

Weather and Society Watch

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Celebrating Five Years of Societal Impacts Success

by Jeff Lazo*

With this issue of *Weather and Society Watch*, we mark a milestone: the fifth anniversary of the Societal Impacts Program (SIP) at the National Center for Atmospheric Research (NCAR). Technically, SIP started even earlier, when the U.S. Weather Research Program funding began, but some people—including me—consider the official start of SIP as the hiring of a program director on April 1, 2004. I began my tenure as director with no idea of the number of acronyms I had to learn to survive in this business—and no idea of the breadth of societal impacts work we would ambitiously undertake.

Five years later, we've invented more than our share of acronyms, essentially one for every project. With contributions such as OUSSSA (Overall United States Sector Sensitivity Assessment), CoFU (Communication of Forecast Uncertainty), WDEWE (Warning Decisions in Extreme Weather Events), NAT SERA (North American THORPEX Societal and Economic Research and Applications, AnDeS (Analysis of Decision Scenarios), HFSEWG (Hurricane Forecast Socio-Economic Working Group) and, of course, WAS*IS (Weather

and Society * Integrated Studies), SIP has been an unqualified success in achieving our mission “to improve the societal gains from weather forecasting by infusing social science and economic research, methods, and capabilities into the planning, execution, and analysis of weather information, applications, and research directions.”

Of course, *Weather and Society Watch* is a forum for the broader community and not simply a mouthpiece for SIP, but many of the people and projects I would like to highlight here have made invaluable contributions to the societal impacts community and Weather Enterprise as a whole. It has been a great pleasure to meet and work with numerous dedicated and passionate people in the weather community. Most of them were dedicated to improving the societal benefits from weather information long before SIP, or I, came along, so I can only hope we have helped them better meet these objectives. Although there are too many to mention them all, I do want to name a few of those closer to the core of SIP.

The SIP would not have existed in the first place if it weren't for

the many NCAR people who formed the idea, developed the initial proposal, and secured

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A spring EF-3 tornado left a 28-mile-long path of destruction in DeKalb County, Ala. in April 2009.

(Photo courtesy of the *Times-Journal*)

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False Alarms, Close Calls, and Tornado Warning Verification Records

by Kevin M. Simmons* and Daniel Sutter**

The National Weather Service (NWS) issued tornado warnings by county until switching to storm-based warnings in 2007. A warning verified when a tornado occurred in the county during the warning period. The false alarm ratio (FAR) is the number of warnings that fail to verify divided by the total number of warnings issued, and is a NWS performance metric. Between 1986 and 2004, the nationwide FAR for tornado warnings was 0.758, so three out of four warnings issued failed to verify. Clearly, a high FAR threatens the credibility of hazard warnings (Breznitz 1984).

Researchers have noted several limitations in the definition of false alarms: a tornado could occur just after a warning expires or just a few hundred yards out of the warning area, or could dissipate just before crossing a county line. Warnings in all these instances are by definition false alarms, and yet may not undermine public confidence in the credibility of warnings. Barnes et al. (2007) suggest adding a conceptual category of a “close call” to our thinking about hazard warnings and recommend “an improved performance measure that calculates close calls differently than false alarms. A close-call performance measure would give credit to forecasters for the many times close calls occur, rather than becoming part of the high FAR”.

The Barnes et al. criticisms imply that because of the many definitional false alarms that are really close calls, the tabulated NWS FAR may not be useful for hazards researchers looking to investigate, say, a false alarm effect (Dow and Cutter 1998). We explore the effect of close calls by defining an alternative false alarm ratio using NWS verification statistics that takes some of these criticisms into account. The alternative definition could result in the NWS FAR being uncorrelated with public perceptions of warning credibility, and slicing the data differently may yield a measure closer to the unobserved true perceptions. At a minimum, the alternative definition allows us to see how significant the problem of close calls may be.

NWS verification records do not allow us to identify all close calls. For example, the records do not indicate when, say, a severe thunderstorm produced a wall cloud that nearly touched down. But some of the concerns discussed by Barnes et al. can be addressed. We calculated a FAR using the state warning day instead of the county warning as the unit of observation. A state warning day is any calendar day on which a tornado warning was issued anywhere in a state. The state warning day verifies that a tornado occurred anywhere in the state on this day; it does not verify that no tornado occurred in the state on this day. The state warning day FAR is the number of state warning

days that fail to verify divided by the number of state warning days.

State warning days eliminate some close calls. For instance, if a tornado strikes one of four warned counties in the path of a super cell thunderstorm, the NWS FAR for the event would be 0.75, but this would be a verified state warning day with a state warning day FAR of 0. We also control for most tornadoes occurring just after or outside the warning. The intuition behind the state warning day is that residents might remember if tornado warnings were issued on a day and if tornadoes occurred that day, but not the exact time and location of the tornadoes and warnings.

For instance, a resident might see warnings reported on TV and then news stories if a tornado occurred. Our state warning day definition probably rules out some events that would not count as a close call; tornadoes could occur 100 or more miles away or hours before or after a warning and still result in a verified state warning day. And in other cases, a tornado might occur just across a state line or after midnight and be counted as a false alarm. Our state day definition is far from perfect, but it does suggest a way to account for some close calls. And importantly, it allows us to divide the available records differently, to explore if controlling for close calls substantially affects the FAR.

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Business Planning & Weather: Case in Point from Croatia

by Zoran Vakula*

Weather Forecasts in Croatia

Meteorology, especially weather forecasting, is considered useful and interesting not only by the Croatian public but globally as well. For many years now, weather forecasts have been among the most watched television programs in Croatia, in particular the forecast following the evening news on channel 1 of the national television network HTV. Remarkably, an on-duty meteorologist of the Croatian National Weather Service (NWS) conducts between 11 and 15 live interviews daily for both national and regional radio stations, as well as recording up to six reports, which are aired throughout the day. During extraordinary weather conditions, the number of interviews greatly increases. And private companies and many amateur meteorologists, who obtain weather data via the Internet from various sources around the world, transcribe the weather results and publish them on the Internet or distribute them directly to users.

Weather Forecasts and Business Planning

Even though for many people weather forecasts are an important and useful part of everyday life, some researchers have shown that most companies still do not plan their activities based on weather reports, nor do they include them in the actual business plans.

