

Bulletin of the American Meteorological Society

Volume 48 Number 1 January 1967



observations of the urban heat island in a small city

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1. Introduction

The existence, nature, and causes of the so-called urban "heat island" are well documented in what are probably the classic papers on the subject (e.g., Duckworth and Sandberg, 1954; Kratzer, 1956; Mitchell, 1961; Sundborg, 1950) and in several more recent papers (e.g., Chandler, 1962; Woollum, 1964). These papers represent a range of city population from that of Palo Alto, California (Duckworth and Sandberg) to that of London (Chandler). They also represent a variety of emphasis from a major concern with time trends in the nature of the heat island (Mitchell) to a major concern with choice of sampling network and development of predictive formulae (Sundborg). Some presentations of mapped isotherms are for individual nights and some for seasonal mean values. Duckworth and Sandberg (1954) and Mitchell (1961) apply normalizing indices to certain aspects of the structure of the urban areas studied and to the temperature patterns observed.

All of the papers cited demonstrate the existence of a warm core coinciding with the most densely built-up and populated portion of the city, and demonstrate that the core is best developed under nocturnal conditions with clear skies and calm winds. Only Sundborg (1950) and Duckworth and Sandberg (1954) make explicit mention of effects on isotherm patterns of topography within the urban areas.

This note is intended as a contribution to the literature on the urban heat island emphasizing three points: 1) the heat island effect is readily observed in cities as small as 20,000 to 25,000 people, 2) the same isothermal pattern may be observed on calm, clear nights produced by quite distinctly different macroscale synoptic situations, and 3) nearly simultaneous observations may be made, with resulting ease of analysis, by a large group of observers using readily available instruments combined with care in planning.

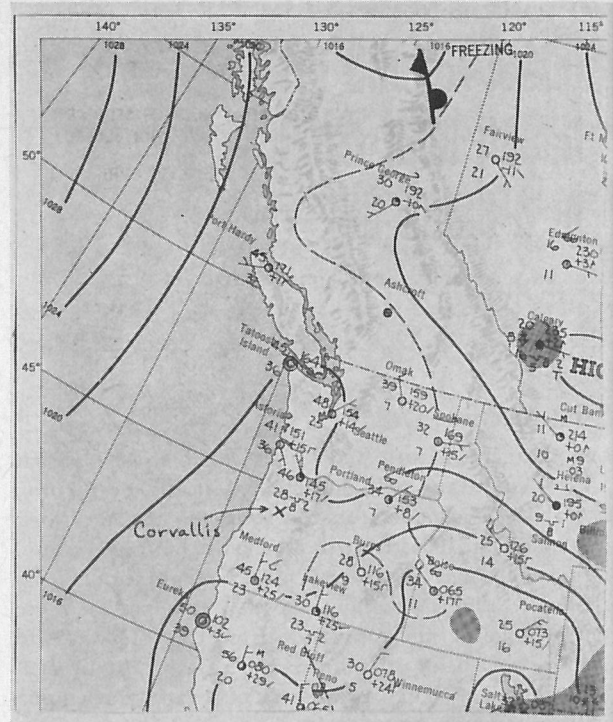
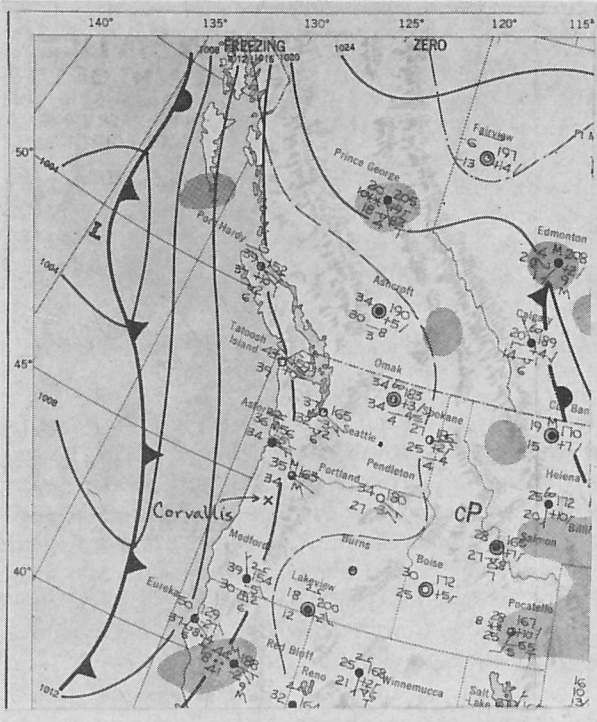
2. Site, methods, and times of observation

