

History of the AOSC Academic Program

The association of Helmut E. Landsberg (1906-1985), world-renowned climatologist, with meteorology at University of Maryland is rather widely known¹. But the origins of the present Department of Atmospheric and Oceanic Science can be traced back to the beginnings of computational fluid dynamics and efforts by Joe Smagorinsky in the 1960s to move NOAA's Geophysical Fluid Dynamics Laboratory to a university campus. Here Professor Alan Faller, who came to the University of Maryland having already done fundamental research on rotating fluids, recounts these early events:

1. The Background.

In the 1950s a group of dynamic meteorologists working at Princeton University under the supervision of mathematician John von Neumann (en.wikipedia.org/wiki/John_von_Neumann) had produced the first large-scale numerical model of the atmosphere using the famous Eniac computer. This group included such notables as Jule Charney, Norman Phillips, George Platzman, George Cressman, and Joseph Smagorinsky. When this unit disbanded in the mid 1950s Charney and Phillips went to M.I.T., Platzman returned to the University of Chicago, and Cressman became Director of the Joint Numerical Weather Prediction (JNWP) unit representing both civilian and military branches of the U.S. Government. Von Neumann brought Joseph Smagorinsky to the University of Maryland where his friend, mathematician Monroe Martin, was the Director of the already renowned Institute for Fluid Dynamics and Applied Mathematics (IFDAM). Von Neumann introduced Smagorinsky with the hope that this Institute would initiate a program of research and development of numerical models of the atmospheric circulation under Smagorinsky's direction.

At that time meteorology was often represented to the public on TV by the reading of very brief and inaccurate forecasts, or so it seemed, and this image helped perpetuate the feeling that meteorology was hardly a science, particularly among most "real scientists". Mathematicians were no exception and Martin, a relatively pure "applied mathematician" could not see a future in mathematical modeling of the atmosphere. So he rejected Smagorinsky who then proceeded to become Director of the Weather Bureau's new Geophysical Fluid Dynamics Laboratory (GFDL, now at Princeton) for the development of extended and long-range prediction models. As Smagorinsky told me years later in private, he was "livid" having been rejected by Martin after being promoted and supported by von Neumann. And years later Martin began to realize his mistake.

In 1963 it became apparent that experimental fluid dynamicist Francis Hama would be leaving IFDAM. So Martin sent Professor Shih I. Pai to a conference at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado to find a replacement for Hama, a conference concerned with applications of fluid dynamics in the geophysical sciences. As it happened I, then a meteorologist/oceanographer at the Woods Hole Oceanographic Institution, was presenting a paper on laboratory studies of the instability of the Ekman boundary layer, and later that spring, apparently at the suggestion of Pai, I was asked to consider a position as an Associate Professor at UMD. I joined IFDAM in the fall of 1963. I also was allowed and encouraged to bring with me Robert Kaylor, a graduate student of meteorology from the University of Chicago who had considerable laboratory and computer experience but who was anxious to leave Chicago. Kaylor was a vital part of my program and of subsequent developments.

2. A Brief Digression to Significant Related Developments.

¹ Landsberg's highly productive career is described in the book, "Climate in Human Perspective", F. Baer, N.L. Canfield, and J.M. Mitchell, ed.s, Kluwer Academic Publishers, 1991

After a few months (February 1964) Martin asked if I would like to invite someone in the general area of dynamic meteorology to give the annual Spring Public Lecture of IFDAM. I immediately contacted Ed Lorenz, whom I knew personally from MIT, and who had just published a remarkable mathematical paper: "Deterministic Non-Periodic Flow" (1963). In preparation I mimeographed 100 copies of this paper for distribution to faculty in the Institute and the Department of Mathematics. There was a modest attendance at the lecture, and Lorenz emphasized the applications of his work to forecasting and to climate modeling, rather than his fundamental mathematical results. That mathematics eventually became the cornerstone of what is now known as "The Theory of Chaos". As a result of his emphasis at the lecture and in part because of Lorenz' droll manner of speaking his paper and his lecture were largely ignored.

