European Geosciences Union

GIFT – Geosciences Information For Teachers

vGIFT 2022

HOW THE PLANET SHAPES HISTORY

Geosciences, Human society and Civilization

4-8 April 2022

As we celebrate this year GIFT's 20th anniversary, our Education Committee is suffering the loss of its Chair. Chris King has passed away due to rapid onset of cancer, some weeks ago.

Chris King joined the EGU Education Committee in 2017 and became its chair the following year. He brought with him a joyful enthusiasm and commitment that inspired a number of new initiatives including the EGU Higher Education Teaching Grants, Higher Education Geoscience Teaching Workshops, and the introduction of the EGU geoscience Education Field Officers to name but a few.

Chris, Emeritus Professor of Earth Science Education at Keele University, has been a great promoter of geoscience education around the world. He has created simple and effective tools to help researchers and teachers to promote geoscience. It is with this spirit that he has also led the Education Committee in recent years. We have learned a lot from him and many new actions have been created under his leadership.

Chris' passion and enthusiasm for geoscience education was borderless. He was an inspiring person.

In the weeks following his demise, testimonies continue to come in. They are unanimous in highlighting, beyond Chris's great expertise, the friendly and kind relations he always had.

He was a colleague, a mentor, a friend... Chris has shared so many projects, advice and kindness around him. We would have loved to learn more from him, but we are truly grateful for the time we could spend together.

We will carry on his precious legacy and we know that someone so special will never be forgotten.

Education Committee

Dear teachers, lecturers and participants of GIFT 2022,

The theme of this year's GIFT workshop, is «*How the planet shapes history. - Geosciences, human society and civilizations*». The workshop will explore key aspects of the influence of geological and climatic processes on the human society and civilisations throughout human history, through topical presentations from scientists at the cutting-edge of research, together with hands-on teaching activities, following the tradition of GIFT workshops.

The theme is very broad, although somewhat not very well known or conceived. The human societies and civilisations, have, throughout history, been shaped by the forces of nature. Climate, for example, influenced the agricultural productivity, economic performance and conflict level of preindustrial societies. We have chosen a variety of talks pertaining to the matter which, we hope, will act as a primer for further exploration in the classroom. In the two-and-a-half days of the workshop we will have time to discuss only some aspects of the influence Earth processes have on shaping human societies. We will touch upon themes such as the influence of geology on the Roman civilization, the role of climate on the rise and fall of empires, records of aurorae from ancient Mesopotamia and Greece to Austrian monasteries sunspot records. We will explore Pleistocene ecology through cave paintings and volcanic eruptions from medieval times to present through their influence on the work of the great masters. We will also study the physical and societal effects of volcanic eruptions through the case study of the 1783 Laki eruption and the volcanic double event at around 536. Medieval climate fluctuations and societal change in Byzantium will also be presented.

Alongside with the oral presentations, hands-on activities will be included in the programme. For example, the activity «*Seismic site effect in Rome and observation of ancient seismic events on Roman archaeological sites*" and the activity "*Geoscience in the classroom*", which will be explored with the EGU Field Officers team.

We are looking forward to welcoming you at this year's virtual GIFT workshop and invite you to disseminate presentations and hands-on activities among your colleagues and students at your school and in the classroom.

EGU Committee on Education

MEMBERS

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EGU Committee on Education

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Programme

European Geosciences Union – General Assembly

GEOSCIENCES INFORMATION FOR TEACHERS
VIRTUAL WORKSHOP (vGIFT) 2022
4-8 April 2022

'HOW THE PLANET SHAPES HISTORY – GEOSCIENCES, HUMAN SOCIETY AND CIVILIZATIONS'

→ THE PROGRAM SCHEDULE USES CENTRAL EUROPE TIME (CEST) ←

Monday, 4 April 2022
Session 1: The influence of Earth processes on civilization: a very diverse theme

Chairperson: Jean-Luc Berenguer

14:00-14:10 **WELCOME**
Helen Glaves (EGU President)

14:10-14:20 **INTRODUCTION TO GIFT 2022**
EGU Committee on Education

14:20-15:10 **THE ECOLOGY OF PLEISTOCENE EUROPE AS REPRESENTED IN PALEOLITHIC CAVE PAINTINGS**
Ray Dueser (University of Virginia)

15:10-15:30 BREAK

15:30-16:20 **THE INFLUENCE OF GEOLOGY ON THE ROMAN CIVILIZATION**
Grant Heiken (IUGG Fellow, book author)

16:20-17:10 **CLIMATIC AND SOCIETAL IMPACTS OF THE VOLCANIC DOUBLE EVENT AT THE DAWN OF THE DARK AGES**
Matthew Toohey (University of Saskatchewan)

Tuesday, 5 April 2022
Session 2: Climate

Chairperson: Francesca Cifelli

9:00-9:10 **INTRODUCTION TO THE MORNING**
EGU Committee on Education

9:10-10:00 **AN OVERVIEW OF THE HISTORICAL SPACE CLIMATE, AS SEEN FROM THE HISTORICAL ARCHIVES AND CLASSICS. RECORDS OF AURORAE FROM ANCIENT MESOPOTAMIA AND GREECE TO AUSTRIAN MONASTERIES SUNSPOT RECORDS DURING THE DALTON MINIMUM**
Hishashi Hayakawa (Institute for Space–Earth Environmental Research, Nagoya University)

10:00-10:50 **MOLECULAR PALEOECOLOGY TO TRACK THE HISTORY OF SPECIES AND ECOSYSTEMS**
Laura Epp (University of Konstanz)

10:50-11:10 BREAK

11:10-12:00 **THE MEDIEVAL CLIMATE ANOMALY AND BYZANTIUM: A REVIEW OF THE EVIDENCE ON CLIMATIC FLUCTUATIONS, ECONOMIC PERFORMANCE AND SOCIETAL CHANGE**
Elena Xoplaki (Justus-Liebig-University Giessen)

Wednesday, 6 April 2022
Session 3: Cities

Chairperson: Stephen Macko

14:00-14:10 **INTRODUCTION TO THE AFTERNOON**
EGU Committee on Education

14:10-15:25 **SEISMIC SITE EFFECT IN THE CITY OF ROME AND OBSERVATION OF ANCIENT SEISMIC EVENTS ON ROMAN ARCHAEOLOGICAL SITES**
Hands-on activity by Jean-Luc Berenguer (Université Côte d'Azur)

15:25-15:45 BREAK

15:45-16:35 **MACHU PICCHU, THE LOST CITY OF THE INCAS**
Carlo Laj (École Normale Supérieure)

16:35-17:25 **URBAN GEOARCHAEOLOGY IN BELGIUM**
Yannick Devos (Vrije Universiteit Brussel)

Thursday, 7 April 2022
Session 4: Environmental history

Chairperson: Phil Smith

9:00-9:10 **INTRODUCTION TO THE MORNING**
EGU Committee on Education

9:10-10:00 **THE PHYSICAL AND SOCIETAL IMPACTS OF VOLCANIC ERUPTIONS: THE CASE OF THE 1783 AD LAKI ERUPTION**
Katrin Kleemann (German Maritime Museum – Leibniz Institute for Maritime History)

10:00-10:50 **FINDING EARTH SYSTEM PROCESSES IN ANCIENT PAPYRI AND MEDIEVAL CHRONICLES, AND HUMAN HISTORY IN TREE-RINGS AND ICE-CORES**
Francis Ludlow (Trinity College Dublin)

10:50-11:10 BREAK

11:10-12:30 **HANDS-ON ACTIVITY FOR THE CLASSROOM: CLIMATE, VOLCANOES**
EGU Field Officers Team

Friday, 8 April 2022
Session 5: Ice and ash

Chairperson: Hélder Pereira

14:10-14:10	**INTRODUCTION TO THE AFTERNOON** EGU Committee on Education
14:10-15:00	**VOLCANOES, GEOPHYSICS, CLIMATE AND ART** Christos Zerefos (Research Center for Atmospheric Physics and Climatology, Academy of Athens)
15:25-15:45	**BREAK**
15:45-16:45	**INFLUENCE OF VOLCANOES AND GLACIATION ON HUMAN HISTORY** Richard Williams (Steffanson Arctic Institute)
16:45-17:30	**FINALE AND NETWORKING EVENT** EGU Committee on Education

RAIMOND D. DUESER
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Ray Dueser is Professor Emeritus in the Department of Wildland Resources at Utah State University, where he served as Department Head and Associate Dean.

He recently returned as a Visiting Scholar in the Department of Environmental Sciences at the University of Virginia, where he began his career. He holds degrees in Anthropology (B.A.) and Zoology (M.S.) from the University of Texas at Austin and Wildlife Ecology (Ph.D.) from the University of Michigan. Ray taught courses in ecology, wildlife management, conservation biology, and environmental science.

He and his students have conducted research at many locations across North America, most prominently on the mammals, birds, and plant communities of the Virginia barrier islands. Ray has been active in the governance of several professional organizations, including the Ecological Society of America and The Wildlife Society. For several years he chaired the U.S. Fish and Wildlife Service Recovery Team for the endangered Delmarva fox squirrel. This animal was the first mammal officially recognized in the U. S. as having been “recovered” through the conservation efforts of state, federal, non-governmental, and private partners.

