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Andrija Mohorovičić as a meteorologist

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Andrija Mohorovičić's meteorology-related activities are reviewed. It is shown that he was involved in teaching and professional work in meteorology throughout his professional career, and in meteorological research until his early forties – i.e. before switching to seismological research and arriving at the famous discovery of discontinuity between the Earth's crust and its mantle. Mohorovičić taught meteorology at the Nautical School in Bakar (1882–1891) and later at the University of Zagreb (since 1894). As for the professional engagement in meteorology, his major achievements were foundation of meteorological station in Bakar (1887), start of meteorological forecasting in Croatia (1893), and establishment of the network of Croatian meteorological stations (1901). Mohorovičić's meteorological research included, but was not limited to, the climatological investigation of clouds and their movements in the Bakar area, the study of tornado that struck Novska, and an early study of the Zagreb climate conditions. As demonstrated in a recent publication, Mohorovičić also made pioneering contribution to the investigation of atmospheric rotors, by describing in some detail a vortex with horizontal axis he had observed from Bakar (1889); this discovery influenced later research of similar phenomena in England and Germany, but was forgotten by the international scientific community some fifty years later.

Keywords: Andrija Mohorovičić, teaching of meteorology, Croatian meteorological network, atmospheric rotors.

1. Introduction

Andrija Mohorovičić spent most of his professional life working at two institutions: from 1882 to 1891 at the Nautical School in Bakar and from 1891 until his retirement in 1921 at the Meteorological Observatory (which later changed the name to the Institute of Meteorology and Geodynamics and finally to the Geophysical Institute) in Zagreb (Skoko and Mokrović, 1982). Both in Bakar and in Zagreb he was engaged in teaching, research and professional activities in the field of meteorology, although under different conditions, with various collaborators and with different outcomes. It therefore makes sense to consider his activities in the two cities separately. Altogether, Mohorovičić published about twenty papers related to meteorology (Orlić, 1998a). The present review is based on a subset of these papers, selected so as to cover the most important results of his work.

2. Bakar years

Andrija Mohorovičić came to Bakar at the age of twenty-five, after completing the study of physics and mathematics and passing the teacher exam at the University of Prague and after working for a while at high schools in Zagreb and Osijek (Skoko and Mokrović, 1982). At the Nautical School in Bakar he taught mathematics, physics and meteorology, the latter being of particular importance in the nautical school curricula because of its significance for the future seamen. It is interesting that during his study in Prague Mohorovičić did not attend meteorological courses (Orlić, 1998b), and it would thus appear that teaching in Bakar encouraged him to master this scientific discipline as an autodidact. It is not exactly known which books he used in the process, but in his papers from the period he cited works by A. Sprung (*Lehrbuch der Meteorologie*, Hamburg, 1885) and W. Ferrel (*Recent Advances in Meteorology*, Washington, 1886), implying that he did not restrict himself to German sources which would be the first choice to somebody whose university study was mostly conducted in German.

At the Nautical School in Bakar Mohorovičić established a meteorological station, which became operational on 1 May 1887. Already before that he carried out some meteorological measurements, but serious activities could start only when, with the help of the government, he acquired a set of basic instruments (a barometer, a psychrometer, maximum and minimum thermometers, an ombrometer and a heliograph). In his own words, the meteorological station was established »firstly, as a support for the lectures; secondly, because these lectures are of big importance for students which will become seamen; thirdly, because of the very special orographic position of Bakar« (Mohorovičić, 1888). From this citation it may be concluded that from the very beginning he intended to use the station to support the lecturing but also to do some research.

At the time it was usual for high school teachers to get involved in other activities besides the teaching. High schools used to publish annual reports to which the employees were expected to contribute scientific and professional papers, and the schools enabled teachers active in research and publishing in different areas to interact on a regular basis. For instance, Mohorovičić's colleagues in Bakar were Narcis Damin, a well-known researcher of spiders, Juraj Carić, author of nautical textbooks and writer on the life of seamen, and Aleksandar Lochmer, author of the English language textbook, grammar and dictionary (Marochino, 1982). Among the colleagues from the Nautical School it is worth to mention also Anton M. Zuvičić, teacher of nautical courses and an experienced sea captain, who enthusiastically helped Mohorovičić to per-