Some years later, shortly after he had become an Assistant Professor, James Yorke brought Robert Brammer, a graduate student in mathematics, to me. Brammer was working at NASA on prediction/corrector methods for the flight of spacecraft and thought that he could improve upon meteorological prediction. Lorenz' work on the fundamental limitations of meteorological prediction was the ideal paper to illuminate the new student on the problems of weather prediction. He showed the paper to Jim Yorke, his advisor, who immediately recognized the significance of Lorenz' work and sent copies to several noted mathematicians. In the meantime Yorke and another student had developed a paper titled "Period Three Implies Chaos". Thus the new science, Chaos and Non-linear Dynamics, spread throughout the mathematical community and eventually through all aspects of science and human affairs. Some time later Yorke told me that the Lorenz paper was one of the two most important mathematical papers of that year -- published in the Journal of Atmospheric Sciences of all places. Although I had encouraged Brammer to work on an extension of Lorenz' work, he chose some other topic for his Ph.D. dissertation. However, years later he became the president of a large meteorological consulting firm in Massachusetts and was once one of two candidates nominated for President of the American Meteorological Society.

3. Back to the Origin of a New Program

About a year after I joined IFDAM (Sept., 1964) Monroe Martin told me the story of Smagorinsky and said that his rejection was the greatest mistake that he (Martin) had ever made! And then he asked if I would consider setting up a teaching and research program in meteorology within the Institute. Now, my being selected to join IFDAM, the invitation to Lorenz to speak, and the story of Smagorinsky all began to coalesce. After some considerable thought and trepidation I accepted the challenge. I first designed a syllabus with three general options: dynamical, physical, and chemical studies. Then I set up a set of course requirements for each option, course descriptions and degree requirements, based largely upon what I knew from MIT and other sources. So a proposal was developed and circulated.

4. Opposition

It soon became apparent that there would be opposition: from the Geography Department because it owned the study of climate, and particularly strong opposition from Aerospace Engineering because it owned the study of the whole atmosphere. The school of engineering (in which IFDAM existed at that time) was vigorously opposed to the idea of the Institute setting up another teaching program in competition for students and research funds. The more secure Physics Department, however, then had an option in Upper Atmospheric Physics and was generally in favor of such a proposal. So Monroe Martin, who was well thought of in the university administration, cleverly arranged a "Graduate Committee on Meteorology" consisting of sympathetic Deans and Department heads. Who could oppose such a committee without very substantial reasons?

In 1965-66, to help ameliorate the bad opinions of engineering faculty toward the Institute, George Mackie, a visiting applied mathematician from Scotland, suggested to me that we organize a joint seminar series with other faculty interested in fluid dynamics. We called it "Fluid Dynamic Reviews", a bi-weekly seminar run by a diverse committee of 6, and before long we had over 20 faculty participating from Aerospace, Civil, Mechanical, and Chemical Engineering, Mathematics, the Wind Tunnel, Meteorology, and the Institute, plus students and visitors from the Washington area. Apparently we were successful since it came about that alternate lectures by invited speakers were

supported (travel and an honorarium) by a fund from the College of Engineering. This collaborative seminar series lasted for over 25 years.

5. Acceptance of the New Program.

I wrote a proposal to the National Science Foundation for a grant to help support such a program, and a second proposal to the University Senate for approval of the program and its courses. Obviously major contributions from Monroe Martin were essential, particularly with the budget, the structure of the program within IFDAM, and within the University. Also, by this time Helmut Landsberg of the Weather Bureau was giving occasional lectures in the Institute, and his experience and advice were reflected in Martin's final versions of these proposals.

Amazingly the proposal passed the usually contentious University Senate without any opposition and with hardly a question. Apparently Martin had done an excellent job paving the way and I had written a credible academic program. But toward the end of the same Senate session, some Senators, noting the extraordinarily swift passage of an entire new program, introduced and passed a new resolution which would require much more review of any such program in the future. The National Science Foundation saw the use (and need) for such a program in the Washington area and approved a 3-year grant to help establish the new department.

