RESOLUTION TO ESTABLISH THE BACHELOR OF SCIENCE DEGREE IN METEOROLOGY

WHEREAS, the bachelor of science degree in meteorology will prepare students for careers with a significant focus on Geospatial Information Technology (GIS) and Remote Sensing, will unite data from both the natural and human environments, and will prepare graduates for careers in forecasting and modeling weather events; and

WHEREAS, geospatial skills are major contributors to the third fastest growing sector of the economy in the United States today—one that is heavily concentrated in Virginia with its proximity to the federal government, defense industry, and consulting firms that service the federal government; and

WHEREAS, this will be the first bachelor of science degree in meteorology in the Commonwealth of Virginia, and may increase the diversity of the undergraduate student body in the department and college, with focused recruiting efforts at Historically Black Colleges and Universities (HBCUs), community colleges, and high schools serving those underrepresented at Virginia Tech; and

WHEREAS, the award-winning Virginia Interoperability Picture for Emergency Response (VIPER) system was developed in Virginia and serves as a national model for assistance during emergency situations, Virginia Tech has a rare opportunity to craft an unrivaled meteorological program that takes advantage of state-of-the-art tools, technology, communications, and digital enhancement; and

WHEREAS, the bachelor of science degree in meteorology supports the goals of the Department of Geography, the College of Natural Resources and Environment, and Virginia Tech in that graduates are educated in ways to create, convey, and apply knowledge to improve the quality of life;

NOW, THEREFORE, BE IT RESOLVED, that the bachelor of science of meteorology be approved effective spring 2012 and the proposal forwarded to the State Council of Higher Education for Virginia (SCHEV) for approval and to the Southern Association of Colleges and Schools (SACS) for notification.

RECOMMENDATION:

That the above resolution to establish the bachelor of science degree in meteorology effective spring 2012 be approved.

June 6, 2011

PROPOSAL SUMMARY Bachelor of Science Degree in Meteorology

The Department of Geography proposes a new bachelor of science degree in meteorology to commence in the spring semester of 2012. A significant focus on geospatial information technology and its ability to unite data from both the natural and human environments will be prominent in the degree requirements. Graduates of this degree program will be proficient in spatial analysis by making use of Geographic Information Science (GIS) and remote sensing as well as the specialized software used in forecasting and modeling weather events. This approach is strongly suggested by university faculty and by professional meteorologists at the National Weather Service office in Blacksburg and the National Oceanic and Atmospheric Administration as a cutting edge niche in the field that will carry Virginia Tech students to new and expanded employment opportunities. Students will be able to predict severe weather (meteorology) and assess its impacts on ground features (geospatial science), on the human environment (building damage, road flooding, or loss of life) and on the natural environment (floodwaters, soil loss, or avalanche danger). This combination of skills will gualify graduates for employment dealing in loss prevention (the Federal Emergency Management Agency, the insurance industry, navigation and routing of ships), weather prediction (the National Weather Service, AccuWeather, meteorological consulting firms), and in geospatial analyst positions dealing with the physical environment (those responsible for environmental impact statements, the Environmental Protection Agency, the Virginia Department of Environmental Quality, the Virginia Department Emergency Management, and environmental non-profits).

Geospatial skills are major contributors to the third fastest growing sector of the economy in the United States, one that is heavily concentrated in Virginia with its proximity to the federal government, defense industry, and consulting firms that service the federal government.

The Department of Labor's 2004 prediction has borne out explosive growth in the use of these technologies in everyday life, from global positioning system navigation units in vehicles, to Google Earth, to on-line information systems, to buses that tell you when they will arrive at your stop, to emergency warnings issued for flooding, tornado activity and hurricane threats, and to emergency response. Weather and climate play into these technologies in ever evolving ways as we seek to keep our shipments safely clear of storms at sea, ground airliners and stop trains under severe weather conditions, and even make personal plans for the day based on weather information from Weather Bug and other on-line GIS supported location-based services on our desktops and smart phones.

