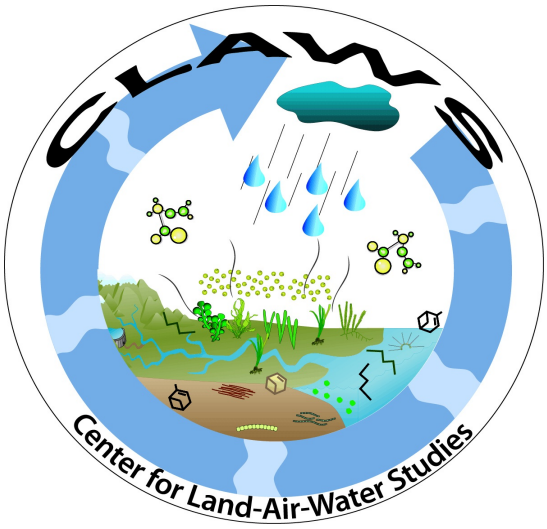
20 April 08

1. CLAWS = Center for Land-Air-Water Studies



Center Proposal for:
Penn State's Earth and Environmental Science Institute, Prof. Susan Brantley, Director

In Response to Call for Proposals due 21 April 2008

2. Proposed CLAWS Director:

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Proposed CLAWS Associate Director:

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Abstract

The EESI CLAWS = Center for Land-Air-Water Studies will bring experts in geochemistry and remote sensing, atmospheric, critical zone and water-related fields together to focus on processes at the interfaces of these domains. The challenges and needs CLAWS uniquely addresses will be met by investigating important scientific issues, not adequately explored at these interfaces. This will be accomplished by fundamental studies with chemical analysis and modeling, field observations in prototype ecosystems, and remote sensing from satellites with ground truth investigations. Process studies and field work are cores to CECG in its current form. The CECG structure, spanning EMS, ECOS, COE and Agriculture, with existing Centers and affiliated Faculty and Staff, is ideal for new activities and foci of CLAWS. We propose CLAWS as the renewal and extension of the CECG EESI Center because lines of inquiry across Colleges and facilities require a similar level of Center-class support.

Proposal Outline

1. Center Name
2. Proposed Director
3. Participants List (see Appendix A-2 – CECG Participants) & CLAWS Steering Committee
4. Rationale - Need for Center = CLAWS (see also Appendices A-1, A-3)
5. CLAWS Proposed Activities and Funding Opportunity Targets
6. Center Needs and Budget
7. Management Structure (refer also to Appendix A-4)
8. Past Budgets and Work
9. Support Letters (Appendix A-5)

Appendices:

A-1 Acronym List
A-2 CLAWS & CECG Participant List
A-3 CECG Facilities Resources in 2007
A-4 Director & Associate Director CVs
A-5 Support Letters: Brune, Fantle, Kane, Kubicki, Lampkin.
Potential Non-PSU Partners: N. M. Donahue (Carnegie-Mellon U.), A. Elmore (Frostburg U.), J. D. Fuentes (U. Virginia), W. R. Stockwell (Howard U.)

3. CLAWS STEERING COMMITTEE

A. M. Thompson (Meteorology), Director; Ming Tien (Biochemistry & Molecular Biology), Associate Director; W. H. Brune (Meteorology), M. Fantle (Geosciences), T. J. Kane (Electrical Engineering/Meteorology), J. D. Kubicki (Geosciences), D. J. Lampkin (Geography), J. Macalady (Geosciences), C. E. Martinez (Crop & Soils Science), K. T. Mueller (Chemistry), J. M. Regan (Civil & Environmental Engineering)

4. CLAWS RATIONALE

A. OVERALL CENTER JUSTIFICATION

The CECG (Center for Environmental Chemistry and Geochemistry - see Acronyms in Apendix A-1) has brought biologists, chemists, engineers and geoscientists together in joint research and educational initiatives since 1997 (Participants in Appendix A-2). Common themes in CECG activities have been investigations into chemical processes in various environments and the employment of a unique set of analytical capabilities across the Penn State campus (Listed in Appendix A-3). By bringing together researchers from multiple disciplines, CECG collaborations have created new Centers and research collaborations and brought enhanced visibility to Penn State's environmental research and educational programs. BRIE and CEKA are among the best examples. The Environmental Chemistry Student Symposium (ECSS) now attracts students across the Commonwealth to its annual forum at University Park.

CLAWS (Center for Land-Air-Water Studies) will build on the strengths and infrastructure of CECG, renewing an energetic commitment to fundamental environmental investigations, while directing new efforts toward integrated observations in the earth system. The latter means (1) research and education that joins land-air-water studies (ie, geosphere/biosphere-atmosphere-hydrosphere/cryosphere), especially at their interfaces with one another; (2) adding new people and instrumentation to the existing CECG complement; (3) reaching to other EESI Centers or beyond to leverage observing capabilities and models where appropriate. In collaborations with other universities, CLAWS will partner with leading scientists in interdisciplinary research and education at both majority and minority institutions.

B. CLAWS, A "RENEWED" CENTER: SCIENTIFIC RATIONALE

We are in a period of highly dynamic change on our planet. The recent IPCC Report (Assessment Report 4, 2007) describes changes in atmospheric composition and radiation that drive "Climate Change" with its impacts on land surfaces (the biosphere and its consequences for food supply), as well as the hydrosphere (oceans, freshwater, precipitation) and cryosphere. Penn State researchers are active in studying basic chemical and physical properties of the Earth System and impacts of climate change in all of the "spheres." EESI unites hundreds of members of the Penn State community across disciplinary lines to study numerous aspects of the changing planet in unique and creative ways. ESSC, the Center for Ice and Climate and CEER have stellar records in integrated Earth System modeling, climate studies (including paleoclimate) and human dimensions of environmental change. The Carbon Center, ACRE, is focused on the biogechemical cycling of the most critical trace gas in the climate system.

CECG has been superbly effective over the past 12 years in integrated chemical and biogeochemical environmental research. For example, CEKA (spawned by CECG) has brought together chemists, geochemists, engineer, biochemists, and others to study fundamental aspects of dissolution, precipitation, and bioreactions in the environment. The CEKA program has brought new research collaborations to fruition, attacking such problems as reactive surface area in the environment, linking laboratory and field rates of important physical and chemical processes, and a deeper understanding of and bacterially-mediated dissimilatory Fe reduction.

The connections among these various areas studies are becoming more important in the face of global climate change. However, *no EESI Center is dedicated to basic studies of critical interfaces across the Earth System.* None integrates a full range of experiments and observations across scales from molecular and microbial to in-situ and remotely sensed properties of each

sphere in the land-air-water system. *Bridging those gaps by facilitating communication between atmospheric and critical zone scientists is the goal of CLAWS.*

What is meant by interdisciplinary approaches to interface processes? A few examples illustrate the scope of problems to which CLAWS is directed.

o LAND-AIR-OCEAN. Global climate changes will change the distribution of arid and semi-arid regions. Arid regions are notorious sources of fine-grained dust (Prospero et al., 1996; 1999; 2002) that can alter atmospheric CO_2 levels via iron fertilization of the biological pump (Martin and Fitzwater, 1988; Martin, 1990, 1991; Martin et al., 1990; 1994). The effects are expected to be appreciable in the short-term and potentially on geological time scales (Steinberg et al., 1998; Landry et al., 2000; Boyd and Abraham, 2001). Although the relief of iron limitation in the modern ocean has been shown to augment primary productivity (Kolber et al., 1994; Martin et al., 1994), the relationship between increased marine productivity and changes in the climate system remains ambiguous. Whereas the iron-enhanced "biological pump" does draw down atmospheric CO_2 over short timescales (Watson et al., 1994; Cooper et al., 1996), there is no *de facto* evidence for this mechanism operating over timescales comparable to ocean circulation (10^3 a). Furthermore, other factors, e.g. co-limitation by nitrate, phosphate, silica, and light, inefficient export of carbon from the surface to the deep ocean, grazing, the release of climatically-important gases such as N_2O, CH_4, and dimethyl sulfide, and the development of community structure following iron enrichment need to be considered when determining iron's effect on climate. *Consequently, links among climate scientists, chemical and biological oceanographers and critical zone scientists are imperative.*

Elucidating the role of ocean iron fertilization, both past and present, requires understanding a variety of processes taking place at land-atmosphere and atmosphere-water interfaces. In evaluating dust formation, transformations and cycling through the oceans, one starts with dust synthesis in arid and semi-arid regimes. Can we identify the mineralogy and composition of dust from various dust sources, use remote sensing to extend individual field-scale observations to regional and global scales and develop estimates of mass fluxes? This field would benefit from expertise on soils, but the atmospheric and soil communities typically do not work together. Is it possible to predict the evolution of dust sources over geological time scales with models? *Again, climate and critical zone scientists must collaborate closely to address this issue.* Furthermore, during dust transport, chemical transformations need to be simulated, including aerosol interactions. *Field researchers, experimentalists and modelers in the areas of atmospheric transport and mineral surface reactions should work in concert on this complex problem.* Once dust reaches the oceans, biological responses to enrichments of various chemical inputs to the ocean must be determined (cf Bishop et al., 2002). Next, mass fluxes throughout the ocean must be estimated, then scaled up to an ecosystem level to regional and global scales. To verify the overall mechanisms, carbon fluxes from photic zones must be observed. *Note the need for scaling up to global remote sensing. Chemical and biological oceanographers are critical for predicting the response to the inputs derived above.*

o LAND-SNOWMELT-ICE. Variability in seasonal snow cover as a component of the cryosphere has important implications for not only climate system response but water resources. Specifically, for snowmelt dominated rivers in the North American West, spring and summer runoff is the largest contribution to annual flow, comprising 50-80%

of the total, and is in danger of significant shifts in timing (Dettinger and Cayan, 1995; Cayan et al., 2001; Stewart et al., 2004). A majority of rivers in western North America have exhibited trends toward earlier snowmelt timing during the last half century (1948-2000) (Stewart et al., 2004), with trend towards earlier melt most prevalent in the Pacific Northwest, Rocky Mountains, Canada, and Alaska. Changes are driven primarily by broad scale warming trends and regional scale moistening (north-western North America) and drying (southwestern North America), with temperature increases as more dominant than the volume of precipitation (Stewart et al., 2004). Projections for snowmelt timing at the end of the 21st century indicate very dramatic changes relative to the 1948-2000 time interval where shifts of 30 to 40 days are predicted for the Pacific Northwest, Sierra Nevada, and Rocky Mountain basins (See Figure 1 in Stewart et al., 2004).

