WeatherZine

NCAR
P.O. Box 3000
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Environmental and Societal Impacts Group

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--SPECIAL NOTE--

We are fortunate to have two guest editorials this month. The first is by D. James Baker, Under Secretary for Oceans and Atmosphere, U.S. Department of Commerce Administrator, National Oceanic and Atmospheric Administration, and Rick Anthes, President, University Corporation for Atmospheric Research. The second is by Tom Stewart of SUNY-Albany.

Remember to check out the Adobe PDF version of the Newsletter (zine20.PDF) for a formatted version should you wish to print out!

Comments? Send us email at thunder@ucar.edu

--IN THIS ISSUE--

Editorial

The Prediction Hall of Fame

Across the earth sciences, weather forecasting is the "only candidate for the prediction hall of fame." So concludes a forthcoming book titled Prediction: Decision making and the future of nature (Island Press) (see www.esig.ucar.edu/prediction/book.html). The book is one product from a project that I have been involved in for the past 3 years. The project has looked at "prediction in the earth sciences: use and misuse in policy making" (www.esig.ucar.edu/prediction/).

Weather forecasting is one of ten case studies that were examined by people from the humanities and physical and social sciences, as well as decision makers from a range of settings. The other nine case studies are floods, earthquakes, asteroid impacts, beach erosion, mining impact, nuclear waste disposal, acid rain, oil and gas resources, and climate. The book concludes that decision makers should view the *process* of prediction to be as or more important than the *products* of prediction.

Weather forecasting illustrates the importance of this process. As the WeatherZine has often argued, (www.esig.ucar.edu/socasp/zine/8.html#1), a technically accurate forecast is only valuable if it is effectively communicated in a useful manner to decision makers who have alternative courses of action before them. Unlike other areas of earth sciences prediction for decision makers, the weather forecasting enterprise has the advantage of well-developed forecasting, communication, and decision processes. This accounts for the documented value of weather forecasting (www.esig.ucar.edu/socasp/weather1/), and the existence of a highly respected private sector community.

Within the predictive enterprise, weather forecasting is unique in the range of experience that it provides. Consider that the National Weather Service issues about *10 million* forecasts every year to hundreds of millions of decision makers. This provides great opportunity for scientists to rigorously evaluate the skill of forecasts and the factors that underlie prospective future improvements. It also provides decision makers

an ability to effectively calibrate the information that they receive and thus more fully adapt and refine their decision processes. In short, the wealth of experience afforded by weather forecasting makes it particularly amenable to constant improvement through evaluation and adjustment. No other area of prediction comes close to these unique aspects of weather prediction.

The comparative assessment provides some lessons for how we think about prediction in general and also about weather prediction specifically.

First, the longer the time frame of a prediction, the less ability there is to judge its accuracy. One conclusion that follows is that decision makers should rely less on predictions the farther in the future the event in question. So the storage of nuclear waste for the next 10,000 years should likely rely more on effective engineering than accurate predictions of groundwater movement at the disposal site. Similarly, disputes over the precise future of the climate that characterize the global warming debate miss the essential point that much, even most, adaptation and mitigation make sense no matter what the future climate happens to be.

Second, decision makers, in cases where they have less experience with predictions, may find that the predictions themselves can have profound impacts. Concern about negative public response to earthquake predictions (from panic to loss of faith) is one factor that has led to a reduced focus on forecasting as a primary societal response to earthquakes. Some might argue that a similar phenomenon exists in seasonal climate prediction, where the sheer lack of experience with such forecasts limits their actual usefulness (www.esig.ucar.edu/signal/guest.html).

For weather forecasting there are lessons as well. Because people do have so much experience with weather forecasts, it can be difficult for the weather community to make the case that forecasts have room for improvement. A 1999 Gallup Poll (www.gallup.com/poll/releases/pr990525.asp) found that 70% of Americans thought the National Weather Service was doing a “good job.” This was up from 51% in 1948. The number who thought the NWS was doing a poor job dropped from 15% to 7% over the same period. But when the weather community presents a case for greater public support, it must be careful to avoid over-selling present or future capabilities. A case can be made that – even as successful as weather forecasters often are -- many people expect too much from the weather forecast community (www.esig.ucar.edu/redriver/index.html).

