

Surface Radiocarbon in the Gulf of Mexico and Caribbean as Recorded in Corals

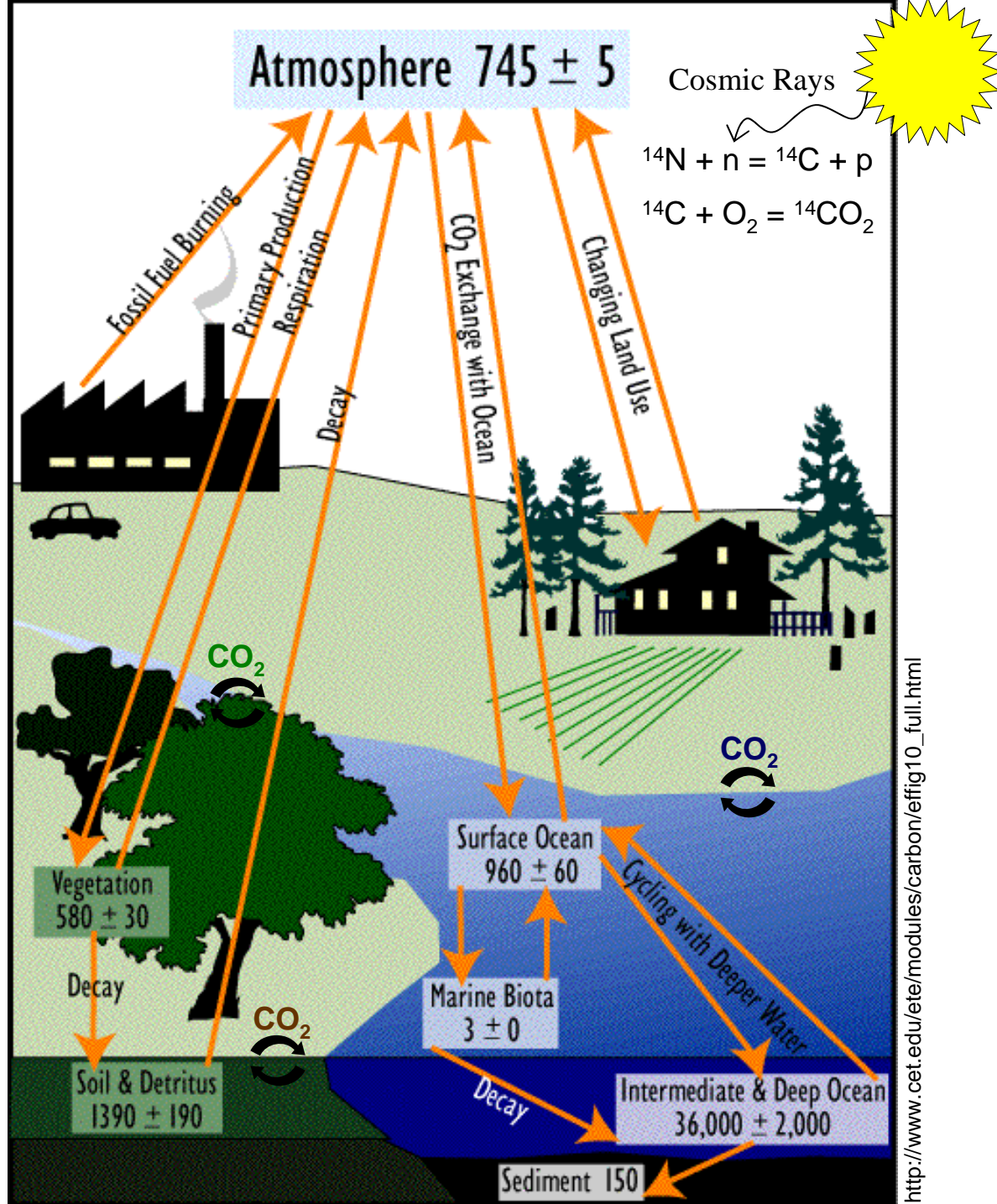
Amy Wagner
GREF Fellow

Department of Oceanography
Texas A&M University

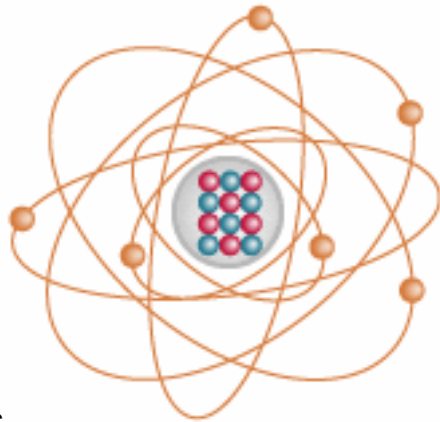


*Currently doing Sea Grant Fellowship with NOAA Climate Program Office