Regional trends in snowmelt timing based on previous research are compelling, but lack comprehensive characterization of changes as a function of scale. Advances in satellite remote sensing platforms may allow for greater spatial detail and improved characterization of snow melt onset, magnitude, and duration. The opportunity for exploring dynamics at the interface among the atmosphere, hydrosphere, and biosphere are numerous and vital. Exchanges at the land surface-atmosphere interface are responsible for the extent and spatio-temporal variability of snow deposition, distribution and ablation. Melt amount and timing has been linked to basin-scale biogeochemical cycles with complex interactions among soil microbial activity and snowmelt dynamics. *Here too, hydrologists, glaciologists and soil scientists must be brought together. Observations on microscales to regional remote sensing are required, as well as an appropriate modeling framework.*

o BIOSPHERE-ATMOSPHERE-HYDROSPHERE. Current understanding about the role of trace atmospheric constituents put aerosols as the key uncertainty in future predictions of radiative forcing and climate impacts (IPCC AR4, 2007; Ramanathan et al., 2007). In the past decade, attention has shifted from traditional foci on sulfate and nitrate particles to the role of "soot" or black carbon and "secondary organic aerosols" (SOA; Menon et al., 2002; Tsigaridis and Kanakidou, 2007) as the most likely agents to modify atmospheric reflectivity (albedo) and the interactions of condensation nuclei, cloud formation and precipitation patterns (Barr et al. 2003; Bell et al., 2007). The nature of secondary organic aerosols, their relationship to primary aerosols and the role of gaseous species in their transformation define a set of critical processes at interfaces (Volkamer et al., 2006; Kleinman et al., 2008). Furthermore, the transformations are very sensitive to the organic and aerosol mixture of a given region (Sciare et al., 2008), as well as to moisture patterns and meteorology.

These processes will continue to be examined in a range of environments, as in mega-city experiments over cities as diverse at Tokyo, Sao Paulo, Cairo, Beijing, Paris (Molina and Molina, 2002). However, a more fruitful approach to interpretation of field data and for prediction and pollution control models would be to study the processes *in one region* end-to-end from soils to biosphere (and stack or car) to atmosphere in the gas phase to particle to cloud nucleus to precipitation to deposition. Prototype locations for US studies would be Houston, an eastern city (e.g. Pittsburgh, New York, Washington), Los Angeles. In such a case, lab studies would be needed to examine initial stages of oxidation with an appropriate simulation of

emissions and an ambient atmosphere. Field measurements are equally vital because they are the only way to determine pathways and likely rates of transformation.

o SOILS-WATER-LAND. Fluid (air and water) and solid (soils and primary minerals) phases are each present in the three earth spheres (terrestrial; aquatic: oceans, surface and underground waters; and atmospheric environments), although in different proportions. An additional component integral to all three spheres is living organisms. Nanominerals (nanocolloids, mineral nanoparticles) are present in atmospheric, aquatic and soil environments, and in living organisms and their generation, mobility and reactivity highly influences the cycling of many important elements (both nutrients and contaminants). An area of study that crosses several environmental interfaces and where nanocolloids are likely to play a major role is the study of elemental biogeochemical cycling among soil solids, soil "solution", and biotic receptors. Penn State has strengths in nano-scale science, environmental microbiology, atmospheric transport and climate change and critical zone geochemistry. *Although ties exist among some of these areas, maintaining and strengthening those ties will be critical to Penn State's success in attracting large center funding for multidisciplinary studies in the future.*

Clearly, the investigations above require expertise in a range of disciplines, from geochemistry to physical hydrology, atmospheric transport and radiation. Some of the greatest uncertainties in our understanding occur at the interfaces between individual disciplines. At each step modeling assumptions and scaling need to be spelled out, then verified with observations. This means investigating individual geochemical processes at small spatial scales and tracing each flux across an interface until regional and global impacts can be measured, the latter ideally with remote sensing.

C. WHY AN EESI CENTER? WHY "CLAWS?"

The above examples of processes at land-air-water interfaces include common approaches: fundamental studies with chemical analysis and modeling, field observations in prototype ecosystems, remote sensing from satellites with ground truth investigations. Process studies and field work are cores to CECG in its current form. The CECG structure, spanning EMS, ECOS, COE and Agriculture, with existing Centers and affiliated Faculty and Staff, is ideal for new activities and foci of CLAWS. *Accordingly, we propose CLAWS as the renewal and extension of the CECG EESI Center because lines of inquiry across Colleges and facilities require Center-class support.*

CLAWS will, then, perform a valuable service by bringing experts in geochemistry and remote sensing, atmospheric, critical zone and water-related fields together to focus on processes at the interfaces of these domains. In other cases, the primary difficulty involves extending observations in the modern system to either the future or the past. In these instances, CLAWS will operate to unite modeling experts with those that make observations in the modern system. This synthesis of expertise allows CLAWS to facilitate research at the interfaces between land, air, and water, investigating important scientific issues using a range of interdisciplinary tools.

5. CLAWS ACTIVITIES AND FUNDING OPPORTUNITIES

A. NETWORKING and FACILITATION

CECG's highly successful facilitation of networking has created new opportunities for joint research among Affiliates, with associated educational activities and curricula for Penn State students. Chief among these are: (1) the annual Wine and Cheese Reception that mixes participants from across four Colleges and the Materials Research Institute - students and faculty alike; (2) a Newsletter and website: <http://www.essc.psu.edu/CECG/>, expertly produced by CECG Assistant Deb Lambert in the EESI office; (3) sponsorship of the ECSS and competitive Summer Fellowships for student research; (4) cooperative use of Center-class analytical facilities across Penn State (See Appendix A-3).

These activities will continue in CLAWS. The networking is vital, as it has led to large Center-class grants. Agency Federal Program Managers have been invited Wine and Cheese Speakers, as have large Center Directors at Penn State. New facilitation efforts will include: (1) regular meetings of the Steering Group and interested parties, aimed at proposal solicitations; (2) re-instituting Research Initiation Grants (RIG) at some level. Prior to 2005, CECG was able to provide modest but crucial support for exploratory studies by a student and several professors. CLAWS proposes a RIG re-start.

CLAWS will undertake one or more of these new activities: (1) Co-sponsorship of seminars across EESI. The overlap of research interests with other EESI Centers has been noted. Joining to host speakers is another way to increase networking for preliminary research and selected proposal responses (see 5C below); (2) CLAWS Workshop in advance of the ECSS (half day) that focuses on Affiliates presentations of cross-disciplinary research; (3) Monthly brown-bag lunch (similar to the ESSC model) with Penn State speakers and potential CLAWS collaborators from other institutions.

B. RESOURCE COORDINATION FOR OBSERVATIONS - PILOT PROJECTS

Among collaborative efforts discussed by the CLAWS team to date are three examples:

o An educational initiative that joins remote sensing for applications – beyond standard instrument and discipline-specific uses – has been tested successfully this semester (Spring 2008, Meteo/EE 597A). With students and Faculty across Engineering, Geography, Meteorology and Geosciences, disciplines covered have been broadened with guest speakers from Penn State and outside institutions (e.g. Frostburg U.). Fostering a larger remote sensing curriculum and more interdisciplinary research in this area is a CLAWS priority.

o Linking geochemical, geomicrobial and soils studies with atmospheric sampling at the Penn State Critical Zone Shales Hills Observatory. Already, hydrological (Susquehanna River Basin Hydrological Observing Station) and chemical studies are combining at this location, thanks to CEKA. This forested location represents a unique environment in which to study plant hydrocarbon emissions, their transformations with radicals to particle formation and subsequent evolution and venting from the canopy. The NATIVE air quality and remote sensing validation trailer can be added to the sampling complement once power upgrades are completed. NATIVE (http://www.meteo.psu.edu/~btaubman/Webpage /native.html) is presently outfitted with standard trace gas instrumentation but also includes an aerosol lidar. NATIVE can accommodate additional

remote sensors as well as state-of-the art free radical and aerosol measuring devices (Ground-based Techniques for Hox Sampling and the Potential Aerosol Measuring devices from the Brune group; Ren et al., 2004; Shirley et al., 2006). Promoting the use of localized remote sensors, with potential to scale up to satellite sampling, is a CLAWS priority.

