CULTIVATING SOCIETIES

ASSESSING THE EVIDENCE FOR AGRICULTURE IN NEOLITHIC IRELAND

Calibrating Dates

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Two faces of radiocarbon dating

Radiocarbon (^{14}C) dating presents us with two personalities;

The ^{14}C date

e.g. 5100 ± 65 ^{14}C BP

The calibrated range

e.g. 4040 - 3713 BC

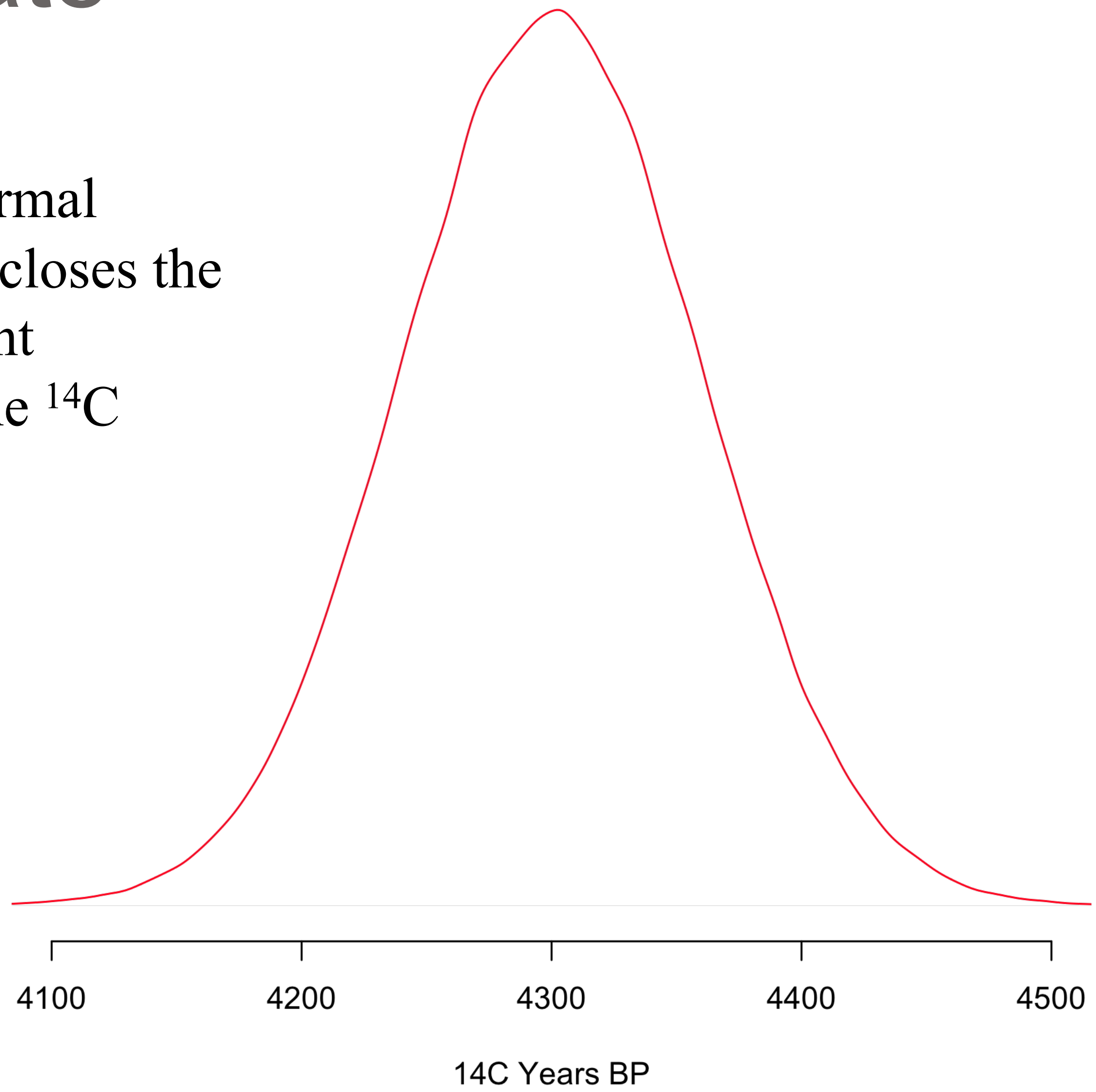
The ^{14}C date

A ^{14}C date is derived from the measurement of radiocarbon in a sample submitted to a laboratory, from which a date is calculated.

Although measurement of a date does involve uncertainty, it is has a mathematically pleasant form

The ^{14}C date

The measurement process essentially gives a nice normal distribution. This curve encloses the uncertainty of measurement involved in determining the ^{14}C date.



The ^{14}C date

Normal distributions can be split equally down the middle (the average).

Thus the uncertainty is the same on either side of this line.

