Atmospheric and Climate Science at ETH from 1860 to 2011

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1 Introduction

This document is issued on the occasion of the 20th anniversary of the creation of the Institute for Atmospheric and Climate Science IAC. The IAC itself resulted from the merger of the Institute for Atmospheric Science IAS (formerly the Laboratory for Atmospheric Physics, LAPETH) and the Institute for Climate Research ICR (formerly the Institute for Geography).

The document recounts the history and major developments of these institutes from the time of their foundation, and it provides an overview of the teaching and research in the atmospheric sciences such as climatology, meteorology, glaciology, etc. from the foundation of the "Polytechnikum" (which later was renamed into ETH) in 1855. In 1880, the operational activities related to weather observation and forecast were separated from ETH and this coincided with the founding of the Swiss national weather service – at that time called "Meteorologische Zentralanstalt".

The period covered by this document ends with the year 2011, exactly fifty years after the unspectacular foundation of the first institute specifically dedicated to atmospheric science, the "Laboratorium für Atmosphärenphysik".

The report was authored by three individuals, each covering a certain period. There is inevitably some overlap between the different parts, and the style of the different sections is not uniform. Only a minimal harmonization of the contributions was attempted and hopefully achieved, but it was decided not to change the personal style of each section.

We realize that the report is incomplete and that certain developments may be missing. Moreover, there have been important steps and decisions for which no written accounts exist. Nevertheless, we have sought to provide a picture that is as objective as possible, whilst at the same time acknowledging that the weighting of different issues remains subjective.

2 Acknowledgments

We thank our colleagues at ETH and at MeteoSwiss for numerous discussions and hints. The compilation of some of the Appendices was massively supported by our colleagues.

A great help in gathering information were protocols deposited in the archives of ETH. Here we want to express our thanks to the personnel of the ETH library, and in particular to Ms. Marion Wullschleger. The staff were always very helpful in locating relevant documents.

Images were downloaded from the Image Archive of the ETH Library or provided by former members of the institute and this is gratefully acknowledged.

Finally, we are deeply indebted to Dr. Fritz Schiesser, President of the Board of the Swiss Federal Institutes of Technology, ETH Board, for his permission to consult some confidential protocols of the *School Board* [Schulrat].

The Authors

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Part 1

Atmospheric Science at ETH, from its Foundation to the Creation of the Laboratory for Atmospheric Physics (LAP), 1855 to 1962

by

Hans Richner

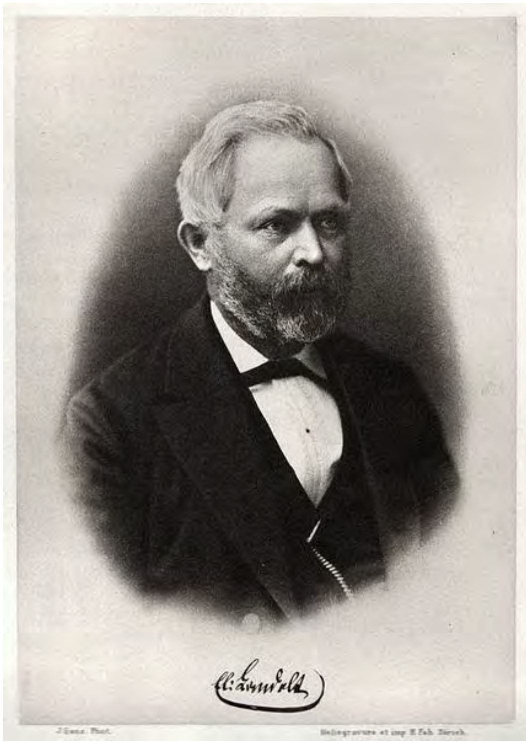
The main building of the Polytechnikum built by Gottfried Semper in the years 1858 to 1864

3 First activities related to meteorology, the birth of MeteoSwiss

Atmospheric science was of interest within ETH from the very beginning: ETH itself was founded in 1855 under the name *Polytechnikum*. Already volume 1 of the *Schweizerische Polytechnische Zeitschrift* which appears in 1856, contains an announcement [Anzeige] with a list of books for individuals planning to study physics at the *Polytechnikum*. Under the heading *Physik*, this list includes a book by J. Müller entitled "Grundriss der Physic und Meteorologie" [Basics of Physics and Meteorology], at this time a standard textbook used in upper-level secondary schools. Thus, from the early days, meteorology is considered a part of physics.

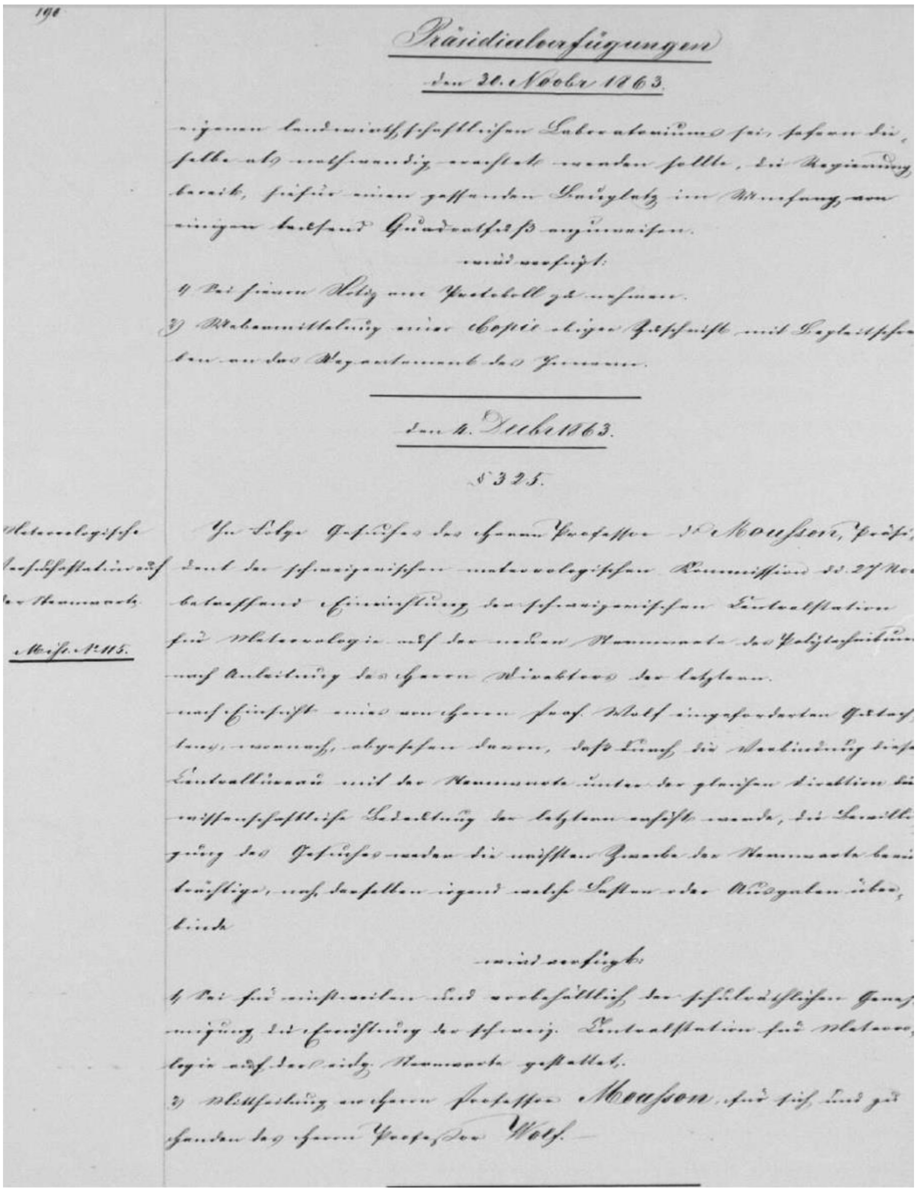
In the *Program of the Federal Polytechnic School for the Summer Semester 1860* [Programm der Eidg. Polytechnischen Schule im Sommersemester 1860], for the first time, a meteorology-related lecture is listed, namely *Experimental Physics and Meteorology* [Experimentalphysik und Meteorologie] to be given by Albert Mousson. (As early as 1837, Mousson lectured meteorology at the University of Zurich.) Research activities covered by Mousson include barometric height computation, wind systems and trajectory computations in a rotating system. In the same lecture list of 1860, climatology there appears in form of a lecture *Soil Science and Climatology* [Bodenkunde und Klimatologie] by Prof. Landolt, offered to students attending the *School for Forestry* [Forstschule].

Prof. Johann Rudolf Albert Mousson (1805 – 1890), physicist and malacologist, the first professor at ETH to lecture on meteorology.



Prof. Elias Landolt (1821 – 1896) forest scientist, giving lectures on climatology for the first time.

In 1864, a country-wide meteorological observing system with 88 stations operated by the Swiss government comes into operation, whereas previous attempts to run such a network by scientific organizations had failed. The *School Board* [Schulrat], i.e., the body supervising the "Polytechnische Schule", is asked to establish the "Meteorologische Centralstation" to manage the network, and to collect and archive its data. To this end, a room is equipped in the newly built Astronomy Observatory. Naturally, Prof. Mousson plays a key role not only in the design of the observation network but also in the planning of the activities at the "Centralstation". This latter station is overseen by an assistant named Robert Billwiller.


Präsidialverfügungen

den 30. Novbr 1863.

den 4. Decbr 1863.

§ 325.

Presidential decree for the installation of the "Meteorologische Centralstation" on the premises of the Astronomy Observatory, dated November 30, 1863. Prof. Mousson is mentioned as initiator; on the last line, it states that Prof. Mousson and Prof. Wolf (Head of the Observatory) should be informed.

Sadly, activities and operations at the *Centralstation* are initially subject to strong criticism. However, with time, opinions change. The publication of meteorological data and climatological analyses is considered to be of increasingly societal value, in particular for agricultural purposes, and a commission, the *Meteorologische Commission*, is set up to oversee the activities. In fact, meteorology is now considered a new emerging scientific activity, important enough that a *Bundesrat* (Federal Councillor) chairs the *Commission* during the first decade of its existence; the assistant Billwiller serves as secretary. Subsequently, activities at the *Centralstation* are expanded, and in 1881 its status is upgraded from *Meteorologische Centralstation* to a Federal Institution under the name *Meteorologische Centralanstalt*. In effect, this elevation constitutes the birth of the Swiss Meteorological Service, and Robert Billwiller becomes its first director.

As the *Centralanstalt* assumes more duties, it requires more room. In 1890 it moves from the Astronomy Observatory to the ETH's physics building on Gloriastrasse, and is simultaneously renamed the *Meteorologische Zentralanstalt* (MZA). Despite its location on the premises of the *Polytechnikum*, it is organizationally independent. Its activities include collection, analysis and archiving of meteorological data, issuing of weather forecasts, and conducting climatological studies. In 1949; then, "MZA" moves to a new building on Krähbühlstrasse.

In 1905, Billwiller passes away unexpectedly. His successor Dr. Julius Maurer (1857 - 1938), a radiation specialist, remains director until 1934.

Robert Billwiller (1849 – 1905) begins his career in 1864 as assistant for the *Meteorologische Centralstation* at the *Polytechnikum*, is promoted to the secretary of the *Meteorologische Commission* and in 1881 becomes 1881 the first Director of the *Meteorologische Centralanstalt.* He retains his position until his death in 1905.

The Physics building of the *Polytechnikum*, home of the *Meteorologische Zentralanstalt* from 1890 to 1949.

4 Teaching meteorology in the second half of the 1800s

Alongside the installation and operation of the *Meteorologische Centralstation*, meteorological and climatological activities at the *Polytechnikum* continue at a low level. The teaching of meteorology in these early days is strongly shaped by August Weilenmann. Having completed his diploma studies in mathematics and physics with outstanding grades in 1865, Prof. Wolf, the Director of the Astronomy Observatory, employs him as an assistant and assigns him the task of monitoring the meteorological elements. In 1874 he leaves the Observatory to take a position as teacher for mathematics – later also for physics – at the *Kantonsschule Zürich*.

In parallel to these two positions, he lectures on meteorology and climatology at the *Polytechnikum* since 1869. His course on *Meteorology* is given on a regular basis, and from time to time he gives special courses that include *Klima in Europa*, *Zusammenhang der meteorologischen Elemente untereinander* [relation among the meteorological elements], *Meteorologie der Schweiz*, *Ausgewählte Kapitel aus der Meteorologie* [selected meteorological topics]. In addition in 1885, Weilenmann is asked to provide a special course for both the *Forestry School* and the *Agricultural School*.

Indeed a related Swiss organization was the *Central Institution for Forest Research* [Centralanstalt für das forstliche Versuchswesen] that pre-existed the founding of the *Centralanstalt* at the *Polytechnikum.* In 1886, new regulations are issued for its Forest Field Station [Forstgarten] so that the Station's assistant [Gehülfe] who is responsible for the maintenance of this meteorological station (not a part of the official network) is charged with forwarding the data to the *Meteorologische Centralanstalt*. This coincides with the formal extension of the *Meteorologische Centralanstalt's* responsibilities.

By 1892 the regulations for diploma students in forest science require them to pass the first of their series of examinations ("Vordiplom", after the third semester), ten subjects that include *Klimatologie und Meteorologie*. Consequently, Weilenmann expands the title of his basic lecture to *Meteorologie und Klimatologie*.

In early 1901, Weilenmann, perhaps unhappy with the lack of formal recognition, informs the *School Board* [Schulrat] that he plans to withdraw from his teaching activities at the *Polytechnikum*. In response, the *School Board* requests the *Federal Council* [Bundesrat] to award Weilenmann the title of a Professor *honoris causa* for his service to and scientific activities at the *Polytechnikum*. As a result, Weilenmann continues his teaching activities. Professor Weilenmann suffers a stroke in October 1906 and passes away in November of the following year.

Prof. hon. Dr. August Weilenmann (1843 –1906) who shapes the education in atmospheric science at the *Polytechnikum* during the first 32 years.

4.1 Teachings in meteorology parallel to Weilenmann

In addition to Weilenmann's activities, there are from time to time other lectures in atmospheric science. In 1868, Dr. Egli, a physical geographer, offers a course that includes meteorological issues. In 1888, Dr. G.H. von Wyss a newly employed assistant at the Physics Institute lectures on "Meteorologische Optik".

From 1894, Prof. Dr. Früh, a professor for physical geography, lectures on *major atmospheric phenomena* [Haupterscheinungen der Atmosphäre] in parallel to Weilenmann's

"Meteorologie und Klimatologie". Früh's program is primarily for geography students, whereas Weilenmann targets the needs of students in the *Forestry School*.

A sidelight to ETH's attitude to Meteorology is offered by the "techn. Bureau C.A. Ulrich & Cie, Zürich" filing a request to the *School Board* that a so-called Lambrecht-column (a weather station) be erected in front of the *Polytechnikum* (it is not clear whether toward the city or in front of the main entrance). The firm includes its own tender for the work, but the *School Board* on "considering the modest financial means for equipment and furnishings" [for the *Polytechnikum*] decides NOT to pursue the matter, "and continues its agenda".

Weather column by the Lambrecht Company (illustration in their 1895 catalog);
the instrument is NOT installed in front of the Polytechnikum.

§ 125.

Der Präsident legt dem Schulrate das Gesuch und die Offerte des techn. Bureau C. A. Ulrich & Cie. in Zürich (Nr. 515) vor, betr. die Errichtung einer Lambrechtschen meteorologischen Säule vor dem Polytechnikum und beantragt, mit Rücksicht auf die ohnehin bescheidenen Mittel, mit welchen die Schule für Anschaffung von Unterrichtsmitteln und Mobiliar aller Art haushalten muss, auf das Gesuch nicht einzutreten. Der Schulrat stimmt dem Vorschlage seines Präsidenten zu und geht zur Tagesordnung über.

Mitteilung an erwähnte Firma durch besonderes Schreiben.

Decision number 125 on the request for a weather column by the *School Board*; September 23, 1902

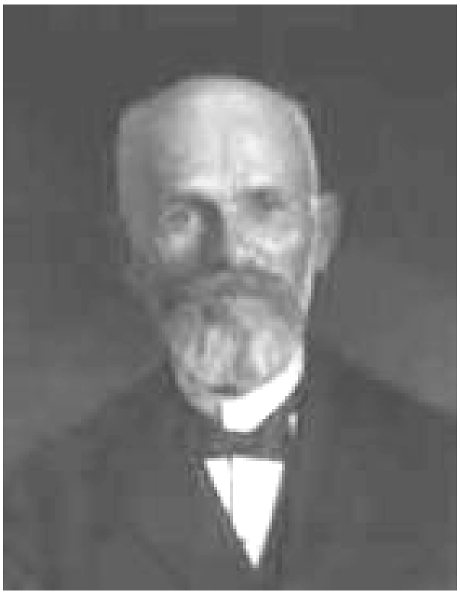
In contrast, the heads of the *Forest School* and *Agricultural School* are more successful. At the end of 1906, they – at an earlier instigation of Weilenmann – request the installation of a meteorological station for use by students. The *School Board* approves the project and grants CHF 250.00 for establishing the station, and in addition a display box is issued for two weather reports by the "Meteorologische Zentralanstalt". Incidentally, the supplier is the "techn. Bureau C.A. Ulrich & Cie"...

The *Centralanstalt's* presence within the Astronomy Observatory is not without its challenges. For example, an order issued in 1905 stipulates explicitly that the newly appointed janitor for the Observatory is to fulfill his duties according to the orders of the Observatory Director (at this time Prof. Wolf); and is NOT allowed to assume any other work, e.g., for the *Meteorologische Centralanstalt*!

Likewise in 1906, the *School Board* writes to the new Director of the *Meteorologische Zentralanstalt*, Dr. Maurer, indicating that for the operation of "a few" emergency lamps, the MZA is to be allowed to run two wires to the transformer of the physics laboratory under the condition that MZA covers the cost of "installation, meter, and energy". A copy of the letter is also forwarded to the head of the physics laboratory, Prof. Dr. Weiss.

Hence, while there is no direct mention of problems between the *Polytechnikum* and the *Meteorologische Centralstation* (later the *Meteorologische Zentranstalt*), the wording of minutes and decisions leaves little doubt that the coexistence is not always friendly and easy. While it certainly was a logical choice to originally install the *Centralstation* in the Astronomy Observatory - astronomers have much interest in meteorological data since their activities are often limited by the state of the atmosphere – its Director appears extremely careful that the *Centralstation* does not spread out or consume directly or indirectly any of his administrative and financial resources. The same can be said for the relationship between the Physics Institute and "MZA" after the move.

From 1907, after the sudden death of Prof. Weilenmann, Prof. Dr. Früh, professor for Physical Geography, takes over Weilenmann's lectures. He replaces *Meteorologie und Klimatologie* with his own lecture *major atmospheric phenomena* [Haupterscheinungen der Atmosphäre], and the length of the lecture course is reduced from three to two hours per week.



Prof. Johann Jakob Früh, (1852 - 1938), founder of the Institute for Geography ETH (around 1900). His most prominent publication is the three-volume standard book "Geographie der Schweiz".

5 A new person appears

5.1 Raymund Sänger's early years at ETH

In the list of students for the winter semester 1916/17, the name Raymund Sänger appears for the first time. He is enrolled as student number 1570 in the *Specialty Department for Special Subject Teachers for Mathematics and Physics* [Fachabteilung für Fachlehrer für Mathematik und Physik]. Next to his name is a symbol indicating that Raymund Sänger – although enrolled – is on leave. Sänger, born on December 17, 1895, is most probably on military service.

In 1921, Sänger receives a diploma for teaching mathematics and physics. Together with colleague Fritz Zwicky (who later becomes an astrophysicist and invents the Morphologic Analysis), he is employed as assistant for physics. After one year of teaching as substitute in Zurich, Winterthur, and Aarau, Sänger returns to the Physics Institute of ETH. Prof. Debey is impressed by Sänger's scientific qualities and installs him as his personal assistant in 1926.

Only one year later, Sänger submits his doctoral thesis "Die Temperaturempfindlichkeit der Dielektrizitätskonstanten von CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 in dampfförmigem Zustand" [The temperature dependence of the dielectric constant of CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 in vapor phase]. His examiner is Prof. Debye and co-examiner is Prof. Scherrer. The thesis is quite remarkable (see Appendix A) in that it consists of a mere eight pages – literature list and curriculum vitae included! With this research, Sänger supports Debey's dipole theory, and molecular structure becomes a focus of his subsequent work and the topic of his habilitation in 1931.

In the military, Sänger is in the artillery. He eventually becomes Captain of the "Forward Observer Artillery Company 6" in charge of building up the new Artillery Weather Service. Being physicist, he is fascinated by the question of how atmospheric parameters affect the path of a projectile, and eventually, he becomes a ballistics expert. One of his subordinates (Heinrich Medicus, priv. comm. 2008) recalls that "Sänger was not an outstanding commander, but he was certainly at the right place for building up the new service."

Some of the required measurements can be made on the surface and extrapolated to the lower atmosphere. However, particularly for the effects of the wind on the projectiles, upper air data is mandatory. A key factor in Sänger's development was his visit to his former colleague Fritz Zwicky, then teaching at Caltech, Pasadena, where he was able to discuss the deployment of balloon-carried radiosondes.

5.2 Sänger's struggle for recognition

In March 1948, ETH proposes granting Sänger the title of an Adjunct Professor [Titularprofessor] "in recognition of his lecturing at ETH" – no adjectives, neither positive nor negative. The *Federal Council* grants him the title. But Sänger is not happy with his position and he contacts Pallmann again and again. Pallmann has sympathy for Sänger and supports him. Within the next ten years, the *School Board* concludes that there is indeed an imbalance between Sänger's accomplishments and activities on one hand and his salary and recognition on the other. In 1960, Sänger bypasses not only the professors of the Institute for Physics but also all ETH officials and the *School Board* and writes directly to the *Federal Councillor* Hans Peter Tschudi proposing the establishment "without delay" of a chair for atmospheric physics and to appoint him, Raymund Sänger, to this chair. In the event of this proposal not being met, he indicates that he should nevertheless be given the right to officially act as reviewer for doctoral theses.

Sänger's list of arguments for the new chair is impressive and in many respects visionary. He notes the needs for: a curriculum in meteorology; the training of experts in meteorology for aviation, agriculture, and industry; a focus on industrial contamination of the atmosphere; artificial weather modification for precipitation enhancement and hail prevention; support for space research by satellite. To this end, he proposes two teaching foci, namely "Physics of the Atmosphere" and "Synoptic Meteorology", and the entire process should be achieved in an organic step-by-step manner, culminating later in the addition of a special chair for "Space Research".

In turn, the *School Board* recognizes that Sänger's request is motivated by his desire to improve teaching and research in atmospheric science. The Board also, recognizing that the importance of meteorology has greatly increased, notes "With great personal dedication and gratifying success ... [Sänger is] dedicated to the care and promotion of atmospheric physics." It is pertinent to note that contemporaneous external reviews and the response to his research confirm that Sänger is an internationally recognized expert.

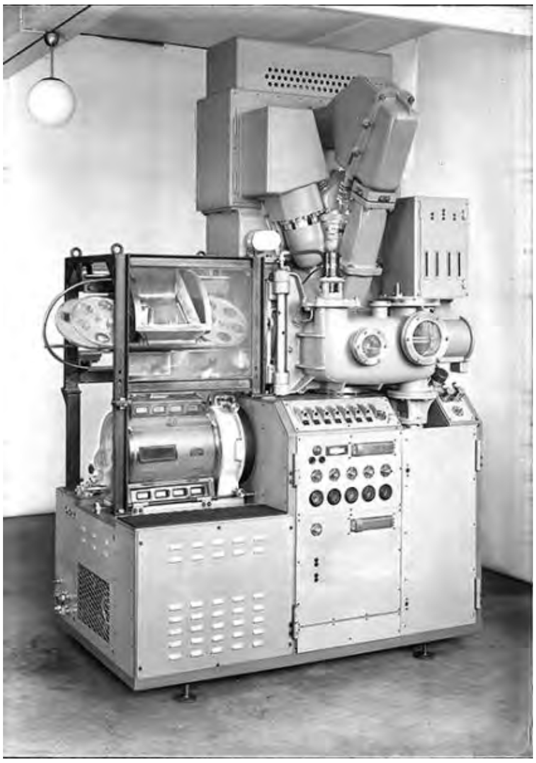
5.3 Sänger's scientific activities

Sänger was active in many fields of science. He had first undertaken research in molecular physics, investigating dielectric properties and ferromagnetism. Thereafter, driven by his military activities, he has become an expert on ballistics and sound propagation, two topics of great interest in artillery with both requiring a sound understanding of the physics of the atmosphere.

When the cumbersome, but ultimately successful Eidophor project (the construction of a television projector for theater-sized screens) is initiated at the Institute for Industrial Research [Abteilung für Industrielle Forschung AFIF], a subdivision of the Institute for Technical Physics, Sänger cooperates utilizing his expertise on molecular science. Apparently, his contributions to finding a reflecting oil surface are much appreciated. Apart from doing physics, he also demonstrates his organizational expertise by managing several international meetings and conferences of television experts.

When in 1947 the inventor of the Eidophor and head of the AFIF, Fritz Fischer passes away aged 49 years, Raymund Sänger is proposed as his successor. However, at this time, a new interesting topic – weather modification – fascinates Sänger, and he turns down the offer.

In 1949, a group of professors in the Physics Institute decides to launch a new journal: "Zeitschrift für angewandte Mathematik und Physik (ZAMP)", (Journal of Applied Mathematics and Physics), and Sänger becomes its editor. The first issue is published in 1950, and initially, articles in German by ETH professors dominate the journal's contents. However, in his twelve years as editor, Sänger establishes ZAMP as an internationally well-reputed journal.



The first prototype of the Eidophor 1943 in the old physics building, developed under Fritz Fischer.

5.4 The Grossversuche

In 1948 the *Federal Office for Agriculture* [Abteilung für Landwirtschaft] starts experiments with small rocket grenades intending to suppress hail damage in Ticino, southern Switzerland. Among the participating institutions are the Swiss Meteorological Service, the Military, the Swiss Hail Insurance Company, the Canton Ticino, and a private company. At this juncture, ETH is not involved. A perfect organization keeps track of every launch, records the local weather, compiles the expenses, and details the activities of the numerous volunteers. However, there remains one overarching issue: How do you prove any effect? Already in their first report, the organizers produce a somewhat philosophical discussion on how prejudice in one or the other direction could influence the results, and they indicate the need for accompanying scientific studies.

In response in 1950, the *Federal Council* sets up the *Federal Commission for Studying Hail Formation and Hail Prevention* [Eidg. Kommission zum Studium der Hagelbildung und Hagelabwehr]. Its aim is to find methods for reducing losses in agriculture, and in the process determine whether the traditional belief that explosions could break up hailstones could be substantiated. Sänger, atmospheric scientist and artillery expert, seems to be the right person to oversee the project and verify the results. Thus, Sänger becomes Director of the Commission.

Realizing that a physical destruction of hailstones by nearby explosions is impossible, the experiment is terminated in 1952. However, based upon the idea that silver iodide (AgI) particles brought up into the clouds by convection could serve as crystallization nuclei producing many small hailstones rather than few big ones, Sänger set up a new large-scale experiment, the Grossversuch II, using ground-based AgI generators. In the yearly reports issued by the *Federal Office for Agriculture* Sänger features as the first author of the (often critical) conclusions. He officially accepts the parts written by the other partners, but there are no scientific discussions. The scientific work appears elsewhere in scientific journals.

Parallel to the field experiments, the formation of hailstones is studied in the laboratory at the *Osservatorio Ticinese*, (the research institution of the *Meteorologische Zentralanstalt*), the *Swiss Federal Institute for Snow and Avalanche Research* on Weissfluhjoch, and at ETH. In particular, the suitability of silver iodide (AgI) and sodium iodide (NaI) as crystallization seed (when water becomes ice) is investigated, resulting in a number of scientific articles.

6 The Laboratory for Atmospheric Physics

6.1 The "foundation"

Sänger's activities are now widely recognized but he remains a minor cog within the Institute for Physics. In this circumstance, on February 23, 1961, Sänger asks his secretary, Ms. Helen Studer, to order 100 copies of envelopes and stationery carrying the label "Laboratorium für Atmosphärenphysik" from the ETH print shop. There is an ambivalent response, possibly prompted by a physics professor, and the shop contacts the secretary of the *School Board*, Dr. Bosshardt. His reply: "There is no such laboratory at ETH!" But Sänger's secretary insists: "The name is in the telephone directory, and is *de facto* approved by Dr. Pallmann, the president of the *School Board*." Although in general very supportive of Sänger, Pallmann dissents from this view stating that he has never approved the laboratory and, furthermore, accuses Sänger of "small finger tactics" [1]. Bosshardt's official reply to Ms. Studer states that there is no "Laboratorium für Atmosphärenphysik" at ETH and, therefore, no such stationery can be printed. Period.

