Again referring to Ritter's methodology, we may note that he compiled abundant data by means of systematic studies of regions, compared the findings, and sought to derive principles. Even though he did not attain great success in this effort, his approach was nonetheless in the right direction. To illustrate our point with a case from the plant world, let us suppose that we have observed a species of plant growing under a given combination of soil, drainage, and microclimatic conditions. Suppose we then map the distribution of the species and note that the physical environment is essentially the same, rarely revealing an exception. Looking over the results of this investigation and noting the similarities, we would feel quite safe in making some generalization with reference to the habitat of the plant and its behavior in a given environment. We could even go so far as to predict where such a plant species may be expected. In contrast, if we had merely observed that this species does not grow where another does grow, or had observed that the conditions under which it grows differ from those under which other species thrive, we could not have determined the optimum conditions for any species, nor derived any guiding principles.

The comparative principle involving the accumulation of many repetitive cases is the same whether we consider plants, lower animals, man, or even physical phenomena such as landforms. Suppose we observe areas A and B, noting that in A, manufactural activities are dominant, whereas in B agricultural occupations attract most of the population.[2] Under the program of areal differentiation our first function would be to describe what takes place in each area. In describing the landscapes we would have made a contribution to the realm of geography, since description is a legitimate and necessary phase of the field. If next we sought to find out why the uses of the lands differed, we might have learned that the reasons were to be found in economic, environmental, physical, or still other circumstances. Then what? Would we have been able to conclude that because of these differences certain reactions would always be true? Suppose we had compared area A with areas C, D, E, F, and many more, always finding that there were differences. Would these comparisons ultimately have brought to light criteria that would enable us to predict the circumstances under which a given area would become dominantly manufactural, agricultural, or something else? Would such observations have revealed the limiting elements with respect to the uses man could make of any area? On the other hand, had we made a systematic study of A and of all other manufacturing areas, seeking to find elements in common, or had we made a systematic study of a given set of physical conditions that would permit man to do any one of a variety of things and had followed this with a study of all such areas on the earth to see whether man reacted in the same way everywhere, then we should have set the stage for the possibility, at least, of discovering some principles. Our approach would have been positive. It seems to us that only through this approach—that is, description, analysis, and comparison of like areas—can we hope ultimately to derive standards of reference and to place the field of geography upon a firm scientific foundation.

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[2] Although we have been emphasizing here the human relations aspect of geography, we do not subscribe to the notion that there is no geography where there is no human occupance. The field of geography is more inclusive than mere human ecology.

Cloudiness in Relation to Choice of Astronomical Sites

THE article "Optimum Location of a Photoelectric Observatory," by John B. Irwin (SCIENCE, **115**, 223), represents a gratifying application of climatological data to a specific practical problem. There is, however, an unfortunate characteristic of the basic data that partially vitiates the conclusions drawn. As an astronomer, Irwin is interested in cloudiness at night, but the basic means of detecting clouds, the human eye and the sunshine recorder, are both most effective during the day. In addition, there are good physical reasons for believing that the spatial distribution of daytime cloudiness may be quite different from that of nocturnal cloudiness.

Daytime clouds tend to be of the cumulus variety and are often caused by solar heating of relatively moist air near the ground. These clouds are at a minimum near Yuma, Ariz., as Irwin points out, and this is due to the pronounced dryness of this region and the prevailing subsidence in about the lowest half of the atmosphere. Nighttime clouds tend to be of the stratiform variety and are usually due to large weather systems, such as frontal storms and cyclonic circulations aloft. The higher nocturnal clouds, at least, should then be relatively independent of the low level factors that produce the minimum of cloudiness near Yuma. One would then expect, for example, that cirrus, Irwin's "photoelectric poison," would not exhibit the same pronounced minimum of occurrence over Yuma that daytime cumulus shows.

Irwin concludes that the region within 40–48 miles of Yuma is far superior for photoelectric photometry of stars to any other region in the United States. It is my feeling that this is too restrictive a conclusion. I would hazard the guess that, if the proper *nocturnal* data were to become available, the entire southwestern United States, including southern California, all of Arizona, New Mexico, and western Texas, would be found about equally suitable. Unfortunately, reliable data on nocturnal cloudiness are almost nonexistent. A major factor in this deficiency is the difficulty of detecting thin cirrus at night.

In the absence of appropriate nocturnal data, I suggest that the apparent superiority of the Yuma region be discounted, and plans for a photoelectric observatory be broadened to include the above-mentioned states. Certainly one should not forego such practical advantages as accessibility, readily obtained power, good seeing, etc., in order to locate in a region where advantage in lack of clouds is probably spurious.

