

# Terrestrial Biosequestration

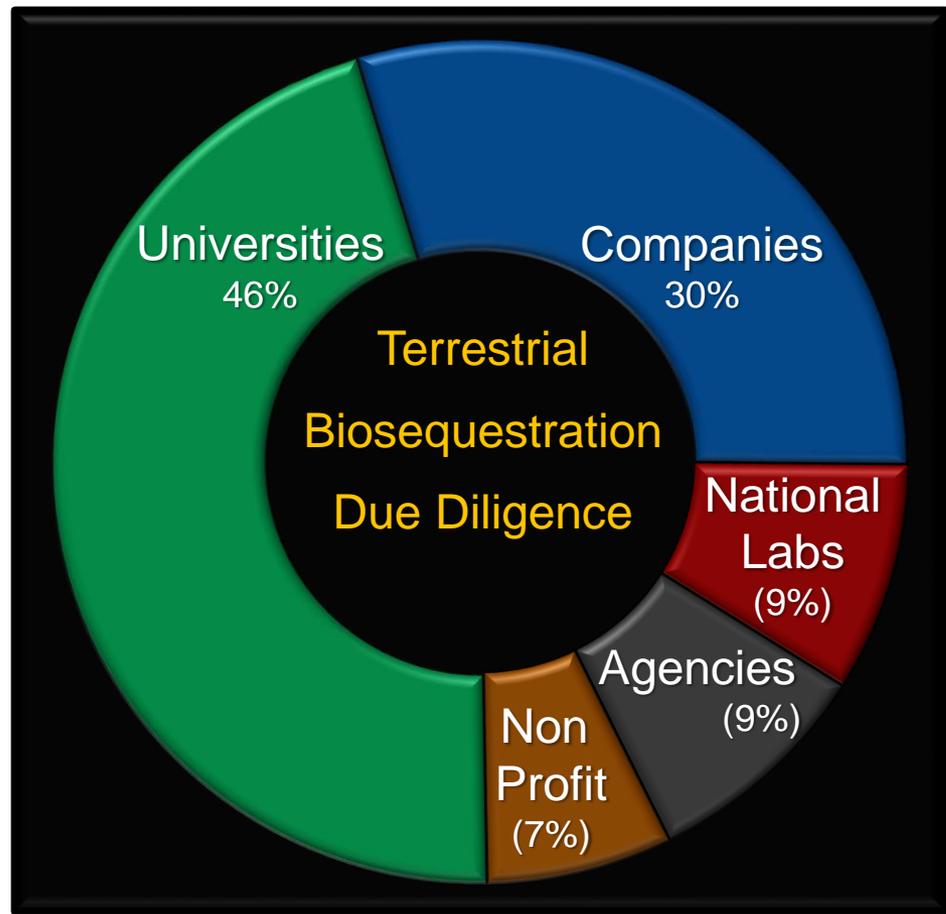
*Development of Innovative Technologies to Enable  
Improved Greenhouse Gas Mitigation and Soil Resilience*

