

THIRTY-SEVENTH CONGRESS OF A.N.Z.A.A.S. CANBERRA, 20-24 JANUARY, 1964

The thirty-seventh Congress of A. N. Z. A. A. S. was held at the Australian National University in Canberra between 20 and 24 January 1964. Selected papers are reported briefly here from three sections of the Congress:-

Section A - Mathematics, Physics and Astronomy;
Section D - Zoology; and
Section K - Agriculture and Forestry.

A symposium on the Upper Atmosphere was conducted within Section A, and was convened by Professor J. H. Carver of the School of Physics at the University of Adelaide. The Symposium was well attended by New Zealand and Australian workers in the atmospheric sciences; representatives were present from the Universities of Adelaide, Melbourne, Auckland and Canterbury, the RAAF Academy, the Weapons Research Establishment, the CSIRO Meteorological Physics Division and Upper Atmosphere Section, and the Bureau of Meteorology.

SECTION A - MATHEMATICS, PHYSICS AND ASTRONOMY

UPPER ATMOSPHERE SYMPOSIUM

The Symposium was divided into five sessions:-

1. Atomic Processes in the Upper Atmosphere
2. The Use of Rockets and Satellites
3. Dynamical Properties of the Atmosphere
4. Ionospheric Physics
5. Lunar and Planetary Effects observable in the Atmosphere.

Dr. Martyn (CSIRO Upper Atmosphere Section), in the introductory lecture, discussed the necessity for a good working knowledge of statistics among workers in the field of atmospheric physics and warned specifically against the practice of data smoothing by the use of 3 or 5 day means which introduces a false periodicity into the data being analysed.

Session 1. Atomic Processes in the Upper Atmosphere

Several papers were presented which were mainly of interest to ionospheric physicists. The papers discussed the composition of the ionosphere and excitation processes due to atomic collisions in this region, and various theories of reactions between free atoms and ions were advanced. Details were given of measurements of airglow in the tropics and the spectra of glowing clouds resulting from the explosion of pyrotechnic grenades.

Session 2. The Use of Rockets and Satellites

Of the eight papers read in this session, two are of immediate interest to meteorologists:-

- (i) "The Rocket as a Tool for Upper Atmosphere Research" by R. Cartwright of the Weapons Research Establishment, traced the development of meteorological rockets at Woomera - in particular, the HAD sounding rocket (High Altitude Density) - and the manner in which the physical characteristics of the rockets condition experiments and experimental techniques and, conversely, the effect of experiment requirements on rocket vehicles.

- (ii) "The Falling Sphere Method of Density Measurement" by P.H.O. Pearson, also of the Weapons Research Establishment. As distinct from the practice in the U. S. A. of using either a small heavy sphere containing a multi-directional transit-time accelerometer or an inflatable polyester sphere containing a corner reflector, W.R.E. has developed an inflatable polyester sphere with a metallised surface in place of the corner reflector; a FPS 16 radar is used to provide trajectory data.

A HAD two-stage solid propellant rocket is used with an apogee of 400,000 ft. The rocket is equipped with tracking lights and a small tracking oscillator to enable the radar to acquire the sphere when it is released at 380,000 ft on the up-leg of the trajectory. The sphere is 2 metres in diameter, made of metallised Melinex 0.0005 inches thick, and weighs a little over 1 lb.

The accuracy of the density results is a function of the drag deceleration and sphere velocity, and the region in which density can be measured to acceptable accuracy is a function of the sphere's cross-sectional area to mass ratio. For the 1 lb sphere, densities can be obtained between 320,000 ft and 230,000 ft, and atmosphere temperature and pressure can be deduced from these results. Below 200,000 ft the sphere becomes an increasingly accurate wind sensor.

Density, temperature and pressure results were also presented by the author.

Session 3. Dynamical Properties of the Atmosphere

Seven papers which are of particular interest to practising and research meteorologists were read in this session. Recent developments in the field were reviewed by the Session Chairman, Mr. F. K. Ball (CSIRO Division of Meteorological Physics).

- (i) "Stratospheric Motions from Tracer Studies" by A. J. Dyer of the C. S. I. R. O. Division of Meteorological Physics was a review of inferences drawn by many workers employing atmospheric tracers.

