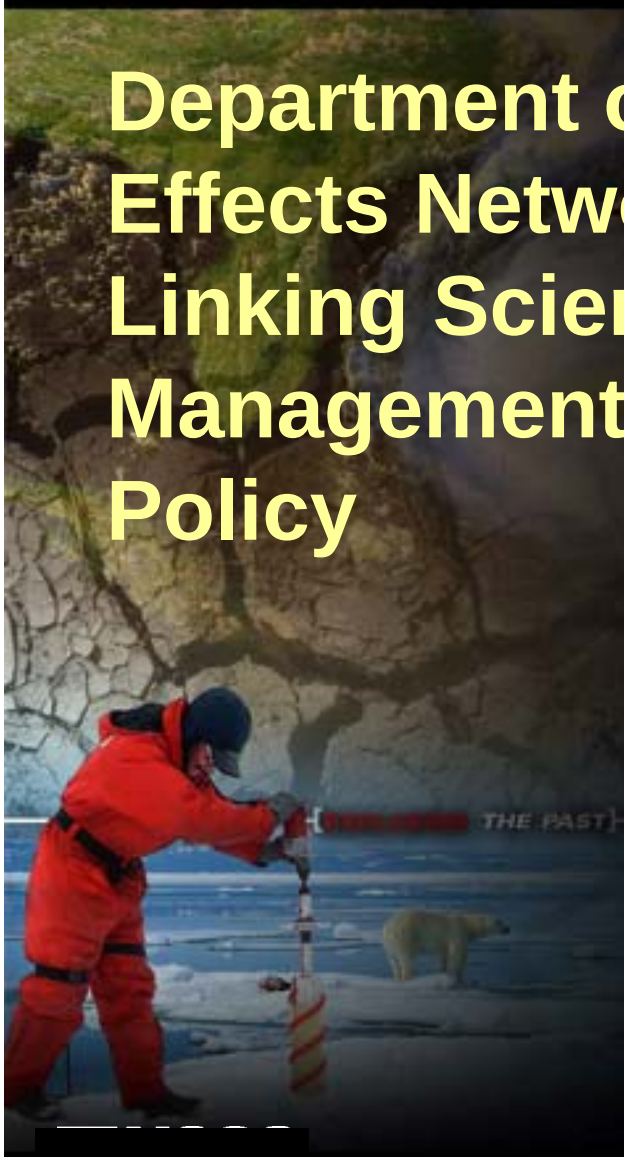
USGS
science for a changing world

Department of the Interior's Climate Effects Network: Linking Science to Resource Management Decision Making and Policy



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U.S. Geological Survey

The Climate Effects Dilemma

- Point data indicate major change is underway where baseline regional data is sparse or non-existent.
- Where and when these changes will disrupt ecosystem function or human activity is uncertain.
- What adaptation or mitigation strategies will be most effective are also uncertain.
- To understand the changes, measuring the effects on whole systems over time is necessary.
- Answers are needed now in some areas, and very soon in many.

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Issues in understanding and responding to Climate Effects

Some Realities:

- By the time resource managers notice a problem, the problem will likely be chronic and critical thresholds passed.
- Long-term records are therefore needed; maintaining existing long-term sites will expedite decision-support.
- Initial climate effects will be episodic: Anticipating abrupt change requires understanding resilience and thresholds.
- Detection of early change will therefore require capacity to measure on a range of temporal scales, and use of “space-for-time” substitution.

The Bottom Line: A Catch-22

- To effectively adapt to or mitigate climate change or variability, we need to track and understand whole-system responses
  - Circulation systems (air and water)
  - Ecosystems
  - Socio-Economic Systems
  - Feedbacks between and within systems
- We don't have system-level information at the range of scales needed, and the cost of building capacity from scratch is prohibitive.
- Only 2 solutions available:
  - Slowly study one project at a time (NSF).
  - Organize existing capacity around key climate issues, and use new resources to fill gaps and support integration.

The logistical issue

PROBLEM:

It is not possible to assess the complex changes, interactions, and feedbacks caused by climate change at every specific location where resource managers need us to be.

THE NECESSARY ASSUMPTION:

Within broad ecoregions, the dominant processes controlling ecosystem responses to climate change are similar; however, ecosystem condition is highly variable.

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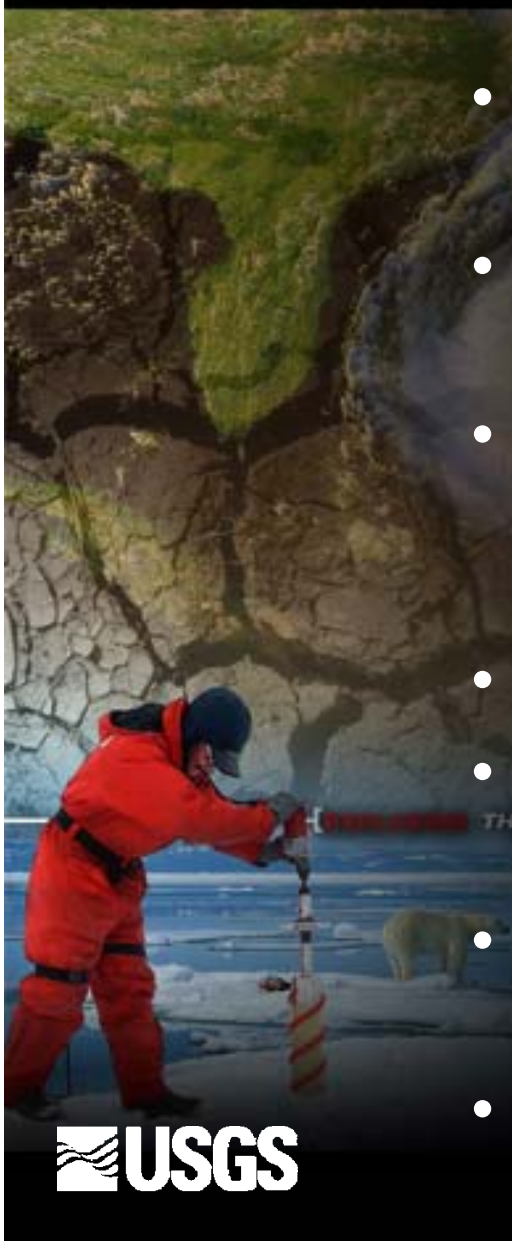
The Vision – A National Climate Effects Network

- A truly integrated National climate effect monitoring network capable at a range of temporal and spatial scales
- A scientific team focused on early detection and scientific analysis in support of adaptation or mitigation strategies
- An information dissemination and decision support system for cost effective, scientifically rigorous management and policy decisions
- The capacity for the next generation to protect and sustain our National trust resources through early detection of change across the landscape.
- Congressional funding obtained in FY08 (1.0M)
- FY09 Climate Change Initiative in Congressional discussions

Steps Involved In Network Implementation



- Determine specific climate effects and response issues by region.
- Determine the types of data needed to address those issues.
- Assess what data is already being collected by existing programs (the “Foundation” Programs), and what can be said with that data.
- Complete a gap analysis relative to each issue.
- Fund integration services and enhancements of existing programs to fill the gaps.
- Fund new observation/research/decision support tool development to fill the gaps.
- Systematically ensure research is linked to applications for decision support.

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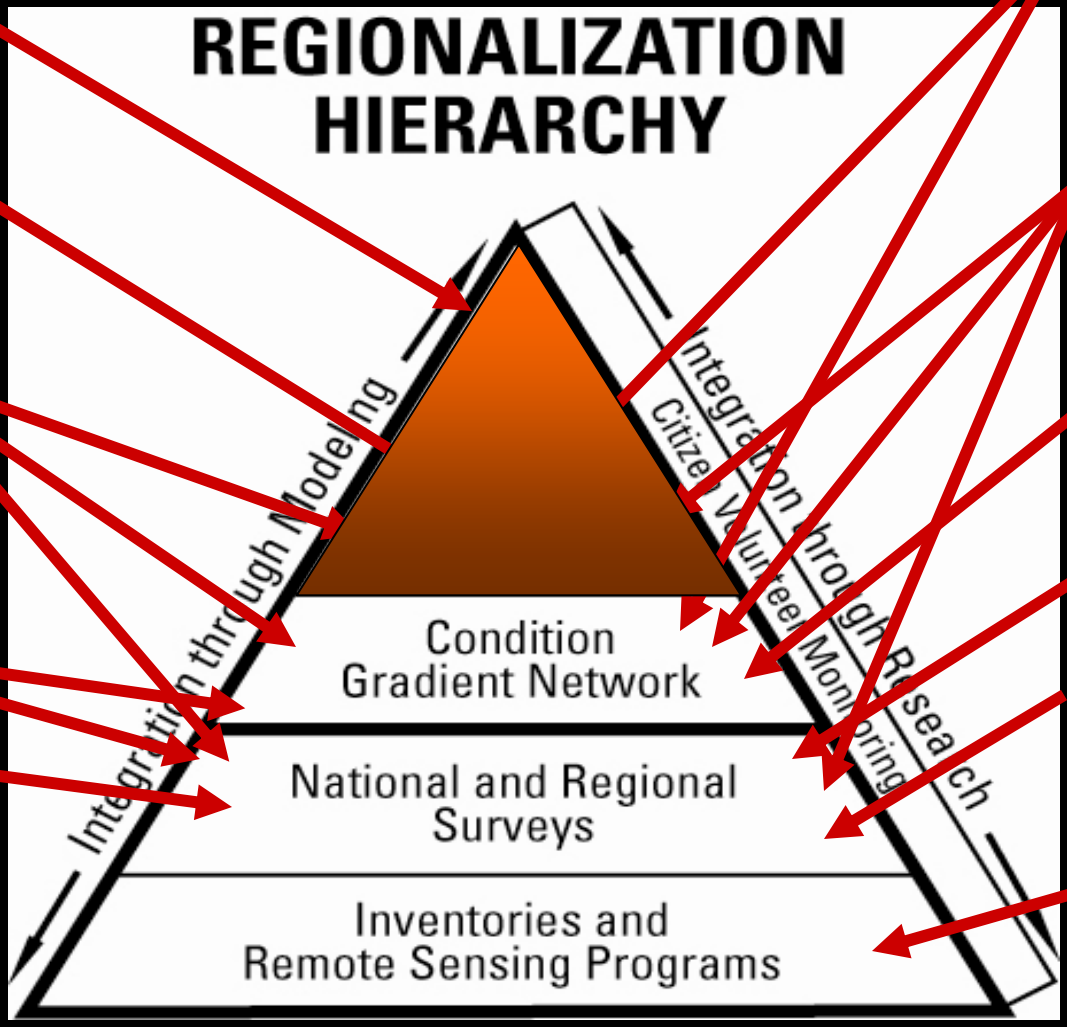
Climate Change in the US?



LTER Sites

WEBB Sites

Vital Signs?

NPS I&M?

NPN?

