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MANUAL OF METEOROLOGY

VOLUME I
METEOROLOGY IN HISTORY

BY
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WITH THE ASSISTANCE OF
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College, Cambridge*

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MCMXLII

TO
THE MEMORY
OF MY COLLEAGUES ON THE
METEOROLOGICAL COUNCIL
1897-1900

Richard Strachey
Alexander Buchan
George Howard Darwin
Francis Galton
William James Lloyd Wharton
Robert Henry Scott

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PREFACE

THE four volumes which this work is intended to comprise are the expensive embodiment of a personal feeling that, for the community as a whole, there is nothing so extravagantly expensive as ignorance, however cheap it may be for any particular section of it.

The feeling developed into conviction during the war when it became my duty to supply, or alternatively to train, officers for various meteorological services. I was working in an environment which contained within its own experience or on its shelves almost all that there is to know about the weather; yet I had to send responsible officers into the services with a formula by which they could “carry on,” in place of the knowledge that would enable them to become a part.

In that respect the war was like a kinema film that is run too fast: one missed what one is accustomed to see and saw things that pass unnoticed in ordinary life.

I realised that an insight into what the study of weather means was at that time and is still a privilege rather wastefully confined to a small minority of a special class, that my work for the science which, for twenty-five years, it was my duty to foster could not be regarded as finished without a definite attempt to rescue from oblivion the vast mass of information about weather that is hidden behind the backs of the books of a meteorological library.

Considering that the mere existence of the human race depends upon its capacity to adjust its behaviour to the exigencies of climate and weather, any ignorance of meteorology which is avoidable is inexcusable. Looking backward, how different the history of the world might have been, indeed must have been, if the conditions which determined the potato-famine in Ireland in 1847 had been known beforehand. Instances of the same kind are numberless and in these days there is hardly anybody so fatalistic as to contend that the anticipation of the condition for a famine is beyond the capacity

of human intelligence. But when we consider the history of the subject it becomes evident that the real meteorology, directed to the solution of that kind of problem in the only way in which it is worth while to approach it, namely the study of the meteorology of the globe as a whole, has never had a fair chance. It has always been dependent upon the economics of other objects and ambitions. Meteorologists have had to be content with such crops as they could grow in other people's fields.

Even with that limitation the science has achieved enough to justify a modest hope of ultimate success. The object of this book therefore is to present the study of meteorology not only as making use of nearly all the sciences and most of the arts, but also as a world-study of a special and individual character going back inevitably to the very dawn of history, and beyond that to the mazes of geologic time, and still looking forward not unmindful of the advantages which it may derive from the blazing and sometimes bewildering light of modern science.

I have no intention of presenting any of the major problems of meteorology as solved. My aim is as far as possible to put the actual facts before the reader and let him draw conclusions for himself. I know from my own experience that drawing conclusions for oneself is an easy and pleasurable task when the facts are really known: anybody can take that step; but to supply himself with the facts is a labour beyond the power of the ordinary reader.

Besides expressing an effort to open up to others the material that gradually accumulates, the book discharges, so far as they can be discharged, two other personal obligations. The first is contained implicitly in a note for the Royal Meteorological Society on the educational equipment which is required for the advanced study of meteorology. It was entitled 'Meteorology for Schools and Colleges,' and it forms the introductory section of the collection of lectures and essays *The Air and its Ways* which was published in 1923 in order to "try out" the technical details of publication of a meteorological treatise. The present volume may be regarded as a more detailed handbook or guide to the necessary knowledge. In it I have tried to represent the knowledge which the reader of a paper on meteorology before a learned society of the present day will assume, perhaps unconsciously, to be in the possession of his audience.

PREFACE

vii

The other obligation is implied in a presidential address to the Royal Meteorological Society in 1919 which took up the position that, although the organisation of climatological work in this country had passed from the Societies to the Government service, the study of weather still afforded innumerable opportunities for effective scientific activity on the part of the amateur. Activity of that kind has been so characteristic of British science from the seventeenth century until recent years that even so enlightened a person as the late Lord Salisbury could not regard scientific research otherwise than as a personal hobby. Times have changed, most of the sciences have now become so specialised that the amateur is left stranded; and it seems quite likely that the study of weather, which in so far as it is specialised is devitalised, may come into its own again as an attractive subject for amateurs if they can obtain access to a point of view from which they can survey the aims and objects within reach.

