A METHOD OF ESTIMATION OF THE INFLUENCE OF A COOLING TOWER WITH NATURAL VENTILATION ON THE ENVIRONMENT

METODA OCENJEVANJA VPLIVA HLADILNEGA STOLPA NA NARAVNI VLEK NA OKOLJE

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SUMMARY

In the process of choosing the location, of the optimisation of technical equipment etc. for the power plant which is planned to be constructed, one of the factors is also the possible influence of the cooling tower on the environment. The present article deals with the estimation of possible influences of the cooling tower with natural ventilation. A numerical model describing dynamics and thermodynamics of the cloud above the tower is used to estimate the frequency of the cloud appearance in different weather conditions, characterised with the meteorological data relevant for the task. Reductions of insolation, of precipitation amount and its distribution around the tower, as well as of the solid deposition, are simulated with separate models. The frequency of appearance and the distribution of certain hydrometeors is estimated on the basis of the results of numerical models.

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The study has been done for the potential location of the nuclear power plant Prevlaka southeast from Zagreb. According to the used models and the available meteorological data (mostly the radiosonde ones), the estimated influences can spread over larger areas in the studied location only in certain weather situations, but in average they are rather small. Clouds can appear above the tower in up to 50 % of time, but their spreading into some of 16 directions can generally occur with frequency of less than 5 % and never with frequencies greater than 20 %. These clouds are several hundred meters high and long, but only occasionally high up to 1500 or long up to 100 km. Longer and higher clouds are rare. Precipitation increase, temperature and humidity changes can only be very small, below the accuracy of measurements. Sunshine duration can be diminished for more than 10 % in average up to a distance of 2 km in summer and 4 km in winter, while the reduction of insolation energy for 10 % is limited to a distance of 1 km the from tower. Also, light snow from stratus cloud and/or fog can be expected, causing slippery roads in the neighbourhood. Other influences can be estimated as being negligible.

POVZETEK

Prikazan je način določanja možnega vpliva hladilnega stolpa termoelektrarne na okolico že v fazi priprave na projektiranje oz. na gradnjo. Za to je bil izbran običajni način: uporabili smo numerični model za simuliranje pojavljanja oblaka nad stolpom na naravni vlek, s posebnima modeloma smo določali tudi količino in razporeditev padavin in trdne snovi v okolici stolpa. S še enim numeričnim modelom pa smo računali, za koliko je zmanjšano trajanje in energija sončnega obsevanja v okolici stolpa.

Vhodni podatki so tako tehnični podatki stolpa kot tudi meteorološki podatki. Glavni vir meteoroloških podatkov so radiosondna merjenja, kajti za pojavljanje oblaka so bistvene razmere v višjih plasteh ozračja, vsaj kakih 500 m od tal. Iz teh podatkov so bile izračunane empirične frekvence pojavljanja posameznih vremenskih stanj in za ta stanja so bili uporabljeni omenjeni numerični modeli. Na osnovi izračunov so bile tudi ocenjene pogostnosti in količine nekaterih pojavov kot so megla, rosa, slana, itd.

Vpliv hladilnega stolpa na okolico utegne biti znaten v posameznih vremenskih situacijah, ki so že same ugodne za pojavljanje oblačnosti. V teh primerih se utegnejo nekateri učinki, npr. dež, pojaviti nekaj prej oz. trajati nekaj dlje, kot bi sicer, po količini pa je povečanje majhno, tako da ga z merjenji sploh ni mogoče potrditi.