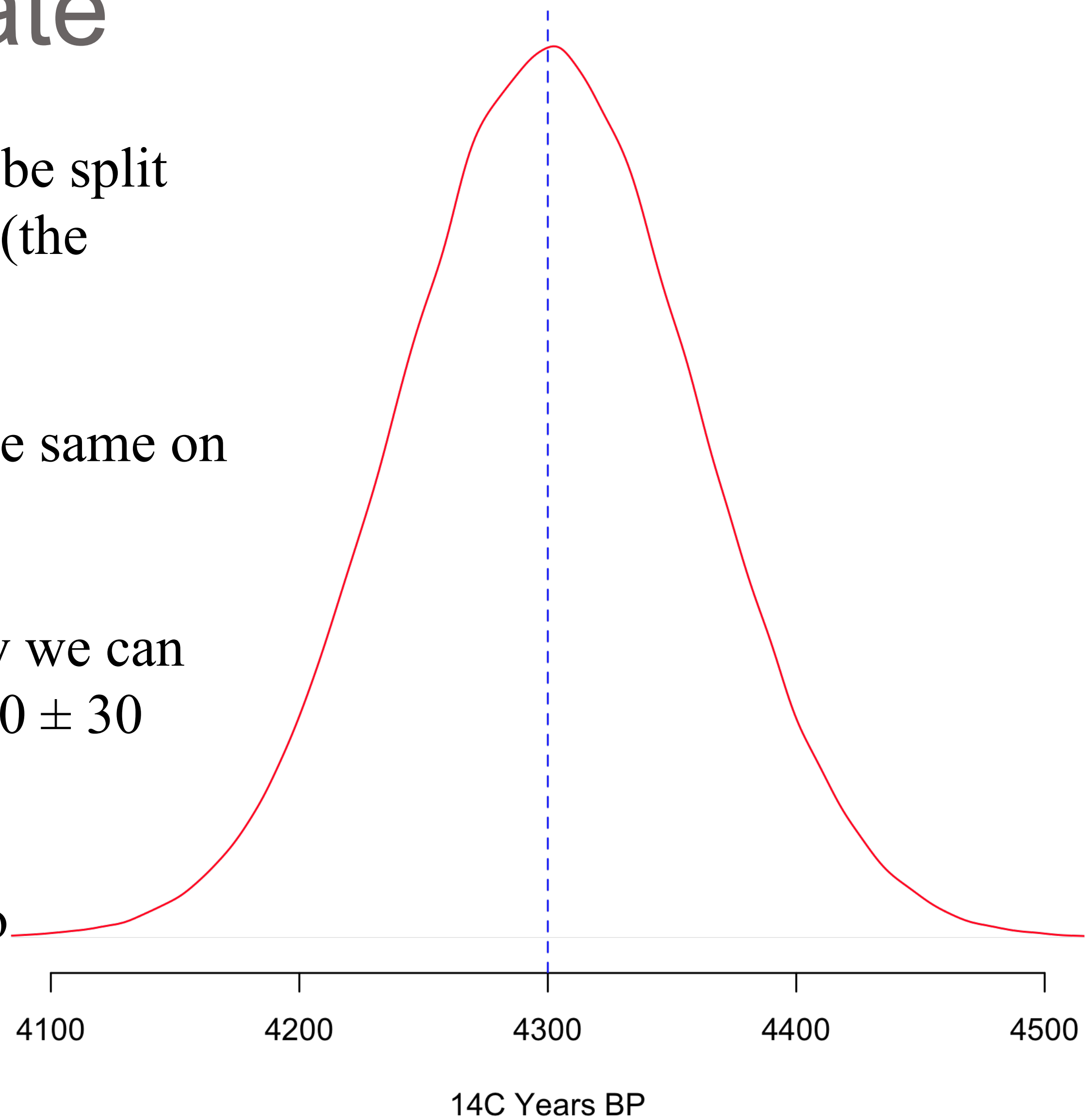
Because of this symmetry we can make statements like 4300 ± 30

i.e.

