atmospheric processes, such as greenhouse gas forcing, and deep ocean circulation? Prospects of making the long-awaited connection between the ice-core records and the records from deep-sea sediments came much closer when the new high-resolution data on $\delta^{18}O$(air) from Summit and Vostok were shown to correlate closely both with the $\delta^{18}O$ deep-sea record and with the summer insolation at 65° N through the past 100 kyr (Malaize and Bender).

For ice over 110 kyr old, the new bipolar data for the gases, together with more evidence from joint detailed comparisons of the structural properties of the cores, now make an overwhelming case that both cores have suffered stratigraphic disturbance. Therefore, what had appeared to be sudden cold events in the Eemian seen in the GRIP core[2] are most probably artefacts caused by flow disturbances. It had been thought that these unexpected features might indicate that the relative stability of our climate over the past several thousand years is abnormal, even for warm parts of the glacial cycle. The rather worrying implications prompted a search of other high-resolution records of this important distant analogue of modern climate, but produced no persuasive corroboration.

Participants were left with grounds for optimism that by using a fingerprint based on these two constituents it should prove possible at least to identify and characterize the genuine Eemian ice in the Greenland ice, with some prospect ultimately of reconstructing an ordered sequence. The latest physical modelling (E. D. Waddington, Univ. Washington), which is benefiting from higher-resolution radar soundings of the layering deep in the ice sheet (H. Miller, Alfred-Wegener Inst.), is starting to identify some of the factors that may have disturbed the ice much further away from bedrock than hitherto encountered. It is possible, for instance, that the lateral migration of the ice divide in central Greenland during the last glacial–interglacial cycle was greater than we had thought. And substantial rheological differences have been discovered between glacial and interglacial ice that could promote folding or boudinage (D. Dahl-Jensen, Univ. Copenhagen).

Part of the meeting was devoted to a re-examination of some of the fundamentals of ice-core science. There has been a recent upsurge in debate on one of the primary climate proxies, the stable isotope content of the ice, and especially on the respective roles of local temperature or changing origin of precipitation in shaping these records[5]. To infer temperature shifts, it has been broadly assumed that present-day relationships between δD or $\delta^{18}O$(air) and local temperature in different regions are valid also for interpreting temporal changes. Although model comparisons indicate that the relationship may also be valid under glacial conditions (J. Jouzel, LGGE, Grenoble), we know that the Greenland climate and atmospheric circulation are sensitive to shifts in the position and strength of the polar frontal system, so considerable effort has been put into independent validation of the stable isotope thermometer for Summit.

Present-day profiles of temperature through the ice sheet, which have been measured extremely precisely down both boreholes, are the relics of former temperature fluctuations at the surface which have propagated into the ice sheet by diffusive heat flow and by ice flow. Working independently, two teams[6,7] have assumed that the surface temperature history is described by the isotope profile but that the calibration is not known, nor necessarily linear. In an iterative procedure, they have then used an adjustable calibration factor to generate a surface temperature history which forces time-dependent, linked heat and ice-flow models until a best fit is achieved. An independent inverse solution for one of the boreholes has also been calculated (Dahl-Jensen).

The three approaches have independently resulted in very close matches with the measured borehole profiles, confirming $\delta^{18}O$ as a reliable proxy for profiling at least the long-term average temperatures at Summit. They do indicate, however, that the calibration is time-dependent, with a considerably smaller gradient of isotope change with temperature in glacial times than today. A striking conclusion is that glacial to interglacial temperature changes were much larger than has previously been concluded from either ice cores or models. Climate in this region may be more sensitive than previously thought, reinforcing the evidence that changes in global temperatures may be amplified in the polar regions. Researchers engaged in predicting future sea level or modelling climate feedbacks arising from changes in polar albedo should take note. □

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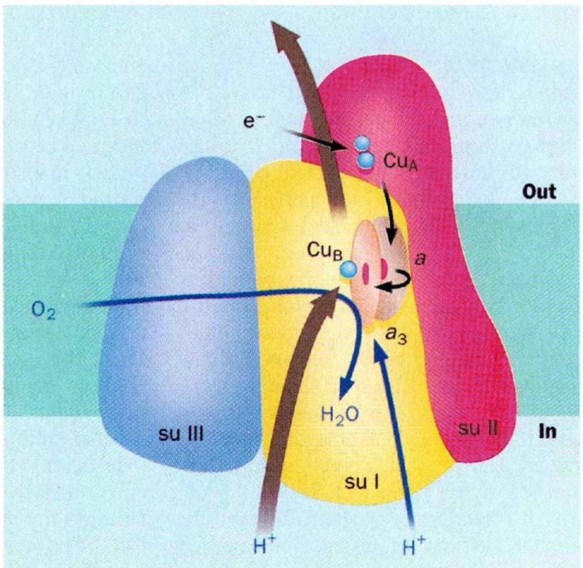
Correction

In R. J. P. Williams's News and Views article of 24 August[1], which discussed the structure of cytochrome oxidase and associated details of proton and electron transfer, the incorrect impression was given that the accompanying diagram was based on the crystal structure data of Michel and co-workers[2] (the main paper under discussion). The diagram was in fact based on earlier work[3,4] (see also refs 5,6). The figure shown here, kindly provided by Professor Michel, shows the appropriate picture from X-ray crystallography that will be the basis for future analysis of proton–electron coupling in cytochrome oxidase. The positions of prosthetic groups are different but much of the beta sheet and helical components are similar; as yet the indicated proton paths, especially for pumping, remain possibilities. The three subunits are labelled su I–III, and the haem groups *a* and a_3. In and out refer to the mitochondrial matrix and intramembranous space respectively. Electron paths are as discussed in detail in ref. 2.



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