Tinker's Twin Twisters of 1948 and the Birth of Tornado Forecasting

*By James L. Crowder**

The sound of breaking glass, splintering wood, wrenching metal, and violent winds all combined to produce a deafening roar. The debris and wreckage left in the tornadoes' wake made the airfield look as if the enemy's aerial bombardments had been right on target. The shocking sight would remain in the minds of witnesses long after the final cleanup. The blows were softened only by the realization that the second tornado could have caused much greater damage had not the interaction of a few key men

changed the course of events. March 20 and March 25, 1948, stand as monumental dates in the history of Tinker Air Force Base (AFB), the state of Oklahoma, and the National Weather Service's Severe Storm Forecasting program.[1]

Tinker AFB was only six years old at the time, but World War II, rapid demobilization, and major facility expansion had given the airfield significant maturity and recognition. At the beginning of 1948, the Oklahoma City Air Materiel Area (OCAMA) was Uncle Sam's largest repair and maintenance depot in the country. Spread over 2,400 acres, the base encompassed 552 buildings and employed nearly 12,000 military and civilian workers. The previous year, its headquarters, the Air Materiel Command, named OCAMA the command's model depot, noting that all new programs and projects would be tested first at Oklahoma City. Even more recently, on January 13, 1948, the newly formed Department of the Air Force, acting under the authority of the new Department of Defense, officially changed the name of Tinker Field to Tinker AFB.

The thrust of the first Tinker tornado on March 20, 1948, was so tremendous its story landed on the front page of most newspapers in America. The cutline of the *New York Times* read, "Twister Tosses Giant Planes About Like Toys in Oklahoma." According to the report, the tornado of March 20 lasted only seven minutes but caused nearly $15 million in damage, primarily to aircraft parked on the runway. Clearly anything of such magnitude was national news.[2]

The tornadic activity came in from the southwest, touching down after bouncing over a lot of barren territory. Hail and heavy rain accompanied the swirling winds whose velocity was officially clocked at 78 miles per hour before the airfield instruments broke. Local weathermen later estimated the winds reached at least 100 miles per hour as the installation felt the brunt of the storm. The next week, Tinker's in-house newspaper inflated the sensational story even more and claimed the winds hit 250 miles per hour.[3]

Ralph Pursifull, the aircraft dispatcher on duty that Saturday night, said, "I knew right away it was a tornado. First thing I did was duck under my desk." He took a peek and saw a P–47 being blown by the window, while several other planes were being lifted into the air and tossed hundreds of feet away. "Then I stuck my face as far down on the floor as I could get," he admitted.[4]

Gene Brock, a sixteen-year-old member of the local Civil Air Patrol, was in observation training in the control tower when the tornado hit. He told reporters he did not know whether to stay in the

swaying tower atop Building 240 or try to get down, but the storm passed through before he could decide. He received minor injuries from exploding glass.

John Hamilton, working the swing shift on transient aircraft, was putting blocks under a B–29 at the moment of impact. He tried clutching one of the plane's big wheels, but the tornado picked up the 137,500-pound aircraft and tossed it the length of a football field. Still shaking, Hamilton said, "I was terror stricken, so I began crawling to the Operations Office. It was 100-yards of nightmare."[5]

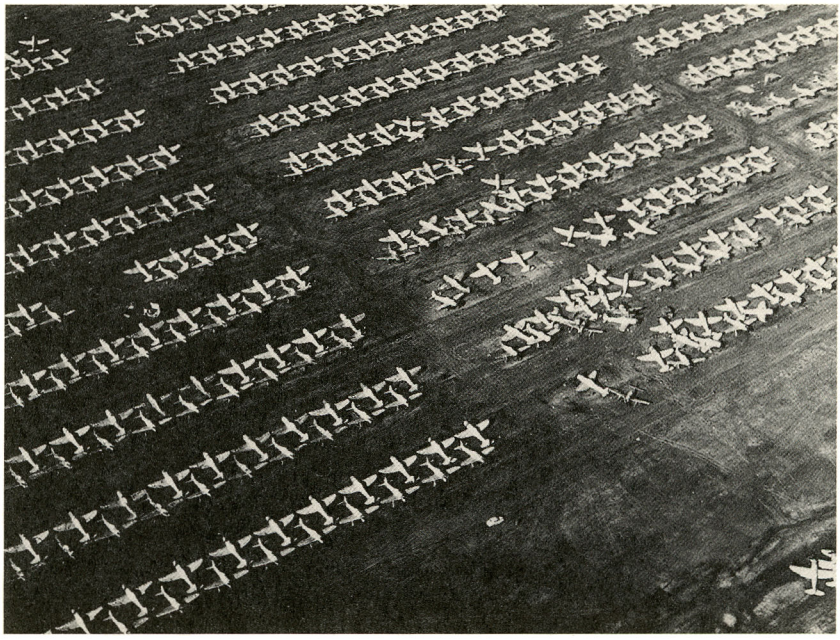
It was not until the light of Sunday morning that a full assessment could begin. Fortunately, only two airmen and four civilians received any injuries and they were minor. The greatest damage was to aircraft on the runway. Seventeen C–54 Skymasters and two B–29 Superfortresses were smashed to bits. Also destroyed were fifteen P–47s, five L–4s, three C–45s, three C–47s, one B–25, three AT–11s, and a PQ–14. Colonel Albert G. Hewitt, chief of the Aircraft Maintenance Division, reported that fifty planes were total losses and at least another fifty were bumped and bruised but repairable.