This can create unrealistic expectations of performance and also lead to pressures on forecasters that actually can serve to *decrease* forecast accuracy (see Tom Stewart’s guest editorial at p. 3, or stewart.html). Another lesson for the weather community from the case studies is that a healthy prediction process requires a shared effort across the process. Prediction, communication, and decision making are not linear, discrete tasks of an assembly line, but rather elements that must mesh together like the instruments in a symphony orchestra. The weather community has shown a tendency to balkanize itself – public versus private, research versus operations, agency versus agency, and so on. Future progress in weather forecasting likely depends as much on paying attention to the effectiveness of the process – and the linkages within -- as to the accuracy of predictions.

The weather community is indeed special in the predictive earth sciences. Its successes provide guidance for other efforts to link scientific predictions with the needs of decision makers. At the same time, its uniqueness suggests that prediction should not always be the first response of decision makers to complex and important problems at the intersection of environment and society.

--Roger A. Pielke, Jr.

Guest Editorials

(1) Weather Forecast Limitations Point To Need For More Research

The powerful snowstorm of Tuesday, January 25, 2000, underscores the urgent need to learn more about the weather. Our National Weather Service, a unit of the National Oceanic and Atmospheric Administration (NOAA), a bureau of the U.S. Department of Commerce, has deployed the best weather service system in the world. But as good as it is, our system still needs to improve warnings of some important events. The strength and track of Tuesday's intense storm was picked up with about 9 hours notice. That's not bad, but it's not enough.

It's not just one event that causes concern. The rapidly growing Tuesday snowstorm closely followed two explosively growing storms that hit Europe in December, neither of which was forecast more than a few hours in advance. These storms inflicted losses totaling billions of dollars, both in property destruction and in business interruption.

What needs to be done to forecast these explosively changing storms? The answer lies in better observations, better understanding of the system, and better models on faster computers. We have a wonderful observational system with a network of satellites, radars, and surface instruments. But if we don't use this system even more effectively, we will continue to suffer observational blind spots. Because water content is so important for storms, we need an improved picture of atmospheric humidity. Since our weather is affected by what happens over the oceans, we need more observations of the weather conditions over adjacent Atlantic, Gulf, and Pacific waters.

To use these observations, we must develop a sharper understanding of the processes responsible for storm formation, intensification, track, and duration. We must accelerate the transfer of research understanding into operational forecast improvements. And we need to improve our computer capability. The new computer recently unveiled by the National Weather Service helped us do as well as we did for the Tuesday storm, but clearly more capability is needed. We also need a better knowledge of how weather impacts are communicated, how that information is used by government, private enterprise, and the general public, and the costs and benefits of such transactions.

To keep pace with growing national needs for timely, more reliable weather information requires the active involvement of all the Nation's weather information deliverers. That's why NOAA is working in partnership with other federal agencies (the Navy, NASA, NSF, and FEMA), with more than 60 of the Nation's research universities (through the University Corporation for Atmospheric Research), and with commercial meteorologists and end users to improve weather predictions and their use. The U.S. Weather Research Program is the partnership that focuses initially on hurricanes, winter storms, and related flooding. Over time it will address other weather events that adversely affect the citizens of our Nation, including tornadoes, hail, high winds, and flash floods.

The forecast for long-term changes in weather offers no relief. With population growth and more migration to the coasts, the U.S. population has become more exposed to storms and floods. Insurance costs due to weather events are increasing dramatically every year. After a lull in hurricane landfalls lasting several decades, the United States appears to be re-entering a period when more active hurricane seasons are likely. In his State of the Union address, the President noted that global warming could lead to more heat waves, droughts, and flooding. It's clear that our weather forecast and warning system has important gaps to fill to address these increasing needs. The U.S. Weather Research Program is aimed at these problems, and needs full support to make significant progress. To date, the program has had inadequate funding to address all of the priority needs. However, the national urgency of this task--the need to minimize weather threats to public safety and business in future years--makes accelerating this collaboration a prudent and necessary investment.

