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Stefan Brönnimann

Climatic Changes Since 1700

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Preface

The Earth's climate is undergoing profound changes that will affect the future of our economies and societies. "The key to learning about the future lies in the past" is a common saying. Indeed, by studying past changes in climate, scientists can learn how the climate system works, test their models, and develop theories. At the same time, past climates exert a fascination for scientists as well as the public. They form a background for legends and are part of our culture.

When the existence of ice ages in ancient times was discovered in the nineteenth century, this stimulated both public imagination and scientific research:

"The belief that it [the weather] has improved or worsened in the course of time quite persistently holds up. There is hardly any human being, even the most common, who has not tried, owing to the experiences of his life, to attribute the eternally changing, chaotic, unpredictable character of the weather with some law. [...] In the Ice Age, however, all miracles of this weather seem to unite. Something like an age-old fear of our ancestors seems to come to life again: of a global winter that destroyed everything. At the same time one believes that whoever solved the secret of the Ice Age would have to understand the magic of today's weather." (translated from p. 13 of Bölsche 1919)

A century later, this quote from a popular scientific booklet appears almost visionary as many climate theories, including the CO₂ greenhouse effect, are rooted in the ice age problem.

The debate on the ice age theory was particularly lively at the end of the nineteenth century. A leading figure in this debate was Eduard Brückner¹ (see Fig. 1), who co-published a standard textbook on ice ages ("Die Alpen im Eiszeitalter", 1909). Brückner also was a pioneer in the study of climatic changes on multidecadal time scales and their effects on society (von Storch and Stehr 2000). In 1890—at that time Brückner was a professor of Geography at the University of Bern—he published a book entitled "Klima-Schwankungen seit 1700" ("Climatic

¹Eduard Brückner, 1862–1927, was a German geographer and climatologist. He was professor at the University of Bern from 1888 to 1904, then in Halle and from 1906 on in Vienna (see Stehr and von Storch 2000).

Fig. 1 Photo of Eduard Brückner (provided by the Institute of Geography, University of Bern)



Changes Since 1700”) that was influential for generations of climatologists. In this landmark publication, several chapters of which were translated by Stehr and von Storch (2000), Brückner promoted the view of climatic fluctuations (against the conception of a stable climate or slow, progressive change) and proposed a 35-year cycle of global climate (see Sect. 4.1.2). He based his work on meteorological or hydrological observations, documentary evidence as well as indirect evidence or “proxy data”, as we would say today. Brückner, likewise, considered studies of past climate to be a key to the future and, most importantly, saw their societal relevance:

“There are numerous hypotheses and theories about climate change. Quite naturally they have caught the public attention, as any proof of past climatic change points to the possibility of future climate change, which inevitably will have significant implications for global economics.” (translated from p. 3 in Brückner 1890)

Over a century later, the field of palaeoclimatology is undergoing profound changes. First, progress in analytical and sampling techniques as well as a better understanding of climate proxies has led to a wealth of information. Second, increased modelling capabilities and computing power has enabled us to address palaeoclimatological problems with full-fledged computer models. Third, powerful techniques such as data assimilation have been introduced to palaeoclimatology. Together with increasingly refined research questions in the light of global climate change, this technical progress has caused a constant reinvention and revaluation of historical data and approaches, accompanied by strong efforts in data recovery.

These developments are about to change our view of the past, specifically of the past ca. 300 years—the period studied by Brückner. This period is of particular interest because the radiative forcings changed considerably during this period.

The intention of this book, which is entitled “Climatic Changes Since 1700” in honour of Brückner’s book, is to discuss mechanisms behind interannual-to-multidecadal climate variability and to analyse climatic changes since 1700 in light

of new tools and data. The book shows *how* we can learn from climatic changes during the past 300 years and *what* we have learned from these changes. It does not replace a textbook, even though it is based on one of my courses and can be used in a lecture hall. There are excellent textbooks on climate and climatic changes, which are referenced at the appropriate places. It is also not a review of climate and climatic changes, which would be an impossible undertaking. Excellent reviews exist for individual topics, and for a comprehensive assessment of the literature, the reader is referred to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2013).

