# Air mass type and season favoring long cross-country soaring flights over the eastern United States

By Chas. V. Lindsay

Environmental Science Services Administration, Weather Bureau Forecast Center, Washington, D. C.

*Paper presented at the XIth OSTIV Congress 1968, Leszno, Poland*

Abstract
The records of long cross-country soaring flights over a period of five years are related to weather type and season to give the soaring pilot and forecaster a better understanding of the conditions most favorable for long flights.

## 1. Introduction

While experience is probably the best teacher, a study of weather conditions associated with actual long cross-country flights is at least a partial substitute. A detailed study of some of these flights should give both the meteorologist (forecaster) and the soaring pilot a better understanding of the weather types most promising for similar successes.
Changing weather conditions which may be of little or no concern to the powered pilot may mean the difference between success or failure to the soaring pilot. Even with favorable conditions deteriorations may be rapid, and timing becomes critical if a successful flight is to be attained. Consequently, the need for a clear understanding of atmospheric conditions best suited for long cross-country flights is essential.

## 2. Record of Long Soaring Flights

The Soaring Society of America in its monthly magazine «Soaring» includes records of long cross-country flights as reported to them by pilots throughout the United States.
During the past five years (1962–1967) some 153 long cross-country flights have been reported to the magazine by pilots from the eastern portion of the United States. A plot of most of these flights is shown on figure 1. There were several flights over approximately the same flight tracks. Of course the tracks do not represent the actual flight paths as they are seldom in straight lines. Long triangle flights are included in the data but are not indicated on figure 1. The tracks do represent the general direction of the flights, which is the important point. Note that most of the flights were made in a direction ranging from east around through the south and south-southwest of the originating point as indicated by the solid lines. Also note that relatively few were made in other directions as indicated by the dashed lines. The proximity of the Great Lakes did affect the choice of direction to some degree at several sites.
Over the central portion of the United States and from the Rocky Mountains westward long flights have been made mostly in directions toward the north around through the east as reported by pilots in «Soaring». Among these flights was the world record distance flight of 647 miles by Parker made toward the north. Also Bikle completed a flight of 557 miles toward the northeast, and Johnson one of 535 miles toward the northeast. The weather conditions most conducive to long flights in one part of the country may not be the most favorable elsewhere. Also weather types that occur in one locality may not occur in other areas or at least in the same form. For instance steering of cPk air masses from Canada in late spring and summer normally brings them into the northeastern part of the country. Therefore, you would not expect to find this air mass over the southern plains or from the Rockies westward, and only frequently would it be found over the southeastern United States.
The weather conditions for each of the 153 flights in this study were checked and it was found that 125 or 82 % were made after a cold front had passed and ahead of the following high pressure center. Generally they were flown in cP air. Twenty-eight of the flights or 18 % were made in the relatively warmer air in advance of a cold front and to the west of a high pressure center in mT air or air that is becoming mT. The bargraph on the right side of figure 1 shows the numer of

