Right for the wrong reason? A new look at the 6 June 1944 D-Day forecast by a neutral Swede

Anders Persson

Affiliation: Department of Earth Sciences, Uppsala University, Villavägen 16, SE 752 36 Uppsala, Sweden.
Home address: Jupitervägen 6, SE 743 40 Storvreta, Sweden
andersoscar.persson@gmail.com mobile: 0046 767 169 756

Abstract: There are at least three popular perceptions surrounding the weather forecast for the D-day landing in Normandy, 6 June 1994: 1) That the Allied weather forecasters predicted a crucial break or "window of opportunity" in the unsettled weather prevailing at the time; 2) That the German meteorologists, lacking observations from the North Atlantic, failed to see this break coming and thus the invasion took the Wehrmacht by surprise; and 3) That the American forecasters, guided by a skilful analogue system, predicted the favourable conditions several days ahead but got no support from their pessimistic British colleagues.

This article will present evidence taken mostly from hitherto rather neglected sources of information, transcripts of the telephone discussions between the Allied forecasters and archived German weather analyses. They show that: 1) The synoptic development for the invasion wasn’t particularly well predicted and, if there was a break in the weather, it occurred for reasons other than those predicted; 2) The German forecasters were fairly well informed about the large-scale synoptic situation over most of the North Atlantic, probably thanks to decoded American analyses; and 3) From the viewpoint of a "neutral Swede", the impression is that the American analogue method might not have performed as splendidly as its adherents have claimed, but also not as badly as its critics have alleged.

© 2020 American Meteorological Society
Finally, the D-day forecast, the discussions among the forecasters, and their briefings with the Allied command, are interesting not only from an historical perspective, but also as an early and well-documented example of decision-making under meteorological uncertainty.

Capsule: The D-Day weather forecast for the Normandy invasion of 1944 is surrounded by many popular perceptions. But were the forecasts so good? Were the German meteorologists so ill-informed? Was the American analogue system so great?
Introduction and background

A brief summary of D-Day events

In meteorology, the greatest story ever told must be about the weather forecasts for the planned D-Day, the Allied invasion of Normandy in early June 1944. The broad outlines are well known: how the weather in the English Channel from late May gradually worsened as the suitable time for the invasion, with respect to light and tides, for the invasion came nearer in early June. The Commander in Chief, Dwight G. Eisenhower, had to postpone a planned landing on 5 June after his team of meteorologists had warned about low clouds, poor visibility and strong winds. The operation was launched the following day, 6 June, under marginal conditions during a lull in a stormy and unsettled spell. In this article, it will be argued that this forecast is surrounded by at least three popular perceptions.

The first builds upon the notion that the invasion succeeded thanks to a forecast break in the bad weather which gave the forces a "window of opportunity" (Beevor, 2010, 21; Stagg, 1971, p 107.) The second holds that the Wehrmacht had been taken by complete surprise because the German forecasters, due to their lack of observations from the North Atlantic, had not spotted the alleged break (Beevor, 2010. p 42). Finally, it has been claimed that an American analogue system forecast the favourable conditions days in advance (Krick and Fleming, 1954, pp 180-81).

It will be shown that the D-Day forecast for 6 June was synoptically not particularly well predicted, and any break in the weather occurred for reasons other than those predicted. It can therefore be said that the D-forecast was "right for the wrong reason" (Gordon, 1996 a & b). Moreover, the German meteorologists knew more about the weather conditions over the North Atlantic than has been assumed, probably because they had managed to decode American forecast information. Finally, the pros and cons of the American analogue method will be discussed

The different forecast groups
The Allies had set up three independent forecast groups, two British and one American, quartered in separate locations around London. By doing so they hoped to prevent a single German bomb from wiping them out. As coordinator and rapporteur to Eisenhower were James M. Stagg, a Scottish geophysicist, and his deputy, Don Yates, an American meteorological colonel. They were stationed in Bushy Park just southwest of London within walking distance of Eisenhower's personal headquarters. This was also the HQ for the newly formed US Strategic Air Forces in Europe. Its codename, Widewing, also became the name of the American meteorological group led by Lt. Col. (Dr) Irving P. Krick from California Institute of Technology (Caltech), with Lt. Col. Ben Holzman as his deputy. They were supported from Washington DC by a Joint Weather Centre (JWC) that the US Army Air Force had organised in the Pentagon, Room 2D260. JWC made twice daily forecasts three days ahead and experimental forecasts six days ahead using synoptic extrapolation and advanced statistical methods (Bundgaard, 1986, p15). The JWC has not figured prominently in the literature, although such statistical techniques provided the basis for further developments e.g. the model output statistics (MOS) technique of the 1950s and 1960s.