These ideas were in my mind when in 1918 the Meteorological Committee concurred in a proposal that I should be relieved from administrative duty and devote my time to the translation into book form of material contained within the office shelves and store-rooms. In addition to the regular official publications, my colleagues and I had already completed *The Seaman's Handbook*, *The Weather Map*, the *Meteorological Glossary*, which ran through several issues, and *The Weather of the British Coasts* which was asked for by the Admiralty for the guidance of inexperienced skippers. An atlas of *Cloud Forms* followed, and this Manual began with the preparation of Part IV as being urgently required at that time for aeronautics. It was published by the Cambridge University Press because, among other reasons, the Manager, the late Mr J. B. Peace, was willing to interest himself in the solution of the many technical difficulties of a work that is so vitally dependent upon the effectiveness of its illustrations.

The final proof of Part IV was handed into the Press on Armistice day. Since that auspicious day many things have happened, including the attachment of the Meteorological Committee to the Air Ministry and the consequential changes, the completion of my own period of office under H.M. Treasury as Director, and Chairman of the Committee, and my appointment as professor in the Imperial

College of Science. Mr Peace's sudden death in 1923 left the work with a number of loose ends.

The Meteorological Committee have not lost sight of the arrangement and have done many things to assist in bringing into book form the scientific material belonging to the Office. Their most effective help was expressed in the work of Miss E. E. Austin who was seconded from the Office as my official assistant during my four years' tenure of the professorship at the Imperial College, and, through the good offices of Dr Simpson, my successor as director of the Meteorological Office, was allowed to continue that assistance after the termination of my official duty.

Although when completed this Manual may have expanded to twice the size that was originally contemplated in 1918, those readers who are familiar with the breadth and depth of meteorological literature will probably be more impressed by its many omissions than by what it contains. My object throughout has been to give not my own views upon subjects of meteorological interest, though I attach some importance to them, but to provide the reader with material upon which he can form his own opinion, or at least indicate to him where he can find the material upon which opinion should be based.

I have now realised that it is not so much a text-book that is wanted as an encyclopaedia or dictionary, in ten parts, one part to be brought up to date each year—a sort of revolving book-case or portable substitute for a meteorological library of larger dimensions. I wish it could have been so, but the task of providing it is beyond the power of my personality and my purse. The book must therefore be offered as a suggestion, I hope prophetic, of what those interested in the study of weather may enjoy if there be the will to satisfy them.

I revert again to the difficulty in the preparation of an effective book on meteorology arising from its dependence upon illustrations. They must in nearly all cases be borrowed or adapted from published works or manuscript material. It was understood from the beginning that illustrations belonging to the Office or its publications should be available, indeed one of the purposes in view was to utilise them for the advantage of a wider public than the regular readers of official documents. But there are many others. It will be best to make the acknowledgments in the several volumes. The list of illustrations in each will give the sources from which the

PREFACE

ix

illustrations have been derived and acknowledgments are appended thereto.

In this volume we are particularly indebted to Mr C. J. P. Cave of Stoner Hill and Mr G. A. Clarke of the Observatory at Aberdeen for a large selection of cloud-studies. We welcome a new kind of illustration in the form of a stereo-photograph of the whole sky which we owe to the kindness of Mr Robin Hill and Mr C. S. Leaf of Cambridge. The sources of other illustrations of clouds are given in a special index of cloud-forms and cloud-groups.

The reader may be surprised to find in the chapter on the upper air a large collection of illustrations of cloud-forms and, contrary to an asserted principle, the author's views upon the subject of the classification of clouds. The reason for the apparent inconsistency is that the latter part of this volume is devoted to an exposition of the means which have been developed in the course of nearly three centuries for the collection of observations of all kinds, in order that in the succeeding volumes the author may deal with results and inferences without having to pause to discuss the methods by which the observations have been obtained. The question of observation of clouds is in the peculiar position of asking What shall be observed? and in that respect differs from the other elements which are referred to in this volume. It is a question which has to be settled before the other parts of the work can be organised.