But Sänger does not give up! In a further step, he writes a letter to Pallmann, pointing out that there are other "Laboratoriums" within the Physics Institute which also have their own stationery and telephone entry. Pallmann having consulted with the head of the Physics Institute meets with a delegation of four physics professors for a meeting on June 8, 1961. This results in an agreement – without enthusiasm! – to recognize the "Laboratorium für Atmosphärenphysik". On June 12, 1961, the print shop receives a letter from the *School Board* with a copy to Sänger "ordering the desired stationary ..." ["zur Bestellung des gewünschten Schreibpapiers, ..."]. Apart from this communication, there is no formal decision.

In effect, this unceremonious letter of June 12, 1961, marks the founding of the "Laboratorium für Atmosphärenphysik" at ETH. For Sänger himself it is the achievement of his long-desired aspirations for the discipline of Atmospheric Physics.

6.2 Sänger's promotion

As noted above, Sänger – although regularly consulted by industrial firms – remains an Adjunct Professor, operating very much in the shadow of Scherrer. With the status of a "notable lecturer", Sänger has since 1959 been in receipt of general teaching assignment with an accompanying but comparatively insignificant lump sum payment. In effect, his duties are akin to those of a Full Professor, but without his rights and salary. Also very significantly, Article 3 of ETH's Promotion Regulation explicitly forbids people in Sänger's position from accepting doctoral theses. Unsurprisingly, the fore-mentioned President of the *School Board*, Pallmann, is keenly aware of Sänger's situation, and sensitive to the issue of whether there should be established a chair for atmospheric physics.

Further complicating factors are the plan for the Institute of Physics to leave Gloriastrasse and move to the new campus on Hönggerberg, and the issue of whether this move is accompanied

1) The German version of the idiom "Give him an inch and he will take a mile."

by a merger of geophysics and atmospheric physics. Details of this transition need to be settled *before* discussions can commence on the question of a dedicated chair, and Sänger, who is now 53, is deemed to be too old!

The situation is resolved in a complicated and unusual fashion. Pallmann, the physics professors, and the *School Board* agree that Sänger's case is special. Further members of the *School Board* feel obligated to correct the unjustness of the past, and there are differing concerns about the future development of atmospheric science within the Physics Institute. A professorship *ad personam* is created for Sänger, granting him the title, rank, and the academic authority of an Associate Professor [ausserordentlicher Professor]. It is stipulated that the professorship will terminate with the retirement of Sänger (i.e., 1966), and will not exert any influence on future decisions regarding new organizational structures. On April 1, 1962, Sänger becomes Associate Professor for the limited duration of four years, and his salary is set to CHF 23'700 plus an extra pay of CHF 6000 because he is "neither entitled nor obliged to join the 'widow and orphanage fund' of professors of ETH".

Sadly, Prof. Raymund Sänger enjoys his new status for only half a year: On September 29, 1962, totally unexpected, he suffers a cardiac paralysis and passes away. In the subsequent issue of ZAMP, Prof. Franz Tank, a colleague of Sänger, publishes an obituary in German (see Appendix B), and a year later, Prof. Peter Debye publishes a fulsome appreciation of Sänger's personality and achievements. He writes: "… What distinguished him as a young man was his irrepressible enthusiasm linked with a tough persistence in taking the necessary trouble. He was not interested in success in any external sense of worldly recognition: it was the problem itself which commanded all his attention. …" (ZAMP, 14, 1963, p. 401).

Following Sänger's death, ETH moves quickly, and on October 17, the *School Board* appoints Werner Känzig, Professor for solid-state physics, as head of the Laboratory for Atmospheric Physics *ad interim*. Given Sänger's aptitude for research, it is also pertinent to record that at the time of his death, several students are pursuing doctoral studies on the formation of ice particles, and research is being undertaken on the Grossversuch in the Ticino.

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Part 2

The Consolidation of the Laboratory for Atmospheric Physics at ETH (LAPETH), 1962 to 1980

by

Hans Richner

Field station Merenschwand with ballooning facilities and remote sensing instrumentation.
(Image courtesy of Werner Nater)

7 The Laboratory for Atmospheric Physics receives a more solid base

7.1 The search for a new professor

Although many of the professors in the Institute of Physics appeared not to be particularly enthusiastic about atmospheric science, there is a common understanding that the "Laboratorium für Atmosphärenphysik" has indeed become a part of the Institute and that a replacement for Sänger should be found. On May 14, 1963, following the request by ETH, the *Federal Council* decides to establish an Associated or a Full Professorship for "Atmosphärenphysik." The chair is advertised in newspapers and scientific publications. This results in six individuals officially applying and a further ten invitations issued to additional individuals.

One of the applicants is Hans-Ulrich Dütsch, a physicist active in ozone research. He has worked together with Prof. Götz of the University of Zürich, measuring ozone at the *Light Climatic Observatory Arosa* [Lichtklimatologisches Observatorium Arosa] and analyzing the data. Dütsch has found a permanent position at the National Center for Atmospheric Research (NCAR) in Boulder, U.S.A., and has moved there with his family intending to stay. He returns to Switzerland regularly to oversee the measurements in Arosa, and he also gives talks at the *Society of Natural Sciences Zurich* [Naturforschende Gesellschaft in Zürich]. There are indications that at one of these meetings he was approached by President Pallmann regarding the new chair for "Atmosphärenphysik", encouraging Dütsch to apply. This poses a dilemma for Dütsch, who as Head of ozone research at NCAR, has research obligations until April 1965.

Dütsch applies for the position and, somewhat unusual for the time, includes a detailed four-page outline on the future directions of atmospheric science and the LAP, entitled "Gedanken zum Aufbau eines Instituts für Atmosphärenphysik an der ETH" [Thoughts on the establishment of an institute for atmospheric physics at the ETH] (see Appendix C). This document indicates that he is well prepared, informed about ETH's current lecture program and weather modification activities, and – most interestingly – that the stratospheric ozone layer might not remain as stable as is thought at the time.

President Pallmann attends three lectures given by two of the five applicants and one of the ten additional invitees. After consulting with senior physics professors in a "not very productive conference" ["nicht sehr ergiebigen Konferenz"], two potential professors are listed. But the participants also acknowledge that they lack expertise in atmospheric science to come to a clear decision. Consequently, it is decided to form an international board of renowned researchers to guide the decision.

Revealingly at this time, many physics professors voice criticisms of almost all the candidates for engaging with "non-pure systems" ["unreinen Systemen"], and to view geophysics and atmospheric physics as "non-pure physics involving second rate scientists" ["unreine Physik zweitklassiger Gelehrter"]. Some are of the opinion that none of the applicants has the "desirable world format" ["wünschbares Weltformat"]. In contrast, Prof. Albert Frey-Wyssling, Rector until 1961, criticizes the physics professors for their arrogance and points out that this attitude lay at the heart of the problems experienced by Sänger.

In Spring 1964, the international selection committee reports back, stating that it proposes two candidates; five votes were cast for Hans-Ulrich Dütsch and four to the other individual. This result is passed on to the professors of the Physics Institute, and the candidates are invited to give presentations. Dütsch proves to be the preferred candidate and it is stated that "He presents himself as a true lecturer ... He spoke clearly and generated excitement, in the discussion he answered the physicists precisely and knowledgeably, and also that he is an agreeable individual" ["Er zeigt sich als ausgesprochener Dozent. ... Er sprach klar und erzeugte Spannung; in der Diskussion antwortete er den Physikern präzis und kenntnisreich. Auch menschlich ist er angenehm"].

The *School Board* recommends that the position be designated a Full Professorship, and be granted to Hans-Ulrich Dütsch for a period of ten years. In turn, the *Federal Council* accepts the suggestion. Further, they agree that Dütsch will be allowed to continue his research on ozone at Arosa, but that ETH will not financially support the operations there. Because of his obligations at NCAR, Dütsch starts working at ETH on April 1, 1965.

7.2 Definition of relations between LAP and Swiss Meteorological Institute

In the early 1960s, under the competent leadership of the *ad interim* head, Prof. Känzig, atmospheric science activities continue at the LAP. The teaching includes lecturers from the "Meteorologische Zentralanstalt", and research involves doctoral students working on ice formation physics.

One of the lecturers is the Director of the "Meteorologische Zentralanstalt", Prof. Jean Lugeon. He has the status of an Adjunct Professor since 1960, but retires in 1963. President Pallmann and the responsible *Federal Councilor*, Hans-Peter Tschudi, are of the view that it would be desirable to develop a closer cooperation between the LAP and the MZA. Raymond Schneider, the newly appointed Director of MZA resolves with Tschudi and Pallmann that climate-related activities and forecasting should be the primary tasks for MZA, while basic research in atmospheric physics should remain at ETH, and that a liaison person be appointed "to organize and sustain the cooperation" ["um die Zusammenarbeit zu ordnen und dauernd lebendig zu halten"].

7.3 Ozone, the new focus of atmospheric physics

With the arrival of Hans-Ulrich Dütsch in 1965, the LAP has a new focus: Ozone! There is some research on hail formation mostly in the form of ongoing doctoral studies. Also, Dütsch inherits Sänger's role in the *Hail Commission*, but this activity is in effect dormant.

Dütsch had received his doctorate under Götz, who had initiated and sustained regular observations of ozone at the *Light Climatic Observatory Arosa* from the early 1920s. The Observatory had experienced turbulent times, politically as well as financially2) and in the 1950s, when Götz became ill, Dütsch – at the time employed as teacher – took over the ozone observations and scientific work. Until his departure to NCAR in 1962, the Arosa work had benefited from his excellent connections with the MIT, his organization of international inter-comparisons projects for ozone observations, and the funding from the U.S. Air Force and from NCAR.

On his return to Switzerland, Dütsch – having negotiated a limited engagement in teaching – can continue his research activities in Arosa. He has no obligations to give introductory courses in general physics, and his doctoral students have no obligation to work as assistants in the physics lab courses. Almost inevitably, these privileges lead to a strained relationship with some professors at the Physics Institute, and indeed the LAPETH (as it is now named) is merely granted the status of an "affiliated" laboratory with limited support from the different shops and services offered by the Physics Institute.

At this time, LAPETH is located on the top floor of the old physics building, but Prof. Dütsch visits regularly the Meteorological Institute at Krähbühlstrasse to examine the weather maps so as to help him interpret the ozone data. Much to the understandable chagrin of the Director of MZA, the new professor absconds with maps of particular interest. This results in a strained relationship between the Director and the head of LAPETH, fortunately, this does not propagate to lower levels.

To solve this problem, the LAPETH acquires a Hellfax Weather Chart Recorder to obtain charts directly from DWD, the German Weather Service, over longwave radio frequencies. However when active, the recorder emits a metallic bang sounding like a hammer hitting an anvil every second. The machine is placed in the corridor annoying everyone with offices in the vicinity. It is no accident that members of the Physics Institute refer to the LAPETH affectionately as "weather smithy" ["Wetterschmiede"], and mercifully, the Hellfax is eventually housed in a soundproof casing.

Towards the end of the sixties, stratospheric ozone depletion becomes an international issue with contrasting views held by research scientists and the manufacturers of the chlorofluorocarbons (CFCs, Freon). In this context, the regular radiosonde ozone ascents initially launched from Thalwil near Zurich and later from the Aerological Station of the Swiss Meteorological Institute at Payerne, along with the time series of the Arosa observations acquire critical importance for all parties, and with it Dütsch emerges as an acknowledged international expert.

2) For details see: Staehelin J. and P. Viatte, 2019: The Light Climatic Observatory Arosa. Scientific Report MeteoSwiss No. 104, 243 pp.

In the early 1970s, tropospheric ozone produced by intense sunlight and high levels of pollution adds another dimension to ozone research. Ozone near ground has severe effects on the respiratory systems of the population. Using technology of the ozone radiosondes, ground-based ozone networks are quickly deployed by the Institute and studies commenced on the associated complex reaction schemes.

Intercomparison at Arosa of radiosondes with ozone sensors.

7.4 *Additional research objectives at the LAPETH*

Around 1970, a new research group is established at the LAPETH. Josef Schlüssel and Hans Richner focus on the dynamics of flow over complex terrain, and in particular on local winds such as foehn. Initial efforts focus on determining the physical parameters inducing weather-related discomfort in humans. For this purpose, a field station is built in the Reuss Valley near Merenschwand and a mobile laboratory on a trailer acquired to sample spatial distributions.

Flow dynamics is studied using numerous ground-based and balloon-borne instruments. These include a sodar, (i.e., a radar using audio frequencies), and constant density balloons (i.e., balloons with a non-elastic skin) that can be tracked optically or with radar to yield air mass trajectories. Some of the instruments are also deployed for tropospheric ozone measurements, in particular the tethered balloon.

In the mid-1970s, another Grossversuch project (Grossversuch IV) is launched for hail research. Under the competent and resolute leadership of Dr. Bruno Federer, an attempt is undertaken to evaluate the so-called Russian hail prevention method in a study that involves the random seeding of clouds in settings deemed favorable for hail storms. Radar data and cumulonimbus activity serves to objectively classify potential hail-bearing or non-hail-bearing clouds. If the classification is positive, i.e. a potential hail-cloud, a random procedure is utilized to determine whether the cloud will be seeded using the Russian Oblakov rockets. These rockets disperse silver iodide particles as condensation and crystallization nuclei, and the height and the duration of the dispersion is programmed such as to be in the optimal upwind region of the cumulonimbus. At the surface the hail damage is assessed and kinetic energy of the hail-fall is measured using hail pads. This assessment is undertaken irrespective of whether the cloud was seeded or not! This resulted in two data sets for hail intensity below comparable clouds, one group seeded with AgI, the other not.

7.5 *The move to Hönggerberg*

From the early 1960s the Physics Institute plans and undertakes its move from the center of the city to the new campus on the Hönggerberg. During the planning tensions arise between some of the senior professors, and the *Executive Board* [Schulleitung] has to intervene to smooth the process. One factor was that LAPETH seeks to retain a measure of independence from the Physics Institute during the planning, and there are also discussions on the possibility of combining Atmospheric Physics with Geophysics. Indeed from the outset, the Physics Institute plans to locate Geophysics and Atmospheric Physics within the same building, and in the protocols the two institutions are always referred to as a single unit.

A key step in the process occurred on April 22, 1966 when the ETH *Executive Board* confirmed the allocation of 217.5 Million Swiss Francs for the construction of new buildings on Hönggerberg of which 153'856'000 Francs was specifically dedicated for "... the laboratory for solid-state physics, the institutes for geophysics and atmospheric physics, for the institutes for molecular biology and biophysics as well as ...".

Thereafter in the late 1960s, LAPETH personnel invests considerable time to the design of the space so as to accommodate the different requirements for laboratory space etc. – a process frustratingly complicated by the fact that the architects themselves massively modify the blueprints several times.

The campus on Hönggerberg showing the buildings housing the different physics institutes, shortly before the LAPETH moves into the tall building. (Comet Photo)

Nevertheless in 1974, the building housing the LAPETH is completed and the Laboratory for Atmospheric Physics moves into the only high-rise building (HPP) on the campus. It was initially planned that this tower block was for the Advanced Lab Course for physics students. However space inevitably proved to be scarce, and eventually the LAPETH and the Geophysics Institute are also squeezed into the HPP so that expectations of more room vanish rapidly.

One very positive development is that the LAPETH has now acquired a well-equipped mechanical shop with modern machine tools, including a lathe and a milling machine. In addition four workspaces are available with sufficient tools and a well-stocked material store is available in the cellar of the building. In effect the LAPETH is now almost independent of the material shop of the Physics Institute allowing for a much more efficient construction of special equipment for the different research groups.

A further increase to the LAPETH repertoire of instruments occurred at the end of the 1970s, when the hail research group acquires a radar. This occurred at about the same time when

Swisscom installs several large antennas on the roof of the HPP building. Initially the architect resisted the installation of the sphere-like radome housing for the radar antenna, but after discussions it is agreed that the sphere be mounted on a high pole above the Swisscom construction. This construction – colloquially referred to as the elephant cage – becomes the landmark for the Hönggerberg campus until the building is refurbished in 2006.

The building HPP on Hönggerberg where the LAPETH was located on the 7th floor from 1974 to 2006. On top of the building is the "elephant cage" with the weather radar.

Part 3

From the Laboratory for Atmospheric Physics to the Institute for Atmospheric and Climate Science, 1980 to 2000

by

Huw Davies

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ETH ZÜRICH

25 Jahre Laboratorium für Atmosphärenphysik

Das Laboratorium für Atmosphärenphysik feiert im Jahre 1987 sein 25-jähriges Jubiläum. Dieses Ereignis soll Anlass dazu geben, über die Vergangenheit, die Gegenwart und die Zukunft des Instituts in Forschung und Lehre zu berichten.

RÜCKBLICK

Der Charakter eines Instituts wie auch dessen Entwicklung werden massgeblich von den Persönlichkeiten seiner Gründer bestimmt. In diesem Zusammenhang sind vor allem zwei Namen zu erwähnen, nämlich Professor *Raymond Sänger* und Professor *Hans-Ulrich Dütsch*.

Das *Laboratorium für Atmosphärenphysik* wurde offiziell am *1. April 1962* von *Prof. R. Sänger* gegründet; zum gleichen Zeitpunkt wurde er als ausserordentlicher Professor für Atmosphärenphysik gewählt. Zuvor schon war er als Privatdozent und seit 1948 als Titularprofessor in Forschung und Lehre an der ETH Zürich tätig gewesen; seit 1954 unterrichtete er Meteorologie an den Abteilungen für Mathematik und Physik sowie für Naturwissenschaften. Nach dem unerwarteten Tod von Prof. Sänger schrieb Pof. Debye 1962 in einem Nachruf über Sänger: «Was den jungen Mann auszeichnete, war sein nicht zu bändigender Enthusiasmus, verbunden mit einer zähen Persistenz der notwendigen Bestrebungen. Nicht so sehr der mögliche äussere Erfolg oder eine erhoffte Anerkennung war es, was ihn trieb, das Problem selber fesselte ihn. Darüber hinaus konnte alles andere vergessen werden. – So fing Sänger an; so hat er sein ganzes Leben lang weiter geschafft».

Heute, 25 Jahre nach Prof. Sängers Tod, ist sein Einfluss immer noch spürbar. So war er auch der Gründer der *Zeitschrift für angewandte Mathematik und Physik (ZAMP)*. Er wirkte als Initiant und wissenschaftlicher Ratgeber von Hagelabwehrexperimenten im Tessin, deren Resultate und Auswertemethodik im Gebiet der Wettermodifikation zur damaligen Zeit aufsehenerregend waren. Seine pädagogischen und motivierenden Fähigkeiten zeigen sich wohl am besten in den Arbeiten und Karrieren seiner Studenten: Mindestens zwei von ihnen gelangten im Gebiet der Wolken- und Atmosphärenphysik zu Weltruhm; von ihnen wurden Labors an der University of California in Los Angeles und der University of Toronto gegründet. Eine für schweizerische Belange wichtige Tatsache war das Interesse von Prof. Sänger an radarmeteorologischen Messungen, und dies zu einer Zeit, als *«Remote sensing»* noch weitgehend unbekannt war. Auch hier zeigte sich der Weitblick und Pioniergeist von Prof. Sänger. Wesentliche Forschungsarbeiten im Gebiete der Radarmeteorologie aus der Schweiz zeugen von der Richtigkeit dieser Entscheide.

Vom Jahre 1962 bis 1965 herrschte am Labor für Atmosphärenphysik das Interregnum. In dieser schwierigen Zeit wurde das Laboratorium von Prof. J.P. Blaser liebevoll überwacht und beraten.

Am *1. April 1965* übernahm *Prof. H.U. Dütsch* als Ordinarius für Atmosphärenphysik die Leitung des Labors. Unter seiner Führung wurden die Aktivitäten des Instituts verstärkt und erweitert. Ein Schwerpunkt seiner eigenen Forschung war die *Photochemie des Ozons*, wo er als international bekannte Kapazität wesentliche Beiträge leistete; besonders erwähnenswert ist die längste Ozonmessreihe des *«Lichtkli-*

Lead article in the December 1987 issue of the ETH Bulletin celebrating LAPETH's 25th anniversary.

8 The 1980s and 1990s: Change, growth and consolidation

8.1 Status Quo: 1980

At the start of 1980s the LAPETH comprised a small and compact Institute with less than twenty personnel, and it was housed in the HPP tower building on the Hönggerberg. The Institute's size and culture was reflected by its weekly in-house informal seminars that were delivered in Swiss German and attended by all (- academics, workshop and administrative staff alike). Held in the small library (L17 of the HPP), the seminars were followed by coffee and cake with the latter almost invariably being baked by Frau Dütsch, the wife of the Institute's Director.

Within the ETH's structure of Schools [Abteilungen] the Institute played a dual role. It was like, say, the Institute for Astronomy an associate Institute of the School of Physics, but it was also closely associated with the School of Natural Sciences. This dual role was borne out in its contribution to the Diploma-level teaching. Under the title "Experimental Atmospheric Physics" it provided one of the specialist set of courses for third- and fourth-year Diploma students of the School of Physics, and its courses also formed an integral part of one sub-division, Abteilung 10 B4, of the School of Natural Sciences. In addition, its courses formed a part of the curriculum of the Schools of Forestry, Agriculture, and Engineering, and also to that of the University of Zürich's Geography Institute.

Its research activities centred around three small but distinct groups. A notable feature of each group was that it specialized in atmospheric observational and field measurements, and the Institute had acquired a deserved international reputation in this area of activity. The head of one research group was Professor Hans-Ulrich Dütsch, the Institute Director. At this time, he was also serving as Vice-President of the International Association of Atmospheric Physics (IAMAP) and was active within that Association's Ozone Commission. His beloved research theme of stratospheric research had for many years been a somewhat esoteric field but had moved into the mainstream with the growing concern regarding ozone depletion, the ozone hole, and the deleterious effects of near-surface ozone upon human health. In line with these concerns Prof. Dütsch's research group undertook studies both of the large-scale airflow and ozone distribution of the stratosphere, and of the micrometeorology and chemistry of the atmospheric boundary layer.

A second group, led by PD Dr. Bruno Federer, sought to observe and measure the hitherto less-readily observed features of severe storms and to this end developed and deployed a range of new measurement techniques. In particular the group engaged actively in research on cloud physics and hailstorms. Contemporaneously Dr. Federer served as Director of the major international Grossversuch IV project that sought to assess the efficacy of the principal extant hail suppression technique. In effect this group's focus and efforts constituted a direct continuation of the research of Prof. R. Sänger, the Institute founder.

The third group, led by Dr. Hans Richner, specialized in another area of burgeoning research interest, viz. the field study of meso-scale flow phenomena. It had been an area bedeviled by the lack of suitable measurement techniques, and to alleviate this limitation the Group sought to design, refine, test, and exploit more sophisticated instrumentation. Thereby it could provide a rich source of new observational data on a range of meso-scale flow phenomena. Particular attention was being devoted to examining the development and detailed structure of Föhn flow, and this was being done in part in the ramp up for the international ALPEX field experiment whose major field component was scheduled for Spring 1982.

In effect the LAPETH's teaching and research at the beginning of the 80s marked it out as an avowedly atmospheric physics-centred Institute. Admittedly the title of one of the Institute's most well attended introductory lecture courses was 'Meteorology', and Prof. Dütsch's regular 'Weather Column' in the Neue Zürcher Zeitung was widely read and appreciated by the general public. However, the emphasis upon the discipline's firm physical foundations was deliberate and deemed to be highly desirable for an Institute embedded within the ETH's School of Physics.

However, there were two factors that would prove seminal in broadening the Institute's scope and perspective in the subsequent decades. Firstly, its dual role within the ETH's teaching structure with a foot in both the physical and the natural sciences and secondly its research focus upon observed phenomena would together provide a platform to enable it to respond constructively and with agility to the sea-change of institutional and scientific challenges that would arise in the late 80s and through the 90s.

8.2 The 1980 to 1987 period

The first half of the 80s found the LAPETH confronted with a significant mix of planned and unplanned developments. One challenge was posed by the striking advances achieved during the previous decade in the theory of large-scale atmospheric dynamics and modeling and in the practice of Numerical Weather Prediction. These developments had opened up new vistas for Meteorology and the Atmospheric Sciences that had often not been matched by comparable development in the curricula and research of academic institutions.

The LAPETH had first addressed this challenge in 1978 with the appointment of Fritz Herbert to a new Chair in Theoretical Meteorology. Prof. Herbert arrived from the Institute of Meteorology at the Johannes Gutenberg University in Mainz, engaged in atmospheric boundary layer research at the LAPETH, and then departed in 1979 to take up another professorial position at the Institute for Meteorology and Geophysics of the University of Frankfurt.

There followed in summer 1982 the appointment Huw C. Davies to a Professorship at the ETH from the University of Reading in the UK. His appointment reflected the fact that the Department of Meteorology at the University of Reading had been in the vanguard of establishing atmospheric dynamics as a sophisticated physico-mathematically based academic discipline that linked directly to the general mathematical modeling of environmental systems and to the challenges of numerical prediction confronting national weather services. Progress made in atmospheric dynamics had helped remove, or at least substantially alleviated, the long-standing stigma associated with the presumed predominantly empirical nature of Meteorology.

Following his appointment Prof. Davies aimed at establishing this new field of research within the ETH. To this end he engaged in research on the dynamics both of weather systems and of Alpine flow, and thereby forged synergies with ongoing LAPETH research and with the activities of the Swiss Weather Service. Establishing a research group in the new field was aided by an 'El Dorado' supply of high-quality students. For example, the first four students to volunteer to do a Diplomarbeit with him went on become professors at the University of Bern (Thomas Stocker), University of Heidelberg (Kurt Roth), University of Applied Sciences of Western Switzerland (Peter Egolf), and the ETH (Christoph Schär).

Collaboration within the Institute and with its sister Institute, the Institute of Geography was exemplified by the activities associated with ALPEX (The Alpine Experiment) programme. It was the last in the series projects associated with the Global Atmospheric Research Programmes (GARP), and was geared to promoting research on and examining features of Alpine meso-scale flow phenomena. Dr. Richner played a major role in the planning of the programme, and he along with Professor Ohmura and the Swiss Weather Service contributed substantially to its execution.

An unplanned development of the early 1980s related to Grossversuch IV. In late 1982 the project was reaching its final phase with widespread national and international interest, and Dr. Federer had presented some of the project's latest results at a conference in South America. In October a special session of the annual SNG event, held that year in Basel, was devoted to the project and was addressed by Dr. Federer. Likewise, in 1982 the LAPETH's Winter Semester seminar programme focused on the project and included presentations by Dr. Federer and his lead associate Dr. Albert Waldvogel. This bustle of activity heightened the sense of shock and loss at Dr. Federer's unexpected and sudden death on Christmas Eve 1982.

Bruno Federer was an exuberant character, a charismatic leader, and a diligent scientist who blended the experimental physicist's arch quality of careful attention to detail with a direct and incisive approach. Likewise, in personal relations he could be, depending upon the circumstances and setting, assertively abrasive or gentlemanly polite. His early death cut short the career of an energetic and forceful leader, and his loss was keenly felt by the LAPETH.

For a complex and on-going major project such as Grossversuch IV, the loss of its dominant leader could have been catastrophic. However, if two measures of a successful leader is that person's ability to select suitable team members and to enable them to develop their potential, then Dr. Federer proved to have been remarkably effective. His associate and deputy, Dr. Albert Waldvogel, stepped in to lead the research group and to head the Grossversuch project, and did so with equanimity and competence. By the Spring of 1983, he had fully established himself, been accepted by colleagues within the group and by the international collaborative partners, brought the last field phase of the project to a successful conclusion, and presided effectively over a successful press conference announcing its final results. A notable component of the final field phase was the management of the flight of a heavily reinforced research aircraft (the T28) into the central core of an active thunderstorm.

Another landmark event occurred in mid-1984 when Prof. Dütsch, ahead of his pending retirement, stood down as Director of the Institute after an eventful 19 years. He had led the Institute from its fledgling and decidedly precarious status within the School of Physics to it being accepted and appreciated as an important player within the overall ETH structure. His replacement as Director was Huw Davies.

