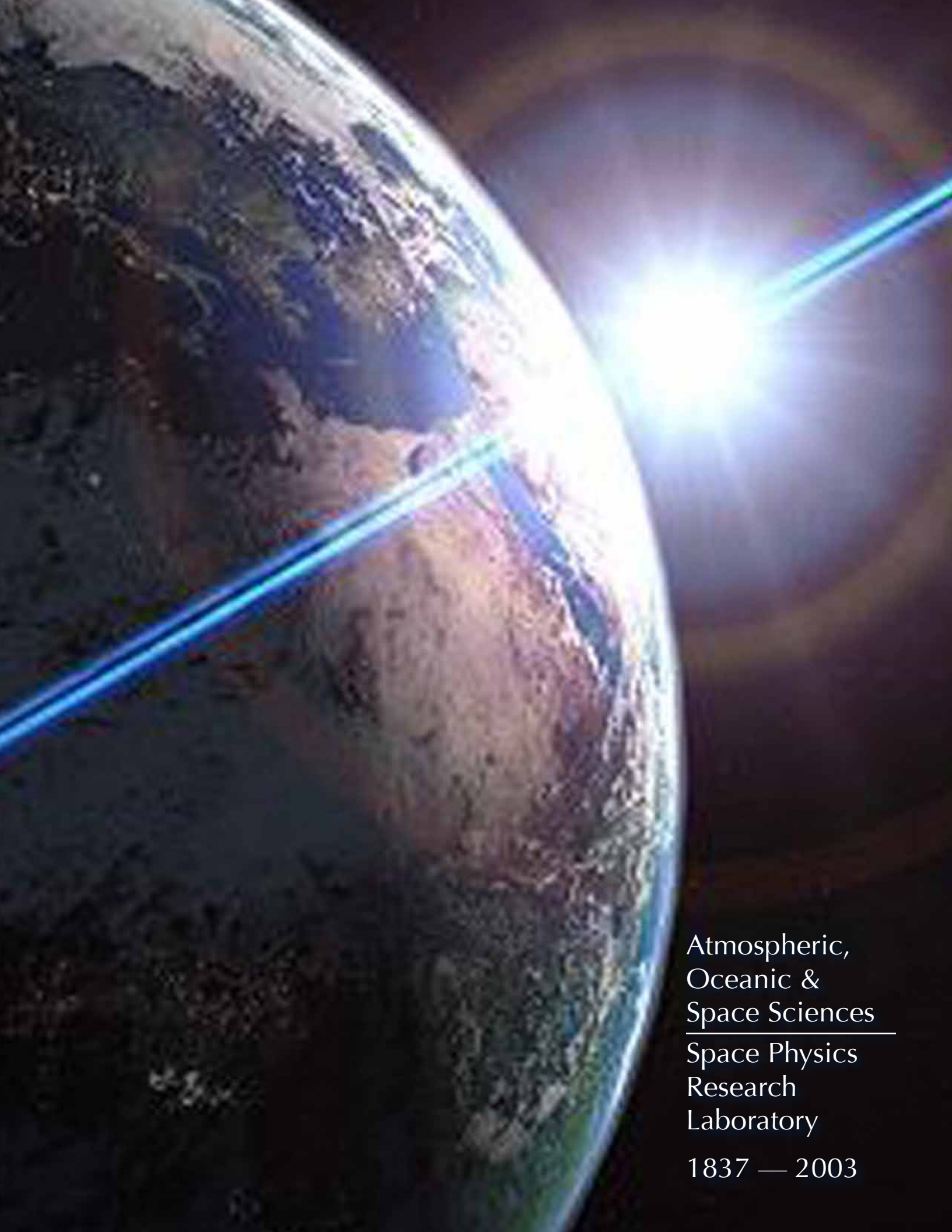

Atmospheric,
Oceanic &
Space Sciences

Space Physics
Research
Laboratory

1837 — 2003

SPRL Directors

Nelson Spencer	*1948 – 1960*
Larry Brace	*1960 – 1962*
George Carignan	*1962 – 1984*
Paul Hays	*1984 – 1989*
Andrew Nagy (interim)	*1989 – 1991*
John Vesecky	*1991 – 1993*
Timothy Killeen	*1993 – 1998*
R. Paul Drake	*1998 – 2002*
J. Hunter Waite (interim)	*2002 – 2004*
Tamas I. Gombosi	*2003 – 2006*
Christopher Ruf	*2006 –*

Department Chairs

Aksel Wiin-Nielsen	*1963 – 1971*
Edward Epstein	*1971 – 1973*
Fred Bartman (interim)	*1973 – 1974*
Thomas M. Donahue	*1974 – 1979*
William Kuhn	*1979 – 1990*
Roland Drayson (interim)	*1990 – 1991*
Paul Hays	*1991 – 1992*
Roland Drayson (interim)	*1992 – 1993*
Lennard A. Fisk	*1993 – 2003*
Tamas I. Gombosi	*2003 –*

Published by
Atmospheric, Oceanic and Space Sciences
Space Physics Research Laboratory
University of Michigan
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Ann Arbor, MI 48109-2143

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History of AOSS and SPRL

Prof. Alexander Winchell

A founding member and president of the Geological Society of America, Alexander Winchell's pioneering efforts were not limited to the field of science. In the late 1870s, Winchell was one of the organizers of the University Musical Society and the Ann Arbor Choral Union and built an enormous octagon house on the site of the Hill Auditorium. Always forward thinking, he was a strong advocate for the admission of women and a fierce opponent of U-M's first president, Henry Tappan.

In 1875-6, Winchell served as president of the University of Syracuse and moved on to teach at Vanderbilt University but was fired because of his advocacy of evolution. He returned to Ann Arbor and was a professor in geology and botany and zoology and paleontology until his death in 1891.

1837 – 1944

In January 1837 the superintendent of public institutions for the State of Michigan presented to the Michigan legislature a comprehensive plan for public education in the state. In this plan he proposed the establishment of three new professorships at the University of Michigan, one in Rhetoric and Oration, one in Fine Arts, and one in Civil Engineering and Architecture. The Civil Engineering professorship was not filled until November 1853, when Alexander Winchell became the first Engineering faculty member at the University of Michigan.

In 1854 Winchell purchased a complete suite of meteorological instruments and began making regular meteorological observations at the University, a tradition that continues to this day. Some of Winchell's early research focused on the effects of the Great Lakes' waters on Michigan's climate. The results of his early work were routinely sent to the Smithsonian Institute for publication and archiving.

Thus the answer to the oft-heard question: "Why is AOSS in the College of Engineering?"

In 1855 Winchell became the chair of Natural History — the precursor to the Department of Geological Sciences.

