The University Senate of Michigan Technological University

PROPOSAL 07-07
(Voting Units: Academic)

PROPOSAL FOR Ph.D. PROGRAM IN ATMOSPHERIC SCIENCES
(HEGIS Code 40.04)

Submitted by the
Atmospheric Sciences Doctoral Planning Group
(Members listed in Table 1)
Contacts: R.E. Honrath (reh@mtu.edu) and R.A. Shaw (rashaw@mtu.edu)
October 3, 2006

There is a large and growing need for scientists and engineers with advanced training in the atmospheric sciences. In particular, there is a recognized need for society to understand and respond to problems related to weather, climate, atmospheric hazards from natural and human sources (local and global pollution, volcanic clouds, etc.), and the hydrological cycle. Powerful new research tools for addressing these problems, such as satellite remote sensors and multi-scale atmospheric computer models, require graduate level training in the atmospheric sciences for their effective use. Furthermore, these research problems and the techniques used to address them are inherently interdisciplinary in nature, and therefore span traditional departmental organizations. Michigan Tech is already a recognized leader in many research areas related to the atmospheric sciences, but our ability to carry out cutting edge research in this area would benefit from greater coherence and broader graduate training. Here, we propose a new doctoral degree program in Atmospheric Sciences, which would consolidate and advance this leadership, would provide a more appropriate degree program for some of our graduate students, and would provide an improved atmospheric sciences program for all students involved in atmospheric studies.

1. Rationale

A growing number of faculty and graduate students at Michigan Tech are working in the area of atmospheric sciences. Active research programs, courses, and a growing number of graduate degrees based on this work already exist. This initiative is to build on this critical mass of effort by developing a new, non-departmental Ph.D. program in the Atmospheric Sciences. The initiative is motivated by the following.

- This program provides a mechanism for recruiting more and better-qualified graduate students, by providing a degree that encompasses the interdisciplinary nature of atmospheric research better than programs within single academic departments. Currently, students must apply to programs in Physics, Environmental Engineering, or Geology. This new program would attract additional Ph.D. students who wish to have broad academic experience in atmospheric chemistry, atmospheric physics, and remote sensing: an uncommon mix in other atmospheric science programs.
- The new program builds on current strengths, with a committed core of seven faculty in three different departments and with several other faculty with expressed interest in participating. Start-up could be virtually instantaneous, and fast startup would accommodate existing students who are interested in entering the program.
- Most of the core graduate-level atmospheric sciences courses are already offered at MTU, and this program would result in organization of these courses into a coherent program.
- The new program would enhance interdisciplinary research at MTU by bringing together graduate students and faculty housed in different departments but conducting related research. The new program is seen as an extension of the successful Remote Sensing Institute, which is committed to the initiative.
- The experience of the core faculty is that research in atmospheric science can be well funded and that the new program could help with efforts to increase external funding.
- The new program responds to a national and international need for more researchers in atmospheric sciences, driven by the importance of weather and climate to human health, economic development, and environmental sustainability.

2. Related programs in the region

There are about 68 atmospheric science graduate programs in the United States (see: Curricula in the atmospheric, oceanic, hydrologic, and related sciences, www.ametsoc.org/amsucar curricula). In the upper Midwest (MI, WI, MN, IL, IN, and OH), there are 8 (Univ. Michigan, Univ. Chicago, UW Madison, UW Milwaukee, Univ. Illinois Champaign-Urbana, Univ. Minnesota, Ohio State, and Purdue Univ.), and in Michigan there is currently only one (through the Department of Atmospheric, Oceanic, and Space Sciences at Univ. Michigan). The character of these atmospheric sciences programs varies markedly: They are housed in Atmospheric Sciences, Geography, Geophysical Sciences, and Mathematics departments, and their research emphasis depends on the faculty mix.

The faculty involved at MTU would make for a rather broad mix, involving atmospheric chemistry, atmospheric aerosols, atmospheric remote sensing, atmospheric turbulence, clouds and the hydrologic cycle. This combination of subject areas is a good basis for global atmospheric change studies and spans the major subdisciplines of the atmospheric sciences. Within the regional programs, the MTU program is quite distinct, and it would complement the existing programs. There would be important opportunities for collaborations within the region, and exchange opportunities for students would be likely. The job opportunities for Ph.D. graduates in atmospheric sciences are good and are expected to remain so as a result of national and international priorities. For example, the website of the American Geophysical Union shows that its atmospheric sciences division is its fastest growing division (also, see the American Geophysical Union's Careers website http://www.agu.org/sci soc/careers.html).

3. Faculty

The primary graduate faculty members for the Atmospheric Sciences Ph.D. program are listed in Table 1. Participating faculty are those who likely would advise Ph.D. students in the program, teach relevant courses, serve on qualifying exam committees, etc. The faculty come from the Department of Civil and Environmental Engineering, the Department of Geological and Mining Engineering and Sciences, and the Department of Physics. We anticipate that a coherent program in the atmospheric sciences will help to attract future faculty with expertise in this area and that this will be an important contribution to the research stature of Michigan Tech. (Such new faculty could be hired into the departments listed in Table 1 or other departments, such as Chemistry.) Statistically, new faculty in the atmospheric sciences are likely to bring in more external funding than the university typically spends on a new position (see “External funding of atmospheric science programs in the

United States: More than the cost of a new professor,” by A. Robock, Bull. Amer. Meteor. Soc., March 2005). However, the proposed new Ph.D. program does not require the hiring of new faculty for its success.The Atmospheric Sciences program is interdisciplinary and inclusive, and therefore is open to faculty and students with overlapping research and academic interests. MTU faculty affiliated with the Atmospheric Science program are S. Green (Chemistry), D. Karnosky (Forest Res. & Env. Sci.), L. B. King (Mech. Eng. – Eng. Mech.), K. Paterson (Civ. & Env. Eng.), and M. C. Roggemann (Elec. & Comp. Eng.). These faculty carry out research that can benefit from the presence of a more coherent effort in the atmospheric sciences and have students who will benefit from the new course offerings and educational activities resulting from the program.

4. Program Requirements and Coursework

Course requirements are designed to ensure that all students have a firm understanding of the fundamentals of atmospheric science, including the principles underlying atmospheric structure, atmospheric dynamics, and atmospheric chemistry. These principles will be covered in three core courses. In addition, each student will take at least two additional courses to obtain additional depth and/or breadth.

The set of core courses may be taken in any order and will be offered at least biannually. This ensures that students will be able to complete the core courses and be prepared to take the Comprehensive Examination by the end of their second year.

Table 1: Primary Graduate Faculty Members

Name	Department	Related Research Interests	Current Related Ph.D. Students	Current Related Research Funding ($k/year)	Related Papers, Past 5 Years
Gregg Bluth	Geo. Eng. & Sci.	Volcanic clouds; atmospheric remote sensing	2	700	15
Will Cantrell	Physics	Heterogeneous ice nucleation; aerosol physics	1.5	180	13
Richard Honrath	Civ. & Env. Eng.	Atmospheric chemistry	3	333	21
Alex Kostinski	Physics	Atmospheric physics	1	100	17
Judith Perlinger	Civ. & Env. Eng.	Atmospheric boundary-layer fluxes	2	125	4
Bill Rose	Geo. Eng. & Sci.	Volcanic clouds; atmospheric remote sensing	5	250	25
Raymond Shaw	Physics	Cloud physics and atmospheric turbulence	2	240	11

4.1 Required (Core) Courses

The core curriculum for the Atmospheric Sciences doctoral program will consist of three courses covering fundamentals of atmospheric sciences, a seminar course, a special topics course, and doctoral research credits. The three core courses will be developed from two existing courses: CE 5515: Atmospheric Chemistry, and PH 4640: Introduction to Atmospheric Physics. The latter will be expanded into two graduate-level courses, one of which will provide the necessary background in atmospheric fluid dynamics. The Department of Physics has agreed to create this new course with support from the Remote Sensing Institute.

