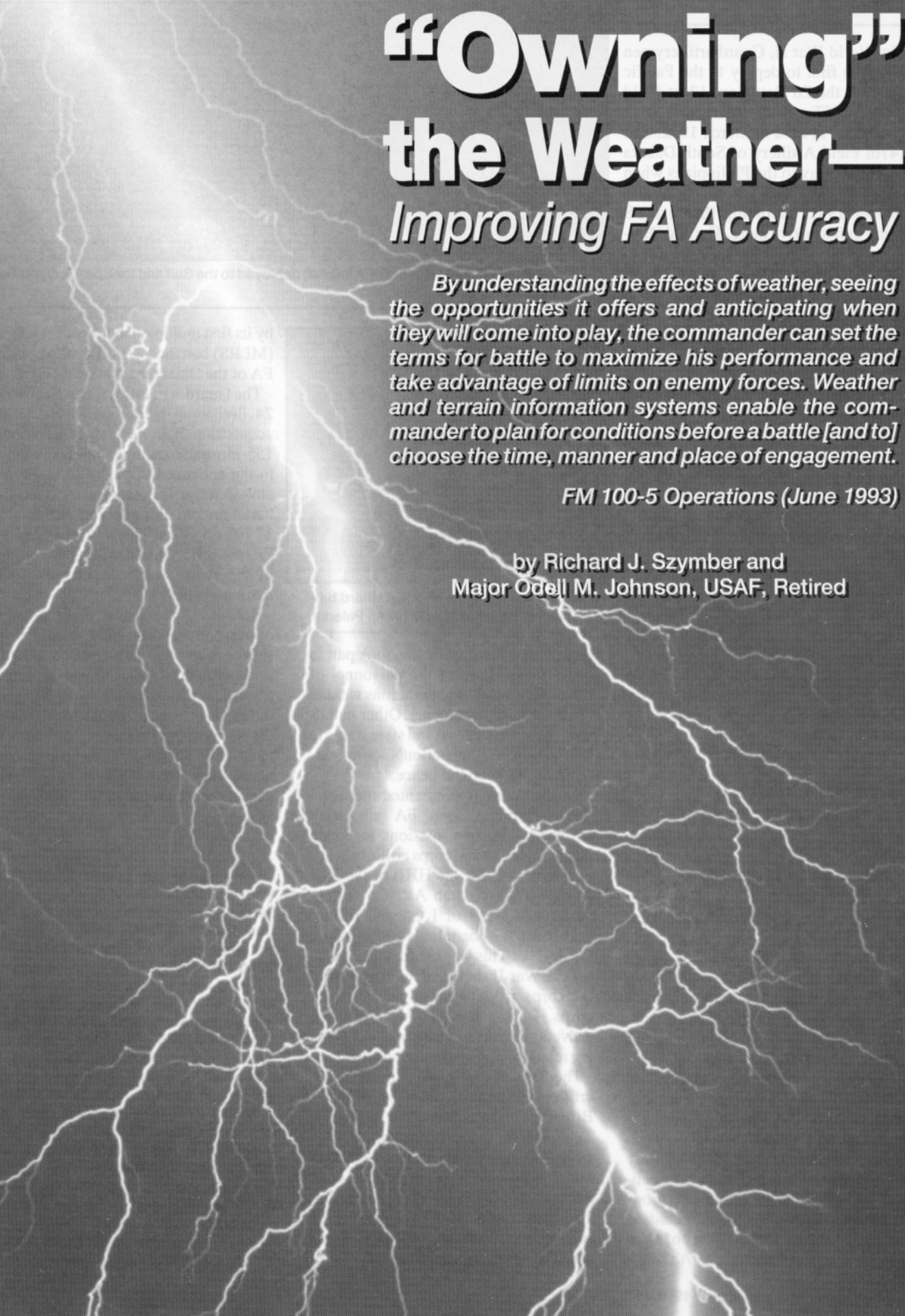

"Owning" the Weather—

Improving FA Accuracy

By understanding the effects of weather, seeing the opportunities it offers and anticipating when they will come into play, the commander can set the terms for battle to maximize his performance and take advantage of limits on enemy forces. Weather and terrain information systems enable the commander to plan for conditions before a battle [and to] choose the time, manner and place of engagement.

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by Richard J. Szymber and
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"Owning the weather" will give the Force XXI warfighter the information he needs to employ smart weapons and munitions for maximum all-weather lethality. That involves exploiting and improving the weather-related technological advantages of our combat systems over hostile systems, making weather a force multiplier.

