Quaternary International 253 (2012) 1–3

Contents lists available at SciVerse ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Guest Editorial

Controversies in the late Quaternary of the Southern Hemisphere

This special issue derives from a symposium held at the V1 Southern Connection Congress in Bariloche, Argentina, in February 2010. It was an initiative of the INQUA Palaeoclimate Commission project, 'Land–Ocean Correlation of Long Quaternary Records from the Southern Hemisphere on orbital and Sub-Orbital Timescales' or 'PASH2' designed in response to the continually growing appreciation of the distinct but generally poorly understood contributions of Southern Hemisphere continents and oceans to the history of global climate. The abbreviation 'PASH2' was adopted to denote the connection with 'PASH', an acronym for a previous INQUA project 'Palaeoclimates of the Southern Hemisphere' conducted under the umbrella of its Global Change Programme. Information on the scope of PASH2, including a metadata base on Quaternary records that contain terrestrial proxy data on palaeoclimates covering at least the last 20 ka, is available at https://sites.google.com/site/palcommpash2/.

The title of the Southern Connection symposium, 'Controversies in the Quaternary of the Southern Hemisphere' was greater in scope than the title of this issue in order to embrace all 15 contributions that together covered the whole of the Quaternary and not just the latter part of it. Unfortunately, only a few of these contributions made it into this issue for various reasons including prior publication, commitment to other journals, and problems with controversy resolution. The most distressing loss, to both the symposium and the special issue, was the proposed contribution of Tim Partridge due to his untimely and unexpected death in December 2009. A dedication to Tim, who had done more than anyone to promote the cause of palaeoclimate research in the Southern Hemisphere within the Quaternary, accompanies this preface. Although only five papers from the symposium are included, the number of contributors in total is very reasonable at 20 and geographical coverage is fairly even with one paper from each of South America, southern Africa, Australia and New Zealand, and one comparing an aspect of climate from the four landmasses (see Fig. 1). This figure also includes the positioning of two major drivers of two Southern Hemisphere climates, the Inter-Tropical Convergence Zone and southern mid-latitude westerlies, that frame most study sites considered and are relevant to study interpretations.

The major time periods covered by each contribution are shown on Fig. 2. Thomas and Burrough address the last glacial cycle, but scarcity of records tends to limit record comparisons largely to the last 50 ka. Other papers are even more temporarily restricted, but all cover at least part of the period since the Last Glacial Maximum. The period titles shown are those flagged in one or more papers and are not globally formalized except for the Younger Dryas and Antarctic Cold Reversal. It is fortunate that the informal subdivisions of the Holocene relate to similar time ranges in all relevant publications.

Thomas and Burrough focus on reconstructing past climate and environmental change within interior drylands of southern Africa, a region of significance for human evolution and dispersal. Due to the lack of sites suitable for production of continuous, highly resolved records from conventional organic or isotopic proxies within this region, it has been difficult, traditionally, to establish a consistent pattern of past climate changes. However, the increased application of geomorphological studies on sand dune and lake shore features using so-called geo-proxies supported by OSL dating is producing a more substantial regional picture of hydrological change but one which seems dominated by temporal and spatial variability with less than expected correspondence with major regional monsoon easterly and monsoon and mid-latitude westerly winds. A rather parallel situation is evident in a semi-arid landscape study in central Australia, presented at Bariloche but in the process of publication elsewhere by Cohen et al. (2011). This review was designed to try and provide some consistent explanation for what had appeared to be problematic and inconsistent records. Hydrological variation constructed largely by OSL dating of relict shorelines of old megalakes was determined to show some relationship with a combination of monsoonal and mid-latitude westerly activity but lake levels appear to have frequently varied independent of insolation variation. Support was provided for increasing evidence through much of Australia of a general trend towards drier conditions through the last glacial cycle.