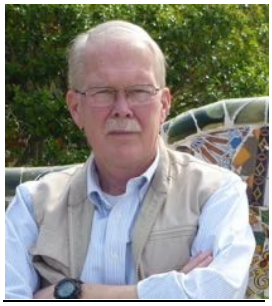
Ray’s recent research has focused on non-lethal ways to reduce the impact of overabundant mammalian predators (i.e. raccoons and red foxes) on threatened colonial and beach-nesting waterbirds on the islands. After retiring from full-time teaching, Ray returned to his early interest in the Paleolithic cave art of Western Europe.

He is particularly interested in regional variation in the species combinations represented in the caves of France and Spain.

WILDLIFE AS DEPICTED IN THE PALEOLITHIC CAVE ART OF WESTERN EUROPE

Dr. Raymond D. Dueser
University of Virginia

The magnificent Upper Paleolithic cave paintings of France and Spain portray a veritable arctic Serengeti. These paintings are attributed to the early modern human occupants of Europe (Homo sapiens) and date from ~35,000 years BP to ~10,000 years BP. They portray a host of large mammalian species, including both herbivores (wooly mammoths, wooly rhinos, horses, bison, aurochs, musk ox, and ibex and chamois) and predators (cave bears, cave lions, scimitar-toothed cats, and giant hyenas). Birds, fish, and smaller mammals are depicted only occasionally and only in specific caves. Humans are depicted even more rarely. Some caves feature only one or two species, while others feature five or six. Horses are the most common element, followed by bison, aurochs, and mammoths. Only a few paintings depict an interaction between humans and wild animals, usually at the apparent expense of the human. There is only a small correspondence between the animals depicted in a cave and the fossil remains associated with the cave. It is often said that the artists ate reindeer but painted horses. Artists varied in the quality of their renderings, but some were sufficiently skilled in their painting and their attention to detail that even rare phenotypes of animals were depicted. A rare “spotted” horse phenotype has been attributed to a similarly rare modern “spotted” horse genotype. Paleo-artists depicted animal locomotion (e.g. foot-fall pattern) more often correctly than even da Vinci. In summary, the cave painters of Upper Paleolithic Europe were observant, skilled and inspired. They developed artistic techniques not practiced again until Classical Greece. They left a spectacular treasury of images of a world that lasted for only a few thousand years, but which inspires us even still.



GRANT HEIKEN
Los Alamos National Laboratory (Retired)
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EDUCATION

University of California, Berkeley, BA 1964
University of Texas, Austin, MA 1966
University of California, Santa Barbara, Ph.D. 1972

CAREER

NASA-Manned Spacecraft Center, Houston, Texas (Apollo Missions), 1969-1974.
University of California, Los Alamos National Laboratory, 1974-2003.
Retired, Whidbey Island, Washington, 2003-Present

RESEARCH INTERESTS

Lunar surface processes, including volcanism. Geothermal exploration and development, volcanic hazard analysis, the uses of volcanic rocks, basic research on explosive volcanism, continental scientific drilling, and integrated urban science. He has done research or exploration on volcanoes or volcanic fields in the United States (Oregon, California, New Mexico, Colorado, and Hawaii), Mexico, Guatemala, Honduras, Guadeloupe, St. Lucia, Italy, Greece, Ethiopia, and the Earth's Moon.

PUBLICATIONS AND SERVICES

He was a co-editor of *Lunar Sourcebook—A User's Guide to the Moon* (Cambridge University Press, 1991) and co-author, with Eric Jones, of *On the Moon—The Apollo Journals* (Springer-Praxis, 2007). He has co-written or edited 11 books. His general interest books include *The Seven Hills of Rome* (2005), with R. Funiciello and D. DeRita,ß *Volcanoes—Crucibles of Change* (1997) with R. V. Fisher and J. Hulen (both Princeton University Press), and *Dangerous Neighbors—Volcanoes and Cities* (Cambridge University Press). The Italian edition of *The Seven Hills of Rome* won the 2007 *Il Premio dei Lettori di Biblioteche di Roma*, an Italian literary prize (non-fiction category and overall winner).

AWARDS AND HONORS

He was president of the International Association of Volcanology and Chemistry of the Earth's Interior (1995-1999). He is a fellow of the Geological Society of America and the American Association for the Advancement of Science.

THE LINK BETWEEN ROME'S GEOLOGIC SETTING TO ITS PAST, PRESENT, AND FUTURE

Grant Heiken*
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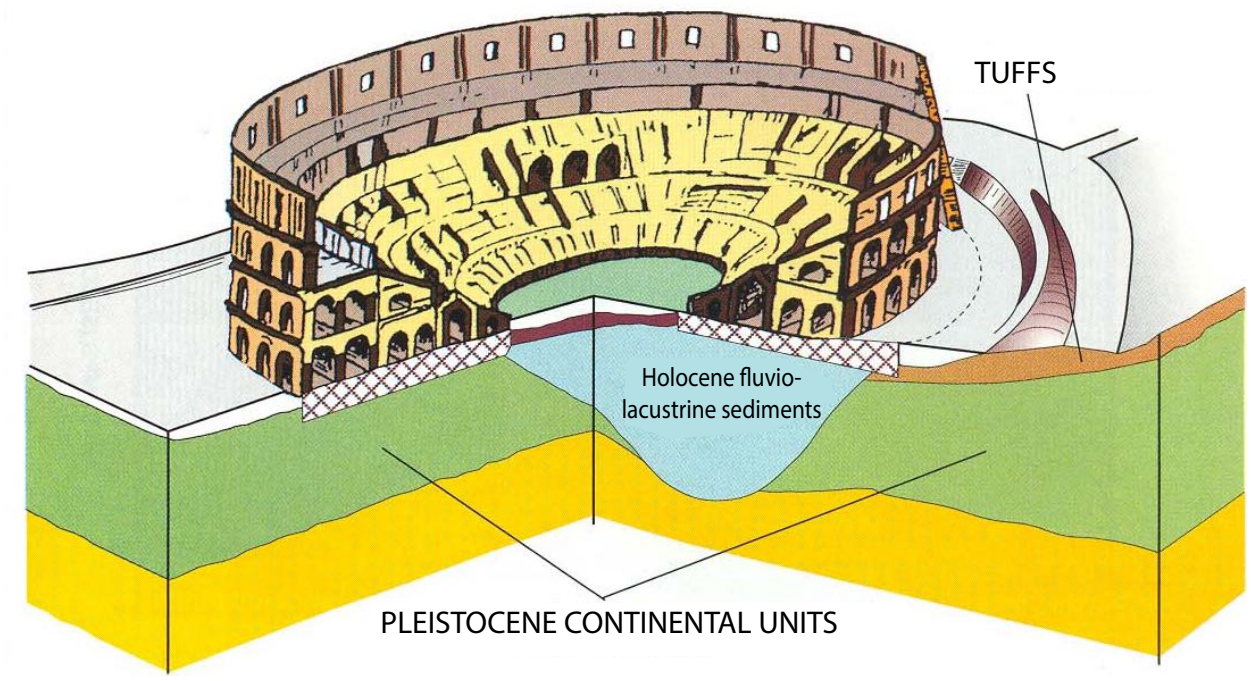
From its time as the historic center of the Roman world, Rome has been continuously a political, religious, and administrative capital. Geologic and terrain factors assured its population growth and provided the conditions for survival of its culture in the ancient world. From lessons of urban development and prosperity, the Roman people developed a capacity to recognize and to manage the natural resources of the region. Modern Rome, born after the unification of Italy, was developed in a haphazard manner after WW II. Most residents have not been pleased with the results of rapid development but have developed a strong awareness for a need to care for the city and to better manage its environment. There are new, detailed geologic maps of the city, programmes for engineering and environmental geology, and cooperative work with archeologists—all within the city and regional governments. It is appropriate that the term *urban geology* has its origin in *Urbs,* which was the ancient name for the City of Rome.

**This work was done in collaboration with Renato Funiciello and Donatella De Rita (Roma Tre University).*



Geological setting of the Colosseum's underground

MATTHEW TOOHEY
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EDUCATION

2009 - Ph.D. Atmospheric Physics, University of Toronto. Thesis title: *Comparing remote sounding measurements of a variable atmosphere* Supervisor: Kimberly Strong; Committee: Ted Shepherd, Dylan Jones, Jon Abbatt
2003 - M.Sc. Atmospheric Physics, University of Toronto
2001 - B.Sc. Physics, University of British Columbia

PROFESSIONAL EXPERIENCE

2019 – Present University of Saskatchewan, Canada. Assistant Professor, Dept. of Physics and Engineering Physics
2016-2019 - GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany. Research Scientist & Principal Investigator
2015-2016 - Max Planck Institute for Meteorology, Hamburg, Germany. Research Scientist
2009-2015 - GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany. Post-doctoral Researcher

COMMUNITY SERVICE

2018-present: Contributing Author: Intergovernmental Panel on Climate Change (IPCC) Working Group I Sixth Assessment Report, Chapter 2: Changing state of the climate system
2015-present: Working group leader: Volcanic Impacts on Climate and Society (VICS), working group within the Past Global Changes (PAGES) project

FIVE MOST IMPORTANT PUBLICATIONS

Toohey, M., Krüger, K., Schmidt, H., Timmreck, C., Sigl, M., Stoffel, M. and Wilson, R.: Disproportionately strong climate forcing from extratropical explosive volcanic eruptions, Nat. Geosci., 12(2), 100– 107, doi:10.1038/s41561-018-0286-2, 2019.

