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I. DESCRIPTION

1.1 Exact Designation: Master of Science in Atmospheric Science

1.2 Department: Atmospheric Sciences

1.3 School or College: College of Earth Systems

1.4 Unit: South Dakota School of Mines and Technology

1.5 Describe How the Program Fits into the Organizational Structure of the Campus.

The Department of Atmospheric Sciences offers one of the six science-oriented Master's degrees at SDSM&T and offers the Atmospheric Resources track in the Atmospheric, Environmental, and Water Resources (AEWR) Ph.D. degree program. The Chairman of the Atmospheric Sciences Department reports to the Dean of the College of Earth Systems and works with the Director of the Institute of Atmospheric Sciences to coordinate academic and research-related activities.

1.6 Current Area(s) of Concentration: Specify the current areas of concentration in the programs.

The Atmospheric Sciences program has two specializations. One is in the area of meteorology and the other in earth systems science. Within the meteorological-specialization there are several areas of concentration. These include physical and dynamic meteorology with coverage of the areas of cloud and precipitation physics and dynamics, and also radar meteorology, atmospheric electricity, radiative transfer, climate, and mesoscale meteorology. Within the earth systems specialization there is study available in atmospheric chemistry, biogeochemistry, land-surface remote sensing and modeling, global biogeochemical cycles, and modeling of complex systems.

1.7 Program Changes Planned: What changes, if any, are planned in the program during the next several years?

- We plan to further develop and refine coursework in both specializations in the M.S. program and enhance the rigor and structure of the AEWR Ph.D. program.
- We are developing stronger links with other undergraduate and graduate departments on campus.
- In addition, we are looking at how best to develop a program fitting the needs of students interested in private-sector employment or in starting their own business. We will work with the M.S. program in Technology Management (TM) to identify ways for our students to incorporate some TM courses into their programs.
- We also plan to develop a pilot program for a summer workshop for pre-college science teachers in areas of the atmospheric sciences, including both classroom
instruction and research, and field studies. This might be done in collaboration with other departments on campus, such as the Department of Geology and Geological Engineering, which runs a field camp program currently focused on geology.

- A new area for development will be wildfire meteorology. New state funding for a fire meteorologist position and developing relations with the NWS fire weather program and the South Dakota State Office for Wildfire Suppression will build upon existing areas of expertise to enable development of study areas related to the wildfire problem. Because wildfire meteorology includes components of many disciplines such as hydrology, ecology, remote sensing, and meteorology, we hope to build an interdisciplinary program using departmental expertise in these areas to train a new generation of fire meteorologists through our program.

- We also will continue to develop and update coursework in the areas of biosphere/atmosphere interactions, climate change, and other areas of our curriculum characterized by rapid growth in new knowledge.

II. PROGRAM OBJECTIVES

2.1 Statement of Program Objectives: This program is designed to accomplish the following objectives:

The primary objective of the Master of Science in Atmospheric Sciences program is to bring students to an understanding of the basic factors controlling weather, and to understand the major components of the earth-biosphere-atmosphere system and their interactions. These include solar and terrestrial radiation; laws of fluid motion and thermodynamics as applied to the atmosphere; physical, chemical, and radiative processes in clouds; global ecological and biogeochemical cycles, and atmosphere-land-surface interactions. A sub-objective is to educate students in the acquisition and interpretation of conventional weather data, satellite data, and radar data; and observations collected by specially-instrumented platforms such as aircraft, trace gas flux towers located above various terrestrial ecosystems, and tethered balloon systems. Students will learn how to evaluate and analyze and visualize such data using various types of data-processing and display equipment. Graduate students are expected to carry out original research in the atmospheric sciences and participate in disseminating their results at conferences and through the scientific publication process.

2.2 Relationship to Existing Unit Mission and Academic Plan: Describe, including relationship to existing department(s) or functional equivalent.

The M.S. program in Atmospheric Sciences is the flagship of the Department of Atmospheric Sciences, which is part of the College of Earth Sciences. It supports the college mission to educate students to function at their highest possible levels, and to develop their problem-solving abilities.

2.3 Relationship to Institutional Mission: Describe how this program fits into the institution's academic plan.

The M.S. program in Atmospheric Sciences prepares students for an enhanced quality of life through both educational and social interactions. The program broadens students’ educational experience with 24 or more hours of graduate-level coursework in diverse areas of the atmospheric and earth system sciences as well as related fields. Students contribute to the expansion of knowledge through basic research and scholarship as they serve as graduate
research assistants to faculty on research projects funded by various local, state, and federal agencies. All students prepare theses describing the results of their efforts. Almost all theses lead to conference presentations by the students themselves or by their faculty supervisor. Roughly half of these theses serve as the basis for formal publications in the refereed literature. Faculty expertise is applied to regional and global needs in atmospheric research with support from external research grants. Faculty perform state-of-the-art research in satellite remote sensing, meteorological radar analysis, numerical modeling of cloud and mesoscale processes, analysis of field data from diverse combinations of platforms, and complex interactions between components of the earth system such as biosphere-atmosphere exchanges of mass and energy.

2.4 Closely Related Unit Programs and Areas of Strength: List other closely related programs or areas of strength currently offered or planned and describe the effect of this program on them. How do related programs and strengths in other academic areas support the proposed program?

A concentration in atmospheric science at the undergraduate level can be accomplished through the Bachelor of Science program in Interdisciplinary Sciences (IS). Advanced undergraduates can take courses with beginning graduate students in many cases. This provides a stimulating academic setting for upper-level undergraduates. Opportunities also exist for undergraduates to participate in research projects and do cooperative work with the Rapid City National Weather Service office.

The Atmospheric, Environmental, and Water Resources (AEWR) Ph.D. program attracts students with an interest in the atmospheric sciences. Atmospheric Sciences faculty currently support and supervise five students in this program. Many of the graduate courses offered by the Department of Atmospheric Sciences are of interest to other students in the program. All students in the AEWR program must take at least one Atmospheric Sciences course at the graduate level. Research by AEWR Ph.D. students working in the atmospheric sciences routinely leads to publication of results in the refereed atmospheric science and earth systems literature.

Students concentrating in environmental engineering and environmental sciences, through majors in the departments of Civil and Environmental Engineering (College of Earth Sciences), and also Chemistry and Chemical Engineering (College of Material Sciences and Engineering) take Department of Atmospheric Sciences courses such as introduction to the atmospheric sciences, global environmental change, and air pollution. Meteorology students take hydrology and numerical methods courses offered by the Department of Civil and Environmental Engineering, various upper-level courses in the departments of Mathematics and Computer Sciences (College of Systems Engineering), and geographic information systems (GIS) coursework in the Department of Geology and Geological Engineering. Faculty in the departments of Mathematics and Computer Sciences, Chemistry and Chemical Engineering, Civil and Environmental Engineering, and Geology and Geological Engineering also collaborate with atmospheric sciences faculty on externally-funded research projects.

The Department of Geology and Geological Engineering is starting to more strongly emphasize the earth systems aspects of geology. We expect to be cooperating more closely with them as their program develops.
2.5 **Changes in Program Objectives**: What changes, if any, have occurred in program objectives within recent years?

There has always been a sizable fraction of students in our program with an interest in weather forecasting. Through the mid-1990’s many of these students have entered the National Weather Service (NWS). Recently, hiring by the NWS has slowed. This major change in the job market has led us to help students with an interest in forecasting to become more prepared for employment in the private forecasting industry. An arrangement exists with a local television station to involve our students in weekend and substitute weathercasting, and to help students develop communication and computer data management skills appropriate to the commercial weather forecasting sector.

Over the past decade there has been an explosion in the need for workers in the analysis of remotely-sensed data, particularly satellite data. A large fraction of the current M.S. student population is exposed to the remote sensing area, and many have been successful in finding employment in this area. In addition, there has been a growing demand for graduates combining expertise in modeling and monitoring environmental change. To this end, we have developed an MS degree specialization in Earth System Science that focuses on understanding and integrating key physical and biogeochemical interactions among the Earth’s systems.

2.6 **Anticipated Changes in Program Objectives**: What changes, if any, in program objectives are being considered for the near future?

The Department of Atmospheric Sciences will continue to adjust its curriculum to changes in the job market. The current downward trend in government employment of scientific personnel means there will be an emphasis on preparing graduates to be better equipped for employment in small, private forecasting and contract research firms. Past graduates currently employed by such firms form a network that will assist current and future students in finding employment. As atmospheric sciences faculty derive the bulk of their support from external research grants, their research will shift to areas with better prospects for funding as funding patterns shift.

Continued development of the earth systems track is anticipated and development of a new track or specialization in wildfire meteorology is anticipated. Wildfire meteorology is an area with few academic education opportunities available and great national need. We have an excellent opportunity to provide this training, with departmental strengths in mesoscale meteorology, land surface processes, biogeochemistry and forest ecology, a strong state wildfire suppression program headquartered in Rapid City, and a state-funded wildfire meteorologist position established within the Institute of Atmospheric Sciences. In addition, we anticipate that the rapidly evolving area of environmental commodity trading (e.g. carbon emission reduction credits, other greenhouse gas credits, clean water credits) that is occurring as a result of state, national, and international laws and negotiations (e.g. the Kyoto Protocol) will create a large demand for students with research expertise in biogeochemistry. We will continue to strive to create coursework and research opportunities for students interested in pursuing this new career area.

### III. PROGRAM STRUCTURE

3.1 **Rationale**: What is the rationale behind the sequence of courses, examinations and other required parts of the program? Please include reference to the ways in which the program’s structure serves to monitor and guide the student's progress toward
completing the various requirements of his degree. Are there special advisory or counseling conferences for students in this regard?

All students are required to take courses in each of the three core areas of Earth Systems, Meteorology, and Techniques. This provides some breadth, and better prepares the students to approach broader issues of the atmospheric sciences they may encounter during their careers. For the meteorology specialization, the proposed outline of courses as listed in the catalog makes it possible for students who do not have an undergraduate meteorology background to acquire the minimum basic knowledge needed to pursue a program to the Master of Science degree level. At the same time the student is taking these basic courses, he or she is also obtaining some graduate level education. Students who have a meteorology background can begin their advanced courses immediately and focus on one of several specialties of the department, including cloud physics and electricity, mesoscale physics and dynamics, atmosphere/land surface interactions, etc. For the earth systems specialization, the curriculum builds on three basic courses with additional coursework in more specialized topics such as remote sensing, atmospheric chemistry, biosphere atmosphere interactions, etc.

