A Review of Air-Stagnation Cases in the Eastern United States During 1981—Annual Summary

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ABSTRACT

The number and location of stagnation days within the eastern United States, as estimated mainly from a surface geostrophic-wind criterion, is presented by month and for the year 1981 as a whole. In 1981, the number of stagnation days exceeded the 40-year average everywhere except Florida, with a maximum frequency of occurrence somewhat to the west and north of the usual location. There were unique occurrences of stagnation in a belt extending from Minnesota to Maine, including extreme southeastern Canada.

1. Introduction

This is the first in a planned series of annual reviews of air-stagnation cases in the United States east of 100°W. Presented are maps showing, by month and for the year 1981 as a whole, the number of stagnation days in this region, as well as the average number of stagnation days during the period 1936–75. Comparison of the two sets of data allows one to estimate how typical a stagnation year 1981 was.

2. Procedures

The method used herein to delineate areas of stagnation is mostly objective, but also partly subjective, and other techniques might yield slightly different results. Basically, the method involves delineating those areas where, for at least four days, the surface geostrophic wind (as determined from the Daily Weather Maps of the National Weather Service) is less than 8 m s^{-1}. In general, this would correspond to a surface (anemometer level) wind speed less than $\sim$4 m s^{-1} (e.g., Brunt, 1941, p. 260; Godske *et al.*, 1957, p. 454). The choice of four days and $\sim$4 m s^{-1} is somewhat arbitrary, but has its origin in studies and conclusions from the Donora, Pennsylvania smog disaster of 1948 (Fletcher, 1949; Willett, 1949; Hewson, 1951). Areas of stagnation, so obtained, were eliminated if fronts crossed through the region, there was precipitation (even a trace), or the wind speed at 50 kPa exceeded $\sim$13 m s^{-1}. The wind speed criterion tended to limit the stagnation cases to those with height ridges at 50 kPa. More details concerning the method used for evaluation of stagnation cases may be obtained from Korshover (1976).

In Figs. 1–9, the solid lines show the number of stagnation days (if any) per month, and for the year 1981 as a whole, in the region east of 100°W and between 20 and 50°N. For example, if, in a given region, there were two stagnation cases during a given month, one of four days duration and one of 8 days duration, the total number of stagnation days during the month would be 12, and a 12-isopleth would enclose that region. The dashed lines in Figs. 1–9 show the *average* number of stagnation days for the month, or the year as a whole, based on evaluations for the period 1936–75. Comparison of the solid and dashed lines allows one to determine whether 1981 was a typical stagnation year, with regard to location of areas of stagnation and, to a certain extent, whether it was typical with respect to number of days of stagnation. The limitation in the latter regard results from the fact that, by our definition, one stagnation case involves at least 4 stagnation days, which is then compared with a 40-year average value made up of many zero values (no stagnation cases in a given month of a given year). Hence, if a stagnation case occurs in 1981, the number of stagnation days for 1981 is likely to exceed the 40-year average in that region for that month.

3. Discussion

There were no stagnation cases, as defined here, in January, February and March of 1981. There was one case in April, in the usual location of southern Georgia and northern Florida (Fig. 1). Stagnation occurred between 26 and 30 April as, following a cold front passage, a cool high-pressure area was transformed into a warm high-pressure area resembling a typical Bermuda High. The flow at 50 kPa was weak from the west and northwest.