4300 - 4330

is equivalent to

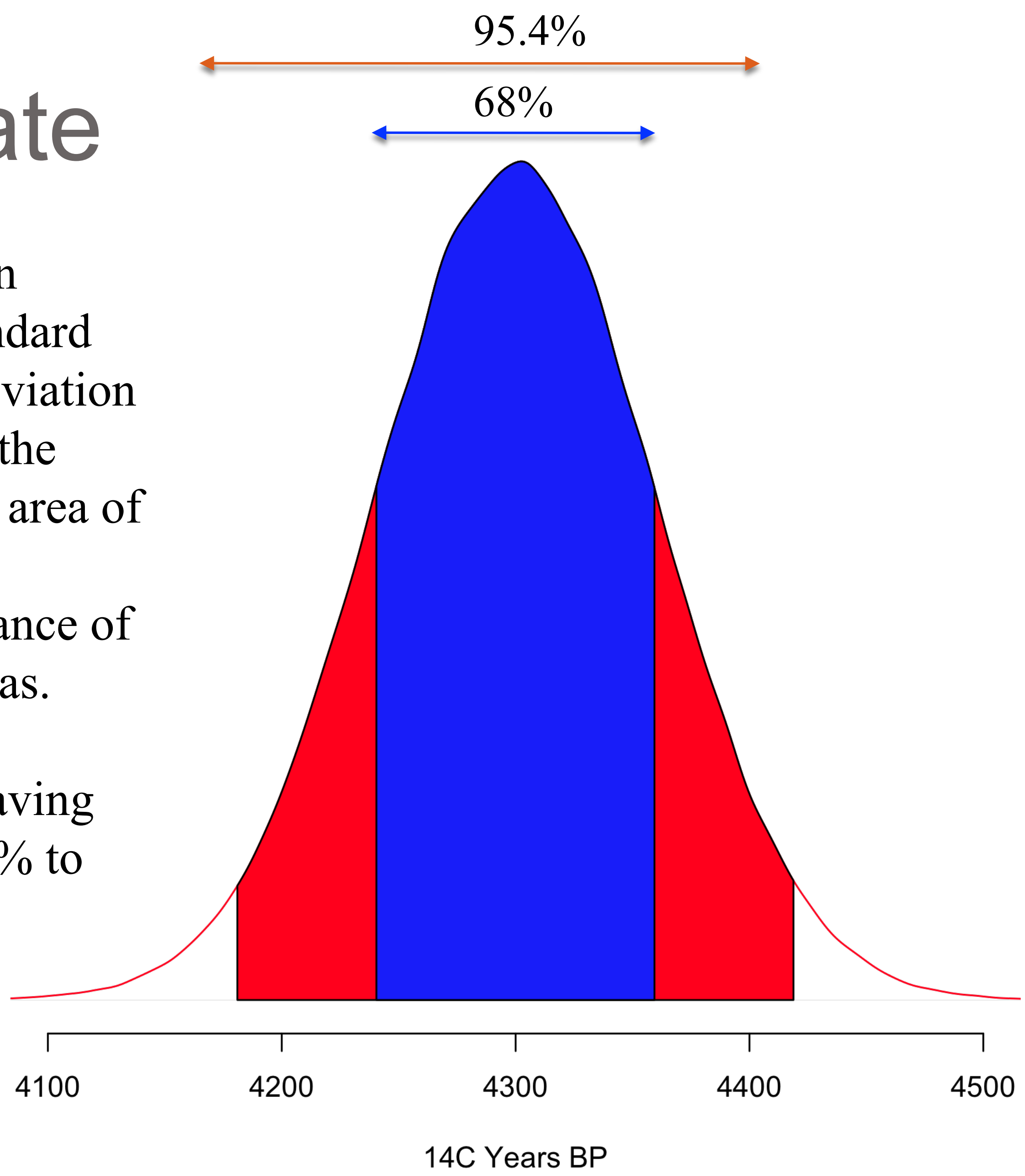
4270 - 4300



The ^{14}C date

A measure of the uncertainty in normal distributions is the standard deviation, where 1 standard deviation means there is 68% chance of the correct value being in the blue area of the curve, and at 2 standard deviations there is a 95.4% chance of it being in the red and blue areas.

Notice that as our chance of having the correct value increases, 68% to 95%, the precision of the date decreases.



Calibrating

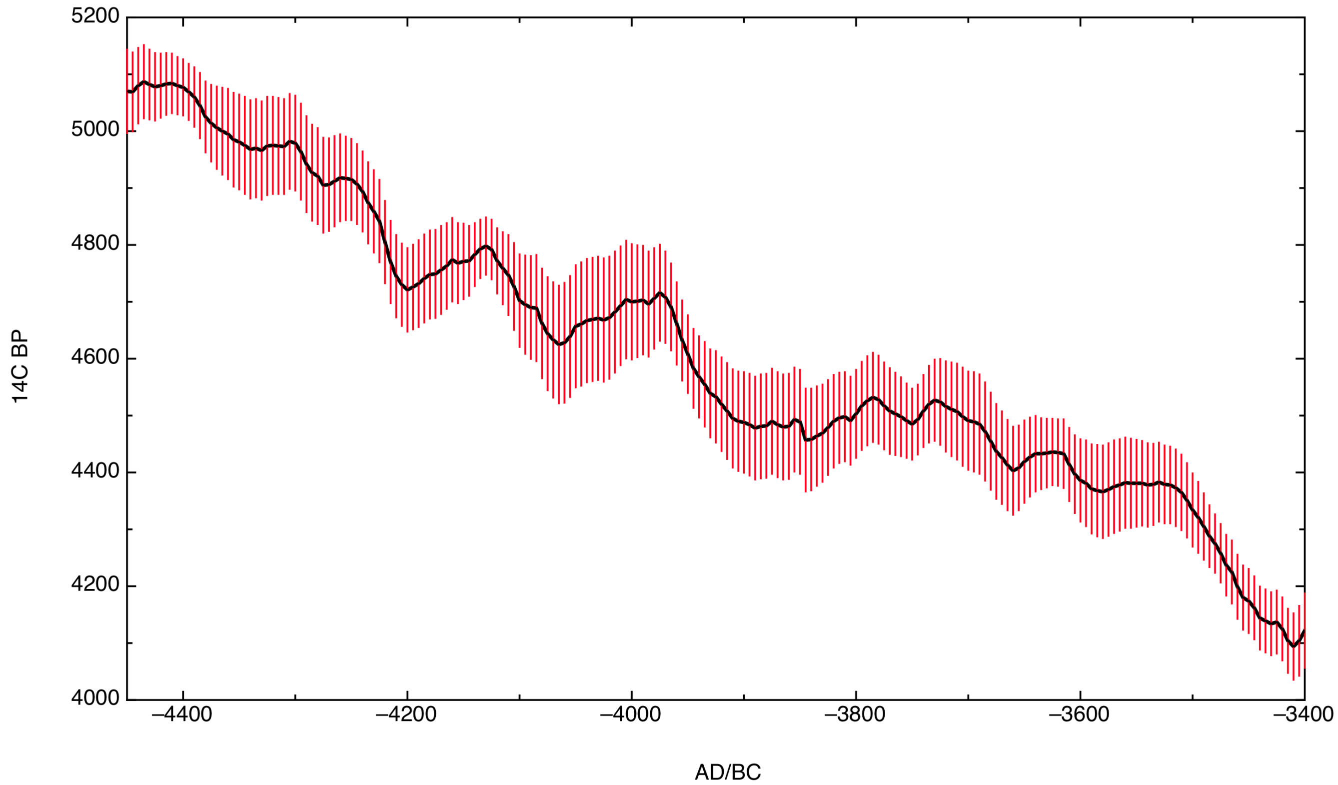
Calibration is necessary because of past variations in the amount of ^{14}C. A radiocarbon date is not a calendar date.

