

# Preliminary comparisons between the Environment Canada Carbon Assimilation System and data from the TCCON network for CO<sub>2</sub>



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## Introduction

The Environment Canada Carbon Assimilation System (EC-CAS) is being developed in order to obtain routine estimates of global and regional fluxes of greenhouse gases. The ability to understand and predict the carbon cycle in the context of a changing climate is an important scientific goal with implications for global climate policy. The project started in April 2011 as a collaboration between Environment Canada, the University of Toronto, and the University of Waterloo. EC-CAS is based on the EnKF (Ensemble Kalman Filter) and the GEM-MACH (Global Environment Multiscale – Modelling Air quality and Chemistry) model.

The Total Carbon Column Observation Network<sup>[1]</sup> (TCCON) is a network of ground-based Fourier transform spectrometers recording direct solar spectra in the near-infrared spectral region. It provides column averaged dry mole fractions (DMF) of CO<sub>2</sub>, CO, N<sub>2</sub>O, CH<sub>4</sub>, H<sub>2</sub>O, HDO, and HF at high precision.

The purpose of this study is to compare data from EC-CAS to TCCON measurements to determine how well the model can simulate carbon dioxide. Model DMFs of CO<sub>2</sub> will be compared to TCCON DMFs.

## Methodology

EC-CAS profiles and TCCON a priori profiles are on different pressure levels. A linear interpolation is performed to put the EC-CAS profiles on the TCCON pressure levels. The model and a priori profiles are given as mixing ratios in a “wet” atmosphere from which “wet” mole fractions profiles can be derived. Those profiles are converted to “dry” mole fraction profiles using the TCCON a priori H<sub>2</sub>O information (for both the model and a priori profiles). EC-CAS DMFs can be calculated from profiles for comparison with TCCON measurements.

To properly compare the EC-CAS data with TCCON<sup>[4]</sup>, the model profiles are smoothed using the TCCON averaging kernels and a priori profiles, and smoothed columns are calculated using :

$$C = C_a + h^T * a^T * (x - x_a)$$

Smoothed column (C) is calculated from TCCON a priori column (C<sub>a</sub>), vertical summation (h<sup>T</sup>), TCCON averaging kernels (a<sup>T</sup>), and TCCON a priori profile (x - x<sub>a</sub>).

(this is still work in progress and smoothed columns will not be shown)

## Data



- EC-CAS:
  - CO<sub>2</sub> mixing ratio (ppm) profiles

- In this preliminary study, data from the TCCON station at Bialystok (Poland) and Park Falls (Wisconsin, USA) are used. Park Falls was chosen because it is an established station. The Bialystok station was chosen as a second site:

- A priori profiles.
- Averaging kernels.
- Retrieved DMFs.

