

National Ecological Observatory Network

Opening new horizons for large-scale Biology



Elizabeth Blood
BioAC April 30, 2009



Biology for the 21st Century



A vision for our planet's future based on a comprehensive understanding of the living world across scales of size, time, and place.

21st Century Biology that is transformed by innovative infrastructure to observe, experiment, synthesize, predict, engage, and learn

Life in a Time of Planetary Change

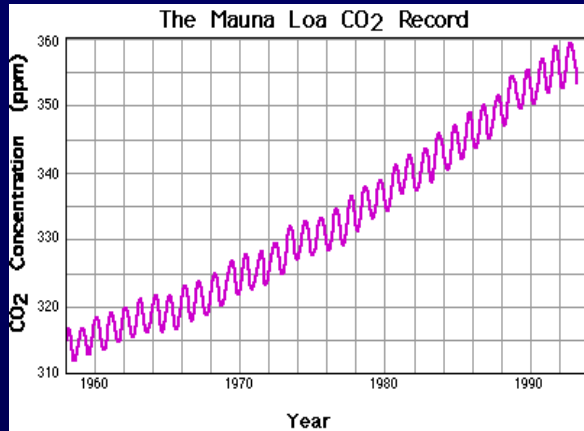


Figure 7.01 The record of CO₂ measured at Mauna Loa, Hawaii shows seasonal cycles — related to the activity of plants in the Northern Hemisphere — on top of an increasing trend to higher values. The record also shows a subtle increase in the seasonal amplitude over time.



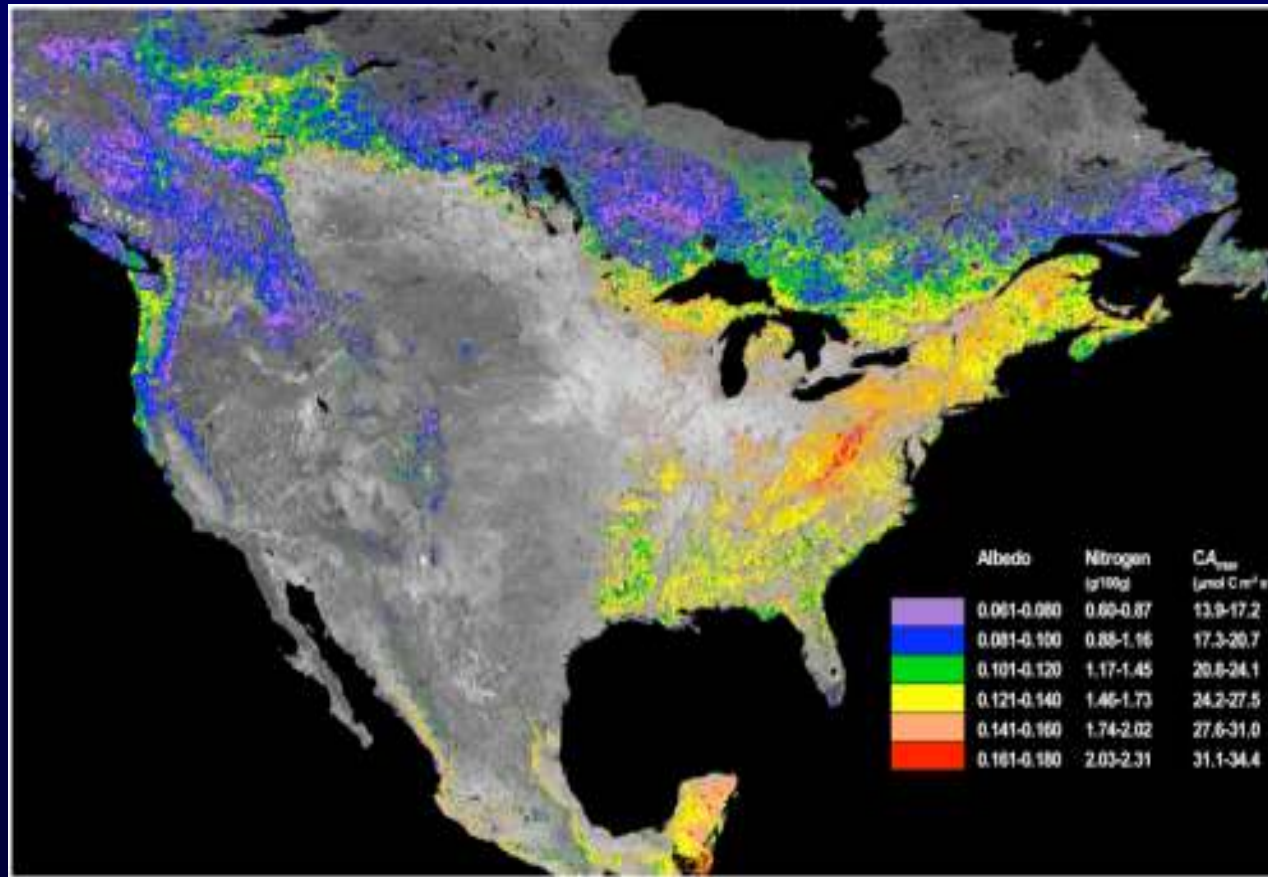
CH₄

CO₂



We are only now beginning to explore the biological drivers of change.

Albedo and foliar N and ecosystem productivity



- Short-wave albedo is strongly related to canopy N-content in forests

- This relation suggests that climate may be strongly linked to ecosystem biogeochemistry

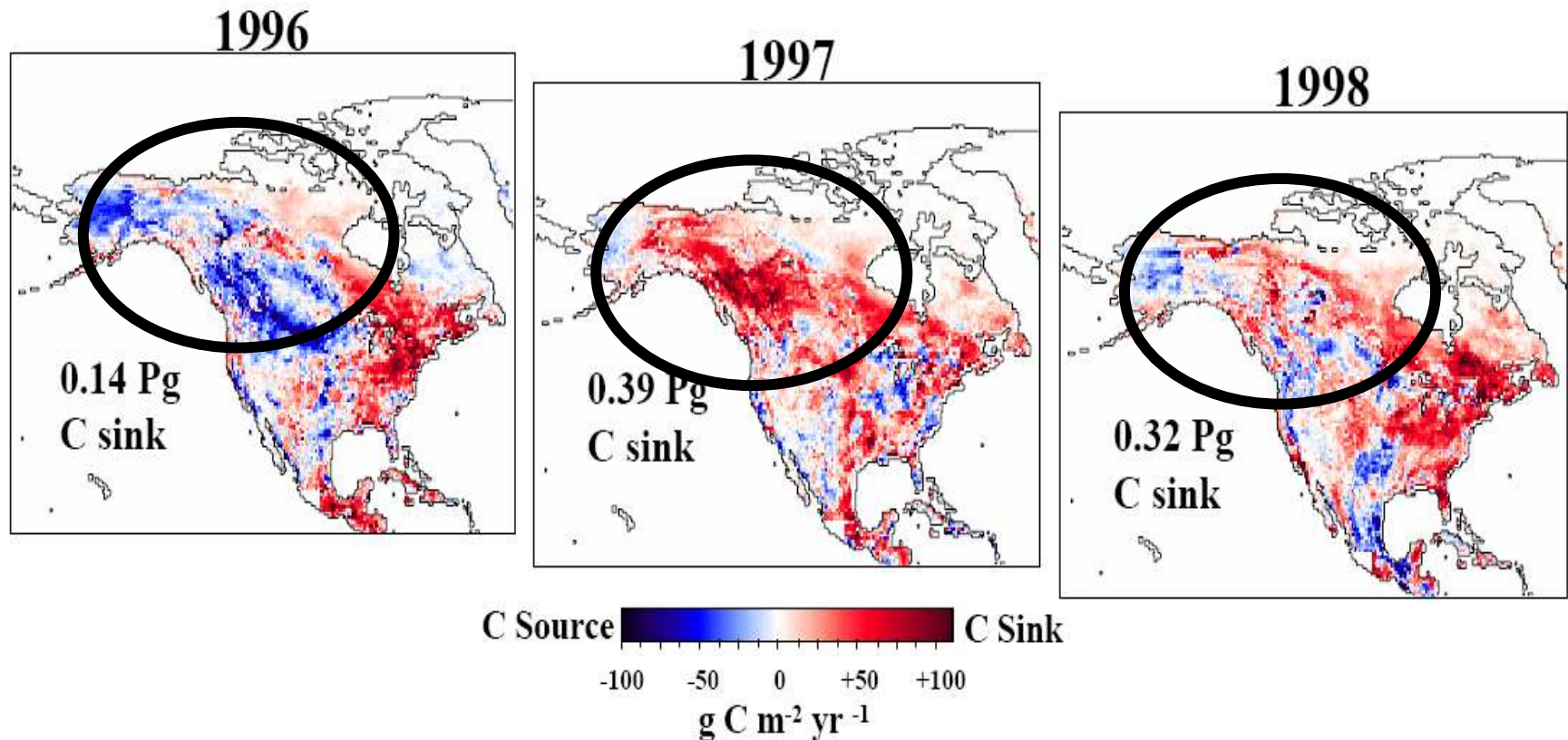
Estimates of canopy %N and CA_{max} for forested areas of North America derived from MODIS short-wave albedo

(Ollinger et al. *PNAS*, 2008)

