meeting review

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Summary of the Sessions on Problems in Forecasting, AMS 57th Annual Meeting, 18–19 January 1977, Tucson, Ariz.

As part of the AMS Annual Meeting in Tucson, Ariz., in January, two days were devoted to the presentation of invited and unsolicited papers dealing with forecasting problems and needed research work. During these sessions, a panel discussion was held on the last afternoon, and the speakers and the audience were invited to consider the question, "What are specific forecast problems that need to be addressed by researchers?" (See the October 1976 BULLETIN, pages 1301–1304, for an outline of these sessions.)

During the sessions, 23 papers were presented. Reflecting the increased awareness in mesoscale atmospheric problems, 10 of these presentations explicitly dealt with features on the mesoscale.

John F. Henz summarized the development and evolution of the Big Thompson Flood in Colorado last spring along with forecasts of the event prepared by his meteorological group. At the conference, Henz and Vincent R. Scheetz received a Special Award from the AMS for their "outstanding example of the use of meteorological knowledge and radio in the public interest during the flash flood. . . ." Later in the session, Henz presented a second paper in which he mentioned that 75% of severe thunderstorms that affect the Plains originate at an elevation of 7000–9000 ft in the Rockies. He emphasized the need to educate the public to mesoscale problems. Charles F. Chappell, Lee R. Hoxit, Fernandó Caracena, and Robert A. Maddox gave a detailed synoptic and mesoscale summary of the events that culminated in the Big Thompson Flood. They found that 8–9 inches of rainfall fell in 3 h or less around the 7000–8000 ft level. The 500 mb winds on this date were light and variable.

Carlos Dunn gave another example of a flash flood occurrence in two counties along the Pennsylvania–New York border on 19 June 1976 that was not detected by either radar or satellite. This inability to observe an extreme rain event was due to the shallow depth of the clouds, indicating the precipitation was controlled primarily by warm cloud microphysical processes. Paul Moore gave examples of an innocuous situation that produced heavy rain over Houston, Tex. He commented that it is a typical occurrence for radar echoes to show persistent movement, which would seem to preclude excessive rain, except that each passing cell builds up to its maximum in the same area. Moore also stated that after-the-fact analyses can often explain the accentuated activity in terms of terrain or the intersection of convergence lines but similar-appearing situations may occur without heavy rain. L. R. Hoxit, C. F. Chappell, and J. Michael Fritsch presented results that indicated that many convective storms are preceded by surface mesolows ranging from several kilometers to a few hundred kilometers in diameter.

Robert A. Clark briefly reviewed hydrologic forecasting and showed that floods cause an annual loss of about $2 billion with most of this attributable to flash flooding. Larger-scale flooding on longer time scales, such as the Minot Flood in North Dakota last spring, can be predicted quite well. He emphasized the need for improved quantitative precipitation forecasts and for better estimates of evapotranspiration in order to obtain better predictions of runoff in the National Weather Service (NWS) River Forecast Model. He mentioned that 4-day forecasts of temperatures are sufficiently accurate for satisfactory snowmelt predictions.

Floyd A. Huff and John L. Vogel presented a paper discussing urban effects on weather forecasting. METROMEX data collected around St. Louis served as their example. Among their results was the observation that a climatological maximum of thunderstorm activity occurred downstream from the city.

Lawrence A. Hughes presented a survey of recent work on the front range of the Rockies' downslope wind problem. His literature survey showed that two distinct types of wind storms occur, the bora and the chinook. These strong winds occur most frequently at night, and January has the highest incidence of events. He maintained that an inversion is not a necessary requirement for all types of wind storms and feels that dynamic modeling of the phenomena presents the optimal avenue of future research on this problem.

J. Owen Rhea reported on the use of upper air features and terrain configurations to obtain quantitative precipitation forecasts in the Colorado Rockies using an operationally oriented kinematic model. Rhea presented results for several different prevailing flow directions and found that the agreement between observed and predicted snowfall was quite good. His results illustrated the effect of shadowing of the mountain barriers on the downstream precipitation, as well as the influence of rate of rise of the airstream and the length of air trajectories over high terrain.

