Introduction
Thank you, Mr. Changnon, ladies and gentlemen. It is a pleasure for me to be with you this evening. I feel very much at home at this conference because of its importance to my organization. As many of you know, the Air Force Weather Service, in providing environmental service to the Army and Air Force, is deeply involved in the practice of applied radar meteorology. Of our 6 different radars, we own and operate 116 storm detection sets and 43 cloud detection systems. The $18 million worldwide network constitutes one of the largest in the world.

To say, therefore, that the Air Weather Service is interested in weather radar and vitally concerned with the outcome of weather radar conferences is clearly an understatement. These conferences and the research presented at them are our lifeblood. Since we have no charter nor resources for research, we depend on your work to enhance our capability. We need operationally useful research results. So far, each of the 15 conferences has yielded some work of this kind, and we in the Air Weather Service have been able to make good use of this research in our operational network.

Talking in this way about the respective roles and importance to one another of the researcher and the operator leads me to my subject tonight, what I think is an interesting story of early practitioners of radar meteorology—a small group of enthusiastic professionals who advanced the state of the art by the diligence and insight with which they applied it.

As scientists we must be concerned with the rigorous, theoretical development of a discipline. But in our preoccupation we sometimes forget how often the first operational applications predated theoretical findings; how often, in other words, the practitioner has found that he must push ahead before the path is cleared and surveyed for him by the research scientist.

This was the case at the time of this story, during World War II, when the Air Weather Service established the world’s first weather radar network. At that time some of Ryde’s first work on attenuation and back-scattering by hydrometeors was complete, but it had not been released beyond various development groups and a few defense agencies. It was widely known that radar showed weather phenomena, but the theoretical background was lacking, and we didn’t really know what we were seeing. Despite these handicaps, Air Weather Service meteorologists in the China-Burma-India theater established that first weather radar network, and, in 1945, led the world in applying radar to operational weather analysis and forecasting.

The world’s first weather radar network
The story starts in the summer of 1944, when B-25 aircraft of the 2nd Weather Reconnaissance Squadron were modified to carry the “radio set” AN/APQ-13. This early radar was originally installed to assist the B-25s in navigating, but it was soon realized that the APQ-13 could sense weather, and thereafter the “Q-13” officially had a dual role as both a navigational instrument and a storm detector.

To give you a rough idea of the kind of business the 2nd Weather Reconnaissance Squadron was in at the time, let me mention that the airborne meteorologists in that squadron were officially called “forecaster-gunners.” The weather version of the B-25, although lightly armed in comparison to the B-25 bomber, nevertheless carried one twin 50-caliber and four single 50-caliber machine guns—this plus a number of dropsondes, believe it or not, which, in a pinch, could be hurled out of the aircraft to the confusion and consternation of the enemy.

When the 2nd Weather Reconnaissance Squadron acquired its APQ-13 radars, it was stateside undergoing training. In the fall of 1944, under the command of Lt. Col. Jim Baker, the unit proceeded to Gusara, India, just north of Calcutta, and was placed under the operational control of our 10th Weather Region, headquartered at Barrackpore.

The 10th Weather Region was, at the time, a rather overtasked unit (Fig. 1). It had the responsibility for observing, analyzing, and forecasting the weather throughout the entire China-Burma-India theater from Ceylon in the south to Chengtu, China, in the north.

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1 An address delivered at the banquet of the Fifteenth Conference on Radar Meteorology, American Meteorological Society, 11 October 1972, Urbana, Ill.
It operated fixed and mobile weather stations throughout that vast area and ran three separate weather centers. In the rosters of the 10th Weather Region can be found many familiar names (Fig. 2), including Dick Ellsworth, after whom Ellsworth Air Force Base, South Dakota, is named; Dr. Bob Fletcher, the Air Weather Service's distinguished and recently retired Chief Scientist; Gordon E. Dunn, who was on loan from the U.S. Weather Bureau to the weather center at Barrackpore, India; J. J. George, now Director of Meteorology for Eastern Air Lines; and Don Martin, now Professor of Meteorology at Saint Louis University.

The 2nd Weather Reconnaissance Squadron operated south to India, the Bay of Bengal, Burma and the Indochina peninsula, and east to China, providing weather data in these areas and also weather scouting for frequent flights “over the hump” into China.

The B-25s' APQ-13 radars worked so well for storm detection that the guys decided to try them on the ground (Fig. 3). One of the APQ-13s at Guskara was modified slightly so it could be mounted in an upright position; a 35-ft wooden tower was constructed; the APQ-13 antenna was placed atop this tower the power was hooked up; and the set was declared operational.