## Preliminary results

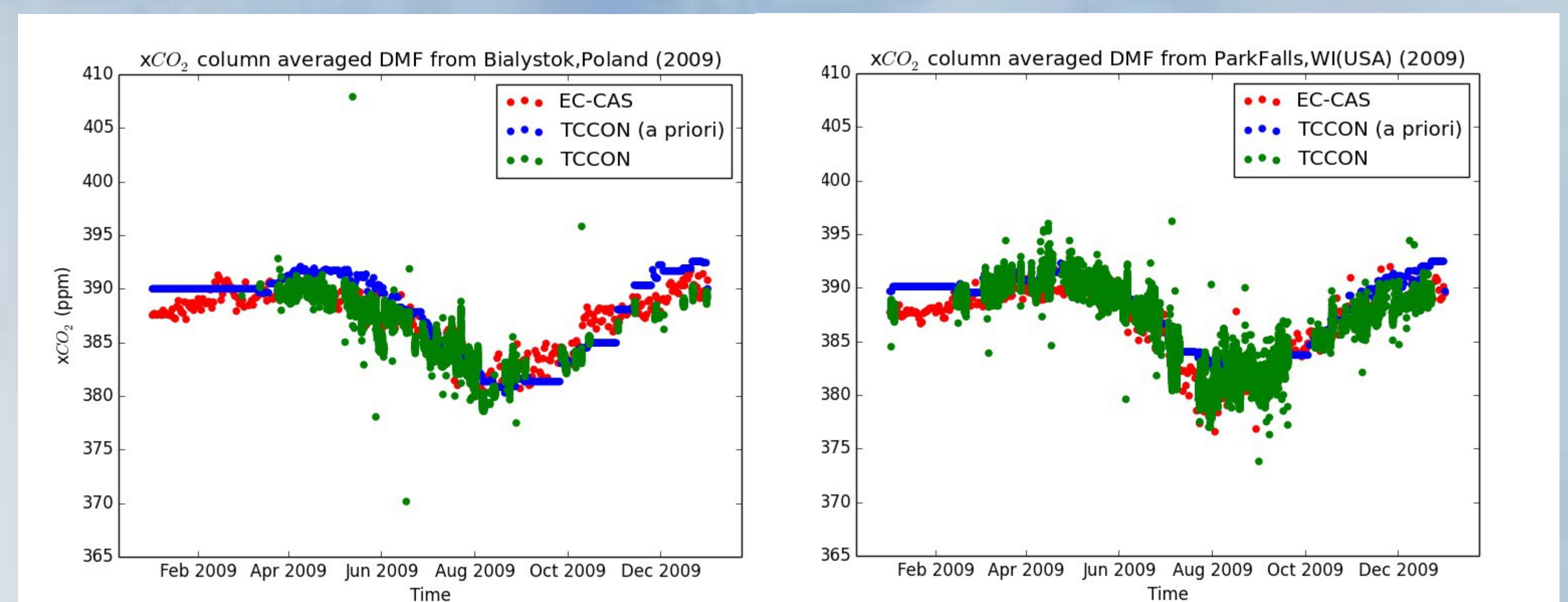


Figure 2: Time series of column averaged dry mole fractions of CO<sub>2</sub> for Bialystok, Poland (left panel) and Park Falls, USA (right panel). EC-CAS (red), TCCON (green), TCCON a priori (blue).

