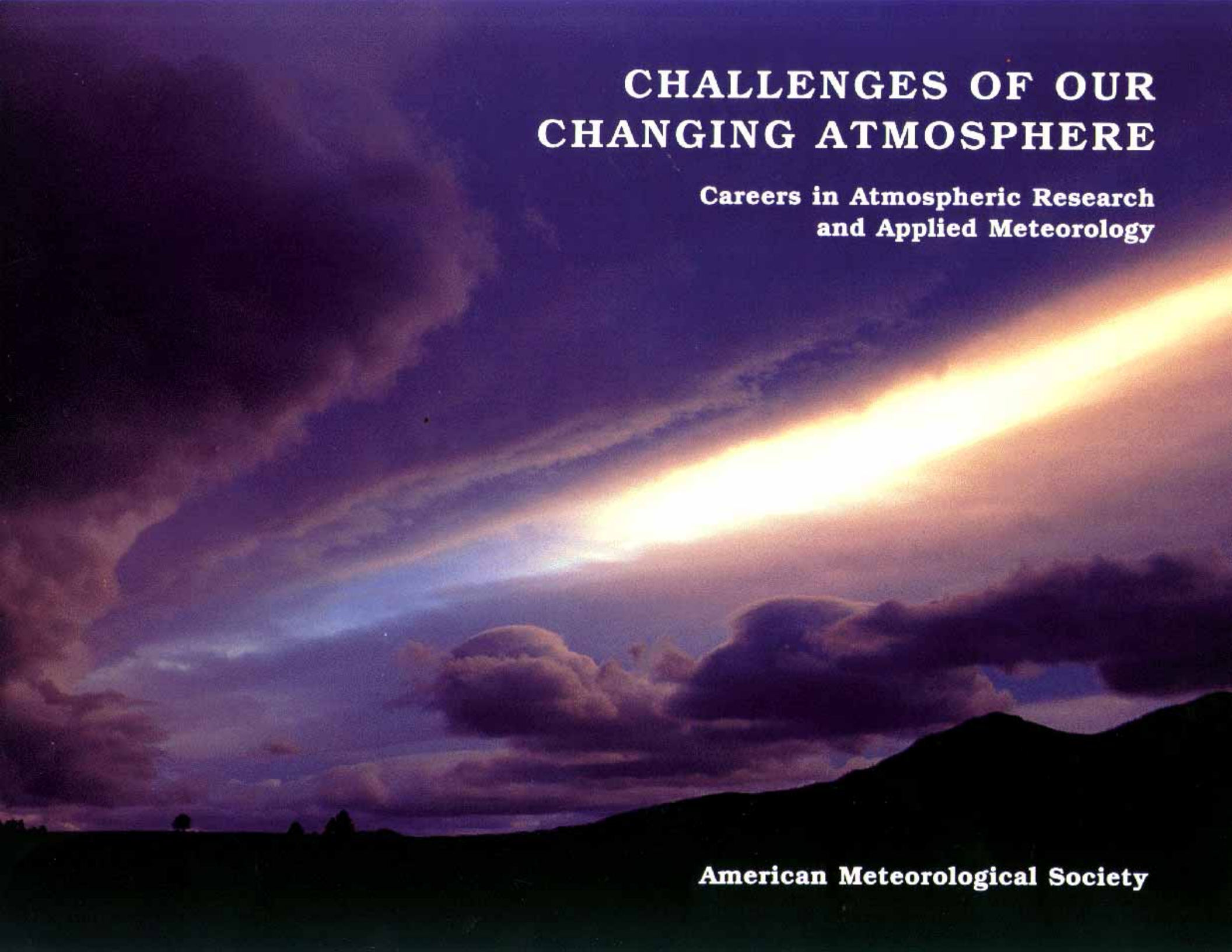

CHALLENGES OF OUR CHANGING ATMOSPHERE

Careers in Atmospheric Research and Applied Meteorology

American Meteorological Society

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Published by the
American Meteorological Society
45 Beacon St.
Boston, Massachusetts 02108

This booklet was produced under the direction of a committee chaired by Warren M. Washington that included Werner A. Baum, Todd Glickman, Ronald D. McPherson, and Pamela Stephens, with input from a large number of AMS members. Henry Lansford, a science writer and communication consultant based in Boulder, Colorado, wrote the booklet and supervised its design and production. It was designed and produced by Michael Shibao of the Graphic Services group at the National Center for Atmospheric Research, which is operated by the University Corporation for Atmospheric Research under the sponsorship of the National Science Foundation. It was reproduced in electronic format for the World Wide Web by David Gershman of the American Meteorological Society.

CONTENTS

THE GREAT FLOOD OF 1993 started with the wettest June on record in the U.S. Midwest. Then, instead of giving way to the usual dry summer weather pattern, a series of storm systems lingered over the region, producing persistent downpours that ran off into the upper Mississippi River and its major tributaries. As the rivers rose to record levels, levees designed to protect cities and farmland started to collapse. By the end of July, 16,000 square miles of the Midwest were under water—an area roughly the size of Massachusetts, Connecticut, and Rhode Island combined. On Sunday, August 1, the Mississippi crested at a record 49.4 feet at St. Louis. Then, instead of continuing to rise as predicted, it started to drop as the weather over the Midwest finally began to shift to a drier pattern. By the time the floodwaters receded, they had taken more than 40 lives, driven thousands of people from their homes, and inflicted $10 billion worth of damage to crops, livestock, and property.

WHY METEOROLOGY?