In this new configuration the LAPETH leadership sought to broaden the scope of the lecture courses within the School of Physics and to stimulate a re-think of the structure, scope and strategy of the environmental sciences within the School for Natural Sciences. In principle the former objective would have required detailed consideration and approval by the School, but was achieved in practice by undertaking step-by-step updates and adjustments of the syllabi for the pre-existing courses. The second objective was confined specifically to the physics-based component of the Abteilung X B4 syllabus, but it helped sow the seed for a vision that would within a decade result in the formation of a new institutional structure within the ETH encompassing the environmental sciences in their entirety.

There were two other pressing issues for the Institute's leadership. The first concerned the profile of Hydrology within the ETH. The LAPETH leadership together with Prof. Vischer, Director of the ETH's Annexe Institute for Hydraulics, Hydrology and Glaciology (VAW), advocated that a re-vamping of the ETH's Institute for Geography with an increased emphasis upon the physical aspects of the subject would form a natural home for the Hydrology component of the VAW. The advice was accepted and, together with the almost concurrent appointment of Prof. A. Ohmura to the vacant professorship in the Institute for Geography, would have far-reaching consequences for the LAPETH and for the future of climate science within the ETH.

Second, with the LAPETH gathering significant additional momentum in research, it was important to secure a suitable and timely replacement for Prof. Dütsch. A Symposium in honour of Prof Dütsch was held on the 24 January 1985, and the international speakers included Dr. C. D. Walshaw (University of Oxford), Dr. W. Attmamnspacher (DWD, Hohenpeissenberg), Prof. J. London (University of Colorado), Prof. H. Pichler (University of Innsbruck), Prof. Oeschger (University of Bern), Prof. R. Newell (MIT) and Prof. P. Crutzen (MPI, Mainz). The concurrent ETH's professorial selection procedure, that now included the new (and then revolutionary) ingredient of open seminar presentations by the short-listed international candidates, proceeded smoothly and resulted in the appointment in Spring 1985 of an internal LAPETH candidate, Dr. Albert Waldvogel, to the vacant Chair of Experimental Atmospheric Physics.

Prof. Waldvogel moved rapidly following his appointment to broaden and underpin the activities of what had previously been the Hail-Research Group. His research foci included Radar and Air Pollution Meteorology, and cloud and aerosol physics. The fruitful combination of these aspects was exemplified in the Group's undertaking of the Mt. Rigi Field Project that was geared to studying the distribution and composition of precipitation and the attendant processes over the northern slopes of the Rigi. The Group also became a key component of a new, ETH-wide, research activity entitled "WaBoLu" that brought together ETH researchers from the fields of Water, Earth and Atmospheric Science. In effect this project was an exemplary forerunner of, and helped underpin the subsequent development of, inter-disciplinary environmental research within the ETH.

In 1987 the Institute celebrated its 25th Anniversary and to commemorate the event it was invited to contribute an article to the ETH Bulletin. The article was published in the December issue and provided a resume of the Institute's history, a description of its extant teaching activities, and an overview of its current research profile. The latter served to underline the LAPETH's approach with a commitment to the feed-back loop 'Observation -Theory - Prediction - Observation'. The article ended with comments on the Institute's possible future development. In particular it highlighted the challenge to extend the depth and breadth of the Atmospheric Physics, noting that:

> *Improvement in the fundamental understanding of the basic atmospheric physical processes and their interaction aided by a range of new technological observational tools will contribute to improvement in both short-range (0 to 12 hour) and medium range (1 week to 2 months) weather prediction. The study of inter-annual and longer time scale climate variations will certainly involve collaboration with oceanographers, hydrologists, glaciologists, solar-physicists and chemists. Moreover, there is now an unprecedented measure of interest in, and recognition of, the importance of the interactive nature of the physical, chemical and biological processes that combine to sustain our living environment…*

The prescience (or otherwise) of these remarks can be assessed in retrospect.

Also, in 1987 Prof. Huw Davies handed over the Directorship of the Institute to Prof. Albert Waldvogel, who was to hold this position uninterruptedly for a decade. Another noteworthy development was the resolution of an issue that had exercised the Institute's leadership since Prof. Dütsch's retirement. The LAPETH's long-standing field out-station in Arosa ably operated for many years by Kurt Aeschbacher had been used primarily for gathering the daily series of total-ozone measurements and the acquired time-series had become the world's longest continuous record of such measurements. The time-series had played a key role in establishing the decadal decrease in stratospheric ozone, and it was viewed by some as a scientific treasure of significant national importance.

Yet the out-station's existence as a long-term monitoring station had long been at odds with the ETH's stipulated over-arching goal of undertaking research as opposed to maintaining a routine monitoring capability. A happy resolution of this quandary was achieved that involved two complementary components:

- the Swiss Weather Service would take over the routine monitoring activity, and
- the LAPETH would establish a small group dedicated to ozone research with an emphasis on analyzing the data gathered at Arosa.

This resolution ensured the continuation of the series, and as a bi-product the LAPETH created an "Atmospheric Chemistry Group" under the leadership of Dr. Johannes Staehelin. He had already been active in this field of research at the Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG).

In line with this development a gradual transition was made in the name ascribed to the Institute from the former "Laboratory for Atmospheric Physics" to the new "Institute for Atmospheric Science". This change was in line with its long-standing status as an ETH Institute, and it more accurately reflected its broadening scientific profile.

8.3 The late 80s and early 90s

In the late 80s and early 90s there were trends and developments on the international, national and ETH levels that were prompted by the rapid expansion of science and the attendant increased investment from the public purse. There was an accompanying assertion that higher education (- encompassing teaching, research and administrative aspects) needed to be organized on more professional lines akin to those adopted by large corporations and business enterprises. This in turn prompted calls for each University to be more accountable in terms of its use of resources, more relevant in terms of its teaching courses, and to divest more administrative and financial autonomy to individual Institutes.

In addition, there was also a growing recognition amongst politicians, lay-people and the science community itself of the challenges and threats posed by climate change and environmental mismanagement and degradation. Arosa's long-term record of stratosphere's ozone content set alongside corresponding time-series of the atmosphere's CO2 content were a powerful testimony of man's sustained influence, and awareness was also fueled by individual events like the Chernobyl and Schweizerhalle disasters of 1986. The nature of the concern and the response was exemplified by the establishment of the International Panel on Climate Change (IPCC) in 1988 and the production of Agenda 21 and the Rio Declaration of 1992.

The foregoing factors contributed to a chain of overarching repercussions within the ETH that were to have a profound effect upon the development of the newly re-titled Institute for Atmospheric Science (IAS). At the level of the ETH itself the columnar 'School Structure' of the ETH was replaced in 1988 by a matrix of 'Schools' [Abteilungen] responsible for teaching and 'Departments' with oversight of the research. Subsequently in 1994 the ETH moved to Departmental structure alone, and with time the Departments were to acquire more autonomy. In turn this organizational change prompted entire segments of the ETH to re-evaluate their goals, assess their effectiveness, and refine their aspirations.

A repercussion at the level of the School/Departments was that professors with research interest in the fields of atmospheric, soil, ecology and water science came together to form a School of Environmental Science at the beginning of 1988, and to form a separate Department of Environmental Science (D-UMNW) in 1990. The new entity, with IAS constituting one of the founding and influential Institutes, sought to offer a coherent, integrated and inter-disciplinary curriculum leading to a Diploma, and to promote inter-disciplinary research across the broad swath of environmental science. From its inception the Diploma proved an enormously attractive, with 180 students in its first year, and it soon dwarfed the combined student numbers of the internationally renowned Schools of Physics and Chemistry. Thereby in a matter of a few years it changed the ETH's teaching landscape.

The IAS itself had doubled in size during the 80s, and on two occasions plans were unsuccessfully made to house the IAS in new and enlarged premises. For the IAS the establishment of the D-UMNW had serious repercussions and opened up new opportunities. On the one hand there was an inevitable weakening of its link with the mother School / Department of Physics, whereas on the other hand the IAS was now involved directly in providing teaching and practical courses for the first- and second-year students in the Schools / Departments of Environmental and Earth Sciences. Likewise, there was a strengthening of the relationship both with the Paul Scherrer Institute (PSI) and the EAWAG. Indeed, exploratory discussions were held on the possibility of bringing the Atmospheric Chemistry Group at the PSI into the IAS fold, and of forming a broad-based Atmospheric and Aquatic Science Centre located on the EWAWG site in Dübendorf.

The IAS also contributed seminally to the planning of the future development of the D-UMNW. At the start of the 90s it strongly supported the case for a Professorship in Atmospheric Chemistry. Also recognizing the comparative lack of climate modeling skills within the D-UMNW, the IAS tabled a discussion paper whose goal was to establish a research initiative for "An Inter-disciplinary Group to Study Aspects of Climate" with an emphasis in the first instance upon modeling the Alpine Environment. The document met with the Department's approval, and a position was assigned for a junior professorship in this field to be included in the D-UMNW's first multi-year professorial planning document. In 1992 Christoph Schär, a former doctoral student of the IAS, was appointed to this professorial position.

This development harmonized smoothly with a new national initiative. In response to the increased awareness of environmental challenges, the Swiss National Science Foundation (SNF) had set up a series of Special Environmental Priority Programmes (SPPUs) with each programme to entrain researchers from several Swiss Universities. One of the selected programmes was "Climate and the Environment of the Alpine Region" (CLEAR). It was initiated in 1992, designed to be a coordinated, multi-faceted research programme on climate change issues relating to the Alpine region, and an IAS professor, Huw Davies, was appointed to serve as the Director.

8.4 The 1995 to 1999 period

A welcome development in 1995 was the appointment of Dr. Hans Richner to an honorary professorship within the D-UMNW in recognition of his long-term and on-going contributions the IAS's teaching and research.

Also, close on the heels of the formation of the D-UMNW, there followed in September 1995 an external evaluation of the Department and its constituent Institutes. The prestigious international committee brought together for the week-long evaluation was chaired by Prof. R. List FRSC, Professor at the University of Toronto. A Swiss by birth Prof. List had decades earlier been a doctoral student of Prof. R. Sänger, the LAPETH/IAS founder!

In general, the evaluation gave a resounding vote of confidence to the Department and its professors and noted the quality and enthusiasm of the students. Moreover, aspects of its report would set the agenda for the IAS in the coming years. In addition to applauding the IAS's teaching activities and research profile, it welcomed the appointment of Prof. Schär, recognized the need to appoint a Professor for Atmospheric Chemistry, supported the concept of a reorientation of the Geography Institute with the upcoming professorial vacancy being allocated to the area of "Atmosphere and Hydrology", and it concomitantly made a case for amalgamating the Geography Institute with the IAS. The IAS and the D-UMNW fully accepted these recommendations.

An interesting insight to the Institute's culture was highlighted in 1996 when the IAS became an object of a study by the Swiss Academy for the Social Sciences on the male/female ratio of doctoral students. The ETH had long had a disproportionate number of male, in comparison to female, Diploma students, and things were even worse at the doctoral level. In contrast to many ETH Institutes the IAS had a better, but a far from adequate, ratio at the Diploma level. However until the mid-80s it had a very poor record at the doctoral level. Nevertheless by 1996 the IAS was selected as an example for the fore-mentioned study because of the strikingly large ratio of female to male doctoral students. This ratio reflected in part the apparent but unspoken decision of one professor to only appoint female doctoral students!

In light of the Evaluation Committee's fleet of positive recommendations, it would have been expected that the Institute forged ahead. Instead circumstances would intervene to force it into a phase of retrenchment. In late 1997 Prof. Waldvogel, who had had been elected Chairman of the D-UMNW some eighteen months earlier, stood down from that position and from his professorial duties at the IAS to become the ETH's Vice-President for Research and a member of the ETH's *Executive Board* (Schulleitung). This appointment bore out the exceptional administrative qualities of Prof. Waldvogel and his sterling leadership of his research Group. The development of the IAS over the previous decade had owed much to his unstinting efforts, and he had also played a key role in the development of the Department of Environmental Science.

Also, in 1997 Professor Schär was appointed to the new Chair of Climate and Hydrology in the ETH's Geography Institute. He had been a highly valued member of the IAS and his enterprise and enthusiasm, energy and effort permeated very many aspects of the Institute's activities. During his short time at the IAS his initiatives included developing new lecture courses, launching and leading a cross-disciplinary seminar series on Climate Dynamics, building up a Group and undertaking research on aspects of regional climate and orographic flow, helping to spearhead international scientific initiatives, and participating fully in the IAS's administrative work-load.

The Institute recognized that the two appointments were testimony to the expertise and qualities of the individuals and that the appointments themselves reflected positively upon the perception of the IAS within the ETH, but their departure nevertheless constituted a substantial loss for the IAS. Moreover, with Departmental plans progressing for the appointment of a "Professor for Atmospheric Chemistry", the IAS now met with opposition to the refilling of the 'Professorship for Experimental Atmospheric Physics', and Prof. Huw Davies now serving a second term as Head of the Institute had to make the counter case. The case was won, but the appointment of a replacement would turn out to be an extended and convoluted process.

The inevitable process of retrenchment and consolidation was reversed with the appointment of Thomas Peter in 1999 to the professorial "Chair in Atmospheric Chemistry". The latter discipline had been propelled into the mainstream of atmospheric research following the discovery of the ozone hole and consideration of the intricate chemistry associated with the phenomenon rendered the science challenging. At the time of his appointment Thomas Peter was affiliated with both the University of Mainz and the MPI at Mainz, and at the latter institute Prof. Crutzen had cultivated a cohort of high-quality researchers. Thus, with one appointment the D-UMNW and the IAS overcame an Achilles Heel in their research profile, and secured for the ETH one of the field's leading young exponents. Prof. Peter took over as the leader of the Institute's reconstituted Chemistry Group, and within a few years widened his research portfolio by establishing a high-quality laboratory (- in the basement of the HPP), and his rapidly growing Group participated in a series of ambitious field projects.

In retrospect the IAS's development over the two decades of the 80s and 90s can be seen to be a period of quasi-continuous change with distinct phases of growth followed by periods of consolidation. At the turn of the new millennium it had evolved to become a leading international Institute for Atmospheric Science. Its leaders were active at the highest level in international and national committees and projects, served on the Editorial Boards of numerous of the field's leading journals, and engaged in and produced a fleet of research results acknowledged for their insight and relevance. Moreover, its teaching was integral to the D-UMNW, which it could be argued was a leader in the broader field of Environmental Science.

Part 4

History of Research and Teaching in Climatology at the Institute of Geography and the Institute for Climate Research at ETH Zürich, 1915 to 2001

by

Atsumu Ohmura

Research tower by the Institute for Climate Research on Greenland Summit, the tallest meteorological tower ever constructed on a glacier

9 The early beginning

The first official recognition of climate research and teaching within the ETH was in 1899 when Prof. Jakob Früh was elected Professor of Geography. He was a physical geographer, with a background in Geology. His research fields were geomorphology and paleoclimatology. In the latter field his achievements were in the area of ice age research (based on geomorphology and morainic stratigraphy) and on the Holocene. In addition his unique contributions to peat bog research was also well acknowledged.

His professorship was elevated to that of an Institute in 1915, with Prof. Früh as the head and housed in Sonneggstrasse 5. On his retirement in 1923, he was succeeded by Prof. Fritz Machatschek, a titan of geomorphology in Europe at that time. His research activities focused on large-scale mountain building and glaciology. He was succeeded by Prof. Otto Lehmann in 1928. Lehmann's contributions were in the area of erosional geomorphology, (especially for the area of Karst-formation) and were internationally respected. He also worked in a related area that today would be classified as surface hydrology.

10 New topics in the second half of the 20th century

In turn Prof. Lehmann was succeeded in 1941 by Prof. Heinrich Gutersohn. He is regarded as the founder of the national and regional planning in Switzerland. In the post-war period, Switzerland needed to introduce the nationwide strategy to reorganize the land use. Prof. Gutersohn established the Institute of National, Regional and Local Planning to carry out the research and training of planners on nationwide land-use planning, and this led the Federal Parliament to introduce laws on the planning. Indeed by the time of Prof. Gutersohn's retirement in the late 1960s, Switzerland had completed the national and regional land-use planning. Thereafter the direction of geography at the ETH became directed more specifically to physical geography. In the realm of teaching there had been, from the establishment of the institute until the establishment of LAPETH, only one lecture concerned with the atmosphere, Wetter und Klima. However with the election of Prof. Hans-Ulrich Dütsch and the subsequent expansion of LAPETH, the teaching of atmospheric science within the ETH was the subject of re-examination by a committee headed by Gutersohn and Dütsch. Thus in 1969, it was decided that LAPETH would be responsible for meteorological subjects, while the Geography Institute would be responsible for climatological aspects. The lecture course that centered on climatology was first given in the Winter-Semester 1969/70.

Prof. Gutersohn retired in 1970 and was succeeded by Prof. Fritz Müller, a glaciologist. The main foci of the Institute became glaciology, climatology, and hydrology. In particular climate research was strongly concerned with climates of the cryosphere, polar regions, and high mountain areas. Lectures on Climatology in the Faculty of Natural Sciences began in winter semester 1970/71 and were given by Atsumu Ohmura. In 1976 a second chair for Quantitative Geography was established in the Institute and filled by Prof. Dieter Steiner. He had pioneered work in remote sensing during the 1960s and early '70s. The unexpected early death of Prof. Müller in 1980 led for several years to a high degree of uncertainty regarding the survival of the Institute.

11 Intensifying cooperation with other research institutes

In 1983 Ohmura was elected to succeed to the Chair of Physical Geography, and instructed by the School Board [Schulrat] to establish a mathematically and physically-based climatology, glaciology, and hydrology. The work on Glaciology was organized to be carried out in cooperation with the Glaciology Section of the ETH's Institute of Hydraulics, Hydrology, and Glaciology (VAW) and led by Prof. Hans Röthlisberger. It was determined that Hydrology would be undertaken within the Institute for Geography and to this end the Hydrology Section of VAW, led by Dr. Herbert Lang, was transferred into the Institute. Lang, who would later be appointed Adjunct Professor, specialized in the Earth's surface hydrology. For Climatology the main research topic was identified as the energy balance of the globe, with an emphasis upon polar regions. (In harmony with the latter focus the Institute assumed in 1992 the function of a World Radiation Monitoring Centre - a core organization of the World Climate Research Programme's Baseline Surface Radiation Network.)

From 1983 onwards climatological research centered around the re-evaluation of the Earth's global energy balance and in particular its relationship to the cryosphere. A series of projects ultimately lead to the discovery and identification of the missing absorption component (of solar radiation) in the atmosphere to global dimming and to global brightening. Further, the energy balance of the glacier surfaces was investigated as the process within major mountain systems, such as the Alps, the Tienshan Mountains, and the Greenland Ice Sheet.

During the 1969-1983 period the fore-mentioned Climatology lecture course remained the only course on climate at ETH. However in 1983 the Institute's teaching curriculum within the Faculty of Earth Sciences changed dramatically. First for its Diploma courses the pre-requisite education in mathematics and physics was to be equivalent to that of the Institute for Geophysics. Second the "Climatology" lecture course was split into two different introductory courses – 'Introduction to Physical Climatology' and 'Introduction to Bioclimatology', and furthermore three advanced lectures were initiated in Theoretical Climatology, Micro-Climatology, and Global Paleoclimatology. Another major realignment occurred in 1987 when some of the Institute's lectures became a component the newly established Faculty of Environmental Sciences.

In this period the issue of Climate Change was gaining increasing importance and this resulted in two major developments for the Institute. First, ahead of the retirement of Prof. Lang in 1997 and partly in recognition of the internationally acknowledged accomplishments of his group, a new professorial chair was established in the realm of Hydrology. In 1998 Christoph Schär, then affiliated to the Institute for Atmospheric Science, was nominated to the chair with the more encompassing title of "Professor for Climatology and Hydrology". Second, the Institute was renamed as the "Institute for Climate Research, ICR" [Institut für Klimaforschung, IKF] in 2000.

A further major event was prompted by the desire of the Institute and the ETH to intensify the research in the overarching realm of climate and atmospheric science, and to provide coordinated teaching in the same subject. To this end the two institutes LAPETH and ICR merged in 2001 to form the "Institute for Atmospheric and Climate Science". Throughout its history the ICR and its earlier incarnations had continually adapted to changing needs and had thereby served Switzerland, the ETH, and the scientific community, and provided purposeful and relevant high-level science. The merge was a further step in this process.

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Part 5

The Merging of the Institute for Atmospheric Science and the Institute for Climate Research, 2001

by

Huw Davies

Building CHN on Universitätsstrasse housing the Department for Environmental Science. The IAC occupies the top five floors of the tower building. On the rooftop there is a meteorological station and a balloon launch facility.

12 Two Institutes become one

The Institute for Atmospheric Science and the Institute for Climate Research merged on the 1st July 2001 to form the new consolidated Institute for Atmospheric and Climate Science. At the time of the merger the two original Institutes were well-established within the ETH, with the former embedded within the Department of Environmental Sciences and the latter in the Department of Earth Sciences. The merger constituted a landmark event for the two Institutes, for the two Departments, and for the ETH itself.

A Celebration Symposium to mark the merger was held in the Audi-Max on June 18th. The various Symposium presentations spanned the research areas of the new Institute, and the invited international speakers included Prof. Hartmut Grassl (Director of the World Climate Programme), Prof. Brian J. Hoskins FRS (President of the Royal Meteorological Society), Dr. Robert Serafin (President of the American Meteorological Society), and Prof. Reinhard Zellner (former coordinator of the German Ozone Research Programme). A copy of the programme for the Symposium is appended below.

In effect the merger amounted to the organic fusion of the two Institutes that had had a history of constructive interaction and successful collaboration. It was preceded by an extended dialogue between the leadership of the two Institutes that was itself facilitated by input from Task Groups set up to examine administrative, workshop, and research and teaching issues.

The dialogue itself had two major components. On the one hand there was the challenge posed by the markedly different culture of the two Institutes, as evidenced by their administrative procedures, the nature of their oversight of Diploma and doctoral students, and their research practices. These differences were in part the product of having undergone a largely independent historical evolution, having different research foci, attracting and catering for diploma students from differing scientific backgrounds and institutional affiliations, and their residence within different ETH Departments.

On the other hand from a broader perspective there was an over-riding desire to bring together the expertise from the two conjoined research areas to furnish the ETH with a world class institutional structure capable of addressing the prevailing pressing challenges in the atmospheric and climate science fields.

The case for the merger was set out in a document prepared for the Department and the *Executive Board* [Schulleitung] (a copy is appended below). In addition to providing the historical background, and the on-going interaction of the two Institutes, the document also noted the motivation for the merger, emphasizing

that it would serve to establish an Institute that straddles the disciplines of atmospheric and climate sciences. Significant advantages will accrue with the passage of time in research, teaching, and organizational effectiveness.

Research in the overlapping fields of atmospheric and climate science is developing in two complementary directions. There is on the one hand increased activity within the existing sub-components (e.g. atmospheric physics, chemistry and dynamics; and global and regional climate studies including energy and water balance studies), and on the other a broadening to encompass activities at the interface of these sub-components and at its interfaces with other disciplines. The new Institute will continue to pursue leading-edge research in the sub-component fields, but it will also actively seek to exploit the synergy provided by the new institutional structure to pioneer new activity at the interfaces. The new Institute will also provide an attractive platform upon which to broaden the D-UMNW's activities in climate science to encompass for example oceanography, and in global change and sustainability to encompass for example integrative numerical modelling.

Teaching goals of the merged Institute at the Bachelor level will be to streamline and consolidate existing lecture and practical activities, and to utilize the potential provided by the fusion to broaden the curriculum across the atmosphere-climate fields. At the Masters level the new Institute will be in a position to compete internationally in the atmosphere-climate field via the breadth and depth of its teaching and its expertise in research.

The new Institute will form the natural condensation point for atmosphere-climate activities within the current D-UMNW, and could serve a similar role in any future revamped environmental studies programme of ETH. It could also help to bring together and contribute to focusing the disparate activities related to meteorology, air quality, hydrometeorology, and climate studies currently taking place within several ancillary ETH institutes.

The document concluded that:

"..... the formation of the new Institute will encourage synergism in research, open new opportunities in teaching, and more generally serve as a focal point for activities in these fields within the ETH and in national and international settings."

13 Ancillary documents related to the merger

13.1 The original proposal

Proposal for the merger of
the Laboratorium für Atmosphärenphysik and the Institut für Klimaforschung
to form the "Institute for Atmospheric and Climate Science".

Historical Background

In 1995 the D-UMNW underwent an external evaluation, and in its submission to the Evaluation Committee the Department indicated that they foresaw the establishment of a "Center of Competence for Atmosphere and Climate". The Evaluation Committee concurred with this proposal and adopted it as a specific recommendation in their final report (Evaluation Report of 1 December 1995, p. iv, 30, 31, 33). In particular they noted (§3.3.3 p.16) that "the integration of the Climatology/Hydrology group with LAPETH should be undertaken ….". Central to this recommendation was the recognition that the Laboratorium für Atmosphärenphysik (LAPETH) was the only institute in Switzerland dedicated exclusively to the study of Atmospheric Science, and that the Geographisches Institut had Hydrology and Climatology as major researcher foci.

The appropriateness of such an integration has been reinforced by subsequent developments. First in 1998 a member of Laboratorium für Atmosphärenphysik (LAPETH) was appointed Professor of Hydrology and Climatology in the Geographisches Institut. Second in 2000 the latter Institute, consistent with its research portfolio, was renamed the Institut für Klimaforschung (IKF). Third in the post-1998 period Professors from the two Institutes have co-participated in Alliance for Global Sustainability, European Union, SNF, and internal ETH research projects.

Current Context

The prevailing links between the two Institutes are driven by research, academic and organizational considerations.

In research the Institutes together play a major and ongoing role in the guidance and execution of the international Mesoscale Alpine Project (MAP); three of the Institutes Professors (Profs. Ohmura, Schär, Davies) will collaborate to constitute the core of one of the four modules of the newly approved NCCR Climate; the incumbent of the recently established Professorship for Atmospheric Chemistry (Prof. Peter) forges inter-professorial and inter-institutional contacts linking chemistry with climate and dynamics.

In the academic realm a major commitment of the two Institutes is the provision of lecture courses to no less than 8 Departments of the ETH. The kernel contribution is to the curriculum in the Environmental Sciences, but special emphasis is also placed upon the contributions in the Earth Sciences, Physics and Computational Science. A Joint Committee of the two Institutes is tasked with (a) coordinating the palette of lectures, field-excursions and laboratory practical activities, and (b) over-viewing and planning the proposed transition to the Bachelors / Masters scheme.

From an organizational standpoint there are two particularly pertinent points. First the Institutsleitung of the two sister organizations have met together regularly over the last 14 months to work toward a seamless and organic fusion, and agreement has been reached on the leadership structure and various management procedures of the (at present geographically-separated) units. Second the D-UMNW in its on-going assessment of its function and form favours the establishment of larger institutional entities, and the proposed merger is in harmony with the Department's declared strategy.

Motivation for the Merger

The proposed merger will establish an Institute that straddles the disciplines of atmospheric and climate sciences. Significant advantages will accrue with the passage of time in research, teaching, and organizational effectiveness.

Research in the overlapping fields of atmospheric and climate science is developing in two complementary directions. There is on the one hand increased activity within the existing sub-components (e.g. atmospheric physics, chemistry and dynamics; and global and regional climate studies including energy and water balance studies), and on the other a broadening to encompass activities at the interface of these sub-components and at it interfaces with other disciplines. The new Institute will continue to pursue leading-edge research in the sub-component fields, but it will also actively seek to exploit the synergy provided by the new institutional structure to pioneer new activity at the interfaces. The new Institute will also provide an attractive platform upon which to broaden the D-UMNW's activities in climate science to encompass for example oceanography, and in global change and sustainability to encompass for example integrative numerical modelling.

Teaching goals of the merged Institute at the Bachelor level will be to streamline and consolidate existing lecture and practical activities, and to utilize the potential provided by the fusion to broaden the curriculum across the atmosphere-climate fields. At the Masters level the new Institute will be in a position to compete internationally in the atmosphere-climate field via the breadth and depth of its teaching and its expertise in research.

The new Institute will form the natural condensation point for atmosphere-climate activities within the current D-UMNW, and could serve a similar role in any future revamped environmental studies programme of the ETH. It could also help to bring together and contribute to focusing the disparate activities related to meteorology, air quality, hydrometeorology, and climate studies currently taking place within several ancillary ETH institutes.

