

1    **Supplemental information for neonSoilFlux:**

2    **An R Package for Continuous Sensor-Based**

3    **Estimation of Soil CO<sub>2</sub> Fluxes**

4

5    **1 Assessment of data gaps**

6    For a given half-hourly time period, the `neonSoilFlux` package assigns a QA flag for a  
7    measurement if more than one values across all measurement depths uses gap-filled data (Section  
8    4.2.1 of the main text). Panel a of Figure S1 reports the proportion of gap-filled data for all  
9    input environmental measurements at each site during the period when field measurements  
10   were made. Soil fluxes are computed from 4 different types of input measurements ( $T_S$ ,  $SWC$ ,  
11    $P$ , and  $CO_2$ ), any of which could have a QA flag in a half-hourly interval. Panel b of Figure S1  
12   displays at each site the distribution of the number of different gap-filled measurements used  
13   to compute a half-hourly flux. The largest cause of measurements needing to be gap-filled was  
14   missing or flagged soil moisture data. Calculating fluxes for WOOD and SJER required using  
15   the largest proportion of gap-filled measurements, due to substantially large fractions of flagged  
16   or missing  $SWC$  and  $T_S$  data.

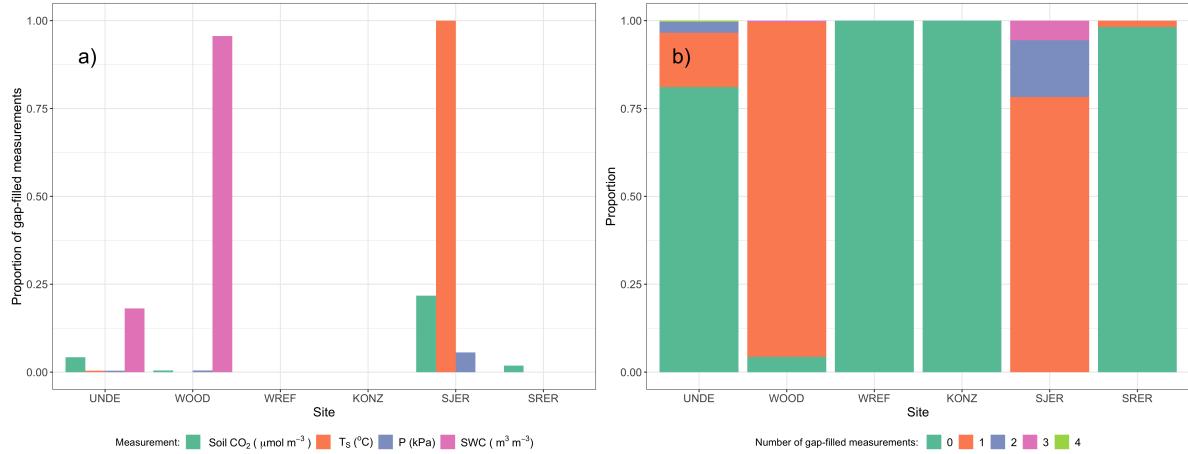


Figure S1: Panel a) Proportion of input gap-filled environmental measurements used to generate  $F_S$  from the `neonSoilFlux` package, by study site. Panel b) distribution of the usage of gap-filled measurements at each site.

17 **2 Assessing the signal to noise ratio (SNR) and evaluating  
18 estimated uncertainties**

19 Following collection of field measurements and calculation of the soil fluxes from `neonSoilFlux`  
20 package, we compared measured  $F_S$  based on closed-dynamic chamber measurements with the  
21 LI-COR instruments to a given soil flux calculation from `neonSoilFlux` for each site and flux  
22 computation method. Beyond the model statistics defined in the main text, we computed the  
23 signal to noise ratio (SNR), defined as the ratio of a modeled soil flux ( $F_{ijk}$ ) from `neonSoilFlux`  
24 to its quadrature uncertainty ( $\sigma_{ijk}$ ).

25 We observed that the range of values (e.g.  $F_{ijk} \pm \sigma_{ijk}$ ) was much larger than the measured field  
26 flux. We evaluated  $|F_S - F_{ijk}| < (1 - \epsilon)\sigma_{ijk}$ , where  $F_S$  is a measured field soil flux from the  
27 LI-COR 6800 (as the LI-COR 870/8250 was used at only three sites in 2024 but the 6800  
28 was used at all sites in both years). The parameter  $\epsilon$  was an uncertainty reduction factor to  
29 evaluate how much the quadrature uncertainty could be reduced while maintaining precision  
30 between modeled  $F_{ijk}$  and measured  $F_S$ .

31 The computed signal to noise ratio (SNR) and the proportion of measured field fluxes within  
 32 the modeled uncertainty for a given flux computation method  $F_{ijk}$  suggest that there was  
 33 substantial variability in the agreement between the gradient method and field-measured  
 34 observations (Figure S2, Section 4.3 of the main text). Here, values of SNR greater than unity  
 35 indicate lower reported uncertainty, as propagated by quadrature due to a relatively higher  
 36 precision of measured input variables ( $\text{CO}_2$ ,  $T_S$ ,  $\text{SWC}$ , or  $P$ ).

37 The sensitivity to an uncertainty reduction factor ( $\epsilon$ , bottom panels in Figure S2) demonstrates  
 38 how concordance between measured and modeled fluxes would be affected if environmental  
 39 measurement uncertainty  $\sigma_{ijk}$  were to decrease. As  $\epsilon$  increases from left to right in each figure,  
 40 the possible range of values for each predicted flux value decreases and the proportion of  
 41 measured fluxes that fall within that range also decreases.

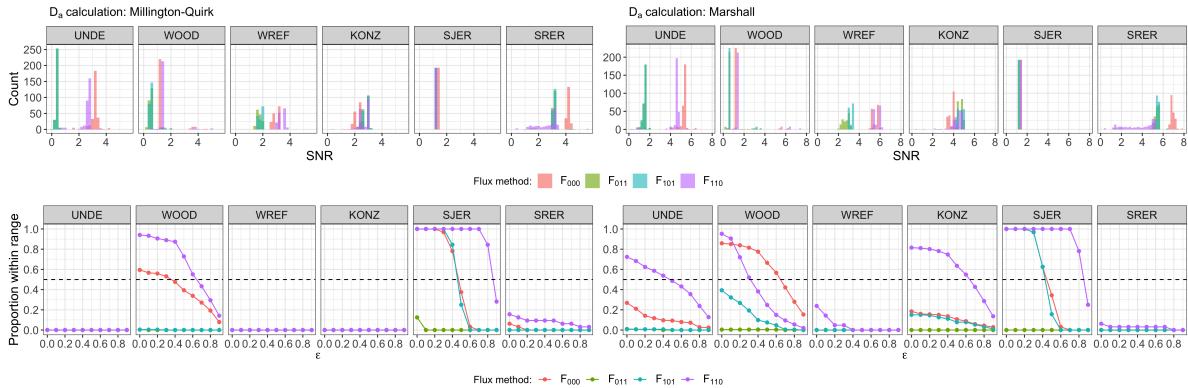


Figure S2: Top panels: distribution of SNR values across each of the different sites for modeled effluxes from the `neonSoilFlux` package, depending on the diffusivity calculation used (Millington-Quirk or Marshall, Section 4.2.2 of the main text). Bottom panels: Proportion of measured  $F_S$  within the modeled range of a flux computation method  $F_{ijk}$  given an uncertainty reduction factor  $\epsilon$ , or  $|F_S - F_{ijk}| < (1 - \epsilon)\sigma_{ijk}$ .