Thousands of career choices are available in our fast-changing society. Why would you choose atmospheric science or applied meteorology? You will find very specific answers in the following pages, but here is a quick look at some of the challenges of our changing atmosphere:

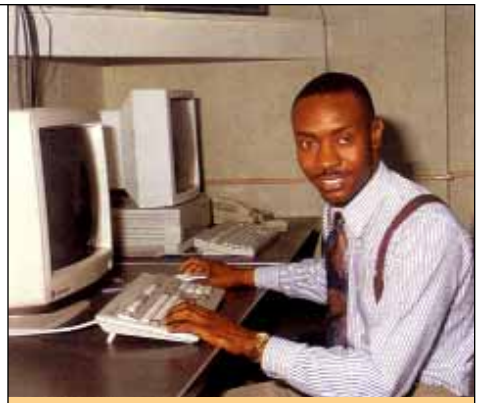
Do you have a deep curiosity about the world around you? As a meteorologist, you can satisfy that curiosity by investigating the natural forces that shape our weather and climate. You can look for answers to important questions that our society is asking—how can we save lives, how can we protect our environment? You can use your knowledge to warn others when danger is approaching in the form of tornadoes and hurricanes. You can use the latest tools of modern technology—computers, radar, satellites—to discover how natural processes and human activities affect our atmosphere. You can learn how we are changing the climate and other global systems by putting pollutants into the environment. You can help make a difference for our planet and for your children and grandchildren.

WHAT IS METEOROLOGY?

Meteorology is the science of the atmosphere. It takes its name from the Greek word *meteoron*—something that happens high in the sky. The ancient Greeks observed clouds, winds, and rain and tried to understand how they are connected to one another. The weather was important in their relatively simple society because it affected the farmers who raised their food and their seamen who sailed the oceans. Today, our complex society and our environment are affected even more seriously by events and changes in the atmosphere. We must address many complicated issues and answer many difficult questions about the behavior of the atmosphere and its effects on the people of our planet.

An Ancient Science

Aristotle is considered the father of meteorology. His book *Meteorologica*, written around 340 B.C., was the first major study of the atmosphere. Although some of Aristotle's ideas about rain, hailstorms, and other kinds of weather were accurate, many were not.



James Marshall Shepherd is a research meteorologist at the Goddard Space Flight Center of the National Aeronautics and Space Administration (NASA), where he works with radar and satellite remote sensing of weather processes. He received a master's degree in physical meteorology in 1993 from the Florida State University, where he also did his undergraduate work. As a graduate student, he held an American Meteorological Society/ TRW Industry Fellowship while conducting research on Doppler weather radar. Shepherd expects to pursue his Ph.D. with NASA support in the near future. He says that he welcomes the challenge of facing new problems in meteorological research and applying his meteorological knowledge to help others.

Like other thinkers of his time, he believed that logic and reason alone could lead to truth. He did not think it was necessary to observe the details of the natural world in order to understand it.

Many centuries later, natural philosophers, as scientists were called in the early years of modern science, realized that speculation and logical arguments alone could not produce real understandings of nature. To understand things that happened in the world around them, it was necessary to measure, record, and analyze them. But for a very long time, the only features of the weather that could be measured were wind direction and rainfall. The thermometer was invented around A.D. 1600, and the barometer, which measures atmospheric pressure, came a few years later. Over the next 200 years, devices were developed for measuring wind speed, humidity, and other important qualities of the atmosphere. Scientists used these instruments to record the long-term trends that are known as climate. However, they still did not understand the day-to-day behavior of thunderstorms, hurricanes, tornadoes, and other weather phenomena.

Meteorology Matures

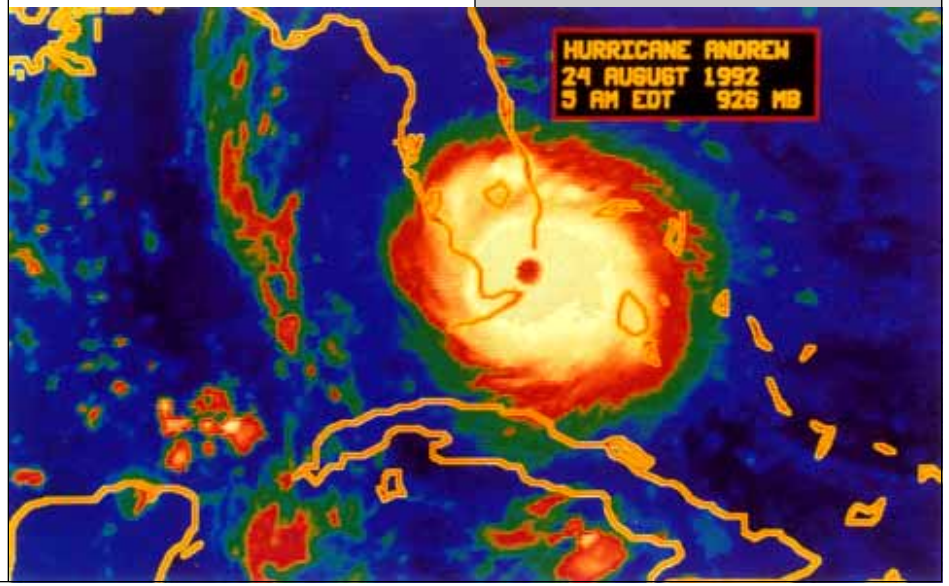
By the mid-1800s, meteorologists began to realize that clouds, winds, and rain at a particular place are produced by large weather systems that grow and change as they move across the face of the earth. However, this knowledge was not very useful as long as weather information could travel no faster than the weather itself. Then the telegraph was invented, allowing weather reports to be sent out almost instantly. Future weather over much of the United States and Europe was predicted by watching storms develop and assuming that they would move eastward. In the early 1900s, a group of Norwegian meteorologists began to study weather systems by applying basic laws of physics to the behavior of the atmosphere. Their approach, based on the movements of huge cold and warm air masses and the "fronts" where they meet, is the foundation of modern weather forecasting.

