleeps in" until 10 AM. Folks going "out for the evening" may have a different view of when evening ends than people who get up early the next day. Regional differences exist as well; for example, dinnertime in much of the south coincides with what is called lunchtime in other parts of the country. When the large variations in time interpretation are examined, it is tempting to conclude that forecasters are afforded considerable latitude in choice of terms. However, the variations arise not from any one individual's uncertainty, but rather from lack of agreement between individuals.

Another forecast wording problem exists in the designation of sky cover. Meteorologists use a wide range of words and phrases to describe the sky. How does a forecaster decide what the sky will look like? Hourly data provide sky information, including coverage of the sky and the heights of the clouds. Information can be inferred from this data about how prevalent and thick the clouds may be. Satellite pictures have added a wealth of information to help solve the sky cover forecast problems in recent years. Still, the forecaster is often confronted with the problem that a range of conditions must be forecast in few enough words that the forecast will not be too cluttered. For example, partly cloudy may be the forecast on a day when a forecaster would like to say: "Clouds of varying shapes will occupy portions of the sky during the day. Some of the clouds will be thick, others will be thin but at any one time they should only occupy part of the sky." While a group of forecasters may be able to agree on a certain terminology for

One curious result is that partly cloudy was perceived by this group as implying more sunshine than partly sunny, despite the view of many proponents of the use of partly sunny that it is the more positive of the two terms because it specifically mentions sunshine. This type of result raises the question of whether our survey was asking the right thing. Suppose we asked about cloudiness and sunshine terminology from an acceptability standpoint instead: "Looking at today's sky, indicate which forecast terms adequately describe what you see." The results may have been different.

600 Pennsylvania Public Television Network Viewers were asked to consider each of these terms and estimate the percentage of the time sunshine should be expected.

%	Mostly Sunny	Some Cloud	Partly Cloudy	Variable Cloud	Intervals Cloud/Sun	Partly Sunny	Some Sunshine
100							
95							
90							
85							
80	X						
75							
70							
65							
60							
55		X	X				
50					X		
45				X			
40						X	
35							
30							X
25							
20							
15							
10							
05							
000							

Table 2: Sky Cover Terminology

displays the results of a survey (conducted by J. Sobel and the author in 1977) of more than 600 viewers of a nightly weather show on the Pennsylvania Public Television Network. Respondents were asked to consider each of the listed sky cover terms, then estimate the percentage of the time they would expect to see the sun if such a term appeared in a forecast.

The point is: one survey in this area is not enough. Another problem in using this survey's results is in extending them to the case wherein two or more sky cover terms are to be used in the same sentence. Consider this forecast: Some sunshine this morning followed by some cloudiness this afternoon. The forecaster probably wants to stress the sun for the morning hours and the clouds for

Group	Term or Phrase	Mean	Range/1 std dev	t calc
P	A Shower	0.68 (hrs)	0.01 to 1.35	0.60
F	A Shower	0.60	0.28 to 0.92	
P	Scattered Showers	1.80	0.35 to 3.25	0.53
F	Scattered Showers	1.96	0.94 to 2.98	
P	Brief Showers	1.16	0.33 to 1.99	0.23
F	Brief Showers	1.21	0.00 to 2.57	
P	Frequent Showers	5.81	3.13 to 8.94	2.43 *
F	Frequent Showers	7.20	5.02 to 9.38	
P	A Thunderstorm	0.88	0.24 to 1.52	0.07
F	A Thunderstorm	0.87	0.27 to 1.47	
P	Scattered Showers	3.10	0.89 to 5.31	1.32
F	and Thunderstorms	2.49	0.88 to 4.10	
P	Scattered	1.81	0.46 to 3.16	1.32
F	Thunderstorms	1.82	0.62 to 3.02	
P	Showers	3.91	1.61 to 6.21	3.63 *
F	Showers	5.77	3.50 to 8.04	
P	Occasional Rain	3.01	1.04 to 4.98	5.92 *
F	Occasional Rain	5.54	3.81 to 7.27	
P	Intermittent Rain	4.97	2.23 to 7.71	1.39
F	Intermittent Rain	5.77	3.76 to 7.78	
P	Rain On and Off	4.77	2.31 to 7.23	1.84
F	Rain On and Off	5.71	4.02 to 7.40	
P	Rain Most of the	10.04	8.82 to 11.26	0.20
F	Time	10.09	9.23 to 10.97	
P	Periods of Rain	4.00	1.85 to 6.15	2.25 *
F	Periods of Rain	5.07	2.99 to 7.15	
P	A Gust of Rain	0.55	0.00 to 1.11	Not Applicable

Table 3 Continuity of rain as expressed by television viewers and meteorologists at the National Weather Service.

the afternoon. However, strict interpretation of the survey results would suggest the opposite effect is being created. The survey provides useful feedback for forecasters, but its results cannot be taken out of context and should be replicated, refuted or modified by additional study. Another way of attacking the sky cover wording problem: on a series of days, ask survey participants to look at the sky, then select from a menu of terms the most appropriate for that situation. Results could be used as a guide for forecasters.

