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A chemical pacemaker to refine chronology for the deep East Antarctic ice cores

J.R. Petit (1), B. Delmonte (2), B. Lemieux-Dudon (1), and F. Parrenin (1)

(1) LGGE, CNRS Université J Fourier Grenoble, 38402 St Martin d'Hères, France (petit@lgge.obs.ujf-grenoble.fr), (2) University Milano–Bicocca, Piazza della Scienza, 20126 Milano, Italy

A current dating approach of ice core records of the deep East Antarctic ice cores relies on ice flow modelling (thinning function of ice layer) as well as on the estimate of the snow accumulation rate. By the use of inverse method, the modelled ice chronology is generally constrained by few dated horizons (volcanic, 10Be peaks from solar or from magnetic inversion related events...) and/or by orbital tuning process (temperature proxy, 18O of air bubbles...). In absence of absolute dating the orbital tuning from new data or proxies is attractive and may serve as a test of the modelled ice age. In this respect a proxy showing orbital frequencies is adequate if: i) it was not already used to constrain the modelled chronology, ii) it reflects properties of the ice rather than properties of the gas (to prevent gas-age/ice age uncertainties), iii) its physical link with insolation must be rather direct, iv) the precession band (20kyr) which supplies more tie points than the obliquity band (41kyr) should dominate.

The continental dust and marine sodium records were so far not used to constrain the modelled chronology. The dust and marine sodium appear firstly correlated to patterns of temperature and therefore to the hydrologic cycle which influences at the same time the source emissions (for dust), the atmospheric cleansing and the deposition onto the ice sheet. Once the overall temperature effects is compensate by best fit functions, the residual signal for dust and sodium concentrations over the last 400 ky from Epica Dome C and Vostok records display strong precession oscillations for both sites. Interestingly, the sodium residuals appear to increase with austral summer insolation while the dust residuals decrease remaining out of phase. Such behaviour could be understood by a positive effect of insolation on sodium emission (strengthening of spring cyclonic activity...) and negative effect on dust sources (reduction of Patagonian dust emission by strengthening of Southern American monsoon...). This dual behaviour which need to be determined, allows combination of sodium and dust residuals providing a "chemical pacemaker" dominated by precession which could be used to refine the modelled chronology. A test was done on the EDC3 modelled age of the Epica Dome C deep ice core which covers the last 800ky.