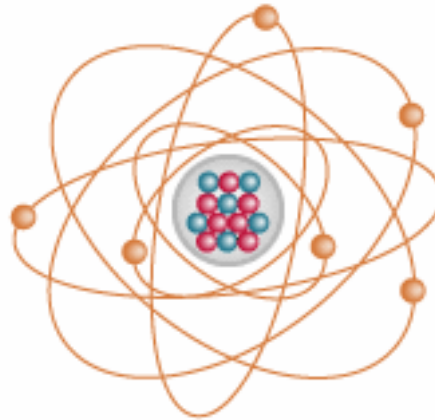
Global Carbon Cycle



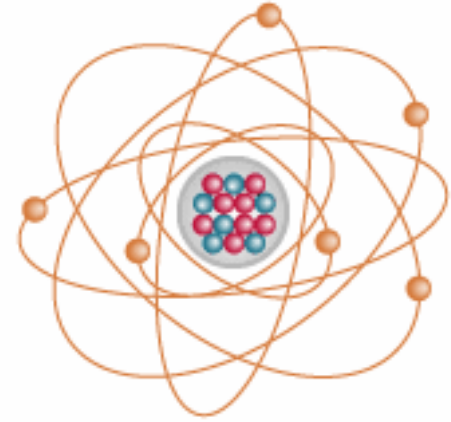
Carbon Isotopes



Carbon-12
stable
98.9%



Carbon-13
stable
1.1%

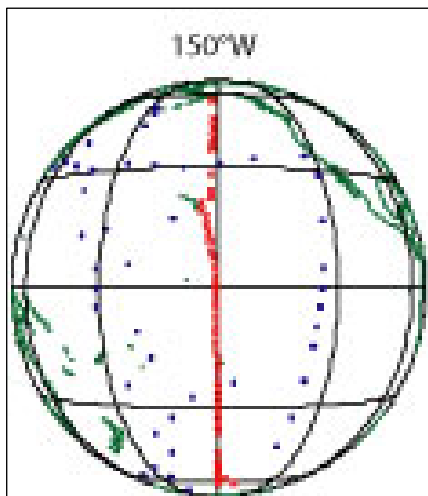
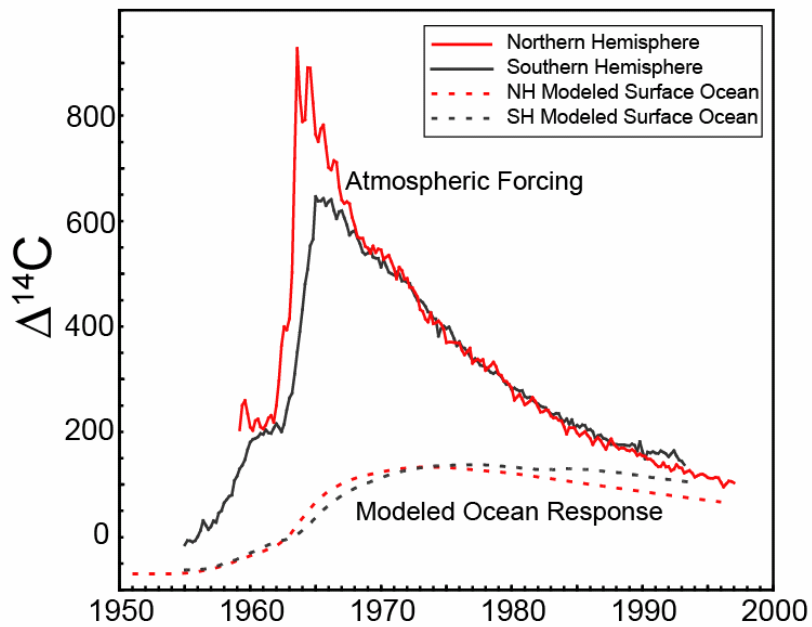


