

Polar Science and Global Climate

An International Resource
for Education and Outreach



General Editor: Bettina Kaiser
Associate Editors: Becky Allen and Sandra Zicus



A Pearson Custom Publication

Polar Science and Global Climate

An International Resource
for Education and Outreach

General Editor:

Bettina Kaiser

Associate Editors:

Becky Allen and Sandra Zicus



Brief Contents



ix	Foreword
1	Introduction
5	Prelude
25	Chapter 1: Teaching Polar Science
129	Chapter 2: Tips and Tricks for Science Presentations
143	Chapter 3: Outreach Initiatives
211	Chapter 4: IPY and Local Competence Building
217	Contributing Polar Research Institutions
220	Glossary
228	Abbreviations and Acronyms
230	References
231	Credits
232	Index

Contents

Foreword	ix
Introduction	1
Polar Science in the Context of Global Citizenship.....	1
How to Use this Book.....	2
Acknowledgements.....	3
Prelude	
The Past and Present of Polar Science	5
Introduction	5
The Significance of the International Polar Year in Communicating Polar Science.....	6
Six Themes of Polar Science Today and their Why, What and How	8
<i>Atmosphere</i>	8
<i>Ice</i>	10
<i>Oceans</i>	13
<i>Land</i>	15
<i>People</i>	18
<i>Space</i>	21
A Personal View: The Wonder of the Polar Regions	23
Chapter 1	
Education: Teaching Polar Science in the Classroom	25
Introduction	25
Six Themes of Polar Science in the Classroom	32
<i>Atmosphere</i>	32
<i>Ice</i>	40
<i>Oceans</i>	57
<i>Land</i>	77
<i>People</i>	92
<i>Space</i>	114
Going Further	122
Chapter 2	
Tips and Tricks for Science Presentations	129
Introduction	129
Paving the Way: Preparing for your Presentation.....	130
<i>Finding your Audience</i>	130





<i>Talk to the Organiser of the Event before you Go</i>	131
<i>Prepare your Presentation</i>	131
Along the Road: Key Aspects of Successful Presentations.....	131
<i>The Hook!</i>	131
<i>Engage your Audience</i>	132
<i>Use Presentation Software Programs Effectively</i>	133
<i>Body Language</i>	135
<i>Use Presentation Aides</i>	135
A Turning Point: Refining your Presentation for Classroom Visits	135
<i>For Younger Students (Ages 5–9)</i>	135
<i>For Middle Grades (Ages 10–14)</i>	136
<i>For Upper Grades (Ages 15 and up)</i>	136
Maintaining Momentum: Guidelines for Educators who Work with Scientists.....	137
Summary: 'To Go' Principles for Science Presentations	138

Chapter 3

<i>Outreach: Inspiring Ideas and Initiatives from around the World</i>	143
Introduction: A Rationale for Education and Outreach	143
Outreach at a Glance: A List of Outreach Categories	144
Outreach in Detail: A Selection of Initiatives from around the World	147
<i>School Level Initiatives</i>	148
<i>University Level Initiatives</i>	177
<i>Public Level Initiatives</i>	187

Chapter 4

<i>IPY and Local Competence Building in the Circumpolar North</i>	211
Introduction	211
The Voice of Reindeer Herding Communities during IPY	212
IPY EALÁT: The Significance of IPY for Reindeer Herding Peoples.....	212
Strengthening Traditional Knowledge in Polar Research.....	214
Conclusion: Adaptation to Change and Unpredictability	215
Contributing Polar Research Institutions.....	217
Glossary	220
Abbreviations and Acronyms	228
References	230
Credits.....	231
Index.....	232

Foreword

A recent paper, published in October 2009, shows that the area of the Arctic Ocean covered by thick multi-year ice has decreased precipitously in only three years. The average annual mass loss from a global reference set of 30 mountain glaciers has accelerated dramatically over the same time span. Mass loss from the Greenland ice sheet has tripled since the last major assessment by the Intergovernmental Panel on Climate Change in its Fourth Assessment Report (AR4) in 2007. As I write this, a new paper already shows faster loss and greater sea level rise than a very thorough overview published only a few months earlier. The huge Antarctic ice sheet, considered stable or in slight decline in AR4, now shows clear signs of deterioration. Because of rapid change, and because of increased attention during IPY, new information about polar systems appears monthly, in some cases even weekly, in science journals as well as in the public media.

