Great Historical Events That Were Significantly Affected by the Weather: Part 8, Germany’s War on the Soviet Union, 1941–45. I. Long-range Weather Forecasts for 1941–42 and Climatological Studies

Abstract

A brief account is given of Baur’s long-range weather forecast prepared in the autumn of 1941 for the 1941–42 winter in Eastern Europe. Baur’s forecast called for a ‘normal’ or mild winter but the winter turned out to be one of the most severe winters on record. The cold, the icy winds and blizzards gravely hit the German armies and coincided with the first major Soviet counteroffensive of the war. A Soviet weather forecast for January 1942, also called for a mild winter.

A review of the climatological studies prepared for the war indicates that the occurrence of mud periods of considerable intensity in autumn was not considered. The autumn 1941 mud period immobilized most of the German armies for a month and caused the attempted final German assault on Moscow to take place in an early and severe winter.

Hitler would not tolerate the mention of winter and still less the mention of the retreat of Napoleon’s Grande Armée from Russia.

The support given by Soviet meteorologists and hydrologists to the Red Army is sketched. For the 1941–42 winter the more-important short- to medium-range forecasts included a forecast for 7 November (anniversary of the October Revolution) at Moscow and a forecast for the start of Zhukov’s counteroffensive in the Battle of Moscow in December 1941.

1. Introduction

A study of the meteorological aspects of the war between Germany and the Soviet Union (USSR) for the autumn of 1941 and the winter of 1941–42 will be presented, using mostly unpublished information on long- and medium-range weather forecasts and German climatological studies that were prepared either for the attack on the USSR or in the course of the war proper. The information that the authors have on the German “side” is far more detailed than that we have for the Soviet side. And, although, as far as forecasts go, primary interest is in long- and medium-range predictions, mention will be made of a few short-range forecasts made by Soviet meteorologists for some particularly important events or operations. Special attention will be devoted to the severe 1941–42 winter and the “mud period” preceding it and will consider the effects of the 1941–42 autumn and winter on the fighting and on the troops.

2. Baur’s forecast for the winter 1941–42

During the 1930s the German meteorologist Franz Baur made a name for himself in the field of experiments on long-range weather forecasts. In addition to studies of the problem, he prepared forecasts for several days ahead, as well as monthly and seasonal forecasts; he coined the notion and term Grosswetterlage, often used by German meteorologists. At the time of outbreak of World War II (WWII), Baur and his institute were part of the Reichswetterdienst (The State Weather Service of the Third Reich). After the war’s outbreak, his institute was subordinated to the chief of the Weather Service of the German Air Force. In actual fact, Baur’s institute was not moved from its pre-war location at Bad Homburg, which was maintained throughout the War, in contrast to some other laboratories of the Reichswetter-

* This article is chapter I of a wider study. Subsequent chapters will discuss some of the important weather forecasts during the years 1942–45 of the German-Soviet War. A special chapter will be devoted to the actual weather of autumn 1941 and winter 1941–42 and its effects on the War.

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Franz Baur was by far the most prominent German meteorologist in World War II. The war between Germany and the Soviet Union, which was then called the Eastern Front, was presented by Baur and by the other authors mentioned here as a war between the Western Front and the Eastern Front. The war was characterized by the presence of large numbers of soldiers and the severe winter conditions.
Since the early 1950s, a very large body of literature has appeared in West Germany on the war with the USSR. Some of these books are war diaries of army commands, as for instance, the war diaries of the Army High Command (Kriegstagebuch des Oberkommandos der Wehrmacht, 1965), the War Diary of Colonel-General Halder, chief-of-staff of the army until 1943 (Halder, 1964); others are diaries of army units; still others are histories of WW II, such as that of Lieutenant-General von Tippelskirch (1963); recollections of former high officers, as, for example, those of Guderian (1951), a famous Panzer general, and books that draw information from published and unpublished "histories" of army units, private diaries, and letters, such as books by Carell (1963) and others. Most of these quote temperatures measured by individuals (as distinct from official meteorological stations). Thus the Kriegstagebuch des Oberkommandos der Wehrmacht (1965), which almost daily gives a brief statement on the weather in the theaters of war in the East, reports for the area held by what was called Heeres-Gruppe Mitte (German Army Group Center [GAGC]), that is, the German Army Group most directly involved in the Battle for Moscow, a temperature down to -35°C on 5 December 1941; Halder (1964) cites a temperature report of -36°C on the same day for the Tula area (160-km south of Moscow), and a temperature of -38°C on the 6th, about the peak day of the cold outbreak, in the Tikhvin region (480-km NNW of Moscow, rather near Leningrad), see Halder (1964, pp. 327-328). The cold outbreak of early December, coming after a cool-to-cold October and November (mean temperatures of Moscow: In October 2.1°C, in November -5.3°C; as against the 1931-60 CLINO values of, respectively, 4.5°C and -1.9°C) gravely hit the German armies that were not appropriately clothed (Hitler expected to break the resistance of the USSR before the coming of winter) and which were not equipped with armaments, tanks, and motorized vehicles that could properly function even in a "normal" winter in the northern parts of the USSR, let alone in a winter as rigorous as that of 1941-42.

