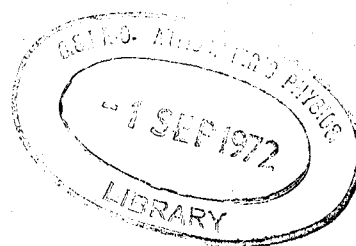


COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION

DIVISION OF METEOROLOGICAL PHYSICS



ANNUAL REPORT

FOR THE YEAR

1956-7.

## DIVISION OF METEOROLOGICAL PHYSICS

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#### I GENERAL

Weather and climate make their impact on many phases of human activity, and meteorology, besides providing innumerable avenues for study as a physical science, is a public utility. As such it provides a wide range of services, but these can prosper only on a foundation of basic research into the many problems yet unsolved. The work of the Division is therefore directed towards a better understanding of the behaviour of the atmosphere with a view not only to improving the prediction of its effects but also to using these to the greatest advantage.

Meteorology is essentially an international science and this is reflected in the establishment and activities of the World Meteorological Organisation. This body has established Working Groups in selected subjects, and the Chief of the Division, Dr. C.H.B. Priestley, is a member of that on Micrometeorology and Chairman of the group on Atmospheric Diffusion. He is also a member of the Executive Committee of the International Meteorological Association, a division of U.G.G.I., while Mr. W.C. Swinbank is a member of the Ozone Commission of the same body.

The first international climatological conference in Australia was held in Canberra in October 1956, under the auspices of UNESCO, organised jointly with C.S.I.R.O. The subject chosen, "Climatology of the Arid Zone with Special Reference to Microclimatology" was at once a tribute to Australian work in this field and a reminder of its importance to this country. Dr. Priestley and Mr. Swinbank served on the Organising Committee for the Conference, and several members of the Division attended and contributed to its success.

The ensuing Study Tour for overseas delegates and the UNESCO Advisory Committee terminated at the Division's Headquarters at Aspendale where the major items of research were demonstrated. Subsequently the Division was privileged to entertain for periods up to a week the following notable overseas meteorologists:- Dr. C.W. Thornthwaite (U.S.A), Professor F.A. Brooks (U.S.A), Dr. A.J. Drummond (U.S.A), Dr. L.A. Ramdas (India), Professor B.L. Dzerdzevsky (U.S.S.R), Professor R. Geiger (Germany) and Dr. J.L. Monteith (England) whose contributions to lectures and informal discussions on specialist topics provided great stimulus and interest.

In December 1956, Dr. C.H.B. Priestley and Dr. F.A. Berson attended a conference in Brisbane on "Tropical Cyclones" organised by the Commonwealth Bureau of Meteorology. This symposium, on a subject of great practical importance to considerable areas of Australia, benefited greatly from the attendance of a strong delegation of overseas meteorologists two of whom, Professor E. Palmen of Helsinki and Professor H. Riehl of Chicago, subsequently spent a short period at Aspendale.

The Chief of the Division has this year been honoured by the University of Melbourne's award to him of the David Syme Research Prize for 1956. During the latter part of the year Dr. Priestley has been at the Department of Meteorology in the University of Chicago on an extended visit at the invitation of the Department.

In May the extensive addition to the Division's Headquarters building was occupied. This provides space particularly for the instrumental workshop, drawing office and synoptic laboratory.

## II DYNAMIC METEOROLOGY

The study of interaction between monsoonal and general circulations in the Australian region previously reported has been temporarily set aside to allow for further intensive field work in the 'cool change' project.

### Cool change project

Upper air soundings of temperature, humidity and wind in rapidly changing weather situations were made at Aspendale serving as a base for the greatly intensified network of recording stations set up in Central Victoria for this purpose during the summer. Analysis of the data has served to complement case histories of cool changes from previous seasons. To date the analyses bear out the complexity of the change mechanism, aspects of which have been treated in a semi-climatological survey. It is evident that, in conditions of strong differential heating between land and sea, ensuing circulations of sea breeze type affect the large scale air flow thus ushering in the 'change' in coastal regions. The process of undercutting by the cold air has been studied in detail.

The flow of cold air from the sea may be influenced by disturbances on the subsidence inversion in the overlying warm northerly air stream. A study of the winter meridional cold front in Western Australia gave evidence

for the synoptically significant disturbances of this kind. Their verification in the pressure jump accompanying the summer cool changes of S.E. Australia is one object of current studies.

#### Wind Surges

The problem of surges in slowly changing or sluggish air streams is important, both theoretically and in forecasting practice. The theory of strong katabatic winds previously developed has been tested on the Antarctic coast where the sudden onset and cessation of the violent wind appears to be adequately explained by slow oscillation of the pressure jump line across the coast.

