**Additional file 1:**

**Continuous monitoring of soil CO2 flux at Aso volcano, Japan: The influence of environmental parameters on diffuse degassing**

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Here we present supplementary information on the continuous monitoring, supplementary figures (Figures S1, S2, and S3), and a supplementary table (Table S1) in the following sections.

**Details of the continuous monitoring of soil CO2 flux**

The station performed soil CO2 flux measurements using the accumulation chamber method (Parkinson 1981; Chiodini et al. 1998). Every hour a chamber automatically descended into the ground, and the gas-air mixture accumulated in the chamber was pumped into a non-dispersive infrared detector LI-820 (LI-COR Inc.). The detector measured the CO2 concentration with a range from 0 to 20,000 ppm. The soil CO2 flux (*F* in g m−2 day−1) was calculated based on an increase in the CO2 concentrations during the measurement (*s* in ppm s−1) using an air temperature (*T* in K) and a barometric pressure (*P* in hPa):   
, (1)  
where *R* denotes the gas constant (= 8.31451 J K−1 mol−1), and *V* and *A* respectively correspond to the volume and the area of the chamber (*V/A* = 0.125 m). A typical example of the increase in the CO2 concentrations is shown in Figure S1. Dionis et al. (2015) reported that the accuracy of soil CO2 flux was within ±25% for the range of 22–220 g m−2 day−1 using a similar instrument. Although a typical value of soil CO2 flux in the present study was one order of magnitude lower than the range of soil CO2 flux for the reported accuracy, the accuracy of soil CO2 flux in the present study unlikely deviated from the previous value, as shown in Figure S1.

The station also performed measurements of environmental parameters, such as air temperature, air relative humidity, barometric pressure, wind speed, wind direction (direction where the wind blew from), soil humidity, soil temperature, and precipitation (Table S1). The environmental parameter data, as well as the soil CO2 flux data, were transferred to a server at Geochemical Research Center of the University of Tokyo by 3G telecommunication networks.

In the present study, the data between 8 January 2016 and 20 November 2017 were reported. During the observation, the sensor for the air temperature and the air relative humidity malfunctioned from September to December 2016 and from August 2017 to the end of the present study. The rain gauge was also out-of-order from October 2016. Therefore, for air temperature and precipitation data of the missing period, those data obtained at a weather station maintained by the JMA (200 m from the soil CO2 flux station; Figure 1) were used. Before the analysis described in the main text, consistency between these data obtained at the soil CO2 flux station and the weather station was checked (Figure S2). For the air temperature and the precipitation, the data of the soil CO2 flux station were consistent with those of the weather station (Figures S2a and S2b). Thus, for these two parameters, we used the data of the weather station without any transformation only when the data of the soil CO2 flux station were not available. For the air relative humidity data, the variability of the data between the two stations deviated from the 1:1 line (Figure S2c). Therefore, the data of the weather station were used for the whole observed period in the analysis. The environmental parameters at the weather station were also missing during October 2016–January 2017 due to damage caused by the 8 October 2016 eruption. It meant that the air temperature data between October and December 2016 were missing at both stations. We linearly interpolated data of the air temperature during this 3-month period. Furthermore, during the winter season (late December to March), our station was often covered with snow, and the accumulation chamber system often froze. Consequently, the soil CO2 flux data in the winter season were frequently missing.

**Figures and Tables**

Figure S1 shows a typical slope of an increase of CO2 concentrations in the accumulation chamber measured at the station. Figure S2 shows correlation plots of air temperature, precipitation, and air relative humidity between the soil CO2 flux station and the weather station. Figure S3 shows a histogram of soil CO2 flux and correlation plots of soil CO2 flux to each environmental parameter. Table S1 presents technical characteristics of the soil CO2 flux station such as sensor type, elevation or depth of the sensor from the ground, and measurement accuracy and range.