Students are counseled by their major professor each semester in which they register for courses. The students normally take two years to complete a Master of Science degree in Atmospheric Sciences. A comprehensive coursework examination is taken in their final semester to verify integration of knowledge from the entire spectrum of coursework. A Master's thesis must be written by all students; emphasis in the summer is placed on research and the last semester is typically devoted to completing the thesis. During the course of the research, the students meet regularly with their faculty advisor.

3.2 Breadth of Coverage: What breadth of coverage of the field is there in your program? Please describe the subfields you offer and the number of faculty active in each. What special emphasis or focus have you established? What unique resources do you have? Describe the research climate and capacity of the department.

Our department maintains a strength in cloud microphysics and dynamics (both observational and numerical modeling), including storm electrification and radar meteorology. We have four active faculty working in these areas. We also have three faculty involved in mesoscale meteorology, remote sensing, and land surface processes (including biogeochemistry and hydrometeorology). Biosphere-atmosphere interactions and atmospheric chemistry are being researched by four faculty. Four faculty are active in global climate change and carbon cycle (including carbon sequestration) studies. We have recently welcomed a wildfire meteorologist who will work both in meteorological and earth systems areas. Departmental faculty work with several unique observing systems, including towers instrumented for meteorological and atmospheric chemical measurements, tethered balloon systems used for atmospheric chemical and remote sensing observations, and an armored aircraft instrumented for microphysical and electrical observations. Several faculty are also involved with the development of 3-D visualization capabilities using the new visualization laboratory.

3.3 External Relationships: Please summarize any arrangements with industry, government, and other agencies outside of the academic community.

The faculty of the Department are experienced researchers and have many contacts with organizations in the United States and internationally. We work actively with the American Meteorological Society in Boston where some of our faculty are members of scientific committees. Some have chaired committees. Our faculty and staff members interact extensively
with the National Oceanic and Atmospheric Administration and its National Weather Service. The local NWS office is collocated on campus and we have had collaborative research grants with forecasters at the office through the COMET program. Students have worked on this research and also may obtain credit for work at the NWS office through a Co-op course program. Our faculty have also served on advisory committees and review panels for the National Science Foundation, NASA, NOAA, the Air Weather Service, and other local, regional, and national governmental organizations. Several members have served as editors or associate editors of major national or international scientific journals. The faculty and staff are often called upon to consult with various local, state, national, and international organizations. Our staff interact and cooperate with the staff at the EROS Data Center concerning remote sensing activities. We currently have a working agreement with Horizons, Inc. of Rapid City to develop remote sensing techniques for estimating forest fuel loadings. As a result of this agreement, one Horizons employee is enrolled as a full time MS student. Some of our students have worked with KOTA television and radio station doing morning and weekend on-air forecasts. Presently, faculty are also working collaboratively with scientists at NASA Goddard Space Flight Center to develop improved algorithms for remote sensing data interpretation using the Black Hills and Siberia as field test sites. Recently, significant efforts have been made to link research in carbon cycling with the development of carbon emission reduction credits that can be traded on the open market. For the past two summers, some faculty members have collaborated with DOE in the operation and maintenance of an Ameriflux tower in the Black Hills.

IV. NEED

4.1 Outside Interest in the Program: Identify interest on the part of local groups, industry, research centers, other educational institutions or state agencies. Indicate the nature of contracts made with these groups and the results of these contracts.

The Department of Atmospheric Sciences and Institute of Atmospheric Sciences work closely with agencies at various levels of government as well as with several local and regional companies. They also collaborate nationally and internationally on various scientific projects.

- Departmental faculty have numerous research contracts with federal agencies, including NASA, NSF, NOAA and DoD.
- Students and staff in the department are working with the Governor’s office to develop a framework for landowners to register their land for purposes of carbon sequestration. This registration will make them eligible for payments for carbon credits from companies and organizations emitting carbon dioxide. The program is called C-LOCK.
- Also through the Governor’s office, a department staff member has been hired to coordinate with state agencies involved in wildfire control. This person provides meteorological guidance during the summer wildfire season. The meteorological guidance includes both traditional meteorological and forecasting guidance based on operational activities and products of the National Weather Service, and specialized spot meteorological observations and guidance concerning cloud-to-ground lightning, as well. During other periods of the year, the fire meteorologist performs research related to wildfire behavior and performs teaching duties.
- The department has several cooperative activities with the Rapid City office of the National Weather Service. Students do cooperative studies for credit while participating in forecast shifts at the office. Faculty collaborate with the office on studies conducted under the COMET program. Faculty also collaborate with the office to host regional technical meetings in Rapid City.
Department faculty are part of collaborative research efforts involving researchers at other universities in the state. Such efforts include those funded under the NASA (remote sensing of ecosystems) and NSF (biocomplexity) EPSCoR programs. There are several more informal collaborations involving individual faculty, as well.

Department faculty develop, operate, and work with users of a storm-penetrating aircraft that serves the atmospheric science research community as a platform for obtaining *in situ* measurements within convective storms.

Department faculty participate in national and international field programs involving groups from various universities and government laboratories in the US and abroad. Recent examples include the Upper Missouri River Basin Pilot Project, the Lake-ICE Field Program, a NASA-sponsored convective turbulence project, the DOE-sponsored Ameriflux program, the ESPRESSO study in Central Africa, and the Severe Thunderstorm Electrification and Precipitation Study. Recent international collaborations include work with NCAR scientists as a part of the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), a collaboration with NASA and the Sukachev Forest Institute to improve remote sensing of forest areas, and extensive work with Chinese scientists and governmental agencies (in addition to work with American federal scientific agencies) to establish and expand trace gas flux measurements and biogeochemical modeling efforts.

Several departmental faculty are involved in collaborative work with the USGS EROS Data Center north of Sioux Falls.

Departmental faculty are involved in the Western Research Alliance, a group comprising people from local and regional business, government and educational institutions interested in linking research and business activities to foster economic development.

Several faculty members participate in the South Dakota Academy of Sciences.

Through a NASA grant, one faculty member is helping to develop an earth systems science and mathematics curriculum for K-4 grades based on national standards of teaching and learning. Through this program, a network of 7 pilot elementary schools (located in South Dakota, Colorado, and Virginia) have been established to field-test curricular modules and lessons with the ultimate goal of widespread national curriculum dissemination.

Horizons Incorporated of Rapid City, a photogrammetry and remote sensing company, has partnered with faculty members to develop new techniques for quantifying forest structure and biomass densities using LiDAR (laser altimetry). Through this partnership, Horizons has supplied LiDAR data to analyze in conjunction with established field plots in the Black Hills. A Horizons employee is currently working full time as an ATM MS student to develop these techniques. The USFS, the SD State Wildland Fire Coordinator, the EROS Data Center, and private timber representatives have shown substantial interest in this research.

4.2 Justification for Program Need: Specify area, state, or national need for graduates. Provide placement data including geographical distribution. Cite any pertinent studies or data.

See Section 5.4.
4.3 Relationship with Other Programs: Are there precedents, previously endorsed program plans, or major existing curricula in a related area which bear on this program? (Explain)

As mentioned above, the students in the undergraduate program in Interdisciplinary Sciences, and the Ph.D. program in Atmospheric, Environmental and Water Resources, take classes, participate in research projects, and interact in other ways with students and faculty in the M.S. program. Faculty in several other departments collaborate with ATM faculty on various research projects.

V. STUDENT DEMAND

5.1 Applicant Pool: Describe the nature of your current applicant pool and changes, if any, that have occurred, or may occur.

The SDSMT Office of Graduate Education and Research compiled the following statistics on our applicants over the past 4 years. We went through a minimum in quantity in 2000-2001 but the recent trend is upward. Following the recent tightening of immigration procedures we experienced a decline in international applications. Domestic applications are on the increase, and the quality of these domestic applicants also is increasing. Beginning in the year 2000, domestic applications have been sub-divided into resident/non-resident (SD) categories.

<table>
<thead>
<tr>
<th>SEM/YEAR</th>
<th>APPLICATIONS</th>
<th>INTERNATIONAL</th>
<th>DOMESTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1999</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>SU1999</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>FA1999</td>
<td>7</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEM/YEAR</th>
<th>APPLICATIONS</th>
<th>INTERNATIONAL</th>
<th>RESIDENT</th>
<th>NON-RES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP2000</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>SU2000</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>FA2000</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>SP2001</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SU2001</td>
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<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>FA2001</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>1</td>
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<td>2</td>
<td>1</td>
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<tr>
<td>SU2002</td>
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<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>FA2002</td>
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<td>1</td>
<td>2</td>
<td>5</td>
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<td>SP2003</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
5.2 **Enrollment Statistics:** Provide enrollment statistics as directed on data table, along with present enrollment and enrollment projections for the future.

Enrollments in the M.S. program at the beginning of the fall semesters starting in 1996 are presented below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>F96</td>
<td>18</td>
</tr>
<tr>
<td>F97</td>
<td>16</td>
</tr>
<tr>
<td>F98</td>
<td>12</td>
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<tr>
<td>F99</td>
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</tr>
<tr>
<td>F00</td>
<td>8</td>
</tr>
<tr>
<td>F01</td>
<td>12</td>
</tr>
<tr>
<td>F02</td>
<td>6</td>
</tr>
<tr>
<td>F03</td>
<td>9</td>
</tr>
</tbody>
</table>

As of the spring semester, 2003, we have 9 in the program. We hope to stabilize enrollment in the M.S. program within a range between 10 and 20 students in the near future. We currently have five students involved in the AEWR PhD program that work on Atmospheric Science externally funded projects.

5.3 **Degrees Granted:** If a degree program, how many degrees have been granted through the program in each of the prior 5 years? If a program has been in operation for a shorter period, list degrees for that period.

See table in Section 5.4, below.

5.4 **Follow-Up and Student Placement:** Provide as much information as possible with respect to former students in the program (placement information, continuing degree work, etc.).

Our graduates have found work in South Dakota and around the country.