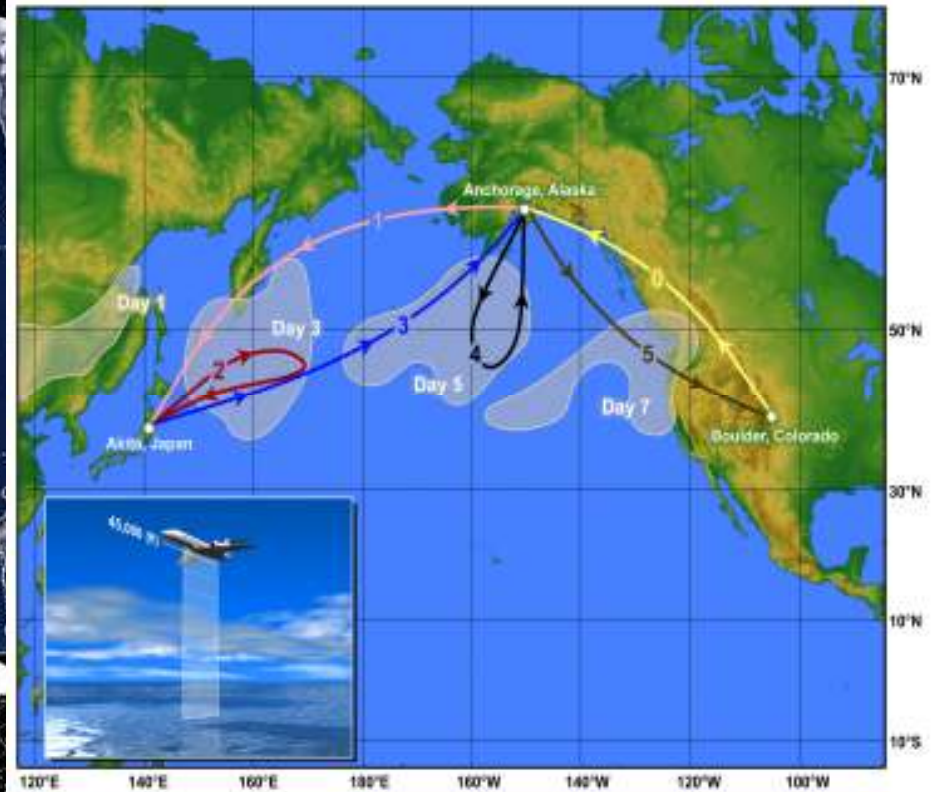
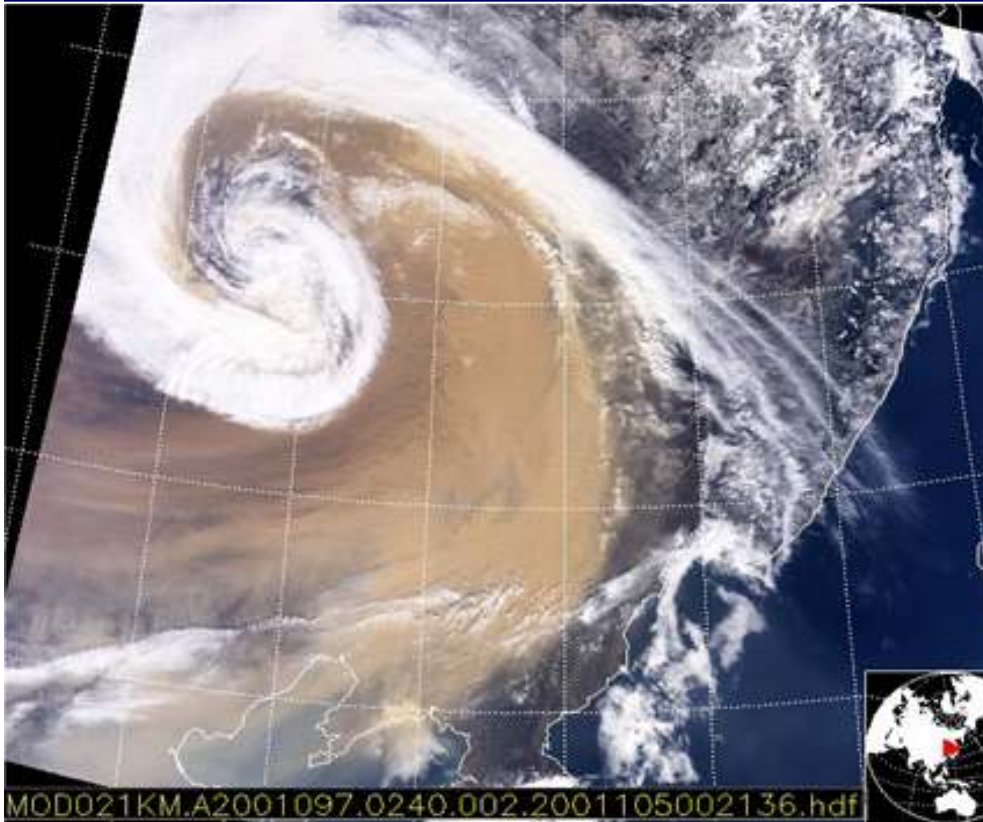
Connections: Biological Feedbacks at Continental Scales

Prediction of the North American Carbon Sink

Potter et al. 2003 "The North America Carbon Sink from 1982-1998
Estimated using MODIS Algorithm Products"



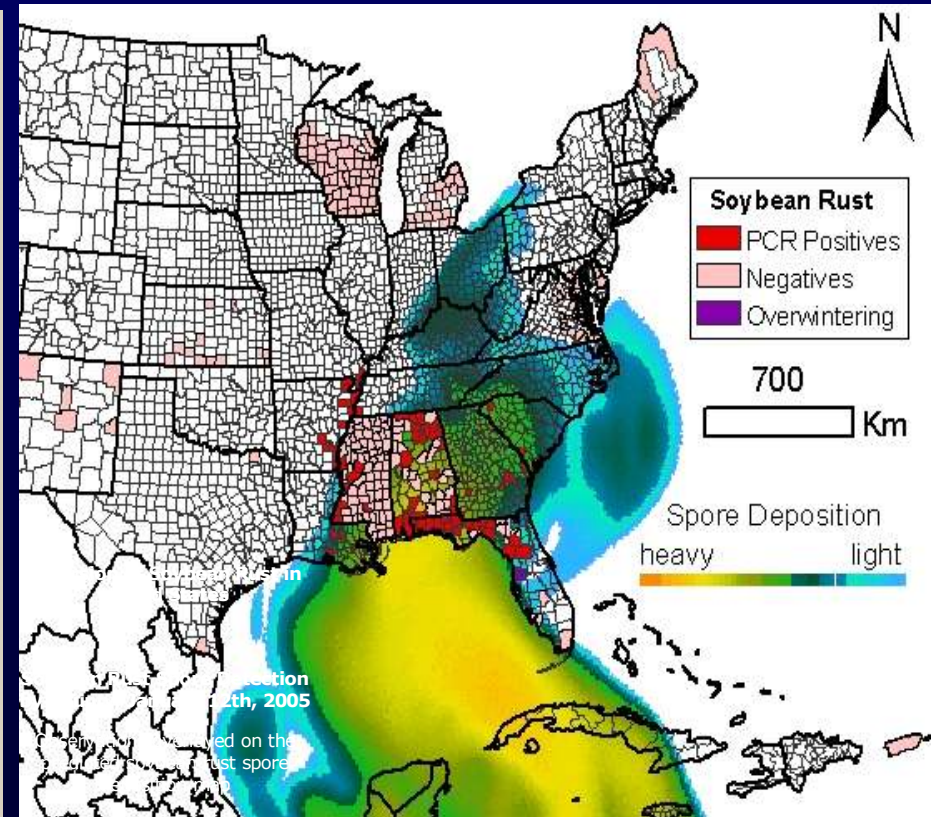
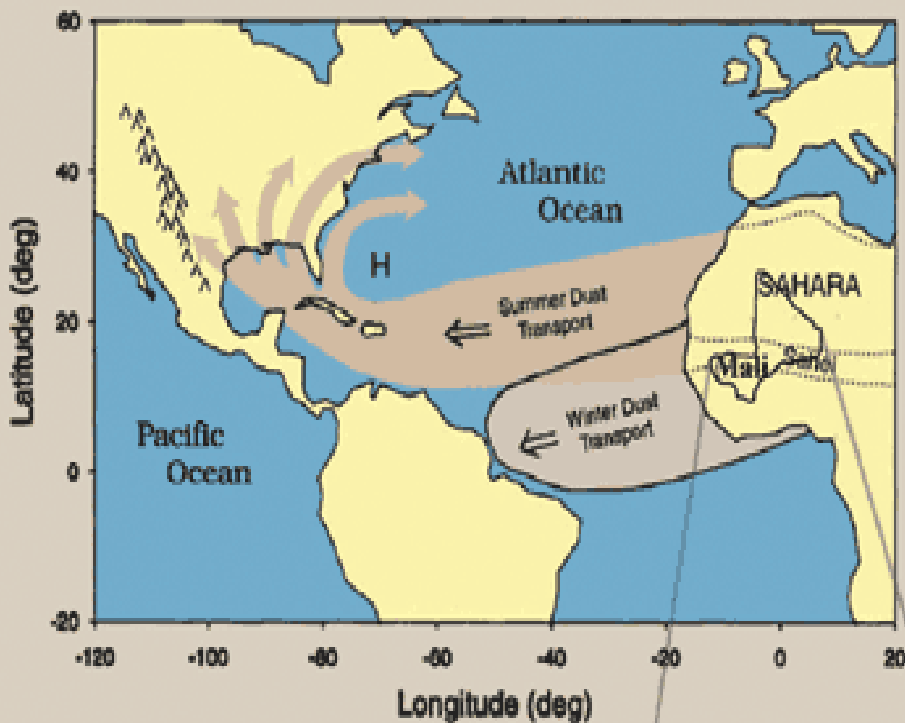
Connections: Landuse & Climate Change