o Penn State atmospheric scientists have conducted ground and aircraft-based research in many environments, from the Pacific Rim, across North America (Singh et al., 2006; Thompson et al., 2007a,b) and the tropics (Sauvage et al., 2006; Thompson et al., 2007c). With a focus increasingly on urban and urban-influenced environments and a productive set of mid-Atlantic results (Taubman et al., 2006; Yorks, 2007), this group has been exploring ways to team with other institutions, from North Carolina, through Virginia, Maryland and Pennsylvania, to investigate regional impacts of land-use changes on ”climate change”, air quality, and the hydrologic cycle. Creating a series of sites for process and interface studies along the Appalachians, from mountain to coast, with key urban areas and the Chesapeake Bay, is an obvious strategy for CLAWS. New investigations are needed to understand the impacts of spatial gradients in biogenic and anthropogenic emissions, and associated chanages in land use, on production, transport and deposition of air toxics and greenhouse gases. The planned studies will offer new science to quantify not only the services that forested landscapes offer in the form of consuming airborne pollutants and recycling of water but also how they can ameliorate climatic impacts. A group called REACCT has formed among Penn State, Frostburg, U. Maryland (College Park and Baltimore County campuses), UVA, NC State, Howard U, Hampton U and Longwood Universities to explore networked approaches in this region. Complementing the field work tentatively discussed in REACCT are the type of laboratory studies, at Penn State and with collaborators at Carnegie-Mellon U., that are required to determine the role of interface processes being addressed in CLAWS. (See Donahue, Fuentes, Stockwell letters of support.)

C. SPECIFIC EXAMPLES OF RFPS TO TARGET

The following are potential initiatives to target. The list is not exhaustive:

(1) NSF Geosciences - Interdisciplinary research dealing with “Emerging Topics in Biogeochemical Cycles (ETBC)”. Since we include researchers over a broad segment of geosciences, hydrological sciences, atmospheric sciences and even oceans, CLAWS should be able to create strong and innovative research proposals. The description in part reads: “Geosciences Directorate (GEO) is substantially augmenting our past funding sources to explicitly support emerging areas of interdisciplinary research. We seek to foster transformational advances in our quantitative or mechanistic understanding of biogeochemical cycles that integrate physical-chemical-biological processes over the range of temporal and/or spatial scales in Earth’s environments. We encourage submission of proposals that address emerging topics in biogeochemical cycles, the water cycle or their coupling, across the interfaces of atmosphere, land, and oceans. Proposals must cross disciplinary boundaries of two or more divisions in Geosciences (e.g. ATM, EAR, OCE) or of at least one division in Geosciences and a division in another NSF directorate.” <http://www.nsf.gov/pubs/2007/nsf07049/nsf07049.jsp>

(2) Dynamics of Coupled Natural and Human Systems (CNH) program. "The Dynamics of Coupled Natural and Human Systems competition promotes quantitative, interdisciplinary analyses of relevant human and natural system processes and complex interactions among human and natural systems at diverse scales." <http://nsf.gov/funding/pgm_summ.jsp?pims_id=13681&org=EAR>

(3) IGERTS - Interdisciplinary Graduate Education and Research Training. Note that a number of CECG Affiliates have participated in previous efforts to assemble IGERTs across EESI and beyond. In the latter case, we have partnered with colleagues from University of Virginia, Carnegie-Mellon University, and Howard University. CLAWS will provide a mechanism for further collaboration in which resources and facilities can be leveraged for laboratory, field and modeling research.

4) Science & Technology Centers - The Science and Technology Centers (STC): "Integrative Partnerships program enables innovative research and education projects of national importance that require a Center mode of support to achieve the research, education, and knowledge-transfer goals shared by the partners. STCs conduct world-class research in partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities to create new and meaningful knowledge of significant benefit to society. **Science and Technology Centers build intellectual and physical infrastructures within and between disciplines**, and bring together the creation, integration, and transfer of new knowledge. STCs nurture and foster education by integrating education with research, and by creating bonds between learning and inquiry so that discovery and creativity more fully support the learning process." http://www.nsf.gov/od/oia/programs/stc/

6. CLAWS NEEDS AND BUDGET

CLAWS requests for EESI support are for Staff support (Deb Lambert) and office space (one office, phone, computer in the EESI Center) at the present CECG level. The budget plan is as follows:

Requests:		
	EESI	10K
	ECOS (and/or other sources)	10K
Expenses:		
	Research Support	
	6 CLAWS Summer Fellows (1.5K each)	9K
	RIGs (one at 5K)	5K
	Wine and Cheese	2K
	ECSS contribution	1K
	Newsletter Copying, office	1K
	Miscellaneous Expenses (guest travel supplement, etc)	2K
	TOTAL	20K

We propose that CLAWS be funded jointly between the College of Earth and Mineral

Sciences and Eberly College of Science at the level of 10K each. In advance of the May 7 EESI Proposal Presentation, CLAWS will be presented to Dean D. Larson of ECOS for consideration, and an update presented at that EESI presentation. Other matches are also being sought at this time. Additional funds would go to more RIGs and travel for potential CLAWS Collaborators.

7. MANAGEMENT STRUCTURE

The management model will follow that of CECG. Anne Thompson, Professor of MeteoroIogy (EMS) and Ming Tien, Professor of Biochemistry and Molecular Biology, will serve as CLAWS Director and Associate Director, respectively (CVs in Appendix A-4). A Steering Committee, consisting of the Director and Associate Director, with a diverse group of Affiliates, will meet several times each semester. A larger group than the CECG Advisory Committee, the CLAWS Steering Committee includes several Affiliates active in CECG and new members from across EMS, ECOS, COE and Agriculture: W. H. Brune (Meteorology), M. Fantle (Geosciences), T. J. Kane (Electrical Engineering/Meteorology), J. D. Kubicki (Geosciences), D. J. Lampkin (Geography), J. Macalady (Geosciences), C. E. Martinez (Crop & Soils Science), K. T. Mueller (Chemistry), J. M. Regan (Civil & Environmental Engineering). Disciplines of the Steering Committee include atmospheric aerosol detection and free radical measurements, geochemistry, geomicrobiology, dust initiation processes, and remote sensing analysis and sensor development. As a continuing Center with new foci, CLAWS Steering Committee meetings are envisioned to build momentum for new collaborations across disciplinary interfaces and to refine strategic directions and initiatives for funding targets.

8. PRIOR CECG BUDGET AND ACCOMPLISHMENTS (2005-08)

Annual Wine and Cheese Reception

The annual Wine and Cheese, held in the Fall or early Winter, brings together the Penn State environmental chemistry community for an evening that features a guest speaker, along with socializing and informal information sharing. The guest speaker is also scheduled for meetings with faculty and students and may also present a second talk that is more department or program specific. In the past three years, the wine and cheese speakers have been: Dr. Russell Kelz (Program Director, Division of Earth Sciences, NSF), Prof. Carlo Pantano (Director of the MRI, PSU), and Dr. Michael Kuperburg (program officer from DOE BER).

Research Initiation Grants (RIGs)

Due to lack of funds, the CECG was unable to continue its successful RIG program in 2005-2008.

CECG Summer Scholars Program

The CECG continued to offer a scholars program for Penn State undergraduate or graduate students to pursue work on research topics related to environmental chemistry during summer sessions. This is a broad request where research areas ranging from the biological sciences to engineering to geochemistry are considered. Students submitting winning proposals receive $3,000 in wages and are selected on the basis of intellectual promise, academic record,

and faculty recommendations. Through 2007, CECG has supported 45 summer fellows. The 2008 competition is currently open, and awards will be made in the near future.

Number of CECG summer scholars by College

	before 2005	2006-2007	total
ECOS	14	6	20
EMS	7	3	10
COE	4	3	7
Ag Sci	3	2	5
Not recorded	3	-	3

Recipients of the 2007 Summer Fellowships include:
Aaron Diefendorf, Department of Geosciences, graduate student
Vanathi Duraisamy, Department of Agronomy, graduate student
Venkata Pradeep Indrakanti, Depart of Energy and Geo-Environmental Engineering, graduate student
Nancy Washton, Department of Chemistry, graduate student
Ren Zhiyong, Department of Civil and Environmental Engineering, graduate student

Recipients of the 2006 Summer Fellowships include:
Apurba Sakti - Department of Energy and Geo-Environmental Engineering, graduate student
Laura Hoch - Department of ERM and Chemistry, undergraduate student
Barbara Fricks - Department of Soil Sciences, graduate student
Suzanne McFarland, Department of Biology, undergraduate student
Joshua Middaugh - Department of Chemical Engineering, undergraduate student

Recipients of the 2005 Summer Fellowships include:
Jennifer Vrentas - Department of Biology, and Molecular Biology, undergraduate student
Jeffrey McDonough - Department of Civil and Environmental Civil Engineering, undergraduate student
Geoffrey Bowers - Department of Chemistry, graduate student
Sharmishtha Dattagupta - Department of Biology, graduate student

Program Support for Interdisciplinary Programs

CECG support has enriched the summer REU experiences offered by the CEKA programs, including participation and assistance in organizing yearly end-of-summer poster sessions with participation of CEKA REU students and CECG summer scholars. In some years, we have also been joined by summer students from the NASA Exobiology "Life on the Rocks" REU program and the Center of Excellence in Chemical Ecology at PSU. The summer 2006 program was organized by CECG summer scholar Suzanne MacFarland.

