CarboFlux Network: Novel Sensor Node Design for Enhanced CO2 Flux Measurement and Global Ecosystem Monitoring

Bulusu, Sahiti (School: BASIS Independent Fremont)

Recognizing CO2's pivotal role in climate change, and soil carbon as the major active pool of terrestrial carbon, Carboflux introduces a novel method to quantify soil carbon flux, which measures the CO2 exchange rate between soil and atmosphere. Traditional approaches suffer from high costs, low spatial and temporal resolution, and regional silos. By innovatively integrating Gradient and Chamber methods in a single node, Carboflux offers a comprehensive solution for continuous monitoring of CO2 flux across various soil depths. Further, the capability to network these nodes allows for scaling on a global level. Comprised of three subunits – a microcontroller unit to sequence measurements, sub-soil sensors for CO2 and environmental variables' measurements, and a low-cost flux chamber – the nodes are part of a global network for data collection and cloud-based analysis. Results revealed depth-dependent soil respiration rates, validated by stable and accurate sensor readings corroborated with gas chromatograph calibration. A mean flux value of 2.1007 µmol m-2 s-1 was measured (by chamber at surface), 2.0516 µmol m-2 s-1 (at 5 cm) and 1.8395 µmol m-2 s-1 at (10 cm). Diurnal CO2 flux variations were observed, increasing post-precipitation, highlighting the ability to capture responses of soil carbon to environmental stimuli. This innovative approach offers scalable and cost-effective soil respiration monitoring, pivotal for validating climate models, enhancing agricultural sustainability and assessing ecosystem biodiversity. CarboFlux has the potential to generate novel datasets that can contribute vital insights for global carbon cycle modeling and be used in international climate change mitigation policy.