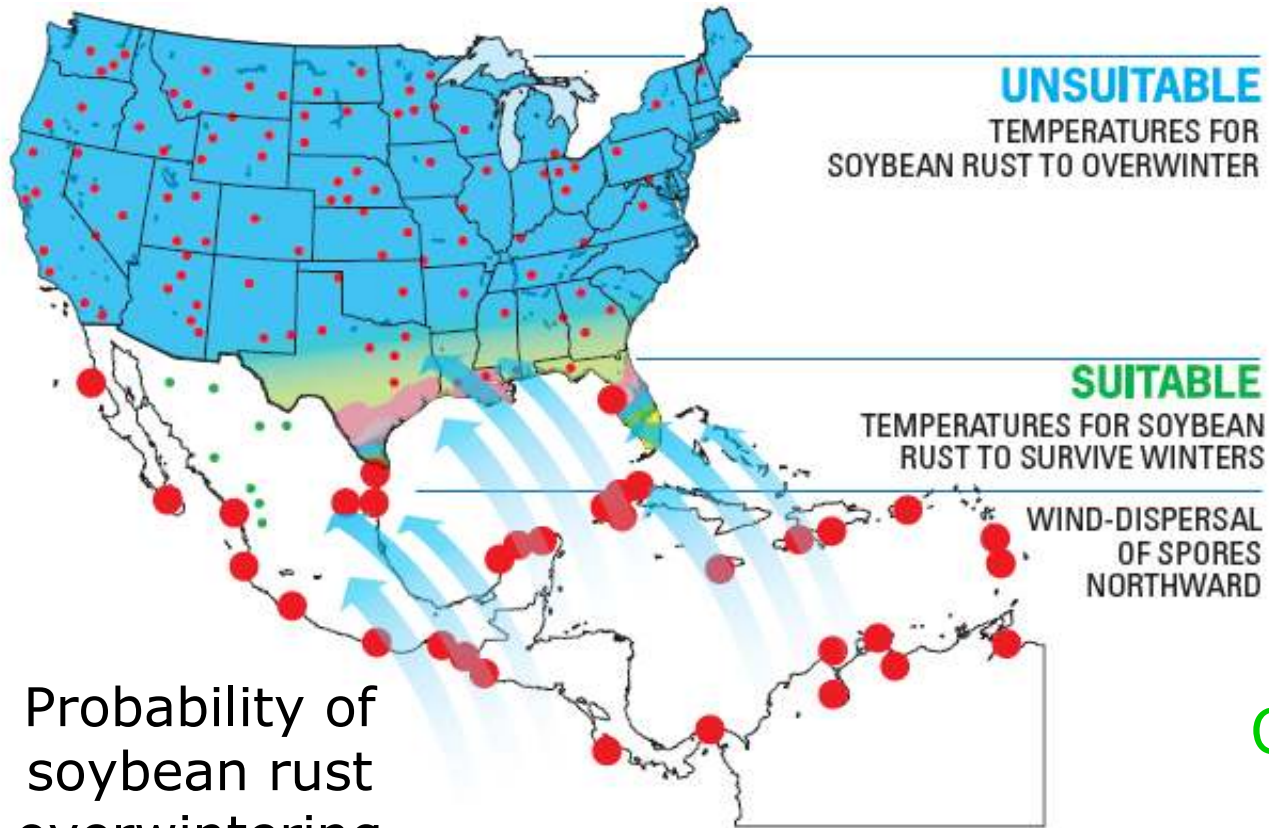
**Global Connections: Increasing Dust Storms in China
Affecting Air Quality and Deposition in the US**

What is the effect of climate change on the future distribution of invasive species and diseases?

PERRY ET AL: LONG-RANGE TRANSPORT OF NORTH AFRICAN DUST



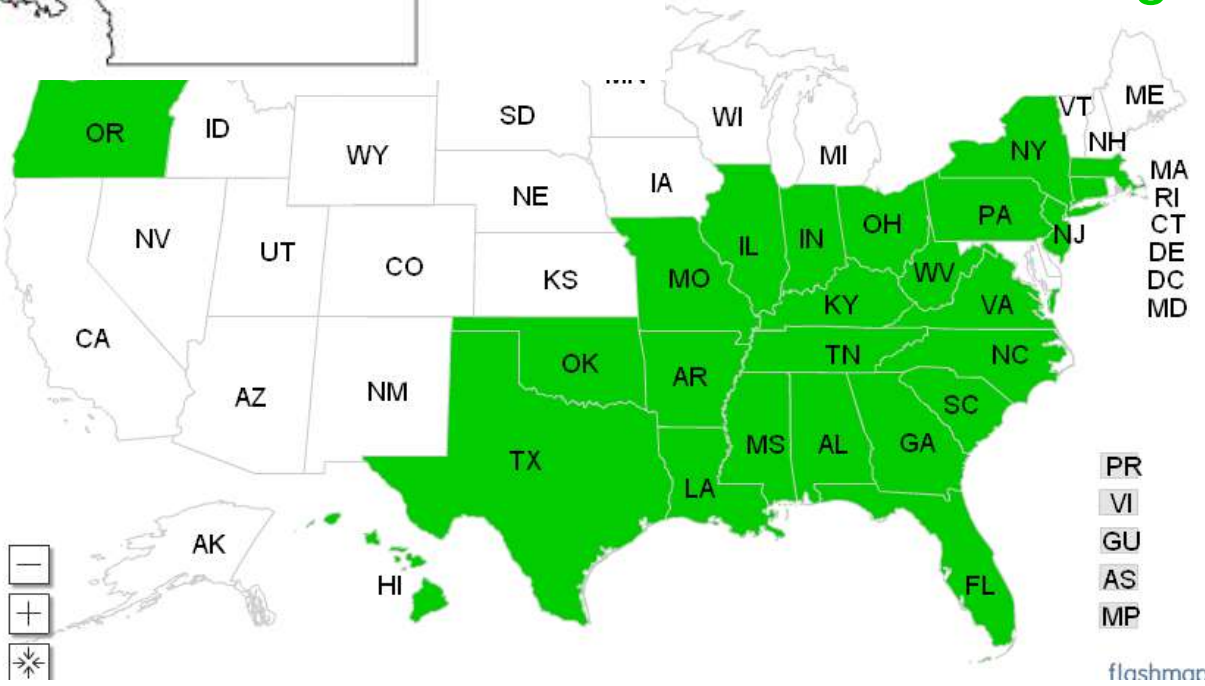
El Niño-Generated Sahel Dust Storms and Air Masses Transport Dust and Rust to the Americas



Probability of soybean rust overwintering

- 0.0-0.2
- 0.2-0.4
- 0.8-1.0

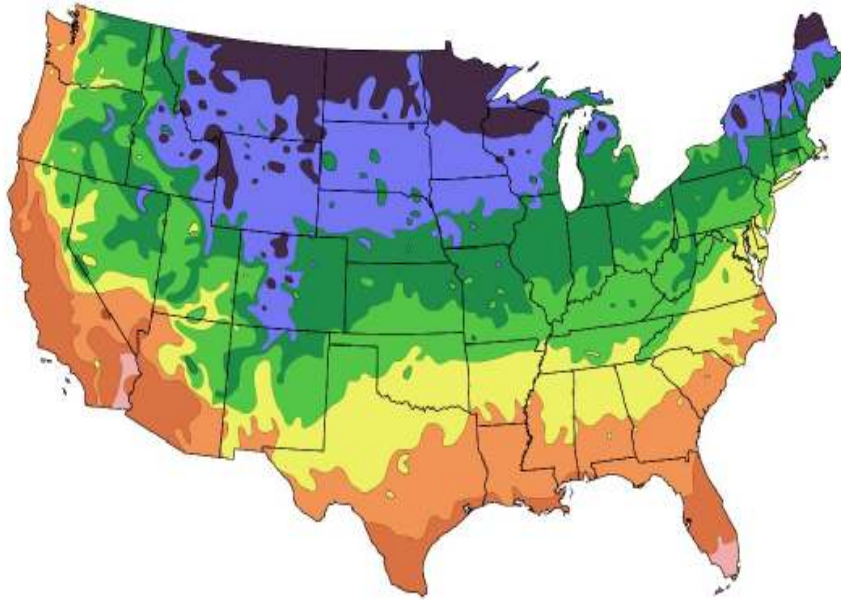
Current kudzu range



- PR
- VI
- GU
- AS
- MP

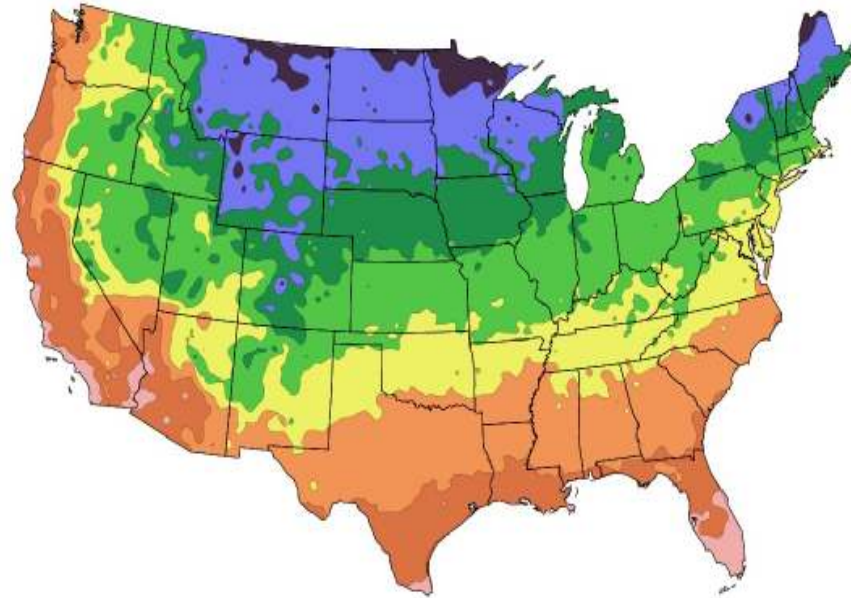
Changing Climatic Zones provide opportunity for the spread of Kudzu and Soybean Rust

1990 Map



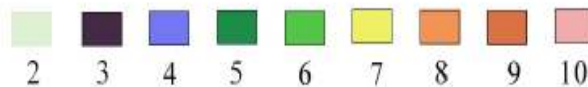
After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

2006 Map



National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

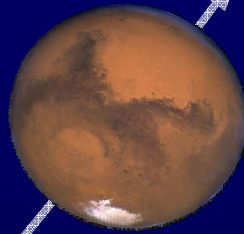


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Making Connections

In an Increasingly Connected World

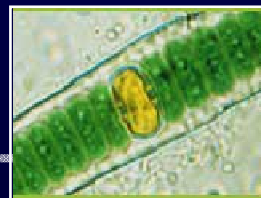
An
absence
of life?



Atmosphere
+
Geosphere
+
Biosphere



Anthroposphere



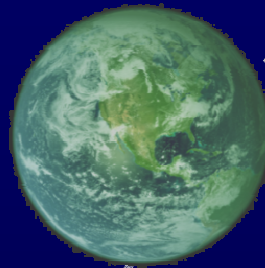
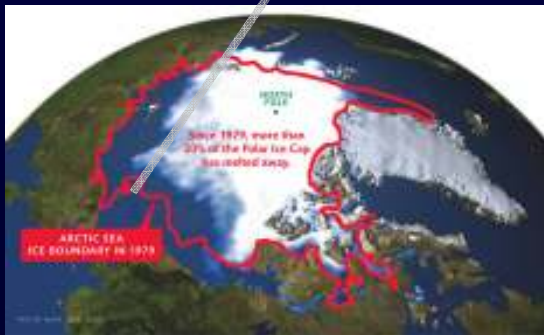
*Integrating across drivers, responses,
scales, and disciplines to reduce
uncertainty about the future of life on Earth*

Adaptation: Transformations and Transitions in the Story of Life

Diversity



Change



What Will Survive and How?

Understanding life's adaptation, resilience and impact will reduce uncertainty about the future of life on Earth in a time of global climate change.



What is NEON?

