

Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Atmospheric Physics of the CAS, v. v. i.

Fields, in which the Institute registered its teams:

Earth and related environmental sciences

Observer representing the Academy Council of the CAS: Josef Lazar

Observer representing the Institute: Dalia Burešová, substitute observer Daniela Řezáčová

Commission No. 5: Earth and related environmental sciences

Chair: Prof. Dr. Franz Fiedler

Date(s) of the visit of the Institute: October 30, 2015

Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:

No. 1 - Department of Meteorology; No. 2 - Department of Climatology; No. 3 - Research team of upper and middle atmosphere; No. 4 - Research team of space plasma physics

A. Evaluation of the Institute as a whole

Report on the Institute of Atmospheric Physics of the CAS

1 Introduction.

The work of the Institute of Atmospheric Physics was presented by two Departments and by two Research Teams. The first two are the classical Departments for atmospheric studies, namely Meteorology and Climatology; the work is connected mainly with regional studies. The work of the two Research Teams on Upper and middle atmosphere and on Space plasma physics is highly specialized and has very important links to international research on the upper atmosphere and on space physics. All four Departments/Research Teams actively make long-term observations, which they then interpret to achieve their scientific research objectives. The two Research Teams have prepared several instruments to be carried into space in two to three years. At Panská Ves, there is a comprehensive set of equipment where valuable observations made on satellites can be received.

These four units were visited by the evaluation commission on 30 October 2015. It was clear that most of the scientists involved in these units are very active. However, some differences in their national and international reputations are visible. The Upper atmosphere and Space plasma physics Teams are deeply involved in global studies with strong international collaborations. On the other hand, studies of cases of heavy convective rain which may cause severe floods (Meteorology) and surface climate studies and climate change (Climatology) are more or less focussed on regional areas, especially in the Czech Republic, and these require stronger collaboration with other national organisations. However, all these research areas have gained excellent reputations in their work. The members of the Institute and its Director play very good roles, nationally and internationally, by writing top quality publications and by contributing significantly to the work of national and international organisations.

2 Strengths and Opportunities.

The Institute of Atmospheric Physics traditionally plays an important role by serving the nation with the tools that are needed for making good weather forecasts, especially the more modern methods of “nowcasting”, together with basic climatological and statistical methods of analysis in connection with changes of the general circulation patterns of the atmosphere. The Institute has also developed internationally widely recognized activities in experimental and theoretical space physics and in the physics of the upper atmosphere. These Teams are extremely well integrated into their international communities, by their publications and by participation in international scientific meetings, and on international committees. The commission was convinced that the four groups will continue their valuable research paths with these chosen topics which, in their different ways, are very relevant to society in the year 2015.

3 Weaknesses and Threats.

It is stated that the scientific facilities available in the Institute are unique in the Czech Republic and even in the European context. This may, however, be a sign that others do not see that such a combination in such a fruitful way. The overlap for cooperation

between the four groups is rather low with traditional atmospheric research forming half of the activities and the fields of the high atmosphere/space forming the other half. This may lead to a further separation of the two halves within the Institute, which would be most undesirable.

Due to the quite large operational costs on the one hand, at the moment, being mainly provided by the Academy of Sciences, too strong a competition may develop between the two halves, which again would be undesirable. A better way may be to have a broader interaction between the research projects (e.g., via lightning studies, or via climatological studies on the middle and upper atmosphere) or by other means (e.g., by seeking sources of European funding) to generate the larger investments which will be needed from time to time.

Several experienced and well known members of the Institute have reached their retirement status. The Institute - and especially the Director of the Institute - should be aware that a well-balanced distribution of the ages of members of the Institute has to be achieved when the replacement staff members are hired.

In the classical Meteorology Department, the too small number of scientific topics may be a hindrance to participation in regional field studies undertaken at a European or broader international level, because of the lack of personnel support inside the Institute.