One of the British groups, Dunstable, under the Air Ministry, was stationed at the Meteorological Office at Dunstable just north of London. It was headed by the Norwegian meteorologist Sverre Petterssen, and his deputy was the legendary British forecaster Charles K. M. Douglas. The second British group, Admiralty, under the Royal Navy, was housed in downtown London with Lt. Comdr. Geoffrey M. Wolfe, and deputy the New Zealander Inst. Lt. George L. Hogben.

The historical accounts

Among the participants, the first to publish an account after the war was Douglas (1952 a & b). A couple of years later Krick gave his version in the semi-autobiographical "Sun, Sea and Sky" (Krick and Fleming, 1954). It was later supplemented by the more controversial "Storm: Irving Krick vs. the U.S. Weather Bureaucracy" (Boesen, 1978). In the early 1970s, Stagg's version of the events, "Forecast for Overlord" (Stagg, 1971) and Sverre Petterssen's autobiographical "Kuling fra Nord" (Petterssen, 1974)
were published. The latter was later republished in its original English as "Weathering the Storm" (Petterssen, 2001).

In 1984, on the 40th anniversary of D-day, the American Meteorological Society organised a symposium in Fort Ord, east of Monterey, California (Fig.1).

The proceedings included a wealth of eye witness reports and important documents (Shaw and Innes, 1986). At the 50th anniversary the UK Meteorological Office published a well-documented account with an emphasis on the British contributions (Cornford, 1994). At the 75th anniversary the Royal Meteorological Society organized a meeting in London where, among others, Brian J. Booth presented a critical examination of Stagg's book "A cold front has appeared from somewhere". It will be referenced as "B. Booth, personal communication".

Transcripts of telephone discussions

Three declassified wartime documents serve as important complements to the personal memoirs. They contain detailed transcriptions of the daily (scrambled) telephone discussions between Stagg and the three forecasting groups, and Stagg's final briefing to Eisenhower and his staff.

Stagg wrote "Report on the Meteorological Implications in the Selection of the Day for the Allied Invasion of France" just after the event, with the help of his aide George D. Robinson (Robinson, 1986 a & b). It is reprinted in Shaw and Innes (1986, pp 133-170) and Cornford (1994) and will, in line with Fuller (1990, p.89), be referenced here as Overlord Meteorological Report (henceforth OMR).

A similar document, "Report by the Allied Naval Commander in Chief Expeditionary Force on Operation Neptune", was finalized in November 1944, and its Appendix 16 (pp156-65) covers the meteorological problems (Neptune Meteorological Report, 1944). It also contains detailed transcriptions from the
telephone discussions, which are similar, but not identical to the ones in OMR. Here it will be referenced as the "Neptune Meteorological Report" (henceforth NMR).

Krick's, Petterssen's and, in particular, Stagg's recollections, apart from being written long after the events, have a personal and polemic character, that makes it difficult to see the forest for the trees. Stagg seemed to have had access to OMR, whereas Petterssen had not - for the chronology Petterssen had relied on Stagg's book. But the transcripts of the telephone discussions, especially in OMR, give a fairly objective, condensed and, therefore, clearer picture of what was discussed.

Stagg's briefings to the C-in-C were also published as Appendix 10 to "The Second World War, 1939-45" by the historical branch of the British Air Ministry (AP 1134, 1954, pp139-46). It also contains post-invasion analyses not found in OMR, but it doesn't have the discussions leading up to the invasion.

There don't appear to be any similar documents from the Widewing side, although we know that both Krick and Holzman kept diaries (Shaw and Innes, 1986, p107) and that the telephone discussions were partly recorded on a captured German Telefunken wire recorder (Bundgaard, 1986, p21).