The merger of weather forecasting with ground analysis and geospatial data mining are significant trends in our society, yet no academic programs in Virginia produce graduates who can speak both of these complex languages. That lack is precisely the reason for this forward-looking degree in meteorology at Virginia Tech. The Department of Geography has long had a strong geospatial reputation and will build its meteorological reputation to match under this new program. Virginia Tech will require both the GIS and liberal arts components of our existing geography options along with courses for full certification in meteorology to provide students optimal employment opportunities in both areas. Virginia Tech will be the only program in the commonwealth to do this, and will be one of very few internationally that stresses geospatial analysis in its program.

The proposed program supports the goals of the Department of Geography, the College of Natural Resources and Environment, and Virginia Tech in the following ways:

- Virginia Tech's mission is to create, convey and apply knowledge to improve the quality of life. The efforts of our geospatial meteorologists will provide for higher quality of life in the future in the commonwealth through better understanding of human-environment interactions. This degree is cutting-edge, and clearly it "invents the future."
- Interests in weather and its effect on forest growth, wildlife habitat, fisheries, and wood structure abound in the College of Natural Resources and Environment. This program will have a direct positive impact on the other programs in Forest Resources and Environmental Conservation, Fish and Wildlife Conservation, and Wood Science and Forest Products.
- Given that this will be the only B.S. in meteorology in the state, it may increase the diversity of the undergraduate student body in the department and college, with focused recruiting efforts to Historically Black Colleges and Universities (HBCUs), community colleges, and high schools serving those underrepresented at Virginia Tech. This effort is consistent with the American Meteorological Society's commitment to diversity in the field as evidenced by its AMS Weather Studies Diversity Project, which targets HBCUs, Hispanic Serving Institutions, Tribal Colleges and Universities, and Alaska Native or Native Hawaiian Serving Institutions.
- Through a strategic change in focus brought on by the department's move to the College of Natural Resources and Environment and allowed by recent retirements, this degree opens opportunities to Virginians in their home state without a large infusion of resources. It will remove the need for students to travel far from home to

obtain education in meteorology, and training Virginians within Virginia is important in maintaining their allegiances to the commonwealth after graduation.

Proposed Curriculum

The curriculum for the B.S. in Meteorology has been developed from recommended guidelines for undergraduate degree programs established by the American Meteorological Society and the National Weather Service, meeting the basic minimum requirements of the federal civil service for a degreed meteorologist. These requirements provide a strong, shared core of coursework with our existing majors leading to the B.A. degree in geography, assuring that our meteorology and geography students have a large common experience. The portion of the coursework in the geospatial science arena is in common with our geospatial and environmental analysis option. Additionally, a critical portion of both our new meteorology and existing degrees is the requirement for a field experience. Students must leave the classroom and study outside as an intern, by doing undergraduate research or by travelling on a field experience. In the B.S. in meteorology program, that experience will take one of two forms, either a meteorology field course (for example, the department's very successful great plains storm chase that runs each May) or an internship with the local National Weather Service in Blacksburg.

The B.S. in meteorology degree is comprised of 120 credits, distributed among the following categories of courses: Curriculum for a Liberal Education (general education; 36 credits); meteorology (25 credits); mapping and GIS (7 credits); geography core (12 credits); human systems (6 credits); math/statistics (8 credits); physical sciences (9 credits); field experience (3 credits); and free electives (14 credits).

The new courses developed to complete this proposal have all been approved through the university governance system. (New courses are indicated below with an asterisk.)

Existing and New Courses in the Meteorology Major

- GEOG 1504: Survey of Meteorology
- GEOG 2505: Weather Analysis I
- GEOG 2506: Weather Analysis II
- GEOG 3114: Introduction to Meteorology
- GEOG 3504: Severe Weather
- GEOG 4504: Synoptic Meteorology
- * GEOG 3515: Dynamic Meteorology I
- * GEOG 3516: Dynamic Meteorology II
- * GEOG 3524: Meteorology Field Methods

- * GEOG 4524: Physical Meteorology
- * GEOG 4554: Remote Sensing of the Atmosphere

Learning Outcomes

Skill sets required for successful meteorologists include data collection, data analysis, data interpretation, and computer modeling—a set of skills already taught to our geospatial scientists in the geospatial and environmental analysis major. A key skill to be measured in a meteorology program is the ability to interpret evidence for upcoming weather patterns and to produce forecasts. The program will evaluate each student's abilities in these areas through standard means, course work and examinations, through course review self-evaluations by the faculty, and through annual student surveys concerning their progress in the major and their changing interests.