To convert to calendar dates we need something to calibrate the ^{14}C dates against – a calibration curve.

A calibration curve is created by radiocarbon dating something of known calendar age such as tree rings.

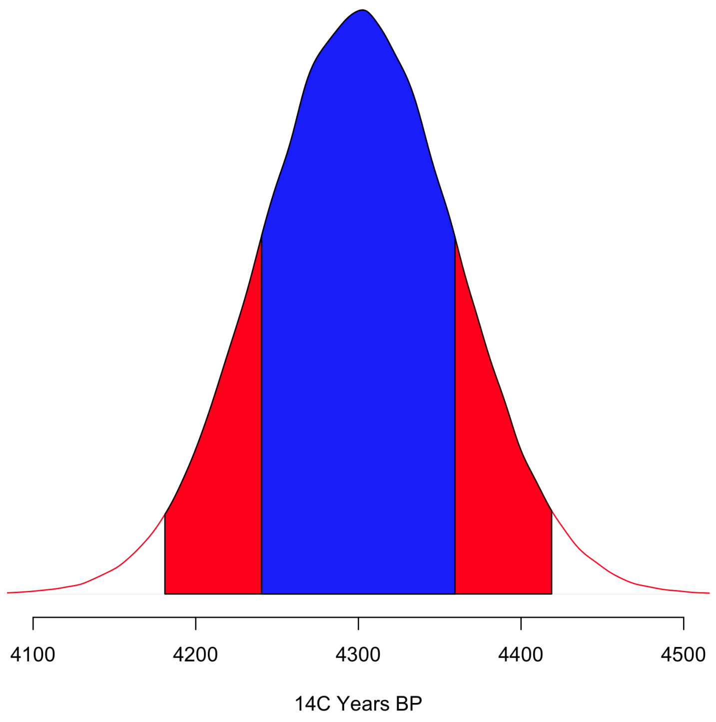
Calibrating

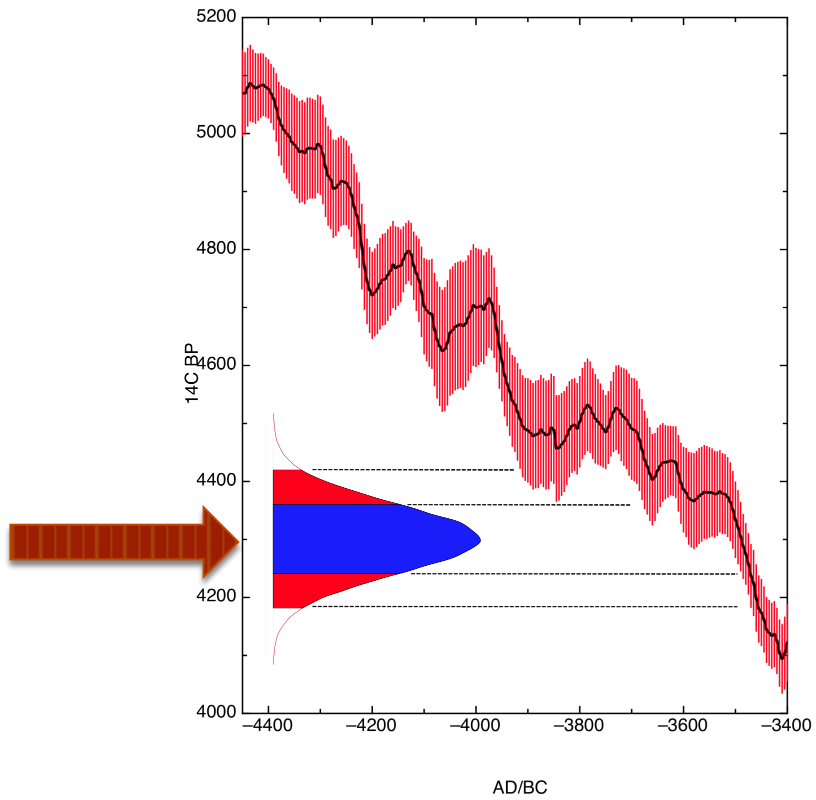
Unfortunately, the calibration curve is not as mathematically well behaved as the laboratory measurements. This is due to those variations in ^{14}C production, and other environmental processes affecting its availability through time.



Calibrating

We have to 'compare' our measured ^{14}C results, at the required precision e.g. 68% or 95%, to the calibration curve. The result of this is a calibrated age range.