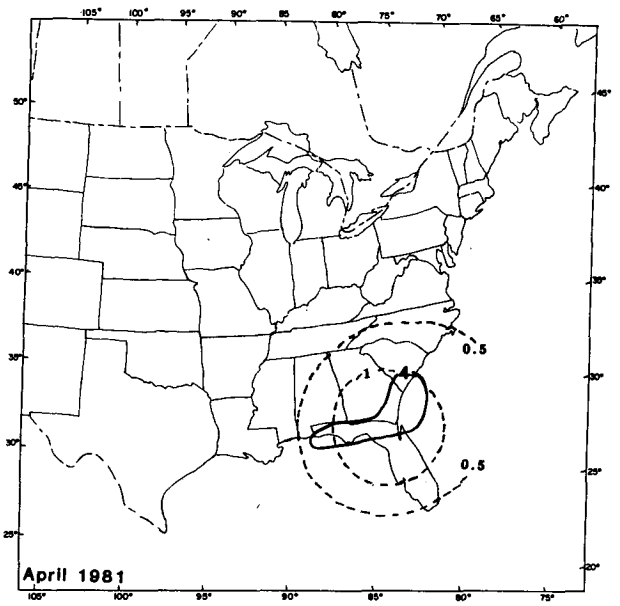

FIG. 1. Number of stagnation days in April 1981 (solid line) in comparison with the April average of stagnation days during the period 1936–75 (dashed line).

There was also one stagnation case in May, again in the usual area in the Southeast (Fig. 2). Stagnation occurred between 22 and 26 May, as a cool polar air mass settled over the southern and eastern part of the country, following the northeastward movement of an East Coast low. Fog was common in the southeastern states during this period. The flow at 50 kPa was weak from the northwest, west and southwest, respectively.

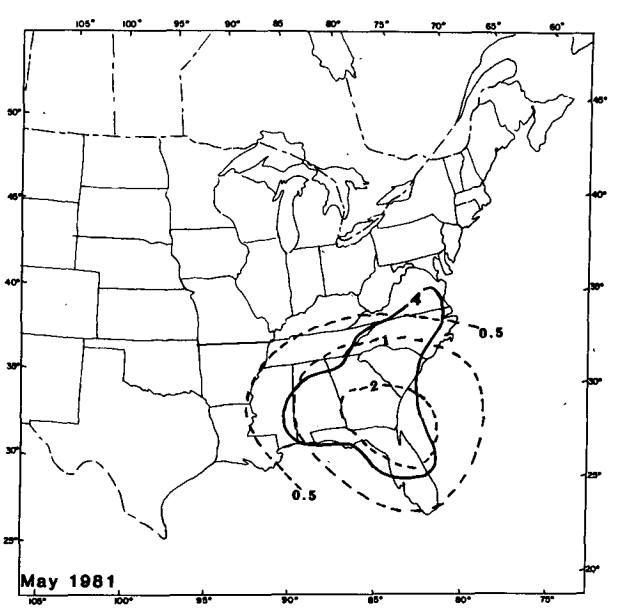

FIG. 2. As in Fig. 1, but for May.

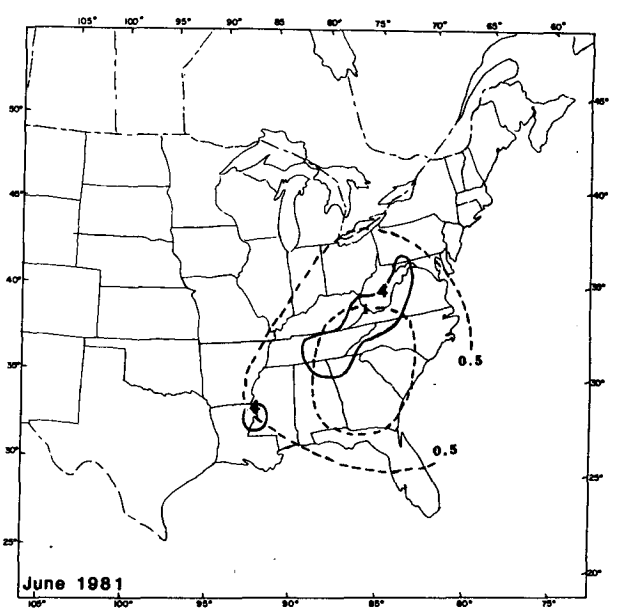

FIG. 3. As in Fig. 1, but for June.

