used copies at $3.75 each and the 50 pupils who arrived later purchased new copies at $7.50 each. In 1943, Professor Torrey will have possibly 50 pupils in all (the other hundred are in military service or war work—I had 8 instead of 80 in an autumn class) and the campus book-dealer has 50 extra copies that he is glad, indeed, to sell for $2.00 each. This is about the price which can be charged in Latin America.

We (the United States) should get busy now so as to have the texts at the places where they are desired at the opening of the new scholastic year in Latin American universities.

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DATED AT MEXICO, D. F., APRIL 9, 1943

THE INSTITUTE OF TROPICAL AGRICULTURE AT TURRIALBA

THE news item in the March 26 issue of SCIENCE relative to the foundation of the new Institute of Tropical Agriculture at Turrialba (Costa Rica) was read with considerable interest here, as we feel that the foundation of said institute represents a definite step forward. Turrialba is also an excellent location because it is there that the U. S. Department of Agriculture Rubber Field Station, directed by Dr. Theodore Grant, is located. Thus the newly announced rubber research program of the new agricultural institute will utilize both the experience and the disease-resistant material already developed by Dr. Grant and his staff. This represents a tremendous saving in time, precisely at the moment when time is the most important consideration.

The foundation of the agricultural institute is also of great value because it will contribute to giving both scientists and government officers in the United States a truer picture of the real conditions of the American tropics. But the greatest hope that some of us long-time residents of the Caribbean area see in the foundation of the new institute lies not so much in what it can do in the way of publishing pretty bulletins and reports or even in the development of improved plant varieties; but rather in the courage which it might display in facing some of the broader problems of tropical agriculture.

Consider, for example, the problem of fuel and power: Every one who has carefully studied the agricultural economics of countries like Costa Rica inevitably concludes that the scarcity and high price of fuels constitute the greatest single barrier against a real development of the country. Regardless as to whether we talk of railroad or automotive freight-rates or about the development of small local industries, we always come back to the painful fact that the only fuel locally produced is wood-fuel and that its continued use at anywhere near the present rate will soon create a terrific problem in forest depletion, soil erosion, irregular stream flow, etc. And thus we also inevitably reach the conclusion that any honestly conducted program of agricultural conservation and development in Costa Rica must first contemplate making available large blocks of cheap hydroelectric power, in order that the people shall not only have an inexpensive source of heat to cook with, but also that electrification be applied to such things as the small farm, the small rural industry and to all railroads in the country not already electrified. Furthermore, any honest-to-goodness program of tropical sanitation will have to dispose of large amounts of cheap chlorine for water disinfection and as the means of oxidizing the harmful residues of the coffee industry. This is intimately tied up with the cost of electricity, as chlorine is a product of the electrolytic cell.

The lands acquired by the Institute of Tropical Agriculture at Turrialba are located in the middle of a region rich in waterfalls which have never been developed because of the financial limitations of the province where Turrialba is located. But we already have an example in the nearby province of Alajuela, where there is a publicly operated electric plant that was built some fifteen years ago by a German-Swiss company. This plant has not only paid for itself, but has also demonstrated that electricity may be produced in the tropics at a fraction of the cost of even the so-called "yardstick" plants in the United States, like T.V.A. Likewise, the government-owned and -operated Ferrocarril Electrico al Pacifico offers another definite example of how a relatively modest investment in electrical transportation facilities pays back a thousand-fold in the tremendous agricultural development made possible on the Pacific sector of Costa Rica.

Considering the ease with which the new Institute of Tropical Agriculture could obtain the loan of technical talent from other Federal agencies, such as the T.V.A. or the Rural Electrification Administration, and the low interest rates at which projects sponsored by the Federal Government may be financed, it seems to the writer that the new institute has in its hand a brilliant opportunity to do some real progress in tropical agriculture if it could only muster the courage to abandon the beaten track and face the economic realities of the Turrialba valley. Naturally, the suggested course is not the easiest; as in order to put across the project, the institute might have to fight both private electric utilities and certain foreign-financed agricultural ventures in which the workmen are kept under the patriarchal conditions which prevailed in Europe during the Dark Ages. But then again, what ever really great institution has ever grown up by following the beaten track?