<table>
<thead>
<tr>
<th># of graduates</th>
<th>Field of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995 3</td>
<td>Private sector: programmer analyst, government</td>
</tr>
<tr>
<td>1996 8</td>
<td>Private sector mostly, some unknown</td>
</tr>
<tr>
<td>1997 5</td>
<td>2 Private, 1 government, 1 continuing ed</td>
</tr>
<tr>
<td>1998 2</td>
<td>Weather forecaster (private media firm), teacher (National American University), and now both PhD students in AEWR</td>
</tr>
<tr>
<td>1999 4</td>
<td>2 government, 1 deceased</td>
</tr>
<tr>
<td>2000 2</td>
<td>Private sector (support scientist in meteorology); government</td>
</tr>
<tr>
<td>2001 4</td>
<td>2 in government, 1 in military, 1 continuing ed</td>
</tr>
<tr>
<td>2002 2</td>
<td>1 private sector</td>
</tr>
</tbody>
</table>

5.5 **Enrollment Capacity:** What capacity does the program have to absorb additional enrollment without significant added cost? Please indicate rationale.

The M.S. program could handle up to 24 students without significant additional teaching costs. Our classes typically are small. Some additional enrollment could lead to more diversity and better class discussions. There would be a need to dramatically increase graduate research
assistantships funded by external grants in order to increase enrollment from the current level to 24.

5.6 **Anticipated Changes:** Provide information on anticipated changes in program size. Give data to justify estimates of growth or decline.

We expect the program to slowly grow and stabilize with between 10 – 20 students in the M. S. program, and 4-6 students in the AEWR program, at any one time. This growth will in large part be predicated on continued growth in the IAS research effort, and the number of research assistantships available to support students. The current weak economy has led to some increase in applications within the last year. We expect building interest in regional and global environmental issues, and interest in the development of research strategies to address these issues, to attract students to our earth systems specialization and the AEWR program. We expect the number of students interested in meteorology to continue at the level of a few to several new students per year, based on national student enrollment and employment statistics compiled by the American Meteorological Society and the American Geophysical Union and presented in October, 2002, at a meeting of heads and chairs of academic departments in the atmospheric and earth sciences. (Much of this information is also available at the organizations’ web sites, http://www.ametsoc.org/AMS/, and http://www.agu.org.) Overall, we have been trending toward a roughly 50/50 gender distribution, and we expect perhaps even a slight majority of female students in the next few years, again based on national trends.

VI. **PERSONNEL (FACULTY-STAFF)**

6.1 **Faculty Who are Direct Participants in the Program:** Attach a list of present full-time and part-time departmental faculty who are involved in the program, including date of appointment, present rank, highest degree and granting institution, and other pertinent information. Attach current brief vitae for all faculty.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date of Appointment</th>
<th>Present Rank</th>
<th>Highest Degree</th>
<th>Granting Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew G. Detwiler</td>
<td>07/01/87</td>
<td>Prof./Chair</td>
<td>Ph.D.</td>
<td>SUNY Albany</td>
</tr>
<tr>
<td>John H. Helsdon, Jr.</td>
<td>01/01/81</td>
<td>Prof.</td>
<td>Ph.D.</td>
<td>SUNY Albany</td>
</tr>
<tr>
<td>Mark R. Hjelmfelt</td>
<td>08/15/88</td>
<td>Prof.</td>
<td>Ph.D.</td>
<td>University of Chicago</td>
</tr>
<tr>
<td>Paul L. Smith</td>
<td>03/30/66</td>
<td>Prof.</td>
<td>Ph.D.</td>
<td>Carnegie Inst.</td>
</tr>
<tr>
<td>Pat Zimmerman</td>
<td>6/1/97</td>
<td>Prof., Director of IAS</td>
<td>Ph.D.</td>
<td>Colorado State University</td>
</tr>
<tr>
<td>Changhui Peng</td>
<td>10/1/01</td>
<td>Assoc. Prof.</td>
<td>Ph.D.</td>
<td>Univ. of Marseille III, France</td>
</tr>
<tr>
<td>William J. Capehart</td>
<td>4/7/97</td>
<td>Assoc. Prof.</td>
<td>Ph.D.</td>
<td>Pennsylvania State University</td>
</tr>
<tr>
<td>Bradly Baker</td>
<td>7/1/00</td>
<td>Assist. Prof.</td>
<td>Ph.D.</td>
<td>University of Colorado</td>
</tr>
<tr>
<td>Lee A. Vierling</td>
<td>6/15/99</td>
<td>Assist. Prof.</td>
<td>Ph.D.</td>
<td>University of Colorado</td>
</tr>
</tbody>
</table>
Vitae and other pertinent information are attached (Appendix A).

6.2 **Support or Advisory Faculty:** List persons, including those in other than the sponsoring department, who are involved in supporting, advising, precepting, or similar roles.

Dr. Mark Rumble, USFS (Adjunct)
Dr. Maribeth Price (Geol/GeolE)
Dr. Toni Logar (Math/Comp. Sci.)
Dr. Kyle Riley (Math/Comp. Sci.)
Dr. Kerri Vierling (Chem/Biol)
Dr. Sherry Farwell (Dean of Graduate Education & Sponsored Programs)

6.3 **Current Support Staff:** Provide the number and position titles of current support staff used in the program.

7 support staff as follows:

- Richard D. Farley Research Scientist IV
- Gary N. Johnson Research Scientist III
- Donna V. Kliche Research Scientist II
- Fred J. Kopp Research Scientist III
- Randall Benson Fire Meteorologist
- Elaine Baker Assistant Director
- Karl Lalonde Research Computer Scientist/Systems Manager

Vitae and other pertinent information for support staff are attached (Appendix B).

6.4 **Special Competencies of Existing Faculty:** Indicate areas of specialized competence as demonstrated by research or prior experience.

<table>
<thead>
<tr>
<th>Professors</th>
<th>Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>John H. Helsdon</td>
<td>cloud electrification, lightning, numerical modeling, cloud and precipitation physics</td>
</tr>
<tr>
<td>Paul L. Smith</td>
<td>radar meteorology, cloud physics, weather modification</td>
</tr>
<tr>
<td>Andrew G. Detwiler</td>
<td>atmospheric physics, aircraft measurements, atmospheric electricity</td>
</tr>
<tr>
<td>Mark R. Hjelmfelt</td>
<td>mesoscale meteorology, modeling, radar meteorology, cloud physics</td>
</tr>
<tr>
<td>Patrick R. Zimmerman</td>
<td>atmospheric chemistry, analytical chemistry, biogeochemistry, biosphere/atmosphere interactions</td>
</tr>
</tbody>
</table>

**Associate Professors**

- Changhui Peng: global carbon cycles, ecological modeling, forest ecology
- William J. Capehart: hydrometeorology, vegetation processes, modeling & remote sensing-land surface processes
Assistant Professors

Brad Baker  analytical chemistry, atmospheric chemistry, and biosphere/atmosphere Interactions

Lee A. Vierling  biosphere-atmosphere interactions, plant ecophysiology, remote sensing, curricular development

Specialty

6.5  *Strengths or Specialties not Existing in Present Faculty:* What strengths or specialties not possessed by current faculty would be desirable to improve the program?

See Section 6.5 below.

6.6  *Anticipated Changes:* What staff losses or additions are expected and how will they affect the program?

No losses are expected in the near-term. We are anticipating a new hire in the area of aquatic ecosystems who will help expand departmental capabilities in biocomplexity and ecosystem studies.

An Assistant Professor with expertise in biocomplexity will be brought to campus in 2003. This hire will strengthen IAS efforts to develop research and educational opportunities in this emerging interdisciplinary field.

VII. CURRICULUM

7.1  *Course Listing:* List departmental courses for the program and give a sample course spread (including non-departmental prerequisite and required courses) for an appropriate period of time. If new courses are to be offered in the next year, please include a separate list of such courses. What courses have been deleted or substantially updated in past five years?

**REQUIREMENTS FOR THE M.S. DEGREE**

1. Fifteen (15) credit hours of course work in atmospheric sciences at the 500 level or above.
2. Nine (9) additional credit hours of non-atmospheric sciences electives at the 400 level or above, atmospheric sciences electives at the 600 level or above; (300 level non-atmospheric sciences courses can be accepted if approved by the Graduate Education and Research Council).
3. Of the twenty-four (24) hours specified in Items 1 and 2, eighteen (18) must be at the 500 level or above, and at least half of the thirty (30) credit hours required for an M.S. degree must be at the 600 level or above.
4. Thesis - six (6) credit hours. The thesis must adhere to the format and content guidelines as set forth by the Graduate School.
COURSE REQUIREMENTS

The following course requirements apply to all students in Atmospheric Sciences:

- At least one course at the 500/600 level must be taken in each of the following core areas: Meteorology, Earth System Science, and Techniques.
- Satisfactory performance on coursework exam covering each of the core courses as well as selected elective course work.
- Must register for ATM 700 Graduate Research (Thesis) each semester and ATM 693 Graduate Seminar each spring semester.

In addition, requirements specific to the two ATM MS options are listed below:

Meteorology Specialization

Students entering the program with a bachelor's degree in physics, mathematics, computer science, chemistry, or engineering must take the following courses: Synoptic Meteorology I (not for graduate credit), Atmospheric Physics, Atmospheric Dynamics I, and Synoptic Meteorology II.

Students entering the program with a bachelor's degree in Atmospheric Sciences or Meteorology from another institution are required to take the Atmospheric Physics course.

Earth System Science Specialization

All students will be required to take the following courses: The Global Carbon Cycle, Biogeochemistry, Earth System Modeling, and at least one Remote Sensing course. Exceptions may be granted in the case of course duplication from a student’s previous course work.

Students may pursue an M.S. degree in Atmospheric Sciences without federal civil service certification as a meteorologist. Examples of subdisciplines where such students might find employment include remote sensing and biogeochemistry. For these specialties, math through calculus will normally be required. Specific course work requirements will be determined on an individual basis depending on a student’s career goals with concurrence from the student’s advisor, graduate committee members, and the department chair.

NOTE: Elective courses offered by other departments are encouraged as long as the fifteen (15) hours of course work in Atmospheric Sciences at the 500 level or above are as outlined in “Requirements for M.S. degree.” Graduate students may take electives in the fields of physics, mathematics, computer science, chemistry, engineering, or the humanities, or other disciplines to further integrate their undergraduate education into the discipline of atmospheric sciences.

Undergraduate students at SDSM&T may decrease the time required to obtain a Master of Science degree in Atmospheric Sciences by taking as electives the preparatory undergraduate courses available to them or by completing the Bachelor of Science in Interdisciplinary Sciences program with an emphasis on atmospheric sciences. They may then enter the graduate program with the necessary background for graduate study in atmospheric sciences as above.

Research credit is not to exceed four credits per semester and not to exceed six credits towards fulfillment of M.S. degree requirements. Research credit is open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an
acceptable thesis is acceptable. Oral defense of thesis and research findings are required. Graduate research assistants and students receiving faculty supervision of their research are required to enroll in this course each semester.

