Combined climatological and societal evidence of the *Late Antique Little Ice Age* (*LALIA*; 536 to ~660 CE)

Short title: *The Late Antique Little Ice Age*

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Helama *et al.*[1] essentially echo one of our main conclusions that climate variability during the first half of the Common Era is still poorly understood[2], because of the decreasing quality and quantity of proxy archives back in time. Their correspondence, however, underestimates the mutual paleoclimatological/-environmental, archaeological, historical and societal signs of abrupt and long-lasting summer cooling after 536 CE over much of the Northern Hemisphere landmass, and also ignores fundamental drawbacks associated with the obsolete terminus 'Dark Ages Cold Period' (DACP).

While we herein resign from re-compiling and re-evaluating the available evidence of the Late Antique Little Ice Age (LALIA; 536 to ~660 CE)[2], we do argue about the problematic usage of DACP on multiple grounds.

Nowadays, most historians and natural scientists refuse the term DACP, which was popular in the 19th century to describe pejoratively an imagined episode of brutal savagery, ignorance, and collapse, sometimes characterized by little useful archaeological remains and written documentary sources. Scholars initially imagined the DACP as the entire Middle Ages from around the 5th to the 15th century, or, more recently, the early Middle Ages (~500 to 900 CE). Historians today refer to these centuries as 'Late Antiquity', which typically defines the interval from ~300-700 CE. Although its initial geographic focus was on the Roman and Persian/Islamic Empires, the term 'Late Antiquity' is now regularly applied for other regions, as well as beyond disciplinary boundaries. It therefore appears essential for scientists to respect the advances and technical terminology of historians, and vice versa[3]. In addition to the semantic meaning of an accurate wording, spatiotemporally imprecise definitions, such as DACP, should consequently be refined and replaced as new data and better vocabulary arise.

The mounting natural and human proxy evidence of the LALIA for much of Eurasia[2,4-7], including northern Fennoscandia and the Mediterranean region[8], will soon be supplemented with externally forced climate simulations for the last two millennia. The new runs will provide insight into the physical mechanisms of positive feedback loops between ocean, sea-ice and

atmosphere, which probably prolonged the volcanic-induced onset of the LALIA. Long-term cooling during the later part of the LALIA was likely amplified by reduced solar activity[9]. Moreover, multi-proxy temperature reconstructions and comparisons with climate model output commonly reveal a continuous level of disagreement throughout time[8], due to the dominant role of internally generated variability. On the other hand, periods of pronounced global forcing, such as the anomalous stratospheric sulphate loadings at the onset of the LALIA (536 to ~550 CE) or the increasing greenhouse gas concentrations during the industrial era (from ~1850 to present), are characterized by relative coherency (not only within but also between continents during the last millennium[10]). Despite methodological and statistical treatments, as well as socio-cultural and political interpretations are glaciers reliable witnesses of past climate variability, offering multiple indications for the LALIA[11].

Finally, we emphasize the importance of overcoming deterministic and reductionist influences when using interdisciplinary approaches, precisely dated records, and regional case studies, to place climatic changes in the context of historical events[6,12,13].

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