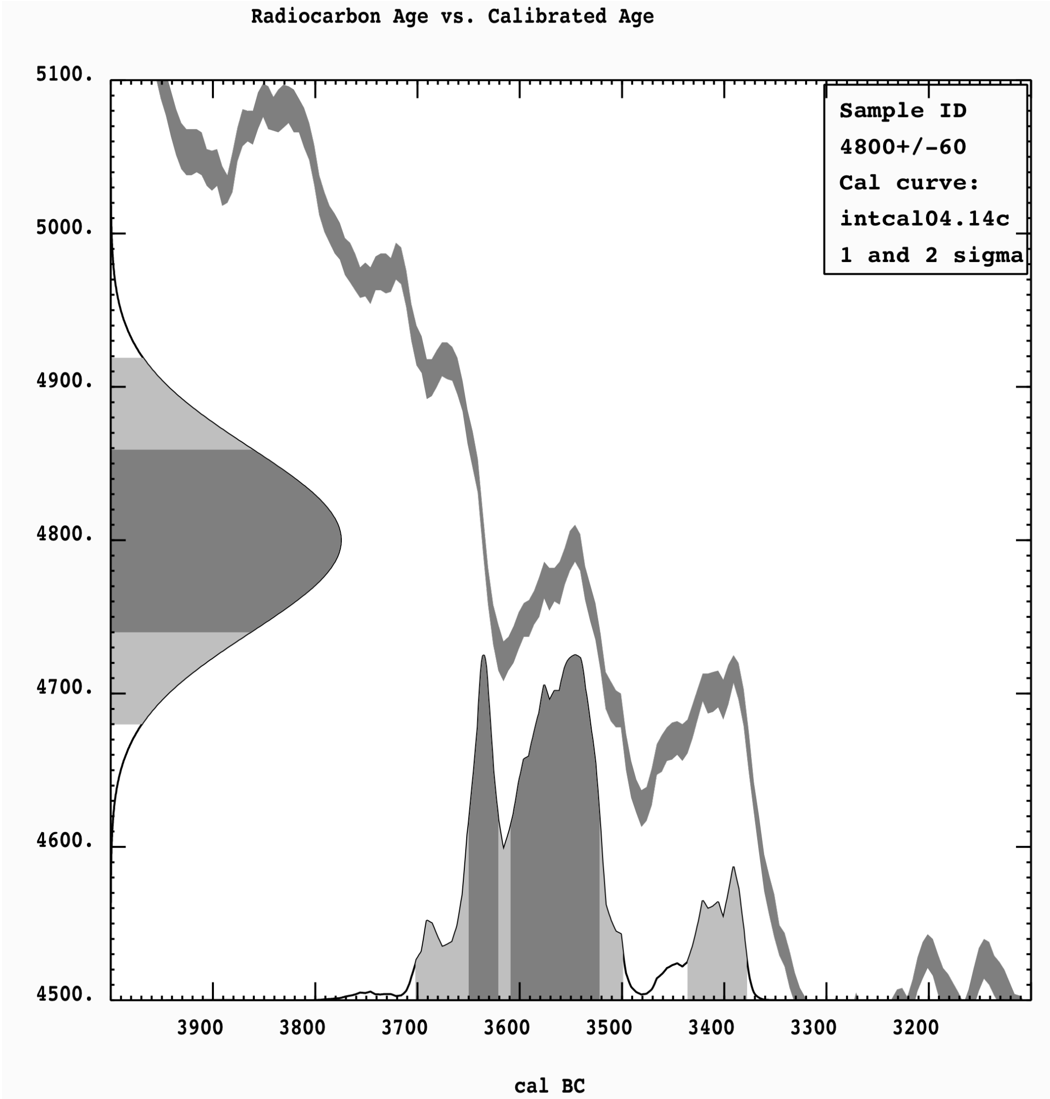
Calibrated

The results of calibrations are ‘messy’ compared to the ^{14}C date.

We often have an irregular shape under which the true date *probably* lies.

Since this is not a nice normal distribution we shouldn’t report the date as 3864 ± 162.

For calibrated dates, the range of the dates needs to be reported.



Reporting Dates

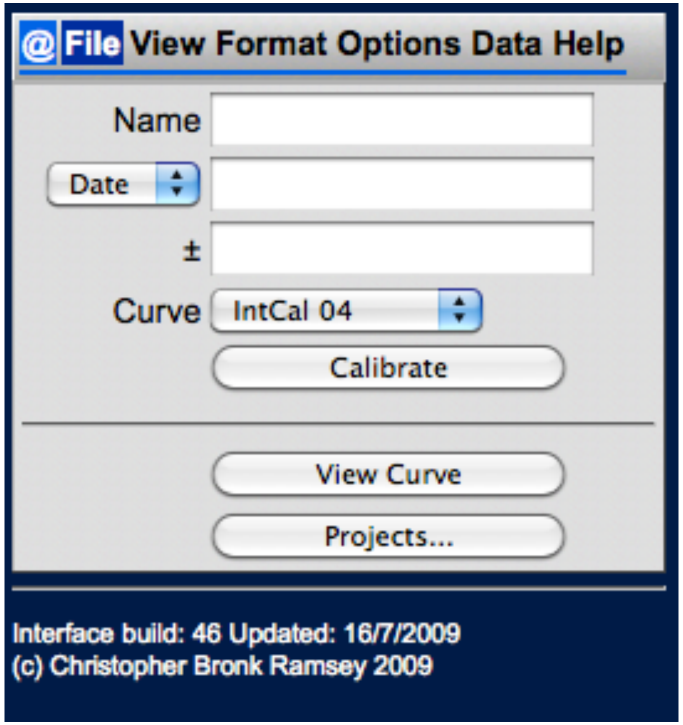
When reporting dates in publications, reports, web sites etc, there are several things that need to be included to make them useful for others

