Comparison of Dating Results achieved using Different Radiocarbon-Age Calibration Curves and Data

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Third Update	19. May 2007	Update to CalPal-Hulu.

The **primary focus** of the following study is to simultaneously evaluate (***test)*** the influence of the **shape** of the selected **calibration curve** on the calibrated output ages, as well as the **proper functioning** of **numeric algorithms**, over an **extended time-scale.** A **secondary focus** of this study is to evaluate the variability of calibrated ^{14}C-ages, as they may appear when using different **calibration curves** (selectable in **CalPal**) and - here for the first time since 14 years - also using different **calibration software** (see below: **Fairbanks0805-OnLine-Version_Sep05, OxCal 3.1-download-version_Sep05, Calib 5.0-download-version_Sep05,** and **WinCal25 1.0-download_version_Sep05**).

The approach here is to apply **purely hypothetical standard errors** ± 1 ^{14}C-BP to the input ^{14}C-ages, in a **hypothetical age-window** 100 to max 52 ka ^{14}C-yrs (the maximum allowed radiocarbon input age varies according to software). By this measure we are undertaking efforts to evaluate the calibrated software under **extreme conditions** (i.e. we aim at testing - at least to a certain extent - the stability of the calibration algorithms). The overall aim of the study is to enhance any existing differences in the results of the software, calibration curves, numeric algorithms, rounding procedures, input/output procedures etc of the "candidates" under study (cf. Table below). The method is to produce - we hope - at least to a certain extent **maximised** (***worst-case***) calendric-scale errors - under as simple as possible input conditions. There may exist better test-approaches, but the following will suffice as a starting point for further studies. There is another point to be made: in the real world (e.g. in archaeological studies), we might expect that the numeric output (cal-scale) dating errors will always turn out larger than the input (^{14}C-scale) errors. This is invariably true, but there are exceptions (and these turn up quite clearly in the following table) namely that there exist cases, when the calendric output age has a smaller error than the radiocarbon input age. This may appear unnatural, but is to be expected, namely when the calibration curve has a slope > 45° and few (at least very closely spaced) reentry wiggles, over an extended time-window. Altogether the intention of the test is to evaluate the overall variability of calibrated ^{14}C-ages, that ***may*** turn up e.g. when using different age-calibration data sets, different derived calibration curves, as well as different calibration software (i.e. mathematical approaches). Although difficult to quantify - due to the variety and complexity of the variables under study - the sensitivity of the test is estimated to be in the (max) range of a few decades.

CONCLUSIONS (5. May 2007)

1. There are no discernible differences in the calendric ouput-ages (in the range of a few decades) between the test candidates (calibration programs & data sets) in the age range 0 to 11 ka ^{14}C-BP.
2. For input radiocarbon ages between 12 and 14 ka ^{14}C-BP all CalPal calibration curves give calendric ages c. 500-600 yrs older than INTCAL and Fairbanks 0508. This is due to the inclusion of the Cariaco-Hulu data set in Calcurve construction. In this age interval the alternative calcurves (INTCAL04, Fairbanks0805) are data-free extrapolations.
3. For input calibration ages between 15 and 16 ka ^{14}C-BP the calibration program WinCal25 gives output calendric ages that differ c. 300 yrs from the other candidates.
4. For input calibration ages between 17 and 19 ka ^{14}C-BP the calibration data set CalPal-2007-Hulu gives output calendric ages that differ by c. 300-400 yrs from other candidates. This is apparently (in part) due to the shape of the calibration spline (in the case of identical calibration data), and (in part) due to the choice of different calibration data.
5. For input calibration ages between 19 and 21 ka ^{14}C-BP the calibration program WinCal25 gives output calendric ages that differ by c. 300 yrs from all other candidates.
6. For input calibration ages c. 20 ka ^{14}C-BP the calibration program Fairbanks 0805 gives output calendric ages that differ by c. 1000 yrs from the other candidates. This is likely due to a combination of calibration data and chosen shape of the calibration curve.
7. We observe practically identical numeric output (often within single yrs) for the "internationally recommended" programs OxCal 3.1 and Calib 5.0 in the entire age range covered by the INTCAL04 data set (0 to 21 ka ^{14}C-BP). It is curious that the "internationally recommended" calibration program WinCal25 should often, for input > 14 ka ^{14}C-BP, give systematically different (c. 300 calyrs) output ages .
8. We observe practically identical numeric output (within quoted errors) for the software (programs/CalCurves) Fairbanks 0805 and CalPal (all versions) in their common age range i.e. back to 45 ka ^{14}C-BP.
9. For input calibration ages at 52 ka ^{14}C-BP the calibration program CalPal-Online gives output calendric ages that differ by c. 1200 yrs from the download version. This is likely due to a combination of calibration data and chosen shape of the calibration curve, near the cut-off limits of the data table.