Support for Guest Speakers

The CECG has hosted guest speakers over the years, the most recent being Prof. Jacob Schaefer from Washington University. Professor Schafer visited in September 2006 and

presented a seminar entitled “Glycine Metabolism in Intact Leaves by in Vivo Labeling and 13 C{15N} Rotational-Echo Double Resonance (REDOR) NMR”.

New Research Funding from CECG Efforts

In the past three years of funding under EESI, the CECG has been instrumental in continuing excellence in multi-disciplinary research. Most recently, funding was obtained to produce the $Chem_XSeer$ environment as a collaboratory mechanism for environmental chemical kinetics. Members of the CECG partnered with researchers in IST to propose creation of an ontology-centric, web-based collaboratory environment, and this project was funded by NSF in 2005. More information can be found at chemxseer.ist.psu.edu.

Environmental Chemistry Student Symposium

In addition, the CECG has continued to sponsor the popular Environmental Chemistry Student Symposium. The ECSS is a consistent success, with environmental students beyond Penn State joining in to present papers on a wide variety of environmental topics. The statistics for the past three years have been added to the following summary of CECG activities since 2005.

Table 1. Distribution of participants for the ECSS

	Total	ECOS	EMS	Ag	Eng	Ecology	External
2006	61	11	24	12	11	1	2
2007	61	11	19	14	11	4	2
2008	60	15	18	14	10	1	2

Table 2. Distribution of winners for the ECSS

	Total	ECOS	EMS	Ag	Eng	Ecology	External
2006	21	8	5	5	1	1	1
2007	15	1	6	6	2	0	0
2008	25	6	6	6	5	1	1

Summary of Past Budget Expenditures

2005 -2006	
Carryover - $16,000.00	
CECG Income - $21,987.36	CECG Expenses - $18,515.81
ECSS Income - $9,000.00	ECSS Expenses - $12,179.18
2006-2007	
Carryover - $8,918.00	
CECG Income - $27,500.00 ($5000 from MRI)	CECG Expenses - $29,292.60
ECSS Income - $9,000.00	ECSS Expenses - $9,304.48
2007-2008	
Carryover - $7,125.00	
CECG Income - $20,000.00	CECG Expenses - $12,952.80

	Balance - $14,172.00
ECSS Income - $9,000.00	ECSS Expenses - ~$10,963.42
	(not all expenses are in yet)

Facilities/Instrumentation Purchases

Lab/Supplies for John Senko (Past CECG Postdoctoral Scholar) - $2124.98
Repair of research instrumentation for Tim White - $798.94
Purchase of Accelrys software - $10,000 (co-funded by MRI)

9. SUPPORT LETTERS FROM PENN STATE AND NON-PSU PARTNERS

Listed under Appendix A-5.

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APPENDIX A-1 – ACRONYM LIST

ACRE	Center for Advanced Carbon-Cycle Research and Education
ATM	Atmospheric Sciences
BRIE	Biogeochemical Research Initiative for Education
CECG	Center for Environmental Chemistry and Geochemistry
CEER	Center for Energy and Environmental Risk
CEKA	Center for Environmental Kinetics Analysis
CLAWS	Center for Land-Air-Water Studies
CNH	Coupled Natural and Human Systems
COE	College of Engineering
CZ	Critical Zone
CZEN	Critical Zone Exploration Network
EAR	Earth Sciences
ECOS	Eberly College of Science
ECSS	Environmental Chemistry Student Symposium
EESI	Earth and Environmental Systems Institute
EMS	Earth and Mineral Sciences
ESSC	Earth System Science Center
ETBC	Emerging Topics in Biogeochemical Cycles
GEO	Geosciences
IGERT	Integrative Graduate Education and Research Traineeship
NATIVE	Nittany Atmospheric Trailer and Integrated Validation Experiment
OCE	Ocean Sciences
REACCT	Regional Ecology, Atmospheric Chemistry & Climate Team
SOA	Secondary organic aerosols
STC	Science and Technology Centers

APPENDIX A-2: Proposed CLAWS Affiliates (Adapted from CECG Website Affiliates)

COLLEGE OF AGRICULTURE

Agricultural and Biological Engineering

Doug Archibald, Research Associate Crop and Soil Sciences
Jean Marc Bollag, Professor of Soil Microbiology
Mary Ann Bruns, Assistant Professor of Agronomy Soil/Micro
Jerzy Dec, Research Associate, Soil Chemistry
Sridhar Komarneni, Professor of Clay Mineralogy
Carmen Enid Martinez, Assistant Professor of Environmental Soil Chemistry

Agronomy

Hershcel Elliott, Professor of Agriculture and Biological Engineering
Jason Kaye, Assistant Professor

Horticulture

Dennis Decoteau, Professor

Plant Pathology

Gretchen Kuldau, Assistant Professor

School of Forest Resources

Hunter Carrick, Assistant Professor of Aquatic Ecology
David De Walle, Professor of Forest Hydrology
James Lynch, Professor of Forest Hydrology
William Sharpe, Professor of Forest Hydrology

COLLEGE OF EARTH AND MINERAL SCIENCES

Energy Institute

Sharon Miller, Research Associate

Energy and Geo-Environmental Engineering

Andre Boehman, Assistant Professor of Fuel Science; Director of the Combustion Lab
Subhash Chander, Professor
Serguei Lvov, Associate Professor
Sarma Pisupati, Assistant Professor of Fuel Science
Harold Schobert, Professor of Fuel Science

Geography

Derrick Lampkin, Assistant Professor

Geosciences

Sue Brantley, Professor, Director of Earth and Environmental Systems Institute, Director of Center for Environmental Kinetics Analysis
Matt Fantle, Assistant Professor
Ray Fletcher, Professor
Kate Freeman, Professor
Tanya Furman, Professor
Peter Heaney, Professor
Klaus Keller, Assistant Professor
Jim Kubicki, Associate Professor of Geochemistry
Lee Kump, Professor
Jenn Macalady, Assistant Professor
Hiroshi Ohmoto, Professor of Geochemistry and Director of the Penn State Astrobiology Research Center
Richard R. Parizek, Professor of Geology and Geo-Environmental Engineering
William B. White, Professor Emeritus of Geochemistry

Materials Science and Engineering

Carlo Pantano, Distinguished Professor, Director of Materials Research Institute
Jorge O. Sofo, Associate Professor

Meteorology

William Brune, Distinguished Professor and Head
Kenneth J. Davis, Associate Professor
Dennis Lamb, Professor
Ray Najjar, Associate Professor
Anne Thompson, Professor

EBERLY COLLEGE OF SCIENCE

Biochemistry and Molecular Biology

Jean Brenchley, Professor of Microbiology and Biotechnology
J. Greg Ferry, Stanley Person Professor
Ming Tien, Professor of Biochemistry

Biology

Charles Fisher, Professor of Biology

Chemistry

Harry Allcock, Evan Pugh Professor
A. Welford Castleman, Jr., Evan Pugh Professor of Chemistry and Physics**,** Eberly Distinguished Chair in Science
Peter Jurs, Professor of Chemistry
Tom Mallouk, DuPont Professor of Materials Chemistry
Robert Minard, Senior Lecturer, Emeritus
Karl Mueller, Associate Professor
Dan Sykes, Lecturer and Director, Analytical Instructional Lab

COLLEGE OF ENGINEERING

Chemical Engineering/Biotechnology Institute

Wayne Curtis, Professor
Darrell Velegol, Associate Professor

Civil and Environmental Engineering

William Burgos, Associate Professor of Environmental Engineering
Fred Cannon, Associate Professor
Brian Dempsey, Professor
Bruce Logan, Kappe Professor of Environmental Engineering
John Regan, Associate Professor
Richard Unz, Professor Emeritus of Environmental Engineering

Electrical Engineering

Tim Kane, Associate Professor

OTHER INSTITUTES, CENTERS, DEPARTMENTS

Materials Research Institute

Barry Scheetz, Professor of Materials, Civil, and Nuclear Engineering
William B. White, Professor of Geochemistry

Environmental Engineering, Penn State Harrisburg

Yuefeng Xie, Associate Professor; Director of Small Public Water Systems Technology Assistance Center

APPENDIX – A-3: Laboratory Facilities Affiliated Through the CECG (From CECG Website, 4/08)

High Resolution Magnetic Sector Inductively Coupled Plasma Mass Spectrometer (HR ICP-MS) is up and running in the CECG-sponsored analytical lab in 316 Hosler Building.

The following is a short listing of analytical or computational facilities available in the labs of individual affiliates of the CECG:

Harry Allcock -
- Gel permeation chromatography. Light scattering, electrical conductivity, hangmin-blodgett trough, DSC, T.G.A.