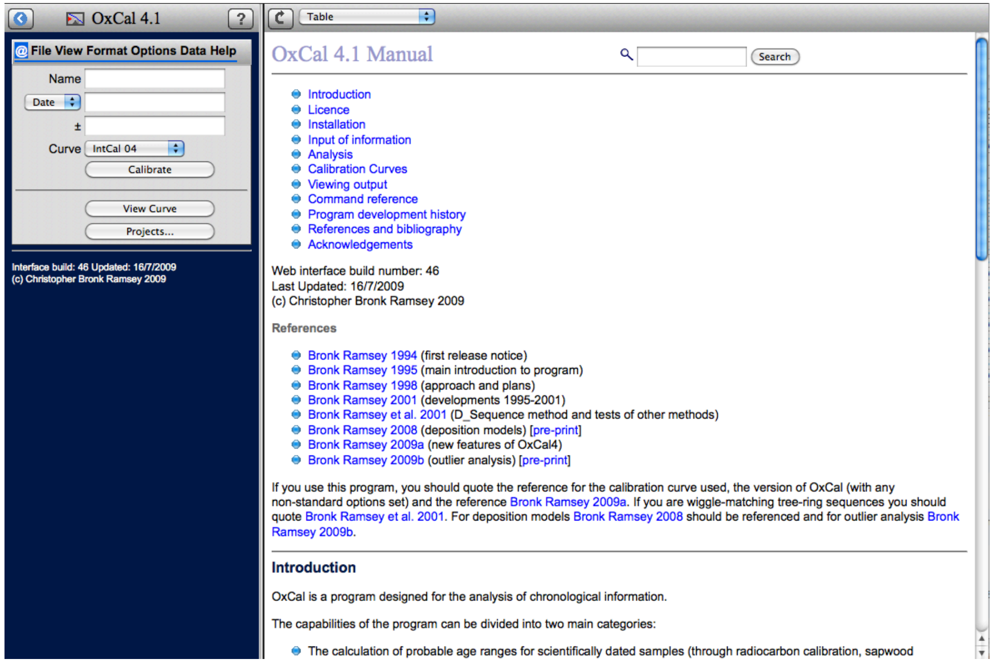
Laboratory number	Lab-010203
14C measurement	4300 ± 30
13C measurement	-25.6 (state whether AMS or other)
Calibrated range	3011-2880 BC
Probability used to calibrate	95.4% (2 sigma)
Calibration curve used	IntCal04
(possibly even software)	Calib
Reservoir correction used	None

With this information others can recreate the calibrated date if new calibration curves become available, improvements in calibration techniques, or so that the date can be used in models.

