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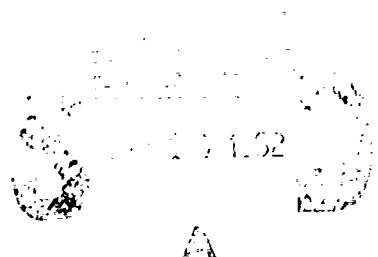
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**WEATHER EFFECTS DURING THE BATTLE OF THE BULGE
AND THE NORMANDY INVASION**

AUGUST 1982

By

Marvin D. Kays



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US Army Electronics Research and Development Command

Atmospheric Sciences Laboratory

White Sands Missile Range, NM 88002

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20. ABSTRACT (cont)

where fog or snow reduced visibility and where thaws or freezes influenced trafficability. Weather events leading up to D-day are given, and surface weather charts for 3, 4, and 6 June 1944 are shown. Adverse weather conditions before D-day and the lack of timely surface observations caused the German commanders not to suspect an invasion on 6 June 1944. The Germans had no knowledge that a maritime polar air mass was pushing into France from the northwest and would cause weather conditions suitable for the invasion.

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INTRODUCTION

Recent research on the effects of adverse weather and other obscuring phenomena upon electro-optical systems has revealed that the composition of the atmosphere in a particular type of air mass has a direct relation to the attenuation of electro-optical transmission. This has created an interest in air mass atmospheric properties, especially in the modeling of extinction coefficients in different battlefield scenarios. As a matter of interest, questions have been asked regarding the type of air masses that occurred during the Battle of the Bulge and the Normandy Invasion. In searching the literature to find these answers, I read numerous interesting accounts of weather related incidents. A few of these incidents are in this report.

These incidents illustrate how natural obscurants such as fog or snow can hamper air support of ground troops and conceal movement of troops and supplies for small skirmishes or large invasions. The incidents also demonstrate how the effects of weather on trafficability can determine the outcome of a battle; for example, tanks and supply columns can move over frozen ground, but not through deep mud.

The bulk of the material in this report came from referenced documents. The only original work is the identification of air masses.

BATTLE OF THE BULGE

Terrain, Roads, and Climate

Figure 1 depicts the Western Front as of 15 December 1944, showing the locations of the Ardennes and Eifel Mountains, various cities and rivers, and the armies. The area through which Hitler chose to launch his counteroffensive was, except for the Vosges, the most difficult terrain on the entire line of the Western Front. It consists of two major parts, the Eifel and Ardennes.

The Eifel and Ardennes are extensions of the Westerwald (Western Woods), blending almost imperceptibly into each other and sharing many of the same characteristics. The Eifel is a complex of hill ranges (they can hardly be called mountains) lying between the Rhine, the Moselle, and the Roer Rivers, mostly in Germany. Only the two westernmost of the Eifel highlands need to be mentioned here. East of St. Vith and just inside the German border is the Schnee Eifel, a high tree covered ridge. It extends from the northeast to the southwest, creating a characteristic thrust line in the entire area, and in 1944 was crested on much of its length by the West Wall fortifications. East of Liege is the Hohes Venn, a long tableland topped with lakes and marshes. The Hohes Venn represents a large outer bastion for Liege and provides a gradual and sometimes indefinable blending of the Eifel and Ardennes.

The Eifel is thickly covered with forests and provides good cover from air observation even in the fall and winter. The area has no large towns but is marked by numerous small villages, requiring extensive dispersion for any large forces billeted there. The streets in the villages are narrow and usually restrict travel to one-way flow.

The Ardennes, like the Eifel, is not a single and well-defined bloc. The general area may be defined as a wedge with the point between Aachen and Düren. The northern edge is a diagonal through Aachen and Liege. The southern edge is a more pronounced diagonal, running from Aachen southwest through Bastogne. The Ardennes has three parts: the High Ardennes in the south, the Famenne Depression in the middle, and the Low Ardennes in the north. The Low Ardennes tends to be open and rolling, but includes two plateaus: that of Herve and the Meuse, a few kilometers north of Givet. The low section is more readily traversed than the High Ardennes, but it is relatively narrow, and maneuverability is constricted by the flanking line of the Meuse River.

The Famenne Depression is only a thin sliver of the Ardennes wedge. The Famenne is free from tree cover, except for the characteristic buttes that dot the depression. It reaches the Meuse approximately 5 kilometers north of Givet, offering a good crossing site that often has been employed by European armies operating on the Meuse; however, any invader from the German frontier must cross considerable difficult terrain before reaching this "march through" depression.

The High Ardennes is a wide plateau or high plain, out of which rises elevations in the form of ridges or higher plateaus erupting from the main mass. These ridges are not connected to one another and combine with large forests to form isolated and independent compartments in which tactical domination of one hill seldom provides domination of another. Perhaps a third of the area is covered with forest, much of which is coniferous. This timber is scattered all over the High Ardennes and presents a patchwork picture rather than a series of large forests. The main ridge mass is cut in zigzag patterns, having been deeply eroded by winding rivers and streams, some flowing parallel to the higher ridges, others crossing so as to chop the ridges into separate sections.

The road net in 1944 was far better than the population and the economic activity of the Ardennes would seem to warrant. This was the result of Belgian and Luxembourgian recognition of the value of automobile tourism just prior to World War II. All the main roads had hard surfaces, generally of macadam. Although the road builders tried to follow the more level stretches of the ridge lines or wider valley floors, in many cases the roads twisted sharply and turned down steep grades into deep ravines and out again on the opposite sides. There were 10 all-weather roads crossing from the German frontier into Belgium and Luxembourg in the sector between Monschau and Wasserbillig, but not a single main highway crossed the Ardennes in a straight east-west direction.

The geography of the Ardennes channels large troop movements east to west, tends to force large units to pile up on each other, and restricts freedom of maneuver once the direction of attack and order of the battle are fixed. To a marked degree, the military problem posed by the terrain is that of movement control rather than maneuver in the classical sense. For the smaller tactical units, the chopped-up nature of the ground and the peculiar timber formations, in which densely wooded areas are interspersed with natural or man-made clearings, indicate the development of a series of small, semi-independent engagements once the large battle is joined. Movement across country is limited

even in good weather, since movement along the narrow valley floors may be blocked there or in the villages at points of descent or ascent.

The weather that occurs in the Ardennes and Eifel terrain during the winter generally is severe, and it was in 1944. This is mountainous country, with much rainfall, deep snows in winter, and raw, harsh winds sweeping across the plateaus. The heaviest rains occur in November and December. The mists are frequent and heavy, lasting well into late morning before they break. Precise predictions by military meteorologists are difficult because the Ardennes lies directly on the boundary between the northwestern and central European climatic regions and is affected by the conjuncture of weather moving east from the British Isles and the Atlantic with that moving westward out of Russia. At Stavelot freezing weather averages 112 days a year, at Bastogne 145 days. The structure of the soil will permit tank movement when the ground is frozen, but turns into a clayey mire in time of rain. A single snow storm often deposits a depth of 10 to 12 inches in a 24-hour period.

The major reasons stated by Hitler for his selection of the Ardennes are listed below.¹

- a. The enemy front in the Ardennes sector was very thinly manned.
- b. A blow there would strike the seam between the British and Americans, which would lead to political as well as military disharmony between the Allies.
- c. The distance from the jump-off line to a solid strategic objective (Antwerp) was not too great and could be covered quickly, even in bad weather.
- d. The configuration of the Ardennes area limited the ground for maneuver, thus requiring the use of relatively few divisions.
- e. The terrain to the east of the break-through sector was very heavily wooded and offered concealment from allied air observation during the buildup for the assault.
- f. An attack to regain the initiative in this particular area would erase the enemy ground threat to the Ruhr.

Hitler knew that the terrain would be an important factor in his offensive battle, but he underestimated the effects of weather.

Decisions and Weather

Decisions. There is an axiom that weather on the battlefield is divided equally between the combatants, but its impact on military operations is not

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

equal in amount nor direction. The German selection of a target date for the commencement of the Ardennes offensive was made on the prediction of poor flying weather. This type of weather had a useful side effect during the rupture of the American lines, since it veiled the attacker with fog and mist, a very important feature for the initial German success, just as it had been in the great offensives of 1918.

However, their buildup was not as secret as the Germans had hoped. Bad weather during the first half of December did reduce the number of Allied reconnaissance sorties, but by no means produced the kind of blackout the Germans wanted. In the last week of November, the number of enemy columns on the roads showed a marked increase. On 30 November 1944, United States reconnaissance planes reported a drastic heightening of rail activity west of the Rhine. Increased train lights at night and trains carrying tiger tanks were indications of the forthcoming attack.¹

At first, the Ardennes target date had been set for 25 November, but this date was discarded due to the Allies hammering at the Roer River, pushing along the Saar River, and converging on the Saverne Gap. In a briefing on 25 November, Hitler set a new date for 10 December. This date finally was scrapped because the fuel dumps were not full and because a number of assault divisions were still enroute to the concentration zone. On the 11th, Hitler approved further postponement until 0530 on 15 December, then on 12 December altered the attack order to read the 16th, with the usual provision that if good flying weather intervened the whole operation would stop dead in its tracks.¹

Weather and Related Engagements: 16 to 22 December 1944. Figure 2 is a meteorological surface chart for 16 December 1944, showing location of the fronts and pressure centers over the Eastern Atlantic, England, and Western Europe. The average weather conditions for 16 to 22 December are shown in figure 3. From figures 2 and 3, with no other meteorological information available, it is apparent that southerly flow existed over the area of interest and that the airmass was modified cold maritime polar. With the prolonged airflow from the Atlantic, it was certain that plenty of moisture was available to support the fog and stratus that continued for several days. As the front that was over England on the 16th approached Belgium, rain began to occur.