ATM5640/PH5640 Atmospheric Physics

Thermodynamics of the atmosphere: adiabatic processes (including lapse rate and potential temperature), phase transformations, relative humidity, stratification; radiation in the atmosphere: Blackbody radiation, Beer’s law, Radiative transfer equations with and without scattering; and cloud microphysics: homogeneous nucleation, K¨ohler theory, growth by condensation, growth by collection. *Credits*: 3.0 (3-0-0). *Prerequisites*: MA3530 and PH2300 (or equivalent courses). *Semesters Offered*: Fall (even-numbered years).

ATM5680/PH5680 Atmospheric Fluid Dynamics

Fundamental forces and conservation laws that govern fluid flow; applications to the atmosphere, including balanced flow (pressure gradient and Coriolis force), vorticity dynamics, turbulence, waves, and boundary layers. *Credits*: 3.0 (3-0-0). *Prerequisites*: MA3530 and PH2300 (or equivalent courses). *Semesters Offered*: Fall (odd-numbered years).

ATM5515/CE5515/CH5515 Atmospheric Chemistry

Study of the photochemical processes governing the composition of the troposphere and stratosphere, with application to air pollution and climate change. Covers radical chain reaction cycles, heterogeneous chemistry, atmospheric radiative transfer, and measurement techniques for atmospheric gases. *Credits*: 3.0 (3-0-0). *Prerequisites*: Graduate standing and CE4501 or CH3520. *Semesters Offered*: Spring.

ATM5100 Atmospheric Sciences Journal and Seminar Club

A weekly discussion of recent literature in the atmospheric sciences. Often coordinated with atmosphere-related seminars in the Remote Sensing seminar series. All Atmospheric Sciences doctoral students are required to register each year. *Credits*: 1.0. *Prerequisites*: ATM5515 or ATM5640 or ATM5680. *Semesters Offered*: Spring.

ATM5200 Special Topics in Atmospheric Sciences

Advanced study of topics in the atmospheric sciences. The subject matter may vary from term to term depending on the needs of students. *Credits*: variable to 3.0. May be repeated. *Restrictions*: Must be enrolled in one of the following Level(s): Graduate.

Semesters Offered: Fall, Spring, Summer.

ATM6999 Doctoral Research

Independent research conducted in partial fulfillment of the requirements for the PhD degree. Scheduled by arrangement. *Credits*: variable to 12.0. May be repeated; Graded Pass/Fail Only *Restrictions*: Permission of instructor and department required; Must be enrolled in one of the following Level(s): Graduate. *Semesters Offered*: Fall, Spring, Summer.

4.2 Additional Courses

Students will select at least two of the following courses, to be approved by the doctoral Advisory Committee.

CE4501 Environmental Engineering Chemical Processes

Application of chemistry, conservation principles, and mathematics to the analysis of chemical processes occurring in natural and engineered environments. Topics include acid-base phenomena, the carbonate system, precipitation/dissolution, redox chemistry, diffusion, mass transfer, and applications to engineering design. Laboratory experiences illustrate principles and modern measurement. Credits: 4.0 Lec-Rec-Lab: (0-3-3) Semesters Offered: Fall Pre-Requisite(s): (CE3501 or CE3503) and CE3502 and CH3500(C)

CE4504 Air Quality Engineering and Science

Overview of air quality regulation in the U.S. and world: basic concepts of atmospheric chemistry and transport: fugitive, point, and area emissions: principles and tradeoffs of operation and design of air pollution control systems: and, application of air quality models. Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered: Fall Pre-Requisite(s): CE3501 or CE3503

CE5512: Applied Boundary Layer Meteorology

Study of how forcing phenomena affect transport of water and chemicals in the atmospheric boundary layer and how this transport is measured in the field, including relevant aspects of fluid dynamics, boundary layer structure, surface energy balance, and flux measurement. Credits: 3.0 Lec-Rec-Lab: (2-1-0) Semesters Offered: Fall - Offered alternate years beginning with the 2006-2007 academic year Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

CE5560: Advanced Topics in Air Quality Engineering

Advanced study of topics related to atmospheric chemistry and/or modeling the transformation and transport of atmospheric pollutants. Credits: variable to 4.0; Repeatable to a Max of 8 Semesters Offered: Fall, Spring, Summer Restrictions: Permission of instructor required

EE5540: Statistical Optics

Study of the effects of randomness in optical systems. Covers coherence theory, photon statistics, wave propagation, and imaging through random media. Presents analytic and computational approaches. Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered: Spring Restrictions: Must be enrolled in one of the following Level(s): Graduate; Credits: 3.0

GE4250 Fundamentals of Remote Sensing

This course focuses on the basic physics behind above-surface remote sensing and remote sensing systems. Topics covered include: properties of the atmosphere, absorption and scattering of electromagentic radiation, instrument design, data acquisition and processing, validation, and basic applications. Credits 3.0 (2-1-0). Semesters Offered: Spring. Prerequisites: PH 2200 and (MA2150 or MA2160).

GE5140 Paleoclimatology

This course will investigate the geologic evidence of global climate and the mechanisms that are interpreted to produce climate change. Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered: On Demand

GE5270 Volcanic Clouds

Synthesis of recent advancements in volcanic cloud research along with theoretical background and practical experience in the study, understanding and remote sensing of volcanic clouds. Techniques covered are also applicable to other atmospheric phenomena although volcanic ash, gas and aerosol remote sensing is the main focus. Credits: 4.0, Repeatable to a max of 8; Graded Pass/Fail only Lec-Rec-Lab: (2-0-6) Semesters Offered: On Demand Restrictions: May not be enrolled in one of the following Class(es): Freshman, Junior, Sophomore

GE5800 Mathematical Modeling of Earth Systems

Introduction to numerical techniques for mathematical modeling of various earthsystem phenomena, including groundwater flow, heat transfer, and atmospheric transport. Numerical techniques covered include finite-difference, finite-element, collocation, and characteristic methods. Students write their own mathematical models. Prerequisite: experience in programming computer languages such as FORTRAN. Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered: On Demand Restrictions: Must be enrolled in one of the following Level(s): Graduate

GE5990 Special Topics (Plasma Dynamics)

Introduction to the dynamics of plasma (an electrically conducting gas). Covers simultaneous solution of the Navier-Stokes fluid equations along with the laws of electromagnetics. The course reviews basic electromagnetics and the motion of charged particles in fields. The conservation laws for plasmas are developed both from a fluid standpoint and a kinetic description. Wave motion, diffusion, and resistivity are presented for plasma systems. Both laboratory and astrophysical manifestations of plasma behavior are discussed. Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered: On demand.

PH5320: Mathematical Physics

Partial differential equations of physics, separation of variables, boundary value problems, Sturm-Liouville theory, Legendre and Bessel functions, inhomogeneous partial differential equations, Green's functions. Fourier series, Fourier and Laplace transforms, complex variables, evaluation of integrals by contour integration, linear algebra, matrix methods with emphasis on numerical applications. Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered: Fall. Restrictions: Must be enrolled in one of the following Level(s): Graduate

PH5090: Selected Topics in Physics

The subject matter may vary from term to term and year to year depending on the needs of advanced students. Credits: 3.0 Lec-Rec-Lab: (2-0-0) Semesters Offered: On Demand Restrictions: Must be enrolled in one of the following Level(s): Graduate

4.3. Potential Future Additional Courses

These courses are not necessary for the program to function, but may be added based on the desires and avaiability of affiliated faculty members.

- **Laboratory in Atmospheric Measurement Techniques**
- **Mathematical Modeling of Atmospheric Transport and Chemistry**
- **Physics of Clouds and Aerosols**
- **Radar Meteorology**
- **Radiative Transfer**
- **Satellite Remote Sensing of the Atmosphere**

4.4 Qualifying (Comprehensive) Examination

Each student must pass the Comprehensive Examination. This examination will cover the topics covered in the core courses ATM 5515, ATM 5640, and ATM 5680. It will be given (when requested) in the fall semester of each year. Each student who intends to sit for the Qualifying Examination must declare that intention by the end of the second week of classes in the term the exam is to be taken. Each examination will be administered by a committee of four faculty members who will decide whether or not each student passes; a student will pass if at least three committee members vote pass. Passing the Comprehensive Examination elevates the student to the status of Doctoral Candidate. After the examination has been taken and graded, the student and the student's Advisory Committee will meet to orally review the exam. Students who do not pass the Qualifying Examination will be allowed a second attempt. Students who do not pass the exam on the second attempt are dropped from the program and may apply to a suitable M.S. program (e.g., within their home department).