6. The First Chairman.

At first Martin asked if I would be the Chairman of the new program. I declined since: 1) I felt that I did not have a sufficient reputation in the community of meteorologists to attract a first class faculty. 2) I was not at all interested in administration, and 3) I was secure in my own program of research. At Martin's urging I contacted a number of dynamicists whom I knew would fit in well with IFDAM. Some expressed interest but eventually declined. As examples, the latter included Seymour Hess (FSU), Larry Gates (UCLA), and Jack Nordo (Norway).

In the meantime we had gotten the attention of Helmut Landsberg who agreed to give a series of seminars at the Institute to acquaint our faculty with the broad range of meteorological problems and interests. Impressed with Landsberg's experience and noting that he would soon be retiring from government service. Martin proposed him as the first Chairman of the Graduate Program in Meteorology. This nomination was passed by the IFDAM faculty and by the Graduate Committee on Meteorology, etc. The Graduate Committee continued to be the governing body of the academic program but, in reality, Landsberg took full control and the Committee agreed with all of his decisions. Among the early academic hires (1967) were Kenneth Gage, David Rodenhuis, Annadu Vernekar, and Owen Thompson (who joined in 1968). The new faculty were hired as members of IFDAM, as I was.

[Bob Ellingson was hired in 1972. Sigmund Fritz joined the Graduate Program as a research scientist after retiring from NOAA during Landsberg's tenure as Director and introduced Remote Sensing into the program's curriculum. Additional research scientists including Josh Holland joined the Department during its early years following their retirements and were active in student training. After Landsberg's retirement in 1976, Owen Thompson was appointed Acting Director until the hire in 1977 of Ferd Baer. Rachel Pinker, an early student, joined the faculty in 1976. From its inception through 1977 the Graduate Program faculty never exceeded 7 members and 25-30 students, including part-time students from NASA and NOAA.

Upon the recommendations of an external Review Committee, the level of State supported academic faculty increased dramatically in 1977 with the addition of new academic faculty members: Alan Robock, Rich Pitter, and Ferdinand Baer.]

7. Evolution from the Graduate Program.

In a series of steps the Graduate Program in Meteorology gradually separated from the Institute in terms of budget, space, self-management, and finally (1978) it was renamed the Department of Meteorology. I remained in the Institute although I continued to teach courses, advise students and participate in every way. My reasons for not switching to the new department were: 1) For a long time the Meteorology Program seemed to be on shaky ground. This was due in part to the lack of a large undergraduate student base. On the other hand external research support per faculty member far exceeded any other department of the University. Despite this fact, in 1972 the University Administration seriously considered moving Meteorology to the Eastern Shore campus, which would have resulted in mass resignations and death of the program; and 2) When it came to counting the number of courses taught per faculty member (as did happen) my name could be omitted, but for external publicity it could be included. (A. Faller, Personal Communication, March, 2010)

As stated above, the program separated from the Institute of Physical Science and Technology (IPST –the renamed IFDAM) in 1978 by accepting self management and was renamed the *Department of Meteorology* through the action of the Board of Regents in 1979. At that point Ferd Baer became the first Chair of the Department and Cliff Mass was hired. A new cooperative institute between NOAA and UMD named the Cooperative Institute for Climate Studies (CICS) was established in 1981 through the efforts of Ferd Baer and James Rasmussen of NOAA; Baer was also appointed its first Director. Jay Winston and Bill Klein joined CICS after their retirement in 1980/81. Rich Pitter left the Department in 1979 and was replaced by Russ Dickerson in 1982. Cliff Mass left for the University of Washington in 1981 and was replaced by George Huffman.