The Germans started firing their artillery at 0530 on 16 December and ended the barrage near 0700. The German infantry was delayed in following up the artillery preparation, due to the undergrowth of the forest, American barbed wire, and mine fields. The groping nature of the attack was enhanced by the heavy mist hanging low in the forest.¹

The 3d Battalion of the 394th Infantry Division, to the south and west of Losheimergarben, first encountered the enemy. (See figures 4 and 5 for locations of small villages.) About 0745, L Company had taken advantage of the

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

lull in the shelling and was just lining up for breakfast when figures were seen approaching through the fog, marching along the railroad tracks in a column of two's. First thought to be friendly troops, the Germans were almost at the Buchholz Station before recognition brought on a fusillade of American bullets. The enemy scattered for the boxcars or sought shelter in ditches along the right-of-way, and a close-quarters fire fight began. It wasn't until noon that the Germans withdrew leaving 75 dead; L Company had suffered 25 or 30 casualties.

On the morning of 16 December, the 4th Infantry Division was on one side of the Sauer River and the Germans on the other side. The thick fog and early morning darkness must have been as great a problem to the German assault units as to the American observers looking across the river. In any case, considerable confusion and delay on the German side of the river resulted in few or none of the rubber assault boats landing on the American side before 0630. Once across, the German assault troops were masked from view by the fog and heavy woods, and they moved rapidly up the draws.¹

The German efforts to capture the village of Hunningen met resistance by the 1st Battalion of the 23d Infantry Division, commanded by Colonel Hightower. Through the morning the 1st Battalion watched through breaks in the fog as German tanks and vehicles moved near their area. Visibility made artillery fire adjustment on the road difficult and ineffective. The Germans did attack at 1600, but were not able to capture Hunningen.¹

The German infantry began moving toward the American cavalry positions near Roth at 0400 on the 16th. Supporting artillery and mortars opened fire over the heads of the German infantry. Roth received only one battery salvo; apparently the Germans were already around the village. When day broke, cloudy and drizzling, the assault force moving between Weckerath and Roth was well on its way to the commanding crossroads village of Auw. Visibility was so poor and the American village positions so dispersed that the cavalymen for some time did not detect or engage the infantry moving past. The Germans, having received no resistance, first suspected that the main American line had been moved back to the Our River.¹

An ominous quiet prevailed around Rocherath during the early dark hours of 18 December, but just before first light the enemy resumed the assault, this time employing his tanks and infantry in ordered company. The 1st Battalion of the 9th Infantry Division (reassigned from the 23d Infantry Division), deployed east of the village along the road from the woods, took the first blow. Apparently a company of tanks had been brought close to the American line during the night battle, and these now attacked with more than a battalion of infantry. While the American batteries on Elsenborn ridge furiously shelled the road, a confused fight spread all along the foxhole line. The morning fog was heavy and visibility almost nil. The American infantry let the tanks roll past, then tailed them with bazookas or turned to meet the oncoming infantry

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

at close quarters with grenades, bayonets, or knives. This first assault was beaten off, while a number of the German tanks were crippled or destroyed by bazooka teams stalking successfully under the cover of fog.

When the fog lifted about 0830, three German tanks rolled right along the foxhole line and fired their machine guns while the German infantry rushed forward. Lieutenant Truppner, of Company A radioed that his company had been overrun and asked for artillery to fire on his own position. For 30 minutes an American battalion shelled this area. Only 12 men escaped.¹

After the fall of Hosingen, the 3d Battalion elements in Consthum offered the last organized resistance in the 28th Infantry Division center east of the Clerf River. The American commander organized a perimeter defense of the town, set out mines along the approaches, and detailed his three effective tanks and three armored cars to watch for the enemy armor known to be on the road from Holzthum. A half hour before dawn on 18 December German guns and mortars opened heavy fire. With daylight the fire lifted and the enemy infantry advanced, attacking in one wave after another as the morning progressed, but making no headway. About 1300, a thick, soupy December fog rolled in on the village. Under this natural screen, German tanks and grenadiers poured into Consthum. While tanks dueled in the streets (like gunmen of the Old West), the 3d Battalion made its orderly way out the west side of the town, reorganized, and as night descended marched to Nocher.¹

In the village of Mageret, on the Bastogne road, the German troops had infiltrated and cut off the fire direction center of the 73d Field Artillery Battalion of the 9th Armored Division. A little before midnight on the 18th the American troops were ordered to begin a withdrawal via Mageret. Near daylight on the 19th two German half-tracks appeared and were blasted with shellfire. The enemy infantry had moved in close under cover of the morning fog, and they drove back the thin American line in front of the batteries. About 0800 the fog swirled away, disclosing a pair of enemy tanks almost on the howitzers. In a sudden exchange of fire, the tanks were destroyed.¹

On the morning of 19 December, the Germans unleashed their artillery against the American-held village of Noville. German Colonel von Lauchert, intent on regaining the momentum that the Second Panzer had lost in the night and determined to get off the miserable side roads that he had chosen as a quick way around Bastogne, tried to blast his way to the west of Noville. At 1000 the fog suddenly lifted, revealing a landscape dotted with German tanks--at least 30. Fourteen tanks from the Third Panzer Regiment made a try for Noville by coming in from the north. Several bogged down in a vain attempt to maneuver off the road; others were stopped by a company of Sherman tanks and by tank destroyer fire. To the east of Noville, the Germans had started an infantry assault, but the fog lifted before the first waves reached the village. Suddenly deprived of cover, most of the attackers turned and ran.¹

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

Now, a weather change became a factor. The high pressure system that moved in from the Atlantic (warmer maritime polar air) on 18 December worked momentarily against the attacker. A thaw set in, which slowed his tanks, and the persistent, thick ground fog began to develop sudden openings, such as those that exposed the German tanks and infantry during the fight at Noville. On the 20th and 21st, the ground at higher elevations began to freeze in patches, leaving stretches of the Ardennes roads slippery and muddy. By the 22d, competing weather systems from Russia and the Atlantic had brought on a hodge-podge of snow, blizzards, fog, and rain. In the north, the Sixth Panzer Army was bogged down by rain and mud. In the south, the Fifth Panzer Army was hampered in its swing around Bastogne by fog and snow. Along the German supply roads beyond the Eifel, the snow fell continuously.¹

23 to 27 December 1944. Figure 6 shows a high pressure area extending east-west across Northern Europe from England to Russia on 23 December. Cold continental polar air was flowing into the Ardennes and Eifel with the easterly winds that prevailed on the southern edge of the high. This high was composed of the merging of the strong Russian high and a maritime polar high that moved in from the Atlantic on 18 December. By the 23d the continental polar air had completely modified the air over the combat zone. A closed upper air low with its southerly trough deep into Europe, which was associated with the surface low near Spitzbergen, was now east of the Ardennes, causing decreasing cloudiness. The weather depicted by figure 7 shows only scattered clouds over the entire area.

The morning of 23 December broke clear and cold. "Visibility Unlimited" was what the air control posts happily reported all the way from the United Kingdom to the foxholes on the Ardennes front. To most American soldiers, this was a red-letter day, because the bombers and fighter-bombers would once more be streaming overhead. The Bastogne air drop began with the first of the carriers dropping its six para-packs at 1150. On 24 December, a total of 160 planes took part in the drop. Poor flying weather on Christmas day over Bastogne forced the scrubbing of virtually all flights, although 11 gliders did bring in a team of 4 surgeons and some fuel for the tanks. The biggest airlift day was the 26th, with 289 planes flying the Bastogne run.¹

The dramatic change of the 23d, brought on by cold, dry winds from the east, stripped the German armies of their immunity to air attack, but this was not the whole story. Because of the winds, snow began to drift in the Eifel hills, bringing traffic on the main supply roads west of the Rhine almost to a standstill. The Germans found that horsedrawn snowplows were few and ineffective, and hastily erected snow fences were torn down by troops scrounging for firewood. No gravel was available, and a large number of engineer construction battalions had been moved west for employment as infantry. By the time power snowplows reached the Eifel, the American fighter-bombers were strafing and bombing every large vehicle that moved.

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

East of Trier, the German LXXX Corps faced the American XII Corps, with the deep valley of the Schwarz Erntz between them. The Sauer river ran through the valley and had few bridges left over it. The Germans suffered from inadequate transport for resupply. The ground that the Germans held favored the defense, with one notable exception: the natural corridor of the Schwarz Erntz. This corridor could be used to split the two German divisions.

