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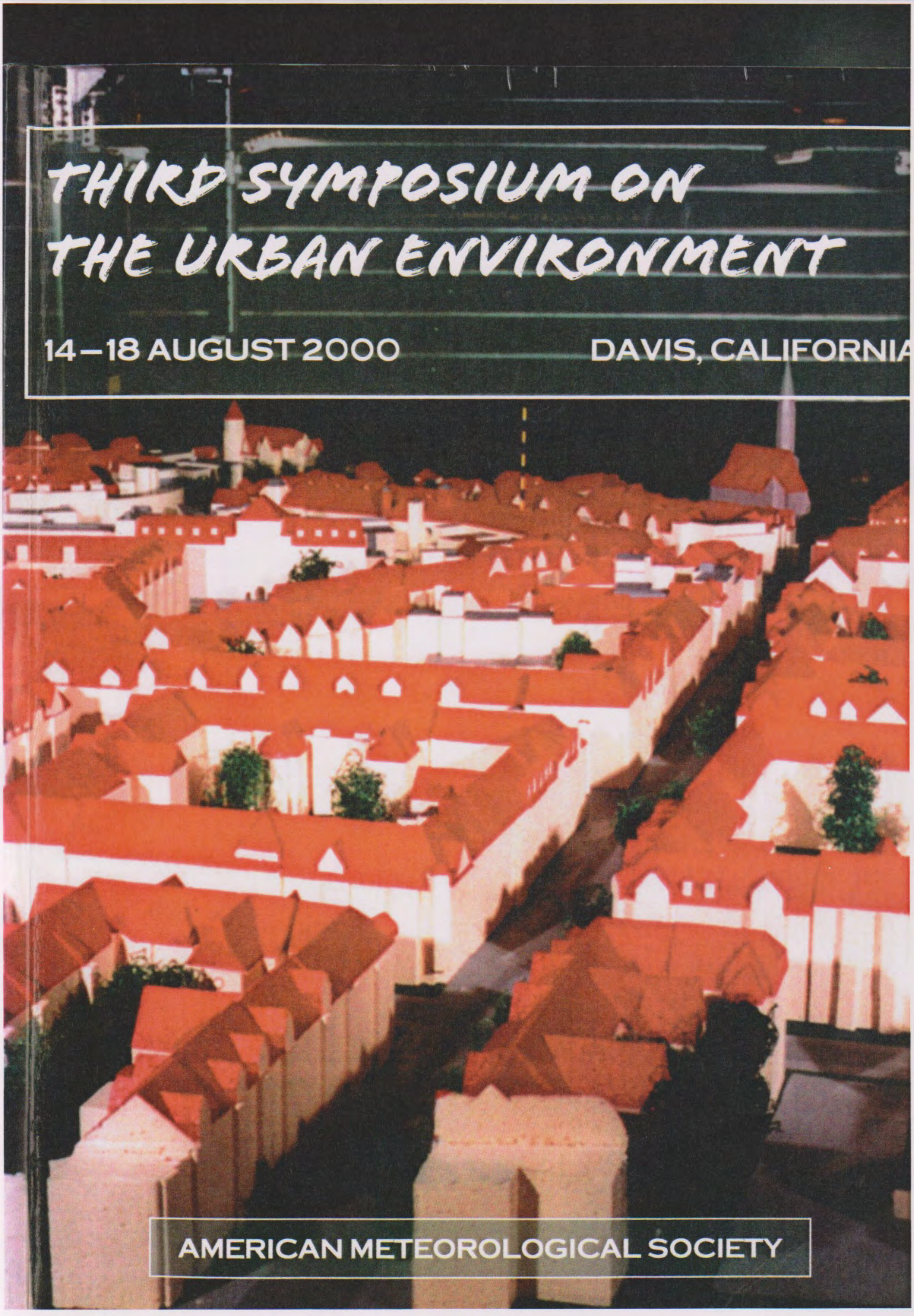

AMERICAN METEOROLOGICAL SOCIETY

14.2 ON THE DETECTION OF INTRA-URBAN GLOBAL RADIATION DIFFERENCES BY MOBILE MEASUREMENTS

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1 INTRODUCTION

In the field of urban climatology, a number of investigations concerning global radiation flux density have already been made (ADEBAYO 1989, HAMDAN ET AL. 1995, PETERSON ET AL. 1978). These investigations have been based on comparisons of data collected at various different stations.

For obtaining large data volumes, mobile measurements are extremely effective. This paper is based on mobile measurements made in a conurbation (Essen, Germany) with a high population density.

2 METHODS

This article presents the results of mobile measurements made along a 15 km long road profile running from north to south through the city of Essen (φ = 51°27', λ = 7°00'; 590,000 inhabitants; 350,000 vehicles), in the Ruhr area, Germany, with the sun at its zenith on clear days (0/8 cloud cover) with low wind velocity between 1998 and 2000.

The average speed of the measuring van, equipped with a pyranometer (Thies CM11; 305 nm < λ < 2800 nm) was 8 m/s, the average resolution of the measured values was 1 Hz and the duration of the test trips was 50 min.

Urban global radiation density may be affected by the following factors, some of which are only relevant in the case of mobile measurements.