The weather discussions up to 4 June

The telephone transcripts show that, from late May until midday Sunday 4 June, there was a strong difference of opinion between Widewing and the two British groups. Widewing, relying on the analogue forecast system (see below), discussed the possibilities of the Azores ridge extending onto the Channel about four times more often than it discussed the possibility of unsettled conditions due to westerly flow and frontal influences. In contrast, Dunstable and Admiralty focused on conditions that could disturb the weather. Cyclonic activity and westerly flow figure about three times more often than the possibility of anticyclonic conditions. Only late on Saturday 3 June and early Sunday 4 June was there any concurrence, when Widewing acknowledged the arrival of a cold front and the British paid attention to a
ridge from the Azores high, albeit in a weakened condition.

The synoptic forecast maps

In all narratives of the D-day forecast, the only maps presented have been surface analyses (mean sea level pressure and fronts). The absence of forecast charts makes it hard to relate forecast discussions to the synoptic situation. From the telephone transcripts, it’s not too difficult for an operationally trained meteorologist to reconstruct, in a schematic way, the synoptic forecast maps that would’ve been available at the time. For an example of such a reconstructed forecast map (valid midnight 4 June) see fig. 2.

Early on Sunday 4 June the consensus, as reflected in Stagg’s briefings to Eisenhower, was that a west to southwest flow of warm moist air would dominate the Channel during the following days. A cold front somewhere west of Ireland would move onto the northern British Isles but would not make it beyond the Channel. In his briefing, Stagg instead focussed on another cold front associated with a depression near Nova Scotia – this front was expected to cross the Channel on the first part of Wednesday 7 June (OMR, 1944, pp9, 26; Shaw and Innes, 1986, pp142-43, 160; Stagg, 1971, pp101-102). No improvement in the weather was expected until then. With low clouds and poor visibility expected on 5 June, the invasion had to be postponed for that day. The evening briefing on Sunday 4 June was probably the most important of all because it seemed to offer Eisenhower the possibility of launching the assault two days later, on Tuesday morning 6 June.

The first popular conception: The break in the bad weather

What happened later on Sunday 4 June appears to have been over-dramatized in the memoirs. According to Petterssen (2001, p243) "a major reorganisation of the atmosphere threw the forecasters into

---

1 According to Stagg (1971, pp108-109; OMR, 1944, p21; Shaw and Innes, 1986, p155) a weather ship far west of Ireland caused confusion by reporting erratic changes in surface pressure. Neither in the Daily Weather Report published at the time, nor in the archived observations, can any such inconsistencies be seen (Brian Booth, personal communication 2014).
confusion", but in the end the three teams "reached a state of harmony that hadn't been attained since February when the conference discussions began". Stagg was alerted to "a cold front [which] has appeared from somewhere...it is already across Ireland and is moving eastward quickly" (Stagg, 1971, p105). This does not tally with the notes Stagg made at the time (B. Booth, personal communication).

Nor did the cold front appear from "somewhere"; it had been on the charts but was not expected to penetrate the Channel area until Wednesday 7 June.

Now it had "moved much further south than was expected" and was in the evening traversing the Channel. It was agreed that a fair interval after the cold front would start at midnight and end in the morning of Tuesday 6 June due to increasing clouds from the approaching warm front in the west coupled to cyclone L₆. On subsequent days the weather would continue to be unsettled and disturbed (OMR, 1944, p9; Shaw and Innes, 1986, p143; NMR, 1944, p162; Stagg, 1971, pp112-113). See figure 3.

There was a general feeling of relief in the evening. "Most of the uncertainties that had plagued us had now been removed" (Petterssen, 2001, p244). But the consensus made the groups overconfident. It was taken for granted that L₅, the low over the British Isles, would move towards Norway followed by L₆, the low approaching from the Atlantic. A transient ridge in between that was expected to bring good weather over the Channel on 6 June. This was the basis for the prediction of a break or "window of opportunity".

For the outlook beyond 6 June most of the discussion seemed to have focussed on the approaching cyclone L₆ which was mentioned twice as much as L₅, See textboxes 1 and 2.[Place boxes 1 and 2 here]

The "let's go" forecast

The agreed forecast that Stagg presented to Eisenhower in the evening of 4 June stated that "there will be an interval of fair conditions, which should last until at least dawn on Tuesday [6 June]." Winds would
decrease to force 3-4 on the French Channel coast and clouds would become mainly less than 5 tenths of
the sky, with base 2000-3000 feet, later to increase to 8-10 tenths. It was assumed that, after that, the
weak transient ridge would give way to a warm front (coupled to L6) that would cross on Wednesday 7
June.