--D. James Baker

Under Secretary for Oceans and Atmosphere, U.S. Department of Commerce & Administrator, National Oceanic and Atmospheric Administration

--Richard Anthes

President, University Corporation for Atmospheric Research, Boulder, CO

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(2) Modernization: The Challenge Continues

The multi-billion dollar, decade-long modernization of the National Weather Service is essentially completed. Weather Service Offices now have advanced instruments and information systems in place. As a result, forecasters have access to more information and model guidance than ever before.

But one component of the weather forecasting system remains unaltered by the Modernization. Indeed, it has changed little since the beginning of weather forecasting. That component is the forecaster's brain. Although the challenges offered by our complex environment and extensive education may make us smarter than our ancestors, we are still equipped with essentially the same cognitive processes they had. As experience has shown repeatedly, those processes can be incredibly powerful on one occasion and hopelessly inadequate on another.

Obviously, technological modernization of the weather service is pointless unless forecasters can use its improvements to issue better forecasts and warnings. After years of studying human judgment, I have high regard for weather forecasters. We have found higher accuracy among weather forecasters predicting temperature and precipitation than any other group of experts we have studied (see additional readings below). But I also believe that there is room for improvement in making use of improved information, particularly when issuing forecasts and warnings of severe weather.

Joe Golden recently wrote that lead times and probability of detection “have improved steadily since

1990. However, the [false alarm rates] have increased slightly over the past few years . . . the reasons for more NWS false alarms are not clear."

But an increase in false alarms should not be a surprise. For any fixed (less than perfect) level of forecast accuracy there are two types of errors--false alarms and misses (or surprises). These two errors are inevitably linked. Efforts to improve one (for example, increasing lead time to reduce surprises) inevitably make the other worse (more false alarms). This is a well known trade-off.

The only way to reduce both false alarms and surprises is to increase the accuracy of forecasts.

The NWS is currently looking for ways to reduce both false alarms and surprises. Reducing false alarms begins with knowing why they occur. Here is a recipe for increasing false alarms that uses ingredients available in any NWS Forecasting Office:

1. Start with a complex problem with high uncertainty, such as forecasting severe weather;
2. Stir in lots of information;
3. Apply institutional pressure to increase warning lead times.
Simmer; serves 274 million.

The first ingredient—uncertainty—creates the inevitable tradeoff between surprises and false alarms. The third—institutional pressure to increase lead times—encourages the forecaster to issue warnings sooner and based on less certainty than he or she might otherwise do. This strategy avoids surprises, but increases the number of false alarms. Overt pressure is not needed. It is sufficient if the forecaster knows that an important organizational goal is increased lead times.

The second ingredient—information—is supposed to reduce both surprises and false alarms by improving the accuracy of forecasts, but it may have the opposite effect. Here's why: Good judgment, and therefore good forecasting, require four things. First, the forecaster must pay attention to relevant information. Second, the forecaster must ignore irrelevant information. Third, the forecaster must understand the uncertainty that he or she faces, that is, the forecasts must not be influenced by over- or under-confidence. Fourth, the forecaster must be consistent. Given identical information, the forecaster should produce identical forecasts. These are the keys to good forecasts.

What happens when you give a forecaster more information? Inevitably, much of the information will be irrelevant in any given situation. The relevant information is then mired in irrelevant information, so there is a greater chance that the irrelevant will distract attention from the relevant. Furthermore, research suggests that people become overconfident when they get more information. Finally, judgments tend to become less consistent when information increases.

Conclusion: More information can actually *reduce* forecast accuracy. This is important: More information is not necessarily better. In practical terms, less accurate forecasts mean we must pay a greater cost in false alarms to gain an increase in lead time.