The paper of Augustinus et al. focuses on the palaeolimnology of a volcanic maar, Lake Onepoto, that, together with Augustinus et al. (2011) which addresses the regional history derived from the same site, provides a multiproxy record of climate change from 30 ka to 9 ka, essentially the period of interest of the Australasian INTIMATE project (e.g., Turney et al., 2006; Alloway et al., 2007). The volcanic nature of the site combined with identification of numerous dated tephras has ensured that the record is continuous, chronologically well-controlled, and has a resolution unparalleled by other sedimentary records within the country. It also is one of the few records in the south-west Pacific region that details the whole of the last glacial maximum and the glacial–interglacial transition, and cements prior proposals of a regionally expanded glacial maximum termed the last glacial cold period dated from 28.5 ka to 18 ka. The nature of variation within the late glacial is characterized by two phases of drier and possibly cooler conditions that overlap,

1040-6182/$ – see front matter
doi:10.1016/j.quaint.2012.01.038

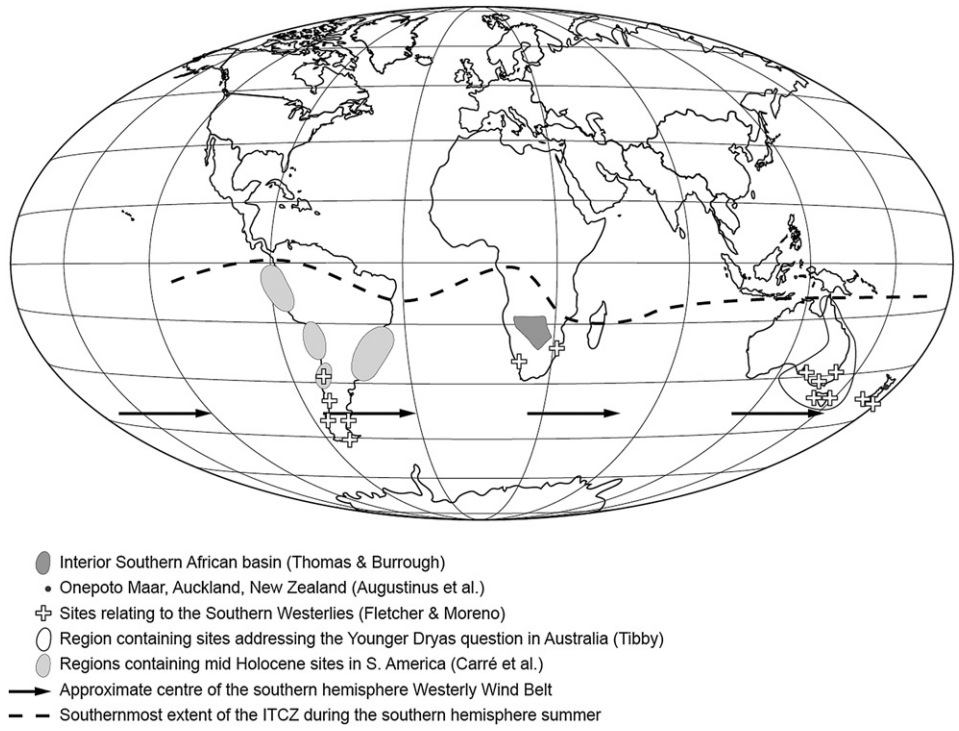

Fig. 1. Location of sites and areas of palaeoenvironmental records addressed in contributing papers in relation to the Southern Hemisphere summer position of the Inter-tropical Convergence Zone and mean location of the Westerly Wind Belt.

but are not synchronous with, the Antarctic Cold Reversal and Younger Dryas.

The possible representation of the Younger Dryas cool period in Australia is examined by Tibby to test the extent of global

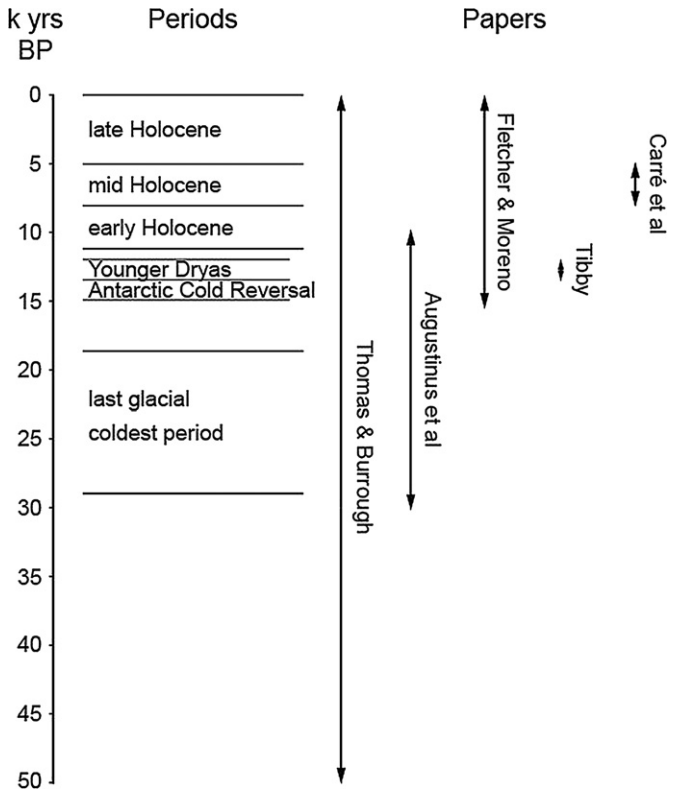

Fig. 2. Time ranges addressed in contributing papers.