Testifying to their structural soundness, all the major concrete, brick, and steel buildings erected quickly in the early days of World War II stood firm under the storm's attack. But seven small storage buildings were destroyed and several others damaged. In addition, almost 100 special purpose military vehicles were wrecked.[6]

Although the overall property loss at Tinker was later lowered to $10.25 million, it still represented the greatest property loss from a single tornado in Oklahoma history. The damage estimate of $10 million for aircraft, $222,000 for buildings, and $15,000 for utilities would be approximately $65 million in 1998 dollars.

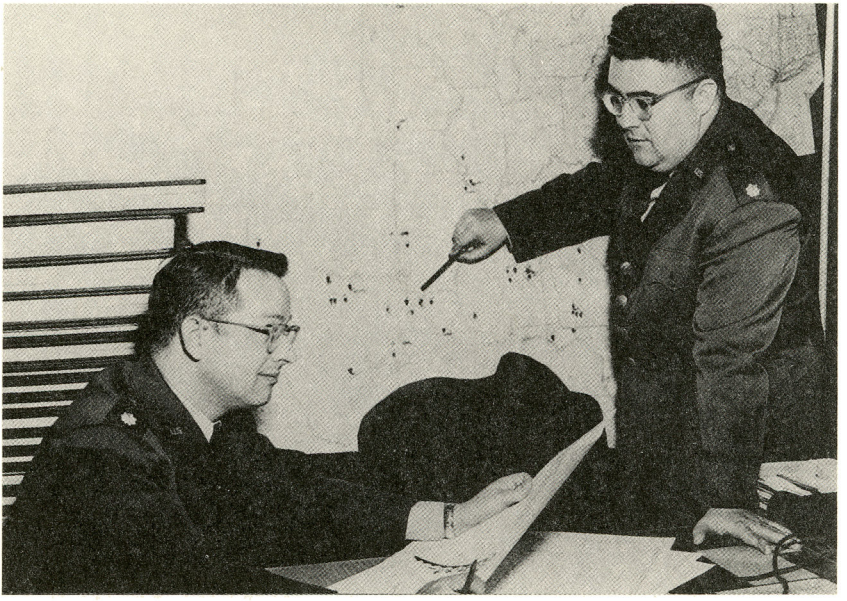
The weather forecaster on duty that evening had been assigned to Tinker for less than three weeks. His backup, a staff sergeant, also was new to the Great Plains. After analyzing the latest surface weather maps and upper level charts, they arrived at the same prediction—effective 9:00 P.M., gusty surface winds up to thirty five miles per hour, without thunderstorms. However, thirty minutes later, a vicious storm appeared on their AN-PQ–13 radar scope. The scope, widely employed by the Air Weather Service for storm detection, was designed for use as a B–29 bomb radar during World War II.[7]

The storm that struck Tinker at 10:22 P.M. apparently was the same one that hit Will Rogers Field twelve minutes earlier. Less than $10,000 in damage occurred at the municipal airport, but the weather bureau station at the airport reported a ninety-eight-mile-per-hour wind and its barograph recorded a vertical line, indicating



At the end of World War II, Tinker AFB was the largest air maintenance depot in the world and the storage site for a multitude of aircraft. With nearly 2,000 aircraft lined up like sitting ducks, the tornado damage at Tinker in 1948 could have been much worse (All courtesy OC/ALC, Office of History).