In the early 1940s, World War II brought great advances in meteorology. Large-scale military land, sea, and air campaigns were highly dependent on weather over vast regions from the North Atlantic to the South Pacific. University meteorology departments grew rapidly as the military services sent cadets to be trained as weather officers. The military also supported scientific research on weather and climate. Wartime technological developments such as radar proved to be valuable meteorological observing systems.

Are hurricanes becoming more intense or frequent? Can their paths and intensity be predicted more accurately?

Meteorologists have developed many more new tools and techniques

A HURRICANE was born as a tropical wave in the atmosphere off the west coast of Africa in late August 1992. As it moved across the Caribbean, it gained strength. By the time Hurricane Andrew had traversed southern Florida and roared northwest into Louisiana, it had become the most costly hurricane on record. Andrew and the tornadoes that it spawned did $30 billion in property damage, breaking the $10 billion record set by Hurricane Hugo in 1989. Largely because of warnings made possible by modern technology such as satellites and radar, the loss of fewer than 40 lives caused by Andrew was relatively small compared to 300 deaths in 1988 from Gilbert, the most intense hurricane on record in the Western Hemisphere.



for observing and studying the atmosphere since World War II. They probe the violent cores of thunderstorms with radar and high-performance aircraft, and they use satellites to observe hurricanes and other major weather systems. They develop numerical models—sets of equations that represent atmospheric processes—and run them on supercomputers to analyze and predict the behavior of the atmosphere on every scale from the formation of raindrops to the circulation of the atmosphere over the entire earth.

More than 2,000 years ago, Greek philosophers looked at the sky and tried to understand what was happening there. Today, the ancient science of meteorology has matured. It is at the cutting edge of research, seeking answers to basic questions about the world around us and working to develop applications that are critically important to our lives and the lives of our children and grandchildren.

WHAT IS A METEOROLOGIST?

When we hear the word "meteorologist," we often think of the person on the television screen who tells us about tomorrow's high and low temperatures and precipitation. Many radio and television weathercasters are professional meteorologists, but others are reporters who are passing on information provided by the National Weather Service or private weather forecasters. The American Meteorological Society defines a meteorologist as a person with specialized education "who uses scientific principles to explain, understand, observe, or forecast the earth's atmospheric phenomena and/or how the atmosphere affects the earth and life on the planet." This education usually includes a bachelor's or higher degree from a college or university. Many meteorologists have degrees in physics, chemistry, mathematics, and other fields. The broader term "atmospheric science" often is used to describe the combination of meteorology and other branches of physical science that are involved in studying the atmosphere.

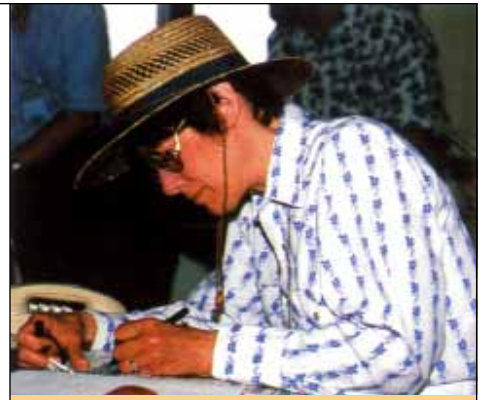
WHAT DO METEOROLOGISTS DO?

Meteorologists do many things, some of which may surprise you. They work in atmospheric research, teaching, weather forecasting, and other kinds of applied meteorology.

Atmospheric Research

Many research meteorologists are seeking answers to the questions that are scattered through this booklet. Here are some examples:

- Atmospheric scientists are working to assess the threat of global warming by collecting and analyzing past and present data on worldwide temperature trends. They use the big-



Margaret A. LeMone is a research scientist at the National Center for Atmospheric Research in Boulder, Colorado. LeMone says that her interest in weather started as a child, when a summer of spectacular thunderstorms and a lightning strike on her home in Columbia, Missouri, turned her into a "weather nut." She went on to earn a Ph.D. in atmospheric science from the University of Washington. Her interest in observing weather directly has taken her on field research projects in Senegal, Taiwan, Mexico and Puerto Rico. In 1993, she spent two months in the Solomon Islands, flying scientific missions over the tropical Pacific Ocean on research aircraft as part of an international study of ocean–atmosphere interactions. For LeMone, part of the fascination of field research is "solving mysteries by finding surprises in new data that aren't explained by existing theories."

INTENSE AND WIDESPREAD DROUGHT struck the United States in the summer of 1988. High temperatures and low rainfall in the Midwestern farm states cut spring wheat production by one-half, corn production by one-third and soybean production by one-fifth. Thousands of barges were stranded as the water level dropped in the Mississippi River. Wildfires raged through bone-dry western national parks and forests.

gest and fastest supercomputers that are available to simulate past changes in climate as well as basic atmospheric processes that are occurring today. They are trying to clear up many uncertainties about how changes in water vapor, clouds, and snow might feed back into the greenhouse effect and alter the warming trend. They also are studying interactions among the atmosphere and the oceans, the polar ice caps, and the earth's plants and animals. These studies are part of a growing field that is known as global change research or earth systems science.