V poprečju so vplivi hladilnega stolpa na okolje majhni. Oblaki, ki se pojavljajo imajo sicer skupno pogostnost do 50 % časa, vendar pa po posameznih smereh (analiza je delana za 16 sektorjev vpliva) v splošnem pogostnosti pojavljanja ne presegajo 5 %, in v nobenem primeru 20 % z posamezni sektor ali mesec. Oblaki so v glavnem kratki: nekaj sto metrov v višino in daljino od stolpa, včasih so kakih 1500 m visoki ali 1000 m dolgi. Daljši in višji oblaki so le redki. Povečanje padavin in sremembe temperature in vlažnosti so zelo majhne, pod pragom natančnosti merjenja. Še najmočneje stolp in oblak nad njim vplivata na trajanje in energijo sončnega obsevanja. Na preučevani lokaciji lahko pride do zmanjšanja trajanja sončnega obsevanja do 10 % tja do oddaljenosti 2 km od stolpa poleti in do 4 km od stolpa pozimi (tik ob njem je za stolpom vpliv seveda še močnejši). Zmanjšanje energije sončnega obsevanja za 10 % pa se lahko razteza do okrog 1 km daleč.

Še en vpliv je omembe vreden: pozimi lahko pride do povečanja rahlega sneženja iz stratusnih oblakov ali megle, kar utegne povzročiti spolzke poti v okolici zaradi tanke plasti zglajenega snega na njih. Drugi vplivi na okolje pa so v poprečju zanemarljivi.

INTRODUCTION

Cooling towers of thermoplants are of three main types: moist with natural ventilation, moist with forced ventilation and dry ones, each having the advantages and disadvantages as regards energy consumption, outflow of moisture and dry matter, dimensions etc. Here we deal with the influence on the environment of the moist cooling tower with natural ventilation and with an effective droplets eliminating system.

Many studies have been made on the same topics, the one of Hanna (1977), being among the first . He estimated that the main effect of the tower (of 1 MW power) are the clouds above it, being several hundred meters high. Later investigations confirm this finding with the constatations of the cloud with vertical dimension of up to 700 m, width of 400 m, and spreading of about 1500 or 2000 m downwind from the tower (Egler and Nester, in the Abwaermekommission, 1981). Schatzmann and Policastro (1984) made a statistics of the observed clouds above three towers of different power plants. They found that 80 % of clouds do not reach the height of 400 m and 95 % are lower than 700 m. About 60 % of clouds do not spread more than 700 m, and almost 80 % less than 1000 m from the tower. But in certain weather situations also very high and long clouds can be observed: in a project Climod in Switzerland, clouds with horizontal extent between 4 and 5 km were observed

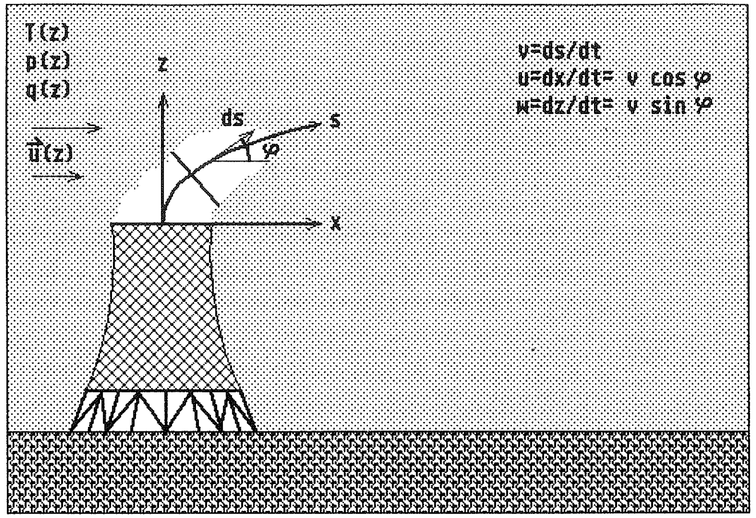

Figure 1: Schematic presentation of the model geometry and variables

Slika 1: Shematična predstavitev geometrije modela in njegovih spremenljivk

in 16 % of the time (reported in EKM, 1981). A great part (70 %) of these extremely long clouds are formed above the tower in a cloudy and/or rainy weather, and so they only contribute to the already existing cloudiness or rain.