The Department of Geography will extend the principles and procedures currently used to evaluate the geography degree program to the new B.S. in meteorology. The learning objectives for meteorology will be the same as those currently emphasized in the geography degree program. Weather is a subject for geographic study—it is inherently a spatial phenomenon. Therefore, graduates will:

- Know and apply principal traditions of geographic inquiry: location, regions, place, scale, and human-environment interaction (for meteorology students this focus gives a grounding in the spatial perspective and human environment interaction issues).
- Make appropriate use of **methods** for geographic inquiry to determine, to analyze, and to interpret spatial and temporal patterns and processes (specifically, existing geospatial methods expectations will be expanded to include meteorological software and interpretive forecasting processes).
- Exercise **critical thinking** and demonstrate skill in written, oral, and graphic communication (for meteorology students critical thinking will include interpretation and analysis of weather data and mapped patterns, development of weather forecasts).

Throughout the program the students will be gaining skills in software, critical thinking, spatial modeling and analysis, and weather forecasting. Specific skills to be attained would make a very long list. Generally, after graduation from the meteorology program at Virginia Tech, graduates will be able to gather and interpret weather data from observation stations; use weather imagery to develop weather maps and view weather patterns; describe the properties of radiation and radiation laws, including temperature

vs. wavelength radiation emission relationships; assess the atmosphere's potential for producing rain, sleet, freezing rain, and snow based upon the moisture and temperature profile shown on sounding plots; describe the thermodynamics of the atmosphere; forecast weather; gather and develop geospatial databases at appropriate scales and using optimal georeferencing systems; evaluate data sources for accuracy and reliability; and, develop geospatial models for the solution of spatial problems, especially for physical processes.

Individual and aggregate student progress in the major will be monitored each spring by the faculty in the department to determine whether or not the program is meeting the desired levels stated above. Students who are contemplating leaving the program will be interviewed to determine if changes to advising or other elements of the program could be made to better serve them.

Program Assessment

Assessments within each course are done through normal processes already in place, examinations, project work involving forecasting, computation and result gathering, written papers and oral presentations. Student grades are assigned based upon measurements of their learning in the courses. However, the Department of Geography recognizes that course grades alone cannot be sufficient measures as they are "independent audits" of performance without regard to the effectiveness of the curriculum as a whole. To determine whether or not the program itself is meetings its mission, each geography faculty member provides a post-course review for each course taught. Faculty reflect on each recently completed course and indicate the level of effort placed on each of our three learning objectives, how well each was met, what changes have been made since the last offering, and on any needed changes and improvements for the next. While this information is collected on a course-by-course basis, the department's undergraduate curriculum committee reviews the aggregate of all reports to look for continued improvement in the curriculum.

The university is committed to educational excellence and the enhancement of its academic programs. Virginia Tech has developed and will implement an ongoing academic program review process whereby all formally authorized undergraduate and graduate programs will undergo a comprehensive review at least once every seven years. The university will review the meteorology degree program using the procedures of the seven-year review after year three to gain a benchmark for further reviews. The program will be considered a success if:

- it maintains 60 majors by the fourth year it is offered (2015-2016);
- 80% or more of the majors complete the program requirements in five years or less;

- 80% of the graduates find employment in meteorology and/or geospatial fields within in one year after graduation, or pursue graduate education, and
- 75% of employers are satisfied with our graduates' job performance after one year of employment.

Evidence of Student Demand

While beginning to think about the expansion of the fledgling program in the spring of 2009, instructor David Carroll ran a survey of students in his meteorology classes to ascertain the amount of interest in an expanded program in meteorology. As these students had already self-selected into a meteorology class, one would expect a pretty high amount of interest. Ninety-seven percent of the undergraduates polled were interested in having access to more meteorology classes than the four the department had in the spring of 2009. Sixty-seven percent were interested in a major, and 90% wanted to learn more about severe weather. Seventy-six percent wanted more instruction on forecasting. General comments pointed to the excitement that students would have for such a program. Two students noted that they would have majored in meteorology had it been available, and two more students lamented the need to go out of the commonwealth to get a degree in meteorology.

