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FUNDAMENTAL CONSIDERATIONS FOR DESIGNING AND IMPLEMENTING THE EXPERIMENTAL FORECAST CENTER CONCEPT

by

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1. INTRODUCTION

A major thrust of the National STORM-Central Program Design Plan is its call for implementation of experimental forecast centers (EFCs). These activity centers would bring together operational forecasters and research scientists to work in concert to accomplish the applied research goals of STORM-Central and to develop, test, and evaluate new analysis, forecasting, and dissemination techniques (Zipser, 1984). Close interaction and high levels of communication between researchers and forecasters in the STORM-Central program could revitalize a working relationship that has been responsible for some of the most substantial advances in meteorology and the weather forecasting profession! During the field phase of the Oklahoma-Kansas Preliminary Regional Experiment for STORM-Central [OK-PRE-STORM (Cunning, 1985)] researchers and operational forecasters worked together at the National Weather Service Forecast Office (NWSFO) in Oklahoma City (OKC) over a two month period (May and June of 1985). The effort was designed primarily to provide forecasting support for the daily research operations of OK-PRE-STORM. However, the co-location of researchers and forecasters provided the opportunity for an exploratory exchange of ideas within what might be considered an early prototype of the eventual EFC environment. The experience provided insights into a variety of factors which may foster or inhibit productive interactions between researchers and operational forecasters. These factors are discussed within the framework of the OK-PRE-STORM experience, from both the forecasters' and the researchers' perspective.

2. FORECASTING FOR FIELD OPERATIONS

Operational forecast support for the OK-PRE-STORM field program activities involved the issuance of both short-term and long-term convective forecasts. Daily forecasts and briefings were designed to assist project leaders in making a "GO" or "NO GO" decision for the day, and on "GO" days in deciding on mission type, and observational strategies for the coming afternoon and evening. The OK-PRE-STORM forecast team worked in a room provided by the OKC Forecast Office. The basic data sets for the forecasts were obtained using an auxiliary (sixth) NWS/AFOS workstation and a satellite facsimile display. Forecasts were issued each day during May and June for the periods noon to midnight (1700-0600 GMT), midnight to noon (0600-1700 GMT) and again from noon to midnight for the coming day. Forecast emphasis was on the location of expected thunderstorm activity, its type, timing, organization and movement within the OK-PRE-STORM region and surrounding area (Fig. 1). Additionally, short-term forecasts (STFs) for convective development and/or evolution were issued routinely at 1700, 2000, 2300, and 0200 GMT valid for the ensuing three hours, focusing on the dense data area of the experiment (e.g., the portions of Kansas and Oklahoma covered by the surface mesonet; see Fig. 2). These STFs were made every day, regardless of the daily OK-PRE-STORM operational status. The STF forecaster routinely used output from the OKC AFOS mesoscale applications program (Bothwell, 1985) as a diagnostic and forecasting aid (i.e., the STFs were partially based upon output from the applications program at 1500, 1800, 2100, and 0000 GMT--at a minimum--each day of the field program). Other products and guidance were used along with

the mesoscale program in developing the thunderstorm outlook and short-term forecasts (i.e., National Severe Storms Forecast Center guidance, stability analysis programs, Limited area Fine-mesh Model, etc.). The OK-PRE-STORM forecasters discussed the meteorological aspects of the STF with the OKC forecasters to varying degrees, depending upon individual involved and and the level of weather activity (more activity or potential activity typically led to less interaction).

Meteorological discussions with the OKC forecasters were facilitated because OKC has been experimenting with an innovative local product, the "Oklahoma Thunderstorm Outlook" (OTO), which is intended to provide timely information about the potential for severe weather to civil defense, law enforcements agencies, and media outlets in Oklahoma, as a planning aid. The OTO is not routinely done within the NWS. The format and detail of the OTO varies, depending on the complexity of each day's weather. However, the outlook generally contains a header which highlights any severe weather expected, a discussion of meteorological features, details on when and where storms are expected, and possible needs for utilizing the services of amateur radio operators and storm spotters (Crawford, 1985). Additional NOWCASTS are issued during the afternoon as conditions warrant and FO staffing permits. As with the STF, the OKC AFOS mesoscale applications program is routinely used to provide an initial framework in the preparation of the OTO and additional NOWCASTS.

Thus, the STF and OTO provided a common focus for forecasters and researchers to interact and work within an operational setting, in support of both operational and field program needs. These activities were very similar to certain objectives of the EFC envisioned in the STORM-Central Program, i.e., both researchers and forecasters were attempting short-term forecasts of the genesis, evolution, intensity, and movement of convective and mesoscale weather phenomena. Although the OKC forecasts were disseminated publicly to users, the OK-PRE-STORM research forecasts were made available only to NWS stations within the experimental area (again, see Fig. 1). We feel the greatest benefit derived from this unique experience is not one of quantifying the success or non-success of the short-term forecasts, but rather the insights provided into the process of fostering close interactions between researchers and forecasters.

