Forum Article / Obituary

The Holocene

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In Memoriam:

Keith R. Briffa, 1952-2017

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Abstract

Keith R. Briffa was one of the most influential palaeoclimatologists of the last thirty years. His primary research interests lay in late Holocene climate change with a geographical emphasis on northern Eurasia. His greatest impact was in the field of dendroclimatology, a field that he helped to shape. His contributions have been seminal to the development of sound methods for tree-ring analysis and in their proper application to allow the interpretation of climate variability from tree rings. This led to the development of many important records that allow us to understand natural climate variability on timescales from years to millennia and to set recent climatic trends in their historical context.

Keywords

Dendrochronology, Tree-rings, Holocene, Climate Change, Palaeoclimate

Keith R. Briffa (Plate 1), who helped to shape the field of dendroclimatology, died peacefully on 29 October 2017 at the age of 64. Keith studied Biological Sciences at the University of East Anglia, graduating in 1974. His scientific career began when he joined the Climatic Research Unit (CRU) at the University of East Anglia (UEA) in 1977 and ended with his death as Emeritus Professor 40 years later. His work ranged across such topics as European droughts, glacier fluctuations, cooling by volcanic eruptions, beetle fossils, and temperatures in ice age Britain. His greatest and most sustained contribution was to unravel the complex climatic signals encrypted in annual tree rings, and to set their interpretation on a sound and rigorously tested footing.

Keith made outstanding achievements in the reconstruction, interpretation and understanding of climate variability and change. His greatest impact has been in the field

of dendroclimatology, where he led many methodological developments that have become widely used in this field (and in other palaeoclimate disciplines). He applied these methods to develop many highly-cited tree-ring chronologies, interpreting their climatic information on timescales from centuries to millennia.

His first major research area was methodological advances in dendroclimatology. A key methodological advance was the introduction of widely-used measures of chronology confidence (such as the Expressed Population Signal, EPS and the sub-sample signal strength, SSS), based on the average inter-core correlation value (r-bar). Keith identified these relationships empirically and Tom Wigley undertook a more formal mathematical derivation. Their article (Wigley et al., 1984) is among the most widely cited in dendroclimatology, with over 2,100 citations in Google Scholar in May 2018 (and related methodological work – Briffa and Jones, 1990 – has almost 500 citations). It is notable that, more than three decades after it was first published, this work is being cited almost 200 times each year. The approach was recently extended to measure the reliability of chronologies on longer timescales, such as their centennial tree-growth variability (Briffa et al., 2013).

Another major methodological focus, with improvements and advances continuing every few years, was on approaches to objectively remove non-climatic variability from tree-ring chronologies while retaining long-timescale climatic information. This challenge was later referred to as the "segment length curse" (Cook et al., 1995). Keith first experimented with Gaussian filters (Briffa et al., 1983, 1988a; Briffa, 1984) and splines, but realized that more fundamental approaches were needed, particularly if long tree-ring chronologies were to be developed combining samples from living trees, archaeological and sub-fossil material. His first approach was "Regional Curve Standardization" (RCS), realigning all the samples to their tree age instead of their calendrical age (Briffa et al., 1992a). Although this worked well there were issues with samples coming from different populations, such as modern samples growing on relatively dry ground whereas those preserved as sub-fossil trees had grown close to, and fell into, small lakes (Plate 1). The most recent approaches use "Signal-Free" methods to minimise modern sample bias (Melvin and Briffa, 2008; Briffa and Melvin, 2011) and multiple RCS curves to represent different populations (Briffa et al., 2013). These innovations in tree-ring standardisation methods will continue to influence the future development of the field for many years and are implemented in freely available software (CRUST – Melvin and Briffa, 2014). Keith's methodological advances pervade the dendroclimatic literature such that most studies cite one or more of his papers.

His second major research area was the development of long (multi-century to multi-millennial) tree-ring chronologies from Fennoscandia, North America, northern Russia and most recently the Tibetan Plateau (Briffa et al., 1992ab, 1995, 2008 and 2013; Yang et al., 2014). They provide annually-resolved information about growth-rate changes on interannual to millennial timescales in these regions, from which summer temperatures or annual precipitation can be inferred. None of these would have been possible without the methodological advances that address the segment length curse.

His third major research area was the combination of chronologies to infer the spatial patterns of past climate variability (Cook et al., 1994; Briffa et al., 2002b) or to reconstruct climate variability of large area averages, such as the northern extratropics (Briffa et al., 2001). Using extensive tree-ring networks compiled by Fritz Schweingruber (Plate 2), Keith demonstrated that maximum latewood density (MXD) measurements have a more sensitive response than ring widths to summer temperatures in high northern latitudes (Briffa et al., 1992b, 2002a). MXD reconstructions led to better isolation of the effects of explosive volcanic eruptions (Briffa et al., 1998a) and with exact dating the realization that these events could be used to improve ice core dating (Vinther et al., 2010). Keith was also the first to demonstrate that a widespread divergence between some MXD data and instrumental summer temperatures in northern high latitude had apparently occurred since about 1960 (Briffa et al., 1998bc). This provided a challenge to the interpretation of long tree-ring reconstructions and a new urgency to more fully understand the impacts of standardization and modern sampling bias, and that many more samples are needed to evaluate the low-frequency climate signal in the presence of multiple climatic and non-climatic influences.