In summary the formation of the new Institute will encourage synergism in research, open new opportunities in teaching, and more generally serve as a focal point for activities in these fields within the ETH and in national and international settings.

11: 02: 01 Zürich

13.2 Invitation to and programme for the Celebration Symposium

The following four pages are copies of the invitation to and the programme for the Celebration Symposium marking the merger of the two Institutes

LAPETH IKF

LAPETH IKF

LAPETH IKF

LAPETH IKF

LAPETHIKF

IAC***ETH***

Celebration Symposium

Monday, June 18, 2001, 0915 h

Auditorium Maximum, ETH Main Building, Rämistrasse 101, Zürich

The Institute for Atmospheric Science (LAPETH) and the Institute for Climate Research (IKF) will merge to become the **Institute for Atmospheric and Climate Science (IAC*ETH*)**. To celebrate this occasion we invite you to join us for a special Celebration Symposium. Highly distinguished experts in our fields of science will present their opinions about the status of research in climate and atmospheric sciences, and will discuss their opinions of what needs to be done tomorrow. You are kindly invited to spend this day among these prestigious scientists and honor the new Institute with your presence.

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Program Celebration Symposium IAC*ETH*

time	*person*	*title*
0915	Prof. Huw. C. Davies Head of the Institute for Atmospheric Science, ETH	**Opening and Welcome**
	Prof. Albert Waldvogel Vice-President for Research, ETH	**Welcoming Address on Behalf of the Schulleitung**
	Prof. Peter Edwards Head of the Department for Environmental Sciences, ETH	**Welcoming Address on Behalf of the Department**
	Prof. Christoph Schär Institute for Climate Research, ETH	**A Brief Portrait of the New Institute**
	Moderator: Prof. Ch. Schär	
0945 - 1030	Prof. Hartmut Grassl former Director of the World Climate Research Program; Max-Planck-Institut für Meteorologie, Hamburg	**Climate Variability Predictions and Climate Change Scenarios**
1030 - 1100		***coffee break***
1100 - 1145	Prof. Gian-Reto Plattner Vice Rector Universität Basel; Ständerat	**Society and Climate in the 21st Century**

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ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

time	*person*	*title*
1200 - 1330		***all participants are invited to a lunch buffet***
	Moderator: Prof. Huw C. Davies	
1330 - 1345	Daniel Keuerleber Director of MeteoSwiss, Zurich	**Atmosphere-related ETH Research and the Public Services - a Fruitful Interaction** **Congratulation Address on Behalf of the Federal Administration**
1345 - 1400	Prof. Thomas Stocker Institute for Physics, University Bern	**Congratulation Address on Behalf of Swiss Research Communities**
1400 - 1445	Prof. Brian J. Hoskins FRS former President of the Royal Meteorological Society; Dept. of Meteorology, Univ. of Reading Reading, UK	**Why Try to Understand the Climate System when We Can Run Models of It?**
1445 - 1530	Dr. Robert Serafin NCAR Director Emeritus; President of the American Meteorological Society, Boulder, USA	**Meteorology, Society, and the Future**
1530 - 1600		***coffee break***

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ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

time	*person*	*title*
	Moderator: Prof. Th. Peter	
1600 - 1645	Prof. Reinhard Zellner former Coordinator of the German Ozone Research Programme; Universität GH Essen	**Ozone Depletion in the Stratosphere: Scientific and Political Lessons**
1645 - 1730	Prof. Roger A. Pielke Sr. Colorado State University, Fort Collins, USA	**Studying Climate: An Integrated Earth System Issue**
1730 - 1740	Prof. Atsumu Ohmura Head of the Institute for Climate Research, ETH	**Closing Remarks**

How to get to the Auditorium Maximum of ETH Zürich:

If you require instructions for getting to the Auditorium Maximum in the Main Building of ETH, please refer to: *http://www.ethz.ch/search/orientation_en.asp* and *http://www.ethz.ch/search/ethzentrum_en.asp*. Upon arrival, further information can be obtained from the information booth at the main entrance.

As mentioned in the above program, all participants at the Celebration Symposium are invited to a lunch buffet on the premises of ETH.

Further information:

For any additional information, please contact:

Eva Choffat	telephone	+41 (0)1 633 27 55
Hans Richner	telephone	+41 (0)1 633 27 59
	fax	+41 (0)1 633 10 58
	email	hans.richner@ethz.ch

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Appendices

Temperaturempfindlichkeit der Dielektrizitätskonstanten von CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 im dampfförmigen Zustande

Von der

Eidgenössischen Technischen Hochschule in Zürich

zur Erlangung der

Würde eines Doktors der Naturwissenschaften

genehmigte

Promotionsarbeit

vorgelegt von

Raymund Sänger

aus Adliswil

Referent: *Herr Prof. Dr. P. Debye*

Korreferent: *Herr Prof. Dr. P. Scherrer*

Leipzig 1926

Druck von August Pries

Meiner lieben Mutter

gewidmet

Veröffentlicht in Band 27 der Physik. Zeitschrift.

Temperaturempfindlichkeit der Dielektrizitätskonstanten von CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 im dampfförmigen Zustande.

I. Theoretische Grundlagen.

Zwischen der Polarisation $\mathfrak{P}$ und dem am Molekül angreifenden inneren Feld $\mathfrak{F} = \mathfrak{E} + \nu\mathfrak{P}$ ($\mathfrak{E}$ das äußere wirkende Feld) besteht die phänomenologische Beziehung

$$\mathfrak{P} = \frac{\varepsilon - 1}{\nu(\varepsilon - 1) + 4\pi}\mathfrak{F}, \qquad (1)$$

darin bedeutet ν die Konstante des inneren Feldes.

Molekular erhalten wir die Polarisation nach der Debyeschen Dipoltheorie (1)

$$\mathfrak{P} = N\left(\gamma' + \frac{1}{3}\frac{\mu^2}{kT}\right)\mathfrak{F}. \qquad (2)$$

(N die Anzahl der Moleküle pro cm^3, μ das permanente Moment des Moleküls, k die Boltzmannsche Konstante.) Hiebei liegt folgender Gedanke zugrunde: Fällt der Schwerpunkt der negativen Ladungen nicht zusammen mit dem Schwerpunkt der positiven Ladungen, ist also auf diese Weise das Molekül mit einem festen elektrischen Dipol ausgerüstet, so versucht es sich in die Feldrichtung einzustellen, wird aber darin von der Temperaturbewegung gestört. Im Mittel wird sich eine Gleichgewichtslage herstellen. Unter Zugrundelegung des Boltzmann-Maxwellschen Verteilungsgesetzes berechnete Debye das mittlere Moment eines Moleküls

$$\overline{\mathfrak{m}} = \frac{1}{3}\frac{\mu^2}{kT}\cdot\mathfrak{F},$$

wobei in klassischer Weise mit einer stetigen Verteilung der Dipolachsen um das äußere Feld gerechnet wird. Zu $\overline{\mathfrak{m}}$ kommt noch der Beitrag von der Deformierbarkeit des Moleküls

$$\mathfrak{m}' = \gamma'\mathfrak{F}$$

(γ' Polarisierbarkeit des Moleküls).

Pauli (2) hatte früher für den Spezialfall zweiatomiger Dipolmoleküle vom Typus HCl die Verhältnisse quantentheoretisch untersucht, mit dem Resultat, daß statt des Faktors 1/3 der größere Faktor 1,5367 zu setzen ist. Zu einem noch etwas andern Faktor kommt Pauling nach Einführung von halbzahligen Quanten. Letzthin hat aber Pauli zusammen mit L. Mensing (3) gezeigt, daß man bei einer quantenmechanischen Behandlung desselben Problems nach Born-Heisenberg bei hoher Temperatur zum gleichen Faktor 1/3 kommt, wie bei der klassischen Rechnung. Und soeben hat auch C. Manneback (4) die gleiche Rechnung auf Grund der Schrödingerschen Mechanik durchgeführt und ist zum selben Resultat gekommen. Wir werden demnach für den Spezialtypus HCl den Faktor 1/3 als gesichert betrachten können. Für andere Typen liegen noch keine umfassenden quantentheoretischen Rechnungen vor. Wir benützen deshalb auch hier den klassischen Faktor 1/3.

Die Gleichung (2) ergibt nun zusammen mit (1) die Debyesche Beziehung

$$\frac{\varepsilon - 1}{\nu(\varepsilon - 1) + 4\pi} = N\left(\gamma' + \frac{1}{3}\frac{\mu^2}{kT}\right). \qquad (3)$$

Bei Gasen genügender Verdünnung spielt das innere Feld keine Rolle mehr, was in der Beziehung (3) formell dadurch zum Ausdruck kommt, daß $\nu(\varepsilon - 1)$ gegenüber 4π vernachlässigt werden kann. So werden wir für Gase und Dämpfe die Beziehung (3) in der Form

$$\varepsilon - 1 = 4\pi N\left(\gamma' + \frac{1}{3}\frac{\mu^2}{kT}\right) \qquad (4)$$

geben können.

Grundsätzlich sei betont, daß in obiger Betrachtung vorausgesetzt wird, daß zwischen den Molekülen keine Kräfte auftreten, daß also die

Assoziation der Moleküle, welche neuerdings elektrisch gedeutet wird, vollständig vernachlässigt wird, und demnach auch die Polarisierbarkeit des Moleküls unabhängig von der Dichte angenommen werden kann. Wie stark dies speziell bei Flüssigkeiten die Verhältnisse beeinträchtigen kann, habe ich jüngst in einer Notiz dargetan (5). Bei Gasen ist die Theorie durch das Experiment restlos bestätigt worden; hauptsächlich seien erwähnt die Messungen von Jona (6) und Zahn (7). Die Dielektrizitätskonstante wurde dabei bei verschiedenen Temperaturen unter Atmosphärendruck bestimmt. Die Dichte ϱ, die für die Ermittlung der Molekülzahl $N = \frac{N_0}{M} \cdot \varrho$ (N_0 = Loschmidtsche Zahl, M = Atomgewicht) notwendig ist, wird in gastheoretischer Weise bestimmt.

In der vorliegenden Arbeit soll die experimentelle Grundlage der Theorie erweitert und hauptsächlich die Anwendung auf Dämpfe erprobt werden.

Es steht zu erwarten, daß eine Disymmetrie in der chemischen Formel eines Moleküls sich dadurch elektrisch äußern wird, daß ein permanentes elektrisches Moment auftritt, welches durch den Temperaturgang der Dielektrizitätskonstanten nachgewiesen werden kann. Beispiele für diesen Zusammenhang liefern einige neuere Arbeiten von Errera (8). Unsere Messungen wurden vom gleichen Gesichtspunkte aus unternommen. Der Unterschied besteht wesentlich darin, daß hier alle Versuche an Gasen ausgeführt wurden, bei denen die Schwierigkeiten, welche mit der Berechnung und Interpretation des molekularen Feldes verknüpft sind, nicht auftreten. Als Versuchsobjekt wurde die Reihe CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 gewählt, in der Annahme, daß die Endglieder sich als symmetrisch, dipolfrei erweisen und permanente Momente nur bei den Mittelgliedern auftreten würden.

Da im Falle von Dämpfen die Dichte ϱ auch mit der van der Waalsschen Korrektur nicht hinreichend genau ermittelt werden kann, wurden die Versuche bei konstanter Dichte ausgeführt, d. h. die gesamte Molekülzahl festgehalten. Dies ist im Sinne der Debyeschen Theorie auch die einwandfreie Versuchsanordnung. Die Dielektrizitätskonstante wird demnach bei verschiedenen Temperaturen gemessen, wobei der zu untersuchende Dampf während der ganzen Versuchsreihe abgeschlossen gehalten wird. Natürlicherweise ändert sich dabei der Druck des Dampfes; er ist bei jeder Temperatur einer Versuchsreihe bestimmt worden. Gelten die idealen Gasgesetze, so sollte der Quotient $\frac{T}{p}$ sich als konstant erweisen, was nur beim Methan über das ganze Temperaturgebiet und bei Methylchlorid in der oberen Temperaturstufe zutraf.

Wird nun die Molekülzahl N konstant gehalten, so fordert die Beziehung (4) das lineare Gesetz

$$\varepsilon - 1 = A + B \cdot \left(\frac{1}{T}\right). \qquad (5)$$

$A = 4\pi N\gamma'$, $B = 4\pi N \frac{\mu^2}{3k}$ bedeuten darin konstante Größen.

In der vorliegenden Arbeit sind die Konstanten A und B aus dem experimentellen Verlauf von $\varepsilon - 1$ als Funktion der reziproken Temperatur vermittelst der Methode der kleinsten Quadrate bestimmt und hierauf aus B auf das Moment des Moleküls geschlossen worden.

Um μ aus der Konstanten B zu ermitteln, ist die Molekülzahl N erforderlich; diese bestimmen wir nach dem idealen Gasgesetze, wodurch zwar ein Fehler im Zahlenwert des gerechneten elektrischen Momentes resultiert, der aber hier vernachlässigt werden kann. Ist p der zu einer beliebigen Temperatur T der Versuchsreihe gehörende Druck, so wird

$$N = \frac{N_0}{R} \frac{p}{T}$$

(R = Gaskonstante), oder also, da $k = \frac{R}{N_0}$

$$N = \frac{1}{k} \frac{p}{T}. \qquad (6)$$

Indem wir dies in den Ausdruck für die Konstante B einführen, erhalten wir für das elektrische Moment des Moleküls

$$\mu = k \sqrt{\frac{3}{4\pi} \frac{T}{p} \cdot B}. \qquad (7)$$

Wird p im Hinblick auf unsere Experimente in cm Hg ausgedrückt, so rechnet sich das Moment des Dipols

$$\mu = 0{,}5814 \cdot 10^{-18} \sqrt{\frac{T}{p_{Hg}} \cdot B}. \qquad (8)$$

Die Konstante A der Beziehung (5) stellt das optische Glied dar. Wir haben deshalb bei jeder einzelnen Substanz, sofern Messungen vorliegen, den Brechungsexponenten n für eine möglichst große Wellenlänge des Lichtes in Vergleich gezogen. Da aber gerade Dipolsubstanzen im Ultraroten Absorptionsbanden zeigen, werden wir keine absolute Übereinstimmung zwischen $n^2 - 1$ und A erwarten dürfen. Für

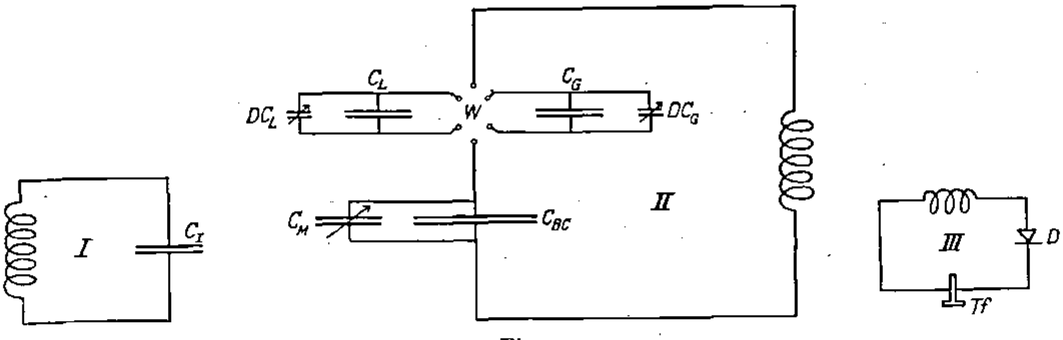


Fig. 1.

dipolfreie Substanzen dagegen wird $n^2 - 1$ sehr nahe dem Werte $\varepsilon - 1$ kommen müssen.

II. Die Apparatur.

Zur Ermittlung der kleinen kapazitiven Veränderungen des Gaskondensators, hervorgerufen durch die dielektrischen Eigenschaften des Gases, wurde die bekannte Schwebungsmethode verwendet, die erstmals von Preuner u. Pungs (9) und Herweg (10) benützt wurde. Die Schwingungskreise sind in Fig. 1 schematisch dargestellt.

Der Vergleichsschwingungskreis I, wie der Meßkreis II werden erregt durch Röhrensender R. S. 59 von Telefunken. Diese werden mit je 5 Akkumulatoren gespeist; die Anodenbatterie 600 Volt ist gemeinsam. Damit beide Kreise vollständig frei voneinander schwingen, wird dafür Sorge getragen, daß beide mit genau derselben Energie arbeiten. Die relativ große Energie der Schwingungskreise ermöglicht einen einfachen Empfängerkreis III (ohne Verstärkung) mit kleiner Spule, Detektor D und Telephon Tf. Kreis III ist äußerst lose mit I und II gekoppelt.

Da die Veränderung der Kapazität des Gaskondensators C_G infolge der Wärmeausdehnung bei der Messung der kapazitiven Veränderung dielektrischer Natur schon mitspielt, bringen wir gleichzeitig einen genau gleich konstruierten Luftkondensator C_L auf die gleiche Temperatur des Gaskondensators und messen die Kapazität von C_G im Vergleich zum Luftkondensator C_L, indem vermittelst der Wippe W der Meßkreis II zuerst über C_L, dann über C_G und wiederum über C_L geschlossen wird. Die Einstellung erfolgte bei jeder Temperatur mehrere Male. Wählten wir nun zunächst im Gaskondensator Luft als Dielektrikum, so konnte gezeigt werden, daß bei einer Erwärmung bis gegen 100° die räumliche Ausdehnung beider Kondensatoren genau dieselbe war. Bei hohen Temperaturen trat eine kleine Verschiebung ein. Zwischen je zwei Meßreihen von Dämpfen wurde immer wieder diese räumliche kapazitive Veränderung gemessen und kontrolliert. Sie ist bei allen Messungen an Gasen und Dämpfen in Abzug gebracht.

Der Gas- wie der Luftkondensator bestehen aus 13 ineinander geschobenen Messingzylindern, dabei schließen der innerste und äußerste Zylinder das eine System des Kondensators, welches mit dem Gas-, bzw. Lufttrog in metallischer Verbindung steht, ab. Die Konstruktion ist derart, daß nur durch 2 Quarzringe die beiden Systeme der Kondensatorflächen voneinander isoliert sind. Der Durchmesser des äußersten Zylinders beträgt 8 cm, derjenige des innersten 2 cm, die Länge aller 20 cm. Die Kapazität des Gaskondensators C_G wurde mit einer Seibt-Brücke zu 2420 cm gemessen. Die relativ große Kapazität bedingt allerdings eine etwas kleinere Frequenz als diejenige, die von andern Beobachtern benützt wurde, und damit eine geringe Beeinträchtigung der Empfindlichkeit der Apparatur; dagegen bietet sie größere Zuverlässigkeit in räumlich geometrischer Hinsicht. Die Apparatur arbeitet mit der Frequenz $1{,}6 \cdot 10^5$; diese ergibt eine in jeder Beziehung hinreichende Empfindlichkeit für die Messungen.

Der Gas- wie der Luftkondensator sind am Deckel ihres Troges befestigt. Die beiden Tröge bestehen aus verzinkten Eisenkübeln, deren Deckel mit Stahlschrauben und Flanschen fest aufgepreßt werden können. Die Dichtung erfolgt mit Graphit belegtem Klingerit; sie hat sich auch bei hoher Temperatur als gut erwiesen. Am Deckel selbst sind die Zuleitungen gastechnischer und elektrischer Natur angebracht. Die kapazitiven Veränderungen des Gaskondensators werden kompensiert durch einen variablen Meßkondensator, indem mit Hilfe einer Stimmgabel ein konstanter Schwebungston festgehalten wird. Zum Gaskondensator ist ein Blockkondensator C_{BC} in Serie geschaltet; dieser besteht aus verkupferten Präzisionsglimmerplättchen; die Gesamtkapazität beträgt 18040 cm. Parallel geschaltet zu diesen befindet sich der Meßkondensator C_M, ein in ein Messinggehäuse eingebauter Seibtscher Präzisionsdrehkondensator. Seine maximale Kapazität ist 2000 cm. Er trägt eine Teilung von 80 Skalenteilen; vermittelst eines Schneckentriebes konnte $^1/_{100}$ eines Skalenteiles abgelesen werden. Durch die Serieschaltung des großen Blockkondensators C_{BC} wird erreicht, daß eine kleine Veränderung der Kapazität des Gaskondensators eine beträchtliche Kompensation am Meßkondensator C_M verlangt; die Kompensationskorrektur erfolgt im Quadrate des Verhältnisses von C_{BC} und C_G. Die Empfindlichkeit der Apparatur ist bei jeder Meßreihe experimentell festgelegt worden, dazu wird ein parallel zu C_G geschalteter kleiner Drehkondensator DC_G (maximale Kapazität 80 cm) zunächst um 7,5 cm, dann um 15 cm geändert. Diese Veränderung, sowie diejenige, hervorgerufen durch die Dielektrizitätskonstante der Dämpfe ist so groß, daß wir die Empfindlichkeit in zweiter Näherung rechnen müssen.

Aus der Formel für Serieschaltung von Kapazitäten $\frac{1}{C} = \frac{1}{C_G} + \frac{1}{C_{BC}}$ (die Kapazität des Meßkondensators in C_{BC} einbezogen) folgt für die kapazitive Veränderung ΔC_G des Gaskondensators, ausgedrückt durch die Kompensation ΔC_M des Meßkondensators,

$$\Delta C_G = -\frac{C_G^2}{C_{BC}^2}\Delta C_M + \frac{C_G^2(C_G + C_{BC})}{C_{BC}^4}\Delta C_M^2$$

oder also

$$\Delta C_G = -a\Delta C_M + b\Delta C_M^2.$$

Diese Konstanten a und b wurden, wie oben schon angedeutet, bei jeder Meßreihe auf experimentelle Weise bestimmt. Wir erhielten im Mittel

$$\Delta C_G = -0{,}448_5\Delta C_M + 0{,}0005_0\Delta C_M^2,$$

wobei ΔC_M in Skalenteilen des Meßkondensators (1 Skalenteil = 27,65 cm), ΔC_G in Zentimeter ausgedrückt ist. Diese experimentell ermittelte Empfindlichkeitsformel steht in vernünftiger Übereinstimmung mit der oben theoretisch hergeleiteten Formel.

Gas- und Lufttrog stehen in einem 50 Liter fassenden Aluminiumkessel, welcher mit Paraffinöl als Temperaturbad aufgefüllt ist. Die Heizung erfolgt auf elektrische Weise vermittelst zweier Widerstandsspiralen. Mit 2 Rührern wird eine möglichst intensive Zirkulation des Öles hergestellt. Der Kessel selbst befindet sich in einer mit Asbest ausgekleideten Holzkiste, um die Wärmeverluste möglichst herabzusetzen. Zur Bestimmung der Temperatur des Bades wird ein Satz von drei Stabthermometern verwendet.

Die elektrische Zuführung zum Luftkondensator erfolgt in einfacher Weise durch eine auf den Lufttrogdeckel aufgesetzte Röhre, welche bis außerhalb der Kiste führt. Durch diese Röhre wurde in einem Quarzrohr der Zuführungsdraht gezogen und oben mit Siegellack abgedichtet. Ein weiteres Rohr stellt die Verbindung her mit einem Hg Manometer und ermöglicht zugleich das Auswechseln der Luft.

Komplizierter gestalten sich diese Verhältnisse am Gastrog, wegen der zu untersuchenden Dämpfe. Die elektrische Zuführung erfolgt über einen Quarz-Invar-Doppelschliff (Fig. 2). Das

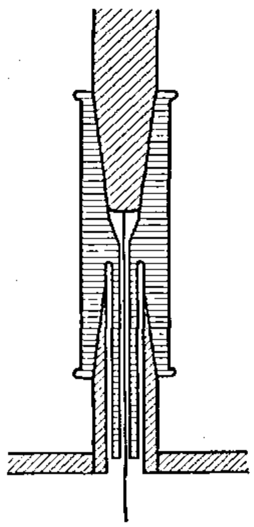


Fig. 2.

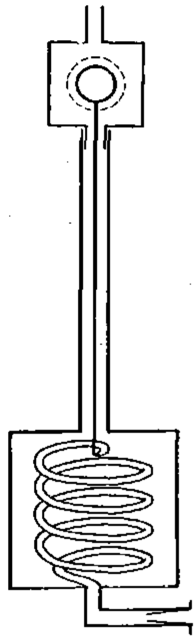


Fig. 3.

Invarrohr steht in Verbindung mit dem Trogdeckel, darauf sitzt eingeschliffen das Quarzstück, durch welches der Draht, der am oben eingeschliffenen Invarstab befestigt ist, ins Innere des Troges führt.

Als Druckmesser dient ein Kompensationsquarzmanometer (Fig. 3), welches wiederum über einen Invarschliff mit dem Troge in Verbindung steht.

Das Quarzspiralrohr (nach E. Breuner u. W. Schlupp (11)) trägt auf einem Quarzstabe, welcher bis außerhalb der Kiste führt, einen Spiegel. Unten ist ein weiteres Quarzgefäß angeschmolzen; dieses trägt oben einen den Spiegel einschließenden, mit Siegellack abgedichteten Messingkopf mit Fenster. Von oben her kann der Druck im Innern dieses Gefäßes verändert werden und dadurch eine Veränderung des Dampfdruckes im Innern der Spirale so kompensiert werden, daß der Spiegel in Nullage bleibt. Dann ist der im Quarzgefäß herrschende Druck, welcher durch ein gewöhnliches Hg-Manometer gemessen werden kann, gleich dem Druck des Dampfes im Troge. Der Dampfdruck konnte auf $^1/_4$ mm genau bestimmt werden.

Um beim Versuchsbeginn den Schwebungston auf den Ton der Stimmgabel einzustellen, ist auch parallel zum Luftkondensator ein kleiner Drehkondensator DC_L wie DC_G geschaltet.

Es sei noch erwähnt, daß der Kondensator des Vergleichskreises I ebenfalls aus einem Blockkondensator mit verkupferten Glimmerplättchen besteht. Seine Kapazität beträgt 2400 cm.

Während einer ganzen Versuchsreihe, die durchschnittlich 12 Stunden dauerte, blieb der Gaskondensator entsprechend der Methode abgeschlossen. Der verwendete Metallhahn befindet sich am Gaszuleitungsrohr innerhalb des Temperaturbades. Die lange Dauer einer Versuchsreihe macht große Ansprüche auf die Konstanz des elektrischen Teiles der Apparatur. Die Dielektrizitätskonstante konnte auf etwa 3—5 Hunderttausendstel genau gemessen werden, was für die Bestimmung des elektrischen Momentes eines Dipoldampfes hinreichend genügt, nicht aber vollständig für den Symmetrienachweis des Moleküls einer dipolfreien Substanz; denn schon eine äußerst schwache Neigung der Geraden $\varepsilon - 1 = A + B \cdot \left(\frac{1}{T}\right)$ liefert rechnungsmäßig ein kleines Moment. In letzterem Falle kann aber, wenn der Brechungsindex einer möglichst großen Wellenlänge des Lichtes bekannt ist, aus der zahlenmäßigen Übereinstimmung von n^2 mit der Dielektrizitätskonstanten ε auf Symmetrie geschlossen werden, da hier ultrarote Eigenfrequenzen nicht in Frage kommen. Um alle äußeren Einflüsse auf ein Minimum zu reduzieren, wurden die Versuche während der Nacht ausgeführt.

Die Untersuchungen sollen im weitern noch verfeinert und auf andere Dämpfe angewendet werden. Für Gase mit kleiner Dielektrizitätskonstanten wird wohl am besten an der frühern Methode (Messung unter Atmosphärendruck) festgehalten.

III. Die Versuche.

Die Bestimmung der Dielektrizitätskonstanten der Dämpfe ist bei einer Temperatur wenig oberhalb des Siedepunktes der Flüssigkeit begonnen worden. Vor der Füllung wurde der Schwingungskreis II zunächst über den Luftkondensator, dann über den noch mit Luft gefüllten Gaskondensator geschlossen und vermöge der kleinen Drehkondensatoren auf gleichen Schwebungston, dem Ton der Stimmgabel, eingestellt. Dies bedeutet demnach die Nullage für die Messungen der kapazitiven Veränderung, hervorgerufen durch die Dielektrizitätskonstante des Dampfes. Diese wird für die verschiedenen Temperaturen der Versuchsreihe aus der nach der besprochenen Methode ermittelten Veränderung ΔC_G des Gaskondensators berechnet nach der Formel

$$\varepsilon = \varepsilon'_L\left(1 + \frac{\Delta C_G}{C_G}\right),$$

worin ε'_L die Dielektrizitätskonstante der Luft des beim ersten Versuch der Reihe herrschenden Atmosphärendruckes und der zugehörigen Temperatur bedeutet. ε'_L berechnen wir aus dem von Zahn bestimmten Werte $\varepsilon_0 = 1{,}000569$ bei 76 cm Druck und 0° Temperatur.