While Professor Winchell was beginning his legacy at the University, President Tappan was moving forward with building the Detroit Observatory (still located on Central Campus near Couzen's Hall), which included two telescopes, the Fitz Refracting Telescope and the Meridian Circle Telescope. A graduate of U-M, Professor Mark Harrington returned and became the third director of the Observatory in 1879, a position he retained until 1891 when he became the first Chief of the Weather Bureau, the forerunner of today's National Weather Service.

Much more interested in meteorology than astronomy, Harrington offered a course in meteorology and in 1880 he installed a complete set of meteorological instruments, which he then used to make observations from the Observatory. In 1884 he established the American Meteorological Journal, serving as its editor until 1892. When he left the University of Michigan in 1891, the meteorology courses were dropped but the collection and reporting of daily meteorological reports continues to this day:

http://cirrus.sprl.umich.edu/wxnet/

In 1871 the subject of removing the Engineering Department from the Department of LS&A was first raised. In 1872, President James Angell requested an endowment for the "purpose of establishing a scientific school at Michigan." In 1895, the Engineering Department separated from the Department of LS&A, however, only the engineering courses were moved to the new College.

Prof. Mark Harrington

Prior to returning to U-M, Harrington served as an astronomer's assistant for the U.S. Coast and Geodetic Survey in Alaska and professor of astronomy in Peking, China.

1945 – 1973

Space Physics Research Laboratory

The University of Michigan became a player in the US space program at its beginning. Two faculty leaders – Emerson Conlon and William Dow – saw to that. In January 1946, these two submitted proposals to the Air Force to carry out experimental research and both were awarded grants. Dow's proposal was to deploy a Langmuir Probe in the upper atmosphere to measure the state of electrons in the ionosphere. The first successful flight of this experiment on a V-2 rocket launched from White Sands, New Mexico was on November 21, 1946 following a spectacular failure of an earlier launch attempt in August of that year.

A national panel of scientists that included three academics – Dow, Myron Nichols of Princeton, who moved to Michigan in March 1946, and Fred Whipple who was at Harvard Smithsonian Laboratory, moderated the use of the captured V-2s. The panel was created in February 1946 and oversaw the use of about 60 V-2s. James Van Allen, then at the Applied Physics Laboratory at Johns Hopkins, after whom the Van Allen Belt is named, was also a member; Van Allen later moved to the University of Iowa and developed a powerful space science program there.

Two research laboratories were founded at the University of Michigan on the foundation of these early activities. Conlon's activities led to the formation of the High Altitude Engineering Laboratory (HAEL) in the Aeronautical Engineering Department and the Space Physics Research Laboratory (SPRL) in the Electrical Engineering Department by Dow. Les Jones directed HAEL and SPRL was headed by Nelson Spencer. These two men eventually became faculty members in their respective departments and led powerful, sometimes competing efforts in the decade of the 1950s that propelled Michigan to an internationally recognized position of leadership.

Nelson Spencer, who was credited by Dow for much of U-M's reputation in space research, left Michigan to head the planetary atmospheres group at NASA Goddard Space Flight Center in 1960 and Larry Brace, who had led the Langmuir Probe work in the '50s, succeeded him. Brace followed Spencer to NASA in 1962. George Carignan, who had been the Chief Engineer for SPRL since 1959, succeeded Brace and kept the laboratory, which had been crippled by the loss of these two leaders, functioning largely in support of the Goddard programs. Hasso Niemann, who was involved in the Omegatron development while obtaining his PhD under the direction of Dow, also left to join the same group at Goddard. Remaining at Michigan with Carignan were several of the pioneers, including Jack Horvath who headed the Pitot program and Dave Taeusch who provided theoretical strength for the work of the laboratory. Taeusch had originally been engaged to develop an ultra-high vacuum calibration system for a lunar pressure measurement but stayed on to become a theoretical consultant to several laboratory programs. Andy Nagy, who joined the lab in 1959, became the leader of the ionosphere group where he remains today.

HAEL flourished in the '60s under Jones's leadership. The laboratory was selected to fly mass spectrometers on OGO II and OGO IV. Fred Bartman led the instrument development and later succeeded Jones as HAEL Director. In the late 60s, Paul Hays, a student in the Aeronautical Engineering Department emerged as a star in the development and application of space optical remote sensing. He was selected as Principal Investigator for a remote sensing photometer on the Atmosphere Explorer satellites and a Fabry Perot optical spectrometer. This program attracted a cadre of scientists to Michigan that included William Sharp , who would later become Chief Scientist of the lab.

In the mid-'60s, HAEL and SPRL were responsible for nearly half of the externally funded research in the College of Engineering. The two labs gradually moved away from their original departments and became College facilities jointly managed by Aeronautical Astronautical Engineering, Electrical Engineering and Meteorology and Oceanography.

OGO VI was launched in the late '60s and included a Langmuir Probe with Nagy as PI and a neutral mass spectrometer with Carignan as Co-PI. The global measurements of atmospheric composition revolutionized the understanding of the response of the atmosphere to geomagnetic disturbances, which had been studied mostly through satellite drag interpretation, greatly heightening the visibility of SPRL.

Meteorology & Oceanography

In 1953 E. Wendell Hewson was appointed Professor of Meteorology in the College of Engineering, Department of Civil Engineering. Between 1954 and 1958, three more faculty members joined the meteorology group: Nelson Dingle (1954), Gerald Gill (1956), and Donald Portman (1958). In addition, the Group also included five lecturers. At that time, the main research thrust was atmospheric diffusion, air pollution, and distribution of ragweed pollen.

Facilities acquired in 1958 by the new Meteorology Program included:

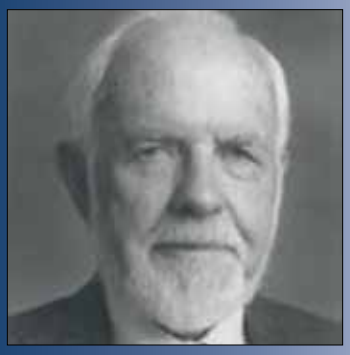
- *A Mobile Weather Radar for instruction and research, and*
- *A Wind Tunnel for instruction and research in meteorological instrumentation and related fields.*

A new program leading to the degree of Bachelor of Science in Engineering (Meteorology) was established in Civil Engineering in 1958. According to the 1958-59 College Annual Report, "The new program will help to meet a growing need for education in a broader field of meteorology than the traditional one of weather forecasting. The new program is believed to be the first of its type in the world." The

The V-2 Panel

Prior to submitting proposals to the Air Force, Dow and Conlon were told about "The V-2 Panel", consisting of scientists and military people organizing research using the captured V-2 rockets. Dow was amazed that the Army and Navy controlled the Panel — the Air Force was not included. Dow relayed to the Army Signal Corps his desire to continue his vacuum tube research at U-M for the Army. It was agreed to, with one exception, he had to conduct his research in "outer space". With the project approved by the Army Signal Corps, Dow proposed to the Air Force that he would represent them on the panel — for a grant of $60,000. Within 30 days, they agreed and Dow went on to explore space: "nature's biggest vacuum".