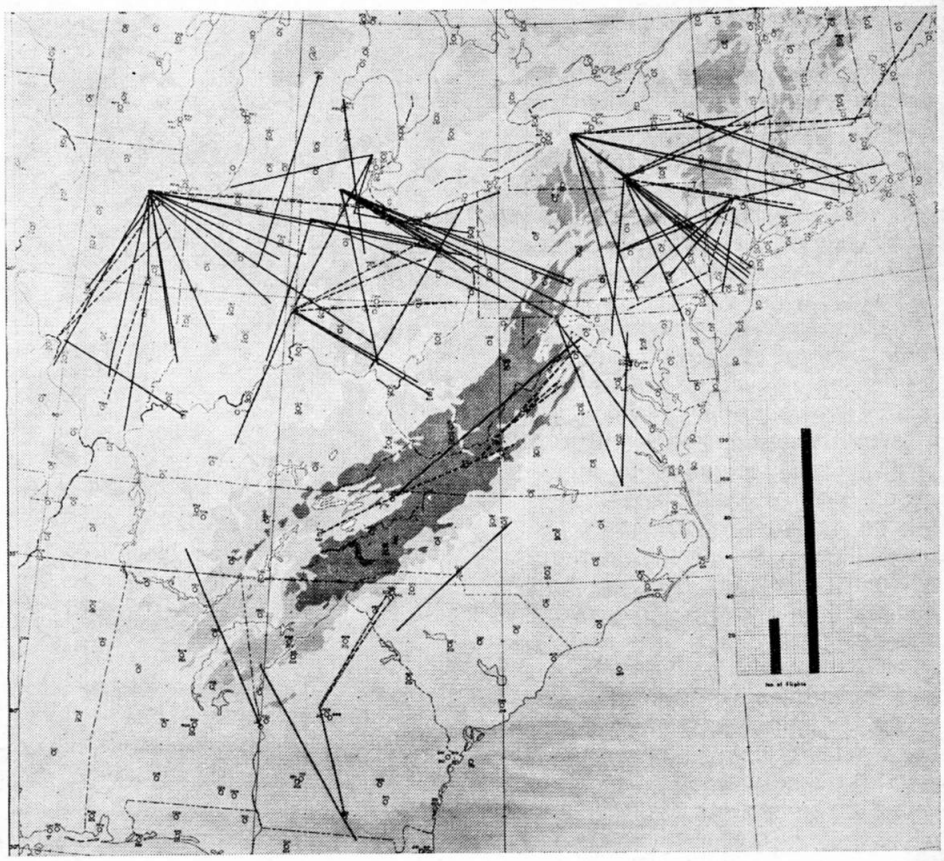


Fig. 1. Plot of long soaring flights over eastern United States for five-year period 1962 through 1967. Solid lines indicate flights made in cP air and dashed lines flights made in mT air. Bargraph on right side of figure indicates the number of flights in each airmass type.

flights in each of the two basic types of air masses. These two types may be in various stages of modification depending on time and distance from the source region.

3. Definitions of cP and mT Weather Types

Air masses by definition are bodies of air which have remained over an extensive area of the earth's surface for a sufficient time to acquire characteristic temperature and moisture properties imparted by that surface. Air so modified becomes identifiable as a distinct air mass.

For the eastern United States there are two main source regions of such air masses. Canada is one region and the air mass that originates there before moving southeastward over the eastern United States is known at Continental Polar (cP) as shown on figure 2.

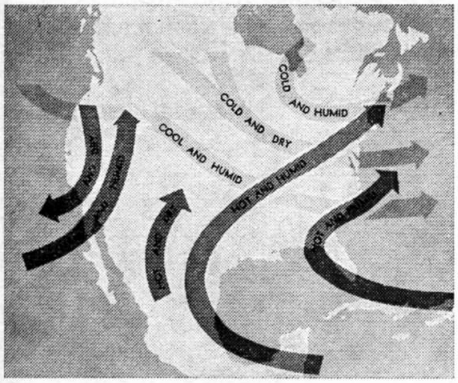



Fig. 2. Typical paths taken by air masses entering the contiguous United States

As this air mass moves southward over warmer surfaces it gradually becomes modified and during this process is further classified as cPk. This modification results in instability even with very little daytime heating and instability sometimes occurs at night as the cool air moves over warmer surfaces.

The other air mass most commonly found over the eastern United States has its source over the Gulf of Mexico and/or adjacent Atlantic Ocean area. This air mass is called Maritime Tropical (mT) indicating its origin over a water area of tropical or subtropical latitude. As its origin implies this air mass is relatively warm and moist and it, too, becomes modified in its northward progress over the eastern United States. Its designation as mTw indicates that it is warmer than the surface over which it moves. However, during the summer it may be heated still further as it moves northward over land areas. This mT air invades the central and eastern portions of the United States with high temperatures and humidities at the surface, but both temperatures and humidities decrease rather rapidly with altitude, often producing a state of conditional instability. In summer, as this moist air mass moves over warm land areas surface heating is sufficient to start convection, resulting in frequent and often heavy thunderstorms.

