The results of this analysis, although based entirely on day-time flights, apply equally well to night flying. There is a small diurnal variation in wind speed at the surface, with a minimum at night, but this variation ceases at a comparatively low altitude and at greater heights is opposite in phase. At the most, however, its interest in aviation is purely academic since it amounts to only a small fraction of the total wind except on comparatively quiet days. In stormy weather no variation at all is apparent.

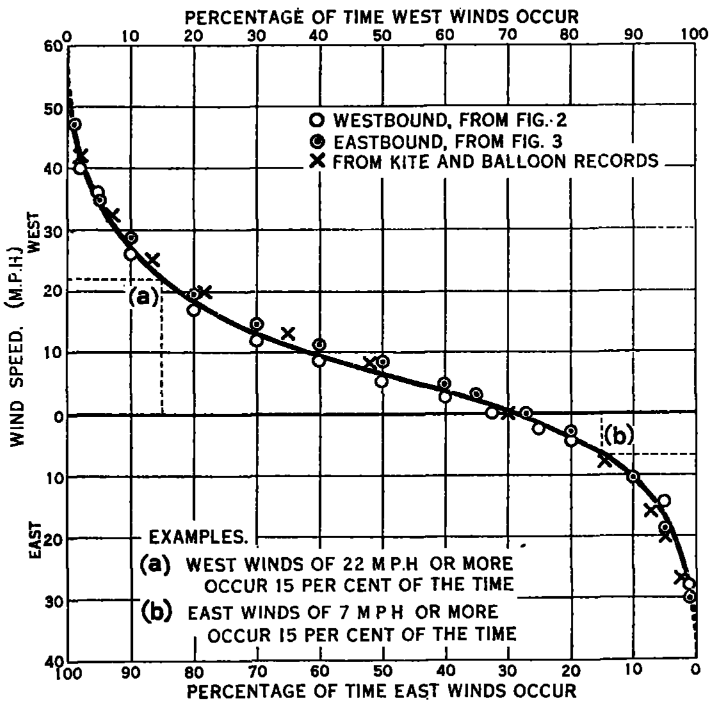

FIG. 7. Annual percentage occurrence of east and west winds of different speeds along the New York–Chicago route.

7. The results given in this paper are strictly applicable only to the Air Mail route between New York and San Francisco, and particularly to that portion of it between New York and Chicago. It has been shown that for that route the kite and balloon records make possible the determination of safe operating flight schedules. For any other route free-air observations made in that region should be used. The resultant wind for the year, and for the seasons also if desired, should be resolved into components parallel and perpendicular to the course. With these data and the cruising speed of the aircraft and with proper allowance for angle of drift the average wind factor can be easily computed. In determining flight schedules that can be guaranteed any required percentage of the time, e. g., 95 per cent, the individual wind records should be examined to find out the speed of head winds, including the equivalent component effect of cross winds, that occurs the maximum percentage of the time delayed trips are permissible, e. g., in the present case 5 per cent. Thus, if the route is from north to south and vice versa, the components into which the winds should be resolved are north and south instead of east and west as in the present paper.

8. The importance of meteorology to aviation is generally recognized. This recognition has as its primary basis the need for information as to weather conditions, current and predicted. The present study of the Air Mail records shows that the usefulness of meteorology is not thus limited, but that past data have almost equal value. In order to serve effectively both purposes there is urgent need for material extension in aerological investigations, comprising a network of stations well distributed and covering all parts of the country.

WIND DIRECTIONS AND THE ORIENTATION OF SCHOOLHOUSES.

By ROSCOE NUNN, Meteorologist.

[Weather Bureau, Nashville, Tenn., April 18, 1923.]

The purpose of this paper is to furnish information that may be useful in connection with the orientation, lighting, and ventilation of schoolhouses in the Southern States.

There is an opinion, more or less prevalent, that it is essential in the Southern States to have the windows of schoolhouses on the south side, as a rule, in order to catch the prevailing breezes in the warm season. The question has arisen whether south winds prevail to such an extent as to justify such a rule, and whether the most advantageous arrangements for lighting and sunning schoolrooms should be sacrificed to any considerable degree in order to secure openings on the south.