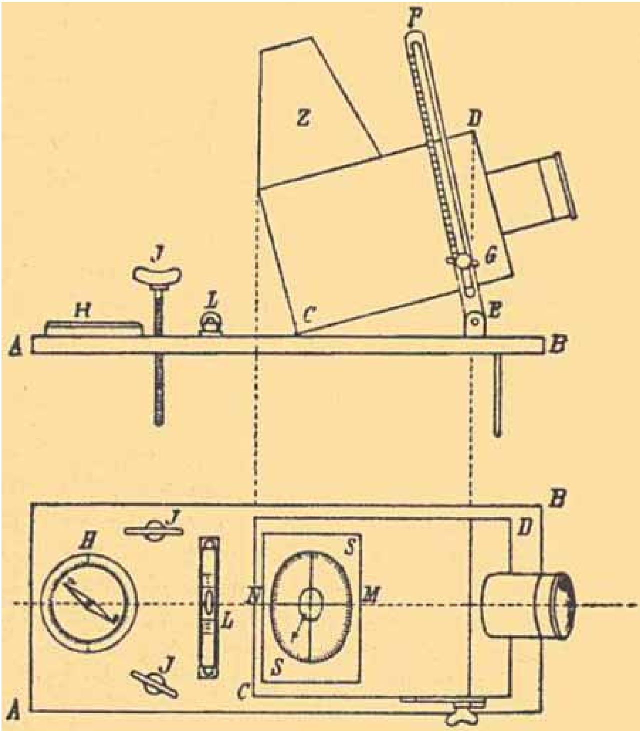

Figure 1. Nephoscope as constructed by Mohorovičić (1888).

form observations at the newly established meteorological station. In his texts Mohorovičić often compares meteorological conditions in Bakar with those in Rijeka. The meteorological station at the Nautical Academy in Rijeka was led since 1877 by Peter Salcher, professor of physics and mechanics. It is interesting that Salcher collaborated with Ernst Mach in a pioneering study of air flow around bullets. Mach, the famous physicist and Mohorovičić's professor at the University in Prague, visited Salcher in Rijeka in spring 1887 (Smokvina, 2004). It is not known if Mach and Mohorovičić met on that occasion, but it is obvious that in Rijeka Mohorovičić could get additional stimulus for his research activities.

How seriously Mohorovičić approached the meteorology can be seen from the fact that he was not contented with the routine equipment of the meteorological station, but decided to add to the basic instruments a device he had constructed – a nephoscope – which enabled determination of the direction and speed of the motion of clouds (Figure 1). Such instruments were used at the time to infer the motion in the higher layers of the atmosphere, and thus to supplement the rare data collected by researchers during balloon flights. For his version of the nephoscope Mohorovičić made use of the school-owned *camera obscura*. His technical solutions ensured high precision, keeping at the same time the construction costs low. In order to use the collected data as thoroughly as possible, Mohorovičić derived trigonometric expressions that enabled him to determine not only the horizontal but also the vertical component of velocity of the cloud movement (Mohorovičić, 1889a). He conducted the measurements very carefully, and so, for example, he states that cloudiness »determines Mr. Zuvičić with me simultaneously, so that we check each other, and we finally note the average value of the two estimations in the diary« (Mohorovičić, 1891). He also paid considerable attention to the measurement errors and the necessity to take them into account during the analysis.

Most of the results of observations and measurements performed at Bakar Mohorovičić presented in three papers (Mohorovičić, 1889a, 1891, 1892) that enabled him to earn the doctoral degree at the University of Zagreb in 1893. The papers focused on climatological analysis of cloudiness, cloud types and related air flow, with the results being presented in numerous tables. Thus, for example, Mohorovičić discovers that there are two maxima of cloudiness in summer, a larger one in the afternoon and a smaller one in the morning, and only one maximum in winter, in the forenoon. He also notices that there is a tendency for clouds to regularly align twice a day, at about 8 a.m. and 5 p.m. The latter observation would nowadays be related to wave phenomena in the atmosphere, and the changes in wave regime during a day to the changes of atmospheric stability. Mohorovičić also finds that the surface winds turn with the Sun in the forenoon and against the Sun in the afternoon, and that the high altitude winds turn in the opposite direction. Regarding the wind speed he emphasizes that there is the surface maximum close to the noon and that the speed is lower in the morning and in the evening, with the high altitude wind having the opposite diurnal variation. Such findings could be related to the coastal circulation and its modification caused by complex topographic effects in the Bakar area as well as to the atmospheric stability being much higher overnight than during the day.