^{14}C-Age STD   All Ages = CalAges-AD/BC (negative = calAD, positive = calBC)

Blue= DataSet INTCAL04
Violett= DataSet Fairbanks
Green= DataSet CalPal_SFCP_2005
Black= ComputerProgram using this Dataset

[BP] [BP]	INTCAL04 CalPal	CALPAL_SFCP 2005 CalPal	CalPal_HULU 2007 CalPal	CalPal_Hulu CalPal ONLINE	Fairbanks Online0805 (1)	INTCAL04 OxCal 3.1 (2)	INTCAL04 Calib 5.0 (3)	INTCAL04 WinCal25 (4)
100 ± 1	-1790 ± 90	-1790 ± 90	-1800 ± 90	-1798 ± 90	-1799 ± 79	-1805 ± 115	-1807 ± 108	-1806 ± 106
200 ± 1	-1780 ± 120	-1790 ± 130	-1760 ± 100	-1728 ± 65	-1852 ± 100	-1875 ± 85	-1808 ± 2	-1866 ± 83
300 ± 1	-1570 ± 50	-1560 ± 50	-1560 ± 50	-1582 ± 52	-1579 ± 49	-1585 ± 65	-1585 ± 56	-1585 ± 57
400 ± 1	-1450 ± 20	-1450 ± 20	-1460 ± 30	-1455 ± 5	-1457 ± 4	-1460 ± 10	-1458 ± 7	-1457 ± 3
500 ± 1	-1420 ± 20	-1410 ± 20	-1410 ± 20	-1421 ± 4	-1425 ± 1	-1427 ± 8	-1426 ± 5	-1425 ± 8
600 ± 1	-1340 ± 30	-1330 ± 30	-1340 ± 40	-1350 ± 36	-1341 ± 22	-1355 ± 40	-1354 ± 40	-1356 ± 37
700 ± 1	-1280 ± 20	-1270 ± 20	-1270 ± 20	-1280 ± 2	-1285 ± 0	-1282 ± 8	-1283 ± 3	-1264 ± 5
800 ± 1	-1230 ± 20	-1230 ± 20	-1230 ± 20	-1235 ± 11	-1240 ± 11	-1237 ± 18	-1239 ± 6	-1241 ± 12
900 ± 1	-1100 ± 50	-1090 ± 50	-1100 ± 50	-1107 ± 47	-1123 ± 44	-1110 ± 60	-1108 ± 54	-1110 ± 50
1000 ± 1	-1010 ± 20	-1010 ± 20	-1010 ± 20	-1019 ± 3	-1024 ± 4	-1022 ± 8	-1022 ± 3	-1022 ± 8
2000 ± 1	0 ± 30	10 ± 30	10 ± 20	10 ± 17	2 ± 15	10 ± 30	8 ± 28	- 6 ± 5
3000 ± 1	1250 ± 30	1250 ± 30	1270 ± 20	1249 ± 22	1245 ± 22	1250 ± 40	1252 ± 38	1241 ± 22
4000 ± 1	2520 ± 40	2530 ± 30	2540 ± 30	2526 ± 32	2533 ± 25	2522 ± 43	2525 ± 39	2525 ± 36
5000 ± 1	3770 ± 30	3770 ± 30	3790 ± 20	3781 ± 8	3779 ± 8	3780 ± 15	3780 ± 12	3782 ± 4
6000 ± 1	4880 ± 30	4890 ± 30	4880 ± 30	4887 ± 26	4882 ± 21	4887 ± 42	4887 ± 40	4874 ± 26
7000 ± 1	5890 ± 20	5910 ± 40	5900 ± 30	5896 ± 7	5895 ± 21	5905 ± 65	5908 ± 59	5887 ± 3
8000 ± 1	6940 ± 90	6940 ± 80	6940 ± 80	6950 ± 87	6949 ± 78	6945 ± 105	6943 ± 99	6953 ± 87
9000 ± 1	8250 ± 20	8250 ± 20	8250 ± 20	8253 ± 5	8246 ± 6	8247 ± 15	8247 ± 9	8246 ± 4
10000 ± 1	9530 ± 100	9530 ± 100	9530 ± 100	9532 ± 121	9527 ± 85	9525 ± 125	9530 ± 121	9543 ± 97
11000 ± 1	10980 ± 30	10940 ± 50	10940 ± 60	10960 ± 94	10974 ± 81	10967 ± 23	10966 ± 18	10973 ± 9
12000 ± 1	11920 ± 60	11930 ± 60	11930 ± 60	12021 ± 190	11942 ± 72	11895 ± 45	11896 ± 43	11870 ± 7
13000 ± 1	13400 ± 90	13930 ± 310	13620 ± 40	13904 ± 386	13458 ± 94	13385 ± 135	13389 ± 130	13345 ± 27
14000 ± 1	14750 ± 110	15380 ± 30	15160 ± 30	15295 ± 206	14906 ± 108	14735 ± 195	14740 ± 190	14763 ± 26
15000 ± 1	16370 ± 180	16400 ± 150	16250 ± 230	16302 ± 233	16318 ± 117	16380 ± 200	16383 ± 192	16676 ± 18
16000 ± 1	17240 ± 110	17270 ± 120	17120 ± 70	17194 ± 212	17226 ± 93	17205 ± 85	17208 ± 78	17419 ± 19