Corvallis, Oregon, is a small university town located in rural surroundings with no city of comparable size nearer than ten miles. With a reasonable adjustment to allow for the "anomalous" concentration of residents in dormitories, the population is near 21,000. The popula-

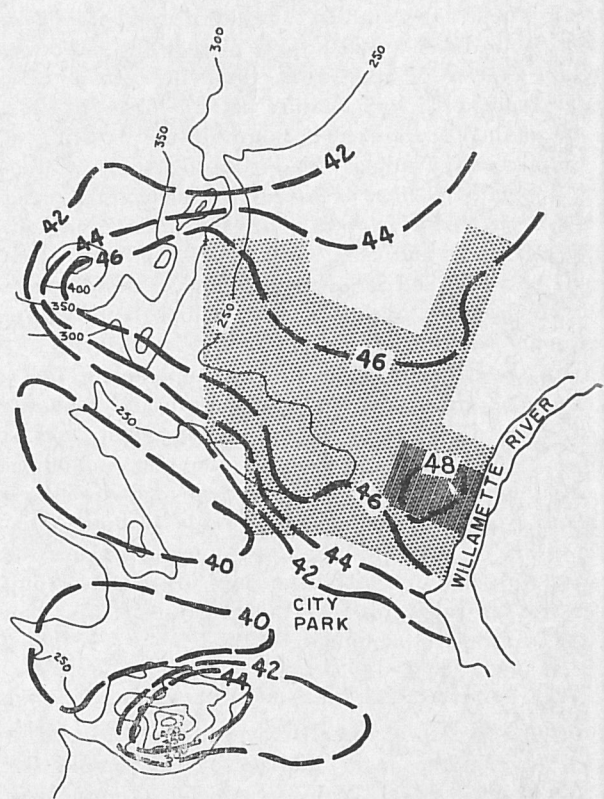
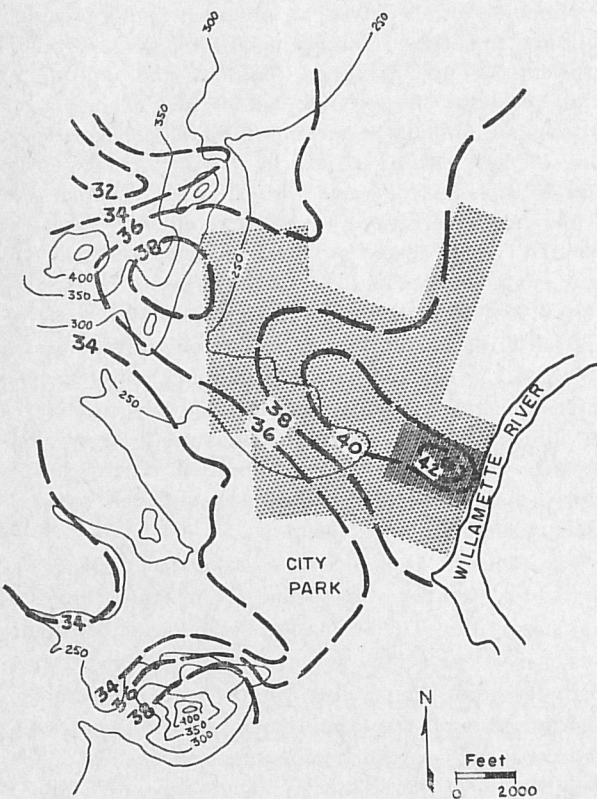
tion density in 6.4 mi² is about 3500, and the value for Mitchell's (1961) growth rate index is about 2.0. Because of frontage on a river and lack of urban development across the river from the city center, the pattern of population and structural density is asymmetric more on the order of that for San Francisco (Duckworth and Sandberg, 1954) than for other cities studied. Like Sundborg's Uppsala (1950), Corvallis has both major vegetated areas and major topographic features within the city.

On 31 January and 18 April 1966, students, faculty, and friends of the Oregon State University Student Chapter, American Meteorological Society, cooperated in obtaining temperature observations throughout the city and environs in an essentially simultaneous manner. On both nights observational units, each consisting of an automobile with a driver, an observer, and a recorder, followed preassigned routes, making temperature measurements at predetermined locations and crossing at least two other routes. Observations were made by observing an unshielded mercurial thermometer held at arm's length outside a vehicle moving at between 5 and 15 mph and operated with all windows open and heater off. Observations were begun on both nights at 2200 LST, were spaced at about 1-minute intervals, and were completed before 2230 LST. Duckworth and Sandberg (1954) indicate the thermal pattern is best developed at this time. On 31 January, six observational units obtained 150 observations in 20 minutes. On 18 April, three observational units obtained 120 observations in 30 minutes. No corrections to observations were found necessary because of either calibration differences between thermometers or differences obtained between units at route intersections.