Regional Aquifer Study

CORE Sites

GC-RFP Sites

NAWQA

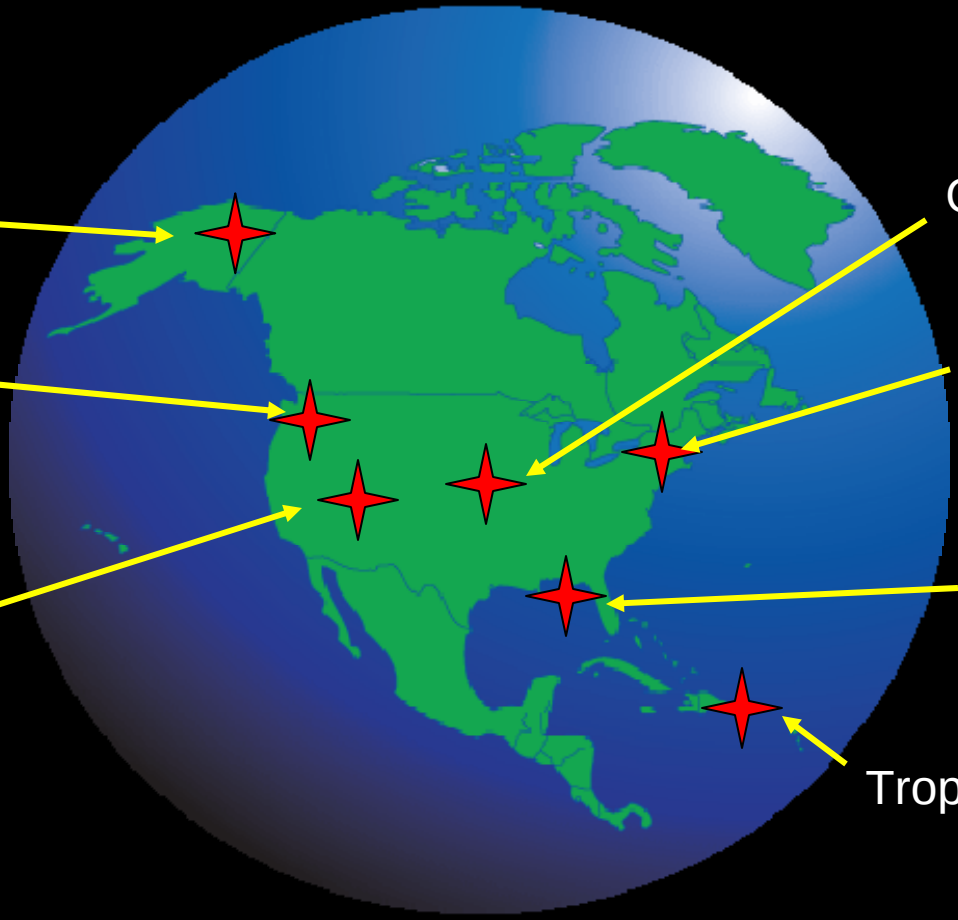
FIA, EMAP

Stream Gage Network

EROS, CCRS, NASA

Step 3: Details on existing capabilities

Possible Collaborative Observation and Research (CORE) Ecoregions



Yukon River Basin and North Slope

Pacific Northwest Rainforest

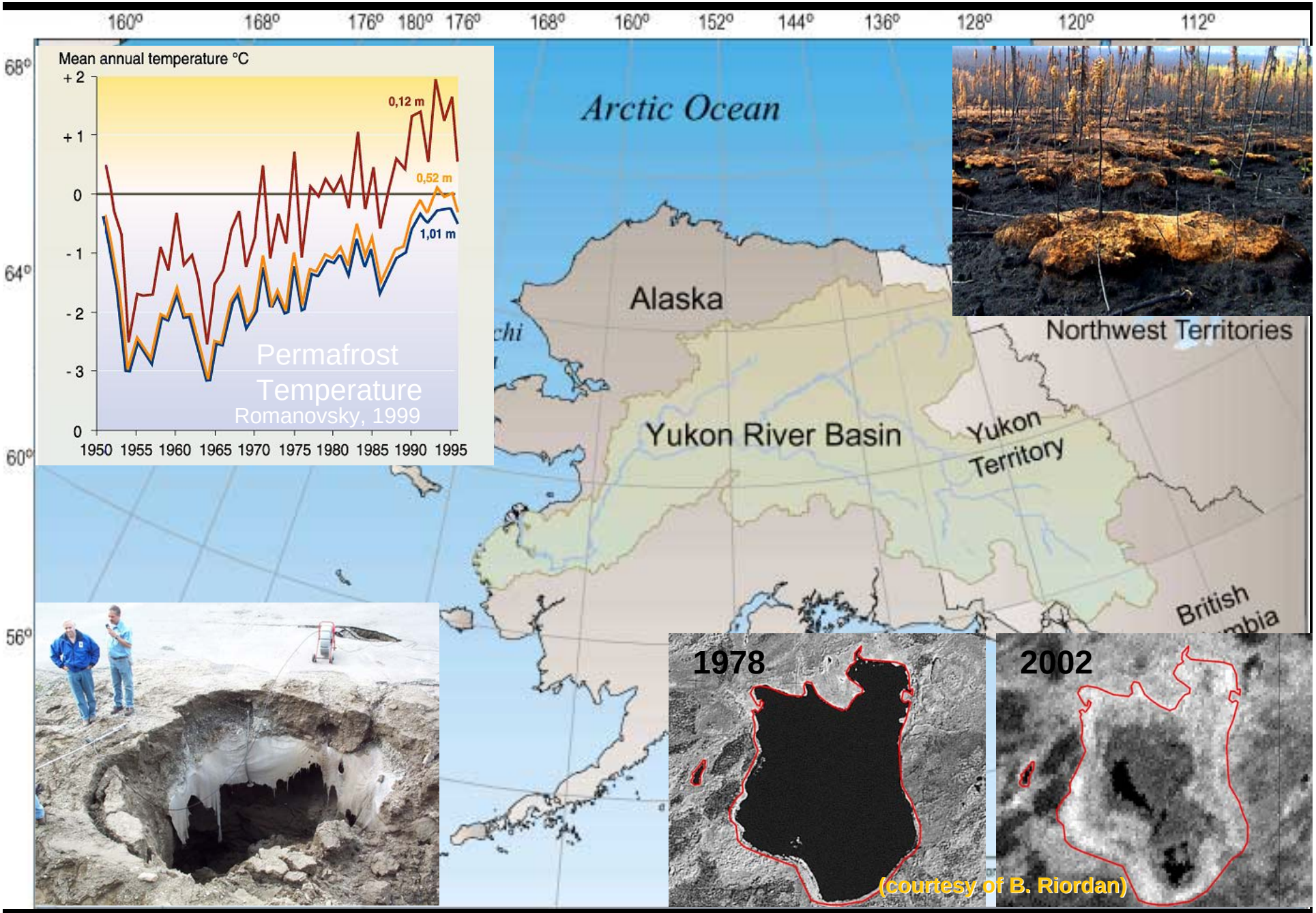
Southwest Mountains and Desert

Grasslands

Northeast Temperate Forest

Gulf Coast/ Florida Wetlands

Tropical Forest



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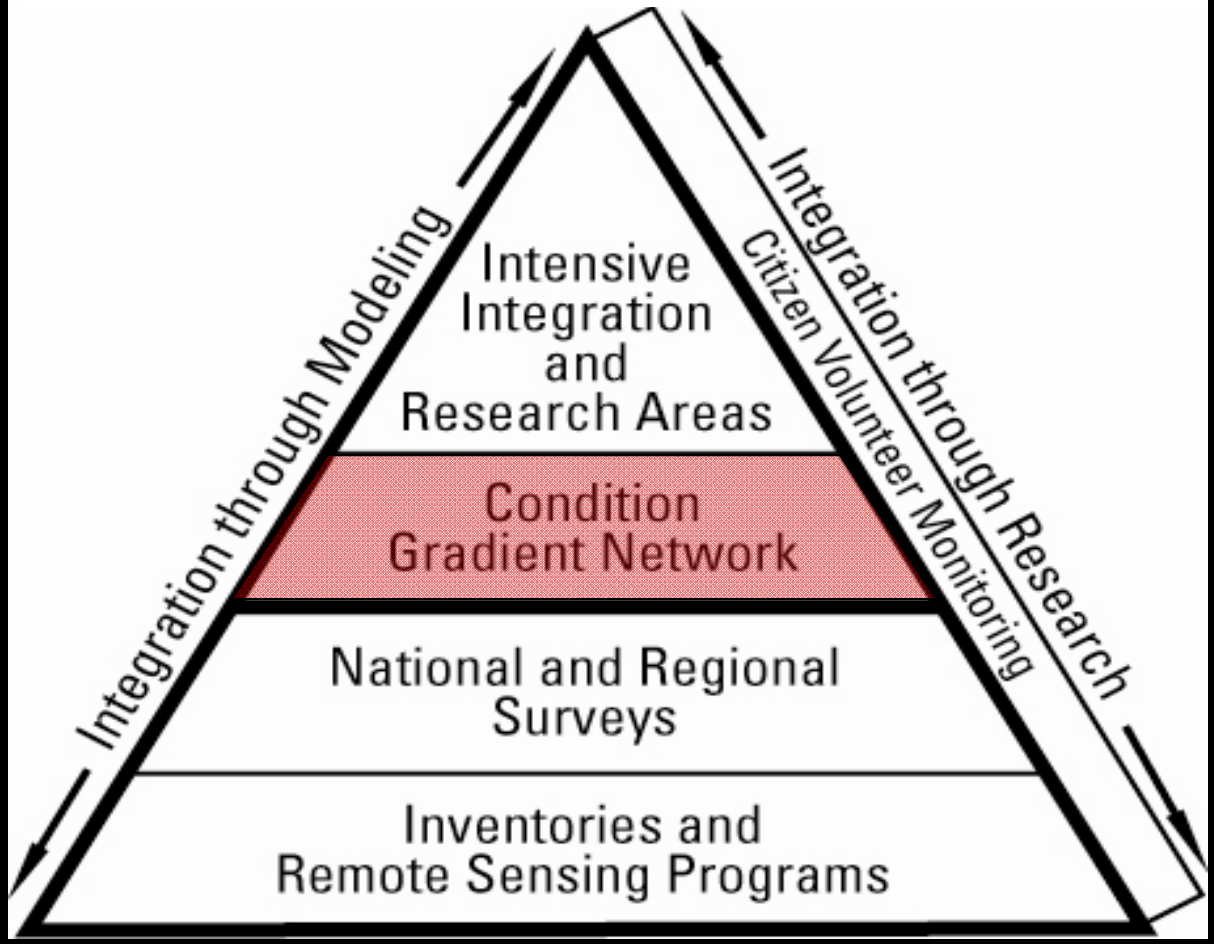
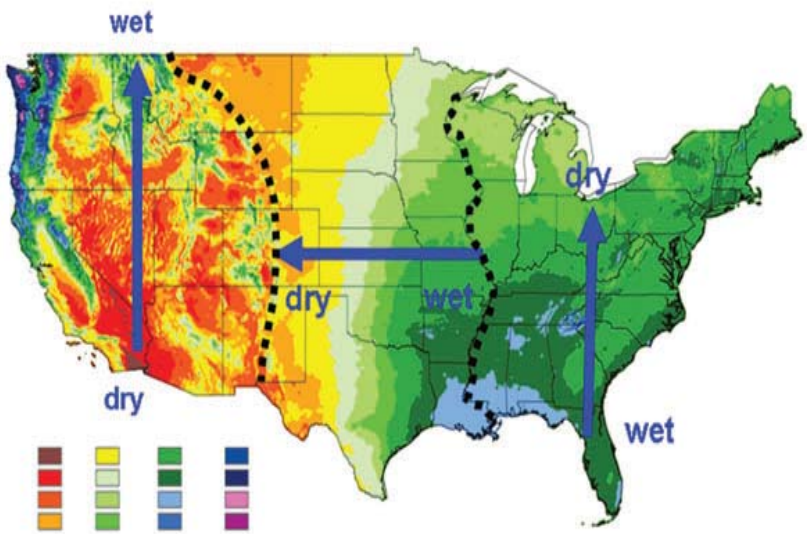
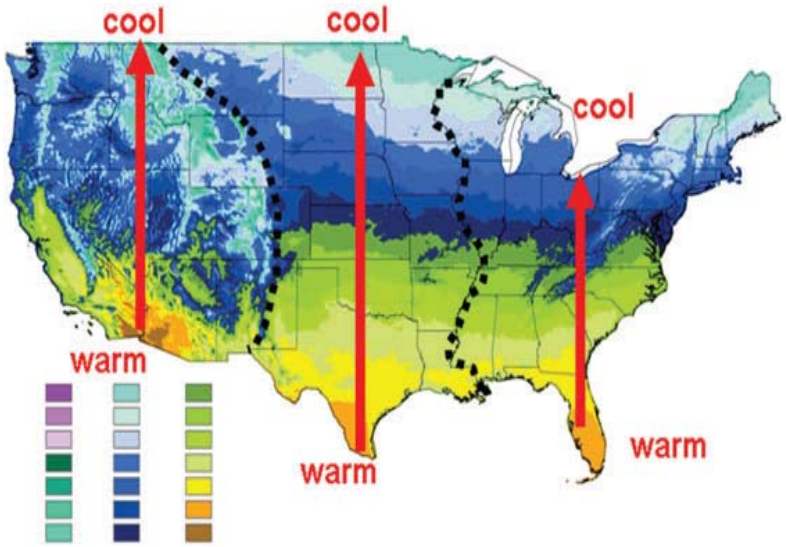
Globally and locally significant rapid change

National Climate Effects Science Network



Systematic organization of capabilities

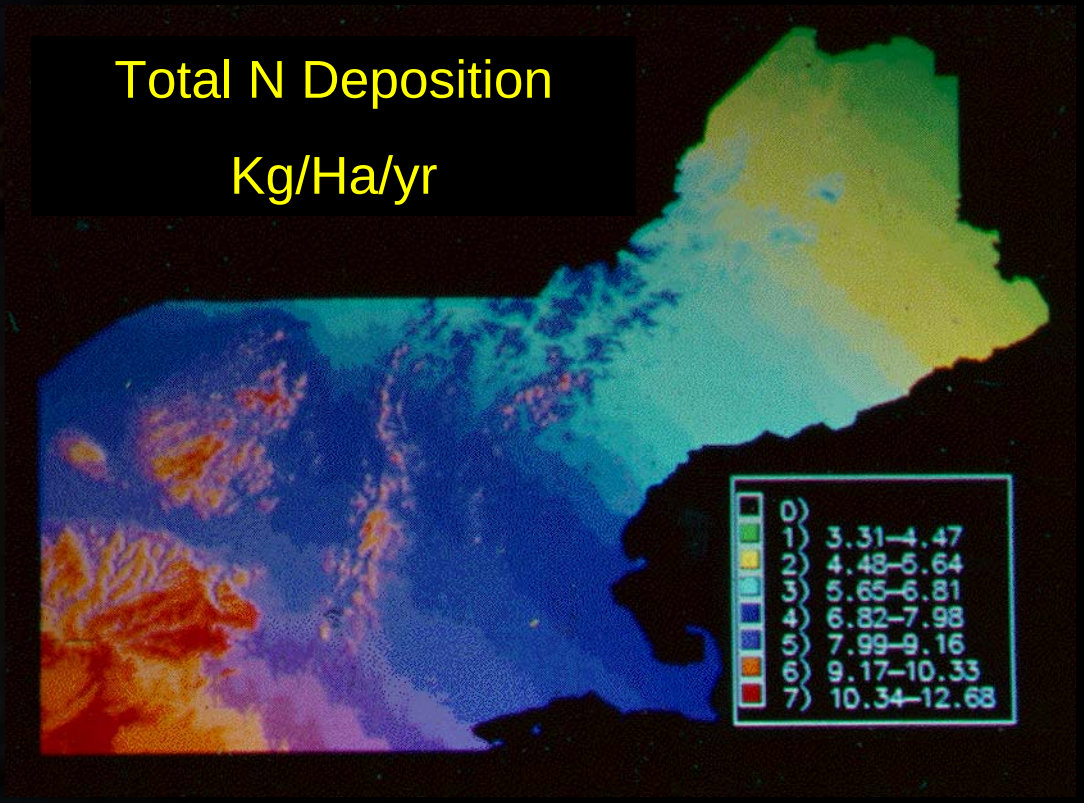




Climate gradients in the lower 48

Debra PC Peters, 2008

Nitrogen Deposition Gradient Across the Northeastern United States



Ollinger et al, 1994

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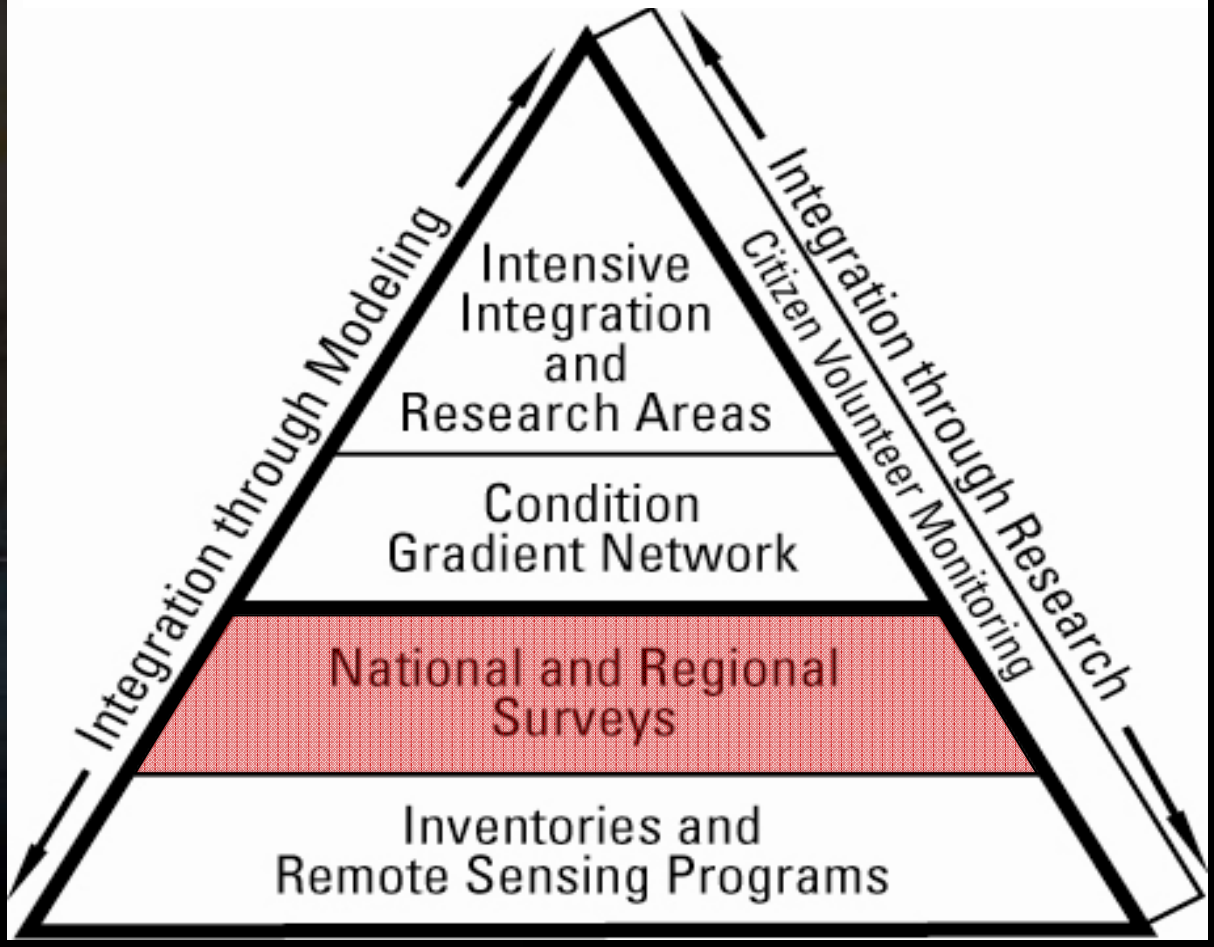
Systematic organization of capabilities

National Climate Effects Science Network



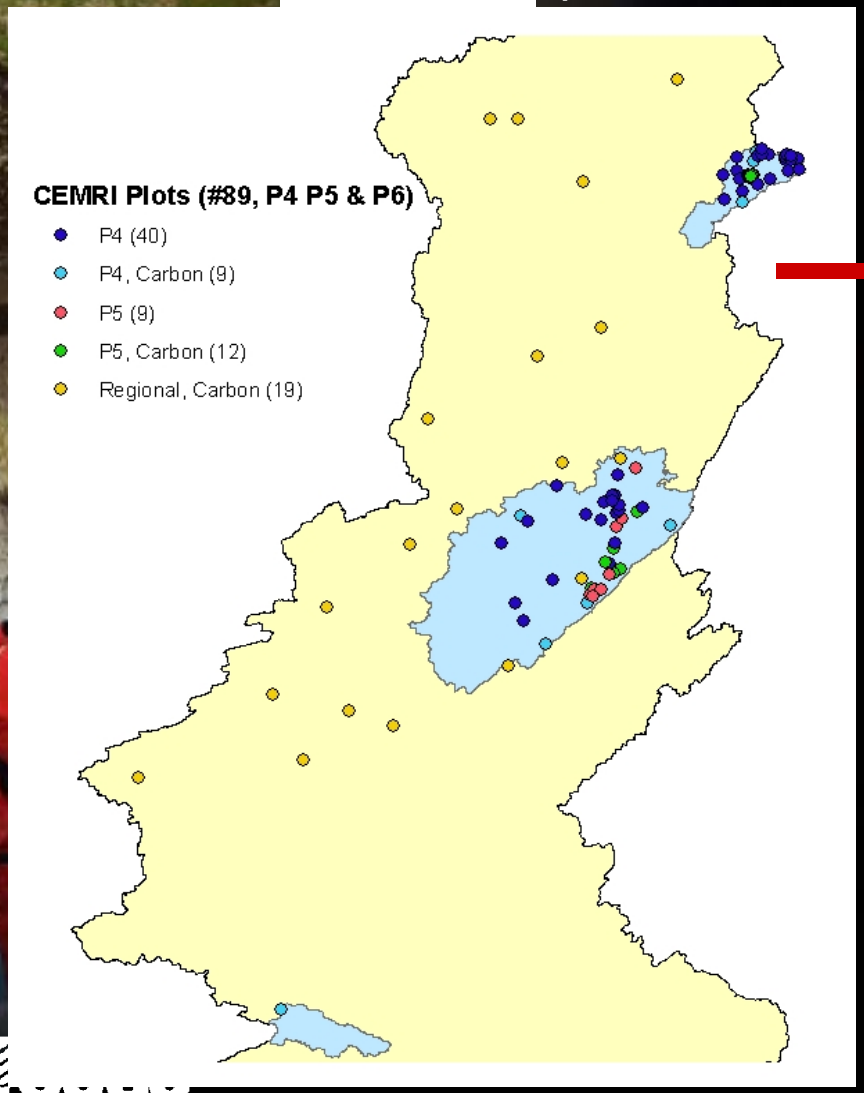
Tier 3: Regional and National Surveys of Key Climate Effects Indicators

- Vegetation Type (FIA)
- Vegetation Health (FHM)
- Soil chemistry
- Wildlife census
- Surficial Geology
- Surface water quality

- Forest Fragmentation
- Precipitation and air temperature networks
- Active layer thickness (north)