The measurable effect of these clouds is on the insolation; close to the tower this effect is important, while the effect on air- and soil-temperature is so small that it cannot be proved by measurements (EKM, 1981; RWE AG, 1981). The common opinion is that precipitations caused by towers with effective droplet eliminators, are limited to the cases of precipitation weather, and so the towers support only slightly the precipitation processes (in the amount of up to 1 % and a little in duration) (RWE AG, 1981), while the operation of towers in general does not act as a trigger for convective clouds and/or precipitation (EKM, 1981).

The clouds from a cooling tower can cause the fog or stratus clouds to be more dense, while the frequency of looping or fumigation of these clouds to the ground is negligible (Spillane and Elsum, 1983). Also the emission of dry constituents is important only from the tower with forced ventilation (Kunaj, 1984), while from the towers with natural ventilation this emission is very small (RWE AG, 1981).

THE MODEL AND THE DATA

The common approach to investigate the potential influence of some future event or process is to simulate it numerically. Here the first task is to simulate the appearance of clouds above the cooling tower, the shape of such a cloud, its density and the eventual precipitation from it. When these characteristics are known for a certain set of typical or average meteorological situations, then the effects on insolation, precipitation at the ground, eventual depostion of solid matter etc. can be estimated.

The model of a cloud

The models for clouds above cooling towers are in general the so called integrated models (e.g. Jiin-lang Lee, 1976; Klug, reported in Abwaermekommission 1981, Schatzmann and Policastro, 1984), what means that they deal with an average cloud and precipitation water content inside a certain volume element. They are twodimensional, what means that the simulation proceeds through consecutive volume elements along the cloud axis, separately for different directions from the tower. The necessary data for these models are the technical data of the tower and its emissions, as well as meteorological data up to the height of 3000 or 5000 m from the ground.

The model we used is similar to the one of Jiin-lang Lee (1976), but modificated in some details, regarding the spectrum of cloud droplets and hydrometeor drops in the cloud. The domain is schematically shown in Fig. 1.

Independent variable is

s - the path along the axis of the cloud;

and dependent variables inside the cloud are

r - radius of the cloud,
v - velocity along the cloud's axis,
φ - the slope of the axis,
T - temperature,
p - pressure,
q - specific humidity,
q_c- specific amount of cloud droplets,
q_h- specific amount of hydrometeor droplets;

all are computed inside the cloud and along its axis.

All of these quantities must be known also for the top of the tower, at $s=0$, where they serve as initial conditions. There they depend mainly on technical characteristics of the tower, but, on the other side, they depend on the environmental conditions as well, while the operating regime of the tower depends on temperature, humidity and pressure of the neighbouring air.

The parameters of the environment (acting as a sort of boundary conditions), which should be known in all relevant heights, are

$T_e(z)$ - environmental temperature,
$p_e(z)$ - environmental pressure,
$q_e(z)$ - environmental humidity,
$u_e(z)$ - environmental wind velocity.

The equations which we use are:

The two equations of motion, for horizontal and for vertical direction:

$$\frac{\partial}{\partial s}(v^2 r^2 \sin(\varphi)) = g r^2 [\frac{T}{T_e} \frac{R_s + q(R_v - R_s)}{R_s + q_h(R_v - R_s)} - q_c - q_e] \pm \frac{C_d}{\pi} r (u_e \sin(\varphi))^2 \cos(\varphi) \tag{1}$$

$$\frac{\partial}{\partial s}(v^2 r^2 \cos(\varphi)) = \frac{C_d}{\pi} r (u_e \sin(\varphi))^2 \sin(\varphi) \tag{2}$$

Here the first (vertical one) considers the unbalanced buoyancy due to temperature difference, due to different weight of humid air(R_s and R_v are specific gas constants for dry air and water vapour, resp., and q and q_e specific humidities of air inside of a cloud and in the environment), and due to extra load of cloud droplets and hydrometeor drops (characterised by q_c and q_h). Both of equations, the first for vertical and the second for horizontal direction, take into account also the drag, caused by the wind, where C_d is the drag coefficient.

