

Interactive comment on “Long-term continuous atmospheric CO₂ measurements at Baring Head, New Zealand” by G. W. Brailsford et al.

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We thank the two anonymous referees that provided constructive comments on this paper. The comments and suggestions made by the referees have been considered and our response to them is listed below. In response we have the following revisions we would make to the manuscript.

Anonymous Referee #1

In response to the general comments provided regarding the title of the paper and the first sentence of the abstract, we feel the title remains appropriate, however we have modified the first sentence to more clearly reflect the nature of the paper, so that it now

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reads: “We present descriptions of the in situ instrumentation, calibration procedures, intercomparison efforts, and data filtering methods used in a 39-year record of continuous atmospheric carbon dioxide (CO₂) observations made at Baring Head, New Zealand.”

In response to the second comment regarding the companion paper, we have included a long-term trend analysis of the Baring Head data within the Figure 3, however feel that the companion paper is the best place to describe the interpretation of the Baring Head CO₂ time-series.

In response to the specific comments raised, we have addressed the grammatical issues, and inconsistencies.

P5892 L6: “northeast” has been corrected to “northwest”

P5892 L10: “GAWSIS ID” has been replaced with “GAW ID”

P5893 Sect 3.2: A reference to Fig 2 has been inserted at the start of the system description.

P5896 L19 & L24: The use of the words program and programme we feel are correct, program is used in relation to a computer controlled system, while programme is the framework within which the measurements are made.

P5896 L6-L8: The sentence has been reworded to now read : “Before removal in 1993, the system had a 10 μm inline particle filter with polycarbonate bowl and manual drain located at the inlet to the pump.”

P5901 L17: Comma removed as suggested.

P5902 L13 & 5903 L12: Comparability has been replaced with compatibility.

P5902 L26: The term “small” has been clarified in the sentence “As the hemisphere is dominated by ocean, the seasonal amplitudes of 1 ppm are small compared to northern hemisphere stations that see strong terrestrial signals.”

P5903 L1: We refer to South Pole, Antarctica in the text as an example of “other stations” and within figure 3 we have included a second panel with the long-term trend of CO₂ for both Baring Head and South Pole stations.

Fig 2 & P5893 L10: The inconsistencies in the use of “reference gas” have been resolved. Throughout the paper reference gas now only refers to the gas flowing through the reference cell of the NDIR. Gases that are traceable to the WMO mole fraction scale are referred to as transfer gases or calibration gases.

Fig 3: The text for this caption has been revised and the “steady period” terminology that is used in the text is used in the caption. The figure has been altered with the trend line removed from the time series plot and the second panel added for the long term trend. The axis has been corrected.

Fig4: The font size has been increased and “loess” has been updated to “Loess”.

Anonymous Referee #2

In response to the general comments regarding the in-house technical reports, we feel these documents contain a substantial amount of information and it is appropriate to reference them.

In response to the specific comments raised:

Section 2: The origin of the air masses have been depicted as a set of 4 day back trajectory clusters for a period of 20 years in figure 1. This figure is referenced in the text of section 2.

P5892 L14-15: The text “, and observations from this site are referenced to the WMO mole fraction scale for CO₂.” is removed and is now in Section 3.3.

Sect 3.5: The comparison of Instruments, when changes have taken place are now referenced to the relevant in-house reports.

Sect 3.5: A topic mapping for the internal reports has been made and the text now

reads : "Further information on specific aspects of the historic measurement programme can be obtained from laboratory reports, which provide detailed summaries of data processing during the first 15 years of measurements (Manning and Pohl, 1986; and earlier references therein), a description of calibration gases over similar times (Manning and Pohl, 1987), a description of the LabView system (Gomez, 1997), and presentations of updated data (Manning et al., 1994a; Manning et al., 1994b; Brailsford et al., 2011). The DSIR/NIWA reports are available through the NIWA library (www.niwa.co.nz/news-and-publications)."

P5897 L3-4: The calibration cycle described are sufficient to capture most sources of drift within the steady periods which can last for a duration of a day or so, without using excessive amounts of gas. The text now reads: "It uses a suite of 4 working gases, 3 of which are selected at a time, and measured in a set twice. This is repeated with a new set every 2 hours in a cycle which is sufficient to capture most sources of drift (Manning and Pohl, 1987). The analyser determines if the ambient CO₂ mole fractions have a standard deviation over a 4-hour period of 0.2 ppm or less. If this stability criterion is met, then a "Cycle 2" similar to "Cycle 1" is run every hour. "

Sect 4: The impact of the carrier gas correction been described with the text now reading: "The Baring Head measurements were initiated before the so called "carrier-gas effect" (Bischoff, 1975; Pearman and Garratt, 1975) was understood. This refers to the importance of the balance of N₂ and O₂ in the calibration gases and their differential impact on pressure broadening of the CO₂ absorption lines. This impact is sensor and time dependent and can typically be as large as 5 ppm."

P5899 L14: Our discussion of the error propagation has been expanded with a section heading, 5.1 Error propagation, and the following text: "We estimate the error contribution from drift in analyser response between calibrations as the geometric mean of a 0.05 ppm repeatability estimate and the monthly standard deviation of instrument sensitivities scaled by the measured span, with resulting values typically 0.1 to 0.2 ppm. We estimate the error in the working tank mole fraction assignments to be 0.2 ppm."

We sum these two error contributions, and the contribution from short-term variability, geometrically to generate final error estimates that are nominally 0.3 ppm on 5-minute to 30-minute measurements during stable CO₂ conditions.”

P5900 L4: The words “trend significantly” have been replaced with “slowly vary”

P5900 L11-12: A new section, 5.2 Data selection, has been inserted. This has a discussion of the filtering process stating, “Steady periods represent 13% of the complete record, occur an average of 36 times per year, and last an average of 17 hours each. The steady periods are further selected for southerly wind conditions only, as strong northerlies can show terrestrial influence but also have low CO₂ variability. This filter removes 8% of the remaining record. “ In addition all available unfiltered hourly data has been included in the Fig 3 plot as a grey shade.

P5900 L24: The Fig 4 is now referenced as suggested after “ independent comparison to the continuous analyser”

P5901 L1: Regarding the results from the stable isotope measurements, we feel it is outside the scope of this paper to discuss them here, and have provided the reader with a link to the data at (<http://ds.data.jma.go.jp/gmd/wdcgg/>).

P5901 L9: The assessment of the CRDS Picarro instrument and the Siemens NDIR are not currently available so it is not appropriate to comment further within the text.

Table 1: The acronym CCL has been stated here, and sub-headings included in the table of Tank 1, Tank 2 and Tank 3 to improve the clarity of the table.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 5889, 2012.

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