4. Advantages and Disadvantages to Soaring in cP and mT Air Masses

Advantages in cP Air Masses

a. Daytime heating of cP air masses from below while being cooled aloft by advection produces a dry adiabatic lapse rate to relatively high altitudes resulting in stronger thermals.

b. Convection normally begins earlier in the morning and lasts longer in the afternoon due to the fact that the air is relatively unstable to begin with.

c. On the average, cumulus develops with higher bases than in the mT air due mainly to the drier air.

d. Since there is generally less moisture at all levels not only are there less cumulus clouds produced but there are little or no middle or high cloudiness to cut down on surface heating.

e. The wind and lapse rate structure of cP air masses is frequently the type that produce streeting of the thermals, whether they be marked with cumulus or are of the dry type.

f. Good visibility normally marks the cPk air mass, which is very important for navigation.

Disadvantage in cP Air Masses.

a. Cumulus clouds are generally relatively flat with little vertical development. This becomes a disadvantage if a pilot desired to fly in cumulus to gain additional altitude.

Advantage in mT Air Masses

a. Cloud flying would be better as cumulus will build to high altitudes in the cumulonimbus stage. It might be added that flying on instruments in clouds is prescribed by the Federal Aviation Regulations and is less restricted in uncontrolled air space.

Disadvantages in mT Air Masses

a. More cloudiness on the average can be expected at all levels which frequently inhibits surface heating.

b. Often one has to contend with showers, and thunderstorms with the latter in lines at times. Lines of thunderstorms can be more of a disadvantage than an advantage to the average soaring pilot.

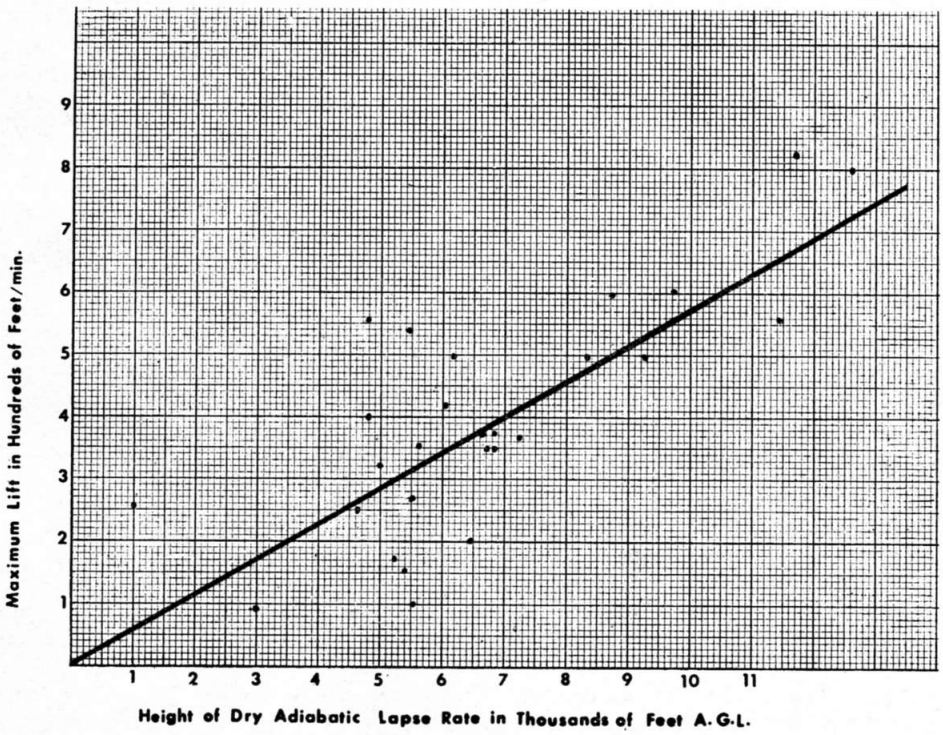
c. Areas affected by showers will become stable which can be the end of a cross-country flight.

d. Visibilities are often poor due to haze and smoke.