Toohey, M. and Sigl, M.: Volcanic stratospheric sulfur injections and aerosol optical depth from 500 BCE to 1900 CE, Earth Syst. Sci. Data, 9(2), 809–831, doi:10.5194/essd-9-809-2017, 2017.

Toohey, M., Stevens, B., Schmidt, H. and Timmreck, C.: Easy Volcanic Aerosol (EVA v1.0): an idealized forcing generator for climate simulations, Geosci. Model Dev., 9(11), 4049–4070, doi:10.5194/GMD-9-4049-2016, 2016.

Toohey, M., Krüger, K., Sigl, M., Stordal, F. and Svensen, H.: Climatic and societal impacts of a volcanic double event at the dawn of the Middle Ages, Climatic Change, doi:10.1007/s10584-016-1648-7, 2016.

Kremser, S., Thomason, L. W., von Hobe, M., Hermann, M., Deshler, T., Timmreck, C., Toohey, M., Stenke, A., Schwarz, J. P., Weigel, R., Fueglistaler, S., Prata, F. J., Vernier, J.-P., Schlager, H., Barnes, J. E., Antuña-Marrero, J.-C., Fairlie, D., Palm, M., Mahieu, E., Notholt, J., Rex, M., Bingen, C., Vanhel- lemont, F., Bourassa, A., Plane, J. M. C., Klocke, D., Carn, S. A., Clarisse, L., Trickl, T., Neely, R., James, A. D., Rieger, L., Wilson, J. C. and Meland, B.: Stratospheric aerosol - Observations, pro- cesses, and impact on climate, Rev. Geophys., 54, doi:10.1002/2015RG000511, 2016.

CLIMATIC AND SOCIETAL IMPACTS OF THE VOLCANIC DOUBLE EVENT AT THE DAWN OF THE DARK AGES

Matthew Toohey
University of Saskatchewan, Canada

In 536 CE and the years following, a number of extraordinary things occurred: 1) A mysterious dust cloud substantially dimmed the light of the sun for 12-18 months as recorded by observers in Europe and the Near East; 2) The temperature dropped by up to 2.5°C throughout the Northern Hemisphere, and remained below normal for a decade or more; 3) Many European societies seem to have experienced famines and socioeconomic crises, with population losses and changes in settlement practices; 4) The plague of Justinian arrived in Egypt in 541 CE and afflicted the Mediterranean Basin, Europe, and the Near East.

What created the mystery dust cloud of 536 CE? And could it have contributed, at least in part, to the climate anomalies and societal downturn that occurred in the years which followed? In this talk, I will review recent discoveries that have unequivocally implicated volcanic activity as the source of the 536 dust cloud. I will then describe research that I performed with an interdisciplinary group of collaborators that has used computer modelling as a laboratory to test the hypothesis of a link between volcanic eruptions and the climate and societal downturns. This process involves reconstructing the optical and radiative properties of the stratospheric aerosol clouds produced by two (or more) major eruptions in 536 and 540 CE based on ice core records and documentary evidence, and using this information in climate model simulations to estimate the resulting impact on climate. We find close agreement between simulated NH temperatures and those reconstructed from tree rings, providing confidence in the model results. The climate model results are then used to explore impacts on societies, and we find support for the possibility of substantial crop failures in Northern Europe resulting directly from the volcanic radiative forcing.

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EDUCATION

2017 Apr. – 2020 Mar.: Graduate School of Letters, Osaka University
2015 Apr. - 2017 Mar.: Graduate School of Letters, Kyoto University
2014 Apr. – 2015 Mar.: Graduate School of Advanced Integrated Studies in Human Survivability, Kyoto University
2010 Apr. - 2014 Mar.: Faculty of Letters, Kyoto University

CAREER

2020 Apr. – present: Designated Assistant Professor, Institute for Advanced Research (IAR) & Institute for Space–Earth Environmental Research (ISEE), Nagoya University
2018 Apr. – present: Visiting Research Fellow, RAL Space, Rutherford Appleton Laboratory, STFC, UK
2017 Apr. – 2020 Mar.: Research Fellow, Japan Society for the Promotion of Science

RESEARCH INTERESTS

Solar-Terrestrial Environment, Solar Storms, Space Weather, Sunspot-Number Reconstruction, Historical Astronomy, Environmental History, and Oriental History

PUBLICATIONS

Hayakawa, H., Lockwood, M., Owens, M. J., Sôma, M., Besser, B. P., van Driel, L. (2021) Graphical evidence for the solar coronal structure during the Maunder Minimum: comparative study of the total eclipse drawings in 1706 and 1715, *Journal of Space Weather and Space Climate*, 11, 1.

Hayakawa, H., Besser, B. P., Iju, T., *et al*. (2020) Thaddäus Derfflinger's sunspot observations during 1802-1824: A primary reference to understand the Dalton Minimum, *The Astrophysical Journal*, 890, 98. DOI: 10.3847/1538-4357/ab65c9

Hayakawa, H., Mitsuma, Y., Ebihara, Y., Miyake, F. (2019) The Earliest Candidates of Auroral Observations in Assyrian Astrological Reports: Insights on Solar Activity around 660 BCE, *The Astrophysical Journal Letters*, 884, L18. DOI: 10.3847/2041-8213/ab42e4

Hayakawa, H., Ebihara, Y., Willis, D. M., *et al*. (2019) Temporal and Spatial Evolutions of a Large Sunspot Group and Great Auroral Storms around the Carrington Event in 1859, *Space Weather*, 17, 1553– 1569.

SERVICES

2021 Apr. – present: Guest Editor of *Geoscience Data Journal*.
2019 Sep. – present: Topical Editor of *History of Geo- and Space Science*.

QUALIFICATION

PhD (Letters) in 2020 Mar. and PhD (Science) in 2020 Mar.

AWARDS AND HONORS

2018 May: EPS Young Researcher Award
2017 Mar.: President Prize, Kyoto University

A BRIEF OVER VIEW OF THE HISTORICAL SOLAR-TERRESTRIAL ENVIRONMENT, AS SEEN FROM THE HISTORICAL ARCHIVES AND CLASSICS

Hisashi Hayakawa
Nagoya University

This presentation briefly outlines the latest attempts for reconstructions of the variable solar-terrestrial environment in the decadal to millennial timescale on the basis of the historical archives and classics. Our planet has shaped human history under influence of the solar-terrestrial environments, whereas the actual impact magnitudes have remained somewhat controversial. The human civilisation has developed geoscience and monitored the solar-terrestrial interactions and the variable solar-terrestrial environments. However, it has been challenging to trace the long-term variability of the solar-terrestrial environments in centennial to millennial timescale, as most of the modern regular instrumental observations lasted at best decades to a century. In order to overcome this difficulty, we have two major data sources: human archives and natural archives. Here, this presentation briefly shows several case studies, which consult the historical archival records to reconstruct and analyse the solar-terrestrial environments in decadal to millennial timescales, putting emphases on the long-term solar variability and the historical solar storms. The long-term solar variabilities have been evaluated with sunspot number and sunspot group number, whereas their reconstructions have remained controversial before 1900. Here, this presentation shows several case studies for the historical archival records of sunspot observations and resultant improvements on the existing reconstructions, taking examples from Austrian monasterial archives. The solar-storms have been reconstructed with historical magnetic measurements and candidate auroral observations. Especially, the latter has been traced back for 3 millennia on the basis of various historical records in Eurasia, back to Chinese and Mesopotamian historical records. Overall, these case studies form basis for us to extend our knowledge of the solar-terrestrial environments for 3 millennia and to better understand how they have influenced our planets in the historical period.

LAURA EPP

Junior Professor for Environmental Genomics in Aquatic Systems
Limnological Institute
University of Konstanz

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https://www.limnologie.uni-konstanz.de/en/ag-epp-environmental-genomics/

EDUCATION

2009	**Dr. rer. nat.**, Evolutionary Biology, University of Potsdam *Molecular genetic analyses of historical lake sediments from the East African Rift Valley*
2004	**Diploma in Biology**, Georg-August-University Göttingen

CAREER

since 2018	**Junior Professor** - University of Konstanz
2013 – 2018	**Researcher**, - Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Research Unit Potsdam, (incl. parental leave)
2009 – 2012	**Postdoctoral researcher** - University of Oslo, Natural History Museum (NHM),
2004 – 2008	**PhD student** - University of Potsdam, **DFG Research Training Group 1364** *Shaping Earth's Surface in a Variable Environment*

RESEARCH INTERESTS

I analyse ecosystems and their history, in particular using environmental DNA (eDNA) stored in samples such as sediment and water. By obtaining biodiversity data through time, both on the level of communities and on the level of populations, I aim to understand how historical trajectories of ecosystems have shaped the biodiversity that surrounds us today. This can help us understand the relative roles of climatic changes and direct anthropogenic modifications on shaping past biodiversity and provide us with information to project possible future changes.