3. THE OK-PRE-STORM EXPERIENCE

The attempt to foster some degree of interaction between researchers and forecasters within the framework of the OK-PRE-STORM program was quite enlightening. It was truly an educational experience to observe a substantial number of forecasters and researchers attempting to collaborate. The interactive process is obviously difficult and worthy of extensive consideration prior to STORM-Central. Researchers tend not to understand the problems and rigor (e.g., rigid work schedules, product deadlines, etc.) of operational weather forecasting and further tend to be reticent in talking about, participating in, and learning of the operational routine. Forecasters tend to regard researchers as intruders likely to upset the highly structured

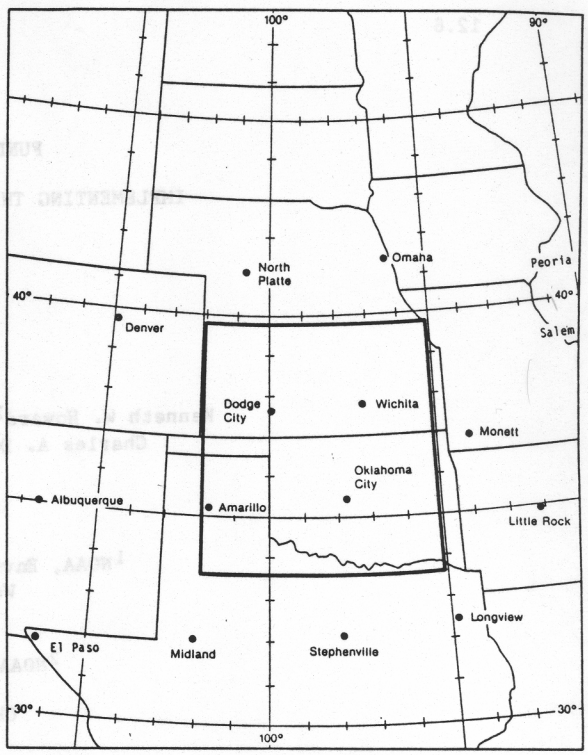

Fig. 1. Forecast area for the OK-PRE-STORM field experiment during May and June 1985.

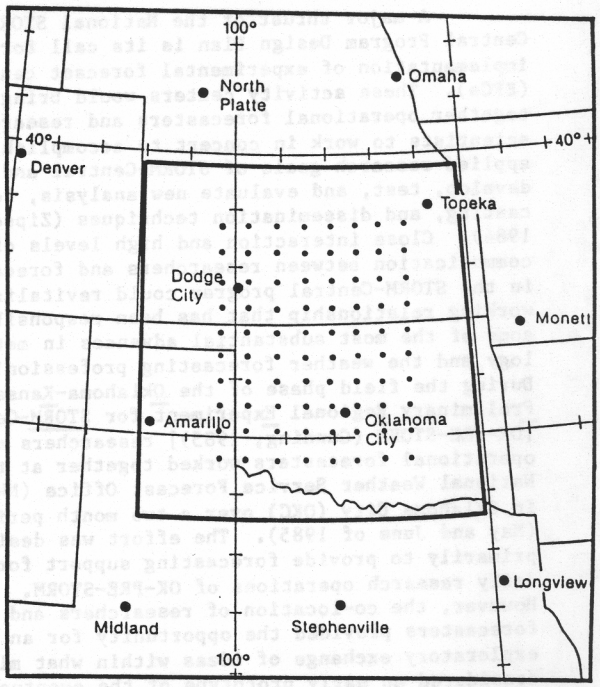

Fig. 2. Forecast area for the short-term forecasts (STFs) is denoted by inner box. Small dotes mark the location of the NSSL SAM systems, lower half of the network, and the NCAR PAM-II systems, upper-half of the network.

routine of the forecast office. These feelings are more than understandable when one considers that the majority of researchers and forecasters share very little mutual work experience (Doswell et al., 1981).

Unfortunately, we were not able to accomplish much of lead-in preparation before commencing OK-PRE-STORM, and so very small part of the OK-PRE-STORM scientists were conscious of NWS routines and procedures. Few were AFOS literate! This forced the burden of coordinating with NWS staff and retrieving of AFOS products upon a very few OK-PRE-STORM support staff. A blossoming of interactions was further hindered by the rapid turnover of research personnel during the field program. Few personnel were present during the entire experiment (indeed, few were present for more than 10 days at a time). The OK-PRE-STORM forecast group was in a continual state of flux, so the degree and effectiveness in coordinating activities and forecasts was highly variable. Therefore, exchanges of roles between the researchers and forecasters, as well as interpersonal communication during the field program, were not as effective as we might have hoped. Although the NWS forecasters were able to join the OK-PRE-STORM forecast team and provide support for OK-PRE-STORM briefings, essentially no one from the research community was able to assist the FO staff easily or knowledgably with, for example writing zone forecasts or issuing severe weather warnings. This imbalance certainly was not a positive factor. Similarly, few of the OKC staff were prepared for the plethora of seemingly unorganized and relatively chaotic activities associated with a complex scientific program.