— Chronicle, summer 1984, Vol. 20 No. 2



same document lays forth a five-year plan for building the program that includes equipment, faculty, growth in graduate students (from less 20 to 50), facilities, new research and teaching programs and supporting funds.

In addition to the program, during the same year the University and 12 other universities established the University Corporation for Atmospheric Research. The goals of the Corporation were to, "foster a very substantial increase in atmospheric research and in education in the atmospheric sciences, both within the universities and by means of a National Institute of Atmospheric Research to be located near a university." This became the National Center of Atmospheric Research (NCAR) located in Boulder near the University of Colorado.

In 1961, the Meteorology Group was transferred to the Engineering Mechanics Department, however, there was discontent about the move and the group sought status as a separate department. But, personalities and politics stalled any formation of a meteorology department either in the College of Engineering or in LS&A. (At one point, the LS&A faculty were told that meteorology was too trivial a field to deserve status as a department at Michigan.)

At the same time, the group was searching for a dynamicist with a strong interest in numerical weather forecasting. Aksel Wiin-Nielsen, a Danish meteorologist then at the recently established NCAR on a temporary appointment, was invited to Michigan to give a seminar. He made a strong impression, and meteorology faculty members decided to suggest him as the chair of the new department as a way to end the stalemate. Engineering Dean Stephen Attwood approved Wiin-Nielsen's appointment as a faculty member and chair-designate.

The meteorology group had become interested in adding an oceanography component at an early stage of forming

Science Magazine
February 1956
"News of Science"

The University of Michigan's College of Engineering has established what is perhaps the first general program in applied meteorology. There are now five professional meteorologists at the university participating in various phases of teaching and research: Frank R. Bellaire; A. Nelson Dingle; Floyd C. Elder; Gerald C. Gill; and E. Wendell Hewson. The program is centered, for administrative purposes, in the department of civil engineering, Earnest Boyce, chairman, and is under the supervision of E. Wendell Hewson, professor of meteorology. The program features studies in which weather and climate play an important part. A recent grant by the National Institutes of Health of $325,000 for a 5-year study of atmospheric pollution by aeroallergens brings together in a cooperative effort, specialists in medicine, meteorology, botany, ecology, biochemistry, and public health. Other research is in progress on various phases of meteorology: penetration of particulates into buildings, dynamic wind loading of structures, and industrial air pollution. A large part of the research is sponsored by private industry. Eleven courses in theoretical and applied meteorology are offered and further courses are planned. The graduate school has established a program of study leading to the degree of master of science in meteorology.

the new department. Prior to Wiin-Nielsen's appointment John Ayers was hired from the Zoology Department where he was a member of the Great Lakes Institute studying biological oceanography. Shortly thereafter, Jack Hough, another oceanographer, was recruited from Illinois.

In July 1963, the Department of Meteorology and Oceanography (M&O) was formally established within the College of Engineering by the University

Regents, and in the fall Wiin-Nielsen arrived from NCAR as the first chair. Interestingly, in a memo prior to regental action from the University Vice President for Academic Affairs to Dean Attwood, it appears that the College had decided the new department would be named Atmospheric Sciences.

Aeronomy

Aeronomy, the physics and chemistry of the atmosphere above the tropopause, had been a subject of research of interest to the College predating the formation of the Department of Meteorology and Oceanography in 1963. Research efforts in this area were lead by SPRL and HAEL. But, in 1966, an interdepartmental graduate program (MS and PhD) in Aeronomy was established as a joint program among the departments of Aerospace, Electrical Engineering, and Meteorology & Oceanography.

The initial steering committee consisted of representatives from each of the three departments: Edward Epstein (Chair, M&O), Fred Bartman (M&O), Les Jones (AERO), Andrew Nagy (EE), Paul Hays (AERO), and Ernest Fontheim (EE). Eight faculty members were associated with the aeronomy program from the three participating departments. This was the genesis of the academic program in upper atmosphere, space and planetary science that has reached such prominence in the University in the last several decades.

According to Professor Nagy, the proposed name for the program was "Planetary and Space Science," however, the Geology Department vetoed the use of planetary and the Astronomy Department vetoed the use of space. With that, "we punted and selected Aeronomy, which no one objected to because most people did not know what it meant.

Shortly after the interdepartmental graduate program was established, there was concern that students were not developing the basic comprehension of the physical sciences sufficient to understand the atmospheric processes important in Aeronomy, and a new course structure was proposed. The structure was designed so that students would be prepared to engage in research ranging from the stratosphere through the magnetosphere, including solar physics and planetary atmospheres. Thermosphere and Ionosphere first appeared as a course offered through Electrical Engineering in 1968, and for the first time in the College of Engineering Bulletin, "Aeronomy" is replaced with "Aeronomy and Planetary Atmospheres."

The undergraduate aeronomy option first appeared in the engineering Bulletin in 1965, with two aeronomy courses offered. In 1966, additional required courses were *Advanced Math for Engineers*; *Intro to Digital Computers*; *Principles of Aerodynamics; Light; Intermediate E and M*; *Heat and Thermodynamics*; *Introduction to IR Spectra*; and *Atomic and Molecular Structure*. It seems, though, that the undergraduate program was "in name only" as most of the undergraduate students lacked the interest in mathematics and physics required and at least one faculty member cannot recall any students electing this option.

In the late '60s-early '70s time frame, there were few College of Engineering programs that involved faculty from other colleges. Apparently the interdisciplinary Aeronomy program had come to the attention of the College as one that could have interaction with other colleges. In their three-year plan, the College of Engineering stated that, "To supplement the Aeronomy…graduate program opportunities with other Colleges should be explored." The Aeronomy faculty must have felt otherwise, since just two years later, in 1971, they began exploring the possibility of unifying the present interdisciplinary graduate program in Aeronomy and Planetary Atmospheres into the Department of Meteorology and Oceanography and changing "Meteorology" to "Atmospheric Sciences".

> *"During the demonstrations in the late '60s, the SRB roof was used as an observation point to get a good view of the tussles between the sheriff's department and students."*

A committee consisting of Fred Bartman, Edward Epstein, and Andrew Nagy was established in 1972 to make recommendations for such an academic program. The field of aeronomy was advancing rapidly with the increase of observing capability and observations of the upper atmosphere, and it was soon realized that the troposphere and upper atmosphere were closely coupled and integrated studies were becoming a necessity. Another reason, though never explicitly stated, was that the Interdisciplinary Aeronomy Program had no budget of its own, relying on finances from the participating departments, which made planning difficult.