PUBLICATION RECORD

Total published ISI indexed: 36, H-index 20

Selected publications

Schulte, L., Bernhardt, N., Stoof-Leichsenring, K. R., Zimmermann, H.H., Pestryakova, L.A, **Epp, L.S.***, Herzschuh, U. (2021) Hybridization capture of larch (*Larix* Mill) chloroplast genomes from sedimentary ancient DNA reveals past changes of Siberian forests. *2nd senior author. *Molecular Ecology Resources* 21 (3): 801-815. *https://doi.org/10.1111/1755-0998.13311*

Ibrahim, A., Capo, E., Srtraile, D., Wessels, M., Martin, I., Meyer, A., Schleheck, D., **Epp, L.S.** (2020) Anthropogenic impact on the historical phytoplankton community of Lake Constance reconstructed by multimarker analysis of sediment-core environmental DNA. *Molecular Ecology*. https://doi.org/10.1111/mec.15696.

Epp, L.S. (2019) A global perspective for biodiversity history with ancient environmental DNA. *Molecular Ecology* 28(10). https://doi.org/10.1111/mec.15118.

Epp, L.S., Kruse, S., Kath, N.J., Stoof-Leichsenring, K.R., Tiedemann, R., Pestryakova, L.A., Herzschuh, U. (2018) Temporal and spatial patterns of mitochondrial haplotype and species distributions in Siberian larches inferred from ancient environmental DNA and modeling. *Scientific Reports.* 8:17436. https://doi.org/10.1038/s41598-018-35550-w.

Willerslev, E., Davison, J., Moora, M., Zobel, M., Coissac, E., Edwards, M.E., Lorenzen, E.D., Vestergård, M., Gussarova, G., Haile, J., Craine, J., Gielly, L., Boessenkool, S., **Epp, L.S.**, Pearman, P.B., Cheddadi, R. *(...)* Brochmann, C., Taberlet, P. (2014) Fifty thousand years of Arctic vegetation and megafaunal diet. *Nature* 506(7486): 47 - 51. https://doi.org/10.1038/nature12921.

ANCIENT ENVIRONMENTAL DNA - MOLECULAR PALEOECOLOGY TO INVESTIGATE THE HISTORY AND FUTURE OF ECOSYSTEMS

Laura Epp
University of Konstanz

Environmental samples, such as water or sediments, contain not only visible remains of some organisms, but also DNA. Such environmental DNA is shed by organisms across the tree of life and can be stored for (hundred) thousands of years in sediments. It can be analysed using the expanding molecular genetic toolbox and enables a detailed and novel view on the history of species and ecosystems. Sediment cores from freshwater and marine settings offer excellent archives for the analyses of ancient environmental DNA, providing both information on terrestrial ecosystems, such as from plants and fungi, and information on past aquatic biota. In particular, through sequencing either of specific marker genes or of the complete DNA pool, we can retrieve detailed information to identify species in communities and to analyse changes within populations of single species. Importantly, the DNA traces are not restricted to organisms with visible remains, thus providing palaeoecological information on organisms that could not be tracked with traditional, microscopic methods. Environmental DNA analyses thus potentially provide a maximum of palaeoecological information in terms of taxonomic resolution and organismal breadth. This potential is somewhat counterbalanced by DNA degradation over time, which limits the timeframe of analyses in warmer climates and has caused a large amount of research to be conducted in high latitudes. However, even under nonoptimal preservation conditions, records from ancient environmental DNA typically can be retrieved for multiple centuries or even millennia - the timeframe most relevant to understanding historic and current anthropogenic impact. Ancient environmental DNA thus promises information of immediate conservation relevance on a global scale and is growing in relevance and visibility.

This talk will provide an introduction to concepts, methods and applications of ancient environmental DNA, from early studies to current developments and future possibilities.

ELENA XOPLAKI
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Climatology, Climate Dynamics and Climate Change
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Justus-Liebig-University Giessen, Germany
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EDUCATION

1995: University degree (BSc) in Geology, Aristotle University of Thessaloniki, Greece
1998: MSc in Meteorology & Climatology, Aristotle University of Thessaloniki, Greece
2002: PhD in Natural Sciences, Faculty of Sciences, University of Bern, Switzerland; "Climate Variability over the Mediterranean"

CAREER

2011-present: Senior scientist, Justus-Liebig-University Giessen, Germany
2010-2011: Research scientist, principal investigator, University of Bern, Switzerland
2009-2010: Research scientist, project coordinator, The Cyprus Institute, Nicosia, Cyprus
2005-2009: Science officer, NCCR Climate, Oeschger Center Climate Change Research (OCCR), University of Bern, Switzerland
2002-2005: Postdoctoral researcher, CH, EU, USA research projects, University of Bern, Switzerland

RESEARCH INTERESTS

Mediterranean climate change from the past to the future. Paleoclimatology, climate reconstructions / model comparison, influence of circulation on European and Mediterranean climate. Climate change impacts on societies of the past. Extreme events.

PUBLICATIONS AND SERVICES

ISI Web of Science (access January 2022); Number of peer reviewed publications (without proceedings): 84; Sum of the times cited (without self-citations): 8788; h-index: 44

Xoplaki, E., Luterbacher, J., Luther, N., Behr, L., Wagner, S., Jungclaus, J., Zorita, E., Toreti, A., Fleitmann, D., Izdebski, A., and Bloomfield, K. 2021: Hydrological changes in Late Antiquity: spatio-temporal characteristics and socio-economic impacts in the Eastern Mediterranean. In: Erdkamp, P., J. G. Manning, and K. Verboven (Eds.) Climate Change and Ancient Societies in Europe and the Near East. Diversity in Collapse and Resilience, Palgrave Studies in Ancient Economies, Palgrave MacMillan, https://doi.org/10.1007/978-3-030-81103-7_18

Degroot, D., K. Anchukaitis, M. Bauch, J. Burnham, F. Carnegy, J. Cui, K. de Luna, P. Guzowski, G. Hambrecht, H. Huhtamaa, A. Izdebski, K. Kleemann, E. Moesswilde, N. Neupane, T. Newfield, Q. Pei, E. **Xoplaki**, N. Zappia, 2021: Towards a Rigorous Understanding of Societal Responses to Climate Change. Nature, https://doi.org/10.1038/s41586-021-03190-2

Xoplaki, E., J. Luterbacher, S. Wagner, E. Zorita, F. Fleitmann, J.F. Haldon, J. Preiser-Kapeller, A. Sargent, A., Toreti, S. White, L. Mordechai, D. Bozkurt, S. Akçer, and A. Izdebski, 2018: Climate and societal resilience in the Eastern Mediterranean in the last millennium. Human Ecology, https://doi.org/10.1007/s10745-018-9995-9

Xoplaki, E., D. Fleitmann, J. Luterbacher, S. Wagner, J. F. Haldon, E. Zorita, I. Telelis, A. Toreti and A. Izdebski, 2015. The Medieval Climate Anomaly and Byzantium: A review of the evidence on climatic fluctuations, economic performance and societal change. Quaternary Science Reviews, https://doi.org/10.1016/j.quascirev.2015.10.004

THE MEDIEVAL CLIMATE ANOMALY AND BYZANTIUM: A REVIEW OF THE EVIDENCE ON CLIMATIC FLUCTUATIONS, ECONOMIC PERFORMANCE AND SOCIETAL CHANGE

Elena Xoplaki*

Justus-Liebig-University Giessen

**with the contribution of Dominik Fleitmann, Juerg Luterbacher, Sebastian Wagner, John F. Haldon, Eduardo Zorita, Ioannis Telelis, Andrea Toreti, Adam Izdebski*

At the beginning of the Medieval Climate Anomaly, in the ninth and tenth century, the medieval eastern Roman empire, more usually known as Byzantium, was recovering from its early medieval crisis and experiencing favourable climatic conditions for the agricultural and demographic growth. Although in the Balkans and Anatolia such favourable climate conditions were prevalent during the eleventh century, parts of the imperial territories were facing significant challenges as a result of external political/military pressure. The apogee of medieval Byzantine socio-economic development, around AD 1150, coincides with a period of adverse climatic conditions for its economy, so it becomes obvious that the winter dryness and high climate variability at this time did not hinder Byzantine society and economy from achieving that level of expansion. Soon after this peak, towards the end of the twelfth century, the populations of the Byzantine world were experiencing unusual climatic conditions with marked dryness and cooler phases. The weakened Byzantine socio-political system must have contributed to the events leading to the fall of Constantinople in AD 1204 and the sack of the city. The final collapse of the Byzantine political control over western Anatolia took place half century later, thus contemporaneous with the strong cooling effect after a tropical volcanic eruption in AD 1257.

We suggest that, regardless of a range of other influential factors, climate change was also an important contributing factor to the socio-economic changes that took place in Byzantium during the Medieval Climate Anomaly. Crucially, therefore, while the relatively sophisticated and complex Byzantine society was certainly influenced by climatic conditions, and while it nevertheless displayed a significant degree of resilience, external pressures as well as tensions within the Byzantine society more broadly contributed to an increasing vulnerability in respect of climate impacts.

Our interdisciplinary analysis is based on all available sources of information on the climate and society of Byzantium, that is textual (documentary), archaeological, environmental, climate and climate model-based evidence about the nature and extent of climate variability in the eastern Mediterranean. The key challenge was, therefore, to assess the relative influence to be ascribed to climate variability and change on the one hand, and on the other to the anthropogenic factors in the evolution of Byzantine state and society (such as invasions, changes in international or regional market demand and patterns of production and consumption, etc.). The focus of this interdisciplinary study was to address the possible causal relationships between climatic and socio-economic change and to assess the resilience of the Byzantine socio-economic system in the context of climate change impacts.

