

THE WEATHER OBSERVER'S HANDBOOK

The Weather Observer's Handbook provides a comprehensive, practical, and independent guide to all aspects of making weather observations. Automatic weather stations today form the mainstay of both amateur and professional weather observing networks around the world, and yet – prior to this book – there existed no independent guide to their selection and use. Traditional and modern weather instruments are covered, including how best to choose and to site a weather station, how to get the best out of your equipment, how to store and analyze your records, and how to share your observations with other people and across the Internet. From amateur observers looking for help in choosing their first weather instruments on a tight budget to professional observers looking for a comprehensive and up-to-date guide covering World Meteorological Organization recommendations on observing methods and practices, all will welcome this handbook.

Stephen Burt has a professional background in physics, meteorology and climatology, information technology, and marketing. He is a Fellow of the UK's Royal Meteorological Society and is also a member of both the American Meteorological Society and the Irish Meteorological Society. He has run his own meteorological observatory for more than 40 years. After almost 10 years with the UK Met Office he took up a business career within the computer industry, successfully managing international marketing roles for several of the world's largest high-technology firms. During this time he was also elected to the UK's Chartered Institute of Marketing.

Stephen is a regular contributor to the Royal Meteorological Society's monthly magazine *Weather*, with more than 100 published papers or articles and several hundred published photographs to date. He is a recent member of the Royal Meteorological Society's Council governing body, Chairman of the Society's South-east Centre and a long-standing committee member of the Society's Special Interest Group on Weather Observing Systems. Stephen was awarded the Royal Meteorological Society's Gordon Manley Prize in 2006. He is also a Trustee of the Chilterns Observatory Trust and Chairman of the Climatological Observers Link. He lives in southern England with his wife and two daughters.

‘This is a very impressive work! Stephen has done a great job of addressing many issues that I have personally wondered about. At last there is a comprehensive book on the tricky issue of accurately measuring the weather. This timely publication is a must for anyone in the market for a weather station, libraries, and weather observers of all stripes, both amateur and professional.’

– Christopher C. Burt (no relation to Stephen), *Weather Historian*, Wunderground, Inc., and author of *Extreme Weather: A Guide and Record Book*

‘Sophisticated equipment for weather observing is now within reach of more people than ever. Yet a poorly sited station or a wrongly interpreted report can do more harm than good. With this marvelous book, Stephen Burt has given us a very practical and helpful guide to installing and using one’s own reporting station, enhanced with perspective drawn from the centuries-long history of meteorological instrumentation. *The Weather Observer’s Handbook* is an ideal companion to the practice of monitoring the atmosphere.’

– Robert Henson, author of *The Rough Guide to Weather* and *The Rough Guide to Climate Change*

‘People have been making observations of the weather for thousands of years, and observations remain central to our capabilities to forecast the weather and predict the changing climate. But it’s not just professional meteorologists who make weather observations; there are literally millions of amateur observers across the world making observations every minute of every day. In meteorology, as well as in other science disciplines, amateur observers (I include all non-professional meteorologists in this) have always played a crucial part in supporting well-established national observation programmes and in making a very valued contribution to our scientific understanding.

‘We have many amateur members and schools in our Society and I’m often asked if I can recommend a good book to help them in their observing exploits. Well, now I can. This is the first comprehensive book of its type that I know of that offers a practical guide to anyone with an interest in making observations of the weather. It’s not only an essential practical handbook, but it showcases the wide range of observations that can now be made with relative ease, and, importantly I think, it helps to enthuse others to follow their interest. If you have an interest in observing the weather, then this book is as essential as your observing equipment.’

– Paul Hardaker, Chief Executive of the Royal Meteorological Society

Cambridge University Press
978-1-107-02681-0 - The Weather Observer's Handbook
Stephen Burt
Frontmatter
[More information](#)

The Weather Observer's Handbook

Stephen Burt



Cambridge University Press
978-1-107-02681-0 - The Weather Observer's Handbook
Stephen Burt
Frontmatter
[More information](#)

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City
Cambridge University Press
32 Avenue of the Americas, New York, NY 10013-2473, USA

www.cambridge.org
Information on this title: www.cambridge.org/9781107662285

© Stephen Burt 2012

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2012

Printed in the United States of America

A catalog record for this publication is available from the British Library.

Library of Congress Cataloging in Publication data

Burt, Stephen, FRMetS.

The Weather Observer's Handbook / Stephen Burt.

p. cm.

Includes bibliographical references and index.