**Atmospheric Sciences (ATM) Course Listing**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM 301</td>
<td>Introduction to Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 391</td>
<td>Independent Studies in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 392</td>
<td>Special Topics in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 401</td>
<td>Global Environmental Change</td>
</tr>
<tr>
<td>ATM 402/502</td>
<td>The Global Carbon Cycle</td>
</tr>
<tr>
<td>ATM 403/503</td>
<td>Biogeochemistry (Satisfies the Earth Systems Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 410/410L/ATM 510/510L</td>
<td>Introduction to Environmental Remote Sensing (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 450/450L</td>
<td>Synoptic Meteorology I</td>
</tr>
<tr>
<td>ATM 491</td>
<td>Independent Studies in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 492</td>
<td>Special Topics in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 501</td>
<td>Atmospheric Physics (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 505</td>
<td>Air Quality (Satisfies the Earth Systems Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 515/515L</td>
<td>Earth Systems Modeling (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 520/520L</td>
<td>Remote Sensing for Research I (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 530</td>
<td>Radar Meteorology (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 540</td>
<td>Atmospheric Electricity (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 550/550L</td>
<td>Synoptic Meteorology II (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 560</td>
<td>Atmospheric Dynamics (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 591</td>
<td>Independent Studies in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 592</td>
<td>Advanced Topics in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 601</td>
<td>Advanced Physical Meteorology (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 603</td>
<td>Biosphere-Atmosphere Interactions (Satisfies the Earth Systems Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 608/608L</td>
<td>Air Quality Modeling (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 612</td>
<td>Atmospheric Chemistry (Satisfies the Earth Systems Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 620/620L</td>
<td>Remote Sensing For Research II (Satisfies the Techniques Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 640</td>
<td>Advanced Atmospheric Electricity (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>ATM 642</td>
<td>Physics And Dynamics Of Clouds (Satisfies the Meteorology Distribution Requirement for the ATM MS Program)</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>ATM 643</td>
<td>Precipitation Physics And Cloud Modification (Satisfies the Meteorology Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 644</td>
<td>Numerical Dynamics And Prediction (Satisfies the Techniques Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 651/651L</td>
<td>Measurement And Instrumentation (Satisfies the Techniques Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 660</td>
<td>Atmospheric Dynamics II (Satisfies the Meteorology Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 662</td>
<td>General (Global) Circulation (Satisfies the Meteorology Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 670</td>
<td>Boundary Layer Processes (Satisfies the Meteorology Distribution Requirement for the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 673</td>
<td>Mesometeorology (Satisfies the Meteorology Distribution Requirement For the ATM MS Program.)</td>
</tr>
<tr>
<td>ATM 690</td>
<td>Graduate Seminar</td>
</tr>
<tr>
<td>ATM 691</td>
<td>Independent Studies in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 692</td>
<td>Advanced Topics in Atmospheric Sciences</td>
</tr>
<tr>
<td>ATM 798</td>
<td>Graduate Research (Thesis)</td>
</tr>
</tbody>
</table>

7.2 **Strengths/Unique Features:** Describe any special departmental strengths and/or unique features of the program.

ATM students and faculty participate in cooperative education, and joint research projects, with NWS forecasters who are located on the edge of campus.

The Institute and Department are involved in a wide variety of research projects ranging from cloud physics to ecology. Additionally the Meteorology-Earth Systems-Techniques requirements for the M.S. degree call for students in any track to be well versed not only in their own field but also in adjacent disciplines within the Institute’s research programs. This ensures a well-rounded graduate familiar with a broad range of issues within the Atmospheric Sciences. Students in the Department have unique opportunities to work with state-of-the-art scientific instrumentation (e.g. trace gas analytical equipment, storm penetrating aircraft, field spectroradiometers) in a nurturing collaborative environment with a low student : faculty ratio.

7.3 **Department Deficiencies and Planned Remedies:** Describe any departmental weaknesses or deficiencies, along with plans for eliminating these (include expected timetable).

SDSM&T offers a BS degree in Interdisciplinary Sciences, one track of which features an Atmospheric Sciences focus. In the past, the Atmospheric Sciences Department was responsible for the meteorological coursework but ATM faculty were not assigned academic advisory roles for these undergraduate students. This has occasionally presented a problem in tracking students through what is a rigidly prescribed program with some required courses being offered only once in a two-year cycle. This has recently changed. As of 2001 IS students identified as having an interest in the Atmospheric Sciences Program are assigned to ATM department faculty for advising. This has greatly improved the situation and we anticipate a smoother transition of underclassmen into their upper level course sequences during the two-year current cycle. Identification of these students is now beginning during their freshman year via the IS program’s mentoring sequence. Given this development, we now expect entry level students to be tracked into their first Atmospheric Science course (ATM 301) during their first Sophomore semester.
7.4 Instructional Methods: What are the program’s primary methods of instruction? Is any of the instruction delivered via media? Please describe. Are any new methods anticipated?

Most courses are taught in the traditional classroom fashion. However, several courses (all remote sensing courses, the synoptic meteorology sequence, and our air quality and environmental modeling courses) make use of hands-on laboratory exercises using state-of-the-art techniques, software packages and visualization technologies. Three courses (our air quality sequence and our environmental modeling course) are also delivered via distance to South Dakota State University and EROS Data Center. Finally, our “Global and Environmental Change” course includes a public outreach component in which students provide public lectures to the local and regional non-university community.

7.5 Interrelationships with Other Curricula: What other programs within the institution make use of instruction provided through this program? Describe.

The remote sensing and biogeochemistry courses attract students from Geology and Geological Engineering, Civil and Environmental Engineering, and the AEWR program. Likewise, the department’s air quality courses are similarly cross-enrolled and are sometimes taken by AEWR students from SDSU who, like their SDSM&T counterparts, require a course from their sister university. New courses in the “Global Carbon Cycle” and “Introduction to Environmental Modeling” also attract a number of out-of-department students. The Department’s “Global and Environmental Change” and “Introduction to Atmospheric Sciences” courses are popular for satisfying general education requirements and also serve as recruitment courses for our interdisciplinary sciences undergraduate program (and present as well options for current undergraduate students who may be considering graduate school). Cross-enrollment is expected to increase as the Geology and Geological Engineering program develop their Earth System Science BS track which has been approved by the University, with pending approval by the Board of Regents.

7.6 Anticipated Changes: Describe curricular changes planned for the program which would affect its enrollment, staffing or costs.

The new emphasis in Earth Systems within the ATM program presents an opportunity to increase enrollment from neighboring universities with strong programs in biology, chemistry, and environmental sciences (e.g., Black Hills State University, Augustana College) as well as attract graduating students from SDSM&T programs such as Geology and Geological Engineering, Civil and Environmental Engineering, and Chemistry.

Though not currently integrated into the Atmospheric Sciences program, the Geology and Geological Engineering Department’s BS Earth System Science Track may provide an opportunity for interaction with another campus unit and may provide a means for integrating the BS in Interdisciplinary Sciences Atmospheric Sciences track with other programs in the College of Earth Systems.

One of our newest researchers is a fire meteorologist. His presence presents the opportunity to plan for a new series of courses in the program centered on forest and fire ecologies as well as hazards-related operational forecasting.
VIII. INFORMATION RESOURCES/LIBRARIES

8.1 Library Resources: What are the strengths/weaknesses of the library resources in terms of specific disciplinary holds and support area holdings? What is the departmental library budget?

Book holdings are generally sparse, but adequate. Periodicals holdings are inadequate with the exception of the holdings in Meteorology, which while not extensive, have been adequate for most of the meteorological work being done. Holdings in the areas of biogeochemistry, boundary-layer meteorology, climate, ecology, remote sensing, and atmospheric aerosols are inadequate. On-line article access and search engines need improvement. Often we have to go to other libraries, or use interlibrary loan, to obtain material. The National Center for Atmospheric Research Library is quite extensive and is not far from us (Boulder, Colorado). We would like to establish a network for accessing NCAR on-line resources. The departmental library budget has normally been $1,500-$2,000 a year for new books. Our annual budget for 15 periodicals is approximately $2,500, but an additional allocation has been made from Departmental funds to augment the serial subscriptions needed to support ongoing research.

8.2 Special Resources: What, if any, special information resources (slides, tapes, etc.) are used in the program? Provide an inventory.

The Department has access to many slides and video tapes. Video tapes and slides of introductory material on atmospheric sciences, severe storms, climate modeling, global chemical cycles, ecology, etc., are owned by the Department and by staff members. We also own audio visual hardware such as slide and LCD projectors.

Some staff members have written extensive class notes for their specialty courses. Such notes are used in Radar Meteorology, and the Physics and Dynamics of Clouds.

One important special data source is the real-time weather data received on a 24-hour, 7 day-a-week schedule through participation in the UNIDATA program.

8.3 What Anticipated Changes: If library or special resources are insufficient, what plans have been made to correct these deficiencies?

These funds are being augmented with grant overhead, and through leveraging of access to on-line journals available to sister institutions. We also hope to inspire changes in SDSM&T institutional priorities towards augmented library funding.

IX. FACILITIES-EQUIPMENT

9.1 Current Facilities: Describe facilities such as classrooms, laboratories and other physical facilities currently available and used in the program.

The Department of Atmospheric Sciences and Institute of Atmospheric Sciences faculty and staff all have individual offices in the Mineral Industries Building. Students have an office in the MI Building as well. The electronics and instrumentation laboratory, and technicians’ offices are as yet housed in the McLaury Building. Future plans are to renovate an existing room in the lower level of the MI Building to house this lab.
Classrooms for teaching Atmospheric Sciences courses are from a campus “pool.” These rooms are generally located in the Classroom Building located nearby, but could be located elsewhere on campus where there is a vacancy. Many are equipped with internet connections, and computers and projection equipment.

The Department of Atmospheric Sciences student PC’s are located in the graduate student office and in the remote sensing lab. The remote sensing lab also houses UNIX high-resolution workstations, large mass storage devices, an image scanner, and several printers.

We have recently installed an immersive visualization lab, which consists of an 18-foot wide Power Wall, driven by an SGI InfiniteReality Graphics computer. This is coupled with head/wand tracking and active stereo vision. Software addressing atmospheric science, geological, and other research fields are available for use. This facility is oriented towards better visualization and understanding of data, and will be used for research, teaching, and interfacing to the business community.

