PRECISE MEASUREMENT OF BACKGROUND $^{14}CO_2$

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ABSTRACT
Measurements of the radiocarbon content of atmospheric carbon dioxide are a potentially powerful, yet relatively unexplored method of improving the understanding of natural carbon dynamics and verifying fossil fuel emissions. Development of $^{14}CO_2$ as a tracer has been limited by measurement capabilities given that seasonal and spatial variation in $\Delta^{14}C$ is currently of the same order as traditional instrument precision: 3-5 per mil. We have demonstrated 1-2 per mil reproducible measurement precision at the Center for Accelerator Mass Spectrometry of Lawrence Livermore National Laboratory. Here we present preliminary measurements of the natural variability of $^{14}CO_2$ from the SIO network of background air sampling stations.

BACKGROUND
Radiocarbon is produced naturally in the atmosphere while its concentration there is diluted by fossil fuel emissions that lack any ^{14}C. The $^{14}C/^{12}C$ ratio can be used to explicitly distinguish fossil-fuel CO_2 from other sources of CO_2 and also provide constraints on the mass and turnover times of carbon in land ecosystems and on exchange rates of CO_2 between air and sea.

Monitoring the global distribution in the background atmospheric $\Delta^{14}CO_2$ and its temporal variation will provide an additional constraint for the detection of variability in global carbon fluxes that may be used in conjunction with present observations of the atmospheric abundance of CO_2, $\delta^{13}CO_2$ and O_2/N_2. These measurements will provide a check for economically reported fossil fuel emissions, and improved estimates in these emissions will help to develop a better understanding of carbon exchange with the terrestrial biosphere. In addition, observations of background $\Delta^{14}CO_2$ are essential for studies of the regional processes that affect $^{14}CO_2$ and CO_2.

RESULTS
By utilizing an archive of samples from the Scripps Institution of Oceanography's carbon dioxide sampling network, we are able to produce a long $^{14}CO_2$ time series at several locations. At La Jolla, CA, we have measured 72 monthly sample dates of an incomplete time series spanning 1992-present (Fig. 1). Monthly samples from 2001-2002 have also been measured from Pt. Barrow, AK, Mauna Loa, HI, American Samoa, and the South Pole. The average error in all flask measurements to date is 1.2‰. Measurement of 46 pairs of replicate flask samples from La Jolla exhibit a pooled standard deviation of 1.75‰ and generally show agreement within one-sigma error.

The data from La Jolla shows a decreasing trend due to the oceanic uptake of bomb-derived ^{14}C and the accumulation of fossil fuel carbon in the atmosphere. A significant amount of variability in the seasonal

amplitude of background $^{14}CO_2$ at La Jolla can be observed, yet a prevailing seasonal pattern shows depressed wintertime values from enhanced fossil fuel emission. Preliminary data from the four other stations suggest there is distinct seasonal behavior at each station and opposite phase in the Northern and Southern Hemispheres (not shown). These data also resolve statistically significant differences in the annual mean value of $\Delta^{14}C$ at different latitudes. The values exhibit a tropical maximum, with $\Delta^{14}C$ decreasing toward both poles. This profile may be qualitatively explained by regional processes causing depletion in the mid-latitudes, by fossil fuel burning in the north and upwelling of old waters in the south [*Levin and Hesshaimer*, 2000].

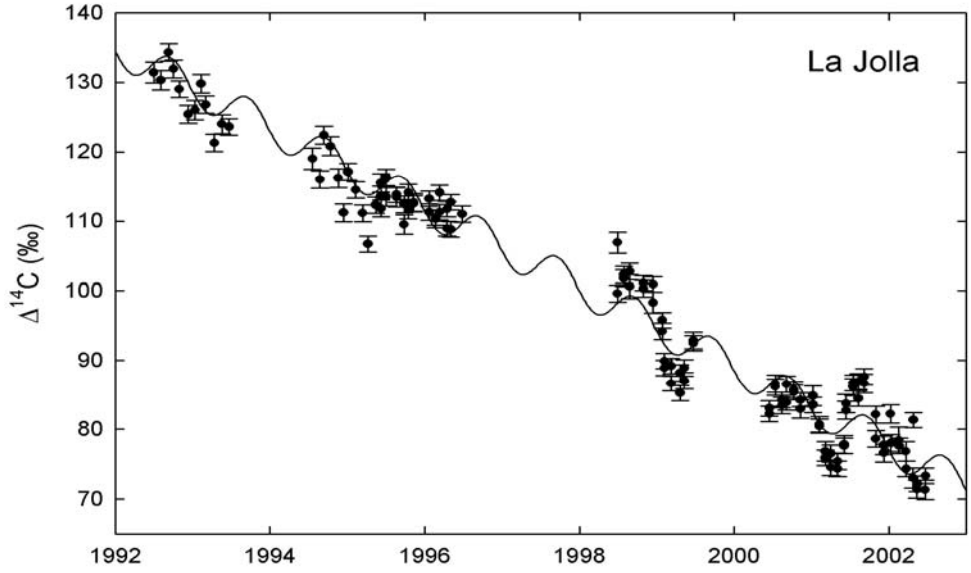

Fig. 1. Monthly measurements taken at the Scripps Pier in La Jolla, CA, between June 1992 and June 2002, plotted with a harmonic fit.

REFERENCE

Levin, I. and V. Hesshaimer, (2000), Radiocarbon - A unique tracer of global carbon cycle dynamics. *Radiocarbon, 42*(1): 69-80.