

Monitoring tree health with NMR

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Monitoring tree health with NMR

Portable NMR system for studying tree health and mortality mechanisms under climate change

BACKGROUND & MOTIVATION

Tree mortality threatens the climate regulation functions of forests

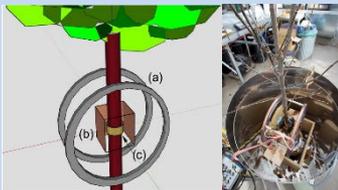
- Continental-scale climate-induced mortality observed globally
- Climate predictions indicate increased in drought
- We lack non-destructive measurement methods to verify theories and improve models



Mortality of piñon pine in northern Arizona

INNOVATION

A portable Nuclear Magnetic Resonance (NMR) system for identifying plant mortality mechanisms in the field.

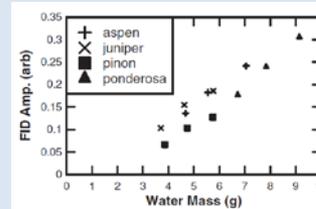


- Non-destructive, continuous measurements of tree water content in field conditions
- Cheap and light electromagnets (a and c); light shielding for signal improvement (b)
- Ultra-low magnetic field technique allows use of other instruments simultaneously

DESCRIPTION

Detecting tree water content changes during drought in non-controlled environments

- NMR signal amplitude is proportional to tree water content
- Tree water content varies diurnally
- Variation ceases during drought, or pathogen attacks
- By detecting these changes progress of tree mortality can be quantified

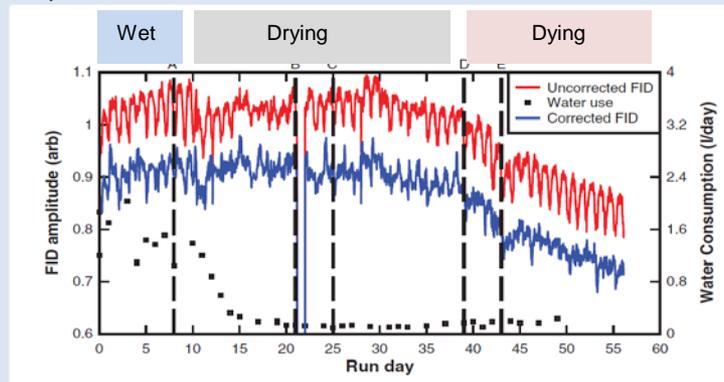


Challenge: Natural diurnal temperature variations affects NMR signal strength

Solution: Temperature correction model

$$S(\tau) \propto I(\tau) \left[\frac{B_0}{k_B(\tau + 273.15)} \right] m_w \approx K [1 - \alpha(\tau - \tau_0)] m_w$$

Long-term measurements of water content changes in an aspen tree.

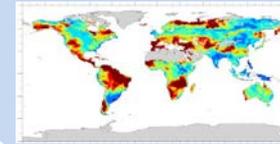


TRL 5: Operation tested and demonstrated both in greenhouse and field conditions. System documented and available for peer review at Yoder et al. 2014. Rev. Sci. Inst. 85, 095110-8

ANTICIPATED IMPACT

Real-time non-destructive detection of physiological changes related to tree mortality

- Better understanding of tree mortality process and mechanisms
- Data for testing hypotheses and conceptual tree mortality models
- Improved predictions of fate of forests under climate change
- Optimization of agricultural practices



Current predictions of drought impact on Net Primary Production (NPP) of terrestrial regions. Red mean large reduction.

PATH FORWARD

Development Steps

- Demonstrate use in plant mortality studies
- Conduct plant manipulation experiments relevant to agriculture
- Apply the technique on larger trees
- Patent disclosures

Potential End Users:

- Researches and foresters studying forest mortality and growth
- DOE Office of Science, USDA
- Agricultural industries interested in monitoring tree health

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