For the conversion of our own rough sketches into book-illustrations we were dependent until 1923 upon the staff of the Cambridge Press who, under Mr Peace's direction, prepared the outlines for the maps and put into proper form the lines to be superposed thereon. These include the charts of isotherms, dew-point lines, isonephs, isohyets and isobars which illustrate comparative meteorology, the subject of the second volume. For many of the later diagrams we have been fortunate enough to obtain the practised assistance of Miss E. Humphreys who acted as artist on the staff of the Meteorological Office for press illustrations in the years before the war. Some of the illustrations are indeed reproductions of drawings made while she was at the Office, but the great majority are new, specially prepared for this work though based in many cases upon original drawings to be found in the Office collection.

In the book are a number of extracts from translations of the classics and from modern writers. For the extracts from Herodotus I have quoted Rawlinson's translation and for Aristotle I have used a free translation of the French of Barthélemy St Hilaire because, when I was writing on that part of the subject, no English translation of the *Meteorologica* was known to me. In Chapter VI however I have taken advantage of Webster's translation through the Clarendon Press. I have in this connexion to acknowledge my indebtedness to the publishers enumerated in this paragraph for permission to reproduce the extracts, and to the authors with whom I have been in correspondence, through the good offices of my friend Dr J. P. Postgate. The long transcript of Virgil's weather lore is taken from Dr J. W. Mackail's translation, published by Longmans, Green and Co. Those from Hesiod, A. W. Mair's version published by the Clarendon Press, from the *Phaenomena* of Aratus, G. R. Mair's translation in the Loeb Classical Library. I must mention also two extracts from a verse translation of the *Clouds* of Aristophanes by B. B. Rogers published by G. Bell and Sons.

I have used for the *Diosemeia* a translation made by C. Leeson Prince as a contribution to meteorology at the request of the late G. J. Symons. To a similar impulse I am indebted for the translation of the *Winds and Weather Signs* of Theophrastus by my colleague of many years at Emmanuel College, J. G. Wood, from which with his permission I have made large extracts. In the earlier chapters are a number of contemporary passages quoted from *Nature*, some of them signed by the authors, others without signature. It was to me remarkable that there should be, just at that time, so many passages which exactly met my need. And since I have put together in this volume the general ideas of the relation of weather and meteorology to humanity at large, I have been astonished at the frequency with which different aspects of the subject appear spontaneously in the public press. The sources of these and other quotations are acknowledged in the text.

In the chapter on the variability of climate I have found myself dependent upon somewhat lengthy extracts from the contributions to the subject in various books and journals: The Royal Geographical Society (Professor J. W. Gregory), the Royal Meteorological

PREFACE

xi

Society (Professor Otto Pettersson), the *Geographical Review* (H. C. Butler), Huntington and Visser's *Climatic Changes, their Nature and Causes* (Yale University Press), and Sven Hedin, *Overland to India* (Macmillan and Co., Ltd.). For the concluding quotation from Jowett's translation of Plato's *Critias* I have to thank the Clarendon Press.

For the information contained in the brief biographies of meteorologists, physicists and mathematicians of the two hundred years after the invention of the barometer I am mainly indebted to the *Dictionary of National Biography*, the *Encyclopaedia Britannica* (eleventh edition) and *Chambers's Encyclopaedia* (ed. 1895).

The biographies are intended to carry the history of the development of meteorology up to the invention of the weather-map. The contributions of living meteorologists have to be considered from a different standpoint. Between these two classes are the meteorologists who gave expression to the idea of meteorology as an international science. They form the class of meteorologists who were active mainly between 1860 and the end of the nineteenth century. I have not ventured to include them in the biographies because the subject cannot be regarded as a collection of separate contributions to the same extent as it was during the two centuries covered by the biographies. Their names occur in other associations of a different kind that can be represented best by photographs of international assemblies which were a characteristic feature of the period, and the mode of representation is the more appropriate because the development of photography is practically contemporaneous with that of the weather-map.

Two groups are represented, the first that of the International Meteorological Congress in Rome in 1879, which finally established the organisation of meteorology on an international basis, and second, the Meteorological Conference at Paris in 1896 at which was initiated the International Commission for the Study of the Upper Air. They contain portraits of most of the prominent meteorologists of the period to which we have referred, but as some very notable exponents of the science do not appear in the groups, I have supplied some of the omissions by portraits from various sources that happened to be accessible. A few of the older school have been included.