17000 ± 1	18180 ± 100	18400 ± 50	18480 ± 50	18322 ± 298	18272 ± 22	18170 ± 90	18172 ± 83	18343 ± 23
18000 ± 1	19350 ± 130	19700 ± 50	19550 ± 40	19763 ± 338	19509 ± 55	19335 ± 165	19339 ± 159	19581 ± 28
19000 ± 1	20550 ± 70	20680 ± 100	20900 ± 80	20916 ± 289	20592 ± 58	20545 ± 65	20544 ± 56	20754 ± 22
20000 ± 1	22010 ± 80	21960 ± 140	21880 ± 70	21975 ± 307	21022 ± 63	22005 ± 105	22008 ± 99	22389 ± 22
21000 ± 1	23330 ± 180	23190 ± 170	22990 ± 50	23188 ± 352	23250 ± 46	23340 ± 220	23339 ± 213	23717 ± 20
22000 ± 1	24700 ± 90	24640 ± 340	24450 ± 190	24459 ± 318	24509 ± 66			
23000 ± 1	25700 ± 90	25880 ± 160	25970 ± 70	25635 ± 427	25565 ± 84			
24000 ± 1		26930 ± 260	26890 ± 280	26881 ± 369	26620 ± 83			
25000 ± 1		28080 ± 180	27950 ± 80	28038 ± 241	28041 ± 300			
26000 ± 1		28870 ± 130	28970 ± 250	29012 ± 324	29171 ± 64			
27000 ± 1		29340 ± 60	29820 ± 80	29823 ± 116	29974 ± 71			
28000 ± 1		30430 ± 490	30500 ± 210	30518 ± 270	30778 ± 80			
29000 ± 1		32300 ± 340	31550 ± 260	31565 ± 295	32111 ± 353			
30000 ± 1		33380 ± 190	32340 ± 140	32337 ± 132	33138 ± 61			
31000 ± 1		34190 ± 230	33060 ± 270	33088 ± 320	33942 ± 121			
32000 ± 1		34960 ± 200	33910 ± 250	34065 ± 228	34925 ± 53			
33000 ± 1		36220 ± 670	35330 ± 720	35555 ± 592	36161 ± 477			
34000 ± 1		38250 ± 850	37600 ± 970	37661 ± 940	37210 ± 76			
35000 ± 1		38760 ± 780	38200 ± 840	38135 ± 815	38687 ± 201			
36000 ± 1		39860 ± 200	39440 ± 270	39406 ± 223	39422 ± 74			
37000 ± 1		40230 ± 210	39950 ± 300	39904 ± 290	40010 ± 76			
38000 ± 1		40740 ± 300	40450 ± 320	40475 ± 306	40597 ± 83			
39000 ± 1		41390 ± 480	41010 ± 390	41306 ± 555	41402 ± 302			
40000 ± 1		41930 ± 430	41640 ± 460	41788 ± 574	42412 ± 62			
41000 ± 1		42680 ± 420	42350 ± 560	42603 ± 657	42802 ± 92			
42000 ± 1		43410 ± 590	43160 ± 710	43431 ± 729	43725 ± 176			
43000 ± 1		44210 ± 710	44030 ± 750	44682 ±1515	44596 ± 146			
44000 ± 1		45260 ± 960	45090 ± 960	45488 ±1519	45438 ± 237			
45000 ± 1		46170 ± 950	46150 ± 1080	46296 ±1524	46910 ± 482			
46000 ± 1		47080 ±1020	47170 ± 1130	47298 ±1732				
47000 ± 1		48500 ±1130	48390 ± 1400	48626 ±1798				
49000 ± 1		50560 ±1380	49700 ± 1540	49936 ±1726				
50000 ± 1		51330 ±1420	50900 ± 1810	51085 ±1872				
51000 ± 1		52360 ±1480	52060 ± 1900	52476 ±2145				
52000 ± 1		54500 ±2120	53280 ± 2040	49936 ±1726				

Methods:

Red = observable (possible) discrepancies
Green = OK (within - often large - errors)
Blue = maybe too small errors

(1) Fairbanks0805 On-Line PrograSep. 2005
(2) OxCal 3.1 Download ProgrSep 2005, using central value of 68.2% probability range.
(3) Calib 5.0 Download ProgrSep 2005, using central value of 68.2% probability range.
(4) WinCal25 1.0 Download ProgrSep 2005, using central value of 68.2% probability range, smallest error.