4 Recommendations.

- a) The good cooperation between the Institute of Atmospheric Physics with several Universities and with the Czech Hydrometeorological Institute should be maintained and continuously strengthened.
- b) Exchange visits to Europe and North America should be especially encouraged.
- c) There are good possibilities for students to participate in several of the research projects and this should be strongly encouraged.
- d) There are opportunities for collaborations between staff working in the Climatology Department and in the Upper atmosphere Team and some staff in the Institute of Geophysics who have interests in "space weather".
- e) The Institute will gain advantage by preparing a full colour brochure, in order to bring to a broader public the wide range of research topics being carried out at present, and why they are so relevant and necessary for society today.

5 Detailed evaluations.

- a) As seen from its publications, the Institute shows a good to very good record, although completely different areas of atmospheric and space science are being addressed. All staff writing papers should be encouraged to submit them to international journals with high rankings and with high Impact Factors.
- b) Broader discussions should take place in order to prepare for broader collaborations concerning the development and improvement of tropospheric models and the use of several specialist models for different applications (e.g., for the boundary layer, or for non-linear studies).
- c) An attractive, full colour brochure of present-day research topics should be prepared for the public and also for interested scientists from other fields, which explains the research directions for the coming period.

6 Director and Board

The role of the Board and of the Director seems to be handled differently from Institute to Institute. Director Sokol has the difficult task of directing an Institute with such diverse research directions. He is very strong in his own research subject, but he seems not to be strong enough to give advice in middle and upper atmosphere science nor in space plasma physics.

Members of the Institute are very motivated and energetic in their research; the Institute plays a leading role among the CAS Institutes in the Czech Republic.

The Board consists of members both inside and outside the CAS. Its role should, however, be more concentrated on the long term developments that are essential, and not so much on the general scientific planning from project to project.

B. Evaluation of the individual teams

Evaluation of the Team No. 1: Department of Meteorology

Report on the Department of Meteorology, Institute of Atmospheric Physics of the CAS

Introduction.

The number of scientists in this Department is quite large; this is a requirement for the three major scientific programmes being carried out. The Meteorology Department carries heavy commitments for making long term observations of many meteorological parameters at three observatories, in Mílesovka, in Kopisty and in Dlouhá Loučka; high quality of the measurements is demanded under all atmospheric conditions. The Department also works on basic scientific problems and on applied science. The basic research topics include the very important case of forecasting heavy convective rainfall, connected with floods and other natural hazards which cause serious damage to the Czech society. This field is studied using synoptic scale models; the cloud physics parameterisations involved are of special interest. Important “nowcasting” methods using radar observations are being developed.

In the area of applied science, valuable research is being conducted on (i) specifying the road surface temperature in winter time, (ii) the microclimate of lakes in connection to landscape planning, (iii) maps of wind energy resources within the country, and (iv) the influence of cooling tower plumes on the surroundings of the power plants.

The age structure of the scientists in the Department has a sound distribution. The group of young scientists is clearly quite strong, with most of them being under 40 years. It is excellent that many students are involved in the research projects.

Strengths and Opportunities.

The strength of the scientific work of the Meteorology Department lies in its involvement with actual problems for the Czech society in making forecasts of severe weather, especially of heavy rainfall and the associated flooding, and in applied problems such as landscape planning. A well trained scientific community is able to meet the demands of society and can be carried on even when some of the older members have to be replaced.

Similar scientific and practical problems are being tackled in other countries. It would be beneficial for younger staff members to gain experience in their studies by having the opportunity to collaborate with scientists in other countries. This opportunity provides a sound basis for expanding the work by working together internationally, and looking for additional funds on a national and international level.

Weaknesses and Threats.

A partial weakness lies in the concentration on problems of national interests. The lack of larger projects in collaboration with other European groups might be a disadvantage the institutional funding on a national level declines further and is replaced by demands for international funding. A broader participation of members of the group presenting their work at European meetings would foster contacts with other groups. A minor threat might be the replacement of two very experienced members in the forthcoming years.

Recommendations.