A major frustration for Redlegs often has been the ever-changing wind and other atmospheric factors that decrease artillery accuracy. By the year 2000, artillerymen will be much less concerned with unexpected meteorological (Met) effects, thanks to payoffs from the mobile profiler system (MPS) and the complementary computer-assisted artillery meteorology (CAAM) software package under development by the Army Research Lab's (ARL's) Battlefield Environment Directorate at White Sands Missile Range, New Mexico.

Improving Accuracy

The objective of MPS is to provide timely and accurate Met data for cannon round and rocket/missile ballistic corrections to help project lethality forward. The system will provide low-level wind data and information about visibility restraints (precipitation type and rate, sky cover, cloud-base height and fog) out to 500 kilometers for selecting the optimal munition and determining the aiming point for a target area. It will include a suite of sensors and software that will be fully operational in 2005 to support the developmental Crusader.

Marksmen down through the ages have known they must account for "windage." Wind, particularly at the projectile apogee, is the major Met factor affecting artillery accuracy. However, today's artillerymen know they need more information about the atmosphere than just windage to accurately fire their projectiles. Temperature, pressure and humidity also affect the round's ability to hit the target. To adjust the direction of fire so a round will hit its target, Redlegs need vertical profiles of Met data to the round's apogee.

The range of artillery fires has steadily increased during the last 50 years, with Crusader's unassisted range planned for 40 kilometers. In addition, the Army is developing weapons that will be able to attack targets hundreds of kilometers into the enemy's territory. As the range of artillery weapons increases, so do the atmospheric effects on their projectiles. With longer range weapons coming into the inventory, the need for accurate, time-ly data is even more critical.

An analysis of the factors known to affect artillery accuracy has shown that Met conditions contribute the most to miss distances and that frequently updating Met data used in aiming, especially wind, significantly improves accuracy and effectiveness. As much as 50 percent of the artillery miss distance is due to inaccuracies in Met data.

MPS will gather the required Met data, and CAAM will process those data and disseminate information about weather effects to the user.

Processing and Disseminating Met Data

There is no single system envisioned that will be able to provide the artillery all the target area Met data it needs. A suite of sensors and associated software will accomplish this mission—sensors that provide a variety of data in different resolutions at various locations and times. This requirement drives the need for CAAM, a software package that can integrate Met data from a wide variety of sensors to build a "best-Met picture" of the atmospheric conditions at the projectile's apogee, generate products that describe these conditions in artillery formats and disseminate this information to the relevant fire supporters. CAAM will optimize available Met data for employing artillery fires.

Existing methods for disseminating this information to fire supporters are largely inadequate. Current practices assume that the atmospheric conditions are homogeneous in time and space. Thus, Met information is disseminated across the battlefield as a single message for the entire area of operations and is assumed to be valid until replaced with a newer message. CAAM will give us the means to display and transmit that information to the various users via existing and near-term command, control and communications (C^3) networks.

CAAM will provide data management functions as well. For example, based on a trend analysis of the sensor data in the data base, CAAM will recommend a slower balloon release rate when the atmosphere is relatively stable and a more frequent rate when the weather is changing rapidly. (MPS will completely remove the balloon from the battlefield after the turn of the century, making this capability unnecessary.) CAAM also will disseminate new Met messages only as necessary. It will compare newly generated Met messages with the last message and recommend dissemination of a new message only when a specified level of artillery accuracy is threatened. This technique will help conserve our communications resources. CAAM software is being inserted into the current Met measuring set (MMS) AN/TMQ-41 as a technology improvement. Fielding of the time-space-weighted model (TSWM) version of CAAM, called CAAM I, will begin in mid-1997.

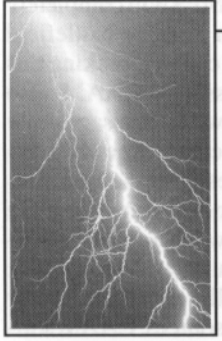
The next version of CAAM—CAAM II—is a battlescale forecast model that not only will give the user Met information on the projectile's apogee, but also on the target area. CAAM II will integrate Met sensors data and generate area-of-interest Met messages that closely represent the conditions in the target area at the time of firing.

The information will include profiles of the upper air via MMS, Met satellites, dropsondes and, eventually, unmanned aerial vehicles (UAVs). The information also will include automated surface data from a network of surface sensors. The target area profiles will provide winds and temperature, height of cloud bases, precipitation type and rate and refractive index. Pending funding, CAAM II could be fielded in 1999.

Met-Artillery Studies

The Field Artillery prefers predicted fire using Met and muzzle velocity corrections over registration or transfer adjusted fire—the element of surprise makes the fires more effective. The Met improvements being developed would enable predicted fire.