Third equation is the mass conservation equation

$$\frac{\partial}{\partial s}(v^2 r^2) = 4 \alpha v^* r \tag{3}$$
$$v^* = f(v, u_e)$$

The entrainment of the environmental air into the cloud is treated through v^*, which depends on velocities inside the cloud and in the environment, and serves as an empirical factor.

Next is the energy conservation equation

$$\frac{\partial}{\partial s}(\frac{T}{T_e} v^2 r^2) = \frac{w r^2}{T_e} [\frac{\partial T_e}{\partial z} + \frac{g}{c_p}] + \frac{L}{c_p T_e}(C_c + C_h) \tag{4}$$

which considers the unsaturated adiabatic process in the first term. The latent heat release at condensation or its consumption at evaporation processes is included in the second term, where C_c stands for condensation or evaporation of cloud droplets, and C_h for processes, connected with hydrometeor drops. Water vapour conservation equation includes the effects of the environmental humidity, and the condensation and/or evaporation processes again:

Conservation equation for water vapour

$$\frac{\partial}{\partial s}(q v^2 r^2) = -w r^2 \frac{\partial q_e}{\partial z} - C_c - C_h \tag{5}$$

This equation takes into account the environmental humidity in the first term, as well as the condensation of vapour (or evaporation): C_c and C_h.

Conservation equation for cloud water

$$\frac{\partial}{\partial s}(q_c v^2 r^2) = -C_c - A_{ch} - B_{ch} \tag{6}$$

Here condensation and/or evaporation processes are included. The autoconversion of droplets A_{ch}, which causes the formation of new hydrometeor drops, and the coallescence B_{ch} of cloud droplets with hydrometeor drops act as mechanism of conversion of water from the class of cloud water into the class of hydrometeor water. Both these processes are parameterised.

The last is conservation equation for hydrometeor water

$$\frac{\partial}{\partial s}(q_h v^2 r^2) = -\frac{\partial}{\partial z}(q_h < v_T > r^2) + C_h - A_{ch} - B_{ch} \tag{7}$$

It is taken into account that drops with terminal velocity $\langle v_T \rangle$, being higher than the updraft velocity in the cloud, are falling out from the cloud. The amount of water falling from the cloud depends on the shape of the spectrum of hydrometeor drops, which therefore acts as a parameter of this problem. Condensation or evaporation is considered as well (C_h), and the already mentioned processes of autoconversion and of coallescence are parameterised.

Modelling of other processes

There are some other processes, which are treated with the help of numerical modelling: At the first place, the effect of the tower and the cloud on insolation. The datails of the model are described in the accompanying paper (Petkovšek, 1987), so here we are going to mention only some of its basic concepts, regarding the determination of the cloud border. Namely, it is known (e.g. Thorp and Orgill, 1984) that the shapes of clouds are not so sharp, to diminish considerably the solar radiation at the very border of clouds.

Following the results of Aumf Kampe (1950) on regression between light scattering cross-section s_c and the visibility V:

$$s_c = a/V \qquad (8)$$

and the results of Zabrodski (1963, cit. in Feigel'son, 1966) on the regression between the total water content in a cloud q_{tot} and the visibility V:

$$q_{tot} = b\ V^c, \qquad (9)$$

it is possible to compute the water content, which diminshes the solar radiation to a certain extent. Namely, the optical path through the cloud is namely determined with the shape of the cloud. (its diameter is known as a function of distance and height), and the Beer's law is used for the computation of extinction. So the borders of the cloud are supposed to be, where at least 5 % of solar radiation would be scattered, if passing through the center of the cloud, in a direction normal to the axis. The geometrical treatment of the problem is described, as already mentioned, in the accompanying paper (Petkovšek, 1987).