Despite the fact that Mohorovičić's work focused on the climatological analysis of the data collected in Bakar, he did not overlook particular situations that ultimately define the climate conditions. Description of one such situation is the subject of the paper that Mohorivičić published in the Viennese journal *Meteorologische Zeitschrift* and that represents his most important contribution to meteorology (Mohorovičić, 1889b). The paper deals with the description of clouds and related air flow based on measurements and observations carried out on 18 October 1888 in the Bakar area. He summarized his findings in a schematic presentation of the state of the atmosphere in a vertical section extending from mountains over Bakar to Rijeka Bay (Figure 2). During a bora event Mohorovičić observed a stationary cumulus cloud lingering almost throughout the day over Kostrena, fragments of cumulus clouds descending down the mountain slope, and stratocumulus clouds moving downwind in the higher altitudes. Based on these observations, as well as on addi-

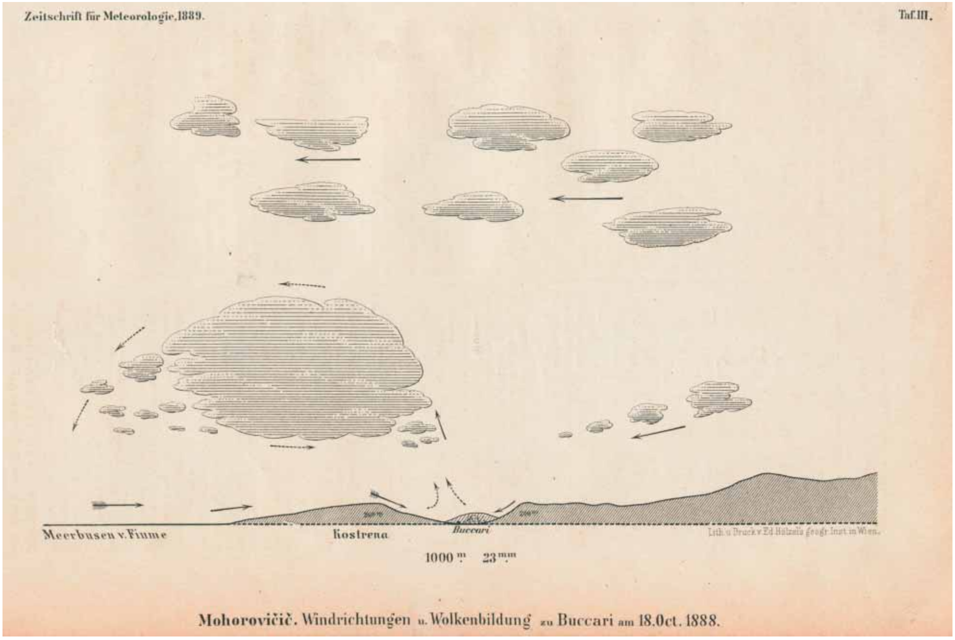

Figure 2. Clouds and air flow observed by Mohorovičić on 18 October 1888, shown in the vertical section extending from mountains (right) over Bakar to Rijeka Bay (left) (Mohorovičić, 1889b).

tional observations and measurements performed at the ground and at the sea surface, he concluded that the air flowed down the mountain slope, upwelled over Bakar, moved in higher altitudes towards Rijeka Bay, where it downwelled and flowed back to Bakar. This allowed Mohorovičić to conclude that a vortex with a horizontal axis developed around the stationary cumulus cloud, and that consequently the surface wind above Rijeka Bay had the direction opposite to the bora. This description of the phenomenon was of great interest to the journal editor J. Hann, who appended it with his commentary on similar phenomena in South Africa, Greenland and England.

A recent historical study has shown that a phenomenon known today as atmospheric rotor was for the first time described in detail in the above paper, that Mohorovičić's discovery influenced later research of similar phenomena in England and Germany, but also that this contribution to the international research of atmospheric rotors was forgotten some fifty years later (Grubišić and Orlić, 2007). It is interesting to consider how the idea on the air flow over mountains evolved in the works of Mohorovičić's precursors and contemporaries (Figure 3). J. F. W. Herschel, son of the famous astronomer W. Herschel, described in 1862 the air flow over a mountain in South Africa as well as the wavelike flow in its lee (Herschel, 1862). W. Marriott, British researcher, schematized in his 1886 paper the air flow over a mountain in England in a similar