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EXECUTIVE BOARD, SUPERVISION STUDENTS, TEACHING, COMMITTEE MEMBERSHIPS :

IESO 2017 FRANCE - Organization Committee President
EduMed Observatory project leader - University Côte d'Azur (http://edumed.unice.fr)
InSight Education project leader in France (http://insight.oca.eu)
EGU Committee of Education Deputy Chair
IGEO Senior Council
French educational seismological network leader
Project leader for :
EDUMED Observatory project (University Côte d'Azur)
INSIGHT Education (Geoazur CNRS, OCA)

MOST RELEVANT PUBLICATIONS :

Orion, N., Shankar, R., Greco, R., **Berenguer J.L.** (2020). Promoting the Earth System approach and the meaning of learning. *European geologist*, v. 50, p. 73-77.

Berenguer, J-L., (2020), Book, SISMO Collector, DDTM 06

Berenguer, J.-L., Balestra, J., Jouffray, F., Mourau, F., Courboulex, F., and Virieux, J.: Celebrating 25 years of seismology at schools in France, Geosci. Commun., 3, 475–481, https://doi.org/10.5194/gc-3-475-2020, 2020.

Balestra J., **Berenguer J-L.**, F. Bigot-Cormier, F. Courboulex, L. Rolland, D. Ambrois, M. Van Driel, and P. Lognonné (2020) The InSight Blind Test: An Opportunity to Bring a Research Dataset into Teaching Programs, SRL - doi: 10.1785/0220190137. Volume 91, Number 2A, March 2020

Berenguer J-L., F. Bigot-Cormier, G. Coupechoux, F. Boutaud (2020) Juega con Namazu en el mundo de las Ciencias de la Tierra / Playing with Namazu in geosciences topic (2020) Enseñanza de las Ciencias de la Tierra, 2020 (28.1) – p.99-106

Berenguer J-L., G. Etienne, J. Balestra (2019) Dix années d'éducation au risque sismique en Haïti - Haïti Perspectives, vol. 7 • nº 2 • Automne 2019, p.59-64

Bigot-Cormier F., **Berenguer J.-L.** , How Students Can Experience Science and become Researchers: Tracking MERMAID Floats in the Oceans, Seis. Res. Letters ., 88 , 10.1785/0220160121 , 2017

Berenguer J.-L. et *al.*, Tuned into the Earth from the school EduSismo: French educational seismological network, *Bull. Soc. Géol. de France*, **184**, 183, 10.2113/gssgfbull.184.1-2.183, 2013.

Berenguer J.-L., Virieux J., How to teach natural hazards in school: Raising awareness on earthquake hazard, Office for Official Publications of the European Communities, 2008

OBSERVATION OF ROMAN ARCHAEOLOGICAL MONUMENTS AND SEISMIC SITE EFFECT IN THE CITY OF ROME

Jean-Luc Berenguer

University Côte d'Azur – Education & Outreach

The "eternal city", capital of an empire to which it gave its name, Rome has preserved treasures from its past, such as the Coliseum, which have earned it the title of the world's first museum city. However, we will focus on two other monuments, the columns of Marcus Aurelius and Trajan built in the 2nd century (figure 1). Located at two separate points in the city, these columns, some 30 meters high, are decorated with a continuous frieze of 'bas-reliefs' spiralling up to the top showing battle scenes and groups of enemies defeated during the wars fought by the Romans.

Figure 1 (*from Wikipedia)*

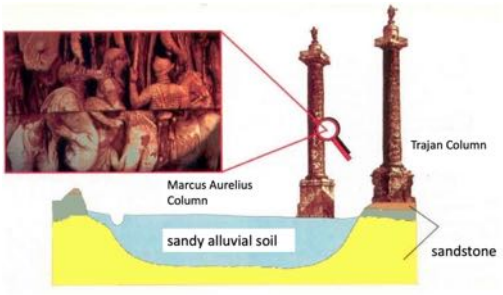
Trajan Column

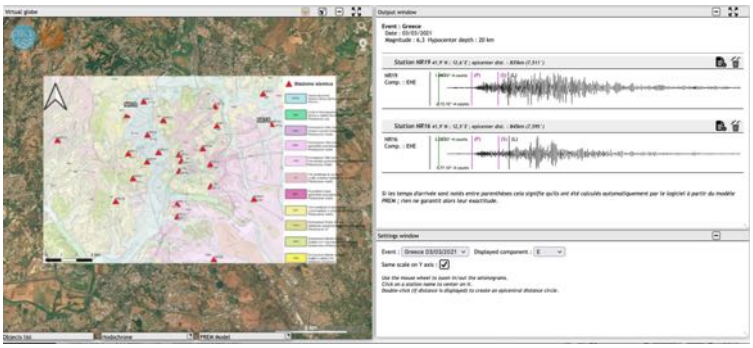
Marcus Aurelius Column

The construction of these monuments required the use of complex techniques. The marble blocks weighing around 40 tons had to be placed one on top of the other and made to fit perfectly.

Close examination of the 'bas-reliefs' of these columns shows an anomaly in one of them. This archaeological observation is consistent with the fact that the city of Rome suffered some major destructive earthquakes in its illustrious past. The end of the Roman Empire was marked by major earthquakes (in 442 and 508), which caused severe damage to the imperial city. The location of the imperial columns in the city suggests a **site effect** during the propagation of the seismic waves.

> Do contemporary seismic events show such a site effect in the city of Rome? We still have to explore seismograms of recent seismic events recorded by the local seismological network (thanks to INGV Roma).





Data references: Thanks to University Roma III, INGV Roma and EduMed Observatory (Univ. Côte d'Azur)

> How can we, as teacher, illustrate at school such a site effect ? We will try to design an easy and simple practical experiment!

Today, Rome is no longer just the marble city left by the Roman emperors, it has become the capital of Italy and is experiencing an unusual and often uncontrolled urban expansion. During all these centuries, the city of Rome and its region have experienced and still experience many earthquakes.
It is therefore important to understand the seismic hazard at a time when the urban agglomeration is populated by nearly four million people.

CARLO LAJ

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École Normale Supérieure
Département de Géologie
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EDUCATION

Secondary school in Italy and the USA (American Field Service Exchange Student). University studies at the University of Paris, PhD in Solid State Physics.

CAREER

I have done all my scientific career as an employee of the French Atomic Energy Commission, first as a researcher in the Physics Department then in the field of geophysics.
In 1985, I was appointed as Deputy Director of the Centre des Faibles Radioactivités and Head of the Department of Earth Sciences. I created and was first director of the Laboratoire de Modélisation du Climat et de l'Environnement, which was later united with the Centre des Faibles Radioactivités to form the present Laboratoire des Sciences du Climat et de l'Environnement (LSCE). After 3 terms as Head of Department (12 years) I stepped down to a researcher position again, until I retired. I have been an "emeritus" researcher since then, and gradually reoriented my activities towards education.

RESEARCH INTERESTS

After my PhD I spent a few years working with critical phenomena (scattering of laser light by critical fluids) then moved into the field of geophysics.
My main interests in this new field has always been linked to the magnetic properties of sediments and igneous rocks (paleomagnetism), used with several objectives: geodynamical reconstructions (particularly in the Eastern Mediterranean and the Andean Cordillera), reconstruction of the history of the Earth's magnetic field (including the morphology of field reversals) and more recently reconstructions of environmental and climatic changes on a global scale.
I have published over 200 articles in international scientific journals and a few general popular articles in different journals.
Supervisor of 12 PhD students, and 8 Masters of Science

EDUCATIONAL ACTIVITIES AND HONORS

Founder and Chairman, Education Committee of the European Geosciences Union
Participant to different National and International Education Committees Union Service Award for creating the Committee on Education of EGU
Excellence in Geophysical Education Award of the American Geophysical Union Fellow of the American Geophysical Union (AGU).
F. Holweck prize of the French Academy of Science
Holmes Medalist of the European Geosciences Union
Elected member of Academia Europea

MACHU PICCHU THE LOST CITY OF THE INCAS

Carlo Laj
École Normale Supérieure

On July 24, 1911, Hiram Bingham of Yale University discovered the site of Machu Picchu in the Andean Cordillera, an icon of the Inca civilisation and one of the most important archaeological sites of Latin America.

Ever since, archaeologists have wondered why the Incas have built Machu Picchu in such an isolated place perched high in the mountains on a ridge overlooking a precipitous river valley. Certainly religious beliefs have played a role in choosing such a remote place, but studies suggest that the geology of the zone is most probably the major reason for this and that the Incas deliberately chose the site of construction.

Structural geology studies of the area have been conducted in past years mainly to ensure the preservation of the site (see i.e. "La Geologia en la conservacion de Machupicchu" ed. by Carlotto, Cardenas & Soll, 2011). These studies have provided evidence of the highly fractured nature of the zone not only at Machu Picchu but also at other zones where major Inca instalments were built, such as Cusco, Pisac, Ollantayhambo. More recently, in a study taking into account also structural data obtained from satellites, R. Menegat (2019) has proposed that two major faults intercept right under the city of Machu Picchu forming an "X". This results into an intense network of faults that provided the construction material – large amount of already fractured granitic rocks - of sizes "easily" useable. The Incas then carved the rocks in a perfect shape, so that the different blocks are so tightly fitted that it is not possible to insert even a sheet of paper between them. It would have been impossible to build such a site in the high mountains if the substrate had not been fractured.