The problem of precipitation reaching the ground, does not depend only on the quantity of water falling out of the cloud, but also on the spectrum of hydrometeor drops, as well as the wind and humidity in the layer below the cloud. Namely, the drops are evaporating if this layer is not saturated and the evaporation depends on the size of each individual drop. So the spectrum is changing during the fall. The fall velocity also depends on size and so the drops of different sizes are carried by the wind to different distances. The problem can be solved even analitically if the shape of the spectrum is not a too complicated function. So the computation of precipitation distribution at the appropriate distances of the tower can be carried out.

There is an almost negligible amount of dry matter released from the tower with natural ventilation. It depends on chemical treatment of the cooling water, for which minimal standards are prescribed. While drop eliminators are very effective in most cases, emission of dry matter occurs with droplets and only evaporative substances can leave the tower. It is supposed that these substances act as condensation nuclei.

If the fraction of these substances is known, it is possible to treat them as being a part of the cloud. So they can fall out of the cloud with precipitations, or stay in a warm thermal even when the cloud evaporates. There are three ways for these substances to reach the ground:

- with precipitations, where the concentration of these substances in drops grows while the drops are partly evaporating,
- with turbulent diffusion of the part of substances corresponding to drops, falling out of the cloud, but evaporating before reaching the ground, and
- with turbulent diffusion of the rest of substances, which remain in the air after the evaporation of the cloud.

There are two maxima in the distribution of solid deposition at the ground, because the transport to the ground is to smaller distances with precipitation, and to greater distances with turbulent diffusion.

The tower data

For the tower it is assumed to have the characteristisc as the tower of the IBE company, Ljubljana:

- flow of circulating water 33.0 m^3s^{-1}
- cooling power 1930 MW
- water temperature decrease 14.0 K
- radius at the top 44.4 m
- height 162.0 m

The emission of droplets is only 17 kg s^{-1}, while the emission of vapour depends on environmental conditions, as shown on Table 1. These values are fitted as initial conditions with analytical polynomial funcitons for the use in numerical model of the cloud.

Meteorological data

Two types of meteorological data are used for the estimation of possible influence of the tower on the environment. Surface data from neighbouring stations serve for the estimation of climatic situation at the site and for non-numerical evaluation of possible changes.

Table 1: Emission characteristics of the tower
Tabela 1: Emisijske karakteristike stolpa

air temperature temperatura zraka	(°C)	-10		10		30	
rel.humidity rel vlažnost	(%)	60	80	60	80	60	80
water temp. temp. vode	(°C)	25.6	25.8	36.4	37.0	47.6	49.0
emission temp. izstopna temp.	(°C)	15.2	15.4	27.3	28.4	39.4	40.7
vapour flow tok pare	($kg\ s^{-1}$)	427	423	588	580	703	692
air flow tok zraka	($10^3\ kg\ s^{-1}$)	39.1	39.2	30.4	30.8	22.5	23.2
vert. velocity[1] vert. hitrost	($m\ s^{-1}$)	5.2	5.2	4.3	4.3	3.4	3.5

[1] the influence of wind and entrainment of the air into the tower from above are not considered
vpliv vetra in vstopanje zraka odzgoraj v stolp nista upoštevana

Radiosonde data are applicable for the estimation of the situation at upper levels, where the cloud above the tower can occur. The radiosonde data of Zagreb for eight years are used. From these the frequencies of the wind from a certain direction (16 directions of the wind and therefore 16 sectors of the influence of the tower) are computed. The average vertical profiles of wind velocity, pressure, temperature and dew point are computed for every 250 m from the ground, for each month separately. These data serve as environmental (boundary) conditions for the model of cloud.