5. Height of Vertical Convection and Thermal Strength

Figure 3 is introduced to show the im-

Fig. 3. Relation of height of vertical convection to thermal strength



portance of an air mass that would produce dry adiabatic lapse rates to higher altitudes, and in turn, produce stronger thermals. To relate the heights of vertical convection to thermal strength the experience of one soaring pilot, Mario Piccagli, was used (figure 3). Using data for 26 of his flights this pilot computed his maximum lift from his barograph records. An attempt was made to show that there is a useful relationship between the maximum height of an unstable layer as shown by the dry adiabatic lapse rate for a given day and the strength of the thermals encountered by the sailplane. The same sailplane, a Standard Austria, was used for all of the flights. The line of best fit on the figure was computed by the method of least squares. The data produced a correlation coefficient of 0.73, which gives a useful relationship for forecasting by offering a more objective approach. The data indicates that with one exception this pilot did not encounter lift of 200 feet/minute or greater until the lapse rate had become dry adiabatic to about 4,500 feet.

6. Specific Examples of Flights

Let us take a closer look at several of these flights in the cool cP air mass and one in the warmer mT air mass.

(a) On April 14, 1944, Neal Ridenour flying a Prue Super Std. flew from Naperville, Ill., to Stow, Ohio, a distance of 360 miles in 6 hours and 5 minutes to earn his Diamond distance (figure 4). Also on this same day John Slack flew an Lo-150 355 miles from Naperville, Ill., to Akron, Ohio, in 5 hours and 10 minutes which is near the track of the previous flight. This was the second Diamond distance flight on that day.

As this cooler unstable air mass moved eastward, bringing with it excellent soaring weather, it enabled another pilot further east to make a good flight the next day. On April 15th David Seymour flying a Ka-6CR flew 194 miles from Danville, New York, to Schenectady, New York, in 5 hours and 25 minutes to earn his Diamond Goal and Gold distance.

The 1200 April 14, 1964, GMT upper air soundings (figure 5) for Peoria, Ill., and Dayton, Ohio, show the type of vertical temperature structure that represents the conditions encountered by the two excellent flights. Conditions on this day were typical of the cPk air mass. With maximum surface heating to 65° F the Peoria temperature sounding became unstable with dry adiabatic conditions to near 14,000 feet. Further east, the Dayton sounding with a surface maximum of 71° F became dry adiabatic to near 10,000 feet and the Pittsburgh, Pennsilvania, sounding (not shown) with a maximum temperature of 61° F was dry adiabatic to near 6,500 feet. The cold front had not passed the Pittsburgh station too long before the sounding was taken and thus the sounding did not show conditions to be as good as those further west.

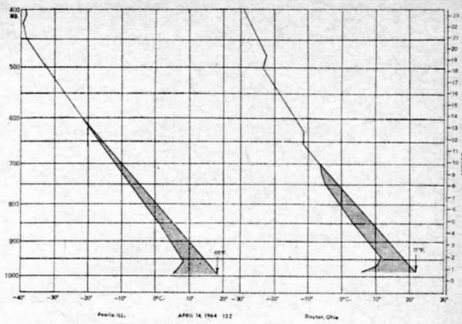


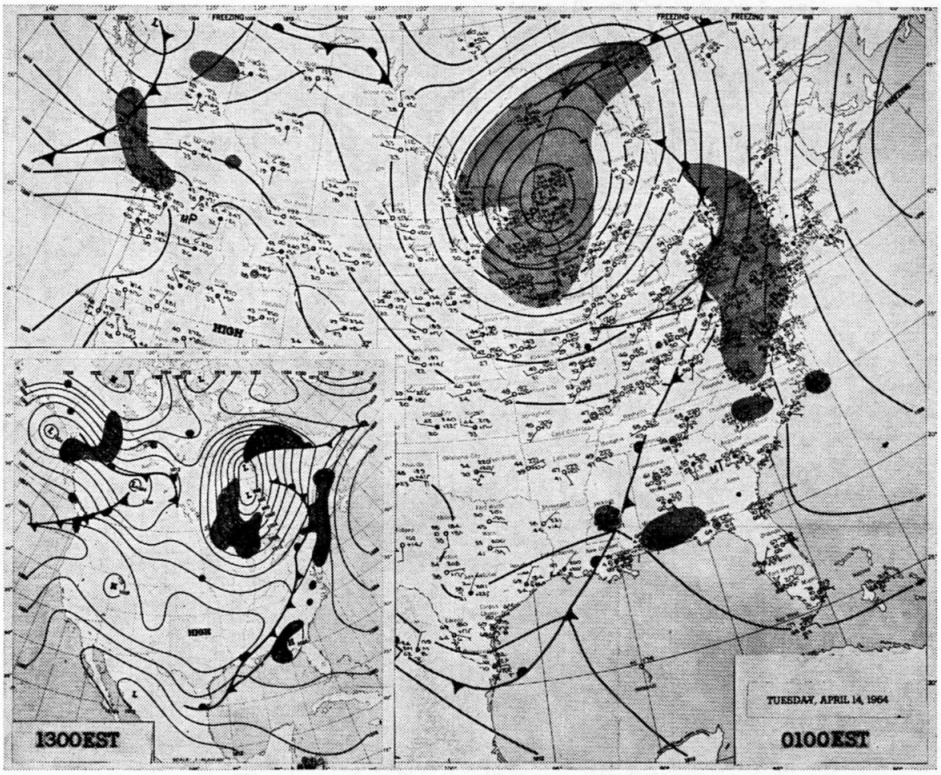
Fig. 5. Peoria, Ill. and Dayton, Ohio, upper air soundings for 1200 GMT (07 EST) April 14, 1964.