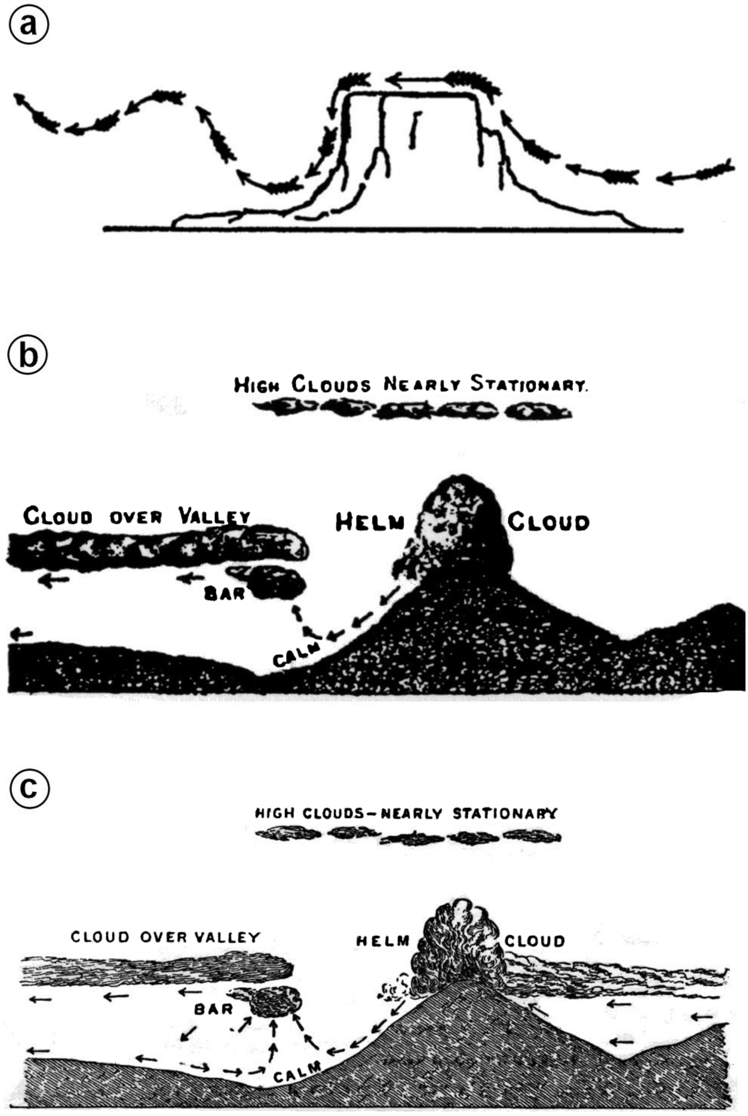

Figure 3. Air flow over a mountain as schematized by Herschel (1862) (a), schematic presentation published by Marriott (1886) (b), and modified version of the latter (Marriott, 1889) (c). The last presentation was published after its author got acquainted with Mohorovičić's results obtained for the Bakar area.

way (Marriott, 1886). However, three years later he changed this presentation by introducing in it the atmospheric rotor as well as the counterflow at the surface (Marriott, 1889). Most probably, Mohorovičić's paper motivated this improvement: Marriott not only mentions Mohorovičić's paper in his later publication, but also includes in it the translation of the whole Mohorovičić's paper into English.

Mohorovičić's German paper of 1889 was later cited in some of the best meteorological textbooks of the time: it was thus mentioned by J. Hann (1901), the respectable meteorologist and editor of the journal in which the paper had been published, as well as by A. Wegener (1911), geophysicist who started his career as a meteorologist but become famous for the continental drift theory from which the plate tectonics theory later evolved. Finally, J. Kuettner (1938, 1939) mentioned Mohorovičić's paper and related diagram several times in his seminal papers, in which he dealt with the atmospheric rotors in the lee of a German mountain. Thereafter Mohorovičić's paper was not cited abroad any more, and it seems that even Croatian scientists lost sight of his diagram. Kuettner's papers have motivated further measurements all around the world as well as theoretical research of atmospheric rotors, which last to date. The most recent large experiment dedicated to atmospheric rotors, called T-REX (Terrain-Induced Rotor Experiment), was carried out in 2006 in the Sierra Nevada area in the USA (Grubišić et al., 2004). The leader of the experiment

Figure 4. Andrija Mohorovičić (right) in company with Ivan Stožir (left), his predecessor at the Meteorological Observatory in Zagreb. In the middle is Spas Vatsov, founder of the Bulgarian Meteorological Service, formerly Stožir's student at the High School in Zagreb.

was Vanda Grubišić, who graduated in geophysics from the University of Zagreb and later earned a doctoral degree from the Yale University. To a large extent her activities enabled the contemporary meteorologists to get familiar with Mohorovičić's pioneering contribution to the atmospheric rotor research.

3. Zagreb years

At the end of 1891 Andrija Mohorovičić started to work at the High School (*Velika realka)* in Zagreb, and soon became the head of the Meteorological Observatory that operated in the framework of the school. Later, the observatory broadened its field of work, changed its name several times and became an independent institution (Skoko and Mokrović, 1982). Mohorovičić took over the management of the observatory from Ivan Stožir (Figure 4), who was professor of physics and who established the observatory on 1 December 1861. Mohorovičić continued to maintain the observatory at the high professional level, gradually substituted some old instruments by new ones (barograph – Figure 5, thermograph, anemograph) and acquired several new instruments (hygrograph, ombrograph, heliograph). From the text he wrote about equipment of the observatory it is evident that he took great care of the instrument positioning and calibration and of the correction of data collected (Mohorovičić, 1902).

