tion progresses, up to a certain point, and after that an increase. According to the first two, the minimum size is reached at about 12° past midday for Linné, and the diameter about sunset is slightly less than about sunrise. Prof. Wirtz, on the other hand, finds the minimum size occurs 12° before midday, and the diameter at sunset to be much larger than at sunrise, which would indicate a certain melting during the lunar night. All three agree, however, that the diameter fluctuates through a range of about 3″. Irregular changes in the shape of the spot and its surroundings were noticed by all three observers.

Thus, Prof. Barnard, on September 1, 1903, detected a small bright point preceding the spot, 5.4″ from its center. On February 12, 1905, Prof. Wirtz saw two irregular, extremely delicate, bright offshoots on the otherwise well-rounded spot; the next day these offshoots had disappeared, leaving the spot slightly elongated. Other observers besides the writer have found the size of the spot to increase slightly at the time of a lunar eclipse, so that a certain amount of literature upon the subject has already accumulated.

Mr. J. G. Burgess, of the British Astronomical Association, has recently called my attention to a spot situated some 12 miles north of Littrow *B*, in longitude 330°, latitude +22°, which is of the Linné type, and according to his description should be of greater interest than Linné itself at the present time, since it contains considerable fine detail close to the crater. His statements are in part confirmed by the writer's Photographic Atlas.[4] Mr. Burgess proposes soon to publish an account of his observations, the results of which in general resemble those made upon Linné. The writer examined the region February 2, 1915, at 132.8° and found covering it at that time a very thin white veil whose density was 0.2 of a unit of brightness. This veil was 6 miles in diameter. The next night it had entirely disappeared. This spot should be of particular interest at the time of a lunar eclipse, since the detail near the crater should make drawings available, thus avoiding some of the subjective systematic errors incident to micrometric measurements.

Conclusion.

It has been the writer's object in the present article to show, not that periodic changes occur in the brighter regions of the lunar surface, for that was known before, notably in the case of the region surrounding Tycho, but to show in just what these changes consist. For this purpose he has selected small bright spots lying in regions showing sharply defined minute detail, in order that the minute changes everywhere occurring upon the moon could be more clearly defined. In order to make the study general, he has also selected the three different types of surface—elevations, depressions, and level areas.

The point of first interest, perhaps, in this investigation is to find when the spots reach their minimum size. Within the craters the dark areas appear and disappear at about the same interval before and after midday, which therefore seems to be the time when the snow presents the smallest area. In the case of Linné, Prof. Barnard and the writer agreed that the minimum occurred one terrestrial day after lunar midday. Since the deviations of their observations from their respective curves were appreciably smaller than those of Prof. Wirtz, doubtless due to better atmospheric conditions in America, and since a minimum occurring after noon seems more probable than one occurring before it, the writer has adopted that view. It would certainly be of interest to prepare a series of drawings of the craterlet near Littrow *B* and determine when its minimum occurs. In the case of Linné and apparently also of Littrow, the white spot is invisible both at sunrise and sunset. Just why this should be so is not very clear, but it would seem to indicate that the moisture can only escape from the vent about midday, and that toward sunset it all evaporates. Toward noon the evaporation occurs before it can get far from the vent; hence the spot is smaller, although brighter at that time than earlier or later.

In the case of the mountains, Pico, Pico *B*, and Straight Range, most of the white spots grow smaller the longer the sun shines on them. Those on the west side of the mountains, toward the rising sun, are of full brightness when the sun first strikes them. Those on the east do not deposit until the sun has been shining on the region for a day or two. It appears as if the ground some little way beneath the surface must be heated up before the moisture can escape. The spots on the western side, on the other hand, must be formed very shortly after the sun sets on them, but while it is still daylight in the surrounding region, for it is clear that nothing can deposit during the night, or both sides of the mountain would be brilliant when the sun first reached them. Pico *c* was seen in January, 1915, distinctly to grow in size and spread over the dark surface of the mountain between colongitudes 9.0° and 16.6°. It then decreased in area until 32.9°, figure 2, after which it increased a second time in size until 55.9°, figure 3, and then rapidly diminished until 68.1°. It had not changed at 81.8°, figure 4, but when the region was next observed at 132.2° the spot was found to have disappeared.

The writer has sometimes been asked, "*What reason is there to believe that there is ice upon the moon?*" The answer is: "For the same reason that we believe there is ice upon Mars, because the phenomena observed can be more readily explained that way than any other." Whether the ice is deposited upon the surface or floats as inute crystals just above it in the form of surface clouds o fog, is not yet clear, but it is believed it occurs in both rms. Where the boundaries are sharply defined it lies pon the surface. Where the boundaries are indistinct and hazy—as, for instance, in the case of Linné—it is still uncertain. In the case of the bright rays surrounding Tycho, it is thought the ice crystals are supported in the lunar atmosphere like those terrestrial cirrus clouds to which we give the name "mare's tails."

AGRICULTURAL METEOROLOGY.[1]

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[Dated: Weather Bureau, Columbus, Ohio, 1915.]

(Author's résumé.)

In this paper agricultural meteorology is defined as meteorology conducted in the interest of agriculture. A part of agricultural meteorology is agricultural climatology, which shows the effect of climate upon the geographical distribution of vegetation and the adjustment of farm activities.

