Radiocarbon in Ecology and Earth System Science – 1st problem set

1. You send four samples (a foraminifera (single celled marine organism with a calcium carbonate shell), a leaf, and two pieces of wood) to a lab for measurement. They send you the following results:

	$\delta^{13}C$ (‰)	Fraction Modern
Foraminifera	+1.5	0.50
Leaf	-28.0	0.50
Wood 1	-25.0	0.25
Wood 2	-25.0	1.79

a. What are the **Radiocarbon Ages** of the three samples (see Lecture 1 notes for definitions)?

b. Which of the samples has the most ^{14}C atoms per gram of sample carbon? (in other words, to which samples was ^{14}C added or subtracted to correct for mass dependent fractionation)?

c. Calculate the calibrated age ranges for these samples using one of the programs available on the web (e.g. **Calib**; http://calib.qub.ac.uk/calib/ or **Oxcal** http://c14.arch.ox.ac.uk/embed.php?File=oxcal.html). Try using error of ±25 years and ±50 years to see how that affects the calibrated age ranges.

d. What would be the $D^{14}C$ (see definition in notes; 1000*(FM-1)) and $\Delta^{14}C$ values for these samples - assume you measured them in 2016 – do you understand why they are different?

Delta

$$\Delta^{14}C = \left[\frac{\left[\frac{^{14}C}{^{12}C}\right]_{sample,-25}}{0.95\left[\frac{^{14}C}{^{12}C}\right]_{OX1,-19} \exp^{\left((y-1950)/8267\right)}} - 1 \right] 1000$$

Problem 2. The spreadsheet (see link below) has data for FM 14C as a function of distance (from the cambium inward or the cambium outsward) from a tropical tree (see photo). Use a calibration program that allows you to use bomb radiocarbon to estimate the growth rates and ages of these two trees.

IDENT. (NAME)	FRACT. MOD.	±	DEL 14C	±	Distance fcambium
TanBark1_15mm	1.1578	0.0031	148.8	3.1	-15
TanBark3_13mm	1.3371	0.0045	326.6	4.5	-13
TanBark5_9.3mm	1.4296	0.0033	418.5	3.3	-9.3
TanBark8_4.7mm	1.1962	0.0042	186.8	4.2	-4.7
TanBark10_3mm	1.1375	0.0038	128.6	3.8	-3
TanBark11_1mm	1.0753	0.0025	66.9	2.5	-1
					0
TanWood1_1mm	1.0449	0.0030	36.7	3.0	1
TanWood2_9.4mm	1.0817	0.0027	73.2	2.7	9.4
TanWood3_16mm	1.1432	0.0025	134.2	2.5	16
TanWood4_24mm	1.2037	0.0027	194.2	2.7	24
TanWood5_30mm	1.2449	0.0027	235.1	2.7	30
TanWood6_43mm	1.3135	0.0035	303.2	3.5	43
TanWood7_60mm	1.4370	0.0035	425.8	3.5	60
TanWood8_90mm	1.5370	0.0037	525.0	3.7	90

3) Corals that grew during the year 1900 off the coast of Hawaii, Galapagos, and the Great Barrier Reef contain ^{14}C Fraction Modern values of 0.945, 0.924 and 0.950, respectively.

a) Now calculate the $\Delta^{14}C$ values for the carbon in seawater from which these corals precipitated. (Use the true ^{14}C half-life of 5730 y in your calculations).

$$\Delta = \left[\frac{\left[\frac{^{14}C}{^{12}C}\right]_{\text{sample},-25} \exp^{\left((1950-1900)/8267\right)}}{0.95 \left[\frac{^{14}C}{^{12}C}\right]_{\text{OX1},-19}} - 1 \right] 1000$$

b) Calculate the reservoir ages (equivalent to the radiocarbon age for the seawater carbon) for each of these coral sites. (Remember to use the Libby ^{14}C half-life of 5568 y in your calculations).