Evidence can be found in an article entitled “Climate Change – 10 Winners and 10 Losers” from the May 2007 edition of the Croatian business weekly magazine *Lider*. The article published the results of a market research agency, which had discovered that the unusually warm and dry period just before the research had affected the business of only 25% of the surveyed companies. And an amazing 79% of the surveyed companies admitted they did not include possible weather-related risks in their business plans. Similarly, NWS data show that two thirds of the total income from both daily and seasonal weather forecasts comes from the media (newspapers, radio, television), one fourth from companies in the road maintenance business, and only an insignificant amount from agricultural and construction companies.

Heating

Nonetheless, one company – the biggest oil company and also the sole gas provider in Croatia – from time to time realizes the importance of having access to good meteorological data, which it occasionally also uses, especially weather forecasts. In fact, it was at their request that a dependence analysis was conducted of monthly heating oil sales during the colder part of the year and monthly mean temperature anomalies with respect to average temperature, and the results showed a strong

correlation between the two sets of data (shown in Graph 1; please see <http://www.sip.ucar.edu/news/vakula> for this and other graphs). The analysis covered October to April, when heating oil sales are at their peak. Temperature anomalies were calculated using an area-weighted averaging scheme in four of the largest cities in Croatia. The weighted factors were derived by calculating the number of residents in each town. The resulting weighted temperature anomalies are represented on the graph as columns – colored for the 2005/2006 reference period and not colored for the 2006/2007 reference period. The lines and scale on the y-axis show the amount of heating oil sold in cubic liters, where the blue line represents the 2005/2006 and the red line the 2006/2007 reference periods. It is evident from the graph that heating oil sales were significantly higher during 2005/2006, when the monthly mean air temperature was generally average and frequently even below average. An exception is the well above average temperatures of April, when the air usually warms up and there is less need for heating. Equal sales in both periods, varying by a meager 5,000 units of sale, were found only in October and November. The reason for this may be habit: users preparing for the cold months ahead stock up regardless of the forecast. This in turn could be a consequence of the fact that many people either do not

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Psychological Perspectives on Weather and Society Research

by Alan E. Stewart*

The familiar quote attributed to Benjamin Franklin, “Some people are weatherwise, but most are otherwise,” conveys much about the nature and scope of psychological research in weather and climate. Psychological research is concerned with the interrelationships of brain, mind, and behavior with the individual’s social and physical environments. Within the realm of weather and climate, this means that psychological research is broadly concerned with (1) how individuals sense and perceive their atmospheric environments (sensation and perception psychology, environmental psychology); (2) how knowledge and experience with weather and climate are stored in the person’s various memory systems (e.g., short- versus long-term memory, semantic and procedural memories); (3) how individuals make decisions cognitively with respect to weather and climate phenomena (cognitive and social psychology); (4) how the aforementioned psychological processes translate into behaviors that may be more or less adaptive given a particular weather event (applied behavioral psychology); and (5) how to help people to understand weather-related risks, to prepare ahead of time, and then to cope and adjust in the aftermath of damaging weather (counseling and clinical psychology along with other applied psychological fields). Environmental psychology brings many of these subdisciplines of psychology together in the study of built and natural environments.

The location of psychology in relation to other social science disciplines like anthropology and sociology on the WAS*IS landscape is marked by several features: (1) focusing on mental processes as they relate to individual differences, behaviors of people in groups, and behaviors of the groups themselves; (2) applying psychometric and psychophysical principles to quantifying individual and group mental processes for basic or applied research purposes; (3) developing psychologically based theories that allow understanding and prediction of individual and group behaviors in a given setting; and (4) providing professional psychological services by consulting with or treating individuals, groups, or organizations.

Although these features are among the ones that chiefly characterize the essence of psychology, other disciplines such as sociology, communications, and anthropology include aspects of these features in their professional definition as well. I illustrate some of the scope and features of psychological approaches to weather and society by providing examples from my research.

Returning to Benjamin Franklin’s saying about weatherwise or otherwise, a statement about individual differences is quite evident. One can ask, What does *weatherwiseness* (or weather wisdom) look like and what makes some people different from others with respect to this characteristic?

One aspect of Franklin’s idea that I have examined concerns the psychological orientation, awareness, and value that individuals place on the weather and its changes. I refer to this as *weather salience*.

Of course, weatherwiseness can be characterized in terms of the weather knowledge people can demonstrate or their accumulated weather experiences people. I drew on earlier research on general environmental salience to create a measure of weather salience. The measure encompasses ways that the weather is psychologically important for people by inventorying their attitudes, experiences, and behaviors with regard to their seeking weather information from electronic sources, their sensing and observing of the atmosphere directly, the effects of weather on day-to-day moods, attachment to particular weather patterns, the need to experience variability in the weather, the effects of weather on daily life behaviors, and attention to the weather when it causes a disruption in the form of a holiday or cancellation. When I administered this measure to university students, and later to a random sample of the U.S. residents, the results suggested that Ben Franklin was correct.

Weather salience indeed follows the bell-shaped distribution, meaning that a small proportion of people are highly attuned in the ways I defined to weather, a majority shows a nominal level of weather salience, and a smaller proportion seem not

to be psychologically oriented to the weather. These results are important, beyond supporting Ben Franklin's contention, in that I have observed that people who know the difference between a weather watch and a weather warning produced higher weather salience scores. Further, people who have been evacuated because of a hurricane or who have experienced weather-related property damages reported higher levels of weather salience.

How does weather salience apply to weather and society? Just like a mesoscale weather model allows the meteorologist greater ability to see significant smaller-scale influences compared to global-scale models, weather salience can inform existing work with intact groups (communities, socioeconomic classes) by revealing differences between individuals' valuing and orientation to the weather because this affects their behavior in dangerous weather. Weather-salient individuals may need less information to make their decisions, and they may be more sophisticated in how they use the information that they receive. Further, highly weather-salient individuals may be the ones in their social networks that others consult when severe weather threatens.

