



Figure 9. Comparison of net ecosystem exchange (NEE) and negative intermediate ions at 2.0–2.3 nm (a), NEE and air temperature (b), and negative intermediate ions at 2.0–2.3 nm and air temperature (c) across different sites. The dots represent median values at midday during summer (10:00–14:00 LT). Error bars indicate the 10th and 25th percentiles for NEE and the 75th and 90th percentiles for negative intermediate ions and air temperature, reflecting the CO₂ uptake rate and aerosol formation under optimal conditions. [TS2](#)

quite site-specific. More observation years are needed to reduce the estimation errors of NEE. Compared with NEE, the inter-annual variation in N_{neg} at midday during summer fluctuated at a small magnitude across years (Table 2). Hence, the measured N_{neg} in the reported year can be considered to be relatively representative of the local aerosol production at the site. Moreover, the N_{neg} may originate from areas (sub-1 km; Tuovinen et al., 2024) larger than the ecosystem coverage, e.g. the agricultural sites within a radius of 500 m, leading to unavoidable uncertainties in the results.

Another potent greenhouse gas, methane (CH₄), can be emitted through microbial activities under anoxic conditions, e.g. peatlands and coastal areas (Mathijssen et al., 2022; Roth et al., 2023). Considering the fact that CH₄ has a sustained-flux global warming potential 45 times that of CO₂ over 100 years (Roth et al., 2023, and the reference therein), the net CO₂ equivalent emission of CH₄ is estimated to be 2.5–8.6 times that of CO₂ uptake at P-SII (Mathijssen et al., 2022). CH₄ emissions may largely compensate for the CO₂ uptake in open and non-ditched peatlands. Similarly, the emission of CH₄ from coastal environments around the Baltic Sea may offset 28 % of the CO₂ sink in macroalgae-

dominated coastal areas (Roth et al., 2023). For ions, the summertime midday median N_{neg} at P-SII was 77 % of that at F-HYY (Table 2). As the open peatland is surrounded by forest within 1 km, the negative ion at 2.0–2.3 nm may be influenced by nearby forests.

Additionally, the albedo varies between each ecosystem type due to variations in vegetation cover (Peräkylä et al., 2025). Our research focused on the potential of different ecosystems for momentary CO₂ uptake and local aerosol production, thus omitting the albedo impact. Further research is still needed to evaluate the total climate impacts at the ecosystem level, including other greenhouse gas emissions and/or uptake, albedo, carbon input from fertilization (for agricultural fields), and biomass harvests.

4 Conclusions

The CarbonSink+ potential concept was established recently and provides a direct comparison of local contributions to CO₂ uptake and aerosol formation at the ecosystem scale. The value of negative intermediate ion concentrations within the 2.0–2.3 nm size range (N_{neg}) was applied as an indicator