Was the drought of 1988 an early sign of global warming or a short-term climate variation?

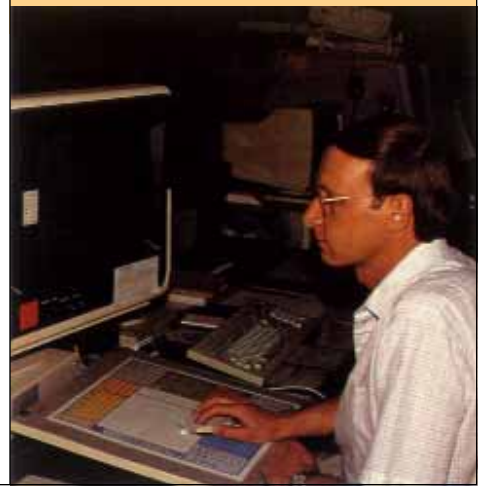
- Several atmospheric research groups have studied microbursts with radar, instrumented aircraft, and other research tools. They have developed an accurate, automatic wind-shear detection and warning system that is being installed at major airports all over the United States to provide safer air travel.

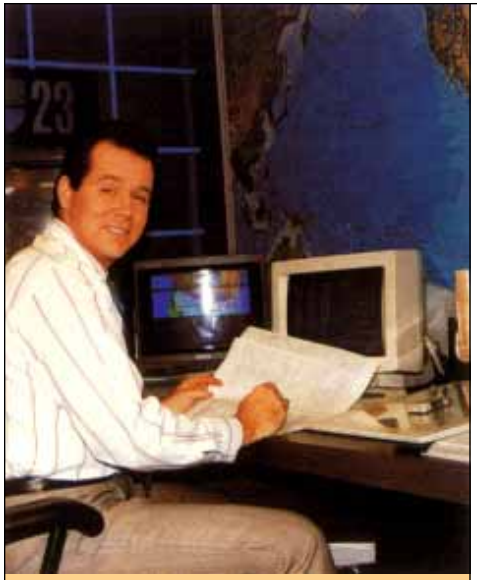
- Meteorologists are collaborating with atmospheric chemists and computer modelers to study the sources, transport, and chemical changes in pollutants that are causing serious regional air quality problems in regions such as California's San Joaquin Valley and the southeastern United States.

- While most atmospheric scientists doubt that the drought of 1988 marked the beginning of long-term global warming, some are looking closely at the causes of droughts and their impacts on agriculture. Short-term variations in weather patterns that produce droughts and floods can seriously reduce world food production.

- Researchers are trying to understand what causes hurricanes to form and how to predict their paths more accurately. Although there is no conclusive evidence of a long-term trend toward more frequent and severe hurricanes, many are concerned about the increasing

Michael J. Szkil is the warning coordination meteorologist with the National Weather Service office in Dodge City, Kansas. Before taking that position in 1991, he was an aviation forecaster with the Federal Aviation Administration, forecasting weather conditions along air traffic routes across the United States. When he was in grade school, Szkil saw a television program on hurricanes that sparked a lifelong interest in weather and its impacts on human lives. He majored in meteorology at Parks College of St. Louis University. "Protection of life and property is the most important aspect of my job," Szkil says. "If I can prevent one person from being hurt or killed by hazardous weather, then I feel that all my training and hard work have been well worth the effort."





John Toohey-Morales was the first Spanish-language broadcast meteorologist on national television when he joined the Miami-based Univision Network after seven years with the National Weather Service. With 45 affiliates, Univision is the nation's largest Spanish-language network. Toohey-Morales says that he gets great professional satisfaction from "following fascinating weather events while understanding the processes that produce them, then explaining these phenomena to the public in understandable terms." A graduate of Cornell University with a B.S. in atmospheric science, he specializes in tropical meteorology and has taken graduate courses in this field at the University of Miami.

numbers of people living in low-lying, hurricane-prone coastal communities who are poorly prepared to survive hurricanes.

Can we develop better tornado prediction, detection, and warning systems to save even more lives?

- Meteorologists who are studying severe storms have developed a new radar system that detects severe storms and tornadoes more accurately than the systems used in the 1980s. The high-resolution data from these systems will provide better warnings of dangerous weather.

Research meteorologists often work closely with scientists in basic physical disciplines such as chemistry, physics, and mathematics as well as with oceanographers, hydrologists, and researchers in other branches of environmental science. Mathematicians and computer scientists help meteorologists design computer models of atmospheric processes. Meteorologists and oceanographers work together to study many important ocean–atmosphere interactions. Research meteorologists work with biologists to try to understand how plants and animals interact with the atmosphere and with political scientists and economists to study the potential effects of global warming on our society.

Weather Forecasting

Forecasting has always been at the heart of meteorology, and many young people have been drawn to the profession by the challenge of forecasting a natural event and seeing that forecast affect the lives of thousands of people. Meteorologists who have worked in the field of forecasting for the last 30 years or so have seen exciting advances in their ability to predict the weather. Five-day forecasts for the weather over North America and Europe now are as accurate as three-day forecasts were in 1970. Outlooks for temperature and precipitation up to seven days ahead are reasonably accurate. Some meteorologists believe that it eventually will be possible to forecast the weather up to

FOUR TORNADOES were spawned by a monster thunderstorm that swept across Kansas on March 13, 1990. A typical Kansas tornado stays on the ground for about 10 minutes and travels about six miles, but these four raked a 100-mile path of destruction for two-and-a-half hours. The 1990 tornado season set a new record for the most tornadoes in a single year, with a total of 1,126. However, these twisters killed 53 people, compared to a 30-year annual average of 82 deaths. Federal officials attributed this low death toll to improved tornado forecasts, effective watches and warnings, and good public education and preparation.