1. Meteorological instruments – Handbooks, manuals, etc.

2. Meteorological stations – Handbooks, manuals, etc. I. Title.

QC876.B87 2012

551.5–dc23

2012002162

ISBN 978-1-107-02681-0 Hardback

ISBN 978-1-107-66228-5 Paperback

Additional resources for this publication at www.measuringtheweather.com

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party Internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Cambridge University Press
978-1-107-02681-0 - The Weather Observer's Handbook
Stephen Burt
Frontmatter
[More information](#)

For Helen

Mr Hook[e] produced a part of his new weather Clock which he had been preparing which was to keep an Account of all the Changes of weather which should happen, namely the Quarters and points in which the wind should blow. 2ly the strength of the Wind in that Quarter. 3ly The heat and cold of the Air. 4ly The Gravity and Levity of the Air. 5ly The Dryness and moisture of the Air. 6ly The Quantity of Rain that should fall. 7ly The Quantity of Snow or Hail that shall fall in the winter. 8ly The times of the shining of the Sun. This he was desired to proceed with all to finish he hoped to doe within a month or six weeks.

From Royal Society Journal Book (JBO/6), dated 5 December 1678. Reproduced by kind permission of the Royal Society Archives

Contents

<i>Acknowledgements</i>	ix
<i>Abbreviations, footnotes and references</i>	xi
PART ONE THE BASICS	
1. Why measure the weather?	3
2. Choosing a weather station	32
3. Buying a weather station	55
4. Site and exposure – the basics	76
PART TWO MEASURING THE WEATHER	
5. Measuring the temperature of the air	87
6. Measuring precipitation	124
7. Measuring atmospheric pressure	167
8. Measuring humidity	183
9. Measuring wind speed and direction	192
10. Measuring grass and earth temperatures	222
11. Measuring sunshine and solar radiation	232
12. Observing hours and time standards	271
13. Dataloggers and AWS software	282
14. Non-instrumental weather observing	294
15. Calibration	304
16. Metadata – what is it, and why is it important?	322
PART THREE MAKING THE MOST OF YOUR OBSERVATIONS	
17. Collecting and storing data	333

18. Making sense of the data avalanche	348
19. Sharing your observations	378
20. Summary and getting started	393
<i>Appendix 1</i> Metrology and meteorology: The basics of instrument theory	409
<i>Appendix 2</i> Useful functions	416
<i>Appendix 3</i> Unit conversions	420
<i>Appendix 4</i> Useful sources	423
<i>Index</i>	435

Acknowledgements

It has often been said that the exercise of writing a book both tests and expands the knowledge of the writer, and that has certainly been my experience in researching and writing this book. I have been fortunate in being able to draw upon on the willing help and assistance of many people around the world in helping to answer my questions, some simply seeking a photograph or a reference to published work, others much more detailed or technical in nature. Sure enough, the process of having to set it all down on a blank sheet of (virtual) paper has immeasurably broadened and deepened my own understanding of the topics covered. I hope that this has, in turn, found its way onto the pages that follow.

Of course, the nature of weather itself knows no international boundaries. The credit for suggesting the expansion of my original book proposal into a global weather observer's manual goes to my Editor Dr Matt Lloyd, of Cambridge University Press in New York: I am very grateful to Matt and to Amanda O'Connor, Editorial Assistant, for their help and support throughout the process from proposal to launch; to Lindsey Anderson from Cambridge University Press's production agency Integra in Chicago, and to Fran Robinson and Joy Mizan for their help in pulling together the book's launch marketing plans in the UK and U.S. markets, respectively. Many individuals around the world willingly provided their expertise in the preparation of this volume, took the trouble to read and comment on draft chapters and offered helpful suggestions; I hope you will recognise your input in the pages following. I would particularly like to thank the following for their contributions and support: Dr Hans Bergström (University of Uppsala, Sweden), Richard 'Heatwave' Berler (Chief Meteorologist, KGNS TV, Laredo, Texas), Christopher C. Burt (Weather Historian for Weather Underground, Inc.), Professor Dario Camuffo (Istituto di Scienze dell' Atmosfera e del Clima, Bologna, Italy), WL Chang and SW Chow (Hong Kong Observatory, China), Professor Claudio Cocheo (Centro di Ricerche Ambientali, Padua, Italy), Steve Colwell (British Antarctic Survey, Cambridge), Joanna Corden and Emma Davidson (Royal Society, London), Nolan Doesken (Colorado State University, and co-founder of CocoRaHS), Dr Wolfgang Fritze and Dr Stefan Gilge (Deutscher Wetterdienst, Hohenpeissenberg Observatory, Germany), Dr Emily Gleeson (Irish Meteorological Society, Dublin), Grant Goodge (formerly of NOAA's National Climatic Data Center, Asheville, North Carolina), Aidan Green (Surface Networks Manager, UK Met Office, Exeter), Richard Griffith (Climatological Observers Link/COL, Horsham), Professor Paul Hardaker (Royal Meteorological Society, Reading, UK), Professor Giles Harrison and Dr Keri Nicoll (Department of Meteorology, University of Reading, UK), Bob Henson (UCAR,

