NOTES AND CORRESPONDENCE

Clear-Day Frequencies and "Indian Summer" at Athens, Georgia and Chattanooga, Tennessee

PHILIP W. SUCKLING

Department of Geography, University of Georgia, Athens, Georgia

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ABSTRACT

Indian summer has been defined as a period of clear weather with warm days and cool nights occurring during mid- or late autumn after the first frost or freeze of the season. Weekly clear-day frequencies (using two definitions of clear days: 0.0 cloud cover and 0.0–0.3 cloud cover) are analyzed in this study for periods of more than 30 years for the southeastern sites of Athens, Georgia and Chattanooga, Tennessee in an attempt to detect Indian summer. Results indicate that distinct periods of high clear-day frequencies occur throughout much of October as well as during the first two weeks of November and the week of 29 November–5 December. Consideration of temperature and synoptic climatological conditions during these latter weeks eliminated their consideration as part of the Indian summer phenomenon. Therefore, Indian summer as defined by clear-day frequency occurs primarily during the October weeks of 4–10, 11–17 and 18–24. As was the case in a previous study for the north-central United States, Indian summer is not usually preceded by the first autumn freeze at Athens or Chattanooga. Therefore, it is recommended that the definition of Indian summer be modified to exclude reference to occurring after the first autumn freeze.

1. Introduction

The term "Indian summer" refers to a period in mid- or late autumn characterized by warm days and cool nights with generally clear hazy skies and calmness (Morrow 1911; Huschke 1959). The American Indian summer is extremely irregular in its time of occurrence and is therefore not a single recurrent irregularity in the autumnal temperature curve (Talman 1919). The definition found in *The Encyclopedia of Climatology* also states that Indian summer occurs in the midst of cooler days after the first frost has occurred and the first signs of winter have made their appearance (Oliver and Fairbridge 1987, p. 515). This latter restriction on the definition relates to the fact that the term has been used most often in the northeastern United States where, in New England, at least one killing frost must precede this warm spell in order for it to be considered a true Indian summer (Huschke, 1959).

From the above definitions, it is clear that discussions of temperature have been the most important criterion for defining Indian summer. However, Baker et al. (1983) have illustrated that analysis of a singularity involving the frequency of clear days may be useful. A meteorological singularity is the regular occurrence of specific weather at approximately the same date (Talman 1919). Baker et al. (1983) found that the frequency of clear days (defined as 0.0 cloud cover) within each week peaked for the week of 27 September–3 October for most of the 14 north-central U.S. sites in their study. They suggested that this occurrence is probably an integral part of Indian summer for the region and they also noted that this week precedes the average date of the first autumn freeze at most of their sites. Therefore, they concluded that it is inappropriate to require that the definition of Indian summer include reference to being after the first frost of the autumn.

In a study of temperature singularities for the southeastern state of North Carolina, Robinson and Peterkin (1986) concluded that the only true temperature singularity was an anomalous cold spell in early November. In other words, they were unable to identify Indian summer through analysis of temperature data alone. It is the purpose of this study to analyze clear-day frequencies for two southeastern sites (Athens, Georgia and Chattanooga, Tennessee) in an attempt to climatologically detect Indian summer.

2. Data

Average daily values of cloud cover (sunrise to sunset) were analyzed for Athens, Georgia for the period August 1952–October 1987, and for Chattanooga, Tennessee for the period April 1949–December 1980. Location changes for these weather stations during the period of study were minimal in both cases. Following the procedure of Baker et al. (1983), the weeks of the year were studied beginning with 1–7 March as week 1 through to 21–27 February as week 52 (see Table 1)

Corresponding author address: Philip W. Suckling, Dept. of Geography, University of Georgia, Athens, GA 30602.

TABLE 1. Week numbers and their corresponding dates.

Week number	Dates	Week number	Dates	Week number	Dates
1	1–7 Mar	19	5–11 Jul	36	1–7 Nov
2	8–14 Mar	20	12–18 Jul	37	8–14 Nov
3	15–21 Mar	21	19–25 Jul	38	15–21 Nov
4	22–28 Mar	22	26 Jul–1 Aug	39	22–28 Nov
5	29 Mar–4 Apr	23	2–8 Aug	40	29 Nov–5 Dec
6	5–11 Apr	24	9–15 Aug	41	6–12 Dec
7	12–18 Apr	25	16–22 Aug	42	13–19 Dec
8	19–25 Apr	26	23–29 Aug	43	20–26 Dec
9	26 Apr–2 May	27	30 Aug–5 Sep	44	27 Dec–2 Jan
10	3–9 May	28	6–12 Sep	45	3–9 Jan
11	10–16 May	29	13–19 Sep	46	10–16 Jan
12	17–23 May	30	20–26 Sep	47	17–23 Jan
13	24–30 May	31	27 Sep–3 Oct	48	24–30 Jan
14	31 May–6 Jun	32	4–10 Oct	49	31 Jan–6 Feb
15	7–13 Jun	33	11–17 Oct	50	7–13 Feb
16	14–20 Jun	34	18–24 Oct	51	14–20 Feb
17	21–27 Jun	35	25–31 Oct	52	21–27 Feb
18	28 Jun–4 Jul				

in order to avoid leap year data. The clear-day definition of 0.0 average cloud cover used by Baker et al. (1983) was utilized; however, for comparison, a less restrictive definition of 0.0 to 0.3 average cloud cover was also used as suggested in the literature for defining clear days (for example, see Changnon 1981).