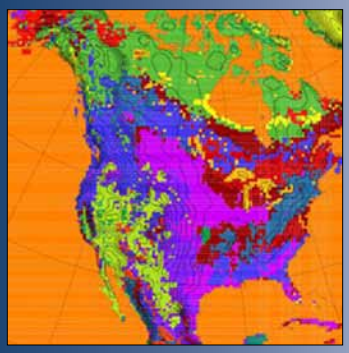
In May 1971, the staffs of Aeronomy and Planetary Atmospheres and Meteorology approved the plan to merge into one department, which then went to the chairs of Electrical Engineering and Aerospace Engineering and the Deans. In April of 1972, the Executive Board approved the plan in principle and the new Department of Atmospheric and Oceanic Science appeared in the College Bulletin in 1973. Upper atmosphere, space, and planetary science have continued to play an important role in the Department in both teaching and research.

Environment Studies to Climate Change

Since the 1960s, environmental studies have been part of the Department, although the emphasis has changed over the years. During the 60s, while the College viewed its role as one of "engineering" a solution to a perceived problem of impacts the environment had at the local and, perhaps, regional level, the Department was concentrating on meteorological effects on a more global scale. In College Bulletins, program descriptions emphasized the evaluation of proposed location, processes and smoke stack characteristics of large industrial plants to avoid and/or minimize air pollution problems and wind loading on towers and suspension bridges.

In the early '70s, SPRL researchers sought to determine what effects the Shuttle's solid boosters may have on the atmosphere. While it was determined there would be no effect, much of their research later led to the identification of chlorofluorocarbons as a danger to the ozone layer.

Since that time, as the faculty composition changed, and the School of Natural Resources and Environment was established, the emphasis within AOS changed to a more science-driven program. Today, the focus of most AOSS atmospheric faculty is on Earth system science and climate change.



A Meteorology degree in LS&A!

While we like to think that meteorology at Michigan has always been the purview of the College of Engineering since the 1800s, this is not quite true. The Department of Geography offered a program leading to the B.S. degree with a meteorology option in the College of LS&A. The M&O 1966 evaluation report states that this program had been in effect for about five years and at the time of the report, there were five students pursuing this major. Twenty-four hours of meteorology courses were required and were specified by the meteorology program (later the M&O Department) in the College of Engineering. Could it have been that discussions were held with the Geography Department before a decision was reached to form a department within Engineering?

It is interesting to note that the Geography Department offered courses in climatology and glaciology for which some of our courses were prerequisites but as stated in the evaluation report, "…but we have tended not to call these courses to the attention of our students."

1974 – 1993

SPRL meets AOS

The increasing visibility of SPRL in the area of global measurements of atmospheric composition was key in luring Thomas M. Donahue to Michigan from Pittsburgh in 1974 to chair the Department. His six years as chair were marked by achievement in space science and in stratospheric chemistry, which, during that time, was of major, international interest. His presence at Michigan, together with the strengths of the AOS Department and SPRL, attracted an outstanding group of young scientists to Michigan. At one time, James Anderson, William Chameides, Ralph Cicerone, John Fredrick, Shaw Liu, Don Stedman, Rich Stolarski, and their supporting staff were engaged with Donahue in stratospheric studies. Members of this group have since defined the field and are now members of the scientific elite of the nation.

With George Carignan Director of SPRL and Thomas Donahue Chair of AOS, the two entities were united and the AOS Department moved to the new NASA funded Space Research Building.

The department has always been somewhat divided over the three central topics of its portfolio – space science, atmospheric science and oceanography. During Donahue's chairmanship, this division was especially acute, with much bickering among the groups. Donahue once observed at a faculty meeting, "the AOS Department had the gall to be divided into three parts," thus capturing the bane of the department illuminated by his sharp wit.

As SPRL and AOS were joining forces, nature took its affect on the destiny of HAEL. In the mid '70s, HAEL director and driving force Les Jones was diagnosed with leukemia. As his health declined, HAEL was unable to transition leadership. When Jones succumbed in 1979 HAEL rapidly disintegrated.

Shortly afterward, Paul Hays moved the optical aeronomy group to SPRL, where it continued to flourish. The combination of in-situ and remote measurements was very powerful and kept Michigan at the forefront of space exploration and atmospheric science. The rest of HAEL, however, scattered to different sectors of the University.

During this time, the practice of "joint" appointments in SPRL and a College department began to be used extensively. For instance, in the early 1970s Aerospace Professor Paul Hays joined SPRL, where he combined his keen sense of data needed to move our understanding forward with an ability to conceive and design instruments to make the measurements. These joint relationships helped merge science and engineering into the science-driven engineering that is at the heart of SPRL and the Department even today.

In 1979 William Kuhn was appointed Chair of AOS and in 1984 Professor Hays succeeded Carignan as SPRL director. With the increasing contribution of space science studies to the department, in 1985 AOS became AOSS — Atmospheric, Oceanic and Space Sciences.

Inventing NASA — at the Michigan League

The American space research community was stunned when the Soviets announced that Sputnik — their "moonlet", Les Jones called it — was circling the globe in 1957. What had gone wrong in the United States? It was well known that von Braun had an Army rocket and two satellites nearly ready to launch as far back as 1956. But the Navy, designated by President Eisenhower to launch the first US satellite, was still months away from being ready.

There had been stirrings of discontent with military control of the space program for some time. Rivalry among the three branches of the armed forces had prevented a scientifically coherent program from emerging. Classification of information sometimes prevented scientists from learning the latest findings of other scientists. And, according to Dow, space scientists felt that their information ought to be shared with the world at large since civilian uses would be enormously important. Another profound issue, says Dow, was "Why and what do scientists choose to measure? These questions should not be limited by military applications. The Rocket Panel wanted an operation where the search for scientific information was the primary goal."

Some months before Sputnik, Nelson Spencer had become a member of the Rocket Panel's sub-committee called the "Committee on Space." Chaired by Homer Newell (the driving force for demilitarization of space) the four-man group met twice. They debated the idea of establishing a new government space agency. When Sputnik went into orbit, recalls Spencer, "All hell broke loose. There was no longer any question about the need to establish something new."

According to Dow, Spencer proposed that the Rocket Panel meet in Ann Arbor to draft such a proposal. They were to define the objectives of a civilian agency which would conduct the national program for space research and exploration.

The Panel met on November 13 and 14, 1957 in U-M's Michigan League. They recommended that the agency be named the National Space Establishment and proposed that it be given authority to explore and occupy outer space in a scientific manner. The price for such an agency? The Panel suggested ten billion dollars for a ten-year period.

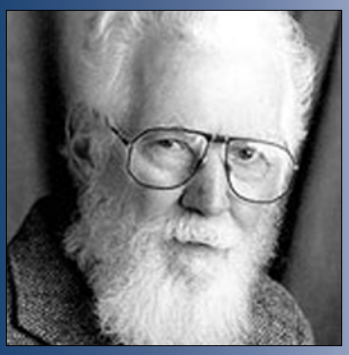
In a U-M news release, Jones emphasized, "The important thing is that this agency should be a civilian group, rather than a military one. We would like to see a sustained, highly organized effort over the next ten years, aimed at conducting scientific investigations of our atmosphere and beyond and at placing man himself in outer space."