Carbon-14
unstable (radioactive)
< 10⁻¹⁰%

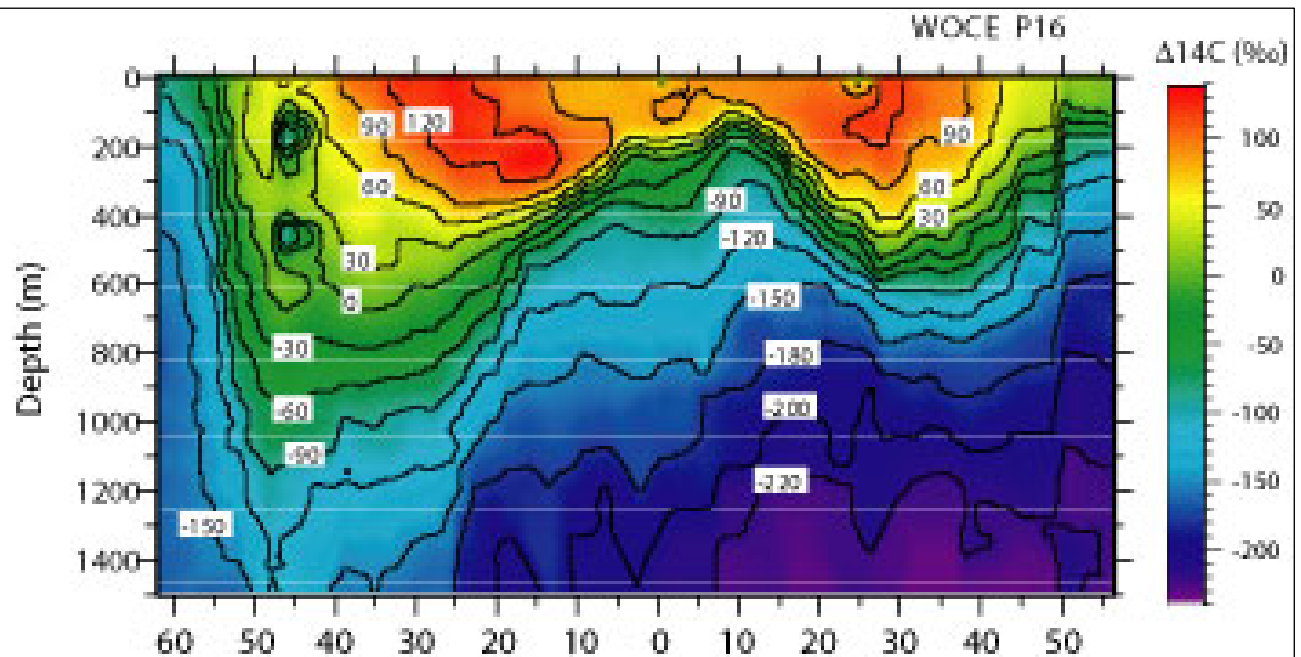
Blue=Protons
Red=Neutrons
Gold=Electrons

- $\delta^{13}\text{C}\text{‰}$ \Rightarrow ratio of $^{13}\text{C}/^{12}\text{C}$
- $\Delta^{14}\text{C}\text{‰}$ \Rightarrow ratio of $^{14}\text{C}/^{12}\text{C}$
 - Naturally occurring and man-made (nuclear bombs)
 - Used to determine age of terrestrial and marine samples