Andre Boehman -
- FTIR for gaseous emissions analysis
- Several gas chromatographs for species characterization
- Sierra instruments BG-1 mini-dilution tunnel for particulate collection
- R & P Co. Series 5100 diesel particulate analyzer for particulate composition analysis
- California Analytical hot Hydrocarbon analyzer

Susan Brantley -
- HR-ICP-MS (Finnigan Element) Dionex IC

Jean Brenchley -
- Microbiological Techniques
- PCR Equipment

William Burgos -
- Varian model 3400 gas chromatographs (two) equipped with Flame Ionization
- Thermal Conductivity and Electron Capture Detectors, and a Varian 8200 Autosampler Hewlett Packard Model
- 5890 Series II gas chromatographs (two) with Flame Ionization
- Thermal Conductivity and Electron Capture Detectors, and HP 6890 Autosampler
- Hewlett Packard 5890 Series IIG gas chromatograph fitted with Hewlett Packard
- 5972 Mass Selective Detector
- Waters 2690 High Performance Liquid Chromatographs (two) with a Waters 996 photodiode array detector and a Waters 2487 dual wavelength detector and Waters autosamplers
- Perkin Elmer Atomic Absorption Spectrometer
- Dionex 100 and Dionex 500 Ion Chromotographs, both with autosamplers

Fred S. Cannon -
- Accelerating Rate Calorimeter (CSI)
- Micromeritics 2000 Accelerated Surface Area and Porosimetry units (three)

- Thermogravimetric Analyzers (Cahn TG-131) with Flame Ionization Detector (SRI 110)
- Gas Chromatograph-Flame Ionization Detection unit (Hewlett Packard 5870)
- Bench-Scale Advanced Oxidation SonoperoxoneTM system, Furness-Newburge
- Atomic Absorption Spectrophotometer (Shimadzu AA-6601F)
- Ozone Analyzer (Dasibi Environmental Corp 1008-HC)
- UV lamp advanced oxidant generation systems
- Automatic Titrator (two) (Metler Toledo DEL 53),
- Ion Chromatography units (two) (Dionex 100 and 500)
- Activated Carbon Thermal Reactivation Pilot Furnace
- High Pressure Liquid Chromatography, - Ternary Gradient LC-95-33
- Supercritical Extraction unit (SFX 2-10)
- Liquid Scintillation Counter (LKB Wallac 1217 Rackbeta)
- Roto Evaporator (Buchi R-114) and Freeze Dryer (Lab Conco 4.5)
- Reverse Osmosis Units (Desal)
- Curie Point Pyrolyzer JHP-5/5S
- Japan Analytical Industry Co.

Hunter Carrick -
- My laboratory offers state of the art faculties to carry out aquatic microbial ecology research. Analytical capabilities include: radio-tracer experiments to measure metabolism and food web dynamics, oxygen microsensors and ultratitrators to assess metabolism, fluorometry to estimate photopigments, Coulometric carbon analysis (DIC, CDOM, and particulate carbon), Microscopy (DIC, phase, and epifluorescence), and facilities to support mesocosm experimentation (incubators, and plant growth chambers).

Subhash Chander -
- Zeta meter
- Tensionmeters for static and dynamic surface tension
- Potentiostat
- Device to measure contact angles
- Rheometer
- Surface charge determination by automatic titrator
- Rapid-Scan UV-VIS spectrophotometer
- Electroacoustic analyzer
- TOC (total organic carbon) analyzer

Wayne R. Curtis -
- Supercritical C02 extractor
- HPLC
- MC-A 1200 Mass Spec.
- access to Chemical Engineering Bioprocess Center equipment

Kenneth J. Davis -
- extensive field site in N. Wisconsin for the study of ecosystem-atmosphere exchange of CO_2, H_2O, energy and trace gases.

- tower based observations. Links to airborne and tethered platforms, as well as lidar and radar remote sensing technology.

Jerzy Dec -
The Laboratory of Soil Biochemistry in Penn State Institutes of the Environment (PSIE) has five laboratories for microbiological, biochemical, and physiological investigations with a total floor space of approximately 2800 square feet, and is equipped with:
- Two gas chromatographs (Hewlett-Packard with computers and data processing software)
- Two high-performance liquid chromatographs (Waters, with computers and data processing software)
- Supercritical fluid extractor SPE-400, Supelco
- Biological sample oxidizer OX 600 (R.J. Harvey Instrument Corporation)
- Liquid scintilation counter (Beta Trac 6805, Tracor Analytic)
- Photospectrometer UV-1601 (Shimadzu)
- Biological oxygen monitor (YellowSprings Instruments)
- System 200 Imaging TLC Scanner (Bioscan)
- Sorvall refrigerated superspeed centrifuge (RC-5Cplus) Incubators, shakers, autoclave, freeze-drier, pH meter, chloridometer

Peter Deines -
- Mass spectrometers and sample preparation facilities for the measurement of stable isotopes of carbon, oxygen and nitrogen

Brian Dempsey -
- Environmental Engineering Laboratories are approximately 16,000 sq. ft., including a 2,000 sq. ft. laboratory at the University Wastewater Treatment Plant (less than one mile from the Department of Civil and Environmental Engineering). Major equipment:
- AAS with flame and graphite furnace
- Various gas chromatographs
- HPLC
- Spectrophotometers
- Scintillation counters
- Carbon analyzers
- Particle counters
- Zeta Meter
- Axiophot microscope with image analysis and photometric detection
- Anaerobic and aerobic respirometry systems

Herschel Elliott -
- Atomic absorption, gas chromatograph, ion chromatograph

J. Greg Ferry -
- Protein purification equipment

Charles Fisher -
- Analytical: Gas Chromatograph (for dissolved gases in environmental samples)
- HPLC
- Scintillation counter
- Spectrophotometer
- Fluorometer
- Gel apparatus
- Assortment of contrifuges, balances, ovens, microscopes, and small lab equipment.
- Image analysis and mosaicising facilities
- A wide variety of specialized equipment for acquiring environmental samples using submersibles in the deep sea.

Kate Freeman -
- Molecular and Isotopic Biogeochemical facilities at Penn State University include laboratory equipment, glassware and supplies for extraction and isolation of organic materials from rock, sediment, soil and water samples and a wide array of chromatographic techniques. Multiple high-resolution gas-inlet stable-isotope mass spectrometers are available, and are equipped with conventional dual inlet systems, combustive and reductive elemental analyzers and a GC interface for compound-specific isotopic (13C, D) analyses.

Peter C. Jurs -
- Three DEC workstations, numerous PCs.

Sridhar Komarneni -
- Autosorb -1 for N2 adsorption-desorption isotherms for porosity, pore-size distribution and surface area determination. Water adsorption-desorption device - home built.

Jim Kubicki -
- Octane, MXE workstation and Cerius2 molecular modeling software.

Lee Kump -
-Autoanalyzer II for automated analysis of nutrient concentrations in aqueous samples. Polarographic analyzer for trace metal speciation of aqueous samples.

Dennis Lamb - Ion chromatography (IC)

Bruce Logan
- Atomic force microscopes (2)
- Microbial fuel cell laboratory
- Image analysis and fluorescent microscopies
- Particle counters (Coulter and laser; liquid samples)
- Dissolved organic carbon
- Gas, liquid and ion chromatography
- Pure culture bioreactors
- Anaerobic glove box

Serguei Lvov -
- Hydrothermal reactors
- Potentiometric cells
- Electrochemical kinetics cells
- Electrophoresis cells
- Electronic devices
- Fuel cell systems
- Conductivity cells
- Lab has most of the essential facilities and resources for conducting electrochemical, electrochemical kinetics, and electrokinetic studies in high temperature aqueous environments

Robert Minard -
- HPLC, GC, GC-MS, LC-MS, NMR, IR UV/Vis, Polarimetry, Synthesis

Ray Najjar -
- Sun Workstations

Hiroshi Ohmoto -
- 3 mass spectrometers for stable isotope analyses
- Carbon, nitrogen, sulfur and hydroflex elemental analyzer; X-ray chemical microscope; liquid chromatography

Carlo Pantano -
- glassmelting and fiberdrawing facilities
- microscopy and surface analysis
- thin films by sputtering, evaporation and sol/gel

Richard R. Parizek
- 546 Deike, clean organic laboratory facilities provided by Kate Freeman, Associate Professor of Geosciences and newly renovated hydro lab 326 Deike.

John M. Regan -
- Real-time PCR thermocycler
- Electrophoresis and gel documentation equipment
- Epifluorescent microscope with video, color CCD, Polaroid, and 35-mm imaging

Barry Scheetz -
- Automated x-ray diffractometer
- Lauie diffractometer
- Full thermal analysis capabilities

William Sharpe -
- Soil processing and extraction

John M. Skelly -
- Continuously stirred tank reactor chamber facility licor 6200; 6400
- Air Quality Monitoring; Ozone

Bradley A. Striebig -
- Gas chromotography
- Mass spectrometry
- Flame ionization detector
- Ozone analyzers
- Ozone generators
- pH meters
- DO meter
- Hach spectrophotometer
- Gas standards generator
- UV reactors
- moisture meters
- temperature probes
- personnel samplers
- Draeger CMS
- relative humidity meter

Dan Sykes -
- HP GC-FID (7)
- Shimadzu GC-MS with purge and trap
- HP GC-μECD
- Shimadzu HPLC w/PDA
- Shimadzu HPLC w/standard UV-VIS (2)
- Dinoex IC
- Bruker 400 MHz NMR variable T/liquid/solids capable (departmental)
- SensIR FTIR microscope
- Bruker bench FTIR near/mid-IR w/ATR
- Nicolet bench FTIR near/mid/far-IR w/Orbit
- DeltaNu Raman spectrometer red-line (instructional grade)
- Perkin-Elmer Fluorimeter
- Shimadzu Fluorimeter
- Varian Flame AA
- Leica polarizing light microscope (5)
- Leica microtome

Darrell Velegol -
- microelectrophoresis with video microscopy
- laser trapping
- bacterial cell culturing

William B. White -
- Infrared and Raman spectroscopy

Yuefeng Xie -
- Two gpm conventional drinking water treatment pilot plant
- Gas chromatograph
- Gas CHromatograph/mass spectrometer
- Atomic absorption spectrophotometer
- Water and wastewater pilot filters

APPENDIX A-4

CVs from:

Director: Anne M. Thompson
Associate Director: Ming Tien

Dr. Anne M. Thompson

Department of Meteorology, Penn State University
503 Walker Building, University Park, PA 16802
anne@met.psu.edu; 814-865-0479; fax-814-865-3663
http://www.met.psu.edu/dept/faculty/Thompson_A.htm

RESEARCH EXPERTISE:
Atmospheric Chemistry: Modeling and measurements of trace gases, air-sea gas exchange, ozone and convective systems, lightning, biomass burning. Remote sensing: Applications – various sensors. Global Change: Simulation of future and pre-industrial troposphere. Observations: Strategic ozonesonde networks.