On or about 8 December, K. Diesing, chief of the CWG and scientific adviser to the chief of the Weather Service of the Air Force (General Spang), asked Flohn to listen in on a second earphone to a telephone call to Baur. In the call, Diesing cited to Baur the reports of very low temperatures in the East and asked him if he maintains his seasonal forecast in face of the reports. Baur's response was "the observations must be wrong." This reply of Baur's greatly impaired the esteem held for him by his colleagues.

Diesing passed away in June 1943, and in September Werner Schwerdtfeger was asked to take over Diesing's position. Late in 1984, Schwerdtfeger prepared a paper of reminiscences of his service with the CWG in 1943-45. When he passed away unexpectedly in January 1985, his family and the University of Wisconsin Department of Meteorology asked H. Lettau to translate into English and edit the paper, which has been published in Weather (Schwerdtfeger, 1986). In his reminiscences the author writes that during the summer of 1942 the field HQ Hitler requested a forecast of temperatures in Eastern and Central Europe during the winter of 1942-43 and that, in turn, Diesing asked Baur to prepare the forecast. According to Schwerdtfeger, Baur's long-range forecast was that the coming winter would not be cold, since the preceding three winters, and particularly two of the three were rather cold; a sequence of four cold winters in a row has never been seen in the 150-year-long series on hand. Schwerdtfeger adds that the winter of 1942-43 turned out much below normal and that the failure of the prediction and the suffering caused to the troops impaired the reputation of meteorologists in the eyes of many a military leader. Table 2 shows a comparison of the winter temperatures of 1942-43 derived by the authors.

3. German climatological reports on the Soviet Union, 1940 and 1941

At the time of Hitler's Germany attack on the USSR (22 June 1941) very few current reports were available on the climate of the European territory of the USSR. They were issued by the Reichsamt für Wetterdienst (Air Force). One such study concerned itself with the soaking of the soil during the melting period. Although this was a careful study, it limited itself to the spring season whereas there also is such a "mud period" in autumn. As a matter of fact, the first such mud period developed in autumn 1941. It was very intense and lamed military operations for about a month. Another investigation examined the beginning of snow cover, partly based on Russian publications that appeared prior to 1941. Both reports contain maps of the state of the soil and snow cover for 10-day periods; both studies suffer from the shortness of record.

Other official reports prepared in 1941 deal with cloudiness (especially low clouds), visibility and winds, average temperatures and precipitation, based on available sources. These reports were hastily collected and used recent synoptic data; the accompanying texts were short and apparently derived from textbooks. The sections on Russian winter emphasized the extreme stress due to strong winds even at moderately low temperatures and extreme stress due to bliz-

1 In citing the temperature near Tikhvin, Halder notes: "Very great frost (minus 38), many froeStites." Carell (1963, pp. 327-328) quotes from printed "histories" of some German Army units that were fighting in the battles for Moscow and Leningrad, temperatures of between -40°C and -50°C. Comments of these very low and questionable temperature reports will be set forth in chapter 11 of this study, which will deal with the weather of autumn 1941 and winter 1941-42. Particularly questionable is a report of -40°C in the Yakhlroma area on 27 November. Stolfi (1980, p. 227) lists some of the low temperatures reported in the literature. See a graph of temperatures for December 1941 in the Battle for Moscow area, prepared from histories of units, (Carell, 1985).