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DR. HESS has suggested—and given reasons for—the interesting possibility that the spatial distribution of nocturnal cloudiness may be quite different from that of daytime cloudiness. This is an important point that should be, and will be, investigated further. The most successful method of attack would seem to be to analyze only the cloudiness data taken at night at those times when the moon was above the horizon. Thin clouds, if present in an otherwise clear sky, should be visible at such times.

The limitations of the immediately available meteorological data that I had to use were acutely in mind when I wrote the paper, and, of necessity, my conclusion concerning the superiority of the Yuma region as the site for a photoelectric observatory was a qualified conclusion that needs further testing. Its superiority *seemed* to be so pronounced, however, that it was felt to be worth while to call attention to it in print, if only as the first approximation. If it turns out that the *nocturnal* cloudiness is about the same over a *large* area of the Southwest, the question of good seeing undoubtedly would be paramount. With a wider area to choose from, a better and more accessible site might perhaps be located.

The other points that I made in my paper seem to need no qualifications: namely, (1) that photoelectric photometry has become of fundamental importance in modern astrophysical research, (2) that the climatological requirements are different for it than for other types of astronomical observational routines, (3) that there is a widespread need among Midwestern and Eastern astronomers for photoelectric research opportunities in an excellent climate, and (4) that such an observatory could be established at a fraction of the cost of a very large reflector.

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The Aeropause

THE upper boundary of the atmosphere is commonly identified with that region of the exosphere where the uppermost geophysical phenomena—namely, the highest auroras—are occasionally observed. In terms of this concept the limit of the atmosphere is located at about 1000 km above the surface of the earth. The peak of the highest rocket trajectory attained so far—400 km—lies within the boundaries of the atmosphere. For all practical purposes of rocket engineering, however, the atmosphere ceases to exist at an altitude of 180–200 km. Unmanned rocket craft are routinely reaching beyond the physically effective regions of the atmosphere, and manned flights into the border region of the atmosphere and, eventually, space must be considered a definite possibility. Consequently, a new concept of the borders of the atmosphere seems necessary. This concept should be based on the functions which the atmosphere fulfills for man and craft, such as supplying breathing oxygen or aerodynamic lift and drag. A functional border between atmosphere and space is defined as that level at which the atmosphere fails as a supporting medium, and space-equivalent conditions begin. Depending on the particular kind of function, the corresponding limit is located at a certain altitude. From this point of view the following functional borders can be listed:

	Function	Altitude (km)
1.	Contributing to respiration	16
2.	Preventing boiling of body fluids	19
3.	Sustaining combustion of fuel	21–23
4.	Absorbing heavy primaries of cosmic radiation	21–36
5.	Absorbing solar ultraviolet between 210 and 300 mμ (Hartley band of O_3)	35–45
6.	Supplying aerodynamic lift	80–110
7.	Supplying diffuse daylight	100–140
8.	Absorbing meteors	110–150
9.	Interacting thermally with the craft (compression and friction heating)	160–180
10.	Interfering by air drag over long periods of time (permanence of satellite orbit)	200

In addition to these data it may be mentioned that the presence of ozone above the 13-km level can result in toxic concentrations of this gas in the cabin air, if the pressurization of the cabin is maintained by compressing ambient air.

Of course the borders so defined are more or less extended regions. Especially are the functions mentioned under 6, 9, and 10 dependent on the velocity of the craft, and the altitude data given are related to a velocity of the order of 8 km-sec. This velocity must be attained in order to establish a craft in a permanent satellite orbit around the planet. Above an altitude of 200 km there are only three factors of terrestrial origin that make the environment of the craft and its crew different from that found at any other point in interplanetary space: (1) the bulk of the earth, which shields off half the number of meteors and cosmic ray particles; (2) the magnetic field of the earth, which deflects cosmic ray particles below a certain magnetic rigidity, if they approach the earth in or near the equatorial plane; (3) the radiation reflected and emitted by the earth and its atmosphere.

The problems that arise in the operation of manned vehicles at very high altitudes and eventually in free space are of an extremely diverse and complex nature. Their solution requires contributions from meteorology, geophysics, astronomy and astrophysics, cosmic ray physics, aerodynamics, radiobiology, physiology, aviation medicine, general medicine, bioclimatology, and human engineering.

Owing to the many different fields involved, semantic difficulties must be anticipated; particularly, the