Radiocarbon in the Atmosphere vs. the Ocean



WOCE P16 (1991) X
GEOSBCS (1973 & 1974) ●



Some Radiocarbon Terminology

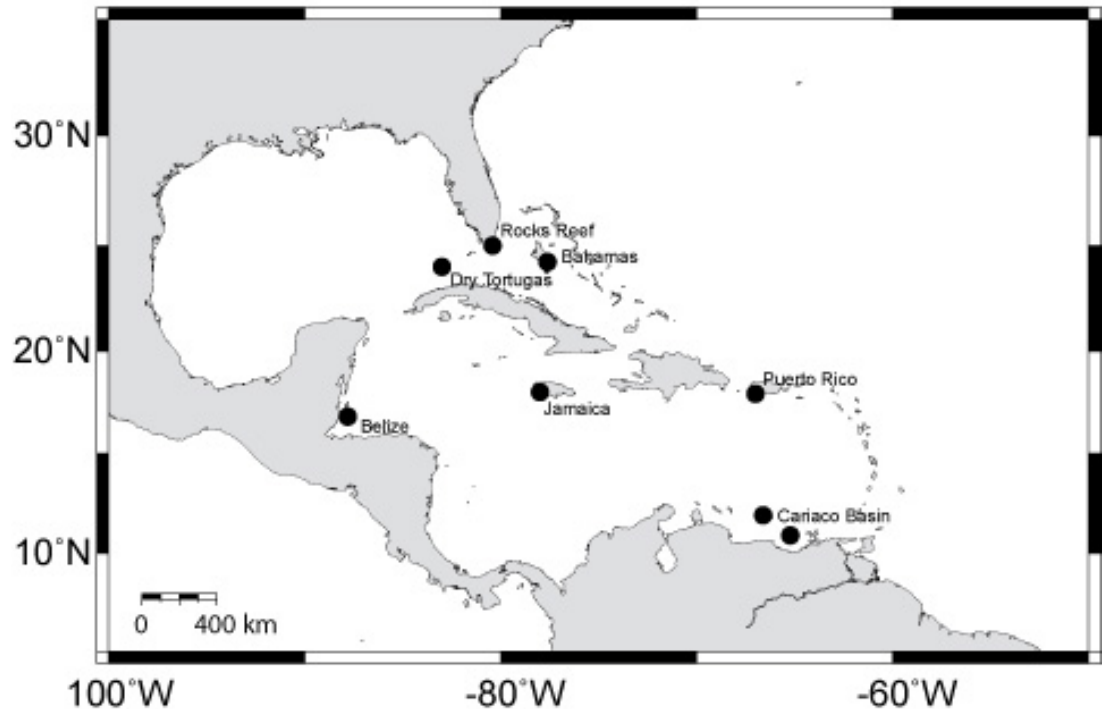
- ^{14}C age BP
 - Conventional radiocarbon age
=> years before 1950
- Reservoir Age
 - Measured marine ^{14}C age – Atmospheric ^{14}C age
- ΔR
 - Difference between the regional and global marine ^{14}C age
 - Measured marine ^{14}C age – marine model ^{14}C age

Why Corals?

- Incorporate geochemical properties of water in which they grow into skeletal material (CaCO_3)
- Relatively fast-growing
 - Get high resolution sampling => monthly or greater
- Grow at different rates through the year
 - Annual density bands => assists in determining age of coral
- Not material limited like other oceanic proxies such as forams