(b) More recently on May 20, 1967 (figure 6) Rudy Mozer flew a Ka-6E 360 miles from Adrian, Michigan, to Clear Springs, Maryland, for Diamond distance. On this same day Robert F. Nichols earned his Diamond distance flying 324 miles in 6 hours and 50 minutes from Adrian, Michigan, to Martinsburg, Pennsylvania. This flight, shown on figure 6, is a little to the north of the previous flight.

On the next day (May 21st) excellent soaring weather continued over this general area in the same air mass and Edward Frappier flew a Ka-7 274 miles from Bryan, Ohio, to Connellsville, Pennsylvania, in 7 hours and 20 minutes to earn Diamond distance.

(c) To the east of the Appalachian Mountains over the states of Maryland and Virginia, on July 5, 1964, five soaring pilots made long flights in the same cP type air mass (1) with cumulus bases to near 7,500 feet AGL (figure 7). Two of the flights were made from Cumberland, Maryland, 216 miles southward to Emporia, Virginia, for Diamond Goal and Gold Distance. One pilot George Nash flying a Ka-8B used cloud streets on the flight. He encountered 500 feet/minute lift with 1,000 feet/minute the best of the day. Mr. Nash landed at Emporia at 1603 EST. He stated that he was getting 900 feet/minute lift just prior to landing and that cloud streets extended downwind as

Fig. 4. Surface weather charts for 0100 EST and 1300 EST, April 14, 1964. The line indicates paths of flights. Black dots over Illinois and Ohio indicate location of upper air soundings.