Following this briefing, provisional instructions were issued for launching the invasion early on 6 June.
This forecast was repeated the next morning (5 June) when the final go-ahead was given.²

An authentic D-Day forecast chart

The schematic reconstruction of the Allied meteorologists' understanding of the synoptic development
(fig. 2 & 3), in particular the expected transient ridge over the Channel, is verified by an authentic
forecast. It was produced on Monday 5 June for an American pilot, a Sergeant Mentz, who was to carry
out a weather reconnaissance flight southwest of Ireland early on 6 June. It was saved for the future by C.
M. K. Douglas in his archive at the National Meteorological Archive in Exeter (Douglas, 1947) (fig. 4).

This forecast map gives the impression that cyclone L5, initially over the British Isles, had moved away
north-eastwards to Norway. It was the transient ridge over the Channel that was expected to provide good
operational weather during the morning of 6 June. It would, in line with the official D-day forecast, soon
be followed by cyclonic conditions, increasing westerly or south-westerly winds, lowering cloud ceiling
and worsening visibility.

An unexpected turn

² Normally Stagg and his group left Eisenhower's room after their briefing. But Stagg (1971, p114) claims that after the
evening briefing 4 June they remained and were privy to the discussions. His account, however, seems to be an edited
extract from page 224 of Chester Wilmot's 1952 best seller "Struggle for Europe" (Brian Booth, personal
communication 2014).
But cyclone L5 never did move away to Norway. Instead it made an unexpected southeast turn onto the North Sea (Douglas, 1952a, p23; Douglas, 1952b, p168; Gordon, 1996a; Simon, 1986, p10; Cornford, 1994, footnote 23). Cyclone L6 stayed over the Atlantic, delaying the arrival of its warm front. The ridge never arrived, and the flow stayed cyclonic. See analysed charts in fig. 5.

Thus, on invasion day of 6 June, the winds didn’t weaken, nor did they back towards the southwest. They remained between west and northwest along the Normandy beaches and reached force 3 to 5, stronger than forecast (OMR, 1944, pp12-13; AP1134, 1954; Shaw and Innes, 1986, pp146-47).

Many soldiers suffered dreadfully from sea-sickness during the 18-hour journey in flat-bottomed boats (Fuller, 1990, p93). The damp sea-sickness bags rapidly filled, and some soldiers resorted to vomiting into their helmets. They were thoroughly exhausted by the time they reached the beaches.

The strong onshore wind piled up the water which meant the advantage of invading at low tide was lost. Tanks that were supposed to land 5 to 8 km from the shore were put in water much closer in. Many of them sank in the choppy 1 to 3 m seas (Beevor, 2009, pp85, 90, 104). On invasion day, there had been a marginal break in the clouds and visibility, but there was no respite with the wind.

Right for the wrong reason?

The British-Australian meteorologist Adrian Gordon, who followed the events from his wartime position in Reykjavik, Iceland, noted later:

"It is somewhat ironic that the forecast upon which Eisenhower made his ‘to go’ decision, a forecast which the meteorologists concerned claim as a success and largely responsible for the success of the invasion and subsequent victory was, in effect, right for the wrong reason." (Gordon, 1996a, p73;
In 1984, in a letter to the Fort Ord meeting, Gordon quoted a letter from Douglas: "A point I could
ealogue upon was the element of luck . . . Everyone thought that [the depression which moved quickly
ortheast to North Scotland] would go on moving NE even if more slowly, but it suddenly became
stationary and then moved slowly SE while filling rapidly" (Gordon, 1986, p104; 1996a, p73; 1996b,
p178).

The element of luck and the role of uncertainty were explicitly recognized at the time. Indeed, when Air
Marshall Tedder received a forecast from Stagg, he asked about the confidence: "Do all the
meteorological centres agree on the forecast?" (Shaw and Innes, 1986, pp143-144; OMR, 1944, pp9-10;
Stagg, 1971, pp99, 113; Fuller, 1990, p91). Roberts (1986, p97) relates a similar experience with his
commander.