The one stagnation case in June was centered in Appalachia, slightly north of the usual location for this time of year (Fig. 3). Stagnation occurred between 27 and 30 June, as a high-pressure area moved slowly eastward behind a low moving down the St. Lawrence River. The flow at 50 kPa was generally from the northwest.

The one stagnation case in July covered Arkansas, Louisiana and Mississippi, south and west of the usual location (Fig. 4). Stagnation occurred between

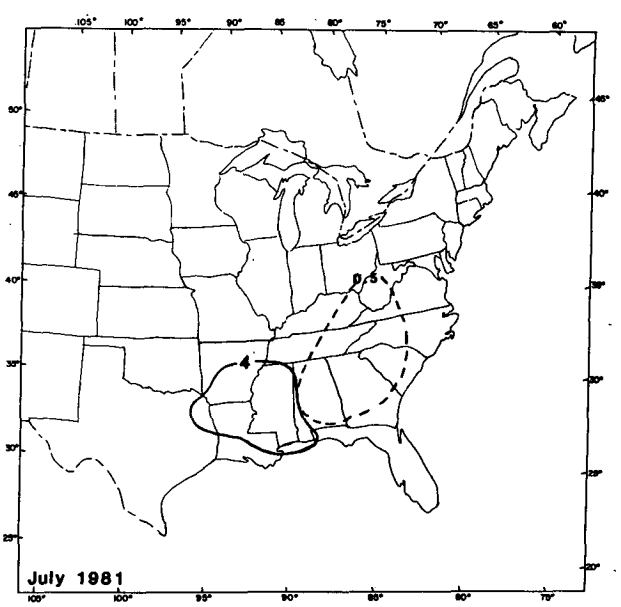

FIG. 4. As in Fig. 1, but for July.

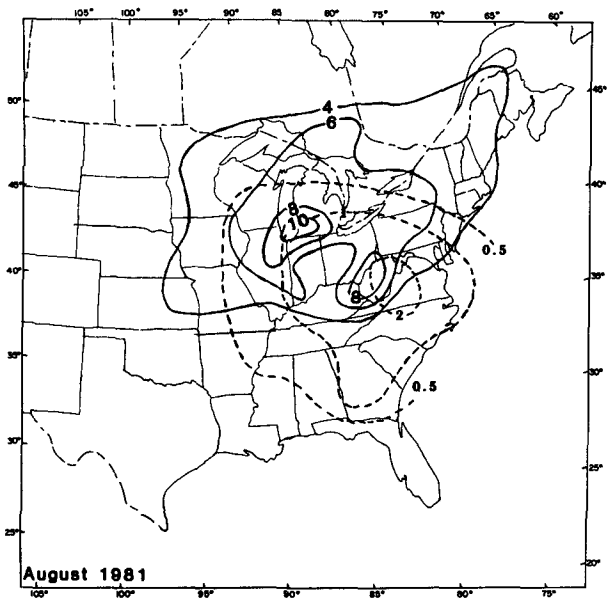

FIG. 5. As in Fig. 1, but for August.

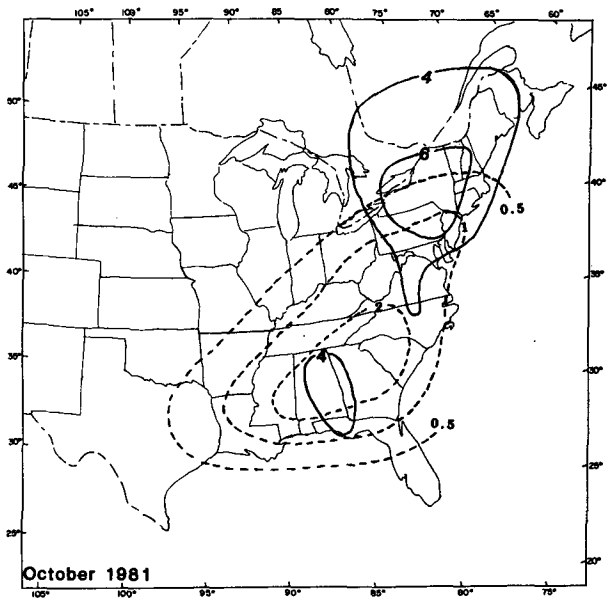

FIG. 7. As in Fig. 1, but for October.