Die Messung von ΔC_G erfolgte jeweils erst, nachdem durch hinreichend lange Konstanthaltung des Temperaturbades (über eine Stunde) der Druck des Luftkondensators nicht mehr merklich zunahm.

Als erster Versuch wurde die Dielektrizitätskonstante von CO_2 und Übereinstimmung mit dem von Jona veröffentlichten Wert gefunden.

In den für die einzelnen Substanzen nun folgenden Tabellen ist in der ersten Kolonne die absolute Temperatur T aufgetragen, dann folgt der tausendfache Betrag des reziproken Wertes der Temperatur; hierauf in der dritten Kolonne der mit 10^5 multiplizierte, aus ΔC_G experimentell gefundene Wert von $\varepsilon - 1$.

Jeder Tabelle sind zugefügt die mit Hilfe der Methode der kleinsten Quadrate ermittelten Werte A und B und zwar auch dort, wo die experimentellen Werte in Berücksichtigung ihres Fehlerbereiches das Clausius-Mossottische Gesetz (die Debyesche Beziehung mit $B = 0$) erfüllen. Im weitern ist angegeben der mittlere quadratische Fehler f_ε zwischen dem mit den Konstanten A und B berechneten theoretischen Wert von ε und dem erperimentell bestimmten, d. h. die mittlere Abweichung von der Linearität.

Der Tabelle ist zugefügt der Dampf- oder Gasdruck p_1 der ersten Temperatur der Versuchsreihe, der Füllungsdruck; im weitern der zur Temperatur T_m des m-ten Versuches der ganzen Reihe gehörende Druck p_m. Diese Werte p_m und T_m benützen wir für die Berechnung des elektrischen Momentes nach Gleichung (8); sie werden bei höheren Temperaturen als die Anfangstemperatur gewählt, um möglichst die beste Voraussetzung zu erhalten für das bei der Berechnung der zahlenmäßigen Größe des Momentes verwendete Gasgesetz. n^2 bedeutet das Quadrat des auf die gleichen Verhältnisse (T_m, p_m) wiederum unter Voraussetzung des Gasgesetzes umgerechneten Brechungsexponenten.

1. Methan CH_4: S.P. — 164°. Die Darstellung des Gases erfolgte durch Wässerung von Aluminiumcarbid; hierauf Trocknen durch Ausfrieren des Wassers, die weitere Reinigung durch fraktionierte Destillation, wobei allerdings wegen der ziemlich großen Löslichkeit von Wasserstoff in flüssigem CH_4 noch Spuren von H_2 übrig bleiben Sie sind, da H_2 kein Dipolträger und ein sehr kleines γ' besitzt, ohne Einfluß.

Tabelle I.

T	$\frac{10^3}{T}$	$(\varepsilon - 1)\, 10^5$
291,7	3,428	84,2
343,4	2,912	84,0
367,7	2,720	86,1
388,8	2,572	85,5
414,8	2,411	87,4 } 1) 81,5 }

$A = 0{,}00086_3$; $B = 0{,}0061$; $f_\varepsilon = 0{,}0002_0$
$p_1 = 71{,}39$ cm; $p_2 = 84{,}05$ cm ($T_2 = 343{,}4$); $n^2 = 1{,}00080_3$
$\varepsilon_{\text{Riegger}} = 1{,}00032_2$

Die experimentellen Werte genügen innerhalb ihrer Fehlergrenze vollständig dem Clausius-Mossottischen Gesetze. Die Dielektrizitätskonstante deckt sich innerhalb der Beobachtungsfehlergrenzen mit derjenigen von Riegger (12) und mit dem Quadrate des Brechungsexponenten. (Letzterer aus Messungen von Koch (13) und Cl. u. M. Cuthbertson (14)). Wir werden somit dem CH_4-Molekül symmetrische Gestalt zuordnen.

2. Methylchlorid CH_3Cl: S.P. — 24,09°. Dasselbe wurde in einer Bombe flüssig in möglichst reinem Zustande von Kahlbaum bezogen und direkt in den Gastrog verdampft.

Tabelle II.

T	$\frac{10^3}{T}$	$(\varepsilon - 1)\, 10^5$
291,2	3,434	978,9
342,8	2,917	844,8
366,5	2,729	784,7
387,4	2,581	738,7
414,6	2,412	691,2

$A = 0{,}00011_6$; $B = 2{,}82_8$; $f_\varepsilon = 0{,}00004_9$
$p_1 = 71{,}88$ cm; $p_3 = 90{,}27$ cm ($T_3 = 366{,}5$); $n^2 = 1{,}00153_0$

Das aus B berechnete elektrische Moment des Moleküls ergibt $\mu = 1{,}9_7 \cdot 10^{-18}$. Wie zu erwarten ist, weicht bei Dipolgasen die Dielektrizitätskonstante stark vom Quadrate des Brechungsexponenten ab. (Brechungsindex nach Messungen von Mascart (15)).

1) Verschiedene Meßgruppen.

3. Methylenchlorid CH_2Cl_2: S.P. 40°. Bezogen in reinem Zustande von Kahlbaum.

Tabelle III.

T	$\frac{10^3}{T}$	$(\varepsilon - 1)\, 10^5$
332,0	3,012	484,3
366,9	2,726	459,9
387,2	2,583	441,7
413,8	2,413	413,2

$A = 0{,}00135_6$; $B = 1{,}17_0$; $f_\varepsilon = 0{,}00005_3$
$p_1 = 48{,}40$ cm; $p_3 = 60{,}10$ ($T_3 = 387{,}2$)

Das elektrische Moment wird $\mu = 1{,}5_9 \cdot 10^{-18}$; es liegen keine Messungen über den Brechungsexponenten vor.

4. Chloroform $CHCl_3$: S.P. 61,21°. Verwendet wurde das von Kahlbaum für Narkose gelieferte sehr reine Chloroform.

Tabelle IV.

T	$\frac{10^3}{T}$	$(\varepsilon - 1)\, 10^5$
342,8	2,917	341,9
367,3	2,723	328,5
387,4	2,581	323,6
414,0	2,415	315,2
443,0	2,257	312,8

$A = 0{,}00212_7$; $B = 0{,}432_8$; $f_\varepsilon = 0{,}00002_2$
$p_1 = 56{,}20$ cm; $p_2 = 60{,}20$ cm ($T_2 = 367{,}3$); $n^2 = 1{,}00167$

Wir erhalten für das elektrische Moment $\mu = 0{,}9_5$; wiederum starke Abweichung der Dielektrizitätskonstanten vom Quadrate des Brechungsexponenten (n aus Messungen von Lorenz) (16).

5. Tetrachlorkohlenstoff CCl_4: S.P. 76,75°. Äußerst reines CCl_4 wurde uns von Herrn Prof. Dr. Henri, Direktor des Physikalisch-chemischen Institutes der Universität Zürich in zuvorkommender Weise zur Verfügung gestellt; dieses wurde von seinem Assistenten Dr. Schôu noch speziell destilliert.

Tabelle V.

T	$\frac{10^3}{T}$	$(\varepsilon - 1)\, 10^5$
360,8	2,772	273,6
377,2	2,651	277,2 } 1) 273,9 }
397,0	2,519	268,6
415,8	2,405	271,9
432,4	2,313	274,8

$A = 0{,}00264_5$; $B = 0{,}034_8$; $f_\varepsilon = 0{,}00002_8$
$p_1 = 68{,}7$ cm; $p_3 = 81{,}62$ ($T_3 = 397{,}0$); $n^2 = 1{,}00261_0$

1) Verschiedene Meßgruppen.

Die experimentellen Daten erfüllen innerhalb ihrer Fehlerquellen das Clausius-Mossottische Gesetz; eine Berechnung des auch kleinen Momentes aus B ist unzulässig. Das Quadrat des Brechungsexponenten stimmt hinreichend überein mit der Dielektrizitätskonstanten (n von Mascart zitiert). Wir werden deshalb dem Tetrachlorkohlenstoff molekulare Symmetrie zuschreiben; dies stimmt auch überein mit der eben von P. Honegger (17) veröffentlichten Arbeit über ultrarote Absorptionsspektren. Nach dieser Arbeit ist CCl_4 bis zu einer Wellenlänge von $9\,\mu$ vollständig durchlässig.

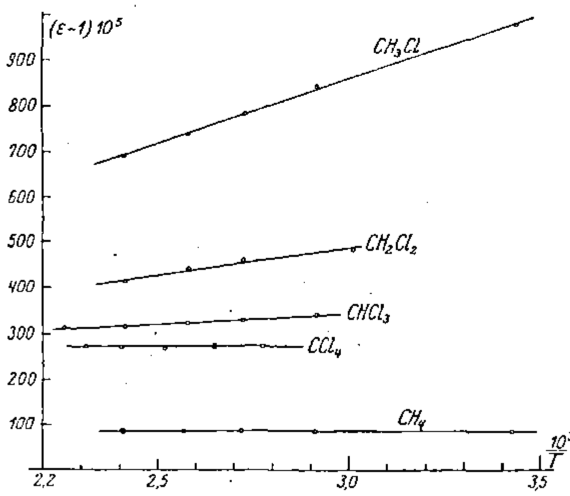


Fig. 4.

In Fig. 4 sind die beschriebenen Messungen graphisch dargestellt und geben eine klare Übersicht über die gemachten Untersuchungen und deren Resultate. (Die ausgezogenen Geraden nach der Methode der kleinsten Quadrate.)

Das optische Glied A fällt bei $CHCl_3$ und CH_3Cl nicht zusammen mit dem Quadrate des Brechungsindex, wie dies wegen der ultraroten Absorptionsbanden auch zu erwarten ist. Der Brechungsexponent[1]) n steigt mit der Zunahme der Chloratomzahl, was auch unserer Vorstellung vollständig entspricht. (Derjenige von Methylenchlorid wird mit ziemlicher Sicherheit zwischen demjenigen von Methylchlorid und Chloroform liegen.) Die Dielektrizitätskonstante dagegen springt zunächst beim Übergang von Methan zu Methylchlorid auf einen sehr großen Wert und nimmt nachher mit der Zunahme der Zahl der Chloratome wiederum ab, dies in Übereinstimmung mit dem Dipolcharakter der untersuchten Dämpfe. So ist z. B. der Brechungsexponent von $CHCl_3$ größer als der von CH_3Cl, da 2 H-Atome durch Chloratome ersetzt sind; die Dielektrizitätskonstante ist dagegen bei CH_3Cl größer, da die größere Unsymmetrie dieses Moleküls im quasistatischen Felde den Einfluß der Polarisationstätigkeit überkompensiert.

Die Resultate entsprechen dem molekularen Bilde der behandelten Substanzen, sofern wir uns das Kohlenstoffatom als Tetraeder denken; die Möglichkeit einer ebenen Anordnung der Atome ist vollständig ausgeschlossen. Wird am Tetraedergerüst CH_4 ein erstes H-Atom durch ein Cl-Atom ersetzt, so erhalten wir eine starke elektrische Asymmetrie. Diese wird durch weitere Ersetzungen reduziert und die Symmetrie bei CCl_4 wiederum hergestellt.

IV. Zusammenfassung.

In der vorliegenden Arbeit sind die experimentellen Grundlagen der Debyeschen Theorie für die Temperaturempfindlichkeit der Dielektrizitätskonstanten durch Untersuchungen an CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 erweitert und die Anwendungsmöglichkeit auf Dämpfe mit positivem Resultat erprobt worden. Das symmetrische Atomgerüst von CH_4 wird durch das Auswechseln eines H-Atoms mit einem Cl-Atom zunächst beim Übergang zum Methylchlorid stark gestört, die Asymmetrie nimmt aber bei Methylenchlorid und Chloroform wiederum ab und führt, nachdem alle H-Atome durch Cl-Atome ersetzt sind, bei Tetrachlorkohlenstoff zur molekularen Symmetrie zurück. Die dabei auftretenden elektrischen Dipolmomente der asymmetrischen Moleküle sind gefunden zu:

$$CH_3Cl \quad \ldots \quad \mu = 1{,}9_7 \cdot 10^{-18},$$
$$CH_2Cl_2 \quad \ldots \quad \mu = 1{,}5_9 \cdot 10^{-18},$$
$$CHCl_3 \quad \ldots \quad \mu = 0{,}9_5 \cdot 10^{-18}.$$

Meinem hochverehrten Lehrer Herrn Prof. Dr. P. Debye bin ich für die Übertragung dieser Arbeit und die vielen wertvollen Anregungen zu großem Dank verpflichtet.

Herrn Prof. Dr. Scherrer möchte ich auch an dieser Stelle für seine mir während der Abwesenheit von Herrn Prof. Debye erteilten Ratschläge herzlich danken.

Literaturverzeichnis.

1) P. Debye, Zusammenfassende Darstellung im Artikel „Theorie der elektrischen und magnetischen Molekulareigenschaften" (Marx: Handbuch der Radiologie VI).

1) Die den Tabellen zugeführten Brechungsexponenten sind zu verschiedenen Bedingungen (T, p) gerechnet. Für den bessern Vergleich geben wir hier die Brechungsexponenten auf 0° und 760 mm Druck bezogen:

CH_4	$n = 1{,}000437$
CH_3Cl	$n = 1{,}000870$
CH_2Cl_2	—
$CHCl_3$	$n = 1{,}001429$
CCl_4	$n = 1{,}001779$

2) W. Pauli jun., Zeitschr. f. Phys. **6**, 319, 1921.
3) L. Mensing u. W. Pauli, Physik. Zeitschr. **27**, 509, 1926.
4) C. Manneback, Physik. Zeitschr. **27**, 563, 1926.
5) R. Sänger, Physik. Zeitschr. **27**, 165, 1926.
6) M. Jona, Physik. Zeitschr. **20**, 14, 1919.
7) C. T. Zahn, Phys. Rev. **24**, 400, 1924.
8) J. Errera, Journ. de phys. **6**, 390, 1925.
9) L. Pungs u. G. Preuner, Physik. Zeitschr. **20**, 543, 1919.
10) J. Herweg, Ber. d. deutsch. physik. Ges. **21**, 572, 1919.
11) E. Breuner u. W. Schlupp, Zeitschr. f. phys. Chem. **68**, 129, 1910.
12) H. Riegger, Ann. d. Phys. **59**, 753, 1919.
13) Koch, Nova Acta soc. Upsal. 1909, zit. L. B.
14) Cl. u. M. Cuthbertson, Proc. Roy. Soc. London, 1920, zit. Tabl. ann. 1925.
15) Mascart, Compt. rend., Acad. d. sciences. Paris 1874; zit. L. B.
16) Lorenz, Sk. Vid. Selsk. 1875, zit. L. B.
17) P. Honegger, Etudes de Photochimie, Travaux du Laboratoire de V. Henri. Fasc. 1. Zürich 1926.

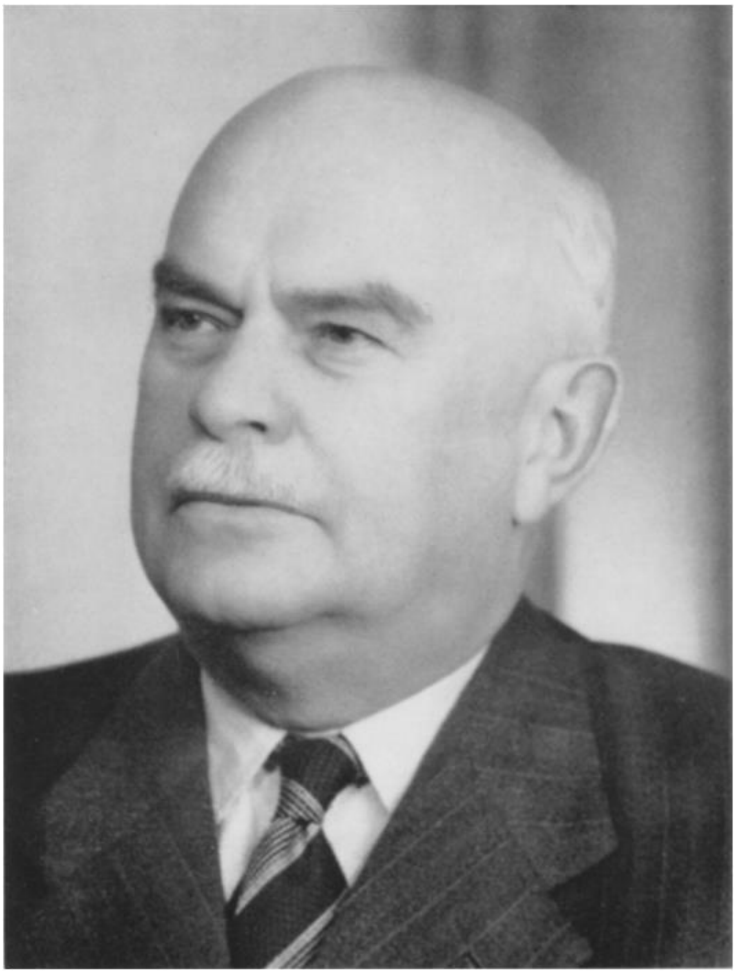
Lebenslauf

Ich wurde am 17. Dezember 1895 in Adliswil als Sohn des Joseph Sänger und der Wilhelmina geb. Franzetti geboren. Nach Besuch der kantonalen Industrieschule Zürich bestand ich im Herbst 1915 die kantonale Maturitätsprüfung. Hierauf studierte ich, mit längeren Unterbrüchen infolge Aktivmilitärdienst, Mathematik und Physik an der Eidgenössischen Technischen Hochschule in Zürich und diplomierte 1921 an der Abteilung für Fachlehrer in Mathemathik und Physik.

Nach einjähriger Assistenzzeit am Physikalischen Institut der E. T. H. erteilte ich vertretungsweise Unterricht an den Kantonsschulen Zürich, Winterthur und Aarau. Seit Herbst 1924 wissenschaftliche Arbeiten am Physikalischen Institut der Eidgenössischen Technischen Hochschule in Zürich.

Appendix B: Obituary Raymund Sänger

Transcription and translation of:
Tank, F. (1962): Raymund Sänger. Z. angew. Math. Phys., 1962, 13, 529-532



Wir haben die schmerzliche Pflicht,
Sie vom Tod unseres geschätzten Freundes und Mitarbeiters
PROFESSOR DR. RAYMUND SÄNGER
Redaktor der ZAMP
in Kenntnis zu setzen. Er starb am 29. September 1962
unerwartet auf der Höhe seines Wirkens.

Redaktionskommission und Verlag
der Zeitschrift für angewandte Mathematik und Physik

RAYMUND SÄNGER
1895-1962

Als die Zeitschrift für angewandte Mathematik und Physik (ZAMP) 1949 gegründet wurde, fiel die Wahl des Redaktors auf Raymund Sänger. Er hat sich während mehr als zwölf Jahren diesem Unternehmen in voller Hingabe seiner Kräfte gewidmet und es zu internationalem Ansehen geführt. Die notwendigen Fähigkeiten brachte er mit: wissenschaftliche Reife, Vielseitigkeit, Arbeitsfreude und Konzilianz im Verkehr; er hat sie zum besten der Zeitschrift eingesetzt.

Mitten aus intensivster Tätigkeit heraus ist Raymund Sänger einer Herzlähmung erlegen.

Sängers Vielseitigkeit und Eigenart machen es nicht leicht, seine Gesamtleistung als Wissenschafter und Organisator in allen Teilen gerecht zu würdigen.

Den Anfang seiner wissenschaftlichen Laufbahn bildete die Dissertation über Temperaturempfindlichkeit der Dielektrizitätskonstanten von CH4, CH3Cl, CH2Cl2, CHC3, CCl4 im dampfförmigen Zustand. Sie ist 1926 auf Anregung seines verehrten Lehrers Peter Debye entstanden und erhellt aufs deutlichste den Zusammenhang zwischen Bau (Symmetrie, Asymmetrie) und elektrischem Dipolmoment der Moleküle. Die Debyesche Dipoltheorie hat durch sie eine bemerkenswerte experimentelle Stütze gefunden, Sänger aber ist durch diese Arbeit auf das Gebiet der Struktur der Materie geleitet worden, das er jahrelang gepflegt und besonders auch nach seiner Habilitation (1931) an der Eidgenössischen Technischen Hochschule in seinen Vorlesungen behandelt hat.

Seine organisatorischen Fähigkeiten hat Sänger insbesondere in der Stellung eines Sektionschefs an der Abteilung für Industrielle Forschung (AFIF) des von Fritz Fischer geleiteten Instituts für Technische Physik entfaltet, die er von 1938 bis 1949 innehatte. In dieser Zeit waren ihm auch Vorbereitung und Durchführung der Internationalen Fernsehtagungen 1938 und 1948 übertragen, und 1950 präsidierte er das Organisationskomitee für die Generalversammlung der Union Radio-Scientifique Internationale (URSI) in Zürich. Er amtete 1934 bis 1940 als Präsident der Zürcher Physikalischen Gesellschaft, deren Tätigkeit er in fruchtbarster Weise belebt hat. In bester Erinnerung ist bei allen Teilnehmern die von Sänger geleitete 50-Jahr-Feier im Januar 1937 geblieben, die mit einer der zahlreichen von ihm organisierten Tagungen über die Physik des festen Körpers verbunden war.

In Sängers Tätigkeit hat noch ein anderes Gebiet einen wichtigen und für seine Entwicklung bedeutungsvollen Platz eingenommen, nämlich das Wehrwesen. Dem wissenschaftlich geschulten Geist des Artillerieoffiziers stellten sich zahlreiche Probleme. Was er als verbesserungsfähig erkannte, verdichtete sich ihm zur Aufgabe. So strebte er insbesondere nach einer besseren Vorausberechnung der Flugbahnen und wurde dadurch zur Ballistik und zur Physik der Atmosphäre geführt. E. Stiefel sagt hie1über: "Von der physikalischen Messtechnik durch Sondierung der Atmosphäre bis zum Richten der Geschütze hat er alle Bausteine zusammengetragen, um eine erstaunlich präzise Wirkung im Ziel zu erreichen." Sänger schloss seine verdienstvolle militärische Laufbahn als Dienstchef des Schweizerischen Artilleriewetterdienstes mit dem Gradeeines Obersten ab.

Die schönsten Leistungen hat Sänger wohl in seinem letzten Jahrzehnt mitseinen Untersuchungen aus der Physik der Atmosphäre vollbracht. Als der Schweizerische Bundesrat im Jahre 1950 die Eidgenössische Kommission zum Studium der Hagelbildung und der Hagelabwehr ins Leben rief, erwies es sich als gegeben, ihm das Präsidium zu übertragen. Er stellte in Zusammenarbeit mit dem Osservatorio Ticinese und dem Eidgenössischen Institut für Schnee und Lawinenforschung auf dem Weissfluhjoch ein grossangelegtes Forschungsprogramm auf, das seither konsequent verwirklicht worden ist. Die wissenschaftlichen Berichte der Kommission, unter denen vor allem Sängers Beiträge zum Mechanismus der atmosphärischen Vereisungsprozesse und über die Möglichkeiten der künstlichen Niederschlagsbildung durch Keime hervorzuheben sind, finden sich zum grossen Teil in unserer Zeitschrift.

Sängers Leistungen sind besonders im Ausland gewürdigt worden. Von 1931 bis 1933 war er als International Research Fellow der Rockefeller Foundation am California Institute of Technology, 1936 als Visiting Professor an dergleichen Hochschule und 1950/51 wiederum für ein halbes Jahr in den Vereinigten Staaten. Im Jahr 1954 organisierte er ein Internationales Symposion über experimentelle Meteorologie in Zürich. In den letzten Jahren nahm er an den Konferenzen über Wolkenphysik in Woods Hole, Mass. (1959), in Verona (1960) sowie in Canberra und Sydney (1961) teil.

Wenn die Eidgenössische Technische Hochschule Raymund Sänger im letzten Frühjahr zum ausserordentlichen Professor befördert hat, so war dies eine längst verdiente Anerkennung seines Wirkens. Mit der Professur war ein Laboratorium für Atmosphärenphysik verbunden, dessen Aufbau er sich im letzten halben Jahr mit besonderer Hingabe gewidmet hat. Ehre seinem Andenken!

TANK [Prof. Franz Tank, 1890-1981]

English translation:

We have the painful duty
to inform you of the death of our respected friend and co-worker
PROFESSOR DR. RAYMUND SÄNGER
Editor of ZAMP
He died on September 29, 1962
unexpectedly on the peak of his action.

Editorial Board and Publisher
of the Journal of Applied Mathematics and Physics

RAYMUND SÄNGER
1895-1962

When the Journal of Applied Mathematics and Physics (ZAMP) was founded in 1949, Raymund Sänger was chosen as editor. For more than twelve years, he has devoted himself to this project with total dedication and led the Journal to international reputation. He brought the necessary skills with him: scientific maturity, versatility, industriousness and conciliation in communication; he has used it for the best of the magazine.

In the midst of intensive activity, Raymund Sänger succumbed to cardiac paralysis. Singer's versatility and peculiarity make it difficult to do justice to his overall achievements as scientist and organizer in all respects.

The beginning of his scientific career was his dissertation on temperature sensitivity of the dielectric constants of CH4, CH3Cl, CH2Cl2, CHC3, CCl4 in the vapor state. It was written in 1926 at the suggestion of his esteemed teacher Peter Debye and shed light on the connection between structure (symmetry, asymmetry) and the electric dipole moment of the molecules. Debye's dipole theory found a remarkable experimental support, but this work has led Singer to the field of the structure of matter, which he fostered for years and, especially after his habilitation (1931) at the Swiss Federal Institute of Technology, taught in his lectures.

Sänger developed his organizational skills in particular in his position of Section Chief at the Department of Industrial Research (AFIF), at the Institute of Technical Physics, directed by Fritz Fischer which he held from 1938 to 1949. During this time, he was also responsible for the preparation and organization of the International Television Conferences in 1938 and 1948, and in

1950 he presided over the Organizing Committee for the General Assembly of the Union Radio-Scientifique Internationale (URSI) in Zurich. From 1934 to 1940 he was president of the Zurich Physical Society, whose activity he revived in the most fruitful way. The 50th anniversary celebration led by Sänger in January 1937, which was associated with one of the numerous conferences on the physics of the solid body organized by him, remained in the memory of all participants.

In Sänger's activity, another area has occupied an important and for his development essential place, namely the military. The scientifically trained spirit of the artillery officer faced numerous problems. Whatever had potential for improvement condensed into a task for him. In particular, he strove for a better prediction of trajectories and was thereby led to ballistics and the physics of the atmosphere. E. Stiefel says: "From physical measurement by probing the atmosphere to the directing of the guns, he has gathered all the building blocks to achieve a remarkably precise effect on the target." Singer completed his meritorious military career as Chief of Staff of the Swiss Artillery Service with the rank of Colonel.

Probably the most beautiful achievements were accomplished by Sänger in his last decade with his investigations of the physics of the atmosphere. When the Swiss Federal Council established the Federal Commission for the Study of Hail Formation and Hail Prevention in 1950, it proved clear to transfer the presidency to him. In collaboration with the Osservatorio Ticinese and the Swiss Federal Institute for Snow and Avalanche Research on the Weissfluhjoch, he set up a large-scale research program, which has since been consistently implemented. The scientific reports of the commission, among which Sanger's contributions to the mechanism of atmospheric icing processes and the possibilities of artificial precipitation formation by condensation nuclei, are found in large part in our journal.

Sänger's achievements have been especially appreciated abroad. From 1931 to 1933 he was an International Research Fellow of the Rockefeller Foundation at the California Institute of Technology, 1936 as a visiting professor at the same college, and 1950/51 again for half a year in the United States. In 1954 he organized an International Symposium on experimental Meteorology in Zurich. In recent years, he participated in conferences on cloud physics in Woods Hole, Mass. (1959), in Verona (1960), and in Canberra and Sydney (1961).

When the Swiss Federal Institute of Technology promoted Raymund Sänger to associate professor last Spring, it was a well-deserved recognition of his work. Associated with the professorship was a Laboratory for Atmospheric Physics, the establishment of which he devoted himself to with particular dedication during the last six months. Honor his memory!

TANK [Prof. Franz Tank, 1890-1981]

Appendix C: Thoughts of H.U. Dütsch

This is a translation of the German document attached to the application of H.U. Dütsch for the Extraordinary Chair of Atmospheric Physics at ETH Zurich. Probably these "thoughts" were put on paper in response to a request from the former president of the School Council (today's ETH Board), Prof. Pallmann.