From the very beginning of his work at the observatory Moohorovičić considered it as the central institution that should act as the focal point for all other Croatian meteorological stations. Already in 1893 he established a network of storm-observing stations, and in 1901 he managed to put 78 meteorological stations under the administration of the Zagreb observatory (Mohorovičić, 1902). Before that, these stations were managed by the Royal Hungarian Meteorological Agency in Budapest, Royal Croatian-Slavonian-Dalmatian Government in Zagreb, Meteorological Observatory in Zagreb and various private persons. With the governmental agreement and its financial support Mohorovičić succeeded to gather all these stations in a single network and to partially equip them with new instruments. In September and October 1901 he personally visited most of the stations in order to inspect the instrument positions, to control whether they are operational and calibrated and to check the way the observations are made. Because of the increased amount of work Mohorovičić always tried to employ more people at the observatory, but it seems that at best he had only one assistant, two clerks and a secretary (Penzar et al., 1986). Assistants changed often, with Stjepan Škreb, Andro Gilić and Milan Kovačević having lasting influences on Croatian meteorology.

Mohorovičić's professional activity in Zagreb was not limited to the supervision of the Meteorological Observatory and the organization of the network of meteorological stations. Already in 1893, after being repeatedly urged by the editor of the Zagreb newspaper *Agramer Zeitung*, he started to publish tentative weather forecasts (Mohorovičić, 1897b). At the end of 1894 he was so disappointed with the results that he wanted to cease this activity. Being, however, unable to resist further persuasion, he continued to publish the forecasts. In the year 1896 he published 286 forecasts, out of which, according to his analysis, 77% were successful. In his text on weather forecasting Mohorovičić mentions that the main goal of this activity is to gain knowledge, which

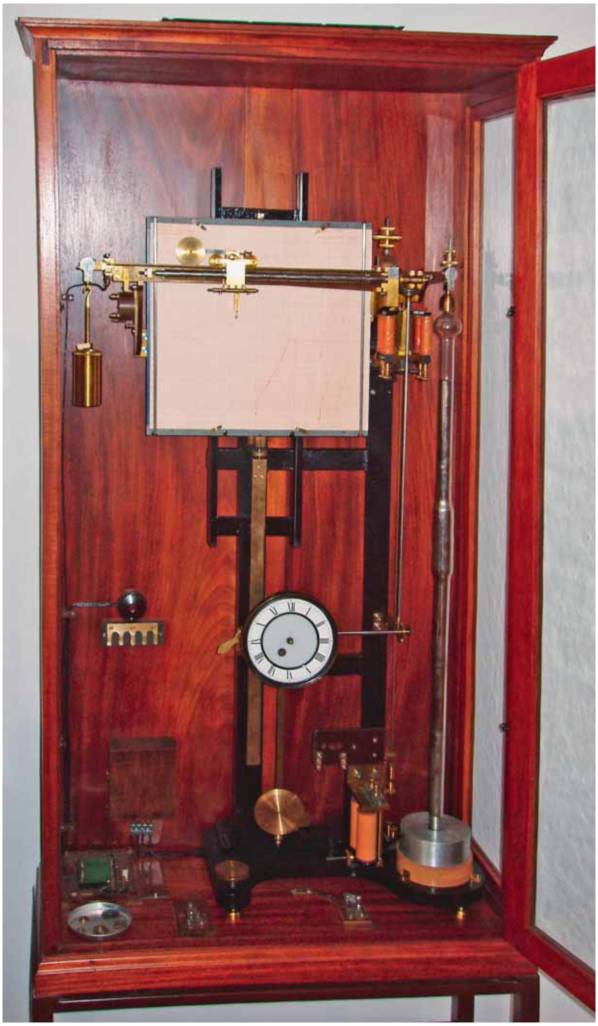

Figure 5. Barograph Sprung-Fuess, installed by Mohorovičić at the Meteorological Observatory in Zagreb in 1903. Among other phenomena, this instrument recorded the passage of atmospheric gravity waves caused by the fall of Siberian meteor in 1908.

will enable more successful forecasting in the future. From the available texts it is difficult to understand how he actually made the forecasts. A glimpse is provided by the statement that »there are two kinds of laws which govern the weather; some are valid for the whole Earth or at least for a continent; the others are specific to a country or even to a region in a country... The weather forecasting thus rests on a proper understanding of general meteorological laws as well as on a familiarity with climatological conditions prevailing in the region for which the forecast is prepared« (Mohorovičić, 1897b). It seems that initially Mohorovičić based the forecasts on the Zagreb data only, but that later he succeeded in organizing the telegraphic data collection from a broader area (Lisac, 1998). The forecasts were short; for example, on 26 July 1904 *Narodne novine* published the following announcement: »Partly cloudy with thunders« (Lisac, 1998). After the World War I started, Mohorovičić ceased to publish the forecasts: because of conscription he was left without assistants, and due to difficulties in communication he lacked adequate information on weather conditions in Europe.

