PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

04/2008

CONTINUOUS, NON-INVASIVE, IN-FIELD SOIL CARBON SCANNING SYSTEM

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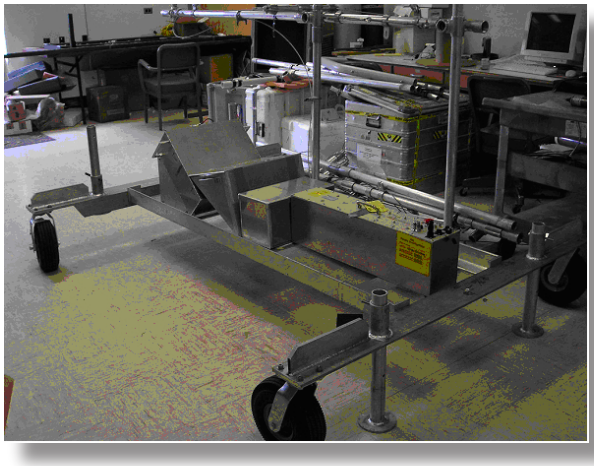
Background

Vegetation and soils serve as carbon storage sinks for the approximately 2 billion tons of carbon absorbed annually by the global biosphere. While global warming is promoted by anthropogenic carbon dioxide (CO_2) emissions into the atmosphere, it is partially mitigated by carbon sequestration in the terrestrial ecosystem. However, a better understanding and monitoring of the underground carbon processes is necessary for evaluating various strategies for terrestrial carbon sequestration and quantification of the carbon stores for carbon credits.

Description

Brookhaven National Laboratory (BNL) has developed a multi-elemental scanning instrument for determining carbon analysis in soil. The method is based on inelastic neutron scattering (INS), which offers a noninvasive means for continuous monitoring of the soil carbon and other elements in situ over both specific plots and large areas. This technique can significantly improve quantification of the efficacy of terrestrial carbon sequestration methodologies. The proposed instrument enables a continuous scan and evaluates the mean soil carbon content in the field to a depth of about 20 centimeters. The benefit from such a system is its capability to monitor belowground carbon processes without disturbing the soil, which allows for continuous scanning of large areas, thus providing a true mean carbon concentration in soil. The system also enables repetitive measurements of the same site, resulting in sequential monitoring of large areas. Proof-of-principle has been demonstrated in several double-blind field studies in which the INS results were calibrated successfully against chemical analyses of soil core samples taken from the same site. The results from feasibility studies suggested that the requirement to measure changes of as little as 100 grams of carbon per square meter could be met with about 5 percent accuracy.



Mobile INS System Developed by BN

PARTNER

Brookhaven National Laboratory

PERIOD OF PERFORMANCE

06/01/2003 to 09/30/2007

COST

Total Project Value

$1,290,200

DOE/Non-DOE Share

$1,290,200 / $0

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Primary Project Goals

The purpose of this project is the development of an instrument with the capability for safe, rapid, non-destructive, multi-elemental, in situ soil carbon quantification and profiling over large areas and soil volumes.

Objectives

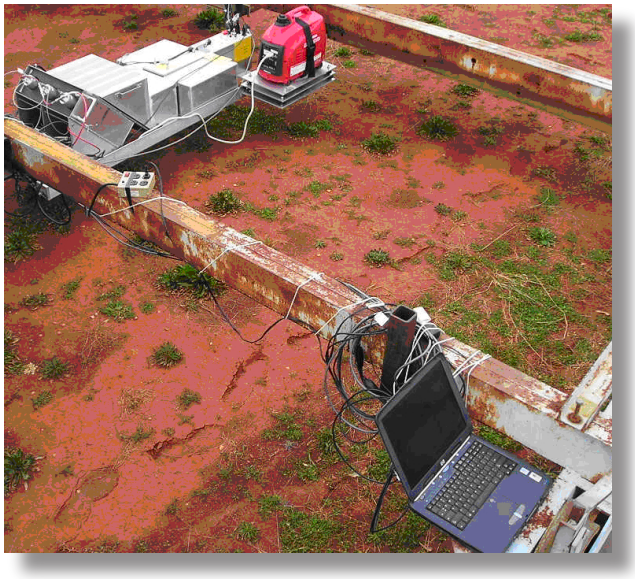
The objectives of this project were: (1) to design and construct an INS system for continuous soil carbon scanning in the field, and (2) to perform measurements in various soil types where the soil carbon content was well characterized. The system also allowed for comparison and development of conversion factors to scale specific point measurements obtained by techniques other than INS to large field values.

Benefits

This project succeeded in developing a robust, flexible, non-invasive, scanning system for in situ monitoring and in verifying temporal changes in soil carbon over large areas. The anticipated benefit from such a system is the ability to monitor belowground carbon processes without disturbing the soil. Furthermore, the system enables continuous scanning of large areas, thus providing a true mean carbon concentration in the soil. This soil carbon scanning system performed, uniquely and for the first time, repetitive measurement of the same site, thus allowing for sequential monitoring of large areas.

Accomplishments

- BNL researchers partnered with the U.S. Department of Agriculture to conduct measurements of soil carbon in Duke Forest in North Carolina and at the Auburn, Alabama, Agricultural Research Service (ARS) facility. Measurements showed relatively high correlation between traditionally measured values and INS system measurements.
- An INS system for non-destructive, in-field soil carbon analysis, in both static and scanning modes, has been constructed and tested. The results demonstrated the proof-of-principle and feasibility of using the system as intended.
- It was shown that elements such as nitrogen (N), potassium (K), calcium (Ca), and phosphorus (P) can also be measured with the INS system.
- The design of an upgraded INS beta prototype system has been completed, with new electronics capable of supporting 16 detectors.
- Software for spectral processing and analysis has been developed and implemented.
- A Monte Carlo N-Particle (MCNP) model of the system has been developed.



INS System at USDA Facility in Auburn, AL