This rapid staccato of harsh messages—the first rumblings of a forthcoming avalanche of IPY results (if I may use that analogy)—presents severe internal challenges to science itself and a grim picture to the interested public. For science the challenges lie in revising our cautious and philosophic communication processes to match swift changes in polar environments, and particularly, in more quickly transforming new knowledge into predictive skill. For the public the latest announcements of disappearing snow and ice raise concern, but also confusion. Have such changes occurred in the past? Do we know the causes? What relevance do the changes have to daily lives? How, if at all, should we react—individually or collectively?

I find reason for optimism in this book, for science and for the public. Herein, on the occasion of IPY, we observe science interacting directly with a large audience through interviews, blogs, web videos, interactive exhibits and live events, exposing the full challenges, complexities and uncertainties of our research processes to public scrutiny. Science and the public learn from this dialogue; science begins to recognise and respond directly to its ‘users’, and the processes of direct communication with the public become (we hope) recognised (and rewarded) responsibilities of scientists. Herein as well, educators and the general public discover the energy and commitment of an international network of fellow educators and communicators engaged in creative, fun and informative advocacy for the health of our planet. I hope the book motivates every reader, as it does me, with the strength and wisdom of the words of Grand Chief Gerald Antione of the Dehcho First Nation, who credited IPY with “connecting the worlds that we work in.” In these connections, demonstrated and documented by this book, we can discover purpose and optimism.

8 November 2009

David J. Carlson

Introduction



NEEM Camp, Greenland: observing seasonal snow deposit layers and summer melting in the snow wall at the entrance to the science trench.

Polar Science in the Context of Global Citizenship

Polar Science and Global Climate: An International Resource for Education and Outreach is the product of a group of international polar researchers and educators with a shared commitment to outreach and education. It is a response to continual requests from teachers, early career and senior scientists worldwide wishing to raise awareness of the importance of polar science. This book is a direct result of education and outreach projects carried out during the International Polar Year (IPY).

The book is written for a multidisciplinary and international audience including educators, undergraduate and graduate students; as well as experts from the natural, physical and social sciences, the humanities, and the arts, who wish to present their work in the classroom or public arena.

Polar Science and Global Climate introduces readers to basic ideas of education and outreach as well as key aspects of polar research. The book combines science teaching in schools with public education and outreach. In the Prelude you will become familiar with six basic

themes of polar science: Atmosphere, Ice, Ocean, Land, People and Space; and in Chapter 1 we show you how these themes can be implemented in the classroom. Chapter 2 explains how polar scientists can present their field of expertise in public. Chapter 3 focuses on how polar research can be addressed in large- and small-scale education and outreach initiatives. Finally, the concluding chapter, an essay on capacity building among reindeer herding peoples in the circumpolar north, introduces you to the variety of indigenous voices in the Arctic regions.

We, the contributors to this book, believe that it serves as a crucial IPY legacy product, capturing the energy and enthusiasm of IPY education and outreach, as well as being a practical handbook for both researchers and educators to raise awareness of environmental issues in general and polar science in particular. Its preparation has benefited from direct financial support from the Canadian IPY Federal Program Office, the Polar Research Board of the United States National Academy of Sciences and Engineering, and the organising committee for the

flagship IPY Science Conference in Norway, 2010. It has been endorsed by the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), the International Council for Science (ICSU), the IPY Polar Books Project, and the Association of Polar Early Career Scientists (APECS).

Being published by Pearson, *Polar Science and Global Climate* will become part of an educational initiative driven by the UK company Edexcel, part of the Pearson Education group, to introduce new qualifications in climate change proficiency—termed ‘Global Citizenship’. Edexcel is currently developing IGCSE (International General Certificate of Secondary Education for students aged 14 to 16) and AS level (for students aged 16 to 18) qualifications in Global Citizenship and will be working with a range of international NGOs and publishers who provide materials in this area to support the qualifications. They will cover a wide range of related areas, including climate change as well as other global issues. Edexcel will provide more information about the qualifications in the near future. Further information is available from Dr David Davies, International Business Manager, Edexcel (david.davies@edexcel.com) and Tom Eats, International Strategic Development Manager (tom.eats@edexcel.com).

How to Use this Book

You have several options using the assembled material. Here, we outline the content and useful tools to navigate through the chapters according to your specific interests. You can use the book by consulting specific chapters or by browsing to find what is relevant for your particular education and outreach purpose. The first part of this section gives you an overview of the content structure, while the second part lists the function of features like icons, cross-references, glossary and CD-ROM.