4 Halder (1964) cites a temperature report of -36°C on the same day for the Tula area (160-km south of Moscow), and a temperature of -38°C on the 6th, about the peak day of the cold outbreak, in the Tikhvin region (480-km NNW of Moscow, rather near Leningrad), see Halder (1964, pp. 327-328).
connection of Germany's attack on the USSR. Whether correct or not, it is probably true that Hitler and his high command paid little attention to meteorological (and other) reports.

Few people are acquainted with the fact that even before the onset of the cold winter of 1941-42 in the areas of the Battle for Moscow (and Leningrad), a mud period immobilized the greater part of the Panzer, artillery, and mechanized units, in general, of the German Army for about four weeks; from about October to October 1941. The Red Army was less hampered by the mud for two reasons: The Soviet tanks had, in the main, wider tracks and larger bogie wheels than the German Panzers and their mechanized vehicles had a higher ground clearance; second, during the period of concern here, the Soviet forces were fighting a mostly defensive war where movement was not an overpowering factor.

At the time of WW II, there were very few paved roads in the USSR. Rains and low evaporation rates of the fall season would turn unhardened roads and fields into quagmires in which many of the tanks, pieces of heavy artillery, and other mechanized transports would dig their own graves by trying to move on. The Germans called this Schlamm Periods, that is, mud period. The Russians call the periods, when roads and fields became impassable, by the name rasputiza. This rasputiza is a nearly always returning "fixture" of spring and autumn in many parts of the USSR. It is mainly the length and intensity of it that varies from year to year and, as was pointed out in footnote 9, it will also develop in excessively wet summers. Rasputizas played a more-or-less important role in earlier Russian history, such as in the campaign of Charles XII, a military king of Sweden at the beginning of the 18th century, the Pugachov rebellion later in the same century and in 1812, Napoleon's retreat from Russia; they also played a minor role in the Crimean War in 1854. The effect of the autumn 1941 mud period on the German Army fighting to reach Moscow will be discussed in chapter III of this study in some detail.

Because of the severe effects of the 1941 autumn rasputiza on the German Army, mention is made here of a report issued by an operations department of the German Army's
high command on 10 June 1941 and a statement made by Hitler on 4 August in which he alleges to quote "experts on the seasons and weather of Russia." Also quoted will be a statement made by Stalin on 31 July concerning the rasputiza expected in the fall of 1941. The report referred to above was prepared by Plett (1941) of the War Maps and Survey Department of the German Army and was issued by Operations Department I of the General Staff of the Army. It is a brief review (or overview [Oberblick]) of the climatic conditions of European Russia during the months August through October. While the review seems to be correct in light of the meteorological data available at the time, the author's remarks concerning the trafficability of roads in the USSR are not. On page 118 of the document (page 2 of the report), Plett says that in summer and autumn the roads become impassable only after abundant rainfalls. Then he goes on to make the statement that "in accordance with the rainfall amounts, road trafficability is expected to be worse in August than in September-October." On page 121 (page 5 of the report), he adds that in western Russia as far as Moscow, "the month of October offers good possibilities for military operations." As has been pointed out earlier in this section, October and the beginning of November 1941 produced deep layers of mud in most battlefield areas of the USSR. The author does not seem to have been acquainted with the simple facts of road and ground conditions that recur with some degree of regularity every spring and autumn in many parts of the USSR. The author also did not take into consideration the factor of evaporation, which is relatively large in summer and which drops off appreciably as from September, making for an increasing excess of precipitation over evaporation in autumn (see Table 3). Further, he does not appear to have been aware of the report of the soaking of soil during the spring-melting period cited in the opening paragraph of section 3.