Applying psychometric and psychophysical principles to develop measures for weather, climate, and society research also represents a unique contribution of psychology. Broadly speaking, psychometrics is concerned with scaling the amount of a human trait or characteristic

as precisely as possible while acknowledging that mental processes are multidetermined and thus cannot be measured without error. Psychophysical principles concern the relationships of stimuli that come from without (e. g., heat, cold, wet, dry) with sensation and perception processes within the individual.

I have used these principles and techniques to develop the Weather Salience Questionnaire along with two newer measures. The first of these instruments assesses the level of fear that individuals have for the features (e. g., wind, rain, lightning) of severe or extreme weather. Fear is an important emotional state that is significant for survival and adaptation. Although some people may be incapacitated by the level of fear that they have for weather conditions (i. e., they may experience a phobia for the weather), others possess various levels of fear of weather that may affect their decision-making and behavior when the weather becomes threatening.

I have also collaborated with Elke Weber to develop a measure of weather-related risk-taking. Weber's research suggests that risk-taking is highly domain specific, meaning that although someone may be comfortable taking a financial risk, that same person may be unwilling to take social or ethical risks. We have found that the same holds true for weather-related risk-taking. For some individuals, the perceived benefits of taking a risk, such as remaining outdoors when lightning is close, outweigh the costs that they associated with the potential

of a lightning strike. This has been an interesting line of research because an individual's risk-taking histories may have a lot to do with their subsequent risk-taking with the weather.

Psychological approaches to weather and society research also involves creating cognitive and behavioral models derived from the individual responses to measures such as those described here. In this regard I have been working with meteorologists, demographers, and other social scientists at the University of Georgia to create a model of responses to severe weather. The model exemplifies a psychological approach in that it not only incorporates demographic and group-level variables but also includes several cognitive, emotional, and behavioral variables that bear on the response the individual makes. This work is ongoing.

Although I have presented a few illustrations of a psychological approach to weather and society research, many other possibilities exist. The particular domain or research question of study along with the psychological methods one chooses for the job can create a broad landscape of inquiry. Regardless of the questions studied, psychological perspectives are valuable in that they can provide a fine-grained analysis of the individuals that, taken together, constitute society.

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necessary funding, including Bill Mahoney, Rebecca Morss, Brant Foote, Bob Gall, Bob Harris, Tim Killeen, Barb Brown, Rick Katz, and Mickey Glantz. Ongoing support at the NCAR managerial level, particularly in the Research Applications Laboratory (RAL) and the Mesoscale & Microscale Meteorology division (MMM) and all the related administrative support from people like Joanne Dunnebecke, Diane Simmons, Jo Zoetewey, Inger Gallo and many more people in ISSE (Institute for the Study of Society and Environment), COMET (Cooperative Program for Operational Meteorology, Education and Training), RAL, and MMM have been important to keep things moving.

I would also like to give immense thanks to my SIP colleagues, including Rebecca Morss, Emily Laidlaw, and Julie Demuth. We've also enjoyed great moral support from Bill Mahoney and Barb Brown. Along the way we've also employed a few who have now moved on, but they have all played a crucial role over the last five years. The contributors include Eric Scharff, Peter Larsen, Asim Zia, Eve Gruntfest, Jenifer Martin, and Nate Bushek. We hope to add a few more to this list before the 10-year anniversary.

We have also been blessed with input from a stellar group of people who currently serve or have served on the SIP advisory board, including Roger Pielke Jr., Eve Gruntfest, Bill Hooke, Ray Ban, Rodney Weiher, Margaret Davidson, Len Pietrefesa, and

Betty Morrow. Their willingness to help us has been more an effort to facilitate the entire society-weather community than simply guide our fledgling program. I feel their continued involvement with the SIP is testimony to the progress we have made over the last five years.

Some of the results of this five year effort that I am very proud to have been part of include the following:

- The *Extreme Weather Sourcebook* (<http://www.sip.ucar.edu/sourcebook>), an online collection of data about losses from extreme weather events, is now updated and being regularly maintained. Our efforts to find updated data ultimately led us into an extremely interesting research project to better understand the sources and reliability of damage data, a project on which we are collaborating with the National Weather Service (NWS) Performance Branch.
- *Weather and Society Watch* is marking its 11th issue (the one you are reading now!). We owe a huge debt to all of our contributors and readers, as well as to Rene Howard and Christina Thomas who skillfully help edit each issue.
- We have held six WAS*IS workshops and have also participated in a number of WAS*IS-related workshops and meetings. And, with a very generous "Thank you!" for support from NWS this year, we are well into the planning stages for the seventh

WAS*IS workshop, which will be held this August in Boulder. It will be exciting to welcome a new "class" of WAS*ISers eager to help change the weather enterprise by comprehensively and sustainably integrating social science into meteorological research and practice. Eve Gruntfest, who is now heading the Social Sciences Woven Into Meteorology (SSWIM) program at the University of Oklahoma and Julie Demuth, who will soon be a Ph.D. student in communication at Colorado State University) ARE the "WAS*IS Ladies," as they became known after the first workshop. They have enabled WAS*IS to grow and prosper to the extent that it isn't possible in this brief editorial to list all of the impacts of WAS*IS. Let's just say that I think WAS*IS in and of itself would qualify the SIP as successful. I also extend thanks to the 171 official WAS*ISers from the first 6 workshops and the dozens and dozens of Friends of WAS*IS who have embraced the vision for your boundless energy and enthusiasm!

As part of the mission of being in a national center (i.e., NCAR), SIP has supported community-building efforts such as the Hurricane Forecast Socio-Economic Working Group (HFSEWG), and the North American THORPEX Socio-Economic Research and Applications workshop (NAT SERA). Both of these brought together researchers from the

“hard” (i.e., physical) and “harder” (i.e., social) sciences to develop integrated meteorology-social science research agendas. Both were successful in leading to publications and building community discussions (see the August 2007 special issue of *Natural Hazards Review* and the March 2008 issue of *BAMS*). I would say though that they have not been as successful in achieving the ultimate goal of leading to funding for the recommended research efforts. Although the HFSEWG efforts have helped NOAA and NSF develop a limited funding effort, there does not appear to be any funding for social sciences in the THORPEX program, at least in the United States. We still have a long way to go in some areas.