The morning of the 24th broke clear and cold on the Schwarz Erntz valley, bringing a mixed blessing. The thermometer stood at 20°F, and although the American foot sloggers suffered, the gunners and fighter-bomber pilots could rejoice. With two fire direction centers handling the corps artillery and with perfect visibility at the observation posts, the battalions fired salvo after salvo for interdiction and destruction. A few wooded areas and villages got special treatment: time-on-target artillery fire with white phosphorus, a killing device for which General Patton had built up some attachment among troops of the Third Army. During the day and night, the XII Corps artillery fired 21,173 shells to support the attack on a 10-mile front. Excellent flying weather allowed the 405th Fighter Group to fly eight missions, dropping fragmentation and napalm bombs at points along the Sauer, then strafing and bombing the road east of the river.¹

For these 5 days, 23 to 27 December, the weather had favored the Americans, in the air and on the ground. Superior numerically in tanks, the Americans benefited more than the Germans from the sure footing the big freeze provided for armor. However, on 28 December, the sky was overcast with low stratus clouds. This was followed a day later by arctic air from Scandinavia, which produced heavy snows, blizzards, and greatly reduced visibility at ground level. Vehicular movement was slow, the riflemen exhausted themselves wading through the drifts, and the wounded (those in a state of shock) died if left in the snow for half an hour or more. This was the state of the weather when, on 3 January, the Allies began their final counterattack.¹ Table 1 contains a summary of the weather conditions from 16 December 1944 through 16 January 1945.²

THE NORMANDY INVASION

Weather and the Great Decision

On 1 June, General Eisenhower arranged to meet daily at 0400 and 2130 with ranking generals and naval task force commanders at Southwick House, Admiral

¹Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

²Allied Air Power in the Ardennes Offensive, 15 December 1944-16 January 1945, Office of the Director of Intelligence, US Strategic Forces in Europe, 16 March 1945.

Ramey's Headquarters, to hear the latest weather forecasts. These were presented by Group Captain J. M. Stagg, RAF, head of a meteorological committee that had every weather facility in the United Kingdom at its disposal.³

While it is true that Captain Stagg had every weather facility in the United Kingdom at his disposal, he also had to present a unified briefing to General Eisenhower from three forecast centers that usually had different opinions.⁴

By Saturday, 3 June, the forecasts began to be highly unfavorable for a 5 June D-day. (See figure 8.) High pressure areas were over Greenland and the Azores, with low pressure centers moving east-northeast across the Atlantic. It seemed probable that the state of wind and sea would rule out the 5th as D-day. Nevertheless, General Eisenhower confirmed sailing orders for the early sortie of Force "U," which had the greatest distance to sail.³

At the 0400 briefing on 4 June, the weather prospect seemed completely hopeless for a 5 June invasion. All experts predicted seas heavy enough to swamp landing craft and a low ceiling, which would prevent the air forces from carrying out their part of the assault. Under these circumstances, the air commanders were unwilling to take off, and Admiral Ramsey, after being advised that the winds would reach 25 to 30 miles per hour, feared that the channel would be too rough for small craft. Only "Monty" (General Montgomery of England) wished to carry out the schedule. Eisenhower decided to postpone the operation for 24 hours, to 6 June. Signals were sent out at 0500, 4 June, recalling all ships and craft already at sea.³

The 5th of June was a miserable day for the soldiers cooped up in little beaching craft under lashing rain, and a day of intense anxiety for the top commanders watching from shore. The surface weather chart for 4 June 1944 (figure 9) shows an intense low pressure system centered to the west of England, with a cold front extending southeast from the low center to Ireland.

The foul weather that set in on 4 June threw all German commanders off their guard, since, lacking weather observation stations west of the Continent, they were unable to predict the favorable weather that would follow the frontal system. The German weather station in Greenland had been evacuated at the beginning of June, and no weather reporting U-boats were in a position to detect the induced small area of high pressure. Rommel was certain that there would be no invasion between 5 and 8 June because the tides were "not right." He was actually at home in Germany on the morning of D-day when news of the landing caught up with him.³

At the 2130 briefing on 4 June, Captain Stagg predicted good prospects for a favorable break on the 6th and for heavy bombers being able to fly during the

³Morrison, Samuel Eliot, editor, "The Invasion of France and Germany, 1944-1945," History of United States Naval Operations in World War II, Volume XI, Little, Brown and Company, Boston, MA, 1957.

⁴Stagg, J. M., Forecast for Overlord, W. W. Norton and Company, Inc., 55 Fifth Avenue, New York, 1971.

preceding night. General Eisenhower postponed the final decision to the next morning, but for the Navy 2300, 4 June was the moment of decision, since orders were then issued for all vessels to resume sailing to meet the 6 June D-day.³

At 0330 Monday, 5 June, General Eisenhower turned out for the final weather conference. His trailer camp was shuddering under the force of the wind, and the rain seemed to be driving horizontally, but the worst was over. The low pressure center north of the Shetlands was filling; the cold front was moving eastward and had clearing skies to the west of it. Captain Stagg predicted a fair interval of 2 days, starting on the morning of 6 June, with moderating west to northwest winds backing to southeasterly. Winds along the assault coasts would not exceed force 4 or 5 (force 5 is 17 to 21 knots), and cloud amounts would generally be three-tenths or less, with bases at 2000 to 3000 feet, becoming ten-tenths at 1000 feet later on Tuesday. He could not predict beyond the 6th, because he was unsure of the movement of the low center located south of Greenland. Ike listened to the final comments from his staff, paused a moment, and at 0415, 5 June made the great decision: "O.K. We'll go." ³ " H hour for the United States beaches was 0630, 6 June.

The Invasion and Supplies

Figure 10 depicts the Normandy Beachhead and the areas of responsibility of the American and British forces.

On 6 June, the weather was still cause for concern. A gusty wind blowing from the west at 15 to 20 knots produced a moderately choppy sea with waves in the midchannel of from 5 to 6 feet in height. This was a heavy sea for the small craft, which had some difficulty in making way. Even the assault area was rough for the shallow-draft vessels, although there the wind did not exceed 15 knots, and the waves averaged 3 feet. Visibility was 8 miles with a cloud ceiling at 10,000 to 12,000 feet. Scattered clouds from 3000 to 7000 feet covered almost half the sky over the channel at H hour, becoming more dense farther inland.⁵ The weather map for 0700, 6 June 1944 is shown in figure 11. Maritime polar air had moved over the channel behind the cold front as the low of 4 June that was west of England moved eastward; the deep low that was off Labrador on 4 June moved north-northeast to just off the southeast coast of Greenland. This was the key to the clearing weather: if the Labrador low had tracked eastward, foul weather would have prevailed. The

³Morrison, Samuel Eliot, editor, "The Invasion of France and Germany, 1944-1945," History of United States Naval Operations in World War II, Volume XI, Little, Brown and Company, Boston, MA, 1957.

⁴Stagg, J. M., Forecast for Overlord, W. W. Norton and Company, Inc., 55 Fifth Avenue, New York, 1971.

⁵Harrison, Gordon A., editor, "Cross-Channel Attack," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1951.

midlevel overcast was most serious for air operations. Heavy bombers assigned to hit the coastal fortifications at Omaha Beach had to bomb by instruments through the overcast. With concurrence of General Eisenhower, the Eighth Air Force ordered a delay of several seconds in its release of bombs, in order to insure that they were not dropped among the assault craft. The result was that the 13,000 bombs dropped by 329 B-24 bombers did not hit the enemy beach and coast defenses at all, but were scattered as far as 3 miles inland.⁵

The weather also contributed to navigational difficulties. Mist mixed with the smoke and dust raised by the naval bombardment obscured landmarks on the coast; in addition, a lateral current of from 2 to 3 knots tended to carry craft east of their touchdown points by 1500 to 2000 yards. Since the men had been briefed only for their particular areas, they were confused by the changed picture. Their difficulties were compounded by the heavier enemy opposition, which isolated boat sections only a few hundred yards apart and at first made reassembly and reorganization or improvised missions almost impossible.⁵

Unloading at Utah beach proceeded in an orderly fashion, the chief distractions being an intermittent shelling of the beaches and air raids in the early morning hours. On the night of 7-8 June, when the Luftwaffe first raided the Utah anchorage, the ship Bayfield was ready with a smoke screen. Ships Somers, Enterprise, and Hawkins had no provisions for making smoke, but were not hit. The destroyer Meredith was sunk by a glide-bomb.³

By D-day plus 12 days, the flow of men and supplies over the beaches was running smoothly: 314,514 troops, 41,000 vehicles, and 116,000 tons of supplies had been landed on the American beaches, with almost identical figures for the British beaches.

The weather favored the Allies until nature intervened with the worst June storm in 40 years. At midnight between 18-19 June, a strong northeast wind began to blow, with heavy rain falling on the assault beaches. During the day of the 19th, the wind increased to 22 knots, with gusts to 32 knots. The sea built up so rapidly that by midafternoon on 19 June unloading had to stop.

