The impact of a large water reservoir on local temperature by using the COSMO NWP model

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1. Introduction

This contribution introduces the project that investigates the impact of a new water area on local climate. The aim is to quantify the influence of the lake on air temperature, humidity and other meteorological elements. The results will be useful for example as a source of information for our state and local authorities in planning future development of the studied area.
The study is performed for the lake Most (**Fig.1**) in northern Bohemia - the former coal mine Ležáky that was flooded after exploitation within the scope of a restoration activities. The lake lies at the altitude of 199 m above sea level, its size is 311 ha and its maximum depth is 75 m.
For the analysis, numerical weather prediction model COSMO is used. The COSMO model is also coupled with the lake model Flake on idealized conditions.
The analysis has been done for the summer (June, July, August) and winter (November, December, January) period. The impact of water area on the temperature was evaluated in dependence on the differences between air temperature at 2 m above ground and water-level temperature.

***Figure 1** – Lake Most*

***Figure 2** – Lake station*

2. Methods

Numerical weather prediction model CO
Model is integrated on these conditions:

- horizontal resolution is **333 m**.
- domain size is 200x99 grids
- time step is **3s**
- length of integration is 4 **hours**
- turbulence type is **itype_turb = 8**
- prognostic calculation of 3D turbulence is used **(l3dturb = .TRUE)**
- Coriolis force isswitched **off**
- radiation switched is **off**
- Flake model is used

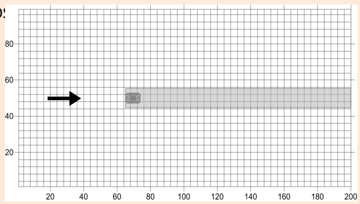

Figure 3– *the COSMO model domain. Grey rectangle shows the lake. In the grey bend the mean values were studied. The arrow indicates the wind direction.*

The input data are derived/obtained from:

- ❖ meteorological observatory Kopisty that is about 1 km far from the lake bands,
- ❖ lake station that measures except of usual meteorological indicators also water temperature in 16 levels up to 20 m (**Fig.2**),
- ❖ analysis of meteorological fields from European Centre for Medium-Range Forecast

The impact of the lake on local climate was calculated as average values in the grey bend in **Fig.3.** It is 11 grid points (3,3 km) wide. The dark rectangle represents the lake.

3. Results

Model simulations/integrations have been done for summer and winter periods and for three different sizes of the lake (2.7x1.6 km, 1.35x1.6 km and 0.67x1.6 km). For every size there were 199 integrations, 110 in the winter period, 89 in the summer period. Table 1 shows frequencies of cases with various differences between measured air and water temperature for which the simulations were performed and results were evaluated.

Table 1. Frequencies of the cases with various differences between air and water temperatures (%). T_{2m} is measured air temperature at 2 m, T_w is measured temperature of the water surface.

Category	Frequency (%)	
	Summer	Winter
T_{2m}-T_w < -5	31,5	16,9
-5 < T_{2m}-T_w < 0	30,3	58,5
0 < T_{2m}-T_w < 3	22,5	20
T_{2m}-T_w > 3	15,7	4,6

Fig.4 shows the impact of the lake on air temperature in both periods (A – summer, B – winter) for tree sizes of the lake. It is obvious that **the biggest influence comes when the difference between measured air temperatures (T_{2m}) and surface water temperatures (T_w) are higher than 3°C**. In the **summer** it means **the cooling down by more than 2°C**, in the **winter** the air temperatures **decrease by more than 1°C** in the case of the biggest size of the lake.
With the reduction of the lake size the influence on air temperature decreases.

The areal estimates of the lake impact on the temperature in the surroundings of the lake for summer (A) and winter (B) period is shown in **Fig. 5.** Left part of the figure shows results for the surface vertical level. On the right picture you can see the areal impact of the lake on air temperature at 12.41 m above the surface.
It is obvious that in the summer the strongest influence is in the **north** and **south-west** direction from the lake. In the winter main impact of the lake is in the **western** direction from the lake.