pressure range between 28.22 and 28.53 inches within a few minutes. The tornado then traveled the ten miles to Tinker, leaving a path of shattered signs, uprooted trees, and damaged buildings. For those who dared look, it was clearly visible due to the nearly continuous lightning. Actually, two funnels followed parallel paths within the storm. One crossed over the southwest perimeter of the base and touched down just east of the Disposal Plant. It continued on a line perpendicular to the diagonal runway and with sinister aim scored a direct hit on Base Operations Building 240 and the facilities around it. Poetically, the base weather office was safe inside. Building 230 received considerable damage to its skylights. Buildings T–237, T–242, T–243, and T–249 were completely destroyed. The canopy of the platform on the west and south side of Building T–245 was destroyed, and large sections of roof were torn off with heavy damage to the glass windows. Buildings 238 and 239 suffered



Tinker AFB weathermen Robert C. Miller, left, and Ernest J. Fawbush discussed their original method of forecasting tornadoes.

minor damage including broken glass and small patches of roofing ripped off. Considerable damage was sustained to windows and several sections of roof on warehouses 95 to 106 inclusive. The funnel remained on the ground until it reached the area immediately northeast of the base.[8]

The other funnel first hit the airfield in the vicinity of the southeast side of the north-south runway and traveled northeasterly. Numerous windows were broken in Buildings 2122 and 2129, while the nearly three-quarter-mile-long Building 3001 lost a section of its roof. All overhead electrical lines between 2121 and 3001 were destroyed, as was the 66,000–volt main feeder to the sub-station. The hangar doors to Building 3102 were damaged. Buildings T–3703, T–3223, CM T–1, CM T–2, T–3709, T–3719, T–3708, and T–3707 were completely destroyed. Buildings 3705, 3718, 3710, and 3721 received considerable damage to their roofs and glass windows. The tornado finally cut across the base's northern property line and stayed on the ground to Northeast Twenty-third Street.

The width of the more destructive funnel was estimated at 880 yards. [9]

Major General Fred S. "Fritz" Borum had been commander of Tinker AFB and the Oklahoma City Air Materiel Area since July, 1945, and would serve in that capacity until his retirement in 1954. In the first issue of the airfield's *Tinker Take Off* following the March 20 tornado, the general told those under his command.

> I saw Tinker spirit in action over the weekend. I saw Tinker people performing stubborn miracles of clean-up in hard driving rain as if they, personally, were responsible for the ugly debris and wreckage which distorted the usual orderly scene. I wish to commend everyone who shouldered responsibility so loyally and carried out their duties with such little regard to their own personal comfort. The fire fighters, the patrolmen, maintenance and supply personnel, operations workers, telephone operators and all those who left the comfort of their homes just to see if they could be of any assistance at all anywhere on the base.[10]

The general's organizational skill and scientific savvy probably motivated his questioning of Tinker meteorologists the morning of March 21. He wanted to know first who was in charge of the installation's weather operations, and second, if they could forecast rain, could they forecast tornadoes? When told that no one could tell if a tornado was coming until they saw it, the general ignored the answer. He was not satisfied with writing off a $10 million loss as an act of God and waiting for the next one to happen. While he pushed his staff to devise a disaster preparedness plan for the airfield, he also used the judgmental prerogative of a general and ordered the head of the base weather unit and his deputy to do what no one else had ever accomplished.[11]

Major Ernest J. Fawbush and Captain Robert C. Miller were youthful but seasoned weathermen of World War II. Fawbush, thirty-three, was an expert on the frigid weather of Alaska, Miller, twenty-eight, was versed in the volatility of the South Pacific warm weather patterns. In just a few days, Oklahoma weather would change their lives forever.

From the moment they left the commander's conference room, the two weathermen began what became an almost around-the-clock historical analysis of tornadic activity. They gathered every ream of information they could from existing air force files and relied heavily on descriptions of the great Woodward, Oklahoma, tornado of the previous year.[12] Their goal was to formulate a model or

profile of a thunderstorm that would spawn Mother Nature's most destructive force. They set up shop in a nondescript frame building near Tinker Gate. Thus, Tinker's Building C–534 became the first severe weather warning research center in the United States.[13]