Roscoe R. Braham, Jr. is a scholar in residence at North Carolina State University and a past president of the AMS. He describes meteorology as "a frontier of science that provides opportunities to discover things that are new, exciting and useful." Like many meteorologists of his generation, Braham entered the field as a military weather officer during World War II. When the war was over, he earned master's and doctoral degrees from the University of Chicago and stayed at the university as a faculty member for almost four decades. Braham was a pioneer in the use of instrumented aircraft and radar to study thunderstorms and other weather phenomena. As a teacher he especially welcomed the opportunity to work with "smart, dedicated young people."

two weeks or more in advance. New knowledge about interactions between the tropical ocean and atmosphere may make it possible to predict regional climate patterns months in advance.

Weather forecasting involves many people in many countries because the systems that bring us our weather are hundreds of miles in extent and move across huge regions of the earth's surface as they grow and change. The weather forecast that you see on your television screen is the end product of a worldwide effort by thousands of meteorologists in the national weather services of many nations. Four times each day, weather observers record atmospheric measurements at nearly 10,000 surface weather stations around the world and several thousand ships at sea. They release weather balloons at more than 500 stations to make upper-air measurements. Radar, aircraft and satellites also are used to collect data on what is happening in the atmosphere. This information is transmitted to world weather centers in Russia, Australia and the United States, where computers produce analyses of global weather. National Weather Service meteorologists in Washington, D.C., use these data as a starting point to produce forecasts for the United States with sophisticated computer models. These forecasts go to regional and local centers where National Weather Service meteorologists apply their skill and experience to fine-tune the predictions for their regions and specific towns and cities. They are also used by broadcast meteorologists who deliver their own local and national forecasts on television and radio.

National Weather Service forecasts help the general public and large special-interest groups such as the aviation and agriculture industries. Private forecasting organizations also serve these groups as well as clients with very specific needs for highly specialized forecasts. They take on tasks such as short-term, small-scale snow forecasts for city public works managers who need to know how many snowplows to put on the streets in various neighborhoods when a winter storm is on the way. Private forecasters work for commodities traders who are concerned about the effects of weather on crop production and prices. They forecast the weather for athletic events such as professional football games

and golf tournaments. They keep gas and electric companies informed about impending hot spells or cold waves that will put heavy demands on generating plants and transmission systems. They provide local weather forecasts to many radio and television stations that do not employ their own meteorologists.

Other Applications

Meteorologists provide a variety of services to industries and other organizations. Some are consulting meteorologists with their own companies and others worked for corporations. Meteorologists help planners and contractors locate and design airports, factories and many other kinds of construction projects. They provide climatological information for heating and air conditioning engineers. They testify as expert witnesses in court cases that involve the weather. Over the past 10 years or so, the fastest growing specialty of meteorology has been computer processing of weather information. Private companies have developed computerized information systems to provide specialized weather data and displays. They produce many of the colorful graphics that you see on television screens and newspaper pages.

Teaching

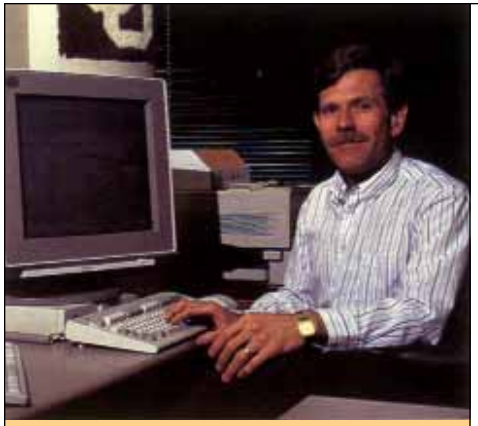
Atmospheric science education at the college and university level has grown tremendously in recent years. In addition to classroom teaching, many university atmospheric scientists direct research that graduate students are performing to earn their degrees. Many institutions offer a major in meteorology or atmospheric science, while others provide atmospheric science courses to supplement related science and engineering fields or as part of a broader educational curricula. Some colleges and universities offer courses in global change and earth systems science. In high schools and lower grades, atmospheric science usually is taught as part of other natural science courses. Training in meteorology is good preparation for a career as a science teacher at any level.

Is the earth really getting warmer? How will this affect our lives and those of our children and grandchildren? Can we or should we do anything to try to slow the warming?

WHAT TOOLS DO METEOROLOGISTS USE?