4.5 Preliminary Examination (Research Proposal Defense)

This is a written and oral description and defense of the research plan made by the student to his/her Advisory Committee. The proposal should be made within one year of achieving Doctoral Candidacy. The student's advisory committee must unanimously agree that the research plan is acceptable. The Chairperson will be notified of the outcome of the Dissertation Proposal. The oral proposal is open to the University community.

4.6 Doctoral Dissertation and Final Oral Examination

The research conducted by the student will be presented to the Advisory Committee as a written dissertation. An oral presentation of that dissertation will be made following the completion of the written work. The dissertation is acceptable if the advisor and at least three of the remaining four members of the Advisory Committee concur on its acceptance. The oral defense is open to the University community.

5 Organizational Structure and Administration

The Atmospheric Sciences Ph.D. program, as an interdisciplinary, cross-department program, will be administered through the Graduate School with assistance from the MTU Remote Sensing Institute (RSI). (All faculty listed in Table 1 are members of RSI.) Participating faculty will form a steering committee, which will include at least one member from each participating department. The committee will elect a program director who will serve as the point of contact with the Dean of the Graduate School and the RSI director, and will be assisted by the RSI staff member as needed. Most atmospheric science research grants at MTU are affiliated with RSI and overhead return through RSI will provide base funding for the program administration provided by the RSI staff member.

Selection of students and administration of the academic program will be handled by the participating faculty. The home departments of the core courses are committed to offering them on a regular basis. Students enrolled in the program will be housed within the home department of their advisors: the home department will provide office space, computational resources, and necessary supplies and infrastructure, and will consider the students for departmental teaching assistantships when appropriate and available. All such students will be counted as members of their home departments for the purposes of internal university accounting. (Note that students entering the program without having chosen an advisor will be given a home department and initial advisor based on their background and interests.) Lastly, student tuition for the program will not include the Engineering Tuition Differential because the PhD in Atmospheric Sciences is not an engineering degree.

6. Items Required by University Senate Proposal 38-04: Formats for Proposing New Academic Programs

Following is a list of the University Senate requirements for new graduate degree programs, with relevant details for the Atmospheric Sciences doctoral program:

1. **General description and characteristics of program.**
   See Section 4.

2. **Rationale.**
   See Section 1.

3. **Discussion of related programs within the institution and at other institutions.**
   See Section 2.

4. **Projected enrollment.**
   We anticipate that two students will enter the program immediately, and that within five years the program will have between five and ten

students.

5. **Scheduling plans.**
   Participating departments have committed to offer core courses on a regular basis.

6. **Curriculum design.**
   See Section 4.

7. **New course descriptions.**
   Course descriptions are provided in Section 4. ATM/PH5640 will be modified from the existing PH4640. ATM5680, ATM5100, ATM5200, and ATM6999 will be added. All other courses are existing.

8. **Library and other learning resources.**
   The program builds on existing resources, so it is not anticipated that new library or other learning resources will be required.

9. **Computing Access Fee.**
   Initially each student will pay the Computing Access Fee appropriate to the advisor's home department. Eventually the program may have its own fee, negotiated with the participating departments.

10. **Faculty resumes.**
    See attached.

11. **Description of available/needed equipment.**
    The research groups of the faculty members listed in Table 1 use extensive laboratory and computing research equipment. This equipment already exists. No new equipment is required for the startup of this program.

12. **Program costs.**
    No new resources are requested, and costs associated with recruiting and other program administration will be handled through RSI, as discussed earlier in this Section.

13. **Space.**
    No new space is required.

14. **Policies, regulations and rules.**
    See Section 4.

15. **Accreditation requirements.**
    Not applicable.

16. **Internal status of the proposal.**
    Approved by Department Chairs, Dean of Engineering, and Dean of Sciences and Arts (see attached signature sheet). Review by the Graduate Faculty Council is pending as of August 2006.

17. **Planned implementation date.**
    Because there are students currently attending MTU who are interested in the Atmospheric Sciences PhD program we are aiming for implementation by Spring Semester 2007.

Gregg J.S. Bluth
Associate Professor, Department of Geological Engineering and Sciences
Michigan Technological University

PROFESSIONAL PREPARATION
University of California, Berkeley (A.B. Geology, 1984)
Pennsylvania State University (M.S. Geochemistry, 1987)
Pennsylvania State University (Ph.D. Geocehmisry, 1990)

APPOINTMENTS
2004 - present, *Director*, Remote Sensing Institute, Michigan Technological University (MTU)
1998 - present, *Associate Professor*, Dept. of Geological Eng. and Sciences, MTU
1998, *NASA Summer Faculty Research Fellow*, NASA/Goddard Space Flight Center (GSFC)
1994-1997, *Research Professor*, MTU
1993-1994, *Assistant Research Scientist*, Geology Dept., University of Maryland
1990-1993, *Research Scientist*, Universities Space Research Association, GSFC

PUBLICATIONS
(i)Bluth, G.J.S. and W.I. Rose (2002) Collaborative studies target volcanic hazards in Central America. *Eos Trans. AGU*, **83**, 429, 434, 435.

Bluth, G.J.S. and W.I. Rose (2004) Observations of eruptive activity at Santiaguito Volcano, Guatemala. *J. Volc. Geotherm. Res.,* **136**, 297-302.

Bluth, G.J.S., W.I. Rose, I.E. Sprod, and A.J. Krueger (1997) Stratospheric loading from explosive volcanic eruptions. *J. Geol.,* **105**, 671-683.

Guffanti, M., J.W. Ewert, G.M. Gallina, G.J.S. Bluth, and G.L. Swanson (2005, in press) The volcanic-ash hazard to aviation during the 2003-2004 eruption of Anatahan Volcano, Commonwealth of the Northern Mariana Islands. *J. Volc. Geotherm. Res.*, Special Issue.

Wallace, P., S. Carn, W. Rose, T. Gerlach and G. Bluth (2003) Integrating petrologic and remote sensing perspectives on magmatic volatiles and volcanic degassing. *Eos Trans. AGU*, **84**, 441-456.

(ii) Carn, S.A. and G.J.S. Bluth (2003) Prodigious sulfur dioxide emissions from Nyamuragira volcano, D.R. Congo. *Geophys. Res. Lett.,* 30, 2211-2216.

Huntoon, J.E., G.J.S. Bluth, and W.A. Kennedy (2001) Measuring the effects of a researchbased field experience on undergraduates and K-12 teachers. *J. Geol. Ed.,* **49**, 235-248.

Rodriguez, L.A., I.M. Watson, W.I. Rose, Y.K. Branan, G.J.S. Bluth, G. Chigna, O. Matias, D. Escobar, S.A. Carn, and T.P. Fischer (2004) SO2 emissions to the atmosphere from active volcanoes in Guatemala and El Salvador, 1999-2002. *J. Volc. Geotherm. Res.,* 138, 325-344.

Sahetapy-Engel, S.T.M., L.P. Flynn, A.J.L. Harris, G.J. Bluth, W.I. Rose, and O. Matías (2004) Surface temperature and spectral measurements at Santiaguito lava dome, Guatemala. *Geophys. Res. Lett.*, 31, doi: 10.1029/2004GL020683.

Watson, I.M., V.J. Realmuto, W.I. Rose, A.J. Prata, G.J.S. Bluth, Y. Gu, C.E. Bader, and T. Yu (2004) Thermal infrared remote sensing of volcanic emissions using the Moderate Resolution Imaging Spectroradiometer (MODIS). *J. Volc. Geotherm. Res.,* 135, 75-89.

