INITIAL RESULTS FROM THE TOTAL CARBON COLUMN OBSERVING NETWORK

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ABSTRACT
The Total Carbon Column Observing Network is a new network of ground-based solar observatories, dedicated to column measurements of greenhouse gases. We present CO_2 column abundances observed in Park Falls, Wisconsin and Lauder, New Zealand during May 2004 – June 2005. In Park Falls, Wisconsin, the peak-to-peak variation of column-average CO_2 is approximately 13 ppmv. In Lauder, New Zealand, the peak-to-peak variation of column-average CO_2 is approximately 4 ppmv. Assuming a secular trend of 2 ppmv yr^{-1}, we infer a peak-to-peak seasonal amplitude of 11 ppmv and 2 ppmv for Park Falls and Lauder respectively. These values are higher than model predictions by Olsen and Randerson [2003].

INTRODUCTION
Different methods to measure atmospheric CO_2 yield different information about carbon exchange. The magnitude of sources and sinks of CO_2 are currently inferred from in situ measurements at a global network of surface sites [e.g. *Globalview-CO2*, 2003]. These surface measurements are highly accurate, but have limited spatial coverage. The proximity of local sources and sinks complicates the interpretation of the data. In addition, because exchange and transport are correlated on diurnal and seasonal timescales, errors in transport fields may be aliased into the inferred exchange terms as "rectifier" effects.

Precise and accurate CO_2 columns are an important complement to existing in situ measurements and can provide information about CO_2 exchange on a larger geographical scale. The column integral of the CO_2 profile should be less sensitive to diurnal fluctuations in boundary layer CO_2 concentrations and should exhibit less spatial variability than surface data, while still retaining information about surface fluxes.

The Total Carbon Column Observing Network (TCCON) is a network of ground-based solar observatories, which will be used for carbon cycle studies and validation of spaceborne measurements. Each site uses a Fourier Transform Spectrometer to record direct solar absorption spectra in the near-infrared (3,900 – 15,600 cm^{-1}). These spectra are used to retrieve column abundances of CO_2, CH_4, CO, N_2O, O_2, H_2O, and HF. In order to provide useful constraints for the global carbon budget, the TCCON must achieve a precision of 0.1% and an accuracy of 0.3% for column CO_2. This requires accurate solar tracking, surface pressure measurements, spectroscopic parameters, and well-characterized retrieval methods.

The five confirmed TCCON sites are listed in Table 1. The first laboratory in the TCCON network was assembled in Pasadena, California and then permanently deployed to northern Wisconsin during May 2004. It is located in the heavily forested Chequamegon National Forest at the WLEF Tall Tower site (45.9 N, 90.3 W), 14 km east of Park Falls, Wisconsin. The second laboratory is an existing observatory, located in Lauder, New Zealand (45.0 S, 169.7 E).

Table 1. Geographical locations of the five existing TCCON observatories.

Location		Latitude	Longitude
Park Falls, Wisconsin	**United States**	**45.9 N**	**90.3 W**
Lauder	**New Zealand**	**45.0 S**	**169.7 E**
Bremen	Germany	53.1 N	8.8 E
Ny Alesund	Norway	78.9 N	11.8 E
Darwin, Northern Territories	Australia	12.5 S	130.9 E

RESULTS

Park Falls CO_2 column abundances demonstrate a precision of ~0.1%. During fives dates in July and August 2004, the DC-8 or King Air aircraft recorded in situ measurements of CO_2 during profiles over the WLEF site as part of the INTEX-NA and COBRA campaigns. Comparison of the retrieved FTS CO_2 column abundances and integrated aircraft CO_2 profiles shows linear agreement, with an absolute accuracy of ~0.7% for the FTS CO_2 column abundances. These results demonstrate the potential of the TCCON network to provide column CO_2 measurements that are both precise and accurate.

