tion in geographical position, that we are to find an explanation of the modified effects of temperature.

The results of recent investigations on this theory seem to warrant the recognition of a principle of modified thermal influence which is intimately related to the principles on which the bioclimatic law is founded.

In an effort to determine a gradient or unit constant by means of which the intensity of this modifying influence, *from whatever cause*, could be measured and computed, it was found that a general average rate of 0.25° F., or its equivalent of one day in time, for each 1° isophane and 400 feet of altitude could be utilized for correcting the recorded thermal means or the computed date constants for any given geographical position so that there would be a reasonably close agreement between the cause as represented by the modified temperature and the effect as represented by the recorded date of an event.

In comparing the departures of the recorded from the computed dates of events in the different regions by the modifying method it was found that, in general, the regional departures, as determined by the usual method, were accounted for. It must not be expected, however, that anything but the general regional influences can be interpreted by this method because it can not provide for the topographic and other influences which are reflected in the local departures.

There is need of further investigations of the problems relating to this proposed principle and it is hoped that they will receive due consideration by meteorologists as related to the laws and principles of temperature, light, etc., and by biologists and physicists as related to the practical application of the principle in their investigations of the responses of organisms to the influences represented by temperature and other elements and that there will be cooperation in the investigations of the relations of causes and effects.

It appears, however, that the present state of information on the coordinate relation of thermal unit constants to the other unit constants of the law will justify a revision of the first table of coordinates[2] as related to (*a*) latitude, longitude, and altitude, and (*b*) the isophanes and altitude, as follows:

Tables of geographic coordinates and unit constants of the bioclimatic law.

(*a*) FOR LATITUDE, LONGITUDE, AND ALTITUDE.

Coordinates.	Unit constants.				
				Modifying.	
Geographic.	(*a*) Geographic.	(*b*) Time.	(*c*) Thermal mean.	(*d*) Thermal.	(*e*) Time.
			°*F.*	°*F.*	
1. Latitude	1°	4 days	1	0.25	1 day.
2. Longitude	5°	do	1	.25	Do.
3. Altitude	400 feet	do	1	.25	Do.

(*b*) FOR ISOPHANES AND ALTITUDE.

Coordinates.	Unit constants.				
				Modifying.	
Geographic.	(*a*) Geographic.	(*b*) Time.	(*c*) Thermal mean.	(*d*) Thermal.	(*e*) Time.
			°*F.*	°*F.*	
1+2. Isophane	1°	4 days	1	0.25	1 day.
3. Altitude	400 feet	do	1	.25	Do.

[2] Journal of the Washington Academy of Sciences, Jan. 19, 1920, p. 38.

CLIMATIC CONDITIONS IN A GREENHOUSE AS MEASURED BY PLANT GROWTH.[1]

Climatic conditions are usually stated in terms of temperature, rainfall, percentage of sunshine, relative humidity, etc. A few attempts have been made to measure such conditions in terms of plant growth. In one of these experiments the climatic conditions of a greenhouse were expressed as rates of certain definite plant processes. The experiment was carried out (1916–1917) in one of the greenhouses of the Laboratory of Plant Physiology of the Johns Hopkins University at Baltimore, Md. Buckwheat seedlings of approximately the same size and from the same stock of seed were grown for a series of 4-week exposure periods over a total time period of 13 months. Such culture plants were considered the instruments for measuring the climatic conditions as these affected the plant processes. Values representing the process of dry-weight production, leaf-area increase and transpirational water loss increased during the spring and decreased during the autumn with maxima in summer and minima in winter. The rates of stem elongation, however, showed remarkably low values for a period about the summer solstice. Approximate indices of efficiency of these climatic conditions in this particular greenhouse to favor these plant processes may be briefly stated in relative numbers for each calendar month as follows:

Month.	Stem height.	Dry weight.	Leaf area.	Transpiration.
January	0.64	0.13	0.20	0.11
February	.70	.27	.35	.24
March	1.03	.61	.63	.63
April	1.30	.90	.84	.87
May	1.34	1.00	.95	.96
June	1.00	1.00	1.00	1.00
July	1.30	.94	.91	1.00
August	1.46	.81	.79	.95
September	1.40	.61	.63	.69
October	1.14	.39	.49	.40
November	.92	.22	.37	.24
December	.76	.15	.27	.15

The approximate annual ranges (ratio of maximum to minimum) were: Stem height, 2; dry weight, 8; leaf area, 5; transpiration, 9.—*Earl S. Johnston, Laboratory of Plant Physiology, Maryland Agricultural Experiment Station.*

THE DISTRIBUTION OF MAXIMUM FLOODS—DISCUSSION.

We have received a letter from Mr. H. R. Leach, of Saginaw, Mich., commenting on the paper by Prof. A. J. Henry upon "The Distribution of Maximum Floods," which appeared in the December, 1919, REVIEW and calling attention to the following points: (1) That true comparison of the magnitude of floods occurring in different years can be made only by comparison of the volume of flow, and (2) that at some of the Weather Bureau gages known to him the zero of the gages are not referred to a fixed plane of reference, and he gives two examples which will be referred to later.

The first point made by Mr. Leach is well taken, but since discharge measurements are not available, recourse was necessarily had to gage heights.

With reference to the second point: In establishing new gaging stations, the uniform practice of the Weather Bureau during the last 8 or 10 years has been to set the zero of the gages to correspond with the bottom of

[1] Author's abstract of paper presented before American Meteorological Society, Washington, D. C., Apr. 22, 1920.

flowing water in the stream; in cases of replacement of old gages, the zero of the old gage has been continued without change.