SYNERGISTIC ACTIVITIES

- Director, MTU Remote Sensing Institute (2004 – present). The Institute is comprised of approximately 30 faculty in eight departments throughout the campus, focusing on research and education in remote sensing. The Institute generates its own funds through research activity and supports a seminar series, and graduate student and junior faculty support.
- Development of a Master's International (Peace Corps) program in Natural Hazards in Latin America (2003-present, with W. Rose). This has attracted top quality, highly diverse, dedicated, and intellectually stimulating group of students from all over the country to our campus, and is opening new research and outreach opportunities in Latin America.
- Team member, NASA's TOMS Science Team (2001-present); Earth Observing System Volcanology team (1995-1999). PI on NASA project to validate and enhance TOMS ultraviolet volcanic retrievals using infrared data from MODIS and AVHRR (2001-present).
- Outreach in volcanic hazard studies in Guatemala (2001-present), focusing on remote sensing evaluation of volcanic activity and development of GIS layers of lava and debris flows, and sediment migration. We have maintained ongoing collaboration with Guatemalan hazard agencies (INSIVUMEH and CONRED) to study and monitor volcanic hazards.
- Co-PI and co-developer of an introductory field course in Utah (1999-present), bringing fundamental geosciences to a highly diverse, nationwide set of participants. PI on several supporting grants which provided scholarship support to underrepresented minorities, preservice education majors, and secondary school teachers.

COLLABORATORS AND OTHER AFFILIATIONS

Collaborators Outside of Michigan Tech: Carn, S. (UM Baltimore Co.); Chigna, G. (INSIVUMEH); Ewert, J. (USGS); Flynn, L. (U Hawaii); Gallina, G.M. (NOAA); Gerlach, T. (USGS); Gu, Y. (McGill); Guffanti, M. (USGS); Guo, S. (McGill); Harris, A. (U Hawaii); Matías, O. (INSIVUMEH); Prata, A.J. (CSIRO, Australia); Realmuto, V.J. (JPL); Stix, J. (McGill Univ.); Swanson, G. (NOAA); Tupper, A. (Bureau Met., Australia); Vallance, J.W. (USGS); P. Wallace (U Oregon); Watson, M. (Bristol U)

Graduate and Postdoctoral Advisors

-M.S.: Dr. Hiroshi Ohmoto, Pennsylvania State University

-Ph.D.: Dr. Lee R. Kump, Pennsylvania State University

Thesis Advisor and Post-Graduate Sponsor, last 5 years

Current: *Elisabet M. Head* (M.S. Geology); *Marika P. Dalton* (M.S. Geology); *Samantha L. Reif* (Ph.D. Geology); *Jeremy M. Shannon* (Ph.D. Geology); *Armeda VanDam* (M.S. Geology).

Graduated: *Emily B. McCarthy* (M.S. Geology, 2004); *Yingxin Gu* (Ph.D Geology, 2004, coadvise, McGill University); *Song Guo* (Ph.D. Geology, 2003, co-advise, McGill University); *Sue Ellen Bunzendahl* (M.S. Environmental Engineering, 2003, co-advise, Houghton County School District); *Colleen M. Riley* (Ph.D. Geology, 2002, co-advise, Northwestern University; *Richard R. Cookman* (M.S. Geology, 2000, UP Engineers, Marquette, MI);

Post-graduate: *I. Matthew Watson* (2001-2004, MTU)

Total supervised: 1 post-doc, 5 Ph.D., 9 M.S.

Will Hart Cantrell II
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Education

University of Alaska Fairbanks
Ph.D., Atmospheric Science, 1999
Thesis : “Relationship between the aerosol number distribution and the cloud condensation nuclei supersaturation spectrum”

Washington University in St. Louis
B.A., major in Physics, 1993

Positions

- Assistant Professor of Physics, September 2001 - present
  Michigan Technological University
  Houghton MI 49931
- Postdoctoral Fellow, June 1999 - August 2001

Indiana University
Department of Chemistry
Bloomington IN 47405

- Graduate Researchand Teaching Assistant, September 1993 - May 1999
  University of Alaska Fairbanks
  Geophysical Institute
  Fairbanks AK 99775

Honors and Awards

Finalist for Teacher of the Year Award (Asst. Prof./Lecturer), 2003
Selected to attend the Early Career Scientist Assembly (ECSA) at the National Center for Atmospheric Research, 2003
Selected to attend Atmospheric Chemistry Colloquium for Emerging Senior Scientists, 2001

Research Interests

- Heterogeneous nucleation of ice
- Physics and chemistry of thin films
- Spatial correlations among aerosol particles and their effect on cloud processes

Publications

Cantrell, W. and C. Robinson. Heterogeneous freezing of ammonium sulfate and sodium chloride solutions by long chain alcohols. *Geophys. Res. Lett.*, in press, 2005.

Ochshorn, E. and W. Cantrell. Towards understanding ice nucleation by long chain alcohols, *J. Chem Phys.*, in press, 2005.

Cantrell, W. and A. Heymsfield. Ice production in tropospheric clouds. *Bull. Am. Meteorol. Soc.*, **86**, 795-807, 2005.

Gochis, D., A. Barros, A. Gettelman, J. Wang, J. Braun, W. Cantrell, Y. Chen, A. Clement, N. Fox, B. Geerts, W, Han, M. Herzog, P. Kucera, R. Kursinski, A. Laing, C. Liu, E. Maloney, S. Margulis, D. Schultz, S. Sherwood, A. Sobel, H. Vömel, and Z. Wang. Meeting summary of UCAR/NCAR junior faculty forum on future scientific directions: The water cycle across scales working group. *Bull. Am. Meteorol. Soc.*, in press, 2005.

Larsen, M., W. Cantrell, J. Kannosto, and A. Kostinski. Detection of correlations among aerosol particles. *Aerosol Sci. Technol.*, **37**, 476-485, 2003.

Larsen, M., W. Cantrell, A. Kostinski, and J. Kannosto. Response from authors to comment on “Detection of correlations among aerosol particles.” *Aerosol Sci. Technol.*, **38**, 129-130, 2004.

Ewing, George E., Michelle C. Foster, Will Cantrell, and Vlad Sadtchenko. Thin film water on insulator surfaces, In Water in Confining Geometries, Eds. J.Paul Devlin and Victoria Buch (Springer-Verlag, New York), pgs. 179 -212, 2003.

Dusek, U., D. Covert, A. Wiedensohler, C. Neusüss, D. Weise, and W Cantrell. Cloud condensation nuclei spectra derived from size distributions and hygroscopic properties of the aerosol in coastal south-west Portugal during ACE-2. *Tellus B,* **55**, 35-53, 2003, doi: 10.1034/j.1600-0889.2003.00041.x

Cantrell, W., C. McCrory, and G. Ewing. Nucleated deliquescence of salt. *J. Chem. Phys.*,**116**, 2116-2120, 2002.

Cantrell, W. and G. Ewing. Attenuated (but not Total) Internal Reflection FTIR spectroscopy of thin films. *Applied Spectroscopy*, **56**, 665-669, 2002.

Cantrell, W., G. Shaw, G. Cass, Z. Chowdhury, L. Hughes, K. Prather, S. Guazzotti, and K. Coffee. Closure between aerosol particles and cloud condensation nuclei at Kaashidhoo Climate Observatory. *J. Geophys. Res.*, **106**, 28711-28718, 2001.

Cantrell, W., and G. Ewing. Thin film water on muscovite mica. *J. Phys. Chem. B*, **105**, 5435- 5439, 2001.

Cantrell, W. and C. Cooper, "Why don’t clouds fall out of the sky?," The PUMAS Collection, http://pumas.jpl.nasa.gov, 2001.

Cantrell, W., G. Shaw, C. Leck, L. Granat, and H. Cachier, Relationships between cloud condensation nuclei spectra and aerosol particles on a south-north transect of the Indian Ocean. *J. Geophys. Res.*, **105**, 15313-15320, 2000.

Cantrell, W., G. Shaw, and R. Benner. Cloud properties inferred from bimodal distributions. *J. Geophys. Res.*, **104**, 27615-27624, 1999.

Cantrell, W., G. Shaw, R. Benner, D. Veazey. Evidence for sulfuric acid coated particles in the Arctic air mass. *Geophys. Res. Lett.*, **24**, 3005-3008, 1997.

Ramanthan, V. + 39 others including W. Cantrell, Indian Ocean Experiment: An integrated analysis of the climate forcing and effects of the great Indo-Asian haze, *J. Geophys. Res.*, **106**, 28371-28398, 2001.