Looked at individually (e.g. for Fennoscandia and locations in northern Russia) the timing of cooler and warmer periods differed (Briffa, 2000). In terms of past temperature variability, local response functions indicated that the trees were responding to variability during high summer (for ring widths) and an extended summer season (for MXD) from May to September. One issue was whether reconstructions for different seasons could be combined and how they would relate to our understanding of the centennial variability over the Northern Hemisphere, where there was then believed to have been a Medieval Warm Period (MWP from ~900 to 1250) and a Little Ice Age (LIA from ~1550 to 1850). Concepts of both the MWP and LIA have evolved since their initial use in their modern form in the 1970s (see discussions in Matthews and Briffa, 2005; Jones et al., 2009), especially as the amount of available information from an expanding array of proxies had multiplied from a handful of reconstructions in the early 1970s to the several hundred available today. Keith was involved in a number of studies that looked at the sensitivity of using only certain proxies (e.g. trees only) or the effects of only using a limited number of series that all extended back for the whole millennium (Jones et al., 1998; Rutherford et al., 2005; Osborn and Briffa, 2006; Juckes et al., 2007; Kaufman et al., 2009), as well as reconstructions of precipitation and drought patterns in mid-latitude regions (Cooper et al., 2013; Yang et al., 2014; Cook et al., 2015).

Keith's scientific contributions extend far beyond dendroclimatology. Examples include other palaeoclimatic areas, such as the use of beetle remains for reconstructions since the last glacial maximum (Atkinson et al., 1987) and combining tree-ring reconstructions with glacier snout reconstructions from Scandinavia and Canada (Raper et al., 1996; Luckman et al., 1997). He investigated the evidence for recent climate change based on instrumental records, encompassing surface air temperature (Jones and Briffa, 1992, 1995; Briffa and Jones, 1993), drought (Briffa et al., 1994, 2009; Trenberth et al., 2014) and atmospheric circulation variability (Briffa et al., 1990a; Cornes et al., 2013).

In all, Keith published more than 140 articles in journals and chapters in books. These have amassed more than 16,000 citations, illustrating his influence on the field (with an *average* of more than 100 citations per article). Beyond his personal research, he was an associate editor of *The Holocene* (of which he was a founding member) for more than two decades, and held similar editorial roles for the journals *Dendrochronologia* (for 21 years) and *Boreas* (for 12 years). Keith saw at an early stage the importance of bringing together communities working with palaeoclimate data and those studying climate variability from a dynamical and numerical modelling perspective. He used his international roles within the International Geosphere-Biosphere Programme Past Global Changes (IGBP PAGES) programme (as a member of its scientific steering committee, 1994–2000 and its executive committee, 1998–2000) and within the World Climate Research Programme (WRCP) CLIVAR / PAGES Intersection Working Group (2005–2011) to foster closer ties between these communities.

Keith's amenable, friendly personality, combined with enthusiasm for his science and a searching and constructively critical mind led to building contacts with many people in the field of palaeoclimatology (e.g., Plates 1 to 3). The fruits of these long-lasting and successful collaborations have been felt across climate science, with Keith leading the development of many important records allowing us to understand natural climate variability on timescales from years to millennia and to set recent climatic trends in their historical context. This spirit of collaboration is apparent in the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), to which Keith made important contributions over four of its cycles. In particular, he was a lead author of the *Palaeoclimate* chapter (Jansen et al., 2007) for the IPCC's Fourth Assessment Report, with a focus on the, at times controversial, topic of climate variations during the last 2000 years. With his characteristic objectivity and openness about the strengths and limitations of palaeoclimate data, he led the careful assessment of scientific understanding about this topic.

Keith Briffa was a great friend to many colleagues throughout his 40 years in the Climatic Research Unit and the School of Environmental Sciences at UEA, and was an admired lecturer among students, especially for his never-ending enthusiasm for his subject. Despite his great achievements, Keith remained remarkably modest and self-effacing. He helped many colleagues and particularly early stage researchers to achieve their potential, and he provided enduring support for the development of dendroclimatology communities in many regions of the world.

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A complete list of Keith Briffa's publications between 1983 and 2017 can be found at https://crudata.uea.ac.uk/cru/people/briffa/Keith_R_Briffa_full_publication_list.pdf

Plates

Plate 1. Keith Briffa, Tom Melvin and Michael Grabner assessing sub-fossil tree samples in the Austrian Alps, 2006. Photo: Kurt Nicolussi.

Plate 2. Fritz Schweingruber and Keith Briffa during field work, Southern Urals, 1999. Photo: Stepan Shiyatov.

Plate 3. Keith Briffa visiting Ed Cook at the Tree-Ring Lab, Lamont Doherty Earth Observatory, 2007.