There is some evidence that wind surges in the hinterland of Western and South Australia, especially sharp evening surges at Renmark some 450 miles inland, are initiated in coastal regions and propagate inland. Though this phenomenon is different from local wind systems such as the katabatic surge in Antarctica they may well be dynamically similar in origin.

#### Revolving Storms

At the Brisbane conference on 'Tropical Cyclones' a paper was presented reporting on a statistical study of the relationship between dominant storm tracks and the trade wind and upper westerlies over Australian waters. There is an indication of a lag relationship which could prove useful in predicting whether a cyclone would pass the Queensland coast or curve southwards and eastwards before affecting the coast.

A preliminary study of storm damage to trees during the passage of a heavy squall-line in the Swan Hill district indicated wind speeds locally exceeding 180 m.p.h.

### III CONVECTION

Observations of the height of a smoke plume from a heated source have been analysed in relation to wind speed, the results being in good agreement with theory. The generation and maintenance of convection plumes from heated ground has been investigated theoretically, with results confirmed by observation, and a criterion established for assessing the relative importance of free and forced convection as heat transfer agents.

## IV MICROMETEOROLOGY

The principal aim in this work has been, through detailed observation of the fine structure of temperature, water vapour content and air motion, to study the turbulent mechanisms which achieve the interchange of heat, water vapour and momentum between atmosphere and earth.

Following on the experimental finding previously reported that the eddy transfer coefficients for water vapour and momentum are approximately equal, a formula has been developed by which it is possible to evaluate the evaporation from measurements of the vertical gradients of wind speed and humidity. This is an improvement on previous formulations in that it takes proper account of the effects of thermal stratification in a simple manner.

Extensive analysis of observations has confirmed that in conditions of strong convection the pronounced decrease of temperature with height just above the ground changes to zero gradient at an unexpectedly low level, which may be less than 30 feet when the wind is light. This finding is related to observations from experiments designed to elucidate the structure of flow in the air above the ground, which reveal the existence of flow patterns of considerable vertical extent, particularly in conditions of moderate convection.

There is a pressing need in agricultural research as well as in irrigation and water conservation practices for an accurate, automatic method of measuring evaporation from natural surfaces, including vegetative cover and open water storage. Such equipment, based on techniques developed for turbulent transfer studies in the Division, has been developed and is now in field use. The present design requires the attention of a highly skilled operator but it is planned to simplify it and make it suitable for more general use. This project has involved the development of specialised components, including a linear anemometer and hygrometer and a device capable of integrating a fluctuating current in the micro-ampere range for unrestricted periods.

Since most of the earth's surface is water, a proper understanding of atmospheric behaviour requires more extensive knowledge of oceanic sources of energy, water vapour and momentum. There is a reciprocal interest in the atmosphere as a controlling factor in ocean currents and temperatures and so in fisheries problems among others. The programme of micrometeorological observations at sea commenced in 1955 has been continued. F.R.V. "Derwent Hunter" was again lent for a month in November 1956 by the Division of

Fisheries and Oceanography, and a large number of observations secured in Port Phillip Bay and the nearby waters of Bass Strait. In addition to consolidation of results obtained in 1955, new data have been obtained on the eddy fluctuations of wind, temperature and water vapour. Analysis of these results is still in progress but the fluxes of heat and momentum so far computed directly from fluctuations are of acceptable magnitude. Values deduced from simultaneous observations of vertical gradients of wind speed and temperature are in moderately close agreement.

## V AGRICULTURAL METEOROLOGY

A small section has been formed within the Division for the purpose of investigating the meteorological aspects of agricultural problems. Its major interest will be the study of evaporation from soils and growing crops, and for this purpose twelve large soil containers (diameter 5 ft. 3 ins. depth 4 ft.) have been installed in the ground on a flat open area to the rear of the Division's buildings at Aspendale. Extensive preliminary work has now been completed, including preparation of the site and construction of a mobile gantry and hoist together with the necessary rail track. As weighing equipment has not yet been developed, the pots will be used initially as potential evapotranspirometers, i.e. they will measure, by an approximate method, the evaporation from a permanently moistened soil.

The work on frost prevention has finished and the final comprehensive report on the work over the last six years is nearly finished.