Early measurements of stratospheric water vapour and ozone suggested a meridional circulation in the lower stratosphere from equator to pole. This suggestion was broadly consistent with requirements of heat and momentum balance in the atmosphere. Further evidence of stratospheric motions has been provided in recent years by the detection of debris from atomic bomb tests. Measurements of radioactivity in rain since 1958 by the CSIRO Division of Meteorological Physics have given numerical support to the strength of the meridional circulation originally proposed. A recent study by Newell of the stratospheric distribution of Tungsten 185 from a single test explosion, together with ozone and other tracers, favours stratospheric polar transport by eddy motion rather than a mean meridional circulation.

- (ii) The subject matter of this paper "The Southern Hemisphere Wind Pattern above 60,000 ft" by B. Rofe of the Weapons Research Establishment has been published recently ("Australian Sounding Rocket Experiments" - Bryan Rofe - WRE Technical Note SAD 127, July 1963).

Further mention was made by this speaker of the development of Australian-designed sounding rockets, falling spheres and dropsondes.

Seasonal wind patterns for the Woomera-Adelaide area were determined from rocket experiments, meteor trails and conventional wind finds using pilot balloons.

An oscillation of winds in the upper stratosphere and lower mesosphere was proposed. A correlation was found to exist between ozone concentrations at Aspendale (38°) and the easterly winds at Woomera (31°) in this region of the atmosphere. Zonal wind oscillations between 60,000 ft and 120,000 ft were discussed also. The author suggested that the periodicity of the oscillation was nearer 24 months than the 26-month cycle found in the Northern Hemisphere. Also, there is evidence to suggest that the amplitude of the biennial cycle decreases away from the equator, reaching a minimum about lat. 25° S, and then increases again.

- (iii) "Seasonal and Diurnal Variations in Winds at 100 km" by W. G. Elford and R. G. Roper (University of Adelaide). This paper, read by Mr. Roper, discussed the considerable fine structure in the winds between 80 and 100 km revealed from an analysis of radio data of the drift of meteor trails. During any one month the air motion can be described in terms of four components — a mean wind and three periodic components having periods of 24, 12 and 8 hours. Each component can vary rapidly with height and fluctuate from day to day.

During some months there is evidence to suggest that wind components with periodicities not harmonically related to 24 hours may be present and a search for these components in the data for the whole year is still being carried out.

- (iv) "Turbulence at Meteor Heights" by R. G. Roper (University of Adelaide). In 1961, a month by month measurement of atmospheric turbulence near 90 km was carried out at Adelaide by means of radio reflections from meteor trails using a spaced station technique. The characteristics of the large scale turbulence were found to be similar to those observed in the Northern Hemisphere. Characteristic velocities range from 20 to 40 m sec⁻¹ and the large eddies are distinctly anisotropic, with a horizontal scale of from 50 to 250 km and a vertical scale of 7 km. Shears measured over separations of 500 m to 3.5 km are found to follow the Kolmogoroff law, and the turbulent dissipation rate calculated from these shears shows a marked seasonal variation, with a maximum in autumn and spring and a minimum in summer and winter. There is a strong correlation between the seasonal variation of the turbulent dissipation rate and the amplitude of the 24-hour component of the mean wind.

The non-linearity of the height shear is of particular interest, as it gives rise to Richardson type instabilities which result in the globular breakdown sometimes observed in visible meteor and sodium vapour trails.

- (v) "Circulation Effects of Concentrations of Minor Constituents between 70 and 100 km" by J. B. Gregory (University of Canterbury, Christchurch). Recent experimental studies at a latitude of 43° S have shown that the vertical distributions of minor atmospheric constituents, including atomic oxygen, and electrons, are strongly affected by circulation changes in the upper mesosphere and lower thermosphere during winter. Vertical velocities of mean flow are found to be larger and to fluctuate more than has been anticipated. The implications of this effect, and available evidence on its planetary characteristics, were discussed.
- (vi) "Some Features of the Stratospheric Circulation over Australia" by G. U. Wilson and E. F. Phillips (Bureau of Meteorology). The main features of the general circulation between 60,000 ft and 110,000 ft were discussed.

A transitional zone is generally found between 60,000 ft and 75,000 ft in sub-tropical and temperate latitudes, separating the westerlies at lower altitudes, associated with disturbances in the troposphere, and the predominant easterly wind regime above.

The easterly regime above 75,000 ft is strongest and remarkably constant in the summer months; it is also in evidence in the spring and early autumn when the winds are lighter and more variable than in summer.

During the late autumn and winter the average wind direction in sub-tropical and temperate latitudes is generally westerly at all levels between 60,000 ft and 110,000 ft, the wind speed increasing with latitude.