By 1982 there were nine full-time academic faculty members and a significant number of research scientists including Huug van den Dool, Jae Schemm, Suru Saha and Muthuvel Cheliah. The first Department External Review in 1982 highlighted a need to expand in the direction of environmental chemistry (early chemistry hires, Gerhard Israel and Rich Pitter, having left) and noted the Department's limited base funding.



Figure 1. Department send-off party for Bob Lutz, October 1982. Standing from left, XX, Ferdinand Baer, David Rodenhuis, Anandu Vernakar, Huug van den Dool, XX, Muthuvel

Cheliah, Peter Ahnert, XX, Gene Norman, Donald Dazlich, John Scialdone, Paul Vongsathorn, Edmund Larsen, Haydee Salmun, Antonio (Ricky) Irving, Marina Zivkovic, Joseph Fiore, Mitchell Goldberg, Jaime Daniels, Hal Bloom, George Huffman, Alan Robock, Caren Klarman, David Kitzmiller, and Robert Ellingson. Seated from left: Jennifer Looper, Ann Schwedfeger, Robert Lutz, Americo (Rico) Allegrino, and Ann Klein. Not present: Owen Thompson, David Unger, Ida Hakkarinen, Louis Corio, Ralph Ferraro, Alan Delman, Francis Agumba, Juan Rivero, David B. Hogan, Thomas Kuscera, Stephan Smith, Jae Schemm, Thomas Piper, and George Serafino. *Source: Dave Kitzmiller.*

In 1983 a further expansion occurred when Jagadish Shukla joined the Department coming from NASA Goddard Space Flight Center, and the University additionally provided two new academic faculty lines. One of these lines was used to develop physical oceanography through the hire of Jim Carton while the other was used to hire Jim Kinter. J. Shukla brought with him a number of research scientists, including Doty, Fennessy, Krishnamurty, Schneider, Sellers², and Straus as part of the new Center for Ocean-Land-Atmosphere (COLA). However, the signing of the formal Memorandum of Understanding for COLA was delayed until 1989, a delay that caused some misunderstandings. By 1986 the Department's academic faculty had grown to twelve (Baer, Carton, Dickerson, Ellingson, Huffman, Kinter, Pinker, Robock, Rodenhuis, Shukla, Thompson, and Vernekar). Research Support grew commensurately from \$192,400 in 1970-71 to \$1,235,547 in 1980-81.

By the time of the second Department External Review in 1988 the Department base support was \$685,701 (\$1,230,000 in 2008 dollars accounting for inflation³) while funding from external grants and contracts had grown to \$3,748,110. At this time the Department had 16 PhD students and 29 MS students and was awarding 1-2 PhDs per year. One of the additional benefits of CICS to the Department was the arrival of Gene Rasmusson upon his retirement as Chief of the Diagnostics Branch of the NOAA Climate Analysis Center. Gene Rasmusson's formidable scientific talent, reputation, and force of will played a critical role in shaping the evolution of the Department during the coming years of rapid change.

²Piers joined the astronaut corps in 1996 and flew on STS-112 Atlantis and STS-121 Discovery

³ Between 1988 and 2010 AOSC state support has remained essentially flat.



Figure 2. Meteorology Department annual party April, 1988. From left: Anandu Vernekar, George Huffman, Bob Kaylor, Winston Luke, Muthuvel Chelliah, Russ Dickerson, George Goldenbaum, Jim Cooper, Caren Grimm, Carlos Nobre, Owen Thompson, Janet Sparacino, William Klein, Bill Ryan, Shirley Simms, David Rodenhuis, Bruce Doddridge, Charlene Mann, Jim Carton, Alan Robock, Marlene, J. Shukla, Huug Van den Dool, Michael Fennessy, Yu-tai Hou, Jim Kinter, Sig Fritz, Larry Marx, Ferdinand Baer, Dan Paolino, Rachel Pinker, Suru Saha, and Dick Derycke. Source: unknown.