Life in an increasingly connected world

NEON is an integrated sensing system to detect, understand, and forecast the consequences of climate and land use change and the effects of invasive species on the biosphere of the U.S. at the regional and continental scales.

Enables research to address questions:

- How does the effect of climate change on biosphere processes vary along regional and continental gradients?
- What is the effect of the biosphere on regional climate?
- How will land use change affect the dispersion of invasive species through a region and across the continent?
- How do large scale physical processes produce regional to continental ecological responses?

National Ecological Observatory Network

BIO's First MREFC Facility

1. Organization & Project Office for design, construction, & operations of facility

2. Construction Plan

Scope: Robust Design to support transformative research

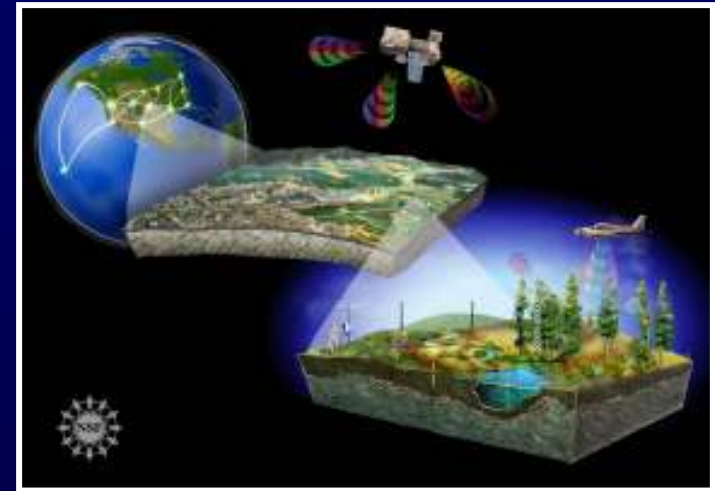
Cost – risk adjusted (contingency)

Schedule – “resource loaded”

3. Environmental Assessment

4. Operations and Maintenance Plan

5. Partnerships Defined



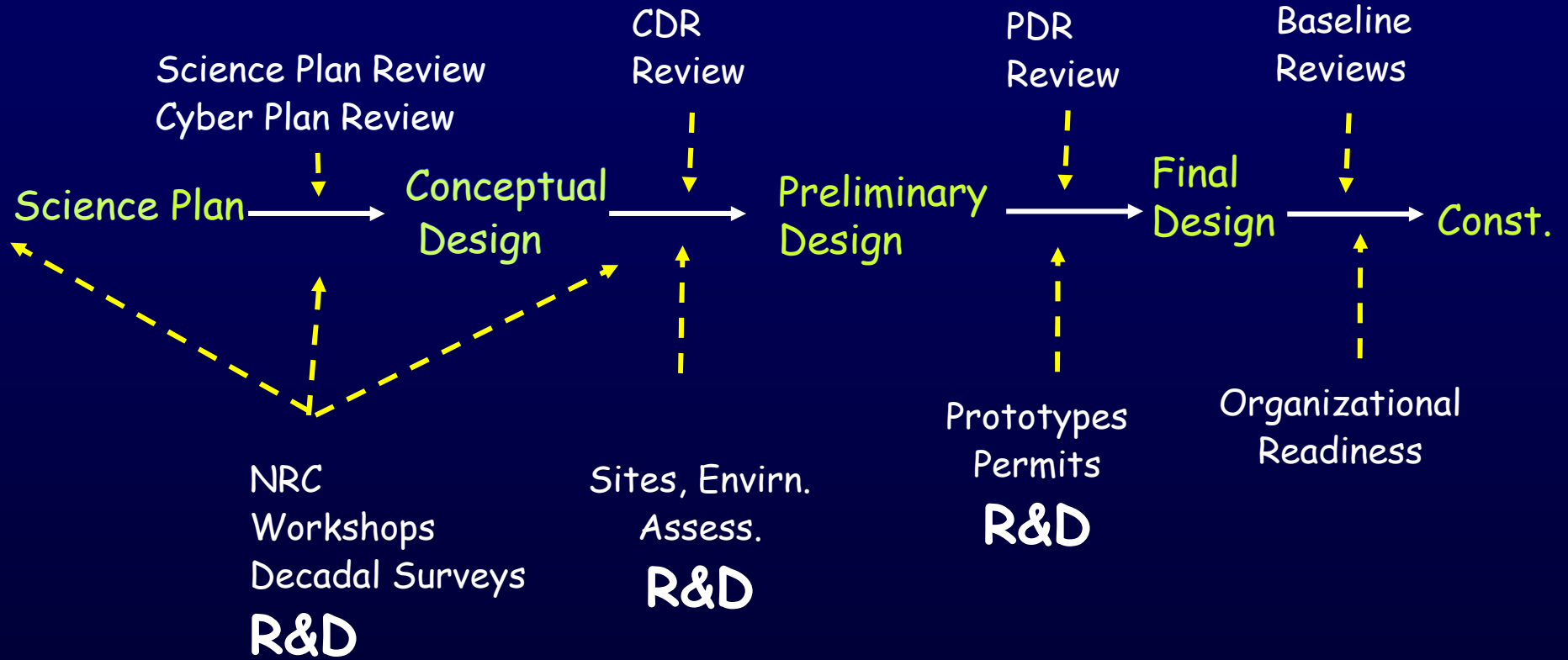
Design Reviews:

1. Conceptual
2. Preliminary
3. Final

"Typical" MREFC Process

NEON

NSF Oversight



Key Leaders Management Entity: University, Consortia, 501C3

Community Participation

NEON in Transition



NEON, Inc.



Design

**Continental
Infrastructure to
Transform Biology**

- Governance
- Platform
- Progress
- Program



Status



Ongoing Activities

NEON, Inc.



CEO
Dave Schimel



COO & PM
Tony Beasley

57 Member Institutions



Boulder, CO
Staff - ~ 50 employees



Director BOD
Jim MacMahon

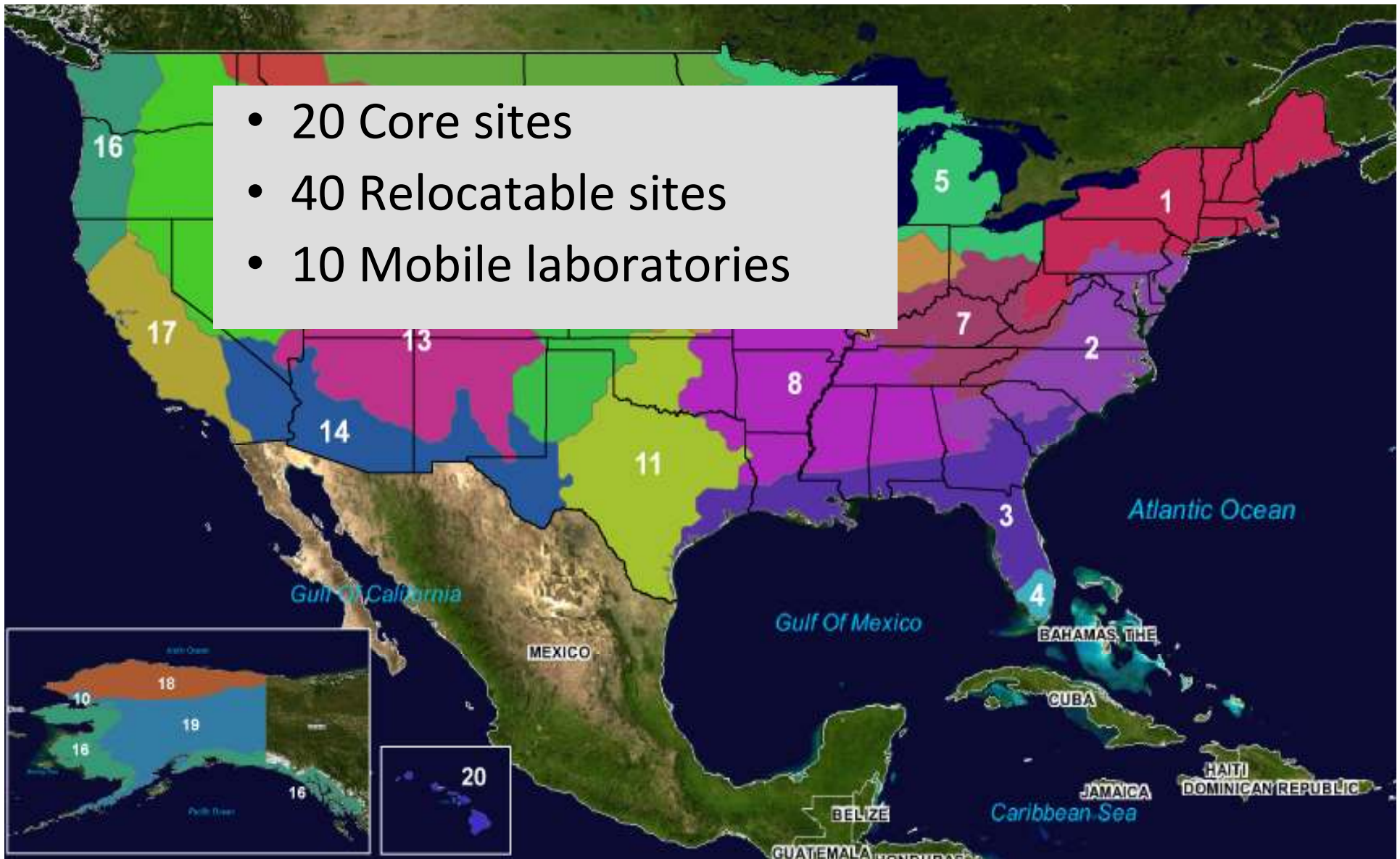


Chair STEAC
Chris Field

www.neoninc.org

NEON Domains

domains			
■ 1 North East	■ 6 Praire Peninsula	■ 12 Northern Rockies	■ 18 Trundra
■ 2 Mid Atlantic	■ 7 Appalachia	■ 13 Southern Rockies	■ 19 Taiga
■ 3 Southeast	■ 8 Ozarks	■ 14 Desert Southwest	■ 20 Pacific Tropical
■ 4 Atlantic Neo Tropical	■ 9 Northern Plains	■ 15 Great Basin	
■ 5 Great Lakes	■ 10 Central Plains	■ 16 Pacific Northwest	
	■ 11 Southern Plains	■ 17 Pacific Southwest	



