REGIONAL-SCALE CHARACTERIZATION OF SUMMERTIME CO_2 SOURCES AND SINKS OVER THE CONTERMINOUS UNITED STATES

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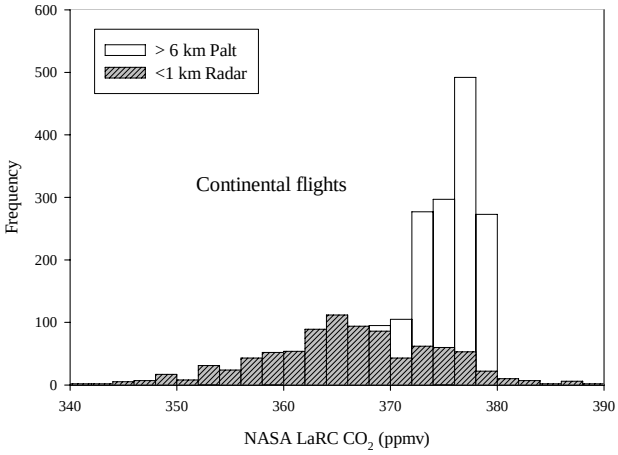
ABSTRACT
Fast-response (1-s resolution) CO_2 measurements were recorded aboard the NASA DC-8 during the Intercontinental Chemical Transport Experiment – North America (INTEX-NA) mission. Utilizing a non-dispersive infrared gas analyzer-based sampling system, measurements were obtained over sparsely sampled areas of North America and adjacent ocean basins providing valuable regional-scale information on carbon sources and sinks.

INTRODUCTION
The Intercontinental Chemical Transport Experiment – North America (INTEX-NA) is a major NASA science campaign designed to understand the transport and transformation of gases and aerosols on transcontinental and intercontinental scales and their impact on air quality and climate. The long-lived greenhouse gases are constituents of primary interest for the mission series, and observations of atmospheric CO_2 are considered critical to INTEX-NA's support of NACP objectives to quantify CO_2 fluxes and spatial variability over the North American continent. During the summer 2004 deployment, the NASA DC-8 flew 18 sorties (~170 hours) from 1 July – 14 August performing large-scale surveys and numerous vertical soundings (0.1 to 12 km). The mission sampling domain prioritized the eastern portion of the United States and the adjacent North Atlantic Ocean basin.

METHOD
A modified Li-Cor model 6252 non-dispersive infrared analyzer was used to determine CO_2 mixing ratios [*Anderson et al.*, 1993; *Vay et al.*, 1999]. The sampling system was operated at constant pressure (250 Torr) and temperature (40° C), and had a precision of 0.07 ppmv (1 sigma) and accuracy of 0.25 ppmv. The CO_2 mixing ratios assigned to our flight standards are directly traceable to the WMO primary calibration standards maintained at NOAA CMDL in Boulder, CO.

RESULTS AND DISCUSSIONS
Figure 1 shows the observed distributions of atmospheric CO_2 for each flight. These data, acquired mostly between 30 – 50° N, display substantial variability reflecting not only the biospheric uptake in the northern summer, but also the preponderance of human population and industrial activity in the northern hemisphere. Measurements over the continent yielded the greatest range of CO_2 mixing ratios; most notably on 20 July where concentrations varied by 66 ppmv or ~ 18% from background. This is in contrast to the over-water flights, evident in Figure 1 by the compactness of the data e.g. 31 July. Median mixing ratios for individual mission sorties (370.4 – 377.7 ppmv) exhibited little change from mean values (368.9 – 377.2 ± 1.17 – 7.68 ppmv).

Fig. 1. Plot illustrating the distribution of CO_2 as a function of flight date. On these types of graphs, median values are represented by the horizontal line, the upper and lower inner quartiles (75^{th} and 25^{th} percentiles) are enclosed by boxes, and the symbols extend over the data range.



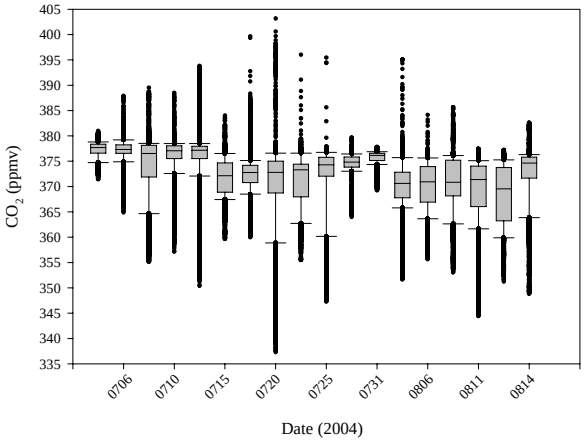


Fig.2 Altitude binned measurement histograms for 1–minute averaged CO_2 data. Data shown were acquired over the North American continent between 30 – 50° N eastward of 100° W.

Figure 2 captures the frequency distribution of CO_2 mixing ratios observed from data acquired over the North American continent within the continental boundary layer (CBL) and upper troposphere (UT). CBL data (N=899) exhibit a symmetrical distribution indicating several source/sink processes contributing to the observed spatial distributions. The non-symmetrical distribution displayed in the UT data (N=1542) suggests, in general, sampling fairly well-mixed, aged air masses. Within the UT, 32% of the measurements fall into the 376 – 378 ppmv category.

When coupled with the enormously sophisticated chemistry payload on the DC-8, these measurements collectively afford extremely powerful multi-tracer constraints for carbon source/sink attribution. In this presentation, a synergy of the ensemble of observations from surface, airborne, and space-based platforms, bottom-up emission inventories, as well as transport history are invoked in a GIS framework to elucidate the source/sink processes reflected in the observations. The airborne CO_2 data, along with simultaneous surface measurements (NOAA, AIRMAP), are examined to establish the vertical distribution and variability of CO_2 as a function of location. The role of convection, trop-strat exchange, localized sources (e.g. power plants), and long-range transport (e.g. 2004 Alaskan fires) on CO_2 spatial variability throughout the tropospheric column will be discussed.

ACKNOWLEGMENTS
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