The need for more data

- Relatively few regional measurements in Caribbean
- None in Gulf of Mexico

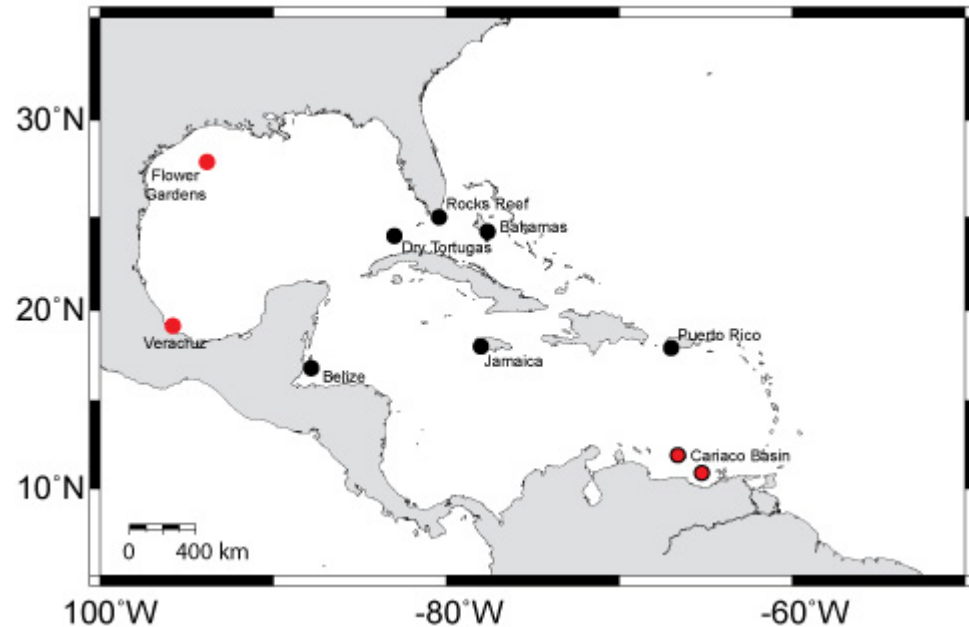


Sample Sites

- *Flower Garden Banks*
 - Northern Gulf of Mexico continental shelf
 - ~20m water depth
 - Collected in 1990
- *Santiaguillo Reef*
 - 20 km off the coast of Veracruz, Mexico
 - ~6 m water depth
 - Collected in 1991
- *Cariaco Basin*
 - Boca de Medio
 - Los Roques archipelago, outside of the Cariaco Basin
 - collected in 1998
 - Isla Tortuga
 - Within Cariaco Basin
 - Collected in 1996