- 20 Core sites
- 40 Relocatable sites
- 10 Mobile laboratories

NEON, Inc

University
Northern F
Domain

Northeast
Domain 1



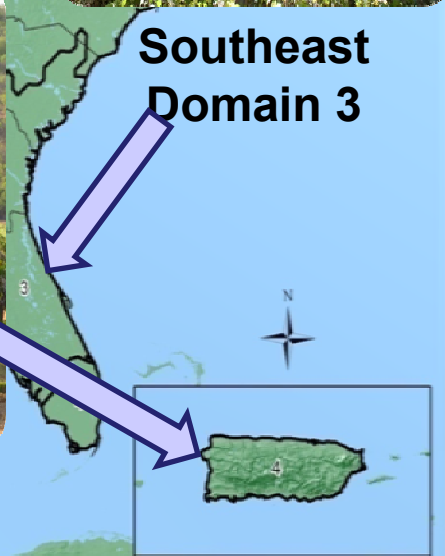
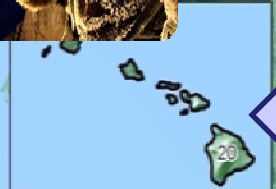
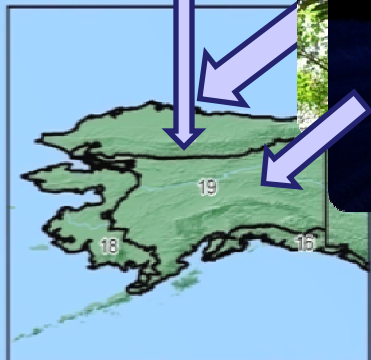
Alaska – Tundra
Domain 18



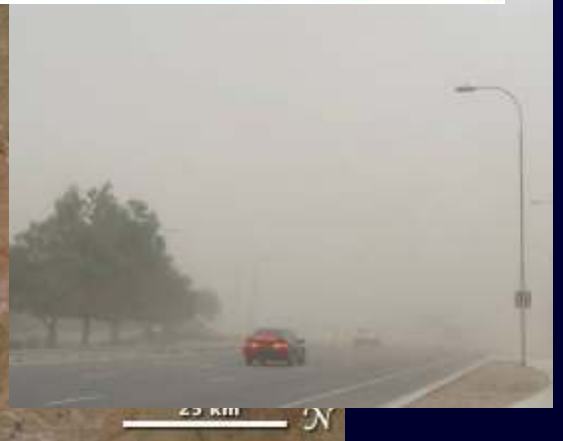
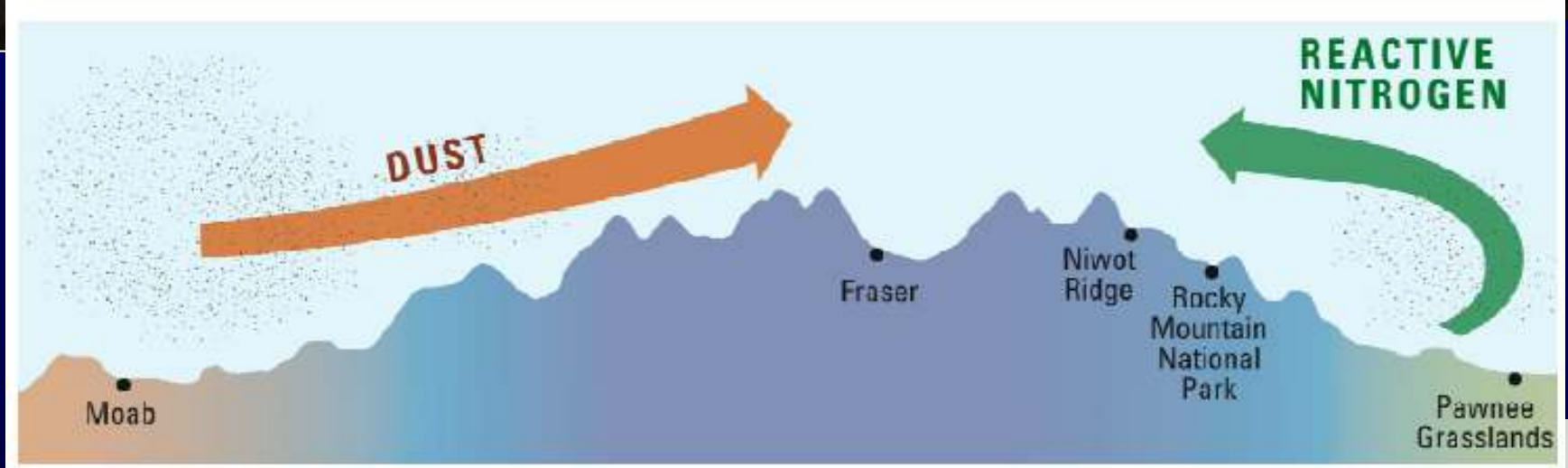
Atlantic
Neotropical
Domain 4

Southeast
Domain 3

Pa
Domain 20



Landuse





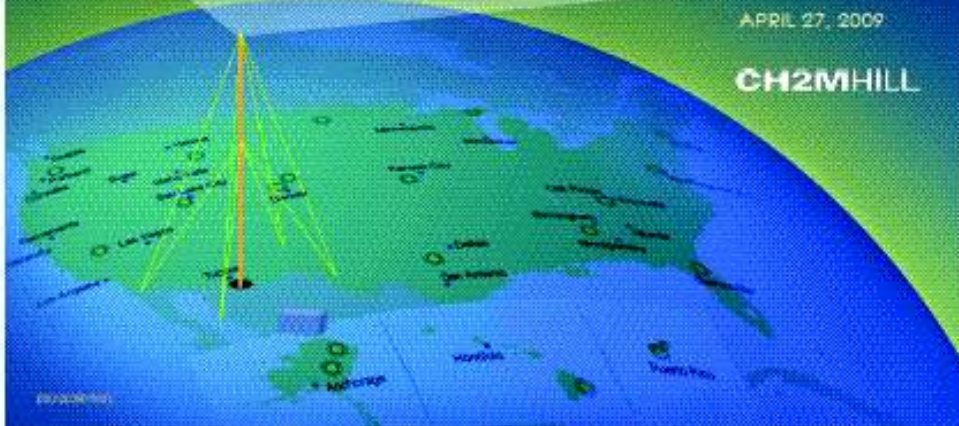
NATIONAL
SCIENCE
FOUNDATION

PRELIMINARY DRAFT

National Ecological Observatory Network (NEON) Environmental Assessment

APRIL 27, 2009

CH2MHILL



16

19

18

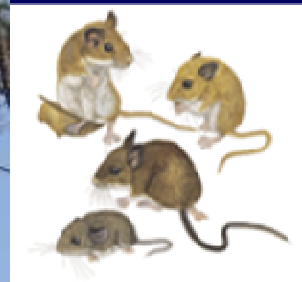
Biological Monitoring Measurements

In situ Sensors

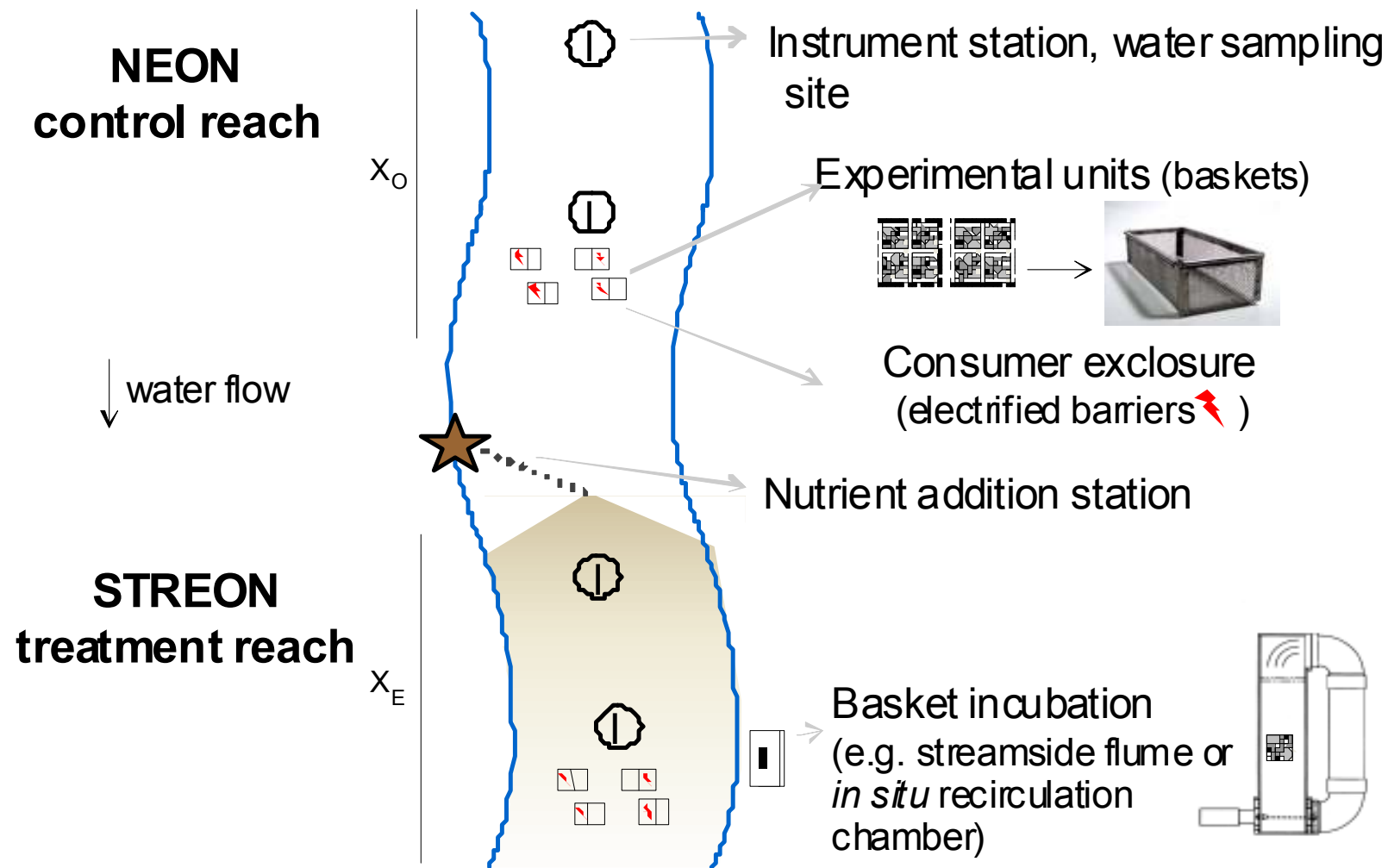
plot

- Vegetation
- Small mammals
- Birds
- Beetles
- Mosquitoes
- Microbes

- Soil chemistry
- Aquatic biology



Experiment Design





What is the scope of the Science Measurement Requirements?