In the area of research, SIP has had modest success in developing social science capacity particularly looking at communication and valuation issues and weather forecasts. While there have been some speed bumps as we've learned to work across the disciplines, I feel our research efforts can serve as a model for others working toward the integration of social science and meteorology. I encourage you to take a look at some of the publications that have been generated from this research effort at: <http://www.sip.ucar.edu/publications.jsp>.

We have also been lucky enough to connect and work with some amazing researchers in the university community including Ann Bostrom, Harold Brooks,

Gina Eosco, Phil Ganderton, Hugh Gladwin, Brian Mills, Betty Morrow, Dan O'Hair, Walt Peacock, Jennie Rice, Jeannette Sutton, Jennifer Thacher, Kathleen Tierney, Don Waldman, and Hugh Willoughby, to name a few. In addition, we continue to work on developing institutional understanding and structures that support societal impacts efforts. SIPers have been active in many American Meteorological Society (AMS) efforts, including the Board on Societal Impacts, an Annual Partnership Topic, the Board on Enterprise Communications, the AMS Council, AMS Policy Program efforts, and the Symposium on Policy and Socio-Economic Research.

We have worked, and plan to continue to work, closely with NOAA and NWS on a variety of efforts, including the Science Advisory Board Social Science Working Group, the ESRL- NCAR Societal Impacts Program Seminar Series, NWS Service Assessments, regional efforts building on WAS*IS, and research working closely with specific forecast offices. While there are many many people in NOAA now supporting and advocating for the integration of social sciences, a few in particular—John Gaynor, Rodney Weiher, Ward Seguin, Jennifer Lewis, Marty Ralph, Steve Koch, and Jennifer Sprague—have played key roles in working with SIP over the last five years. Numerous other NOAA folks have been critical as well in regional Weather Forecast Offices (WFO), including Kevin Barjenbruch, Dan Nietfeld, Andy Bailey, Tanja Fransen, and many, many more.

Finally, we've also been lucky to connect with and support efforts at the World Meteorological Organization (WMO) to bring social sciences and societal impacts concerns into the broader (i.e., global) Weather Enterprise. The Socio-Economic Research and Applications Working Group (headed by Brian Mills) and the WMO Forum: Social and Economic Applications and Benefits of Weather, Climate, and Water Services (supported by Haleh Kootval and chaired by Donald Wilhite) are key players in addressing societal-weather issues on a global level. The Workshop on Assessment of Socio-economic Benefits of Weather, Climate and Water Services, supported by WMO's Public Weather Services Programme and facilitated by SIP, brings socioeconomic methods and applications literally around the world with workshops in places such as Bulgaria and China.

In closing, I am proud to have been part of the SIP for these last five years. I am proud of our accomplishments and of our role in the progress made by the larger societal impacts community. Given the momentum that has built over this time, I have no doubt that, wherever SIP is in five years, we will have seen fundamental societal benefits as a result of “infusing social science and economic research, methods, and capabilities into the planning, execution, and analysis of weather information, applications, and research directions.”

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Societal Impacts News & Announcements

NWS Partners to Raise Preparedness for Severe Weather

On a recent spring Saturday, the Springfield National Weather Service (NWS) forecast office hosted a severe weather awareness day at Battlefield Mall that introduced nearly 60,000 shoppers to severe weather awareness and preparedness information to mitigate the hazards of severe thunderstorms, tornadoes, flash flooding and lightning. The event was held in conjunction with the county emergency management agency, as well as several local television and radio stations.

As part of the interactive event, NWS meteorologists conducted severe weather safety presentations and discussed the dangers of tornadoes via a tornado simulator and booth, while the American Red Cross provided essential medical information along with selling. Emergency management officials discussed the Hometown Ready and Community Emergency Response Team programs, while amateur radio operators demonstrated the importance of communication both during severe weather and disaster recovery efforts. Two local television stations hosted a Kidcast contest where kids were recorded presenting a weather forecast and were featured on a morning newscast.

In 2008, 64 tornadoes occurred in the area near southwester Missouri resulting in 19 fatalities and over 230 injuries. During the same time period, flash flooding resulted in nine fatalities, while lightning strikes caused 17 injuries.



*A future meteorologist prepares to deliver a forecast with the KOLR 10-TV and KSFX-TV Kidcast contest.
(Photo courtesy of Springfield NWS office)*

Report Uncovers Why People Ignore Weather Warnings

In March 2009, NOAA's National Weather Service (NWS) issued a report analyzing forecasting performance and public response during the second deadliest tornado outbreak in U.S. history. Dubbed the "Super Tuesday" tornado outbreak due to the presidential primary elections held that day, 82 tornadoes raked nine states throughout the South, killing 57 people, injuring 350 others and causing \$400 million in property damage. The report, entitled *Service Assessment of the Super Tuesday Tornado Outbreak of February 5-6, 2008*, also addressed a key area of concern: why some people take cover while others ride out severe weather.

The NWS assessment team included Julie Demuth, a scientist from the Societal Impacts Program at NCAR, to better examine why many people did not take action to protect themselves. In reviewing the public response, the team found that two-thirds of the victims were in mobile homes, and 60 percent did not have access to safe shelter (i.e., a basement or storm cellar). The majority of the survivors interviewed for the assessment sought shelter in the best location available to them, but most of them also did not have access to a safe shelter. Some indicated they thought the threat was minimal because February is not within traditional tornado season. Several of those interviewed said they spent time seeking confirmation and went to a safe location only after they saw a tornado.

"Protecting life and property is not as simple as issuing a forecast," NWS Director Jack Hayes said. "A number of barriers often deter people from making risk-averse decisions, and we want to learn all we can to determine if there is more the National Weather Service can do to change this."

As a result of the assessment, NWS will improve wording and call-to-action statements to more effectively convey the urgency and danger of the message. NWS also plans to continue using social science research in future service assessments to better understand people's interpretation of and response to severe weather situations, and improve public response to severe weather communication. For more information on the report, please visit http://www.noaanews.noaa.gov/stories2009/20090309_tornadoreport.html.