13 and 17 July, in association with a typical summertime high-pressure system extending from the Midwest into the Gulf of Mexico. Initially, the 50 kPa winds were light from the southeast, later from the southwest.

There were three separate stagnation cases in August, generally to the north and west of the usual location (Fig. 5). The first episode occurred between 30 July and 4 August, as a cool anticyclone moved slowly from the Great Lakes to the East Coast while a stationary front persisted in the Southeast. Stagnation was found in the Midwest, with longest duration near Chicago. The weak 50 kPa flow was generally from the west. The second episode occurred between 17 and 23 August, as an unusually large (for this time of year) polar anticyclone moved into the North Central States from Hudson Bay. The area of stagnation extended from the upper Midwest to the East Coast. This episode is unique in that during the period 1936–75 there were no cases at all of stagnation in the belt extending from Minnesota to Maine during the month of August. A light northwesterly

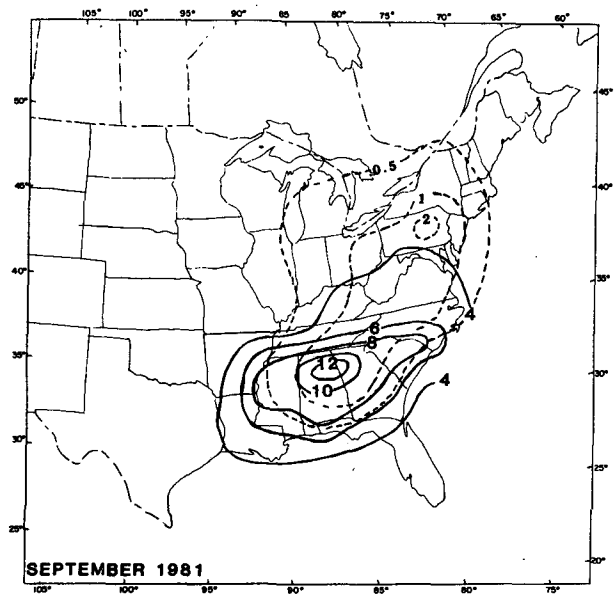

FIG. 6. As in Fig. 1, but for September.

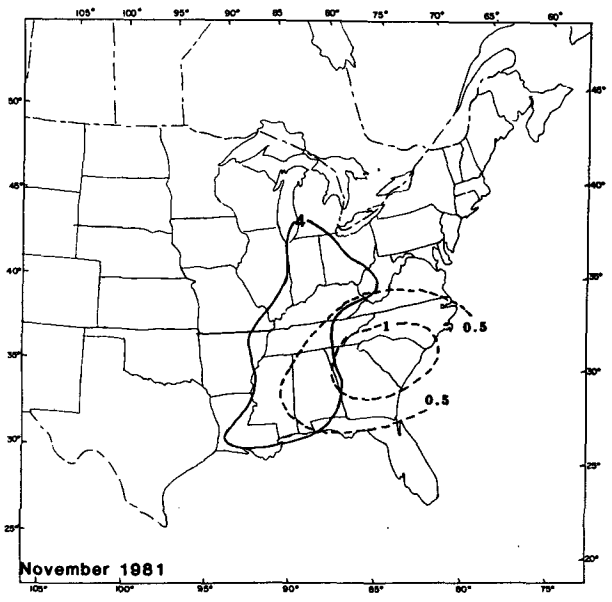

FIG. 8. As in Fig. 1, but for November.