- 60 Sites in 20 Domains across the Continental USA and Puerto Rico
- 60 Tower Locations
- 36 Aquatic Stream and Pond Locations
- 10 STREON Locations
- 10 Mobile Platform Locations
- 2,000+ Individual Measurement Suites or Assemblies
- 20,000+ Sensors
- 40,000+ Measurement streams
- Generating over 10 Tb per year of data to be processed

Supporting Facilities for Science and Education

- Chemical analysis resources
- Isotopic analysis resources
- Genetic analysis resources
- BioArchive collections and curation
- Calibration/Validation (cal/val) Laboratory
- Education facilities/programs
- Disease facility
- Digital field guides, keys, & manuals
- Information for decision support
- Data and forecast production facility
- NEON satellite sites

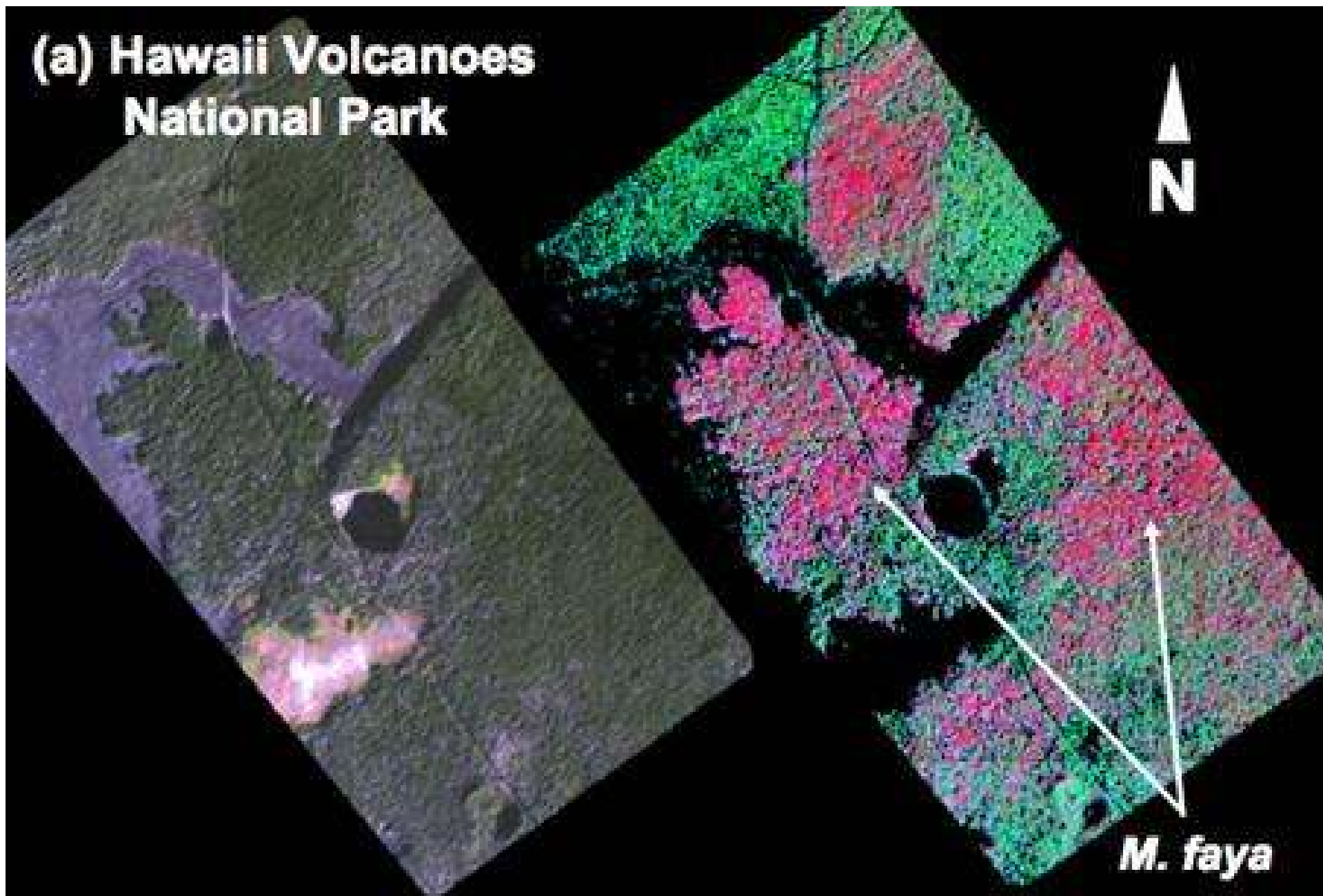
Infrastructure Testbeds



Microbes
Barcoding - Identification



**(a) Hawaii Volcanoes
National Park**



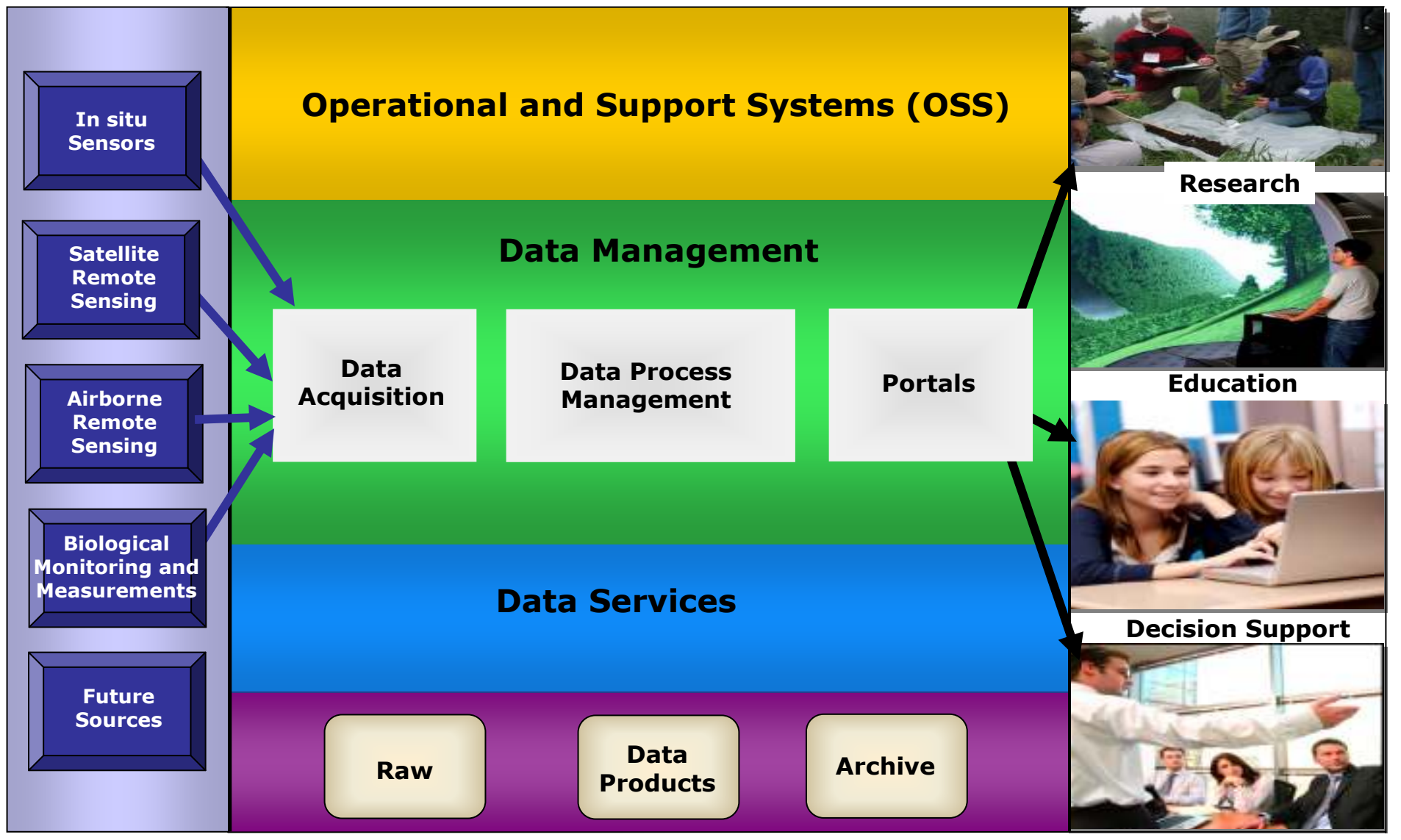
M. faya

Cyberinfrastructure

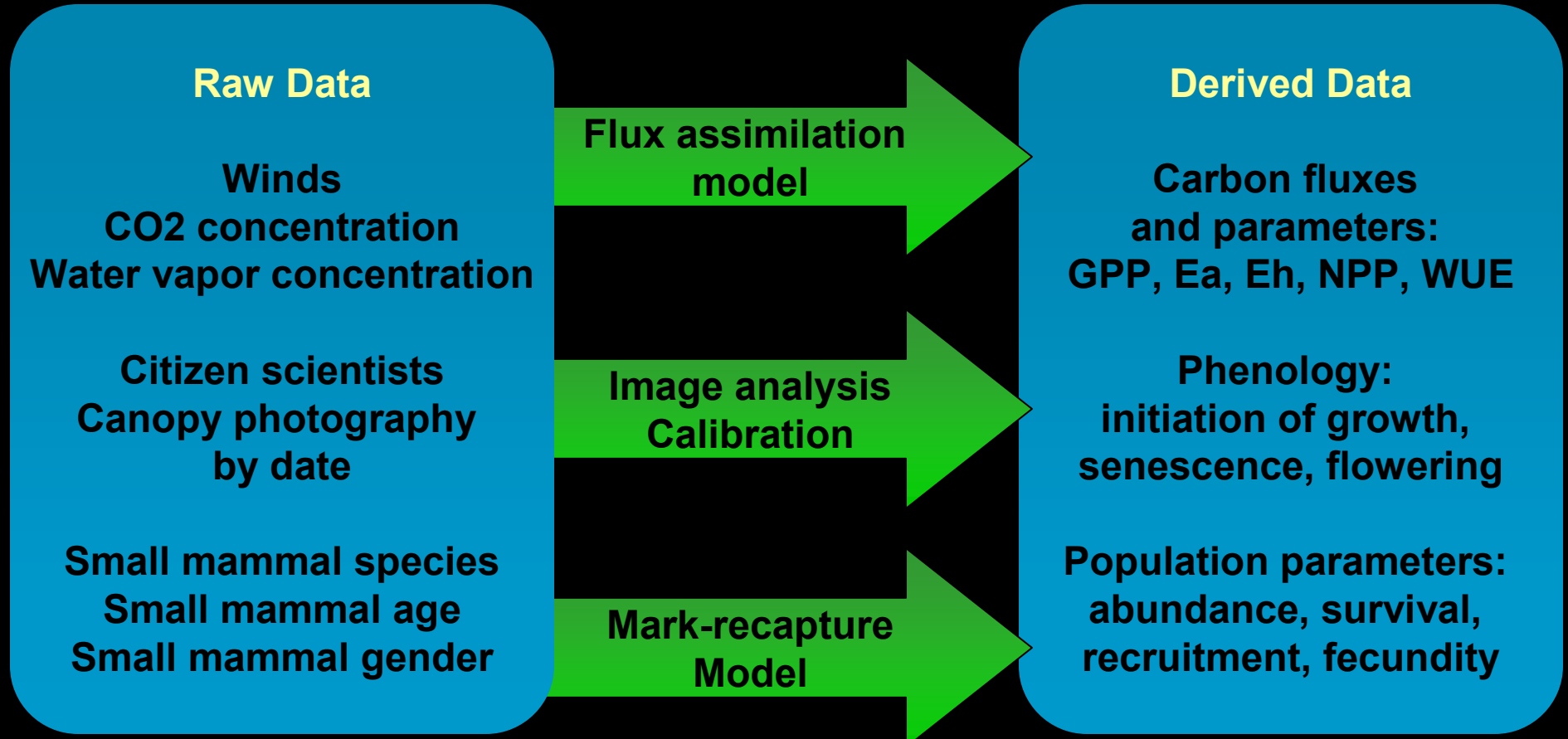
Distributed

Centralized

Distributed



Raw & Derived Data Products



Making Connections

Translational Genomics Connecting Genomes to Ecosystems

Genotype



Phenotype



Breeding Ecosystems



**EVOLVING
GENOMES**



**EVOLVING
POPULATIONS**



**CHANGING
ECOSYSTEMS**