ARPA-E Workshop  
July 23-24, 2015  
Chicago, IL



*"A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people."*

Franklin D. Roosevelt



# ARPAE Mission: Reduce Green House Gas Emissions and Maintain Technological Leadership

## Climate Change is Real... Now What?

### Headwinds:

#### **Fact 1: 2°C “baked in”**

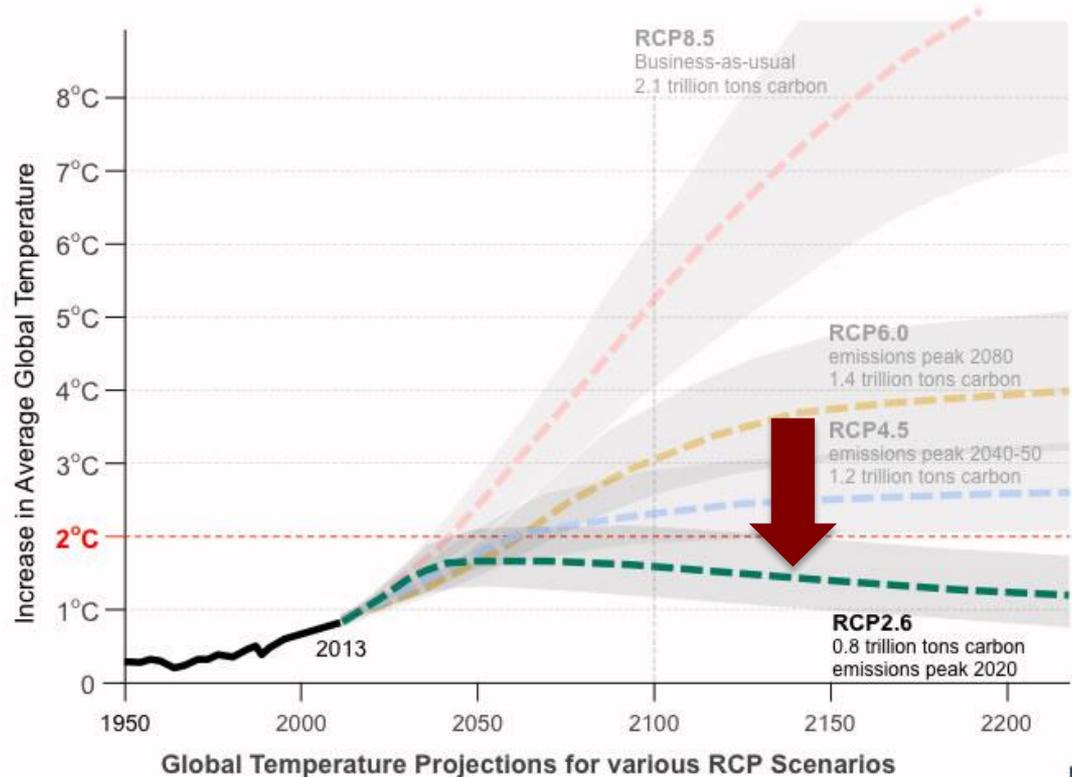
- Peak emissions 2020?

#### **Fact 2: Global Carbon Emissions are Rising**

- Fossil Fuels
- Land Use Changes

#### **Fact 3: CAPEX**

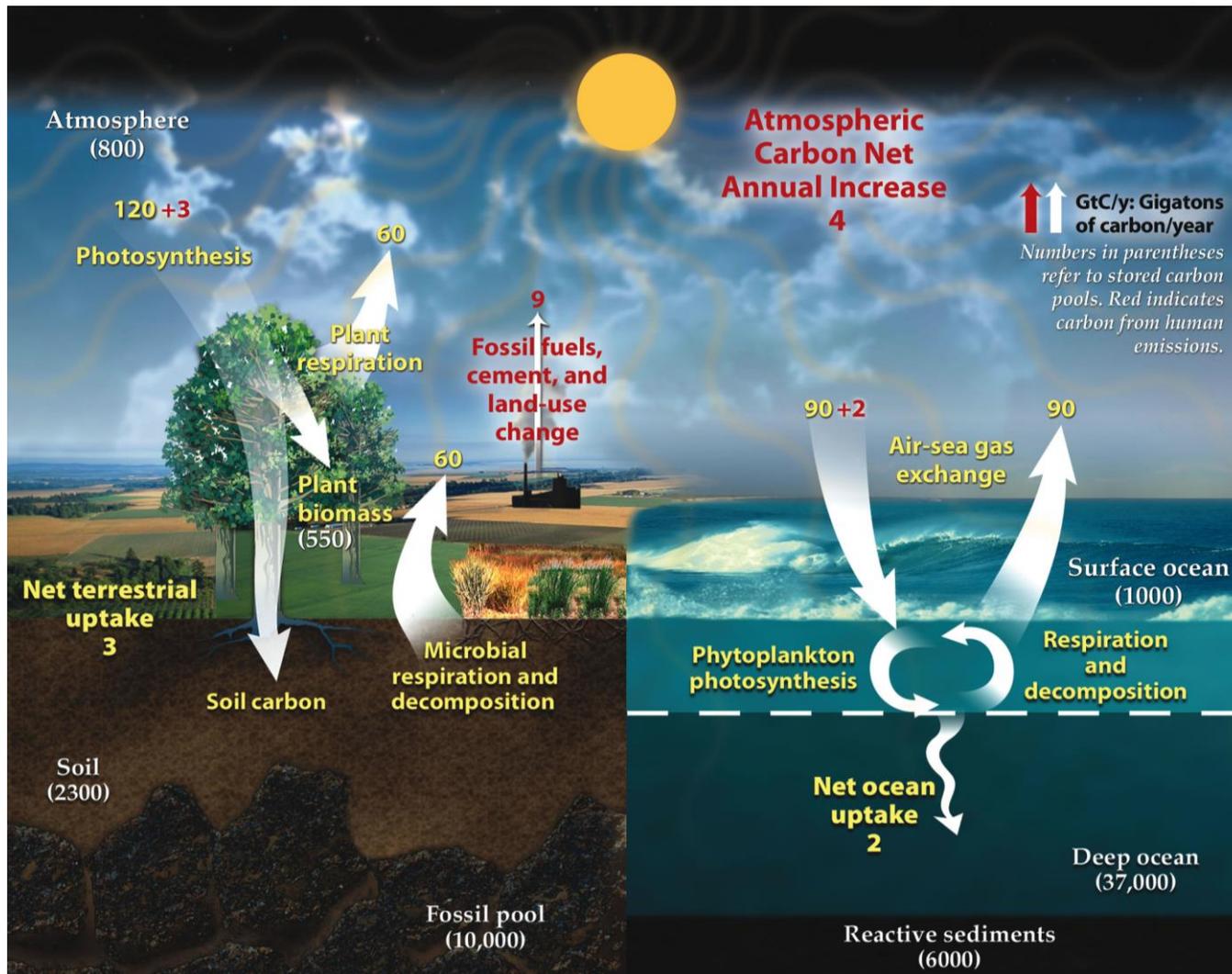
- Installed Capital 50+ years
- New Direct Air Capture costly
  - Minimum of \$300/ton



