Age Models Working Group

Age-depth models are vital for many NEOTOMA-based studies, especially when multiple proxy archives need to be compared. Dates can be relative (e.g., a pollen-stratigraphic marker) or absolute (e.g., radiocarbon dates). Most cores in the NEOTOMA database will contain only a handful of dates. From this limited amount of information, the ages of the dated and undated depths of a fossil proxy sequence are estimated. This is done by drawing curves through the dated points (e.g., see Blaauw 2010). It is important for the users to be aware that all dates and all age-depth models possess a degree of uncertainty.

Blaauw, M., 2010. Methods and code for 'classical' age-modelling of radiocarbon sequences. Quaternary Geochronology 5: 512-518

Contact(s): Maarten Blaauw

Participants at the September 2010 meeting:

- Maarten Blaauw
- Mihaela Enache
- Thomas Giesecke
- Richard Telford
- Debra Willard

Data Priorities:

Calibration of ^{14}C dates

It is vital to work in the calendar time scale, in order to facilitate comparisons between archives. The use of a table with C14 and calBP ages to “calibrate” interpolated C14 ages is suboptimal, because the relation between C14 age and calendar age is far from linear. What should be done is calibrate ^{14}C dates and draw age-depth models through the calendar age distributions. This can be done in available software such as OxCal (http://c14.arch.ox.ac.uk/oxcal.html), clam (doi:10.1016/j.quageo.2010.01.002), or Bacon (http://chrono.qub.ac.uk/blaauw/bacon.html). The latter two software packages can be ran in batch mode and could thus prove especially useful for producing age-models for large numbers of sites.

Include chronological uncertainties

Currently in for example Tilia, age-models are reported without any indication of chronological uncertainties. Lately much emphasis has been placed by the age-modelling community on estimating chronological uncertainties and including these in any following interpretation of the timing of proxy events. As a first feasible solution, an extra field should be included in Tilia/Neotoma which reports the (95%?) confidence ranges of age-depth models, as estimated by algorithms such as clam, Bacon, mixed-effect modelling or OxCal. Clam seems to be working well for many EPD sites and is recommended as interim age-modelling routine until more advanced (Bayesian) routines have “come of age” (this might not be too far away).
However, much better would be to include the entire estimated calendar age histogram (also known as posterior distribution function, pdf) for each proxy depth. Files can be produced for

each proxy depth with calendar ages (cal BP / BC/AD) and their probabilities, and it would be great if they could be uploaded to the database. From these files, confidence ranges can be calculated, and more informative age estimates provided for any proxy event in cores. For example, grey-scale graphs of proxies can be produced. Several chronologies can be provided in Neotoma, with one default (e.g. the one provided by the authors if this seems free of obvious errors).

Inclusion of additional fields
The inclusion of a few additional fields for C14 dates could help with deciding on for example outlying dates or possible systematic age offsets. Additional information on the reliability of C14 dates includes %C (percentage radiocarbon; e.g., low percentages for charcoal might indicate contamination) and mgC (low weights such as < 1mg result in less reliable dates). Systematic age offsets for marine dates (e.g., from terrestrial organisms with a partly marine diet) would require the following fields: %marine (percentage of marine C14 in diet) and deltaR (incl. errors; obtainable from databases such as http://calib.qub.ac.uk/marine/)

Star system
Besides quantitative estimates of a model's chronological uncertainties, there are also error sources that are much harder to quantify. For example, the depths of a site/section which has accumulated linearly over a long time might be more reliable than those depths in a section with variable (reconstructed) accumulation rate. Also, the further away from dating information a depth is, the less reliable it should be. Finally, any age reversals between dates cause uncertainties about the correctness of age-depth modelled ages for depths close to such reversals. The EPD age-model group has devised a qualitative star system where depths are awarded stars when none of the above problems occur, while depths with such problems receive fewer stars. The algorithm is working but more work is needed to test and update it.

Multiple sources of dates
C14 dates are obviously not the only source of dating information for sites in Neotoma. Other dating information that can easily be included in age-models include OSL dates, 210Pb dates, tephra markers, and biostratigraphical/relative dating information such as pollen markers (hemlock decline; is this one synchronous event or are there spatial timing differences or even multiple declines?). All such dates should however come with a proper estimate of their dating uncertainties, and there is a danger of circular reasoning if pollen events are used as dating information and later used to infer the ages of the same pollen events! In fact, the working group thinks that chronological uncertainties of relative dates are much larger than estimated by many palynologists.

Workshop
There are plans to organise a Neotoma age-model workshop in Northern Ireland, in 2011 or 2012. This workshop would discuss current age-modelling approached in Neotoma and ways forward. It would also include hands-on sessions where participants learn about common problems and solutions for C14 calibration and age-depth models.