Ji, Q., G. Shaw, and W. Cantrell. A new instrument for measuring cloud condensation nuclei: Cloud Condensation Nucleus “Remover”. *J. Geophys. Res.*, **103**, 28013-28019, 1998.

Shaw, G.E., R.L. Benner, W. Cantrell, and A.D. Clarke. The regulation of climate: A sulfate particle feedback loop involving deep convection - An editorial essay. *Climatic Change,* **39***,* 23-33, 1998.

Wiedensohler, A., D. Orsini, D. Covert, D. Coffman, W. Cantrell, M. Havlicek, F. Brechtel, L. Russell, R. Weber, J. Gras, J. Hudson, M. Litchy. Intercomparison study of the size dependent counting efficiency of 26 condensation particle counters. *Aerosol Sci. Technol.*, **27**, 224-242, 1997.

Professional Memberships

American Chemical Society
American Geophysical Union

Member of the National Center for Atmospheric Research's Ice Initiative Steering Committee.

Reviewed for National Science Foundation, Department of Energy, Petroleum Research Fund, CGRP, *Journal of the Atmospheric Sciences*, *Atmospheric Environment, Journal of Geophysical Research – Atmospheres, Journal of the Optical Society of America*, and *Quarterly Journal*

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Professional Preparation

B.S., with honors	1984	California Institute of Technology (Engineering and Applied Science)
M.S.	1985	Carnegie Mellon University (Civil Engineering)
Ph.D.	1991	University of Alaska Fairbanks (Atmospheric Chemistry)
Postdoctoral Res. Assoc.	1991–1992	Geophys. Inst./Chemistry, Univ. Alaska (Atmospheric Chemistry)

Appointments

2003–present	Professor, Dept. of Civil & Environ. Engg., Michigan Technological Univ.
1998–2003	Assoc. Prof., Dept. of Civil & Environ. Engg., Michigan Technological Univ.
1992–1998	Assist. Prof., Dept. of Civil & Environ. Engg., Michigan Technological Univ.
1985–1987	Air Quality Engineer, Radian Corporation, Sacramento, California

Five Related Publications (reprints posted at http://www.cee.mtu.edu/~reh/)

R. C. Owen, O. Cooper, A. Stohl, and R. E. Honrath, An analysis of transport mechanisms of North American emissions to the central North Atlantic, J. Geophys. Res., submitted January 2006.

K. Lapina, R. E. Honrath, R. C. Owen and M. Val Mart´ın, Evidence of significant impact of large-scale boreal fires on tropospheric ozone levels in the midlatitude Northern Hemisphere, Geophys. Res. Lett., submitted January 2006.

R. E. Honrath, R. C. Owen, M. Val Mart´ın, J. S. Reid, K. Lapina, P. Fialho, M. P. Dziobak, J. Kleissl, and D. L. Westphal, Regional and hemispheric impacts of anthropogenic and biomass burning emissions on summertime CO and O3 in the North Atlantic lower free troposphere, J. Geophys. Res., 109, D24310, doi:10.1029/2004JD005147, 2004.

A. J. Hamlin and R. E. Honrath, A modeling study of the impact of winter–spring arctic outflow on the NOx and O3 budgets of the North Atlantic troposphere, J. Geophys. Res., 107, 10.1029/2001JD000453, 2002.

M. C. Peterson, R. E. Honrath, D. D. Parrish, and S. J. Oltmans. Measurements of nitrogen oxides and a simple model of NOy fate in the remote North Atlantic marine atmosphere. J. Geophys. Res., 103, 13,489–13,503, 1998.

Five Additional publications (reprints posted at http://www.cee.mtu.edu/_reh/)

J. Kleissl and R. E. Honrath, Analysis and application of Sheppard's airflow model to predict mechanical orographic lifting and the occurrence of mountain clouds, J. Appl. Met., submitted September 2005.

J. Yang, R. E. Honrath, M. C. Peterson, J. E. Dibb, A. L. Sumner, P. B. Shepson, M. Frey, H.-W. Jacobi, A. Swanson and N. Blake, Impacts of snowpack emissions on deduced levels of OH and peroxy radicals at Summit, Greenland, Atmos. Environ., 36, 2523–2534, 2002.

J. Yang, R. E. Honrath, M. C. Peterson, D. D. Parrish, and M.Warshawsky. Photostationary state deviationestimated peroxy radicals and their implications for HOx and ozone photochemistry at a remote northern Atlantic coastal site. J. Geophys. Res., 109, doi:10.1029/2003JD003983, 2004.

R. E. Honrath, S. Guo, M. C. Peterson, M. P. Dziobak, J. E. Dibb, and M. Arsenault. Photochemical production of gas-phase NOx from sunlight irradiation of ice-crystal NO−3 , J. Geophys. Res., 105, 24,183-24,190, 2000.

M. C. Peterson and R. E. Honrath, NOx and NOy over the northwestern North Atlantic: Measurements and measurement accuracy, J. Geophys. Res., 104, 11,695-11,707, 1999.

Synergistic Activities

- Worked and working to develop atmospheric chemistry infrastructure in the Azores for use by the international atmospheric chemistry community and to assist in the development of Portuguese atmospheric scientists: assisted Prof. Paulo Fialho (Univ. of the Azores, Dept. of Agric. Sci.) in the development of his measurement system and papers presenting results from that work; working to develop international funding for and use of a permanent GAW station to replace the PICO-NARE station.

- Pursued activities to enhance the incorporation of atmospheric science and air quality science in middle school and high school curricula:

    - Co-instructor, Weather & Atmosphere: Meeting the Benchmarks, Western Upper Peninsula Center for Science, Mathematics, and Environmental Education course for high school and middle school teachers, February 15, 2002.
    - Lectures on air quality and the greenhouse effect to Houghton Middle School science classes, 2004.
    - Curriculum Reviewer, Clean Michigan Environmental Education Initiative Air Quality lesson plans (a set of lesson plans for implementation in Michigan middle schools and high schools), 2005.

- Coauthored undergraduate environmental engineering textbook based on team-taught Michigan Tech course that applies knowledge from basic science and math courses to environmental engineering and science: in Fundamentals of Environmental Engineering, J. R. Mihelcic (ed.), John Wiley & Sons, Inc., New York, 1998: Chapter 4, "Physical Processes" (R. E. Honrath and J. R. Mihelcic), pp. 139–207; Chapter 2, "Units of Concentration" J. R. Mihelcic, R. E. Honrath, and N. R. Urban, pp. 11–41.

- Served as one of eight panel members in the World Meteorological Organization Global Atmosphere Watch Consultation of Experts on CO Instrumentation for Remote GAW Sites, Geneva, Switzerland, 8-10 September, 1999.

Collaborators and Other Affiliations

- **Collaborators and co-editors: M. Albert** CRREL; **M. Arsenault**, Univ. New Hampshire; **R. C. Bales** Univ. Arizona; **F. Barata**, Univ. Azores; **H. Beine** CNR-IIA ; **S. Bertman** Western Michigan University; **N. Blake** Univ. Arizona; **H. Boudries** MSC (Canada); **J. Bottenheim** MSC (Canada); **B. Cambpell** unknown; **O. Cooper** NOAA AL; **Nic Cullen** unknown; **J. E. Dibb** Univ. New Hampshire; **F. Domin´e** CNRS, Grenoble; **M. Dziobak**, Michigan Tech; **P. Fialho** University of the Azores Portugal; **Kevin Ford** unknown; **M. Frey** Univ. Arizona; **J. Fuentes**, Univ. Virginia; **A. Grannas** unknown; **S. Green**, Michigan Tech; **C. Guimbaud** unknown; **D. Helmig** University of Colorado; **A. D. A. Hansen**, Magee Scientific; **D. Henriques**,

Portuguese Met. Inst.; **H.-W. Jacobi** Alfred Wegener Institute; **M. King** unknown (U.K.); **J. Merrill**, Univ. Rhode Island; **D. Parrish** NOAA AL; J. Reid NRL Monterey; P. Shepson Purdue Univ.; W. Simpson Univ. Alaska Fairbanks.; **K. Steffen** Univ. Colorado; **A. Stohl** NILU; **A. L. Sumner** UC-Irvine; **A. Swanson** unknown; **D. Tanner** Univ. Colorado; **K. Steffen** University of Colorado. **B. Vieira**, Univ. Azores; **M. Warshawsky** unknown; **D. Westphal** NRL Monterey; **X. Zhou**, Wadsworth Center.