The German text is a faithful copy from the minutes of the School Council; obvious typos were corrected. The layout of the translation follows more or less the original layout.

Das folgende deutschsprachigen Dokuments war eine Beilage zur Bewerbung von H.U. Dütsch für die ausserordentliche Professur für Atmosphärenphysik an der ETH Zürich. Wahrscheinlich wurden diese "Gedanken" als Reaktion auf eine Anfrage des damaligen Schulratspräsidenten (heutiger ETH-Rat), Prof. Pallmann, zu Papier gebracht.

Der Text und die Darstellung sind eine originalgetreue Abschrift aus dem Protokoll-Archiv des Schulrats; offensichtliche Tippfehler wurden korrigiert.

Gedanken zum Aufbau eines Instituts für Atmosphärenphysik an der ETH

Bedeutung des Studiums der Atmosphäre

Mit der rapiden Ausdehnung des Flugverkehrs seit dem zweiten Weltkrieg erfuhr die Zahl der im praktischen Wetterdienst benötigten Meteorologen eine rasche Zunahme. Diese Entwicklung brachte zwar der Meteorologie viele neue Impulse, gleichzeitig förderte sie aber auch ein verbreitetes Missverständnis, nämlich die Identifizierung von Meteorologie mit praktischer Wettervorhersage. Diese Gleichsetzung bedeutet eine völlig unzutreffende Einschränkung und führt zu einem falschen Bild in Bezug auf den "benötigten" akademischen Nachwuchs. Sie hat auch zu einer bedauerlichen und ungerechtfertigten Abwertung des Begriffs Meteorologie in wissenschaftlichen Kreisen geführt, aus welchem Grund manches amerikanische Meteorological Department seinen Namen in Dept. of Atmospheric Physics oder Atmospheric Sciences abgeändert hat.

In Wirklichkeit ist der Bedarf an jungen wissenschaftlichen Kräften auf dem Gebiet der Atmosphärenphysik viel grösser, als sich aus der Stellearithmetik der nationalen Wetterdienste ergibt, indem die gegenwärtige Entwicklung dringend verlangt, dass grosse Teile der ausgebildeten jungen Meteorologen sich der eigentlichen Grundlagenforschung zuwenden. Deren intensive Förderung wird etwa durch den sog. Pettersson-Report postuliert: Das Planungskomitee für Atmospheric Sciences in USA hebt in seinem Bericht an den wissenschaftlichen Berater des Präsidenten (The Atmospheric Sciences 1961-1971, National Academy of Sciences, National Research Council, Publication 946) die Bedeutung der Grundlagenforschung hervor und verlangt grosse Anstrengungen zur Erweiterung der Zahl der entsprechend ausgebildeten Wissenschafter. Als Ziel wird genannt, die Zahl der jährlich absolvierenden Doktoranden in Atmosphärenphysik (Aeronomie inbegriffen) von gegenwärtig 40 auf 180 zu steigern, was bedeutet, dass gleichzeitig die Gesamtzahl der graduate students auf etwa 2500 ansteige müsste (prozentual auf schweizerische Verhältnisse übertragen bedeutet dies etwa 70 Studierende).

Intensive Grundlagenforschung ist die Voraussetzung für Fortschritte in der Behandlung einer Reihe von praktischen Probleme, die sich heute stellen, oder die in naher Zukunft aktuell werden dürften:

Selbstverständlich gilt dies für eine Verbesserung der Wettervorhersage. Es ist dazu eine immer vollständigere Kenntnis der allgemeinen Zirkulation und ihrer allfälligen Beeinflussung durch den Sonnenfleckenzyklus (spez. im Hinblick auf Langfristprognosen) sowie der Dynamik der Strömungsvorgänge in verschiedener Grössenordnung (Kurz- und Mittelfristprognose) nötig.

Es zeichnen sich aber in steigendem Masse auch andere, neue Probleme von praktischer Bedeutung ab, von denen hier nur zwei genannte werden sollen:

Zunehmende Impfung (Verunreinigung) der höchsten Atmosphärenschichten mit von Natur aus dort nicht oder in nur sehr geringem Masse vorhandenen Substanzen (vor allem durch Raketenbrennstoffe bewirkt) kann möglicherweise beträchtliche Störungen im bisherigen Gleichgewicht dieser Schichten mit der kurzwelligen Sonnenstrahlung herbeiführen, mit noch nicht genau übersehbaren Wirkungen auf den Menschen und seine Tätigkeit.

Aktive Wetterbeeinflussung: Mit Versuchen zu Niederschlagsvermehrung und Hagelbekämpfung hat diese in bisher kleinräumigen Masstab bereits begonnen. Es muss damit gerechnet werden, dass in absehbarer Zeit grossangelegte Experimente zur Wetter- resp. Klimabeeinflussung eingeleitet werden. Ihre Auswirkung, die -- wenn die Versuche erfolgreich verlaufen -- in einem bestimmten Gebiet positiv sein wird, kann anderswo sehr wohl negativ sein. Die politischen und wirtschaftlichen Implikationen sind damit nicht zu übersehen. Auch in einem kleinen Land muss deshalb, wenn dieses seine Unabhängigkeit in jeder Hinsicht bewahren will, und es gegen Ueberraschungen gesichert sein soll, Vertrautheit mit der Materie bestehen, damit eine eigene Meinung rechtzeitig gebildet werden kann.

Bekanntlich ist die Meteorologie wie fast keine andere Wissenschaft auf internationale Zusammenarbeit angewiesen. Auch ein kleines Land kann dabei seinen wertvollen Beitrag leisten, sei es durch die Lösung einzelner Problem und durch die tatkräftige Mitwirkung an internationalen Beobachtungsprogrammen, oder sei es durch die Ausbildung von heute auf diesem Gebiet dringend benötigten Wissenschaftern. Je aktiver ein Land an dieser Zusammenarbeit teilnimmt, in desto höherem Masse wird seine Stimme bei allfälligen zukünftigen Diskussionen über Wetterbeeinflussung auf internationaler Ebene gehört werden.

Es mag noch beigefügt werden, dass auch der praktische Wetterdienst im letzten Jahrzehnt eine Entwicklung erfahren hat, welche eine fundierte akademische Fachausbildung des wissenschaftlichen Personals dringend notwendig erscheinen lässt; eine blosse Anlernung im Betrieb von auf anderen Gebieten ausgebildeten

Leuten muss immer mehr als ungenügend und vor allem als sehr unrationell bezeichnet werden.

Folgerungen für den Aufbau eines Instituts

Die Bildung eines eigenen fundierten Urteils über Fragen, die, wie im vorhergehenden Abschnitt ausgeführt, bald von grosser praktischer Bedeutung werden könnten, verlangt sehr vielseitige Kenntnisse auf dem Gebiet der Atmosphärenphysik. Die Fachausbildung der Studenten darf sich deshalb nicht auf ein oder zwei wissenschaftlich interessante Spezialgebiete beschränken, sie darf aber noch viel weniger nur auf die momentanen Bedürfnisse des praktischen Wetterdienstes zugeschnitten sein. Die notwendige, möglichst umfassende Ausbildung sollte ferner, wenn immer angängig, von auf dem betreffenden Gebiet selbst kompetenten Dozenten vermittelt werden können, und eigene Forschungsmöglichkeiten für den Studierenden sollten auf einer grösseren Anzahl von Spezialgebieten zur Verfügung stehen.

Infolge er rapiden Entwicklung, welche die Atmosphärenphysik in den vergangenen zwei Jahrzehnten erlebt hat, und infolge der starken Spezialisierung, die auch auf diesem Gebiete eingetreten ist, ist dies eine Aufgabe, die ein einzelner Dozent kaum mehr befriedigend bewältigt werden kann, Ein Institut sollte deshalb möglichst bald über drei vollamtliche Dozenten verfügen, wobei die Aufspaltung der Verantwortlichkeiten ungefähr wie folgt aussehen müsste:

I. Physik der Troposphäre

Thermodynamik der Atmosphäre
Wolkenphysik, Niederschlagsbildung
Turbulenz und Luftverunreinigung
Strahlung
Grenzschichtphänomene
Biometeorologie

Eine genaue Kenntnis der Probleme der Niederschlagsbildung spielt eine wesentliche Rolle bei einer Gruppe von Versuchen zur Wetterbeeinflussung. Mit verstärkter Industrialisierung und weiterer Zunahme der Bevölkerungsdichte wird ein eingehendes Studium der Luftkontamination und ihrer Bekämpfung ein immer dringlicheres Problem. Die Bearbeitung dieser beiden Spezialgebiete, die übrigens miteinander verknüpft sind, verlangt auch eine gute Kenntnis der übrigen hier angeführten Kategorien.

II. Physik der hohen Atmosphäre

Wirkung der kurzwelligen Sonnenstrahlung und der Korpuskularstrahlung auf die hohen Atmosphärenschichten (Ionisation, photochemische Vorgänge sowie Aufheizung)
Traceruntersuchungen (radioaktives Material, Ozon, Wasserdampf usw.)

Allgemeine Zirkulation der hohen Atmosphäre und ihre Beziehungen zum Sonnenfleckenzyklus, mögliche Rückwirkungen auf die Troposphäre.

Raketen und Satelliten als Forschungsmittel des Atmosphärenphysikers.

Die Entwicklung von Raketen und Satelliten hat nicht nur die Kenntnis des oberen Teils unserer Atmosphäre enorm verbessert, sondern gleichzeitig das Interessen an diesen Schichten, die gewissermassen das Tor zum Weltraum darstellen, mächtig gefördert. Aber auch abgesehen von solchen z.T. emotionalen Gründen ist mit einer verbesserter Kenntnis die Bedeutung dieses Teils der Atmosphäre immer deutlicher hervorgetreten. Hier muss das immer noch unbekannte Bindeglied zwischen Sonnenfleckenzyklus und Wetterablauf in der Troposphäre gesucht werden. Der stratosphärischen Zirkulation kommt eine grosse Bedeutung für die Ausbreitung von radioaktiven Abfallprodukten vor allem thermonuklearer Explosionen zu; und schliesslich ist, wie schon länger bekannt, die Zone oberhalb 100 km, die sog. Ionosphäre, von ausschlaggebender Bedeutung für die Radiokommunikation. Es muss ferner im Auge behalten werden, dass die im ersten Abschnitt erwähnten Impfung der hohen Atmosphäre vor allem wegen der möglichen Wechselwirkung mit der Ozonschicht einmal zu einem Wetterbeeinflussungsexperiment grössten und auch gefährlichsten Stils verwendet werden könnte.

III. Synoptik, Dynamik und allgemeine Zirkulation sowie Klimatologie.

Diese Gebiete gehören zur grundlegenden Ausbildung jedes Atmosphärenphysikers, unabhängig vom Spezialstudium, dem er sich zuwenden will. Synoptische Methoden werden abgesehen von ihrer Bedeutung für den praktischen Wetterdienst mehrt und mehr auch bei der Behandlung verschiedener anderer Probleme der Atmosphärenphysik zur Anwendung gebracht. Mit der Entwicklung moderner Verfahren, vor allem mit der Einführung der numerischen Methoden in den Wettervorhersagedienst, muss in viel höherem Masse als früher auch vom praktischen Meteorologen Vertrautheit mit den Problemen der Dynamik verlangt werden. Solide Kenntnisse auf diesem Gebiet können auch den Atmosphärenphysiker, der auf den unter I und II erwähnten Gebieten arbeitet, vor gefährlichen Trugschlüssen bewahren; Aehnliches gilt für Vertrautheit mit den Gesetzen der allgemeinen Zirkulation.

Selbstverständlich sind manche Ueberschneidungen zwischen den hier angeführten drei Hauptgruppen vorhanden, was aber nur von Vorteil sein kann, da dies der Gefahr des blossen Spezialistentums und des Auseinanderfallens eines grösseren Instituts entgegenwirkt.

Boulder, Colo., den 28. 12. 1962

H.U. Dütsch

[translation]

Thoughts on the establishment of an Institute for Atmospheric Physics at the ETH

Importance of studying the atmosphere

With the rapid expansion of air traffic since World War II, the number of meteorologists needed in the practical weather service experienced a rapid increase. Although this development brought many new impulses to meteorology, at the same time it also promoted a widespread misunderstanding, namely the identification of meteorology with practical weather forecasting. This equation implies a completely inappropriate restriction and leads to a false picture regarding the "required" junior academic. It has also led to a regrettable and unjustified devaluation of the term meteorology in scientific circles, for which reason some American meteorological Departments renamed themselves in Dept. of Atmospheric Physics or Atmospheric Sciences.

In fact, the demand for young scientists in the field of atmospheric physics is much greater than that resulting from the computational mathematics of the National Meteorological Services, as current developments urgently demand that large parts of the trained young meteorologists turn to basic research proper. Their intensive support is postulated, for example, by the so-called Pettersson Report: The Planning Committee for Atmospheric Sciences in the USA emphasizes in its report to the scientific adviser to the President (The Atmospheric Sciences 1961-1971, National Academy of Sciences, National Research Council, Publication 946) emphasizes the importance of basic research and requires great efforts to expand the number of suitably trained scientists. The goal is to increase the number of graduate students in atmospheric physics (including aeronautics) from 40 to 180, which means that the total number of graduate students should increase to about 2,500 (In percentage terms, this amounts to about 70 Swiss graduate students).

Intensive basic research is the prerequisite for progress in the treatment of a number of practical problems that arise today or which may soon become relevant:

Of course, this applies to an improvement of the weather forecasting. For this purpose, an ever more complete knowledge of the general circulation and its possible response to the sunspot cycle (in particular concerning long-term predictions) as well as the dynamics of the flow processes in different time-scales (short- and medium-term prediction) is necessary.

But there are also increasing numbers of other, new problems of practical importance, of which only two are mentioned here:

Increasing injections into the highest atmospheric layers of substances that are not naturally there or only to a very limited extent (mainly caused by rocket fuels) may cause considerable disturbances in the previous equilibrium of these layers with the short-wave solar radiation, with not exactly obvious effects on humans and their activities.

Active Weather Control: With experiments on precipitation enhancement and hail control, this has already begun on a hitherto small scale. It must be expected that in the foreseeable future large-scale experiments on the weather resp. climate change will be initiated. Their effect, which – if successful – will be positive in a particular area, may well be negative elsewhere. The political and economic implications are therefore not to be overlooked. Even in a small country, therefore, if it wants to preserve its independence in every respect, and if it should be protected against surprises, familiarity with the issues must exist, so that its own opinion can be formed in good time.

As is well known, meteorology, like almost no other science, relies on international cooperation. Even a small country can make its valuable contribution here, either by solving individual problems and by actively participating in international observation programs, or by training urgently needed scientists in this field. The more active a country participates in this cooperation, the better its voice will be heard in the event of any future discussions on weather modification at the international level.

It may also be added that the practical weather service has undergone a development in the last decade, which makes a sound academic education of the scientific staff necessary without delay; a mere training on the job of people educated in other fields must always be described as insufficient and above all as very inefficient.

Conclusions for the establishment of an institute

The formation of an in-depth assessment on issues which, as stated in the previous section, could soon become of great practical importance, demands very diverse knowledge in the field of atmospheric physics. The specialized training of students must therefore not be limited to one or two scientifically interesting special areas, and much less be tailored to the current needs of the practical weather service. The necessary and most comprehensive training should also be available, as appropriate, from competent lecturers in the area concerned, and research opportunities for the student should be available in a greater number of special areas.

Due to the rapid development that atmospheric physics has undergone in the past two decades, and due to the strong specialization that has also occurred in this area, this is a task that a single lecturer can hardly cope with satisfactorily. An institute should, therefore, comprise three full-time lecturers as soon as possible, with the responsibilities split among them approximately as follows:

I. Physics of the troposphere

Thermodynamics of the atmosphere
Cloud physics, precipitation processes
Turbulence and air pollution
Radiation
Boundary layer phenomena
Biometeorology

> Accurate knowledge of the problems of precipitation formation plays an essential role in a group of weather modification experiments. With increased industrialization and a further increase in population density, a thorough study of air pollution and its fight against it becomes an increasingly urgent problem. The treatment of these two specialties, which are, by the way, linked, requires a good knowledge of the other categories mentioned here.

II. Physics of the high atmosphere

Effect of short-wave solar radiation and corpuscular radiation on the high atmospheric layers (ionization, photochemical processes as well as heating)
Tracer studies (radioactive material, ozone, water vapor, etc.)
General circulation of the high atmosphere and its relationship to the sunspot cycle, possible repercussions on the troposphere.

Rockets and satellites as research tools of the atmosphere physicist.

The development of rockets and satellites has not only vastly improved the knowledge of the upper part of our atmosphere, but has also greatly promoted the interests in these layers, which are effectively the gateway to space. But also apart from such somewhat emotional reasons, with the increased knowledge, the importance of this part of the atmosphere has become more and more apparent. Here, the still unknown link between the sunspot cycle and weather patterns in the troposphere must be sought. The stratospheric circulation is of great importance for the propagation of radioactive waste products, above all thermonuclear explosions; and finally, as has long been known, the zone above 100 km, the so-called ionosphere, is of decisive importance for radio communication. It should also be borne in mind that the high-atmosphere seeding mentioned in the first paragraph could be used, because of the potential interaction with the ozone layer, for a weather impact experiment in the most massive and most dangerous manner.

III. Synoptics, dynamics and general circulation as well as climatology.

These areas are part of the basic training of any atmospheric physicist, regardless of the special studies he wants to turn to. Synoptic methods, apart from their importance for practical meteorological service, are being used more and more in the treatment of various other problems of atmospheric physics. With the development of modern methods, especially with the introduction of numerical methods in the weather forecast service, familiarity with the problems of dynamics are required from practical meteorologist to a much greater extent than before. Sound knowledge in this field can also save the atmospheric physicist working in the areas mentioned under I and II from dangerous fallacies; The same applies to familiarity with the laws of general circulation.

Of course, there are some overlaps between the three main groups mentioned here, which, however, can only be of advantage, since they counteract the danger of mere specialization and the break-up of a larger institute.

Boulder, Colo., 28. 12. 1962

H.U. Dütsch

Appendix D: List of Professors active in atmospheric science teaching at the LAP, IAS and IACETH

Please note:
- Individuals are ordered according their first appearance in the official Vorlesungs-verzeichnis [Catalogue of Courses] as Lecturer
- Time spans indicate the period during which the person was active in teaching; of course, the titles did not expire
- If no final year is given, teaching activities continued beyond 2011.

Raymund Sänger (1895-1962)

1931-1947 Senior Lecturer
1948-1961 Adjunct Professor
1962-1962 Associate Professor

Walter Kuhn (1915-2003)

1955-1968 Lecturer for Meteorology
1969-1980 Adjunct Professor

Hans-Ulrich Dütsch (1917-2003)

1965-1985 Full Professor for Atmospheric Physics

Hans Richner (*1944)

1979-1994 Lecturer for Atmospheric Physics
1995 Adjunct Professor

Fritz Herbert (*1944)

1978-1979 Assistant Professor for Meteorology

Herbert Lang (*1933)

1980-1998 Senior Lecturer for Hydrology
1986 Adjunct Professor

Huw Cathan Davies (*1944)

1982-1989 Associate Professor for Meteorology
1989 Full Professor for Physics

Atsumu Ohmura (*1942)

1983-1986	Assistant Professor for Physical Geography
1986-1992	Associate Professor for Physical Geography
1992	Full Professor for Physical Geography

Albert Waldvogel (*1941)

1979-1984	Lecturer
1985-1990	Associate Professor for Experimental Atmospherics Physics
1990-1996	Full Professor for Experimental Atmospherics Physics
(1997-2001	Vice President Research and Corporate Relation)

Martin Wild (*1964)

1988-2009	Lecturer
2010	Adjunct Professor

Christoph Schär (*1958)

1992-1998	Assistant Professor for Climate Dynamics
1998-2001	Associate Professor for Hydrology and Climatology
2001	Full Professor for Climate and Water Cycle

Heinz Blatter (*1946)

1992-1998 Senior Lecturer for Physical Climatology
1999 Adjunct Professor

Thomas Peter (*1958)

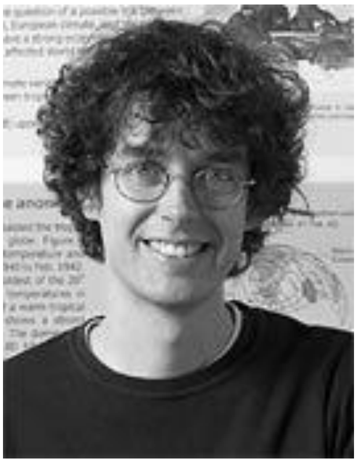
1999 Full Professor for Atmospheric Chemistry

Johannes Staehelin (*1949)

2001 Adjunct Professor

Ulrike Lohmann (*1966)

2004 Full Professor for Experimental Atmospherics Physics



Stefan Brönnimann (*1970)

2004-2010 SNF-sponsored Professor for Climatology

Urs Baltensperger (*1955)

2006 Adjunct Professor

Sonia Seneviratne (*1974)

2007 Assistant Professor for Land-Climate Interactions

Reto Knutti (*1973)

2007 Assistant Professor for Climate Physics

Heini Wernli (*1964)

2009 Full Professor for Atmospheric Dynamics

Appendix E: List of individuals who taught meteorological and related subjects but were either not directly affiliated with, or were not professors at the Institute

Please note:
- Individuals are ordered according their first appearance in the official Vorlesungs-verzeichnis [Catalogue of Courses] as Lecturer
- Time spans indicate the period during which the person was active in teaching; the teaching might have been intermittent.
- Teaching topics are not necessarily identical with the (mostly German) title of the lectures
- Title and affiliations are those which the persons had when active at the Institute
- WS: winter semester; SS: summer semester; number added: year

Dr. Jean Lugeon (1898-1976), Director of the Meteorologische Zentralanstalt Zurich

WS59/60 - WS64/65 General meteorology with particular emphasis on aviation meteorology.

Prof. Jean-Pierre Blaser (1923-2019), ETH Physics Institute, filled in before H.U. Dütsch arrived

SS65 Physics of the high atmosphere

Prof. De Quervin (1915-2007), Director of the Institute for Snow an Avalanche Research, Weissfluhjoch-Davos, filled in before H.U. Dütsch arrived

SS63 General atmospheric physics, cloud, snow, and avalanche physics

PD Dr. Theo Ginsburg (1926-1993), Lecturer (PD) for numerical mathematics, ETH

WS67/68 - WS69/70 Mainly mathematical-statistical topics in Earth and atmospheric science

Dr. Fabian (*1937), Stand-in for H.U. Dütsch during his sabbatical leave

SS71 Atmospheric physics II

Prof. Julius London (1917-2009), University of Colorado, Boulder, U.S.A.

SS67, WS74/75 Atmospheric radiation

Dr. Desmond Walshaw (1925 - 2013), St. Cross College, Oxford, U.K.

SS70 Atmospheric radiation; Radiation in GCMs; Sounding the atmosphere from satellites

Dr. Jürg Joss (*1937), Meteorologische Zentralanstalt, Osservatorio Locarno-Monti

WS 71/72 -WS72/73 Radarmeteorology

Dr. Bruno Federer (1936-1982), Director of the Grossversuch IV (hail suppression experiment)

WS71/72 -WS82/83 Cloud physics; Weather modification; Aerosols

Prof. Bernhard Haurwitz (1905 - 1986), Guest Professor, National Center for Atmospheric Research NCAR, Boulder, U.S.A.

SS72 Atmospheric waves

Prof. François Baatard (1919-1978),

WS73/74 Atmospheric turbulence

Prof. Roland List (*1929), Guest Professor, University of Toronto

SS74 Cloud dynamics

Antoine Zelenka (*1941),

SS74 Star atmospheres

Dr. Claus Fröhlich (1936-2019), Director of the World Radiation Center Davos

SS79 - SS83 Radiation processes in the lower atmosphere

PD Dr. Wolfgang Seiler (*1940), Max-Plank-Institut, Garmisch

WS80/81 Air chemistry

Dr. Alexandre Piaget (*1922), Swiss Meteorological Institute, Zurich

WS80/81 Atmospherics physics lab course

Prof. Helmut Pichler (*1929), University Innsbruck

SS81 Dynamical meteorology

Appendix F: List of doctoral theses completed at or supported by the IAC and its previous structures

List of doctoral theses that were supervised by ETH professors who were active in atmospheric sciences, (i) prior to 1962, (ii) at the Laboratory for Atmospheric Physics LAPETH, (iii) at the Geographical Institute, (iv) at the Institute for Climate Research IKF, or (v) at the Institute for Atmospheric and Climate Science IAC

year: year of acceptance

age: age when receiving the doctoral degree

th.no.: ETH thesis number

l:	language of thesis;		d: German,	f: French,	i: Italian,	e: English
n:	nationality;	at: Austria	au: Australia	ch: Switzerland	cn: Canada	co: Colombia
		cz: Czech Republic	de: Germany	es: Spain	et: Ethiopia	fr: France
		gb: United Kingdom	hu: Hungary	id: Indonesia	it: Italy	jp: Japan
		li: Liechtenstein	nl: Netherlands	no: Norway	ro: Romania	ru: Russian Fed.
		sg: Singapore	se: Sweden	sk: Slovakia	th: Thailand	us: United States
s:	sex	m: male	f: female			

Notes (attached to examiner)

1) Sänger's own thesis;
2) theses overviewed by Sänger;
3) theses actually led by Sänger, because he was not professor yet, he could not be examiner;
4) the first thesis where Sänger could have been examiner, unfortunately he passed away before it was completed;
5) theses de facto carried out at a forerunner institute of IAC, but for organizational reasons submitted to another ETH institute (with the approval of the Executive Board [Schulleitung]).

