It will be noted that in the upper layers the west components are larger in winter from 4 to 7 km, and in the 3 coldest months from 4 to 9 km, excepting at 8 km, where a weakening is indicated.

Since most of the Antarctic Continent is in the form of an elevated land mass with a downward slope from the Pole to the edges of the continent, radiational cooling in the lower layers must lead to a drainage of cold air outward and as a result of the deflective influence of the earth's rotation this drainage effect alone would act to increase the east component of the atmospheric motion in the lower layers. The outward drainage to the north in the lower layers will lead to an inflow aloft toward the south which, as a result of the deflective influence, would be indicated by northwesterly winds in the upper levels. As stated below the *annual* means show very clearly winds with south and east components at the low levels and with north and west components at the higher levels and agrees qualitatively with the concept of the outward drainage of cold air below and a compensating inflow aloft. During the colder months, one should therefore expect an increase in the south component in the lower layers and increased north components aloft. In table 4 are given the north-south components of the resultant wind velocity in summer winter, and the 3 coldest months. It is seen that the south components are distinctly larger in winter than in summer up to 1,000 m; this is even more pronounced during the coldest period and extends to 2,000 m. In the upper layers it is seen that there are larger north components in winter than in summer at 7 and 8 km. and in the coldest period from 5 to 9 km.

TABLE 4.—*North-south components of the resultant wind velocity at Little America*

Altitude (meters)	Summer (December, January, and February	Winter (June, July, and August)	3 coldest months (July, August, and September)
	m. p. s.	*m. p. s.*	*m. p. s.*
9,000	3.81	----------	3.80
8,000	3.16	4.17	3.47
7,000	1.47	2.79	1.58
6,000	1.20	.68	1.46
5,000	.49	−.21	1.07
4,000	−.95	−.29	−.04
3,000	−1.31	−.27	−.73
2,500	−1.69	−.52	−1.36
2,000	−2.14	−1.35	−2.19
1,500	−2.24	−2.04	−2.67
1,000	−1.61	−2.59	−3.46
750	−1.53	−2.96	−3.74
500	−1.53	−2.96	−3.74
250	−1.80	−3.03	−3.57
Surface	−1.34	−1.31	−1.50
South = − North = +			

In general, the seasonal variation of the north-south components agrees with what would be expected if the circulation over the continent were controlled mainly by the drainage of the cold lower layers. The seasonal variation of the east-west components in the upper layers also agrees with this; but that of the lower layers does not, since as pointed out above the east components are smaller in winter and are lacking entirely during the 3 coldest months. In high latitudes where the Coriolis effect attains its maximum value, any drainage of the cold air toward the north in the lower layers should be acted on by the deflecting influence to a maximum extent so as to produce southeast or east winds. Just why these east components do not appear in the coldest months when the drainage should be a maximum is not clear.

It should be emphasized, however, that the direction of the drainage flow must depend largely on the direction of slope of the surface. Little America is situated on the Ross Shelf Ice, which is a large area of low, level surface surrounded by high land to the west, east, and south, that has a general downward slope into the shelf ice area. Thus, there is South Victoria Land to the west, Marie Byrd land to the east, and the Queen Maud Range and Polar Plateau to the south. This area is therefore well situated to act as a drainage basin for the cold air from these high slopes and to serve as an outlet for it to the north. This is supported by the fact of the larger south component in the air transport found in the coldest months. Along the western side of the shelf ice the damming effect of the high South Victoria land is sufficient to prevent any easterly component in the movement which would arise as a result of the earth's rotation and to cause the main motion there to take place in a north-south direction. It is doubtful, however, if this effect would be present at Little America since it is 400 or more miles to the east.

It should also be pointed out that easterly winds can be produced by cyclonic as well as anticyclonic pressure distributions, and it would be important to separate, if possible, the contribution of these two types of pressure distribution in producing easterly winds. It is also important to study the relation between the eastward moving depressions and the release of large masses of cold air.

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TROPICAL DISTURBANCE OF JUNE 12–16, 1939

By JEAN H. GALLENNE

[Marine Division, Weather Bureau, August 1939]

The first tropical disturbance of 1939 attained only moderate intensity, but moved in a rather unusual course from the Gulf of Honduras northward and north-northwestward to the east Gulf coast.

The earliest report of disturbed conditions in connection with this depression was received on the morning of June 12, through the Mexican weather service at Chetumal, placing the center near latitude 18°45′ N. and longitude 87° W. During the afternoon of the same day, although no reports of strong winds were received, vessels in the area just east of the Yucatan Peninsula reported squally weather conditions, with moderate to rough seas.

The Amer. S. S. *Carrillo* at 7 a. m. (E. S. T.) of June 12, near latitude 18.7° N. and longitude 86.6° W. reported a barometer reading of 29.77 inches; east-southeast winds, force 5; slight drizzle, with rough sea. At 7 a. m. (E. S. T.) of the following day, the *Carrillo*, then in the easterly quadrant of the disturbance, encountered east and southeast winds of force 7–8 accompanied by very rough seas.

The center of the depression, by evening of June 12, was near Cozumal Island, where there had been a fall in pressure from 29.88 inches at the morning observation, to 29.61 inches at 7 p. m. (E. S. T.).

During the period from the morning of June 12 until the evening of June 14 the disturbance moved slowly northward.