Despite the fact that Plett's report was issued by an operations department of the Army High Command, it appears that it received no attention in higher echelons, for we find that at the beginning of August 1941 Hitler made a different statement. Toward July's end Hitler began to waver about his decision to operate on the Donets Basin, and concentrate instead on the reduction of Leningrad on the one hand, and on a major thrust to the south, on the other. The thrust to the south was to aim at the Donets Basin with its mineral and industrial wealth, as well as at the oil fields of Maikop in the Caucasus. (As from 1941 the Reich increasingly suffered from shortages of raw materials, including oil.) On 4 August Hitler flew to the HQ of the GAGC, accompanied by Field-Marshal Keitel, General Jodl, and others. On the part of the GAGC the conference was attended by von Bock, Guderian, and Hoth (Hoth was another important general). Hitler persuaded himself that the conquest of the south will deprive the USSR from much of its resources as well as enrich those of the Reich. Meteorologically, he tried to justify the diversion from Moscow to the south by quoting unnamed "experts on seasons and weather of Russia," according to whom the autumn-rain season of Southern Russia begins in September, whereas in the Moscow region it sets in about mid-October. A summary of Hitler's statement is reproduced as Document 88 in the Kriegstagebuch der Wehrmacht (1965, pp. 1041-1042).

With reference to Hitler's meteorological statement, it is not correct to speak of an autumn rain season either in the central or in the northern regions of the western USSR. The maximum of precipitation is in July and August. It is not precipitation but the excess of precipitation over evaporation that increases from summer to fall, as can be seen in Table 3. Added to Table 3 are evaporation estimates by Soviet meteorologists, as quoted in Lydolph's (1977) tables at the end of his volume. The estimates are those of actual evaporation. Curiously enough, four days before Hitler's above cited meteorological pronouncements, an essentially similar statement was made by Stalin—but with an important difference. On 31 July, Harry L. Hopkins, President Roosevelt's special envoy, had a long conversation with Stalin in the Kremlin, at a time when the offensive action of the German Army was still powerful. In the conversation, Stalin expressed his confident opinion that "it would be difficult for the Germans to operate offensively after the first of September, when the heavy rains begin, and after October first the ground would be so bad that they would have to go on the defensive" (Sherwood, 1948, p. 339). Stalin's expectation was fulfilled. We have pointed out earlier that a mud period, from about the tenth of October to the tenth of November, immobilized most of the German mechanized forces. Despite Hitler's statement of August that the "autumn rain season of the Moscow region begins about mid-October," in September he authorized a renewed thrust at Moscow to be launched 2 October. (Oberblick)

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Sources: Precipitation in 1941: World Weather Records, Mean precipitation 1931-60 (P) and estimates of mean actual evaporation (E) in the Western Soviet Union. All quantities are in mm.
Large-scale operations are impossible during the muddy season. In the autumn of 1941, an entire German army was completely stopped by mud. The muddy season of that year began in mid-October and was more severe than any other muddy season experienced in World War I or World War II. During the first stages cart and dirt roads were impassable, and then the road from Roslav' to Orel became mud-choked. Supply trucks broke through gravel-top roads and churned up traffic lanes until even courier service had to be carried out with tracked vehicles. Finally only horse-drawn vehicles could move; all other transport and the bulk of the tanks and artillery were stopped dead. The muddy season lasted a month.

5. A climatological study of the Central Weather Group (German)

After 25 June 1941 at the CWG, Flohn was requested to investigate the winter climate in the western USSR in a comparative manner. This study was based on the long series of temperature data for St. Petersburg–Leningrad since 1743, published by Wahlén (1881). In Wahlén's volume the mean daily temperatures of each month of the years 1743–1878 are printed on pages 15–17; the absolute minima of the individual months on pages 43–46; and the absolute extremes of each of the calendar days on pages 24–29. It was found that the sum of "degrees of frost" (Kältesumme in German, or sum of coldness) was a convenient tool for characterizing the severity of any given winter.

A diagram of the variation of coldness sums of severe and of mild winters was prepared, including the "famous" winter of 1812–13. The severity of the latter winter was surpassed by several other winters of the late 18th and 19th centuries, i.e. during one of the peaks of the "Little Ice Age," e.g., in 1808–09. Figure 1 has been drawn after a yellowish copy of one of the later versions of the diagram (during the relatively mild winter of 1942–43). A similar diagram—with cumulative graphs for other winters and the updated track of actual data measured at a mobile weather station 20-km southwest of Leningrad—had been demonstrated during the winter of 1941–42 to high-ranking officers and also to Hitler, see below. Flohn added the data for Potsdam, thus bringing out clearly the great differences in winter climate. Lacking better resources, such simple investigations formed the basis of CWG reports and forecasts.