3. Results and discussion

Average clear-day frequencies using both clear-day definitions are presented for Athens and Chattanooga in Figs. 1 and 2 (see Table 1 for week number dates). It is apparent that the frequency of clear days is much higher in autumn, especially during October and early November. A rank ordering of the six highest clear-day frequency weeks is presented in Table 2.

For Athens, the weeks of 4–10 October and 11–17 October have the highest clear-day frequencies for the two definitions of clear days while the week of 18–24 October ranks first for both definitions at Chattanooga. At Chattanooga, the 4–10 October and 11–17 October weeks also rank very high. It is also noteworthy that the first two weeks of November (1–7, 8–14) have high clear-day frequencies in all cases and the week of 29 November–5 December ranks second for the 0.0 cloud cover clear-day definition at Chattanooga. This latter week also shows an anomalous peak in the clear-day frequency curve shown in Fig. 1 for Athens and was also the week with the least number of weeks in the record with no 0.0 cloud cover days at both sites. However, temperature records reveal that the clear days for this week were not generally warm, given that average maximum daily temperatures for clear days during the 29 November–5 December week were less than the week's overall climatological average daily maximum temperature. Also, the clear days during this week do not represent distinct groupings or periods of clear weather that would be indicative of Indian summer.

The two early November weeks (1–7, 8–14) correspond to the anomalous cold spell detected by Robinson and Peterkin (1986) for North Carolina. This cold spell is marked by the passage of a cold front with the first major outbreak of polar continental air of the winter season following the passage. Therefore, many of the clear days of early November are cold and "following the outbreak, temperatures increase relatively slowly" (Robinson and Peterkin 1986, p. 133). For the present study, average daily maximum temperatures for early November, especially the week of 1–7

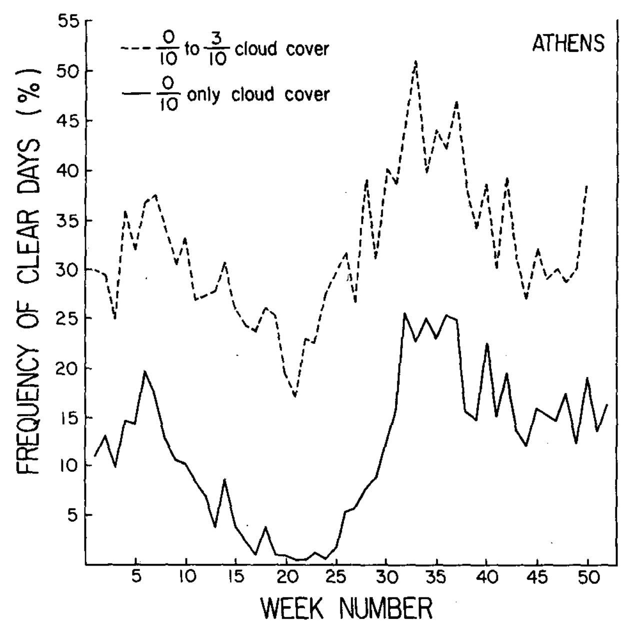

FIG. 1. Weekly average frequency (%) of clear days (0.0 cloud cover is solid line; 0.0–0.3 cloud cover is dashed line) for Athens, Georgia. Dates for week numbers are given in Table 1.

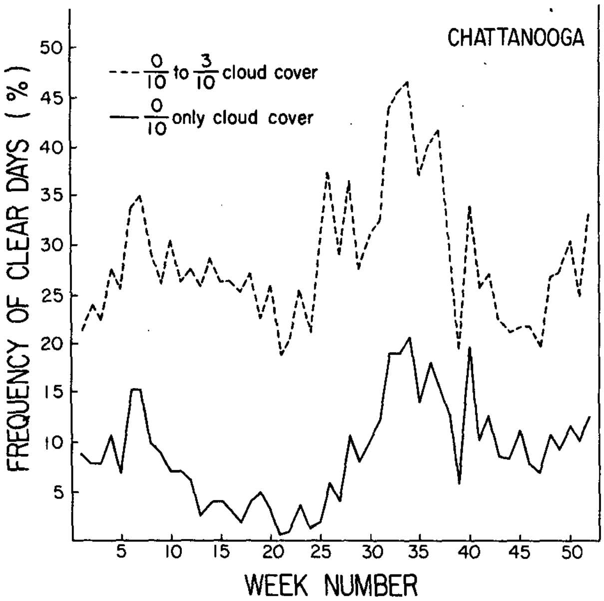

FIG. 2. Weekly average frequency (%) of clear days (0.0 cloud cover is solid line; 0.0–0.3 cloud cover is dashed line) for Chattanooga, Tennessee. Dates for week numbers are given in Table 1.