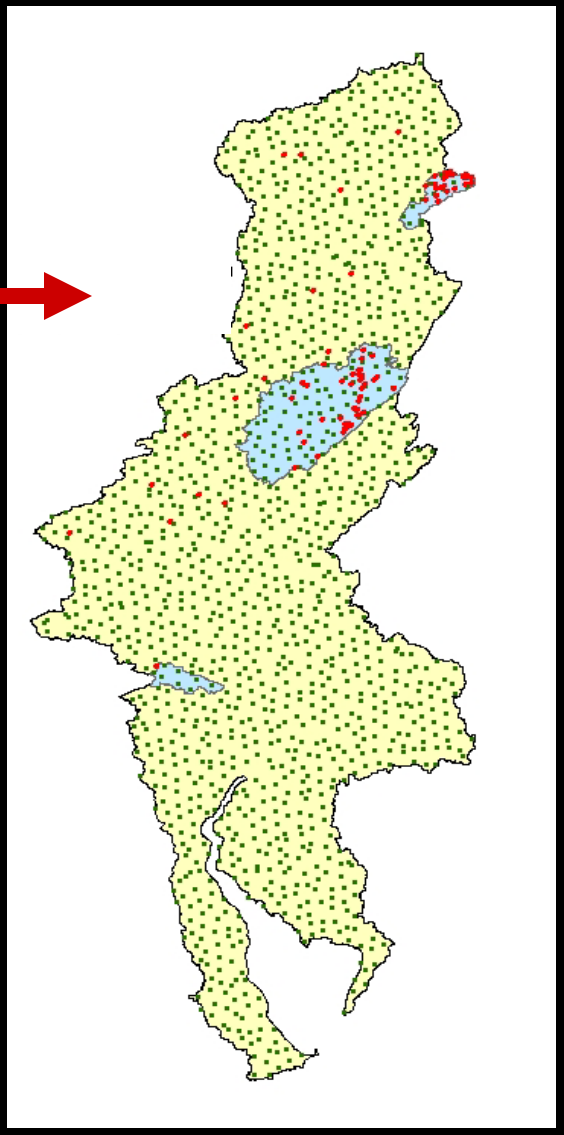
Scaling strategy Tiers 1 to 3

CEMRI carbon plot network



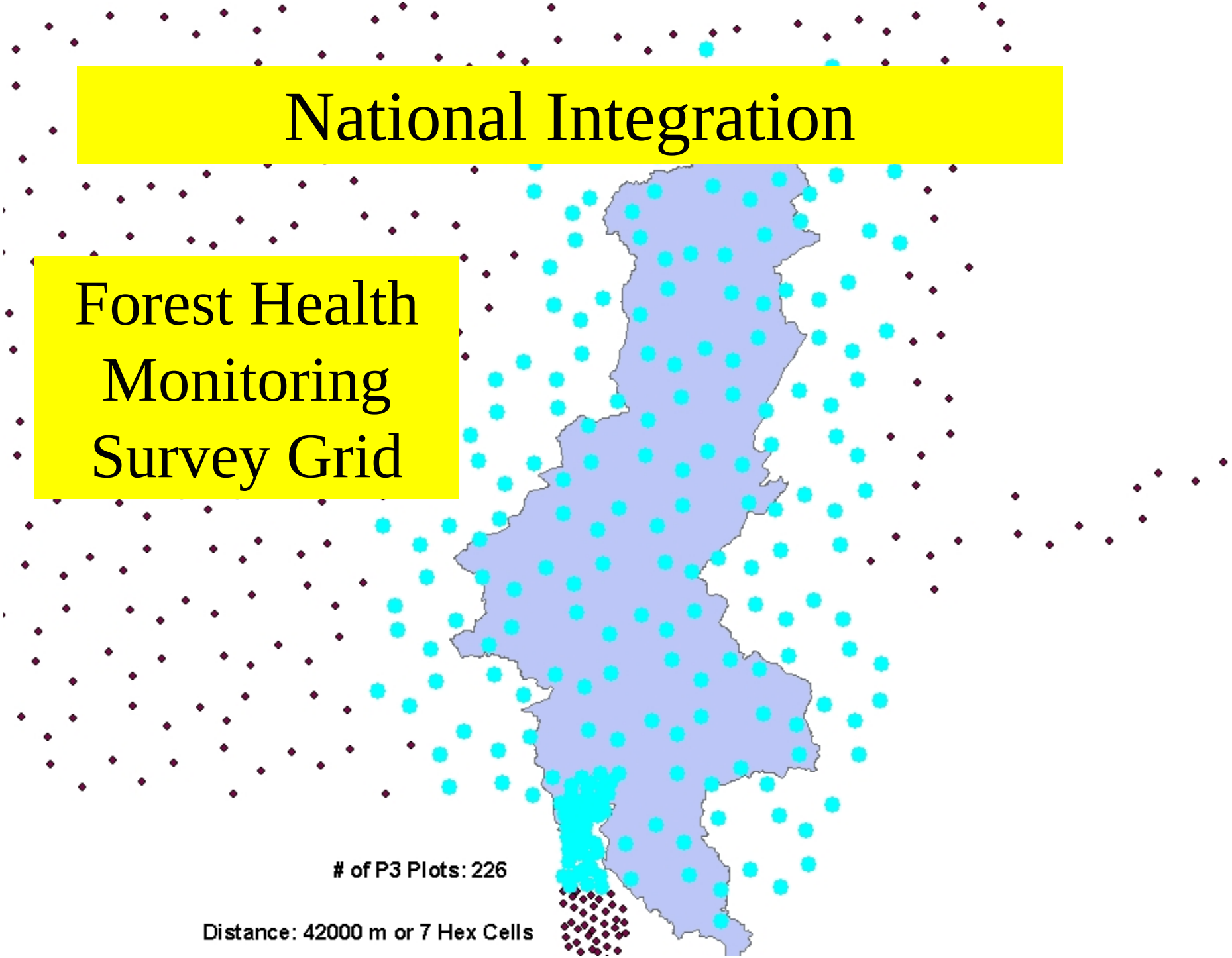
Nested within

FIA P2/P3 plot network

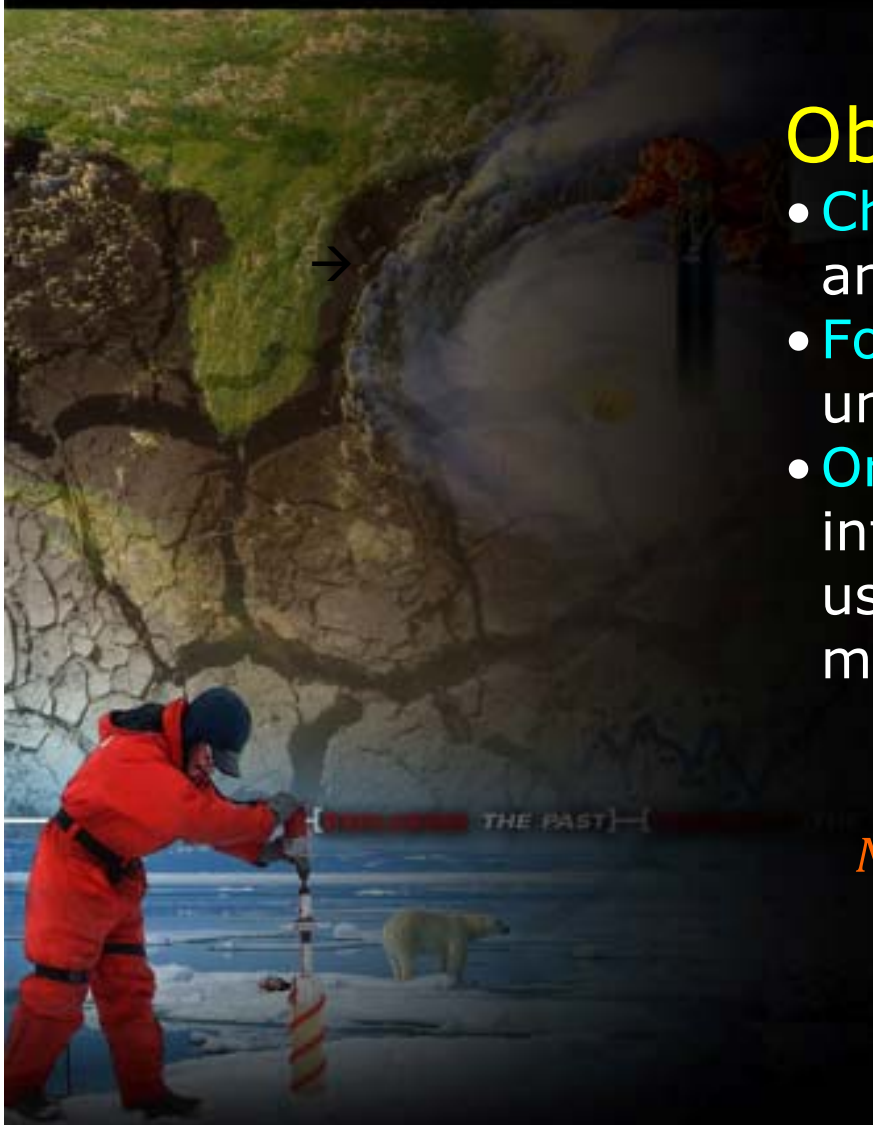


National Integration

Forest Health Monitoring Survey Grid



National Soil Carbon Network (in development)



Objectives:

- Characterize the current distribution and stability of soil carbon in the U.S.
- Forecast carbon vulnerability to loss under changing climate.
- Organize and distribute this information at resolutions that are useful to scientists, land managers, modelers, and policy makers.

No single agency or institution can accomplish these objectives across these scales; it will require a coherent effort.

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www.soilcarb.net

National Soil Carbon Network (in development)

Iterative Tasks and Products:

- Synthesis: creation and integration of soil carbon knowledge and databases.
- Prediction: development of spatially explicit soil carbon turnover models.
- Collection: identification of gaps in data and knowledge, with coherent study and surveys to fill those gaps.
- Interaction: production of interactive, scalable maps that link to data and text, in addition to providing visual summaries of carbon dynamics.

Status:

- Scientific Steering Group: a 19-member SSG from the USFS, EPA, USGS, DOE, CSREES, ARS, NRCS, NCAR, Cornell, UC Irvine, and Colorado State University.
- Workshops: organize shared scientific and logistical infrastructure, data management, and products (in planning: Alaskan deep soils; ^{14}C use in carbon cycling).
- Meetings: AGU scientific session on networks and C vulnerability; further organization and inclusion at the North American Carbon Program meeting.

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www.soilcarb.net

Structure tasks

Task I
Synthesis of existing soil data

Task II
Predictive efforts and gap identification

Task III
Field and archive data generation

Climate & Management Scenarios

Specific Vulnerabilities
Temp.,moist., physical disruption, vegetation shifts.

Boundary conditions

Eco data

Soil C Dynamics

Synthesis
Calibration
Verification

Basic models

Process models

Eco-models

Soil-models

Data Synthesis

Initialization

Spatial data

Present C stock maps

Extrapolation

Measurement-based modeled pools

Resilience, risk, & turnover maps

Error estimation

Confidence maps

Importance Criteria
Eg: potential loss, ecological resilience, information density.

Agency focus

"Gap" identification
(areas needing most attention)

Prioritized areas

Iterative feedback to Task I

Extensive Collection
(*Data gaps:* survey & monitoring)

Spatial data gaps

Databases
(FTIR-MIR, Radiocarbon, ...)

Soil C Stocks and Fluxes

Intensive Collection
(*Knowledge gaps:* study & manipulation)

Process understanding gaps

Site and Archive Selection
(adaptive sampling)

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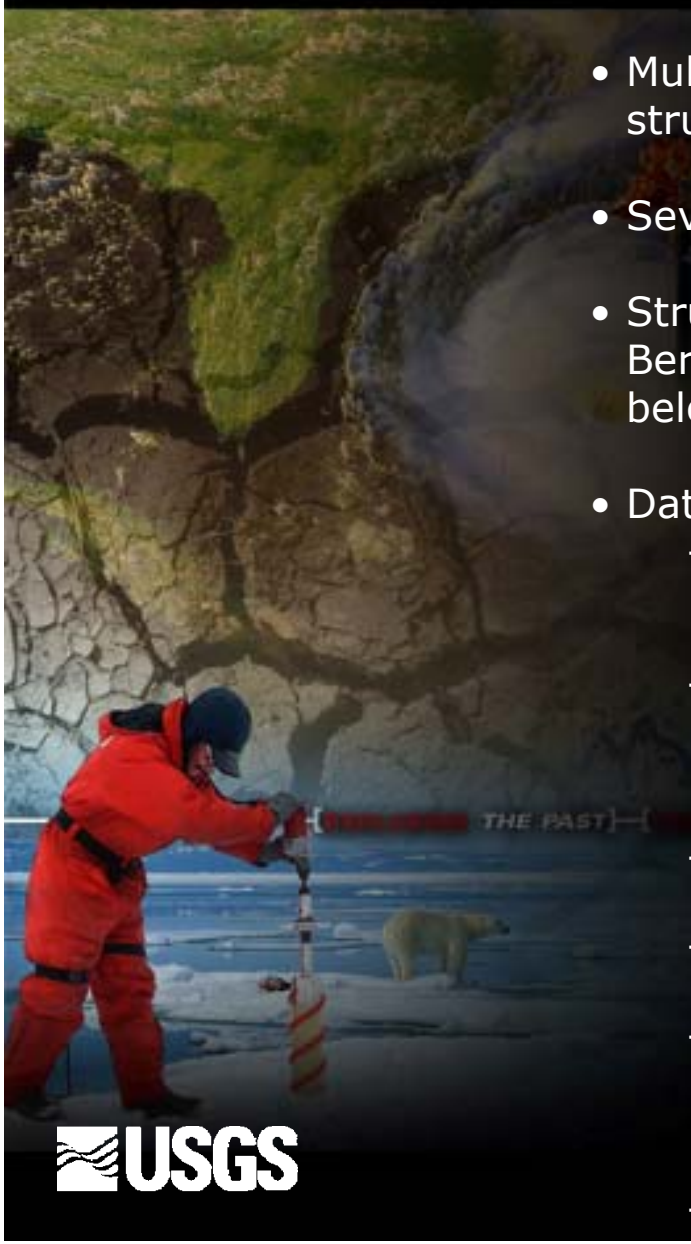
Initial activities databases



- A repository for soil carbon data and metadata
- Multiple linked and searchable databases with a common structure
- Several groups are currently collaborating
- Structure being developed in consultation with Lawrence Berkeley Lab, the Berkeley Water Center, and the groups listed below.
- Databases (in planning/development)
  - Radiocarbon values and turnover rates
    - Torn, Trumbore, and Swanston
    - published and unpublished data
  - Black carbon
    - Lehmann, Krull, Johnson
    - database of FTIR-MIR spectra and related chemical analyses
    - regional and national correlations
  - Alaskan deep soil carbon
    - McGuire and Harden
  - Hawaiian chronosequence soil carbon
    - Kramer et al.
  - US carbon, nitrogen, and water linkages
    - USGS Mendenhall position
    - takes advantage of 40 years of soil archives on multiple landforms
  - …several other interested groups

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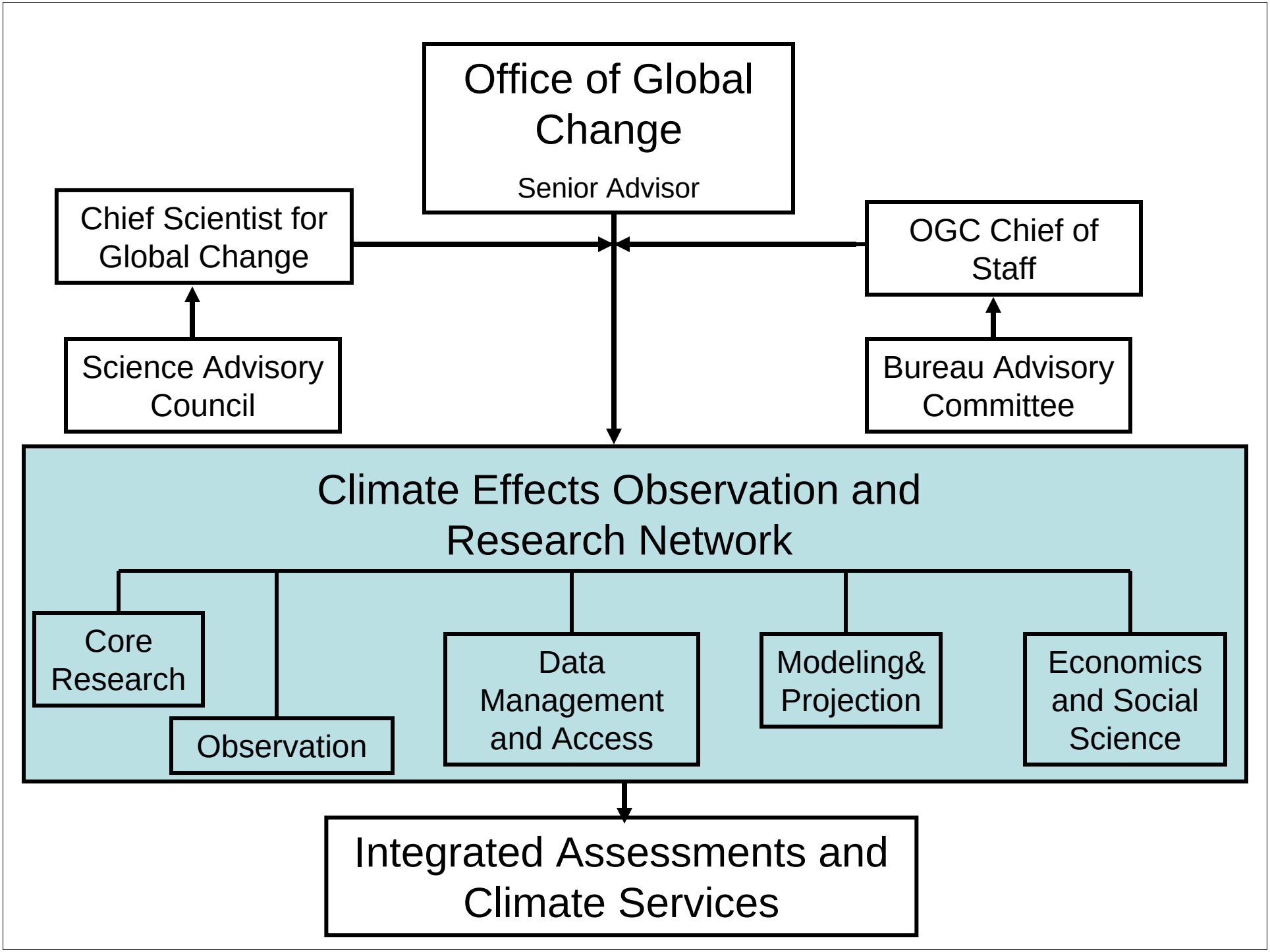
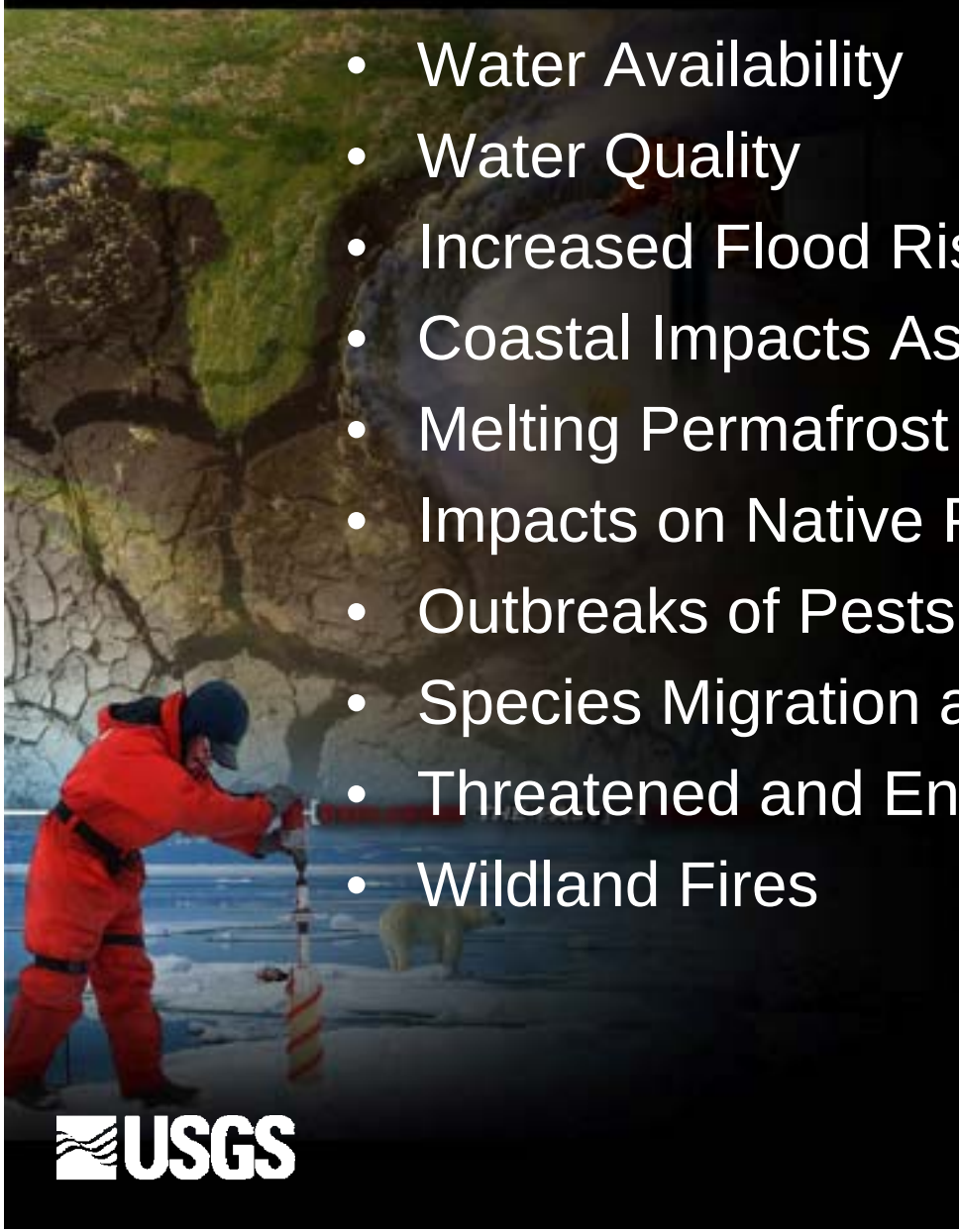
Proposal for the Climate Effects Network