We must admit that a number of mistakes were made in OK-PRE-STORM, with regard to the forecaster-researcher interaction. Perhaps most important of the mistakes was that no "start-up" time was allocated for integrating researchers into the operational routine prior to commencing field program operations. Even when most of the participants on both sides are willing to attempt the interaction (as appeared to be the case in OK-PRE-STORM), good will alone may not be enough. It seems that the operations-research gap has widened sufficiently to prevent its bridging solely by good intentions. Curiously, the scientific and technical issues do not appear to constitute much of the barrier--instead, we think that the most crucial element is that of the humans involved.

4. THE HUMAN ELEMENTS

Although the functions of an EFC will require substantial hardware and communication support and sophisticated interactive meteorological computer systems, the human element and psychology likely will prevail as the most important aspects determining the success of the EFC concept. Success hinges upon having the "right" individuals working in the EFC. What do we mean by the "right" individual? Such an individual, whether forecaster or researcher, might be described as a "weather freaks" but besides an interest in the weather, he or she must be a functional meteorologist. Precisely what and who constitutes such an individual will undoubtedly be a matter of some debate (Doswell, 1986b). However, from OK-PRE-STORM and related experiences, we feel that all the EFC players must be committed to learning everything possible within both the operational and research realms. The qualifications of such individuals encompass far more than operational experience and/or formal education. Members of the EFC must have the ability to break down the communication barriers which have hindered meaningful interactions and transfer of knowledge within meteorology (see Doswell et al., 1981). Obviously, such individuals are not abundant. If they were, we would not be exploring the EFC concept; it would already be a reality! If forecasters and researchers are unable to work together on identified problems within an operational setting, the effectiveness of the EFC concept is undermined, regardless of the technology employed. The productivity of any EFC depends upon collaboration of individuals who are truly committed to solving fundamental weather forecasting problems that have been directly defined by operational needs.

In our view, researchers involved in an EFC must be able to perform the duties of a lead forecaster. This represents a type and level of meteorological experience that will present a significant psychological challenge to many researchers (see Doswell and Maddox, in this volume). At the same time, training and education will be required to bring forecasters up to a level of awareness commensurate with the flow of new knowledge and technologies that will characterize an EFC. The presence or involvement of a single senior scientist or senior forecaster with both research and operational experiences will not suffice. Rather, the EFC concept calls for a broad mixture of scientific staff, the majority of whom are capable of performing dual roles. Such an approach will require substantial planning, preparation and training of EFC staff prior to EFC implementation.

If we are able to locate the proper personnel (forecasters and researchers alike) the next essential element for constructing a viable EFC will be the "right" local (NWSFO) management. Understandably, many managers might be uncomfortable with the EFC concept. No matter how supportive higher administrators might be, without the backing and active participation of local management, the potential of EFC activities likely will not be realized. A significant factor is that the NWSFO manager must understand the issues of concern to forecasting, which implies that he or she must be a functioning forecaster. Local management must serve in a leadership role that can facilitate the meshing of daily operations and a wide range of EFC activities within the forecast office. Again, we feel that there are few such individuals. None of this is intended to be derogatory to either forecasters, managers, or researchers. Rather, the EFC concept will require such a range of qualifications and experience that it would not be realistic to expect large pools of eligible personnel.

5. ESTABLISHING EFC ENVIRONMENTS

The implementation of an EFC (the coordinated collaboration of researchers and forecasters on operational weather forecasting problems) need not await the execution of a major field program (e.g., STORM-Central). The typical problems associated with operational meteorology require results that realistically may be implemented within the forecast office and new techniques must be based on operationally available data streams.

To delay implementation of the EFC concept awaiting the operational advent of new observation technologies only lessens the current potential for advances in operational meteorology. Innovative diagnostic tools (e.g., mesoscale application programs, omega diagnostics, upper-air sounding analyses, etc.) are already being explored operationally, in conjunction with output from numerical prediction models and associated guidance products (Barnes, 1985). Initial EFC efforts should be directed toward exploring and evaluating these tools and data now.