So, can we think that the Incas had knowledge of the structural geology of the Machu Picchu area? Most certainly not in the modern meaning of the term, yet they were aware of the faults: linguists have identified a word "quijlo" in their original language which means "fracture or fault", an indication that the Incas were aware of the faults in the domain where they built their cities. They also most probably knew that the faults were linked to water seeps and this is the way most scientists believe that they located fracture zones by following these seeps from down in the valley to Machu Picchu's location.

The connexion to water is important, because the fractured nature of the soil allowed to drain the water originating from the heavy precipitations, one of the reasons why the city has lasted so stable so long.

Therefore, the structural geology of the Machu Picchu area is the main reason why the Incas deliberately chose this zone (as well as the location of other cities) for its construction. The Incas benefitted of the fractured granitic rocks to build their structures so precisely that they resisted some strong historical earthquakes that largely affected the colonial (Spanish) buildings.

In this presentation I will show a short personal video of how Machu Picchu looked in 1911, a second video showing how well many structures (including water drainages) have resisted and a series of slides illustrating the major features of the Inca structures.

YANNICK DEVOS
Research Professor
Vrije Universiteit, Brussel, Belgium

Yannick Devos is a research professor and post-doctoral researcher at the Maritime Cultures Research Institute (MARI) at the Vrije Universiteit Brussel (Belgium).

Over the last 20 years his research focused on urban geoarchaeology, the study of urban soils and sediments. Research topics include the understanding of complex stratigraphies, the study of urban Dark Earth, (pre-) urban agricultural and horticultural practices, the evolution of urban spatial organization with an emphasis on 'open space' and ancient pollution.

Other research themes he worked on include the Holocene evolution of the Senne valley in Brussels, phytolith analysis on soil and sediment thin sections and issues of site taphonomy and preservation.

Currently he is scientific coordinator of the palaeo- and archaeo- environmental research team in the Brussels Capital Region. This team is composed of specialists in geoarchaeology, archaeobotany, archaeozoology and physical anthropology. He is also responsible for the geoarchaeological studies conducted in the Brussels Region, including field study, sampling and micromorphology.

URBAN GEOARCHAEOLOGY: DISCOVERING THE LEGACY OF URBAN SOILS: EXAMPLES FROM FLANDERS AND BRUSSELS (BELGIUM)

Yannick Devos

Vrije Universiteit Brussel

Soils and sediments are an essential part of towns. As they remain typically hidden from view, and basically only surface during road construction, demolition or construction works, they do not get the attention they deserve. Beyond constituting the very fundaments of the towns, they are also at the very centre of many actual challenges in urban contexts, such as soil pollution, water management and urban gardening. Present contribution intends to focus on one particular aspect: the memory of urban soils and sediments. Indeed, besides being the matrix in which archaeologists discover structures and artefacts, the soils and sediments can also provide valuable information on past activities and the evolution of town development. As important quantities of soils and sediments are removed as a result of major transformations due to city planning and reorganisation of space, it is important to document their legacy. Over the last decades urban geoarchaeological research has abundantly demonstrated that soils and sediments indeed have a story to tell. A story that not only concerns the individual site biography, but also overarching themes such as:

the evolution of the physical landscape

human impact on this landscape, including the draining of wetland areas, the embarkment of rivers, quarrying and levelling, etc.

the origins and early developments of towns often poorly known from historical sources

the spatial organisation of towns and especially the 'open space', including gardens and fields, the creation of market areas

the management of waste and pollution issues in pre-industrial times.

A selection of case studies from Flanders and Brussels will be presented to illustrate the potential of geoarchaeological research in urban contexts to come to a better understanding of this legacy of urban soils.

KATRIN KLEEMANN
Postdoctoral Researcher
German Maritime Museum – Leibniz Institute for Maritime History, Bremerhaven, Germany
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EDUCATION

10/2015—07/2020: Doctorate (Dr. phil.) from LMU Munich / Rachel Carson Center for Environment and Society, Germany
10/2011—10/2014: Master of Arts in Early Modern History from Freie Universität Berlin, Germany
10/2007—09/2010: Bachelor of Arts in History and Cultural Anthropology from Christian-Albrechts-Universität Kiel, Germany

CAREER

From 08/2021: Postdoctoral Researcher at the German Maritime Museum – Leibniz Institute for Maritime History, Bremerhaven, Germany
03/2021-05/2021: Fellowship at the John Carter Brown Library in Providence, RI, USA
10/2020—07/2021: Lecturer in the History Department at Albert-Ludwigs-Universität Freiburg, Germany
07/2020—07/2021: Visiting Scholar at the Rachel Carson Center, Munich, Germany
2020—2021: Lecturer for two courses for the Junior Year in Munich programme at LMU Munich and Wayne State University, MI, USA
12/2015—12/2017: Research Associate at the Environment & Society Portal, Rachel Carson Center, Munich
03/2012—10/2014: Student Research Assistant at the Max Planck Institute for the History of Science, Berlin, Germany

RESEARCH INTERESTS

- Early Modern and Modern History (ca. 1500 to the present time)
- Maritime History, History of Science, History of Technology, Environmental History, Climate History, History of Geology, Historical Volcanic Eruptions and Historical Earthquakes
- Interdisciplinary Collaborations between History and the Natural Sciences

PUBLICATIONS AND SERVICES

Author of one monography, several scientific, Encyclopaedia and blog articles.
From 2020: Reviews for several scientific journals, including Arcadia: Explorations in *Environmental History, Environmental History, Climate of the Past*
From 2019: American Society for Environmental History (ASEH), Member of the IT Committee, consulting on matters regarding the ASEH website
From 2018: *Arcadia: Explorations in Environmental History*; *Arcadia* is the open-access, peer-reviewed publication platform of the Rachel Carson Center and the European Society for Environmental History; Board Member and Curator of the "Disaster Histories" collection
2017—2019: "Environment and Society" Doctoral Program, Rachel Carson Center, Munich, Germany Elected speaker of the program to represent the interests of the other doctoral candidates
From 2016: Climate History Network and HistoricalClimatology.com, Georgetown University, USA; Social Media Editor, communicating climate history news on Facebook and Twitter

AWARDS AND HONORS

2021: Winner of De Gruyter's Open Access Book Anniversary competition for "A Mist Connection: An Environmental History of the Laki Eruption of 1783 and Its Legacy" (which will appear fully open access with De Gruyter's Historical Catastrophe Studies series in early 2022)
2021: Finalist of the World History Association's dissertation prize 2020
2020-2021: Envirotech Communications Fellowship
2018-2019: Andrea von Braun Foundation doctoral research grant for interdisciplinary research
2019: European Society for Environmental History Research Grant Awardee
2017: LMU Munich's GraduateCenter photography competition "My Research Object": The Jury's First Prize

THE PHYSICAL AND SOCIETAL IMPACTS OF VOLCANIC ERUPTIONS: THE CASE OF THE 1783 AD LAKI ERUPTION

Katrin Kleemann
Leibniz Institute for Maritime History

In mid-June 1783, a peculiar haze arrived above much of Europe. Contemporaries quickly realized that it was far from a regular fog: This haze was dry, rather than wet, it lasted for months, and turned the moon and sun bloodred. The haze grew increasingly dense, and by the last week of June, the concentrations of its pollutant properties seemingly reached their peak: In different places in western Europe, contemporaries started to complain about a sulfuric smell and even taste. Health problems arose, such as sore eyes and throats, breathing difficulties, and asthmatic attacks. Seemingly overnight, from England to northern France, the Dutch Republic, and the German Territories, something like a frost or thaw damaged the vegetation.

This weather inspired many to speculate about its cause. However, unbeknownst to the Europeans at the time, a 27-kilometer-long fissure volcano had sprung to life in Iceland on 8 June 1783. The Laki fissure produced the largest lava volume of any volcanic eruption on planet Earth in the last millennium. In Iceland, the lava and ashes poisoned the fields, meadows, and ponds, which caused malnutrition, hunger, and diseases in the human population, killing approximately a fifth of the population. The eruption and its aftermath are still remembered as Iceland's worst disaster in its history. This eruption also released large amounts of volcanic gases, such as sulfur dioxide, which reacted with moisture in the atmosphere and formed sulfuric acid aerosols. The jet stream carried these to Europe and beyond.

News about an Icelandic volcanic eruption, however, reached Europe only after the fog had vanished again. Thus, the contemporaries in the summer of 1783 were left alone to speculate about the cause of the unusual weather. Europe was in the midst of the Enlightenment during this time and many theories were developed, but an Icelandic volcanic eruption was only one theory among many.

FRANCIS LUDLOW

Associate Professor of Medieval Environmental History
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EDUCATION

Francis obtained a B.A. in Geography & Economics from Trinity College Dublin (TCD) in 2003, a Postgraduate Diploma in Statistics from TCD in 2005, and a PhD in Geography from TCD in 2011. His PhD thesis is entitled "The Utility of the Irish Annals as a Source for the Reconstruction of Climate".