Although the D-day forecast wasn’t quite correct, Eisenhower, as we now know, still made the right
decision to launch the invasion. It remains a matter of speculation what he might have decided if he had
received a 100% correct forecast. Intriguingly, the German High Command seem to have made the wrong
decision from a reasonably accurate forecast!

The second popular perception: The Germans had been ill-informed of the weather

It is sometimes stated that it was a lack of upstream observations over the British Isles and the North
Atlantic which hampered the German meteorologists’ possibilities to forecast the weather (Beevor, 2010.
p42). It is, however, well documented that the Germans conducted weather reconnaissance flights west of
Ireland (Kington and Selinger, 2008), received observations from the German Embassy in Dublin, and
listened in to the exchange of weather information between the RAF controls and arriving planes
(Cornford, 1994, footnote 7). This information would have been sufficient for a one-day forecast for the Channel and we know that the German short range forecasts were fairly correct (Gordon, 1986; Bates and Fuller, 1986, pp259-60; Kington and Selinger 2008, pp223-24). Still, the Germans appeared quite capable of issuing skillful forecasts for more than one day ahead.

On 3 June, at his headquarters halfway between Paris and Rouen, Field Marshal Rommel started to plan his departure for Germany to see his family and visit Hitler. On 4 June the chief meteorologist of 3rd Air Fleet reported that weather in the Channel would be so poor that there could be no landing attempts until 10 June (Beevor, 2009, p42). How could the German meteorologists have any opinions, right or wrong, about the weather almost a week ahead? The explanation is that they knew much more about the synoptic situation than they have been credited for.

German North Atlantic analyses

Wartime German Tägliche Wetterbericht (Daily Weather Reports) are available at the National Meteorological Library and Archive in Exeter, UK and the Swedish Meteorological and Hydrological Institute, Norrköping, Sweden. The 3 June 1944 edition (figure 6) has a 00 UTC analysis (lower left) which covers most of the North Atlantic as far west as Labrador and Hudson Bay (figure 6).

The text at the bottom right describes the synoptic situation, but also indicates what the German meteorologists thought about the future development (translated from German): "On the north side of this high-pressure ridge, which reaches from the Azores to France, the Atlantic cyclones, or at least parts of them, will continue to advance into northern Central Europe in the next few days." (Shaw and Innes, 1986, p117). This is consistent with the long-range outlook given to
Rommel on 4 June.

Westward extent of the German analyses

For months leading up to May 1944 the westward extent of the German analyses in their Daily Weather Reports had been longitude 40°W. In early May there was a sudden extension westward to 80°W. This date doesn’t coincide with any significant change in the allied observational network. Additional allied weather ships were placed in the eastern Atlantic only 10-15 days later. During the rest of May the westernmost extent of the German analyses alternated between 40°W and 80°W, then remained at 80°W for most of June (fig. 7).

From where did the Germans get this extra synoptic information? There were too few German submarines to supply enough observations for their North Atlantic analyses, even fewer for the extensions into mainland Canada. A detail in the German surface pressure analyses – the small kinks in the isobars – might reveal their origin. In synoptic weather maps, kinks in the isobars indicate where fronts intersect. There were no facsimile transmissions of isobaric maps (Simon, 1986, p9; Robinson, 1986a, p88), which leaves as the only possibility that the information came from coded MSLP analyses. Would it have been possible for the Germans to decode these messages?

Did the Germans use US analyses?

At least twice a day, JWC provided coded surface and upper-air analyses for North America and the west Atlantic to not only Widewing and US meteorological units in the outfields, but also the British and Russian forces (Allan, 1986, p5; Bundgaard, 1986, p15; Fuller, 1990, p38 ff). The forecasters used them to supplement their own local analyses in preparing one to two-day

---

3 These forecasts are lost, but it would be possible to infer from the German military archives what kind of information the meteorologists gave them.
The Americans generally used less strong encryption than their British allies. An over-complicated coding/decoding procedure would cause delays and misinterpretations of the meteorological information. These drawbacks could outweigh the advantage of secrecy (Brian Booth, personal information 2014; Ratcliff, 2006, pp47-48).

The change on 10 May 1944 (in fig. 7) might be coupled with a change in the JWC’s coding of the disseminated analyses, perhaps on Sunday 7 May. This would explain why the westward extension of the German analyses temporarily declined on 7 to 9 May from the normal 35 - 45°W to around 25°W. It probably took the Germans some days to break the new code.