Now this station at Guskara was established not simply out of scientific curiosity nor just as an experiment. Quite the contrary. From the very first, this installation was intended to solve one of the 10th Weather Region’s toughest forecasting problems, namely, providing warnings of the violent, convective nor’westers, the intense, fast-moving, squall line-type systems consisting of violent thunderstorms, high winds, and hail, that were peculiar to the provinces of Bengal, Orissa, and Assam during the transition season between the monsoons. These storms caused considerable damage and greatly disrupted air and ground operations whenever they occurred. Consequently, they were of great concern to U.S. forces in the Ganges valley.

Synoptic analysis methods proved of little use in identifying these nor’westers. And so 2nd Weather Reconnaissance Squadron aircraft had been directed to maintain an airborne watch. This proved quite expensive in terms of money, flying hours, and crew time. Ground-based radar proved to be the right answer. With it, forecasters could watch these storms form and begin moving. From this advance information, forecasters were able to issue warnings with enough lead time to be useful. Flying operations could be halted or diverted. Aircraft on the ramp could be hangered or tied down, and other protective measures could be taken. This radar warning service proved an overwhelming success—so much so that the B-25 aircraft reconnaissance efforts were soon suspended, and the aircraft were released to perform other jobs.

Our historical records give us an idea of how radar was used in analysis and forecasting at Guskara. We had a
six-man radar staff there, more radar people than any Air Weather Service station has today. There were four so-called “radar weather officers,” including the Project Director, Lt. Harold T. Neal. These men were assisted by two enlisted maintenance technicians. Each day, the radar was turned on shortly after noon and kept operational until all echoes had dissipated. As soon as echoes appeared on the scope, the radar staff began to take routine hourly observations of echo location, coverage, movement, and intensity. When storms became ominous or began to move toward the station, the frequency of observing was increased to half-hourly. Observations were reported to the base weather station, where they were plotted and analyzed along with conventional weather data, then warnings disseminated by teletype to all weather stations. At Guskara, in other words, the Air Weather Service was doing the first regularized radar observing, reporting, and analysis and was operating one of the first radar-assisted point warning services.

But the radar staff at Guskara weren’t just observing, reporting, plotting, and preparing warnings. They were taking scope photographs regularly, performing radar and synoptic post-analyses of storm outbreaks, and showing associations between radarscope photographs, visual cloud photos from the B-25s and synoptic analyses. The value of radar echo tops in identifying severe convective storms was realized, and they developed an operational technique by which, using the tilt function of the APQ-13 antenna, they could routinely plot and analyze vertical cross sections along meteorologically or operationally selected azimuths.

In May 1945, plans were announced for the activation of four additional ground radar stations, all to be equipped with APQ-13s. These stations were to cover the Assam valley and the approaches and routes eastward over the “little hump.” In June the first of these additional stations was activated at Chabua in the Assam valley near the Burma-India border. In July another ground-based APQ-13 was activated at Tezgaon.

With the inauguration of the 3-station operation, each station began plotting regular observations from its own and the other radars. The first operational radar summary chart was devised and used as a weather briefing chart to pilots. It was found that the radar data could be used effectively to reroute, reschedule, or cancel flights.

Another APQ-13 station was being readied at Jorhat, India, when thankfully, hostilities ceased on 14 August 1945. Although the historical record is not clear on this point, it appears Jorhat never went on the air. Nevertheless it is clear that a great deal had been learned in an exceedingly short time by a relatively few people in a small corner of a large war. At the end of the war, this knowledge, plus our experience with ground-based radars in the states, and the findings of researchers in radar meteorology were combined to form the basis of modern military and civilian weather radar networks, which, of course, is a story all its own. Since these early times, as all of us know, radar meteorology has grown very rapidly, and its growth has in turn led to advances in other areas of meteorology.

We in the Air Weather Service are proud to have been associated with radar meteorology and its applications from the first—from APQ-13s on the banks of the Ganges; through CPS-9s, the world’s first weather radar; through FPS-77s deployed worldwide; and on to a digital weather radar system for which we are now laying the groundwork. We are convinced of the indispensability of radar in providing forecasting, weather watch, and warning services. From 1945 to 1972, radar has been a consistent success story, having been used for everything from issuing short-range forecasts and warnings for terminals, to giving service to aircraft in flight. Our involvement stretches over more than 27 years and now includes the management of the world’s largest storm detection and cloud detection network. In our operational system, weather radar is fulfilling much of its promise, and to a significant degree we look to you, ladies and gentlemen, to show us the promise and prospects for the future of this exciting field in our challenging science of meteorology.

An historical postscript

After the banquet, Polly Austin and others commented about the early days of radar meteorology. Ron Collis, Director of Stanford Research Institute’s Atmospheric Sciences Laboratory, recalled what he felt might have been an even earlier weather radar network, this one organized in Panama by Lieutenant Myron G. H. Ligda of the Air Weather Service’s 6th Weather Region.

Later Ron sent us documents and photographs from the late Herb Ligda’s papers confirming that the Air Weather Service effort in Panama indeed did predate our network in the China-Burma-India theater.