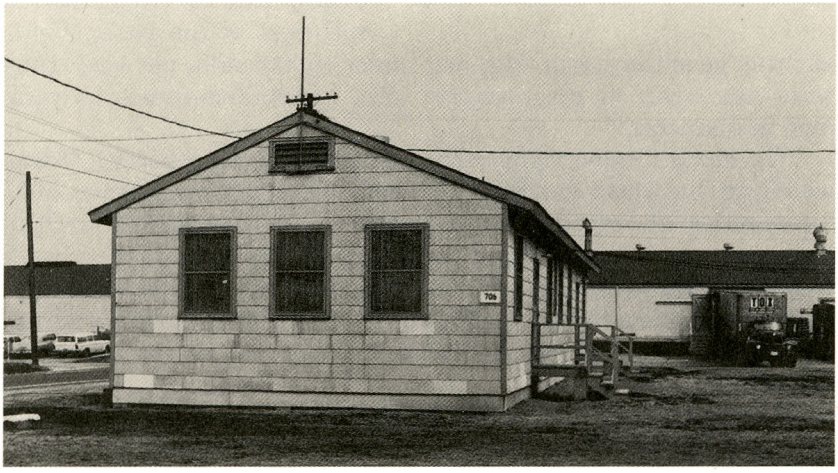
Although most methods of forecasting severe weather in 1948 were no more reliable than a farmer's nose or a rancher's eye, Fawbush and Miller noted similarities in the moisture distribution and the flow of surface winds compared with wind patterns in the lower atmosphere. While updating the weather situation after lunch on March 25, the two men were stunned to see virtually the same weather pattern developing that had occurred on March 20. They knew thunderstorms could pop up almost daily in America's heartland, but the similarities they saw were eerie. They notified the command section of the approaching squall line and within minutes Borum's staff car pulled up. Borum marched into the weather station and for the next ten minutes watched the radar scope while the weathermen commented on the rapid development and increasing intensity of the storm.[14]

Normally brash and confident, Fawbush and Miller were reluctant to tell Borum another tornado was coming.[15] As Miller subsequently stated, "The chances of a tornado hitting the same spot five days later must have been astronomical. It must have been billions to one." So, like all good weathermen, the two deliberative airmen presented the situation to the commander with a lot of possibilities, ifs, coulds, and mights. Borum was not in a timid mood and bellowed with a few expletives, "Are we going to have another tornado or not? Yes or no?" Pressed into a corner with their weather maps

and radar scope, the meteorologists committed to a gamble and possible humiliation and responded, "Yes; yes sir, we are." The general told them to get the word out; Fawbush composed the notice, Miller typed it and carried it across the foyer to Base Operations for dissemination, and the nation's first, operational tornado forecast was issued on March 25, 1948 at 2:50 P.M.[16]

Oddly, Captain Miller went home when his duty-day ended at 4:45 P.M. He later classified it as "abandoning ship"; both he and Fawbush bemoaned the fact that, if their prediction proved false, they would have to go back to the general and his staff the next day and explain their mistake. Miller was sure his career was about to go down the drain for predicting that a tornado would hit a specific location. He wondered if he could make a living as an elevator operator. Thus in a macabre fashion, both forecasters were praying for another twister.

Borum's unrelenting pressure did not end with getting the word out, as he swiftly ordered implementation of the new Tornado Safety Plan. Personnel pushed as many planes as they could into the hangars; then they closed doors and windows. They tied as securely as possible the rows and rows of aircraft cocooned for storage across the diagonal runway. Meanwhile, all swing-shift workers were



The first tornado research center in the United States was housed in a small, frame building much like this one at Tinker AFB. Although it survived, frame buildings generally stood little chance of surviving the tornadoes' fury (opposite).

Tinker commander Major General Fred S. Borum (1945–1953) pushed his reluctant weathermen into making the first tornado forecast.

evacuated to basement shelters and the interiors of thick, solid buildings. And on that day, everyone was told to get out of the control tower on Building 240.[17]

The tornado struck near the Disposal Plant at 5:58 P.M., almost exactly at the same spot as the tornado five days earlier. In its northeasterly mile-and-a-half path, the tornado damaged eighty-four B–29s and P–47s, thirty-five beyond repair. It also ripped up and crinkled several hundred yards of steel planking used as the planes' parking surface. Buildings 240, 95, and 106 suffered additional damage. One person was slightly injured. Apparently, the funnel formed when two thunderstorms converged about three miles southwest of the base. Winds at the edge of the storm were just under eighty miles per hour; they were accompanied by moderate hail, one-half-to-three-quarters-inch in diameter.[18]

"The cloud formed right over the field," Borum reported. "I was watching that cloud and it just formed and zipped right down." The commander, who stood in the back doorway of his quarters on Staff Drive, watched it and heard the crash of airplanes as they were tossed around the airfield. He said the cloud was yellowish in color and shaped like a radish as it rumbled through the parked aircraft, picked up a load of muddy water, and swirled across the north boundary.[19]