The Pan American Airways Observer at San Julian, located on the extreme western tip of Cuba, reported south wind, force 7, with a rainfall of 10 inches, during the night of June 12–13. On the morning of the 13th, the S. S. *Alabama*, near latitude 25.3° N. and longitude 85.8° W., recorded a falling barometer; fresh gales from the east-southeast and southeast, with overcast skies and rain. By noon the wind had increased from force 8 to force 9; this was the highest wind reported in connection with this disturbance. The lowest barometer reading during the progress of the disturbance (29.54 inches) was observed on the evening of June 14, on the American Steamship *Kofresi*, near latitude 29.5° N. and longitude 87.6° W. This vessel reported that during that period she met with heavy rain squalls, moderate gales, and rough seas.

During the 24 hours following the evening of the 14th, the center of the disturbance described a small left-hand loop, then resumed a north-northwestward movement on the night of June 15, which carried the depression inland, over Mobile, Ala., on the morning of the 16th.

The explanation of this loop by R. A. Dyke, Forecaster in charge of our New Orleans Office, is as follows:

The westward turn at the beginning of the loop early on the night of the 14th–15th was attended by a tendency toward equalization of pressure along the coast north of the disturbance. The pressure at Pensacola rose from 29.66 at 7:30 p. m. (E. S. T.) of the 14th to 29.68 at 9 p. m., while the pressure at Mobile fell from 29.74 to 29.70 inches. However, instead of movement to the coast, as expected, the disturbance continued to move in a small curve which brought it slightly farther south on the morning of the 15th.

Until the movement of the disturbance was halted off Pensacola, the straight northward progress was evidently under the influence of upper winds in line with those over Florida, where the western portion of an upper anticyclonic circulation gave upper winds from the south. The northward drift prevailed as far west as New Orleans up to 14,000 feet on the 12th.

With northward advance the winds aloft from Florida westward to New Orleans came under the influence of the disturbance. At the same time the winds aloft from 8,000 to 14,000 feet were moving anticyclonically over Texas and the Lower Mississippi Valley. The center of this upper anticyclonic circulation moved east-northeastward from Texas and Oklahoma to eastern Kentucky, or thereabouts, from the 14th to the 16th, and the upper winds over the Lower Mississippi Valley became easterly instead of northeasterly, except over New Orleans, where winds in the afternoon of the 15th were northeast up to 27,000 feet, with the upper winds showing velocities of 30 to 42 miles per hour. In the early morning of the 16th, the upper winds at elevations of 8,000 to 12,000 feet from Montgomery, Ala., to Memphis, Tenn., and Little Rock, Ark., had veered to southeasterly, while winds over New Orleans, under the influence of the disturbance, had backed to northerly. During the shift of the center of the upper anticyclonic circulation from the Southern Plains to a more eastern position the northward movement of the disturbance was halted by blocking winds; but when the upper circulation became central farther east the upper winds favored the resumption of northward movement. Indeed, the blocking winds apparently forced the disturbance farther southward so as to form the small loop described.

At Mobile, Ala., at 9:37 a. m. (E. S. T.) of June 16, as the center moved inland, an abrupt wind-shift from north to south was observed. The wind was of only moderate force. At 7:30 p. m. (E. S. T.) of the 16th, its center lay to the southwest of Meridian, Miss.; the disturbance thereafter advanced to the northward, and merged with an extra-tropical LOW pressure area.

There was no loss of life reported in connection with this disturbance, except that a boy fell into the swollen waters of the Peace River near Wauchula, Fla., and was drowned.

The first advisory in connection with this disturbance was issued from the Weather Bureau Office at Jacksonville, Fla., at 9:30 p. m. (E. S. T.) of June 12, and as the depression passed through the Gulf of Mexico, frequent timely warnings and advisories were issued from New Orleans, La.

Chart XIII, shows the situation on the morning of June 13, and the track of the disturbance.

THE CHAMPLIN-ANOKA, MINNESOTA, TORNADO

By M. R. HOVDE

[Weather Bureau, Minneapolis, Minn., June 1939]

On Sunday afternoon, June 18, 1939, between 3 and 4 p. m., a destructive tornado crossed the northwestern portion of Hennepin County and entered southern Anoka County. Several villages and the small city of Anoka were in the path of the funnel-shaped cloud; and death, injuries, and destruction were left in its wake.

The towns of Champlin and Anoka, center of greatest damage, are located on the Mississippi river, 17 miles north of Minneapolis. The combined population of 5,000 is practically all centered in Anoka, which is on the east bank of the river; the small village of Champlin is on the west bank.

The studies of Finley, Henry, and the Climatological Service of the Weather Bureau indicate that 122 tornadoes have occurred within the limits of Minnesota during 40 years of record, an annual average of 3. The Champlin-Anoka storm must be placed among the most disastrous 10 in loss of life and value of property destroyed.

The tornado was first observed southwest of Corcoran in Hennepin County and traveled in a northeasterly course through Maple Grove, Champlin, Anoka, and Cedar, a distance of 25 miles. The storm struck Anoka at 3:20 p. m. and its last fury was spent in Cedar at 3:38 p. m. These times indicate a speed of translation of about 30 miles per hour.

The occurrence of the storm can best be explained by the convective instability of the air that prevailed over this region during the 18th. At 6:30 a. m. C. S. T. that morning, a disturbance was centered over eastern North Dakota. Tropical maritime air has been transported northward into western and southern Minnesota. About 2 kilometers above this moist air was a Superior air mass overrunning from the southwest. As shown by the meteorograph sounding made at Fargo, the lapse rate of this Superior air was almost the dry adiabatic. When this sounding was plotted on the Rossby diagram it showed that the atmosphere in the warm sector of this disturbance was extremely convectively unstable. In fact, a layer of air would have had to be lifted only a little more than 1 kilometer to realize absolute instability.