The earliest photographs are those of Sir Edward Sabine and John Welsh which date from 1852 and are from a group preserved in Kew Observatory. It is a daguerreotype or collodion positive taken at Vauxhall on the occasion of one of Welsh's balloon ascents. The full picture includes Colonel Sykes, Prof. W. A. Miller and Mr J. P. Gassiot, the principal benefactor of Kew Observatory, as well as the two portraits which are here reproduced, also the table of instruments ready for the ascent.

For the reading of the proof-sheets I owe my thanks to Captain D. Brunt and Commander L. G. Garbett, R.N., of the Meteorological Office, who were at one time associated with me in the work of the School of Meteorology at the Imperial College.

The reader will share my obligation to Mr W. Lewis and his staff at the Cambridge University Press for the manner in which they have continued the work which Mr J. B. Peace began.

NAPIER SHAW

8 July 1926

The necessity for a second impression of this volume has been met by the reproduction of the original with only the necessary correction of the errors that have disclosed themselves in print and the rectification of statements that have become obsolete.

Some additions have been notified in square brackets in the text, and the notes at the end have been amplified to include some contributions by readers of the original volume.

N. S.

28 November 1931

TABLE OF CONTENTS

VOLUME I. METEOROLOGY IN HISTORY

Chapter I. METEOROLOGY IN EUROPEAN CULTURE *page 1*

 The practical importance of weather.
 Civilisation and the study of weather.
 The contributions of meteorology to ancient culture.
 Before and after the weather-map.
 The place of forecasting in modern meteorology.
 The earliest records.
 The diversity of climates.

Chapter II. WEATHER AND CLIMATE IN THE “WORLD AS KNOWN TO THE ANCIENTS” *page 12*

 The climates of the Mediterranean region.
 The numerical expression of the meteorological elements.
 Observations without instruments.
 Wind-vanes, the direction and force of the wind, the amount of cloud and visibility.
 Beaufort scale of wind-force.
 Instrumental observations.
 Climatic summaries for Mediterranean stations.
 Rainfall, pressure and winds.

Chapter III. THE MEASUREMENT OF TIME: THE KALENDAR AND THE CYCLE OF THE SEASONS *page 44*

 Specification of seasons by the stars.
 Day and night. The hour.
 Heliacal rising.
 The moon as time-keeper.
 The sun and moon as joint time-keepers.
 The relation of the kalendar to the cycle of the seasons.
 Egypt, Cyprus, Greece, Iraq, Sicily, Northern countries.
 The present position of the kalendar.
 The quarters of the May Year.

Chapter IV. POETS AND HISTORIANS: THE APPLICATIONS OF METEOROLOGY TO AGRICULTURE AND NAVIGATION. HERODOTUS *page 63*

 The Greek and Hebrew poets.
 The conflict between religion and science.
 Historical notes of weather.
 The relation of climate to the study of weather.

xiv

TABLE OF CONTENTS

Chapter V. METEOROLOGY IN THE TIME OF ARISTOTLE . . . page 73

Aristotle's *Meteorologica*.

“On dew and hoar-frost.”

On the classification of winds.

The sculptures of the eight winds.

Chapter VI. VARIABILITY OF MEDITERRANEAN CLIMATES IN HISTORICAL TIMES page 84

A survey of the position.

Syria.

Central Asia: Sin Kiang.

Baluchistan, Sistan, Afghanistan.

Central America.

Europe.

Northern Africa.

Palestine and California.

The general circulation of the atmosphere.

Variations and their causes.

Climate and civilisation.

Sand.

Soil.

Conclusion.

Chapter VII. FROM ARISTOTLE TO THE INVENTION OF THE BAROMETER. WEATHER-LORE, ASTROLOGY AND ALMANACS . . . page 98

Greek weather-lore.

Roman weather-lore.

Mediaeval and modern lore.

Astrology—the voices of the stars.

Almanacs.

Lunar weather-lore.

The acceptance of proverbial philosophy.

The popular appreciation of weather-signs.