Faculty carry out work in the Analytical Atmospheric Chemistry Laboratory. This laboratory is equipped with the latest technologies available to measure extremely low concentrations of important trace gases in the atmosphere. Lab personnel and ATM graduate students develop instrumentation and methods in the lab that are deployed during the summer months in various locations in order to understand the atmospheric chemistry and chemical cycling of certain elements.

9.2 Capital Equipment: List major capital equipment (over $250 in value).

Audio-visual Equipment:
27” stereo color TV and VCR
Overhead projectors
256-color overhead LCD panel
2 BARCO high power projection systems with Active Stereo Emitter System
(Visualization Wall)
Immersive Tracking System (Visualization Wall)
4 sets of active stereo viewing glasses
LCD computer projector

Computer Equipment:
14 SGI IRIX workstations
2 Linux Workstations
1 170 GB Windows RAID array
1 1.4 TB UNIX/Linux RAID array
20 Intel-based desktop PC computer systems
3 laptop PC computer systems
Multiple CD/DVD Writers and media
Digital image scanner
2 Color Ink Jet Printers
2 Laser printers
Graphics plotter

Laboratory/Field Equipment
T-28 research aircraft and related meteorological sensors with data acquisition system
Access to the National Lightning Detection Network
Mobile radio transmitters/receivers
Weather station sensors, display units and recorders
2 portable meteorological tower packages with satellite uplink
Microscopes
Two Gardner small particle detectors
Cloud condensation nucleus counter
Hi-volume large particle sampler
Dichotomous particle sampler
Solar powered Ameriflux tower, fully instrumented (cooperatively run with DOE-Oak Ridge)
Mobile 4 meter trace-gas flux tower
Proton-transfer-reaction mass spectrometer
Atmospheric Pressure Time-of-Flight Mass Spectrometer
Fast Isoprene Measurement System
Various (5) gas chromatograph systems
Miscellaneous gas handling and sampling equipment
Trimble Navigator GIS/Mapping Pathfinder Pro (real-time satellite corrected GPS)
Gas Chromatography equipment
Open-path Infrared Gas Analyzer for CO$_2$ and H$_2$O flux quantification
Li-COR Leaf Area Index Plant Canopy Analyzers (2)
Li-COR photosynthesis instrument
TRAC instrument
ASD Dual Field Spectroradiometer
Short Wave Aerostat-Mounted Imager (SWAMI)
Large tethered balloon system
Digital rangefinder and digital compass

Office Equipment

Telephone fax machine
Copier
Microfiche/microfilm reader-printers

9.3 **Needed Additional Facilities:** What additional facilities, if any, are needed in order to improve the quality of the programs being offered? List any such items proposed for the next two years and provide a cost estimate for that period.

Further development of a “cave” for visualization is underway and will be our major focus in terms of facility. Some equipment is already in-hand; additional resources and a place to erect the facility are still needed.

An increase in office space for graduate students is needed in the future. The current graduate student office is at full capacity, and is being renovated on a small scale to accommodate increased graduate student population in the short term.

Office space is also needed for the expected new hires within the next year. Additional laboratory space also is needed.
9.4 **Needed Additional Equipment:** What additional fixed and movable equipment, if any, is needed in order to improve the quality of the program being offered? List all items proposed for the next two years and provide a cost estimate for that period.

The existing network of SGI IRIX workstations is composed of relatively old equipment. We plan to replace these machines with high-end PC’s able to dual-boot into either Windows or Linux operating systems. Total cost will be in the range of $25K.

X. **FINANCING OF PROGRAM**

10.1 Prepare a table listing the amount of financial support available to the program from all sources.

<table>
<thead>
<tr>
<th>Fiscal Yr</th>
<th>Salaries</th>
<th>Fringe Benefits</th>
<th>O&amp;E</th>
<th>Total Budget</th>
<th>FTE</th>
<th>FTE (includes admin support)</th>
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</thead>
<tbody>
<tr>
<td>FY 97</td>
<td>$106,284</td>
<td>$19,150</td>
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<td>$6,962</td>
<td>$178,243</td>
<td>0.85*</td>
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</tr>
</tbody>
</table>

*Fall 2002 semester only
The resources of the Institute of Atmospheric Sciences (IAS) are critical to the Department of Atmospheric Sciences. In FY 2001, IAS spent $1.42 Million from grants and contracts and $0.32 Million from state research support. Direct support of students FY2002 consisted of $104,000 to 13 graduate students.

10.2  **Is it likely that adequate financial support will continue to be available to the program?**

Although it will require a continued high level of effort, we will maintain and expand the financial support for our program.
APPENDIX A – Faculty of the Department of Atmospheric Sciences

Bradley Baker

Brad Baker received his B.S in Chemistry from the University of Washington in 1995. There, he began his research career assisting in studies of the chemical composition of marine aerosol particles. He went on to earn his Ph.D. in analytical and atmospheric chemistry in 2000 under the supervision of Ray Fall at the University of Colorado, and Alex Guenther at the National Center for Atmospheric Research. His thesis involved developing instrumentation systems for observing the exchange of naturally produced compounds between the biosphere and the atmosphere.

Brad joined the Institute of Atmospheric Sciences at the South Dakota School of Mines and Technology in the summer of 2000 where he currently is an assistant professor and manages the analytical atmospheric chemistry laboratory. His research interests continue to include the development and implementation of new methods for quantifying gas exchange between the biosphere and atmosphere, as well as using the data to improve predictive models. He has also initiated studies into the effect of biogenic compounds on atmospheric aerosols. Brad holds an appointment to the faculty of the Department of Atmospheric Science, where he has taught atmospheric chemistry, biogeochemistry, and has led several seminar classes. He has also advised graduate students on their independent research and mentored undergraduates working in his laboratory.

Refereed Publication:


**Funding Obtained:**


“Investigation of Particle Nucleation and Growth due to Biogenic VOC Emissions.” EPSCoR Career Research Award, 2002, $72,300.

“Biogenic Hydrocarbons from Grasslands - Flux Measurements and Education Outreach.” NSF CAREERS, 2002, $376,000.

“Planning trip to finalize plans for a collaborative project in China involving the effects of land use change on reactive biogenic compounds in the atmosphere.” NSF International Program Grant, 2001, $5,585.

Dr. Capehart attended the University of North Carolina at Asheville, between 1985 and 1989, where he received his Bachelor of Science degree in Atmospheric Sciences - Climatology Track in May 1989. While there, he was a laboratory assistant for the Atmospheric Sciences program developing the department's meteorological database and investigating water budget aspects of the 1984-88 southeastern US drought. While at UNC-Asheville, Dr. Capehart was also a research assistant at the National Climatic Data Center, where he worked on the remote sensing of snow melt on the Arctic ice cap and compiling a database of snowfall and snow cover for the United States.

In 1989, he came to Penn State University where he developed a soil hydrology model for meteorological applications including providing initial soil moisture conditions for the Penn State/NCAR Mesoscale Model (MM). He received his Master of Science degree in Meteorology from Penn State in May 1992. While at Penn State, he participated in the EOS-supported Susquehanna River Basin Experiment (SRBEX), an interdisciplinary project examining processes relevant to the hydrologic cycle of the region across local, regional, and continental scales. Within SRBEX, Dr. Capehart investigated the potential for incorporating remote estimates of medium scale soil moisture and other remotely-derived parameters into hydrological models. He received his Ph.D. in Meteorology from Penn State in May 1996.

Dr. Capehart was appointed a post-doctoral scholar at Penn State in 1996 where he worked in verification of the Penn State/NCAR MM coupled with the Biosphere Atmosphere Transfer Scheme (BATS) and added a snow component to the soil hydrology model. In 1997, he joined the South Dakota School of Mines and Technology's Institute for Atmospheric Sciences as an assistant professor in the meteorological analysis group.

At SDSM&T, Dr. Capehart has been involved in a number of projects in the modeling of regional- and local-scale hydrologic processes including the coupling of atmospheric models’ land-surface parameterizations to surface and ground water hydrologic models, quantifying regional carbon storage potentials in the soil, initialization surface conditions for modeling Great Lakes boundary layer processes, and scientific computing and visualization in the geosciences.

Dr. Capehart is a member of the American Meteorological Society, American Geophysical Union, European Geophysical Union, IEEE Remote Sensing Society and the Society of Wetland Scientists. He is published in the Journal of Hydrology, Bulletin of the American Meteorological Society, Remote Sensing of the Environment, Water Resources Research, and Journal of Hydrometeorology. His research interests include hydrometeorology, remote sensing and modeling of biosphere-atmosphere interactions, and regional-scale coupled atmospheric and ecological modeling. His teaching interests include Remote Sensing, Climatology, Modeling, and Boundary Layer Processes. Dr. Capehart is also active in interdisciplinary research efforts in South Dakota in scientific computing and geosciences through the NASA and NSF EPSCoR programs and serves on the national Internet 2 Geospatial Data Working Group and Steering Committee.

Refereed Publications


**Funding Obtained**


“Scaling issues in the direct use of satellite data in mesoscale model land-surface parameterization,” NSF, 1998, $185,000.
Andrew G. Detwiler

Dr. Detwiler, a native of upstate New York, received his B.S. from the University of Michigan in 1974, majoring in meteorology. He did graduate work in the Atmospheric Science Department at the State University of New York's Albany campus, earning an M.S. in 1976 and a Ph.D. in 1980. He remained for two additional years at Albany to do post-doctoral work, then joined the Advanced Study Program at the National Center for Atmospheric Research in the fall of 1982 where he worked in the Convective Storms Division. From late 1983 through early 1987, Dr. Detwiler worked with the General Electric Company's Aircraft Engine Business Group on various problems in the area of low observables.

He joined the Institute of Atmospheric Sciences at the South Dakota School of Mines and Technology in the spring of 1987 where he currently serves as a research professor with the T-28 aircraft research facility. His research interests have centered around experimental and numerical simulation studies of the physical, electrical, and dynamical characteristics of clouds. He also holds an appointment to the faculty of the Department of Atmospheric Science, where he has taught general meteorology, climate and global change, physical meteorology and synoptic meteorology at the undergraduate level, and air pollution, synoptic meteorology, atmospheric dynamics, and fundamentals of nucleation at the graduate level. He currently serves as Department Chair.

Refereed Publications:


Mo, Qixu, A.G. Detwiler, M. Stoltzenburg, T. Marshall, R. Black, and J. Hallett, 2001: Horizontal variation of the vertical electric field in the stratiform region of an Oklahoma MCS. Submitted to *JGR-Atmospheres*. 