Since that time, the Department of Geography has added two additional classes, and enrollments continue to indicate high levels of student interest. To be certain that interest in the program was not fleeting, the department completed a second, more thorough survey in the meteorology classes during the fall of 2010. Results show that little has changed. Forty-four persons responded to the survey—35 males and 9 females. All respondents were undergraduate students at Virginia Tech: 1 freshmen, 4 sophomores, 20 juniors, and 19 seniors. Results showed that 79% of students stated that they would be likely to take more classes in meteorology (two noted that they were seniors so they could not take more, but would have if they were underclassmen). Of those interested in more classes, 58% said they would definitely take more classes, 43% said they definitely would change to the major if it would not extend their time at Virginia Tech; a total of 61% were at least somewhat likely to do so.

The department has a number of other avenues that point to student interest in the program. Advisors in the University Academic Advising Center for undecided majors report 10-15 requests per year for meteorology. Since we began talking about the program internally in late 2006, the department has had increased requests for information. Although we have not done any advertising, word has leaked out around the commonwealth that Virginia Tech is working toward this program. As of spring 2010, the department had developed five new courses in meteorology (with one already existing on campus), so it is likely that current students are generating some of the talk

about program establishment. The Department of Geography also runs a highly publicized tornado chase course each May, with an Internet blog following that has grown each year and certainly attracted additional attention.

The geography faculty have met with several families—parents taking college tours with children typically in their junior year of high school. At those meetings, faculty pointed to the desire to start a program and the intention of proposing one. In all cases, the student interest in attending Virginia Tech was dependent on the meteorology program. None expressed interest in going far away for this education; all expressed a strong preference to stay within Virginia.

Evidence of Occupational Demand

Jobs held by meteorologists are widely varied, and this degree will cast the net even farther. It is worth looking at the variety of positions that our graduates might take.

Traditional meteorologists perform many tasks including weather forecasting, atmospheric research, meteorological technology development and support, information services, forensic services, broadcast meteorology, and teaching. New jobs in siting wind farms and tracking shipments around the world also involve meteorologists.

The demand for meteorologists can be gleaned from statistics, although it is difficult to assess the total need because the profession overlaps into many other areas. For example, the Bureau of Labor Statistics lists related occupations in which meteorologists might also be employed as "environmental scientists and specialists," which is closely allied to "surveyors, cartographers, photogrammetrists, and surveying and mapping technicians," a group that the Department of Geography educates in its geospatial and environmental analysis major, and a primary focus area for meteorologists.

Students of meteorology will find employment in both public and private sectors. The top five primary employers of meteorologists are the National Oceanic and Atmospheric Administration, the military (especially the Air Force and Navy), TV/radio stations, secondary and higher education, and consulting meteorology businesses. Demand for meteorology graduates currently is strongest in the private sector. The starting salary for meteorologists in the public sector is at the GS-5 level (\$31,949 in Richmond), quickly increasing to the GS-11 level (\$58,569 in Richmond) after completing three years of employment. Our students will also find employment in climate and green energy fields as they will integrate meteorology with geospatial science.

Using the closest match for our graduates, atmospheric and space scientist positions

are expected to grow nationally by 15% from 2008 to 2018. Popular job search websites such as *Simply Hired* listed the following total new jobs under the headings weather forecasting, meteorologist, and atmospheric scientist in October 2010:

- weather forecasting 58
- meteorologist 15
- atmospheric scientist 88

Median annual wages of atmospheric scientists in May 2008 were \$81,290. The middle 50 percent earned between \$55,140 and \$101,340. The lowest 10 percent earned less than \$38,990, and the highest 10 percent earned more than \$127,100. The average salary for meteorologists employed by the federal government was \$93,661 in March 2009 (Bureau of Labor Statistics, 2010).

Similar data for the geospatial industries indicate the robust job market in that field in October 2010 (*Simply Hired*, 2010):

- geospatial analyst
 80
- GIS technician
 54
- imagery analyst
 54
- GIS specialist 47
- GIS analyst 36
- intelligence analyst 17
- geographic information systems 14

The Virginia Employment Commission (VEC) predicts the need in Virginia for cartographers and photogrammetrists to be growing by 37% for the next decade, increasing in raw numbers from 974 to 1338 positions. The VEC lists this area as a "bright outlook" in the Virginia economy. Indeed, a very large percentage of all geographers and geospatial scientists in the United States are located in the National Capital Region and work for federal agencies, the military, support for the military, and for private firms doing business with the federal government and military.