Thirteen-year-old Jack Reise had just moved with his family into the Fleetwood Apartments across from the airfield. He had no fear of the situation until major debris from the swirling dervish started flying past him. He jumped into the bar ditch along Southeast Twenty-ninth Street and wrapped his head in his hands until the

winds finally died down. "I never really saw the tornado," he admitted; "I was too afraid to look."[20]

A few days later, Arthur Barrows, United States Army undersecretary for air, toured Tinker to assess the damage. He emphatically denied to local reporters there was any foundation for the story in the March 27 *Chicago Tribune* that Washington officials were considering the idea of closing the Oklahoma depot, rather than repairing it.[21]

Carried aloft by their prophetic breakthrough, Fawbush and Miller earned the support and cooperation of every weatherman who learned of their forecast. W E. Maugham, head of the Oklahoma City Weather Bureau, gave the two researchers complete access to his office's forty years of weather data. Later, when their reputation rippled nationwide, they gained an open door to the regional weather records unit in New Orleans, the records center for the National Weather Bureau, plus the archives of both the United States Air Force Air Weather Service and the United States Navy's weather organizations.[22]

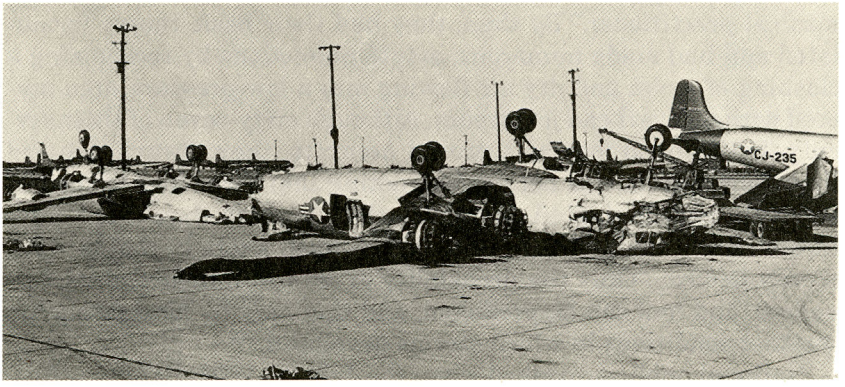
In 1949 Fawbush and Miller prepared tornado forecasts for air force operations in most of the central part of the United States. In October, 1949, they flew to Kansas City and presented their findings at a seminar for weather bureau forecasters. The next year they both spoke at the annual meeting of the American Meteorological Society in St. Louis. And in February, 1951, they established the official United States Air Force Severe Weather Warning Center at Tinker. They described their relationship to the base weather station as "analogous to that of the medical specialist to the general medical practitioner." By then, they had their basic theory formulated and had made numerous, astute predictions by recognizing a clashing of moist and dry air flowing into a low-pressure area covered with an overhead jet stream. Although sixty-seven of their seventy-five tornado forecasts proved accurate, they always stressed that their system was not perfect, noting that tornadoes formed so suddenly and dissipated so quickly that no more than a few minutes warning could be expected. As Fawbush wrote in the *Air University Review,* "Only the probability of severe thunderstorms, tornadoes, and hail can be predicted, and that only by forecasting the weather conditions in which storms developed."[23]

National publicity peaked when the July 28, 1951, *Saturday Evening Post* included the article, "Flash. Tornado Warning," which explained the Fawbush-Miller methodology for predicting storms. Not one to brag about giving birth to great ideas, Fawbush said their

formula really did not have a starting point; "It was more like Topsy, it just grew and grew."[24] However, their statistics boasted that out of more than 200 predictions Tinker's forecasters had been correct in more than 90 percent of them. Although Pat McDermott wrote the story without ever visiting Tinker or interviewing the famous weathermen in person, Miller was highly complementary of her report and said, "After reading the article, I'm inclined to believe Miss McDermott must be a weather observer, herself."[25]

As the military men's prestige rose, so did criticism from civilian forecasters working for the United States Weather Bureau. Perhaps it was professional jealousy, but the civilians believed they had laid the foundations and recorded all the data only to see the men in uniform use it and get the glory. But if notoriety was the goal, the weather bureau was its own worst enemy, because at the time the bureau did not release severe weather information to the public in the paternalistic belief that it would only cause undo anxiety and perhaps panic. Ivan R. Tannehill, chief of the bureau's forecast division in Washington, D.C., reminded everyone, "A tornado funnel is only about 1,000 feet in width. More people are likely to lose their lives in mass hysteria than in a tornado." In contrast, the air force wanted the military prepared to protect its resources and announced their forecasts loud and clear.[26]

The weather bureau's rationale became indefensible in early March, 1952, when news reporters learned that a Fawbush and Miller warning of tornadoes across central Alabama had enabled



Tinker's twin twisters of 1948 tossed enormous B–29s around like so many toys (above and opposite).