Thus, from early March 1944, the Germans might, twice daily, have intercepted state-of-the-art surface and upper-air analyses covering a large part of the Northern Hemisphere. This would have enabled them to make fairly realistic forecasts for the Channel several days ahead.

The third popular perception: The role of the American analogue system

The idea behind analogue systems was that, by finding a similar meteorological situation in past surface maps (1899-1940), the current situation was likely to follow a similar sequence to that of the past. This method was used most when forecasting beyond a few days ahead. The third perception is that Widewing’s analogue system was the main factor behind the success of the D-day forecast.

The performance of the analogue system

According to the transcripts, the analogues beginning on Sunday 28 May 1944 (eight days ahead) called for an extension of the Azores high north-eastwards toward Ireland by 5 June. This extension would push...
approaching cyclones towards the north and protect the Channel (Cornford, 1994; Bundgaard, 1986, p17). Even if the details were quantitatively not correct, e.g. in the exact position of the ridge, the analogue system nevertheless qualitatively indicated a change in the weather regime, from a generally zonal flow to meridional. It should be noted that on the evening of 3 June, both Widewing and Admiralty suggested that L5 would not move north-eastwards to Norway, but south-eastwards onto the North Sea. In the case of Widewing this idea might have been inspired by the analogue system.

Applying a modern **trough ridge diagram** or **Hovmöller diagram** to the days around D-day shows that the synoptic development on 6 June was part of a downstream development. It originated with a deep cyclogenesis over the North Pacific on 3 June (outside the diagram). Energy propagated rapidly eastwards leading to deep cyclogenesis over the western Atlantic (50°W) on 5 June, the downstream narrow ridge of high pressure (20°W) on 5-6 June being a consequence of this cyclogenesis. (fig. 9).

At this time (1944) the use of Hovmöller diagrams lay some years in the future. Yet synopticians before the war already had an intuitive feeling that weather systems affected each other downstream (Persson, 2017, p951). Such downstream development events are quite common and have most likely figured in the selected analogues.

**Opinions about the analogue system**

In the 1940s, the analogue method developed by Krick at Caltech, was not particularly controversial for the simple reason that it was one of the few long-range methods available (Petterssen, 2001, p194). It only became controversial after the war. In his 1954 semi-autobiographical "Sun, Sea and Sky" Krick claimed that "the British, using short-range methods, could see no weather coming up in the unstable atmospheric conditions of those touch-and-go days of the first week in June 1944". "Had not the skilled meteorologists using modern methods [i.e. analogue techniques] correctly foreseen tiny chinks opening in the [weather of 1944 in Western Europe] all the mighty preparations for D-day might have gone for

Accepted for publication in *Bulletin of the American Meteorological Society*. DOI 10.1175/BAMS-D-18-0311.1.
nought, and the war in Europe might have gone on for years” (Krick and Fleming, 1954, pp180-181).

Krick's book was reviewed in the Quarterly Journal of the Royal Meteorological Society by none other than James Stagg: “[Krick’s account], to speak mildly, is hardly likely to be an acceptable statement of what took place: it is not even worthy of Dr Krick as a professional meteorologist, and as one who contributed honourably to the D-day forecast” (Stagg, 1955, p116).

As noted by Fleming (2004 a & b), Krick's account was given quasi-official status in the celebratory volume "A Century of Weather Service" (Hughes, 1970, p89). By then the appreciation of the analogue method had become influenced by other issues such as the controversy about Krick’s work and the role of statistical forecasting in relation to dynamic-numerical forecasting.

Summary and a look ahead - what can be learned from the D-day forecast?

Much of the perception of the D-day forecast centres on an alleged break in the bad weather. It was supposed to occur in a ridge between two low pressure systems, one leaving the area and the other approaching. In reality the first low stayed in the area for longer than expected and it was within this system there was a lull, an improvement in the visibility and cloud ceiling, but not the winds, which kept the sea very choppy.

