the organizers, who provided the delegates with a timetable for each day and who enforced a most rigid control over the time taken by each speaker. However, on occasion, as many as twenty choices were afforded at any one time, in as many different places, and it is unlikely that anyone managed to attend all the papers which he wished to hear.

An excellent item of organization, and one which can be recommended to organizers of future congresses of this size, was the provision of ample space for informal meetings between delegates, both at the Congress headquarters at the University of Brussels and in the adjacent Cité Universitaire, where all manner of facilities were provided.

In addition to the opening reception a number of social activities were arranged, the main one being a concert given by the Belgian National Orchestra at the Palais des Beaux-Arts. There was no formal Congress banquet, but some informal sectional dinners were given, and the International Association of Clinical Chemistry arranged a banquet open to all members of the Congress. Both the Russian and the Polish delegations gave receptions at their respective embassies, and these were attended by guests from both sides of the Atlantic. An exhibition of scientific equipment was given at the Congress headquarters, and a number of British scientific equipment manufacturers were represented. The closing lecture was given by V. du Vigneaud (New York) on the isolation and proof of structure of the vasopressins and the synthesis of octapeptide amides with pressor-antidiuretic activity.

The next Congress will be held in Vienna in 1958.

RADIATIVE BALANCE IN THE ATMOSPHERE

ROYAL SOCIETY DISCUSSION

IT is appropriate, in view of the forthcoming intensification of atmospheric research during the International Geophysical Year of 1957–58, to examine the present state of research in such a subject as radiative balance in the atmosphere, and a one-day discussion meeting on this subject was held in London at the Royal Society on June 9. In such a short period it was clearly out of the question to attempt any comprehensive survey, and attention was concentrated instead on subjects in which research is being actively pursued. Many of those who took part are contributors to the Gassiot Committee programme of research on photochemical equilibrium in the atmosphere. Two invited speakers from abroad, Dr. F. Möller (University of Mainz) and Dr. M. V. Migeotte (Institut d'Astrophysique, Liège), made interesting contributions. The programme was arranged so that the morning and early afternoon were mainly devoted to the lower atmosphere, up to and including the stratosphere, and the late afternoon to the higher levels of the atmosphere.

The discussion was introduced by Prof. H. S. W. Massey (University College, London), who first outlined the general nature of the radiation balance in the atmosphere and indicated the importance of the different absorption, emission and scattering processes which are involved. The second part of his talk was concerned with the temperature and pressure distribution in the atmosphere. These may be directly studied up to altitudes of 150 km. by means of instruments transported by rockets. Methods of measurement of pressure, temperature and density were outlined, and the interrelation of these three quantities was pointed out as a useful check on the results obtained. Special attention was directed by Prof. Massey to the way in which the rocket observations of pressure, taken above White Sands, New Mexico, agree well with results obtained by balloon flights up to altitudes of 24 km. The importance of further rocket measurements in different geographical locations was stressed.

Dr. Möller next discussed the pattern of radiative heating and cooling in the troposphere and lower stratosphere. After describing the distribution of temperature and of the cooling-rate by water vapour in some characteristic atmospheres at different latitudes, he directed attention to systematic differences from this characteristic behaviour which have been observed in the last year. These differences he ascribes to the effect of cloud layers, and the remainder of his contribution was concerned with these effects.

Statistical studies of the frequency and thickness of clouds over Germany during the period 1930–40 are now proceeding at the Meteorologisch-Geophysikalisches Institut at Mainz, these being based on the observations of the Wetterflugstellen. Using these data, radiation fluxes and mean cooling water characteristics of cyclonic warm air have been computed and show that at every height the cooling is slightly increased by the cloud. Further work on these lines is proceeding.

Dr. A. R. Curtis (University of Sheffield) described the elaborate computations which he is carrying out on radiative heating-rates in the atmosphere. The starting-point is the derivation from the equation of radiative transfer of an expression for the rate of heating at any height in a plane-stratified atmosphere due to interaction of molecules of a single absorbing constituent with radiation. Even in this simplified case the expression is quite formidable. Knowledge of line frequencies and intensities and of line shape as a function of height is required. To make the calculations tractable, it is assumed that the line intensities are distributed according to a probability function. Approximate calculations for the 15-μ carbon dioxide band have been made, but further work will be carried out using electronic computation.

Dr. Migeotte described the results of high-resolution spectroscopic investigation of minor atmospheric constituents—ozone, nitrous oxide, methane, monodeuterated water and carbon monoxide. Several bands, as they appeared on solar spectrograms taken at the International Scientific Station on the Jungfraujoch at an altitude of 3,850 m., were shown; they were obtained using the prism-grating infra-red spectrograph of the University of Liège. Attention was directed by Dr. Migeotte to the presence of the 9-μ band of ozone and the 17-μ band of nitrous oxide in the solar spectrum. An atlas of the solar spectrum containing reproductions of the Jungfraujoch records is now ready for publication.

The afternoon session of the meeting began with a discussion by Dr. G. D. Robinson (Kew Observatory) of the scope of observations of solar and terrestrial radiation at the earth's surface. This included a critical survey of recent measurements of quantities important in determining the radiative balance at the latitude of Kew. In addition, Dr. Robinson discussed the contribution that can be made to the solution of the meteorological problem by the programme of measurements proposed for the Inter-

national Geophysical Year. He concluded that, although these measurements must of necessity be limited for economic reasons, useful results can be obtained with existing equipment. The importance, both during and after the International Geophysical Year, of observations on solar radiation at a high level, such as those made by the Meteorological Research Flight, was stressed. He also said that, in order that separate estimates of albedo in the infra-red and visible plus ultra-violet can be made, as many stations as possible should make measurements of solar radiation in the infra-red.

