**Supplemental Material**

*Gas Flux Calculations*

Gas fluxes were calculated from the linear periods of change in gas concentrations in the chamber over time (dC/dt) using the ideal gas law (Eq. 1).

F=dC/dt(PV/RAT) (1)

Where F is the calculated flux (moles per unit area per unit time), dC/dt (ppm s-1) is the slope of the linear regression of concentration vs. time, V is the chamber volume (m3), T is the temperature (K), P is pressure (Pa) and A is the surface area (m2) of the mesocosms or field plots that were measured. The Picarro measures gases on average every seven seconds but interpolated concentrations are reported for each gas approximately every two seconds. These raw interpolated data were used in the flux calculations. Fluxes calculated from Shimadzu GC-2014, Picarro and LGR concentration data will be referred to as Shimadzu GC-2014 fluxes, Picarro fluxes, and LGR fluxes, respectively throughout the manuscript.

*Monte Carlo simulations of instrument noise*

For the Picarro G2508 the noise of the instrument was first quantified by connecting it on a closed loop to a single bottle of compressed ambient air with approximately 0.33 ppm of N2O, 400 ppm of CO2, and 1,800 ppb of CH4 (Air Liquide America Specialty Gases). This single bottle was continuously measured for 30 hours. The Allan standard deviation of the resulting data set was modelled (Allan 1966) for each of the three gases with a combination of a Gaussian white noise term that follows a square root law, a flicker noise (also called 1/f or pink noise) term that leads to a constant Allan standard deviation independent of averaging, and a random walk noise term (also called brown noise). A Monte Carlo simulation of the instrument noise was performed, using optimized parameters for each of these three noise sources for each gas species. The simulation generated 200 realizations of a 30 hour time series and computed the Allan standard deviation of the resulting time series. This analysis was repeated for N2O only for the LGR analyzer with measured data provided by Los Gatos Research, Inc.

The average Allan standard deviation from the 200 Monte Carlo realizations is shown in Figure 1A as light colored symbols; the variability (1-sigma) of the simulated Allan standard deviation is also shown as error bars in the figure. Simple Gaussian (white) noise improves with the square root of the averaging period $τ$, as indicated by the dashed gray lines in the figure. For N2O and CO2, the averaging follows the square root dependence for more than 1000 seconds; for CH4, the averaging improves out to about 200 seconds, after which, it becomes rather flat. The LGR analyzer exhibits a dramatically smaller (40X) white noise contribution, and a moderately smaller brown noise contribution (2.6X) than the Picarro analyzer.

*Mesocosm conditions for Objective 2*

Prior to gas flux measurements, both mesocosms were placed in a climate controlled chamber (Conviron® Model PGR15) for 11 weeks with the following conditions: CO2: 700 ppm, day temperature: 33°C, and night temperature: 23°C. The chambers simulated 15 hours of day (875 µmol m-2 s-1 of fluorescent and incandescent lamps) and 9 hours of night (lamps off). The mesocosms were maintained in bins of 12 -15 psu seawater.

*Gas Chromatography Methods*

Gas samples were analyzed on a Shimadzu GC-2014 equipped with a flame ionization detector for CH4 and CO2 and an electron capture detector for N2O. Helium was used as a carrier gas and p5 (5% CH4, balance Argon) as a makeup gas with a flow rate of 2.5 mL/min. The column flow rate was 25 mL/min. Hydrogen and Air were used for flame gases. The Shimadzu GC-2014 contains four 1/8” packed, stainless steel columns: 1.0 m Hayesep N or T 80/100 mesh, 4.0 m Hayesep D 80/100 mesh, 1.5 m Hayesep N 80/100 mesh, 1.5 m Hayesep N 80/100 mesh, 0.7 m Shimalite Q 100/180 mesh. The temperature of the columns was 80°C. The temperature of the FID and ECD were 250°C and 325°C respectively.