The book aims at readers interested in climatology and climatic changes, particularly graduate students in geography or climate sciences but also palaeoclimatologists, palaeoecologists, historians or other scientists interested in climatic changes. It starts with an introduction and a chapter on data and methods used in climatology and palaeoclimatology—an area in which our research group is strongly engaged. The chapter also introduces key data sets and some main concepts used in the later parts of the book. The third chapter introduces the most important mechanisms causing climatic changes on interannual-to-multidecadal time scales. These first chapters of the book will appeal to less-advanced readers as they start at a rather basic level. However, it is important, in my view, to discuss past climate changes by building upon a solid background in climatological methods and climate physics.

The fourth and main chapter of the book discusses major climatic variations since 1700, some of which are important in their own right, while others exemplify cases that are typical or characteristic for a certain period. Rather than to review the literature on these events, one main goal of this book is to reproduce and interpret these variations in the new data sets and the new approaches introduced in the second chapter. These analyses, though imperfect and preliminary, serve the purpose of illustrating what palaeoclimatology can do. The book concludes with a summary.

The choice of topics and of climatic events included in this book is not objective or comprehensive—this would be beyond my expertise. The selection of climatic events, data sets and models is therefore strongly biased by the work of our research group, and it has a focus on Europe and Switzerland. The book thus conveys a personal view of how and why the climate developed over the past 300 years; it does not do justice to all the excellent work that has been done by others in the field.

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Stefan Brönnimann

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Contents

1	Introduction	1
2	The Basis: Past Climate Observations and Methods	9
2.1	Observations of Weather and Climate	9
2.2	Historical Climate Observations	12
2.2.1	Documentary and Early Instrumental Data	12
2.2.2	From National Weather Services to a Global Observing System	15
2.3	Upper-Air and Satellite Observations	17
2.4	Data Dissemination in the Course of Time	19
2.5	Uncertainties in Climatic Data	23
2.5.1	Uncertainties and Errors in Measurement Series	23
2.5.2	Inhomogeneities and Homogenisation	26
2.5.3	The Chain of Uncertainties	29
2.6	Data Products and Dynamical-Statistical Methods	30
2.6.1	Spatial Information and Geostatistical Methods	30
2.6.2	Data Assimilation and Reanalyses	34
2.7	Climate Models	38
2.7.1	Characteristics of Climate Models	38
2.7.2	Types of Climate Models and Experiments	44
2.7.3	Downscaling, Nudging, and Other Techniques	47
2.8	Palaeoclimate Information and Techniques	48
2.8.1	Climate Proxies	48
2.8.2	Problems Arising When Working with Proxies	52
2.8.3	Calibration and Modelling of Proxies	54
2.8.4	Climate Reconstructions	56
2.8.5	Data Assimilation in Palaeoclimatology	59
2.9	Datasets Used in This Book	62
2.9.1	Overview	62
2.9.2	Observations and Reanalyses	62
2.9.3	Model Simulations	64