By dark on the 20th, makeshift piers began to break. Many landing craft and barges were driven ashore and smashed. When the winds abated on 22 June, the Omaha beaches were a shambles of stranded and wrecked craft, coastal vessels, barges, and pier fragments. General Bradley was "appalled by the desolation." Yet, even before the wreckage was surveyed, unloading of the ships had to be resumed, since almost nothing had been landed during those 3 days. This storm created the necessity to ration ammunition among the troops ashore.³

⁵Harrison, Gordon A., editor, "Cross-Channel Attack," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1951.

³Morrison, Samuel Eliot, editor, "The Invasion of France and Germany, 1944-1945," History of United States Naval Operations in World War II, Volume XI, Little, Brown and Company, Boston, MA, 1957.

SUMMARY

Several occurrences of weather and their sometimes awesome effects upon battles, ranging from isolated skirmishes to major invasions, have been noted. It was shown that when natural obscuring phenomena (fog or snow) occurred, troops and equipment were able to use the obscuration to advance or move to a more desirable location. The German Army used darkness and cloud cover to reinforce their supplies and troop buildup for the Ardennes attack. However, weather was also the cause of their downfall, when rain and mud bogged down their tanks in one area, and drifting snow and fog hampered reinforcements and the movement of supplies in another. The 5 days of good flying weather allowed the Allies to provide low level support from 23 to 27 December 1944, helping stem the German last-gasp offensive.

The D-day forecast is probably the most publicized weather forecast ever made for military operations. Weather charts prior to the D-day forecast are presented along with a discussion of the synoptic situation and the weather that occurred on that day. A maritime polar air mass had pushed its way over England and France on D-day and was responsible for the break in the weather that permitted the invasion.

TABLE 1. ACTUAL WEATHER CONDITIONS FOR TACTICAL
AIR FORCE BASES AND NORTHERN BATTLE AREAS

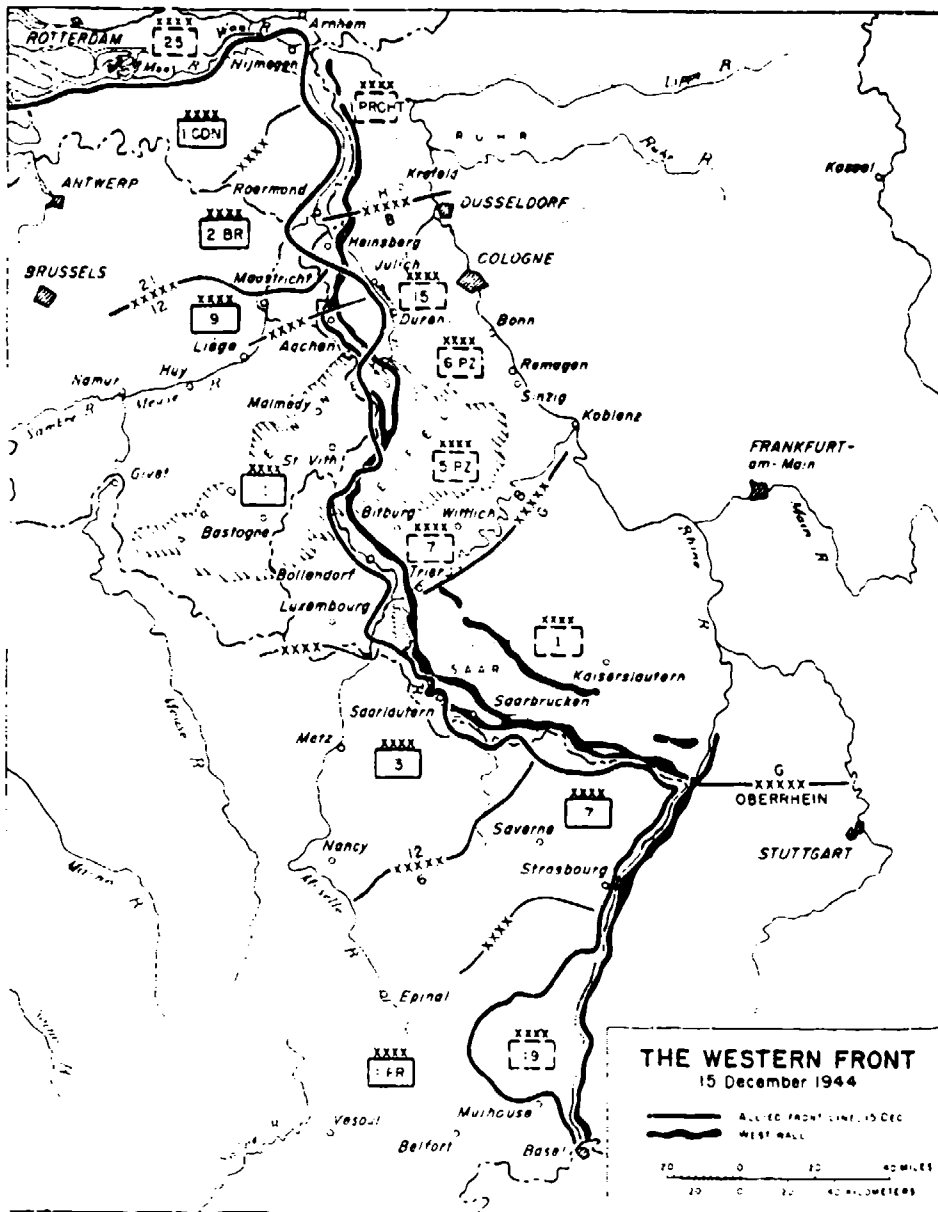
Date Dec 1944	Weather Summary
16	Very low clouds and fog patches. Visibilities poor. Light rain.
17	Overcast clouds, bases 1000 to 2000 feet, with intermittent rain. Visibility 3 to 5 miles.
18	Overcast clouds, bases 300 to 600 feet, with light intermittent rain, becoming 500 to 1000 feet broken during late afternoon. Visibility 2 to 6 miles. Also, fog patches in the southern sector.
19	Foggy conditions all day. Visibility less than 100 yards.
20	Foggy all day. Visibility less than 100 yards.
21	Foggy all day. Visibility less than 100 yards.
22	Overcast from 300 to 500 feet, with light intermittent rain and snow. Visibility 500 to 1000 yards, reduced to less than 100 yards in precipitation.
23	Fog and stratus in morning, with visibility 500 to 1500 yards, improving in afternoon to scattered clouds with visibility 2 to 4 miles.
24	Clear. Visibility 3 to 5 miles.
25	Clear, except for fog patches in the morning. Visibility 1000 to 2000 yards, becoming 2 to 4 miles in the afternoon.
26	Clear, visibility 1 to 3 miles, except 1000 yards in fog patches.
27	Clear, except for ground fog. Visibility 500 to 2000 yards in fog, increasing to 2 miles in afternoon.
28	Fog and stratus, bases of stratus 100 to 400 feet. Visibility 100 to 1000 yards.
29	Fog and stratus, bases of stratus 300 to 700 feet. Visibility 200 to 500 yards.

TABLE 1. (Cont)

Date Dec 1944	Weather Summary
30	Broken to overcast clouds at 2000 to 5000 feet, lowering to 500 to 1000 feet in precipitation during afternoon. Visibility 1000 to 3000 yards, reduced to 500 to 1000 yards in patchy fog.
31	Broken clouds with snow showers. Visibility 3 to 5 miles, restricted to 1000 to 2000 yards in snow showers.
<u>Jan 1945</u>	
1	Clear to scattered clouds with visibility 3 to 5 miles, except 1 to 2 miles in patchy fog/haze.
2	Scattered to broken clouds becoming 500 to 1000 feet broken to overcast with light rain in the afternoon. Visibility 1 to 2 miles, except less than 1 mile in fog and rain
3	Foggy conditions in morning, 200 to 300 feet overcast during afternoon. Visibility less than 50 yards in morning, becoming 1000 to 1500 yards in afternoon.
4	Overcast with bases 100 to 500 feet with snow. Visibility 1 mile, except 100 yards in snow.
5	1000 to 2000 broken clouds with snow showers. Visibility 3 to 5 miles, except less than 500 yards in patchy fog.
6	Fog with visibility 50 to 200 yards, improving to 500 to 1000 yards during afternoon.
7	Fog in morning becoming 300 to 900 feet broken to overcast during the afternoon. Visibility 500 to 1000 yards in fog, improving to 2 to 4 miles during afternoon, except 1 mile at 500 to 1000 feet, snow showers.
8	Broken to overcast at 500 to 1000 feet, with heavy snow showers. Visibility 2 to 4 miles, except 1 mile in snow showers.
9	Overcast at 500 to 1000 feet, with visibility 1 to 2 miles in snow showers.