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4 Annals, Harvard College observatory, v. 51.

1 Read before Section IIB, Second Pan-American Scientific Congress, Washington, Dec. 28, 1915. Will appear in full in the special publication issued by the Ohio Academy of Sciences on the occasion of its twenty-fifth anniversary.

Russia has apparently taken the lead in trying t determine the most critical period of growth for field crops, although Canada has recently started investigations along similar lines.

The United States Weather Bureau has long maintained special services in the interest of agriculture which may be classed under agricultural meteorology, such as the special corn and wheat region service, cotton and rice service, fruit service, etc.

The personal investigations of the author have been to find the critical period for farm crops and the weather most affecting them by correlating the crop yields with the weather conditions for periods long enough so that accidental coincidences will be eliminated.

This has been done graphically by the curve chart and the dot chart, as well as by the mathematical calculation for giving the exact measure of relation between two factors, as expressed in the correlation coefficient.

The crops considered in this paper have been corn, potatoes, and winter wheat, and the periods covered between 50 and 60 years.

Most of the correlations have been made between the yields and the temperature and rainfall for calendar months and groups of months. From these correlations it has been found that the most important weather factor for corn is rainfall and the most important month July. For potatoes the most important factor is temperature, and the critical month is also July. March is the critical month for winter wheat and temperature is the most important weather factor.

The critical rainfall point for July, in its effect upon the corn yield, is 3 inches. It is found that a variation in the rainfall of one-fourth inch in July in Ohio at this critical rainfall point makes a variation in the corn yield of nearly $3,000,000, and a variation of one-half inch in the rainfall a variation in the yield of over 15,000,000 bushels. In the four greatest corn States of the central part of the United States a variation of one-half inch of rain at this critical point makes a variation in the value of the amount of corn raised of $5 an acre, or a total of $150,000,000.

When the rainfall in Ohio in July is more than 1 inch above the normal the probability of the corn yield being above the normal is 92 per cent, and when the rainfall is 1 inch or more below the normal, the probability of the corn crop being above the normal is only 13 per cent.

While July must be wet and moderately warm for the best crop of corn, it must be cool and moderately wet for the best development of potatoes. If July averages more than one degree a day warmer than the normal the probability of the potato crop being above the average is only 12 per cent. When the temperature has been above the normal and the rainfall more than one inch either greater or less than the normal, the yield of potatoes has always been less than the normal.

Weather effects for shorter periods than months have been determined, and it has been found that the most important 10 days for corn is immediately following blossoming, when it must be wet and moderately cool. For potatoes the 10 days following blossoming must be cool and should be moderately wet. For arbitrary 10-day periods the most critical for corn is from August 1 to 10, and for potatoes from July 1 to 10.

In connection with winter wheat it is found to be much more difficult to determine the dominant weather factor as well as the critical period of growth for any fall-seeded crop or one with a long growing period than for spring-seeded crops or those with a comparatively short-growing period.

Careful correlations between rainfall for months and groups of months and the yield of winter wheat in Ohio show that the rainfall is neither too great nor too little often enough to have an appreciable effect upon the yield in calculating for the correlation coefficient.

Neither are the temperature variations great enough to show a dominating effect except for the month of March. If we consider only those years when the mean temperature has varied two degrees or more a day from the normal the probability of a wheat yield being above the normal is 94 per cent with a warm March and only 25 per cent with a cold March.

It is customary to credit a good snow covering with a good yield of winter wheat or to say that a lack of snow blanket is sure to cause a poor yield. But careful correlations made in Ohio seem to show no beneficial result from a snow covering or damage from lack of it. At least the snow covering does not have a dominating influence. On the other hand, the studies seem to show that bare ground with freezing and thawing weather in January is beneficial.

Further, while a snowfall in January seems to be favorable it is found, contrary to the usual opinion, that snowfall in March is decidedly detrimental to winter wheat. In several counties of the State it has been found that in nearly every instance the greater the snowfall in March the less the wheat yield, and that when the snowfall is light the yield is nearly always above the normal.

It is believed that one of the first developments of agricultural meteorology should be to find the critical period in the growth of the various staple crops in different sections of the country, and that when these are found all farm activities can be put on a much more profitable basis.

Those who irrigate in the western districts will know better just when to apply the water for the best results, and farmers in the central and eastern districts will learn that it will pay to aid natural rainfall by irrigation.

It is believed that this new agricultural meteorology when properly developed will enable us to express rainfall in terms of cash value rather than in inches, temperature in the ability of the farmer to buy instead of in degrees, and sunshine in the increased number of automobiles and tractors rather than in calories.

BREATHING WELLS AND PRESSURE CHANGES.

Mr. John Free, of New Carlisle, Clark County, Ohio, has kept a daily record of the "breathing" of his well (see this REVIEW, Nov., 1915, p. 562) through the month of February, 1916, and has sent it to this bureau with the remark "In looking over the high and low pressure maps for November I see that none crossed Ohio; but my well was active just the same."

This record is very interesting for it permits us to compare the subterranean conditions with the pressure-changes going on at the earth's surface and recorded at our Weather Bureau stations. The following table presents Mr. Free's observations, and in addition the 12-hour changes in pressure at Columbus, Ohio, as telegraphed to the central office at 8 a. m. and 8 p. m. daily.