A further, escalating danger accompanies delay of EFC activities. The onslaught of new observational systems and data streams (NEXRAD, ASOS, GOES Next, Profiler) could overwhelm the EFCs if they have not had an opportunity to establish themselves before the new data begin to pour in. This could undermine the potential operational implementation of new technologies and data processing tools. In other words, we may be facing eminent, meteorological "Future Shock". It seems clear from the OK-PRE-STORM experience that many new insights leading to specific improvements in operational forecasting techniques based on new observing systems will evolve rather slowly, and only as a result of their assessment within a wide range of day-to-day weather forecasting activities.

In order to have a research-supportive environment, resources and personnel for EFC's must be made available, above and beyond those required for routine maintenance of a forecast office. The resources needed to begin implementing, experimenting, and refining the EFC concept must, in the near term, be provided by the research players. The hard constraints of NWS operational budgets call for an early commitment to the EFC concept by the research groups which would naturally be involved during STORM-Central (e.g., ERL and perhaps NCAR).

We feel that a significant part of the total resources brought to the EFC is the augmentation of the staff. An EFC staff should devote roughly 30% of its time working at the desk and 70% doing research. Continuing, substantial deviations from these percentages would likely undermine the effectiveness of the EFC approach. In order to function in this complex role, EFC members must be routinely integrated into the office's forecasting duties. However, if the staff spends too much time away from research, they are really unable to perform research effectively.

6. AN EFC STRATEGY

We suggest that the start-up of any EFC, while it need not await STORM-Central, should begin slowly, perhaps with a very small and carefully selected group of forecasters and researchers who are willing to work together at a carefully selected NWSFO. The staff might consist initially of only one or two individuals from both the operational and research communities. The participating NWSFO forecasters should not be chosen on the basis of seniority or grade, but rather because of their enthusiasm, effectiveness, and their willingness to participate. Researchers should be able to: work effectively within an operational environment, communicate easily with forecasters, and plan and conduct scientifically sound weather forecasting research. It is imperative that during these initial stages, the researchers quickly develop competence to carry out forecast duties.

These constraints would allow pairing one forecaster and one researcher, similar to the forecaster team concept presently used in some forecast offices. As such a team works through a number of months of rotating forecast shifts, we anticipate that the researcher will develop an appreciation of operational challenges, while a high level of mutual understanding simultaneously develops between the researcher and forecaster. It is at this point that the process of identifying operational forecasting/research problems can begin.

Observe that we feel that considerable effort must be expended before true research into operational problems can even begin. Due in large measure to the research-operations schism, it is impossible for researchers to know a priori what the real operational problems are, much less how to go about solving them. This tends to make administrators uncomfortable, because there is no way to specify what research an EFC is to accomplish in a given time period. In our view, there can be no hope for success of any EFC if the forecasting research does not arise "organically" from an extended mutual experience base, shared by forecasters and EFC staff alike. If we can avoid the temptation of letting technology alone be the primary reason for initiating these interactions, broader scientific interchanges and smoother transfer of results will occur. Additional resources and meteorological observations can be added, as funding permits, if the EFC has demonstrated that it is possible to accomplish relevant applied research based on researcher-forecaster interactions. If an EFC is not meeting its primary goals, additional resources and personnel would hardly be justified.

7. CONCLUDING REMARKS

We have tried to demonstrate via the OK-PRE-STORM experience that there are four essential components which will determine the success (or failure) of the EFC concept advanced in the STORM-Central proposals. The first two vital ingredients concern the staffing at a proposed EFC. The working level staff must be "weather freaks" who have demonstrated a commitment to both forecasting and research, while the local NWSFO management must combine meteorological expertise with real leadership capabilities. It seems obvious to us that people fitting these requirements are likely to be in short supply.

A third critical component of a successful EFC is the resource base upon which to build real scientific accomplishment. This includes the tools of research (computers, data bases, etc.) and meaningful support (typing, drafting, travel funds, allowances for publication of findings, etc.). It also means that the staffing permits an appropriate blend of forecasting and research activities within the EFC.

The last essential element is a conceptual one: the EFC must be permitted the time to explore the territory. A truly successful EFC cannot operate when the problems to be dealt with are mandated in advance. It is even more damaging to force the character of the solutions (e.g.,

implementation of a particular technology) before the problems have been clearly defined.

The EFC concept and related activities should be considered not only at locations where a number of meteorological organizations happen to be co-located, but as potentially applicable to a majority of NWS forecast offices and facilities. It is at individual offices that the needs of operations and forecasters can be identified, and where training and transfer of results can be tested under fire. Eventually, if implemented broadly and diversely, the EFC approach need not lead to a few favored centers of activity and resources, but rather to a new era of communications and interactions linking operational and research meteorology.

Finally, we believe the EFC concept must be explored as soon as possible, if it is to become a truly viable resource in solving operational meteorological problems and coping with expected technologies. Somewhat paradoxically, we also believe the process of implementing the EFC environment should proceed carefully and slowly to insure that a proper emphasis is found and that the "right" players are put in the game.

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