EDUCATION:
1970 - B.A., Chemistry (Honors), Swarthmore College
1972 - M.A., Chemistry, Princeton University
1978 - Ph.D., Physical Chemistry, Bryn Mawr College

POSITIONS:

1978 - 1979	Woods Hole Oceanographic Institution, Woods Hole, MA, Postdoctoral Scholar
1979 - 1981	UC-SD - Scripps Institution of Oceanography, LaJolla, CA, Postgraduate Marine Chemist
1981 - 1984	National Center for Atmospheric Research (NCAR), Boulder, CO, Visiting Scientist; ASP Postdoctoral Fellow
1984 - 1986	Applied Research Corporation, Landover, MD, Contract Scientist at NASA/GSFC
1986 - 2004	Physical Scientist, Atmospheric Chemistry and Dynamics Branch, Lab. for Atmospheres, NASA/Goddard Space Flight Center, Greenbelt, MD
1995 -	Adjunct Faculty, Univ. Maryland-College Park, Atmospheric & Oceanic Sciences Dept.
2005 -	Professor, Penn State University, Meteorology Department

MEMBERSHIPS:
AAAS, AMS, AGU -- Member and Fellow; AWIS; Am. Chemical Society

AWARDS:
1970 BA with Honors (External Examination), Phi Beta Kappa, Sigma Xi, Phila. Chapter ACS Best Student Award; NSF Predoctoral Fellowship
1987, 1989, 1995, 2003 GSFC Director's Discretionary Fund
1990-1996, 1998-2002 GSFC Performance Awards
1992 Goddard Equal Opportunity Award;
1993, 2001 GSFC Lab. for Atmospheres Peer Award for Outstanding Leadership
1995 NASA Exceptional Achievement Medal.
1995 Fellow, American Meteorological Society (AMS)
1998 Nordberg Medal, COSPAR (Committee for Space Research)
2002 Fellow, American Association for Advancement of Science (AAAS)
2003 Fellow, American Geophysical Union (AGU)
2004 Women in Aerospace, International Achievement Award
2004 NASA Honor Award (SHADOZ Group Achievement)
2004 ISI - Highly Cited Author (Geosciences)
2007 William T. Pecora Award for Satellite Achievement (NASA/Dept. Interior to TOMS Team)
2007 Wilson Award for Excellence in Research (Penn State Univ, College of Earth and Mineral Sciences)
2007 NOAA OAR Outstanding Paper Award for IONS-04 (Cooper et al, *JGR*, 2006)
2007 UNEP/WMO Recognition Letter (for Nobel Peace Prize IPCC Contributions)

SPECIAL EXPERIENCE: **Research & Projects**
1. PI on NASA Project: "Tropospheric Photochemical Modeling" 1984-present. Also PI on EPA and NOAA Interagency Agreements, 1985-present.
2. EOS-IDS Teams: Stratospheric Chemistry and Dynamics (M. Schoeberl, PI); Biogeochemical Fluxes at Air-Sea Interface (P. Brewer, PI); Chemistry-Climate Interaction (D. Jacob, PI), 1988-1995.

3. NASA Satellite & Aircraft Science Teams: TOMS Satellite, 1994-2004; GTE/TRACE-A; PEM-Tropics-B, TRACE-P; UARP/ STRAT, POLARIS, ACCENT, SAFARI-2000; INTEX-NA (2004), INTEX-B (2006), TC4 (2007), ARCTAS (2008)
4. Oceanographic cruises, *Knorr 73/7*, 1978; Soviet-American Gases and Aerosols (SAGA 3), 1990; Aerosols99 Cruise, *R/V R H Brown,* 1-2/99; NEAQS, July 2004
5. Co-Mission Scientist, SONEX (SASS Ozone and Nitrogen Experiment), 1997
6. NASA HQ Detail: Project Scientist, AEAP/Subsonic Assessment, HQ Office of Aeronautics, 1993-1994
7. SHADOZ PI (Southern Hemisphere Additional Ozonesondes, 1997-present) and Field Work - Aerosols99 Cruise, PAUR II, 1999 (Crete); SAFARI-2000, Zambia
8. IONS (INTEX Ozonesonde Network Study) PI, 2004; 2006. Ozonesonde Field work at INTEX-B/Milagro in Mexico City & Richland, Washington, 2006, TC4 at Panama, 2007.

Service & Committees

1. AGU: Education and Human Resource Committee, 1986-1988; Editorial Advisory Board, *Earth in Space*, 1988-1990; Secretary, AGU Atmospheric Sciences Section, 1990-1992; AGU Publications Committee, 1994-1996; Associate Editor, *Journal of Geophysical Research*, 1992-1996; Chair, GRL Editors Search Committee, 1995-1996; Member, JGR-Atmospheres Editors Search Committee, 1996; Chair, 1999-2000.
2. AMS: Atmospheric Chemistry Committee, 1996-1998; AMS Council and Executive Council, 2001-2004; Nomination Committee, 2004-2007
3. International Societies: (A) Commission on Atmospheric Chemistry and Global Pollution (CACGP), 1994-2002. President, 2002-2006. (B) Member, International Ozone Commission, 1996-2004; Program Committee, Quadrennial Ozone Symposium (1992). (C) IGBP/IGAC Steering Committee (2000-2002)
4. Global Change and Assessments: Rapporteur, Workshop on UV Effects on Aquatic Systems, 1989; Working Group 1, IPCC (Intergov. Panel on Climate Change) 1989; Rapporteur, NASA/NOAA /EPA Workshop on Global Warming Potentials, 1990; Lead Author, Tropospheric Ozone Chapter, UNEP/WMO 1998 Ozone Assessment.
5. NSF-NAS/NRC: Chair, NSF, NCAR-Atmos. Chemistry Div. Review Panel, 1996. NAS/NRC Committee - Major Ocean Programs (1996-1998); NAS/NRC Climate Research Committee (1996-2000): NAS/NRC Earth from Space Committee (2006-2007)
6. AAAS: Member-at-Large (2002-2005); Council (Section W, 2005-2007); Chair-Elect (Section W, 2007-2008)
7. UCAR/NCAR, University Relations Committee, 2005-2006; Board of Trustees, 2006-2008
8. WMO: Committee on Atmospheric Science, Management Advisory Council, 2006-2008

Education & Outreach

1. Adjunct Professor - University of Maryland Earth Systems Science Interdisciplinary Center (ESSIC), 2000-present; previously JCESS Fellow, 1995-2000. Course Taught: Atmospheric Chemistry & Physics, 2002.
2. Adjunct Research Professor (Thesis Committees): Univ. Miami (Rosenstiel School), NC State, Florida State Univ.
3. Students Advised/Co-advised: PhD -- C. Herbster, Florida State Univ. (1998), S. A. Yvon, U. Miami (1990-95); J-H Kim, U. Maryland (1996), D. J. Allen (1998); Masters -- C. Phelps, U. Maryland (1995), R. M. Todaro, U. Maryland (1997), H. Guo, U. Maryland (1999); M. G. Seybold, NC State (1999); J B. Stone, PSU (2006); S. M. Michaels, PSU (2006); A. Loucks, PSU (2007); D. Giles (U. Md., 2007); J. E. Yorks, PSU (2007); W-C Hui, PSU (2008); K. M. Dougherty, PSU (2008).
4. External Examiner or Student Host/Co-author: G. Bodeker (U. Natal, So. Africa, 1995), D. Jeker (ETH-Zürich, 1999), K. Longo (U. Sao Paulo, 1998), W. Peters (U. Utrecht, Netherlands, 2002)
5. GSFC Programs: Summer Institute Atmos. Sciences, Coordinator 1987-1989; Education Office, Public Affairs Speaker, 1988-Present; Summer Advisor: 1989, D. Davidoff, Yale; 1996, N. Dang, UNH; 1993-94, K. Patterson, Salisbury State and UCSB; 1996, M. Lakin, UC-Irvine; 2003 E. Deviatova, UMCP
6. Courses Taught: Penn State - Meteo 565: Middle Atmosphere, Meteo 532, Chemistry of the Atmosphere; Meteo 436: Atmospheric Physics I; Meteo 440W, Meteorol. Measurements; Meteo 597, Remote Sensing
7. NCAR - Advanced Study Program, Philip D. Thompson Lecturer, 2005
8. Penn State Committees: Meteorology MS: 2005: A. Metcalf; K Bailey; 2006: C. Beatty; 2007: M Root, A K. Huff, D. M. Shelow. PhD - J. Mao (Meteorology, 2007), J.H. Park (Elec. Engineering, 2008)

