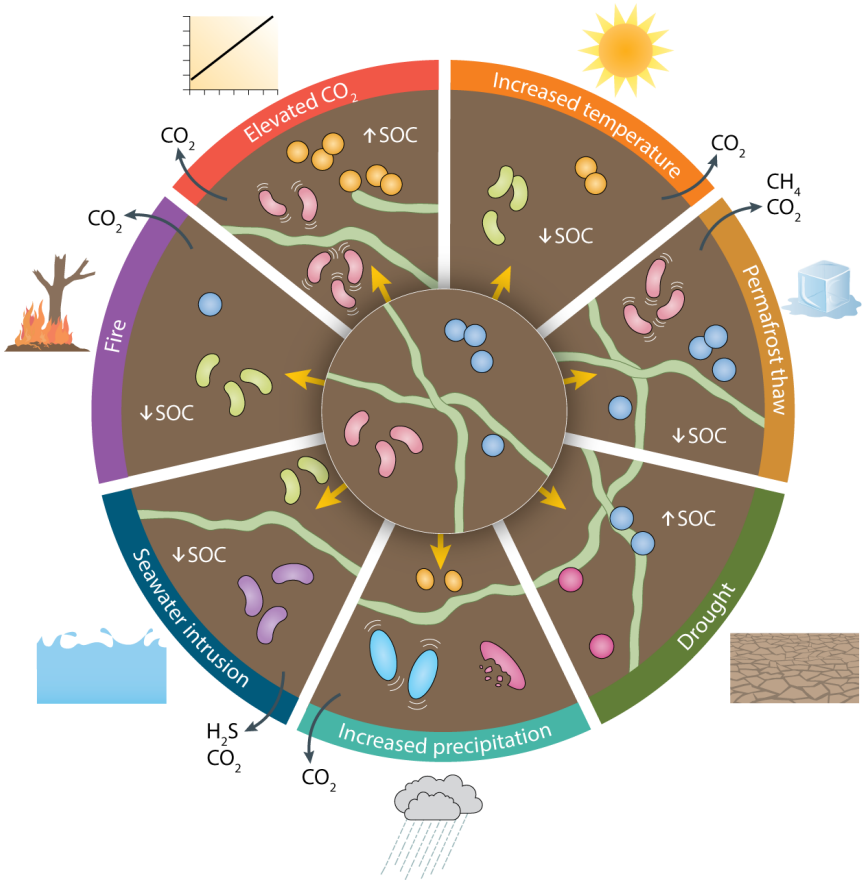
Pacific Northwest
NATIONAL LABORATORY

Real Time Probing Respiration in Soils

Mary S. Lipton
Pacific Northwest National Laboratory

U.S. DEPARTMENT OF ENERGY BATTELLE

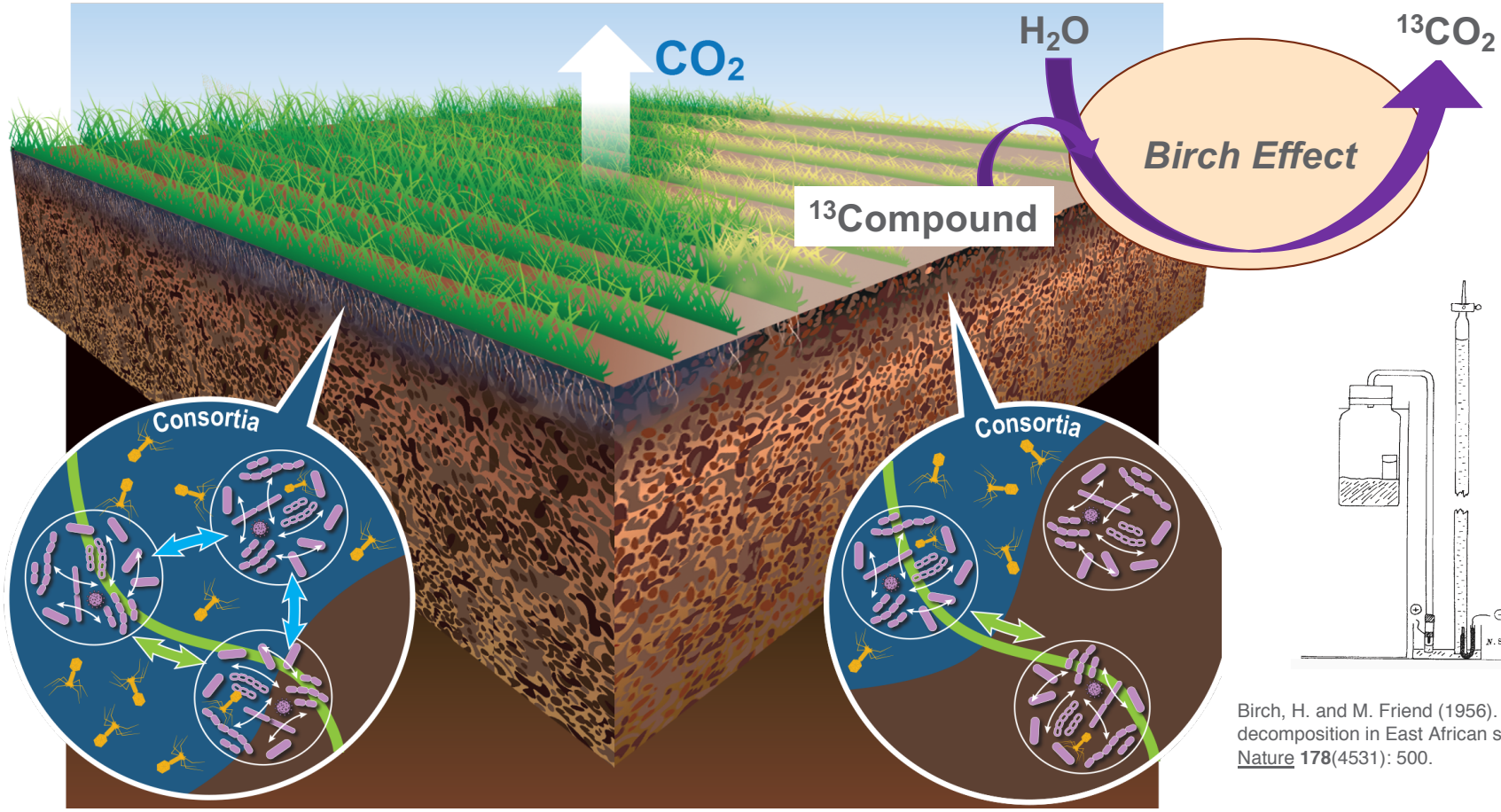
PNNL is operated by Battelle for the U.S. Department of Energy



Jansson & Hofmockel. Nature Microbiology Reviews. 2019

Pacific Northwest
NATIONAL LABORATORY

How will changes in soil moisture impact the metaphenome of grassland soils?