A considerable number of river gages now used by the Weather Bureau were installed by other branches of the public service—the Army Engineers, the Mississippi River Commission, the U. S. Reclamation Service, and the U. S. Geological Survey. Almost without exception the original zeros have been continued. The gage at Yuma referred to by Mr. Leach is a case in point. The Weather Bureau is using the gage established by the U. S. Reclamation Service, and in order to prevent confusion a note is printed in each volume of Daily River Stages to the effect that stages at that station do not indicate the volume of water in the river. In the case of Umatilla, on Columbia River, that station was established by the Army Signal Corps in 1878 and the zero was placed to correspond with low water of 1874.

In the early days of gaging rivers in this country it was a common practice to refer the zero of the river gage to the lowest known water for the gaging station.

It should be remembered that the object of Weather Bureau river gagings is primarily to secure data on which to base flood forecasts and that the gagings do not and are not intended to indicate the volume of water in the stream. It is, of course, to be regretted that it was not foreseen that the selection of arbitrary points of reference for the zero of the gages would lead to complications in the future.

SOME METEOROLOGICAL OBSERVATIONS OF A BOMBING PILOT IN FRANCE.[1]

By THOMAS R. REED, Meteorologist.

SYNOPSIS.

Smooth flying is generally found above cloud summits in summer, and bumpy air beneath them. Exceptions to this rule were so rare in the writer's experience on the western front during the summer of 1918 as to be worthy of note, and one such exception was made the subject of memoranda on the occasion of its occurrence. This was on the afternoon raid of August 29, 1918, in connection with the Oise-Aisne operations, when roughness was found at all levels. The cumuli that occupied the lower levels were left far below, but roughness was still encountered, although an altitude of 5,000 m. was reached before the lines were crossed. Phenomena, associated by the writer with the disturbed conditions in the upper air, were noted later in the appearance of cirro-stratus clouds overhead, the remainder of the journey to the objective being made between two cloud-strata—cirro-stratus above, cumulus and strato-cumulus beneath.

The term "bumpy weather" has come into such general use among aviators that it has ceased to be slang and become a proper part of aeronautical parlance. No other term expresses so succinctly the presence of atmospheric disturbances arising from convection and topography, the commonest sources of those localized turbulences that affect the piloting of airplanes. Although frequently employed by flyers in referring to undulatory movements or air swells of any kind, the conditions to which the expression specifically applies are more often attributable to convection and topography than to anything else.

Convection, of course, is most active in summer, or the warm season, while topographic influences are more likely to be felt in the winter or during the season when horizontal air currents are strongest. The height to which an uneven landscape may extend its influence depends on the ruggedness of the surface and the speed of the wind passing over it. In general a few hundred or a thousand meters of elevation will smooth out the irregularities arising from this cause, while convectional irregularities are often found in their greatest vigor at that height or above.

Pilots who were on the west front in the summer of 1918 and stayed in action until the armistice had an excellent opportunity to experience both these conditions in their most typical forms, particularly if they were engaged in the American sector where the terrain was notoriously broken. During the warm season convectional disturbances were very active, and raids were executed almost daily in spite of weather conditions. It was no unusual thing for the writer's escadrille (Breguet No. 128) to leave the Roissy airdrome on a raid during the Oise-Aisne operations when the sky was almost filled with the cumuli of an impending storm. Under such circumstances it was customary for the commandant who led the group to take us above the clouds, for although the interstices in the latter might afford only scanty vision of the landscape, and navigation therefore be difficult, the group was less liable to attack, and the problem of managing the planes and keeping a good formation was greatly simplified. The bumps were left below and we had an undisturbed medium in which to perform the journey.

Flying in group, though never employed in peace times, except for exhibition purposes, is of first importance in war, and all branches of the flying corps, whether pursuit, reconnaissance, or bombardment, must employ it on occasion or be exposed to successful attack by lurking enemy planes.

Formation flying brings home to the pilot more forcibly than any other form of air work the fickleness of his atmospheric medium. This is because the sense of motion is so purely relative that unless one has some object close at hand with which to relate his course he soon loses consciousness of his own speed, and is quite oblivious to the factor of wind velocity (and, to some extent, of direction) so long as exerted in the plane of his own movement. Even undulatory movements are not realized unless abrupt, especially if one is flying with the wind.

Vertical currents, of course, are evident enough under any circumstances, but until one finds himself flying in a group and trying to maintain a certain position with respect to other planes close at hand he does not accurately estimate all the components of movement that are agitating the air.

The greatest obstacle to formation flying is convection. The plane does not always rise or sink on an even keel, as might be supposed; more often it is pitched this way and that, one wing now up and the other down. The sensation under a thunder cloud is exactly that of an antiaircraft bomb exploding underneath you, with the difference that you don't get any shrapnel holes in the process.

Every meteorologist knows theoretically, and every pilot from experience, that bumps generally are found in and under (at least close under) cloud formations, and smooth flying above them. In an arid region one would feel the currents of convection without the attendant clouds to define their limits. Not so in France. Here clouds formed so readily that the presence and strength of vertical currents might oftentimes be safely gaged by their visible outlines, the character of the summer cumuli serving as an excellent indicator of the roughness of one's projected flight. We knew that flying below them

[1] Presented before American Meteorological Society, Washington, D. C., Apr. 22, 1920.