TABLE 1. (Cont)

Date Jan 1945	Weather Summary
10	Small amounts of clouds and fog. Visibility 100 to 200 yards, locally less than 50 yards.
11	Fog with visibility 100 to 500 yards, improving to 500 to 1500 yards in the afternoon.
12	Overcast at 300 to 600 feet, with light snow. Clouds becoming scattered in afternoon. Visibility 500 to 1000 yards, except less than 500 yards in local areas.
13	Foggy conditions with scattered clouds. Visibility 500 to 1000 yards, except less locally.
14	Clear to scattered clouds. Visibility 2 to 4 miles, restricted in local areas to 1 to 2 miles in fog and haze.
15	Foggy with visibility less than 500 yards, becoming 800 to 1500 yards in afternoon.
16	Foggy in morning, becoming clear in afternoon. Visibility 500 to 1500 yards, becoming 3 to 5 miles during afternoon.



Legend US German FR French
 XXXX Army XXXXX Group of Armies

Letters or numbers above or below boundary lines designate the units separated by the lines

Figure 1. The Western Front on 15 December 1944.¹

¹ Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.

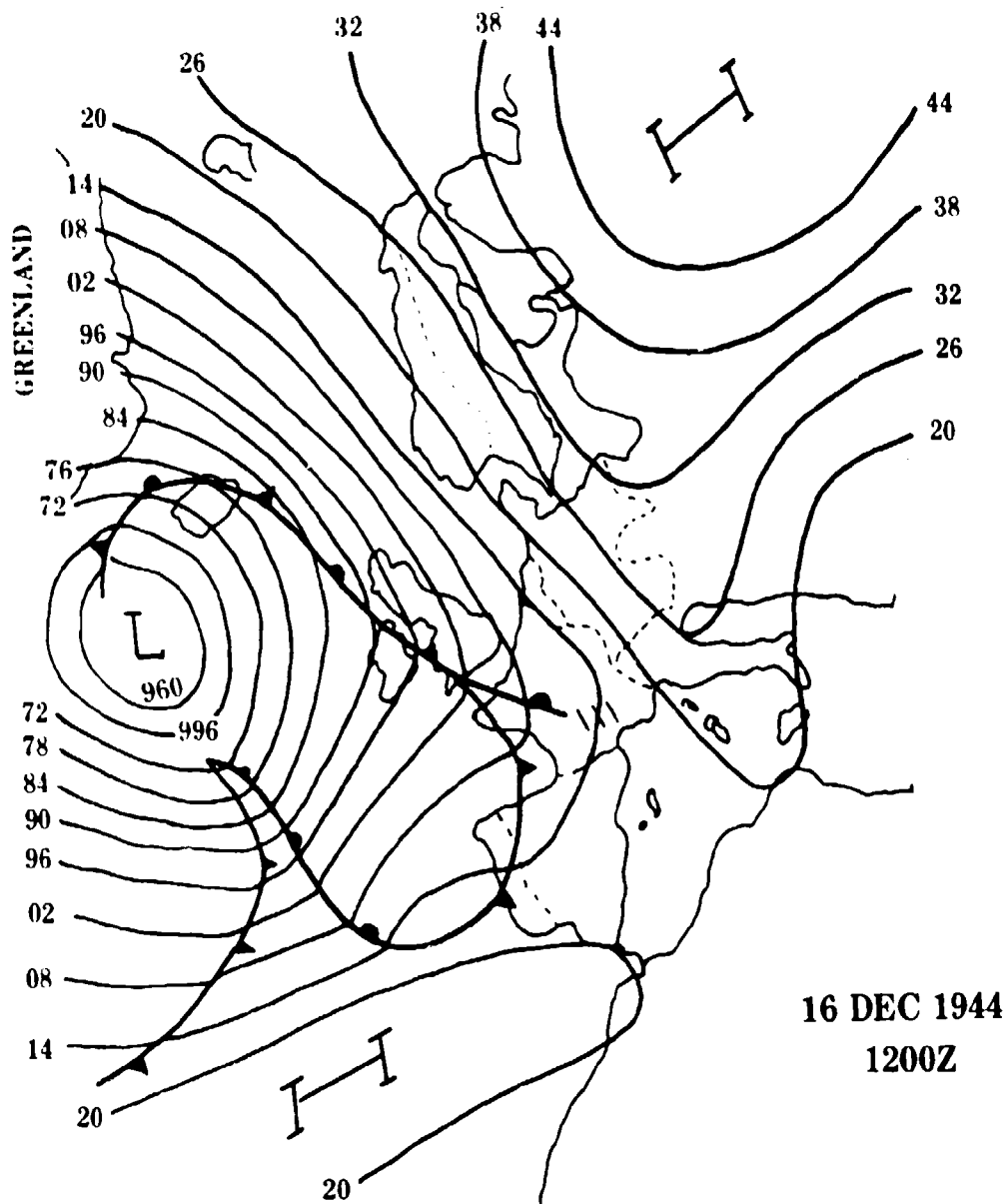


Figure 2. Surface meteorological chart for 16 December 1944.²

²Allied Air Power in the Ardennes Offensive, 15 December 1944-16 January 1945, Office of the Director of Intelligence, US Strategic Forces in Europe, 16 March 1945.

AVERAGE
WEATHER CONDITIONS
16-22 DEC 1944

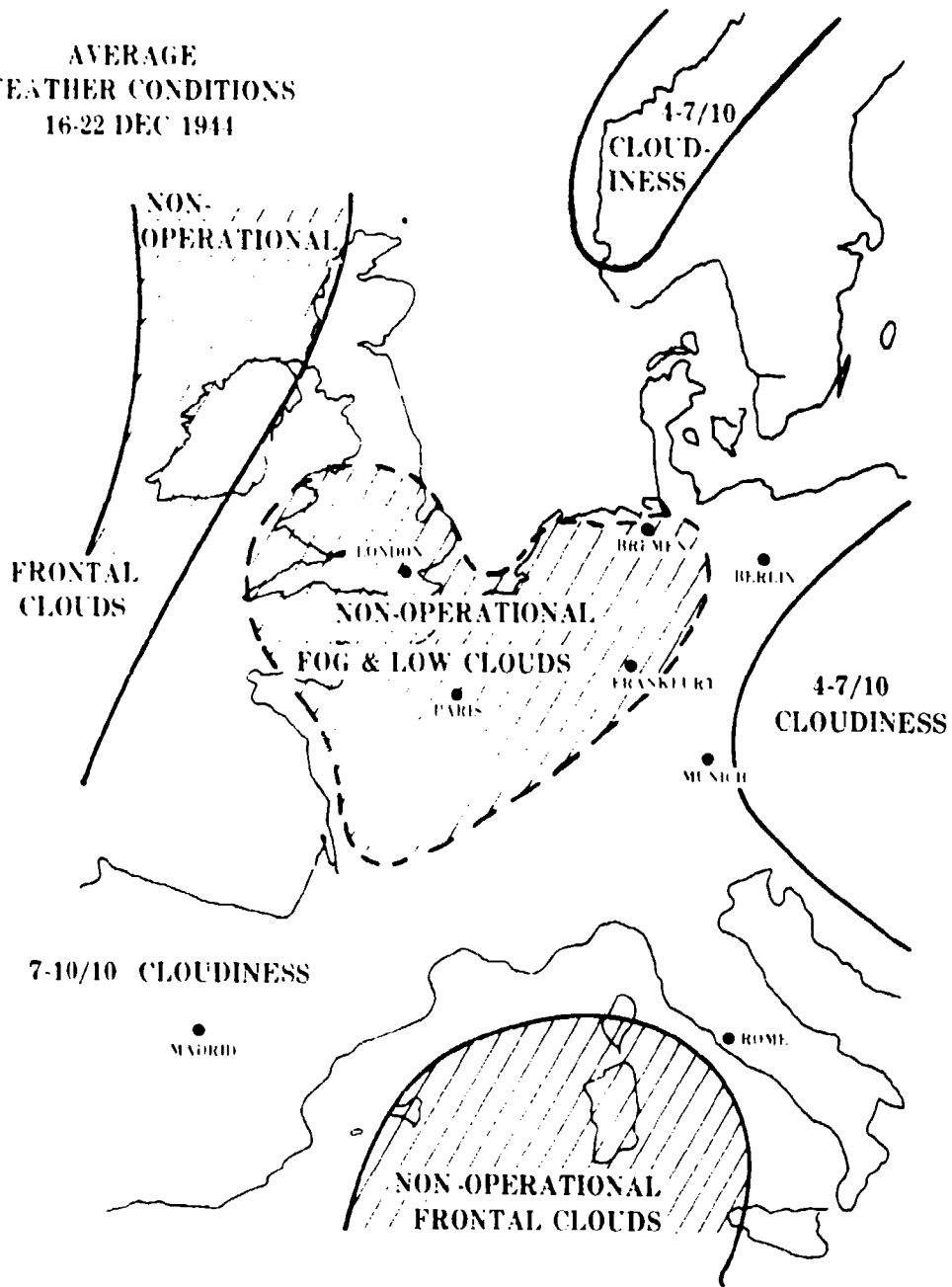


Figure 3. Meteorological conditions, 16-22 December 1944.²

²Allied Air Power in the Ardennes Offensive, 15 December 1944-16 January 1945, Office of the Director of Intelligence, US Strategic Forces in Europe, 16 March 1945.