Early in December 1941 the diagram was presented to Hitler. As was stated earlier, the diagram included the data for 1812–13. A witness whose name is not remembered, reported that Hitler, seeing the diagram, furiously exclaimed: "These damned meteorologists, also they are talking about Napoleon." Hitler would not tolerate the mention of winter 1812–13. Nevertheless, members of his staff frequently discussed it among themselves in the days of the December 1941 crisis. Major-General Warlimont (1962, p. 237), deputy chief of the Armed Forces Command Staff, who was with Hitler's HQ, writes that in the discussion among the staff, the book recording the conversations between Napoleon and General Caulaincourt (Napoleon's Ambassador to Tsar Alexander I until 1811), conducted during the 13-day long journey back...
The statement pointed out, additionally, that there is no comparison between Russian and German winters; even a "normal" Russian winter would be considered a very cold winter in Germany. (The temperature of winter, December through February, is around 0°C in Berlin, but -7°C to -10°C in Moscow.)

The text of the statement was approved by Diesing and it was presented to Göring, commander-in-chief of the German Air Force, in the presence of Colonel-General Jeschonnek, chief-of-staff of the Force, by O. Schuster, liaison officer of the CWG to the chief-of-staff. In Schuster's memory (verbal communication to Flohn), Göring's reaction was to bang his fist on the table and shout furiously: "In Russia it will never be colder than -15°C, the war goes on!"11

After the meeting Jeschonnek ordered Hitler's air force adjutant to report the statement to Hitler. It appears, however, that this was never done. As was pointed out in the previous section, the Russian winter was not to be mentioned in Hitler's presence. A kind of an exception is described in the next section.

7. Early December 1941 at the German High Command—Severe cold and a powerful Soviet counteroffensive

The first great and successful Soviet counteroffensive of the war in the Battle for Moscow, prepared and directed by Zhukov, opened on 5–6 December 1941. The counteroffensive, its ferocity and strength took the GAGC and the German High Command by surprise. The shock was all the greater that at the beginning of December some German Panzer units stood but 25–30 km from Moscow. The Soviets were effectively able to conceal the massing of their troops, tanks, equipment, and supplies for the offensive. Undoubtedly, the success of concealment was largely due to weather conditions that made it hard to carry out any aerial and other reconnaissance activities. Moreover, some three days before the start of the offensive the cold outbreak, to which reference was made in an earlier section of this paper, struck the German troops. They did not have appropriate winter clothing; many items of German weapons, tanks, and mechanized vehicles stopped functioning in the great cold. Even many of the German train engines malfunctioned below -15°C (see Appendix A).

The stunning success of the Red Army's offensive prompted Hitler and his staff to ascribe it to "a surprisingly early outbreak of a severe winter in the East" (Hitler's Instruction No. 39, dated 8 December 1941; reproduced in Hubatsch, 1962, p. 171). On 7 December, about a day after the launching of Zhukov's counteroffensive, O. Schuster, Diesing's deputy and liaison officer with the German High Command, was...
ordered to a conference with Hitler at his headquarters in East Prussia (Wolfschanze, near Rastenburg); also in attendance were Field-Marshall Keitel, chief-of-staff of the Armed Forces, Lieutenant-General Jodl, chief of the Armed Forces Command Staff (chief of Wehrmachtführungstab), and other high-ranking officers. Subject of the meeting was the weather situation in the East. According to Schuster (personal communication to Flohn), during the coffee meeting following the conference, Hitler repeatedly said: “If I had known this before.”