**Funding Obtained:**


“Airborne observations and storm modeling in support of the severe thunderstorm electrification and precipitation study (STEPS).” 1999, 1st yr: $135,600; 2nd yr: $151,200; 3rd yr: $156,000.


John H. Helsdon

Dr. Helsdon holds a B.S. degree in Physics from Trinity College, Hartford, Connecticut, and M.S. and Ph.D degrees in Atmospheric Science from the State University of New York at Albany. He joined the Institute of Atmospheric Sciences in February 1979 and received an appointment as an Associate Professor in the Department of Atmospheric Sciences in 1981, teaching courses in radiation and turbulence, cloud physics and dynamics, precipitation physics and weather modification, and atmospheric electricity. In addition, he was Acting Head of the Institute's Numerical Modeling Group from February 1982 through February 1983 and holds an affiliate faculty appointment with the Department of Atmospheric Science at Colorado State University. He was appointed full Professor in the Department of Atmospheric Sciences in 1993, and served as Chairman of the Department from July 1994 until June 1997.

His major research interests are in the numerical modeling of cloud physics processes with a specialization in the modeling of cloud electrification mechanisms and lightning. He also is interested in the relationships of lightning to the dynamic, microphysical and chemical properties of clouds. He has authored and coauthored papers dealing with lightning, coastal frontogenesis, and cloud electrification and lightning modeling.

Dr. Helsdon is a member of Sigma Pi Sigma, the American Geophysical Union, and the American Meteorological Society, and has served two terms on the American Meteorological Society Committee on Atmospheric Electricity.

Refereed Publications


Funding Obtained:


“Capability enhancement for the modeling of NOx production by lightning using a 3D storm electrification model.” Nelson Research Grant/SDSM&T, 1998, $5,000.

“Airborne observations and storm modeling in support of the severe thunderstorm electrification and precipitation study (STEPS).” NSF, 1999, $466,500.
Mark R. Hjelmfelt

Dr. Hjelmfelt received his B.S. degree in Physics from Kansas State University in 1969. Following a year studying meteorology at Purdue University, he entered the Air Force, serving as a Russian linguist and weather observer. While in the Air Force, he enrolled in the Department of Meteorology at the South Dakota School of Mines and Technology and received his M.S. degree in 1975. He obtained a Ph.D. degree in meteorology from the University of Chicago in 1980. From 1980 to 1982, Dr. Hjelmfelt was a Post-doctoral Fellow in the Advanced Study Program at the National Center for Atmospheric Research (NCAR).

During 1982 and 1983, he was employed in the Atmospheric Sciences Group at Brookhaven National Laboratory. In 1983, he returned to NCAR as a Scientist I with the Field Observing Facility (FOF), serving as Field Manager and engaging in research on microbursts and lake effect snowstorms. In 1986, he was promoted to Scientist II and served as Acting Head of the Applied Science Group of the Research Applications Program at NCAR. Dr. Hjelmfelt joined the Institute of Atmospheric Sciences in September 1988 and serves as Professor in the Department of Atmospheric Sciences.

Dr. Hjelmfelt is a member of the American Meteorological Society and is an Associate Editor of the Journal of Applied Meteorology; he has served on the AMS Committee on Mesoscale Processes, and as Chair of the Department of Atmospheric Sciences at SDSM&T. Dr. Hjelmfelt has authored or coauthored a number of papers covering topics such as mesoscale meteorology, microbursts, and cloud physics. He has participated in the scientific planning and field operations for a number of meteorological research programs, including the recent Lake-ICE experiment where he served as ELDORA radar scientist and Operations Director. His current research interests involve both numerical and observational studies relating to the initiation and organization of cloud systems and their interactions with their environment. Numerical modeling studies have emphasized convection initiation and storm structure and the influences of orography and surface inhomogeneities on clouds and precipitation. He teaches undergraduate and graduate courses in dynamics, radar, mesoscale and boundary layer meteorology, air quality modeling, cloud dynamics, and numerical weather prediction.

Refereed Publications


and J. Young, 2000: The Lake-Induced Convection Experiment (Lake-ICE) and the snowband dynamics project. *Bull. Amer. Meteor. Soc.*, 81, 519-542.


**Funding Obtained:**


“Supplement to ‘Investigation of Mesoscale Convective Systems over the Northern Great Plains and Mid-Missouri Valley’.” UCAR/COMET, 1998, $8,000.

“Investigations of mesoscale boundary layer structures observed in the lake-induced convection experiment (LAKE-ICE).” NSF, 1999, $349,300.


Dr. Changhui Peng is an associate professor in the Institute of Atmospheric Sciences at South Dakota School of Mines and Technology since Oct. 2001, and an adjunct professor in the Faculty of Forestry and Forest Environment at Lakehead University (Canada). As a Research Scientist, he has been working at the Ontario Forest Research Institute for Ontario Ministry of Natural Resources from 1997 to 2001. Between 1995 and 1997, he conducted his postdoctoral study at Canadian Forest Service (Edmonton, AB) and University of Alberta after finishing his Ph.D. from the University of Marseille III (France) in 1994. Dr. Peng is currently serving as editorial board member for the journals of Mitigation and Adaptation Strategies for Global Change, Science Bulletin (China), and Acta Phytoecological Sinica. He is a member of Sigma Xi, Geophysical Union (AGU), Ecological Society of American (ESA), and International Society for Ecological Modelling (ISEM), SINO-ECO, and CP-GIS.

Dr. Peng’s research interests include forest ecology, global ecology, global carbon cycles, ecological modeling and simulation, and impacts of global climate change and ecosystem disturbances on spatio-temporal dynamics of ecosystem productivity, structure and function in Europe, China and Canada. Over the past decade, he has been pursuing an integrated-systems approach that combines both theoretical ecosystem modeling and spatial analysis with experimental and field measurements at a variety of scales ranging from stands to globe, with time scales ranging from past (last glacial maximum, about 21,000 C\textsuperscript{14} yr. BP), present, and into the future 50 to 100 years. The focus of his recent research is understanding how changes in climate, ecosystem disturbance, and land use affect the structure and function of terrestrial ecosystems, land-atmosphere interactions, and global carbon cycles. Dr. Peng’s teaching interests include “Global Carbon Cycle” and "Ecological Modeling and Simulation."

To date, Dr. Peng has authored and co-authored 1 book, 40 peer-reviewed journal papers (including recently two papers in *Science*), 11 peer-reviewed book chapters and research reports, 5 conference proceedings. He has also delivered over 30 research presentations at national and international conferences and workshops.

**Refereed Publications (since 2000):**


**Peer-Reviewed Book Chapters and Reports**


**Funding Obtained:**

“Developing a Strategy and Infrastructure for Modeling the Complexity of Biogeochemical Cycles of South Dakota Ecosystems under a Changing Climate and Land Use.” Regents Rushmore Faculty CAREER Research Award, NSF, 2002-2003 $75,000 (US).


“Effects of Climate Change on Ontario’s Boreal Forest Ecosystem: Assessment of Impacts and Consequences to Carbon Budgets.” Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), Canada, 2001-2004, $210,000.

Dr. Smith is a native of Missouri. He received a B.S. degree in physics, and M.S. and Ph.D. degrees in electrical engineering, from Carnegie Institute of Technology (now Carnegie-Mellon University).

Dr. Smith was Instructor and later Assistant Professor of Electrical Engineering at Carnegie Tech from 1955 through 1963. He then joined the Midwest Research Institute, where he had previously worked for several summers, as a Senior Engineer. In 1966, he accepted a post with the Institute of Atmospheric Sciences of the South Dakota School of Mines and Technology. He served initially as Research Engineer, then Chief Engineer, Group Head, Senior Scientist, and (during 1976-77) Acting Director. He was the Director of the Institute from 1981 to 1996, and is now a Professor Emeritus in the Institute. He also held a joint academic appointment as Research Professor of Meteorology and Electrical Engineering.

Dr. Smith was a National Science Foundation Postdoctoral Fellow in meteorology at McGill University in Montreal in 1964. He returned to McGill as Visiting Professor of Meteorology during the 1969-70 academic year. He served as Chief Scientist at Air Weather Service (AWS) Headquarters, Scott Air Force Base, during 1974-1975 and received the Award for Meritorious Civilian Service for his contributions to the AWS radar program. During parts of 1984 and 1985, he was a Visiting Scientist in the Atmospheric Sciences Department of the Alberta Research Council. In the spring semester of 1986, he served as a Fulbright Lecturer in Radar Meteorology at the University of Helsinki. He served on the Executive Committee of the International Commission on Clouds and Precipitation from 1988 to 1996, as Director of the South Dakota Space Grant Consortium from 1991 to 1996, and as a member of the National Research Council’s National Weather Service (NWS) Modernization Committee from 1997 to 1999. He currently serves on the NEXRAD Technical Advisory Committee.

His major research interests are in radar meteorology, with emphasis on quantitative measurement techniques and physical interpretation of the data; cloud physics, with emphasis on studies of storm microphysics and kinematics using aircraft and radar; and weather modification, with emphasis on the design and evaluation of experimental and operational projects. He manages the armored T-28 research aircraft facility and has worked on the development of various types of meteorological instrumentation. He has taught numerous courses in electrical engineering and meteorology, and is the author of a widely-used set of lecture notes in radar meteorology. He has authored or coauthored over 50 papers in more than a dozen different engineering and scientific journals, as well as numerous conference presentations and countless reports. He has consulted for several commercial firms and government agencies in the U.S. and elsewhere, mainly on the applications of weather radar.

Dr. Smith is a Fellow of the American Meteorological Society (AMS), and chaired the AMS Committee on Radar Meteorology on two separate occasions. He received the 1992 Editor’s Award from the AMS Journal of Applied Meteorology. He is also a Life Senior Member of the IEEE, a member of the Weather Modification Association (receiving its 1995 Thunderbird Award), and a member of Sigma Xi.
Refereed Publications


**Funding Obtained:**

“Further investigation of microphysical, kinematic and electrical characteristics of CaPE thunderstorms.” NSF, 1994, $348,000.


“In-situ verification of hydrometeor algorithms for polarimetric radar.” NSF, 1999, $395,000.


“STEPS project (T-28 deployment)”, NSF, 1999, $129,000.


“T-28 Deployment to Norman, OK”, NSF, 2003, $100,090.