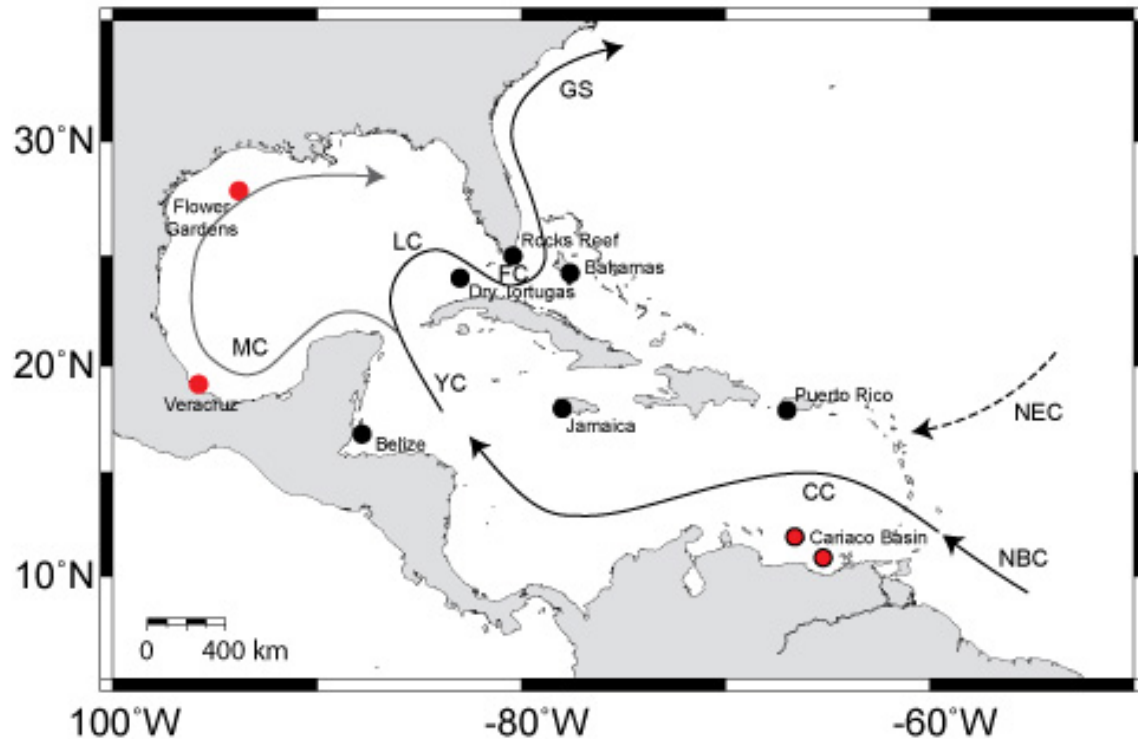


Montastrea faveolata



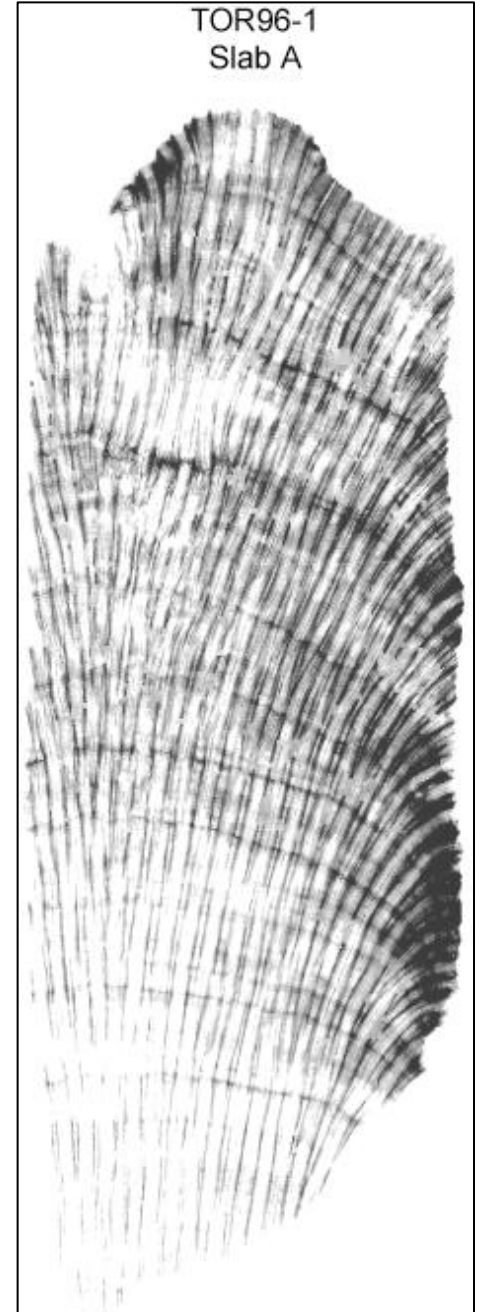
General Surface Oceanography of Region

- Caribbean Sea
 - Surface water enters SE Caribbean and exits through Yucatan Channel