During the 1990s the Department again went through substantial changes with the separation of COLA and its personnel. Robert Hudson joined the Department as Chair in the 1990 (replacing George Goldenbaum⁴: (1987-89) and Anandu Vernekar (1989-90)). During the early 1990s the Joint Center for Earth System Science (JCESS) was created by a Memorandum of Understanding with NASA Goddard. JCESS brought a rapid expansion of the Department Research Faculty in the broad areas of earth system science, including air chemistry, oceanography, cryospheric studies, and biogeochemistry. The year 1991 also brought a revision of the graduate curriculum designed to streamline the PhD degree requirements, which substantially reduced the time to degree for MS students. Air chemistry continued to expand with Bruce Doddridge joining Russ Dickerson and Ken Pickering. The early 1990s also brought a shift of the Department location into the new wing of the Computer and Space Sciences building. Hugo Berbery joined the Department in 1992, Dalin Zhang in the fall of 1996 (bringing strength in meso-scale meteorology) and Alan Robock left for Rutgers in 1997 for family reasons.

⁴ Appointed from Physics by then Dean Bob Dorfman. George devoted considerable effort to fill the void during a transition period of search for a new Chair.

Later in the decade JCESS was shifted out of Meteorology into an independent center in our college with affiliations with the Departments of Geology and Geography. After an extended search, Eugenia Kalnay was hired as Chair in 1999 and in the same year Anandu Vernekar retired. Following the arrival of Eugenia Kalnay, a number of new academic faculty joined the Department including Tony Busalacchi (2000), Ning Zeng (2001), and Zhanqing Li (2002). Under Tony Busalacchi's leadership JCESS became the basis for the expanding Earth System Science Interdisciplinary Center (ESSIC) and was soon joined by CICS which shifted from Meteorology to ESSIC in 2001. The shift of CICS was followed by a rapid expansion of its size and scope. ESSIC and CICS moved to their MSquare location in 2008.

The 21st century brought new academic faculty with appointments split between ESSIC and the Department, including Sumant Nigam and Ragu Murtugudde (both of whom had been on the research faculty), and Ross Salawitch, and the retirements of Professors Bob Ellingson⁵ (2002) and Ferd Baer (2002). Dan Kirk-Davidoff joined the Department in 2003 adding to the strength in climate dynamics, and Kayo Ide in late 2007. Russ Dickerson became Chair in 2002, having previously been Acting Chair, and was followed in 2007 by Jim Carton.

By the early 2000s the number of graduate students had increased to around 50 with the number of PhDs awarded increasing to an average of 5/yr and MS degrees awarded ranging from 5-9. The curriculum was again revised in 2002 putting greater emphasis on earth system science. By the mid-2000s the shift toward earth system science was reflected in a change in the name of the Department to the *Department of Atmospheric and Oceanic Science* (AOSC). Under Eugenia Kalnay's leadership AOSC developed an international reputation in the area of data assimilation. The number of PhD degrees granted continues to increase, now averaging around 10-11/yr, with more and more students from adjacent departments such as Chemistry, AMSC, and CHPH, but completing their dissertations with AOSC faculty.

Now in late 2009, we are in the midst of a new succession of changes. We anticipate the arrival of significant components of the National Weather Service onto the MSquare research campus and have created a corresponding professional MS degree program. We expect our core expertise to be broadened by the broadening scientific interests of ESSIC. We are currently developing an undergraduate BS degree program underscoring our growing involvement in undergraduate education. Looking forward 30 years after the department began we surely expect these changes to alter AOSC in new, exciting, and unanticipated ways.

Acknowledgements/Apologies

This history focuses on the academic aspect of the Department and thus provides insufficient information on many of the outstanding research faculty and staff who have found their home in AOSC. Many thanks to Ferd Baer, Alan Faller, Rachel Pinker, Alan

⁵ Bob Ellingson retired from University of Maryland to become Chair of the Meteorology Department at Florida State University.

Robock, Huug Vanden Dool, and Anandu Vernekar for comments/corrections. The mistakes of course are my own. -- JAC

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