FIGURE 1.—Ptolemy's map, A. D. 150, showing Dnieper River (Borysthenes)

THE FLOW OF THE DNIEPER RIVER

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[Jackson, Mich., January 29, 1931]

The Dnieper is the third largest river on the European continent. It was well known in antiquity, as shown on Ptolemy's map from his Geographica, A. D. 150. (Fig. 1.) The ancient Greeks named the great stream Borysthenes, after a Greek city located near the mouth on the north shore of the Euxine (Black Sea), a colony of Miletus in Asia Minor. Named Danapris by the Romans, Uzi-Uzu by the Turks, Eksi by the Tartars, Lerene by Contarini (1437), and Luosen by Baptista di Genoa (1514), its great drainage basin has been the stage of momentous scenes in history. Napoleon's armies perished while crossing the Beresina, one of its tributaries.

At present one of the great power stations of the world is under construction on this river by the Moscow Government, in consultation with Col. Hugh L. Cooper, builder of the Muscle Shoals and other large power dams. The dam is located in 47° 49′ north latitude and 35° 8′ east longitude. The backwater curve extends over a distance of 150 kilometers upstream. This great work is based on an exhaustive study made by Professor Alexandrov (1) from which the following data are taken.

The drainage area of the Dnieper above the rapids is 460,000 square kilometers. The average rainfall on the drainage basin is 540 millimeters (21.3 inches) per year. The average yearly run-off is 110 millimeters (4.3 inches) over a 40-year period, or 20.2 per cent of the rainfall. The mean annual temperature is 8.6 C. Snow cover is usually insignificant, hence the soil freezes to about 1.7 meters in depth.

The whole drainage area is practically level; near the lower reaches the river breaks through the granites and gneisses of ancient proterozoic formation and drops about 37 meters over a length of 150 kilometers.

The discharges of the Dnieper in the rapids are recorded at the long-established gaging station, Lotsmanskaja Kamenka, situated between the upper extremities of the rapids and the mouth of the Samara River. Daily discharges were computed for 49 years and special attention was given to the discharge under ice cover. These were analyzed as shown in Figure 2.

In this graph the discharge is resolved into the Clough cycle and a residual; the sum of both is equal to the original hydrograph.

It may be seen that the Clough cycle averages 28.5 months, or closely equal to the average value evaluated by Mr. Clough (2). This cycle varies the flow from 100 to 900 cubic meters per second between maximum and minimum of the cycle. Subtracting the Clough cycle from the hydrograph, the residual curve is obtained, which shows some remarkable characteristics.

The Wolf (11-year) cycle is at once plainly visible, and apparently culminates during the maxima of the Wolf numbers. Superimposed on this Wolf cycle is the Horton cycle of 5.5 to 6 years, so-called after R. E. Horton, who first discovered this cycle in stream flow in the year 1898 (3). The maxima and minima of the Horton cycle coincide with the maxima and minima of the Wolf numbers in a remarkable manner.

In its correlations with the Wolf numbers the chart compares very favorably with the records from the Great Lakes region in North America. The maxima of flow agree with both the maxima and minima of the Wolf numbers with neither lead nor lag, constituting the best example of this relation which the writer thus far has found.

The watershed is part of the great plains of Russia, and this confirms that the above-named relations are very pronounced in the continental plains, but show greater dispersion in mountainous regions. The flow of the Danube River near Florisdorf, draining the Austrian and Bavarian Alps, does not show a marked correlation. It seems that the presence of mountain chains has a tendency to disturb the general circulation of the atmosphere, and with it the sequence of precipitation and runoff. Also on the North American Continent do the flow records show the same characteristics.

The difference between the maxima and minima of the Wolf and Horton cycles (combined) is as much as 1,000 cubic meters per second. The flow during maxima is up to 80 per cent greater than the flow during minima.

Here again the vast difference between meteorological and hydrometric data is demonstrated. The difference

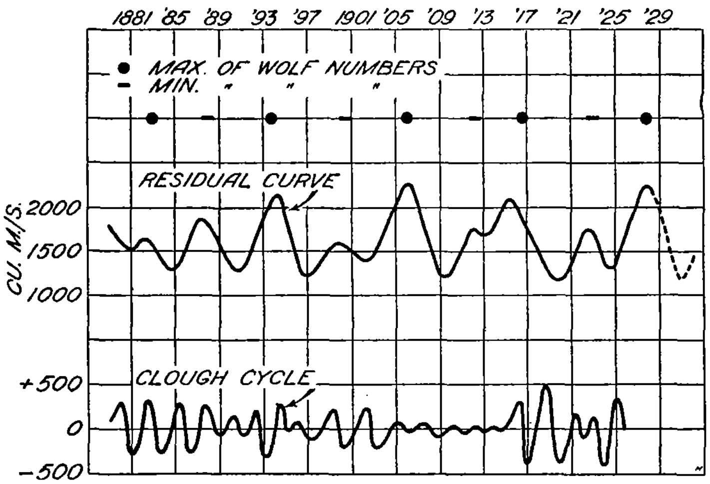

FIGURE 2—Flow of Dnieper River. From data furnished by Professor Alexandrov; Dnieprostroy project

in temperature due to the Wolf cycle is less than 1° C. (4), but the flow of this river varies as much as 80 per cent due to some unknown agency apparently in unison with the Wolf cycle (5).

As to the prognostication of future flow, it may be seen that 1931 should be a dry year on the Dnieper. The exact period of 22.6 years, or Brückner cycle (5) is here between minima fairly well confirmed in the stream flow. The distances between the minima of flow of the residual curve are 22, 24, 22, 23, 22 years, average 22.6 years. This should bring the next minimum in 1931. The low river stages will be favorable for the completion of the great Dnieprostroy dam and powerplant.