November, are distinctly lower for the clear days compared to the weeks' overall climatological averages. This fact, coupled with the findings of Robinson and Peterkin (1986) suggest that the high frequency of clear days in early November is not climatologically part of Indian summer.

For the three October weeks of 4–10, 11–17 and 18–24, average daily maximum temperatures for clear days are usually at least equal to, if not greater than, the weeks' overall climatological averages. Therefore, the high clear-day frequencies during these weeks may indeed represent an integral part of Indian summer, as was the case for the week of 27 September–3 October for the north-central region found by Baker et al. (1983). In that study, the subsequent weeks in October (most notably the week of 11–17 October) also had relatively high clear-day frequencies. The results from the current study suggest that Indian summer occurs climatologically slightly later in the southeast compared to the north-central region of the United States.

It should be noted that the mean date of the first autumn freeze for Athens occurs during early November (Suckling 1988). Therefore, when a distinct period of clear days indicative of Indian summer occurs during October in the southeast, it almost certainly will occur before the first autumn freeze. This was also the situation found by Baker et al. (1983) for the north-central region.

Basically, generally clear weather is a normal development expected during October over much of the United States as a function of climatologically significant synoptic conditions (Wahl 1954, 1972; Lanzante 1983). The mean position of the jet stream does not shift southward into the United States until very late October or early November. Thus, during October, much of the United States is still south of major frontal activity associated with the jet stream. At the same time, the rapidly lengthening nights of October favor cooling of the land relative to the oceans. This causes the development of stable anticyclonic conditions with a lack of convective cloud and thunderstorm development over continental America. The stable anticyclonic conditions also trap pollutants, thus reducing visibility and resulting in hazy sky conditions. The first autumn freeze normally does not occur before this Indian summer anticyclonic period of October except in some northern parts of the United States such as New England and the Great Lakes area. Farther south, the Indian summer anticyclone usually develops prior to the first freeze.

4. Conclusion

For the southeastern sites of Athens, Georgia and Chattanooga, Tennessee, utilization of a clear-day frequency definition for Indian summer reveals that the phenomenon occurs primarily during the October weeks of 4–10, 11–17 and 18–24. This is slightly later than that found in an earlier study for the north-central region (Baker et al. 1983). Whereas the use of clear-day frequencies in the north-central U.S. study revealed a single singularity identified with Indian summer, this southeastern study also found distinct climatological peaks of high clear-day frequencies for two weeks in early November and for the week of 29 November–5 December. It was necessary to consider temperature

TABLE 2. Weeks ranked in order of frequency of clear days. The actual frequency in percent is given within the parentheses.

	Athens		Chattanooga	
Rank	0.0 cloud	0.0–0.3 cloud	0.0 cloud	0.0–0.3 cloud
1	4–10 Oct (25.4)	11–17 Oct (50.8)	18–24 Oct (20.5)	18–24 Oct (46.4)
2	1–7 Nov (25.3)	8–14 Nov (46.9)	29 Nov–5 Dec (19.6)	11–17 Oct (45.5)
3	18–24 Oct (25.0)	4–10 Oct (44.4)	4–10 Oct (18.8)	4–10 Oct (43.8)
4	8–14 Nov (24.9)	25–31 Oct (43.7)	11–17 Oct (18.8)	8–14 Nov (41.5)
5	25–31 Oct (23.0)	1–7 Nov (42.0)	1–7 Nov (17.9)	1–7 Nov (40.2)
6	11–17 Oct (22.6)	20–26 Sep (40.1)	8–14 Nov (15.6)	25–31 Oct (37.1)

conditions during these weeks in order to eliminate their consideration as part of the Indian summer phenomenon. Nevertheless, given that assessments of temperature alone have failed to detect a climatological period identifiable as Indian summer (Robinson and Peterkin 1986), the use of clear-day frequencies appears to be necessary for detecting Indian summer in the southeastern region.

This study confirms the results of Baker et al. (1983) in that Indian summer is not necessarily preceded by the first autumn freeze. Indeed, Indian summer is part of a large-scale phenomenon associated with anticyclonic development over the United States during October. Therefore, it is appropriate to make the term Indian summer applicable to a broad geographic area. It is recommended that the definition given in *The Encyclopedia of Climatology* be modified to exclude reference to Indian summer having to occur after the first frost.

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