- Collaborate with the National and Northeast Soil Cooperatives to develop protocols for a national soil chemistry survey.
- Assist in the development of a soils archive
- Fund enhancements to existing capabilities to created a panelled national soils sampling program (5 yr).
- Fund enhancements of laboratory and data management capabilities.


THE PAST


Office of Global Change
Senior Advisor
Chief Scientist for Global Change
OGC Chief of Staff
Science Advisory Council
Bureau Advisory Committee
Climate Effects Observation and Research Network
Core Research
Observation
Data Management and Access
Modeling& Projection
Economics and Social Science
Integrated Assessments and Climate Services

DOI Resource Management Issues and Challenges



- Water Availability
- Water Quality
- Increased Flood Risk
- Coastal Impacts Associated with Sea-level Rise
- Melting Permafrost and Sea Ice
- Impacts on Native Peoples
- Outbreaks of Pests, Invasive Species, and Diseases
- Species Migration and Habitat Change
- Threatened and Endangered Species
- Wildland Fires

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The Critical Science for Rapid Response

- Understanding of system-level processes affected by climate.
- Thresholds of accelerated or permanent change.
- Trends in both average conditions and the frequency or duration of stress conditions
- Potential feedback loops that mitigate or exacerbate disturbances in system function.
- Early assessment of ecosystem vulnerability using “space-for-time substitution.
- Potential adaptation or mitigation actions based on analysis of the above.
- Rapid assessment of the consequences or benefits of adaptation or mitigation actions.

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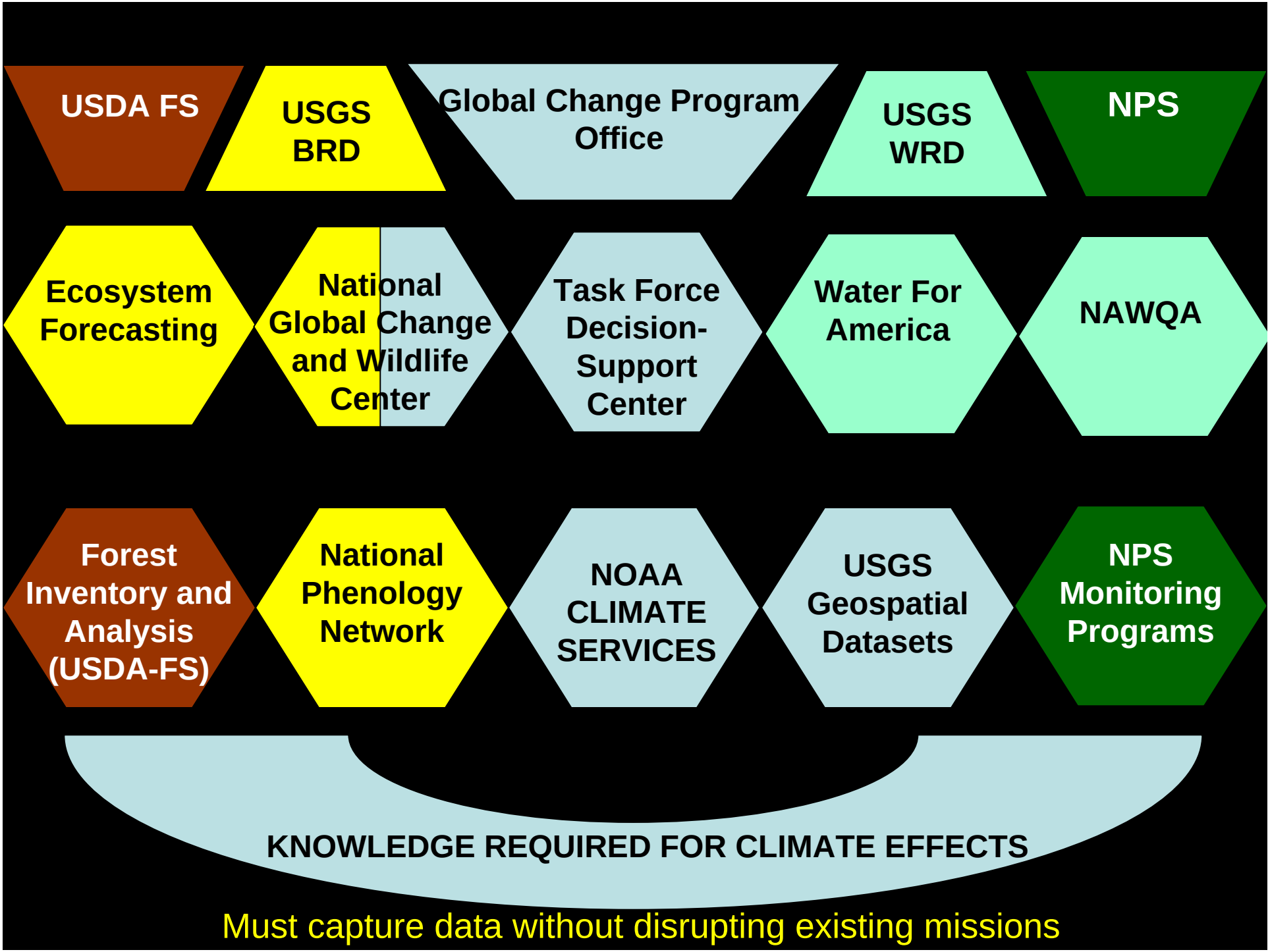
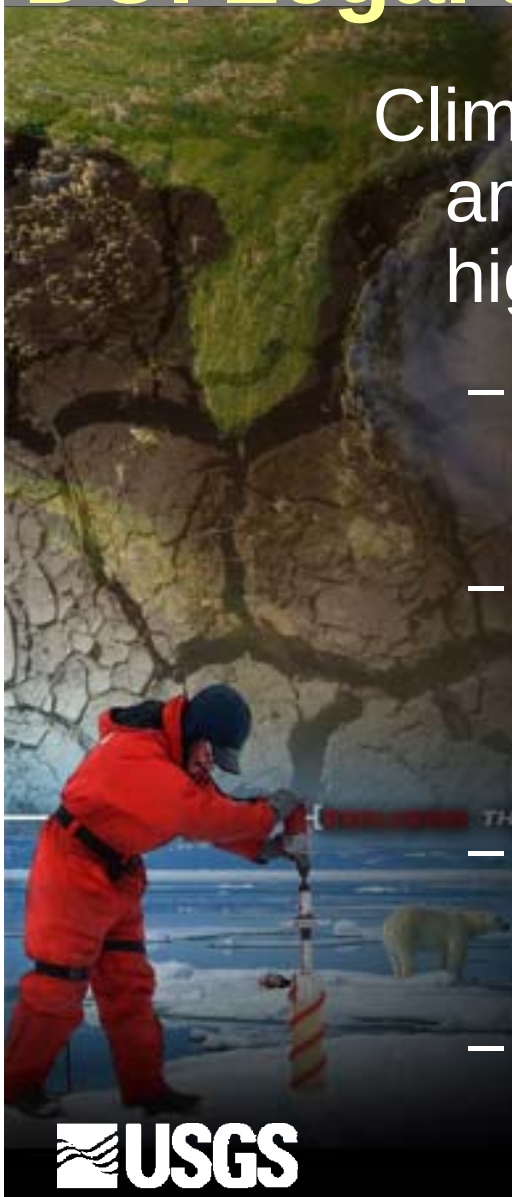

USDA FS
USGS BRD
Global Change Program Office
USGS WRD
NPS
Ecosystem Forecasting
National Global Change and Wildlife Center
Task Force Decision-Support Center
Water For America
NAWQA
Forest Inventory and Analysis (USDA-FS)
National Phenology Network
NOAA CLIMATE SERVICES
USGS Geospatial Datasets
NPS Monitoring Programs
KNOWLEDGE REQUIRED FOR CLIMATE EFFECTS
Must capture data without disrupting existing missions

Examples of Science Needs for DOI Legal and Policy Issues



- Climate change may move existing plant and animal species farther north and to higher elevations
  - Should we revisit the definition of “invasive species”?
  - How will species shift outside of their existing range and the currently designated critical habitat?
  - Should we preserve species through artificial habitat or captivity?
  - What are the change thresholds (e.g.when is extinction inevitable)?

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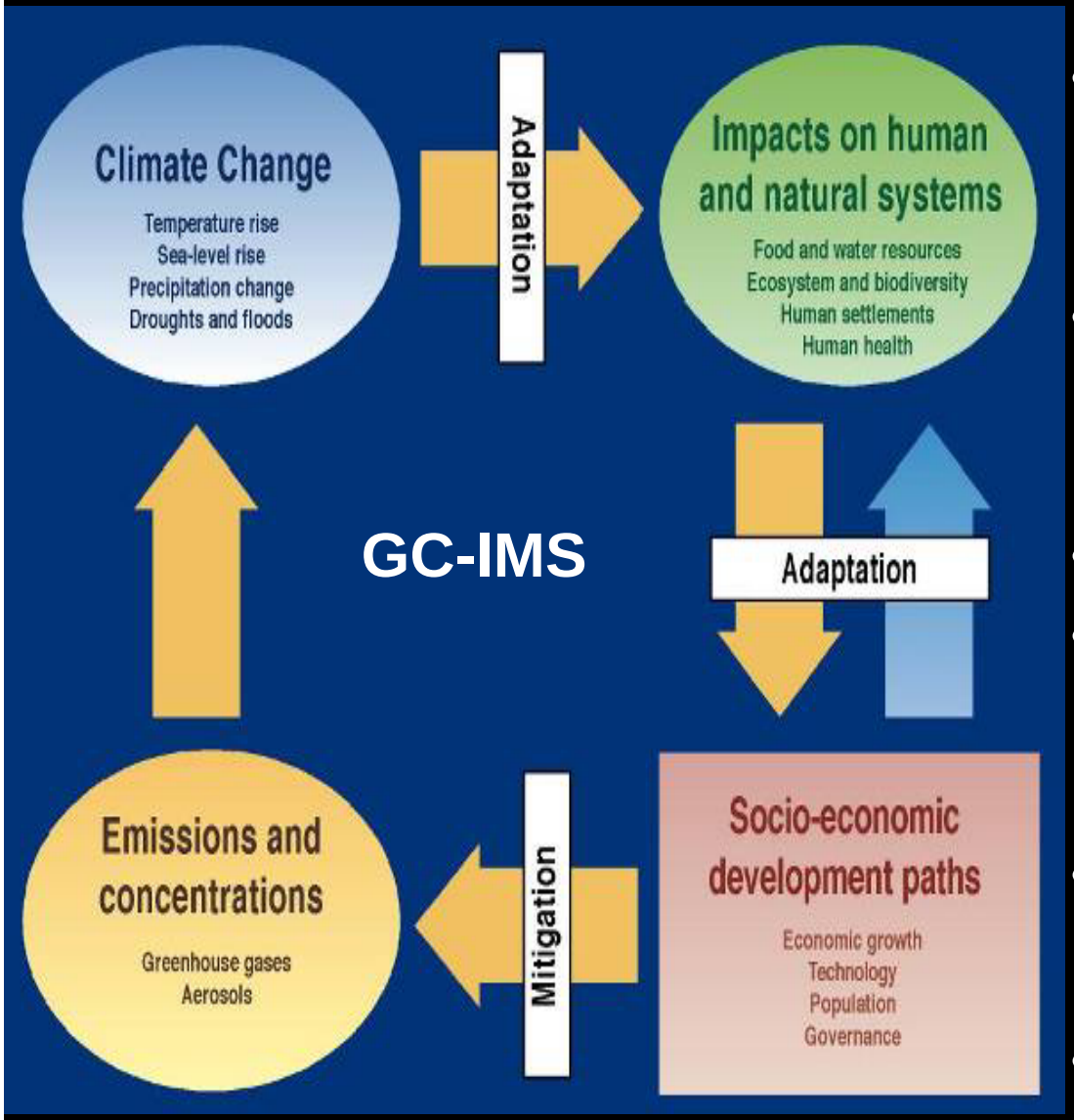
Proposed Science Needs from the DOI Task Force Science Subcommittee



- Development of a DOI integrated science and monitoring plan, building upon existing monitoring networks ("foundation" programs)
- Improving integration and access to USGS and other DOI Bureau data sets crucial to climate change science and resource management
- Downscaling of models
- Building decision-making capabilities centered on a robust Global Change Information Management System (GC-IMS)
- An adaptive management approach with USGS science and DOI resource Bureaus
- Reports prepare by DOI scientists, and a climate effects network has been ordered by congress.

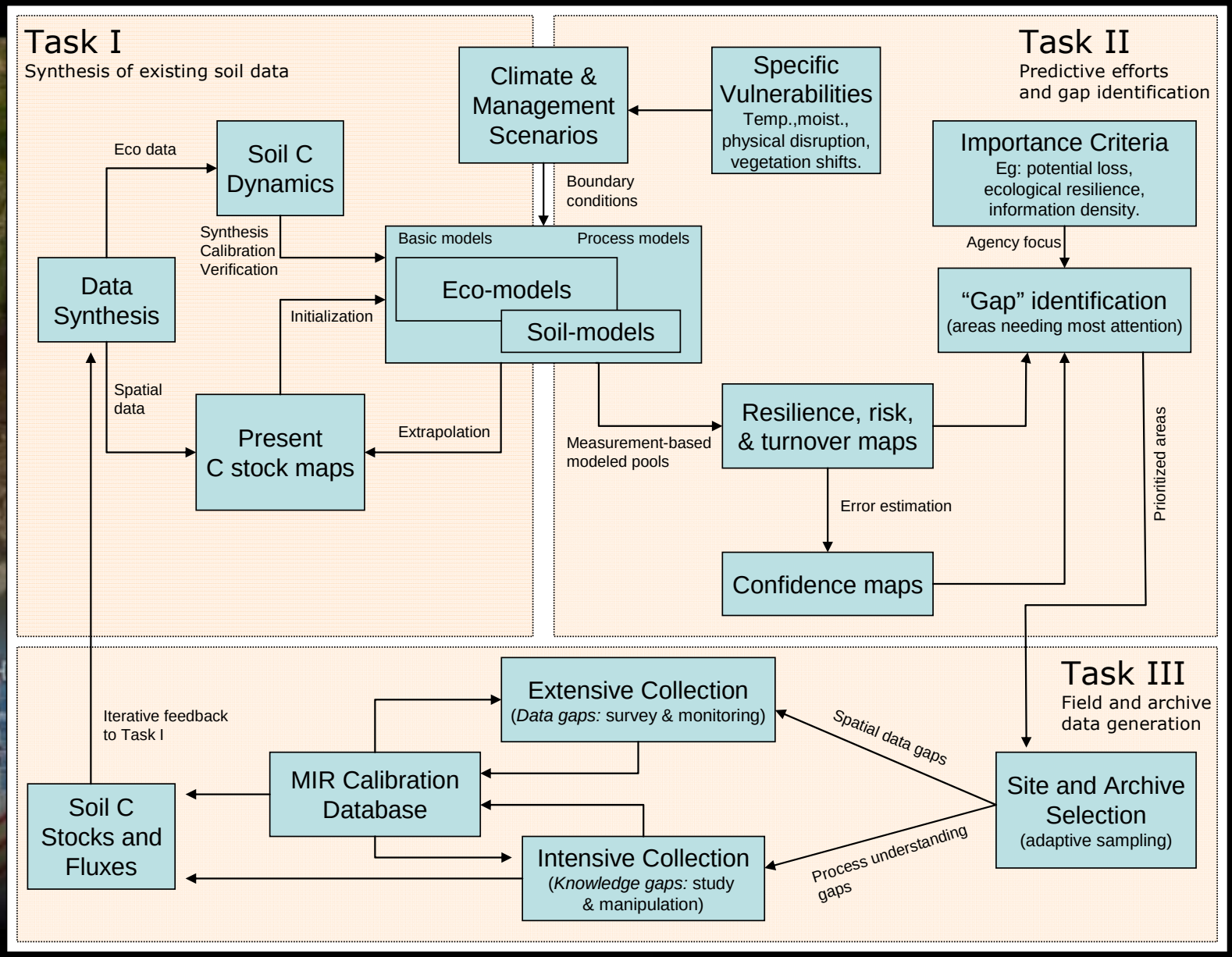
Near-term activities planning stage

- Workshops
  - — 'network design and data integration'
  - — 'radiocarbon measurement, analysis, and modeling'
  - — 'high latitude carbon cycling'
  - — 'critical tests of carbon-nitrogen-climate model structure'
  - — 'soil impacts from management for biofuels'