Dennis S. Walts and Larry O. Pochop presented a forecast procedure that is used to obtain daily maximum and

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minimum temperatures for selected towns in Wyoming. They used nonlinear regression relations between MOS (model output statistics) sites and other locations where climatological data are available but for which MOS predictions are not generated. Since the technique requires MOS data, it is directly linked to the operational numerical model forecasts.

Allen D. Pearson commented on specific difficulties in timing and locating certain meteorological events. He has observed that the time of formation and dissipation of fog, for example, is very difficult to forecast. Pearson presented examples of particularly difficult predictions such as the regions of heavy snow during the January 1977 Midwest blizzard and the timing of a tornado outbreak in the Mississippi Valley. Better predictions of timing, he maintained, would significantly improve our public image. He emphasized that radar and satellite are not particularly useful for obtaining the areal distribution of snow because of low cloud top heights. This limited cloud depth permits the radar beam to overshoot the precipitation size hydrometers and makes it difficult for the satellite to discriminate in the infrared and visible between cloud and ground. Pearson advocated the measurement of soil temperature in our regular synoptic reporting sites.

Vincent J. Oliver presented some new uses of the geostationary satellite imagery. Among his examples were high spatial resolution analyses of lower- and upper-level winds over south Florida (generated by T. T. Fujita, using 2 min interval observations). In contrast to the current operational procedure whereby there are ~30 min periods between images, data obtained with this higher frequency permit the resolution of individual cumulus cells and, therefore, a more detailed analysis of the wind field.

Allan H. Murphy presented a comparison of the cost effectiveness of different forms of weather predictions and showed that probability forecasts are superior to categorical forecasts. He maintained that climatology is a better competitor to probability than categorical forecasts.

William H. Klein gave an overview of the Automation of Field Operations and Services (AFOS) system and reported that forecasts should take about one-third the time they do now. He reported that the AFOS system will not only facilitate improved communication of weather information but in conjunction with the minicomputers at AFOS sites will also permit the development of new analyses and forecast methods for local applications.

C. Gordon Little and Freeman F. Hall, Jr., reported on the new 300 m meteorological tower under construction 25 mi east of Boulder, Colo. The installation is expected to be instrumented by 1 August 1977 and operational by 1 October 1977. Among its many tasks will be intercomparisons between tower-mounted sensor and remote-sensing devices, such as the acoustic radar.

John S. Jensenius and John J. Cahir presented results using a statistical method to estimate infrared flux density at the top of the atmosphere from meteorological variables available from the National Meteorological Center's Limited Fine Mesh Model. The predicted fields were found to be somewhat smoother than those observed, but using five predictors, they explained ~65–70% of the variance in the developmental and independent samples. Jensenius and Cahir suggested that predictions of infrared flux could be used as aids for forecasters or as displays for public dissemination on television.

In a related paper, Cahir and Jensenius presented a possible method for objectively predicting mean daily sunlight in the winter. They found that there is a usable relationship between daily insolation and departures from a seasonal average of infrared radiant flux as seen from a polar-orbiting satellite.

John C. Freeman and John A. Bujnoch reported on operational wind and wave forecasting in the North Sea, as part of a project during the past 20 months to provide a daily weather service for a company engaged in offshore operations. The use of satellite interpretation, supplementary forecast methods, and an improved wave forecast method were discussed.

Conley R. Ward summarized the operational forecasting program of the Navy and discussed the problem of quality control and methods of modifying the output from the forecast models. He described the Naval Environmental Display Station (NEDS) and its use in a man-machine mix operation. Albert J. Kaehn overviewed the environmental support provided by the Air Weather Service (AWS) to the Air Force and the Army. Kaehn reported on the reduction-in-force in the AWS, which is expected to continue into the 1980s. He also discussed the planned consolidation of AWS observers and forecasters into one job description called weathermen. He explained that new weapons technology will require more advanced meteorological forecasting and observational support. Mesoscale information is particularly needed.

Paul W. Kadlec discussed the forecasting needs of commercial and general aviation. Among the areas of needed research are better specification of the location of thunderstorm gust fronts and of other regions of significant low-level wind shear. Other terminal forecasting problems relating to low ceilings and slant-level visibilities are also important, and improved predictions of en route winds and turbulence are needed to minimize fuel expenditure and associated costs. He urged continued research into a mechanism to disseminate information concerning serious weather problems in real time to the VFR (visual flight rules) pilot. He reported that 15 times as many fatalities occur in general aviation as in commercial flights and many of these are related to weather.