For hundreds of years, observations of the atmosphere have been the starting point for efforts to understand and predict its behavior. Most observations were made at ground stations equipped with instruments to measure temperature, barometric pressure, humidity, and wind speed and direction. Then the rawinsonde (from "radio wind sounding") was developed. This instrument package is carried aloft by a weather balloon and tracked to measure wind speed and direction. It transmits measurements of atmospheric temperature, pressure, and humidity back to receivers on the ground. These observational data provide meteorologists with basic information about what is happening at many levels of the atmosphere, not just at the earth's surface. Although rawinsondes are gradually being replaced by new remote sensing systems that can make upper-

THE GLOBAL ATMOSPHERE may be gradually warming. Some atmospheric scientists believe that the warming is real and that it is caused by rising levels of carbon dioxide and other trace gases emitted by human activities that cause warming in the lower atmosphere through the so-called greenhouse effect. We have released increasing amounts of carbon dioxide into the atmosphere by burning coal, oil, and gas in factories, power plants, and cars. Some scientists suggest that global warming might cause heat waves and droughts that could reduce world food production, produce more frequent and intense hurricanes, and raise the ocean level enough to flood coastal cities. However, others maintain that worldwide temperature records are not complete enough to establish a long-term warming trend. They also point out that we don't really understand how the warming would affect weather patterns.



Kelvin K. Droegemeier is an associate professor of meteorology at the University of Oklahoma. "Meteorology encompasses mathematics, physics, thermodynamics, aerodynamics, computer science and other disciplines," he says. "I find the combination of these elements and their application to the atmosphere intriguing and rewarding." Droegemeier holds and M.S. and a Ph.D. in atmospheric science from the University of Illinois. His professional interests include thunderstorm dynamics, computational fluid dynamics, numerical weather prediction, and aviation weather. He finds professional satisfaction in "addressing problems that significantly and directly influence our society, such as wind shear and storm prediction, and using advanced computer technology to work with them."

atmosphere measurements from ground stations, they still are basic tools of meteorology.

Instrumented Aircraft

High-performance airplanes equipped with measuring and sampling instruments are used to observe many kinds of weather and other atmospheric phenomena. "Hurricane hunter" aircraft fly into the hearts of these huge, intense weather systems. Armored research aircraft penetrate hailstorms to study the processes that produce hailstones. High-performance jets fly into plumes of smoke and ash over erupting volcanoes to sample particles that are ejected into the atmosphere, where they can affect weather and climate.

Radar

Radar—an acronym for "radio detection and ranging"—was developed to detect enemy aircraft flying under cover of clouds or darkness. The radar transmitter sends out any electronic beam that is reflected back by the metal skin of aircraft. When meteorologists discovered that water droplets in the atmosphere also reflect radar beams, radar became a valuable tool for detecting and measuring rain and other precipitation. Radar observations first identified the rainbands that spiral into the eye of a hurricane. A special kind of radar known as Doppler can measure wind speed and direction. Doppler radar has become the best tool available for detecting tornadoes and other dangerous kinds of severe weather. It also is the key element of the new wind-shear detection and warning system that is being used at major U.S. airports. Acoustic sounders have been developed that use sound waves to measure winds in the same way that radar probes the atmosphere with an electronic beam.

Satellites

The two tools of modern meteorology that truly have revolutionized the field are satellites and computers. The first weather satellites could only provide pictures of the earth's surface and its cloud cover, not the measurements that were needed to go into computer models that were coming into widespread use in research and forecasting. Today's satellites use advanced remote-sensing techniques to measure temperature, winds, and other qualities of the atmosphere at many levels. Satellites are among the most valuable tools of meteorology because they can cover the entire surface of the earth,

including vast ocean areas where no weather stations exist, and can monitor changes in global climate.

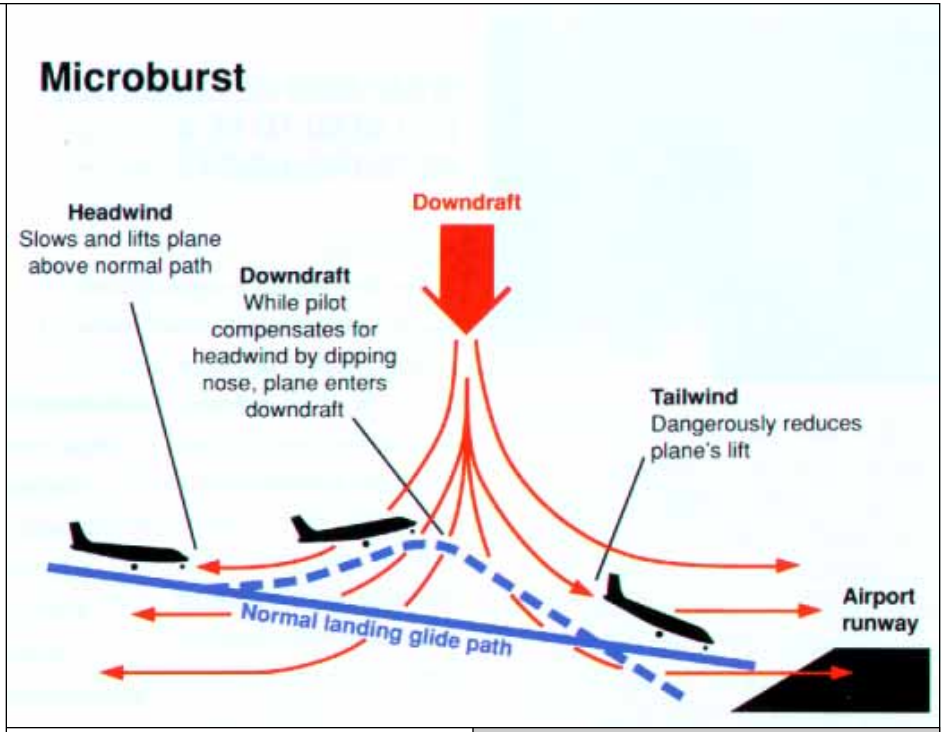
Can better detection and warning systems protect airline passengers from wind shear?