CONTENT STRUCTURE

IPY and Six Themes of Polar Science

The *Prelude* gives you an introduction to polar science and the history of the International Polar Year. It provides important background on six polar research themes: Atmosphere, Ice, Ocean, Land, People and Space. We explain why and how we study them, and what further questions are being asked in these research fields to determine the effects of global climate change. This chapter also provides background information for further use in Chapter 1.

Teaching Resources for Teachers

Chapter 1 contains teaching resources for use in the classroom, lab or during a field trip. An Icon indicates whether it is a lab, field or classroom activity. Resources are grouped under the book’s six polar themes. We give you a list of activities under each polar theme to help you find specific resources. Each resource contains background information, a description of the activity, a list of necessary material, estimates of preparation and classroom time, objectives, graphics, and suggestions for extensions. The resources are not laid out for students of a certain age group; we leave it to the teacher and educator to adapt them to particular age levels. Activities include student worksheets and visuals that you can also find on the CD-ROM. The CD-ROM further contains background material on indigenous communities in the circumpolar north and additional web links for each activity.

Presentation Guide for Scientists

Chapter 2 lists ‘do’s and don’t’s’ of successful public engagement for polar scientists. This unit helps you understand how presentations should be planned and structured when going into a classroom or a community. We tell you what to expect from certain age groups, how to present inclusively to all audiences, and what you should know when presenting to the Inuit communities of Nunavut.

Outreach Initiatives for Educators

Chapter 3 provides you with an overview of successful education and outreach initiatives in polar science during IPY. It begins with a list of education and outreach categories, which is followed by a one-page list of school level, university level, and public level initiatives. The rest of the chapter showcases successful initiatives in these three groups. Each project description lists the country, key aspects, keys to success, and the relevant education and outreach category that they fall into.

IPY and Local Competence Building in the Circumpolar North

Chapter 4, written by Ole Henrik Magga (politician and Sámi linguist), Svein D. Mathiesen (Advisor at the International Centre for Reindeer Husbandry [ICR] and veterinary scientist), Anders Oskal (Director of ICR), and Johan Mathis Turi (Secretary General of the Association of World Reindeer Herders on the Arctic Council) discusses the role of IPY for indigenous communities in the circumpolar north and the significance of Traditional Knowledge in polar science.

TOOLS FOR EASY USAGE

Icons

There are four icons used in the book to help identify activities in Chapter 1, and CD-ROM material used in the book.



classroom activity



lab activity



field activity



CD-ROM

Cross References

Teaching resources, outreach descriptions and tips and tricks for science presentations occasionally relate to one another. When this is the case, we tell you where you can find more information.

Contributing Polar Institutions

There is a list of ‘Contributing Polar Institutions’ at the end of the book. It contains the acronym, full name, country and website of each listed polar research institution. The list is in alphabetical order. If you are not sure, for example, what country an institution belongs to, you can use this list to find further information.

Glossary

There is a Glossary at the end of the book. It is arranged in alphabetical order and lists key terms that are critical for understanding aspects of polar science.

Abbreviations and Acronyms

Throughout the book you will come across a number of abbreviations and acronyms. We give you a complete list with short explanations at the end of the book. Acronyms that are also part of ‘Contributing Polar Institutions’ are highlighted in italics.

References

Each chapter contains a number of interesting references to further online and print material. You find a list of full references at the end of the book.

CD-ROM

The Prelude and Chapter 1 contain references to additional CD-ROM material. At the beginning of each of these chapters you find a list with the relevant features; in addition, Chapter 1 lists CD-ROM material

for each activity. The CD-ROM icon highlights additional material in the text.

The CD-ROM contains:

- Material on indigenous communities in Arctic regions
- Chapter 1 student worksheets and visuals
- Chapter 1 additional web links

Index

The Index at the end of the book helps you find information on a particular term or area of polar research.

Acknowledgements

We would like to thank the international group of enthusiastic educators and young polar scientists who developed the vision of this project. Mieke Sterken from Belgium brought the idea to the attention of the IPY Programme Office. Mélianie Raymond from New Zealand, chair of the APECS Education and Outreach committee; Bettina Kaiser from Germany, chair of Polarjugend; and Rhian A. Salmon from the United Kingdom, Education and Outreach Coordinator at the IPY IPO, stirred the interest in this book, created the Resource Book Steering Group, and refined the vision of this project.