In contrast to the situation in India, the Air Weather Service did not own or exclusively operate the radars in Panama. Rather, on a non-interference basis, we were permitted to use the Aircraft Warning Service and harbor defense radar systems already in place on the Atlantic and Pacific sides of the Isthmus of Panama. Although these radars were first used for weather surveillance in September 1943, the network operation did not begin until April 1944, when radar weather reporting began at two low-power Harbor Defense Cristobal installations. These radars, with an effective range of no more than 30 statute miles, were located on either side of Limon Bay, facing the Atlantic. On 1 May 1944 radar weather observing programs began at the higher power aircraft warning radars located on Taboga Island (10 miles south of Balboa, on the Pacific side) and at Ft. Sherman (near Limon Bay, on the Atlantic side). These two aircraft warning radars, with their effective range of 85 to 100 statute miles, provided good coverage of the Isthmus. During May 1944 the Panama network
totalled four radars, but in late May one of the Cristobal radars was taken off the network because its area was covered by the larger aircraft warning radar at Ft. Sherman.

The operations and research activities of the Panama radar network were managed by Lt. Herb Ligda, who was assigned in February 1944 as the 6th Weather Region's Radar Weather Officer. Under study were relationships between echo "intensity" (probably back-scattered power in this case) and surface visibility, the characteristic differences between echoes over land and echoes over water, effects of the land-sea interface on the movement of storms, the life cycle of convective storms, the effects of topography on storm movement and intensity, and steering of storms by winds aloft. Interestingly, in 1944 the radar staff prepared one of the first radar climatology studies, attempting to pinpoint genesis regions and typical storm motion patterns on the Isthmus and in surrounding waters. Also under study was the detection of lightning by radar.

news and notes

Brookhaven's ongoing research

A major new research project on the transport dispersion of plumes from an over-ocean source toward the shore is being pursued at the Brookhaven National Laboratory, Upton, L.I., New York. The project is related to the safety analysis of nuclear power plants that are being proposed for offshore sites. Other research projects underway include studies of the long distance transport of power plant plumes, transport of aeroallergens, diffusion modeling, and the regional transport air pollutants. Additionally Brookhaven scientists are participating in studies with atmospheric chemists.

Brookhaven's Meteorology Group, which is spearheading these projects, has a new head. Dr. Paul Michael has succeeded Maynard E. Smith, who left the Laboratory to form a consulting firm. The Meteorology Group is a part of the Department of Applied Science at Brookhaven, Brookhaven National Laboratory is operated by Associated Universities, Inc. under contract to the U.S. Atomic Energy Commission.

New NACOA appointments

Ten new appointments to the National Advisory Committee on Oceans and Atmosphere, which was established in 1971 to advise the Secretary of Commerce with respect to the National Oceanic and Atmospheric Administration, and the President and Congress with respect to the national program in marine and atmospheric affairs, have been announced.

The new appointees are: L. W. Lane, Jr., President, Lane Magazine and Book Company, Menlo Park, Calif., and Chairman, California Tourism and Visitors Services Commission; Betsy Ancker-Johnson, Academic/Science Advisor, Research and Engineering Division, Boeing Company, Seattle, Wash.; Perkins Bass, law firm of Sheehan, Phinney, Bass, and Green, and former Congressman from New Hampshire, Peterborough, N.H.; Arthur Godfrey, radio and television personality, and International Trustee, World Wildlife Fund; Charles L. Hosler, Jr., Dean, Earth and Mineral Sciences, Pennsylvania State University, University Park, Pa.; John W. Luhring, Executive Director of Public Affairs, Union Bank, Los Angeles, Calif., and President, Los Angeles Board of Water and Power Commissioners; Arthur E. Maxwell, Provost, Woods Hole Oceanographic Institution, Woods Hole, Mass.; Donald B. Rice, Jr., President, Rand Corporation, and former Assistant Director, Office of Management and Budget, Santa Monica, Calif.; Clement Tillion, Member and Minority Leader, House of Representatives, Juneau, Alaska; Elmer P. Wheaton, Vice President and General Manager for Research and Development, Lockheed Missiles and Space Corporation, Sunnyvale, Calif.

These early networks in Panama and India reflect great credit on the meteorologists involved. More important, they show how far and how fast practicing meteorologists can advance the state of the art when an operational need exists. The story of these networks in Panama and India should be an inspiration to meteorologists behind the forecast counters and light tables of today. Much can be done when there is a will to do it.

Finally, we should mention how obscure the early history of radar meteorology is. The secrecy with which radar programs were conducted during the war years has frustrated the would-be historian. We would encourage those who know bits and pieces of this early history to comment, either publishing their recollections in the BULLETIN or sending the material to us at Headquarters Air Weather Service. Much interesting history still remains clouded or under question regarding the origins of one of meteorology's earliest, most interesting, and most productive specialties.