The “cause” of abnormalities in weather.

A new astrology.

Chapter VIII. THE REIGN OF THE BAROMETER AS WEATHER-GLASS. PIONEERS IN THE SCIENCE OF WEATHER page 115

Meteorology as a science.

Pioneers in the study of weather and of the physical processes of the atmosphere.

The barometer as weather-glass.

FitzRoy’s instructions for the use of the barometer to foretell weather.

The threshold of modern meteorology.

Chapter IX. METEOROLOGY AS AN INTERNATIONAL SCIENCE. THE METEOROLOGICAL LIBRARY page 156

The distinction between the sciences of meteorology and physics.

Limits of accuracy of meteorological measurements.

The purposes of meteorological observation.

The early appreciation of the meteorological problem.

Meteorology, a world-study. The *réseau mondial*.

TABLE OF CONTENTS xv

International co-operation as a means of promoting meteorology
as a world-study.
The future of international meteorology.
An international meteorological college.
The next step.
Survey of the surface air of the world.

Chapter X. THE METEOROLOGICAL OBSERVATORY. THE SURFACE
AIR *page 175*
Meteorological equipment.
Time-keeping.
Surveying instruments.
The photographic camera.
Instruments for the exploration of the elements of atmospheric
structure and their changes.
Wind.
Pressure.
Temperature. Screens.
Humidity.
Note on the density of atmospheric air.
Rainfall.
Evaporation.
Reduction to sea-level.
The duration of sunshine, and of clear sky at night.
Pole-star recorder.
Certificates of examination of common meteorological instruments.

Chapter XI. THE METEOROLOGICAL OBSERVATORY. THE UPPER AIR *page 207*
The varying atmosphere.
Cloud-forms.
Index of cloud-forms and cloud-groups
Classification of clouds.
Measurement of the height of clouds.
Measurement of the motion of clouds.
Meteorological optics.
The winds of the free air by pilot-balloons.
Pressure, temperature and humidity in the free air.
Troposphere and stratosphere.
Meteorographs for balloons and kites.
Balloons.
Kites.
Kite-balloons, Drachen-ballons, Ballons-Caquot.

Chapter XII. THE METEOROLOGICAL LABORATORY. THE STUDY
OF THE ATMOSPHERIC HEAT-ENGINE AND THE CYCLE OF
PHYSICAL CHANGES IN THE GENERAL CIRCULATION . *page 234*
The energy of the atmosphere, thermal and electrical.
Instruments for the measurement of thermal radiation, solar and
terrestrial.
Solar maximum and grass minimum thermometers.
Pyrheliometers.
Radiometers.
Wilson's radio-integrator.
Pyranometers and pyrgeometers.

TABLE OF CONTENTS

The relation of energy to wave-length in solar and terrestrial radiation.
 The use of colour-screens in the measurement of radiation.
 Ultra-violet radiation: actinometers.
Measurements of ozone.
The absorption by the atmosphere and the solar constant.
Instruments for the study of visibility.
Dust-counters.
Atmospherics and thunderstorm-recorders.
Lightning conductors.
Measurements of the earth's electric field and its changes. Ionisation and air-earth current.
Magnetic forces in the atmosphere, absolute and recording instruments.
 Record of changes in the vertical force.

Chapter XIII. THE DEVELOPMENT OF ARITHMETICAL AND GRAPHICAL MANIPULATION page 254

Graphic representation.
 Isograms.
 Projections.
 Representation by graphs—the Cartesian method.
 Polygraphs.
 Logarithmic scales.
 Isopleths.
 Climatic diagrams.
 The nomogram.
The treatment of vector-quantities.
 Wind-roses and vector-diagrams.
Continuous records.
Periodicity.
 Fourier's theorem.
 Harmonic analysis.
 The analysis of a curve for unknown periodicities. Method of residuation.
 The periodogram.
Curve-parallels.
Regression equation and correlation.
 Partial correlation coefficients.

Chapter XIV. THE ANALYSIS OF AIR-MOVEMENT INTO THE GENERAL CIRCULATION AND THE CYCLONE page 287

Early charts of the distribution of the meteorological elements.
Tropical revolving storms.
 The centripetal theory.
The weather-map.