This project would not have been possible without the skilful coordination of hundreds of submissions, reviews and international conference calls by Karen Edwards from Canada. Without Sandra Zicus from Australia, the quality and structure of the book, in particular of Chapter 1, would have been unthinkable. We also thank Becky Allen from the United Kingdom for her editing support on Chapter 3 and the Glossary. Sandy Riel of Studio X Design put the material into its final form and was an invaluable support during the final stages of the project. We also thank Melissa Deeds for creating the web-presentation of the project.

The authors of this book also wish to thank Pearson Custom Publishing, in particular, Debbie Cole and Tom Eats for their assistance with this project.

Without the ceaseless support of the IPY Resource Book Steering Group, this project would not have come to fruition. We thank Khadijah Abdul Rahman-Sinclair, Jenny Baeseman, Lucette Barber, Miriam Hebling Almeida, Louise Huffman, Bettina Kaiser, René Malherbe, Nicola Munro, Liz Murphy, Mélianie Raymond, Mieke Sterken, Elena Bautista Sparrow, Rhian A. Salmon and Sandra Zicus.

We benefited greatly from the advice of our science reviewers:

Nicola Blake, Jody W. Deming, Cindy Dickson, Marianne Douglas, James Drummond, Steven Ferguson, Susanne Fietz, Duane Froese, Gerlis Fugmann, Ken Golden, Jose A. Gonzalez, Barry Goodison, Daniela Haase-Liggitt, David Herring, Haylay Hung, Kim Jochum, Loïc Jullian, René Malherbe, Mark McCaffrey, Cameron McNaughton, Stephanie Meakin, Klaus Meiners, Nazune Menka, Charlene Nielsen, Joan Nymand Larsen, Stig Petersen, Jason Roberts, Ursula Schauer, Christian Spiering, Colin Summerhayes, Barbara J. Thompson, Roland Warner, Peter Wasilewski, Kirsten Werner, Scott Williamson, Cameron Wobus, Thomas Woodruff, Anthony Worby and José Xavier.

We also wish to express our gratitude to our numerous professional educators for their reviews:

Sheena Adamson, Elke Bergholz, Anne Briggs, Anica Brown, Christina Ciarametaro, Tanya Connors, Elizabeth Eubanks, Lollie Garay, Kathleen M. Gorski, Mike Hansen, Patricia Janes, Rainer Lehmann, Tim Martin, James P. McGinn, Mark McKay, Janet Nadeau, Jason Petula, Gunnar Sandvik, Dave Shoesmith, Walter

Staveloz, Mats Svensson, Betsy Wilkening and Jillian Worssam.

We extend our deep appreciation to our two professional photographers who gave us permission to use their work.

Christian Morel: For 25 years, the French professional photographer has focused on the polar regions. During IPY, he began the Our Polar Heritage project. As a result, for two years he joined many international teams of scientists in the field, and created an exceptional set of innovating and surprising pictures to stir people's interest in the significance of the Poles for the Earth system. His work has been display at the UNO in Geneva during the closing ceremony of IPY. Contact: <http://www.ourpolarheritage.com>, <http://www.morel-photos.com>.

Douglas Yates: In semi-arid interior Alaska, Douglas Yates pays attention to the coming and going of water. His photography of this valued resource informs the heart and mind. See more of his work in the Arctic at www.arcticrefugeart.org. Contact: dayates@mosquitonet.com.

Fundamentally, this book represents the ideas, energy and enthusiasm of hundreds of researchers, students, teachers, journalists, and outreach professionals who voluntarily developed, implemented and supported the education and outreach impact of IPY. Their talent and dedication created the opportunity and the content for this book.

All contributors to this book wish to thank David J. Carlson, head of the IPY International Programme Office (IPO), for making this project a reality, for believing in the importance of education and outreach, and for recognising and respecting the dedication and commitment of volunteers from around the world. This book would not have been possible without him.

Finally, the IPO, the contributors to this book, and the IPY community owe a substantial debt to the general editor Bettina Kaiser, who provided a compelling vision, unique talent and vital energy to the daunting tasks of assembling and editing the final product. From so many sources, across languages and specialities, in such a short time, with grace and skill, Bettina has given us an integrated, attractive and effective book, one that exceeds our most optimistic expectations.