Calibrate in OxCal

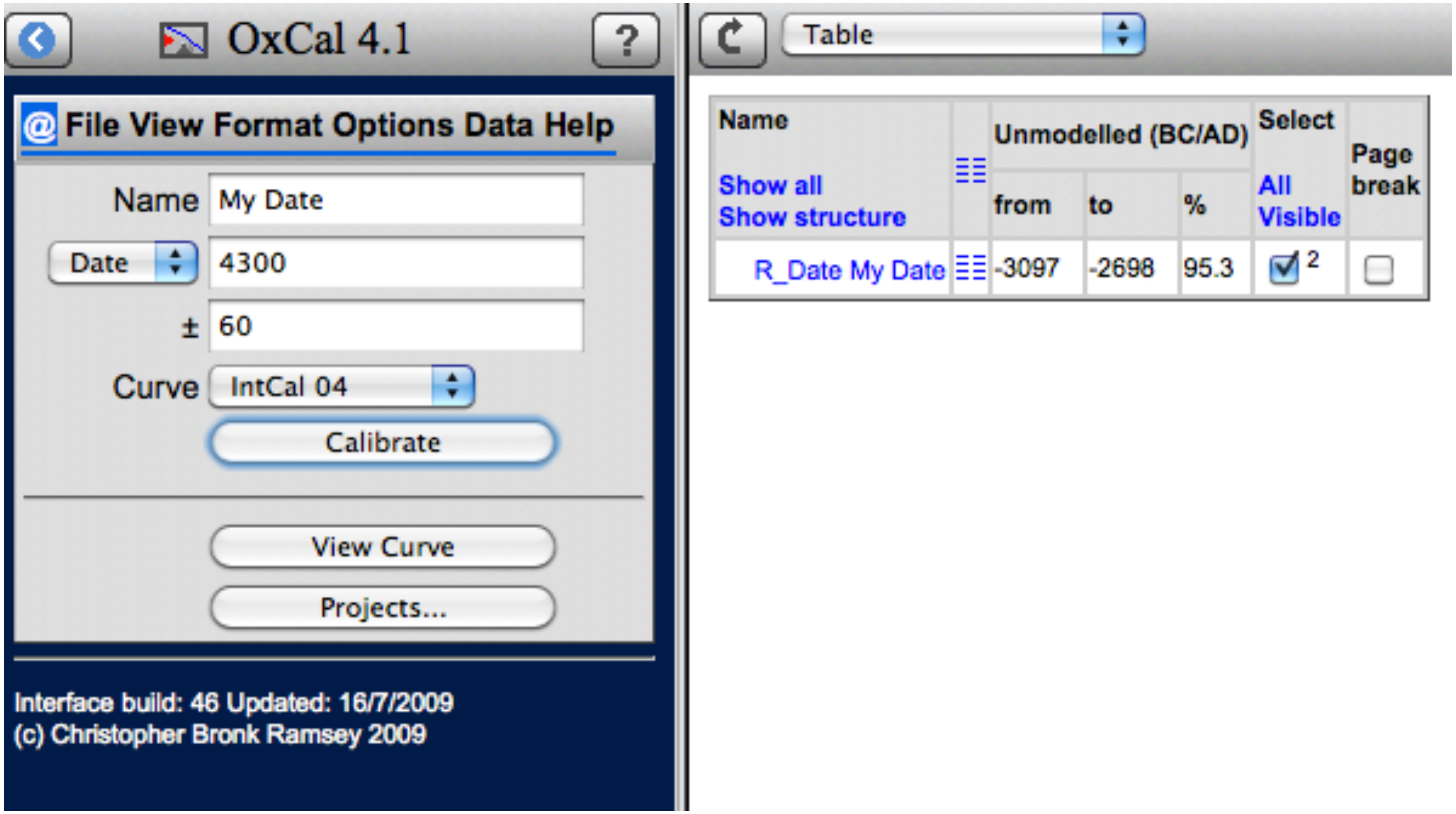
Data input



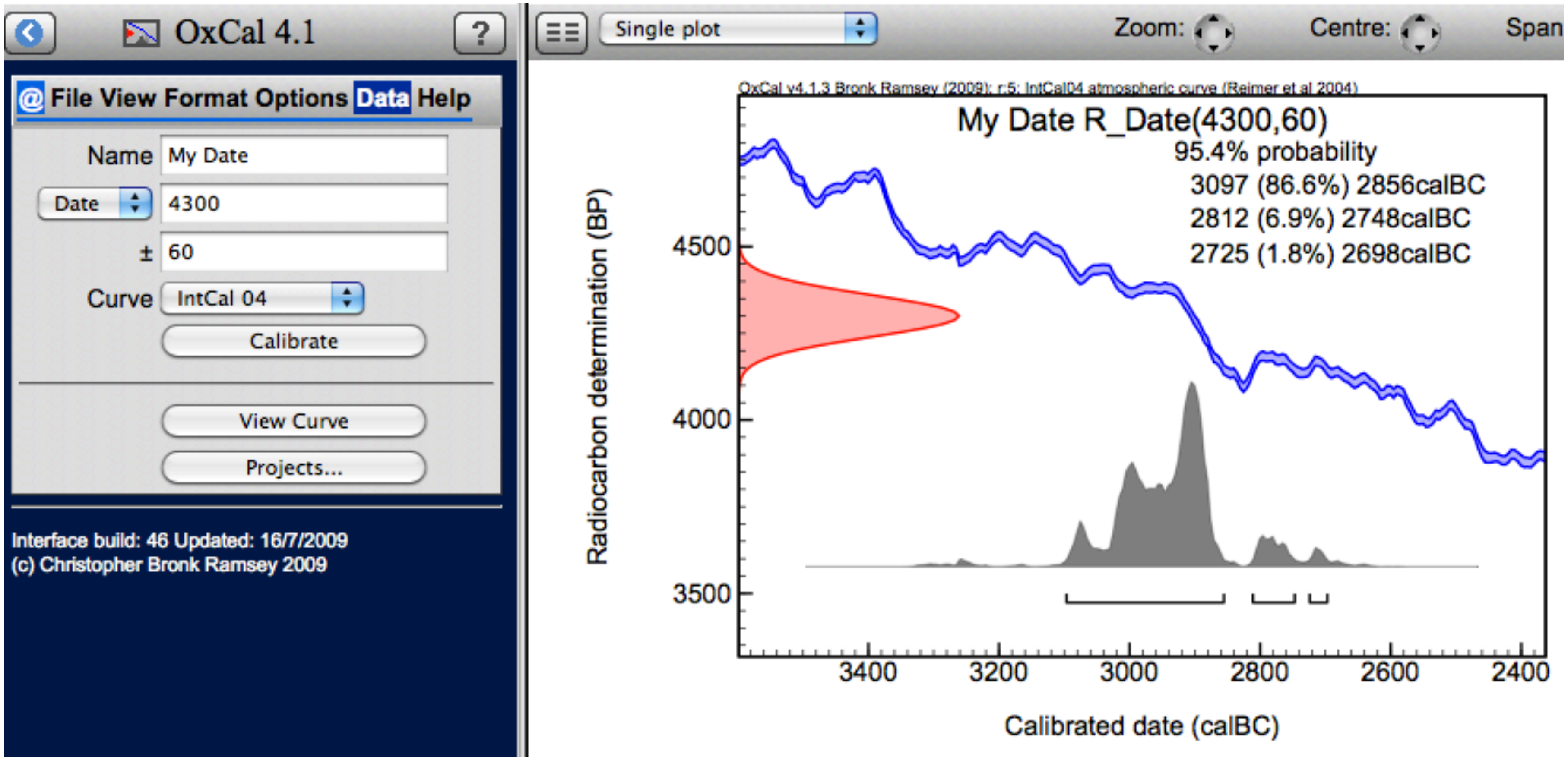


Main screen

Calibrate in OxCal



Calibrate in OxCal



Precision

Two types of precision

One limited by laboratory techniques and technology

One limited by the calibration process.