The forecasts issued by the German meteorologists have not been as well documented as those of their Allied colleagues. It has been taken as almost self-evident that the German forecast had to be worse than the Allied's because of a lack of observations. But judging from the available material, in particular to their synoptic mapping over the North Atlantic, it is not surprising that the Germans managed to give fairly correct advice to their High Command, both in the short and longer term. Their forecasts might even have been more realistic or at least less optimistic with no speculations about any break in the weather. In the 1930’s the German meteorologists were regarded as the leading experts in extended
The role of Irving Krick’s analogue system has come to dominate the historical debate on the D-day forecast. Although claims by Krick that the system forecast favourable weather conditions several days ahead cannot be vindicated, its virtue was to indicate the crucial transition from mainly zonal to more meridional flow.

Finally, is there something to be learned from the D-day forecast? It was 75 years ago and the observational coverage has improved tremendously since then, both qualitatively and quantitatively. Our understanding of the atmosphere is much better, and the forecast methods have reached a standard that could hardly have been dreamt of in 1944. However, there’s one element that has a familiar ring to it and is of great interest today. That is when Air Marshall Tedder asks about *an assessment of the confidence in the forecast he has just heard from Stagg*. This illustrates that the D-day forecast is a significant early example of decision-making under meteorological uncertainty. The details of the discussions and the deliberations in OMR and NMR offer, more than the autobiographical narratives, unique material for further studies.

**Anders Persson**

**Acknowledgments**: My interest in the D-Day forecast began during my time at ECMWF in the 1990s. In those days I benefitted from discussion and correspondence with meteorologists who were active during the war: Oliver Ashford, Odon Godard, Adrian Gordon, Irving Krick, Patrick Meade, Walter Munk and Norman Phillips.

For the current article, I warmly appreciate assistance from Brian Booth, Jim Doyle, Brian Gross, Gunnar Larsson, Linus Magnusson, and Frida Österdahl. A special thanks to Chris Webster and three anonymous reviewers.
reviewers whose comments and criticism highly improved the manuscript.

References:


Cornford, S., 1994: With Wind and Sword, the story of meteorology and the D-Day 6 June, Meteorological Office, Exeter


Accepted for publication in Bulletin of the American Meteorological Society. DOI 10.1175/BAMS-D-18-0311.1.


Krick, I.P., 1986: Role of Caltech Meteorology in the D-Day forecast (in Shaw and Innes, 1986, 24-26)


Neptune Meteorological Report, 1944: Report by the Allied Commander-in-Chief Expeditionary Force on Operation Neptune. The National Archives, Kew, ADM 199/1661 Case no 10910 (also in the UK National Meteorological Library and archive, Exeter. US copies are in box 41 of the Eisenhower Presidential Library, Abilene, Kansas or Joint Forces Staff College, International Military Student Office (IMSO), 7800 Hampton Boulevard Norfolk, VA 23511-1702).


Petterssen, S, 1974: *Kuling fra nord, En værvarslers erindringer* (Gale from the north, recollections by a weather forecaster), H. Aschehoug & Co, Oslo.


Accepted for publication in *Bulletin of the American Meteorological Society*. DOI 10.1175/BAMS-D-18-0311.1.


4 June 1944 evening: OMR:

**Dunstable:** L₅ not expected to have passed Shetland on the 5 June, therefore still expect L₆ to move east, not NE. Ridge between L₅ and L₆ weakening. L₅ moving northeast to Norway coast on 6 June, and filling. L₆ south of Iceland Tuesday morning, with wave on cold front. Disturbed conditions after 6 June.

**Widewing:** L₆ expected to move NE so that by midday 5 June its centre will be about 59°N 35°W with 980 mb centre, and by midday 6 June at 64°N 25°W with 990 mb centre.

**Admiralty:** Cold front of L₅ through area early 5 June, linking back through flat wedge to warm from of L₆. L₆ expected to move into Iceland area and fill. Warm front of L₆ near Scillies by 1300 6 June, moving east slowly. Cold front of L₆ through Channel area on 8 June or 9 June.

Textbox 1: The transcripts in OMR of 4 June evening discussions. L₅ is the cyclone just west of Scotland and L₆ is an approaching cyclone in the North Atlantic.
4 June 1944 evening: NMR:

Dunstable now anticipated that L₅ would at 54°N 38°W by 0700 5 June with a pressure of 980 mb or less, and 60°N 22°W by 0700 6 June. L₅ would move slowly up to the west of Norway as previously indicated. At 0700 on 6 June [fronts from L₅] would run from the centre southwards over the Baltic to West Germany, then westward across the Western Channel and finally become [warm front] running up to L₆ in 60°N 22°W. Wave developments on [cold front from L₆] was considered probable.