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
1926	Sänger, Raymund	1895	31	Temperaturempfindlichkeit der Dielektrizitätskonstanten von CH4, CH3Cl, CH2Cl2, CHCl2, CCL4 im dampffoermigen Zustande	Debey 1)	Scherrer	473	d	ch	m
1930	Wintsch, Heinrich	1903	27	Über Dielektrizitätskonstante, Widerstand und Phasenwinkel des Eises	Scherrer 2)	Baur	509	d	ch	m
1930	Good, William	1905	25	Streuung von Röntgenstrahlen an Wasser und an wässerigen Salzlösungen	Scherrer 2)	Tank	603	d	uk	m
1931	Steiger, Oscar	1902	29	Über das dielektrische Verhalten der Methylamine	Scherrer 2)	Tank	649	d	ch	m
1945	Rott, Nikolaus	1917	28	Das Feld einer raschbewegten Schallquelle	Ackeret 3)	Sänger	1351	d	hu	m
1952	Sulzer, Peter	1918	34	Intensitätsverteilung eines kontinuierlichen Absorptionsspektrums in Abhängigkeit von Wellenzahl und Temperatur	Scherrer 3)	Sänger	2051	d	ch	m
1953	Roth, Ernst	1921	32	Zur Berechnung der Flugbahnen von Leitstrahlraketen	Stiefel 3)	Sänger	2220	d	ch	m
1956	Wieland, Walter	1924	32	Die Wasserdampfkondensation an natürlichem Aerosol bei geringen Übersättigungen	Scherrer 3)	Sänger	2577	d	ch	m
1958	Voellmy, Hans Rudolf	1922	36	Experimentelle Untersuchungen an verschieden stark konvergenten, schlanken Rotationskörpern bei mässig hohen Überschallgeschwindigkeiten	Ackeret 3)	Sänger	2692	d	ch	m
1957	Steinemann, Adolf	1928	29	Dielektrische Eigenschaften von Eiskristallen	Scherrer 3)	Sänger	2696	d	ch	m
1960	List, Roland	1929	31	Zur Thermodynamik teilweise wässriger Hagelkörner	Busch 3)	Sänger	2995	d	ch	m

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
1962	Katz, Ulrich	1931	31	Wolkenkammeruntersuchungen der Eiskeimbildungsaktivität einiger ausgewählter Stoffe	Busch 3)	Sänger	3229	d	ch	m
1965	Gyr, Albert	1935	30	Ein Tropfenakkreszenzmodell in Atmosphäre von homogen isotroper Turbulenz	Fierz 4) (Sänger†)	de Quervin	3599	d	ch	m
1968	Aufdermaur, Armin Niklaus	1937	31	Windkanalversuche und theoretische Betrachtungen zum lokalen Wärme- und Stoffübergang an Hagelkornmodellen	Dütsch	de Quervin	4221	d	ch	m
1969	Junod, Andre	1930	39	Contribution à la methodologie granulometrique des aerosols amicroscopiques	Berger	Dütsch	4280	f	ch	m
1970	Piaget, Alexandre	1922	48	Utilisation de l'ozone atmospherique comme traceur des echanges entre la troposphère et la stratosphère	Dütsch	Kuhn	4594	f	ch	m
1971	Kälin, Max	1943	28	The active push moraine of the Thompson Glacier, Axel Heiberg Island, Canadian Arctic Archipelago, Canada	Müller	Gansser	4671	e	ch	m
1972	Waldvogel, Albert	1941	31	Ueber den N-o-Sprung von Tropfenspektren	Dütsch	Kuhn	4892	d	ch	m
1974	Iken, Almut	1933	41	Velocity fluctuations of an arctic valley glacier	Müller	Roethlisberger	4959	e	de	m
1973	Züllig, Walter	1937	36	Beziehung zwischen der Intensität des stratosphärischen Polarnachtwirbels und dem Ozongehalt der Winterhemisphäre	Dütsch	Kuhn	5162	d	ch	m
1974	Richner, Hans	1944	30	Zusammenhänge zwischen raschen atmosphärischen Druckschwankungen, Wetterlagen und subjektivem Befinden	Dütsch	Grandjean	5253	d	ch	m
1974	Müller, Andreas	1940	34	Eine Lasermethode zur vorzeichenrichtigen Geschwindigkeitsmessung in stroemenden Medien und deren Anwendung zu Untersuchungen an einem gewellten Wassersprung über einer abfallenden Sohle	Dütsch	Lukosz	5372	d	ch	m
1975	Birrer, Walter	1933	42	Homogenisierung und Diskussion der Totalozon-Messreihe von Arosa 1926-1971	Dütsch	London	5531	d	ch	m
1979	Ito, Hajime	1946	33	On the mechanics of the fast ice the North Water area	Müller	Vischer	6365	e	jp	m
1979	Nater, Werner	1947	32	Grenzschichtwellen als Ursache von kurzperiodischen Druckschwankungen	Dütsch	Rott	6469	d	ch	m
1980	Ohmura, Atsumu	1942	38	Climate and energy balance on Arctic tundra, Axel Heiberg Island, Canadian Arctic Archipelago, spring and summer 1969, 1970 and 1972	Müller	Dütsch	6587	e	jp	m
1980	Gassmann, Fritz	1947	33	Untersuchungen zur Turbulenztheorie am Beispiel des rotationssymmetrischen Freistrahles	Dütsch	Sarlos Thomann	6772	d	ch	m
1983	Haschke, Dieter	1940	43	Die Simulation des zeitlichen Ablaufes regionaler Wetterlagen mit einem mathematischen Modell der planetaren Grenzschicht	Dütsch	Pichler	7251	d	at	m
1984	Müller, Hans	1954	30	Zum Strahlungshaushalt im Alpenraum	Vischer 5)	Ohmura	7381	d	ch	m
1984	Steffen, Konrad	1952	32	Oberflächentemperatur einer arktischen Polynya	Steiner	Ohmura	7485	d	ch	m
1984	Broder, Christoph Benedikt	1953	31	Der Einfluss der Kopplung zwischen Transportvorgängen und chemischen Prozessen auf den Tagesgang des Ozons in der planetaren Grenzschicht über komplexer Topographie	Dütsch	Davies	7501	d	ch	m
1984	Blatter, Heinz	1946	38	On the thermal regime of Arctic glaciers	Visher 5)	Ohmura	7596	e	ch	m
1984	Funk, Martin	1954	30	Räumliche Verteilung der Massenbilanz und ihre Beziehung zu den Klimälementen	Visher 5)	Ohmura	7643	d	ch	m
1984	Braun, Walter	1948	36	Nachweis des stratosphärischen Ozontransportes in die Winterhemisphäre aufgrund von Beobachtungen und Trajektorienberechnungen	Dütsch	Davies	7652	d	ch	m

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
1984	Braun, Ludwig Nikolaus	1951	33	Simulation of snowmelt-runoff in lowland and lower alpine regions of Switzerland	Ohmura	Vischer Lang	7684	e	ch	m
1985	Gygax, Hans Adrian	1955	30	Das regionale Windfeld über komplexer Topographie und sein Einfluss auf den Tagesgang der Temperatur und einer Auswahl von Spurengasen in der planetaren Grenzschicht	Dütsch	Davies	7703	d	ch	m
1985	Graber, Werner K.	1951	34	Die Auswirkung von Photochemie und Windtransportsystem auf das Ozon der planetaren Grenzschicht über Arosa	Dütsch	Davies	7719	d	ch	m
1987	Thalmann, Bruno Max	1953	34	Folgerungen aus Isotopen- und Strukturanalysen von Hagelkoernern	Dütsch	Waldvogel	8198	d	ch	m
1986	Weber-Woywod, Marion Alice	1955	31	Das Klima des Einzugsgebiets der Rhone oberhalb Gletsch	Ohmura	Steiner	8209	d	ch	f
1987	Neininger, Bruno	1955	32	Quasi-Lagrange'sche Turbulenzmessung mit Schwebeballonen planetaren Grenzschicht	Davies	Kraus Richner	8463	d	ch	m
1988	Moser, Werner	1957	31	Dynamische Effekte über hügeligem Gelände und die Analyse von NOx, Ozon und anderen Photooxidantien in der PBL während typischen Photosmolagen	Dütsch	Davies	8510	d	ch	m
1988	Müller, Guido Albert	1957	31	Methodische Untersuchungen zur Bestimmung der Verdunstung im voralpinen Raum	Ohmura	Lang	8525	d	ch	m
1988	Schmid, Hermann Wilhelm	1949	39	Hagelvorhersage mit Radar	Waldvogel	Kuensch	8684	d	ch	m
1989	Enomoto, Hiroyuki	1957	32	Kinematics of sea ice and atmospheric conditions in the Antarctic	Ohmura	Davies	8823	e	jp	m
1989	Schumann, Thomas	1958	31	Precipitation scavenging of aerosol particles	Waldvogel	Pruppacher	8843	e	ch	m
1989	Schär, Christoph Josef	1958	31	Dynamische Aspekte der aussentropischen Zyklogenese	Davies	Egger	8845	d	ch	m
1989	Müller, Johannes Christoph	1960	29	Semigeostrophische Entwicklung von Fronten und Stoerungen in der unteren Atmosphäre	Davies	Pichler	8878	d	ch	m
1989	Bernath, Andre	1956	33	Zum Wasserhaushalt im Einzugsgebiet der Rhone bis Gletsch	Ohmura	Lang	9025	d	ch	m
1990	Chen, Jiyang	1957	33	Changes of alpine climate and glacier water resources	Ohmura	Lang Häberli	9243	e	cn	m
1990	Boehm, Johannes Peter	1960	30	On the hydrodynamics of cloud and precipitation particles	Waldvogel	Pruppacher	9286	e	ch	m
1991	Schuhmacher, Peter	1957	34	Messung und numerische Modellierung des Windfeldes über einer Stadt in komplexer Topographie	Ohmura	Beniston	9390	d	ch	m
1991	Hofer, Beat	1957	34	Klimatologische Grundlagen für Solarkraftwerke in den Schweizer Alpen	Ohmura	Durisch	9437	d	ch	m
1991	Rotach, Mathias	1960	31	Turbulence within and above an urban canopy	Ohmura	Davies Oke	9439	e	ch	m
1991	Gronowski, Terence V.	1957	34	Die natürliche Grundwasserneubildung in einem urban beeinflussten Einzugsgebiet im Voralpenraum	Lang	Ohmura Balderer	9451	d	ch	m
1991	Rohrer, Mario Bruno	1958	33	Die Schneedecke im schweizerischen Alpenraum und ihre Modellierung	Lang	Ohmura Keller¨	9452	d	ch	m
1991	Steiner, Matthias	1960	31	Die Kombination von Doppler- und Polarisationsradarmessungen im Niederschlag	Waldvogel	Davies Joss	9558	d	ch	m
1992	Kang, Ersi	1942	50	Energy-water-mass balance and hydrological discharge modelling of a glacierized basin in the Chinese Tianshans	Ohmura	Lang	9755	e	cn	m
1992	Ghelli, Anna	1961	31	Data assimilation for numerical weather prediction	Davies	Gronas Gassmann	9844	e	it	f
1992	Oberholzer, Beat	1962	30	Untersuchungen über den Einfluss von anorganischen Spurenstoffen auf die Zusammensetzung des Niederschlages während winterlichen Feldmessungen an der Rigi (Zentralschweiz)	Waldvogel	Staehelin Collen	9854	d	ch	m

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
1992	Binder, Peter	1957	35	Aspects of precipitation simulation in numerical weather prediction	Davies	Houze	9908	e	ch	m
1993	Felber, Markus	1953	40	La storia geologica del Tardo-Terziario e del quaternario nel Mendrisotto (Ticino meridionale, Svizzera) da Markus Felber	Ohmura	Bini Schindler	10125	i	ch	m
1993	Bader, Juerg Dieter	1958	35	Ein zweidimensionales Modell mit variabler horizontaler Aufloesung zu Simulationen von Cumuluswolken	Waldvogel	Davies	10165	d	ch	m
1993	Abe-Ouchi, Ayako	1963	30	Ice sheet response to climatic changes	Ohmura	Hutter Jouzel Blatter	10222	e	jp	f
1993	Calanca, Pierluigi Stefano	1963	30	The atmospheric water vapour budget over Greenland	Ohmura	Davies Holopainen	10243	e	ch	m
1993	Konzelmann, Thomas Michael	1962	31	Radiation conditions on the Greenland Ice Sheet	Ohmura	Fröhlich Steffen	10310	e	ch	m
1993	Lüthi, Daniel	1962	31	Mesoskalige diabatische und orographische Anregung atmosphärischer Stroemungen	Davies	Hoinka	10322	e	ch	m
1993	Trüb, Jürg	1962	31	Dynamical aspects of flow over alpine-scale orography	Davies	Miller Schär	10339	e	ch	m
1994	Frei, Christoph	1962	32	Excitation and modification of geophysical boundary-related flow phenomena	Davies	James	10470	e	ch	m
1994	Appenzeller, Christof	1962	32	Wave developments on surface fronts and stratospheric intrusions	Davies	Thorpe	10471	e	ch	m
1994	Koenig, Peter Niklaus	1960	34	Abflussprozesse in einem kleinen voralpinen Einzugsgebiet	Lang	Gurtz Peschke Schädler	10473	d	ch	m
1994	Mosimann, Lukas Rudolf	1964	30	Die Bestimmung der Verreifung von Schneekristallen mittels vertikalem Doppelerradar	Waldvogel	Pruppacher	10510	d	ch	m
1994	Steiner, Anton	1959	35	Doppler-Radar Windprofiler	Waldvogel	Richner Ruester	10520	d	ch	m
1994	Volken, Marc Antonio	1965	29	A model for below-cloud scavenging of aerosols and trace gases	Waldvogel	Schär Staehelin	10743	e	ch	m
1994	Blumer, Felix P.	1960	34	Hoehenabhängigkeit des Niederschlages im Alpenraum	Lang	Kuhn Barry	10784	d	ch	m
1994	Li, Li	1962	32	On the use of variational analysis for determining the motion, growth and decay of radar echoes over complex orography	Waldvogel	Joss Davies	10823	e	cn	m
1995	Häfliger, Marcel Peter Silvester	1962	33	Radiation balance over the Greenland ice sheet derived by NOAA AVHRR satellite data and in situ observations	Ohmura	Steffen Key	10919	e	ch	m
1994	Prevot, Andre Stephan Henry	1965	29	Photooxidantien und Primärluftschadstoffe in der planetaren Grenzschicht in der Schweiz nördlich und südlich der Alpen	Waldvogel	Staehelin Volz-Thomas	10956	d	ch	m
1995	Grebner, Dietmar Franz	1942	53	Klimatologie und Regionalisierung starker Gebietsniederschläge in der nordalpinen Schweiz	Ohmura	Lang Roth Schädler	11003	d	de	m
1995	Wernli, Johann Heinrich	1964	31	Lagrangian perspective of extratropical cyclogenesis	Davies	Browning Schär	11016	e	ch	m
1995	Huntrieser, Heidi Inger Christine	1965	30	Zur Bildung, Verteilung und Vorhersage von Gewittern in der Schweiz	Waldvogel	Smith	11020	d	se	f
1995	Rossa, Andrea Massimo	1963	32	The impact of latent heat release on the dynamics of extratropical cyclogenesis	Davies	Buzzi	11039	e	it	m
1995	Nešpor, Vladislav	1960	35	Investigation of wind-induced error of precipitation measurements using a three-dimensional numerical simulation	Lang	Hutter Sevruk	11060	e	sk	m
1995	Van Allen-Heuberger, Renate	1962	33	Atmospheric thermal radiation over the South Pole	Ohmura	Murcray Fröhlich	11082	e	ch	f
1995	Willemse, Saskia	1966	29	A statistical analysis and climatological interpretation of hailstorms in Switzerland	Waldvogel	Schoenwiese Heimann	11137	e	ch	f

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1995	Bünzli, Daniel	1962	33	The influence of subgridscale surface variations on the atmospheric boundary layer flow	Ohmura	Schmid Beljaars	11163	e	ch	m
1995	Gassner, Martin	1956	39	Untersuchung der planetaren Grenzschicht mit einem auf digitalen Betrieb umgebauten Doppler Sodar	Waldvogel	Richner Vogt	11168	d	ch	m
1995	Held, Eduard Carl	1965	30	Radarmessung im Niederschlag und der Einfluss der Orographie	Waldvogel	Joss	11191	d	ch	m
1995	Bauer-Messmer, Bettina	1968	27	Remote sensing of severe hailstorms	Waldvogel	Parlow	11316	e	ch	f
1996	Kaufmann, Pirmin	1965	31	Bodennahe regionale Windfelder über komplexer Topographie	Waldvogel	Parlow Weber	11565	d	ch	m
1996	Hirter, Hans Arnold	1961	35	Mehrdimensionale Interpolation von meteorologischen Feldern zur Berechnung der Brechungsbedingungen in der Geodaesie	Waldvogel	Richner Geiger	11578	d	ch	m
1996	Mazzoni, Roberto	1962	34	Turbulenzstruktur im gestoerten Nachlauf einer künstlichen Oberflächenmodifikation	Ohmura	Schmid Hojstrup	11602	d	it	m
1996	Schraff, Christoph H.	1965	31	Data assimilation and mesoscale weather prediction	Davies	Schär	11627	e	ch	m
1996	Plüss, Christian Georg	1962	34	The energy balance over an alpine snowcover	Ohmura	Foehn Fröhlich	11641	e	ch	m
1996	Berlowitz, David R.	1961	35	Implicit coupling of turbulent diffusion with chemical reaction mechanisms for prognostic atmospheric dispersion models	Ohmura	Moussiopoulos Gassmann	11657	e	ch	m
1996	Aebischer, Urs	1961	35	Low-level potential vorticity and cyclogenesis to the lee of the Alps	Schär	Davies Heimann	11732	e	ch	m
1996	Widmann, Martin Ludwig	1963	33	Mesoscale variability and long-term trends of Alpine precipitation and their relation to the synoptic-scale flow	Schär	Davies von Storch	11769	e	de	m
1996	Hering, Alessandro Michele	1964	32	Primäre und sekundäre Aerosolpartikel in der planetaren Grenzschicht während Photosmog-Episoden in der Schweiz	Waldvogel	Staehelin Baltensperger	11811	d	ch	m
1997	Henrich, Werner Josef	1965	32	Mikrophysikalische Vorgänge im Hellen Band	Waldvogel	Joss	11883	d	de	m
1997	Wild, Martin	1964	33	The heat balance of the earth in general circulation model simulations of present and future climates	Ohmura	Roeckner Davies	11982	e	ch	m
1996	Lehning, Michael	1967	29	Transport processes and regional pollutant budgets over topography of varying complexity	Waldvogel	Richner Nieuwstadt	11991	e	de	m
1997	Schulla, Joerg	1966	31	Hydrologische Modellierung von Flussgebieten zur Abschätzung der Folgen von Klimaänderungen	Lang	Kinzelbach Schulze	12018	d	de	m
1997	Tschuck, Peter	1966	31	Atmospheric blocking in a general circulation model	Ohmura	Davies Arpe	12214	e	ch	m
1997	Fehlmann, Rene	1966	31	Dynamics of seminal PV elements	Davies	Simmons Schär	12229	e	ch	m
1997	Vitvar, Tomás	1967	30	Water residence times and runoff generation in a small prealpine catchment (Rietholzbach, Northeastern Switzerland)	Lang	Balderer McKenzie Gurtz Michelot	12298	e	cz	m
1997	Yetergil, Devrim	1960	37	Externe Kosten von Krebserkrankungen durch kanzerogene Luftschadstoffe	Waldvogel	Schelbert-Syfrig Wanner	12308	d	ch	f
1997	Hoellrigl, Peter Martin	1967	30	Modelling the distribution of aerosols and their effects on the atmospheric radiation budget	Ohmura	Tegen Waldvogel	12344	e	at	m
1998	Morgenstern, Olaf	1967	31	Alpine-southside precipitation events	Davies	Steinacker Schär	12421	e	de	m
1998	Hock, Regine	1963	35	Modelling of glacier melt and discharge	Lang	Holmlund Ohmura Braun	12430	e	de	f
1998	Griesser, Thomas	1965	33	Multipeakanalyse von Doppelspektren aus Windprofiler-Radar-Messungen	Waldvogel	Richner Steinhagen	12470	d	de	m

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1998	Brunner, Dominik Wilhelm	1967	31	One-year climatology of nitrogen oxides and ozone in the tropopause region	Waldvogel	Schumann Staehelin	12556	e	ch	m
1998	Linder, Wolfgang	1967	31	Development of thunderstorms in Switzerland in relation to surface winds	Waldvogel	Schär Schmid	12589	e	de	m
1998	Barthazy Meier, Eszter Judit	1967	31	Microphysical properties of the melting layer	Waldvogel	Pruppacher	12687	e	ch	f
1998	Gut, Urs Andreas	1967	31	Characterisation of the soil-atmosphere exchange fluxes of nitric oxide	Waldvogel	Neftel Meixner	12694	e	ch	m
1998	Poggio, Lionel	1970	28	Use of scintillation measurements to determine fluxes in complex terrain	Waldvogel	Richner Andreas	12755	e	ch	m
1998	Renaud, Anne Sophie	1967	31	Solar erythemal ultraviolet radiation	Waldvogel	Staehelin Fröhlich	12788	e	ch	f
1998	Ammann, Christof	1965	33	On the applicability of relaxed eddy accumulation and common methods for measuring trace gas surface fluxes	Ohmura	Desjardins Meixner Rotach	12795	e	ch	m
1999	Forrer, Jann	1964	35	The structure and turbulence characteristics of the stable boundary layer over the Greenland ice sheet	Ohmura	Hoegstroem Rotach	12803	e	ch	m
1998	Orb, Joachim	1967	31	Modeling in-cloud scavenging a comparison of measurements and modeling results	Waldvogel	Staehelin Pruppacher	12853	e	de	m
1998	Bresch, David N.	1970	28	Coupled flow and SST patterns of the North Atlantic	Davies	Frädrich Schär	12878	e	ch	m
1999	Beroud, Jean-Marc	1971	28	On the influence of land-surface processes on the near-surface atmospheric state	Davies	Schär Quiby	13006	e	ch	m
1999	Niederbäumer, Gunthard	1962	37	Katabatic wind over Greenland	Ohmura	Parish Barry Blatter Calanca	13050	e	ch /it	m
1999	De Haan, Peter	1969	30	Studies on short-range air pollution modeling	Ohmura	Rotach Hanna	13089	e	nl	m
1999	Hünerbein, Sabine Uta Maria von	1969	30	Fallstudien an Hochnebelwetterlagen über komplexem Gelände mit Sodar-Geräten	Waldvogel	Richner Beyrich	13109	d	de	f
1999	Roesch, Andreas Carl	1965	34	Assessment of the land surface scheme in climate models with focus on surface albedo and snow cover	Ohmura	Schär Wild Jacob	13151	e	ch	m
1999	Sprenger, Michael	1970	29	Rotational aspects of atmospheric flow past alpine-scale orography	Schär	Davies Mayr	13250	e	li	m
2000	Albrecht, Olaf	1968	32	Dynamics of glacier and ice sheets : a numerical model study	Ohmura	Blatter Clarke	13278	e	de	m
1999	Heck, Pamela	1972	27	European-scale vegetation-climate feedbacks since the time of the Romans	Schär	Eltahir Davies	13296	e	de	f
1999	Massacand, Alexia Jeanne Christiane	1972	27	Linkages between upper-tropospheric flow and European seasonal weather	Davies	Trenberth Schär	13300	e	fr	f
1999	Hanesch, Monika	1966	33	Fall velocity and shape of snowflakes	Waldvogel	Joss	13322	e	de	f
1999	Goeke, Sabine	1965	34	Microphysics of the melting layer	Waldvogel	Levin	13352	e	de	f
1999	Grüebler, Franca	1971	28	Reactive hydrocarbons in the Milan area	Peter	Hofer Staehelin	13410	e	ch	f
1999	Jeker, Dominique Paul	1972	27	Nitrogen oxides and ozone measurements at the tropopause and attributions to convection and lightning	Peter	Thompson Staehelin	13423	e	ch	m
2000	Mecklenburg, Susanne Martha	1971	29	Nowcasting precipitation in an alpine region with a radar echo tracking algorithm	Waldvogel	Joss Schmid	13608	e	de	f
2000	Marty, Christoph	1968	32	Surface radiation, cloud forcing and greenhouse effect in the Alps	Ohmura	Philipona Fröhlich Heimo	13609	e	ch	m
2000	Thielmann, Axel	1966	34	Sensitivity of ozone production derived from field measurements in the Po Basin	Peter	Prevot Staehelin	13611	e	de	m
2000	Weiss, Andrea K.	1972	28	Anthropogenic and dynamic contributions to ozone trends of the Swiss total ozone, Umkehr and balloon sounding series	Peter	Harris Staehelin	13635	e	de	f

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2000	Meilinger, Stefanie K.	1969	31	Heterogeneous chemistry in the tropopause region: Impact of aircraft emissions	Peter	Staehelin Kaercher	13819	e	de	f
2000	Schwarb, Manfred	1970	30	The alpine precipitation climate	Schär	Daly Frei	13911	e	ch	m
2000	Germann, Urs	1971	29	Spatial continuity of precipitation, profiles of radar reflectivity and precipitation measurements in the alps	Waldvogel	Joss	13932	e	ch	m
2000	Schmidli, Jürg	1971	29	22. Reconstruction and analysis of mesoscale precipitation in the Alps for the 20th century	Schär	Jones Davies Frei	13967	e	ch	m
2001	Bourqui, Michel	1971	30	Analysis and quantification of STE: A novel approach	Davies	Haynes Wernli	14054	e	ch	m
2001	Vieli, Andreas	1970	31	On the dynamics of tidewater glaciers	Blatter	Funk Echelmeyer Ohmura	14100	e	ch	m
2001	Schmucki, Daniel A.	1972	29	Erythemal UV radiation in the Alps	Ohmura	Philipona Lenoble Fröhlich	14138	e	ch	m
2001	Z'graggen, Ludwig	1968	33	Strahlungsbilanz der Schweiz	Ohmura	Calaca Zelenka	14158	d	ch	m
2001	Hauck, Christian	1970	31	Geophysical methods for detecting permafrost in high mountains	Ohmura	Vonder Mühll Maurer Davies	14163	e	de	m
2001	Lehmann, Andre A.	1968	33	Direct and diffuse components of erythemal irradiance	Ohmura	Fröhlich Heimo	14303	e	ch	m
2001	Colberg, Christina Anja	1971	30	Experimente an levitierten $H_2SO_4/NH_3/H_2O$-Aerosolteilchen	Peter	Carslaw Baltensperger	14331	e	de	f
2001	Schwierz, Cornelia Bettina	1970	31	Interactions of Greenland-scale orography and extra-tropical synoptic-scale flow	Davies	Gronas Wernli	14356	e	de	f
2001	Jasper, Karsten	1966	35	Hydrological modelling of alpine river catchments using output variables from atmospheric models	Schär	Schulz Lang Gurtz	14385	e	de	m
2002	Kljun, Natascha	1971	31	Footprint modelling in the planetary boundary layer	Ohmura	Rotach Schid Wilson	14482	e	ch	f
2002	Laternser, Martin Christian	1966	36	Snow and avalanche climatology of Switzerland	Waldvogel	Wanner Schneebel	14493	e	ch	m
2002	Weiss, Alexandra	1967	35	Determination of thermal stratification and turbulence of the atmospheric surface layer over various types of terrain by optical scientillometry	Ohmura	Ingensand Andreas Rotach	14514	e	de	f
2002	Doorschot, Judith	1973	29	Mass transport of drifting snow in high alpine environments	Waldvogel	Hertig Lehning	14515	e	nl	f
2002	Liniger, Mark Andrea	1973	29	Extratropical synoptic structures at tropopause levels	Davies	Stohl Wernli	14632	e	ch	m
2002	Kleinn, Jan	1973	29	Climate change and runoff statistics in the Rhine basin	Schär	Schädler Frei Gurtz	14663	e	de /at	m
2002	Zillig, Matthias	1972	30	Dynamics of jet-like flow patterns in the neighbourhood of storms, the tropopause and orography	Davies	Volkert Wernli	14685	e	ch	m
2003	Schneeberger, Christian	1972	31	Glaciers and climate change: a numerial model study	Ohmura	Blatter Oerlemans	14743	e	ch	m
2002	Bärtsch-Ritter, Nathalie Sabrina Paula	1968	34	Three-dimensional model study of the ozone production in the Po Basin	Peter	Prevot Vogel	14786	e	ch	f
2002	Füglistaler, Stefan Andreas	1970	32	Polar stratospheric clouds and arctic denitrification	Peter	Mauersberger Wernli	14860	e	ch	m
2002	Fukutome, Sophie A.	1963	39	Interannual variability of Japan precipitation	Schär	James Ohmura Frei	14861	e	us	f

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2002	Zappa, Massimiliano	1975	27	Multiple-response verification of a distributed hydrologial model at different spatial scales	Schär	Bloeschl Gurtz Weingartner	14895	e	ch	m
2003	Koch, Gisela	1974	29	Lagrangian analysis of stratospheric ozone in mid-latitudes	Peter	Kelder Staehelin	14931	e	de	f
2003	Seneviratne, Sonia	1974	29	Terrestrial water storage	Schär	Viterbo Kinzelbach	14944	e	ch	f
2003	Dirren, Sebastien	1975	28	Vortex forcing of extratropical disturbances	Davies	Morgan Wernli	14945	e	ch	m
2003	Walser, Andre	1974	29	Predictability issues in meso-β scale numerical weather forecasting	Schär	Davies Ehrendorfer	14997	e	ch	m
2003	Bukowiecki, Nicolas Philippe	1974	29	Mobile pollutant measurement laboratories - Spatial distribution and seasonal variation of aerosol parameters in the Zürich (Switzerland) and Minneapolis (USA) area	Peter	Baltensperger Prevot Pretsch	15083	e	ch	m
2003	Knopf, Daniel Alexander	1973	30	Thermodynamic properties and nucleation processes of upper tropospheric and lower stratospheric aerosol particles	Peter	Schurath Koop	15103	e	de	m
2003	Campana, Mike	1972	31	Variability of trace gases at the alpine site Arosa in relation to meteorological processes	Peter	Prevot Staehelin	15107	e	ch	m
2003	Huwald, Wolf Hendrik Rudolf Fritz	1971	32	Numerical modeling of sea ice	Ohmura	Blatter Lemke Tremblay	15114	e	de	m
2003	Spirig, Christoph	1972	31	Biogenic volatile organic compounds and their role in the formation of ozone and aerosols	Peter	Neftel Günther	15163	e	ch	m
2003	Gysel, Martin	1974	29	Hygroscopic properties of aerosols. Investigations of particles from jet engines and the remote troposphere	Peter	Baltensperger Weingartner Petzold	15245	e	ch	m
2004	Buss, Sandro	1970	34	Dynamical aspects of polar stratospheric cloud formation, denitrification and ozone loss	Davies	Peter Wernli Knudsen	15267	e	ch	m
2004	Mäder, Joerg Alexander	1975	29	Haupteinflussfaktoren auf das stratosphärische Ozon in der nördlichen Hemisphäre	Peter	Staehelin Stahel	15331	d	ch	m
2003	Li, Yingshi	1975	28	Concentration of ozone and its precursors at Arosa and Jungfraujoch and their relations to the regional and hemispheric background	Peter	Staehelin Reimann	15401	e	cn	f
2004	Schefold, Raphael	1975	29	Messungen von Schneeflocken: Die Fallgeschwindigkeit und eine Abschätzung weiterer Groessen	Davies	Beheng Barthazy Richner	15431	d	ch	m
2004	Müller, Wolfgang Alexander	1972	32	Analysis and prediction of the European winter climate	Schär	Appenzeller Latif	15540	e	ch	m
2004	Hegglin, Michaela Imelda	1975	29	Airborne NOy-, NO- and O_3-measurements during SPURT: Implications for atmospheric transport	Peter	Fischer Staehelin Brunner	15553	e	ch	f
2004	Koch, Patrick	1974	30	Novel perspectives of jet-stream climatologies and events of heavy precipitation on the alpine southside	Davies	Gyakum Wernli	15622	e	ch	m
2004	Dürr, Bruno	1975	29	The greenhouse effect in the alps - by models and observations	Ohmura	Philipona Kuhn	15668	e	ch	m
2004	Sheppard, Raelene	1974	30	On the parametrisation of the turbulent fluxes in GCMs	Ohmura	Wild Rotach Bosveld	15677	e	au	f
2004	Stoeckli, Reto	1973	31	Modeling and observations of seasonal land-surface heat and water exchanges at local and catchment scales over Europe	Schär	Vidale Schmid	15742	e	ch	m
2005	Grimbacher, Tobias	1975	30	Bestimmung und Vorhersage von Bewoelkung mit bodennahen Temperaturmessungen	Davies	Schmid Simmer	15798	e	de	m
2005	Leuenberger, Daniel	1974	31	High-resolution radar rainfall assimilation: exploratory studies with latent heat nudging	Davies	Rossa Macpherson	15884	e	ch	m
2005	Fuhrer, Oliver	1975	30	From advection to convection	Schär	Smith Richard Davies	15892	e	ch	m