Source: Architecture 2030: Adapted from IPCC Fifth Assessment Report, 2013  
Representative Concentration Pathways (RCP), temperature projections for SRES scenarios and the RCPs.

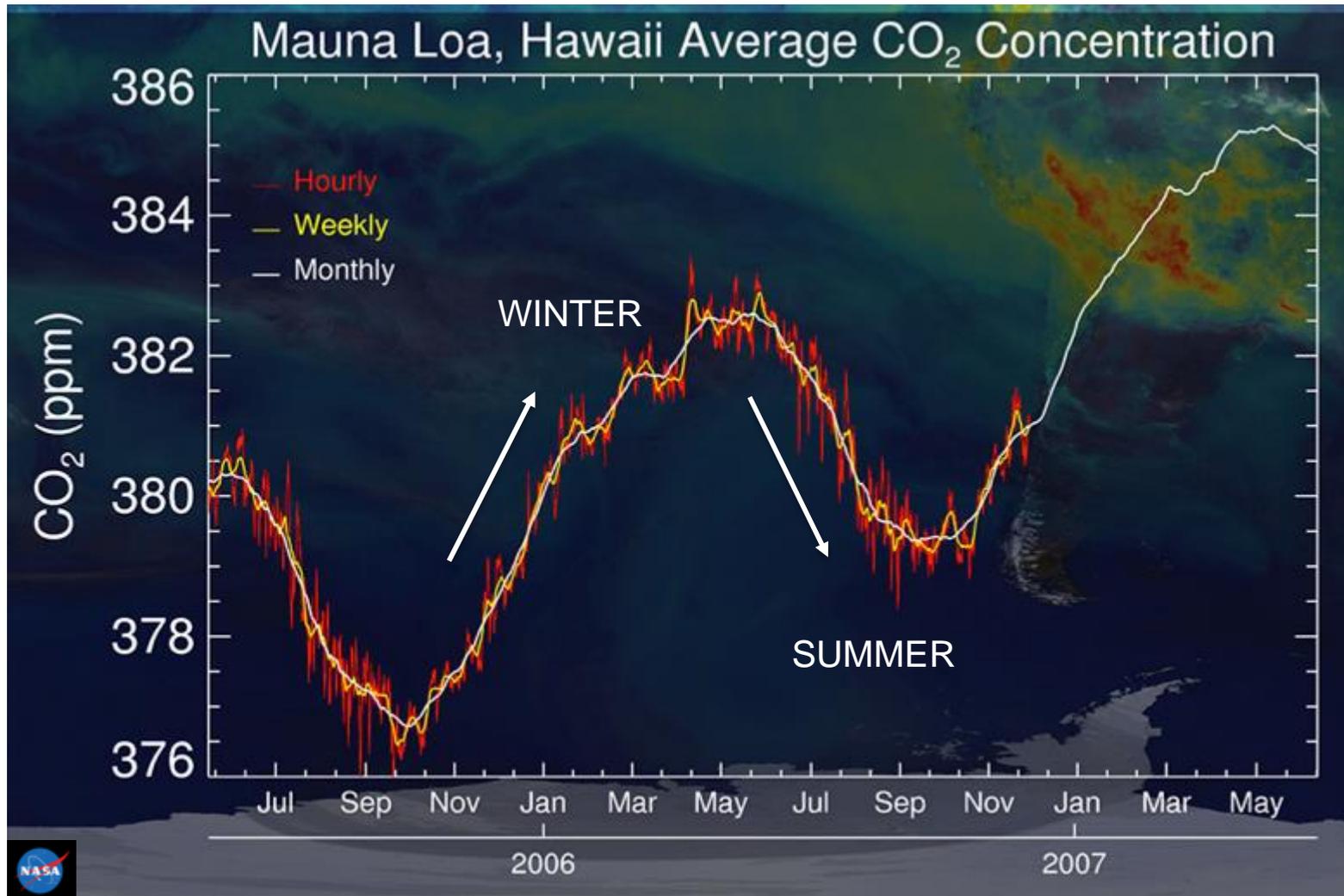
New direct mitigation strategies are needed