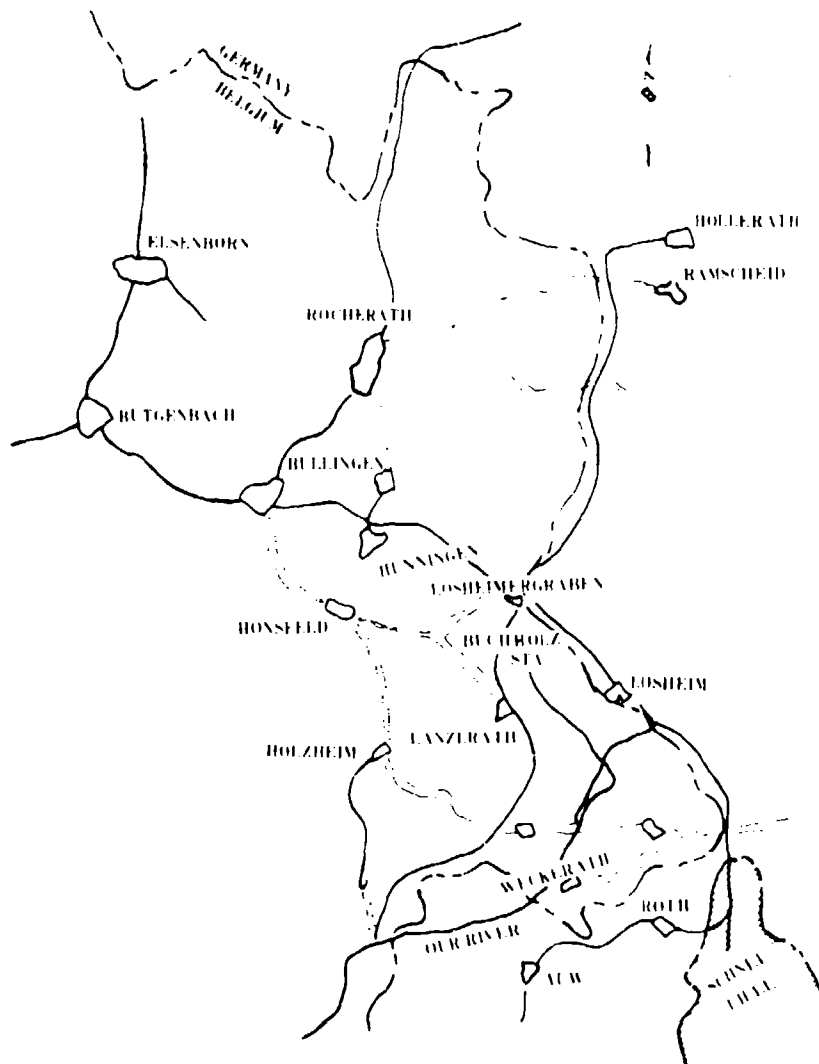


Figure 4. Locations of small villages in Belgium and Western Germany.

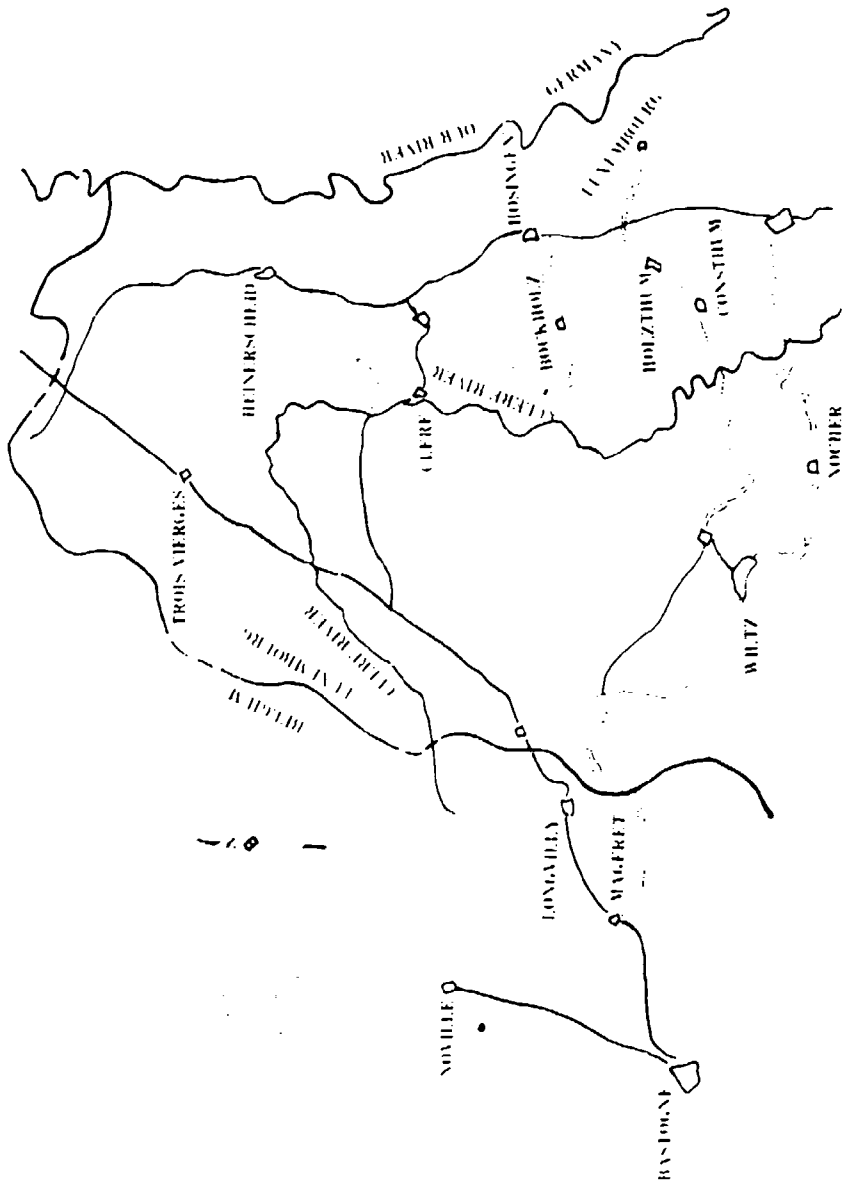


Figure 5. Locations of small villages in Belgium and Luxembourg.

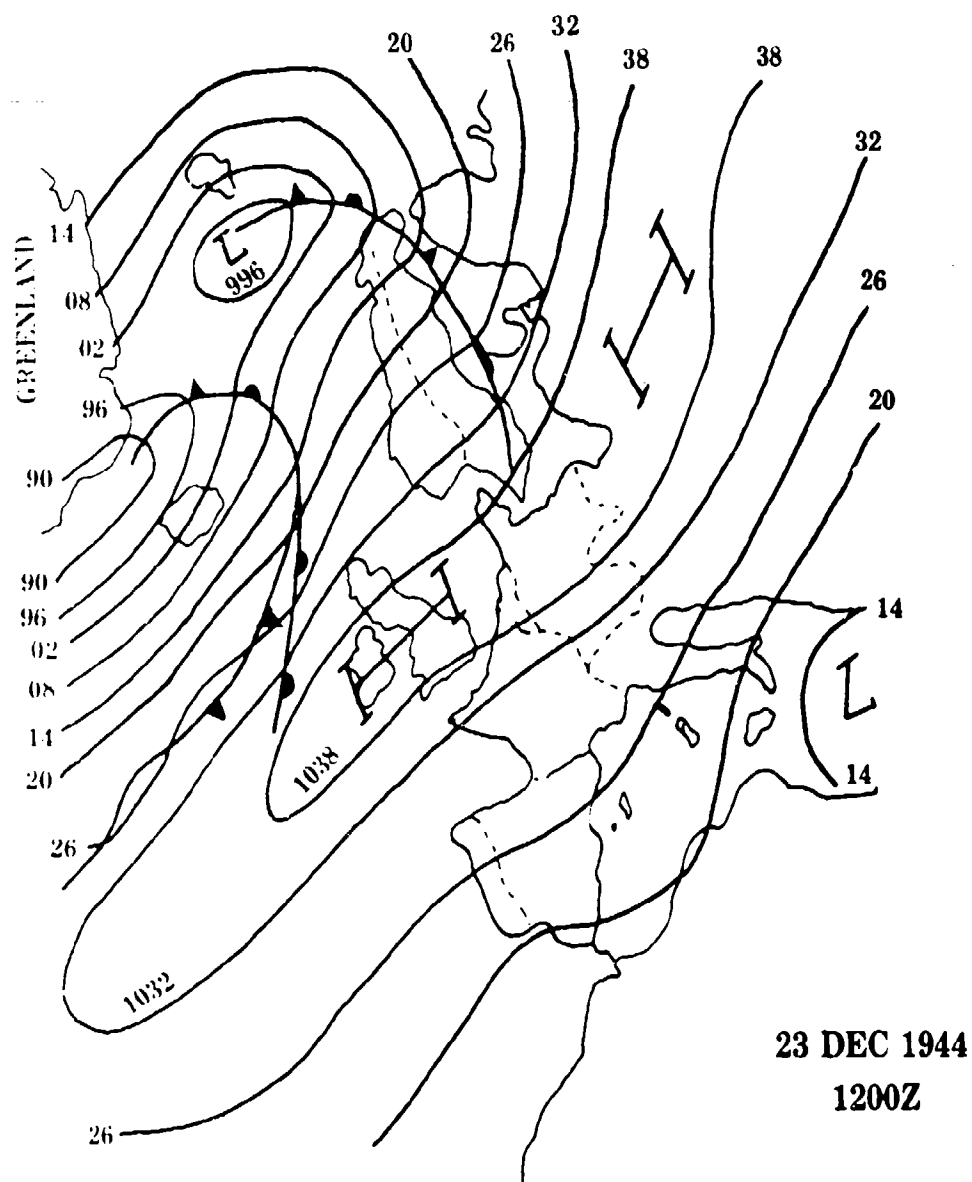


Figure 6. Surface meteorological chart for 23 December 1944.²

²Allied Air Power in the Ardennes Offensive, 15 December 1944-16 January 1945, Office of the Director of Intelligence, US Strategic Forces in Europe, 16 March 1945.