impact of this and potentially other millennial-scale glacial events generally considered to emanate from the North Atlantic region. Despite the paucity of continuous, well-dated records, it is considered that there are now sufficient data to allow the conclusion that there is no evidence of cooling, or in fact any other climate event corresponding with this event. The paper of Augustinus suggests that this conclusion can also be applied to New Zealand. However, the suggestion of late glacial cooling in south-eastern Australia corresponding instead with the Antarctic Cold Reversal is not totally supported by the New Zealand evidence. Clearly the transition period is complex and additional high quality data are needed to resolve temporal and spatial uncertainties.

The last glacial–interglacial transition is also, along with the Holocene, the target of the paper by Fletcher and Moreno, that aims to resolve long lasting issues over the dynamics of the Southern Hemisphere westerly wind system and their influence on mid-latitude climates. It reassesses interpretations of a variety of high resolution, well-dated Southern Hemisphere mid-latitude records from all landmasses in relation to likely changes in westerly intensity and latitude based on present westerly-precipitation relationships within various geographic environments. In contrast to many previous syntheses, it suggests that the Westerly Wind Belt moved in a zonally synchronous manner every few thousand years between 14 and 5 ka. In addition, after about 5 ka it is proposed that the increasing azonal influence of the tropical Pacific El Niño-Southern Oscillation (ENSO) on precipitation resulted in the development of marked asymmetry.

ENSO also features in the contribution by Carré et al. who address a long lasting debate on climate conditions existing in the eastern Pacific during the mid Holocene from new and reviewed data in regions of South America known to be impacted by the eastern Pacific and away from complicating forcing influences such as those related to the westerlies and ITCZ. From

high-resolution (monthly resolved) mollusk-based oxygen-isotope measurements, and terrestrial proxy data, it was determined that mean climate, although varying between regions, was similar to that experienced during present-day La Niña conditions suggesting that this was the average state in the tropical Pacific through the mid Holocene. These general La Niña conditions were accompanied by ~1–4 °C lower coastal sea-surface temperatures caused by increased upwelling due to an intensified Southeast Pacific Subtropical Anticyclone, and a strengthened Peru-Chile current. The authors speculate that this general climate state during the mid Holocene could be considered an analogue for a future warmer climate.

Overall, these papers contribute substantially to resolution of uncertainties and controversies and to a clearer understanding of late Quaternary climate change in the Southern Hemisphere. However, they also demonstrate that there is a high degree of spatial variability that probably emanates, to some degree, from the number of relatively equal forcing influences. In the Northern Hemisphere, the dominant signals on both orbital and millennial scales relate to North Atlantic ice sheet dynamics while, although these are evident in at least parts of the Southern Hemisphere, their dilution here allows tropical, mid-latitude and Antarctic zonal influences as well as tropical Pacific ENSO to provide effective competition. Regional heterogeneity could also be a result of temperature gradients that are shallower and less influential relative to precipitation variation in the Southern Hemisphere. Clearly, a complete understanding of climate change and variation in the Southern Hemisphere will require a much greater and updated data base than exists at present.

We thank our colleagues who helped improve the manuscripts by critical and constructive reviews: Patrick De Deckker, Rene Garreaud, Martin Grosjean, Tom Johnson, Vera Markgraf, Dave McWethy, Dave Nash, Rewi Newnham and Jamie Shulmeister.

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Jan-Berend W. Stuut
NIOZ – Royal Netherlands Institute for Sea Research, P.O. Box 59, NL-1790 AB, Den Burg, The Netherlands

MARUM – Center for Marine Environmental Sciences, P.O. Box 28334, D-28334, Bremen, Germany

A. Peter Kershaw*
Centre for Palynology and Palaeoecology, School of Geography and Environmental Science, Monash University, Melbourne, Victoria 3800, Australia

* Corresponding author.
E-mail address: peter.kershaw@monash.edu

Available online 3 February 2012