Another professional activity that Mohorovičić had to accept was related to the hail defense. At the beginning of 1901 he led a testing of five cannon types »with the goal of seeing which system is the safest and the most simple, and which system provides the largest effect under the lowest costs and the minimum use of gunpowder« (Mohorovičić, 1901b). Thorough as usual he involved two co-workers – captain Đ. Čačković and assistant S. Škreb – to measure simultaneously with him the durations of reverberations after the shots, so as to obtain the times as reliable as possible.

Despite the abundance of professional work he had to handle after his arrival to Zagreb, Mohorovičić did not lose sight of other activities. As already mentioned, in 1893 he earned the doctoral degree at the University of Zagreb, and a year later he habilitated at the same university with a paper on tornado at Novska (Mohorovičić, 1893). During the next twenty years he worked as an adjunct lecturer, and later as an adjunct associate professor, offering courses on different meteorological subjects (Introduction to general climatology, Special climatology, Meteorology and climatology, On meteorological instruments and their use, Practical instructions in observation at meteorological stations, etc.). Later he supplemented these with some seismological courses (Anonimus, 1894–1917). It should be pointed out that his laudatory review of M. Milanković's book *Théorie mathématique des phénomènes thermiques produits par la radiation solaire* contributed to its acceptance by the Academy of Sciences and Arts in Zagreb and a Parisian publisher and to its publication in 1920 (Makjanić, 1979). In the book the famous astronomical theory of climate changes was thoroughly developed for the first time.

The first Mohorovičić's research activity after his arrival to Zagreb was motivated by tornado that struck Novska on 31 May 1892 and whose effects he analyzed as the governmental appointee. After surveying Novska and its surroundings Mohorovičić compiled a detailed report, in which he skillfully com-

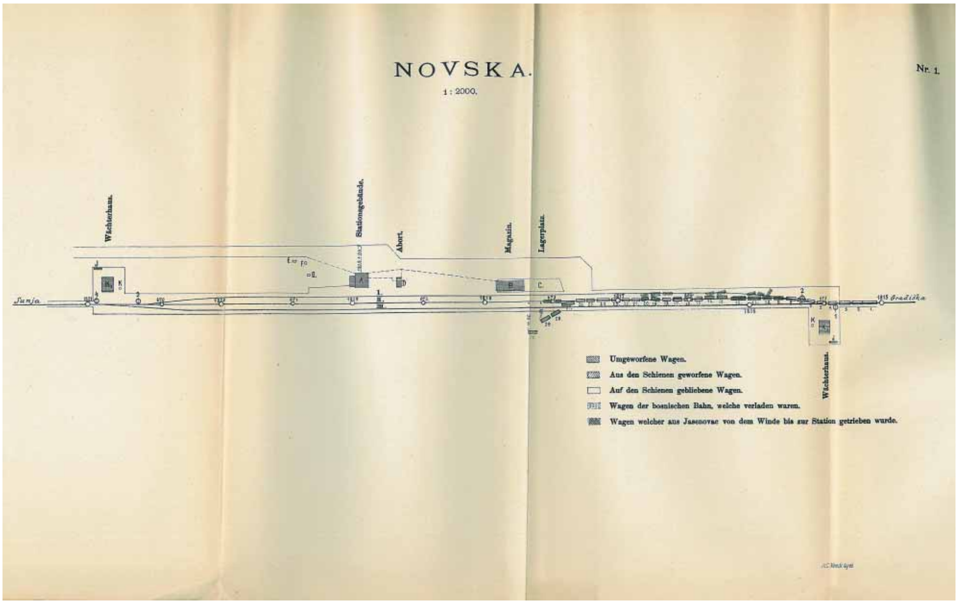

Figure 6. Position of the train coaches expelled from the railway by tornado that struck Novska on 31 May 1892, according to Mohorovičić (1893).

