# Meetings

## Agricultural Meteorology

The sixth national conference on agricultural meteorology of the American Meteorological Society was held 8–10 October 1964 at the Nebraska Center for Continuing Education, University of Nebraska, Lincoln. The 41 papers which were presented covered a broad spectrum, from meteorological instrumentation through energetics and biometeorology to Markov chains and drought climatology. They ranged from basic theoretical studies to "fire fighting," or quick applied answers needed for immediate problems.

In the opening session, which was devoted to instrumentation, J. Pearson (University of Illinois) discussed a system for measuring the emanation of radon-222 from the soil surface, a procedure suggested as a method of estimating the diffusion of water vapor and carbon dioxide from the soil surface. H. Vaughan (Iowa State University) described one of the first single-beam infrared instruments developed specifically for direct measurements of carbon dioxide and water vapor in the lower atmosphere; this is a rugged field instrument troubled mainly by the transmission characteristics of the optical system. G. Robertson (Canada Department of Agriculture) pointed out how light measurements in several biologically important bands of the spectrum vary under different weather conditions, within the plant canopy, and diurnally. This work illustrates the difficulties in properly balancing incandescent and fluorescent lighting to simulate natural conditions in climate control chambers.

Several of the papers presented dealt with aspects of the U.S. Weather Bureau's new Agricultural Meteorological program. V. Valli (Tifton, Georgia) described the data-logging systems recently purchased by the Bureau; L. Hand (Portageville, Missouri) suggested a method of estimating moisture within a cotton lock to improve the quality of harvested cotton; and J. Hursh (Stoneville, Mississippi) evaluated the effect of several petroleum mulch treatments as reflected by soil temperature and the developmental response of cotton.

K. Knoerr (Duke University) showed that the overall energy balance and Bowen ratio over plant canopies result from an integration of heat sources or leaves in the sun and heat sinks or shaded leaves in the interior of the plant canopy. E. Plate (Colorado State University) demonstrated the use of wind tunnels in predicting the wind speed distributions inside and above crop covers. While wind barriers were shown to decrease wind speed and evaporation as measured by atmometers inside and outside a sheltered area, N. Rosenberg (University of Nebraska) found that the actual transpiration from sheltered bean plants was greater than that from unsheltered plants. This effect was shown to be due to physiological control of transpiration. J. Griffiths (Texas A&M), using only temperature to estimate evaporation from pans, reminded members that simple relations may be quite useful if restricted to appropriate areas and that they can furnish information valuable in agricultural operations and meteorological network planning.

A lively discussion session on instrumentation needs in agricultural meteorology followed. The earlier papers were discussed, especially one by C. Sakamoto and H. Vaughan (Iowa State University) which dealt with discrepancies in temperature readings according to the size of thermocouple used, and whether or not the thermocouple was ventilated or shielded. The discussion revolved around the broad question of sophistication and accuracy of instruments balanced against durability, portability, and simplicity, as related to the specific purpose for which each instrumentation effort is intended. More than one member criticized manufacturers for the low quality and poor calibration of many instruments, but it was also clear that the researcher should know what he wants to measure before purchasing equipment.

The temperature-humidity index was used by H. Johnson (University of Missouri) to show depressional effects of high temperature and humidity on milk production in cattle. E. Van Arsdel (U.S. Forest Service, St. Paul, Minnesota) presented a convincing meso-climatic explanation for the geographical location of outbreaks of White Pine blister rust on the Upper Peninsula of Michigan. He used actual chemical smoke tracers to illustrate the movement of the lake breeze, which he postulated as the mechanism for the transport of blister rust spore from White Pine to the host currant plant. W. Lowry (Oregon State University) showed how graphical analysis could be used to interpret plant responses from more than one weather variable and used data from Went and others to show photoperiodic effects of day and night temperatures. Working with 20 normal-yield years, 10 poor-yield years, and 10 high-yield years, J. Caprio (Montana State College) used Chi-square tests to delineate the growth periods in which wheat is most sensitive to temperature and precipitation.

T. Crawford (University of California) startled meteorologists by displaying results which showed close agreement between observed heating requirements for protection of orchards from freezing and requirements as computed from two theoretical meteorological models, one for neutral cases and the other for turbulent transfer conditions. In comparing long-range forecasts with climatological estimates of dates of last freeze in the spring, J. Ellis (U.S. Weather Bureau, Washington, D.C.) verified that freeze dates forecast up to three days in advance were more accurate than climatological probabilities. He demonstrated that conditional climatological probabilities based on the consecutive anomalies of the 3 months February, March, and April showed some degree of forecasting skill in Michigan.

The contributions which agricultural meteorology has made to other fields and the spheres to which research and coordinative efforts should be directed were the subject of an open-floor discussion. The consensus was that the most promising agricultural mete-

orological work under way at present and envisioned for the future will be carried out by teams of researchers consisting of physiologists, agronomists, meteorologists, and representatives of other disciplines needed in a specific research endeavor. J. Young (University of Nebraska) suggested that agricultural meteorological work has not helped as much as it could in agricultural problems, not because information is not available but because it has not been applied. J. McQuigg (U.S. Weather Bureau, Columbia, Missouri) challenged the members to forget they are meteorologists and approach specific problems from the standpoint of the person who must decide how to solve them. An analysis of the decision-making processes will show whether or not weather information would be helpful, and if so, how and when and what information is required.