Birch, H. and M. Friend (1956). "Humus decomposition in East African soils." Nature **178**(4531): 500.

What microbial mechanisms encompass the nutrient and carbon pulses?

Nutrient and carbon pulses are due to a hypo-osmotic stress response of the soil microbial community after sudden changes in soil water status

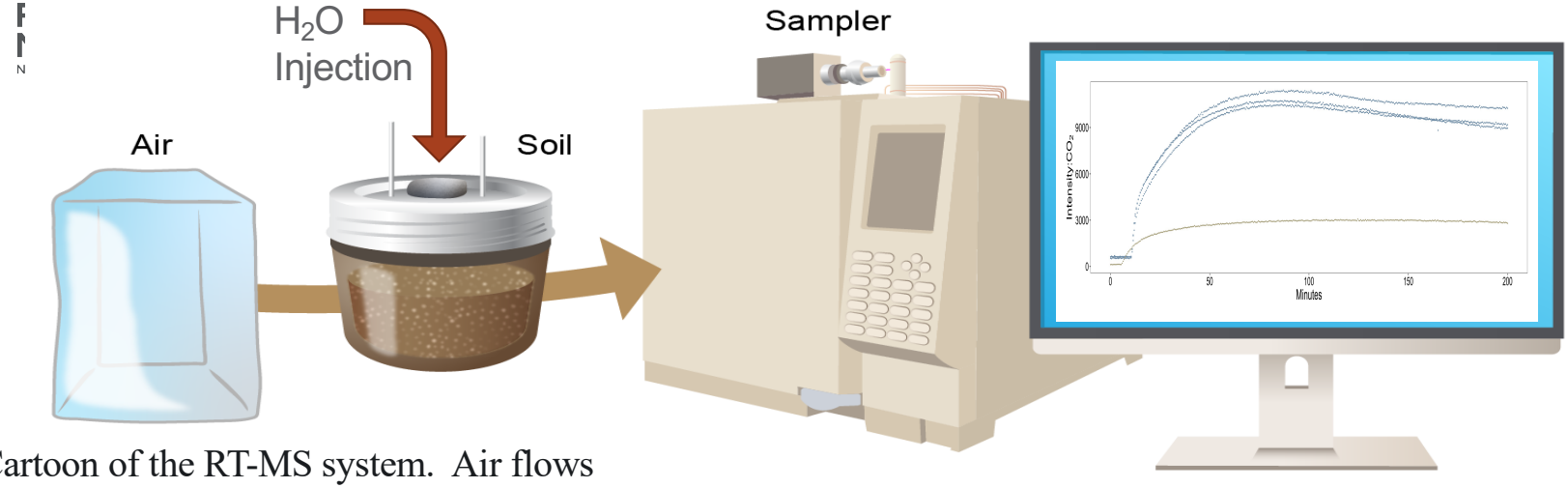
1. **Microbe rapidly metabolize osmotic biomolecules to reduce their intracellular concentration as well as provide energy for cell growth and division**