In explanation of the name Brückner cycle for the 22.6-year period, whereas it usually is supposed to have a length of 35 years, it may be referred to a previous article in the October, 1929 issue of the MONTHLY WEATHER REVIEW.

More can be concluded from the data shown as to future expectations. The next maximum will probably occur in 1935, and a high maximum in 1940. The amplitude of the Brückner cycle (not shown) is estimated at 350 cubic meters per second. Referring to Figure 3, page 408 (5) the mean flow should reach a level toward the period 1945–1950 which may be 500 cubic meters per second greater than the present long-term average. The increase in the general mean of 1,600 cubic meters per second would amount to as much as 31 per cent. This latter estimate is necessarily uncertain and depends on the expectation that the "secular" cycle will repeat itself in the future with similar amplitudes as in the past. Accurate records are too short to conclude this with the same degree of probability as is possible in the case of the Horton cycle.

Thus the great Borysthenes of the anicent Greeks demonstrates the apparently close relations between variations in streamflow and the solar cycle. The records on which the above investigation is based were obtained by courtesy of Mlle. T. Maretsky, chief hydrologist, Nijne Dnieper, Moscow, Union of Socialist Soviet Republics.

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SANDSTORMS IN TEXAS

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Large volumes of sand and dust are occasionally raised by the wind in dry weather over the western plains of the United States. These storms are of three distinct types: (*a*) Strong winds blowing across the plains sometimes attain gale force over a wide area and pick up large quantities of dust, particularly in late winter and early spring when the ground is bare and especially over cultivated land. Such winds attain their highest velocities during the day. (*b*) The second type is the whirlwind, very local and of minor importance; these whirls, sometimes called "sand devils," occur on hot summer afternoons when the lapse rate equals or exceeds the adiabatic. From an airplane they can be seen for miles and easily avoided. (*c*) The most spectacular storms appear to form along the wind-shift line of a barometric trough; they may therefore be expected when cyclonic activity is at a maximum.

Figure 1 shows a sandstorm approaching Big Spring, Tex., on the afternoon of September 14, 1930. It occurred in an elongated LOW that moved eastward across Texas on that date. The trough of low pressure extended at least from the Rio Grande Valley to northern Kansas. At 10 a. m. (ninetieth meridian time) there was a moderate sandstorm at Abilene, with a 20-mile south wind, and thunderstorms were occurring near Wichita Falls, Tex., Oklahoma City, Okla., and Springfield, Mo. At 1 p. m. there were fresh southerly winds from central Texas to Kansas and moderate northerly winds in the Panhandle and west Texas. At 4 p. m. Amarillo reported "moderate sand storm since 1 p. m.," and thunderstorm activity continued in the northern end of the trough, in Missouri. At 7 p. m. scattered thunderstorms were reported from the middle Rio Grande Valley to Kansas and Missouri.

The exact time of the Big Spring storm is not known, but judging from the shadows cast by the sun in Figure 1, it was approaching from a westerly direction at about 4 p. m. The sun was obscured in the second exposure and it was getting much darker in the third, due to the approach of the wall of dust.

Typical of the dry atmospheric conditions in west Texas, the temperature at 7 p. m. at El Paso was 86 and the dew point, 17; at Amarillo, 78 and 35, and at Abilene, 94 and 34. These conditions give rise to "dry squalls" in the semiarid plains of the West—a sudden shift of the wind through 90° or more generally from a southwesterly to a northwesterly direction. The speed of the wind in some of these dry squalls at times reaches gale force and is very gusty. In more humid regions these wind shifts are accompanied by thunderstorms and line squalls.

While the dry squalls do not usually equal in violence the line squalls of humid regions they are always very turbulent and at times violent. Except for the dust they may be practically invisible to the pilot in the air. Pilot J. G. Ingram relates that a few years ago he was flying across a wind shift in west Texas, when the ship dropped a thousand feet and was then carried up above its previous level, accompanied by violent turbulence. Pilot Homer Rader, flying between Dallas and El Paso, passed over a dry wind shift in west Texas late in 1930. From an altitude of 5,000 feet the ship settled slowly at first and then ran into a really violent windstorm, without rain or clouds. The ship was carried up 1,500 to 2,000 feet and dropped a like amount. The air was so rough that control of the ship was at times taken from him, and to relieve the strain the ship was allowed partly to adjust itself to the shock of the variable movements of the air.

Severe sandstorms for more than a short time are unusual, and flights are seldom canceled because of them, for, although the visibility may be zero at times, the dust comes in waves with the gusts of wind, and during the lulls the visibility improves enough for flight.

At times the sand drifts along the ground like drifting snow obscuring the ground but not rising to any great extent. Dust enough to interfere with visibility occasionally rises to 10,000 feet or higher, but it is more likely to be below 6,000 feet so that the pilot can climb above it. At other times the dust rises in columns like cumulus clouds and the pilot can fly around it.

The downward draft of a strong wind blowing across a mountain range often has a focus where it strikes the ground in the lee of the mountain, raising a layer of dust as well as making landing dangerous on account of the currents which are extremely variable in direction and force.

The following notes on sandstorms are furnished by Mr. W. H. Green, Weather Bureau official at Abilene, Tex.

Most of our sandstorms occur with moderately high westerly winds, being rather severe when the wind reaches 33 miles or above. They seem to be most severe when the wind is from west-northwest. High winds from other directions sometimes cause considerable dust but usually precede thunderstorms and are therefore of short duration.

The severity of the sandstorm depends to a very great extent on whether or not the ground is bare or covered with vegetation