**References**

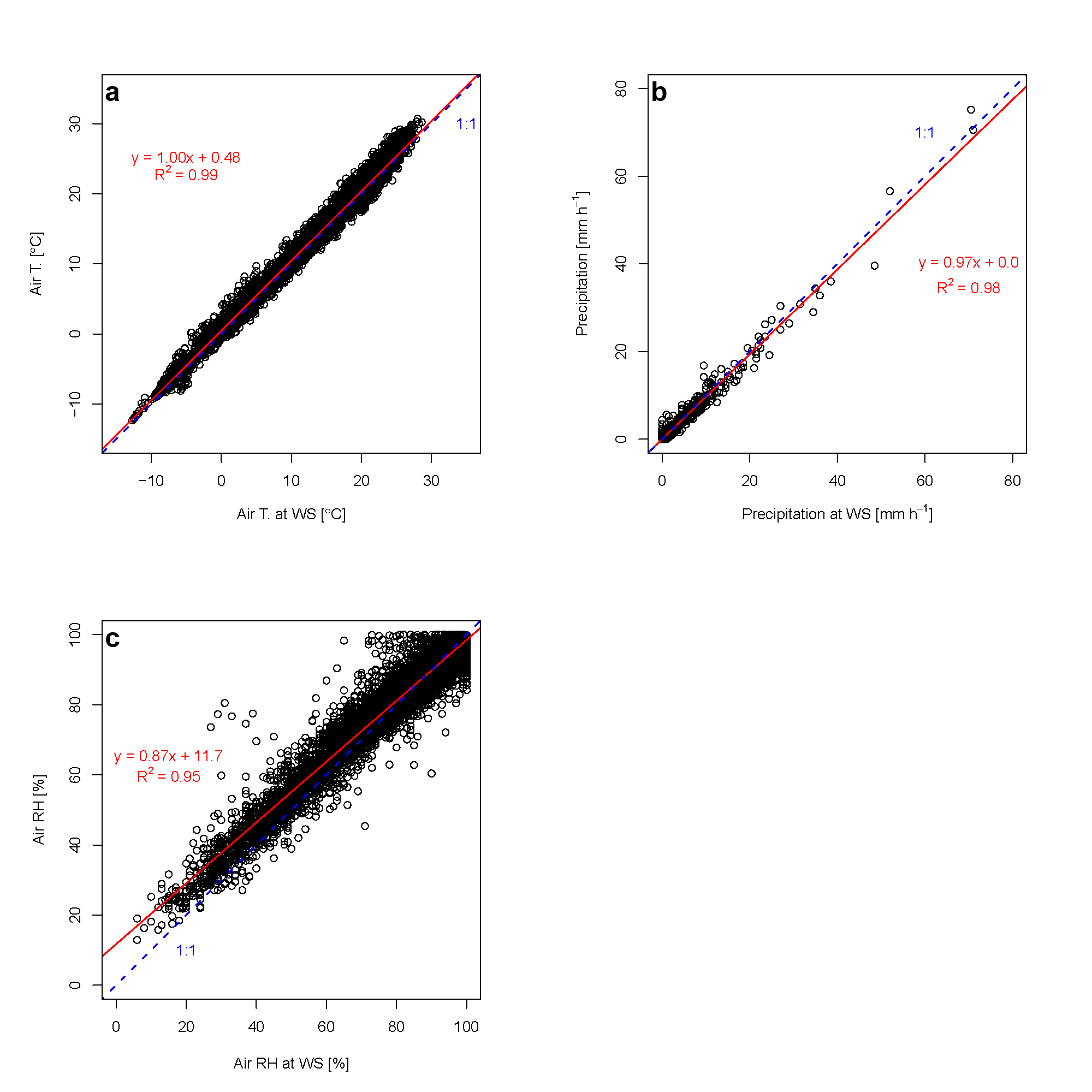
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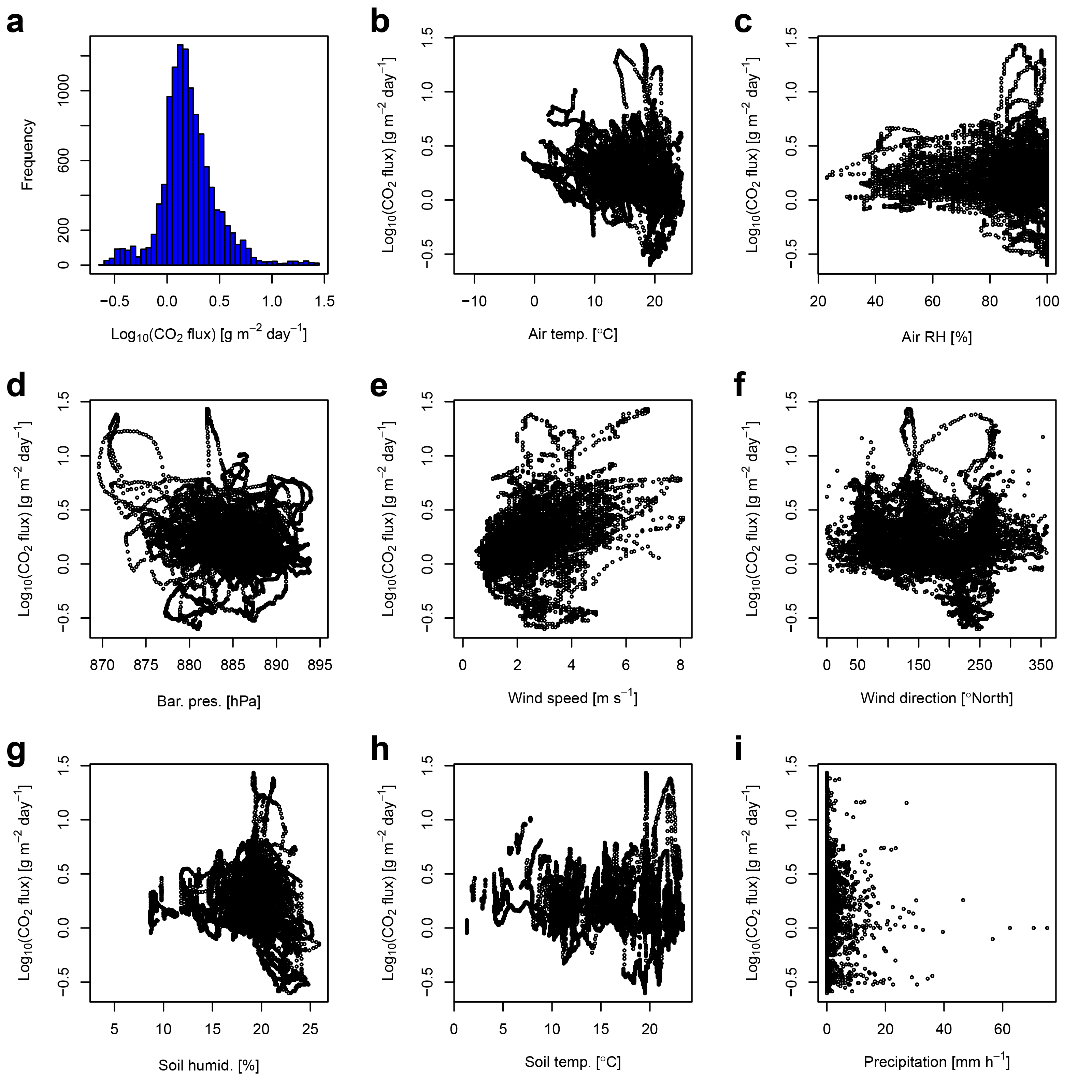
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**Figure S1**