Maxwell AFB and Gunter AFB to save resources and personnel to take cover. At the same time, the general public received no warning of the severity of the situation and suffered the full brunt of surprise storms as funnels touched down not only in Alabama but in Arkansas, Missouri, Tennessee, Kentucky, and Mississippi. The death count exceeded 200, at least 1,200 people were injured, and more than 3,000 homes were damaged or destroyed. The storm of criticism from the media, the public, and elected officials finally changed the bureau's "don't tell" policy. Just a few days later, on March 17, the National Weather Bureau in Kansas City issued a tornado warning for north-central Texas that helped people take precautions before twisters struck near Wichita Falls and Mineral Wells.[27]

For a while, the air force's prime forecaster and the bureau's weathermen appeared to be in competition, and radio announcers seemed to delight in reporting any conflicting information from the two scientific communities. Miller said, "We resolved this by setting up phone linkups between Kansas City and Tinker. We would discuss these forecasts before either one [of us] issued them." The rivalry died down after that.[28]

Meanwhile, Tinker's expert weather team was engaged in a new project called "Tornado Alley." They concentrated their study on severe weather activity over an area extending from Lubbock, Texas, to Enid, Oklahoma, and north to the Kansas-Nebraska border. It was the line of convergence where moist air from the Gulf of Mexico collided with the cool winds of the upper atmosphere. They relied on detailed studies of upper and middle air with barometric readings, radar reports, and information flashed back by radar equipment. In Oklahoma and Texas, the 2060th Mobile Weather Squadron manned rawinsonde stations at Fort Sill and Vance AFB in Oklahoma and Amarillo AFB, Reece AFB, and Connally AFB in Texas. Rawinsonde was a combination of radio, wind, and sounding equipment that tracked weather changes at various atmospheric levels up to 90,000 feet. The little storm warning facility at Tinker was soon inundated with massive stacks of teletype rolls of empirical weather data.[29]

The weather pioneers later began another study called "Sferices," a shortening of the word "atmospherics." It dealt with the tracking of tornado-like clouds after they formed. The key feature of the study was the reproduction of lightning discharges on a scope or screen to determine the storm's movement. Although "Sferics" had been used in meteorology for some time, the system was first applied to tornado activity in 1953. Dr. Herbert L. Jones of Oklahoma Agricultural and Mechanical College advocated its use after becoming interested in the Fawbush-Miller method of severe weather forecasting. The two air force officers saw merit in the professor's storm-tracking idea and began assisting in its development. With Tinker AFB as the center, they established a three-state network for studying the movement of tornadoes. Other stations were located at Stillwater and Altus AFB, Oklahoma, Camp Chaffee, Arkansas, and Smoky Hill AFB, Kansas.[30]

At the same time, on-base disaster preparedness rested on the reputation of the two researchers. Tinker's tornado alert plan was disseminated to all supervisors, and its author, Clifford L. Pamplin of the Comptroller's Office, stated.

> When weather conditions indicate high winds, Lt. Col. Ernest J. Fawbush and Maj Robert C. Miller of the Severe Storm Warning Center, will alert the Base Weather Officer at Flight Operations. This officer, in turn, will notify the dispatcher in the Air Provost Marshall's Office, who will channel the message from echelon to echelon either by telephone or public address system. In event the winds rise to tornadic volume, the evacuation warning will be relayed in the same manner. We have an added advantage in that

> Colonel Fawbush and Major Miller are quite accurate in their severe weather forecasts.[31]

If it seemed to take forever for the weather service to recognize the obvious need to warn the public, it took even longer for the Department of the Air Force to fully appreciate the economic and scientific significance of what Fawbush and Miller had done. It was not until January, 1953, that Fawbush and Miller received department-level recognition for their unique act of patriotism. The Tinker officers received commendation medals and citations signed by the secretary of the air force, Thomas K. Finletter, from Colonel Andrew L. Haig, base executive officer, during a Saturday review of troops at Tinker. The dual citations, for service rendered from March, 1948, to April, 1952, read in part:

> His technical ability and devotion to duty in developing a tornado and severe storm warning forecasting method has resulted in the saving of many lives and untold amounts of government property. Through the use of his forecasts, military installations throughout the United States have been enabled to prepare for tornadoes, high winds and hail, while pilots have been forewarned of icing conditions

Tinker's pioneer forecasters, Robert C. Miller and E. J. Fawbush, peered over stacks of teletype rolls collected at the Severe Weather Center.

