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Precise time-window for the onset of glacial termination found

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Following a set of three simple rules, we have found a precise time-window (TW) for each onset of a glacial termination (GT) appeared during the last million years. The onset of GT (OGT) is defined as the year when the following two conditions are met: (1) the benthic delta 18-O is a maximum and greater than 4.5%■ and (2) its value continually drops 1%■ within 5 Ky.

We developed the rules based on three hypotheses. We hypothesize that:
(H1) The Earth's three orbital parameters (eccentricity, obliquity and precession of equinox) determine the insolation which is the key force to the climate system.
(H2) However, only a small fraction of insolation is converted into sensible heat (SH) and chemical energy through photosynthesis (CETP) as influxes to the climate system's main heat capacitors (HCs), namely the world oceans. When insolation increases, both the SH flux and CETP increase. The downward SH flux will only increase the stability of the seawater. Nonetheless, the CETP gets accumulated faster than average. The CETP cascades through the marine food web and bacterial degradation. Finally, it is stored in the simple gas molecules (such as CH_4) that form methane hydrate (MH) and other hydrates such as hydrogen sulfide hydrate (HSH) in deep sea sediments after a long time. While hydrates deposit accumulates with time, it also breaks off from the sediments from time to time. Since the density of MH is slightly smaller than average seawater, the MH ascends slowly from deep sea into upper part of ocean. But, HSH is slightly denser than the warm seawater in the upper part of ocean. Over the portion of glacial cycle when insolation is strong, the existence of a residual SH prevents the ascension of hydrates. (H3) Internal forcing – An internal energy converter or a heat generator exists in the oceans. Lai (2007) has found the link between the observed seawater warming at intermediate depth (400 – 750 m) (Barnett et al. 2001) and the dissociation of floating microscopic MH and subsequent methane oxidation via bacteria. We postulate that the cooling of deep seawater when the insolation is weak leads to more hydrates ascending through seawater to the level for dissociation (which is a process depending on seawater temperature and pressure). The oxidation of CH_4 and H_2S after hydrate-dissociation is a multi-step process/phenomenon that we refer to as ocean slow-burn (OSB). It generates the maximum heat per mole of atom-C among all carbon-containing compounds, including sugars. Through oxidation, the CETP is now released as heat that is transferred via biomass, eventually being deposited into the seawater. Since the heat generated in the OSB is greater than that required to dissociate hydrates, they become self-sustained and run-away as long as all players (MH, bacteria, and methane ice worms (Fisher et al. 2000)) are present. So, the glacial termination is a process to release the stored CETP instead of trapping more insolation energy.
(H4) Having accumulated enough energy sources, the OGT will happen when the joint effect of the three parameters triggers the discharge of the HCs. The trigger is an abrupt reduction in insolation over the Southern Oceans, especially South Atlantic under which lies the active Mid-Atlantic Ridge.

The three rules were found through following steps: (1) finding a wide time-window (WTW) within which the energy (stored in hydrates) required to sustain a GT can be accumulated. (2) Then, we find a narrow time-window (NTW) (within that WTW) when the HC is abruptly cooled down due to a quick reduction in insolation. That NTW shall be the ideal time for the OGT.

The variation of eccentricity is the factor controlling the annual global integral of insolation (AGII). The bigger the eccentricity the greater the AGII is. The greater the AGII the more the global CETP capture is. Presume that eccentricity varies like a sinusoidal function of time with a single period of 95 Ky. Then, the CETP being stored into the HCs varies in the same cycle, too. On the other hand, the hydrates are being consumed by OSB process at a rate, (namely r(OSB)), that is not directly controlled by the eccentricity. Assume that during the glacial period r(OSB) is significant but smaller than the accumulation rate of CETP (namely, r(CETP)). This leads us to think that during the phase -90o to 90o (valley to peak) half cycle is a better WTW to accumulate hydrates than the 90o to 270o (peak to valley) half cycle. This is Rule 1.

The NTW is regulated by Rules 2 and 3. Rule 2 is that the obliquity must be increasing. Rule 3 is that precession must be near 180o phase angle. The reasons for these two rules will be explained. The NTW will be shown to match every OGT appeared in last one million years.