Chapter XV. METEOROLOGICAL THEORY IN HISTORY page 316

NOTES AND INDEX page 323

LIST OF ILLUSTRATIONS

FIG. 1.	The World as known to the Ancients	page 12
„ 2.	The velocity and the pressure of wind in relation to the Beaufort scale (<i>First Report of the Meteorological Committee</i> , London, 1906)	18
„ 3.	Normal distribution of rainfall over the regions of the ancient world in January, April, July and October	23
„ 4.	Normal distribution of pressure over the regions of the ancient world in January, April, July and October	26
„ 5.	The tower at Athens bearing sculptures of winds and sun-dials	46
„ 6.	The Zodiac and the Kalendar	48–51
„ 7.	A sandstorm of the Sudan (photograph by G. N. Morhig, the English Pharmacy, Khartoum)	69
„ 8.	The wind-rose of Aristotle and Theophrastus, and the deviation of the compass in London within a modern wind-dial	78
„ 9.	The winds of Hellas	82
„ 10.	Changes of climate as deduced from the rings of trees in California and changes of climate in the Eastern Mediterranean region. (From Huntington and Visher, <i>Climatic Changes</i> , Yale University Press, 1922)	90
„ 11.	The barometer as weather-glass. An observer's experience referred to the weather-map. (Redrawn from <i>The Weather of the British Coasts</i>)	152
	International Meteorological Congress, Rome, 1879 Plate facing	157
„ 12.	Meteorological instruments to illustrate Hooke's scheme of weather observations. (From Sprat's <i>History of the Royal Society</i> , 2nd edition)	160
„ 13.	Hooke's scheme of observations. (From the same)	161
„ 14.	Charts of the Northern and Southern Hemispheres showing the relation of standard time of zones of sea and land to Greenwich mean time	180
„ 15.	The graduation of a millibar barometer	190
„ 16.	Land-barometer. (Lent by Messrs Negretti and Zambra)	190
„ 17.	Barometric pressure in millibars	190
„ 18.	Diagram for obtaining the relative humidity from readings of the wet and dry bulb thermometers in strong wind and calm	199
„ 19.	Photographic record of the sky at the Royal Observatory, Greenwich. (The Astronomer Royal)	206
	International Conference of Meteorologists at Paris, 1896 Plate facing	206

xviii	ILLUSTRATIONS
FIGS. 20 to 95.	Cloud-forms and cloud-groups. (The sources are noted in a special index) Inset between <i>pages</i> 208–9
FIG. 96.	The launch and recovery of sounding-balloons at sea. (After Teisserenc de Bort and Rotch) 225
„ 97.	Trace of Dines meteorograph. (Royal Meteorological Society) 226
„ 98.	A record of pressure, temperature and humidity from a meteorograph of the type used at Trappes. (Office National Météorologique de France) 227
„ 99.	Graphs of temperature and of direction and velocity of wind obtained from a kite-balloon. (Advisory Committee for Aeronautics) 229
„ 100.	Solar radiation and terrestrial radiation. The relation of energy to wave-length 241
„ 101.	Normal pressure and winds in the intertropical region, July. (<i>The Air and its Ways</i>) 259
„ 102.	Halley’s map of the winds. (<i>Royal Society, Philosophical Transactions</i>) 259
„ 103.	Humboldt’s charts of isotherms of the Northern Hemisphere. (Addendum to <i>Cosmos</i>) 260
„ 104.	Polygraph of changes of temperature with height above sea-level, balloon-ascents 1907–8. (<i>The Free Atmosphere in the Region of the British Isles</i> , M.O. publication, No. 202). 264
„ 105.	Examples of graphs of soundings of the atmosphere referred to pressure-temperature and pressure-potential-temperature respectively for an ascent by J. Welsh in 1852, and for a sounding in Canada in 1911 266
„ 106.	Entropy-temperature diagrams for the atmosphere on the occasions represented in Fig. 105 Inset to face 266
„ 107.	Chrono-isopleths of the meteorological elements at Kew Observatory (Richmond) and at Valencia Observatory (Cahirciveen). (<i>The Weather Map</i> , M.O. publication, No. 225 i) 267
„ 108.	Isopleths of temperature in the free air over Paris, 27 January to 1 March, 1901. (Teisserenc de Bort) 268
„ 109.	Climatological diagrams of normal temperature and relative humidity at three stations in Egypt. (J. Ball, <i>Cairo Scientific Journal</i>) 269
„ 110.	Nomogram for the calculation of dew-point and vapour-pressure (J. Ball, Royal Meteorological Society) 269
„ 111.	Six harmonic components of an eleven years’ period and their resultant curve with figures for the yield of wheat in Eastern England, 1885 to 1906 276
„ 112.	Curve-parallels. The relation of pyr heliometric values and mean temperature-departures to sunspot numbers and violent volcanic eruptions. (W. J. Humphreys) 278
„ 113.	Curve-parallels. The variations of pressure from year to year at Bombay and Cordoba, 1860–1905. (Solar Physics Observatory, H.M.S.O., London) 279