The 26-month cyclic oscillation in the zonal wind at all levels above 60,000 ft in tropical latitudes, first observed in the Northern Hemisphere, also occurs in the Australian region. The effect is most noticeable in very low latitudes and is barely discernible at Alice Springs (24° S). However, the biennial cycle becomes increasingly evident again at Laverton (38° S).

Workers in the Northern Hemisphere have postulated that, in tropical areas, successive layers of westerly and easterly winds descend through the stratosphere at approximately 1 km.month⁻¹. Australian data do not confirm this hypothesis in respect of the easterly wind. At Darwin and Lae, an easterly "jet" appears at and above levels of 100,000 ft accompanied simultaneously by weaker easterly winds at all lower levels in the stratosphere and troposphere.

The winds remain easterly above 70,000 ft for twelve months when another "jet" appears between 75,000 ft and 90,000 ft, followed by a rapid change-over to a westerly regime. As a result, in the region about 95,000 ft there is no pronounced wind maximum during the easterly regime but a maximum is found during the relatively brief westerly regime.

- (vii) "Atmospheric Potential Gradient Variations in Time and Height" by G. Paltridge (R. A. A. F. Academy). A radiosonde instrument has been developed for the purpose of measuring the small electrostatic fields (less than 4 volts/metre) in the stratosphere. The instrumental design and factors affecting the stratospheric potential gradient were discussed. Flight results to date confirm the predicted exponential decrease of electric field with altitude, and point the way to research into global variations of atmospheric electricity.

Session 4. Ionospheric Physics

This session, of interest principally to physicists, is not covered in this report of the Symposium.

Session 5. Lunar and Planetary Effects Observable in the Atmosphere

Professor J. H. Carver (University of Adelaide) chaired the final session of the Symposium. Two papers were presented:-

- (i) "The Effect of the Moon on Meteor Rates Observed at Christchurch" by C. Ellyett (University of Canterbury, Christchurch). The author stated that recent Australian theories, based partly on radar meteor observations from Christchurch, New Zealand, have postulated a pronounced effect of the position of the moon on meteor rates measured in the earth's atmosphere.

The Christchurch 1960-61 results have accordingly been analysed further at Christchurch. First, instead of using untreated hourly rates, the results have been normalized. For each hour of the year the observed rate value has been divided by the mean of the 29 values for that hour over the 29 days centred about the day containing the given hour.

In this way each value is normalized to the level of activity to be expected in the absence of any 29-day lunar influence.

The resulting curve does not agree with that published by E. G. Bowen (J. Geophys. Res., 68, 1401-1403, (1963)) due to the effect of normalization. The curve, however, still appears to show the presence of a lunar effect.

Comparison of the lunations added for adjacent six-month periods shows no similarity. The same conclusion is reached when alternate lunations are added, and so it is concluded that the existence of a lunar effect on meteor rates is not yet proven. (This work will appear in J. Geophys. Res., (1 April 1964)).

- (ii) "Studies of Supposed Lunar Influences on Geomagnetic Activity" by T. Davidson and D. F. Martyn (CSIRO Upper Atmosphere Section). Dr. Martyn, in presenting the paper, said that a statistical examination was made of a possible lunar influence on geomagnetic activity and other geophysical phenomena, and conclusions were drawn regarding the significance of the results obtained by other workers. The effects investigated were the reality (or otherwise) of:
 - (a) the existence of certain calendar days when there is excessive rainfall throughout the world (E. G. Bowen);
 - (b) an excess or deficit of daily meteor rates at certain phases of the moon (E. G. Bowen);
 - (c) an excess or deficit of ozone in the upper atmosphere, at certain phases of the moon (E. E. Adderley);
 - (d) a dependence of the (planetary) geomagnetic index - and also of the occurrence of great magnetic storms - on the phase of the moon (E. K. Bigg);
 - (e) a planetary effect of geomagnetic activity (E. K. Bigg);
 - (f) a dependence of rainfall in the phase of the moon (Bradley, Woodbury and Brier, U. S. A.).

In speaking to the first of these effects, Dr. Martyn mentioned that he had discussed the subject in Aust. J. Physics, Vol. 7, p. 358 (1954) as did Swinbank (ibid, p. 352). Martyn showed that Bowen's supposed days of excessive rain (over a 40 year period) were due to one storm in one year, and it was possible to produce rainfall singularities on any given date simply by selecting a suitable recording station. He said that this conclusion was confirmed by several overseas authors and has never been refuted. (It should be noted that all this work refers to world-wide rainfall singularities, not to local singularities).