Precision 1

Just now we calibrated the ^{14}C date 4300 ± 60 ^{14}C BP (span of 120 ^{14}C years)

Our calibrated date was 3097 - 2698 BC (span of **399** years)

Suppose we have managed to get a more precise ^{14}C date

4300 ± 30 ^{14}C BP (span of 60 ^{14}C years)

Calibrate this date and look at the range

The calibrated range is 3011 - 2880 BC

This is a shorter and more precise span of **131** years rather than **399**.
This is the effect of laboratory measurement precision.

Precision 2

What if we were to calibrate a different date but with the same measurement precision of ± 30 ?

So if 4300 ± 30 ^{14}C BP gave us a calibrated range of 3011 - 2880 BC (**131** years), what would the calibrated range for ^{14}C date **4100 ± 30** ^{14}C BP be?

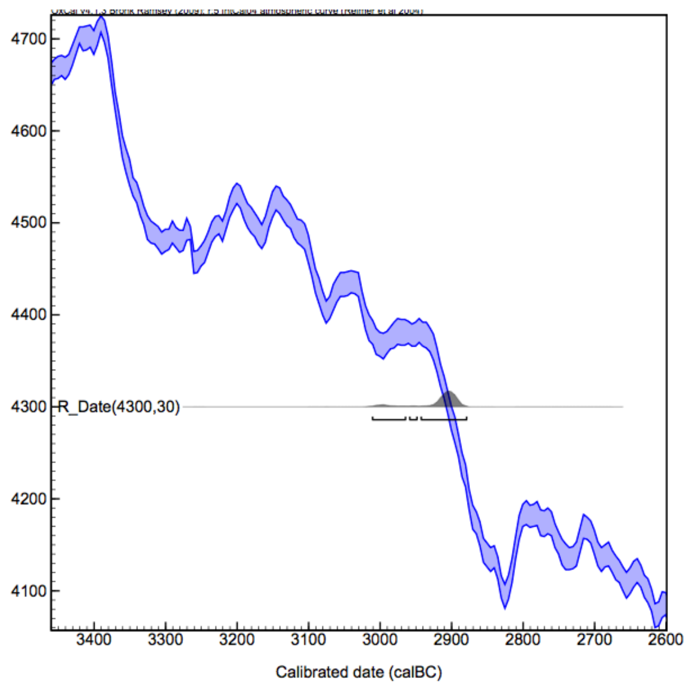
The calibrated range is 2863 - 2502 BC

Although the two dates had the same measured precision they have given very different date ranges, this one of **362** years and the previous **131**.

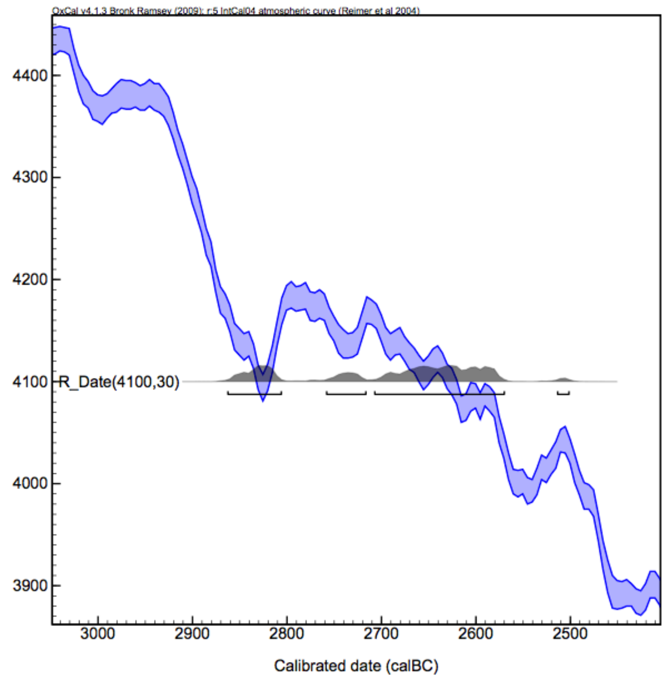
This is the effect of the calibration curve.

Calibration Plateaux

4300 ± 30 ^{14}C BP -131 years
4300 ± 10 ^{14}C BP -23 years



4100 ± 30 ^{14}C BP - 361 years
4100 ± 10 ^{14}C BP - 263 years



On the left the steepness of the calibration curve allows a greater precision to be derived from a ^{14}C date. Where the curve become flatter – reaches a plateau, the calibrated date becomes 'smeared' and increased measurement precision is of limited help.

Precision - the next step

Today we can move beyond calibration alone as a tool to derive more precise dates.

Bayesian analysis