ILLUSTRATIONS	xix
FIG. 114. Curve-parallels. Curves of variation of rainfall from year to year. (H. H. Hildebrandsson)	page 280
„ 115. Dot-diagrams and regression-lines of pressure and temperature at the surface and in the upper air of Canada. (<i>The Air and its Ways</i>)	282
„ 116. Curve-parallels and a dot-diagram for the variations in the mean number of sunspots and the levels of Victoria Nyanza from 1902-1921	284
„ 117. Synoptic chart of Western Europe for March 6, 1783, constructed by Hildebrandsson from the data used by Brandes	299
„ 118. Synoptic charts for October-November 1852 constructed by Buys Ballot. (<i>Poggendorff's Annalen</i> Ergänzungsband IV, 1854)	304
„ 119. (i) "Circular Letter to Meteorological Observers" by Sir Francis Galton in 1861	306
(ii) Galton's synchronous weather-chart of England, 16th January 1861, 9 a.m.	307
„ 120. (i) Prospectus of the Daily Weather Map Company	308
(ii) Specimen weather-map of the British Isles issued by the Daily Weather Map Company about 1863	309
„ 121. Chart prepared by Alexander Buchan to show the travel of depressions over the Atlantic. (Scottish Meteorological Society)	310

The authorities to whom acknowledgment is due for the several illustrations are noted in the respective titles in the foregoing list. Figures 2, 11, 104, 107, and 113, which are taken from official publications, are reproduced by permission of H.M. Stationery Office.

The derivation of the portrait-groups and separate portraits which face pages 156-7 and 206-7 is as follows: The International Congress in Rome, 1879, and the International Conference at Paris, 1896, are from framed copies preserved in the Director's room of the Meteorological Office at South Kensington. In the same room are the portraits of Admiral FitzRoy presented by his daughter Miss Laura FitzRoy, Sir Richard Strachey presented by Lady Strachey, Sir Francis Galton presented by his nephew Mr E. G. Wheler, and Dr Richard Assmann by his daughter Fraülein Helene Assmann. That of Alexander Buchan is from a photograph by Elliott and Fry, Ltd.

The portraits of H. W. Dove and James Glaisher are from cartes-de-visite presented by the late J. S. Harding, Admiral FitzRoy's chief clerk and secretary in the Meteorological Department of the Board of Trade.

The picture of Luke Howard is from a copy of a pencil drawing in possession of the Royal Meteorological Society; those of Sir E. Sabine and John Welsh are from a collodion positive of a portrait-group belonging to Kew Observatory, taken at Vauxhall on the occasion of one of Welsh's balloon ascents. Those of Buys Ballot and G. J. Symons are from commemorative medals in the possession of the author.

The other portraits are from published works, J. B. Biot and M. F. Maury from *Harper's Monthly*, by permission of Harper Brothers, U. J. J. Le Verrier

ILLUSTRATIONS

from the volume commemorating the centenary of his birth, H. F. Blanford from the Administrative Report of the Indian Meteorological Department for 1924, S. P. Langley from the commemorative volume of the Smithsonian Institution, J. M. Pernter from the *Meteorologische Zeitschrift*, R. Abercromby and W. H. Dines from the *Quarterly Journal of the Royal Meteorological Society*.
The other picture, which is by Knudsen of Bergen and is not named, will be recognised as an effective snapshot of the meteorology of the future.