AVERAGE
WEATHER CONDITIONS
23-27 DEC 1944

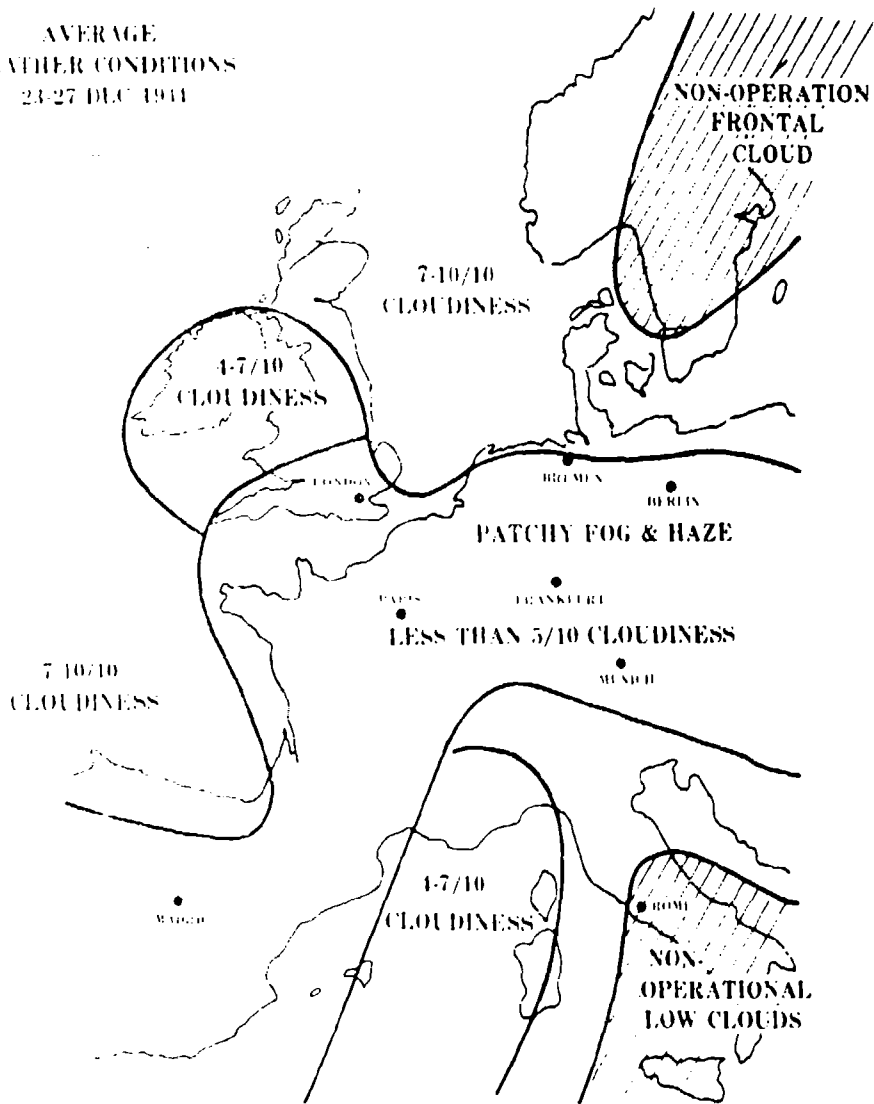


Figure 7. Meteorological conditions, 23-27 December 1944.²

Allied Air Power in the Ardennes Offensive, 15 December 1944-16 January 1945, Office of the Director of Intelligence, US Strategic Forces in Europe, 16 March 1945.

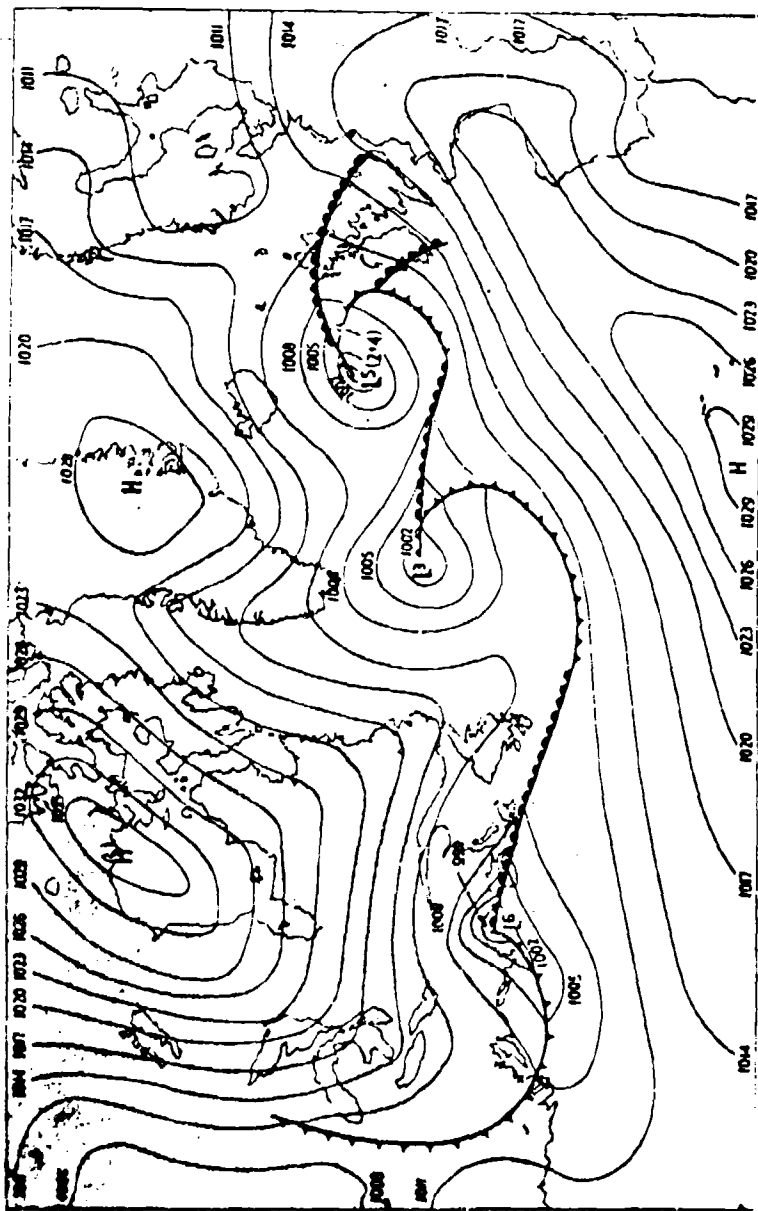


Figure 8. Weather chart for 1300 Gmt, 3 June 1944.⁴

⁴Stagg, J. M., Forecast for Overlord, W. W. Norton and Company, Inc., 55 Fifth Avenue, New York, 1971.