The modernization of the National Weather Service is a triumph of ingenuity, science, technology, and vision. It is time now to build on that achievement by addressing the human element in forecasting. Further improvement in forecast accuracy (resulting in the desired decrease in both false alarms and surprises) is possible by addressing the problems that modernization can create for the human component of the system. That requires a two-pronged effort.

First, an obvious way to improve human forecasting is through training and selection of forecasters. Some forecasters are better than others. Presumably, some people are, by nature or experience, better able to cope with the information burden presented in the modern forecast office. If we better understood the reasons for individual differences in forecasting skill, we could select and train forecasters for more accurate forecasts.

But training and selection are not enough. In general, forecasters are already well trained and highly competent. It's a common mistake to look inside the forecaster's head for ways to improve forecasts. Part of the problem, probably the largest part (and the part that can be most effectively addressed) is outside the forecaster. It's the surroundings, the context, the circumstances under which the forecast is made. How much information must the forecaster absorb in the time allotted? How is that information arranged? How reliable is the information? Does the format of the information display induce intuitive or analytic cognition (people are capable of both; there are advantages and disadvantages to each; and certain characteristics of the situation determines which will be used)?

The second prong requires systematic study of the forecasting environment. The four keys to good forecasting (Pay attention to relevant information -- Ignore irrelevant information -- Assess uncertainty accurately -- Be consistent) are simple to understand but difficult to implement. Information displays and forecasting procedures can help or hurt. The only way to make sure they help is by a program of empirical study.

The NWS deserves congratulations on the completion of its technological modernization effort. With

congratulations comes a challenge to take the next step and to invest in the application of what we in the decision sciences know about judgment and decision making to address the most important component of the weather forecasting system: the human forecaster.

--Thomas R. Stewart

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Additional Reading

Golden, J. "Tornadoes," pp. 103-132 in *Storms*, (R. Pielke, Jr. and R. Pielke, Sr., eds.), Routledge Press, 2000.

Stewart, T. R., Roebber, P. J., & Bosart, L. F. (1997). The importance of the task in analyzing expert judgment. *Organizational Behavior & Human Decision Processes*, **69**(3), 205-219.

Stewart, T. R. and Lusk, C. M. (1994). Seven components of judgmental forecasting skill: Implications for research and the improvement of forecasts. *Journal of Forecasting*, **13**, 575-599.

Heideman, K.F., Stewart, T.R., Moninger, W.R. and Reagan-Cirincione, P. (1993). The weather information and skill experiment (WISE): The effect of varying levels of information on forecast skill. *Weather and Forecasting,* **8,** 25-36.

Correspondence

Dear WeatherZine,

Regarding Michael R. Smith's Guest Editorial, "The Future of the 'Public-Private Partnership'" (December 1999 WeatherZine, www.esig.ucar.edu/socasp/zine/guest.html):

Generally speaking, I find myself agreeing with most of what Mike has to say. Some colleagues and I expressed a not-too-dissimilar viewpoint at www.nssl.noaa.gov/~brooks/waf15/bfd.html.

My current view of the future suggests that the "infrastructure" of the public weather service left in place by the middle of the next century is almost certainly going to have very few, if any, human forecasters left. The automation of most of the current NWS products and services will create a real opportunity for the private sector to fill in the resulting quality gap of service to customers; in particular, those forecast users who need something better than the generic products coming mostly from automated forecasting (and, eventually, warning) systems. Thus, a private sector can flourish where substantial, validated improvement in forecast quality (beyond that provided by the public sector) to serve specific user needs is the primary selling point for their services. There will be a real role for sophisticated forecasting (and research) skills in the future. Although the public-private mix will change substantially, there should be an abundance of opportunities for meteorologists in this altered future.

My only disagreement with Mike is a minor one, concerning his statement that "...the private sector weather industry is the only 'customer' of the National Weather Service that pays the incremental cost of the service it receives from the NWS. We pay 'user fees' for the Domestic Data Service, WSR-88D data, and other services. The public does not pay a user fee for NOAA Weather Radio." Strictly speaking, of course, this is true, but taxes nevertheless are paid by the public, in return for which it receives such "services" as the NOAA Weather Radio, and all the rest of the NWS products. Per taxpayer, this is about $7 per year, which is a bargain.