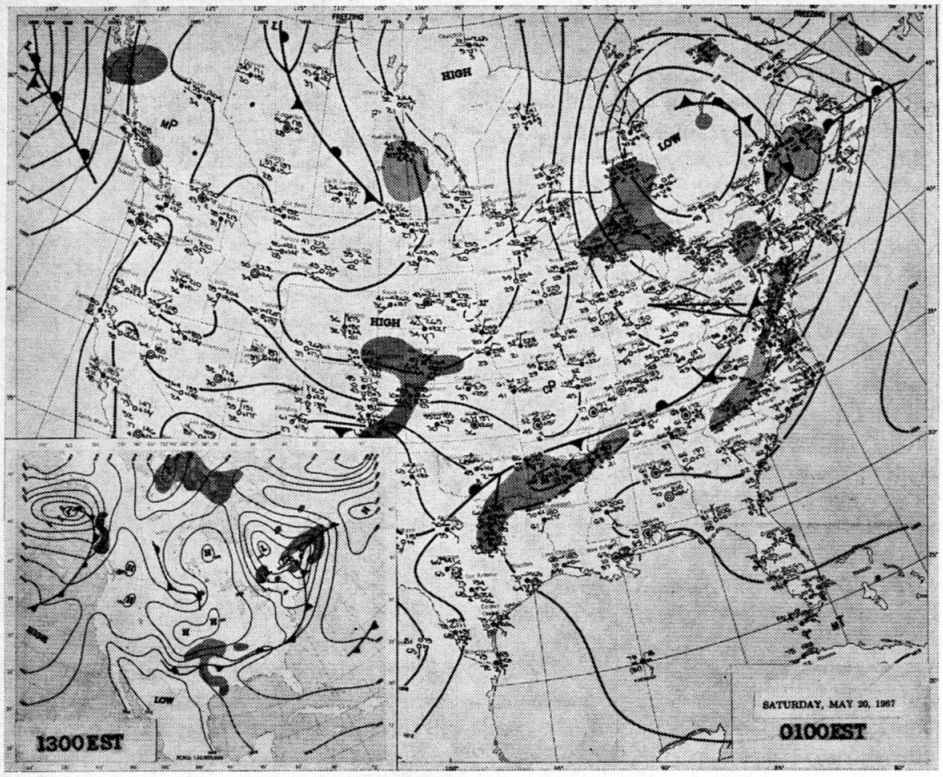



Fig. 6. Surface weather charts for 0100 EST and 1300 EST, May 20, 1967. The lines indicate paths of flights.

setts, a distance of 350 miles to earn Diamond distance. This flight was made in a southwesterly flow in advance of a cold front. The cloudiness in advance of front did not appear to affect the flight. The 1200 GMT sounding at Albany, New York, and Portland, Maine, indicated dry adiabatic conditions to about 9,000 feet at the time of maximum heating.

7. Months Best for Long Flights

The 153 flights were tabulated by month, as shown on Figure 10. Sixty-eight percent of the flights were made during three months of the year, namely May, June and July.

The total possible number of hours of sunshine for each month is also plotted. Note that the three months with the most long flights coincide with the months of the greatest possible hours of sunshine. Of course, the longer flights would be expected during the days of longer hours of sunshine.

The number of flights with duration of six hours or longer are also indicated at the top of figure 10. The maximum number of flights of six hours or longer occurred in the months of June, July, and August.

8. Conclusion

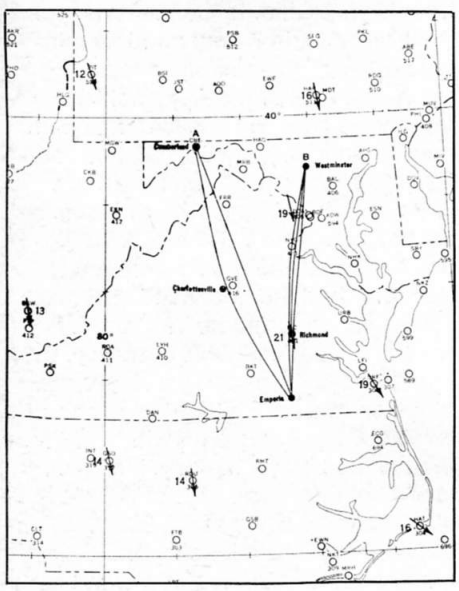
The records in this study show that the cool cP air mass offers the best chance for long cross-country flights during the months of May, June, and July. A few good flights have also been made in other months and in warmer mT air mass.

Soaring pilots will find that from April to September the best conditions for long flights are associated with the passage of cold fronts. The passage or expected passage of a cold front should alert the soaring pilot to get ready for an attempt at a long flight.

far as he could see from an altitude of 7,500 feet ASL. If he had not declared Emporia as a Goal he felt he could have made Diamond distance.

The other three flights were made from Westminster, Maryland. The best was by Gene Wilburn in a Bergfalke II. Gene flew 203 miles south to Emporia, Virginia. He experienced good lift and flew mostly above 4,000 feet to 7,300 feet. He flew under cloud streets for about 50 miles. He stated he had frequent lift of about 1,000 feet/minute along with strong sink between thermals.