On March 25, 1998, University of Oklahoma, military, and weather officials joined the Fawbush and Miller families in the dedication of the "First Tornado Forecast" monument at Tinker AFB (above and opposite).

and degree of turbulence. These services have forestalled equipment damage amounting to millions of dollars.

In cooperating with the United States Weather Bureau, he has also rendered a great service to the American public, by dispelling to a large degree, the surprise factor inherent in most violent storms. By pioneering in this new meteorological field, by helping to save human lives and great amounts of government property, and by giving unstintingly of his time to the development of severe weather forecasting methods, he has brought great credit upon himself and the United States Air Force.[32]

Interestingly, Miller always believed Borum should have received the credit for the historic warning because he was the one who pushed them into it.[33]

General Borum lived in Oklahoma City until 1977 when he and his wife of sixty years moved to Cocoa Beach, Florida, to be near their daughter. He died the next year. Colonel Fawbush continued weather research for the United States Air Force and departed Tinker in early October, 1955, for an assignment with a weather squadron stationed in Libya. He later worked for the Department of Defense in New Mexico and Arizona and died in 1982. Miller served at

Tinker until 1955, when he became chief forecaster at the air force's Weather Central at High Wycombe Air Base, United Kingdom. He completed his military career only to become chief civilian scientist for analysis and forecasting with the air force's global weather center at Offutt AFB, Nebraska. He later moved to Laurel, Maryland, to operate a military memorabilia store in the Washington, D.C., area. However, the Los Angeles native who always wanted to be a college professor was physically unable to attend the national celebration of the fiftieth anniversary of tornado forecasting.[34]

On March 23, 24, and 25, 1998, the National Oceanic and Atmospheric Administration's National Weather Service and National Severe Storms Laboratory, in cooperation with the University of Oklahoma and Tinker AFB, hosted an extended celebration in Norman and at Tinker. It included an open house at the Severe Storms Laboratory, a symposium hosted by the Central Oklahoma Chapters of the American Meteorological Society and National Weather Association at the University of Oklahoma, and a special ceremony to unveil a historical marker at Tinker AFB. Several hundred people attended the ceremony, including members of the Fawbush and Miller families, Lieutenant Governor Mary Fallin, and University of Oklahoma president David Boren.[35] It was a fitting tribute to two men who had done so much for the field of weather forecasting.

ENDNOTES

* James L. Crowder is Chief of the Office of History, Oklahoma City Air Logistics Center, Tinker Air Force Base. He holds the Master's and Ph.D. in Political Science from the University of Oklahoma. He delivered this paper at the 1998 Annual Meeting of the Oklahoma Historical Society.

[1] For exposition on Oklahoma tornadoes, see Leo Kelley, "Not An Upright Stick Remained: Oklahoma, Home of the Real Twisters," *The Chronicles of Oklahoma*, 74 (Winter, 1996–1997): 426–435; *Oklahoma Almanac* (Oklahoma City: Oklahoma Department of Libraries, 1997), 832–833; W. David Baird and Danney Goble, *The Story of Oklahoma* (Norman: University of Oklahoma Press, 1994), 20–21, Snowden D. Flora, *Tornadoes of the United States* (Norman: University of Oklahoma Press, 1953); and Gary England, *Weathering the Storm. Tornadoes, Television, and Turmoil* (Norman: University of Oklahoma Press, 1996).

[2] *New York Times*, March 21, 1948. In the week that followed, Tinker's Public Information Office assisted Paramount, Fox Movietone, International News Service, Associated Press, United Press International, and all local radio stations in collecting information.

[3] "Damaged Planes Undergo Repair: Vital Parts Will Be Salvaged," *Tinker Take Off*, March 26, 1948.

[4] Ibid.

[5] Ibid.

[6] Ibid., (Washington, D.C.) *Evening Star*, March 22, 1948.

[7] Robert C. Miller, "The Unfriendly Sky," 1978, unpublished manuscript, OC-ALC/Office of History, Tinker AFB, Oklahoma.

[8] *History, Hq. OCAMA, Tinker AFB, Oklahoma City, Oklahoma* (Tinker AFB: History Office, 1948); *The* (Oklahoma City, Oklahoma) *Sunday Oklahoman*, March 21, 1948; *The Daily* (Oklahoma City, Oklahoma) *Oklahoman*, March 22, 1948.