At the suggestion of Dr. F. B. Dresslar, of the department of health and sanitation, George Peabody College for Teachers, and special agent of the United States Bureau of Education, the writer undertook to gather statistics that would show the prevailing winds at various Weather Bureau stations for the hours 8 a. m. to 4 p. m., in the months of April, May, June, September, and October, covering the warmest part of the school year. Dr. Dresslar made an experimental investigation of the effects of various orientations of a model schoolhouse on the lighting and sunning of rooms, which showed that windows on the west or east are most advantageous.

Do southerly winds predominate to such an extent as to make it really important to have the windows of schoolrooms on the south side? Or, are the prevalence of southerly winds and the advantages to be derived from them so slight as to be negligible when weighed against the advantages of better lighting and sunning of rooms secured with west or east windows?

A condensed table of the wind-direction statistics obtained is given herewith. The table shows the prevailing direction from which the wind comes during the hours given. When we say the "prevailing" direction is, for instance, southwest, we mean that the wind came from the southwest oftener than from any other of eight directions. This does not mean that it was from the southwest most of the time; in fact, a prevailing wind, in the sense here used, might show only slightly more than one-eighth of 100 per cent of the whole, because the other seven directions might have been represented by almost one-eighth each. For example: the most frequent wind direction at Nashville, based upon records of many years, is northwest, but the general average percentage of times that the hourly prevailing direction was from the northwest is only 20; while other directions are represented by 10, 12, 13, etc., the lowest, 7 per cent, being east.

At Weather Bureau stations the wind direction is automatically recorded each minute; but, in tabulating the data, the direction having the greatest percentage of time in any hour is given credit for that full hour, while all other directions represented get no credit. This method, evidently, will balance out fairly for each direction in the course of time; so that, if records for a number of years are used, the time credited to each direction will be approximately correct. The table, therefore, may be accepted as a fairly accurate, general presentation of the facts.

In considering the data in the table, it should be remembered that some stations have a much more pronounced prevailing direction than others; for example, Nashville has wind prevailing from the northwest during the hours given in April, with an average of 49 per cent, while New Orleans has southeast, with 68 per cent.

The last column of the table gives the direction or directions found most often in the preceding columns for each station and may be considered as presenting the prevailing direction for the whole period for the hours 8 a. m. to 4 p. m. of April, May, June, September, and October. But the question, which of these months are most important in this connection (ventilation of school buildings) must be considered, for it may be that the warmer months of May and June should be given greater weight, while the cooler months of April and October should be given less weight. It would be wise to consider the whole record at near-by Weather Bureau stations, with an eye to the most important portions of the warm-weather period.

The records show a rather mixed distribution of air movement over the Southern States, due principally to local topography and the varied conditions of exposure of wind vanes. But there are also regional characteristics of wind direction, due to geographical differences, the paths of general storms, and the distribution of mean temperature and mean atmospheric pressure.

Topographical effect is shown clearly at Fort Smith, Ark., where the wind rarely blows for any length of time from any direction other than east, due to the trend of the valley in which the wind vane is located. This is the most conspicuous case of the kind among Weather Bureau stations in the Southern States, but doubtless other similar situations exist. In the highland and mountain districts of Tennessee, Georgia, the Carolinas, and Virginia, the wind directions are evidently affected to some extent by the broken character of the land surface, ridges, and valleys; otherwise, it is difficult to account for some of the characteristics of the records at the several stations. The westerly component is prominent at Nashville, Knoxville, Atlanta, Asheville, Wytheville, and Lynchburg.

The suggested regional distribution may be grouped as, (1) the States of Arkansas, Oklahoma, Texas, Louisiana, southern Mississippi, and western Alabama, where southerly winds, especially south and southeast, predominate decidedly throughout the period; (2) the eastern half (roughly) of the States of Virginia, North Carolina, South Carolina, Georgia, southern Alabama, and all of Florida, where the prevailing winds in spring and early summer are from the southwest and in September and October from the northeast; (3), the remaining portions of the Southern States, embracing Tennessee and the highlands and mountainous portions of Georgia, the Carolinas, and Virginia, where the westerly component (southwest, west, and northwest) predominates.

Means or averages of the data in the table, covering the whole area, are probably of little value. It is difficult to compute a correct mean from these data, as the sections of the area are disproportionately represented. However, it may be stated that, considering all the data in the table, we find that southwest is the most frequent direction recorded. This is followed by south, which is considerably less frequent; then by northwest, northeast, and southeast, of equal frequency, but considerably less than south.

Prevailing winds (8 a. m. to 4 p. m.) for the months given.