The very active team carrying out a broad field of weather related research in the national interests and also the long term commitment to meteorological observatories should be strongly supported in the future. No other programme can replace the observations at these long term stations. The Department Head should become more proactive, seeking strong collaborations with other groups in the Czech Republic (e.g., at the Czech Hydrometeorological Institute) and in Western Europe and North America, and seeking additional sources of funding for studies that are so very relevant to Czech society.

Detailed Evaluations.

a) The record of publications is very good. Even with papers concentrating mainly on topics of national interests, the output is well visible in the broad science community. Of the 24 papers submitted for evaluation, 1 was ranked in category 1, 8 reached category 2 and the majority (14) was in rank 3. Only 1 was ranked in category 4.

b) The Department of Meteorology has quite strong connections to the Charles University via the broad teaching activity of several staff members. Through this connection a remarkably large number of students worked on their Bachelor and Master theses and also their PhD dissertations were supervised by members of the Department. It is recommended that this connection should continue in a strong way.

c) The main activity in the Department's research which is of national interest lies in making weather forecasts of severe weather phenomena and in problems where regional planning influences the environment. It is recommended that these activities continue with modern tools in order to further develop understanding.

d) The Department should seek several collaborators in the Czech Republic (not only at other Institutes of the CAS) and also with international partners who work in their home countries on similar problems, in order to reach a further exchange of scientific ideas and of state-of-the-art working tools such as numerical models and radar software.

e) The vitality of the Department is good, and its sustainability is absolutely essential.

f) The sound scientific programme should be continued on all three major scientific programmes considered here, but with more effort being made to develop numerical models further. It may be possible that the long term observations at the three field stations could be brought into a joint international European experiment as a permanent ground station.

Evaluation of the Team No. 2: Department of Climatology

Report on the Department of Climatology, Institute of Atmospheric Physics of the CAS

1. Introduction

Within the Institute of Atmospheric Physics of the Czech Academy of Sciences, the teams of Meteorology and Climatology have long traditions in innovative research. Their research domains have been continuously developed and broadened.

The present activity of the Department of Climatology is concentrated on the issues of changes in atmospheric circulation due to changes in the energy input from different sources, and their connected trends in surface temperature.

The department is rather small (5.8 FTE), and exhibits a young age structure. Most scientists are younger than 35 years. At the same time, the department attracts a reasonable number of highly motivated students (at master and doctoral level), which mirrors a stimulating working atmosphere at the department. The number of publications in internationally recognized journals is reasonably high and in part of high to excellent quality.

2. Strengths and Opportunities

Based on their research activities, including the participation at numerous national and international conferences, the department has gained international visibility and expertise in climate dynamics and other connections to climate change, e.g., the interrelation of heat waves and human mortality (i.e. cardiovascular diseases). This successful and timely research direction, i.e. biometeorology and climatology, is recommended to be strengthened in the next years.

The department has also gained admirable skills in using regional climate models to study the specific challenges in regional climate forecasting in the Czech Republic. Especially the use of model output statistics has been widely applied, in order to present the numerous results for a broader use by scientists and decision makers alike.

However, this research domain is still at a starting point; additional improvements in applications are required, before they can be fully used to support climate adaptation strategies.

3. Weaknesses and Threats

Due to the small number of scientists a possible change of one of the leading persons to another laboratory outside of the country or inside of the universities may weaken the research activities. Also climate research with large interrelations of the atmospheric processes can be achieved only with a broad view and experience. Cross-departmental collaborations within the Institute, as well as with complementary institutes nationally and internationally, are not yet fully exploited and should be strengthened.

4. Recommendations

A strong link of the research on climatology with its different aims should be sought with other groups within the Academy of Sciences, especially at the Global Change Research group in Brno. It should be considered, how the different models and different activities could be reorganized to a joint model based on the good experience of the present groups. This could form an excellent basis for concentrated work on different aspects of applications. The research domain of bioclimatology should be strengthened because it is of high societal relevance. Collaboration with the leading research institutes internationally needs to be better elaborated and exploited, e.g., through joint EU-funded projects.

