# Harmonization of database chronologies

Sanchez Goñi, M.F.[1], S. Desprat[1], A.-L. Daniau[2], F. Bassinot[3], M. Blaauw[4], S. P. Harrison[5,6] and ACER members*

[1] Ecole Pratique des Hautes Etudes, UMR CNRS 5805 EPOC, University of Bordeaux, 33615 Pessac, France
[2] UMR CNRS 5805 EPOC, University of Bordeaux, 33615 Pessac, France
[3] CEA, LSCE UMR CNRS 8212, Gif-sur-Yvette, France
[4] School of Geography, Archaeology and Palaeoecology, Queen's University Belfast, U.K.
[5] Department of Biological Sciences, Macquarie University, Sydney, North Ryde, NSW 2109, Australia
[6] Centre for Past Climate Change and School of Archaeology, Geography and Environmental Sciences (SAGES), University of Reading, Whiteknights, RG6 6AH, Reading, UK
ACER members http://www.ephe-paleoclimat.com/acer/Home%20acer.htm

## 1. Introduction

In 2010 a special issue on "Vegetation response to Millennial-scale variability during the Last Glacial" was published in Quaternary Science Reviews (volume 29) in the framework of the QUEST-DESIRE (UK-France) bilateral program. This special issue compiled a series of papers dealing with the regional/continental vegetation response to Dansgaard-Oeschger (D-O) cycles as documented by terrestrial and marine pollen records at a global scale. We applied the biomization technique to these worldwide pollen records to obtain a global picture of biome responses to the rapid climate changes that punctuated the last glacial period. The first results from this attempt evidenced several incongruences between individual age models that hindered the biomization analysis. A reappraisal of each of these age models and the development of a common chronology are necessary to produce accurate and reliable maps of biome changes. Here we present the methodology we used for harmonizing the chronology of almost 100 marine and terrestrial pollen sequences distributed around the world (Fig. 1). The same strategy is being applied for the global Sea Surface Temperatures records (*see poster by Bassinot et al., this session*)

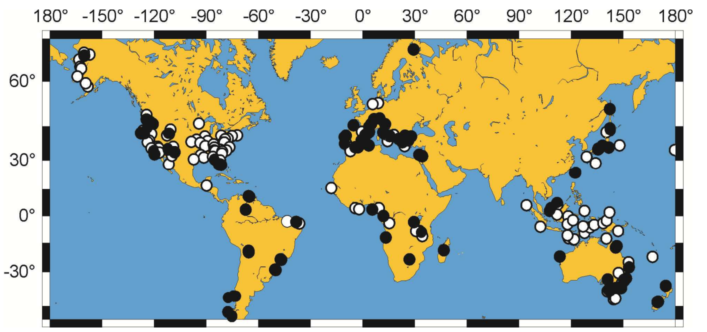


**Figure 1** – Map with location of marine and terrestrial pollen sites covering part or all the last glacial (MIS 4, 3 and 2). Sites with better resolution than 1 sample per 1000 years are shown as black circles[1].

## 2. Methodology

**-** As a first step we used **CLAM software**[2] and priviledged **linear interpolation**. The ultimate goal, in progress, is to applied a Bayesian approach (BACON software)[3]

- **IntCal13 and Marine 13 calibration curves were used for terrestrial and marine samples, respectively**[4]. These calibration curves incorporate the new chronology of Lake Suigetsu based on varve-counting and modeled varve deposition for no-varved sections assessed with the Hulu Cave speleothem chronology.

-For marine samples we calculated the reservoir age using the **Marine Reservoir Correction Database**. We selected the closest 1 to 20 sites with a similar distance to the study site. Temporal variations of ΔR are not to be taken into account since they are not well established yet for many locations and can change in the future from modern understanding.

## 3. Major guidelines

- **$^{14}C$ ages were used** when available. If the error (uncertainty) of the $^{14}C$ date was not provided, the level of uncertainty was estimated using surrounding dates. The data input was the mid-point of depth (if applicable)
- When there was no radiometric dating we applied an age model **based on "event stratigraphy"**. The ages of Marine Isotopic Stages (MIS) boundaries were based on the stratigraphy of core MD95-2042. The similarity of the planktonic foraminifera $\delta^{18}O$ from MD95-2042 and the Dansgaard-Oeschger (D-O) cycles allowed the identification of D-O cycles in the marine realm[5], which were directly compared with the pollen percentage curves giving an age to the latter. However, no age was provided for D-O 15 and D-O 16.
- **Non-radiocarbon dates** have to be presented in the same **BP** notation as for radiocarbon determinations and **refers to 1950 AD**.
- For marine records, we did not assume that the top of cores represent the year of collection of the core
- We avoided event stratigraphy for the Tropics for periods younger than 50 ka BP.

