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SWEDISH CLIMATE FOR ABSORPTION OF SOUND BY THE ATMOSPHERE

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1. INTRODUCTION

The understanding of sound propagation outdoors has increased during the past decades [1-3]. Today there exist different types of prediction schemes and propagation models for planning purposes. They are often restricted to certain meteorological conditions and do not take the local climate into consideration. How frequent these conditions are for an actual site is not considered. The predicted quantity is often a single value and gives no information about the highest noise levels and how often they occur.

They only way to obtain the distribution, without expensive longtime sound level measurements, is to include the effects of the weather and the climate for an area. Data-sets over a limited time such as a year are often used. Meteorological variables show variations between different years. The climate can be defined if data-sets for thirty years are used. This paper deals with calculations of the absorption of sound by the atmosphere during 30 years for one location in Sweden.

2. METEOROLOGICAL EFFECTS ON SOUND PROPAGATION

The most significant meteorological effects on sound propagation are: refraction-ground attenuation, atmospheric absorption and scattering by turbulence. This paper will focus on atmospheric absorption.

The atmospheric absorption depends on frequency, humidity, temperature and atmospheric pressure. The sound attenuation due to the absorption can be calculated using the ISO standard 9613-1 [4]. This standard specifies an analytical method of calculating the attenuation of sound as a result of atmospheric absorption for a variety of meteorological conditions when the sound from any source propagates through the atmosphere outdoors.

Atmospheric absorption is particularly sensitive to the widely varying concentration of water vapour.

Annual and diurnal variations of relative humidity and temperature introduce large variations of atmospheric absorption. Relative humidity reaches its maximum close after sunrise and it's minimum in the afternoon when temperature is highest. The diurnal variations are greatest during the summer.

3. RESULTS

A computer program was written to calculate the atmospheric absorption based on the ISO standard [4]. Hourly values of temperature and relative humidity at a height of 1.5 m above the ground and at atmospheric pressure were used to compute the atmospheric absorption. Long-term measurements of temperature and humidity close to the ground at one location in Sweden were used as raw data to calculate the distribution for horizontal sound propagation.

Uppsala is situated in the southern part of Sweden, 59° 53'N and 17° and 36' E at an altitude of 18 m above sea level.

Table 1. Calculated atmospheric absorption in dB/km for Uppsala based on hourly values of temperature, relative humidity and atmospheric pressure during thirty years (1961 to 1990).

Frequency, Hz	Mean	Maximum	Minimum
63	0.11	0 .54	0.06
125	0.36	1.67	0.20
250	0.91	4.32	0.60
500	1.92	10.10	1.34
1000	4.26	26.43	2.00
2000	11.89	46.34	2.45
4000	37.54	102.14	4.20
8000	114.46	220.81	11.18

Let us now study the variations over the normal year and the normal day. The mean values for every hour and month for Uppsala are presented in Figs. 1-3. The frequencies 500, 2000 and 8000 Hz are given. Atmospheric absorption for the high frequencies changes at different times of the year. The absorption for low frequencies varies both over the day and the year. The size of the monthly and diurnal variance is frequency-dependent.

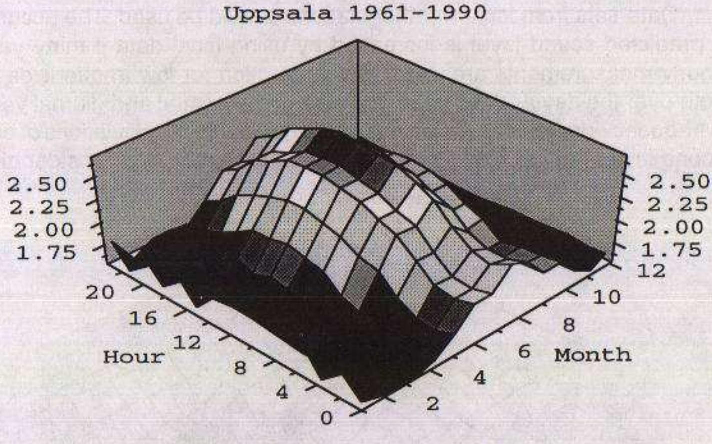

Fig.1. Mean atmospheric absorptions in dB/km at 500 Hz for different times of day over the course of a year.

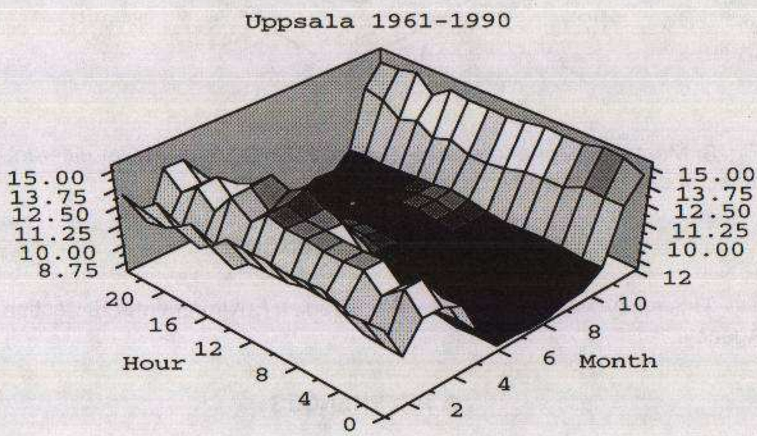

Fig. 2. Mean atmospheric absorptions in dB/km at 2000 Hz for different times of day over the course of a year.

4. CONCLUSIONS

Atmospheric absorption is important for long range sound propagation. Correct estimates of long range sound propagation need correct information for temperature and humidity.

Data-sets from local weather stations should be used. The accuracy of a predicted sound level is increased by using local data if thirty years of hourly measurements are used. The absorption for low frequencies varies both over the day and the year. The size of the annual and diurnal variance is frequency-dependent. An increase in the accuracy of calculations of outdoor sound levels can be made by taking the local climate into consideration.

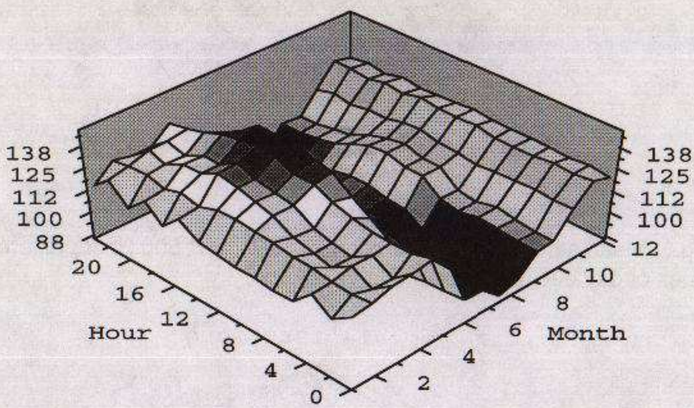

Fig. 3. Mean atmospheric absorptions in dB/km at 8000 Hz for different times of day over the course of a year.

5. ACKNOWLEDGEMENTS

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