# The Big Picture... Terrestrial Ecosystems have Scale



U.S. Department of Energy, 2008

# Importance of Photosynthesis...



# The Big Question... How Much Carbon can we Capture?

atmosphere

atmospheric  
CO<sub>2</sub> 750 Pg

photosynthetic  
CO<sub>2</sub> capture

DB Kell (2012)

soil C  
1500 Pg

re-respiration of soil  
organic molecules at  
various rates

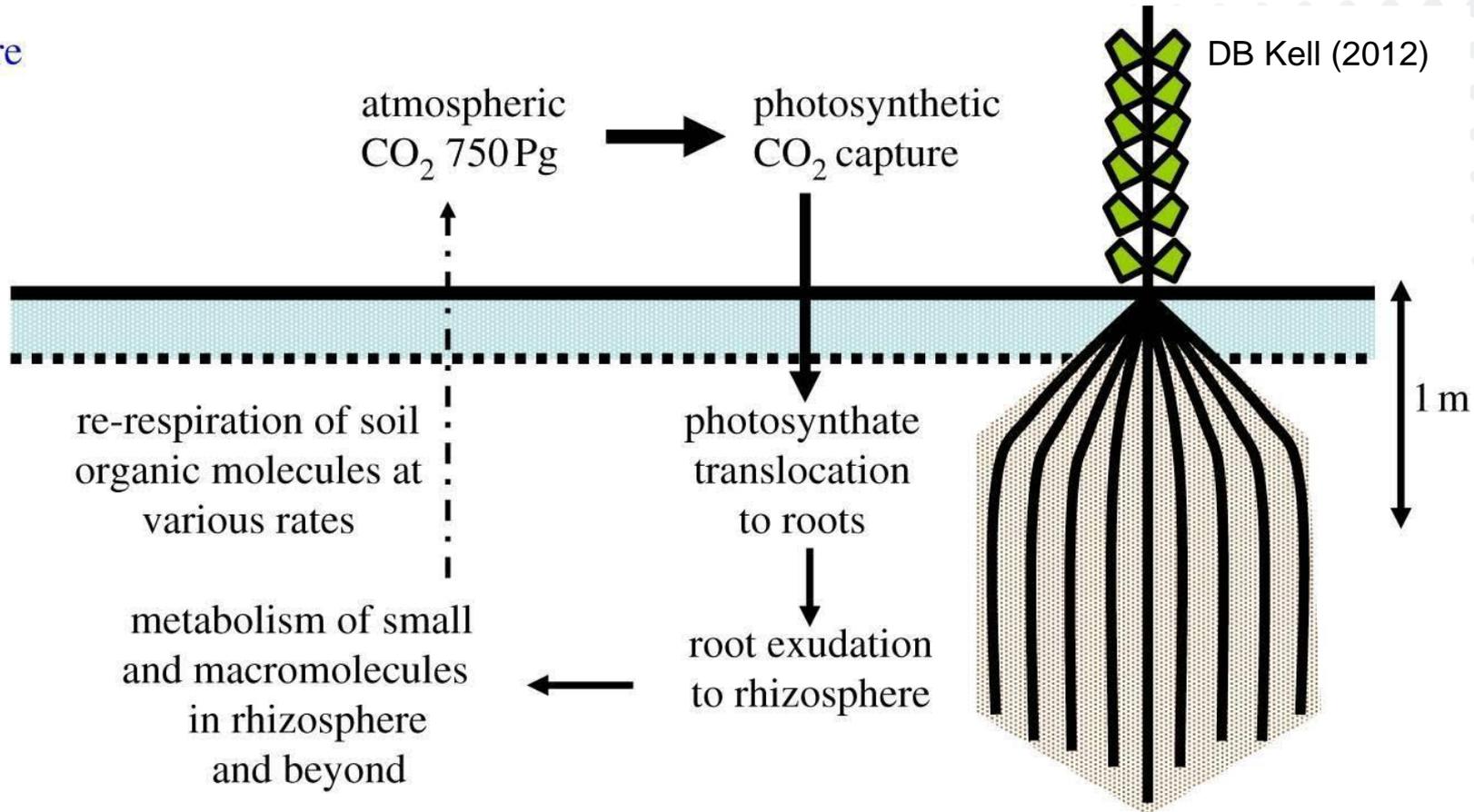
photosynthate  
translocation  
to roots

1 m

soil

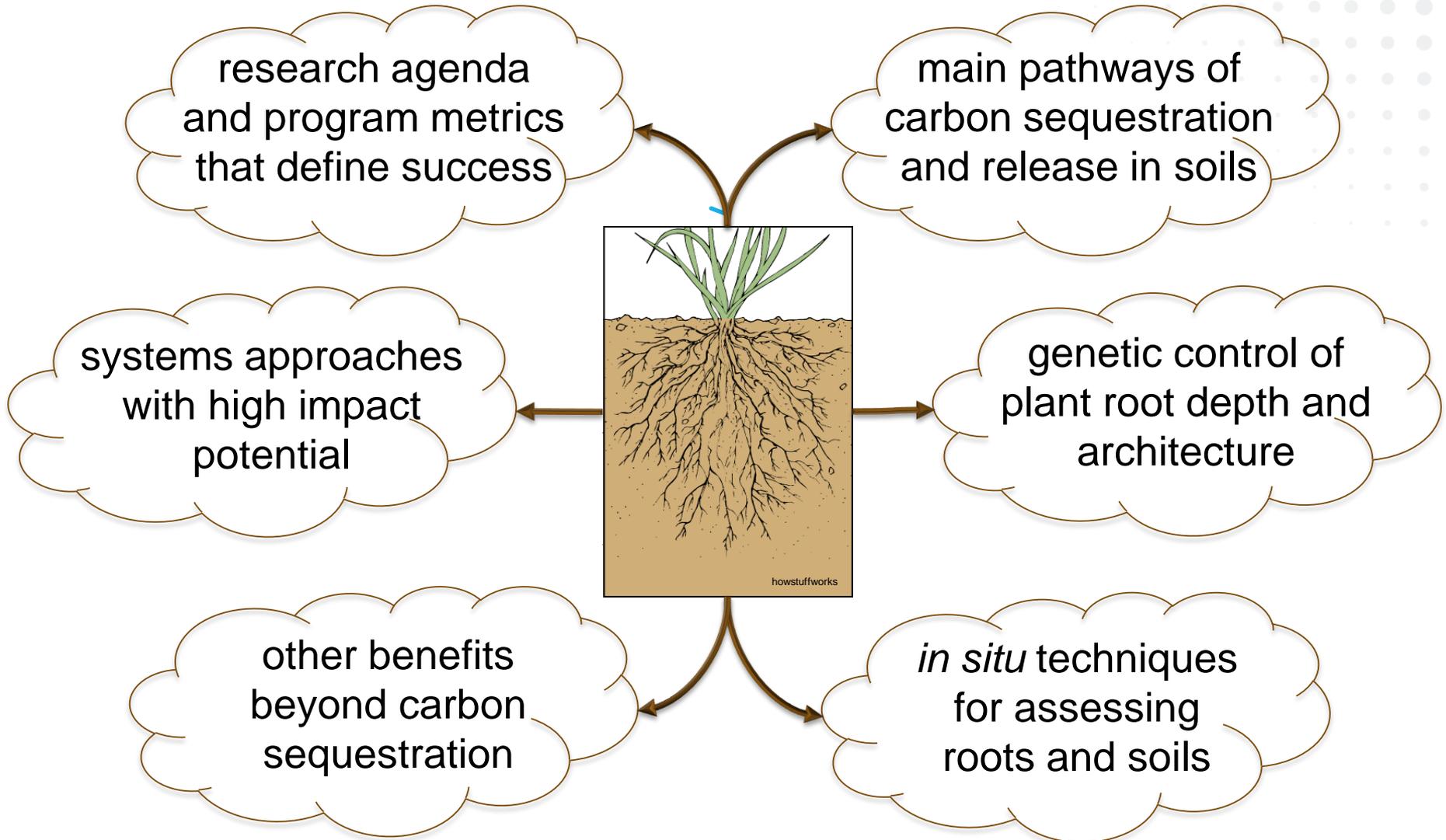
metabolism of small  
and macromolecules  
in rhizosphere  
and beyond

