CORRESPONDENCE

Comments on "Dynamics of an Urban Temperature Field—A Case Study"

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23 November 1976

We have read with interest a recent paper by Lawrence C. Nkemdirim (1976) which concerns Calgary's urban heat island. We were gratified to see that meteorological data collected with helicopter and pilot balloons by Western Research & Development Ltd., under contract to Alberta Environment, were being subjected to analysis and evaluation.

We found, however, that there were several aspects of the paper which were very hard for us to understand. We assume that other readers may share our puzzlement. Answers to several questions would be helpful.

1) What do the area boundaries of Figs. 1–3 depict? They do not seem to be related to the city limits as we know them.

2) Why are two helicopter flight paths shown in Fig. 1? Only one path (northwest-southeast) was utilized on 28 February 1975.

3) Vertical cross sections of temperature and CO presented in Figs. 6 and 8, respectively, for 0800 local time 28 February 1976 seem to have been based upon only one vertical profile observed at 0820 in the west central portion of the city. How were the details of these figures generated?

4) The wind direction associated with Fig. 6 is said to be southeast. Data from a meteorological tower, the city airport and from pilot balloon observations indicate, however, that the wind was northwest. How would this effect the interpretation of the data?

5) The author concludes that during the early morning the height of the mixing layer above downtown increases with distance from the southeast. The terrain, however, rises of the order of 100 m from the southeastern to the northwestern portion of the city. Shouldn't this terrain rise be discussed in connection with data presented in Fig. 6?

6) How was the areal distribution of heat release shown in Fig. 7 computed from a maximum of eight vertical temperature profiles observed along only one

cross section? In the absence of reference points how does one compare the isopleth pattern of heat release to the location of downtown and industrial parks?

7) Surface temperature data encouraged Professor Nkemdirim to identify the area source heat emissions of southeast Calgary as significant. The upper air data leads him to conclude that the area source emission data published by Alberta Environment are acceptable. Yet these data show that area heat emissions from southeast Calgary are negligible. How does he resolve this apparent contradiction?

8) How many vertical temperature profiles were used to establish the information presented in Fig. 9? When and where were these data collected?

9) The temperature fields "mapped by computer" are intriguing. What data guidance did the computer have? To what time of day do these temperatures pertain? Were the surface temperature fields shown in Figs. 2 and 3 also "mapped by computer"?

10) Why do the vertical temperature data of Figs. 6 and 9 disagree with the surface temperature data presented in Figs. 2 and 3?

11) What are the units of S shown in Fig. 4?

The above questions summarize the basis of our doubts concerning the value of Professor Nkemdirim's article. There were, however, many phrases employed in the paper with which we were not familiar. What, for example, is a "simple model of the cliff-plateau type"? In what sense is a temperature field "a dynamic system"? What does it mean to say that surface temperature patterns undergo "internal realignments"?

Answers to the above questions would be helpful to us in our attempt to appreciate the concepts presented in this paper on urban heat island effects.

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FIG. 2. Calculated accumulated rainfall from warm stratus clouds located in the plume from a paper mill (ambient cloud + seed droplets) and in nearby ambient air (ambient cloud) in the Pacific Northwest. The curve labeled "seed droplets" represents the amount of rainfall due to the seed droplets alone.

The effect of the "seed" droplets on precipitation was determined by calculating the rainfall from the stratus with and without the "seed" droplets being present. The results of the calculations (Fig. 2) are expressed in terms of accumulated rainfall at the ground as a function of time elapsed from seeding. The results of the calculations indicate that the rainfall from stratus clouds affected by the plume from the paper mill should be ~6% greater than for stratus clouds unaffected by the plume. The amount of rainfall due to the "seed" droplets alone was found to be 5.88%. Only 0.12% of the increase in rainfall is due to collection of the ambient cloud droplets by the "seed" droplets. In other words, the calculated 6% increase in rainfall is due primarily to the water content of the "seed" droplets and not to the collection of the stratus cloud droplets by the "seed" droplets. The 6% increase in rainfall for the clouds in the plume, therefore, is not considered significant.

4. Conclusions

The plume from the paper mill at Port Townsend, Wash., contains high concentrations of large and giant CCN and these nuclei increase the concentrations of large droplets in nonraining warm clouds located downwind of the mill. The results of the model calculations indicate that the large and giant CCN emitted by the mill should not significantly affect rainfall from nonsheared, warm cumulus clouds and from maritime, warm stratus clouds.

We conclude from the results of the calculations that the large and giant CCN emitted by the Port Townsend paper mill are unlikely by themselves to be responsible for the 30% increase in annual precipitation near this mill which was reported by Hobbs *et al.* (1970a). A qualitative study (Hindman, 1976) of the effects on rainfall caused by heat, water vapor and

CCN from a paper mill indicates that these factors, working in combination, may be responsible for the increased precipitation in the vicinity of paper mills in the Pacific Northwest reported by Hobbs *et al.* (1970a). Further field observations and measurements as well as theoretical studies are required to test these suggestions.

Acknowledgments. The field portion of this study was carried out at the University of Washington and was supported in part by grants from the National Science Foundation's RANN Weather Modification Program, the most recent of which is ENV75-19701. One of us (E. E. H.) was supported at the University of Washington by a Naval Weapons Center Fellowship.

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