Business (continued from page 3)

have access to weather reports, or do not trust them, or do trust them but still believe it is a good idea to have heating oil ready. As a matter of fact, the weather forecast for winter 2005/2006, which was accessible to both small and large customers, predicted average winter temperatures, and those for winter 2006/2007 predicted above average temperatures. It is interesting to note that the highest sales were recorded in January of both periods. However, although this may not be surprising for the 2005/2006 reference period, it remains to be explained for 2006/2007, when temperatures were notably higher. There could be a psychological reason underlying the results, because people expect temperatures in winter to be low, or maybe the reason lies in the regular annual shopping plans of big companies at the beginning of every year. Analysis has shown that a quality report on monthly mean temperature anomalies can help in planning heating oil stocks and sales during winter. Furthermore, because long-term weather forecasts are becoming more reliable, the user will surely realize the importance of monthly weather reports as an aid in the planning process and ultimately as a key factor in ensuring profit.

One user who has recognized the importance and value of weather forecasts and has already started adapting its business accordingly is the largest gas distributor in Croatia. The company has been successfully collaborating with the NWS for many years. As the graphs clearly show, a negative correlation between temperature

change and gas consumption is to be expected. The blue line in Graph 2 (please see <http://www.sip.ucar.edu/news/vakula> for this and other graphs) shows air temperature changes in 2007 at one meteorological station, and the red columns represent daily gas consumption. September 6, marked with the letter A, was the third day in a row with temperatures below 15°C and the official beginning of the heating period for 2007/2008. Daily gas consumption during September was relatively low compared to the end of October, as well as November and December. During that winter there were a few days when air temperature rose above 10°C and yet gas consumption drastically fell (marked B), as well as the opposite case, marked C, when temperatures were below 0°C for days and daily gas consumption reached its record high for 2007. In the cases marked D and E, there is a clear interdependence between temperature and gas consumption, whereby a fall in temperature causes a rise in gas consumption. The need for good and reliable weather forecasts, which can facilitate gas distribution and consumption planning, was recognized a long time ago and has enabled successful collaboration with the NWS. The collaboration would be even more valuable to users if reliable daily temperature forecasts existed for both the month and the season ahead. Furthermore, maximum daily gas consumption is extremely important. On certain days, gas consumption can be radically higher than average, which makes it especially important to ensure that enough gas is available, not only to avoid gas shortages in the system but also to be ready for last-minute sales—unfortunately, the

most expensive option for the user.

Clothing

Another user that recognizes the importance of meteorological data and actively uses it is one of the largest Croatian textile manufacturers in the commerce and retail sector. The descriptive model they created contains predictions, yet strongly relies on experts and decision makers. The model was based on the Bayesian network, which represents the probabilistic relationship between sales trends of various types of clothing and external data—in this case meteorological data. The model uses daily mean and maximum air temperature, precipitation amount and type, wind direction and velocity, cloud amount, pressure value and tendency, relative humidity, and sunshine amount in hours. Graph 3 (please see <http://www.sip.ucar.edu/news/vakula> for this and other graphs) shows the empirical data of a selected group of clothing and daily mean air temperatures, which were used as a basis for creating the model. The graph indicates that sudden drops in temperature could have triggered an increase in sales during February and May, and warm days in August probably decreased sales. However, the graph illustrates only the relationship between temperature and sales. In practice, it is necessary to take into account a variety of other factors that a Bayesian network model incorporates. The model proposes an efficient way of analyzing the interdependence of various factors that affect textile sales as well as offering solutions using Bayesian

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Conferences & Opportunities

Conference on the Inland Impacts of Tropical Cyclones (IITC)

Conference Date: June 10-12, 2009

Location: Atlanta, Georgia

For More Information: Please visit <http://www.ametsoc.org/chapters/atlanta/iitc.html>

The Conference on the Inland Impacts of Tropical Cyclones, hosted by the Metro Atlanta Chapter of the American Meteorological Society (AMS) and National Weather Association (NWA), will be held June 10-12, 2009, at the Westin Peachtree Plaza in Atlanta, Georgia. Conference early registration fees are \$130 for general admission and \$80 for students, and include a ticket to the conference banquet dinner. Early registration ends May 10, 2009, and late registration after that date will be an additional \$20. Hotel rooms can also be reserved at the group rate of \$140 until May 10. For more information, please visit <http://www.ametsoc.org/chapters/atlanta/iitc.html>.

Disasters Roundtable: Children and Youth in Disasters: Ways for Research and Practice to Inform Policy

Roundtable Date: June 25, 2009

Location: Washington, D.C.

For More Information: Please visit <http://www.dels.nas.edu/dr/f25.shtml>

This workshop will strive to identify key areas in need of research, address opportunities and challenges, and facilitate conversations about children and youth in disaster planning, mitigation, response, and recovery among practitioners, academics, and policymakers. All Disasters Roundtable workshops are free and open to the public. Registration will open May 5, 2009. For more information, please visit <http://www.dels.nas.edu/dr/f25.shtml>.

Association of State Floodplain Managers 33rd Annual National Conference

Roundtable Date: June 25, 2009

Location: Washington, D.C.

For More Information: <http://www.floods.org/Conferences,%20Calendar/Orlando.asp>

This comprehensive conference will allow local, state, and federal officials, industry leaders, consultants, and other interested parties to share state-of-the-art techniques, programs, and resources to accomplish flood mitigation, watershed management, and other community goals relevant to this year's theme: "Green Works to Reduce Flood Losses." For more information, please visit <http://www.floods.org/Conferences,%20Calendar/Orlando.asp>.

Jobs & Opportunities

Flood Recovery and Reinvestment Director City of Cedar Rapids, Iowa

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Review of Colorado Weather Almanac

by Jeff Lazo**

In the Centennial State, there's a common saying, "If you don't like the weather, wait five minutes and it'll change." Of course, I've heard this said about pretty much every place I've been in the nation except perhaps southern Florida and California—but it seems especially true in "Colorful Colorado." Mike Nelson, chief meteorologist for KMGH-TV in Denver, Colorado, is the author of *Colorado Weather Almanac*, a nicely written and produced book on all aspects of the state's weather and climate. It's important to know that this is a book about weather, not meteorology, and Colorado has plenty of weather.

The book opens with an overview of the basics of weather and weather systems in Colorado, with very readable explanations of the effects of the mountains and other geographic features that can shape Colorado weather. This chapter also explains the effects of El Niño and La Niña, weather patterns, clouds, and winds. It's not a technical discussion that would enthrall meteorologists, but it is highly accessible to readers like me who are interested in understanding the weather but don't need or want to know the Navier-Stokes equations (whatever those are!).