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i. Professional Preparation

B.A. Anthropology, University of Michigan, Ann Arbor, Michigan 1975
Ph.D. Biochemistry, Michigan State University, East Lansing, Michigan 1981
Postdoctorate Associate 10/81-6/82 with Steven D. Aust at Michigan State University
Postdoctorate Associate 7/82-8/83 with T. Kent Kirk at Forest Products Laboratories

ii. Appointments

Full Professor	8/93-present	Pennsylvania State University
Associate Professor	8/87-8/93	Pennsylvania State University
Assistant Professor	10/85-7/87	Pennsylvania State University
Research Chemist	8/83-9/85	Forest Products Laboratory, Madison, WI

iii. Publications in Journals (from over 100)

Five most relevant

1) Tien, M., and Kirk, T.K. (1983) "Lignin-Degrading Enzyme from the Hymenomycete *Phanerochaete chrysosporium* Burds." Science 221, 661-663.
2) Tien, M. and Tu, C.-P. D. (1987) "Cloning and Sequencing of a cDNA for a Ligninase from *Phanerochaete chrysosporium"* Nature, 326, 520-523.
3) Zapanta, L.S., Hattori, T., Rzetskaya, M. and Tien, M. (1998) “The Cloning of *Phanerochaete chrysosporium leu2* by Complementation of Bacterial Auxotrophs and Transformation of Fungal Auxotrophs” Appl. Environ. Microbiol. 64, 2624-2629
4) Abbas, A., H. Koc, F. Liu, and M. Tien, Fungal degradation of wood: initial proteomic analysis of extracellular proteins of *Phanerochaete chrysosporium* grown on oak substrate. Curr. Genet., 2005. **47**(1): p. 49-56.
5) Sato, S., F. Liu, H. Koc, and M. Tien, *Expression analysis of extracellular proteins from Phanerochaete chrysosporium grown on different liquid and solid substrates.* Microbiology, 2007. **153**: p. 3023-3033.

Five others

1) Tien, M. and Kirk, T.K. (1984) "Lignin-Degrading Enzyme from *Phanerochaete chrysosporium*: Purification, Characterization, and Catalytic Properties of a Unique H2O2-Reguiring Oxygenase" Proc. Natl. Acad. Sci. U.S.A., 81, 2280-2284.
2) Bumpus, J.A., Tien, M., Wright, D., and Aust, S.D. (1985) "Oxidation of Persistent Environmental Pollutants by a White Rot Fungus" Science, 228,1434-1436.
3) Stewart, P., Whitwam, R. E., Kersten, P. J., Cullen, D., and Tien, M. (1996) "Efficient Expression of a *Phanerochaete chrysosporium* Manganese Peroxidase Gene in *Aspergillus oryzae*" Appl. Environ. Microbiol. 62, 860-864.
4)Varela, E. and M. Tien, *Effect of pH and Oxalate on Hydroquinone-Derived Hydroxyl Radical Formation during Brown Rot Wood Degradation.* Appl. Environ. Microbiol, 2003. **69**(10): p. 6025-6031.
5) Varela, E., T. Mester, and M. Tien, *Culture conditions affecting biodegradation components of the brown-rot fungus Gloeophyllum trabeum.* Arch. Microbiol., 2003. **180**(4): p. 251-256.

Synergistic Activity

The PI is actively involved in interdisciplinary research and teaching at Penn State University. The PI initiated, along with two other faculty members, the Chemical Biology Option of the Life Science consortium. These options created new graduate training

programs that spanned not only departments but also colleges here at Penn State. The PI just recently stepped down after serving three years as the program co-director.

The PI is also serves on the steering committee of BRIE (Biogeochemical Research Initiative for Education). BRIE is support by Penn State and also by the NSF Integrative Graduate Education and Research Traineeship Program (IGERT). The PI is also on the steering committee for the Penn State Center for Environmental Chemistry and Geochemistry (CECG). CECG is another inter-college program involved in sponsoring research and educational activities on campus. Most recently, the PI and 11 other Penn State investigators were successful in establishing an NSF-funded EMSI (Environmental Molecular Science Institute) named CEKA (Center for Enviromental Kinetic Synthesis). He serves on the Steering committee for CEKA. Outreach activities for the PI include sponsoring summer REU students for the past 6 years.

The PI also serves on the college level and the department level (chair) Climate and Diversity Committee. This committee, among other missions, focuses on recruitment and retention of under-representated groups.

Collaborators (past 4 years)

Banci, Lucia (Univ. of Florence), Berlett, B. S. (NIH), Bertini, I. (Univ. of Florence), Chock, P. B. (NIH) Natan, M. (Nanoplex Technologies, Inc.), Stadtman, E. R., (NIH) Ambert-Balay, K. (Penn State), Ciofi-Baffoni, S. (Univ. of Florence) Cullen, D. (Univ. of Wisc.). Gaskell, J. (Univ. of Wisc.), Hatcher, P. G. (Ohio State University) Hattori, T. (Univ. of Kyoto), Levine, R. L. (NIH), Pell, E. J. (Penn State).

Graduate Students Advised (past 5 years)

Hernan Romero (Penn State University), Laura Zapanta (Science Editor, Academic Press), Ross Whitwam (Faculty, Mississippi State University), Shane Ruebush (postdoc, Montana State Univ.), Dan Ross, Camille Stephen, Fang Cong, Yufeng Qian, Prashanti Iyer

Post-doctoral Scholars Supervised (past 5 years)

Elisa Varela (Penn State University), Tunde Mester (Penn State University), Katia Ambert-Balay, Shin Sato, Emily Fleming and Ruth Helmus.

Graduate and Post-Graduate Advisors

Graduate advisor: Steven D. Aust, Department of Chemistry, Utah State University
Postgraduate advisor: T. Kent Kirk, University of Wisconsin, Department of Bacteriology, Emeritus

APPENDIX A-5

Support Letters from:

Penn State: Brune (Meteorology), Fantle (Geosciences), Kane (Elec Engineering), Kubicki (Geosciences), Lampkin (Geography).

Potential Non-PSU Partners: N. M. Donahue (Carnegie-Mellon U.), A. Elmore (Frostburg U.), J. D. Fuentes (U. Virginia), W. R. Stockwell (Howard U.)

CLAWS
PENNSTATE
1855
Department of Meteorology
College of Earth and Mineral Sciences
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The Pennsylvania State University
503 Walker Building
University Park, PA 16802-5013

20 April 2008

Professor Anne Thompson
Department of Meteorology
Pennsylvania State University
University Park, PA 16802

Professor Thompson:

I am strongly in favor of the holistic approach that you and your colleagues have adopted for the Center for Land-Air-Water Studies (CLAWS). This Center draws on the considerable strengths within the College of Earth and Mineral Sciences and couples them to additional strengths at collaborating universities. This effort is truly interdisciplinary and multi-disciplinary.

I clearly see a role in CLAWS for the faculty members in the Department of Meteorology. In the Earth system, a substantial amount of chemistry that affects life on Earth's surface occurs in the atmosphere. Yet this atmospheric chemistry is directed by the meteorology that contains winds for transport and clouds for transformations. Studying atmospheric chemistry requires studying meteorology. Thus, CLAWS is an opportunity for more Meteorology faculty members with a wide range of expertise to get involved in this interdisciplinary research.

CLAWS presents new opportunities to tie into the national and international focus on solving complex, multidisciplinary problems. CLAWS is well positioned to respond to the impending strategic vision from the NSF Division of Geosciences, which will call for a more comprehensive approach to solving problems in the Earth sciences, many of which have high societal relevance.

I and, I believe, many of my colleagues in Meteorology wholeheartedly support CLAWS and its concept. The real connection of air with water and land is ripe for research. CLAWS gives researchers from Penn State and collaborating universities the platform from which to launch several efforts to improve the understanding of the land-air-water system, which has impacts on people and their environment.

Sincerely,

William H. Brune
Professor and Head of Meteorology

PENNSTATE

Phone: 814.863.9968 Fax: 814.863.7823

Department of Geosciences

Dr. Matthew S. Fantle
212 Deike Building
The Pennsylvania State University
University Park, PA 16802
mfantle@geosc.psu.edu

Dr. Anne Thompson
Dept. of Meteorology
Penn State University
University Park, PA 16802

Dear Dr. Thompson,

Please accept this letter as proof of my support for your proposed Center for Land-Air-Water Studies (CLAWS). Having served on the CECG board briefly before the most recent call for new centers, I am somewhat aware of the importance of the various centers to the University's research community. I have been especially impressed by the annual CECG-sponsored student symposium and the ability of the CECG to bring researchers from many different disciplines together.

Personally, I am extremely excited at the prospect of integrating my current research involving dust generation in arid environments into a larger scale, interdisciplinary project that examines the issues of dust transport, chemical transformations of mineral dust in aerosols, deposition in the ocean, and utilization by organisms. I eagerly anticipate the cooperation between atmospheric modelers, chemists, biochemists, and those in the remote sensing community, all brought together by CLAWS.

In particular, I look forward to building on the successes of the CECG through CLAWS. It appears that CLAWS will carry forward those aspects of CECG that are so valued by the community, such as the student symposium and interdisciplinary research, while at the same time adding interesting new sensing capabilities and instrumentation (such as NATIVE). I am eager to help propel the new center forward and look forward to producing novel research through the interactions supported by CLAWS.