## VI OZONE INVESTIGATIONS

Atmospheric ozone, though small in total amount, and concentrated in the layer 20-50 km above the surface, makes an important contribution to the radiation balance of the atmosphere. Furthermore, measurements made for several years under international auspices in a number of countries, mainly in the northern hemisphere, have revealed a connexion between ozone amount and latitude, season and synoptic situation. The three Dobson spectrophotometers already adjusted and calibrated in the Division are now in regular use. In preparation for the International Geophysical Year instruments have been placed at Brisbane and Macquarie Island where observations

are being made by staff of the Commonwealth Bureau of Meteorology and the Australian National Antarctic Research Expedition respectively. The third instrument will remain at Aspendale, where it has been in use for two years. The data already accumulated are being studied to seek relationships between ozone and the weather situation.

#### VII MISCELLANEOUS

The Division has acted in an advisory capacity for problems relating to primary production and has made special apparatus for a number of Divisions and other institutions. A calibration service for anemometers and air meters is provided for outside bodies.

STAFF LIST

Chief	C.H.B. Priestley, M.A., Sc.D., F.A.A.
Senior Principal Research Officer	W.C. Swinbank, B.Sc.(Hons), F.Inst.P.
Principal Research Officer	E.L. Deacon, B.Sc.
Principal Research Officer	A.F.A. Berson, Dr.Phil.
Senior Research Officer	R.J. Taylor, B.Sc.
Senior Research Officer	I.C. McIlroy, B.Sc.
Senior Research Officer	E.K. Webb, B.A.(Hons), B.Sc.
Senior Research Officer	R.H. Clarke, B.A., B.Sc.
Research Officer	A.J. Dyer, M.Sc., Ph.D., F.Inst.P.
Research Officer	F.K. Ball, B.Sc.(Hons)
Research Officer	C.F. Barrett, M.Sc.
Research Officer	P.J. Funk, Dr.Phil.
Senior Technical Officer	D.E. Angus, B.Sc.
Senior Technical Officer	R.R. McGregor, Dip.App.Sc.
Technical Officer	A.J. Troup, B.Sc.
Technical Officer	I.S. Groodin, Dip.Mat.
Technical Officer	D.R. Samuel, Dip.App.Phy.
Technical Officer	N.E. Bacon, B.Sc.
Technical Officer	Miss S-A. Yeo, B.Sc.



# PUBLICATIONS

- |   |   |
|---|---|
| Ball, F.K. (1956)                                     | The theory of strong katabatic winds<br><u>Aust.J.Phys.</u> <u>9</u> (3): 373-386   |
| Berson, F.A., Reid, D.G. and<br>Troup, A.J. (1957)    | The summer cool change of south-eastern<br>Australia. I - General behaviour.<br>Division of Meteorological Physics<br>Technical Paper No. 8 |
| Cohen, E.A. (1956)                                    | The use of a ballpoint recording system<br>on the Dines anemometer.<br><u>J.Sci.Inst.</u> <u>33</u> (7): 280-281                            |
| Deacon, E.L. (1956)                                   | The second purple light<br><u>Nature</u> <u>178</u> (4535): 688   |
| Deacon, E.L. and<br>Samuel, D.R. (1957)               | A linear temperature compensated hot<br>wire anemometer<br><u>J.Sci.Inst.</u> <u>34</u> (1): 24-26  |
| Deacon, E.L., Sheppard, P.A.<br>and Webb, E.K. (1956) | Wind profiles over the sea and the drag<br>at the sea surface<br><u>Aust.J.Phys.</u> <u>9</u> (4): 511-541                                  |
| McIlroy, I.C. (1957)                                  | The measurement of natural evaporation<br><u>J.Aust.Inst.Agr.Sci.</u> <u>23</u> (1): 4-17   |
| Priestley, C.H.B. (1956)                              | Convection from the earth's surface<br><u>Proc.Roy.Soc.(London)A</u> <u>238</u> : 287-304   |
| Priestley, C.H.B. (1957)                              | The heat balance of sheep standing<br>in the sun.<br><u>Aust.J.Agr.Res.</u> <u>8</u> (3): 271-280   |
| Reid, D.G. (1957)                                     | Evening wind surges in South Australia<br><u>Aust.Meteorol.Mag.</u> <u>16</u> : 23-32   |
| Summer, C.J. (1956)                                   | A reversible message register<br><u>J.Sci.Inst.</u> <u>33</u> (12): 505-506   |
| Swinbank, W.C. (1957)                                 | Crystallisation of supercooled water<br>by ultrasonic irradiation.<br><u>J. Meteorol.</u> <u>14</u> (2): 190                                |
| Taylor, R.J. (1956)                                   | An electronic analogue of the saturated<br>vapour pressure curve of water<br><u>J.Sci.Inst.</u> <u>33</u> (11) : 436-438                    |
| Troup, A.J. (1956)                                    | An aerological study of the meridional<br>front in Western Australia<br><u>Aust.Meteorol.Mag.</u> <u>14</u> : 1-22                          |