Three papers followed on the important subject of the use of high-altitude aircraft as laboratories from which measurements of radiant intensities and infra-red spectroscopic studies can be made. The opening paper was by Dr. F. E. Jones (Royal Aircraft Establishment, Farnborough), who described the design of an infra-red spectrometer for use in a Canberra aircraft, with which it is hoped to record the solar spectrum out into the far infra-red from heights up to 50,000 ft. Initial measurements from a Lincoln aircraft at 30,000 ft. have permitted observation of the ν_3 band of methane (this being the first observation of methane as a constituent of the atmosphere over England) and the complete nitrous oxide doublet at 4·5 μ. Next, Dr. J. Yarnell (de Havilland Propeller Co.) gave an account of the promising experiments undertaken in collaboration with Dr. R. M. Goody with an aircraft of the Meteorological Office Research Flight. Although these experiments did not lead ultimately to definite results, they were of interest and importance in providing design data and experience for the work which is now projected. The final paper on this subject was read by Dr. J. Houghton (University of Oxford), who described work carried out with Dr. A. W. Brewer on the measurement of the water vapour and ozone in the troposphere and lower stratosphere from aircraft. The technique used has proved successful in obtaining important results over Britain. At the time of the discussion, Dr. Brewer was in Norway carrying out similar measurements with the collaboration of the Norwegian Air Force; this work has also proved very successful.

The origin and distribution of the polyatomic gases in the atmosphere was next discussed by Prof. G. M. B. Dobson (University of Oxford), special attention being paid to water vapour and ozone. The water vapour concentration usually decreases rapidly with increasing height, particularly in the lower stratosphere, and this leads to a very low concentration at an altitude of about 15 km. Ozone, on the other hand, has a maximum concentration at an altitude of about 30 km. and diffuses downwards. Data were presented on the water vapour content of the lower stratosphere and on the average values of the ozone/air ratio in the upper troposphere and lower stratosphere (obtained largely from flights over southern England by the Meteorological Office Research Flight). The difficulties encountered in attempting to interpret these results were pointed out.

The next paper to be presented, by Dr. R. M. Goody (Imperial College of Science and Technology, London), was an account of work carried out with Dr. A. R. Curtis on thermal equilibrium in the upper atmosphere. Dr. Goody pointed out that the assumption of a Boltzmann distribution of molecules among the vibrational and rotational levels, which is usually assumed in atmospheric radiation calculations, must break down at sufficiently high altitudes when the pressure is inadequate to maintain a sufficiently high collision-rate. An equation of transfer was derived for a vibration-rotation band which does not assume a Boltzmann distribution among the vibrational levels. From this in turn was derived an equation for the heating-rate due to the band in a plane-stratified atmosphere. Departure from a Boltzmann distribution becomes serious above about 75 km. For the rotational levels the effect is unimportant for vibration-rotation bands, but it limits computation in the rotation bands of water vapour to heights less than about 90 km.

The temperature distribution at higher altitudes (200 km. and above) was the subject of a paper by Prof. D. R. Bates (The Queen's University, Belfast), which was concerned primarily with the importance of thermal conductivity in relation to the temperature distribution at these high altitudes. Prof. Bates argued that the temperature gradient, instead of remaining almost constant up to great altitudes, as commonly assumed, must fall off above the base of the F_1-layer. Rocket and radio measurements suggest that the temperature near the 250-km. level is only about 800° K.; and the usual theory of the apparent escape of atmospheric helium into interplanetary space requires that the temperature in the exosphere is at least 1,500° K. According to Prof. Bates, the temperature rise of about 700 deg. K. that is thus indicated is an order of magnitude greater than can be accepted. It would necessitate that the local rate of gain of thermal energy by absorption at the 250-km. level be some 10^5 eV./cm.^{3} sec. Little plausibility can be attached to the existence of such a potent heat source.

The important new data now being obtained in the solar spectrum in wave-length regions previously unobservable because of atmospheric absorption were described by Dr. R. L. F. Boyd (University College, London). The results have been obtained in the United States using apparatus carried by rockets to altitudes greater than 100 km. A variety of techniques have been used employing photon counters, photographic plates, thermoluminescent phosphors and spectrographs as observing devices. More than forty flights have been made. At the height of the E-layer, solar X-radiation has been detected, of sufficient intensity to produce the E-layer ionization. Lyman α-radiation concentrated in a narrow line has been observed down to altitudes of 74 km. It has also been found that the intensity of the solar spectrum falls off in the ultra-violet at a faster rate than for a black body at 6,000° K.; thus at 2000 A. the intensity corresponds more nearly to that from a black body at 4500° K. The importance of these results was discussed.

The concluding paper was given by Prof. R. W. Ditchburn (University of Reading) on the absorption of ultra-violet radiation by the atmospheric gases. He discussed the order of magnitude of the absorption coefficients for photoionization and photo-dissociation continua and their relation to absorption lines and bands. A summary was given of measurements and calculations on nitrogen, or molecular and atomic nitrogen and oxygen and ozone. Using these data and the model atmosphere assumed by the United States Rocket Panel on the basis of its observations, effective depths of penetration of radiation into the atmosphere were obtained. Data available on the absorption by minor atmospheric constituents were also presented in tabular form.