- Explore funding opportunities
  - — NSF RCN, AFRI REE-NET proposals
    - — website development
    - — software engineering and database management
    - — Post doctoral research
    - — student scholarships
  - — Internal agency and institutional funding
    - — USDA Forest Service
    - — US Geological Survey
    - — Northern Institute of Applied Carbon Science

Structure

general flow



National Soil Carbon Network

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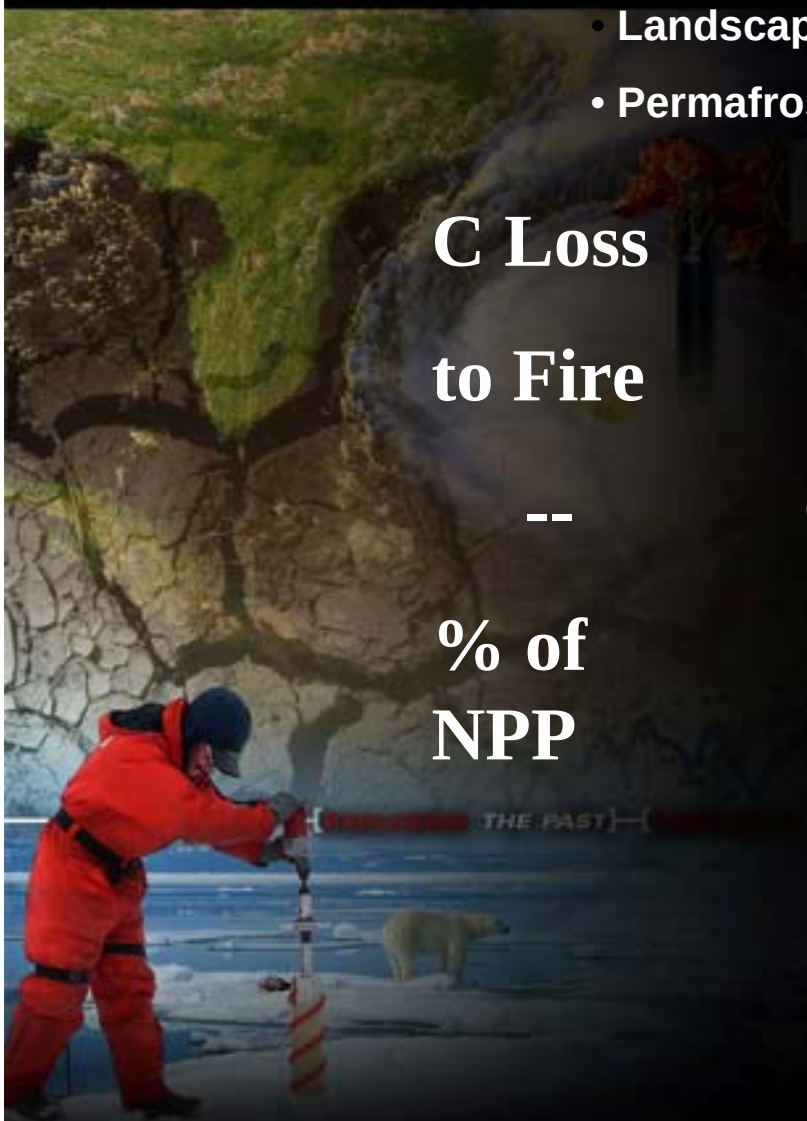
A network designed to enhance communication, collaboration, efficient use of scientific resources, and the advancement of soil carbon research.

Goals (from the SoilCarbNet Charter):

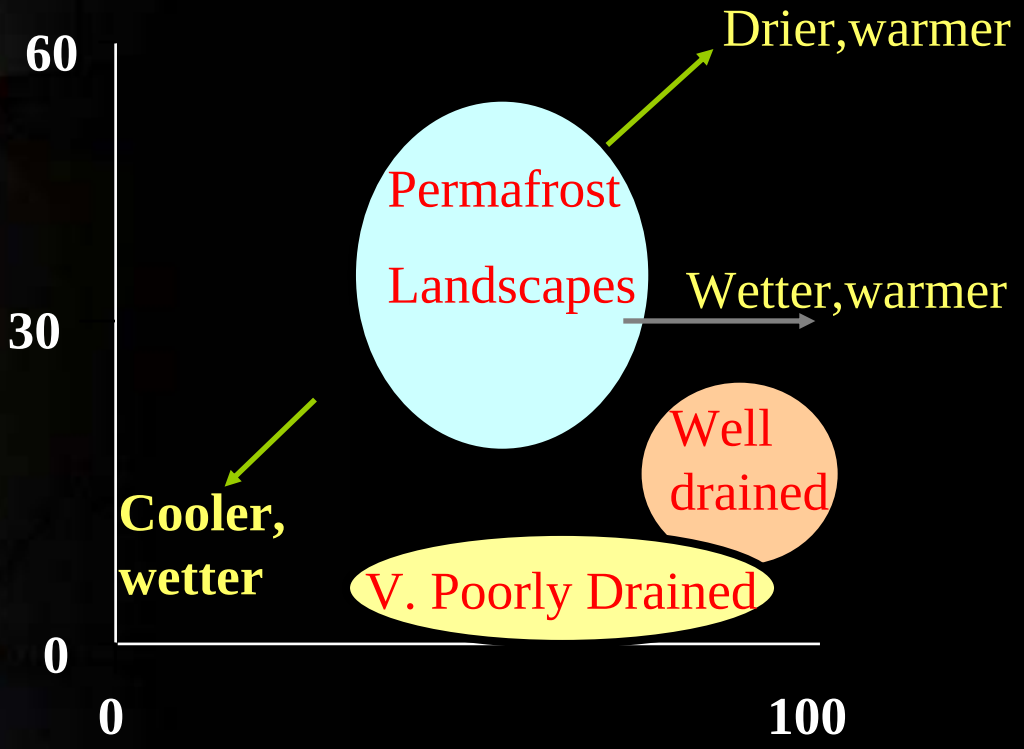
- Coordinate soil carbon observation, archiving, experimentation, and modeling.
- Understand the relationship between soil carbon and ecosystem services.
- Forecast soil carbon vulnerability under changing climate, land use, and other disturbance.
- Contribute to organizing and communicating this information for land managers, modelers, and policy makers

Will thawing permafrost greatly accelerate CO_2 flux?

- Landscape is Heterogeneous, Controlled by Soil Drainage
- Permafrost Landscape Highly "Elastic" in C exchange



C Loss to Fire -- % of NPP



C Loss to Decomposition % of NPP

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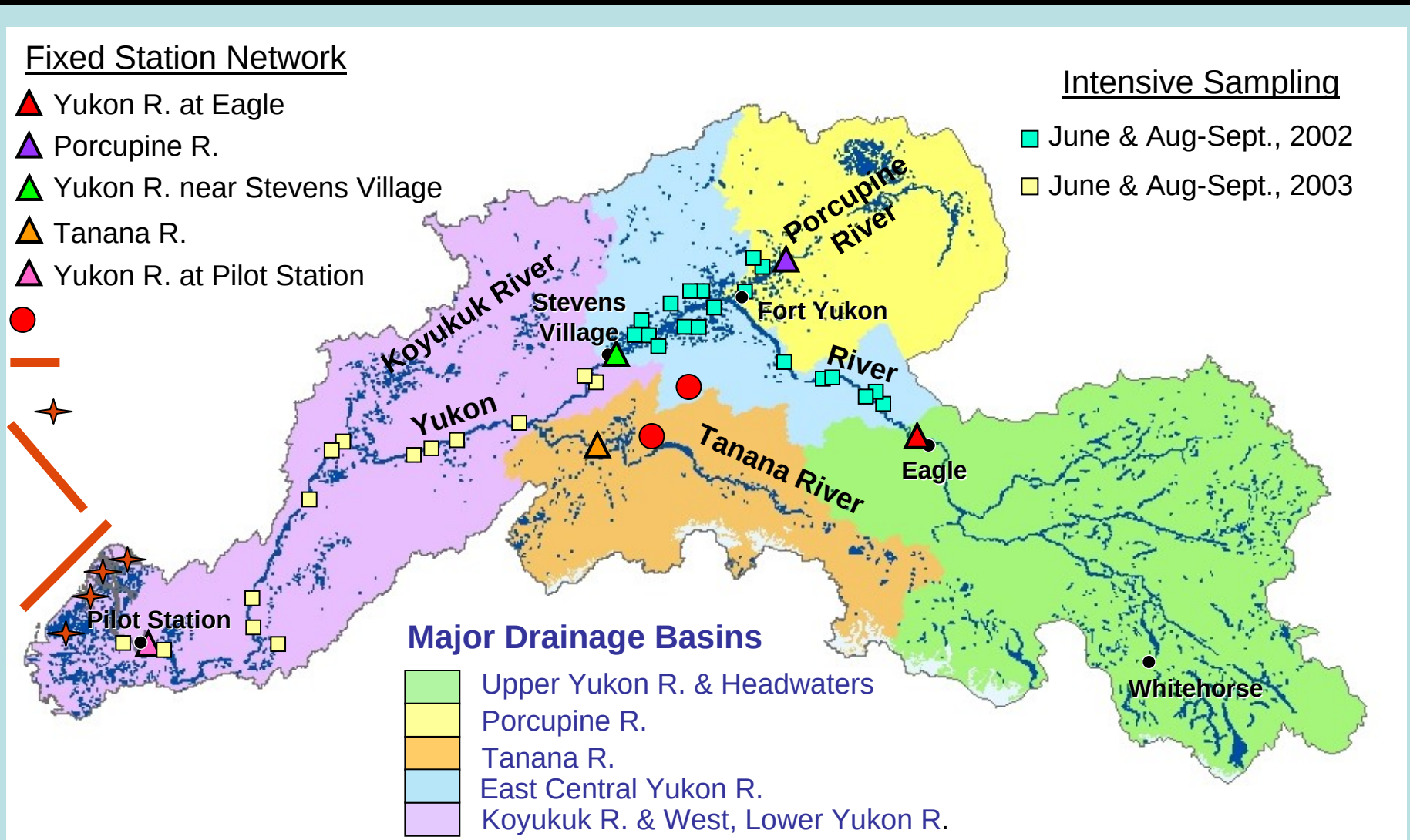
Harden et al, GCB Dec. 2000

Integration of DOI Monitoring, Assessment, and Management

Yukon Basin:

- 5 National Parks/ NRAs (Vital Signs)
- 8 Wildlife Refuges
- 3 Large military land holdings (CRREL)

Hydrologic Data Collection- USGS/Canada



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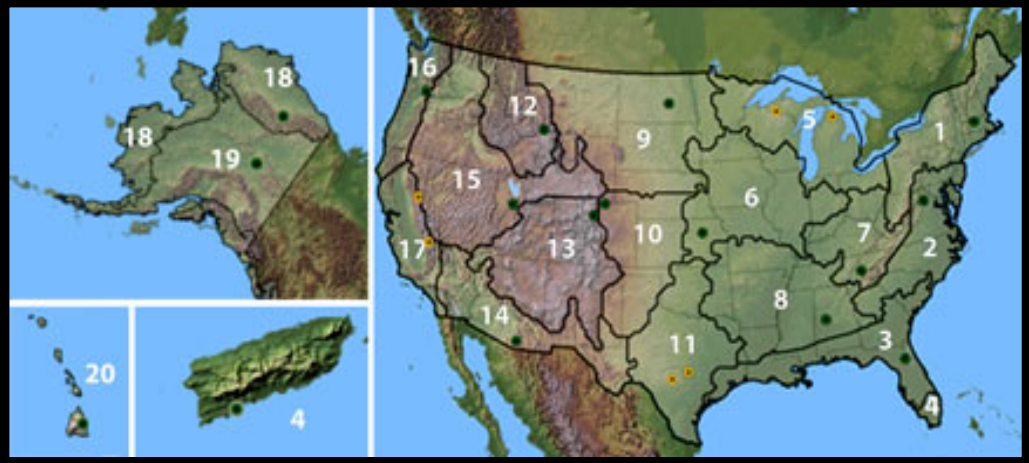
Research Watersheds (Tier 1) and Fixed river stations (Tier 2)

Proposal: Initiation workshops engaging all potential partners

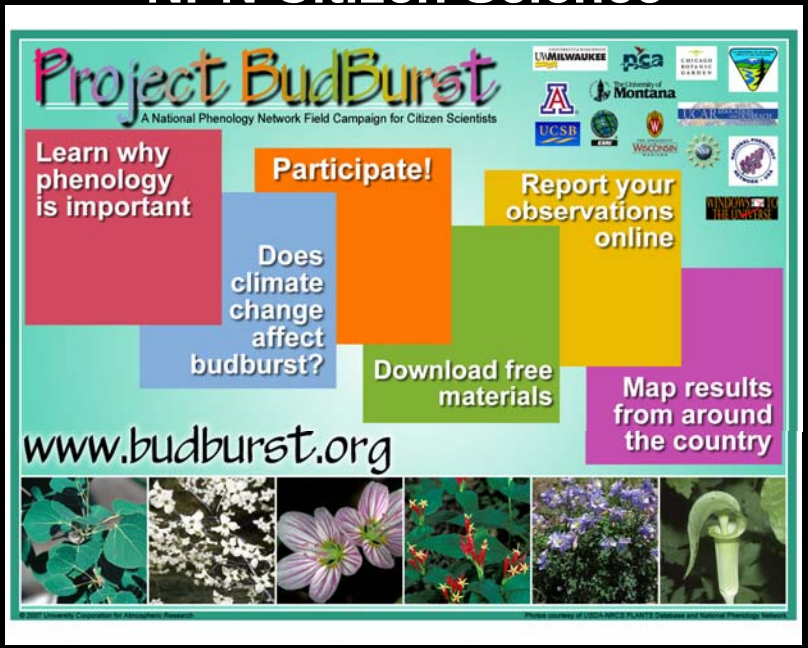
Research Sites

National Ecological Observatory Network (NEON)