CO_2 column abundances observed at Park Falls, Wisconsin and Lauder, New Zealand during 2004 – 2005 are shown in Fig. 1. During May 2004 – May 2005 at Park Falls, the observed peak-to-peak variation of column-average CO_2 is approximately 13 ppmv, with an average value of 378 ppmv. In contrast, at Lauder the observed peak-to-peak variation of column-average CO_2 is approximately 4 ppmv with an average value of 376 ppmv.

Assuming a secular trend of 2 ppmv yr^{-1}, we infer peak-to-peak seasonal amplitudes on the order of 11 ppmv and 2 ppmv for Park Falls and Lauder, respectively. These results are somewhat higher than model results by *Olsen and Randerson* [2003], which predict mean seasonal column CO_2 amplitudes of 7 – 9 ppmv in Wisconsin and 0.6 – 1.2 ppmv over Southern Hemisphere oceans.

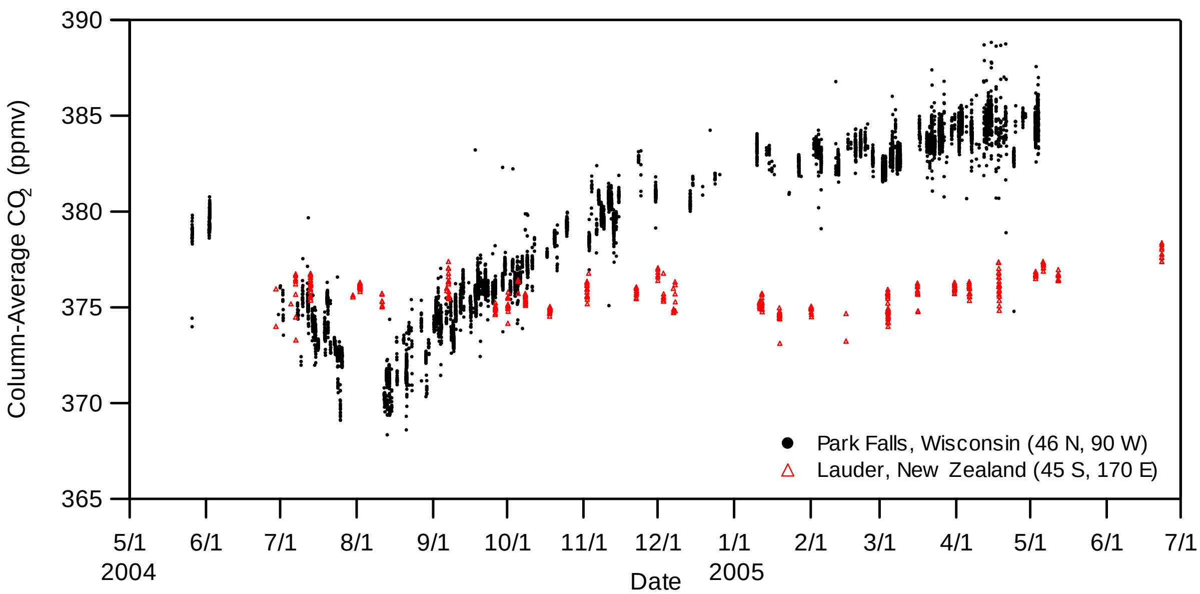

Fig 1. Column-average CO_2 observed at Park Falls, Wisconsin and Lauder, New Zealand during 2004 – 2005.

The reason for the difference in seasonal amplitude between our preliminary column CO_2 measurements and Olsen and Randerson's model results has not been determined. The difference could potentially result from an FTS retrieval bias which is dependent on solar zenith angle (e.g. averaging kernel or systematic error in the CO_2 air-broadened width parameters) and thus varies seasonally. Alternatively, it may result from an error in the model predictions, e.g. due to errors in specification of surface fluxes and/or parameterisation of mixing. Differences may also be due to representation errors associated with model spatial resolution and the comparison of spatially averaged model results with point observations.

REFERENCE

Olsen, S.C., and J.T. Randerson (2004), Differences between surface and column atmospheric CO_2 and implications for carbon cycle research, *J. Geophys. Res.*, *109*, D02301, doi:10.101029/2003JD003968.