Any repentance that Hitler may have had (or affected), it was short-lived. The next day he was elated (Domarus, 1965, p. 1792) at the news of the attack on Pearl Harbor, which resulted in the outbreak of open hostilities involving the United States. The same day he issued the above quoted Instruction No. 39; on the 11th he increased Germany’s fatal entanglement by bringing war on the United States. On the 16th the German High Command issued an order to the GAGC, which directs commanders and officers to see to it in person that the troops put up “fanatical resistance” and hold their present positions, without regard to the enemy’s possible breakthrough to their flank or rear (Kriegstagebuch des Oberkommandos der Wehrmacht, 1965, Document No. 110, p. 1084). Document No. 111, dated 21 December repeats the “stick-to-your-position” order; item 5 orders that prisoners and inhabitants (of the USSR) should be stripped of their clothing without any consideration (rückzichlos). Returning to the events of 8 December, German radio broadcasts of the day spoke of a natural catastrophe (viz. the “a surprisingly early outbreak of a severe winter”) striking the German forces. No word was said about the forceful Soviet counteroffensive.

The reference adopted by Hitler’s HQ for the cold wave of early December 1941 in the Western USSR was used to cover up its own failure in preparing for the contingency of winter warfare and to conceal the disastrous effects of the unexpectedly powerful Soviet counteroffensive; from 30 November to 7 December, morning temperatures at Moscow dropped 28°C from -1°C to -29°C (Zhukov, 1984, p. 324). Temperature drops of nearly as large magnitude occurred in the past in the western USSR (Leningrad) around November’s end (that is, somewhat earlier than in 1941) or at the beginning of December. Although the frequency of such cases is low, it is not justified to call their incidence as “unexpected.” Three cases are mentioned here using Leningrad observations as daily temperature data are not available in published form for Moscow.

The three cases are as follows: 1812-13, 1855-56, and 1864-65. According to Wahlén (1881, pp. 111, 113, and 116), on 1 December 1812, the mean temperature of the day was -0.4°C on the 4th to -21.2°C. (The mean daily rates of temperature decrease were: 3.5°C·day⁻¹ in 1941, 5.3°C·day⁻¹ in 1812.) In 1855, on 21 November +2.0°C; on 30 November -22.1°C. In 1864, on 20 November -0.1°C on the 26th -23.3°C. Thus in these three cases the drops amounted to 21°C to 24°C. Moreover, both in 1855 and 1864, the winters set in especially early.

If the results of measurements of the early 19th century are admissible for comparison with those of recent decades, then November and, particularly, December 1812 were colder than the parallel months of 1941 in Leningrad. At the imperial capital in 1812, November had a mean temperature of -5.2°C and December -14.0°C (Wahlén, 1881, p. 16) while the World Weather Records show that in 1941 the parallel quantities were -6.2°C and -12.6°C. However, the modern data may be influenced by the growth of Leningrad.

8. A Soviet long-range weather forecast for January 1942

A review of some of the medium- and long-range weather forecasts made by Soviet meteorological (and hydrological) services in the war with Germany, as reported in Soviet literature, will be presented. A Soviet weather forecast for January 1942, a copy of which was accidentally found by German forces, will be discussed first.

The forecast predicted a “normal” January for the area of the Soviet Western Front, that is, for the Moscow Front, with a temperature departure of from 0°C to 1°C. We do not know what was the precise value of the normal adopted by the Soviet forecasters, but, if we take it that it was close to what was to become the 1931-60 CLINO for Moscow, viz. 10°C, and, if we compare it with the mean of -20°C for January 1942 (see World Weather Records and the forthcoming chapter III of this study), then the forecast underestimated the actual mean by 10°C. That is, the Soviet forecasters erred in the same direction as Baur. ¹⁴

Aside from the cold outbreaks in November and December (three major outbreaks in December) in the Western USSR, January 1942 turned out particularly cold, as indicated by the aforementioned mean value for Moscow. January was cold on the whole, but an extreme cold wave invaded during the last few days of the month. On 24 January an exceptionally cold pool of air (Kaltilufttragen) was advected from the northeast to the general area of Kaliningrad (then Königsberg) and Riga. The diameter of the upper-tropospheric cold pool amounted to, roughly, 500 km. and, although the pool center was about 700 km to the west of the area of the Battle for Moscow, the latter was affected as well. This cold pool was so exceptional that it became a kind of a textbook example. Scherhag (1948, p. 233) refers to it as “one of the most memorable phenomena of this coldest winter of the last 200 years in northern and eastern Europe.”¹⁵ Indeed, the mean temperature of the 500/1000 hPa air layer of this area of Europe was 1°C-2°C colder than the mean for the winter of Yakutsk, the cold pole of Siberia (Flohn, 1944).
9. Soviet reports on long- and medium-range forecasts in support of major military operations