Leonard W. Snellman discussed the problems that automation is causing the forecaster. He maintains that unless strong steps are taken, the forecaster of tomorrow is in danger of becoming more of a communicator than a meteorologist. He advocates a man-machine mix and emphasized that man performs superior to MOS during adverse weather conditions.

As part of his talk, Paul Moore reported that in the Southern Region of the NWS, forecasters felt that the prediction of local excessive rainfall, thunderstorms, and low ceilings and visibilities were the three most difficult problems they faced in their jobs and that these were the areas in which research should be done. Other problem areas included general precipitation, wind, and temperature. In the northern part of the Southern Region, snow and freezing rain were also considered problem areas, whereas in some of the western offices, prediction of dust storms causes significant difficulty. In Miami and San Juan, forecasters are particularly concerned with tropical waves and hurricane development. In his survey, Moore found that forecasters consider their greatest research need to be in the area of predicting the spatial and temporal distribution of locally heavy rainfall.

The panel discussion was held during the last afternoon of the forecasting sessions. Each panelist was permitted 4 minutes to express his views as to what specific problems need to be addressed by researchers. The audience was then invited to respond and/or comment within the same time period. Notes were taken of the brief presentations, and the suggestions are summarized below. The panelists were L. F. Bosart, R. A. Clark, C. R. Dunn, N. L. Frank, L. A. Hughes, P. W. Kadlec, A. J. Kaehn, Jr., W. H. Klein, P. L. Moore, V. J. Oliver, A. D. Pearson, L. W. Snellman, and C. R. Ward. Unfortunately, it is not possible to record the names of each participant from the audience, but their comments are included in the summary.

A listing of the avenues and areas of specific suggested research, along with other related problem areas, as obtained from the panel and audience is given below with no order of priority or relative importance intended:

1) research into better methods of presenting forecast material to the public is needed;
2) the forecaster should be provided with time-evolving animated displays of analyzed meteorological fields;
3) better observation of the distribution of precipitation on the ground is needed;
4) research into 5- to 15-day forecasts, which are "ripe" for improvement, should be accentuated;
5) methods of predicting amount, type, timing, duration, and location of precipitation, should be improved;
6) more emphasis should be placed on forecasts of flash floods and lightning events;
7) methods using satellite, radar, and raingage data to obtain accurate estimates of rainfall in rough terrain should be developed;
8) improved forecasts of frost, dew, evaporation, relative humidity, soil temperature and moisture, and winds are needed by farmers;
9) improved forecasts of mountain and valley winds, dry lightning strikes, wind gusts, and surface relative humidity are needed by forest fire fighters;
10) improved forecasts of ceiling, slant-range visibility, clear air turbulence, icing, and low-level wind gusts and wind shear are needed by aviators;
11) improved forecasts of local winds and waves, fog and other restrictions to visibility, and ice formation are needed by boaters;
12) improved predictions of planetary boundary layer winds, mixed layer depth, and stability are needed to evaluate air pollution hazards;
13) work should be continued into the coastal flooding problem due to both tropical and extratropical cyclones;
14) alerting mechanisms from satellites, radar, and surface observations for the occurrence of local extreme events are needed by forecasters;
15) additional work on downslope winds and a study of the different mechanisms in the bora and the chinook are necessary;
16) the vorticity source of the tornado should be studied;
17) observation and better understanding of the low-level jet over the Plains states are needed;
18) the influence of terrain on thunderstorm development needs to be understood;
19) model temporal and spatial resolution should be improved in order to provide additional skill further in the future;
20) the marine planetary boundary layer needs to be observed and incorporated into the numerical models;
21) the storm surge in estuaries should be investigated so that it can be predicted;
22) the effort to educate the public to forecasts should be expanded (a survey indicates there is more of a payoff, in terms of human response to hurricane forecasts, to education than to improved technology);
23) forecasters should not be rotated among sites but should be permitted to become intimately familiar with a local weather pattern;
24) work is needed to apply statistical corrections to numerical model output before it is disseminated to the forecasters;
25) physical explanations are needed as to why models fail for specific situations;
26) two additional radiosonde observations per day are required;
27) better understanding and prediction of stratus and fog along the west coasts of continents are needed;
28) the use of microwave spectroscopes to improve quantitative precipitation forecasts should be researched;
29) the relation between surface air electrical conductivity and fog occurrence should be investigated;
30) the relationship of intensity of weather systems to the synoptic wave frequency should be investigated;