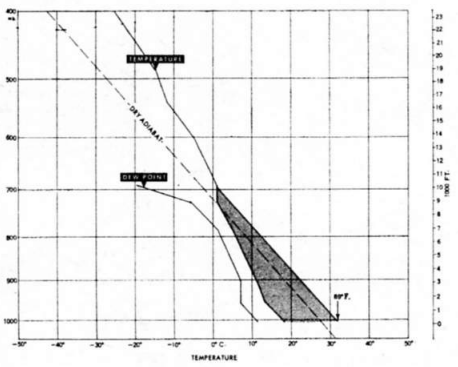
Fig. 7. Soaring flight path A (Cumberland, Md., to Emporia, Va.) and flight path B (Westminster, Md., to Emporia) with average winds aloft in the thermal layer over the area of the flights, July 5, 1964. (Arrows indicate wind directions and numbers average wind speed in knots.)




Gordon Bagora flying a Schweizer 1-26 made 200 miles to a point 3 miles north of Emporia with a late start. Joe Caicuts flew a BG-12A south to Richmond, Virginia a distance of 139 miles also with a late start. He had maximum lift of 1,500 feet/minute and also flew along cloud streets without having to circle in thermals. For these flights the winds aloft in the thermal layer were from the NNW at 15 to 20 knots. Cumulus coverage was less tahn 5/10 with bases to about 7,500 feet. Figure 8, the Washington, D. C. sounding, shows the temperature structure at 7 a. m. EST and with maximum surface heating which reached 89° F.

(d) For comparison a flight (figure 9) in the warmer air to the east of a cold front is shown. On May 4, 1963, Kia Gertsen flew a Ka-6CR from Danville, New York to Newberryport, Massachu-

Fig. 8. Washington, D. C., upper air sounding, 1200 GMT (0700 EST), July 5, 1964.