There are two main important questions how to use the radisonde data. The first is connected with the choice of the height at which the classification is made according to wind direction. In the first place, it is worth considering that close to the ground there is a strong local influence on the measured values. As the radiosonde data are not available at the location, but several ten kilometers away (without considerable orographic obstacles between the locations), the surface values are not used for this purpose. Next factor for the choice is the fact that clouds above the tower occur mainly between 700 and 1000 m above the ground, so that the wind above 1000 m is not very important. At last, it is important to consider the fact that at the location the maximum of recorded precipitations occur when surface wind blows from northeastern quadrant (Ćurković et al., 1986). It is obvious that here, like elsewhere in Mediterranean, the governing factor for this phenomenon is the movement of a cyclon over the area. When southwestern winds at upper levels still advect moist and warm air masses to the area, causing intense precipitations, at the ground, after a cold outbreak, eastern component is prevailing in a not very deep air layer. The wind in this layer is therefore important for the distribution of influences of the tower around it. So the average wind in such a layer, computed from the values at 250 and 500 m above the ground, is used for the classification of the data according to wind directions (and as a consequence, according to the sectors of the eventual influence of the tower).

The second important question is whether average sounding profiles can be used for simulation with numerical model. Namely, it is known that clouds above towers occur in moist weather situations which are in general cloudy and even with precipitations. So it is possible that averaging can wipe out these typical situations. The alternative could be to use a great sample of individual data and then to compute the average influence of the tower from individually simulated cases. This approach is not acceptable where a long series of data would be necessary and therefore an enormous number of individual numerical simulations. There is an indication that grouping according to the above mentioned method would not be too bad (as it is shown just from the close connection between the surface wind and the precipitation amount). The grouping according to months can support this opinion as there are moister and drier seasons as well. Still, we also make tens of individual simulations at extremely moist and extremely dry situations in winter and in summer months to illustrate the extreme possible cloud appearances, caused by the cooling tower.

SOME RESULTS

Detailed results of possible effects of the cooling tower on the environment according to different directions, as well as for separate months and for the whole year can be found in a report of the study (Rakovec et al., 1987). For the illustration of the usefulness of the chosen method of estimation, only some are given here.

First, it is interesting to know which are the simulated frequencies and average cloud shapes. In general, frequencies can reach 50 %. But, if looking into separate sectors around the tower, frequencies of appearance can also be zero in some directions, while the greatest frequencies do not exceed 20 % in any direction or in any month of the year. Clouds are of courseless frequent in summer months. Most frequent is the appearance of clouds to the SW direction, where the probability of cloud appearance is more than 10 % also in summer months (but in these summer cases clouds generally do not extend more than 100 m from the tower). This is in accordance with the measured natural precipitations, which are most frequent when surface winds blow from NE.

In general, clouds have the extension of several hundred meters in horizontal direction, while prevailing vertical dimensions are from 600 to 1400 m in winter, but in summer some can reach the height of over 2000 m. Also very long clouds are simulated according to average conditions: in winter and in early spring they can be more than 2500 m long in particular sectors; their frequencies of appearance are small: 3 to 7 % of the time, and this frequency can reach 10 % only close to the tower.

The computed frequencies and dimensions are in accordance with the values of other investigators (e.g. RWE AG, 1981, Schatzmann and Policastro, 1984).

All precipitation amounts simulated in our study according to average conditions are less than 0.2 mm per month. This value is found only close to the tower in certain sectors, in winter months. Already at a distance of 500 m from the tower the value of 0.1 mm per month is never and nowhere exceeded. As an example the distributions for January and for July are shown in Fig. 2. Also solid deposition is distributed similarly.

But it is also interesting to look closer at some individual simulations. It is possible that absolute extremes are not simulated, while only January and July cases are chosen. From these the extreme quantity of precipitation amount which is simulated occurs in January, but the value of 0.016 mm per hour is limited to a very small area of 200 m x 400 m close to the tower. This is due to extremely moist atmosphere and very light wind, causing nearly vertical cloud and no precipitation drift (Fig. 3). Some situations in winter with broader areas of precipitations can be found as well but with small amount of precipitation.