Computers

Numerical models of the atmosphere are sets of mathematical equations that represent the physical principles that govern atmospheric structure and motions. By using high-speed computers to solve the equations over and over, meteorologists can simulate days, weeks, and years of atmospheric behavior in minutes or hours, depending on the complexity of the model and the speed of the computer. The U.S. National Weather Service and most of the world's other weather services produce large-scale weather forecasts by making the weather "happen" in the computer faster than it happens in the real atmosphere. Because these simulations are so complex and use such vast quantities of data, the world's biggest and fastest supercomputers are used in atmospheric research and large-scale weather forecasting.

WHERE DO METEOROLOGISTS WORK?

The largest employer of meteorologists in this country is the United States government. Many work for the National Oceanic and Atmospheric Administration (NOAA), which includes the National Weather Service. Some are on active duty with the military services, primarily the Air Force and the Navy, while others are civilian employees of the Department of Defense. Other federal agencies such as the National Aeronautics and Space Administration (NASA), the Department of Energy, and the Department of Agriculture also employ meteorologists. Other major employers include universities and private industry. University meteorologists teach and work in atmospheric research programs. There are increasing employment opportunities for meteorologists in industry, private consulting firms, and research organizations. Many television stations employ professional meteorologists rather than reporters to present weather information to their viewers.



A MICROBURST—a small, intense downward gush of cold air—formed beneath a Texas thundershower on an August afternoon in 1985. Microbursts produce sudden changes in wind speed and direction that meteorologists call wind shear. A wide-body jet airliner on final approach to Dallas–Fort Worth International Airport flew into the microburst and crashed, killing 134 passengers and crew members. They were among more than 600 people who have died since 1962 in airline accidents caused by wind shear, the number one cause of air-travel–related deaths.

WHAT DO METEOROLOGISTS EARN?

This subject is covered in an insert that you will find at the end of this booklet.

Vivian Brown is an on-camera meteorologist with the Weather Channel in Atlanta, Georgia. "Ever since I was 15," she says, "I have been fascinated with cloud patterns and daily weather changes. Studying meteorology at Jackson [Mississippi] State College gave me an opportunity to learn more about these areas." Brown's first job at the Weather Channel was in the background—she analyzed data and prepared information for presentation by broadcast meteorologists. In 1989, she moved to an on-camera position. In addition to a comprehensive knowledge of meteorology, this job requires the ability to communicate weather information to national audiences in a natural and easy-to-understand manner. "The most gratifying aspect of my job," Brown says, "is being able to provide important information that people need to protect themselves, their homes, and their crops from hazardous weather."

WHAT KIND OF EDUCATION DO I NEED TO BE A METEOROLOGIST?

High School

The first step in preparing for a career in meteorology is a well-balanced college preparatory program in high school. Essential science courses include physics and chemistry. Earth science courses can provide a valuable introduction to the atmospheric environment. Mathematical proficiency is essential in every branch of physical science today, and the computer is a basic scientific tool. If you want to be a meteorologist, take every math and computer science course that is available. A good command of written and spoken English is important in communicating scientific knowledge effectively. Foreign languages such as Russian, German and French can be useful in keeping up with new international developments in atmospheric science.

How can we do a better job of identifying and controlling the sources of air pollution?

College and University

The most direct path to a career in meteorology is an undergraduate program that leads to a bachelor's degree in meteorology or atmospheric science. Many colleges and universities in the United States and Canada have such programs. Some offer broad-based meteorological studies while others focus on specialties such as agricultural meteorology. If you are interested in a specialized area, choose an undergraduate program that also will give you a broad and solid foundation in atmospheric science. If you are interested in a career in research, an under-

DARK PALLS OF AIR POLLUTION have hung over New York, Los Angeles, and other cities for many years. By the early 1990s, air pollution alerts were being declared on an increasing number of winter days in Denver, Phoenix, and other cities in the wide open spaces of the western United States. Even the skies over western national parks such as the Grand Canyon are hazy with pollutants. Government policy-makers, industry executives, and environmental advocates disagree about how much of the pollution comes from various sources such as power plants, factories, and automobiles.

graduate major in physics, chemistry, engineering, or mathematics can prepare you to study atmospheric science in graduate school. Although many careers in meteorology are available to college graduates with a bachelor's degree, graduate-level education opens the door to many more professional opportunities. A master's or doctoral degree is very important if you plan to go into atmospheric research. If you are interested in the expanding field of global change research, you should take courses in subjects such as oceanography, geophysics, biology, and ecology, in addition to meteorology and basic physical sciences.

How Do I Choose a School?

Your school counseling office should be able to help you identify colleges and universities that offer undergraduate and graduate programs in meteorology or atmospheric science. Consult *Curricula in the Atmospheric, Oceanic, Hydrologic, and Related Sciences* for detailed information on specific programs. This book, which is updated every two years, is published by the American Meteorological Society (AMS) and the University Corporation for Atmospheric Research (UCAR). It contains extensive information on the faculty, programs, courses, facilities, and research programs of about 100 colleges and universities in the United States, Canada, and Puerto Rico. It may be purchased from the AMS if it is not available in your school or local library. For ordering information on the current edition, write to the American Meteorological Society, 45 Beacon Street, Boston, Massachusetts 02108 or call 617-227-2425.