Part of the May 1985 issue of the Soviet meteorological journal *Meteorologiya i Gidrologiya* is devoted to the 40th anniversary of termination of WWII in Europe. In an article titled "The USSR Center of Hydrometeorological Forecasting During the Period of the Great Patriotic War" ("Great Patriotic War" is the designation used by the Soviets for World War II as far as the USSR was involved in it), the author, the article, A. P. Zhidikov, states, on page 8 of his paper, that in addition to short-range forecasts, the Central Forecasting Institute regularly prepared forecasts for three days, for the "natural synoptic periods" (7-10 days), for monthly and for three-month periods. On page 9 of the same paper, the author writes that long-range forecasts were also made for the maximum flood elevation, monthly maxima and minima of water levels, dates of freezing, and breakup of ice cover of water bodies. Virtually no details are given and no mention is made of any cases where the forecasts failed although the state of the art of forecasting was, and still is, such that failures are likely to be incurred from time to time.

In the same issue, in a paper carrying the title "The Central Aerological Observatory During the Years of the Great Patriotic War," S. S. Gaygurov, G. I. Golyshchev, and N. Z. Pinus describe a medium-range forecast prepared at a special demand for 7 November 1941, the 24th anniversary of the October Revolution. It was desired to hold a major military parade in Moscow, provided that a low-cloud cover develops that day over the capital. The low-cloud cover was needed to prevent the German Air Force from bombing the parade. It might appear, perhaps, at first sight, that the forecast was not of military significance. It was militarily significant in so far, as the parade was to raise the morale of the people and the army. About mid-October, the German forces were but about 100 km from Moscow. This was serious menace. At the order of the Central Committee of the Communist Party and the State Defense Committee (one of the highest organs of the wartime USSR), a partial evacuation of Moscow began on the night of 16 October (Zhukov, 1984, p. 286). Several government and central committee offices and even some of the army directorates as well as the diplomatic corps were moved to Kuibyshev, about 800-km east of Moscow. The parade was intended to indicate that Stalin and all the authorities of the party, the government, and the army had faith that Moscow would not fall. The forecast was delivered personally to Stalin. It called for clear skies on the 6th and overcast skies with low clouds and snowfall on the 7th. According to the authors, the predictions turned out correct. On page 17 they present a time cross section of the weather for the five days, 4-8 November. The observations for 08 h on the 7th show snow falling, a surface temperature of -5°C and a sky with 10/10 nimbostratus. The isotherms of the cross section are drawn up to altitudes of 15-20 km and indicate a "warm low" close to the surface, overlain by cold air.

On pages 18-19 of their paper, Gaygurov, Golyshchev, and Pinus state that soundings of the Central Aerological Observatory were of great importance in both the planning and implementation stages of the counteroffensive of the Soviets in the Battle for Moscow in December 1941. They point out that while the air was relatively warm at the beginning of the month (about -4°C) in the general area of Moscow, the aerological observations for 3-4 December showed a rapid cooling of the troposphere with the approach of a cold front. The forecast for 5-7 December, the start of the counteroffensive, called for a rapid drop in temperature and a decrease in cloudiness. Clearly, the forecast was of great operational importance because it suggested that the Soviet Air Force would be able to participate in the battle.

Appendix A. Lack of winter clothing and malfunctioning of equipment during the winter of 1941-42

Hitler was directly informed that winter clothing for the German troops in the Easy lay for weeks at the Warsaw Rail Station by Colonel-General Guderian at a meeting on 20 December 1941, (see Guderian, 1951, p. 242). Colonel-General Halder, chief-of-staff of the German Army at the time, states in his war diary (Halder, 1964, p. 236; entry for 10 Novem-

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14 The issues of this Russian language journal are regularly translated into English and published (by Allerton Press, New York) in the journal *Soviet Meteorology and Hydrology* in the United States. It is to be regretted that the Publishers (or Editors?) found it "right" not to translate and publish the articles of historical nature in the May 1985 issue, despite the fact that the pertinent articles are important for the history of meteorology and for the role of meteorology in historical events of very great significance in human history.