- Gulf of Mexico
 - Enters through Yucatan Channel and exits through Florida Straits



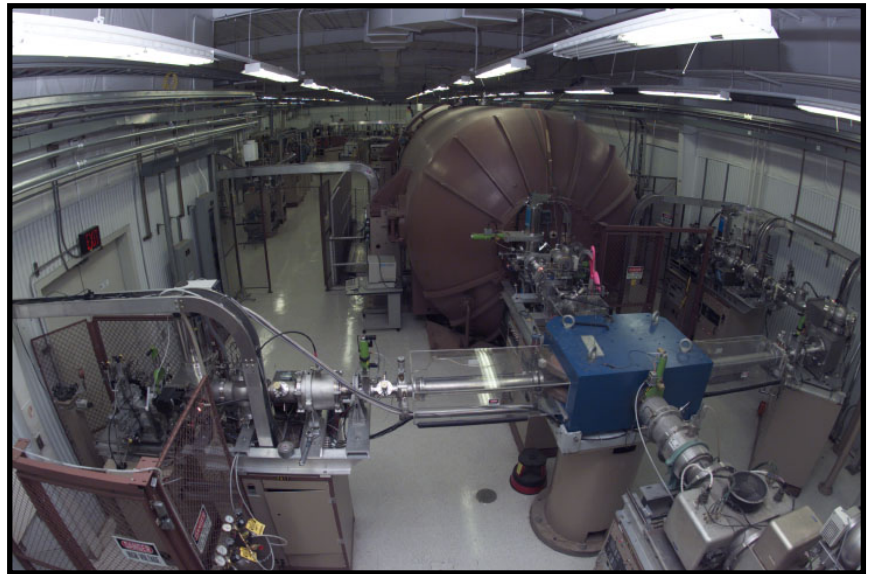
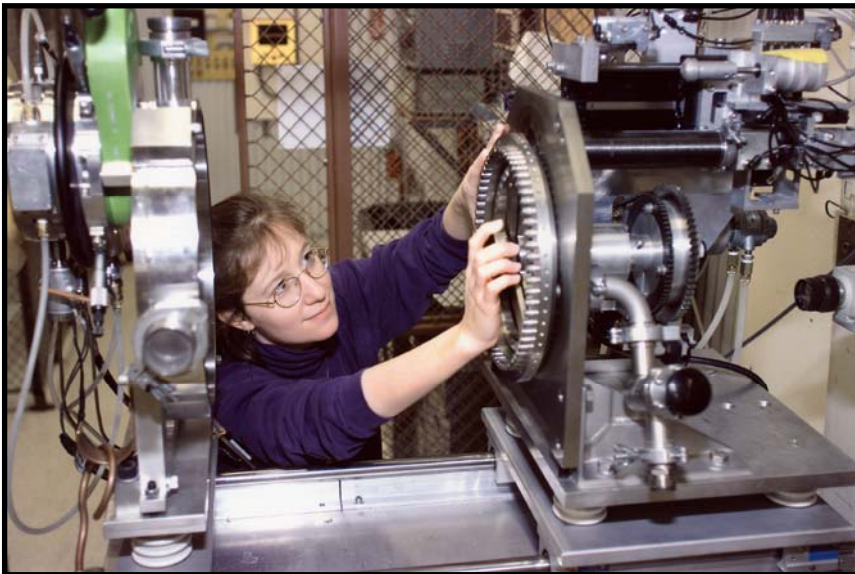
Methods