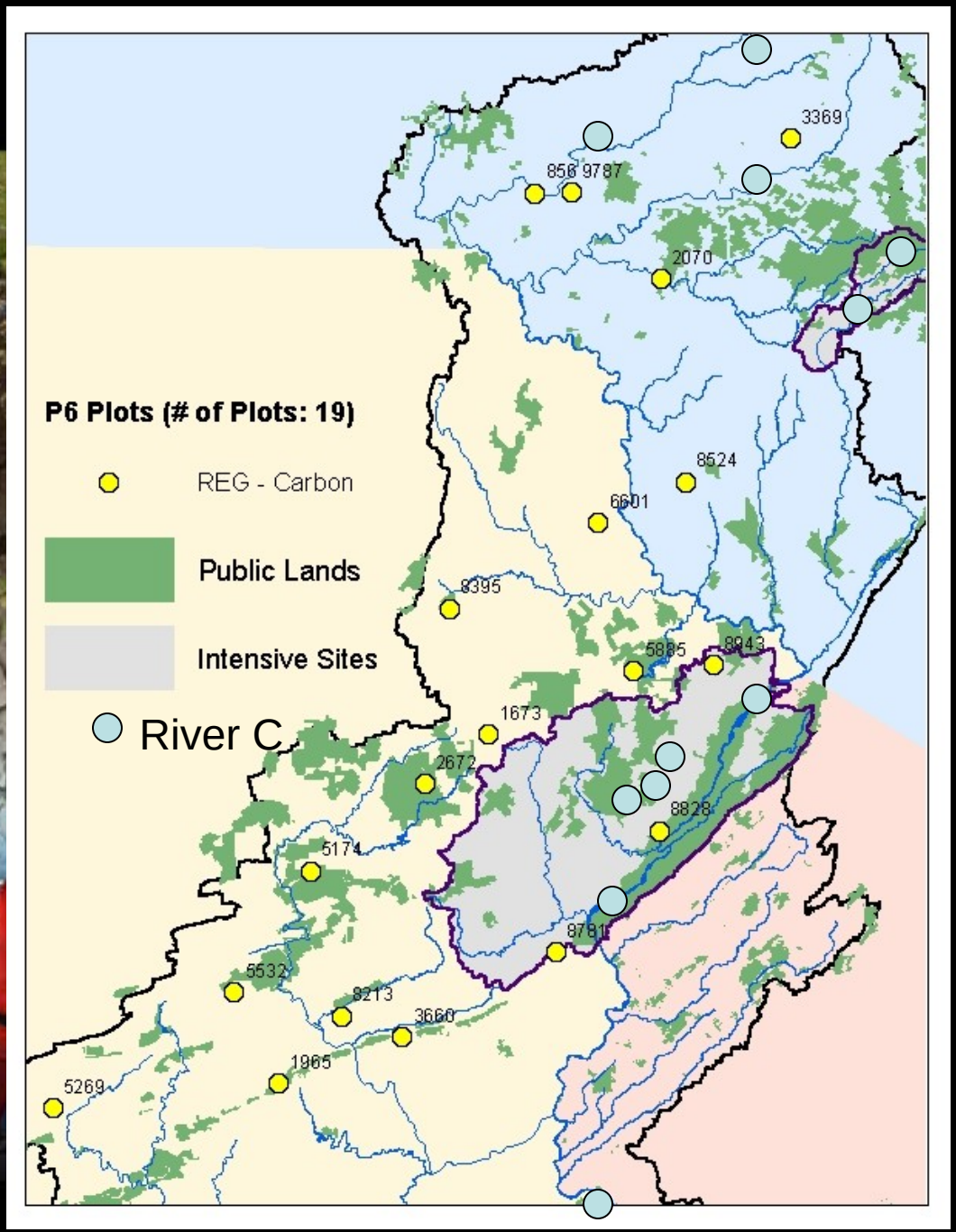


Extensive science networks

NPN Citizen Science



USGS science for a changing world



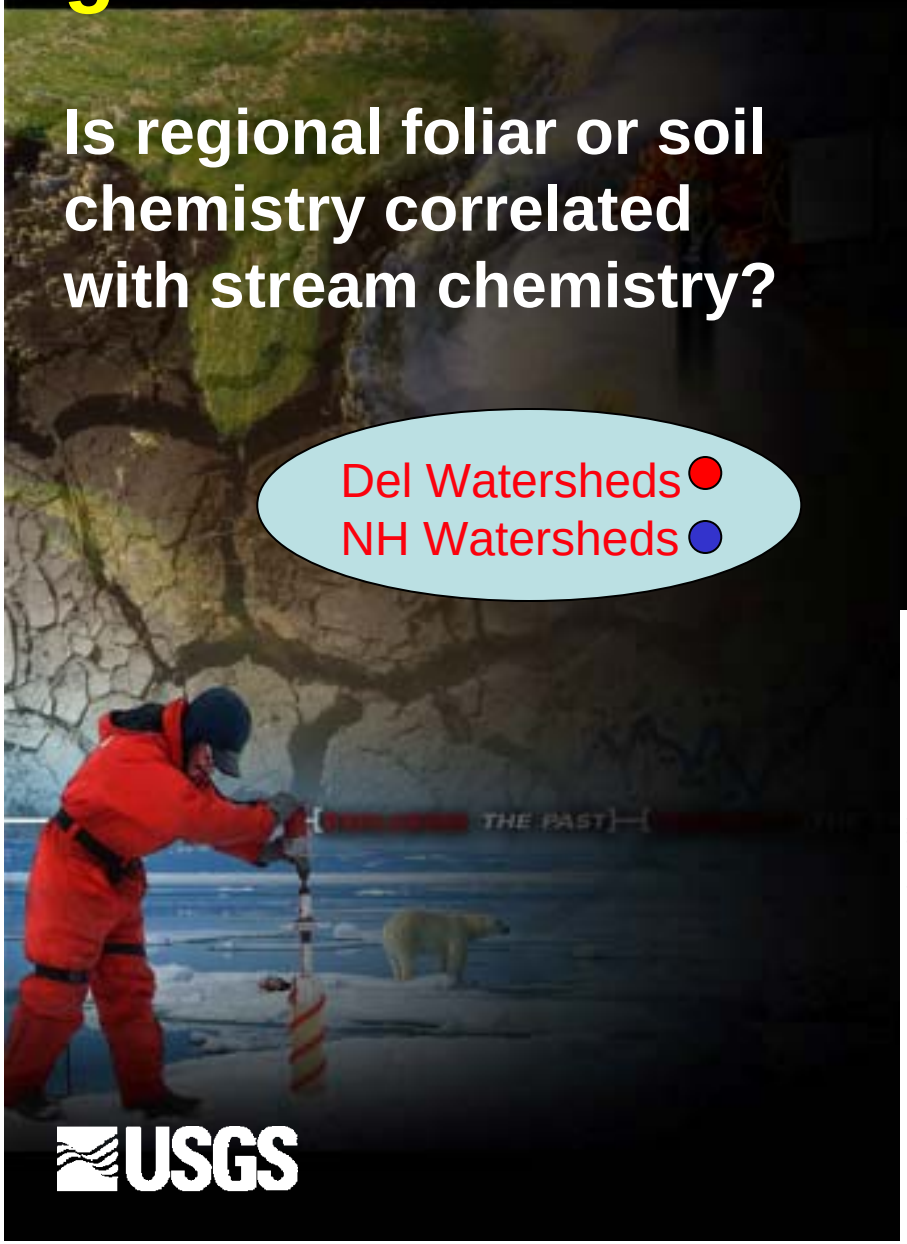
Tier 2:Regional Validation Plots

Independent validation of estimates to test scaling methods.

Tier 2: Regional gradient studies

Is regional foliar or soil chemistry correlated with stream chemistry?

Del Watersheds
NH Watersheds



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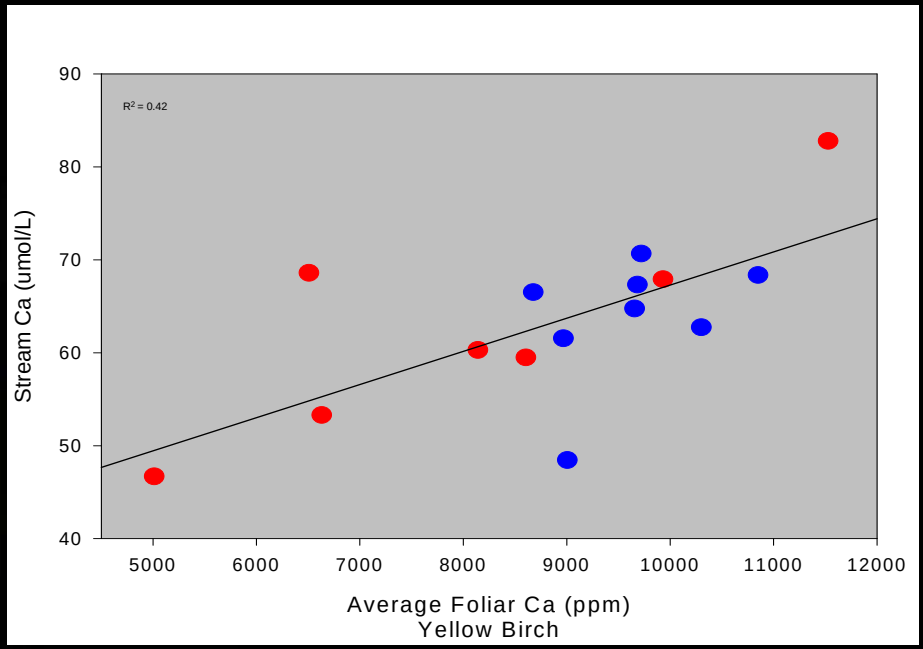
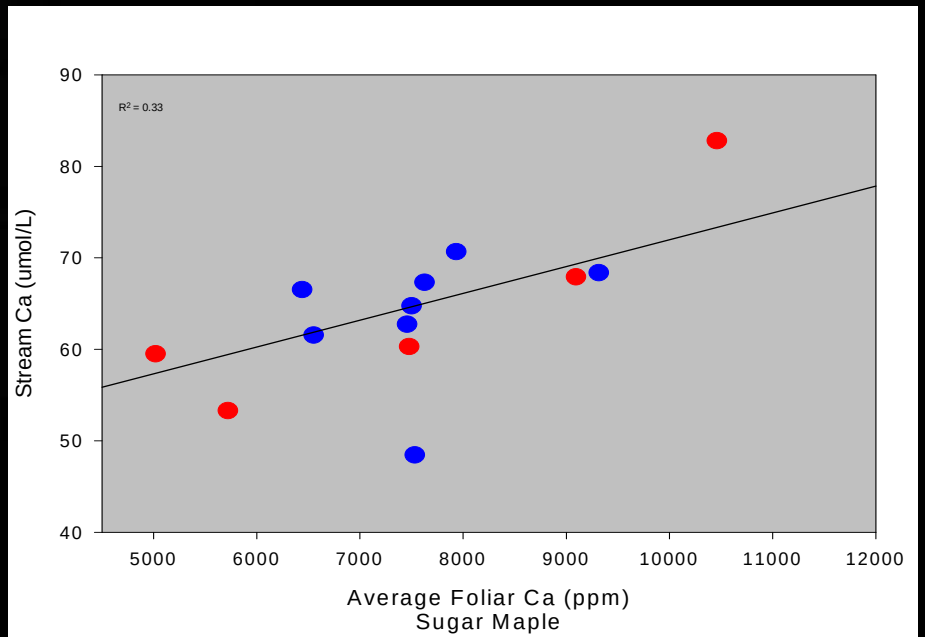
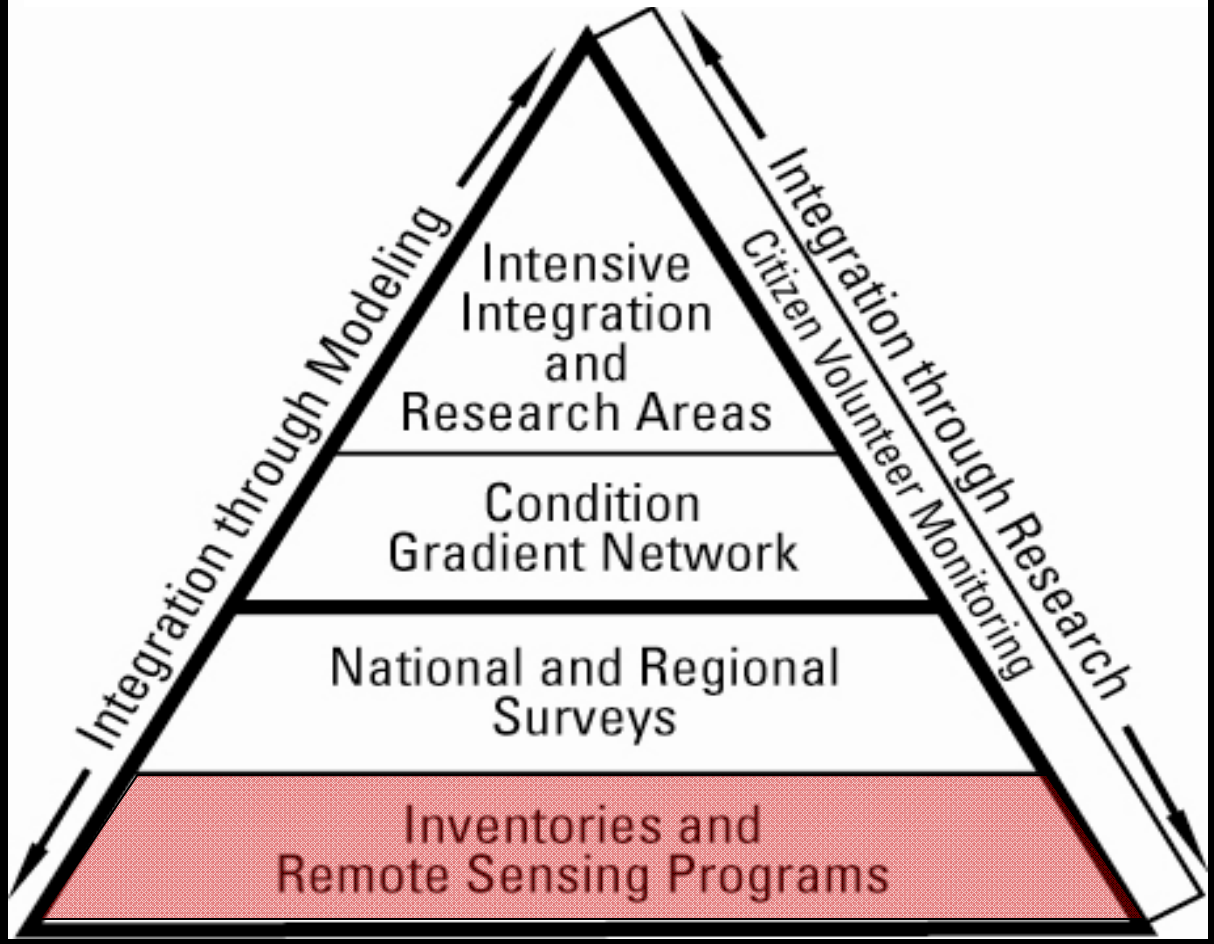
Regional gradient study of stream and foliar Calcium concentration



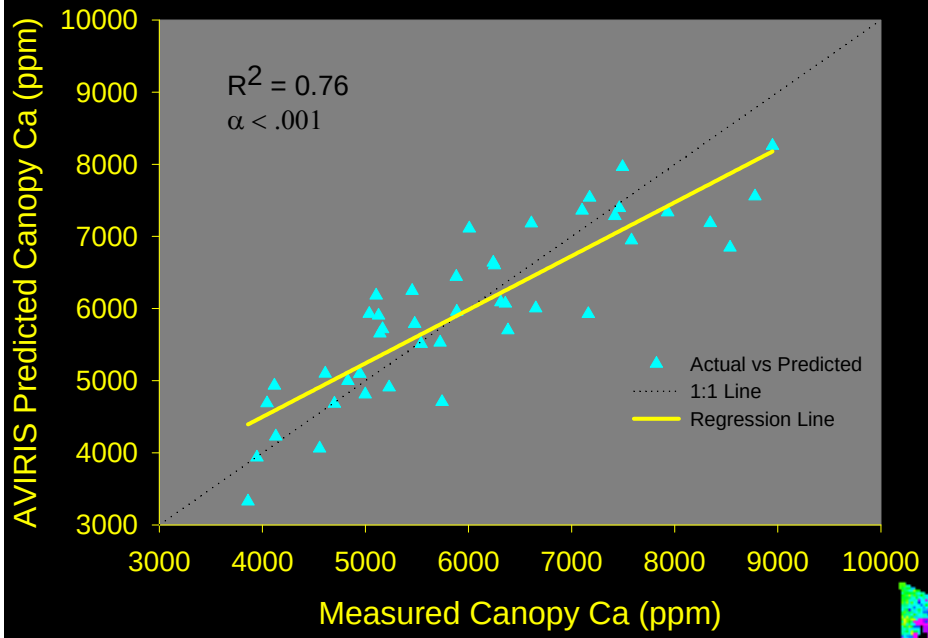


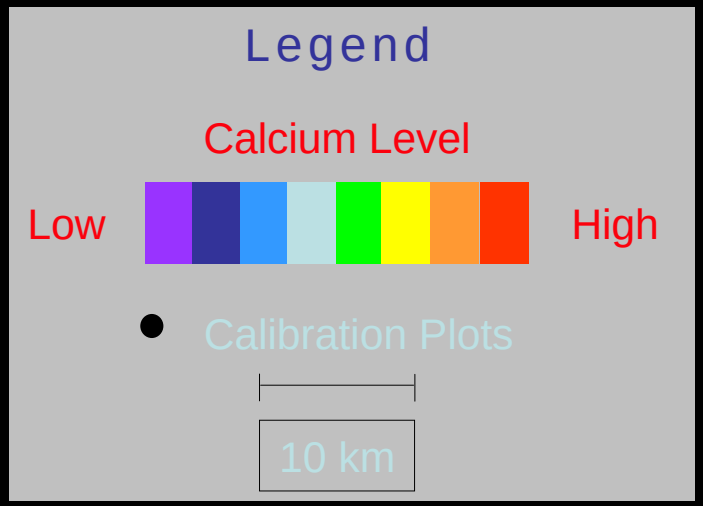
National Climate Effects Science Network