Subsequent chapters focus in depth on cold-season weather, warm-season weather, and the underlying meteorology during these different seasons. They discuss related phenomena and

impacts from major snow storms, blizzards, and avalanches in the cold season to flooding, tornadoes, and wildfires in the warm season (all of which make Colorado an interesting place to live). Chapter 4 covers storm chasing, a passion of the author, discussing supercells, thunderstorms, and tornadoes in greater detail.

A history of major Colorado weather events follows, largely with insights from Colorado Climatologist Nolan Doesken. These events range from major blizzards in the 1800s to recent, nationally known events such as the Big Thompson flood of 1976, the Limon tornado of 1990, the Storm King Mountain fire of 1994, and the holiday storms of 2006. A chapter on climate change and current and potential impacts on Colorado is followed by a final chapter on weather forecasting from the perspective of a broadcast meteorologist.

The book includes tables of weather data for things such as date of first snowfall, lightning injuries by month, notable flash floods, average precipitation by month, and average date of first frosts by city or county—all interesting, quantitative insights into Colorado climate norms and extremes that provide more context for the reader. And great photographs—many of local places I know well—add immensely to the book's visual impact.



Colorado Weather Almanac by Mike Nelson is available from Johnson Books, Boulder, Colo, ISBN-13: 9781555664015.

As noted in the acknowledgments, the book was designed and created as part of a college credit program with Front Range Community College. I believe this has added greatly to the quality of this book and makes for a nice experience in the reading. It is obvious that a great deal of research underlies this book, and a lot of people contributed their knowledge of weather and climate, Colorado history, graphics and photographs, and book design, layout, and publication. The book was also a fun read for me because of my personal connection with many of the recent major weather events in Colorado history and the mention of numerous, familiar local experts and researchers, including Eve Gruntfest, Matt Kelsh, Micky Glantz, Kevin Trenberth, Claudia Tibaldi, and Carl Sagan (OK—I never knew Carl Sagan—and he wasn't really a local).

(continued on page 15)

Table 1 illustrates our measure for Alabama in 1986. Forty county warnings were issued in Alabama in 1986 on eight different days, so there were

eight state warning days. The table has one row for each warning day, and also reports for each day the number of warnings issued, the number of tornadoes in Alabama, the number of verified county warnings, and whether the state warning day verified. Three of the state warning days verified, so the state warning day FAR was 0.625 for the year, and the FAR for county warnings for Alabama in 1986 was 0.8.

The nationwide state warning day FAR between 1986 to 2004 was 0.420, and the county warning FAR was 0.758. Not surprisingly, the FAR falls when some close calls are reclassified. Yet even with our rather generous state warning day definition, false alarms do not vanish. Also, unwarned events still occur; over these 19 years, tornadoes occurred on 2,389 days on which no warnings were issued in the state.

The real value of an alternative definition of a FAR arises from comparison with the NWS FAR. That the NWS FAR deviates from the “true” FAR if we could

Table 1: Constructing State Tornado Warning Days (Alabama in 1986)

Date	# of tornado warnings	# of tornadoes	# of verified warnings	Verified state warning day
February 2	1	0	0	0
February 10	1	0	0	0
March 12	27	5	5	1
May 18	2	0	0	0
May 24	4	1	2	1
June 18	1	0	0	0
August 10	3	0	0	0
November 26	1	3	1	1
Totals	40	9	8	3

NWS FAR = 0.800 = 32/40.

State Warning FAR = 0.625 = 5/8.

exclude all close calls does not render the NWS FAR useless for research. The pattern of deviation is what is really important. Suppose that the “true” FAR excluding all close calls was always exactly half of the NWS FAR. Since the NWS FAR in this case perfectly tracks the true FAR, hazards researchers could still use the NWS FAR to, for example, try to document a cry wolf effect.

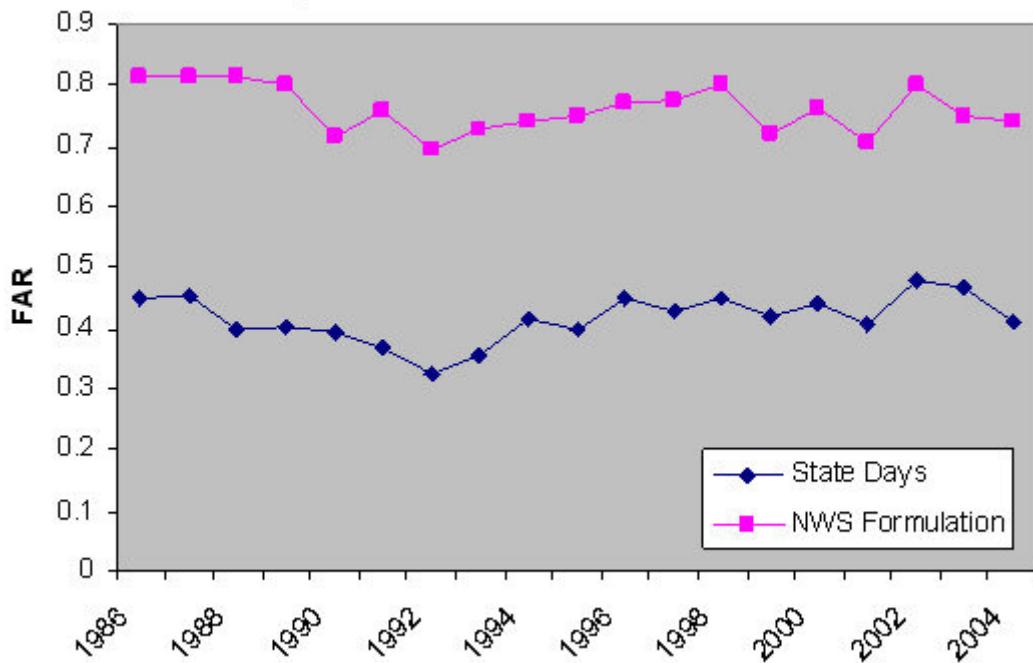
We explored the relationship between the state day FAR and the NWS FAR over time and across states. Figure 1 graphs the national NWS FAR and state warning day FAR by year from 1986 to 2004. The state day FAR is less than the county warning FAR in each year, as we would expect, and the two measures move together; the correlation between the annual FARs is +0.57. But the measures are not perfectly correlated.