Widewing's main modifications to this were in the probable track of L₆ which they still maintained would move into Denmark Strait. Its position at 1300 5 June would be 59°N 35°W with a depth of 980 mb and at 1300 on 6 June 64°N 25°W with a pressure of 990 mb. Wave development on [cold front from L₆] was also considered likely but it was thought [warm front from L₆] would be rather inactive.

Admiralty agreed with the Dunstable forecast of the movement of L₅ and wave development on [cold front from L₅]. Their prognosis of L₆ was as follows: 1300 5 June 57°N 38°W depth of 980 mb, 1300 6 June 61°N 30°W depth 980 mb and 1300 7 June 64°N 24°W depth 990 mb. It was maintained that L₆ was deepening so rapidly now that it must soon undergo marked retardation; continued intensification of the ridge between L₅ and L₆ was therefore likely. Position of [fronts from L₅] at 1300 on 6 June was from 61°N 30°W across the south of Ireland and thence southwards to Blacksod Point, from here [a warm front from L₆] ran south to the west of Brest.

Textbox 2: The transcripts in NMR of 4 June evening discussions. Some of the notations of synoptic features have been changed to correspond with OMR in textbox 1.
newspapers. The invasion was said to have occurred in a "break" or a period of a "brief lull" in the weather.

Figure 2, Upper left: synoptic analysis at 4 June 01 UTC. Upper right: tentative sketch of the predicted development of the synoptic pattern on 5 June 1944 at 01 UTC. Bottom left and right: as for upper right, but for 6 June and 7 June respectively. The forecast maps are based on the transcripts of telephone discussions and briefing Sunday morning 4 June. Notations of cyclones L₅ and L₆ are as given in OMR.
Figure 3. Upper left: synoptic analysis at 4 June 12 UTC. Upper right: tentative sketch of the predicted development of the synoptic pattern on 5 June 1944 at 12 UTC. Bottom left and right: as for upper right, but for 6 June and 7 June respectively. The forecast maps are based on the transcripts of telephone discussions on Sunday evening 4 June.
Figure 4: Forecast map from 5 June valid at 01 GMT 6 June given to an American pilot, probably copied from the official forecast map which has been lost (from C.M.K. Douglas papers in the National Meteorological Archive, Exeter). System L₅ is predicted to have reached southern Norway while system L₆ is approaching the British Isles, threatening to increase the clouds and worsen the visibility later on 6 June.
Figure 5: Synoptic analyses at 00 UTC from 5 to 8 June 1944. The low that was supposed to move northeast to southern Norway remained over the North Sea for some days. On 6 and 8 June the observed winds in the Channel were force 4 and occasionally force 5.

Figure 6: The German routine Daily Weather Report from 3 June 1944. Upper left: maps valid at 12 and 18 UTC the day before. Lower left: the European-Atlantic map at 00 UTC where the...
analysis over the North Atlantic appears not to be based on observations but intercepted American coded analyses. Right: map at 06 UTC (Courtesy Gunnar Larsson, Chief archivist at SMHI, Norrköping, Sweden).

Figure 7: Westward extent of the MSLP analyses on the German Daily Weather Reports at 00 UTC during Spring 1944. Around 10 May 1944 most of the analyses were extended from 40°W (the longitude from Iceland to the Azores) to 80°W (the eastern shores of Hudson Bay).

Figure 8: The 00 UTC analyses in the German Daily Weather Report 4 June (left) and 6 June (right). Note the kinks in some of the isobars. Also, the analyses over the Soviet Union might be...
based on decoded MSLP analyses.

Figure 9: Time-longitude or Hovmöller diagram for the 1000 geopotential height, 35-58°N between 90°W and 30°E, for the period 4-8 June 1944. Blue indicates low pressure areas, brown and yellow are high pressure areas. The thin black line shows the speed of downstream development as 30°/day. Image courtesy NOAA/ESRL Physical Sciences Division, http://www.esrl.noaa.gov/psd/ The "finger of high pressure" was formed 5-6 June west of the British Isles downstream from a deepening low at 45°W in the North Atlantic.