A third forecast wording problem involves the concept of time continuity of precipitation. Included here are such questions as: How long is a shower? How long can it rain before a forecast of showers is inappropriate and must be changed to say rain? What happens when more than one term is used in the forecast (does it affect people's view of how long it will rain)? What percentage of the time will people think it will rain if modifiers such as occasional, intermittent or periods are used (and is current usage appropriate)? In 1970, the author surveyed viewers of the Pennsylvania Public Television Network and forecasters employed by the National Weather Service at 10 cities in the northeast quarter of the U.S. Each group was asked to consider a list of precipitation continuity descriptions and imagine each term or phrase was intended to apply for a twelve-hour forecast period. On this basis, the respondents were told to estimate the number of hours out of 12 they would expect it to actually be raining. The results are shown in Table 3. The asterisked entries in the column marked T calc show cases in which the Student's t test suggested significant discrepancies between forecaster and public responses. Some of the terms were perceived quite equally, such as "a shower" and "a thunderstorm." These terms can be used with confidence that users will derive the intended message from the forecast. The same is true with the phrase, "rain most of the time." However, there were significant discrepancies in the case of "showers", "occasional rain", and "periods of rain." At the time this survey was completed (1970), the NWS operations manual suggested rain would be more frequent when intermittent than when it is occasional. The forecasters did not reflect this in their responses, yet the viewers recognized a distinction.

Participants were asked: assume each term was intended for use in a 12-hour forecast. The question to be answered: out of the 12 hours, how many hours should it actually be raining. Answers on lines marked P were supplied by television viewers. Answers on lines marked F were supplied by the professional forecasters. For each term, the mean response for the group is given, plus the range of values within 1 standard deviation of the mean (i.e., about 68 percent of the responses were within this interval).

Perhaps the main problem brought to light by surveys of this kind is that we may not safely assume forecasters and forecast users are on the same wavelength where terminology is concerned. The utility of any forecast is greatly reduced because this. One interesting result is what happens when a forecaster uses showers and thundershowers in a forecast. People will think it will rain longer when both terms are used than when just showers or just thundershowers are included. Since the background meteorological situations may not differ too much between shower cases and thundershower cases, forecasters should be aware of a possible inadvertant connotation of a longer duration of rain when both terms are included. The result for "gust of rain" shows us that in this case there is a term that could be used in forecasts with high expectations of success, even though the word gust is usually reserved for describing the wind!

In forecasting temperatures, there is evidence that the use of numbers is superior to the use of terms such as "upper 80's" or "low to mid 30's" etc. In another survey by the author, it was found that single number temperatures were recalled best; ranges of temperature were slightly less well remembered and the uppers and mids were lowest. People tended to confuse the uppers and lowers when a series of them appeared in a forecast. Some forecasters will object to the use of a single number, and there is firm reasoning behind the objection. First, it is misleading to infer that we can really be that precise. Second, in any given forecast area, the temperature varies. Still, we have to consider the user. If it is a utility company, every degree is critical. The public, on the other hand, may appreciate the single number because it is easy to remember and gives a flavor to the forecast. On a day when 95 is the predicted high in Boston, it is going to be hot. Few people will be able to tell the difference between 93, 95 or 97. As a hedge, the forecaster can say "high close to 95" or some other similar thing to allow for the fact it is partly luck if the exact high is hit at the official observing site.

Other temperature forecast problems can be illustrated by considering this example: Partly cloudy with little temperature change through tomorrow. High today and tomorrow near 80; low tonight 55. Thursday, sunny and cooler. High 70. Meteorologists have no trouble with this, but the phrase "little change in temperature" is at odds with the 25-degree temperature range forecast between day and night. "Cooler" for Thursday obviously refers to the 80 today and tomorrow, but what is obvious to meteorologists and what the public perceives may be two different things. This example may seem trivial, but anytime we have a chance to clarify our messages we should do so. This version of the forecast gives a better picture of what is going to happen: Partly cloudy through tomorrow with warm afternoon highs near 80 both days. Tonight will be comfortably cool with a low near 55. Thursday will be sunny with cooler daytime temperatures; the high will only be 70. Here, more words were needed to make the message clearer. An even better situation exists when a for can be shortened while clarity is increased. An example: Partly sunny, warm and humid today with a chance of a late afternoon or evening thundershower. High 85. Partly cloudy and humid tonight with patchy fog forming toward morning. Low 68. Tomorrow, morning fog then becoming partly sunny, warm and humid with a high near 85. There could be an afternoon or evening thundershower. Thursday, morning fog, then partly sunny, warm and humid with a chance of an afternoon or evening thundershower. High again near 85. That version contained 78 words. Using only 44 words, this version says just about the same thing: Partly sunny, warm and humid today, tomorrow and Thursday with highs near 85. There could be a thundershower each afternoon and evening. Nights will be warm and humid with lows near 68. Patchy fog will form late each night, then evaporate the next morning.

The use of probabilities has been a source of debate for many years. Allan H. Murphy has contributed a number of insightful papers on this subject in recent years. Some people argue that the public cannot understand probabilites. However, percentages are used in sports and financial news every day and people do not seem to have trouble with those numbers. The key to the problem in weather forecasting may be that people do not understand the event that is being probabilized.

When a forecast says "Cloudy today with a chance of thundershowers this afternoon. Probability of rain 30 percent.", many people are surprised if it rains hard or long. However, the probability 30 percent does not say anything about either of those problems. We need to do a better job in estimating the duration and amount of rain in our forecasts if we expect the probability misinterpretation problem to go away.

As you can see, there are many problems in forecast wording. Meteorologists differ about how the problems should be approached. There is a need to catalogue what the problems are in a more systematic fashion, then develop consistent solutions. We spend enormous amounts of time and money looking for ways to improve our forecasting accuracy. We cannot afford to have this effort go to waste because of ineffective writing.

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