

Abrupt climate change: Past, present and the search for precursors as an aid to predicting events in the future (Hans Oeschger Medal Lecture)

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The demonstration using Greenland ice cores that abrupt shifts in climate, Dansgaard-Oeschger (D-O) events, existed during the last glacial period has had a transformational impact on our understanding of climate change in the naturally forced world. The demonstration that D-O events are globally distributed and that they operated during previous glacial periods has led to extensive research into the relative hemispheric timing and causes of these events.

The emergence of civilization during our current interglacial, the Holocene, has been attributed to the “relative climate quiescence” of this period relative to the massive, abrupt shifts in climate that characterized glacial periods in the form of D-O events. But, everything is relative and climate change is no exception. The demise of past civilizations, (eg., Mesopotamian, Mayan and Norse) is integrally tied to abrupt climate change (ACC) events operating at regional scales. Regionally to globally distributed ACC events have punctuated the Holocene and extreme events have always posed significant challenges to humans and ecosystems.

Current warming of the Arctic, in terms of length of the summer season, is as abrupt and massive, albeit not as extensive, as the transition from the last major D-O event, the Younger Dryas into the Holocene (Mayewski et al., 2013). Tropospheric source greenhouse gas rise and ozone depletion in the stratosphere over Antarctica are triggers for the modern advent of human emission instigated ACCs. Arctic warming and Antarctic ozone depletion have resulted in significance changes to the atmospheric circulation systems that transport heat, moisture, and pollutants in both hemispheres.

Climate models offer a critical tool for assessing trends, but they cannot as yet predict ACC events, as evidenced by the inability of these models to predict the rapid onset of Arctic warming and resulting changes in atmospheric circulation; and in the model vs past analog differences in projections for the state of atmospheric circulation in the Southern Hemisphere that will result as a consequence of greenhouse gas rise and “healing” of the Antarctic ozone hole (Mayewski et al., 2015). Climate change perspective gained from instrumentally calibrated ice core and other past climate proxies is essential to the construction of plausible scenarios for future climate and actionable planning.

More ACC events are in our future and the early manifestation of these events is apparent in the emerging change in the severity and frequency of extreme events. Searching for a precursor for ACC events is a major challenge for the scientific community and humanity. For the climate community to undertake this challenge it is necessary to investigate both past and present sub-seasonal and longer extreme events associated with past D-O and ACC events and their impact on societies. Examples of sub-seasonal scale investigation of these events will be included in the presentation.

Mayewski, P.A., Sneed, S.B., Birkel, S.D., Kurbatov, A.V. and Maasch, Holocene warming marked by longer summers and reduced storm frequency around Greenland, *Journal of Quaternary Science*, 267-8179. DOI: 10.1002/jqs.2684, 2013.

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