Supervisor's review on Doctoral thesis

L. Kukačka started his Ph.D. studies at the Department of Meteorology and Environmental Protection, now at the Department of Atmospheric Physics of the Faculty of Mathematics and Physics, Charles University immediately after graduation and defence of his diploma thesis in 2009. With the basic principles and methods of physical modelling, which became one of the instruments for studying flow and diffusion in the atmospheric boundary layer and was used during the dissertation, the Ph.D. student became acquainted with the bachelor thesis entitled "Kvalitativní odhad vlastností prouděné velikosti mikroměřítka“(Qualitative estimation of the properties of microscale flow). He successfully defended this thesis in 2007. He gained a deepening of his knowledge and skills during the dissertation entitled " Charakteristiky proudění a difúze velikosti mikroměřítka uvnitř městské zástavby” (Microscale flow and diffusion characteristics within urban areas). It can be noted that the conclusions of the diploma thesis became part of the results of the COST 732 project. Another source and especially skills became from the collaboration with the staff of the laboratory. Further inspirational for the dissertation was the study stay at the University of Hamburg and mainly regular active participations of PhD student at international conferences or workshops. Here is a need to underline a regular international workshop called Physmod. Its participants are mostly specialist in physical modelling and Ph.D. students of the branch. In the framework of the workshop new projects, new proposed methods, results often unpublished are discussed. Here, L. Kukačka has received new suggestions and recommendations for his further work.

The original aim of the work was the general formulation of the ventilation of the urban area, depending on its geometrical arrangement. This goal was clarified through participation in the international workshops. For qualitative and quantitative ventilation assessments, the Ph.D. student applied the field of new variable, describing the correlation between flow and concentration, especially the pollution flux across the boundary of a limited area embedded in urban area. The urban model was an X-shaped city junction created by two canyons of the same geometry street at first. At this stage, the influence of the flow direction on the ventilation inside the urban canopy was observed. Since the flow is turbulent, it was necessary to observe the "advective" fluxes and the turbulent fluxes, i. e. to measure the components of the tensor of the turbulent pollution fluxes. This means that it is necessary to perform simultaneous measurement of instantaneous velocity using the LDA system and instantaneous concentrations using the FFID at a given point up to relatively high frequencies. This task has not been solved at that time and it has become one of the key issues for moving forward. After relatively complicated research and testing, the PhD student managed to design a method and test it precisely. The method is currently being used in some foreign universities.

The small imperfections of the aerodynamic tunnel at the Institute of Thermomechanics were manifested in its applications. Among others, minor asymmetries of the flow field in the horizontal direction, likely to occur during assembly of the tunnel were detected. Even these problems have been successfully solved by the PhD student. It meant designing and plotting the tunnel details at the level of a qualified engineer so that the components were able to produce the Institute of Thermomechanics workshop. It must be noted that, such a doctoral skill did not come from previous studies. For L. Kukačka precision and ability to solve problems that were beyond his expertise, he became a key worker for the lab, and this was reflected in the subsequent period.

It is still necessary to mention the fact that during this period he completed his master's degree at the Faculty of Environmental Studies of the Czech University of Life Sciences Prague (CULS) in a completely different subject.

Such a well-prepared workplace (set up) and sophisticated methods have already allowed him to solve the goals of the dissertation. On the proposed model, he measured both the turbulent flow field and the pollutant fluxes, and conducted extensive discussion of the effects of geometry. He focused mainly on ventilation of the intersection both in the vertical and in the horizontal direction. Above the main goal of the thesis, he compared his results with the numerical solution using the LES model of the turbulent flow. Based on experience and discussions on international workshops, he proposed together with Š. Nosek a new model of urban development with non-homogeneous street canyon configuration for the next phase of the solution. It has been shown that the various building heights that make up individual streets have a significant effect on the ventilation of the city's canopy. It has been shown that such configurations often have a favourable effect.

At this point, it is necessary to mention the almost fatal deficiency that was manifested in this doctoral study. The shortage was not by the doctor but by the institutions. They were not able to provide sufficient financial support to enable the doctoral student to adequately support his family. That is why the doctoral student prematurely left the Institute of Thermomechanics of the Academy of Sciences of the Czech Republic in the private sphere. Here he used the knowledge and skills acquired in his studies at the CULS and he was able to provide better financial support for his family. This caused a substantial extension of the final stage of his doctoral studies. That is why the doctoral student has been a co-author when published his results of the last phase of his studies, although he participated in the solution in a substantial way. In addition, I believe that comprehensive results of the dissertation could be published in prestigious journals. Unfortunately, above mentioned fact did not allow it.

I note that the thesis has significantly exceeded the requirements for doctoral dissertation and it is at a high international professional level. I can still say that similar professional results have so far only been obtained at a few of foreign top-level institutions. For objectivity, it is also necessary to state that due to the complexity of the problem, to the sophisticated experimental methods and the evaluation methods, to the above mentioned problem, the length of the study was longer than the usual dissertation. I would add that specialists in meteorology will certainly find weaknesses in his or her field of work, specialists in the field of fluid mechanics will similarly find shortcomings in his or her field, but the combination of these fields is another significant benefit of the work.

For these reasons, as a supervisor I can state that the original goals doctoral studies were not only achieved but were significantly exceeded. A large part of the results have been successfully published. Further, I note that L. Kukačka has fulfilled all study duties according to the study plan.

Based on the above, I recommend that the submitted thesis be accepted as a doctoral thesis for defence and after her successful defence L. Kukačka was awarded by the Ph.D. degree.

Prague, on July 30, 2018

prof. RNDr. Zbyněk Jaňour, DrSc.
Supervisor