Acknowledgements

Colorado), Rob Hughes (Fredericton, NB, Canada), Dr Gert König-Langlo (World Radiation Monitoring Center, Alfred Wegener Institute, Bremerhaven, Germany), Melody Magnus (NOAA/NWS webmaster, Silver Spring, Maryland), Maurizio Maugeri (University of Milan, Italy), Dr Joe Michalsky (NOAA), David Myers (ex-IBM and ex-Dell), Charles T. Orloff and Mike Iacono (Blue Hill Observatory, Massachusetts), Isabel Plana (Meteoswiss, Zürich), John Prior (National Climate Information Centre, UK Met Office, Exeter), Henry Reges (CoCoRaHS, Colorado), Francesca Steffanoni (Ev-K2-CNR Committee, Bergamo, Italy), Dr Ian Strangeways (Terradata, Wallingford, UK), Phil Thomas (COL, Alvechurch), Professor Frank Vignola (Department of Physics, University of Oregon), Julia Wessels (Swiss Institute for Snow and Avalanche Research, Davos), Gary Wicklund (NOAA/National Weather Service, Pocatello, Idaho), and James Zdrojewski (National Weather Service HQ, Silver Spring, Maryland). As ever, Steve Jebson and Mark Beswick in the National Meteorological Library, Exeter, UK, provided exemplary support in the tracking down of references and other source materials. Other individuals and organisations preferred or requested not to be mentioned by name; my thanks are there all the same.

This book is deliberately independent of any instrument manufacturer or supplier, but it would be incomplete without the willing help and assistance of many individuals within those companies who went the extra mile (or should it be 1609 metres?) to help out with sourcing product specs, photography and a thousand other details for me. Particular thanks go to Dick Saffell, Iain Thornton and Mike Brettle from Campbell Scientific Ltd (Loughborough, UK); Dr John Dann from Prodata (Ely, UK); and Dan Anderson and James Thoreson from RM Young USA (Traverse City, Michigan).

Special thanks go to Dr Roger Brugge (University of Reading), Philip Eden (Chilterns Observatory Trust) and Kevin Sangwell (COL, Woking), who kindly read through a complete early draft of each of the chapters and provided detailed and constructive feedback at all stages. Any remaining errors are, of course, entirely my own.

Finally, a special thank-you to my family – to my wife Helen and my two daughters, Fiona and Jennifer. Without your support, love and understanding I could not have started, far less completed, this seven-year project.

Stephen Burt
Berkshire, England
www.measuringtheweather.com

Abbreviations, footnotes and references

Abbreviations are defined within the text when first used; they are listed below only if used more than once.

Footnotes (indicated by superscripted symbols^{*†} and so on) are given at the foot of the page.

References and further reading are indicated within the text by bracketed numerals as [9]. They indicate sources of material or further reading for those who require more detail on the topic. References are numbered within each chapter and listed at the end of that chapter.

ASOS	Automated Surface Observing System
AWS	Automatic weather station
DWD	Deutsche Wetterdienst – the German state weather service
KNMI	Koninklijk Nederlands Meteorologisch Instituut – the Dutch state weather service
LAT	Local Apparent Time
MMTS	Maximum-Minimum Temperature System
MSL	Mean sea level
NOAA	National Oceanic and Atmospheric Administration
PC	Personal computer
PRT	Platinum resistance thermometer
RTD	Resistance Temperature Device
SRG	Standard Raingauge (US)
TBR	Tipping-bucket raingauge
USB	Universal Serial Bus (a communications port on computers)
USCRN	U.S. Climate Reference Network
USRCRN	U.S. Regional Climate Reference Network
USWB	United States Weather Bureau (now the National Weather Service)
WMO	World Meteorological Organization

Important note

Throughout this book, suggestions and recommendations are completely independent of manufacturer or supplier influence. No sponsorship or incentives were requested or offered by any of the companies whose products are referred to in this book. Although it is not possible to be fully conversant with every instrument or system described in this book, wherever possible usage details are from firsthand experience. System specifications and performances have been taken from published manufacturer literature or websites, except where specifically stated otherwise. Because product specifications change over time, it is suggested that potential purchasers always check manufacturer literature or websites for the latest information.

If you use this book to help choose an automatic weather station, or the components of one, please mention this to your reseller or dealer when you make your purchase.

For the latest product information, occasional equipment reviews, useful references and downloadable material related to this book, please visit www.cambridge.org/9781107662285 and the author's website www.measuringtheweather.com.

The information in this book is given in good faith. No liability can be accepted for any loss, damage or injury occasioned as a result of using this book or any of the information contained within, howsoever caused.

The photographs used in this book remain the copyright of the named photographers. If any photograph or diagram is incorrectly credited or referenced, please contact the publisher, who will correct the acknowledgement in any future edition.