How do living systems respond to rapidly changing environments?

Connectivity: NPGI & NEON

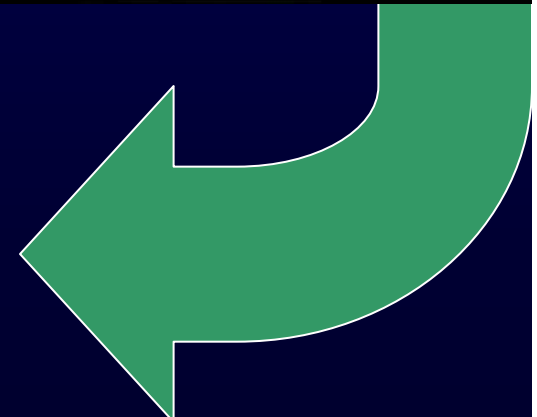
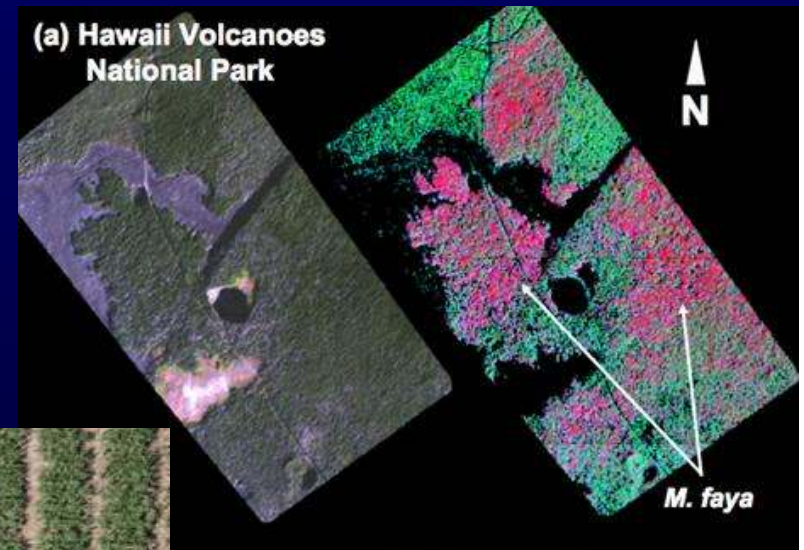
Phenotype = Genotype + GxEnvironment

Maize cultivars



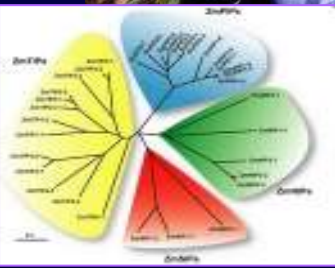
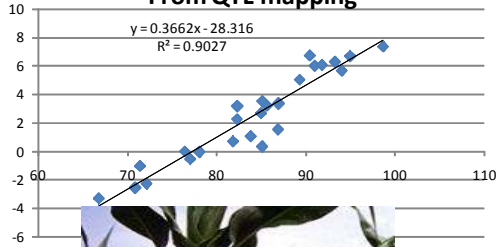
Genomic Selection

NEON Airborne Remote Sensing



Potential NEON Crop Analysis & Forecast

Prediction of Parent Flowering
From QTL mapping



**PREDICTION OF THE BEST
GERMPLASM-ENVIRONMENT
RELATIONSHIP**

**FORECASTING USING
ECOLOGICAL NICHE &
AGRONOMIC MODELS**

**SITE-BASED
DATA**

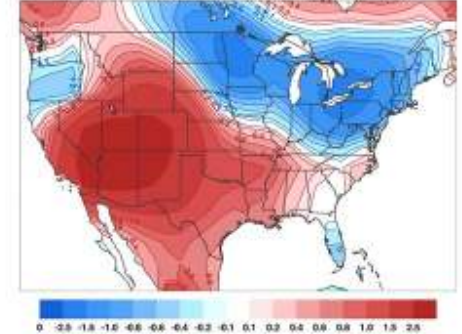
**SPATIAL
& REMOTE
OBSERVATIONS**

**DISTRIBUTION & ABUNDANCE
OF CROP PHENOTYPES**

GERMPLASM

**REGIONAL
SCALE**

Forecasted Temperature Anomaly Jan-Feb-Mar 2009



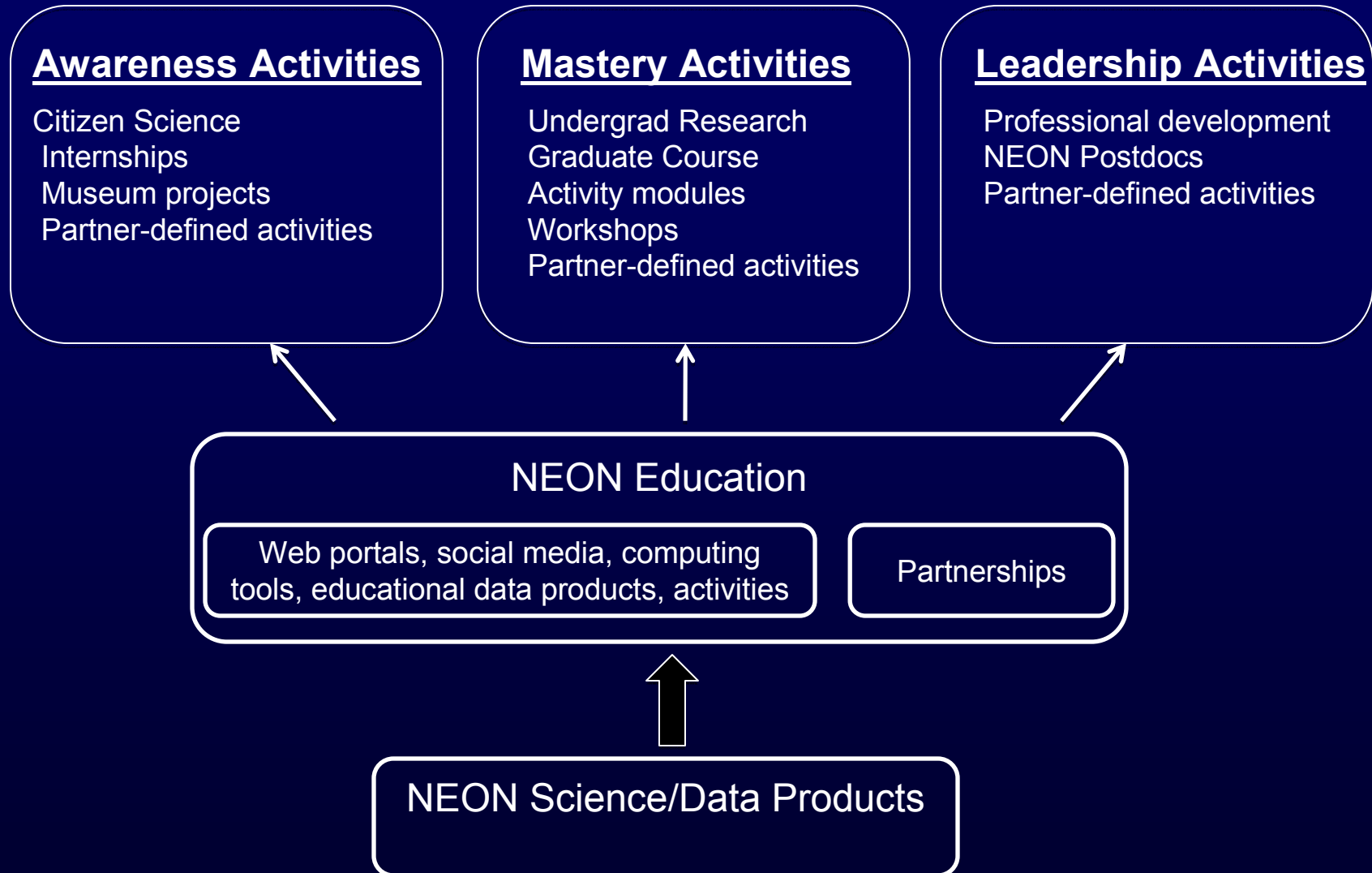
NEON Education: Guiding Framework

- **Accessible and Usable** by a diversity of communities
- **Facilitating partnerships** – NEON acts as broker to provide resources for stakeholders to use as they deem appropriate
- **Transforming science to include citizens**
- **Active learning** or “doing science”
- **Decentralized** process of learning and **Free-choice learning** context
- **Catalyst** to advance “science as a way of knowing”

