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## Kavli Frontiers of Science Symposium Series

### Ninth Annual Japanese-American Kavli Frontiers of Science Symposium

Japan Society for the Promotion of Science  
U.S. National Academy of Sciences

December 8-10, 2006  
Irvine, California

#### Holocene Climate and the Sun: Weak Forcing, Strong Response

Peter B. deMenocal (Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964)

Please click on the above link to watch the presentation - both slides and audio. This presentation file is in [Flash](#) format, available free online.

One of the more surprising and significant recent discoveries in paleoclimate research has been that climate has been remarkably sensitive to relatively weak climate forcing. The nearly 12,000 years of the present warm interglacial period, the Holocene, was previously viewed to have been very stable. However recent results from deep-sea sediments have provided strong evidence that the Holocene was punctuated by a series of century-scale cooling events which were paced roughly every 1500 years. The most recent of these events was the Little Ice Age (1300-1850 AD) when much of northern Europe and Greenland was significantly cooler than today (1-3°C). These cooling events impacted surface and deep ocean temperatures, and are expressed in the tropics as synchronous hydrological changes. The pacing of these Holocene cool events corresponds closely with past changes in solar irradiance as reconstructed by cosmogenic isotope variations. This correspondance is remarkable because the direct (visible radiation band) impact of these solar changes is most probably very weak, only about 0.2% variation, and the observed climate responses are much larger than would be expected from this weak forcing from simple energy balance considerations. Plausible amplifying mechanisms have been proposed and these will be discussed but our understanding is still incomplete. Current and near-future anthropogenic greenhouse gas forcing represents surface energy imbalances that are nearly an order of magnitude greater than this solar forcing.

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Key words: Paleoclimate, Holocene, Little Ice Age, Ice-rafted debris, Sea-surface temperature, climate sensitivity, Solar irradiance, Thermohaline circulation, Cosmogenic isotopes.

Review Articles:

Bond, Gerard, et al, Persistent Solar Influence on North Atlantic Climate During the Holocene, *Science*, Vol. 294, pp. 2130-2136, 2001.

Marchitto, Thomas M. and deMenocal, Peter B., Late Holocene variability of upper North Atlantic Deep Water temperature and salinity, *Geochemistry Geophysics Geosystems*, Volume 4, Number 12, 2003.

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