Furthermore, any endeavor that the agricultural institute can sponsor tending towards the more intelligent utilization of the natural resources of the Turrialba Valley will be supported by the common people of Costa Rica, who are as a whole industrious and literate.

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SAN JOSE, COSTA RICA

SCIENTIFIC BOOKS

METEOROLOGY

Harvard Meteorological Studies, No. 6. Heat Transfer by Infrared Radiation in the Atmosphere. By WALTER M. ELSASSER, Harvard University, Blue Hill Meteorological Observatory, Milton, Mass. 106 pp. Appendix, bibliography and copy of the Atmospheric Radiation Chart, second edition. 1942.

THIS publication comprises three parts, more or less independent, namely: Part I, "Principles of Radiative Transfer." Part II, "Structure and Absorption of Infrared Bands." Part III, "The Measurement of Atmospheric Emission." Then follows the Appendix, descriptive of a mechanical computing device, the Bibliography and the Radiation Chart.

Students of atmospheric radiation have been under deep obligation to Dr. Elsasser for several years on account of his excellent chart. Making use of additional observations and reconsiderations the chart has now been recomputed, and has undoubtedly become a far more trustworthy representation of the complex problem of atmospheric radiation. The author calls attention, however, to the need of much additional observation to cover many doubtful matters in this difficult field.

Part I begins with a demonstration of Kirchhoff's principle: "The ratio of emission and fractional absorption in any direction of a slab of any thickness in thermodynamic equilibrium equals the black body intensity." To this reviewer the author's demonstration lacks something of completeness. He considers a constant temperature enclosure with totally opaque walls, and shows that the second law of thermodynamics requires that the transfer of energy from one wall to the opposite must equal the return. He says: "Therefore, the emission of a perfectly opaque wall is generally independent of the optical properties of the wall." Suppose one wall was of soot and the opposite wall was of polished silver. The emission of the soot would be many times as intense as the emission of the silver. But within the enclosure by reflection, supplementing emission, the flux from the silver is built up to be the flux from an absolutely black body, and the same holds to a minor extent with the soot. Had this point been established and made clear, the author could have passed logically to his statement in the next paragraph: "We call I_b the intensity of this beam which, in thermodynamic equilibrium, is just the black body intensity." From this statement the Kirchhoff expression $E/A = I_b$ follows at once, as the author shows.

The author continues in Part I with Schwarzschild's equation of radiative transfer and its integration under the particular conditions which prevail in the atmosphere. Planck's law connecting temperature and frequency, Stefan's fourth power law for total radiation are considered, and a valuable table follows representing for the black body the integration of radiation intensity by wave number and the change of intensity with temperature.

Transfer of monochromatic radiation, and of non-monochromatic radiation are treated mathematically, bringing in, of course, the important exponential principle of Bouguer and Lambert and the relation: "For isotropic radiation the flux [total over a hemisphere] is π times the intensity of a straight beam," and developing an important set of functions useful in radiation transfer problems including the so-called recursion formula. These mathematical steps lead on to the general transfer problem of the flux emitted by an atmosphere of arbitrary constitution, and the first mention of the Atmospheric Radiation Chart.

And now observation comes to the fore with its showing of the special radiative and absorptive properties of water vapor, carbon dioxide, ozone and the permanent gases oxygen and nitrogen. The application of these properties in the Radiation Chart and the use of the chart for particular problems is discussed. The reviewer, however, believes that ordinary users of the chart would have appreciated several completely worked-out numerical applications of it to specific examples from actual observations. Something of this, indeed, is given in Table 2, but more extensive numerical examples would be helpful.

Two aspects of absorption in spectral lines, namely, broadening under pressure and Doppler effects of motion, are found to be of some importance concerning atmospheric radiation problems, and are treated by the author at considerable length. Then comes the discussion of overlapping spectrum lines in band spectra, ending in the derivation of a formula for band absorption in the most general case. Following is a reference to the effects of pressure and temperature on absorption coefficients of the atmospheric constituents.

Water vapor, as is well known, presents a very difficult problem in atmospheric radiation and absorption. Rapidly falling off with altitude, presenting many bands of line structure, subject to rapid and large changes of quantity from day to day, affected by both pressure and temperature in its absorption, effective in both solar and terrestrial spectral ranges,