bined pieces of information from different sources to create a comprehensive idea of the phenomenon (Mohorovičić, 1893). For example, he noticed that the train coaches at the local station were expelled from the railway in different directions (Figure 6), which led him to conclude that the flow in the tornado was cyclonic, i.e., counterclockwise. From the information that a coach weighting 13 t was thrown 30 m away he calculated that both the horizontal and the vertical components of the near-ground wind speed amounted to about 70 m/s. From the directions in which the trees were scattered in a nearby forest he concluded that two tornados, with diameters equaling 800–1200 m and 2300 m, passed over the forest, and that distance between their paths was 1200–1500 m. He also constructed a synoptic map (Figure 7) and noticed four weak depressions as well as a large temperature gradient in Croatia and neighboring countries. On the basis of recorded times at which the employees of Croatian telegraph stations switched off electricity because of thunder, he demonstrated that the front moved from the southwest to the northeast with a velocity of 20–30 km/h. Finally, he completed the report with the testimonies on a strong hail, on the shape of vortices as well as on a very low pressure in their centers – the last provided by a woman who claimed that during the passage of the tornado »she could not, together with a servant, open a room door, and after the tornado moved on the door opened by itself, and the windows fell into the room together with frames« (Mohorovičić, 1893). He did not attempt the

Figure 7. Synoptic map that Mohorovičić drew for 14 h on 31 May 1892 (Mohorovičić, 1893). This is the first such map published in Croatia.

dynamical explanation of the phenomenon, but only remarked that its cause has to be sought in the large temperature gradient in Croatia.

Upon taking over the management of the Meteorological Observatory in Zagreb, Mohorovičić inherited from his predecessor meteorological time series whose length exceeded 30 years. This enabled the first analysis of climate conditions in Zagreb to be attempted. As the parameter most appropriate for the start of investigation Mohorovičić chose precipitation (Mohorovičić, 1897a). After a typically conscientious discussion of conditions under which the measurements were performed as well as of the data quality, he applied harmonic analysis on the precipitation time series and found a 30.5 year periodicity. By applying the same method on the fluxes of the Sava River measured at Stara Gradiška he found an oscillation of the same period, with the river flux maximum lagging two years behind the precipitation maximum. Thus he made an early contribution to hydrology. In the remainder of the paper he determined some additional smaller periods, and then proceeded to investigate the mean annual course and to determine the precipitation maxima in June and October, a maximum of the number of days with precipitation in June and a maximum of the precipitation intensity in October. He concluded the paper by announcing a similar analysis for other meteorological parameters, which, however, did not materialize.

In his last scientific paper dealing with meteorology Mohorovičić considered vertical profile of temperature (Mohorovičić, 1901a). In the study he used the temperature data simultaneously measured at Zagreb and on the mountain of Sljeme as well as the data the foreign researchers collected during balloon flights and using some new instruments – especially probes equipped with autographs. After discussing the data taken up to a 12 km height Mohorovičić hypothesizes that »the temperature at a 20 km height is 110–120° lower than at the surface of the Earth and that at a 30 km height it is 150–160° lower. From this we can conclude that the temperature at the upper limit of the atmosphere is very close to the absolute zero« (Mohorovičić, 1901a). Shortly after this paper was published the stratosphere was discovered, which disproved Mohorovičić's assumption on the constant decrease of the temperature with height.

4. A big career turn

Around 1900, in his early forties, Andrija Mohorovičić quitted meteorological research and turned to another field – seismology. So, at the moment when a decade of his efforts aimed at improving the Meteorological Observatory in Zagreb and establishing the network of meteorological stations culminated, he decided to proceed with the professional and teaching activities in meteorology but also to refrain from using the data collected at the network in his further research. Instead, he devoted himself to the organization of seismological station and to the study of seismology, for which he needed another decade because obviously the governmental support for seismology was not better than for meteorology. After that, he started research in seismology, which soon resulted in discovery of the discontinuity that separates the Earth's crust from its mantle (Skoko and Mokrović, 1982; Herak and Herak, 2007). This is Mohorovičić's most important scientific achievement, accomplished in his early fifties after a risky turn in the scientific career. What motivated him to such a move?

As far as is known, Mohorovičić did not left behind any memoirs or letters that could explain this decision. However, careful studies of his published papers provide some clues on the possible motivation. Thus, for example, when writing on the climate of Zagreb he emphasizes that for the research of climate changes »we should have at disposal about 1000 years of observations.

Since we do not have for any of the meteorological parameters the time series that is longer than 100 years, we ought to relegate the secular periodicity problem to our far descendants« (Mohorovičić, 1897a). From this it may be concluded that he did not consider the available meteorological data, even those originating from the oldest stations, suitable for the climate change research. Regarding the short term processes, he presumably missed the data documenting conditions in the higher layers of the atmosphere, especially because at the very beginning of his scientific career he dealt with meteorological problems in all the spatial dimensions. The wrong conclusion on the vertical temperature profile (Mohorovičić, 1901a) had to draw his attention to the importance of new instruments that were revolutionizing research of the free atmosphere at the time, but it is not clear whether he did not manage to equip his meteorological network with such instruments because of a lack of financial support or due to the small number of co-workers.