Dow recalls a man from the Army Signal Corps protesting, "It's no use. The Air Force is too powerful." Dow indignantly reminded him that the United States was a democracy and that their job was to recommend what they felt best — not to implement it. Dow, shrewd as well as patriotic, also knew that Congress often became stubborn if they perceived that the military was trying to railroad them.

The Panel chose a remarkable emissary to carry their message to Congress — Wernher von Braun. The man who had first designed and used rockets to wage war now took a proposal for civilian control to Washington. On December 14, 1956, his delivery of that proposal began the political battle to create the National Aeronautics and Space Agency.

Two years later, on April 2, 1958, the Rocket Panel met for one of their regular meetings in Washington, DC. While eating supper at O'Donnel's restaurant, they spotted a Washington Post headline announcing President Eisenhower's request that Congress create the National Space and Aeronautics Administration. Excitedly they bought copies of the paper and autographed the headlines for each other. As far as they were concerned, their baby had just been born.

In many important ways it had been. NASA grew from the rocket program and the upper atmosphere research sponsored by the Rocket Panel of the prior decade. And throughout it all, scientists and engineers at the University of Michigan had been part of the story.



Another Early Pioneer

In 1959, a young man arrived in Ann Arbor to work on his PhD in electrical engineering. Looking for a summer job, Andy Nagy was steered towards SPRL and, like so many scientists in the early days of the "Space Age", he became an early pioneer in atmospheric and planetary science. After working on the electronics of early "dumbbell" and Langmuir probes and mass spectrometers, he moved more towards theoretical rather than experimental aeronomy research. Nagy and Tom Donahue, became Co-Investigators and Interdisciplinary Scientists on NASA's Pioneer Mission to Venus, which was launched in 1978. The Pioneer Mission provided continuous observations of the atmosphere, ionosphere and solar wind interactions at Venus for more than 14 years, adding greatly to our understanding of the solar system. Today, Nagy continues to add to our understanding of the solar system as a member of the Radio Science Team of the Cassini Mission to Saturn.

During the 20 years after 1974 the atmospheric component of the Department was more involved in synoptic meteorology and forecasting — due mainly to student interest. The faculty and students were forecasting for races including the annual Mackinaw to Detroit sailboat race and many hot air balloon competitions. They provided forecasts for a local radio station and Friday afternoon weather briefings were held with faculty making weekly forecasts — regardless of their expertise. "Usually embarrassing but fun." Alas, one pitfall was the impression that synoptic meteorology and forecasting were too "soft" for an engineering college.

1983: SPRL's Biggest Hardware Project

When Paul Hays became SPRL Director the focus of laboratory research shifted toward optical remote sensing. Hays had demonstrated the capability to measure atmospheric winds remotely and the promise of global wind field measurements excited the atmospheric science community. At the same time, NASA was becoming interested in Earth's upper atmosphere dynamics, as it was becoming more and more evident that this region, above the tropopause, plays a fundamental role in global climate and provides a shield against harmful ultraviolet radiation from the sun. Hays was selected to be Principal Investigator for the High Resolution Doppler Imager (HRDI) on the Upper Atmosphere Research Satellite (UARS). HRDI was designed to address the dynamic state of the upper atmosphere and its influence on the chemistry and thermodynamics of the region.

Work on HRDI, the largest instrument project taken on by SPRL, began in October 1983 and was launched September 12, 1991. HRDI continued collecting data and relaying it to SPRL scientists until March 31, 2005. Prior to UARS, there were very few global wind field measurements in the upper atmosphere, but with HRDI the high promise of global measurements of atmospheric winds was achieved.

Prof. Thomas Donahue

Donahue was a major figure in the department and in the nation until shortly before his death in 2004. He was elected to the National Academy of Sciences in 1983 and chaired the Space Science Board from 1982 to 1988. He was awarded the University of Michigan Henry Russel Lectureship in 1986. He remained active in space research and his prestige added immensely to the attraction of Ann Arbor as a place to study space and atmospheric science. AOSS and the Donahue Family established the Thomas M. Donahue Memorial Student Fund to provide support to graduate students.

Hays attracted Tim Killeen to SPRL as a postdoctoral fellow and Killeen carried on this work with a derivative instrument on the TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics) spacecraft. In 2000, Killeen left U-M to become the Director of NCAR.

Life in AOSS-SPRL with a space scientist for a dean

In 1990, a year after Hays' term as SPRL director ended, Professor Peter Banks, a well-known space scientist from Stanford University, was recruited to U-M as the new Dean of the College of Engineering. With him came a group of space scientists from Stanford and, in 1991, he appointed Hays chair of AOSS thus continuing the strong role of the department in space sciences.

Oceanography

As early as 1967, just four years after establishment of the department, concerns were raised about the oceanography program. The first departmental review found the research too focused on the Great Lakes and water/air pollution to garner national attention more emphasis should be placed on oceanographic research. "After all, the Department did have 'oceanography' in its name."

A JPL of the Midwest? Twice tried

In February 1962, a memo was circulated among the members of the University of Michigan Space Science Committee putting forth the proposed organization of a University Space Research Program. It was put forth that a separate institute or center attached to the University would be the most ideal organizational structure. The recommendations took much from the structure of the Jet Propulsion Laboratory, which was established in the 1930s by the California Institute of Technology. At the same time the University Committee was requesting funding from NASA to construct "a facility to house certain of the major space-research programs being conducted at the University…" Originally submitted as a letter in March 1962, a full facilities proposal was submitted in October 1962, and in 1963, funded the construction of the Space Research Building.

While the space research work of Aeronautical and Astronautical Engineering, Electrical Engineering and Astronomy departments was emphasized in the proposals, in the end, only SPRL, and Radio Astronomy, moved to the new facility, with other space-related research continuing to be scattered across campus.

In the Fall of 1985, James Duderstadt, Dean of the Engineering College, sent a memo to A&OS chair, William Kuhn, from Alfred Sussman, the Vice President for Research, explaining an initiative to bring together various University groups involved in Earth and planetary science into a center that he envisioned would be "… a kind of mini-analog to Caltech's Jet Propulsion Laboratory …" It was suggested that, due to A&OS Professor Tom Donahue's close association with NASA, this would be an ideal time to pursue the project. The concept was to build a multidisciplinary center with "individuals representing A&OS, Geology, Physics, Chemistry, Astronomy, other engineering, IST [Institute of Science and Technology], and possibly Natural Resources … undoubtedly a role for ERIM."

