

## WHY LIBERAL ARTS COLLEGES NEED METEOROLOGY AND OCEANOGRAPHY

BY STANLEY Q. KIDDER, LEONARD J. PIETRAFESA, AND PAUL J. CROFT

Classicists know that Aristotle wrote the first textbook on meteorology, his four-volume *Meteorologica*. Most historians will tell you that it was winter, not the Russian army, that defeated Hitler and Napoleon on the Eastern Front. And who defeated the Spanish Armada? The British navy had considerable help from intense cyclonic storms that form via the ocean's fueling of the atmosphere. Biologists tell us that life began in the sea. Art historians know that when Monet painted the cathedral at Rouen, he was depicting the effects of the atmosphere on the colors of the facade.

A meteorologist or an oceanographer could add insight about all of these popular academic topics and more. But meteorologists and oceanographers are rarely found in the classrooms where discussions like this take place: in liberal arts colleges. At nearly every liberal arts college, students can study the "pure" sciences of physics, chemistry, and biology, and usually one "applied" science: geology, but not oceanography or meteorology. Liberal arts colleges should give serious consideration to offering these critical sciences as well.

Having connections with other disciplines, of course, is not sufficient to warrant inclusion in

the liberal arts curriculum; the subject must stand on its own as a significant aspect of human life. Meteorology and oceanography more than meet the criterion. All of life on land depends on six inches of topsoil and the fact that it rains. Civilization itself may be a function of climate change—warm temperatures during the climatic optimum 5,000 to 10,000 years ago made conditions favorable. Certainly geographers know that people tend to settle and prosper where estuaries meet the seas. Maritime commerce has been critical since before the Roman Empire.

Students will deal with weather and climate every day of their lives. Our health and psychology are closely tied to the atmosphere, such as the critical ozone layer that protects us from skin cancer. And many real-world, front-page issues are also the province of meteorology or oceanography: global warming, acid rain, air pollution, coastal flooding, hurricanes and tornadoes, toxic algal blooms, and sustainable development on barrier islands, to name a few.

Difficult, expensive decisions will be made about all of these issues. Economists predict that a single future hurricane could cost the U.S. economy \$100 billion. The effect of weather on business is acknowledged by the fact that the National Weather Service is part of the U.S. Department of Commerce. Liberal arts students, who are educated to think broadly, will have to contribute to these decisions. It would be good if some of them could have instruction in the fundamental characteristics and principles of the problems.

Furthermore, critical thinking—a fundamental life skill—is at the heart of meteorology and oceanography. For instance, we all make forecasts all the time. Where is that car going, and how can I avoid it? What will happen if I invest my savings in that beach house? Meteorologists and oceanographers learn not only to make weather and marine forecasts, but also to *verify* them by comparing the forecasts with what re-

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ally happened and making quantitative assessments of accuracy. This is a key both to using forecasts and to improving them, yet it is seldom taught systematically.

Finally, meteorology and oceanography are well suited to undergraduates who will never specialize in science. These applied sciences are multidisciplinary, drawing on physics and mathematics as well as on chemistry, biology, computer science, and other disciplines. They present new challenges every day as the wind, waves, and currents constantly change. They are unavoidable: one enters the laboratory whenever one ventures outdoors. And they're fun: people whose careers and education have little to do with meteorology or oceanography enjoy both the real and virtual (model) worlds of weather and seas.

But if meteorology and oceanography are so useful in education, why are they not already part of the liberal arts curriculum the way that geology is? Perhaps the answer lies in economics. Geology may be a part of the curriculum because for centuries it has aided in the exploration for minerals, metals, and fuels. By contrast, weather forecasting had little skill or value until recently. Indeed, François Arago, director of the Paris Observatory and permanent secretary of the French Academy of Sciences, wrote in 1846, "Whatever may be the progress of sciences, NEVER will observers who are trust-worthy, and careful of their reputation, venture to foretell the state of the weather."

Although national weather services have existed for over a hundred years, and the equations that govern the motion of the atmosphere and the ocean have been known for nearly that long, only since World War II have we had the worldwide observation networks and the computers necessary for numerical weather and sea state prediction. And the radars and satellites with which short-term forecasts are made have been in existence only since the 1950s and 1960s, respectively.

Today, weather and sea state prediction as far as 10 days ahead has some skill, and it has become

## ECHOES

“**From agriculture to energy, on down to the small convenience store owner who is stockpiling snow shovels, El Niño really is an all encompassing phenomenon.**”

—VERNON KOUSKY, NOAA climate specialist, on an advisory issued that El Niño might return this spring. Government forecasters issued an El Niño advisory in January.

a staple of modern life. Government agencies are now proposing to create a "climate forecast service," like the National Weather Service, and predict future climate variation effects by continent, region, and state, and even do ecological and health effects forecasting. The public will be attuned; economists, city managers, emergency managers, and public health officials will

be listening; but college courses haven't kept up.

Perhaps we oceanographers and meteorologists haven't been paying attention to the situation in liberal arts colleges. Our sciences have grown up in the age of Vannevar Bush's 1945 report, *Science—The Endless Frontier*, with plentiful research money and challenging research careers. Both sciences have been considered to be research, not academic, fields. Meteorologists and oceanographers have tended to work in government, private industry, or research universities. Few have actively sought positions at liberal arts colleges. This has been a disservice both to students and to ourselves. We have denied liberal arts students access to our sciences, and we may have failed to establish the broad base of support needed to sustain our sciences.

The time is right to update the liberal arts curriculum by offering meteorology and oceanography courses. Liberal arts colleges could fill positions in physics, chemistry, biology, and geology or geography departments in a way that would simultaneously meet their needs and provide expertise in meteorology and oceanography that would significantly enhance the breadth and vitality of their students' academic programs.

Planet Earth is becoming more and more crowded, placing increasing demands on the atmosphere, the ocean, the land, and the biosphere. Yet our knowledge about these realms and their connections to each other are rapidly increasing, too. The addition of meteorology and oceanography to the liberal arts curriculum will help the students of today make the informed decisions that tomorrow will require.