CAREER

From 2016-2018, Francis was a Marie Sklodowska-Curie Individual Fellow in TCD, leading the "Historical Dynamics of Violence, Conflict and Extreme Weather in Medieval Ireland" project. From 2013-2016, he was Yale Climate & Energy Institute Postdoctoral Fellow, leading a project entitled "Climate as Catalyst in 1,224 Years of Violence and Conflict in Ireland, AD425-1649". From 2014 to 2015, he was Visiting Scholar with the Yale MacMillan Center Genocide Studies Program. He also held a Carson Fellowship at the Rachel Carson Center for Environment and Society (LMU Munich) from 2013 to 2014. From 2011 to 2013 he was a Ziff Environmental Fellow (Harvard University Center for the Environment), working on a project entitled "Unifying High-Resolution Records of Environmental and Societal Stresses for Ireland, AD425-1650", combining Irish annals, tree-ring and ice-core records. From 2012 to 2013 he was a Research Affiliate of the Harvard University Center for Geographic Analysis. From 2009 to 2011 Francis was Research Fellow, and from 2011 to 2016 was Research Associate, with the Trinity Long Room Hub. From 2009 to 2011 he was Treasurer of the Irish Quaternary Association, and from 2015 to 2019 was part of the Scientific Programme Committee and Local Organizing Committee that brought the 20th International Union for Quaternary Research (INQUA) Congress to Dublin in 2019.

RESEARCH INTERESTS

Francis's interests lie in climate history, a discipline at the intersection of environmental history and climatology, with its major foci being (1) the reconstruction of past climatic conditions using the evidence of historical archives (an approach also often defined as historical climatology), and (2) the impacts of past climatic changes on societies.

SELECTED PUBLICATIONS AND SERVICES

Gao, C., Ludlow, F., Matthews, J., Stine, A. R., Robock, A., Pan, Y., Breen, R. and Sigl. M. (2021) "Volcanic Climate Impacts Can Act as Ultimate and Proximate Causes of Chinese Dynastic Collapse", *Communications Earth & Environment*, 2, Article Number: 234. DOI: 10.1038/s43247-021-00284-7.

Campbell, B. M. S. and Ludlow, F. (2020) "Climate, Disease and Society in Late-Medieval Ireland", *Proceedings of the Royal Irish Academy*, 120C, 159-252. https://doi.org/10.3318/priac.2020.120.13

Ludlow, F. and Crampsie, A. (2019) "Climate, Debt and Conflict: Environmental History as a New Direction in Understanding Early Modern Ireland", In: Sarah Covington, Vincent Carey and Valerie McGowan-Doyle (eds.), *Early Modern Ireland: New Sources, Methods, and Directions*. London: Routledge, 269-300.

Manning, J. G., Ludlow, F., Stine, A. R. Boos, W., Sigl, M. and Marlon, J. (2017) "Volcanic Suppression of Nile Summer Flooding Triggers Revolt and Constrains Interstate Conflict in Ancient Egypt", *Nature Communications*, 8, Article 900. doi: 10.1038/s41467-017-00957-y

AWARDS AND HONORS

Francis is a Principal Investigator of the ERC Synergy Award project "Human History of Marine Life: Extraction, Knowledge, Drivers & Consumption of Marine Resources, c.100 BCE to c.1860 CE" (4-OCEANS; 2021-2027), the Principal Investigator of the IRC Laureate Award project "Climates of Conflict in Ancient Babylonia" (CLICAB; 2018-2023), and Co-PI of the U.S. National Science Foundation project "Volcanism, Hydrology and Social Conflict: Lessons from Egypt & Mesopotamia" (2018-2023). He is also Project Partner of the IRC COALESCE project "Irish Droughts: Environmental and Cultural Memories of a Neglected Hazard" (2019-2022).

FINDING EARTH SYSTEM PROCESSES IN ANCIENT PAPYRI AND MEDIEVAL CHRONICLES, AND HUMAN HISTORY IN TREE-RINGS AND ICE-CORES

Francis Ludlow
Trinity College Dublin

This presentation will showcase ongoing work within the interrelated fields of climate history and historical climatology through a series of case studies that will range from Ancient Egypt and Babylonia through to Medieval Ireland and Imperial China. In spanning such a large temporal and geographical range, the intent will be to demonstrate both the challenges and benefits of integrating methods and evidence from history with those from the natural sciences in pursuing questions about how our climate has changed in the past, what drove these changes, and how humans perceived and adapted to (and sometimes failed to adapt to) a variable climate. The presentation will thus attempt show how historical records and the skills of the historian can unlock sources of past climatic data that complement the information found in palaeoclimatic proxies such as tree-rings and ice-cores, whilst in turn showing how the evidence of tree-rings and ice-cores can supply historians with a means to understand how the environment (and environmental change) contributed to human history.

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Gina P. Correia, MSc in Environmental Education and PhD in Geology, has been a Biology and Geology teacher at lower and upper secondary school for over two decades. She is also a teacher trainer and integrates the research group 'Earth Dynamics' of the Earth and Space Research Centre, University of Coimbra (CITEUC).
Since 2019, she is EGU Geoscience Education Field Officer for Portugal.

Xavier Juan
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Xavier Juan has been a secondary teacher for 37 years. He is now Vice-President of the Spanish Earth Science Teachers Association (AEPECT) and member of the International Group of the UK ASE (Association for Science Education).
He is also involved in the training of science teachers, especially through the Teachers' College of Catalonia.
Since 2019 he is EGU Geoscience Education Field Officer for Spain.

Giulia Realdon
EGU Geoscience Education Field Officer for Italy
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Giulia Realdon, BSc in Biology, MSc in Science Communication, PhD in Earth Sciences Education, has been teaching Natural Sciences in high school for many years.
After retiring, she is working in education research within the University of Camerino, in non-formal science education and teacher training.
Since 2019 Giulia is EGU Geoscience Education Field Officer for Italy.

Guillaume Coupechoux
EGU Geoscience Education Field Officer for France
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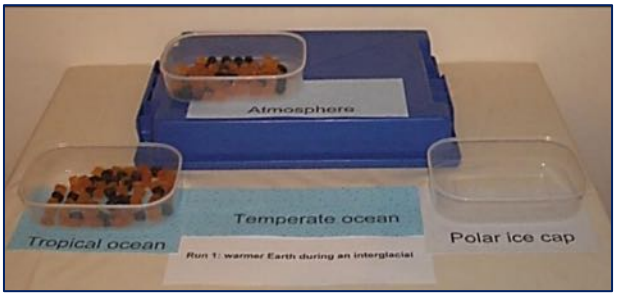
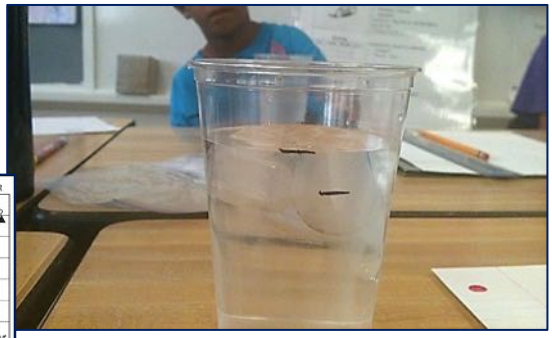
Guillaume Coupechoux, MSc in Biology and Geology has been teaching these subjects in French schools abroad and now he is teaching in Nice, France.
He is also working at the organization of sciences events in the South-East part of France, and he has also one eye on Mars as a member of the Mars2020 & InSight Education Team.
Since 2019, Guillaume is EGU Geoscience Education Field Officer for France.

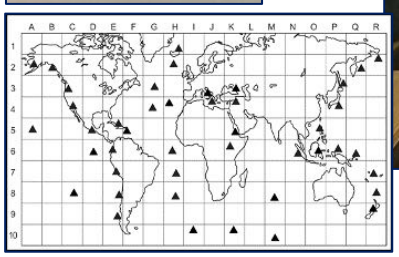
CLIMATE, VOLCANOES AND HUMANS: HANDS-ON FOR THE CLASSROOM
EGU Field Officers Team

This workshop, presented by EGU Geoscience Education Field Officers (FO), proposes some activities focused on how climate change and the volcanic distribution and activity have influenced the development of humans upon our planet. After a short introduction about the Field Officers project - countries, goals, activities - they will provide simple and engaging activities to be performed in the classroom. These activities are all linked with school curricula, and ready to be used with students of different levels and ages, from normal teaching rooms to school science laboratories. All the activities are interactive 'hands on', use cheap and common-use materials, are designed to make clear some aspect of the Earth sciences, and are available at the Earthlearningidea website (www.earthlearningidea.com). There are nearly 400 Earthlearningidea activities, many of which translated in different languages, all free to use, and designed to develop students' critical thinking and research skills, while developing their knowledge and understanding of Earth processes and products.

FOs will present hands-on about Earth history, the role of oxygen isotopes as proxies of past Earth climate, how climate change is modifying sea level, how volcanoes are distributed on Earth, how they erupt and what influences lava speed.







CHRISTOS S. ZEREFOS
Secretary General
Academy of Athens
Climate Envoy for Greece

Christos Zerefos, Secretary General, Academy of Athens. Climate Envoy for Greece. Head, Research Center for Atmospheric Physics and Climatology, Academy of Athens. Professor of Atmospheric Physics at the Universities of Athens, Thessaloniki, Visiting Professor, Universities of Minnesota and Boston. Samarbeidspartnere (Scientific Collaborator), University of Oslo. He has been known for his research in ozone, UV, ozone-climate interactions and climate extreme events. His research led to important contributions to international agreements such as the Montreal Protocol. Member, Academy of Athens, Academia Europaea, Norwegian Academy of Sciences and Letters, European Academy of Sciences, Russian Academy of Natural Sciences and other distinguished scientific societies.