The typical slope of an increase in CO2 concentrations of the accumulation chamber measured at the station (18h00 local time on 24 May 2016). The blue circles are the concentrations, and the red line corresponds to the fitted slope. In this case, the slope was 0.228 ppm s−1, which was converted to 3.97 g m−2 day−1.

**Figure S2**

a) Air temperature, b) precipitation, and c) air relative humidity data at the soil CO2 flux station (y-axis) and the weather station (x-axis). The red line shows the linear regression line, and the blue dotted line shows the 1:1 line.

**Figure S3**

a) Histogram of the daily average values of soil CO2 flux data and correlation plots of the daily average values of soil CO2 flux to those of b) air temperature, c) air relative humidity, d) barometric pressure, e) wind speed, f) wind direction, g) soil humidity, h) soil temperature, and i) precipitation. Soil CO2 flux values are shown in log scale.

**Table S1**

Technical characteristics of soil CO2 flux station.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Sensor | Elevation/Depth from the ground | Accuracy | Range |
| Soil CO2 flux | LI-820, LI-COR | 0 m | ±25% at 22–220 g m−2 day−1 *a* | nd*b* |
| Air temperature | Solid-state sensor | 1.5 m | ±0.4 °C at 5–40 °C | −30–70 °C |
| Air relative humidity | Solid-state sensor | 1.5 m | ±2% at 10–90% | 10–98% |
| Barometric pressure | PTB110, VAISALA | 1.5 m | ±0.3 hPa at 20 °C | 500–1100 hPa |
| Soil temperature | Pt100 probe, RS Components | −0.5 m | ±0.5 °C | 0–200 °C |
| Soil humidity | CS616, Campbell Scientific | −0.5 m | ±2.5% | 0–50% |
| Wind speed | Ultrasonic sensor, Gill Instruments | 1.5 m | ±2% at 12m s−1 | 0–60 m s−1 |
| Wind direction | Ultrasonic sensor, Gill Instruments | 1.5 m | ±2° at 12m s−1 | 0–359 °North |
| Precipitation | DQA130, LSI-Lastem | 1.5 m | ±1% | 0–600 mm h−1 |

*a*Dionis et al. (2015), *b*: not determined