Dr. Lee A. Vierling

Dr. Vierling attended Colorado College from 1988-1992, where he received a B.A. with distinction in Geology in May, 1992. For his undergraduate thesis, Dr. Vierling conducted original research to examine the relation between paleoclimates and vegetation communities in central Colorado (Vierling, 1998). In early 1993, Dr. Vierling joined the Biosphere-Atmosphere Interactions group at the National Center for Atmospheric Research, where he conducted atmospheric and ecological research to quantify biogenic trace gas fluxes from a variety of plant and ecosystem types. His work spanned a wide range of spatial scales, from gas flux measurements on individual leaves to regional estimation of fluxes from entire forests using several data sources including satellite remote sensing.

In 1994, Dr. Vierling began a doctoral program at the University of Colorado-Boulder. During the summer of 1995 he participated in a NASA experiment on the North Slope of Alaska and worked with scientists at the NASA-Goddard Space Flight Center to develop a new approach to assess tundra vegetation phenology and radiation budgets using multi-angle remote sensing. In 1996 he received a 3-year graduate fellowship from the U.S. Environmental Protection Agency. Using these fellowship moneys, he conducted his dissertation research to examine how changes in cloud and haze cover influence the radiation and trace gas budgets of a Congolese tropical rain forest canopy. As a part of this project, he also did preliminary research to examine how satellite-derived estimates of global net primary productivity may be affected by varying cloud cover. Dr. Vierling received his Ph.D. in biology from the University of Colorado in May, 1999. In June, 1999, he joined the Institute of Atmospheric Sciences at the South Dakota School of Mines and Technology as an assistant professor.

Dr. Vierling has extensive experience gathering empirical micrometeorological and radiometric data in the field, often in remote locations characterized by extreme weather conditions. He also has experience processing and interpreting optical remote sensing data. His primary research interests include local- to regional-scale biosphere-atmosphere interactions, with particular interest in how human activities change various aspects of biogeochemical cycling. His teaching interests include ecology, environmental science, and biosphere-atmosphere interactions, with a special interest in educating non-scientists about various aspects of global change. He is a member of the Ecological Society of America, the American Geophysical Union, and Sigma Xi.

Refereed Publications


**Funding Obtained (since coming to SDSM&T)**


“JSTOR: Expanding the Electronic Wing of Devereaux Library to Enrich Undergraduate Research at SDSM&T.” Bush Faculty Development Program and SDSM&T EPSCoR office, 2001, $6,000.


“Geometric Calibration of the QuickBird Satellite in Western South Dakota.” EarthWatch, Inc., 2000, $14,000. (Note: this contract did not reach completion due to satellite launch failure).

“Studying integrated impacts of environmental change on the prairie potholes region of eastern South Dakota.” SDSM&T Nelson Research Grant, 1999, $5,000.
Patrick R. Zimmerman

Dr. Zimmerman holds a B.S. degree in Environmental Science (Zoology) and an M.S. in Environmental Science (Chemical Engineering) from Washington State University. He received his Ph.D. from the Dept. of Rangeland Ecosystem Science at Colorado State University in 1996.

Dr. Zimmerman has served as the Director of the Institute of Atmospheric Sciences (IAS) at the South Dakota School of Mines and Technology since June, 1997. Prior to this position, from 1979 to June 1997, he served as Senior Scientist and head of the Atmospheric Chemistry Division’s Trace Gas Biogeochemistry Section at the National Center for Atmospheric Research, which he originated in 1979 as the Biosphere/Atmosphere Interaction Project. Dr. Zimmerman was recruited to NCAR by Dr. Paul Crutzen (Nobel Laureate) in 1979 as a Staff Scientist II in the Air Quality Division, promoted to Scientist III in 1985 and named Section Head in 1989. His NCAR research focused on measurements of biogenic hydrocarbon emissions, including tropical biomass burning; measurements of ambient hydrocarbons in the remote troposphere; tethered-balloon hydrocarbon profiles; laboratory and field measurements of methane fluxes; the development of methods to study the physiological basis of biogenic hydrocarbons; and the development of tracer and micrometeorological flux measurement techniques. At NCAR, Dr. Zimmerman assembled an interdisciplinary team including expertise in ecology, plant physiology, remote sensing, micrometeorology and analytical chemistry. The group developed technology, experimental approaches and models which allowed measurements and predictions of ecosystem trace gas emissions over scales ranging from leaves to landscapes. Their publications have shown that these emissions affect regional and global atmospheric chemistry.

From 1973 to the present, Dr. Zimmerman has been a principal investigator on over two dozen grants and contracts from federal agencies (Environmental Protection Agency, Department of Energy, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration), industry (Gas Research Institute, American Petroleum Institute) and nonprofit organizations (National Geographic Society, Frost Foundation). He is the author or co-author of more than 80 refereed publications and holds two patents. Dr. Zimmerman has been on seven graduate student committees, as well as supervising many graduate and undergraduate research assistants.

**Refereed Publications:**


**Funding Obtained:**


“Development of remote sensing links to water vapor flux measurements.” University of North Dakota, PARC program, 1998, $118,800.

APPENDIX B - Current Support Staff

Richard D. Farley

Mr. Farley is a native of South Dakota. He received his B.S. degree in Chemical Engineering from the South Dakota School of Mines and Technology in 1969. Upon completing the requirements for an M.S. degree in Meteorology from the same institution in 1972, he joined the Institute of Atmospheric Sciences. He currently holds the position of Research Scientist IV with the Institute.

During the period December 1979 through August 1981, he left the Institute of Atmospheric Sciences to work with Dr. Terry Clark and associates at the Mesoscale and Microscale Meteorology Division (formerly Convective Storms Division) of the National Center for Atmospheric Research. During that time, he was involved in the continuing evolution of Clark's three-dimensional cloud model, especially the development of interactive grid nesting.

Mr. Farley is a member of the Society of Sigma Xi. He has over 25 years of experience working on the numerical simulation of rain and hail processes, using both highly parameterized and detailed treatments. His current research interests are atmospheric electricity, cloud physics, weather modification, multi-dimensional cloud modeling with emphasis on the hail problem, and airflow over topography. He has authored and coauthored numerous papers and reports in these areas.

Refereed Publications


Wobrock, W., A.I. Flossmann, and R.D. Farley, 2003: Comparison of observed and modeled hailstone spectra during a severe storm over the Northern Pyrenean foothills. Atmospheric Research, Special Volume on Severe Storms, ed. John Snow (accepted for publication).


Wobrock, W., A. Flossmann and R. D. Farley, 2003: Comparison of observed and modelled hailstone spectra during a severe storm over the Northern Pyrenean foothills. Atmos. Res. [accepted for publication]


Funding Obtained:

“The numerical simulation of weather modification by cloud seeding.” National Science Foundation, 1996, $460,300.


Gary N. Johnson

Mr. Johnson began his professional career as an engineer in 1966, after receiving a B.S. degree in electrical engineering from the South Dakota School of Mines and Technology. For the following two years, he was employed as a junior engineer at Collins Radio Company. During that time, he also studied electrical engineering at the graduate level through Iowa State University. In 1968, he joined the engineering staff of Honeywell, Inc., as an electronics development engineer specializing in communications electronics and security systems design. In 1970, he returned to the South Dakota School of Mines and Technology to complete the requirements for the M.S. degree in electrical engineering.

After obtaining the M.S. degree in 1971, Mr. Johnson became a member of the professional staff of the Institute of Atmospheric Sciences as a research engineer. He later served one year as Acting Head of the Engineering Group of the Institute. He has specialized in instrumentation electronics, data communication, and data acquisition since joining the Institute. He has been involved primarily in the development of airborne instruments and data systems for the Institute’s T-28 research aircraft.

Mr. Johnson is a Registered Professional Engineer in South Dakota and is a member of Sigma Xi, IEEE, NSPE, and the Data Processing Management Association.

Donna V. Kliche

Donna V. Kliche (Vulcan) was born in Tirnaveni, Romania. She graduated from the University of Bucharest, Romania, with a B.S. degree in Physics.

In September 1987, Ms. Kliche was admitted to the United States as a political refugee. In January 1988, she entered the Department of Meteorology, South Dakota School of Mines and Technology (SDSM&T), Rapid City, South Dakota, to pursue a Master's degree in Meteorology. During 1988-1989, Ms. Kliche was a graduate research assistant at SDSM&T. Her research was on cloud electrical development using a modified two-dimensional model. Ms. Kliche was awarded an M.S. degree in Meteorology in December 1989. Between 1990-1991, Ms. Kliche finished a second Master's degree with Georgia Tech, School of Earth and Atmospheric Sciences, Atlanta, Georgia, the major field being atmospheric chemistry. During her graduate study at Georgia Tech, Ms. Kliche performed research related to atmospheric chemistry of natural and anthropogenic sulphur compounds involving field measurements and laboratory work.

From October 1991 to May 1994, Ms. Kliche worked as Director of the Pennington County Air Quality Office, South Dakota, and in May 1994 she joined the Institute of Atmospheric Sciences (IAS) at the SDSM&T as a Research Scientist in the Remote Sensing Group of IAS. In her five years at SDSM&T, Ms. Kliche was involved in the remote sensing research that includes study of the global biomass burning through a variety of satellite sensors such as AVHRR, LANDSAT, GOES, MAPS, SCARB, ERBE and Pathfinder; remote sensing of aerosols; detailed investigation of the radiative properties of aerosols and their influence on climate; global survey of jet contrails; as well as the study of the optical properties of jet contrails using a discrete ordinate model. Recently, Ms. Kliche has devoted much of her effort in the application of GIS and remote sensing to problems involving the emergence of infectious diseases, in relation to climatological and ecological changes.

After the Satellite Remote Sensing Group moved to the University of Alabama in Huntsville, during August 1998 and May 2000, Ms. Kliche took the responsibility of managing and developing the PRIME (Personalized Resources for Individualized Mathematics Education) program within the Mathematics and Computer Sciences Department. In May of 2000, Ms. Kliche joined again the Institute
of Atmospheric Sciences at the SDSM&T as a Research Scientist – Computer Programmer in the T-28 group. Since then, Ms. Kliche provides support research activities involving the T28 aircraft observations of cloud microphysics, kinematics, electrification, and atmospheric chemistry. She is responsible for the maintenance and development of the data acquisition and reduction software for the T-28 system, and participates in the T-28 field research projects, processes the T-28 field data for use by the facility user community, and contributes to scientific analysis of the data. In addition, Ms. Kliche processes and analyzes the cloud microphysics data from various aircrafts to support work on validation of hydrometeor classification algorithms for polarimetric radars. Ms. Kliche has co-authored several papers for publication in scientific and professional journals, and has made conference and poster presentations.