Referring to the second (b) effect, Martyn said that the non-reality of Bowen's lunar "effect" on meteor-rates had been convincingly demonstrated by two previous speakers (Ellyett; and independently by Davidson in the discussion of Ellyett's paper).

The third effect (c), the supposed lunar-ozone effects, had been examined by other Australian workers (results so far unpublished). Martyn did not wish to anticipate their findings.

The supposed geomagnetic-lunar effect (d) had been examined independently by Bartels and the author. (Bartels, Naturwiss, 50, 592, (1963); also a full paper (Bartels) in course of publication). Bartels, using "shaker" tests had shown Bigg's results to be non-significant; Martyn, using harmonic dial analysis reached the same conclusion and showed slides to illustrate this.

Martyn, using Bigg's method (reductio ad absurdum) showed it was possible to claim that lunar phase affected occurrence of kanor flares on the sun.

Evidence for a planetary effect (e) on geomagnetic index was so fragmentary that it could not be taken seriously unless the author made significance tests.

Evidence for a dependence of rainfall on the phase of the moon (effect (f)), as developed by Bradley, Woodbury and Brier, was much more soundly based statistically, and was not yet disproved by anyone. There were disquieting features, however. The three-day smoothing used tended to introduce artificial periodicity; also there was accumulating evidence that the effect, if real, was very different in different parts of the world. While it was admittedly much too small to have any use for practical forecasting, it would be of great scientific interest if eventually proved to be real. Consequently it deserved continuing close study, with rigorous statistical procedures, and especially with the application of "shaker" tests.

SECTION D – ZOOLOGY

Dr. J. Gentili of the University of Western Australia spoke on "Climatic Fluctuations at the Present Time" and presented a wealth of data demonstrating fluctuations of 10-yearly rainfall means at selected stations. Apart from a general discussion on the vagaries of synoptic behaviour no real attempt was made to explain these fluctuations. Sydney climatological data were presented in greater detail, viz., maximum and minimum temperatures, relative humidity, pressure and rainfall, without explanation.

SECTION K – AGRICULTURE AND FORESTRY

The two papers of direct meteorological interest, presented in this Section, are reported in the following paragraphs:-

- (i) The paper "Meteorological Aspects of Frost Protection" by C. E. Hounam, was introduced with a review of the physics of cooling. Terms in the heat balance equation near the ground at night are terrestrial radiation, heat exchange by turbulent diffusion, heat flux from the soil, latent heat of condensation and the advection of cold air. The relative effectiveness of each of these was discussed. Various methods of protective action, both passive and active, were then discussed in relation to the terms in the heat balance equation. For example, burners, infra-red radiators and electrical heaters aim to replace the terrestrial heat loss, smudge heaters and aerosol sprays aim to reduce it. Glasshouses cut off the heat loss by turbulent exchange; wind machines and helicopters attempt to bring warmer air down from above the surface. Proper soil management can maintain at a maximum the heat flow from soil to surface and irrigation water can accelerate the upward movement of soil heat. The latent heat of fusion from a fine water spray can offset radiation cooling and maintain a crop at about freezing level. Finally, advection can bring over the crop air which has been cooled elsewhere and the dangers in this situation can be offset to a considerable extent by proper planning and orchard layout.
- (ii) "Microclimatic Measurements in Wet Sclerophyll Forest at Whian Whian, Northern New South Wales" by G. B. Stirk. A comparison of some features of the microclimate in two wet sclerophyll forests dominated respectively by E. andrewsii and E. pilularis with a warm temperature rainforest of Ceratopetalum apetalum (Coachwood) and sites in the open, was presented. Although the measurements were undertaken primarily for a broad description of the forest communities, and have limitations in adequately describing the microclimate, they provide some information of the effect of forest type on the physical environment.

The seasonal modification of soil and air temperatures, atmometer evaporation, atmospheric saturation deficit, light and rainfall interception are generally in agreement with results reported elsewhere, but differences between forest types are not always large.

This suggests that differentiating features of the habitats may be chemical or biological rather than physical. If the determined factors are primarily physical it should be possible, as microclimate is a function of external

climate, to derive a quantitative expression for it in terms of the physiognomy and structure of the forest.

The next Congress of A. N. Z. A. A. S. will be held in Hobart in August 1965.