**Table 1** – Control points used for age models when $^{14}C$ ages were not available

| Event stratigraphy | | GICC05 (age b. 1950) | Tephra layers | ACER chronology | Uncertainties |
|---|---|---|---|---|---|
| MIS | Shackleton et al., 2000 ; 2004 Svensson et al., 2006; 2008 ; Sanchez Goñi, 2007, 2013 | Wolff et al., 2010 Sanchez Goñi et al., 2013 | Smith et al., 2013 ; Magri & Sadori, 1999 Deino et al., 2004 | | Wolff et al., 2010; Bazin et al., 2013 (*uncertainty of the closest age in AICC_2012*); Smith et al., 2013 |
| MIS 1/2 | D-O 1 | 14.60 ka | | 14.6 ka | 93 yrs |
| | | | NYT | 14.9 ka | 40 yrs |
| LGM | | | | 21 ka | 315 yrs |
| | | | BW1021 AT | 25.12 ka | 270 yrs |
| MIS 2/3 | D-O 3 | 27.73 ka | | 27.73 ka | 416 yrs |
| | | | AT | 30.01 ka | 189 yrs |
| | D-O 7 | 35.43 ka | | | 661 yrs |
| | D-O 8 | 38.17 ka | | | 725 yrs |
| | D-O 10 | 41.41 ka | | | 817 yrs |
| | D-O 11 | 43.29 ka | | | 868 yrs |
| | D-O 12 | 46.81 ka | | | 956 yrs |
| | D-O 14 | 54.17 ka | | | 1150 yrs |
| MIS 3/4 | D-O 17 | 59.39 ka | | 59.39 ka | 1287 yrs |
| | Onset HS 6 | 64.60 ka | | | 1293 yrs |
| | D-O 18 | 64.04 ka | | | *1500 yrs* |
| MIS 4/5 | D-O 19 (onset Ognon II) | 72.28 ka | | 72.28 ka | *1478 yrs* |
| | D-O 20 (onset Ognon I) | 76.40 ka | | 76.4 ka | *1449 yrs* |
| | C 20 (stadial I) | 77.00 ka | | 77 ka | *1476 yrs* |
| MIS 5b/5a | D-O 21 (onset St Germain II) | 82.90 ka | | | *1500 yrs* |
| | C 21 | 85.00 ka | | 85 ka | *1448 yrs* |
| | | | Vico | 87 ka | 7000 yrs |
| | | | Aso-4 | 87.05 | 250 yrs |
| | | | K-Tz | 95 ka | 1665 yrs |

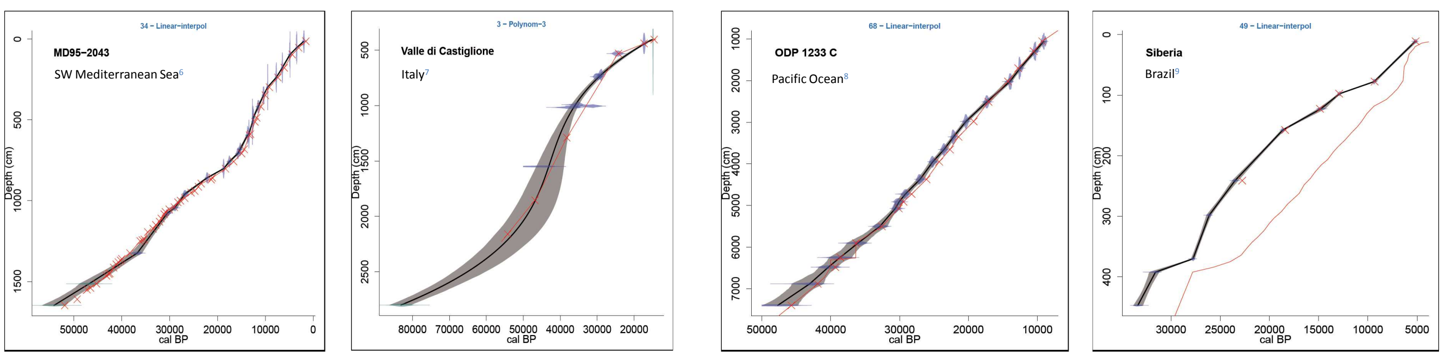


**Figure 2** - Red line and crosses: previous age model – Black line: new age model – Blue: calibrated $^{14}C$ age distribution – Green: non-$^{14}C$ age distribution (OSL, tephra, event stratigraphy)

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