Ms. Kliche is a member of the American Meteorological Society, the Society of Sigma Xi and the Association for Computing Machinery professional group.

Fred J. Kopp

Mr. Kopp received his B.S. degree in 1969 and M.S. degree in 1971 in Physics from the South Dakota School of Mines and Technology. Since that time he has been employed in the Institute of Atmospheric Sciences as a Research Scientist. During the 1977-78 and 1980-81 terms, he was on sabbatical leave at Colorado State University, taking courses in Meteorology.

Mr. Kopp is a member of the American Meteorological Society, the American Geophysical Union, and the Society of Sigma Xi. He has authored and coauthored several papers for publication in scientific and professional journals.

Randall P. Benson

Mr. Benson, a native of Texas, received his B.F.A. from Texas Christian University, majoring in Communications Graphics. He did graduate work in the Meteorology Department of the University of Utah, earning an M.S. in 1996. He began work as a Regional Climatologist for a five state region at Louisiana State University shortly after graduation and then landed a job doing micro-scale and fire weather forecasting at Deseret Chemical Depot outside Salt Lake City, Utah in 1997 until late 1998. From early 1999 to late 2002, he worked for Cinergy Corporation in Cincinnati, Ohio as the chief meteorologist and developed both short-term and seasonal demand forecasts for the energy commodities business.

He joined the Institute of Atmospheric Sciences at the South Dakota School of Mines and Technology in the fall of 2002 where he currently serves as fire meteorologist for the State of South Dakota. His research interests include the development of predictive tools in fire weather prediction including the effects of lightning strikes on wildfire ignition potential, analog model development for seasonal wildfire prediction incorporating large-scale climate index data, and the understanding of the identifying characteristics of dry-lightning type thunderstorms and their wildfire ignition risk in complex fuels environments. While working in the energy business he developed an operational analog model incorporating climate indices to forecast weather in the medium-range.
Karl Lalonde
South Dakota School of Mines and Technology

Karl Lalonde received a degree in Geology from South Dakota School of Mines and Technology in 1982, concentrating primarily on ore deposits and mineralogy. He worked from 1985 through 1999 for Homestake Mining Company, first in the Open Cut Mine as a geologist, mining engineer, blast monitoring engineer, and software engineer. He developed all of the mission-critical survey and geologic sample processing software used by that mine in its thirteen-year history. He was also involved in the remediation, mine planning, and institutional control facets of the Whitewood Creek Superfund Project. He was later instrumental in the Homestake Vulcan Project, an effort to move 120 years of mine history and geologic information into a three-dimensional visualization system. He was responsible for the analysis and implementation of the graphic database, as well as the diamond drill, underground survey, and mining engineering support database tools.

Mr Lalonde earned a Masters Degree in Computer Science from South Dakota School of Mines and Technology in 1998, focusing on parallel processing, artificial intelligence, and computer graphics. He accepted a position at the School of Mines in 1999 as a system administrator and research scientist, and is currently pursuing a Ph.D, concentrating on self organizing neural network applications in remote sensing. He is also currently overseeing the development of the Black Hills Advanced Visualization Lab, which includes high end visualization and high performance computing equipment.

His research interests include scientific application development, scientific visualization, and neural network applications in the geosciences. He is also currently involved in efforts to increase and expose the benefits of three dimensional visualization and virtual reality in various research areas.
APPENDIX C – Student Surveys

Summary Results for Graduate Survey

The following is a summary of the IAS graduate student survey administered to the grad students in the Spring, 2003.

A total of 10 surveys were completed of which 7 were by MS and 3 were by PhD students. Average years involved in the program equals 1.43 and range from 0.5 to 3 years

When asked how they heard about the program, two responded that they heard via the internet, one from either a friend or via recruiting, three from their undergraduate advisor, and two from other unspecified sources.

Comments regarding why these students applied to the program included:

- Determined if atmospheric sciences was viable career
- Closely related to interdisciplinary field previously interested in
- Have interest in research project to acquire a M.S. to teach full-time
- Learn analytical instrumentation
- Learn more about met research
- Sounded interesting
- Seeking challenge and inspiration for work
- To apply math in interesting fields
- Interested in research
- Best offer
- Opportunity to expand technical skills
- Personal interest

Five of those surveyed applied solely to SDSM&T. The remaining five applied to 12 other graduate programs besides SDSM&T, of which nine acceptances were offered.

This section includes information on areas of interest in Atmospheric Sciences and other fields.

- When asked which area of atmospheric science most interested in; 7 responses were for traditional meteorology; 4 responses for cloud physics and dynamics; 3 for boundary layer, atmospheric chemistry and remote sensing of the atmosphere; 2 for atmospheric electricity; and one each for dynamics, biosphere interactions, atmospheric transport and mountain meteorology.
- When asked which other sciences they are interested in, 9 responses were for surface remote sensing; 7 for GIS and computer science; 6 for life science and physical science; 3 for engineering; 2 for math; and one for statistics, materials science and astronomy.
- When asked which choices were closely related to undergrad program, 7 responses for physical science; 4 responses for life science; 3 for computer science; 2 for math and remote sensing/GIS; and one for hydrology.

Students were asked to rank their skills in the following with 1 indicating weak skills and 5 indicating strong skills:

<table>
<thead>
<tr>
<th>Field</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meteorology</td>
<td>3.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>2.9</td>
</tr>
<tr>
<td>Computer Programming</td>
<td>2.8</td>
</tr>
</tbody>
</table>
Life Sciences 3.3
Statistics 3.4
Writing 3.8
Public speaking/presentation 3.7
Calculus 4.0
Physics 3.5

When MS students were asked what their career goals were following their MS program, seven responded to acquire work, of which one responded to work in public service. Four also indicated an interest in moving on for a PhD, of which two would be interested in SDSM&T and two would not be. For the two not interested in a PhD at SDSM&T, one indicated funding and the other a change of scenery as their reasons.

When PhD students were asked what their career goals were following their PhD work, three indicated finding work, of which one was interested in public work. Three responses showed interest in a Post Doc position and two were uncertain.

Students were asked to rate their overall experiences in the ATM Science Program with 1 indicating poor, 3 indicating fair, and 5 indicating good:

<table>
<thead>
<tr>
<th>Area</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty Accessibility</td>
<td>4.3</td>
</tr>
<tr>
<td>Quality of Instruction</td>
<td>3.9</td>
</tr>
<tr>
<td>Quality of Course Selection</td>
<td>3.0</td>
</tr>
<tr>
<td>Quality of Course Content</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Students were asked to rate their individual graduate studies and research program with 1 indicating poor, 3 indicating fair, and 5 indicating good:

<table>
<thead>
<tr>
<th>Area</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisor Accessibility</td>
<td>4.7</td>
</tr>
<tr>
<td>Quality of Guidance</td>
<td>4.4</td>
</tr>
<tr>
<td>Availability of Resources</td>
<td>3.7</td>
</tr>
<tr>
<td>Quality of Resources</td>
<td>3.9</td>
</tr>
<tr>
<td>Overall Experience</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Following is a list of additional comments listed on the survey:

- Need to match growth in research with office space and labs
- Need more computer resources
- Quality of instruction and guidance is great
- Courses need to be more organized
- Team-taught courses need to be coordinated better
- If research so important why so many classes to graduate?
- Enjoy working with grad committee and other faculty and staff and students

When asked if ATM courses were required, which were most useful, three responded that Remote Sensing for Research I & II were most useful; two indicated that Boundary Layer was most useful; and one each for Global C Cycle, ATM Physics, Mesoscale Meteorology and Intro to Meteorology. None were listed as least useful.
When asked which courses outside the department were most useful; four responded with GIS; two each for Calculus refresher, Calc III, Sfc Water Techniques, Numerical Analysis; and one each for C++ programming, Modeling, Dynamics, Sfc Water Hydrology and Water Quality Investigations.

When asked which aspects of work here at SDSM&T were most positive, the comments included:
- Collaboration with other institutions
- Teamwork
- Good courses
- Interesting research
- Contact with other grads and advisor
- Faculty and other students
- Encourage to do own research
- Informal approach and attitude-personable
- Enthusiasm by faculty, staff, and students
- Research
- People
- Small class sizes
- Availability of Resources
- Results - if you work hard you get rewarded
- Open door policy from faculty, staff
- Latitude to explore multidisciplinary resources
- Ability to work on current research efforts

When asked which aspects of work at SDSM&T were most negative, comments included:
- Mesoscale modeling fickle and takes patience
- Computing facilities
- Desired courses not offered here
- Poor instruction- learn better on my own
- Quality of teaching by some professors
- Lack of time with profs-too busy
- More guidance with research
- Courses offered every other year
- Courses dropped due to low enrollment

When asked what issues might be addressed in departmental orientation for incoming students, comments included:
- Clearly define grad expectations and procedures
- Procedures for course requirements
- Limited class offerings
- Requirements for thesis research
- Importance of written and oral communication
- Encourage taking technical writing course
- Step by step degree process
- Limitation of resources here
- Meeting other students from other depts.
- Introduction to MET and ESS research currently underway
- Work opportunities post graduation
• Grading procedures and requirements
• Thesis/dissertation requirements
• Anything a new student should know- no assumptions

When asked to provide suggestions for improvement, the suggestions included:
• Fire met course
• Grad met overview course
• Combine resources with geology into one dept
• Improve grad student office
• More grad office space
• More grad computers
• Wish MS program not so rigid with courses to be taken
• Professors think out lectures before lecturing
• More access to online journals (Web of Sci, Science Direct, Nature, Science)
• Include field investigation in coursework
• Establish laboratory to study land surface processes related to atmospheric effects

All surveyed said they would recommend this program to other students interested in graduate education in Atmospheric studies. Some of the comments included:

• Yes-good one on one interaction in current research areas
• Yes- have a quality program-faculty energetic and excited about research
• Yes-individual attention and good work environment
• Yes- already have recommended to BS students
• Strong math background would help research studies
• Would suggest an M.S. but may not have diversity for PhD
• Yes- the atmosphere and program and variety of research areas
• Yes-it’s a good program
• Not sure yet
• Yes-experienced faculty with authority on atmospheric sciences, ability to prepare students to be professionals in atmospheric sciences, judicious course selection
• Yes-have enjoyed time here and hope to become alumni soon

(This survey summary completed by T.M. Bull Bennett)