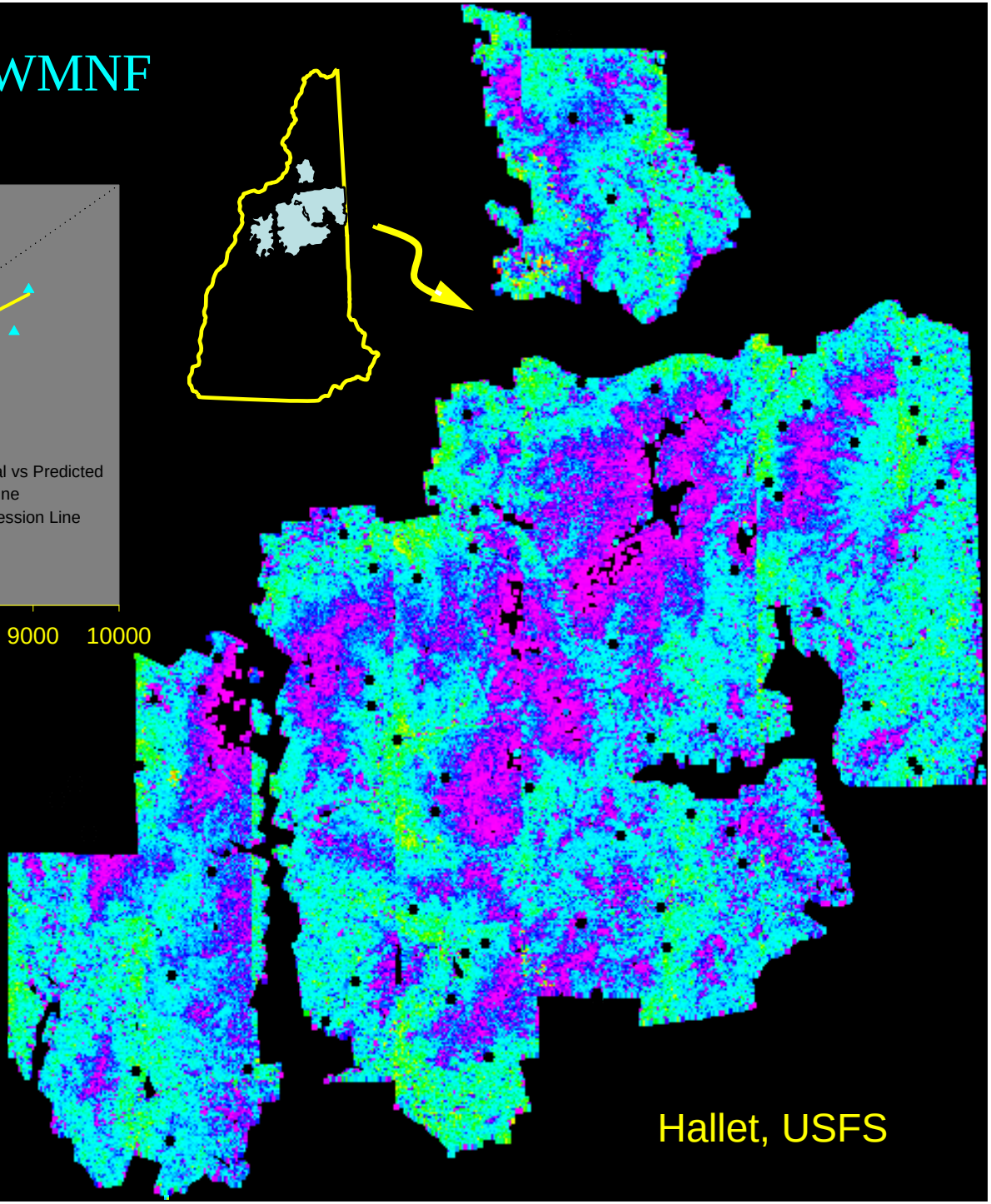


Systematic organization of capabilities

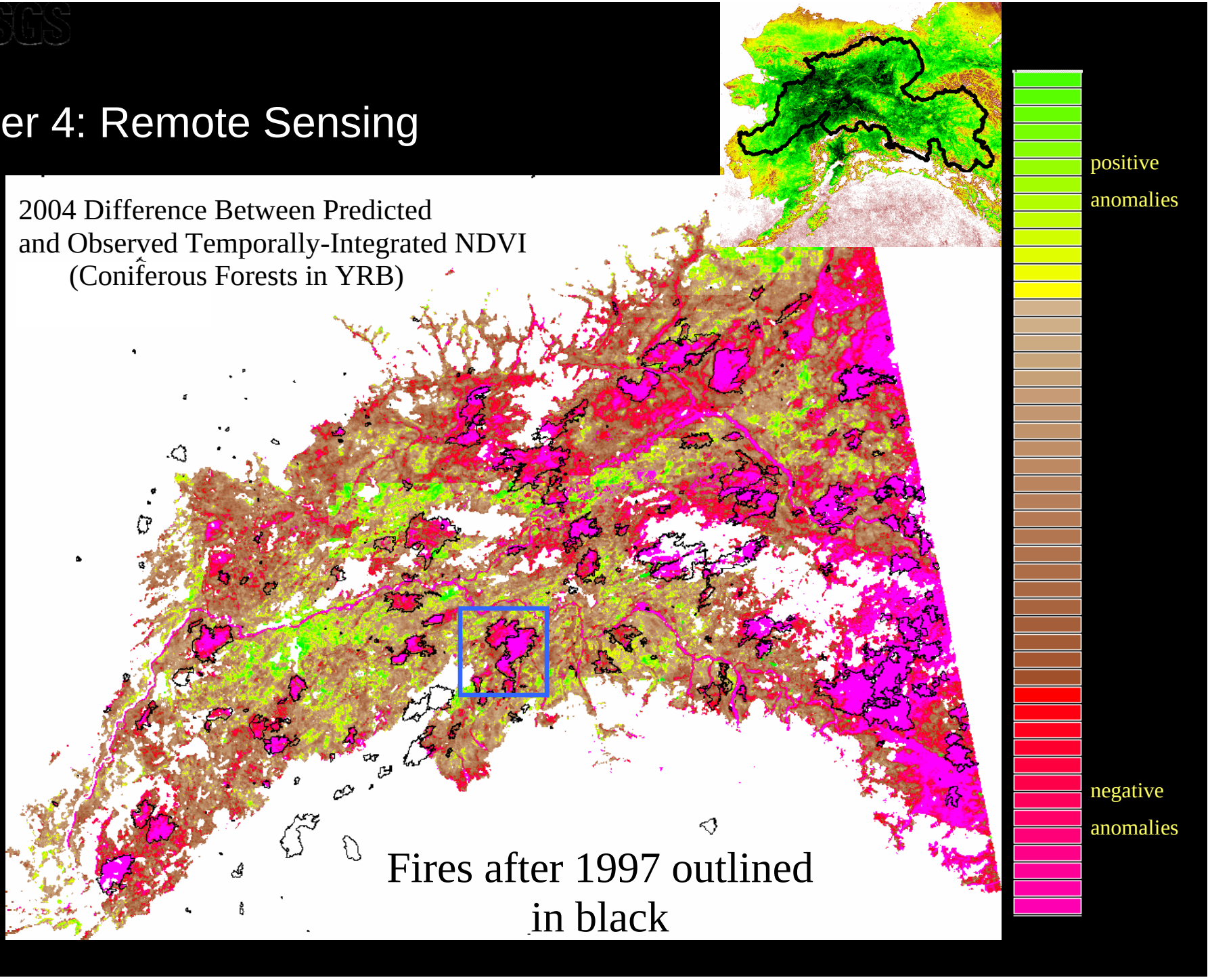
Predicted Foliar Ca for the WMNF



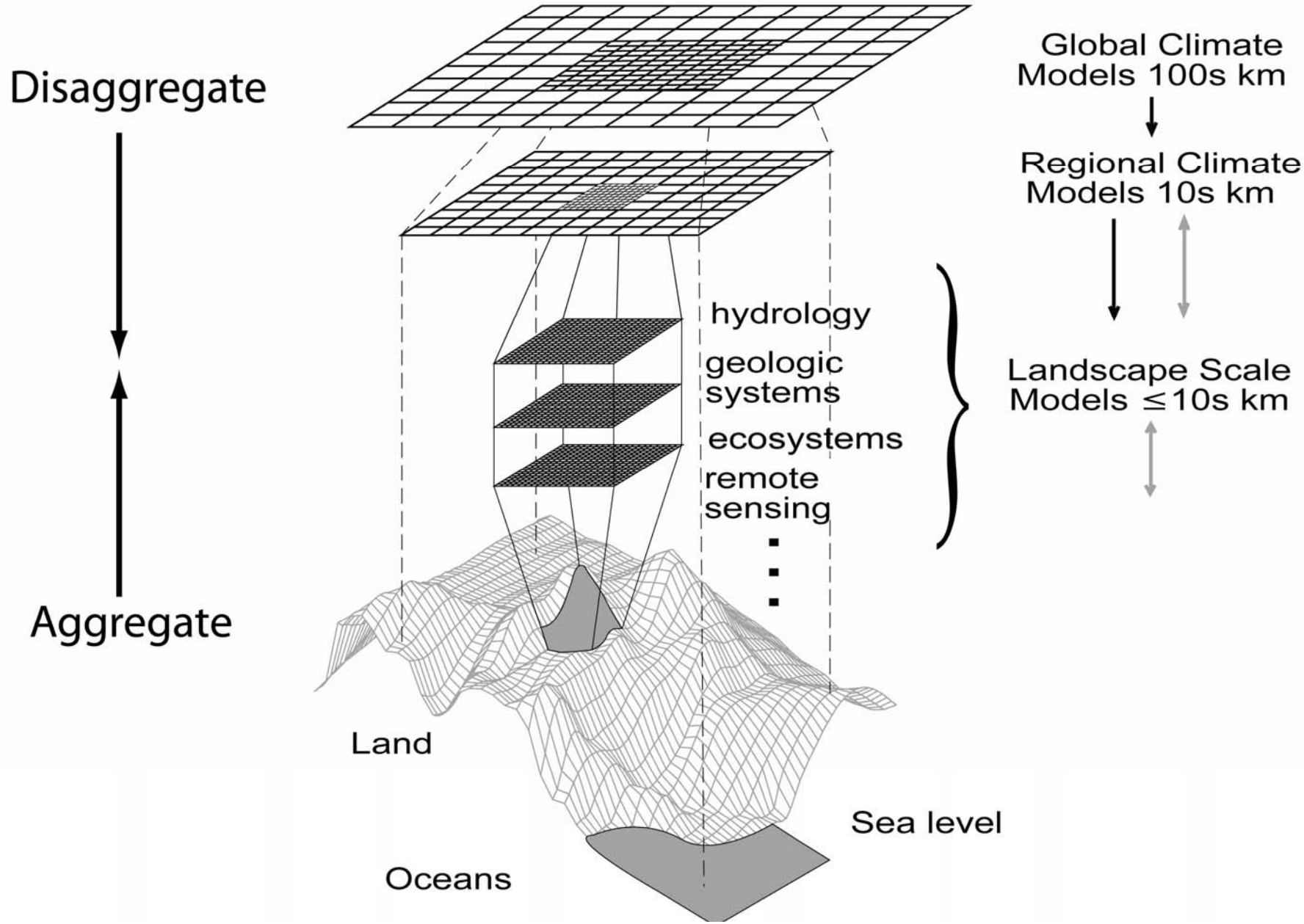




Tier 4: Remote Sensing



Modeling Landscape Responses to Climate



Ecosystem Modeling

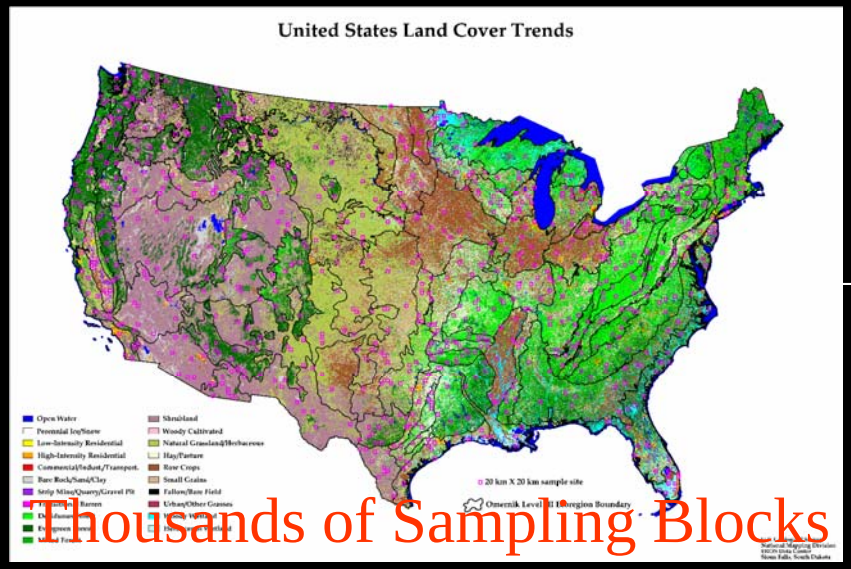
GEMS (General Ensemble Biogeochemical Modeling System)

Requires modeling staff, data management, computing infrastructure

National Benchmark Databases

Land Cover: USGS Land Cover Trends
Soil: STATSGO
Climate: CRTUS2.0 (1900 – 2000)
N Deposition: National Atmospheric Deposition Program
Crop Information: USDA Agricultural Census Data
FIA: Forest biomass, NPP, Age Distribution

Data Assimilation



Thousands of Sampling Blocks

GEMS

Carbon dynamics simulated at 60 m x 60 m spatial resolution within 20 km x 20 km or 10-km by 10-km sampling blocks

Climate Effects Support Services

- Data management and dissemination systems, staff, and maintenance.
- Common protocol development and data comparability screening.
- Adaptation and mitigation strategy development
- Science delivered for decision support
- Workshops and Symposia.
- Communication and outreach

USGS

Adaptive Management Built Upon Multi-scale Science Information, Decision Support and Models

- Field management-level input capability
- Flexible and rapidly responsive information framework- “extension” agents
- Regional and National data network coordination
- Rapid information acquisition and dissemination must be a top priority

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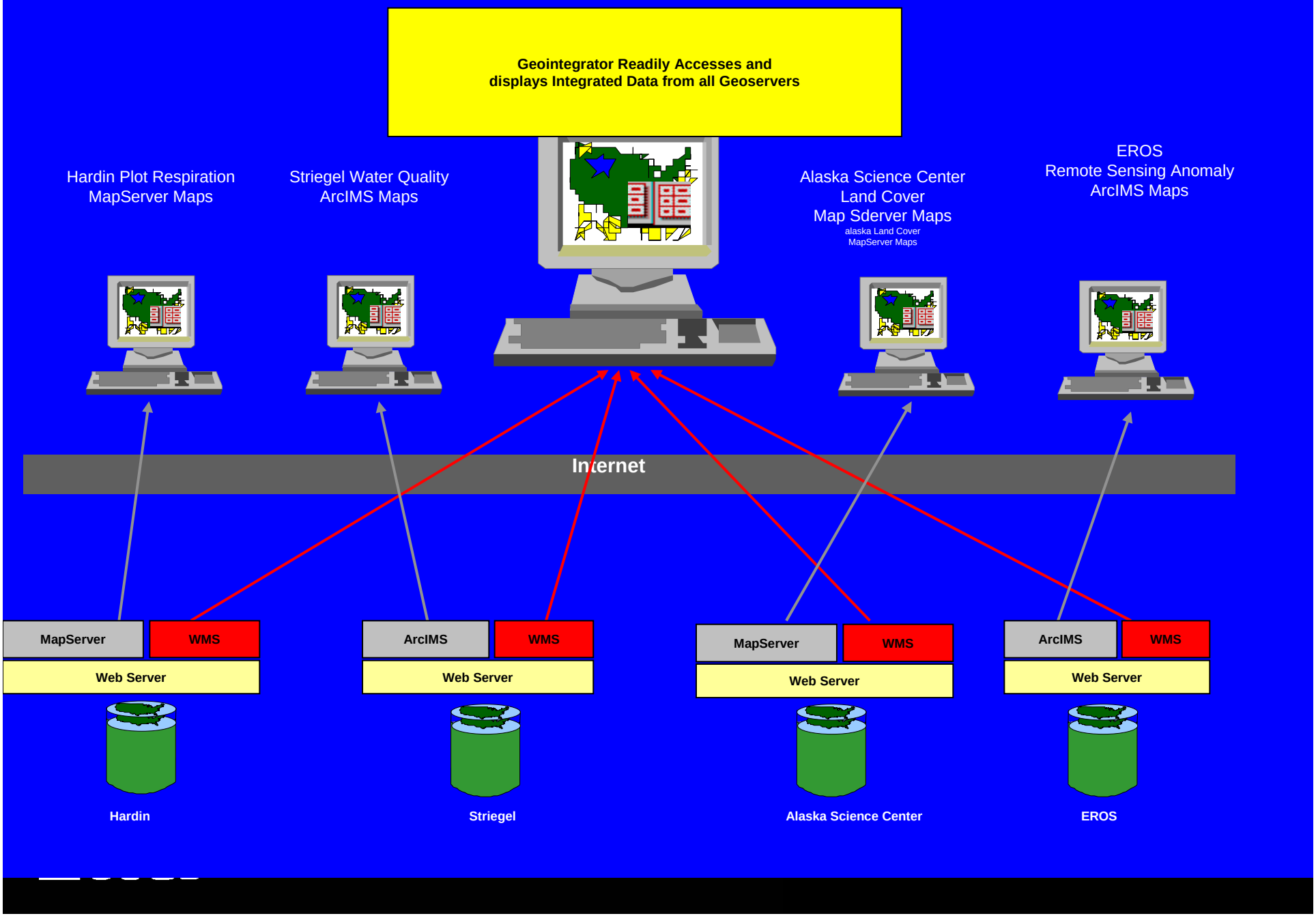
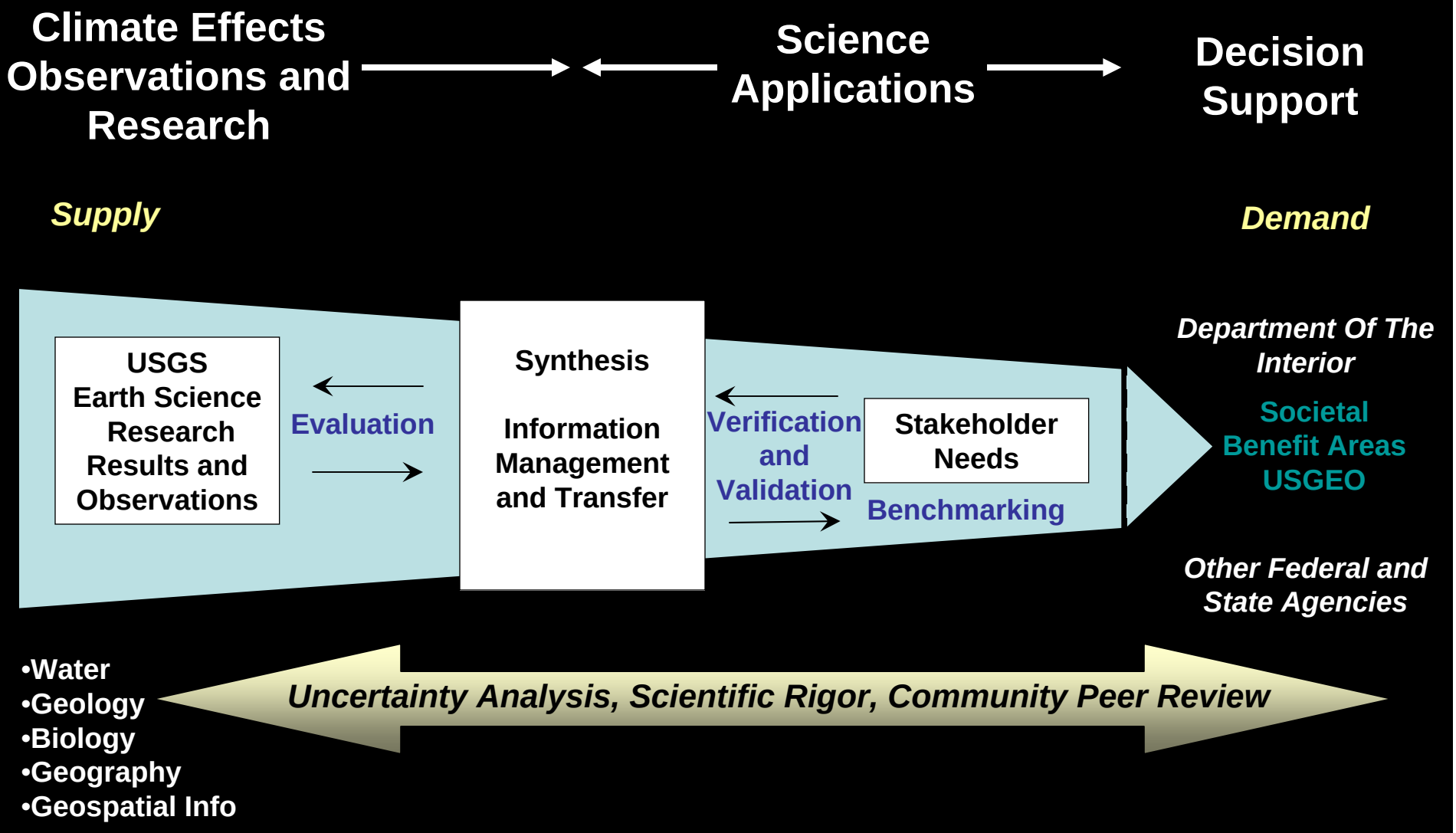
Overview of the GeoIntegrator and the links with four geoservers