Suppose we wanted to test for a change in the FAR over this period. A regression of the FAR on a constant and a linear time trend yields a reduction of 0.04 over the period with the NWS

FAR, which suggests a modest improvement in false alarms and credibility. But the same regression using the state warning day FAR indicates an increase of 0.04 over the period. Neither time trend attains significance at conventional levels, but the difference in results suggests that the observed decline in the NWS FAR might be caused by fewer definitional false alarms with little gain in credibility.

Figure 2 plots the state warning day FAR and NWS FAR for each state from 1986 to 2004. The plot shows an approximate linear relationship between the FARs, as would be the case if the state warning day FAR were proportional to the NWS FAR. The correlation between the FARs is +0.61, slightly greater than the correlation over time. The NWS FAR captures the risk across states fairly well, but again the FARs are not perfectly correlated. California and Utah, for example, have two of the highest NWS FARs and yet very low state warning day FARs; South Carolina has a relatively high state warning day FAR but the second lowest NWS FAR. The biggest deviations in the FARs, however,

Figure 1: False Alarm Rates over Time



do tend to occur in states with relatively few tornado days.

Conclusion

The NWS undoubtedly counts as false alarms many cases where a tornado warning alerts residents to danger. The national tornado FAR of about 0.75 suggests that warnings are possibly less credible than they in fact are for residents. But how big is the divergence between the reported FAR and the credibility of warnings? To offer some perspective, we constructed an alternative measure of false alarms using NWS verification statistics. Differences in the state warning day FAR track the NWS FAR reasonably well, so the NWS FAR probably measures differences in the credibility of tornado warnings across the country fairly well. But the modest reduction in the yearly FAR observed over 20 years might be more definitional than real.

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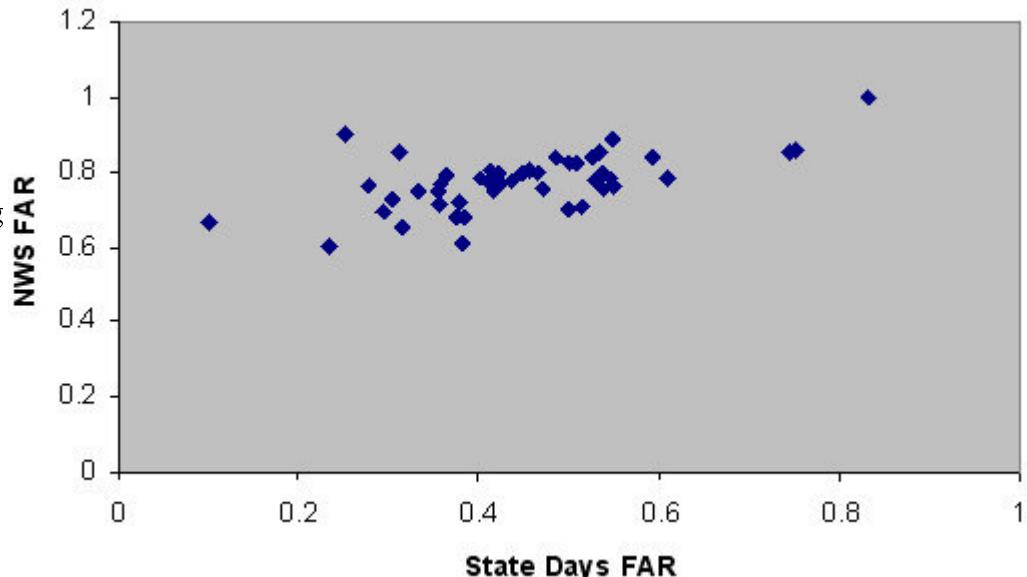
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Figure 2: False Alarm Ratios by State



logic in commerce. Areas where such a model could be applied include sales predictions, trend predictions, impact analysis, point of sale scoring, risk analysis (for example, a drop in sales related to changes in weather conditions), and impact analysis of marketing campaigns on sales.

Beer

The previously described models could be used to improve the analysis of my last example. Because they require a higher level of expertise, I describe a simplified version for the beer industry and sales. According to the article on climate change from the Croatian business weekly magazine, one of the possible future winners could be the beer industry. Even though not one brewery is an official user of long-term weather forecasts, an NWS analysis has shown the benefits of becoming one. The relationship between heat and beer sales is shown in Graph 4 (please see <http://www.sip.ucar.edu/news/vakula> for this and other graphs).

The model is the same as in the first example, where temperature anomalies were weighted against the number of residents. The colored columns represent data from 2005, and the uncolored columns represent data from 2006. The blue line indicates the amount of beer sold in 2005 and the red line in 2006. The data refer to a two-month reference period, which was both familiar and accepted by most producers and traders. It was gathered from retail stores and included sales in

supermarkets, grocery stores and kiosks; it did not, however, include cash & carry stores, seasonal stores, gas stations, sales in institutions, or catering.

During the April and May reference period, higher sales were achieved in May 2005, which was significantly hotter than May 2006, with more days of temperatures above 24°C. The heat probably resulted in more frequent grabs of beer for refreshment. Although more anomalies were recorded with respect to the average, temperatures in April were not as significant: the maximum was rarely above 24°C. Furthermore, surveys done by the beer industry show that more beer is sold when the temperature is 30°C.

During the June and July reference period, sales were naturally higher than the period before, especially in 2006. Apart from the above-average heat during those months, especially in July, the impact of increased beer advertising during the FIFA World Cup must also be considered.

On the other hand, exceptionally high beer sales in August and September 2005 lack a comprehensive explanation. More beer was sold in those two months than in the months before or in the same period in 2006, even though August was colder both years and September was hotter than average. Lower sales in 2006 than in 2005 could be explained by the large beer stocks from two months before, less advertising, or a colder August.