*Impacts of closure time and averaging period with Picarro and LGR data*

For the Picarro, there is an improvement in the minimum detectable slope for each gas with increased chamber closure time, improving as 1 / T1.5 (T = seconds). Some of this improvement was due to the increased data contained in the measurement period (leading to an improvement with 1 / T0.5), and the remainder was due to the larger time span of the fit, improving the determination of the slope (leading to a 1 / Timprovement). For the LGR the minimum detectable slope improves with increased chamber closure time, as 1/T0.75. This is due to an increasing influence of the brown noise component for times greater than 100 seconds for the analyzer. The minimum detectable slope for N2O for the LGR analyzer is one to two orders of magnitude lower than for the Picarro (Table 1). The LGR also had a higher precision for N2O because the lines used by mid-IR (LGR) are about 105 times stronger than the lines used in near-IR (Picarro). However, the Allan variance for the Picarro extends to an hour for N2O (rather than 100 seconds for the LGR) (Figure 1) and is evidence of the reduced sensitivity of the Picarro to environmental factors.

|  |
| --- |
| **Table 1.** Methane and carbon dioxide fluxes calculated from Picarro and Shimadzu GC-2014 data from mesocosm A-1 and A-2. Fluxes with p-value >0.05 and/or with slopes below the detection limit are reported as “not determined” (ND) in the table. Normalized root mean square error (NRMSE) is also shown.  |
| A. CH4 |  |  |  |  |  |  |  |  |  |  |  |  |
| Mesocosm | Meas.# | Picarro |   | GC |
| p-value | NRMSE | R2 | Slope (ppb/s) | Flux(µmol m-2h-1) |   | Flux(µmol m-2h-1) | Slope(ppb/s) | R2 | NRMSE | p-value |
| A-1 | 1 | <0.05 | 0.18 | 0.63 | 4.98 x 10-3 | 1.0 |  | ND | 0.06 | 0.00 | 0.18 | 0.93 |
| 2 | 0.58 | 0.31 | -0.04 | 9.28 x 10-4 | ND |  | ND | 0.08 | 0.01 | 1.60 | 0.85 |
| 3 | <0.05 | 0.20 | 0.38 | 3.64 x 10-3 | ND |   | ND | 0.14 | 0.01 | 1.54 | 0.79 |
| A-2 | 1 | <0.05 | 0.04 | 0.98 | 22.28 | 4604 |   | 4414 | 21.47 | 0.93 | 0.50 | <0.05 |
| 2 | <0.05 | 0.01 | 1.00 | 6.63 | 1371 |  | ND | 4.58 | 0.81 | 0.93 | <0.05 |
| 3 | <0.05 | 0.01 | 1.00 | 4.91 | 1016 |   | ND | 4.21 | 0.75 | 0.38 | <0.05 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| B. CO2 |  |  |  |  |  |  |  |  |  |  |  |  |
| Mesocosm | Meas.# | Picarro |   | GC |
| p-value | NRMSE | R2 | Slope (ppb/s) | Flux(µmol m-2s-1) |   | Flux(µmol m-2s-1) | Slope(ppb/s) | R2 | NRMSE | p-value |
| A-1 | 1 | <0.05 | 0.03 | 0.99 | 31.90 | 1.8 |  | ND | 75.64 | 0.00 | 0.17 | 0.89 |
| 2 | <0.05 | 0.03 | 0.99 | 26.44 | ND |  | ND | 141.37 | 0.11 | 0.31 | 0.46 |
| 3 | <0.05 | 0.03 | 0.99 | 23.50 | ND |   | ND | 214.29 | 0.20 | 0.47 | 0.30 |
| A-2 | 1 | <0.05 | 0.02 | 1.00 | 550.02 | 31.6 |   | ND | 639.03 | 0.53 | 2.38 | 0.05 |
| 2 | <0.05 | 0.01 | 1.00 | 339.33 | 19.5 |  | ND | -149.71 | 0.10 | 0.44 | 0.52 |
| 3 | <0.05 | 0.01 | 1.00 | 284.95 | 16.4 |   | ND | 261.69 | 0.22 | 0.69 | 0.28 |