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2005	Egorova, Tatiana	1968	37	Modeling the effects of short and long-term solar variability on ozone and climate	Peter	Ohmura Haigh	15898	e	ru	f
2005	Weber, Heidi C.	1975	30	Classification of contaminated data from wind profiler measurements by neural networks	Richner	Kretzschmar Lohmann	15909	e	ch	f
2005	Feddersen, Berend	1973	32	Wind tunnel modelling of turbulence and dispersion above tall and highly dense urban roughness	Richner	Lohmann Rotach Schatzmann	15934	e	de	m
2005	Henne, Stephan	1975	30	Characterization of high alpine pollution plumes	Staehelin	Prevot Peter Lelieveld	15949	e	de	m
2005	Weigel, Andreas Hans Philipp	1975	30	On the atmospheric boundary layer over highly complex topography	Ohmura	Rotach Whiteman	15972	e	de	m
2005	Fisseha Derseh, Rebeka	1974	31	Gas and aerosol phase determination of water soluble compounds in the atmosphere - field and smog chamber studies	Baltensperger	Peter Saurer Winterhalter	16094	e	et	f
2005	Verbunt, Mark	1978	27	From small-scale modelling of alpine catchments towards probabilistic flood forecasting in the Rhine basin	Schär	Bronstert Gurtz	16115	e	nl	m
2005	Goeldi Cheda, Brigitte	1967	38	The influence of clouds on the radiation at Payerne, Switzerland	Ohmura	Wild Heimo	16118	e	ch	f
2005	Croci-Maspoli, Mischa	1977	28	Climatological investigations of atmospheric blocking - A dynamically-based statistical analysis	Davies	Simmons Schwierz	16151	e	ch	m
2005	Martius, Olivia Caroline	1978	27	Climatological aspects of wave disturbances on the tropopause and links to extreme weather in Europe	Davies	Blackburn Schwierz	16152	e	ch	f
2005	Hoch, Sebastian Wilhelm	1973	32	Radiative flux divergence in the surface boundary layer	Ohmura	Calanca Kuhn	16194	e	de	m
2005	Hoyle, Christopher Robert	1978	27	Three dimensional chemical transport model study of ozone and related gases 1960-2000	Peter	Staehelin Bregman	16271	e	ch	m
2005	Ubl, Sandy	1975	30	Backward lagrangian particle dispersion modeling: applications for a high alpine measurement site	Peter	Kaiser-Weiss Kaufmann Stohl	16282	e	de	f
2006	Gubser, Stefan	1970	36	Wechselwirkung zwischen Foehn und planetarer Grenzschicht	Richner	Steinacker Davies	16286	d	ch	m
2006	Scherrer, Simon	1977	29	Interannual climate variability in the European and Alpine region	Schär	Appenzeller Stephenson	16338	e	ch	m
2006	Zobrist, Bernhard	1975	31	Heterogeneous ice nucleation in upper tropospheric aerosols	Peter	Koop Schwarzenbach Marcolli	16411	e	ch	m
2006	Corti, Thierry	1977	29	The impact of cirrus clouds on radiation and vertical transport in the tropics	Peter	Luo Fu	16449	e	ch	m
2006	Hess, Maurus	1976	30	Utilizing backscattering spectrometry for studying physical and chemical processes on salt crystals	Peter	Lanford Krieger	16454	e	ch	m
2006	Sawyer, William	1961	45	Efficient numerical methods for the shallow water equations on the sphere	Jeltsch	Ohmura Schär Bonaventura	16477	e	us	m
2006	Sutter, Marcel	1971	35	Surface radiation and climate at high latitudes. Homogenization and analyses of data from Arctic and Antarctic BSRN sites	Ohmura	Philipona Raschke	16502	e	ch	m
2006	Ordóñez, García Carlos	1972	34	Trend analysis of ozone and evaluation of nitrogen dioxide satellite data in the troposphere over Europe	Staehelin	Prevot Peter Richter	16544	e	es	m
2006	Didone, Marco	1977	29	Performance and error diagnosis of global and regional NWP models	Davies	Zardi Lüthi	16597	e	ch	m
2006	Sodemann, Harald	1975	31	Tropospheric transport of water vapour: Lagrangian and Eulerian perspectives	Davies	Wenli Schwierz Masson-Demotte	16623	e	de	m
2007	Schelander, Carl Peter	1974	33	Turbulence characteristics of the atmospheric boundary layer over the dry snow zone of the Greenland ice sheet	Ohmura	Parlange Calanca	16677	e	se	m

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2006	Bourgeois, C. Saskia	1973	33	The radiative properties of snow at Summit, Greenland	Ohmura	Kuhn Steffen Calanca	16758	e	ch	f
2006	Schaub, Daniel	1974	32	Tropospheric nitrogen dioxide from GOME and SCIAMACHY measurements over the alpine region: strengths and limitations	Staehelin	Peter Kaiser-Weiss Kaiser	16829	e	ch	m
2006	Hohenegger, Cathy	1979	27	Dynamical analysis of atmospheric predictability in cloud-resolving models	Schär	Davies Palmer	16871	e	ch	f
2006	Hirschi, Martin	1975	31	Seasonal variations in terrestrial water storage	Schär	Seneviratne Beljaars	16902	e	ch	m
2006	Zardini, Alessandro	1973	33	The effects of organic compounds on the hygroscopic properties of inorganic aerosols	Peter	Leisner Krieger Weingartner	16930	e	it	m
2006	Ekeren, Johannes Stefanus van	1979	27	Characterization of an expansion-type cloud condensation nuclei chamber	Peter	Noone Baltensperger Fierz	16944	e	nl	m
2006	Legreid, Geir	1973	33	Oxygenated volatile organic compounds (OVOCs) in Switzerland	Staehelin	Peter Simmonds Reimann	16982	e	no	m
2007	Landl, Barbara Maria	1977	30	Investigation of small scale characteristics of the energy balance over snow covered Alpine terrain	Ohmura	Lehning Kuhn	17116	e	au	f
2007	Kew, Sarah Frances	1979	28	Structure and dynamics of distinctive flow anomalies in the lowermost stratosphere	Davies	Davis Sprenger	17231	e	uk	f
2007	Balzani Loeoev, Jacob Marcus	1977	30	Carbonyls and PANs at Jungfraujoch and the related oxidation processes at the boundary layer / free troposphere interface	Staehelin	Monks Reimann Peter	17234	e	it	m
2007	Sjoegren, Nils Olof Staffan	1976	31	Hygroscopic properties of organic and inorganic aerosols	Peter	Hansson Baltensperger Weingartner	17260	e	se	m
2008	Nyfeler-Brunner, Aurelia	1973	35	Characterisation of volatile organic compounds emission from grassland systems	Peter	Schwarzenbach Staehelin Neftel Wildt	17377	e	ch	f
2007	Schiemann, Reinhard	1978	29	Forcing and variability of the hydroclimate in Central Asia	Schär	Davies Barlow	17426	e	de	m
2007	Posselt, Julia Rebekka	1978	29	Influence of giant sea salt aerosols on global precipitation and aerosol indirect effect	Lohmann	Schulz Knutti	17467	e	de	f
2007	Fischer, Erich Markus	1978	29	The role of land-atmosphere interactions for European summer heat waves	Schär	Allen Seneviratne	17473	e	ch	m
2007	Zünd, Andreas	1978	29	Modelling the thermodynamics of mixed organic-inorganic aerosols to predict water activities and phase separations	Peter	Marcolli Carslaw	17533	e	ch	m
2008	Ruckstuhl, Christian	1976	32	Surface radiation changes and their impact on climate in Central Europe	Ohmura	Philipona Kuhn Knutti	17578	e	ch	m
2008	Wehrli, Christoph Johannes	1952	56	Remote Sensing of Aerosol Optical Depth in a global surface network	Ohmura	Barrie Brönnimann Fröhlich	17591	e	ch	m
2008	Hoose, Corinna	1980	28	Aerosol processing and its effect on mixed-phase clouds in a global climate model	Lohmann	Baltensperger Kristjánsson	17648	e	de	f
2008	Nicolet, Mathieu	1979	29	Characterization of ice crystals and water droplets with the ice optical detector device (IODE) using depolarization measurements	Lohmann	Stetzer Schnaiter	17659	e	ch	m
2008	Nowak, Daniela	1975	33	Radiation and clouds: observations and model calculations for Payerne BSRN site	Ohmura	Vuilleumier Fischer Knutti	17687	e	ch	f
2008	Sandradewi, Jisca	1975	33	A study of wood burning versus traffic aerosols using a multi-wavelength aethalometer	Lohmann	Baltensperger Prevot Schnaiter	17694	e	id	f
2008	Volken, David	1979	29	Mesoklimatische Temperaturverteilung im Rhone- und Vispertal	Ohmura	Seneviratne Z'graggen Weigel	17705	d	ch	m

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
2008	Buzzi, Matteo	1975	33	Challenges in operational numerical weather prediction at high resolution in complex terrain	Ohmura	Rotach Schär Holtslag	17714	e	ch	m
2008	Scarnato, Barbara	1977	31	Total ozoner measurements at Arosa (Switzerland)	Staehelin	Peter Groebner Stuebi	17747	e	it	f
2008	Jenkner, Johannes	1977	31	Stratified verifications of quantitative precipitation forecasts over Switzerland	Davies	Schwierz Dierer Nurmi	17782	e	de	m
2008	Jaun, Simon	1976	32	Towards operational probabilistic runoff forecasts	Schär	Weingartner Ahrens Gurtz	17817	e	ch	m
2008	Schraner, Martin	1975	33	Systematische Untersuchung der Abhängigkeiten eines Klima-Chemie-Modells von Randbedingungen und Parametrisierungen	Peter	Dameris Ohmura Rozanov Schnadt	17824	d	ch	m
2008	Aschwanden, Andreas	1977	31	Mechanics and thermodynamics of polythermal glaciers	Blatter	Schär Jansson	17874	e	ch	m
2008	Mühlbauer, Andreas	1980	28	Aerosol-cloud-precipitation interactions in moist orographic flows	Lohmann	Schär Carslaw	17878	e	at/ de	m
2008	Fischer, Andreas Marc	1979	29	Interannual-to-decadal variability of the stratosphere during the 20th century	Brönnimann	Rozanov	17922	e	ch	m
2008	Spengler, Thomas	1978	30	Influence of the ambient flow upon Rossby wave propagation between the tropics and extra-tropics	Davies	Egger	17932	e	de	m
2008	Griesser, Thomas	1978	30	Reconstruction of global upper-level circulation 1880-1957 for analyzing decadal climate variability	Brönnimann	Seneviratne Luterbacher	17962	e	ch	m
2008	Weimer, Silke	1979	29	Particle emission of traffic and wood combustion and its impact on spatial distributions of submicron particulate matter	Lohmann	Prevot Mohr Schneider	17995	e	de	f
2008	Lanz, Valentin Andreas	1980	28	Atmospheric transformation and source attribution of reactive organic compounds	Lohmann	Hüglin Prevot Poeschl	18019	e	ch	m
2008	Cui, Junbo	1978	30	Lagrangian analysis of ozone trends at selected receptor sites in the Northern Hemisphere	Staehelin	Stohl Sprenger Peter	18052	e	cn	m
2009	Huss, Matthias	1980	29	Past and future changes in glacier mass balance	Funk	Bauder Blatter Schär Kaser	18230	e	ch	m
2009	Herich, Hanna	1981	28	The relationship between aerosol chemical composition and hygroscopic growth	Lohmann	Cziczo Curtius	18239	e	de	f
2009	Kenzelmann, Patricia	1980	29	Global warming by increased methane release and global cooling by stratospheric sulphur injections	Peter	Rozanov Füglistaler	18241	e	ch	f
2009	Makowski, Knut	1979	30	The daily temperature amplitude and surface solar radiation	Peter	Ohmura Wild Liepert	18319	e	de	m
2009	Walker, Daniel	1976	33	Cloud effects on erythemal UV radiation in a complex topography	Lohmann	Brönnimann Vuilleumier Blumthaler	18415	e	ch	m
2009	Amsler, Peter	1972	37	Digital in-line holographic microscope for ice crystals	Lohmann	Stetzer Shaw	18467	e	ch	m
2009	Joos, Hanna	1979	30	Modeling of orographic cirrus clouds	Lohmann	Spichtinger Giorgetta	18492	e	de	f
2009	Jäger, Eric Benjamin	1980	29	Land-atmosphere interactions	Seneviratne	Schär van den Hurk	18597	e	ch	m
2009	Brockhaus, Marc Peter	1981	28	Role and representation of moist convection in a regional climate model	Schär	Bechtold Lüthi	18624	e	ch	m
2009	Mahecha Ordóñez, Miguel Darío	1979	30	Ecosystem-atmosphere exchange on multiple time scales	Seneviratne	Reichstein Kuensch	18665	e	de co	m

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
2009	Lüönd, Felix	1980	29	Experimental study on immersion freezing of size selected mineral dust particles	Lohmann	Stetzer Stratmann	18666	e	ch	m
2010	Ciobanu, Viorela-Gabriela	1981	29	Liquid-liquid phase separation and efflorescence in mixed organic/inorganic aerosol particles	Peter	Marcolli Rudich	18749	e	ro	f
2010	Fierz, Rahel Andrea	1980	30	Enhancement of the light scattering coefficient of atmospheric aerosol particles by water uptake	Baltensperger	Peter Laj Weingartner	18784	e	ch	f
2010	Isotta, Francesco Alessandro	1982	28	Shallow cumulus clouds parameterization in the climate model ECHAM5-HAM	Lohmann	Spichtinger Neggers	18881	e	ch	m
2010	Siegenthaler-Le Drian, Colombe	1980	30	Stratocumulus clouds in ECHAM5-HAM	Lohmann	Spichtinger Stevens	18886	e	ch	f
2010	Kammermann, Lukas Peter	1980	30	Aerosol hygroscopicity and CCN properties at remote sites	Lohmann	Swietlicki Weingartner	18910	e	ch	m
2010	Jess, Stephanie	1980	30	Impact of subgrid variability on large-scale precipitation formation in the climate model ECHAM5	Lohmann	Spichtinger Quaas	19058	e	de	f
2010	Mahlstein, Irina	1979	31	Improving climate model projections by model evaluation and regional aggregation	Knutti	Appenzeller Solomon	19113	e	ch	f
2010	Chirico, Roberto	1977	33	Primary emission and secondary formation of organic aerosol from vehicles	Baltensperger	Lohmann Prevot Donahue	19237	e	it	m
2010	Jurányi, Zsófia	1982	28	Characterisation of the cloud condensation nuclei properties of complex aerosols. from the smogchamber to the free troposphere	Baltensperger	Lohmann Wex Gysel	19238	e	hu	f
2011	Calisto, Marco	1973	38	Influence of energetic particle precipitation on atmospheric chemistry and climate	Peter	Rozanov Reddmann	19252	e	ch	m
2010	Soonsin, Vacharaporn	1976	34	The influence of physical state on hygroscopicity and vapor pressure of single, levitated aerosol particles containing organics	Peter	Krieger Bilde	19316	e	th	f
2010	Chiacchio, Marc	1968	42	Decadal variations of surface solar radiation and its connection to climate and atmospheric processes	Schär	Wild Hatzianastassiou	19360	e	us /it	m
2010	Zhou, Yipin	1981	29	Optimization and application of satellite observations for tropospheric NO_2 monitoring in Europe	Staehelin	Brunner Peter Van Roozendael	19366	e	sg	f
2011	Rieder Harald	1983	28	Extreme events in total ozone on local, regional and global scale	Staehelin	Peter Harris Ribatet	19379	e	au	m
2010	Panziera, Luca	1982	28	Orographic forcing, the key for heuristic nowcasting of rainfall in the Alps	Lohmann	Burlando Mätzler German	19460	e	it	m
2011	Fusina, Fabian	1979	32	The multiscale aspect of cirrus cloud dynamics	Lohmann	Spichtinger Achatz	19476	e	ch	m
2010	Zubler, Elias Markus	1981	29	Representation of aerosol and cloud microphysics in a regional climate model: Implementation, evaluation and long-term simulations	Schär	Lohmann Lüthi Stier	19480	e	ch	m
2011	Zelenay, Veronika	1984	27	Water Uptake and Chemical Composition in Single Submicron Particle analyzed by X-ray Microspectroscopy	Peter	Ammann Rudich	19497	e	ch	f
2011	Chou, Cedric	1982	29	Investigation of ice nucleation properties onto soot, bioaerosol and mineral dust during different measurement campaigns	Lohmann	Stetzer Bingemer	19520	e	fr	m
2011	Ladino Moreno, Luis Antonio	1983	28	Experimental study on collection efficiency and contact freezing of aerosols in a new collision chamber	Lohmann	Stetzer Moehler	19552	e	co	m
2011	Schlemmer, Linda Babette Ricarda	1983	28	The diurnal cycle of midlatitude, summertime moist convection over land in an idealized cloud-resolving model	Schär	Stevens Schmidli	19558	e	de	f
2011	Sesartić Ana	1983	28	Bacteria and fungal spores in the global climate model ECHAM5-HAM	Lohmann	Storelvmo Poeschl	19574	e	ch	f

year	name, first name	born	age	title	examiner	co-examiner(s)	th.no.	l	n	s
2011	Zieger, Paul Christoph	1978	33	Effects of relative humidity on aerosol light scattering	Peter	Baltensperger de Leeuw Weingartner	19659	e	de	m
2011	Martin, Maria Anna	1982	29	Measurements of cloud condensation nuclei properties of remote and anthropogenic aerosols	Lohmann	Sierau Mentel	19741	e	de	f
2011	Tritscher, Torsten	1979	32	Hygroscopicity and volatility of fresh and processed aerosols from different sources	Baltensperger	Lohmann Laj Weingartner	19799	e	de	m
2011	Brabec, Martin	1978	33	Backscatter and Humidity Measurements in Cirrus and Dust Clouds using Balloon Sondes	Peter	Wienhold Voemel	19825	e	ch	m
2011	Sintermann, Joerg	1980	31	Reduced nitrogen release by agriculture emission quantification by advanced methodology	Peter	Neftel Famulari Ruuskanen	19833	e	de	m
2011	Mohr, Claudia	1982	29	Source apportionment of ambient submicron aerosol using stationary and mobile aerosol mass spectrometer data	Baltensperger	Lohmann Prevot Kiendler-Scharr	20053	e	ch	f
2011	Heringa, Maarten Frans	1978	33	Primary emission and secondary formation of organic aerosol from domestic wood burning	Baltensperger	Peter Prevot Zimmermann	20087	e	nl	m
2011	Mittelbach, Heidi	1980	31	Soil moisture in Switzerland	Seneviratne	Vereecken Teuling Lehner	20114	e	de	f

Appendix G: Dissertation statistics for the time period 1962 to 2011

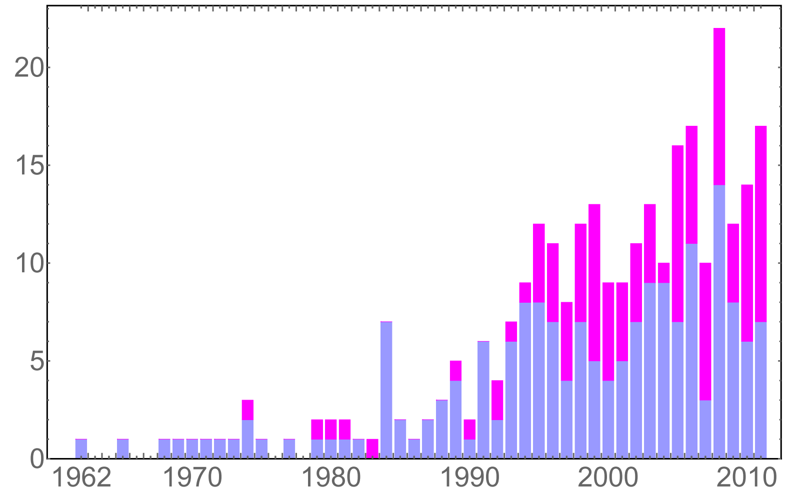
As in all institutes, much of the research activity at the IAC is accomplished by doctoral students. In addition, they act as assistants in lectures, laboratory courses, exercises, excursions, etc., either supporting their professor or independently with a teaching assignment. In the early years of the Institute, the duties of the doctoral students are only vaguely defined, the same holds for the support they receive by the supervisor. Consequently, the time length for completing their dissertation varies greatly.

In particular before the 1980s, there is often no clear starting date for the doctoral thesis. The students work on a problem which later might become the topic of their dissertation. Consequently, a statistic on the time spent for completing the thesis cannot be produced. However, the graph showing the age when receiving the degree gives an impression of the situation over the years.

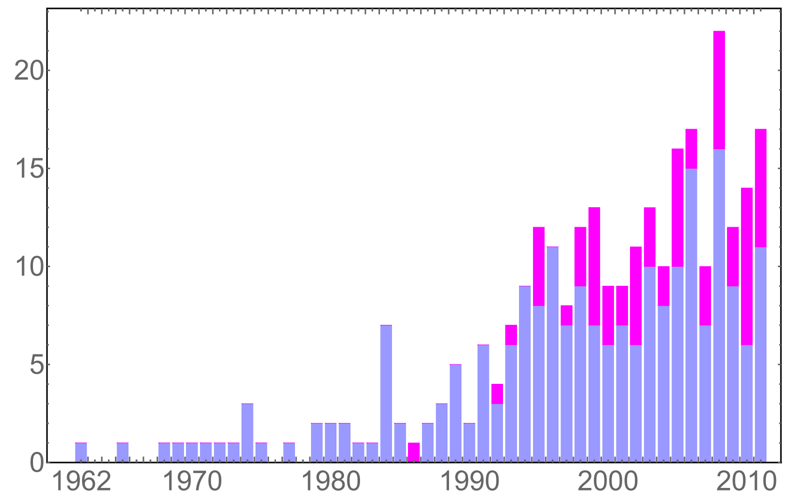
In the late 1980s, doctoral studies at the IAC become structured: The time for completing the thesis is now limited to three years, and each doctoral student gets a supervisor and a committee which oversees the progress of his or her studies. In case of problems, this committee acts also as supporting or mediating group. The student reports to the committee at least twice during the doctoral work. His or her duties, respectively, within the Institute are clearly assigned and limited in time.

country	*number*	*percentage*
Switzerland	180	63.2
Germany	53	18.6
Italy	8	2.8
Canada	5	1.8
Netherlands	5	1.8
Japan	4	1.4
Australia	3	1.1
Austria	3	1.1
Sweden	3	.1.1
United States	3	1.1
France	2	0.7
Hungary	2	0.7
United Kingdom	2	0.7
Colombia	1	0.4
Czech Republic	1	0.4
Ethiopia	1	0.4
Indonesia	1	0.4
Liechtenstein	1	0.4
Norway	1	0.4
Romania	1	0.4
Russian Fed.	1	0.4
Singapore	1	0.4
Spain	1	0.4
Slovakia	1	0.4
Thailand	1	0.4
all	***285***	

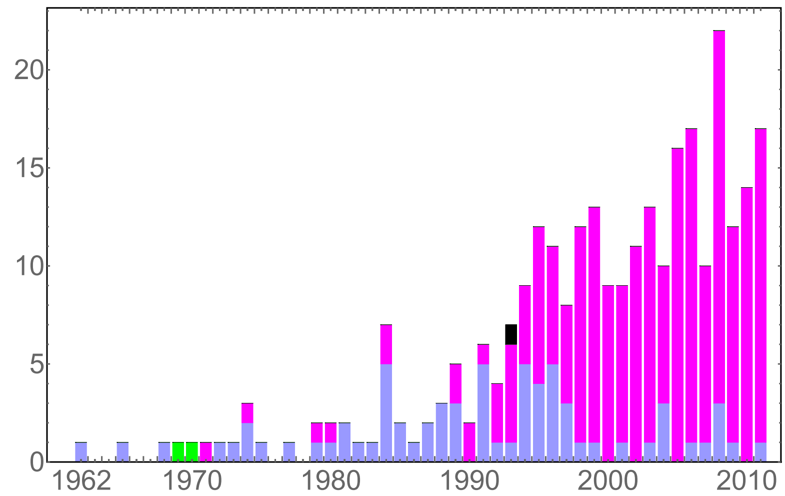
List of dissertations by nationality of its author
Note: There are six students with two nationalities. They are listed under the country which appears first on the title page of their dissertation.



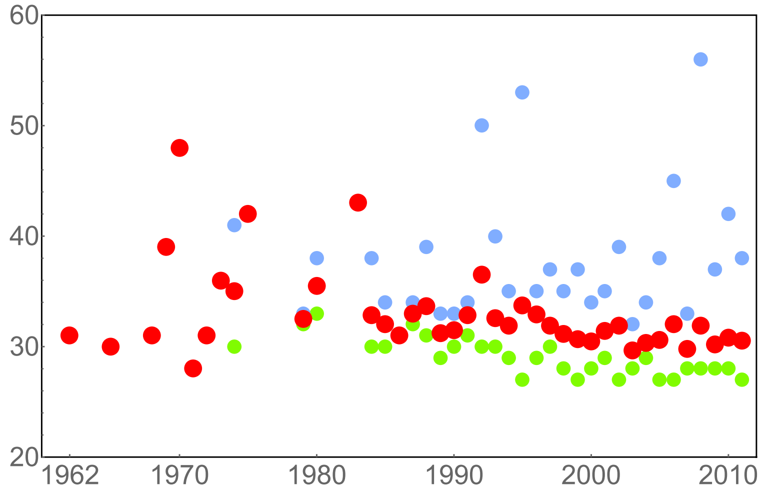
Number of dissertations by nationality of its author
the total number is 285
blue columns: Swiss
magenta columns: non-Swiss



Number of dissertations by sex
the total number is 285
blue columns: male (218 ≙ 76.5%)
magenta columns: female (67 ≙ 23.5 %)



Number of dissertations by language
the total number is 285
blue columns: German (69 ≙ 24.2 %)
magenta columns: English (213 ≙ 74.8 %)
green columns: French (2 ≙ 0.7 %)
black column: Italian (1 ≙ 0.4 %)



Age of students when completing their dissertation by year
red dots: mean (31.7)
green dots: lowest (25)
blue dots: highest (56)

	male	*female*	*all*
number	219	66	285
mean age ± std.dev.	32.0 ± 4.1	30.5 ± 2.8	31.7 ± 3.9
skewness of distr.	+ 2.6	+ 1.1	+ 2.6
median age	31	30	31
minimum age	25	27	25
maximum age	56	39	56

Basic statistics of students' ages when completing their dissertation

*   *   *