Follow-up

A more comprehensive analysis of the impact of meteorological elements in all my examples

would, on the one hand, yield more reliable results and, on the other hand, demonstrate the feasibility of investing in each of the sectors, while at the same time changing the currently negative perception of the cost/loss ratio. Further benefits could result from an analysis of the quality and reliability of long-term monthly and seasonal forecasts as well as user contact. In conclusion, apart from a meteorological perspective of the world, albeit a prognostic one, a more decisive stand should be taken by economic experts, who until now have hesitated and been divided in their views on how much a weather forecast might actually help a business and how much damage an unfavorable forecast can bring.

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Contribute to WSW

Weather and Society Watch is currently accepting items for publication in the July and October 2009 editions. We welcome solicitations for guest editorials, research articles, articles detailing upcoming weather and society projects, general weather interest articles, weather photos, conference and job announcements, and book reviews. If you are interested in contributing an item for an upcoming edition, please contact Emily Laidlaw at laidlaw@ucar.edu.

In addition, we always welcome your feedback of what you like to see more—or less—in future editions and how we can better tailor the newsletter to meet your needs. Please submit any feedback you have at any time to Emily Laidlaw at laidlaw@ucar.edu or visit the feedback page on our Web site at <http://www.sip.ucar.edu/news/submit.jsp>.

As you may have guessed by now, I highly recommend this book to anyone interested in learning more about Colorado, and anyone with an interest in weather and weather impacts. This book may not provide much new information to the professional meteorologist, but that isn't its purpose. It should be read by anyone living in Colorado if for no other reason than to learn more about our weather hazards and how to be "weather-aware." It is also a great role model for meteorologists or broadcasters from other states who might want to produce similar books for their states; for example, there is a book entitled "Minnesota Weather Almanac," that appears to be a much more traditional, historical almanac. On the whole, Mike Nelson's book does an excellent job covering the whole range of weather issues, and is worth a read.

*Jeff (lazo@ncar.edu) is the director of NCAR's SIP.



Traffic was backed up for hours on I-70 near Denver, Colo. after a spring snow-storm dumped several feet of snow. (Photo by Blake Beyer)

What Language Are You Speaking?

by Emily Laidlaw*

Note: This column replaces Jeff Lazo's "From the Director" column for the April edition. Check back in July for Jeff's next column.

A new and, sadly, short-lived member of the Societal Impacts Discussion Board (<http://www.rap.ucar.edu/forums/phpBB2/>) recently remarked that, much to his dismay, there were no discussions of "societal impacts" on the board. Specifically, he lamented, "Advertising available faculty positions is not related to societal impacts, is it? Advertising upcoming conferences and forums is not related to societal impacts, is it? To me, societal impacts embraces subjects like environmental impacts, physical and mental health impacts, cultural impacts and financial impacts."

As Karen Pennesi, a linguistic anthropologist and member of the Weather and Society * Integrated Studies (WAS*IS) movement skillfully noted in her article, "Improving Forecast Communication: Linguistic and Cultural Considerations" in BAMS Vol. 88, Issue 7, distinctions salient to one group may be meaningless to another. It is not enough to clearly define scientific terms; we also must find out what they mean to others.

It seems there are many definitions of societal impacts floating around, and we need to do our best to make sure the correct definitions persevere. To borrow some suggestions from numerous WAS*ISers—and add a few of my own—we can strive to

better "speak the same language" by doing the following:

- Recognize assumptions – I don't know what you know or think.
- Identify barriers – Know what obstacles prevent mutual understanding, and work to overcome them.
- Embrace clarity – Avoid comfortable, habitual jargon. It further isolates those who might consider themselves "outsiders."
- Respect culture – We're not all from the same place geographically, academically, or experientially. We're all members of multiple interpretive communities.
- Demonstrate sensitivity - Always be sensitive to fears, concerns and questions, even if they seem trivial to you.
- Talk at your audience, not down to them – An expert in astrophysics may feel like a first-grader when trying to join an interdisciplinary weather impacts discussion.

I am happy to report that the discussion board members who responded to our short-lived member exhibited these qualities and did their best to encourage the member to post ideas for discussion rather than complain about the lack of them. But as they say, it's not what we know we don't know, but what we don't know we don't know. I hope that we can continue to do a better job of recognizing the things that people on the fringes of our community don't know they don't know and continue to expand and broaden the weather impacts community.

* Emily Laidlaw (laidlaw@ucar.edu) is an associate scientist with NCAR's SIP and managing editor of *Weather and Society Watch*.

About Weather and Society Watch

Weather and Society Watch is published quarterly by the Societal Impacts Program (SIP) at the National Center for Atmospheric Research (NCAR). The University Corporation for Atmospheric Research (UCAR) operates NCAR with support from the National Science Foundation and other sponsors.

The purpose of *Weather and Society Watch* is to provide a forum for those interested in the societal impacts of weather and weather forecasting to discuss and debate relevant issues, ask questions, and stimulate perspective. The newsletter is intended to serve as a vehicle for building a stronger, more informed societal impacts community.

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of NSF or other sponsors. Contributions to *Weather and Society Watch* are subject to technical editing at the discretion of SIP staff.

Weather and Society Watch is available on the World Wide Web at: <http://www.sip.ucar.edu/news/>. Archives of Weather-Zine, a previous weather impacts newsletter upon which *Weather and Society Watch* was modeled, are available on the Web at <http://sciencepolicy.colorado.edu/zine/archives/>.

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About SIP

All aspects of the U.S. public sector, along with the nation's economy, are directly and indirectly affected by weather. Although the economic impacts of weather and weather information on U.S. economic agents have been loosely documented over the years, no definitive assessments have been performed, and information generated from the previous studies is difficult to locate and synthesize.

SIP, initiated in 2004 and funded by NOAA's U.S. Weather Research Program (USWRP) and NCAR, aims to improve the societal gains from weather forecasting. SIP researchers work to infuse social science and economic research, methods and capabilities into the planning, execution and analysis of weather information, applications, and research directions. SIP serves as a focal point for developing and supporting a closer relationship between researchers, operational forecasters, relevant end users, and social scientists concerned with the impacts of weather and weather information on society. Program activities include primary research, outreach and education, and development and support for the weather impacts community.

For more general information on SIP, contact Jeff Lazo at lazo@ucar.edu or <http://www.sip.ucar.edu>.