The Army Materiel Systems Analysis Activity (AMSAA) at Aberdeen Proving Ground, Maryland, evaluated the Met improvements in its study "155-mm Howitzer Accuracy and Effectiveness Analysis" (DN-G-32, Reichelderfer and Barker, December 1993). The results showed the value of proposed Met solutions to generate predicted fire vice adjusted fire. The study examined MPS' measurement of Met data accurate enough for artillery and CAAM I yielding the equivalent accuracy by managing the radiosonde-balloon release schedule on the battlefield.



Current techniques employ predicted fire with Met data approximately two hours old and collected 20 kilometers from the application location. The current practice of correcting artillery fire for a Met effect introduces two errors; one is due to the data time staleness (the Met team is dedicated to specific users) and the other is due to space displacement (the Met team is not collocated with the weapon system, and balloon-borne sensors drift). These errors induce slight inaccuracies at short ranges and major, unacceptable inaccuracies at long ranges.

CAAM I pools all artillery Met messages and manages the data via modeling algorithms to produce Met messages tailored for specific users; it provides 30-minute-old Met data collected no more than 10 kilometers from the location of application.

Based on the AMSAA study, Figure 1 shows the results of a 155-mm howitzer firing the M483A1 dual-purpose improved conventional munition (DPICM) 15 kilometers and firing the M864 extended-range DPICM 35 kilometers comparing current Met techniques versus CAAM I. The study assumed the location error was zero circular error probable (CEP), the target size was 25 square meters, the bomblet lethal area was 15 square meters, the weather was average mid-latitude continental and the terrain was moderate (hilly).

Compared to current practices, CAAM I results in significantly fewer rounds required to suppress or kill a target at both shorter and longer ranges. But the longer the range, the more dramatic the reduction in the number of rounds required. For example, the number of rounds required to suppress a target (defined as a fractional damage of 0.1) at a range of 35 kilometers was reduced by 50 percent. There was a 75 percent reduction in the number of rounds required to kill a target (a fractional damage of more than 0.3) at 35 kilometers.

Firing Range	Suppress (FD = 0.1*)	Kill (FD > 0.3*)
15 km	20%	58%
35 km	50%	75%

*Fractional Damage (FD) defined as 0.1 for Suppress and more than 0.3 for Kill.

Figure 1: This chart shows the percent of the reduction in the number of 155-mm howitzer rounds required to suppress or kill a target by using computer-assisted artillery meteorological (CAAM) versus current Met practices. (The percents are based on the 1993 Army Materiel Systems Analysis Activity Study DN-G-32.)

Range & Munition	Dollars Saved
M483A1 at 15 km	6.4 K*
M864 at 35 km	273.4 K*
SADARM at 23 km	66.0 K**

*Value based on the AMSAA Study (DN-G-32, 1993).

**Value based on Martin Marietta Study (1993).

Legend:
M483A1 = Dual-Purpose Improved Conventional Munition (DPICM)
M864 = DPICM-Extended Range
SADARM = Sense and Destroy Armor

Figure 2: The chart shows the savings (cost per kill) gained when we "Own the Weather," reducing the number of 155-mm howitzer rounds required per kill.

Figure 2 converts the reduction in the number of rounds to kill a target into savings in thousands of dollars per target. One can see that, using CAAM I, the Army could save as much as $273,400 in extended-range DPICM rounds. The 1993 "DMSP Tactical Enhancement Analysis/Army" conducted by Martin Marietta-Astro Space determined the cost saving per kill for the sense and destroy armor (SADARM) smart munition fired at a range of 23 kilometers. The SADARM savings result from improved knowledge of the target area weather derived from a 40 percent increase in the accuracy of the artillery Met data (i.e., profiles of wind velocity and temperature).

MPS and CAAM I completed an advanced technical demonstration at Fort Sill in September 1994. AMSAA-simulated results reveal significant improvements to the accuracy and effectiveness of current and future weapon systems.

As the Army moves into the 21st century with an ever-diminishing base of resources, we must find ways to achieve our missions more efficiently and effectively, including taking advantage of battlefield weather information never before available. For the artilleryman, owning the weather means having accurate, timely Met data all the time so he can hit his target first time, every time.

The words spoken by former Chief of Staff of the Army General Gordon R. Sullivan in 1993 say it best: "...as we leap technologically into the 21st century, we will be able to see the enemy—day or night, in any weather—and go after him relentlessly. The technology is there, waiting for us to pull it all together. Own the night. Own the weather. Three minutes from sensor-to-shooter. Smart weapons, smart munitions. *Decisive victory!*"

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The authors wish to acknowledge the contributions to this article of Charlie S. Taylor, Chief of the Meteorological Branch of the Target Acquisition Division, Directorate of Combat Developments, Field Artillery School, Fort Sill.