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The Late-Quaternary ice-age cycle: Milankovic plus!

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Several characteristics of the quasi-cyclic variation of northern hemisphere continental ice-cover through the Late Quaternary remain enigmatic, even though it is widely understood that orbital forcing has provided the primary metronome. A series of new calculations of the primary, orbitally forced, relaxation oscillation will be described that re-inforce previous conclusions concerning the primacy of this forcing mechanism. Embedded within the individual expressions of this 100 kyr oscillation during the most recent 900,000 years of Earth history, however, are higher frequency millennium timescale variations consisting of Dansgaard-Oeschger oscillations and episodic Heinrich events that appear to be deeply connected to a combination of forced and free oscillations in the strength of the North Atlantic thermohaline circulation. Among the latter, the Younger-Dryas event is of particular importance as its mechanism is more accessible to direct investigation than are those associated with the earlier Bond Cycle related variations that were characteristic of Marine Oxygen Isotope Stage 3 (MOIS 3). Recent detailed analyses of the mechanism that was apparently responsible for the Younger-Dryas event will be discussed. These have relied upon a combination of detailed calculations of freshwater runoff from the continents during deglaciation, together with complete coupled atmosphere-ocean simulations of the response of the THC to the implied freshwater inputs to the oceans.