2. **Microbes dump osmotic biomolecules into the extracellular space to mitigate the rapid flow of water into the cell and avoid bursting**

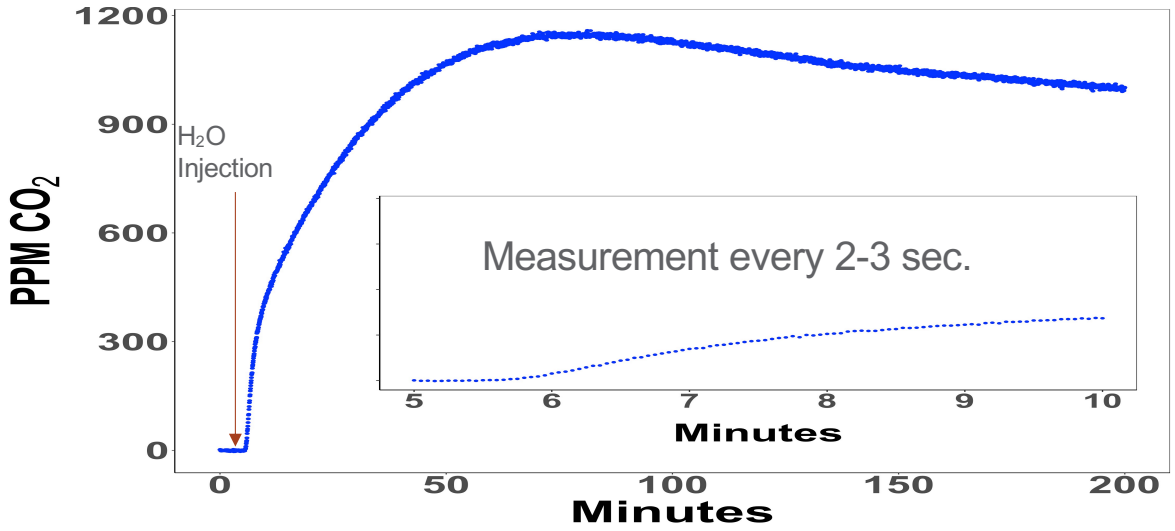
Field site

- Marginal soil
- USDA Texture- Sandy Loam
  - 2.5% Calcium Carbonate
  - Texture: 50% Texture, 5% Clay, 45% Silt
- Seasonal Temperatures
  - Average: 53.7F
  - Average high: 82-90 in summer
  - Average low: 28-33F in the winter
- Average Rainfall: 9.03 in
- Average Snowfall: 3 in