15 The gravity of the situation in November and the need for morale lifting is illustrated by the following incident cited by Zhukov (1984): "I don't remember the exact date that Stalin telephoned me, but it was soon after the Germans' greatest tactical breakthrough... November 19, I think. He asked: 'Are you certain we can hold Moscow? I ask you this with pain in my heart. Speak the truth, like a communist.' Zhukov replied: 'We'll hold Moscow without doubt. But we have got to have at least two more Armies and no fewer than 200 tanks.'
ber 1941]) that the specific outfit will not be available to the troops before January in the case of the German Army Group South, and not before January's end in the case of the GAGC. Actually, the troops of the latter were engaged in the Battle of Moscow, and they needed the winter clothing even more than those of the Army Group South, but the number of locomotives, lines, various train-station facilities as well as the number of engine drivers were not able to cope with the demand, especially in the case of the center. In November, even before the great cold outbreaks, the GAGC received 16 trains daily in the mean, as against the 31 required (Halder, 1964, p. 299, [entry for 19 November]). The situation worsened as November drew to its close, as in the cold many items of weapons, tanks, and mechanized vehicles stopped functioning in many instances. Even the German locomotives malfunctioned in the cold. A report of the GAGC to the Army High Command, dated 10 December, a week after the first major cold outbreak, states that at temperatures below -15°C the rail services could supply only 50 percent of the needs; on occasions of blizzards and snow flurries, the trains stopped altogether (quoted in Reinhardt, 1972, p. 216). The frost that was awaited by the German Army during the mud period, came in with a vengeance.

Hitler and his associates reckoned that Soviet resistance will be broken by the winter and that, therefore, there will be no need for winter clothing for the whole of the force engaged in the war during summer and autumn in the USSR. After the onset of the cold, the German population was urgently requested to collect furs, coats, warm underwear, and socks; the soldiers had to use newspaper under their uniforms for thermal insulation.

Zhukov (1985, p. 41) remarks that

'It is true that Nazi soldiers wrapped themselves up in clothing seized from the population and walked about shod in unsightly home-made 'galoshes'. Warm clothing and uniforms are also a weapon. [Authors' italics.] But the Nazi Army was not prepared for the winter.

Despite the profound truth in Zhukov's maxim that "warm clothing and uniforms are also a weapon," the Soviet army was not adequately prepared for the winter either, especially in the early part of winter 1941-42. Marshal, Golikov (1984, p. 314), commander-in-chief of an army formation in the Battle of Moscow, writes the following:

In mid-November (1941), the commander of the 323 Division sent me the following message: 'In connection with the onset of heavy frosts, I request your permission to postpone the Division's drill for a few days, in view of the fact that the men are in summer uniforms, garrison caps and without gloves. During the November 12 drills the Division had incidents of first degree freezing of the extremities.'

Pages 315-316 refer to shortages of food, arms, and equipment. He returns to the subject of lack of winter clothing and writes as follows:

We were greatly worried by the lack of winter uniforms. The 323rd, 325th, and 328th divisions had no padded jackets and trousers, warm foot-cloths, caps with earmuffs, or gloves, until mid-November. The 322nd and 330th Rifle Divisions had only 30-50 percent of their quota of warm clothing. The lack of overcoats and undergarments was especially bad in the 324th Rifle Division.

At the time the Soviet troops most properly dressed for the winter (and envied by the Germans) were those of the divisions brought over in October and November 1941 from Eastern Siberia, after Stalin was ready to give credence to messages of his outstanding spy in Tokyo, Japan, Richard Sorge, and other sources of intelligence that Japan prepares to go against the United States and not against the USSR.

In August 1942 the German High Command brought out a kind of a handbook Taschenbuch für den Winterkrieg in which a great number of suggestions were put forth on how to cope with winter conditions using the simplest local resources. This handbook was translated and published under the name German Winter Warfare (1943) by the Military Intelligence Division of the US War Department.

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