--Charles A. Doswell III

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Dear WeatherZine,

Regarding Mike Augustyniak's letter (December 1999 WeatherZine, www.esig.ucar.edu/socasp/zine/correspond.html):

I like idea #3 in your WeatherZine letter [that insurance companies helping to build more resistant houses develop a standard booklet for prospective house buyers building from scratch that would cover safety, insulation, utilities, siding, roofing, flooring, etc.]. In Maine we do not have a statewide building code. Building codes are left up to local officials and some do a good job in this regard but far too many do very little.

Many of the smaller towns have only an electrical and plumbing code and nothing that addresses wind, earthquakes, etc. In Maine it will be very hard to get a state building code passed by our legislature. We have to promote good building practices by educating the potential owners and builders. We have to try to create customer demand for a more disaster resistant, lower-cost-to-repair dwelling that keeps its contents warm, dry and safe when Nature acts up. It's slow going.

A booklet put out by insurance companies illustrating some basic principles of disaster resistant siting and construction would certainly be a big help. The fact that it was being distributed/produced by insurance companies would give additional weight to the message.

I also feel it is extremely important for insurance companies to offer premium reductions for those who build to a higher standard. Those who build in hazardous areas should be required to incorporate extra mitigation measures in the building design or pay a premium commensurate with their poor choices.

Insurance companies have been reluctant to embrace this concept. Last year, however, USAA announced at the National Hurricane Conference (NHC) that it was going to offer a major discount for houses built to a disaster resistant standard. Hopefully more will follow its lead.

See you at the NHC in New Orleans.

--Gene Maxim

Natural Hazards Planner

Weather Related News

The American Meteorological Society has initiated an Atmospheric Policy Program (APP). The APP will conduct studies and provide education on policies that shape atmospheric research and services in both the public and private sectors, as well as on policies that are affected by advances in atmospheric understanding and the provision of meteorological services. Potential policy research issues include: ensuring data access in the context of full and open national and international data exchange; intellectual property conflicts; public-private sector provision of weather and climate services; air quality regulations and incentives; and issues connected with responses to climate variation and change. The APP anticipates engaging scholars to conduct studies of these issues and, ultimately, to educate generations of atmospheric and other environmental scientists for key policy and managerial posts in government, the private sector, and academia.

The APP will develop the following portfolio of educational activities: opportunities for graduate students to become knowledgeable about atmospheric policy issues and techniques used to analyze them; education for professionals who are near the midpoint of their careers and likely to move into decision-making positions; and education of professionals with policy influence who lack atmospheric science backgrounds. With support from UCAR, the APP has established an AMS Congressional Fellowship through the American Association for the Advancement of Science. Atmospheric scientists will be placed in congressional offices for one year in the early stages of their careers.

During its first two years, the APP seeks to develop broad involvement, solicit initial funding support, initiate two policy studies, organize a policy forum for the 2001 annual AMS meeting, and develop a 2001 summer colloquium. For more information or to provide comments and suggestions, please contact:

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Web: www.ametsoc.org/ams (select Atmospheric Policy button on navigation menu)

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Several new citations have been added to our Weather and Climate Forecast Use and Value bibliography (www.esig.ucar.edu/biblio/) thanks to a suggestion from Caitlin Simpson of NOAA's Office of Global Programs (OGP). The citations include publications resulting from NOAA's Economics and Human Dimensions Projects.

Web Site Additions

General

www.nws.noaa.gov/om/reachout/
Office of Meteorology Public Outreach

Tornadoes, Lightning, General

www.spc.noaa.gov
Storm Prediction Center

The Storm Prediction Center (SPC) is part of the National Weather Service (NWS) and the National Centers for Environmental Prediction (NCEP). Its mission is to provide timely and accurate forecasts and watches for severe thunderstorms and tornadoes over the contiguous United States. The SPC also monitors heavy rain, heavy snow, and fire weather events across the U.S. and issues specific products for those hazards. It uses the most advanced technology and scientific methods available to achieve this goal.