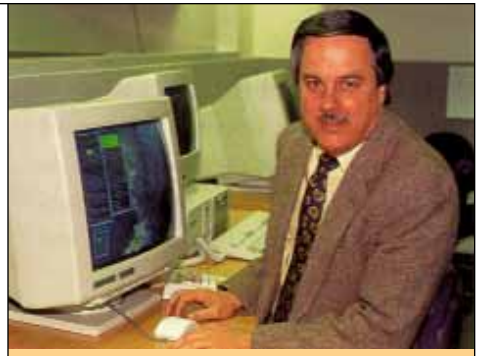
WOULD METEOROLOGY BE A GOOD CAREER FOR ME?

Here are some questions you may want to ask yourself if you are considering a career in meteorology:

- Am I curious about the world around me and why it is the way it is?
- Would I like to work in a field of science that has many important applications in human affairs?
- Am I challenged by the idea of applying basic scientific principles to understand the behavior of the atmosphere?
- Am I intrigued by the concept of using mathematics as a language to describe things that happen in the world around me?
- Do I enjoy science and math courses?
- Would I like to work with supercomputers, satellites and other sophisticated research tools?
- Am I open to change?

There are no right or wrong answers, but all of these questions are closely related to the nature of modern meteorology and the challenges of our changing atmosphere.

In the past, not many women or members of ethnic minority groups have gone into careers in meteorology or other branches of the physical sciences. Today, many rewarding career opportunities are open to anyone who



Kenneth C. Crawford became Oklahoma state climatologist and associate professor of meteorology at the University of Oklahoma in 1989 after a 27-year career with the National Weather Service (NWS). He says that he chose meteorology as a career because he saw science as "an opportunity to impact the world around me." Crawford holds degrees in meteorology from the University of Texas at Austin, the Florida State University, and the University of Oklahoma. Much of his professional career has focused on weather radar. He played a key role in testing the prototype version of the NEXRAD (Next Generation Radar) system that NWS is deploying across the nation to provide better detection and warning of severe storms and tornadoes. After a devastating flood in Tulsa, Oklahoma, in 1984, Crawford led the development of a radar-based flood warning system there. This system, the only one of its kind in the United States, is still in operation.

has a good knowledge of meteorology and the ability to use it in atmospheric research or applied meteorology. In meteorology, as in many other professions, employers are actively recruiting women and minorities.

ABOUT THE AMS

The American Meteorological Society was founded in 1919 to develop and disseminate knowledge of all phases and applications of meteorology and to advance its professional ideals. Today, the Society represents and provides a means of communication for individuals and groups concerned with the atmosphere and related oceanic and hydrological sciences.

The Society's scientific services include:

- publishing technical and popular journals
- encouraging international cooperation
- holding meetings and conferences
- maintaining local chapters
- operating abstracting services
- issuing policy statements to the public.

Professional services include:

- maintaining an employment listing
- publishing a professional directory
- certifying consulting meteorologists
- awarding seals of approval to radio and television weathercasters
- presenting achievement and recognition awards.

Educational services include:

- holding meetings, symposia, workshops, and short courses
- supervising preparation of educational films and monographs
- publishing career guidance and educational information
- administering scholarships and fellowships to undergraduate and graduate students.

For information about any of these services, contact the American Meteorological Society, 45 Beacon Street, Boston, Massachusetts 02108, 617-227-2425.

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EMPLOYMENT OUTLOOK AND SALARIES IN METEOROLOGY

Employment outlook in meteorology

Meteorology is a relatively small field with about 20,000 practicing meteorologists and about 1000 new meteorologists entering the work force each year in the United States. Historically, there have been about as many positions available as there are meteorologists looking for work. This means that almost all graduating meteorologists are able to obtain a job in meteorology if they are diligent in their job search, but few are in a position to choose between several job offers and most have to be flexible concerning both the region of the country and the type of meteorological position they will consider. This situation is improving at present. The National Weather Service (NWS) is going through a period of restructuring and modernization that includes plans to increase the number of NWS meteorologists. This is not only increasing the availability of jobs in the National Weather Service, but also improving the opportunities for employment across the spectrum of meteorological positions. As the NWS modernization concludes during the next few years, employment activity will likely return to somewhat lower, historical levels.

Salaries in meteorology

The following salary information is based primarily on information collected as part of a survey conducted by the AMS in 1992. Over 5000 meteorologists provided information on their jobs, which included salary information.

Entry-level salaries in meteorological positions. The average annual salary for entry-level positions in the atmospheric sciences is about $28,000, but this figure is somewhat misleading since an entry-level research meteorologist position requiring a Ph.D. will generally have a much higher salary than an entry-level forecaster position requiring a B.S. degree. It is more useful to look at entry-level salaries by degree level. The first column shows the average annual salary for all types of positions, and the second column shows the starting salary range for positions at the National Weather Service. Note that while the entry-level salaries for the NWS may appear low by comparison, advancement is rapid. For example, a GS-5 intern will progress to a GS-9 position in two years.

	All positions	National Weather Service positions
With a B.S. degree	$22,000	$18,340–$22,717 (GS-5–GS-7)
With an M.S. degree	$27,000	$22,717–$27,789 (GS-7–GS-9)
With a Ph.D. degree	$37,000	$27,789–$33,623 (GS-9–GS-11)

Broadcast meteorology. The salaries for jobs in the broadcast fields (television and radio) cover an enormous range. While the average annual salary for AMS members who are broadcast meteorologists is $46,000, there are nearly 10% who make under $20,000 and over 10% who make more than $100,000 annually. The typical starting salary in a broadcast position for a meteorologist who has just begun his or her career is about $20,000.