He has received a number of internationally recognized awards, among which the Order of Honour from the President of the Hellenic Republic (2020), the title of Honorary Professor of the Physics Department of the Aristotle University of Thessaloniki (2018), Badge of Honor of the Bulgarian Academy of Sciences (2018), "Honorary Member" of the International Ozone Commission (2016), the Honorary Doctorate Degree, University of Patras (2016), the Yoram Kaufman Award of the American Geophysical Union (2015), the French Government Decoration "Commandeur dans l'ordre de Palmes académiques" (2015), the Blaise Pascal Medal, European Academy of Sciences (2015), Award and "Ioan Ursu" Medal of the Balkan Physical Union (2015, 2018), Medal of the City of Athens (2010), Professor Emeritus of the National and Kapodistrian University of Athens (2010), the "European Union Prize for Cultural Heritage / Europa Nostra Award" awarded to the National Observatory of Athens for the establishment of the Geoastrophysics Museum and the rehabilitation of the buildings, the laboratories and the astronomical Library by D. Aiginitis with more than 10.000 historical volumes under his supervision (2010), the Gold Medal of the City of Thessaloniki (2008), the Honorary Degree of Doctor of Humane Letters, University Division of the American College ANATOLIA, Thessaloniki (2008), Award Certificate and Letter from UNEP and from IPCC for his substantial contribution to the reports of IPCC, which shared the 2007 Nobel Peace Prize with the former Vice President of USA, Al Gore (2008), Fellow, Institute of Physics (2002), UNEP Honourable Mentions (2013, 1999, 1995), Editors Award for Excellence in Refereeing, American Geophysical Union (1998), Global Ozone Award, UNEP on the 10th Anniversary of the Montreal Protocol (1997). In the past 30 years has acted as author, contributor or reviewer in almost all WMO/UNEP Scientific Assessments of Ozone Depletion (*Montreal Protocol Who's Who* https://montrealprotocolwhoswho.org/*).* More than 200 research papers, h-index 55 (from Web of Knowledge, March 2021).

His proposal to the Greek Government for the creation of a flexible international mechanism to protect natural and cultural heritage monuments from climate change has been included in the emblematic UN activities by H.E. the Secretary General of the UN, Antonio Guterres. This initiative has been supported by 80 countries, by UNESCO and the World Meteorological Organization.

Christos Zerefos has created from zero (1) The Research Centre for Atmospheric Physics and Climatology, Academy of Athens (1978) (2) The Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki (1981) (3) The WMO Northern Hemisphere Ozone Mapping Centre (1991) (4) The Graduate Programme on Environmental Physics, Aristotle University of Thessaloniki (1991) (5) The Laboratory of Atmospheric Environment, Biomedical Research Foundation, Academy of Athens (2003) (6) The UNESCO Chair on Natural Hazards in the Geosphere, the Hydrosphere and the Atmosphere (2007) (7) The Geoastrophysics Museum, National Observatory of Athens (2008) (8) The Navarino Environmental Observatory in Messenia (2009).

VOLCANOES, GEOPHYSICS, CLIMATE AND ART

Christos S. Zerefos
Secretary General, Academy of Athens
Climate Envoy for Greece

Red-to-green ratios as depicted in paintings by great masters in the past (1500-1900) and with digital cameras at present can provide important environmental information towards estimating aerosol optical depths (AOD) at sunsets. The method has been tested at a number of large known volcanoes in the past and provides an estimate that has been tested with a large number of cases. Following large volcanic eruptions, statistically significant excursions of red-to-green ratios have been observed and radiative transfer mode calculations were used to compile time series of aerosol optical depths at 550nm over northern middle latitudes. The 1815 Tambora eruption is among the most prominent AOD phenomena of the past few centuries as far as the red-to-green ratios in historic paintings are concerned. Comparisons with different proxy methods with the proposed chromatic method will be presented for the case of the Tambora eruption in an attempt to further quantify and rank the phenomenon and its environmental consequences.

RICHARD S. WILLIAMS
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Richard S. Williams, Jr., Ph.D. is a Senior Associate Scientist at the Stefansson Arctic Institute, Akureyri, Iceland. His other affiliations are Emeritus Senior Research Geologist, Woods Hole Coastal and Marine Science Center, U.S. Geological Survey (USGS); Vice Chairman Emeritus, Committee for Research and Exploration, National Geographic Society; and Director-Science, Geoscience Information Services. He has B.S. and M.S. degrees from the University of Michigan and a Ph.D. degree from Pennsylvania State University, all in geology. He specializes in using airborne and satellite remote sensing technology to carry out investigations of dynamic geologic, glaciologic, and geomorphologic processes. Iceland is of special interest, where he and his Icelandic colleagues have been studying changes associated with volcanic activity and glacier fluctuations for more than 55 years. He is a strong proponent of cooperative international programs that use satellite image data to monitor changes globally on the Earth's surface that result from natural processes and/or human activities. His more than 350 papers, maps, books, chapters, and abstracts cover a wide range of topics, including remote sensing, geologic and glaciological hazards, volcanology and glaciology of Iceland, global environmental change, planetary exploration, sea-level change, and natural and human history of the Earth, especially the human impact on the Earth System [For example, What will be the fate of the Earth´s Biosphere?]. He is a member of the Cosmos Club and the Explorers Club, a Fellow of the American Association for the Advancement of Science (AAAS) and the Geological Society of America, a Corresponding (Foreign) Fellow of the Icelandic Science Society, and a recipient of the Meritorious and Distinguished Service awards by the U.S. Department of the Interior. During his active duty service with the U.S. Air Force, he was awarded the Airman's Medal, the highest non-combat award for heroism. In honour of his work on mapping glaciers in Antarctica, two glaciers in Antarctica are named for him: Williams Glacier and Williams Ice Stream.

NATURAL HAZARDS FACED BY ICELANDERS

Richard S. Williams, Jr.
Stefansson Arctic Institute, Akureyri, Iceland

During the 8th century, Norse explorers were already sailing to the west looking for new lands to settle. The Færoe Islands (17 inhabited islands of which Streymoy is the largest at 1,400 km^2) were first settled at about 800 CE; explorers continued to sail west and had chance encounters with Iceland during the 9th century. About 870 CE, the first settlers, mostly from Norway and some from Ireland and the Scottish Isles, accompanied by Celtic thralls, began to arrive.

Iceland´s name comes from earlier Norse explorers, such as Hrafna-Flóki Vilgerðarson from Norway, who saw sea ice in Ísafjörður, Iceland has an area of 103,000 km^2. In coastal areas, particularly in the Mývatn lake area in north-central Iceland and along the Þjórsá and Rangá rivers in southwest Iceland, forested and grassland areas were located. One of the men who accompanied Hrafna-Flóki, Þórólfur, had reported that in Iceland, "the grass was dripping with butter." The early explorers had chanced upon a place in which no other humans were present and a beautiful land which could easily support the Norse culture. By the early 10th century, all of the best places had been settled (according to *Landnámabók*), and the world´s first parliament (Alþing) had been established in 930 CE which lasted until 1262-1264.

Although the preceding brief history is true, the unsuspecting Norse settlers would soon have to confront and adapt to many natural hazards, some of which they had never encountered before , such as volcanic eruptions and jökulhlaups (glacier-outburst floods) that continue to test the mettle of Icelanders to this very day, more than 1,150 years later. The early Norse settlers and their Celtic thralls had settled in a most favorable land, but one partly covered (10 percent) by mountain glaciers, ice caps and associated outlet glaciers (from which large and powerful rivers flowed to the sea, hindering cross-country travel), and, in one of the most volcanically active locations on Planet Earth – astride the spreading axis of a mid-ocean ridge in the North Atlantic!

The presentation will focus on the history of volcanic eruptions and jökulhlaups as the principal natural hazards, among many, including earthquakes and rifting of the land, Icelanders have had to deal with during their 1,150+ years of settlement. The principal hazards have been explosive (tephra- and gas-producing) and effusive (lava flows) volcanic eruptions; jökulhlaups from subglacial eruptions, some of which have exceeded, for a few hours, the normal flow of the Amazon River, the largest river on Earth; earthquakes and rifting of the land, all hazards unknown to them from their original homelands. With volcanic eruptions occurring every 3 to 5 years, only selected

historical and recent eruptions will be addressed. Yesterday, Katrin Kleeman, has already given a presentation on the 1783-1784 Laki (Skaftáreldar – “Skaftár Fires”) eruption in the Environmental History Session. In chronological order, the following selective volcanic eruptions, some accompanied by jökulhlaups and copious tephra deposition and gas emissions, will be discussed: Öræfajökull – 1362, Askja – 1861, Katla (Mýrdalsjökull) – 1918, Hekla – 1947-1948, Surtsey – 1963-1968, Eldfell (Heimaey) – 1973, Grímsvötn (Vatnajökull) – 1996, Eyjafjallajökull – 2010, Holuhraun – 2014, and most recently, Geldingadalir/Fagradalsfjöll – 2021. Note: I landed by Zodiac on Surtsey in 1966 and was in Heimaey in early February 1973, so my comments will be first-hand for those two eruptions.