- **Graduate and postdoctoral advisors** M.S. advisor: **Cliff Davidson** Carnegie Mellon University. Ph.D. advisor: **Dan Jaffe** University of Washington (Bothel).

- **Thesis advisor** (total advised 10 M.S., 5 Ph.D.): **M. Val Mart´ın** (current, Ph.D.); **R. C. Owen** (Ph.D., current); **K. Lapina** (Ph.D., current); **M. Peterson** (1999, Ph.D.: DePaul High School); **A. Hamlin** (2002; Ph.D.: Michigan Tech); **R. Gopalan** (2002; M.S.: Unknown, India); **Y. Lu** (2002; M.S.: Unknown); **C. Edlin** (2001, M.S: Houghton County Health Department); **J. Yang** (1999, M.S.: URS Corp.).

- **Postdoc sponsor** (total 2): **J. Kleissl** (New Mexico Tech; Ph.D., Dept. of Geography and Environmental Engineering, Johns Hopkins University); **D. Cheng** (Unknown; Ph.D., Atmospheric Science, SUNY Stony Brook).

Alex Kostinski

Biographical Sketch

Alex Kostinski was born in Kiev, Ukraine (former USSR) in 1957, received B.S. in mathematics in 1978 from the Hebrew University of Jerusalem, and Ph.D. in physics in 1984 from the University of Illinois, Chicago. His Ph.D. thesis dealt with turbulence in jets and wakes. He became a postdoctoral fellow at the UIC Electrical Engineering Department in 1985 (Research Assistant Professor in 1987-9). There he worked on radar polarimetry and signal processing. He joined MTU Physics Department in the Fall of 1989, was promoted to tenured Associate Professor in 1993 and to Professor in 1997. Spent sabbatical year (98-99) as a Visiting Fellow of the Laboratory for Atmospheres, NASA Goddard Space Flight Center. In 2004, he received MTU Research Award and was elected a Fellow of the Institute of Physics (United Kingdom). Also in 2004, he accepted an invitation to joint the editorial board of the “Reports on Progress in Physics”. In 2005, he participated in the Aspen School of Physics workshop on novel approaches to climate, and this summer he will be a Weston Visiting Professor at the Weizmann Institute (Division of Complex Systems), Israel. His research interests continue to evolve but with current focus on applications of stochastic processes to physical meteorology.

Taught following courses (Introductory level): Mechanics, Electricity and Magnetism; (Senior level): Quantum Physics, Thermodynamics and Statistical Mechanics, Introduction to Meteorology, Qualitative methods, Senior Research, Introduction to General Relativity; Graduate courses: Statistical Physics, Classical Mechanics, Classical Electrodynamics, Atmospheric Physics, Mathematical Physics, Remote Sensing.

Doctoral Students graduated: Larry Coke (defended 1994 - Fluid Dynamics); John Kwiatkowski (defended 1995 - Radar Meteorology); Alan Koivunen (defended 1999 - Radar Signal Processing); Weidong Yang (defended 2004 - astronomical optics, holography). Current Ph.D. students: M. L. Larsen (fluctuation phenomena in atmospheric physics).

M.S. students graduated: Manish Kulkarni, “Signal Processing of Random Phasors: Remote Sensing Applications” M.S. thesis, MTU/Physics 1994; David Wittaveen, M.S. report (Physics) on “Thermal Infrared Remote Sensing of Volcanic Plumes using the Thematic Mapper Radiometer”, 1992; Sally Rogers, M.S. report (Mathematics) on “Generating Weibull Distributions”, 1991.

List of PI’s Five Most Relevant Publications

A. B. Kostinski and R. A. Shaw, “Fluctuations and Luck in Droplet Growth by Coalescence”, Bulletin of the American Meteorological Society, 2005, vol. 86, pp. 235-244.

M.L. Larsen, W. Cantrell, J. Kannosto, A.B. Kostinski, ”Detection of Spatial Correlations Among Aerosol Particles”, Aerosol Science and Technology, 2003, vol. 37, no. 6, pp. 476-485.

A.B. Kostinski, ”On the Extinction of Radiation by a Homogeneous but Spatially Correlated Random Medium: Response to Comments”, J. Optical Society of America, A., 2002, vol. 19, no. 12, pp. 2521-2525.

A.R. Jameson and A.B. Kostinski, ”Spurious Power-law Relations Among Rainfall and Radar Parameters”, Quarterly Journal of the Royal Meteorological Society, 2002, vol. 128, pp. 2045-2058.

A. B. Kostinski and R. A. Shaw, ”Scale-dependent Droplet Clustering in Turbulent Clouds”, Journal of Fluid Mechanics, 2001, vol. 434, pp. 389-398.

List of PI’s Five General Publications

M. L. Larsen, A.B. Kostinski and A. Tokay, “Observations and Analysis of Uncorrelated Rain”, Journal of the Atmospheric Sciences, in press.

Weidong Yang, A.B. Kostinski, ”One-sided Achromatic Phase Apodization for Imaging of Extra-solar Planets”, Astrophysical Journal, 2004, vol. 605, pp. 892901, 2004 April 20.

C. Ftaclas and A. Kostinski, ”Curvature Sensors, Adaptive Optics and Neumann Boundary Conditions”, Applied Optics, 2001, vol.40, no.4, pp. 435-438.

A.B. Kostinski and A.R. Jameson, “On the Spatial Distribution of Cloud Particles”, Journal of the Atmospheric Sciences, 2000, vol.57, no.7, 1 April, pp.901-915.

C.R. Givens and A.B. Kostinski, “A Simple Necessary and Sufficient Condition for the Physical Realizability of Mueller Matrices”, Journal of Modern Optics, March 93, vol. 40, no. 3, pp.471-481.

List of Collaborators, Advisors and Advisees

W. Cantrell, C. Ftaclas, C. R. Givens, A.R. Jameson, J. Kannosto, D. Lanterman, M. L. Larsen, W. Rose, R. A. Shaw, W. Perger, Bryan Suits, T. Schulz, B. Smith, Ali Tokay, Z. Wang, Weidong Yang.

Former Advisors: Richard A. Carhart (thesis advisor) and Wolfgang M. Boerner (postdoc advisor)

Former Advisees: Weidong Yang, Alan Koivunen, Larry Coke, Manish Kulkarni, John Kwiatkowski, David Wittaveen, Sally Rogers.

Judith A. Perlinger

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E-mail: jperl@mtu.edu

a. Professional Preparation

B.S. Civil Engineering, University of Minnesota, 1985
M.S. Civil Engineering, University of Minnesota, 1990
Doctor of Natural Science, Swiss Federal Institute of Technology, 1994

b. Appointments

Visiting Scientist, NOAA Environmental Technology Laboratory, September 2003 – May 2004
Associate Professor, Michigan Technological University, 2002 – present
Assistant Professor, Michigan Technological University, 1995 – 2002
Post-Doctoral Scholar, Swiss Federal Institute for Environmental Science and Technology (EAWAG), November, 1994 - May, 1995

c. Peer-Reviewed Publications

Rowe, M.D., Perlinger, J.A., and Urban, N.R., Modeling contaminant behavior in Lake Superior: A comparison of PCBs, PBDEs, and mercury, In State of Lake Superior, Ecovision World Monograph Series, M. Munawar (Ed.), Taylor & Francis Publ., London, UK, *in review*.

Perlinger, J.A., Tobias, D.E., Morrow, P.S., and Doskey, P.V., Evaluation of novel techniques for measurement of air-water exchange of persistent bioaccumulative toxicants in Lake Superior, Environ. Sci. Technol., 39, 8411-8419, 2005.

Perlinger, J.A., Micrometeorological Measurements of Air-Water Exchange Rates of Persistent Bioaccumulative Toxicants in Lake Superior, Final Report to Michigan Great Lakes Protection Fund, 53 pp., September, 2004.