Stations.	April.	May.	June.	September.	October.	Period.
Alabama:						
Anniston	nw.	nw.	n.	se.	se.	se. and nw.
Birmingham	s.	s.	s.	s.	se.	s.
Montgomery [1]	se.	sw.	sw.	e.	e.	sw. and e.
Arkansas:						
Bentonville	s.	s.	s.	s.	s.	s.
Fort Smith	e.	e.	e.	e.	e.	e.
Little Rock	s.	s.	s.	ne.	s.	s.
Florida:						
Jacksonville	sw.	sw.	sw.	ne.	ne.	sw.
Pensacola	se.	s.	s.	s.	se.	s.
Tampa	ne.	sw.	sw.	ne.	ne.	ne.
Georgia:						
Atlanta	nw.	nw.	w.	e.	e.	nw. and e.
Augusta	nw	nw.	sw.	ne.	ne.	ne. and nw
Macon	nw.	ne.	sw.	ne.	ne.	ne.
Savannah	sw.	sw.	w.	ne.	ne.	ne. and sw.
Thomasville	sw.	sw.	sw.	ne.	ne.	sw.
Louisiana:						
New Orleans	se.	se.	se.	ne.	ne.	se.
Shreveport [1]	s.	se.	s.	se.	se.	se.
Mississippi:						
Vicksburg	sw.	sw.	sw.	nw.	nw.	sw.
North Carolina:						
Asheville [1]	nw.	nw.	nw.	nw.	nw.	nw.
Charlotte	sw.	sw.	sw.	ne.	ne.	sw.
Raleigh	sw.	sw.	sw.	ne.	ne.	sw.
Wilmington	sw.	sw.	sw.	ne.	ne.	sw.
Oklahoma:						
Oklahoma	s.	s.	s.	s.	s.	s.
South Carolina:						
Charleston	s.	s.	s.	ne.	n.	s.
Greenville	sw.	sw.	w.	ne.	e.	sw.
Tennessee:						
Chattanooga [1]	s.	sw.	sw.	ne.	ne.	sw. and ne
Knoxville [1]	sw.	sw.	sw.	ne.	ne.	sw.
Memphis	sw.	sw.	sw.	sw.	sw.	sw.
Nashville	nw.	sw.	sw.	nw.	nw.	nw.
Texas:						
Abilene	sw.	sw.	se.	sw.	sw.	sw.
Amarillo	sw.	s.	s.	s.	s.	s.
Dallas	s.	s.	s.	s.	se.	s.
Fort Worth	s.	s.	s.	s.	s.	s.
Galveston	se.	se.	se.	se.	se.	se.
Houston	se.	se.	s.	se.	se.	se.
San Antonio	se.	se.	se.	se.	se.	se.
Virginia:						
Lynchburg	nw.	sw.	sw.	ne.	nw.	nw. and sw.
Norfolk	nw.	ne.	ne.	ne.	ne.	ne.
Richmond	sw.	sw.	ne.	ne.	sw.	sw.
Wytheville	w.	w.	w.	e.	w.	w.

[1] Hourly data not available; therefore the monthly prevailing direction has been used.

If we take the States east of the Mississippi River, we find southwest winds distinctly predominating, followed by northeast and northwest. Taking Arkansas, Oklahoma, and Texas, we find south strongly prevailing, with southeast next, and but little from any other direction.

By months, considering the whole area, we find that southwest winds prevail in April, May, and June, and northeast in September and October; but south is a pretty strong second.

But these groupings and averages are considered of no great value for guidance in the orientation of a schoolhouse in any particular locality. They do indicate that there is no strong prevalence of south winds except in Arkansas, Oklahoma, Texas, and Louisiana. Emphasis should be placed upon the advisability of making as thorough investigation as practicable of conditions in each locality in the preliminary plans for school buildings, and this generally can be done through near-by Weather Bureau stations.

It is obvious that south windows would catch the breezes from the southeast, south, and southwest; west windows would catch them from the southwest, west, and northwest. But west windows, it seems, are decidedly preferable from the standpoints of light and sanitation. Therefore, where the prevalence of south winds is very strong, as in the Southern States west of the Mississippi River, a choice of west or south windows may be difficult to make; but in the States east of the Mississippi River, generally speaking, it would seem that any sacrifice of other features to secure south breezes would be a mistake.