5. Detailed evaluations

- a) The list of publications is, in general, of high quality. 16 papers have been involved in the evaluation. One was evaluated into category 1, two in category 2 and six in category 3. Only one was taken into category 4. For a young group in climatology this is a remarkably good outcome of their research. However, there is still major room for improvement. The number and in particular the quality of publications must be further increased, for example by teaming-up with leading research institutions, nationally and internationally.
- b) The scientific work is partly the result of a good involvement of students mainly from the Charles University. This could be achieved by several research grants from the Czech Science Foundation and a very active contribution of several members in giving courses in the educational program. In this way a well-developed interrelation between university departments and the Institute of the Academy of Sciences is visible, which should be a link to be taken great care of.
- c) Climatological studies are very relevant to society
- d) The participation in the international context is sound and is visible. It should also be fostered in the future by motivation and subsidence for grants to present their results in important meetings
- e) In the next period it should be carefully observed that a sound age structure is developed and maintained.
- f) The research plan for the oncoming period is partly involved in joint research plans with other groups, mainly the Cordex group. Also the other topics are of great societal interests and relevance.

Evaluation of the Team No. 3: Research team of upper and middle atmosphere

Report on the Research Team on Upper and Middle Atmosphere, Institute of Atmospheric Physics of the CAS

1. Introduction.

The main activity of this productive team is to make ionospheric observations (using modern equipment including a digital sounder in the Czech Republic and Doppler sounders in the Czech Republic, Argentina, South Africa and Taiwan). The team interprets these and related observations of the atmosphere, and is also involved with international modelling activities and several international Working Groups. Five interesting and valuable scientific areas are pursued – atmospheric waves and their effects on the ionosphere, solar activity and space weather effects on the ionosphere, long term trends, ozone and stratospheric dynamics, and developments of the International Reference Ionosphere.

2. Strengths and Opportunities.

The major strength of this team is its many important roles in the international scientific arena. These range from the position of the team leader, Dr Jan Lastovicka, as Editor in Chief of *Advances in Space Research* and member of the Councils of COSPAR (space research) and SCOSTEP (solar-terrestrial physics), as well as a member of several international Working Groups, to four other team members being on international Working Groups. There are good opportunities for the future because significant plans are in place to expand all of these experimental activities in the Czech Republic, in Europe and in more distant nations in the next five years, as parts of ambitious and internationally agreed programmes. It is excellent that the team is part of the EU funded ARISE2 project. The team's REPIN instrument is included on the Russian RESONANCE space mission, which should be launched in 2018.

3. Weaknesses and Threats. One weakness could be the lack of a suitable replacement for Dr Lastovicka when he eventually retires. One threat is the possible lack of future funding if the situation regarding obtaining grants from Czech Scientific Funds worsens.

4. Recommendations. This very effective team should be supported strongly in the future; valuable and relevant research work is being performed across quite a broad range of topics.

5. Detailed evaluations.

a) The publication record of this team is strong. For the 16 papers submitted for evaluation, the first author was a team member; 2 were judged to be in category 1, 9 in category 2, 4 in category 3 and 1 in category 4. The quality of the results published is seen to be high. Six other papers were not submitted for evaluation because their first author was not a member of the team. Notably, however, these papers were published during the evaluation period in the highly prestigious *Journal of*

Geophysical Research (published by the American Geophysical Union) – perhaps they should also have been submitted for evaluation.

b) The involvement of postgraduate students in these research activities is good, despite the fact that the team does not have a strong link with a university department.

c) The societal relevance of the team's work is very high, because it relates to perturbations to the high atmosphere associated with energetic events on the Sun and to climate change near the Earth's surface. The disturbed ionosphere exerts an influence on radio signals from GPS satellites passing through it. Because society today relies so much on GPS systems for both positioning and navigation, let alone for highly accurate timing for financial transactions, this research is of immediate relevance to society.

d) In an international and national context, the team's work is excellent. It is more than comparable with that of leading teams of comparable size in other countries.

e) The age structure of the team is excellent. Its vitality and sustainability is primarily due to the strong influence and leadership of Dr Jan Lastovicka.

f) The plans for the future of the team are very sound, and the strategy on which they are based is very firm – international links are paramount here. There are no missing issues in the strategy.