Perlinger, J.A., Simcik, M.F., and Swackhamer, D.L., Synthetic organic toxicants in Lake Superior, Special issue of Aquat. Ecosyst. Health Manage., on Emerging Issues in Lake Superior Research, 7, 491-505, 2004.

Venkatapathy, R., Bessingpas, D.G., Canonica, S., and Perlinger, J.A. Kinetic models for trichloroethylene transformation by zero-valent iron, Appl. Catal., B: Environmental, 37, 139-159, 2002.

Perlinger, J.A., Kalluri, V.M., Venkatapathy, R., and Angst, W., Addition of hydrogen sulfide to juglone, Environ. Sci. Technol., 36, 2663-2669, 2002.

Perlinger, J.A., Venkatapathy, R., and Harrison, J.F., Linear free energy relationships for polyhalogenated alkane transformation by electron-transfer mediators in model aqueous systems, J. Phys. Chem., A, 104, 2752-2763, 2000.

Perlinger, J.A., Buschmann, J., Angst, W., and Schwarzenbach, R.P., Iron porphyrin and mercaptojuglone mediated reduction of polyhalogenated methanes and ethanes in homogeneous aqueous solution, Environ. Sci.Technol., 32, 2431-2437, 1998.

Perlinger, J.A., Angst, W., and Schwarzenbach, R.P., Kinetics of the reduction of hexachloroethane by juglone in solutions containing hydrogen sulfide, Environ. Sci. Technol., 30, 3408-3417, 1996.

Perlinger, J.A., Eisenreich, S.J., and Capel, P.D., Application of headspace analysis to the study of sorption of hydrophobic organic chemicals to α-Al2O3, Environ. Sci. Technol., 27, 928-937, 1993.

Perlinger, J.A., Almendinger, J.E., Urban, N.R., and Eisenreich, S.J., Groundwater geochemistry of aquifer thermal energy storage: long-term cycle, Water Resour. Res., 23, 2215-2226, 1987.

d. Synergistic Activities

Development of techniques to measure atmospheric concentrations and air-water exchange fluxes of semi-volatile organic compounds and comparison with conventional flux measurement approaches.

International Joint Commission Science Advisory Board Member, 2003 – Present

Instructor, Ecology of the Great Lakes Teacher Institute aboard the USEPA's *R/V Lake Guardian*, July 5-9, 2004

Session Co-Chair, 48th Annual Meeting of the International Association for Great Lakes Research, Ann Arbor, MI, May 23 - 27, 2005.

Co-Chair, Flux Measurement Techniques Workshop, NOAA, April 6, 2004

Co-Organizer, 22nd Annual Midwest Environmental Chemistry Workshop, Michigan Tech. Univ., 1999

Advisor, NSF Research Experiences for Undergraduates Program; advised one minority student in summer, 1997, and one student in summers of 1998 and 1999

Presenter, Girls + Math + Science = Choices Videoconferencing Forum, Spring 1998.

e. Collaborators & Other Affiliations

Collaborators and Co-Editors – W. Angst (EAWAG, Switzerland), D. Bessingpas (Michigan Tech), S. Canonica (EAWAG), W. Cantrell (Michigan Tech), J. Chen (U. Toledo), R. Cory (U. Colorado), P. Doseky (ANL), C. Fairall (NOAA), A. Grachev (CIRES), S. Green (Michigan Tech), J. Hare (U. E. Anglia), J. Harrison (Michigan State U.), R. Honrath (Michigan Tech), V. Kalluri (STS Consultants), P. Morrow (MSA Professional Services), D. Perram (Michigan Tech), P. Roblee (U. Wisconsin – Milwaukee), J. Seeley (Oakland U.), M. Simcik (U. Minnesota), D. Swackhamer (U. Minnesota), D. Tobias (Michigan Tech), N. Urban (Michigan Tech), R. Venkatapathy (EPA), M. Wesely (ANL), Q. Zhang (Michigan Tech), B. Zhu (Purdue U.)

Graduate & Post-Doctoral Advisors - Masters Advisor: Steven J. Eisenreich, JRC Institute for Environment and Sustainability; Doctoral and Post-Doctoral Advisor: René P. Schwarzenbach, Swiss Federal Institute of Technology.

Thesis Advisor and Postgraduate Scholar Sponsor - I have advised the work eleven graduate students: Gregor Welti (Diplomarbeit 1993), Ignaz Buerge (Diplomarbeit 1994), Thomas Hofstetter (Diplomarbeit 1995), Vasanta Kalluri (M.S. 1999), Rose Cory (M.S. 2001), Patrick Morrow (M.S. 2003), Beibei Zhu (M.S. 2003), Raghuraman Venkatapathy (Ph.D. 2001), David Tobias (Ph.D. Current), Heidi Ochsner (Ph.D., 2003-2004), Mark Rowe (Ph.D., Current).

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PROFESSIONAL PREPARATION:
Ph.D. in Geology, **Dartmouth College**, 1970;
A.B. in Geography, Geology, **Dartmouth College**, 1966.

APPOINTMENTS:.
9/79-present: Professor of Petrology, Michigan Technological University, Houghton.
12/99-6/01: Director Michigan Technological University Remote Sensing Institute.
6/90-6/98: Depart. Chair, (planned new building; hired 8 new faculty); 9/74-9/79: Assoc. Prof. of Petrology, 9/70-9/74; Assist. Prof. of Petrology.
1/99-12/99: Visiting Leverhulme Fellow, Dept of Earth Sciences, University Of Bristol, UK.
8/85-6/86: Visiting Scientist, Los Alamos National Laboratory.
1/81-present: Geochemist (W.A.E. basis), USGS, Cascade Volcano Observatory , Vancouver, WA; Alaska Volcano Observatory, Anchorage; VDAP.
8/77-8/78: Senior Visiting Scientist, Upper Atmosphere Group, National Center for Atmospheric Research**,** Boulder, CO.
8/77-8/78: Visiting Scientist, Branch of Isotope Geology, USGS , Denver, CO.

RELATED PUBLICATIONS

Rose, W I, F M Conway, C R Pullinger, A Deino and W C McIntosh, 1999, **A more precise age framework for late Quaternary silicic eruptions in northern Central America**, *Bulletin of Volcanology, 61:106-120.*

Harris, A.J.L., W I Rose and Flynn, L.P., 2003, **Temporal trends in Lava Dome extrusion at Santiaguito, 1922-2000,** *Bulletin of Volcanology 65: 77-89.*

Bluth, GJS and W I Rose, 2002, **Collaborative studies target volcanic hazards in Central America,** *EOS Trans Amer Geophys Un 83 no 39, pp 429-435.*

J. W. Vallance, S. P. Schilling, O. Matías, W. I. Rose, and M. M. Howell, 2001, **Volcano Hazards at Fuego and Acatenango, Guatemala,** *U S Geol Survey Open File Report 01-431.*

Rose, W I, J J Bommer, D L López, M J Carr and J J Major (eds), 2004, **Natural Hazards in El Salvador**, *Geol Soc Amer Special Paper 375, 498pp.*

SYNERGISTIC ACTIVITIES

1. Since 1970: Efforts to help build infrastructure within volcanic hazards efforts in developing countries, funded by NSF International Programs and OFDA/USGS/VDAP grants: **Guatemala**--Decade Volcano Workshop 1993; Collaborative hazards work 1999-2004. **Ecuador**: Cospec training, 1989; Lahars work, 2002. **El Salvador**: Synergistic efforts at post war science contacts; 1996-2004; Special GSA Publication 2004. **Mexico**: PhD student training, 1995-98; Collaborative visits from Hugo Delgado, 2002-4. **Chile**: initial research collaborative visit, 1989. **Argentina:** Initial visit 2002; field studies 2003. Several field projects in Guatemala and El Salvador funded by USGS/OFDA. Support for two Central American students via USGS/VDAP (CAMI).
2. Since 1980: Educational efforts shared with many other campuses: Video based educational efforts in Optical Mineralogy, 1982; Volcanic Rock Textures, 1985; and video field trips: 1987-1993; Volcanic Rocks and their vent areas, Industry Short Courses (field trips and lectures); 1976-1985; Graduate Student field trip efforts, 1997 (Western Mexico and IAVCEI meeting); NSF funded International Travel Grant to IAVCEI Bali meeting, and associated Hawaii and Pinatubo field trips, July 2000; NSF Int Travel Grant (pending) for students to attend IAVCEI meeting in Chile, 2004. Special session exploring graduate volcanology educational efforts, AGU 2002.
3. Since 1986: Development of volcanic cloud detection algorithms for meteorological satellite detectors, and communication about the use of these for hazard mitigation—continual outreach to advanced users from regional Volcanic Ash Aviation Centers; extensive webbased communications effort; International Volcanic Cloud Remote Sensing Workshops, 2001, 2003, Managua 2004; South American Workshops, March 2002, Nov 2004.
4. Since 1992: Development of Michigan Tech Remote Sensing Institute. Co-organizer and Interim Director of an institute with 35 faculty members from nine different MTU departments, Development of shared lab facilities, success with equipment funding as a NASA center of excellence, development of an interdisciplinary minor program in remote sensing; many interdisciplinary seminar series and several new interdisciplinary classes.
5. 2004: New Peace Corps Masters International Program, Mitigation of Geological Natural Hazards. 1992-2001: NASA EOS IDS Science group member, Volcano Remote Sensing.