[9] Ibid., *History, Hq. OCAMA, Tinker AFB*, 1948; *Monthly Weather Review*, March, 1948, 61.

[10] Major General Fred S. Borum, "In my Out Basket," *Tinker Take Off*, March 26, 1948. Borum's management reputation was already established in 1948 and in just a few months he would lead a cadre of Tinker officials to Burtonwood, England, where they would direct the overhaul and maintenance of aircraft used in the Berlin Airlift. Borum also was known as an innovator and experimenter. In the 1930s he served as head of the Equipment Laboratory at Wright Field, Ohio, and under his direction, many aviation equipment items, such as pilot oxygen masks, were developed.

[11] Dudley Lynch, "Second Guessing Mother Nature," *Orbit Magazine*, February 11, 1973. The weather organization at the time was the Sixty-seventh Air Force Base Unit which was redesignated the Fifty-ninth Weather Wing on May 26, 1948, and became the 2059th Air Weather Wing on October 1, 1948. Commander of the weather group at the time of the storm was Colonel Lewis L. Mundell, who would return to Tinker in August, 1960, as a major general and commander of the air depot.

[12] For an anecdotal history of the Woodward tornado see Richard Bedard, *In the Shadow of the Tornado: Stories and Adventures From the Heart of the Storm Country* (Norman, Oklahoma: Gilco, 1996).

[13] Ibid.

[14] Miller, "The Unfriendly Sky."

[15] Fawbush had been embarrassed at Barksdale Field, Louisiana, a few years earlier when he forecast a day of "nice weather" only to later watch a tornado dip down two blocks away. Keay Davidson, *Twister: The Science of Tornadoes and the Making of an Adventure Movie* (New York: Pocket Books, 1996), 76–77

[16] Ibid., *Dallas Morning News*, March 29, 1992; National Weather Service news release (untitled), March 6, 1979, Oklahoma City, Oklahoma.

[17] National Weather Service news release; *Dallas Morning News*, March 29, 1992; Miller, "The Unfriendly Sky."

[18] Miller, "The Unfriendly Sky"· *Monthly Weather Review*, March, 1948, 62; Washington, D.C., *Evening Star*, March 26, 1948.

[19] *Daily Oklahoman*, March 26, 1948.

[20] Interview with Jack Reise, Midwest City, Oklahoma, September 8, 1997

[21] *History, Hq. OCAMA Tinker AFB*, 1948; *Sunday Oklahoman*, March 28, 1948.

[22] Pat McDermott, "Flash—Tornado Warning!" *Saturday Evening Post*, July 28, 1951.

[23] William Hauptman, "Blown Away," *Texas Monthly*, July, 1996; Ernest J. Fawbush and Robert C. Miller, "Forecasting Tornadoes," *Air University Review*, 6 (Spring, 1953): 108–117· *Sunday Oklahoman*, July 22, 1951.

[24] Topsy was the provider of comic relief in Harriet Beecher Stowe's classic *Uncle Tom's Cabin*. Her replies to questioning, "never was born," and "I spect I grow'd," made her the symbol of that which originates spontaneously and expands aimlessly.

[25] "Magazine Article Draws Praise," *Tinker Take Off*, August 3, 1948.

[26] Lynch, "Second Guessing Mother Nature."

[27] Fawbush and Miller, "Forecasting Tornadoes," 108–117

[28] Ibid.

[29] *Daily Oklahoman*, March 4, 1952; "Weather Officers Commended," *Tinker Take Off*, January 16, 1953.

[30] "Colonel Fawbush Departs," *Tinker Take Off*, October 14, 1955.

[31] "Tornado Alert Program Set," *Tinker Take Off*, March 13, 1953.

[32] "Weather Officers Commended," *Tinker Take Off*, January 16, 1953.

[33] *Dallas Morning News*, March 29, 1992.

[34] Ibid., *Tinker Take Off*, October 14, 1955; James Crowder, *The Oklahoma City Commanders* (Tinker AFB, Oklahoma: OC-ALC/Office of History, 1986); "Tough Task: AF Weather Forecasting in UK," *The Stars and Stripes*, January 22, 1959; interview with Charles Crisp, Norman, Oklahoma, March 31, 1998.

Miller died in Washington, D.C., on September 13, 1998, after this paper was delivered at the Oklahoma Historical Society Annual Meeting.

[35] Ronea Alger, "Tornado prediction at Tinker still makes history," *Tinker Take Off*, April 3, 1998; Stephanie Kenitzer, "NOAA Marks 50th Anniversary of First Tornado Forecast," *US Department of Commerce News*, March 16, 1998.