Program Resources

The Department of Geography has lost three faculty members to retirement and/or relocation. One retired human geographer has been replaced with another human geographer, but, rather than trying to grow larger at this difficult time, we are asking for this new degree platform as a shift in direction. The department has just replaced a second retired human geographer with a meteorologist, and a geospatial scientist with another geospatial scientist. With reallocated faculty lines, and existing geography

courses supporting the new program, the department has kept its resource requests as minimal as possible for a successful new degree program.

The department already has on board an excellent instructor of meteorology in David Carroll. He has developed the basis of the program, excited students about weather, and taken students on very well received and well-publicized field forecasting experiences in the Great Plains each summer since 2007. Further, an associate professor has just been hired who will join the department in the fall of 2011. Therefore, the program will have two full-time faculty members and six additional geography faculty members in part-time service to the meteorology majors. All in all, attracting 60 majors translates to a majors/FTE ratio of 21.2, a bit higher than the ideal, but well within the department's capabilities as it offers a current B.A. degree in geography at a majors/FTE ratio of 35.5. It is expected that a broader program will be developed over time with the addition of faculty lines assuming some departmental growth or through reallocation after the retirement of other faculty members in the upcoming years, though the department is not planning that growth at this time.

As initial class sizes will be relatively small, the department is not requesting additional graduate assistants at this time. The department does anticipate success that will require adding two funded salary lines for graduate teaching assistant positions by the end of 2015-16. The faculty are well aware that meteorology and collaboration in meteorology research is a fruitful area and foresee externally funded graduate research assistant positions as the program develops.

Most of the data and information required by this undergraduate program are real-time and are readily available over the Internet. The department finds no shortcomings of the library at Virginia Tech in this area. A catalog search for the top 10 impact journals publishing in meteorology showed that all are held by the Virginia Tech library.

The Department of Geography has dedicated computer laboratory space for undergraduate education. Lecture/discussion classes will meet in regular general assignment classrooms or in the department's class space in McBryde Hall. Current meteorology offerings are taught successfully in both the existing classroom and the laboratory spaces. Office spaces for new faculty members will be those vacated by the retirees.

Virginia Tech has sufficient computer facilities for the new program. The university's Equipment Trust Fund allocations have been adequate for computer upgrades. Computers in the geospatial lab (which will also serve the meteorology students) are being replaced this summer. For out-of-class work projects that do not require specialized software, all undergraduates purchase a laptop or desktop computer sufficient for anticipated meteorological work. The university's practice of providing a

start-up package to new faculty for moving expenses, equipment, and software (partially funded by the host department) will cover needed computing and specialized software.







Why Meteorology?

The wealth of concern about the changing environment around us is evident to all members of society almost daily. We regularly read of floods in places that do not usually have torrential rains, of stronger and stronger hurricanes during the fall hurricane season, of the continuing slow recapture of the vitality of the city of New Orleans in the aftermath of hurricane Katrina, of longer and more prolonged droughts, some here in Virginia, of clean fresh water being the next critical resource (after oil) to be depleted, and of continued desiccation around the perimeters of existing deserts.

Along with these critical issues are the social considerations that they force us to confront. What role does humankind have in the changes going on around us? How can we maintain a lifestyle to which we have become accustomed if that lifestyle is a culprit in creating these changes? What will the future look like for an ever expanding population with ever expanding and probably unsustainable "needs"? What will be the economic and social cost of all of this to society?







Meteorology Content		
	Survey of Meteorology	role of meteorologists in society
	Introduction to Meteorology	atmospheric study: structure, models
	Weather Analysis I	tools and processes of forecasting
	Weather Analysis II	numerical modeling
	Severe Weather	mesoscale environments for thunderstorms
	Dynamic Meteorology I	atmospheric thermodynamics
	Dynamic Meteorology II	thermodynamics and air movement
	Synoptic Meteorology	large scale weather systems
	Physical Meteorology	physical processes of the atmosphere