Sincerely,

Matt Fantle

Dr. Matthew Fantle
Assistant Professor
Geosciences

PENNSTATE

Tim Kane
Professor
Depts. of Electrical Engineering and Meteorology

PHONE: (814) 863-8727
FAX: (814) 865-7065
E-MAIL: tjk7@psu.edu

121 Electrical Engineering East
The Pennsylvania State University
University Park, PA 16802

April 20, 2008

Dr. Anne Thompson
Dept. of Meteorology
Penn State University
University Park, PA 16802

Dear Dr. Thompson,

I am writing this letter in support of your proposed Center for Land-Air-Water Studies (CLAWS). I believe we are on the right track here, and I am excited to participate! The Earth Sciences have evolved, and looking *forward* requires an interdisciplinary approach, just as you have outlined. Getting a broad collection of varied scientists working together, with a few engineers thrown in the mix for good measure, is the way to go!

I can speak from the point of view of the remote sensing community, which I hope will be a crucial part of CLAW. I can definitely see roles for remote sensing faculty members from several colleges in your center. In reciprocation, I can see CLAW being a catalyst for our current efforts to unify existing remote sensing efforts and coursework across campus (including the grad level Meteo class that you and I team-taught this semester).

In summary, I look forward to active participation in CLAW, as well as encouraging other colleagues in the college of Engineering to join in. As the science and associated funding for land, air, and water research requires a more comprehensive approach, CLAW will enable Penn State to be a true leader in the field!

Sincerely,

Tim Kane

PENNSTATE

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814-865-6711

Support Letter from J. Kubicki

April 20, 2008

Dr. Anne Thompson
Dept. of Meteorology
The Pennsylvania State University
University Park, PA 16802

James D. Kubicki
Dept. of Geosciences
The Pennsylvania State University
University Park, PA 16802

Professor Thompson:

I wholehearedly endorse the ideas you have set forth in your description of the Center for Land-Air-Water Studies (CLAWS). The possibility to work on bringing together research at PSU and other partner institutions to focus on common issues related to air-land-water interfaces has re-energized me to put effort into organizing multi-disciplinary research groups.

I believe CLAWS will position Penn State to take advantage of the increasing number of calls for interdisciplinary research centers to deal with environmental and energy problems facing our nation. Furthermore, the institutionalization of contacts with institutions serving under-represented groups will help to diversify the research community at PSU.

The engagement of new faculty in CLAWS to expand and revitalize the past efforts of CECG is something we have been striving for within CECG for the past few years. Your focus on the ability to attract large grants should be a prime motivating factor to engage more faculty in the interdisciplinary team-building effort. It has been my experience that this factor more than any other has the power to bring our colleagues together for serious discussions.

Yours truly,

James Kubicki

Support Letter from Prof. Derrick J. Lampkin, Penn State University

Dear Dr. Thompson,

The contemporary challenges we face force us to confront the inherent complexities of our terrestrial system. Many of these critical issue lie at the nexus of several well defined subdisciplines. We intrinsically know these boundaries are artificial and now is the time to address the concerns with greater conviction. This seemingly herculean task cannot be accomplished without a creative frame work for drawing scientists and specialists together. I deeply feel the proposed Center for Land-Air-Water Studies (CLAWS) at the Pennsylvania State University is a unique organization that has the capacity to provide a synergetic environment. As an assistant professor in Geography, with research interests spanning snow hydrology dynamics, I find my participation in this organization an opportunity to support greater collegiality which first and foremost fosters deep intellectual exchange. Intellectual exchange necessary to incubate creative, high risk, high reward research. Given the Dean of the College of Earth and Mineral Sciences expressed interest in fostering greater avant garde work, I believe this proposed center has the capacity to answer our deans challenge. With this letter, I expressed my full support of CLAWS and commit my time and effort to supporting the mission of this organization.

Sincerely,
Derrick J Lampkin

Assistant Professor
Department of Geography

Graduate Faculty
Department of Geoscience

Room 313 Walker Building
phone [office]: 814-865-2493 email: djl22@psu.edu
[cell]: 520-331-8455

Support Letter from Prof. Neil M. Donahue, Carnegie Mellon University

Dear Anne,

I would be delighted for the Carnegie Mellon University Center for Atmospheric Particle Studies to have the opportunity to collaborate with your Center for Land-Air-Water Studies. CAPS has 5 core faculty members, myself, Spyros Pandis, Allen Robinson, Peter Adams, and Cliff Davidson. Between us we bring a wide range of disciplinary perspectives and expertise to the study of atmospheric particulate matter, including primary sources, atmospheric transformation, particle-water interactions, particle microphysics including cloud formation parameterizations for global climate modeling, particle deposition, and health effects. Broader relationships with researchers focused on atmospheric chemistry and hydrology would be of significant interest. I look forward to a close relationship!

Neil

Professor Neil M. Donahue
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and Engineering and Public Policy
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EESI
Pennsylvania State University

April 20, 2008

Dear Colleague,

This letter is written to support and to express my sincere interest in your proposed EESI center, CLAWS (Center for Land-Air-Water Studies). It is my belief that the frontier of science exists at the interface of basic science disciplines. In my own academic activities I have attempted to elucidate interactions between geology, hydrology, and ecology, to provide insight into many aspects of land and resource management. I would therefore very much benefit from interaction with an interdisciplinary center such as CLAWS.

The University of Maryland Center for Environmental Science - Appalachian Laboratory (UMCES-AL) is dedicated to the study of terrestrial and freshwater ecosystems. We seek to determine the effects of natural and human-induced changes on organisms, landscapes, and biogeochemical and hydrological cycles. Our faculty advise graduate students through the University of Maryland Marine, Estuarine, and Environmental Science Graduate Program.

Located just 2 hours south of Pennsylvania State University, UMCES-AL is ideally situated to collaborate on externally funded research and assist in advising graduate at the proposed EESI center. I greatly look forward to developing a working relationship with PSU faculty.

Sincerely,

Andrew J. Elmore
Assistant Professor

UNIVERSITY of VIRGINIA
DEPARTMENT of ENVIRONMENTAL SCIENCES

April 19, 2008.
Professor Anne M. Thompson
Department of Meteorology, Penn State University
503 Walker Building, University Park, PA 16802-5013

Dear Anne,

With this letter I offer my enthusiastic support for the establishment of your Center for Land-Air-Water Studies (CLAWS). As you know, here at the University of Virginia we have been working on establishing partnerships with faculty members from several universities and colleges in the mid-Atlantic region. The purpose of such partnerships is to undertake investigations on regional climate, ecology, and air quality in response to land use changes and atmospheric warming. We will be delighted to collaborate with your Center and provide a wide range of disciplinary expertise in ecological, atmospheric boundary layer, atmospheric chemistry, climate dynamics, and hydrologic processes. Working closely with your Center, we will forge broader interactions with the view of jointly defining research activities and proposing such initiatives to federal government funding agencies. In particular, we envision working with your Center on initiatives such as the ones supported by the National Science Foundation on the Integrative Graduate Education and Research Traineeship (IGERT), Science and Technology Centers (STC), Emerging Topics in Biogeochemical Cycles (ETBC), and Opportunities for Enhancing Diversity in the Geosciences (OEDG). Between your group at Penn State, other partners, and us here at the University of Virginia we bring a wide range of disciplinary perspectives and expertise to the study of the timely topics you have outlined in your proposal for the Center. As you know our mid-Atlantic partnerships include researchers from majority (e.g., University of Virginia) and minority (e.g., Hampton University) institutions. Such interactions will allow scientists from under-represented groups to participate in broader relationships with researchers focused on regional climate, ecology, hydrology, and air quality investigations.

Given the national trends in extramural funding opportunities, the creation of your Center is timely as funding agencies are increasingly encouraging more interdisciplinary research and integration of research results in a broader context. Your Center will not only count on critical mass in the scientific expertise required to pursue environmental sciences research but also include national research leaders. My team and I look forward to collaborating with your Center to undertake truly interdisciplinary research.

Sincerely,

Jose D Fuentes

Professor
Department of Environmental Sciences

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April 18, 2008

SUBJECT: Letter of Support for an EESI Center Dedicated to Basic Studies of Critical Interfaces Across the Earth System

Dear Colleague:

This letter is written in support of an EESI center that would focus on fundamental scientific studies of the linkages between critical interfaces within the earth system. At Howard University we have a vibrant program that produces approximately half of all African-American Ph.D.s in the atmospheric sciences in the United States. Our atmospheric science program is a joint effort between the departments of Chemistry, Physics and the College of Engineering.

Howard University faculty have a number of successful collaborations with Dr. Anne Thompson including studies of biospheric and anthropogenic emissions, solar radiation measurements and ozonesondes at Howard University's Field research campus at Beltsville, MD. I have been working with Dr. Thompson and other PSU faculty on an NSF funded study titled: "What is a 'Better' Prediction System: Combining Statistical and Economic Metrics of Prediction Quality." Where the purpose is to evaluate the net economic utility of air quality of air quality forecasts.

Creation of the proposed center would greatly strengthen our joint ability to compete for new grants including NFS's Interdisciplinary Graduate Education and Research Training (IGERT) program. The new EESI center would facilitate our joint efforts to assemble an IGERT team that would include Howard University as a partner.

Therefore I strongly support the creation of the proposed new center at PSU and I look forward to continuing to working with PSU faculty.

Sincerely,

William R. Stockwell
Associate Professor of Chemistry