- Cores collected using underwater hydraulic drill
- Ages determined from annual density bands

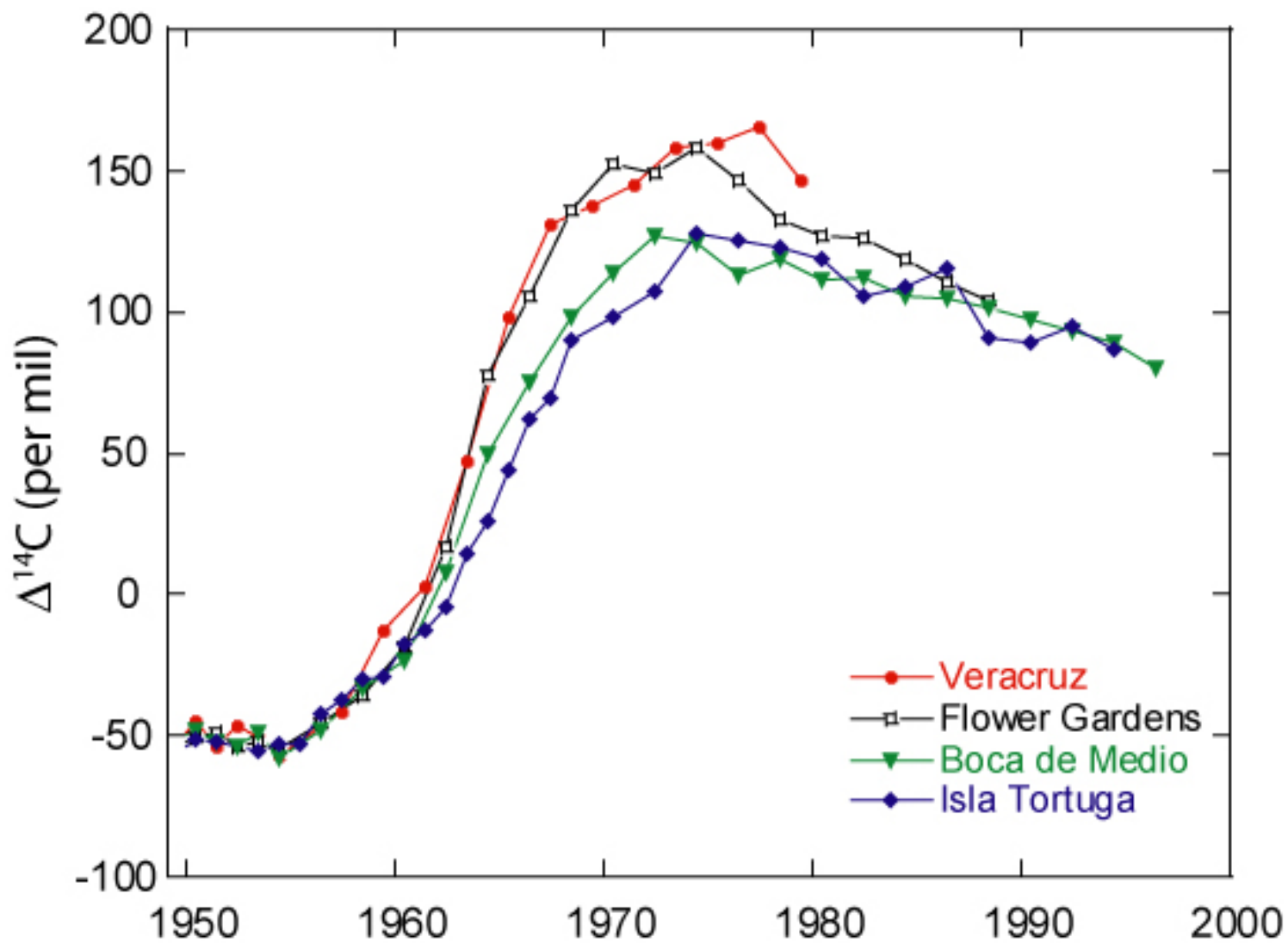


Methods

- Convert $\sim 10\text{mg CaCO}_3$ to graphite for analysis
- ^{14}C analysis at LLNL
 - Center for Accelerator Mass Spectrometry (CAMS)



Results



Results

Site	Midpoint (year)	Delta ^{14}C (‰) (age corrected)	^{14}C Age conventional	Reservoir Age (years)	ΔR (years)
Flower Garden Banks	1950 (n=9)	-53.2 ± 1.0	439 ± 9	240 ± 13	-30 ± 26
Veracruz, Mexico	1950 (n=10)	-51.9 ± 1.1	428 ± 10	229 ± 13	-41 ± 26
Gulf of Mexico Avg	1950 (n=19)	-52.6 ± 0.7	434 ± 7	235 ± 11	-36 ± 25
Boca de Medio	1950 (n=10)	-53.2 ± 1.0	438 ± 9	239 ± 13	-31 ± 26
Isla Tortugas	1950 (n=3)	-53.9 ± 1.5	447 ± 14	248 ± 17	-22 ± 28
Caribbean Avg	1950 (n=13)	-53.4 ± 0.8	441 ± 8	242 ± 12	-28 ± 25

GoM/Caribbean Average Reservoir Age and ΔR = 238 years and -32 years

Global Atmospheric ^{14}C age = 199 years

Global Average Marine ^{14}C age = 469 years

Comparison with Existing Data

Site	Year	Reservoir Age	ΔR	Reference	Material
Bahamas	1950	229 \pm 43	-40 \pm 42	(Broecker and Olson 1961)	Gastropod
Bahamas	1885	423 \pm 59	56 \pm 59	(Broecker and Olson 1961)	Gastropod
The Rocks, FL Keys	1850	405 \pm 18	33 \pm 16	(Druffel and Linick 1978; Druffel 1982)	Coral
Tortugas, FL	1884	482 \pm 52	114 \pm 51	(Lighty et al. 1982)	Coral
Golden Cay, Bahamas	1912	493 \pm 66	146 \pm 66	(Lighty et al. 1982)	Coral
Gulf of Honduras, Belize*	1950	270 \pm 54	0 \pm 58	(Druffel 1980)	Coral
Jamaica	1884	323 \pm 42	-44 \pm 41	(Broecker and Olson 1961)	Gastropod
Jamaica	1930	273 \pm 43	-30 \pm 42	(Broecker and Olson 1961)	Gastropod
Cariaco Basin, Venezuela	1935	336 \pm 61	33 \pm 60	(Hughen et al. 2004b)	Foraminifera
Cariaco Basin, Venezuela	1910	361 \pm 50	12 \pm 50	(Hughen et al. 2004b)	Foraminifera
Isla Tortuga, Venezuela	1941	264 \pm 41	-22 \pm 40	(Guilderson et al. 2005)	Coral
Isla Tortuga, Venezuela	1906	290 \pm 41	-70 \pm 40	(Guilderson et al. 2005)	Coral
Boca de Medio, Venezuela	1945	256 \pm 42	-18 \pm 41	(Guilderson et al. 2005)	Coral
Los Testigos, Venezuela	1940	285 \pm 43	-1 \pm 42	(Guilderson et al. 2005)	Coral

Conclusions

- This study has updated Caribbean reservoir age and ΔR and added Gulf of Mexico information to ^{14}C database
- Caribbean and Gulf of Mexico results within error of each other
- Useful when dating marine samples from this region
 - Only applicable during times of similar oceanographic conditions
 - Could be variable during different oceanographic regimes
- ΔR negative compared to global marine average
- Small ΔR suggests global marine model estimates close for regional

Acknowledgments

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