Emergency Management

www.egs.uct.ac.za/dimp/
Disaster Mitigation for Sustainable Livelihoods Programme

DiMP promotes disaster mitigation as a strategy to achieve sustainable development. It encourages the integration of disaster mitigation with development programs, particularly those targeted at economically vulnerable communities. This site provides a description, history, background information, and details about current areas of interest of the program; more information about Periperi, a network of organizations and institutions committed to risk reduction in southern Africa; a list of DiMP publications; and links to related regional and international organizations.

www.ignoudismgtconf.org/index.html
International Conference on Disaster Management: Cooperative Networking in South Asia

In November 1999, the Indira Gandhi National Open University sponsored the International Conference on Disaster Management. This site includes dozens of technical papers from the conference addressing a variety of issues relating to disaster management in Asia and elsewhere around the world.

www.bghrc.com/frameset_intro.htm
Benfield Greig Hazards Research Center Disaster Management Unit

The Disaster Management Unit (DMU) "adds operational expertise in disaster mitigation and preparedness to the Centre's existing scientific expertise. Its work comprises research, information dissemination and education, project management, training and consulting. Outlines of some of the current projects can be found on this website."

Floods

www.fema.gov/mit/tsd/
Flood Hazard Mapping

This FEMA site provides an overview of the National Flood Insurance Program and FEMA's map modernization program.

www.floods.org/mitsucc.htm#co
Mitigation Success Stories in the U.S.

A joint project of the Association of State Floodplain Managers' Flood Mitigation Committee and the Federal Emergency Management Agency Mitigation Directorate, 1999, Mitigation Success Stories in the United States is intended to showcase examples of natural hazard mitigation activities and to publicize the benefits of mitigation successes across the country. The project's sponsors hope these examples can serve as models for others to use and provide decision makers with valuable information about how to formulate, undertake, and ultimately achieve natural hazard reduction in our communities.

www.cira.colostate.edu/fflab/stuart/website/index.htm
CSU Flash Flood Lab

The Flash Flood Lab at Colorado State University is a problem-focused, multi-disciplinary center providing applied research, education and a communication forum to reduce the future impact of flash flood disasters. This site provides information about the lab and flash floods, upcoming events, how to prepare for and survive a flood, and links to other relevant sites.

Jobs

EXECUTIVE DIRECTOR

Center for Integrated Study of the Human Dimensions of Global Change (CIS-HDGC)
Department of Engineering & Public Policy
Carnegie Mellon University

The Center for Integrated Study of the Human Dimensions of Global Change (www.hdgc.epp.cmu.edu) is seeking an Executive Director. The Center involves over 40 investigators at more than a dozen institutions with an annual budget in excess of $2 million. The Center is housed in the Department of Engineering and Public Policy at Carnegie Mellon University.

The successful candidate will work closely with Granger Morgan, Terry Jones, and Hadi Dowlatabadi. He or she largely will be responsible for the Center's day-to-day management and outreach activities. Management will occupy approximately 30-50% of the effort for this position. There will be periods of intense activity when proposals are due and meetings are held. Outreach will occupy another approximately 20-50% of the effort for this position. Outreach activities including maintaining a presence in print and on the Web, organizing seminars and public lectures, and possibly developing textbooks for K-12 and university students on global change and the human dimensions perspective on problem solving. Beyond these tasks, the successful candidate will be encouraged to engage in research and teaching within the Center's areas of interest.

The successful candidate should be an accomplished manager. A Ph.D. is not required. Candidates with a

desire to pursue an academic career are also welcome and, depending on their track records, could be hired into the research faculty track at CMU. Interested candidates should submit, preferably in electronic form, a letter of interest, writing samples, a CV, and contact information for three references, to:

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About Us

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To submit an item to the *WeatherZine,* use the on-line form at: www.esig.ucar.edu/socasp/forms/join.html or send email to thunder@ucar.edu, and include the following information:

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