Real time monitoring of gas production in soils

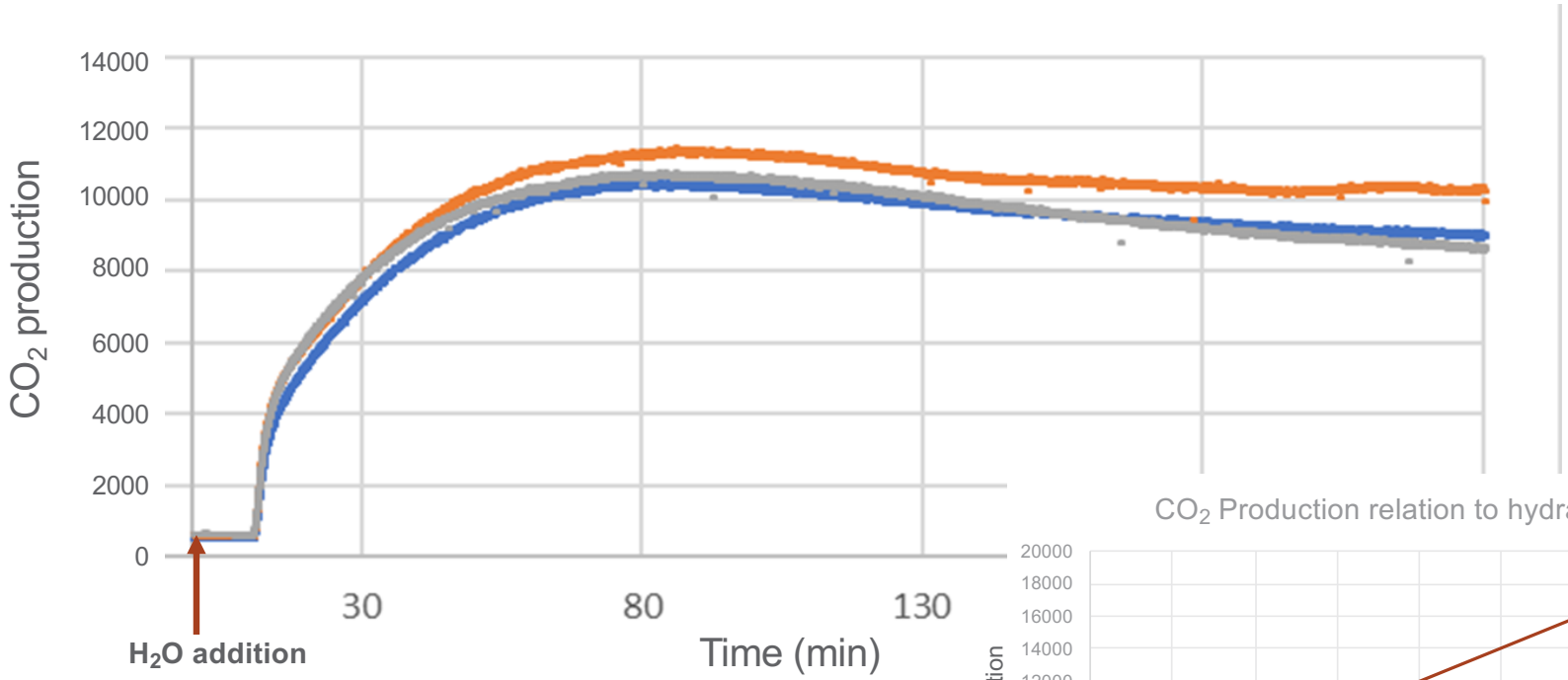


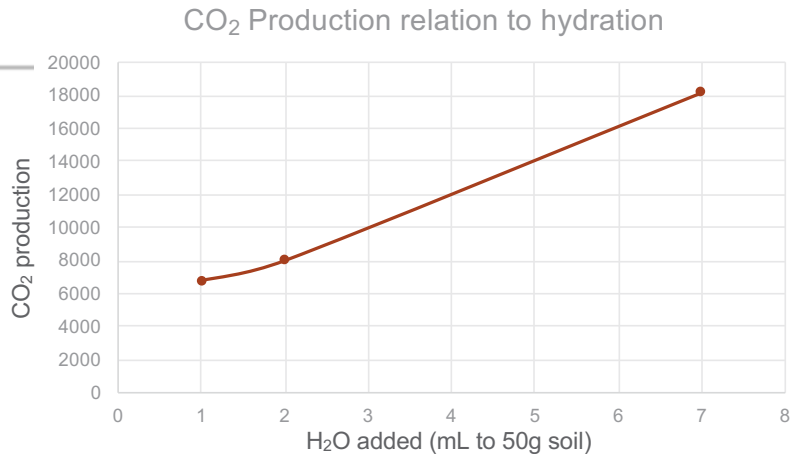
Cartoon of the RT-MS system. Air flows from the air source, through the reaction chamber and into the mass spectrometer. Data is collected in real time.



Output of the RT-MS system. After injection of the H2O into the soil, increased production of CO2 is observed. Measurements are taken every 2 to 3 seconds for a high temporal granularity

Initial measurements of CO_2 production upon rewetting is reproducible





Overlay of three post wetting CO_2 production traces illustrates the reproducibility of the measurement (top). Linear relationship of CO_2 produced with the amount of H_2O added to 50g of soil illustrates that the method is quantitive.

Summary

- Drought plays a role in terrestrial carbon cycling
- The Birch effect has been observed for over 50 years, but the molecular physiology is yet to be fully understood.
- We have developed a real time mass spectrometry method to directly measure CO2 release from desiccated soils after rewetting in real time with a measurement granularity of seconds.
- The method is reproducible and quantitative where the amount of CO2 produced is directly related to the amount of H2O added.
- CO2 can emerge from abiotic release, metabolism of intracellular metabolites or extracellular metabolites.
- We are using substrate amendments and stable isotope tracing to determine the molecular level immediate (first 10 minutes) events of the Birch Effect.

- For more information contact Mary Lipton at mary.lipton@pnnl.gov