At the final session L. Pierce (U.S. Weather Bureau, Columbus, Ohio) showed from measurements of soil moisture made simultaneously under fallow and under corn that soil moisture is first used directly beneath the row of corn and exceeds evaporation from a fallow surface when the corn is about 18 inches (46 cm) high. Only when the reservoir had been depleted was the moisture between the rows extracted. Surprising persistent differences in measured precipitation due to differences in elevation of less than 20 feet were presented by A. Eichmeier (U.S. Weather Bureau, East Lansing, Michigan).

A study of departures from normal precipitation reported by S. Changon (Illinois State Water Survey) indicates that droughts in Illinois tend to have a SW–NE orientation and are more severe in the southern part of the state. W. Palmer (U.S. Weather Bureau, Washington, D.C.) applied his method of measuring the severity of meteorological drought to the study of drought patterns and frequencies in the eastern and central United States. The conference closed with a study of drought in relation to corn near Ames, Iowa. R. Dale (U.S. Weather Bureau, Iowa State University) speculated that the combined frequencies of soil moisture supply and atmospheric evaporative demands result in moisture stress conditions which reduce corn yields in about half of the years.

ROBERT F. DALE
*Office of the Regional Climatologist, U.S. Weather Bureau, Ames, Iowa*

## Orbits in the Solar and Stellar Systems

In recent years much new work has been stimulated in dynamical astronomy by new observational techniques, by applications of powerful computing facilities, and by a renewed interest in the mathematical analysis of dynamical systems. Results of some of this work were reported at the International Astronomical Union Symposium 25 on the Theory of Orbits in the Solar System and in Stellar Systems, held 17–22 August 1964 in Thessaloniki, Greece, in conjunction with the 12th General Assembly of the IAU. Sixty-five astronomers representing 13 countries participated in the symposium.

Owing to results announced years ago by Kolmogorov, the problem of small divisors has at least been partially solved by topological methods. These investigations are important toward achieving a better understanding of the nature of integrals of dynamical systems and therefore of orbits in the solar system as well as in stellar systems. In view of the significance of their contributions to this area of research, it was particularly regrettable that no Soviet scientists participated in the symposium; the organizing committee had invited a strong representation from the Soviet Union, but had been informed that organizational difficulties would prevent their participation.

The keynote address of the symposium was given by G. Contopoulos (Greece) on the subject "Recent developments in stellar dynamics." This address foreshadowed the considerable interest during the symposium in the subject which is generally, but not entirely accurately, called the "third integral." A dynamical system of $n$ degrees of freedom is represented by a system of differential equations of the $2n^{th}$ order. Integrals of such a system of differential equations are helpful in obtaining the solution of the dynamical system; their role in promoting the understanding of the general behavior of the system is essential. The existence of integrals expressing energy and momentum conservation in galactic problems permits reduction of the order of the differential equations. An additional integral (the third one in this special case), if available in analytical form, renders problems of two degrees of freedom completely solvable since the last integral can always be found.

Depending on the force field (that is, potential field), additional integrals can be found analytically or numerically, exactly or approximately. An $n$-body gravitational problem, for instance, has ten known integrals, the restricted problem of three bodies using rotating coordinates has only one, the generally used galactic potential problem has two, and so forth.

Significant progress indicating the existence of a second integral of the restricted problem by numerical experiments was shown by M. Henon (France) for a large variety of initial conditions. For collision orbits and for the elliptic restricted problem, similar results were offered by V. G. Szebehely (Yale). A. Ollongren (Netherlands), L. Perek (Czechoslovakia), and B. Barbanis (Greece) made contributions to the third integral of galactic problems.

The pure concept of an integral of a system of differential equations is stretched somewhat and is intermingled with the ergodicity of the system; nevertheless, at a time when experimental evidence is accumulating, a rigid sorting out of results of special and general significance seems to be difficult.

The two generally accepted dynamical models available for studying the behavior of stellar systems are (i) the averaged potential and (ii) the $n$-body field. The first of these was discussed in some detail in connection with the concept of the "third integral." The second was a subject of considerable interest at the meeting, since the availability of large-scale, high-speed digital computers makes it possible to find simultaneously the motion of an impressive number of particles. These bodies all attract each other according to the Newtonian gravitational force. Results of numerical integrations were described for order of 10 and order of 100 bodies. The contributors' understanding of the difficulties of such undertakings assured a most profitable exchange of information. Improvement of analysis and numerical techniques seems to be necessary if meaningful results are to be obtained in the future. S. M. Ulam (Los Alamos), R. H. Miller (University of Chicago), and S. Aarseth (England) discussed results of considerable interest.

The outstanding contribution presented during a session called "New method in celestial mechanics" was by W. J. Eckert (I.B.M.), who gave an account of his numerical verifica-