In July there is no individual case, in eight years' period, of precipitations only close to the tower. An example is given in Fig. 4, showing precipitations with intensity greater than 0.01 mm per hour between 1700 and 3700 m from the tower. They are caused by saturated layer between 860 and 700 mbar level: all extra moisture of any agregate state entering into this layer is removed from it. Precipitations evaporate only partly, and are driven by the wind also far from the tower.

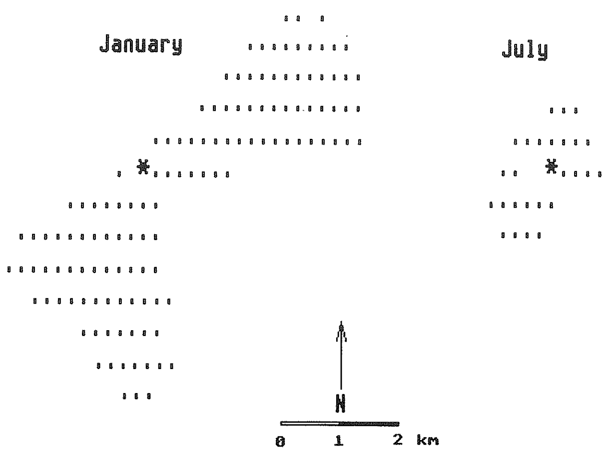

Figure 2: Distribution of precipitations near the cooling tower for January and for July

Slika 2: Razporeditvi padavin v okolici hladilnega stolpa v januarju in v juliju

The effects on insolation are presented in a separate, accompanying paper (Petkovšek, 1987). Here we are going to mention only the fact that there is a broad area of influence in morning and evening hours, but as at that time the amount of energy is not great, these broader areas are affected mainly as regards sunshine duration. The shapes of the affected areas resemble a heart in summer and a kidney in winter months. Both, the quantity of effects and the shapes are in accordance with the observed ones at other locations (RWE AG, 1981).

CONCLUSIONS

The described methods of simulation of possible influences of the cooling tower with natural ventilation are proved to be appropriate for the estimation of these influences in advance, in the phase of planning of the thermo plant with the tower. This is prooved by comparisons with the observed influences (EKM, 1981; RWE AG, 1981; Abwaermekommission, 1981; Schatzmann and Policastro, 1984). The simulated values agree with the observed ones as regards the area of possible influence and as regards the quantitative values of these influences.

From the obtained results for the planned great tower with cooling power of 1930 MW in the investigated area it is possible to summarize:

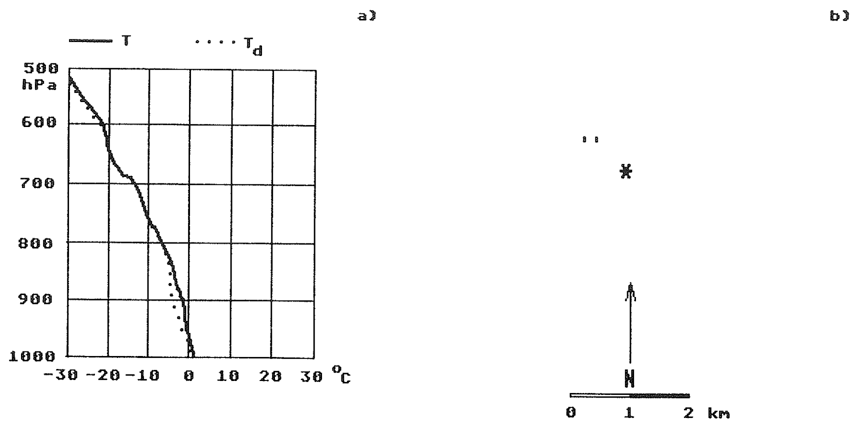

Figure 3: An example of distribution of precipitations near the cooling tower for the selected case in January: a) vertical distribution of temperature and dew temperature and b distribution of precipitation