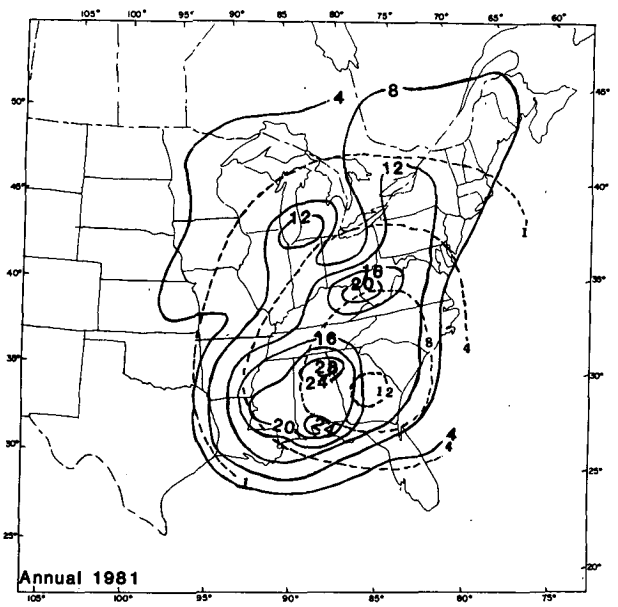

FIG. 9. Number of stagnation days in 1981 (solid lines) in comparison with the annual average of stagnation days during the period 1936–75 (dashed lines).

flow persisted at 50 kPa during this episode. The third episode occurred between 25 and 28 August as a polar anticyclone moved southward from eastern Canada into the eastern United States (associated with a so-called "back door cold front"). The stagnation area was limited mainly to Kentucky and West Virginia because of rain showers. Winds at 50 kPa were light from the west and northwest during this time.

There were also three separate stagnation cases in September, generally to the southwest of the usual location (Fig. 6). The first episode occurred between 10 and 14 September, in association with an extensive anticyclone which covered the whole southeastern part of the country following a cold front passage. Stagnation was found within the triangle formed by Maryland, Louisiana and Georgia. The 50 kPa winds were light northwesterly. The second episode occurred between 19 and 23 September as a large anticyclone moved into the Deep South from central Canada and then became nearly stationary. Stagnation was confined mainly to Mississippi and Georgia. Again light northwesterly winds prevailed at 50 kPa. The third episode between 24 and 27 September was associated with an intense anticyclone which moved southward from Hudson Bay to the Greak Lakes and thence southeastward to the East Coast. The stagnation area was limited to the southern states of Alabama, Georgia and South Carolina because of relatively strong west winds at 50 kPa. Note the consistency of location of all three stagnation episodes in September.

There were two stagnation cases in October, with the most important one to the north of the usual location (Fig. 7). The first episode occurred between 3 and 6 October as a polar anticyclone moved from the Great Lakes into the Southeast. Because of relatively strong west winds at 50 kPa, the stagnation area was limited mainly to Alabama. The more important episode occurred between 9 and 15 October in association with an intense anticyclone which extended from Hudson Bay to Virginia. Stagnation occurred throughout this entire region. This episode was unique because during the period 1936–75 there were no cases of stagnation so far north into Canada. This stagnation episode was also of relatively long duration, related as it was to a nearly stationary cut-off High at 50 kPa over Hudson Bay.

There was only one stagnation case in November, and none in December. The case in November, centered in the Mississippi and Ohio watersheds, was somewhat west of the usual location (Fig. 8). Stagnation occurred between 12 and 15 November, in association with an anticyclone extending from eastern Canada to the Gulf of Mexico, and to the west of an East coast low. The winds at 50 kPa varied from southwest to northwest.

4. Summary

In average for the year 1981, stagnation tended to occur slightly west and north of the usual location (Fig. 9). Only in Florida were the number of stagnation days fewer in 1981, than the average for the period 1936–75. Thus, in general, 1981 must be considered a year with an above-average number of stagnation days in the eastern United States, as well as a year with unique stagnation episodes in northern United States, and extreme southeastern Canada.

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