RECENT COLLABORATORS EXTERNAL TO MICHIGAN TECH (1999-2004)

Stephen Self (Open University); Andrew Harris (University of Hawaii); Luke Flynn (University of Hawaii); Hans Graf (Cambridge Univ); Fred Prata (CSIRO, Australia); Gerald Ernst (Univ of Bristol, UK; Univ of Ghent, Belgium); Arlin Krueger (UMBC); Nick Krotkov (UMBC); Vincent Realmuto (NASA/JPL); Christiane Textor (Max Planck Inst Meteorology); Alain Bernard (University of Bruxelles); Craig Chesner (E Illinois Univ).

THESIS ADVISEES AND POSTDOCTORAL SCHOLARS SPONSORED, LAST 5 YEARS

Gari C Mayberry, Smithsonian Institution Global Volcanism Program/ USGS, Washington DC

Carlos Pullinger, Director Geological Survey, SNET, El Salvador
Darrell Sofield, GeoEngineers, Tacoma, WA
Emily Constantine, Institute for the Application of Geospatial Technology, Auburn, NY
Tianxu Yu, STC/NOAA Washington, DC
Colleen Riley, Northwestern University
Song Guo, McGill University
Sebastien Dartevelle, Los Alamos National Lab
Demetrio Escobar, Volcanologist, SNET, El Salvador
Yingxin Gu, Canadian Meteorological Centre (Montreal VAAC)
I Matthew Watson, (current Post Doc) *Owen P Mills, Adam Durant, Janelle Byman* (current graduate students)

GRADUATE STUDENTS SUPERVISED: 39 M.S. and 14 Ph.D.

GRADUATE ADVISOR: Richard E Stoiber, Dartmouth College, deceased.

Raymond A. Shaw

Department of Physics
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Research Interests
Turbulence–cloud interactions; Cloud and aerosol physics; Ice nucleation.

Appointments
2003-present, Associate Professor, Department of Physics, Michigan Technological University
Fall 2004 & Summer 2006, Visiting Professor, Dept. of Physics and Sibley School of Mechanical and Aerospace Engineering, Cornell University
Spring 2005, Visiting Scientist, Institute for Tropospheric Research, Leipzig, Germany
1999-2003, Assistant Professor, Department of Physics, Michigan Technological University

Professional Preparation

National Center for Atmospheric Research, Advanced Study Program	Cloud Physics	Postdoctoral Fellow 19981999
Pennsylvania State University	Meteorology	Doctor of Philosophy 1998
Brigham Young University	Physics	Bachelor of Science 1993

Publications

5 Recent Publications Most Closely Related to Proposed Project

Kostinski, A. B., and R. A. Shaw, 2001: Scale-dependent droplet clustering in turbulent clouds. *Journal of Fluid Mechanics* , **434**, 389-398.

Kostinski, A. B., and R. A. Shaw, 2005: Fluctuations and luck in droplet growth by coalescence. *Bulletin of the American Meteological Society*, **86**, 235-244.

Saw, E. W., R. A. Shaw, S. Ayyalasomayajula, P. Y. Chuang, A. Gylfason, and Z. Warhaft, 2006: Inertial clustering of particles in high-Reynolds-number turbulence. *Physical Review Letters*, in review.

Shaw, R. A., 2003: Particle-turbulence interactions in atmospheric clouds. *Annual Review of Fluid Mechanics*, **35**, 183-227.

Shaw, R. A., W. C. Reade, L. R. Collins, and J. Verlinde, 1998: Preferential concentration of cloud droplets by turbulence: Effects on the early evolution of cumulus cloud droplet spectra. *Journal of the Atmospheric Sciences*, **55**, 1965-1976.

Grants and Awards
NSF Research Grant – Turbulence in Atmospheric Clouds, 2005-2008
NSF Major Research Instrumentation Grant, 2003-2005
NASA New Investigator Program Grant, 2001-2004
National Science Foundation Career Award, 2000-2005
AMS Robert Leviton Award, 2001
NASA Graduate Fellowship in Global Change Research, 1994-97

Synergistic Activities

Member “International Collaboration for Turbulence Research”

Member “American Meteorological Society Committee on Cloud Physics” (2000-present).

Participant in “Winningen05” cloud field experiment with helicopter-borne turbulence and microphysical measurement payload (ACTOS). Work carried out in collaboration with the Institute for Tropospheric Research, Leipzig, Germany. Phase-Doppler Interferometer for Cloud Turbulence (PICT), developed in collaboration with P. Chuang at UC Santa Cruz and W. Bachalo at Artium Technologies, was deployed.

Participant in “Instrument Development and Education in Airborne Science, phase 3” (IDEAS 3) flight research project, held the NCAR Research Aviation Facility in August-September 2003. Flight tested first version of Holographic Detector for Clouds (Holodec).

Chair, organizing committee for “Workshop on Fine Scale Turbulence and Cloud Microphysics,” NCAR Geophysical Turbulence Program, Boulder, CO, November 2000; See http://www.asp.ucar.edu/gtp/cloud2000.html for more information.

Reviewer for Atmospheric Research, Bulletin of the American Meteorological Society, Geophysical Research Letters, Journal of Applied Meteorology, Journal of Atmospheric and Oceanic Technology, Journal of Fluid Mechanics, Journal of the Atmospheric Sciences, Physics of Fluids, Quarterly Journal of the Royal Meteorological Society, National Science Foundation, NASA, Department of Energy.

Active science-outreach volunteer for public elementary schools and youth organizations.

Collaborators and Other Affiliations

Collaborators in Last 48 Months
Will Bachalo, Artium Technologies, Sunnyvale, CA
Eberhard Bodenschatz, Department of Physics, Cornell University, & Max Planck Institute for Dynamics and Self Organization
Patrick Chuang, Department of Earth Sciences, UC Santa Cruz
Lance Collins, School of Mechanical and Aerospace Engineering, Cornell Univ.
Alexander Kostinski, Department of Physics, Michigan Technological University
Alfred Moyle, Department of Meteorology, Pennsylvania State University
William Rose, Dept. of Geological Engineering and Sciences, Michigan Technological Univ.
Holger Siebert, Leibniz-Institute for Tropospheric Research
Zellman Warhaft, School of Mechanical and Aerospace Engineering, Cornell Univ.
Weidong Yang, Department of Physics, Michigan Technological University

Postdoctoral Sponsor

William A. Cooper, Advanced Study Program, National Center for Atmospheric Research

Graduate Thesis Advisor

Dennis Lamb, Department of Meteorology, Pennsylvania State University

Thesis Advisor
Adam Durant, M.S. Geological Science, Michigan Technological University
Youshi Mi, M.S. Physics, Michigan Technological University
Aleksandr Sergeyev, M.S. Physics, Michigan Technological University

Graduate Students Currently Advised
Jacob Fugal (Ph.D. Engineering Physics; NSF Graduate Research Fellow), Jiang Lu (Ph.D. Physics), Ewe Wei Saw (Ph.D. Physics)

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