The night of 31 January was calm and clear except for a broken cirrus overcast due to an approaching Pacific storm front. The air mass over the Pacific Northwest was of maritime origin, as may readily be seen from the high dew-point temperatures in the area (Fig. 1). The night of 18 April was calm, completely clear, and exhibited very low dew-point temperatures everywhere in the area (Fig. 2) as the region lay on the western fringe of a late-season arctic outbreak. Several stations in the state reported record low minima during the night.



FIGS. 1 and 2. Synoptic maps (2200 PST) for the Pacific Northwest on the nights of 31 January 1966 and 18 April 1966.



FIGS. 3 and 4. Topographic and isothermal maps of the Corvallis, Oregon, area for 2200 PST on the nights of 31 January 1966, and 18 April 1966. Elevations are in feet above MSL; temperatures are in deg F.

3. Results and discussion

Figs. 3 and 4 present the results of the two series of observations on a map of the area also showing topography and location of greatest urban development. On both nights three areas of higher temperatures are apparent. The first area is associated with a hilltop to the southwest; the second with a hilltop to the northwest; the third with the commercial city center on the river front to the east. The third is clearly the true heat island, though on both nights it blends into the warm hilltop area to the northwest. The first area is disjunct from the other two because of the effect of a large city park lying on low ground. Although it may not be deduced directly from either map, careful measurements on and beyond the bridge near the city center yielded no indication the Willamette River exerted any major influence on the temperature field.

From the maps may be obtained the information that the temperature ranges on the two nights were 13F and 10F, and that the values for the differential intensity expression of Duckworth and Sandberg (1954) (the inverse of maximum horizontal temperature gradient in the urban center) are about 0.075 and 0.150 mi deg⁻¹. These values fit very well with those of the Bay Area cities given by Duckworth and Sandberg, and indicate the

nights observed in Corvallis must have been near the extremes of occurrence for this area.

4. Conclusion

We would like to urge similar groups of observers to undertake observation series such as are reported here. With the variety of city sizes and topographic features available to such groups across the country, it would seem possible to assemble rather quickly and effortlessly a large and useful fund of data on a currently much-discussed topic: the urban heat island.

References

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neurology

Alan Harrison Newcomb

1921-1966

Alan H. Newcomb, announcer and weather reporter for WBTV, Charlotte, N. C., died 21 October 1966.

Mr. Newcomb was born in Lakewood, Ohio, and served as a pilot in the Air Force from 1942 to 1945. He had been with WBTV, the Jefferson Standard Broadcasting Company, since 1953, and had held membership in the American Meteorological Society since 1960.

Alden Paul Richter

1926-1966

Alden P. Richter of Idaho Falls, Idaho, died on 15 October 1966.

Born in Reseda, Calif., he began his meteorological studies at Los Angeles City College, Calif., but interrupted them to enter the U. S. Navy in 1944. Following two years service in Naval aerology, he resumed his education at the University of California, Los Angeles, and Spartan School of Aeronautics, Tulsa, Okla. In 1949 he joined the Weather Bureau and worked at various assignments in California for four years. He then returned to UCLA where he received an A.B. in 1956.

He rejoined the Weather Bureau as a meteorologist at Las Vegas, Nev. Subsequent assignments took him to Wallops Station, Va., and, in 1962, to the Air Resources Field Research Office at Idaho Falls, Idaho, where he was a research meteorologist until the time of his death. His work in support of test vehicle launchings for the National Aeronautics and Space Administration earned him letters of commendation from the chairman of the Nevada Test Site Organization Advisory Panel in 1958 and from the chief of the Weather Bureau in 1960.

Mr. Richter had been a member of the American Meteorological Society since 1949 and a professional member since 1961.

He is survived by his wife, Margaret J. Richter, and three children.

Ross Cowing Seekins

1916-1966

Ross C. Seekins, Lieutenant Colonel, U. S. Air Force (retired), died on 3 August 1966.

His birthplace was Jamestown, N. Y., and he attended Alfred University, Alfred, N. Y., prior to joining the Army Air Corps in 1936. He received meteorological training at Fort Monmouth, N. J., and Chanute Field, Ill. In the course of his fourteen years military service, he held assignments as detachment commander and staff weather officer in this country, in the Southwest Pacific and in Europe. Since his retirement in 1960, he had made his home in Folsom, Calif.

Colonel Seekins' membership in the American Meteorological Society dated from 1949.

He is survived by his wife and children.