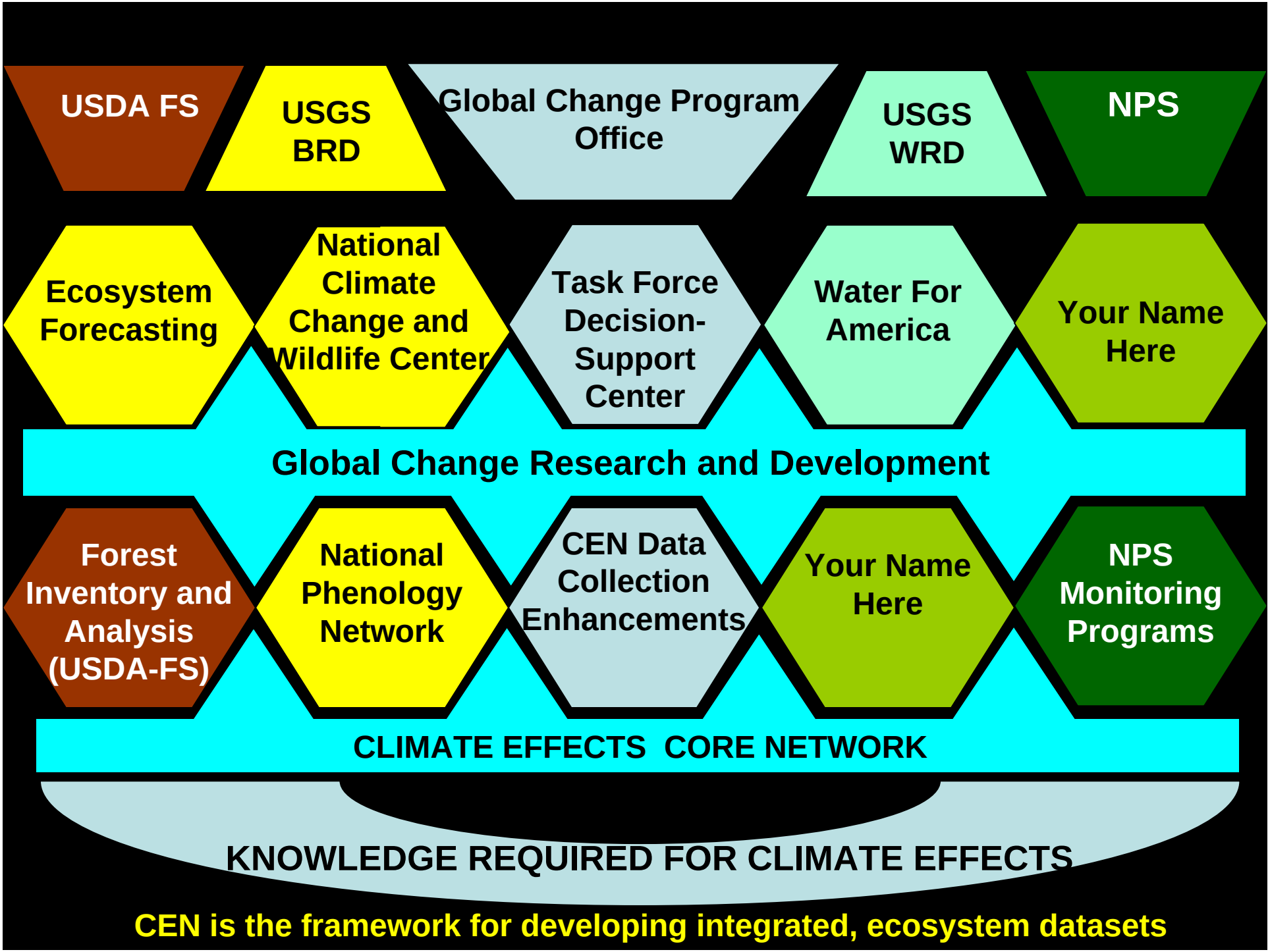
A Systematic Network Approach for Applying Research Results and Information to Decision Support

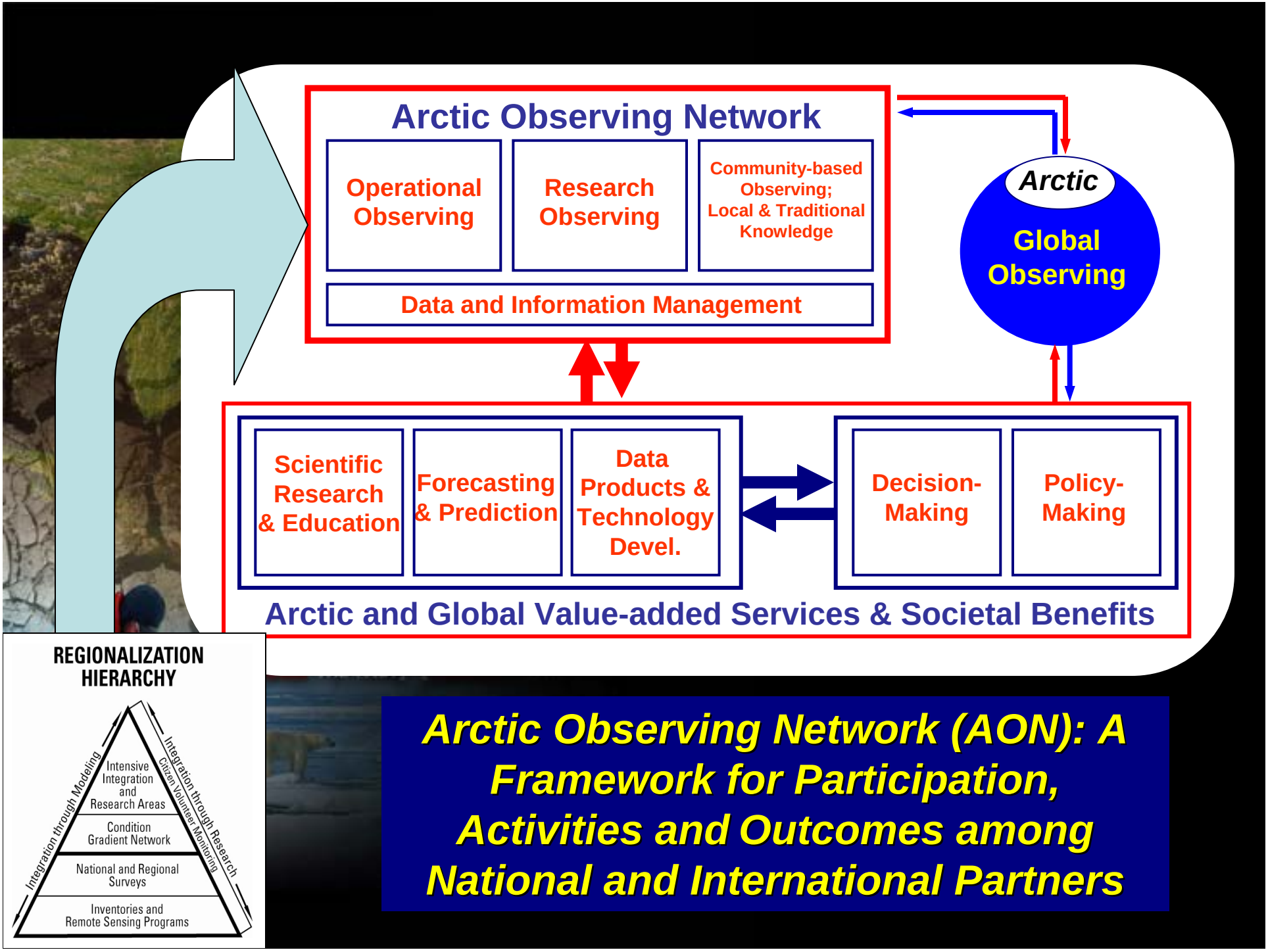


What is CEN?

- CORE intensively-instrumented sentinel watersheds
- A network of gradient study sites
- Expanded local to national surveys
- New and enhanced remote sensing tools
- Improved Laboratory capabilities
- Science-based decision support tools
- State of the Art data management and dissemination system
- Institutionalized communication between resource managers, policy makers, and scientists
- An integrated early warning system for the effects of climate on ecological and societal resources, that will become a critical and valued legacy for future generations.

USGS


USDA FS
USGS BRD
Global Change Program Office
USGS WRD
NPS
Ecosystem Forecasting
National Climate Change and Wildlife Center
Task Force Decision-Support Center
Water For America
Your Name Here
Global Change Research and Development
Forest Inventory and Analysis (USDA-FS)
National Phenology Network
CEN Data Collection Enhancements
Your Name Here
NPS Monitoring Programs
CLIMATE EFFECTS CORE NETWORK
KNOWLEDGE REQUIRED FOR CLIMATE EFFECTS
CEN is the framework for developing integrated, ecosystem datasets


Arctic Observing Network
Operational Observing
Research Observing
Community-based Observing; Local & Traditional Knowledge
Data and Information Management
Arctic
Global Observing
Scientific Research & Education
Forecasting & Prediction
Data Products & Technology Devel.
Decision-Making
Policy-Making
Arctic and Global Value-added Services & Societal Benefits
REGIONALIZATION HIERARCHY
Integration through Modeling
Integration through Research
Citizen Volunteer Monitoring
Intensive Integration and Research Areas
Condition Gradient Network
National and Regional Surveys
Inventories and Remote Sensing Programs
Arctic Observing Network (AON): A Framework for Participation, Activities and Outcomes among National and International Partners

Next Steps

- Workshops to build the implementation strategy for the network within DOI
- Negotiating partnerships with the foundation programs (win-win)
- Data and metadata management development.
- Proof of concept pilot in the Yukon River Basin. A process for choosing other CORE sites will begin this spring.
- Evolving the vision as requested by the transition and partner discussions.
- Establishing the network, effectively but rapidly.

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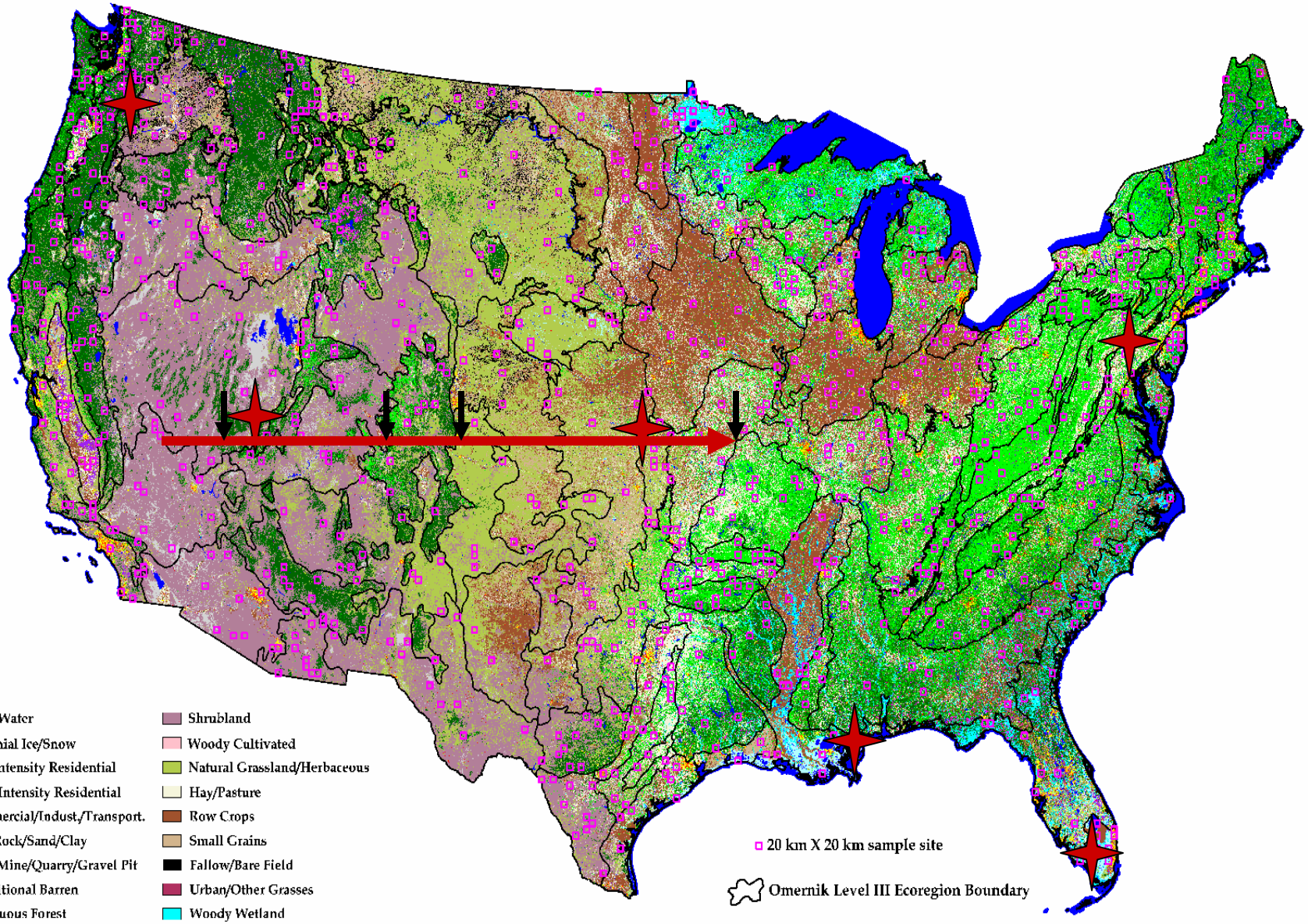
Final Points

- Strong decisions require scientific input
- The complexity of ecosystem response to climate requires a wholistic science approach for a common frame of reference (eg. a watershed, ecoregion)
- No one program will ever be able to generate the needed data alone.
- A collaborative effort among new and existing program is the only cost-effective and timely solution for addressing climate effects issues.


THE PAST

Scenario 2: Organize by Land Cover/Ecoregion Categories

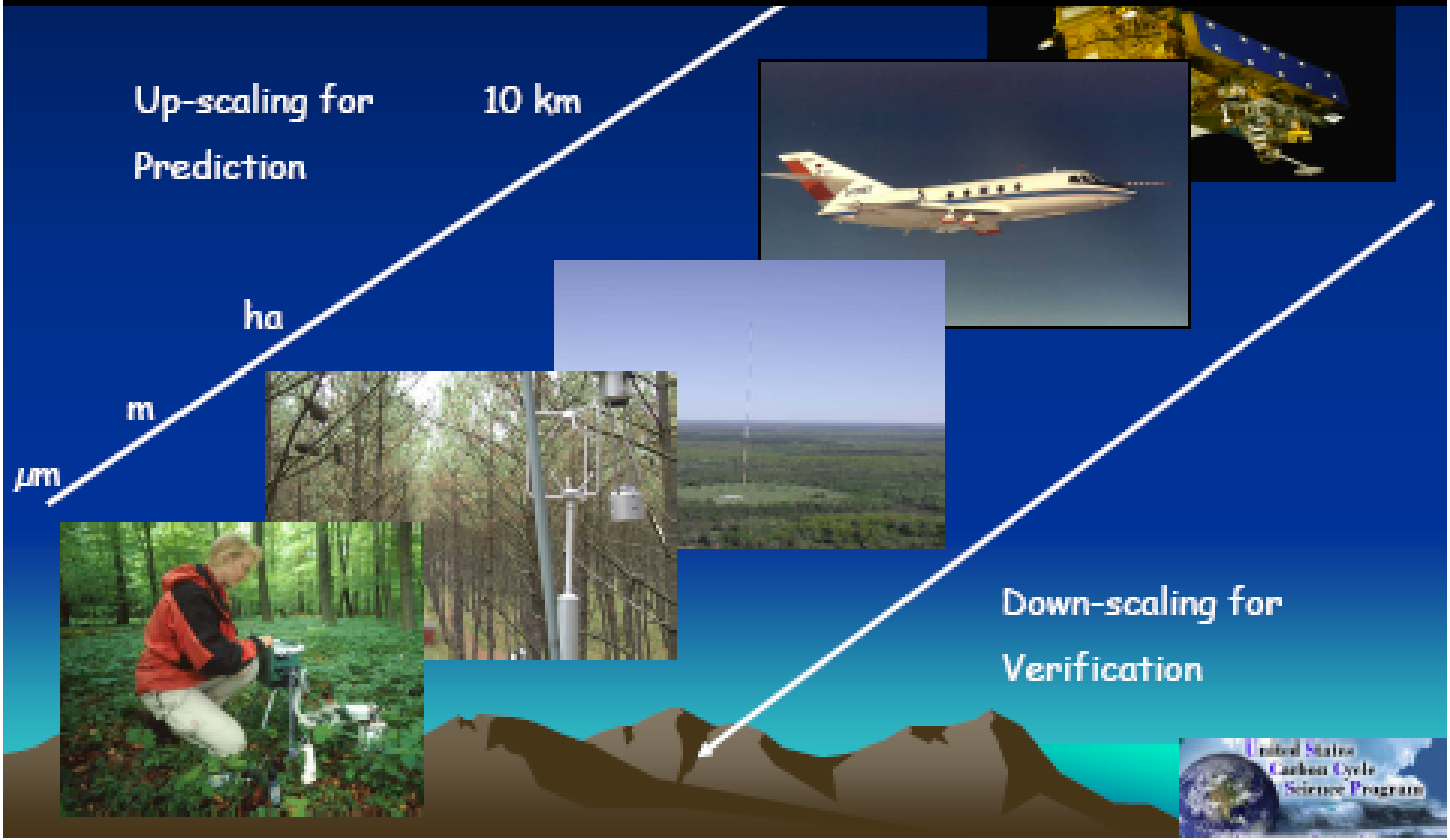


Change will be in ecotones first

U.S. Geological Survey
National Mapping Division
EROS Data Center
Sioux Falls, South Dakota

How Do We Do this?

Multi-component –Multi scale Observations and Research Results For Decision Support



Soil Survey, FIA

USGS