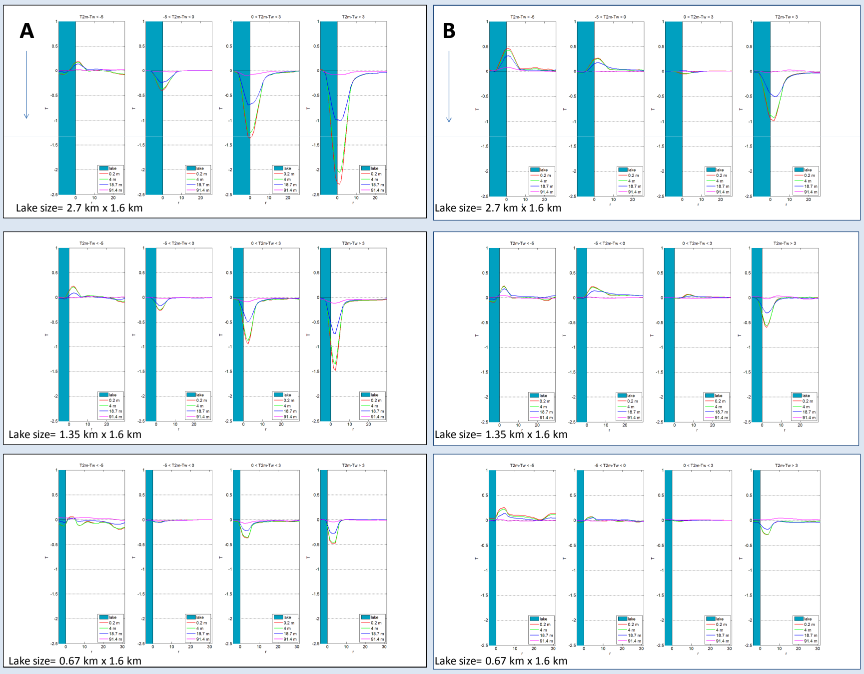

***Fig. 4.** Impact of the lake on air temperature in 4 vertical levels (0.2, 4, 18.7 and 91,4 m) in summer (A) and winter (B). Results are shown for tree sizes of the lake – 2.7 km x 1.6 km, 1.35 km x 1.6 km and 0.67 km x 1.6 km.*

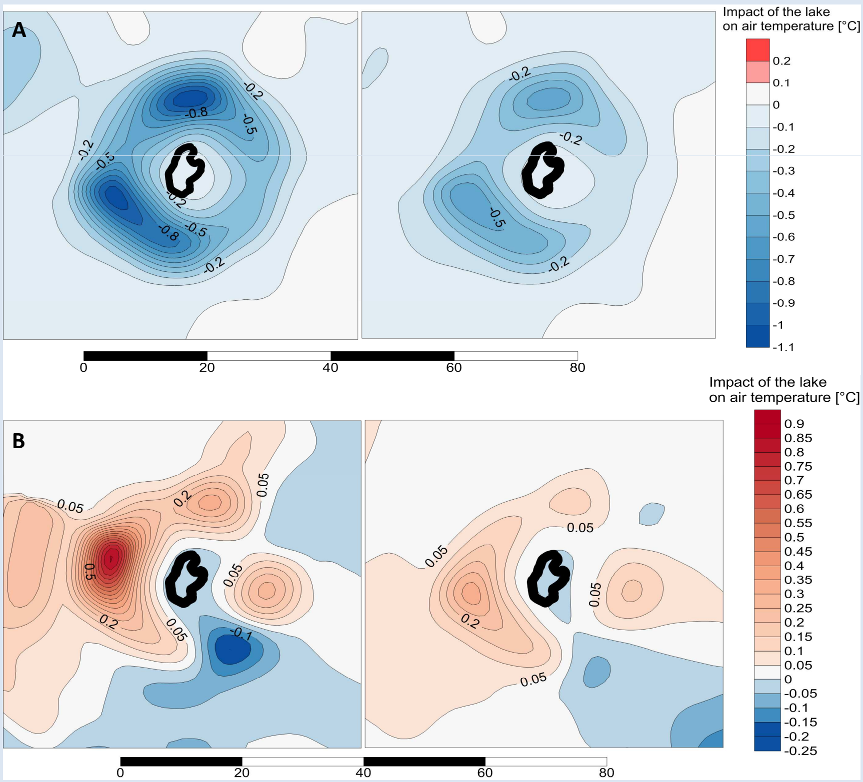

***Fig. 5.** Areal estimates of the lake impact on air temperature for summer (A) and winter (B) periods at two vertical levels – surface level (left) and at the level of 12.41 m above the terrain (right). The black contour represents the lake.*

4. Conclusions

- The impact of the lake area with the sizes 2.7 km x 1.6 km on air temperature is apparent.
- It was obtained cooling down by more than 2°C in the summer period, when differences between measured air and water temperatures are higher than 3°C.
- The lake impact on other meteorological element is now being studied.

Acknowledgement

This work was supported by the grant TACR TA01020592. The authors also want to thank to Computing and Information Centre of the Czech Technical University for supercomputer facilities providing.