NEON Education: Design

- Facilitating use of NEON products
 - Design **web portals**, educational **data products**, **social media**, and **computing tools** that provide access to NEON data in a variety of contexts and formats that are usable by a diversity of audiences
 - Build effective and meaningful **partnerships** that enable partners to develop NEON-based activities appropriate for their communities
 - Facilitate activities that support **awareness, mastery and leadership in continental-scale ecology**
- Participating in NEON
 - Opportunities for a **diversity** of people to participate in NEON data collection, analysis, and interpretation through “citizen science”
 - Opportunities for scientists, educators, and **decision-makers** to develop educational tools and/or data products

Accomplishment focused Education

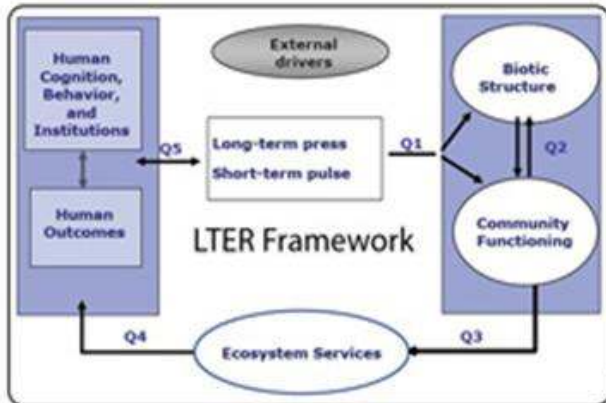


Undergraduate Curricula in Continental Biology

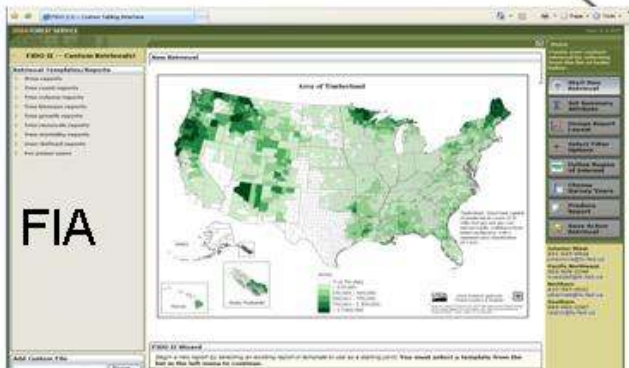
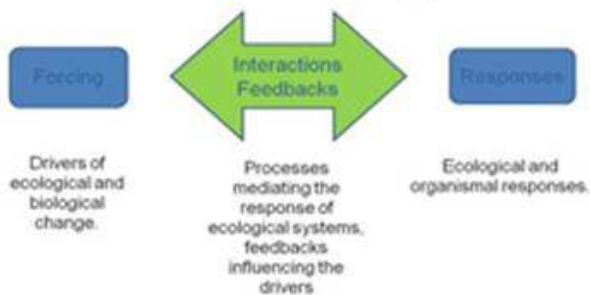
“Continental Scale Research to Understanding Climate Change Effects on the Biosphere”

- Scientific Framework (LTER, NEON, USFS FIA, USGS Watershed)
- Spatial and Temporal Continental-scale data
- Inter-disciplinary approach
 - Observation, experimentation, modeling
- Activities and Decisions to obtain and organize “data”
- Cognitive, Analytical, Technical Skills
- Collaborative Modules

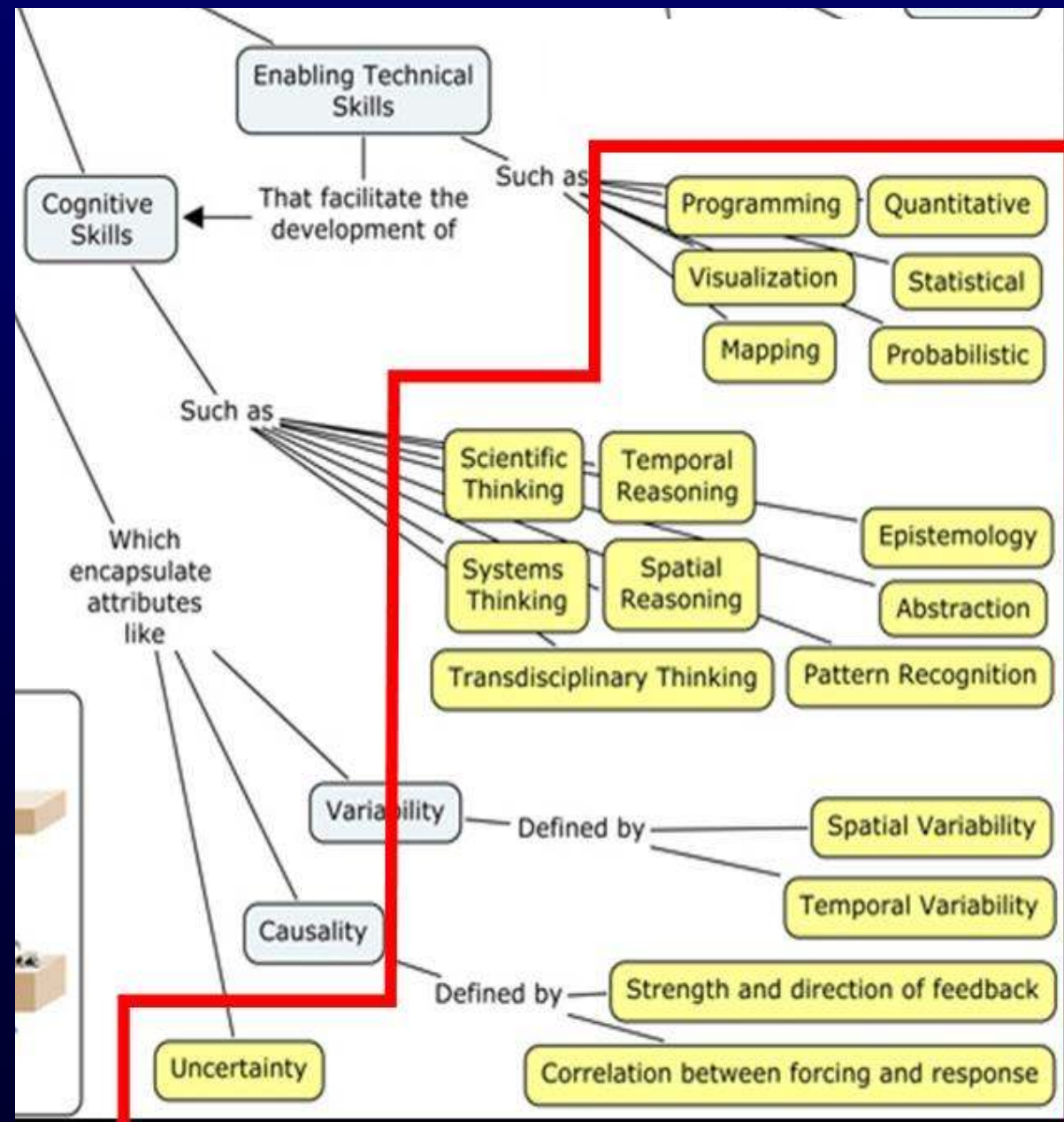
Education using continental-scale data



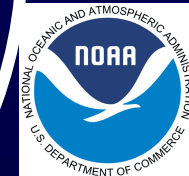
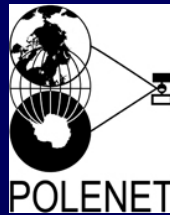
NEON's Research Approach



Curricula in Continental Biology



Partnerships



NSF



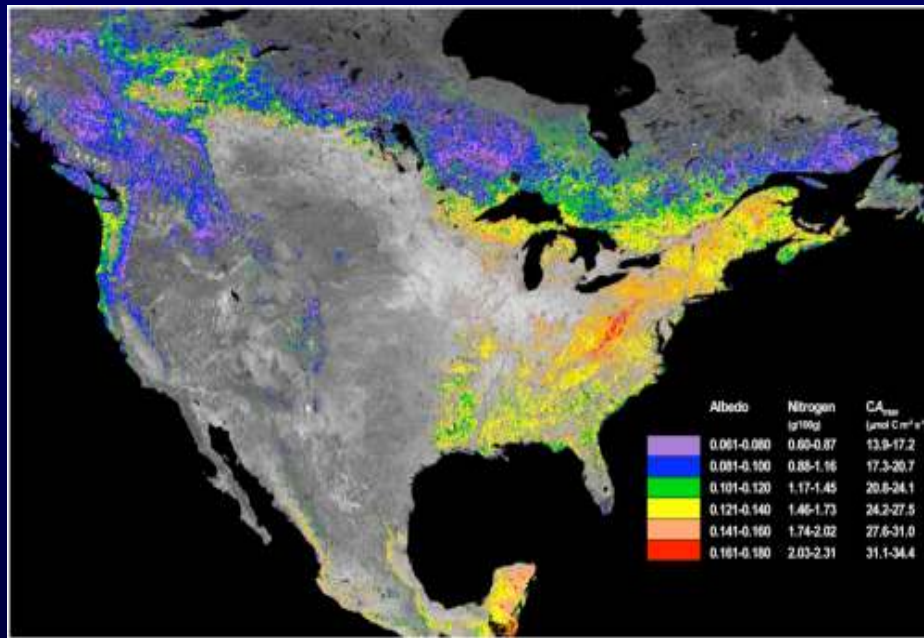
A New Tool for Transforming Biological Research

*NEON
enabled
science
provides the
fundamental
scientific
underpinning
for a
sustainable
planet*



Enabling Ecological Science

How does the change in albedo and foliar N affect ecosystem productivity?



Estimates of canopy %N and CA_{max} for forested areas of North America derived from MODIS short-wave albedo
(Ollinger et al. *PNAS*, 2008)

How NEON can enable science?

- FIU anchored albedo and NEE
- FSU measured LAI, foliar N, EP
- LUAP land cover
- AOP 20 x 20 km scale albedo, foliar N at Adv. and Reloc. Sites
- Researchers/NEON collaboration to develop temporally/spatially explicit assimilated models

NEON Project Structure