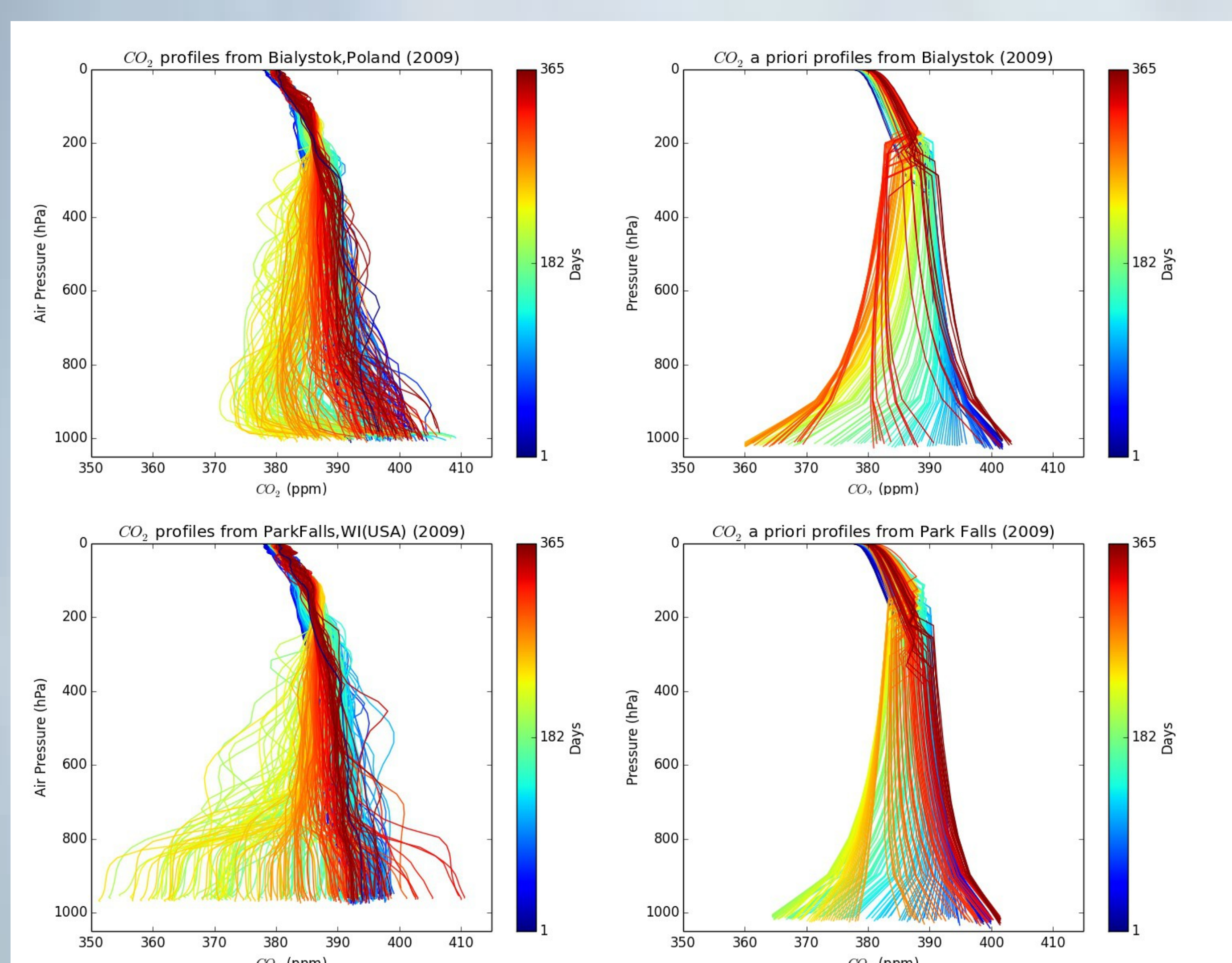


Figure 1: EC-CAS (left panels) and TCCON a priori (right panels) CO<sub>2</sub> profiles for Bialystok, Poland (upper panels) and Park Falls, USA (lower panels) in 2009.

	Difference		Fractional difference	
	DMF <sub>EC-CAS</sub> - DMF <sub>TCCON</sub> (ppm)		100 * (DMF <sub>EC-CAS</sub> - DMF <sub>TCCON</sub> ) / DMF <sub>TCCON</sub>	
	Bialystok	Park Falls	Bialystok	Park Falls
Mean	0.43	-0.50	0.11	-0.13
Standard Deviation	1.21	1.63	0.31	0.42

Table 1: EC-CAS data are given at 00:00 UTC. For this comparison, each EC-CAS column has been compared to the closest TCCON DMF within ± 12 hours of 00:00 UTC. There are 138 coincidences for Bialystok data and 202 coincidences for Park Falls data.

## Conclusion

- In this preliminary study, the 2009 EC-CAS DMFs agree with TCCON data from Bialystok with a mean difference of 0.43 ± 1.21 (std devn) ppm, which corresponds to 0.11%.
- For Park Falls the mean difference is -0.50 ± 1.63 (std devn) ppm, which corresponds to -0.13%.
- TCCON measurements of CO<sub>2</sub> have a precision of 0.2%<sup>[1]</sup> which corresponds to 0.77 ppm for both sites.
- Future work:
  - Smoothing with TCCON averaging kernels and a priori.
  - Error analysis.
  - Extend these comparisons to all TCCON sites.
  - Include comparisons with EC-CAS CH<sub>4</sub>, when available.

## Acknowledgements

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## References

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