2.9.4	Reconstructions and Offline Assimilation	65
2.9.5	Conclusions	68
3	The Machinery: Mechanisms Behind Climatic Changes	71
3.1	Basic Climate Physics: The Mean State	72
3.1.1	Energy Budget and Heat Transport	72
3.1.2	The General Circulation of the Atmosphere.....	76
3.1.3	Stratospheric Circulation	85
3.1.4	The Ocean, Air–Sea and Land-Sea Interactions.....	93
3.2	Expressions and Mechanisms of Climate Variability.....	101
3.2.1	Statistical and Physical Perspectives of Climate Variability	101
3.2.2	Overview of Circulation Variability Modes	103
3.2.3	The North Atlantic Oscillation (NAO).....	104
3.2.4	Variability Modes in the Pacific and the Southern Hemisphere	108
3.2.5	Extratropical Circulation Variability Modes and the Stratosphere	111
3.2.6	Tropical Variability Modes: El Niño–Southern Oscillation (ENSO)	113
3.2.7	Variability Modes in the Atlantic and Indian Ocean	119
3.2.8	Decadal Climate Variability Modes.....	120
3.3	Forced Climatic Changes	123
3.3.1	Volcanic Effects.....	123
3.3.2	Solar Influences	136
3.3.3	Well-Mixed Greenhouse Gases	145
3.3.4	Tropospheric Aerosols and Reactive Trace Gases	150
3.3.5	Land Surface	157
3.4	Coupling Between Systems and Feedback Mechanisms	161
3.4.1	Interaction Within the Machinery	161
3.4.2	Feedbacks Involving Water Vapour and Clouds.....	163
3.4.3	Feedbacks Involving Freezing Water: Arctic Amplification and the Cryosphere	164
3.4.4	Water as a Reactant: The Role of the Hydroxyl Radical.....	164
3.4.5	Feedbacks Involving Evaporating Water: Land Surface Feedbacks	165
4	Climatic Changes Since 1700	167
4.1	Climatic Changes of the Past Centuries: An Overview	168
4.1.1	The Last Millennium	168
4.1.2	An Overview of Climatic Changes Since 1700: Brükner’s View	171
4.1.3	Climatic Changes Since 1700 in Climate Reconstructions ...	174
4.1.4	Climatic Changes in CCC400 and EKF400	185
4.1.5	Drivers of Global Climate Since 1600.....	193

- 4.2 The Period from 1700 to 1890: The Little Ice Age..... 197
 - 4.2.1 Climate of the 18th and 19th Centuries 198
 - 4.2.2 The Maunder Minimum: A Compelling Case
for Solar Forcing?..... 201
 - 4.2.3 The 1790s: Temporary Warmth and Strong
Tropical Circulation 205
 - 4.2.4 Tambora Eruption, Dalton Minimum, and the Year
Without a Summer of 1816..... 210
 - 4.2.5 The Maximum State of Alpine Glaciers in the 1850s..... 216
 - 4.2.6 Global Droughts During 1876–1878 and El Niño..... 221
 - 4.2.7 Frequent Flooding in the Central European Alps:
1830–1880s 226
 - 4.2.8 The Broad Lines: The Little Ice Age 229
- 4.3 The Period from 1890 to 1945: Out of the Cold..... 230
 - 4.3.1 Global Drivers and Global Changes 231
 - 4.3.2 The Warming of the European Arctic from the
1910s to the 1940s 237
 - 4.3.3 The “Dust Bowl” Droughts of the 1930s 243
 - 4.3.4 Global Climate Anomalies During the 1939–1942
El Niño 250
 - 4.3.5 The Broad Lines: Out of the Cold 254
- 4.4 The Period from 1945 to 1985: Delusive Stability 259
 - 4.4.1 Global Drivers and Global Changes 260
 - 4.4.2 Changes in Atmospheric Constituents 262
 - 4.4.3 European Summers of 1945–1949 267
 - 4.4.4 Sahel Pluvial and Drought..... 273
 - 4.4.5 The Climate Shift of 1976/1977 276
 - 4.4.6 The Broad Lines: Delusive Stability 279
- 4.5 The Period Since 1985: Accelerated and Slowed Warming..... 283
 - 4.5.1 Global Drivers and Global Changes 284
 - 4.5.2 The Ozone Hole..... 289
 - 4.5.3 Eruption of Pinatubo..... 296
 - 4.5.4 Warm European Winters, Increased Storminess
and Positive NAO in the 1990s..... 300
 - 4.5.5 The El Niño of 1997/1998, Forest Fires and the
Atmospheric Brown Cloud 305
 - 4.5.6 Droughts in Australia and the Northern Subtropics 308
 - 4.5.7 Megaheatwaves 310
 - 4.5.8 Recent Arctic Warming..... 312
 - 4.5.9 The Global Warming Hiatus 316
- 5 Conclusions 323**
- References..... 327**