Evaluation of the Team No. 4: Research team of space plasma physics

Report on the Research Team of Space Plasma Physics, Institute of Atmospheric Physics of the CAS

1. **Introduction.** The major activities of this team are data analysis studies using electromagnetic wave and charged particle observations made aboard European and NASA satellites such as Cluster, DEMETER and the Van Allen probes in the Earth's ionosphere and magnetosphere, and aboard the Cassini spacecraft in Saturn's magnetosphere. Another important activity is the numerical simulation of plasma processes using particle in cell and other computational techniques. A third activity is the design and development of new wave analysis instruments for different future space missions. These range from the French TARANIS mission (to study radio waves from lightning and transient luminous events above active thunderstorms) to the Russian RESONANCE mission (to investigate whistler-mode instabilities and amplification processes) and to ESA's Solar Orbiter mission and the ESA mission (known as JUICE) which should arrive at Jupiter in the year 2030.
2. **Strengths and Opportunities.** The undoubted strength of the team is its academically excellent leader, Prof Ondrej Santolik; he is recognised as a national and an international authority in the field. All the other team members are well qualified and scientifically bright too. The opportunities provided by these future space missions are most exciting and they constitute the foundations for the long term success of the team. Prof Santolik is "well connected" internationally; he organises doctoral and post-doc positions outside the Czech Republic to which the post holders return with much increased experience. This benefits both the individuals themselves and their nation state.
3. **Weaknesses and Threats.** The only significant weakness and threat to this team is that of the accidental incapacity of the team leader.
4. **Recommendations.** This truly outstanding team of distinguished researchers deserves as much support as it can be given. It is bringing kudos to the Czech nation, and will continue to do so as long as it is fully financed.
5. **Detailed evaluations.**
 - a) The publication record of the team is truly outstanding, being the best of all the teams at the nine Earth and related environmental sciences institutes being evaluated. Eighteen papers were submitted for evaluation; 9 were judged to be in category 1 and 9 in category 2. The quality of the science is phenomenally good. The superb capabilities of the Czech space data analysis procedures used is absolutely essential as it leads to the excellence of the scientific papers written jointly with international colleagues. The computer simulation results are also excellent; there are opportunities for more comparisons with recent space mission data.

- b) Prof Santolik leads his significant team of post-docs, top quality doctoral students and masters students with great skill and devotion. Further, he delivers lectures at the Charles University, where he enthuses students, some of whom then join the team. The mentoring of students in this team is first class.
- c) The non-linear process by which Van Allen radiation belt electrons are accelerated by whistler-mode “chorus” emissions up to one million electron Volts (MeV) generates “killer” electrons which can penetrate into satellites and damage their electronic circuits. Any significant damage to communications satellites and to GPS (positioning) satellites by such “space weather” processes would have consequences of great relevance to society today which so greatly and increasingly relies on satellite technology. Thus the processes involved require detailed study and an evaluation of their impact on society.
- d) In the national and international context, the team is outstanding, since it has many strong links with European countries and with the USA; the team develops major collaborations with many scientists abroad. The research being carried out by the team members and their collaborators is world leading science of the highest quality.
- e) This team of professionals has an excellent age structure which should be sustainable for the next twenty years or more. Because the subject is exciting, young members are continually being attracted to the team. The team benefits from significant amounts of funding which it succeeds in raising and which are external to those funds provided by the state. However, the team is not “biting off more than it can chew”. Realistic plans are carefully made and carried through to fruition.
- f) The strategy and future research plans are excellent in all respects. The team will continue to bring prestige to the Czech Republic.

Date: December 28, 2015

Commission Chair: Prof. Dr. Franz Fiedler