RADIO REPORTS GIVE TIMELY NOTICE OF RAINS IN CALIFORNIA.

By GEO. H. WILLSON, Meteorologist.

[Weather Bureau, San Francisco, Calif., April 26, 1923.]

From radio reports received twice daily at San Francisco from vessels in the North Pacific ocean the presence of storms and their approximate location is in nearly all instances known several days before their approach is indicated at coast stations, but the reports are generally so scattered that the direction in which the storm is moving and its rate of progression are too indefinite for use as a basis for a forecast. To make a definite forecast, that is, one that would be of any practical value, it is necessary to have sufficient data to know what the pressure distribution over the Canadian northwest, Rocky Mountain States and off the California coast will be about the time the storm is expected to reach the coast.

In general, a storm moving east or southeast from the North Pacific will not give rain in California unless its eastward movement is deflected southward by an area of high pressure over Alaska or British Columbia. When this is the case, the storm will, in nearly all cases, when about 500 or 1000 miles off the coast, develop a trough extending southward to about the latitude of San Francisco, and the center will enter the coast south of the Columbia river.

These conditions prevailed during the last week of March, 1923, and the writer was enabled to make a forecast of the approach of a storm several days in advance of its appearance on the coast. Subsequent comment by both the press and the public showed a deep appreciation of the work.

The storm which reached the Pacific coast on Friday night (March 30), and broke the long drought in California was first shown by a report from the S. S. *West Ivan* (en route from the Orient to San Francisco) on the morning of the 26th, when in latitude 37° N., longitude 151° W. On the morning of the 27th, the *West Ivan* in latitude 37° N., longitude 148° W.; *Bearport* in latitude 39° N., longitude 154° W.; *Protesilaus* in latitude 52° N., 157° W., and the *Wairuna* in latitude 36° N., longitude 140° W., showed the cyclonic circulation around a large storm, but no high winds or low pressures were reported. On the morning of the 28th, the *West Ivan* reported a barometer of 29.44 inches, with fresh southeasterly winds and rain, and was nearing the center of the storm, while the *Bearport*, about 500 miles to the northwest, reported fresh northwesterly gales. Based upon these reports the following statement was made to the manager of the Associated Press: "A storm is central about 1300 miles off the California-Oregon coast moving eastward and will probably reach the coast about Friday evening (March 30) and extend later into California and break the drought." Advisory warnings were also sent to all ports from San Francisco north, advising shipping about to sail for the Orient of the location of the storm and the time it would reach the coast.

On the afternoon and evening of the 28th, the *West Ivan* sent the following reports:

1 p m, barometer 29.34, wind southwest, force 10; 3 p m, barometer 29.26, wind southwest, force 10; 9 p m, barometer 29.08, wind west, force 9, and at 11 p m, barometer 29.14, wind west, force 9—

Showing that she had passed through the center of the storm. At this time the weather was clear over the entire Pacific coast and a marked warm wave was in progress. Cloudiness began to increase along the coast Friday morning from San Luis Obispo northward; by Saturday morning rain had begun at all coast stations from San Francisco north, and by night the rain area had extended over western Washington, western Oregon, northern California, and the northern portion of southern California.

SOME TEMPERATURE AND HUMIDITY RELATIONS OF THE AIR.

By W. J. HUMPHREYS.

[Weather Bureau, Washington, D. C., May 2, 1923.]

The following is only a condensed, and slightly modified, derivation of some of the more interesting portions of an important paper by Dr. C. W. B. Normand, published in 1921 as Part 1, Vol. 33, of the *Memoirs of the Indian Meteorological Department*.

Let an aspiration psychrometer meet the following conditions, as it may to any required approximation:

1. That there be no net radiation gain or loss by the thermometer element.
2. That there be no addition of heat to, or subtraction from, the system, air, water vapor, and water, within and passing through the psychrometer.
3. That the exit air be saturated. This assumption is not necessary, but convenient.
4. That the pressure be constant.

Let T be the absolute temperature of perfectly dry intake air (if not fully dry, some of the following equations will need slight but obvious changes); T' the absolute temperature of the wet bulb; C_p and C'_p the specific heats of dry air and of water vapor, respectively, at constant pressure; and x the mass ratio of water vapor to dry air in saturated air at the temperature T'.

Then, counting from the freezing point, the heat in $1+x$ grams of saturated air at the temperature T' is