Apart from the lack of high-quality data, there are some other reasons that may have estranged Mohorovičić from meteorology. We know that he was unsatisfied with the weather forecasts he was forced to publish (Mohorovičić, 1897b). At the beginning of the 20th century the sense of frustration was widespread among the meteorological forecasters (Friedman, 1989), due to the impossibility of producing successful forecasts on the basis of physically founded methods and the consequent need to resort to statistical methods. The fact that Mohorovičić himself was aware of shortcomings of the theoretical approach to meteorology is evident from a text in which he states that the eventual task of the meteorologist is »to formulate differential equations describing motion of the air, and to obtain as an integral the general circulation of the atmosphere and as particular integrals the cyclones, anticyclones, tornados and thunderstorms. We are still far from completing this task …« (Mohorovičić, 1901a). During the second half of the 19th century a lot of effort went into application of both the hydrodynamic and the thermodynamic laws to the atmosphere. The problem, however, was that these two lines of research were separated (Friedman, 1989). For the first time it was V. Bjerknes and his collaborators who started to relate the atmospheric circulation to the changes of density and the latter to the variability of temperature and humidity. This ultimately led to a new approach to the weather forecasting, but at that time Mohorovičić was already retired.

After switching from meteorology to seismology Mohorovičić succeeded to organize measurements that were at the time comparable with the best in the world, whereas in his research he could for the first time combine empirical and theoretical approaches: it was exactly such a methodology that enabled his discovery of the discontinuity between the Earth's crust and the mantle. This discovery had a direct impact on the development of geosciences and it elevated Andrija Mohorovičić to one of the greatest geoscientists of all times. As already mentioned, his discovery of the atmospheric rotors was also respected by the international scientific community. However, the investigation of such meteorological phenomena was slow in developing, and Mohorovičić's contribution – although incorporated in the findings of his successors – was gradually forgotten. Still, already with this work he showed an ability to collect high-quality data and to arrive at an important result after carefully analyzing the data. Some recent numerical simulations have shown that during a bora event the atmospheric rotors may develop (Gohm and Mayr, 2005), thus verifying the discovery Mohorovičić achieved almost 120 years ago and fulfilling his dream about the unity of empirical and theoretical research in this branch of meteorology. The fact that it took so much time for the unification to occur, during which geophysical fluid dynamics evolved on one hand and electronic computers and numerical methods developed on the other, shows that the scientific progress depends on many factors and that a successful scientist must be able to recognize when a problem is ripe for solution.

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SAŽETAK

Andrija Mohorovičić kao meteorolog

Mirko Orlić

U članku se iznosi pregled aktivnosti Andrije Mohorovičića u području meteorologije. Pokazuje se da je kao meteorolog bio uključen u nastavni i stručni rad tijekom cijelog svojeg profesionalnog djelovanja, te da se znanstveno bavio meteorologijom do svojih ranih četrdesetih godina – dakle, prije nego se posvetio znanstvenom seizmološkom istraživanju i tako došao do čuvenog otkrića plohe doskontinuiteta između Zemljine kore i plašta. Mohorovičić je predavao meteorologiju na Nautičkoj školi u Bakru (1882–1891) te kasnije na Sveučilištu u Zagrebu (od 1894. godine). Što se tiče stručnog rada u području meteorologije, najznačajnija su mu postignuća utemeljenje meteorološke postaje u Bakru (1887), početak meteorološkog prognoziranja u Hrvatskoj (1893) i uspostavljanje mreže hrvatskih meteoroloških postaja (1901). Mohorovičićeva meteorološka istraživanja uključivala su, između ostalog, klimatološku studiju oblaka i njihovog gibanja u području Bakra, izučavanje tornada koji je pogodio Novsku te rano istraživanje zagrebačkih klimatskih prilika. Kako je pokazano u jednom nedavno objavljenom članku, Mohorovičić je također dao pionirski doprinos istraživanju atmosferskih rotora, detaljno opisujući vrtlog s horizontalnom osi što ga je opažao iz Bakra (1889); to je otkriće utjecalo na kasnije istraživanje sličnih pojava u Engleskoj i Njemačkoj, ali ga je nakon pedesetak godina međunarodna znanstvena zajednica zaboravila.

Ključne riječi: Andrija Mohorovičić, nastava meteorologije, hrvatska meteorološka mreža, atmosferski rotori.

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