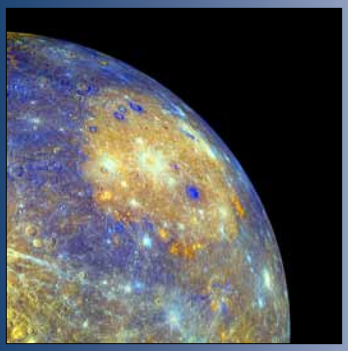
But, nothing more was heard about the proposal in AOS, and this appears to be the last that was heard of a JPL of the Midwest.

However, as AOS did not own or control any facilities, such as a ship, laboratories and apparatus, all research had to be conducted through the University of Michigan Great Lakes Research Division (GLRD). All research grants were administered by GLRD and all equipment acquired for new research became the property of GLRD, which, in the future, could only be used for Great Lakes research. The faculty found ways around this "Catch-22" and by the mid '70s, the program was growing both in research and number of students and was a stable, integral part of the department. Great Lakes research now exists as part of the Aquatic Research Programs of the University of Michigan Biological Station

By the early '80s, enrollment in the oceanography program was on the decline, the space science program was growing and there was tension between oceanography faculty, whose research was funded primarily by NSF, and the College. While the College expected faculty to offset their academic year salaries, this was prohibited in some NSF oceanography programs. In the mid 80s, AOS oceanography faculty approached the College of Literature, Science and Arts about transferring into the Department of Geology.

In July 1987, the official transfer of the oceanography faculty to LSA took place, although where the "oceanography program" would reside was still up in the air. It was later decided that both undergraduate and graduate programs in physical oceanography only would be offered through AOS; all other courses in oceanography (biological, chemical and geological) would be the responsibility of LSA. The AOS undergraduate program last appeared in the 1992 CoE Course Bulletin, while the graduate program continued for a while, but typically attracted only a few students.

In 1991, AOSS Chair Paul Hays suffered a heart attack and stepped down. Following Professor Roland Drayson's tenure as interim department chair, Lennard Fisk joined AOSS after a five-year tenure as NASA Associate Administrator for Space Science and Applications, becoming chair in 1993. Also in 1993, Tim Killeen replaced John Vesecky as SPRL Director. Both men took these positions at the beginning of a whirlwind decade of change.



FIPS

On August 3, 2004, the Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) spacecraft was launched and headed for Mercury. On board was the Fast Imaging Plasma Spectrometer (FIPS) instrument, which was designed and developed by SPRL. Work on FIPS, an innovative breakthrough design in low-mass and low-power mass spectrometry, began in 1998. MESSENGER has completed two flybys of Mercury with the FIPS instrument performing perfectly, transmitting data for scientists to "see" Mercury's space environment.

MESSENGER is the first spacecraft to visit Mercury since Mariner 10 in 1975.

1994 – 2003

Ch-Ch-Changes

During the 1990s, AOSS and SPRL were compelled to react to powerful internal and external forces. The space industry had matured into an established enterprise, with the attendant checks, balances and increased costs. State appropriations for higher education were tightening, increasing the need for fund raising by the University. And what was once an electronic highway for the Defense Department and computer nerds — the Internet — was married to the World Wide Web and a new way of doing business was born. The new technology gave rise to a decade of entrepreneurial business that was faster, easier and quicker.

While the 90s still saw some large space missions in which SPRL engineering was involved, such as the Cassini-Huygens Mission to Saturn, NASA had begun looking "in-house" to its space centers for more engineering and science as well as proposing smaller, shorter missions as a way to contain costs and move missions along the pipeline faster. Space mission proposals were beginning to require collaboration among many institutions, thus spreading mission components and costs amongst a greater number of entities and effectively cutting cost margins.

The University's reaction to the economic challenges was two-fold. The first was to become more "businesslike" in its financial operations. The University found it necessary to institute some campus-wide standard criteria for evaluating academic programs. The value of a particular academic program or project was no longer measured purely on the value of its greater good. Instead, "operating in the red" became a meaningful phrase in the halls of academia and higher weight was given to the amount of tuition generated within each college and school during annual allocations — commonly known as Student Credit Hours or SCHs.

At the same time, the Federal Government changed its rules on administrative support charged to grants/contracts. These costs could no longer be a budgetary line item. Rather, they were moved to the project "overhead" that was collected by the University, but not returned to departments. Suddenly these costs had to be absorbed by the individual departments.

The second change in the University was to increase its quest for donors. While U-M had conducted fund raising campaigns in 1964 and 1983, the one launched in 1992, had the highest goal ever for a public university, $1 billion. Another campaign, The Michigan Difference, was launched in 2000 with a goal of $2.5 billion. In addition to administrative, academic and research duties, courting donors became a larger part of a chair's portfolio.

"Faster, better, cheaper" was becoming harder to accomplish within the University.

Funding, SCHs, Overhead and Reporting

For the most part, the College determined general departmental funding based upon two criteria: tuition dollars generated by SCHs and overhead generated by research and paid to the University. Historically, AOSS has generated more revenue for the University via research than tuition.

Throughout the '90s, as SCHs became more of a benchmark for budget decisions by the University, the College would raise the issue of SCHs. Classes taught outside the College of Engineering — in LSA — couldn't be counted towards College SCHs. Yet, teaching lower level (100 and 200) courses in LSA drew students to AOSS. While SCHs were never raised as a serious issue because of the high overhead contributions to the College, they were used in various funding formulas used to determine educational support. A certain level of support (graduate student instructors) had to be maintained and was covered by the Department. In AOSS, this resulted in one of the highest levels of additional support paid by the faculty through their research money.

In the mid '90s, the University began upgrading its financial and student reporting to M-Pathways, a computer-based process system. At the same time, accounting and allocation reporting and formulas were changed. Staff were faced with learning new

Michigan Aerospace Corporation

In 1996, Len Fisk and Paul Hays joined together and formed The Michigan Aerospace Corporation initially to commercialize technology developed at SPRL. Since then, Michigan Aerospace has grown into a successful company in the state of Michigan and is viewed as an excellent example of economic diversification by the University.

The Company's products, which includes lidar systems that measure winds, temperature, and density from a variety of platforms — ground-based, aircraft and space — have their heritage in a series of space flight instruments developed by Paul Hays in SPRL and flown on NASA scientific missions: the Visual Airglow Experiment flown on the Atmosphere Explorer –C, – D, – E; the Fabry-Perot Interferometer on Dynamics Explorer 2; and the High Resolution Doppler Imager (HRDI) on the Upper Atmospheric Research Satellite (UARS). The Company has diversified into a number of other areas, including Chemical/Biological/Radiation/Nuclear/Explosives (CBRNE) detection for Homeland Security and food protection applications and docking systems for space and marine applications.