Slika 3: Primer razporeditve padavin v okolici hladilnega stolpa za izbrani primer v januarju: a) potek temperature zraka in rosišča z višino, b) razporeditev padavin

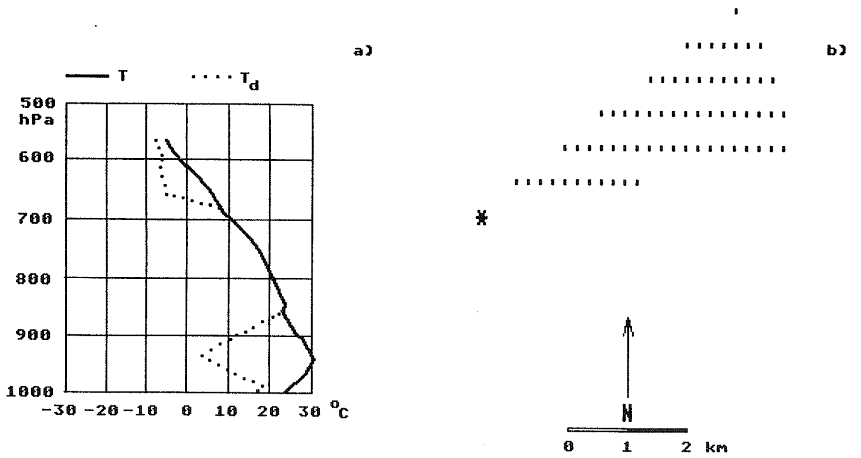

Figure 4: As Fig. 3, but for a case in July

Slika 4: Kakor slika 3, toda za izbrani primer v juliju

Cloudiness

The appearance of the cloud has an allover frequency of 50 %, but for individual directions this frequency is generally less than 5 % and never greater than 20 %. In summer the distribution is more uniform, while in winter some directions have greater frequencies. Long clouds, as well as high ones, are rare: only a few cases are found with average radiosonde data. Most clouds are several hundred meters high, sometimes up to 1500 m, and they extend several hundred meters from the tower, sometimes even thousand meters.

Precipitations

The duration of precipitations is slightly increased over the natural duration, mainly in colder parts of the year. The quantity can be slightly greater too, but this increase (for about 1 %) is below accuracy of measurements and cannot be verified. Amount of drizzle is estimated to be increased from stratus cloud and fog, for several mm per year. The number of precipitation days can be greater for a few days per year due to the drizzle, while the number of the days with precipitation from Nimbostratus and Cummulonimbus clouds is not increased.

Insolation

Sunshine duration can be diminished for 40 % close to the tower and for more than 10 % of the present duration as far as 4 km from the tower in winter, and 2 km in summer. The area of influence on insolation energy is smaller. The decrease for 50 % is close to the tower, while the decrease in energy for more than 10 % does not extend more than 1 km from the tower. In winter mainly northern places are affected, but in summer the ones lying souhteast and southwest from the tower.

Temperature and humidity

Neither air nor soil temperature can be modified to such an extent that this could be verified with measurements. The same is valid for humidity.

Hydrometeors

Due to only very small changes in temperature and humidity, the changes in dew and frost are not to be expected. Frequency of fog cannot be changed, only density of fog or Stratus can be increased, which is the reason of a possible slightly increased hoar. Glaze can be slightly more frequent, but more important can be slippery roads due to light snow from Stratus clouds or deep fog.

Visibility

Visibility at the ground is not affected by the cooling tower, but is changed only in clouds; these are not of a great extent.

Human activities

In winter there can be more slippery roads due to glazed snow. This effect can be expected not more than 2 km from the tower. There is a lack of precipitations in the area in summer months, but the quantity of precipitation in general is not great enough to be important for agriculture. So also effects on plant deseases are negligible. Only in certain situations some precipitations, which could affect the agriculture are possible.

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