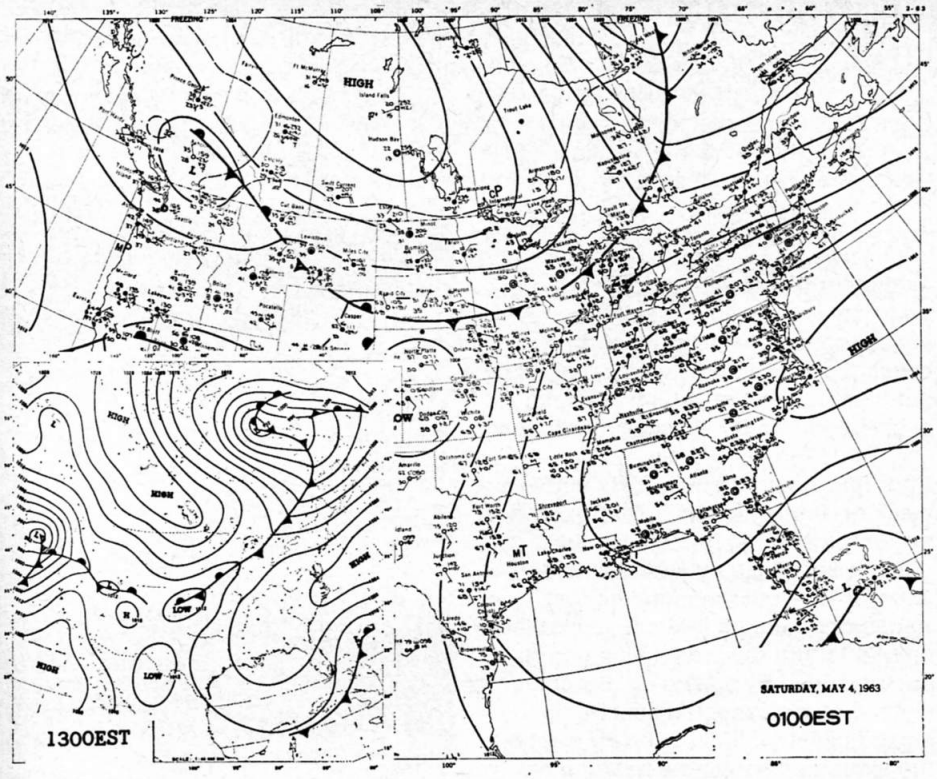


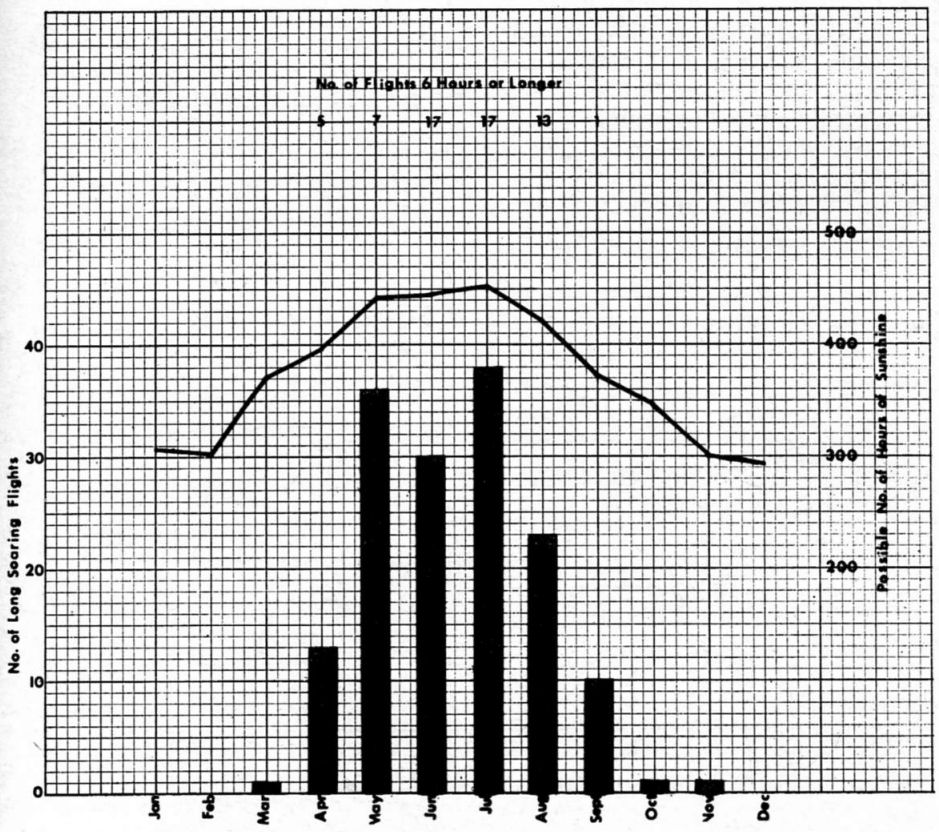

Fig. 9. Surface weather charts for 0100 EST and 1300 EST, May 4, 1963. The line indicates path of flight.

However, upon occasions, immediately to the rear of a cold front when the wind is too strong it tends to break up or distort the thermals. Strong winds also produce marked turbulence effects, making flight difficult.

The duration of most favorable soaring conditions over a particular area in a cP air mass is limited by frontal cloudiness, changes in lapse rate, and strong winds. Areas of most favorable soaring conditions can be identified and tracked. An attempt can be made at forecasting the future movement of these areas with consideration given to improving or deteriorating conditions.

It is hoped that this will assist the soaring pilot and the aviation forecaster in better understanding the weather types and time of the year a pilot can expect to have the best probability of making a long flight in thermals over the eastern United States. A study of this type should also help to determine the best time to hold a contest. Following the procedure used in this study, one could determine for all areas of the world the air mass types and time of the year that is most favorable for long cross-country soaring flights.

Fig. 10. Number of long flights and number of flights 6 hours or longer by month for five-year period. The line indicates total possible number of hours of sunshine for each month.




Acknowledgements

The author is grateful to the many soaring pilots who reported their flights to Soaring magazine and in particular Mr. Mario Piccagli who contributed data from his many soaring flights. Special thanks are also extended to Mr. R. J. Younkin and Mr. J.L. Hudson for their helpful suggestions.

References

1. C. V. Lindsay, «Type of Weather Favoring Cross-Country Soaring,» Soaring Magazine, Vol. 28, No. 12, December 1964, pp. 6–9.

Zusammenfassung

Die vorhandenen Berichte über 5 Jahre langer Ueberland-Segelflüge in den USA werden mit Bezug auf Wettertyp, geographische Lage und Jahreszeit analysiert. Die Resultate geben dem Segelflieger und Wettervorhersager Aufschlüsse über die günstigsten atmosphärischen Verhältnisse für Langstreckenflüge. Kuettner.