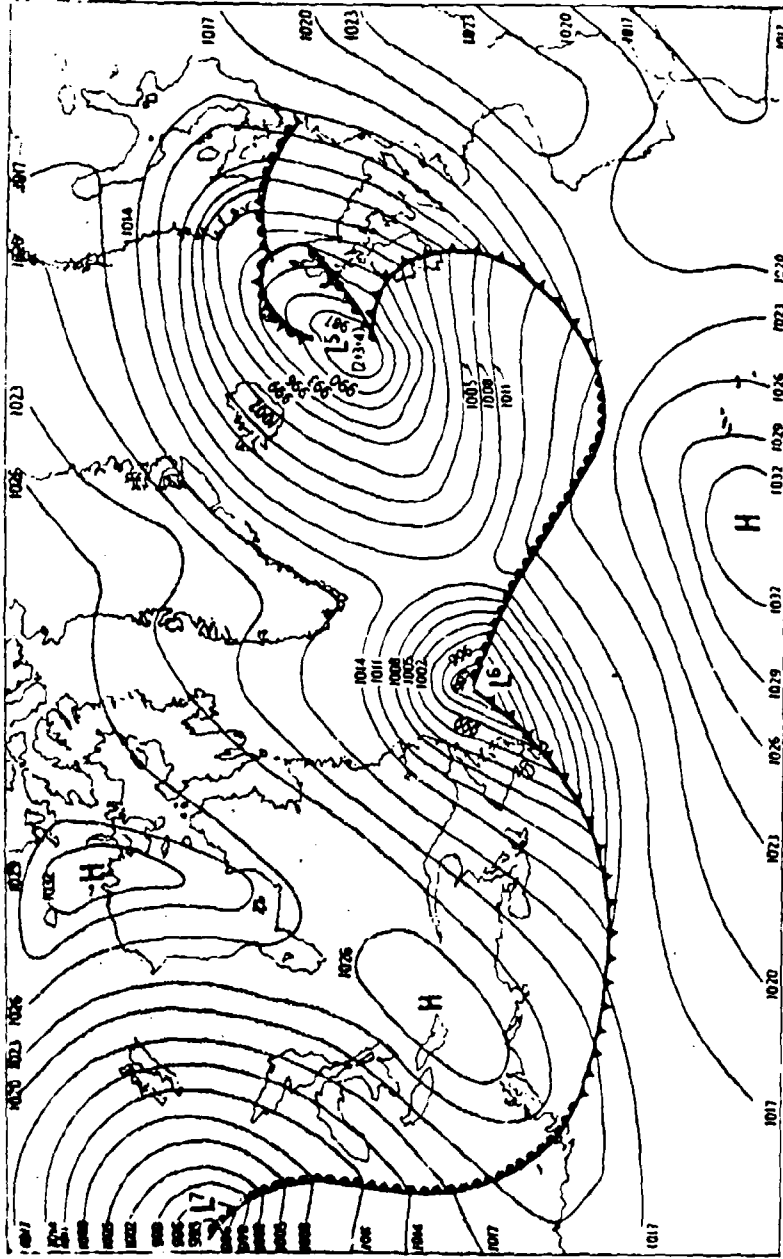


Figure 9. Weather chart for 1300 Gmt, 4 June 1944.⁴

⁴Stagg, J. M., Forecast for Overlord, W. W. Norton and Company, Inc., 55 Fifth Avenue, New York, 1971.

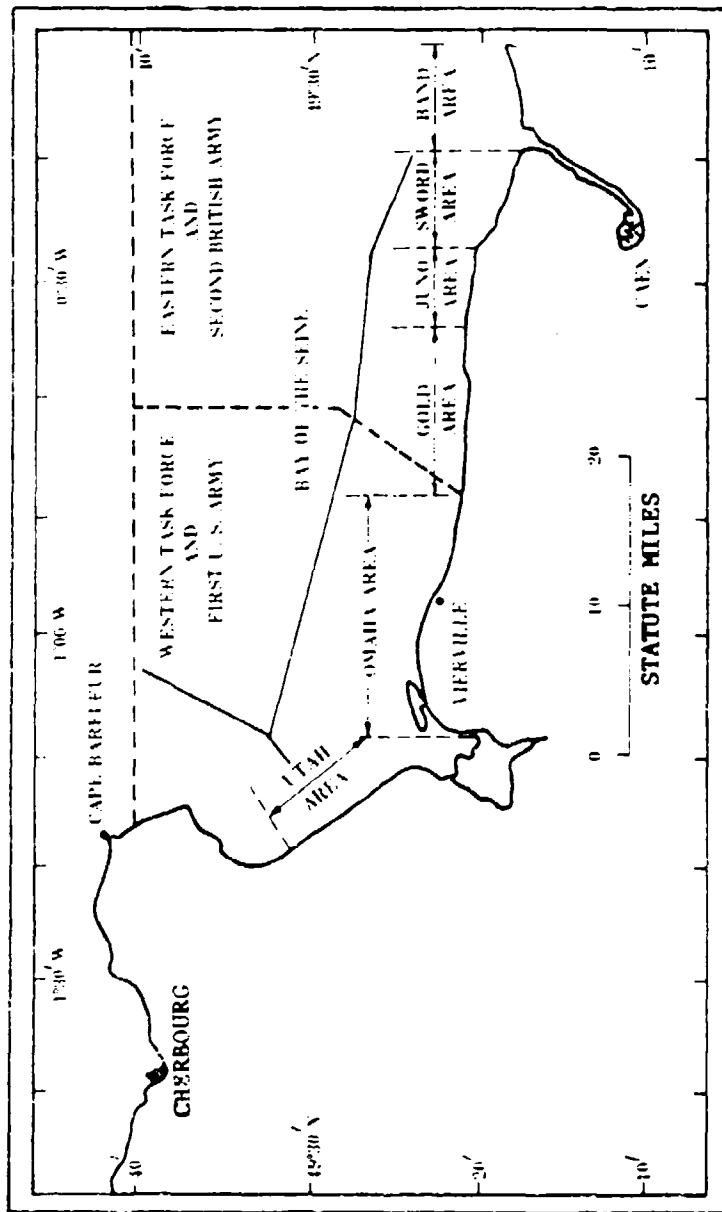


Figure 10. The Normandy Beachhead.

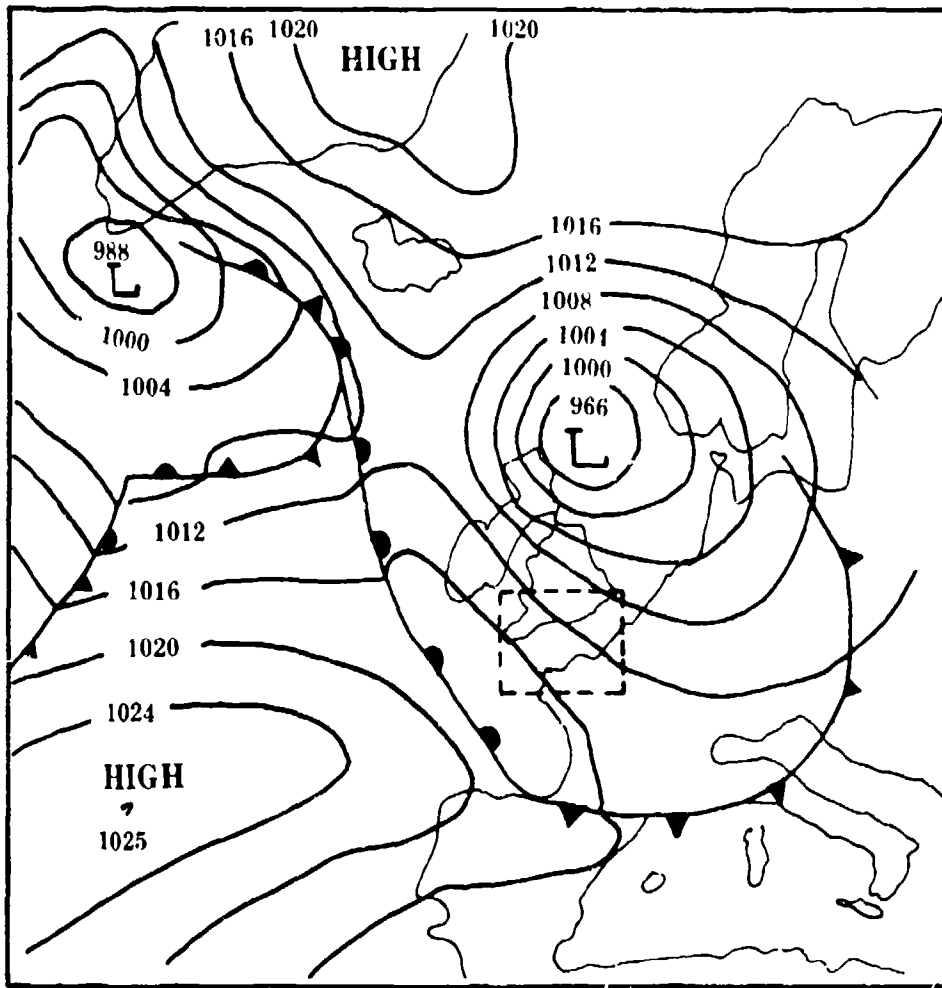


Figure 11. Weather chart for 0700 Gmt, 6 June 1944.³

³Morrison, Samuel Eliot, editor, "The Invasion of France and Germany, 1944-1945," History of United States Naval Operations in World War II, Volume XI, Little, Brown and Company, Boston, MA, 1957.

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1. Cole, Hugh M., editor, "The Ardennes: Battle of the Bulge," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1965.
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3. Morrison, Samuel Eliot, editor, "The Invasion of France and Germany, 1944-1945," History of United States Naval Operations in World War II, Volume XI, Little, Brown and Company, Boston, MA, 1957.
4. Stagg, J. M., Forecast for Overlord, W. W. Norton and Company, Inc., 55 Fifth Avenue, New York, 1971.
5. Harrison, Gordon A., editor, "Cross-Channel Attack," The U. S. Army in World War II, European Theater of Operations, Office of the Chief of Military History, Department of the Army, 1951.