31) an understanding of the physical mechanism that causes a particular hemispheric weather pattern to become persistent is needed;
32) education of meteorologists should begin with basic principles and introduce numerical guidance and statistical predictions later;
33) additional evaluation of the use of dynamic and statistical objective forecast techniques on all time and space scales is needed;
34) the support of social scientists should be enlisted to ascertain the optimal way to run the man-machine mix of weather forecasting;
35) Weather Service Offices (WSO) should have meteorologists who are capable of looking at observations from the satellite, radar, surface analyses, etc., and of making a short-range forecast that is immediately disseminated to the users;
36) the interaction of researchers outside meteorology into the entire range of research problems should be encouraged (e.g., behavioral scientists could recommend ways to optimally word severe weather advisories, and physicists could help in the development of improved instrumentation);
37) priorities should be established relating to the importance of these and other problem areas in meteorology relative to a limited budget. •

announcements

NCAR Research Aviation Facility Advisory Panel meeting

The Advisory Panel for the Research Aviation Facility of the National Center for Atmospheric Research will meet in Boulder, Colo., in October 1977 to consider requests for flight support using NCAR's four aircraft instrumented for atmospheric research. At the October 1977 meeting the Advisory Panel will recommend to NCAR the allocation of aircraft concentrating on those programs requesting operations commencing during the period 1 February 1978 to 1 November 1978. Requests for the long-range Electra aircraft are considered further in advance (up to 1 May 1979) to allow sufficient time to organize joint use of the aircraft among several investigators, thereby making each flight hour as useful as possible. Programs requesting NCAR flight support within the context of National Science Foundation (NSF) grants should include the NCAR aircraft requirements in the total NSF proposal. Internal NCAR flight requests and proposals not part of NSF programs should submit sufficient justification so that a meaningful comparison with NSF supported programs can be made.

The Advisory Panel is composed of atmospheric scientists from universities, government agencies, and NCAR. They ordinarily meet twice each year, in the spring and in the fall, to consider the scheduling of NCAR aircraft.

NCAR operates two twin-engined Beech Queen Airs that provide basic thermodynamic measurements and flight level wind data, as well as provisions to accommodate user-supplied instrumentation, at altitudes up to 7500 m MSL. One Queen Air is instrumented with a gust probe and an inertial navigation system and is able to measure all three components of air velocity. NCAR's two-engined jet, a Sabreliner, provides similar measurement capabilities to 14 000 m. The four-engined turbo-prop Electra provides long-range performance at altitudes up to 8000 m for a variety of atmospheric dynamics, cloud physics, and radiation measurements. The Electra instrumentation includes an INS gust probe turbulence flux measurement system.

In order to be considered by the panel at the October meeting, requests must be submitted in complete form by *1 September 1977* to: Manager, Research Aviation Facility, NCAR, P.O. Box 3000, Boulder, Colo. 80307. For additional information, call: 303-494-5151, ext. 7834.

NCAR Field Observing Facility Panel meeting

The Advisory Panel for the NCAR Field Observing Facility (FOF) will meet in October 1977 to consider requests for field observing support. FOF operates two C-band (5.5 cm) Doppler radars, the Portable Automated Mesonetwork (PAM), a vertically pointing ruby lidar, two tethered balloon Boundary Layer Profiler systems, two radiosonde systems, a variety of manual surface meteorological stations, photographic equipment, diesel power generation equipment, and calibration facilities.

Requests for use of these facilities during 1978 should be submitted now. Scientists requesting NCAR field observing support within the context of National Science Foundation (NSF) grants should include those requirements in their NSF proposals.

In order to be considered by the Panel at the October meeting, requests should be submitted by *1 September 1977* at the latest and addressed to Robert Serafin, Manager, Field Observing Facility, NCAR, P.O. Box 3000, Boulder, Colo. 80307. For additional information, write to Serafin or call him at NCAR, 303-494-5151, ext. 740.

Continued on page 433