Michigan Aerospace is in the process of forming a new company and raising capital to manufacture and sell its products, which have both defense and civilian applications. Products that will be available next year include a wind measurement lidar system to increase efficiency and reduce maintenance costs for wind energy farms. The company works closely with a number of University departments, including AOSS, Aerospace, the Marine Hydrodynamics Lab, the Kellogg Eye Center and the Physics Department. Michigan Aerospace plans to continue its history of taking new ideas to the marketplace and providing high technology job growth in Michigan.

procedures, new software and new ways of accomplishing their tasks with what many felt was inadequate training. Many departments, including AOSS, faced financial turmoil for a number of years as each M-Pathways component was brought online. Early in the new millienium , a web-based reporting system, the University of Michigan Administrative Information Services (MAIS) was also added to the mix. Faster and easier seemed elusive.

The Era of Big Space Missions

In 1993, SPRL received a contract to redesign and build a mass spectrometer for the Midcourse Space Experiment satellite, which launched in 1996. In 1994, SPRL scientists led a 20-person working group that, using the Hubble Space Telescope, observed the Comet Shoemaker-Levy 9's impact on Jupiter. The Lab also received a grant from the NSF to establish the Global Change Laboratory, a teaching/research facility to measure global change in the entire atmospheric column from the ground to the exosphere. Both projects were scientific in nature.

As one of his first projects as SPRL Director, Tim Killeen submitted a proposal for experiments to be flown on the Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) mission. Work on the TIMED Doppler Interferometer (TIDI) began in 1996 and the satellite was launched in 2001. To date, TIDI is the largest instrument that has been designed and built by SPRL. In 1997, Tim Killeen was appointed U-M Associate Vice President for Research and stepped down as the SPRL director the following year. In 1999 he left the University to take over as director of the National Center for Atmospheric Research (NCAR). In 1998 R. Paul Drake stepped in as the new director of SPRL. In space science, the research work was flipping from 80% engineering and 20% science to 80% science and 20% engineering.

Ushering in New Foundations

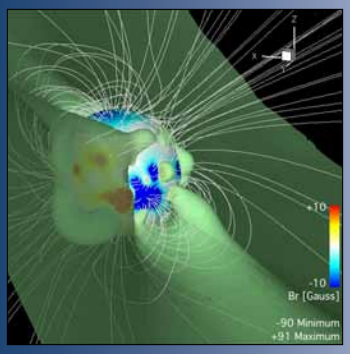
The 1990s saw the establishment of new science groups and hiring of highly acclaimed faculty that continue to contribute to the well-being and reputation of the Department. In 1996, atmospheric scientist Joyce Penner and physicist Paul Drake joined AOSS from Lawrence Livermore National Laboratory. In addition to leading a research group in ground-breaking climate modeling, Penner was selected as a member of the UN Intergovernmental Panel on Climate Change (IPCC) that was the co-winner of the 2007 Nobel Peace Prize.

When Len Fisk left NASA for AOSS in 1993, he resumed his work in solar and heliospheric research. George Gloeckler, Distinguished University Professor at the University of Maryland and AOSS Research Professor, transferred his experimental program to SPRL, and the Solar and Heliospheric Research Group was formed. In 1996, Thomas Zurbuchen joined the group; his first instrument was FIPS on the MESSENGER mission to Mercury.

AOSS Research Centers

In 1992, Tamas Gombosi and a group of U-M scientists submitted a proposal to the first NSF Computational Grand Challenges competition to develop a massively parallel finite volume MHD (magnetohydrodynamic) code on adaptive grids. The proposal failed. But, in 2001, a NASA Computational Technologies proposal was funded to develop the Space Weather Modeling Framework. Soon after, the Center for Space Environment Modeling (CSEM) was established with Professor Gombosi as its Director. This was the first University research center housed in AOSS.

In 2008, the second research center to be housed in AOSS was established after another team of Michigan scientists led by AOSS professor R. Paul Drake won a $15 million contract to establish the Center for Radiative Shock Hydrodynamics at the University of Michigan. The Center aims to advance predictive science through studying and simulating these cosmic shock waves.



In 1999 mission hardware specialist David Young joined AOSS coming from the Southwest Research Institute; soon after J. Hunter Waite followed. Their research brought an infusion of funds into SPRL.

Establishing a Stronger Academic Program

In his first strategic plan for AOSS in 1994, Fisk recommended introducing a MEng program, in part to cover an expected downturn in the number of PhD students that was occurring nationwide. In 1996, the first students were admitted to the program in either Space Systems or Remote Sensing and Geoinformational Science. The MEng program continues to be offered and in the early 2000s, the department established the Sequential Graduate/Undergraduate Studies Program (SGUS) in Space Engineering, which allows students to complete the academic requirements for an undergraduate and a master's degree in five years.

As early as 1997, awareness of an impending loss of faculty due to retirement and the resultant changes that would bring to the department, particularly in atmospheric science, was high. It was recognized in the 1998 External Review of the department and in subsequent hiring plans.

The meteorological degree was the major of choice for most AOSS undergraduates. However, in the late '90s, faculty who could teach the meteorology courses were retiring or leaving and efforts to recruit in this area were difficult. In 1999, in the first of a number of efforts to redirect the emphasis in the undergraduate program, AOSS proposed a Center for Atmospheric and Geospace General Circulation Model Technologies as a joint project with NCAR. Not only was this to be a research center with three core areas (Advection Technology, Atmospheric General Circulation Models and Space Weather), the proposal envisioned the creation of "new opportunities to build an academic program in atmospheric GCMs." This was also the first time that a collaborative effort of AOSS atmospheric and space modelers was proposed.

"The Plan for the Rebuilding of the Department of Atmospheric, Oceanic and Space Sciences" was submitted to the College in 2000 and it is clear that the faculty understood that changes needed to occur: "Unless we take immediate corrective actions, AOSS is in danger of not having a viable educational program in the near future." At the time, there were less than 25 undergraduate and approximately 50 graduate students — with the prospect of decreasing rather than increasing these numbers. To solve this somber problem, the following were suggested:

1. Reconstruct the undergraduate program
2. Reorganize the MS/PhD program
3. Maintain and enhance the MEng program
4. Attract CoE non-AOSS students to courses

While the Department requested slots for five new atmospheric faculty and two new space faculty, it also suggested exploring the possibility of a joint program with the LSA Department of Geological Sciences.

Merger Talks

In April 2002, Stephen Director, College of Engineering Dean, charged the AOSS atmospheric science faculty to explore a merger with Civil and Environmental Engineering and the space science faculty with Aerospace Engineering. Specifically, the Dean stated, "Examine all relevant issues, both positive and negative, associated with a potential merger of AOSS Sciences with [CEE and AERO] as well as consider alternative arrangements that might better accomplish the goals of building cohesive programs."

The Atmospheric Science and CEE faculty, meeting weekly during the fall, began an informal seminar series with one speaker from each department to learn more about each department. The Committee members from both departments found that while the "cultures of both groups are similar" they weren't able to "identify intellectual common ground among the majority of AS and CEE faculty. Their recommendation was no merger.