1. Cloud cover and type,
2. Shadows of trees and houses,
3. Elevation of the sun as a function of the season,
4. Gradient of road,
5. Vehicle speed and
6. Air temperature and humidity.

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Various algorithms were used to ensure that the effects of these factors were eliminated.

1): The measurements were only made on cloudless days as it was not possible to record cloud cover and type with sufficient accuracy during the test trips. The results therefore only apply to clear days.

2): Shade areas were identified and then eliminated using a continuously recording UV measuring instrument (Eppley, Type TUVR) with the very low response time of 2 s.

3): In order to take the angle of the sun over the course of the day into account, the quotient of the data recorded by the test van and a fixed station outside the city area was used.

4): As an inclined road reduces the values measured, compared with a flat road, the values were corrected using Lambert's law.

5): In order to take the potential effects of speed into account, the mode of travel (standstill or moving at a constant speed of 30 km/h) was recorded. A comparison of values recorded in the two travelling modes did not indicate any statistically significant differences.

6): Neither air temperature nor humidity had any statistically significant effect on the measurement results.

3 RESULTS

3.1 *Effects of angle of sun*

Global radiation intensity in the city is significantly reduced, with an average fall of 5.8 % compared with the surrounding area (σ = 2.0 %). Global radiation is significantly affected by the angle of the sun and therefore also by the season (see Fig. 1).

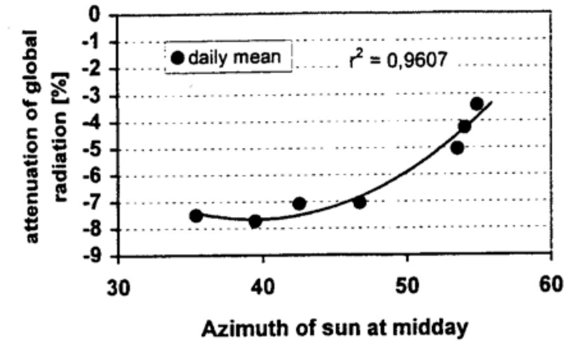

Fig. 1: Average reduction in global urban radiation per day during mobile measurements as a function of the position of the sun in calm weather conditions with high radiation

3.2 Differences in inner city areas

Apart from differences between the various measurement trips, differences in accordance with a specific pattern were observed during each trip (Fig. 2). The reduction in global radiation ranges from –0.9 % (measurement point 31, surrounding area) to –8.0 % (measurement point 16, inner city). This reduction, depending on land use, is shown in Table 1.

These figures show that the most severe reduction in radiation density occurs in traffic areas (highway crossings and areas with traffic congestion during the measurements) and in the inner city, where traffic densities are generally higher. On the other hand, radiation densities are significantly higher in the suburbs and surrounding area, where traffic densities are lower.

Table. 1: Attenuation of global radiation by land use types compared with a station in the surrounding area under the same conditions as in Fig. 1.

land use	global radiation attenuation [%]	standard deviation [%]
Suburbs	-5,8	0,8
City center	-7,1	1,0
Surrounding area	-3,1	1,6
Traffic	-7,5	0,4

4 CONCLUSIONS

The reduction in global radiation density in the city of Essen (Ruhr area, Germany) was measured using a new mobile method. The attenuation is a function of the land use; traffic has a significant effect.

5 REFERENCES

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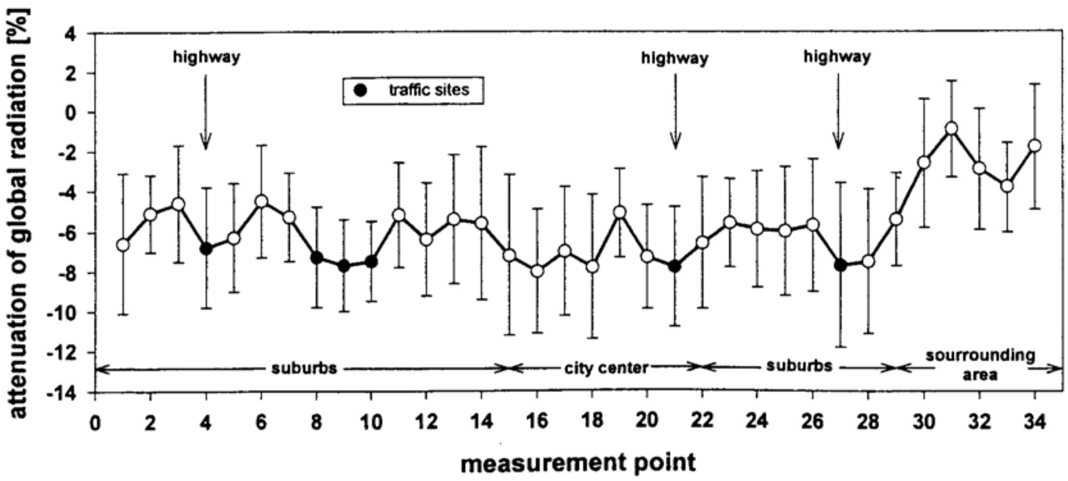

Fig. 2: Differences in global radiation reduction in an urban area (Essen, NRW, Germany) compared with a station in the surrounding area on the basis of 13 measurement trips (08/1998 to 05/2000) under the same weather conditions as in Fig. 1.