root exudation  
to rhizosphere



Manage the Roots, Soil and Microbes....  
Manage the Carbon

# Terrestrial Biosequestration Workshop Mind Map

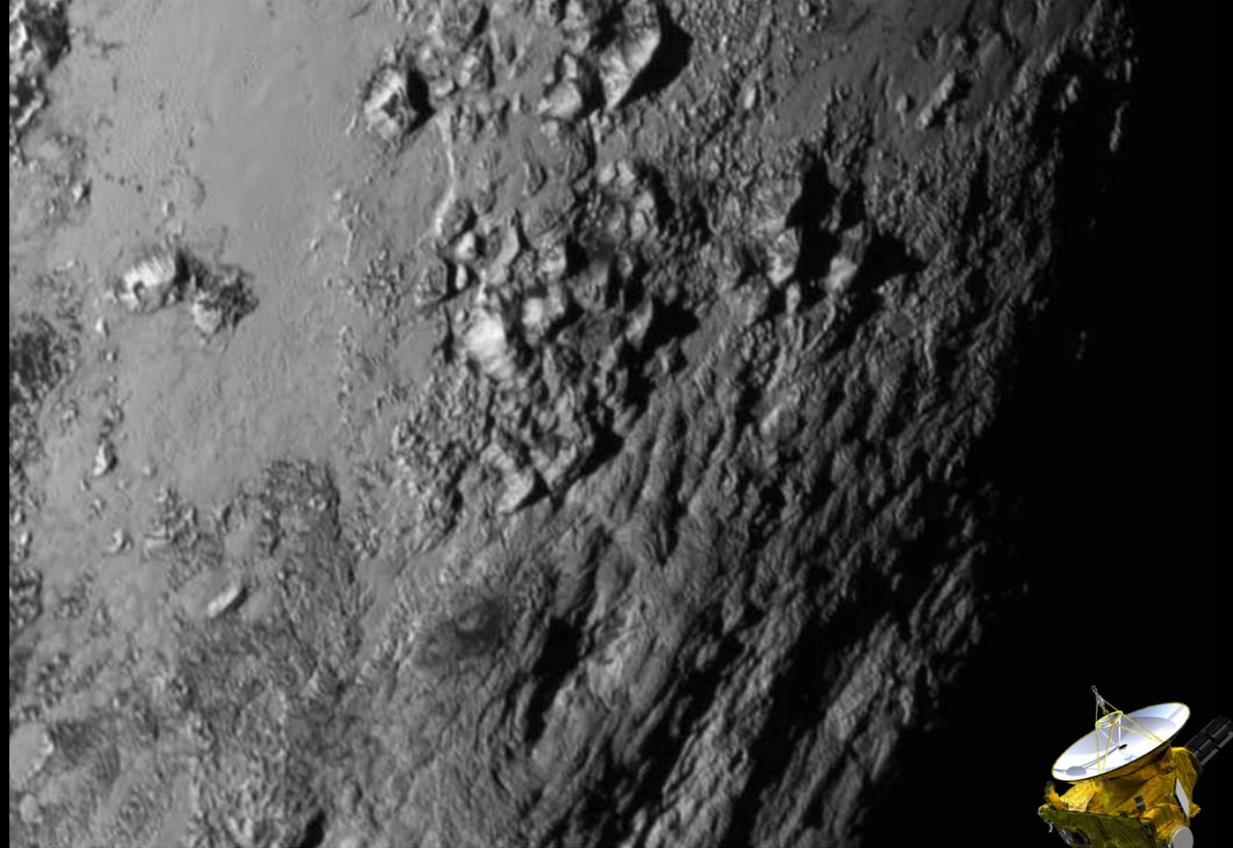


# Strange Trip to Pluto... How NASA Nearly Missed It

NASA SUCCESSFULLY PHENOTYPES PLUTO



New Horizons  
lifted January  
2006



The Icy Mountains of Pluto July 2015



15 years ago  
NASA called it  
quits on Pluto

*"We know more about the movement of celestial bodies  
than about the soil underfoot." Leonardo da Vinci (1500)*

# Biosequestration Workshop Speakers

<p>09:15 – 11:00</p>	<p><u>Root Physiology and Root Ideotypes</u> (45 min)</p> <ul style="list-style-type: none"> <li>• Root Phenes and Resource Use Efficiency in Plants</li> </ul> <p><u>Genetics and Microbial Influence:</u> (45 min)</p> <ul style="list-style-type: none"> <li>• Genetics of Carbon Allocation and Partitioning in Populus</li> <li>• Field Scale HT Phenotyping</li> </ul>	<p>Jonathan Lynch (PSU) Kathleen Brown (PSU)</p> <p>Gerald Tuskan (ORNL) Jan Leach (CSU)</p>
<p>11:00 – 11:45</p>	<p><u>Technology Toolbox:</u> (45 min)</p> <ul style="list-style-type: none"> <li>• Modern Tools for Proximal Soil Sensing: Lessons from Field</li> <li>• Probe based laser diagnostics and optical image-guided interventions and metrology</li> <li>• MRI in the Wild</li> </ul>	<p>Cristine Morgan (TAMU) Eric Seibel (U. Washington)</p> <p>Matthew Rosen (Harvard)</p>
<p>12:15 – 02:00</p>	<p><u>Technology Toolbox:</u> (30 min)</p> <ul style="list-style-type: none"> <li>• Ground Penetrating Radar</li> <li>• Non-Contact Imaging of Internal Structures in High Loss Packaging</li> </ul> <p><u>Leveraging Industrial and Medical Phenotyping Tools</u> (20 min)</p> <ul style="list-style-type: none"> <li>• Integrated Understanding of Plant-Environment Interactions</li> </ul> <p><u>FutureRoots – Systems Solution Root Phenotyping</u> (30 min)</p>	<p>Scott Macintosh (Black Cat Sci.) Amin Arbabian, (Stanford)</p> <p>Chris Topp (DDPSC)</p> <p>Tony Pridmore (U. Nottingham)</p>

# Workshop Goals

## Learn

- Leading experts in biology, physics geochemistry and imaging technologies — take advantage!

## Evaluate

- Sharing our collective due diligence, but we want you to validate, challenge and improve the data.

## Collaborate

- If this effort leads to an APRAE funding opportunity multidisciplinary teams will yield the best results. Think about teams and look for partners!