The Weather Underground

In 1991, AOSS Professor Perry Samson's graduate student Jeff Masters wrote a menu-based telnet interface that displayed real-time weather information around the world. By 1992, the two servers his system used were rattling off their desks as "um-weather" became one of the most popular services on the nascent Internet. In 1993, Perry and Jeff recruited Jeff Ferguson and Alan Steremberg to help bring Internet weather into K-12 classrooms. "Blue Skies for Windows" was developed in 1994 and the growing Internet weather program was given the name Weather Underground.

In late spring of 1995, the Weather Underground, Inc., evolved as a separate commercial entity from the university. By fall, the official web site, http://www.wunderground.com, was released with daily forecasts and hourly conditions for 550 US cities. After announcing the new web site on the telnet service, traffic immediately soared, creating a substantial user base. During 1996 and 1997, the site was transformed into a dynamic service where information was updated in real-time with several innovative new features such as the first zip code searches, severe weather warnings and advisories, international conditions, marine weather, and detailed local forecasts.

The web site has never stood still and many new features have been added in recent years. Of particular note, Weather Underground has developed the world's largest network of personal weather stations (almost 10,000 stations in the US and more than 3,000 across the rest of the world) that provides users with the most localized weather conditions available. In 2007, AOSS Professor Richard (Ricky) Rood, began a blog on the popular Blogs section, which allows members to post weather-related blogs. Other popular features include a tornado tracking product, in-depth sports and ski weather and Trip Planner applications and new Wundermaps® using Google Tools to overlay multiple data sets in real-time.

The Space and AERO faculty discussions were more acrimonious. In November 2002, the AOSS Space faculty informed the Dean "that negotiations between the Department of Atmospheric, Oceanic and Space Sciences and the Department of Aerospace Engineering have reached an unproductive impasse." They closed the door on a merger and offered an alternative: "the education and research goals of the space science and engineering faculty of AOSS … can best be accomplished within a stand-alone department."

Talks of merging with CEE and AERO were occurring during the final year of Len Fisk's tenure as department chair. Paul Drake stepped down as SPRL director and on an interim basis was replaced by J. Hunter Waite. By Fall 2003, AOSS had a new Chair, Tamas Gombosi, a new financial manager and the beginnings of a new joint undergraduate program with Geological Sciences.

Epilogue

Many changes have occurred in the Department of Atmospheric, Oceanic and Space Sciences since 2003. There is a new undergraduate program in place — students now receive a BSE in Earth System Science and Engineering after earning 128 credits. There are almost 50 undergraduate and 100 graduate students and the department continues to grow.

After a major reorganization in 2004-05 under the directorship of Gombosi, SPRL has expanded its focus to include an emphasis on pre-flight engineering research and development and on ground based and airborne sensors, in addition to its core activity in space instruments. The SPRL engineering staff is also becoming much more involved with the educational mission of the College of Engineering by participating in numerous "hands on" student projects. In 2006, AOSS faculty member Christopher Ruf was named SPRL director — an indication of the increasing activity within SPRL in the realm of remote sensing instrumentation.

AOSS has met its challenges with other changes, too. In atmospheric science, four new instructional faculty have been hired and in space sciences two additional instructional faculty were added.

While challenges still exist — known and unknown — AOSS is looking towards continued growth in research and education.

Atmospheric, Oceanic and Space Sciences Faculty: 2009 – 2010

Vince Abreu
Natasha Andronova, Member, UN Intergovernmental Panel on Climate Change, co-winner, '07 Nobel Peace Prize
Sushil Atreya, Fellow, American Association for the Advancement of Science; Elected Member, International Academy of Astronautics
John Barker
Jeremy Bassis
Kiran Bhaganagar
Steve Bougher, Andrew F. Nagy Collegiate Research Professor
John Boyd
Mary Anne Carroll
Michael Combi, Distinguished University Research Professor
Jason Daida
Roger De Roo
Darren De Zeeuw
R. Paul Drake, Henry Smith Carhart Collegiate Professor of Space Physics; Fellow, American Physical Society
A.W. (Tony) England, Senior Scientist-Astronaut, NASA; Fellow, Institute of Electrical and Electronics Engineers
Lennard A. Fisk, Thomas M. Donahue Distinguished University Professor of Space Science; Former Chair, NAS Space Studies Board; Member, National Academy of Sciences; National Associate, National Research Council; Fellow, American Geophysical Union; Elected Member, International Academy of Astronautics
Mark Flanner
Richard Frazin
Brian Gilchrist
George Gloeckler, Member, National Academy of Sciences; Fellow, American Geophysical Union; Fellow, American Physical Society
Tamas I. Gombosi, Rollin M. Gerstacker Professor of Engineering; Fellow, American Geophysical Union; Elected Member, International Academy of Astronautics
Kenneth Hansen
Xianglei Huang
Christiane Jablonowski
Jerry Keeler
Janet Kozyra, George Carignan Collegiate Research Professor; Fellow, American Geophysical Union
Sue Lepri
Michael Liemohn
Tariq Majeed
Ward Manchester
Frank Marsik
Darren McKague
Guy Meadows
Anna Michalak, Recipient, Presidential Early Career for Scientists & Engineers Award
Mark Moldwin, Recipient, National Science Foundation CAREER Award
Eric Myra
Andrew Nagy, Fellow, American Geophysical Union; Elected Member, International Academy of Astronautics
Rick Niciejewski
Chris Parkinson
Joyce Penner, Ralph J. Cicerone Distinguished University Professor of Atmospheric Sciences; Fellow, American Geophysical Union; Contributor, UN Intergovernmental Panel on Climate Change, co-winner, '07 Nobel Peace Prize
Derek Posselt
Chris Poulsen
Nilton Renno
Aaron Ridley
Richard Rood, Fellow, American Meteorological Society; Recipient, World Meteorological Organization Norbert Gerbier-Mumm International Award
Christopher Ruf, Fellow, Institute of Electrical and Electronics Engineers; Recipient, IEEE Resnick Field Award
Perry Samson, Arthur Thurnau Professor
Sandy Sillman
Wilbert Skinner
Igor Sokolov
Allison Steiner
Quentin Stout
Valeriy Tenishev
Gábor Tóth
Bart van der Holst
Kensall Wise, William Gould Dow Distinguished University Professor; J. Reid and Polly Anderson Professor of Manufacturing Technology; Fellow, American Institute of Medical and Biological Engineering; Elected Member, National Academy of Engineering
Thomas Zurbuchen, Recipient, Presidential Early Career for Scientists & Engineers Award

Emeritus Faculty

Dennis Baker
Fred Bartman
George Carignan
Roland Drayson
Ernest Fontheim
Paul B. Hays, Dwight F. Benton Professor Emeritus - Advanced Technology
Stan Jacobs
William Kuhn
Donald Portman
William Sharp
Tong Shyn
Lee Somers
John Vesecky
James Walker