

VERTICAL TEMPERATURE AND HUMIDITY PROFILES IN OSAKA CITY AND ITS EFFECT ON AIR-CONDITIONING LOAD

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ABSTRACT

Temperature and humidity in upper atmosphere are different from those of the ground level. For the design of thermal performance of buildings and air-conditioning systems, weather data obtained at a meteorological station are commonly used not depending on the building height. However, the climatological difference may result in significant mistakes in the design of highrise buildings. Observations of temperature and humidity in urban areas of upper atmosphere below several hundreds meters high, where most buildings exist, has not been reported abundantly. In the present study the results of temperature and humidity observations at different height and locations in Osaka city, the second largest city in Japan with population of 2.5 million, are reported for summer and winter season. The way to express the results is based on the weather model which was proposed by one of the authors. The structure of the weather model has mathematical expressions, for instance, the random variations are modeled by an ARMA time series formula. Finally the difference in air-conditioning loads estimated for the upper and lower climate is discussed

1. INTRODUCTION

In Japanese large cities highrise buildings have been built since the late 1960's. Although the number of new highrise constructions and projects decreases due to the present economic recession, the demand of highrise buildings is still high. One reason is that Japanese land is small and especially in urban areas shortage of land or open space is a serious issue. Providing highrise buildings, which can make urban areas more spacious, is a solution for this problem. Since the average building height in Tokyo is estimated less than 2 stories, increasing the number of story in buildings will be a remedy to improve the urban environment, above all, the thermal environment.

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The municipal government of Tokyo has already been promoting or enforcing that every type of highrise buildings should include residential spaces. The purpose of this policy is to avoid making Tokyo a monotonous city by keeping residential activities inside urban areas. Usually the residential floors are located in the upper part of the highrise buildings, consequently, the upper weather information is necessary in this context also.

2. OBSERVATIONS

Observations of temperature and humidity in urban areas of upper atmosphere below several hundreds meters high, in which layer most buildings exist, has not been reported abundantly. Especially long term observations are limited. The reason is that the common way for observations is the use of balloon or kytoon, although, for loan term observations a fixed tower structure is required. Our observations were carried out by installing measuring devices in high-rise buildings in Osaka city, which is 500 km west of Tokyo and the second largest city in Japan with a population of 2.5 million.

The locations of buildings are shown in Fig. 1 with population density. Most buildings are located in densely populated urbanized areas. For comparison ground-level observatory in suburbs: