Measuring the Success of the Long Term Ecological Research Network

LTER

Challenges to the Long Term Ecological Research Network

- **To *measure* long-term ecological phenomena in order to help understand the dynamics of ecological systems, provide a baseline against which to measure environmental changes, and evaluate and mitigate the adverse impacts of human activities.**

- **To *enhance* the spatial dimension of the program so that it will be possible to determine the conditions under which lessons learned in one location can be applied to other locations.**

- **To *expand* the network of sites to represent additional important ecosystems that are absent from the existing program.**

Challenges to the Long Term Ecological Research Network, cont.

- **To *increase* the scope of the research program to include a primary emphasis on various levels of biological organization (e.g., genetic to landscape levels) since research has conclusively demonstrated that multiple levels of investigation are required to understand key ecological processes.**

- **To *broaden* the range of scientific disciplines to include the physical sciences and the social sciences, since understanding ecological phenomena requires the integration of these disciplines and because practical solutions to environmental problems can only be developed and implemented by involving these additional disciplines.**

Challenges to the Long Term Ecological Research Network, cont.

- **To *develop* programs and new technologies for measuring and understanding the environment and, as appropriate, for testing the environmental impacts of new technologies.**

- **To *contribute* to the nation's educational effort at all levels, particularly by providing educational opportunities and materials directed toward multidisciplinary, field-oriented, and problem-solving education and training.**

Recent Scientific Policy Dialogue Signals Future Directions for Ecological and Environmental Science…

"New Directions Ecology has to take include
•Interlinkages
•Scales
•Extremes
•Consequences
•Partnerships
•And Assessment"

Rosina Bierbaum
ESA keynote, 1998

"We do not normally use the word 'Comprehensive' in Ecology our discipline has a narrowness…"
Steward Pickett
ESA Symposium, 1998

We are just beginning to learn about how ecosystems function...

Recent Scientific Policy Dialogue Signals Future Challenges for Ecological and Environmental Science…

"We Need to study Bio*complexity*…
…There *will* be collaboration and integration instead of separation and strictness…"
Rita Colwell,ESA keynote, 1998

"Research and the way we do research *will* change in Biology…"
Mary Clutter
ESA Symposium, 1998

"...a scientist that cannot translate his/her research into *useable knowledge* is not a good scientist-citizen...

…the time of ecological scientists sitting in their ivory towers is gone…"

Rosina Bierbaum, ESA Keynote, 1998

Recent Scientific Policy Dialogue Signals Future Challenges for Ecological and Environmental Science…

"This contract represents a commitment on the part of all scientists to devote their energies and talents to the most pressing problems of the day, in proportion to their importance, in exchange for public funding."

Entering the Century of the Environment: A New Social Contract for Science

Jane Lubchenco (*Science* 279:491-7)

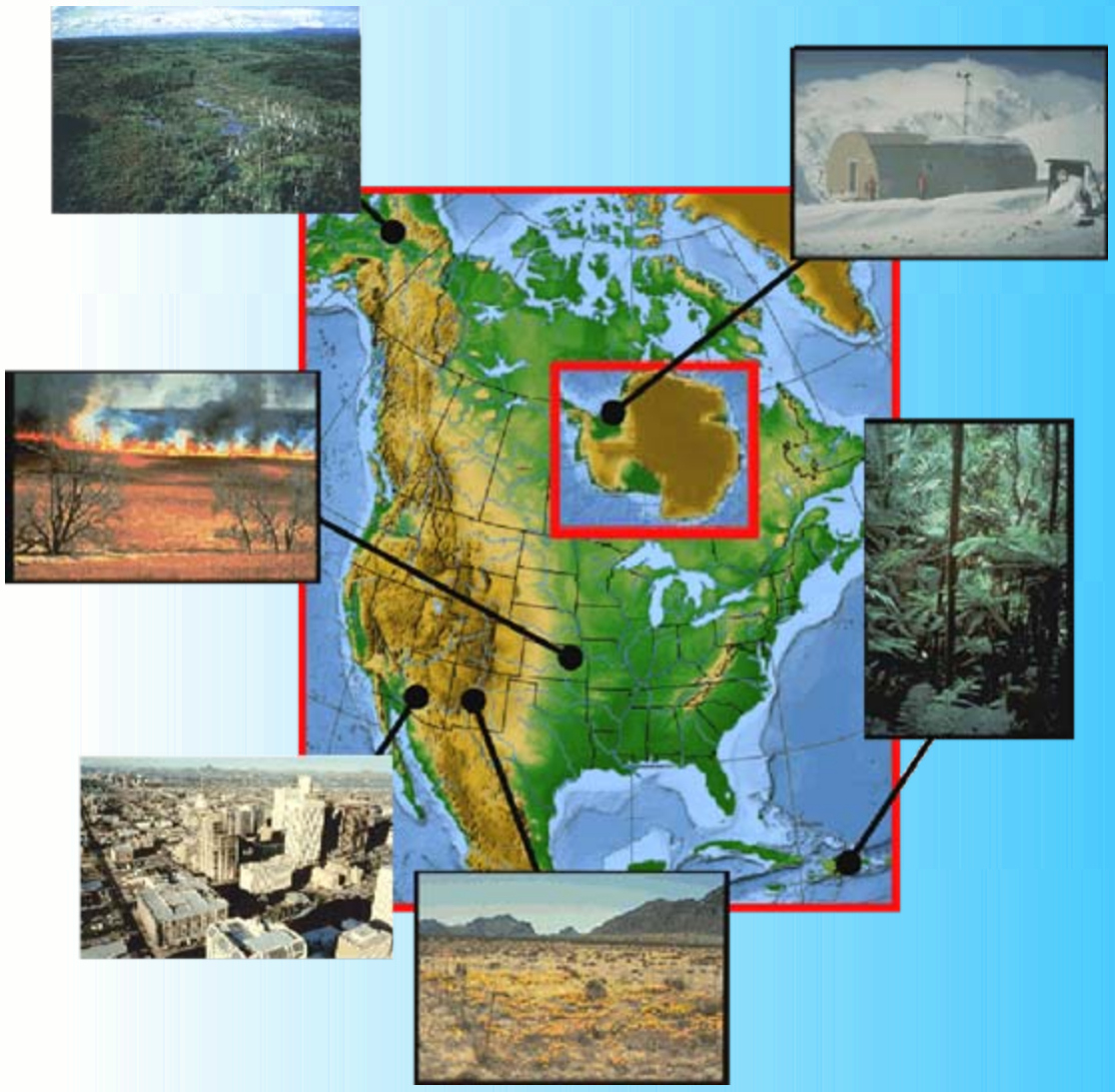
How is LTER Meeting these challenges?

Objectives of this presentation:

To provide diverse examples that demonstrate how the LTER Network is meeting these challenges through

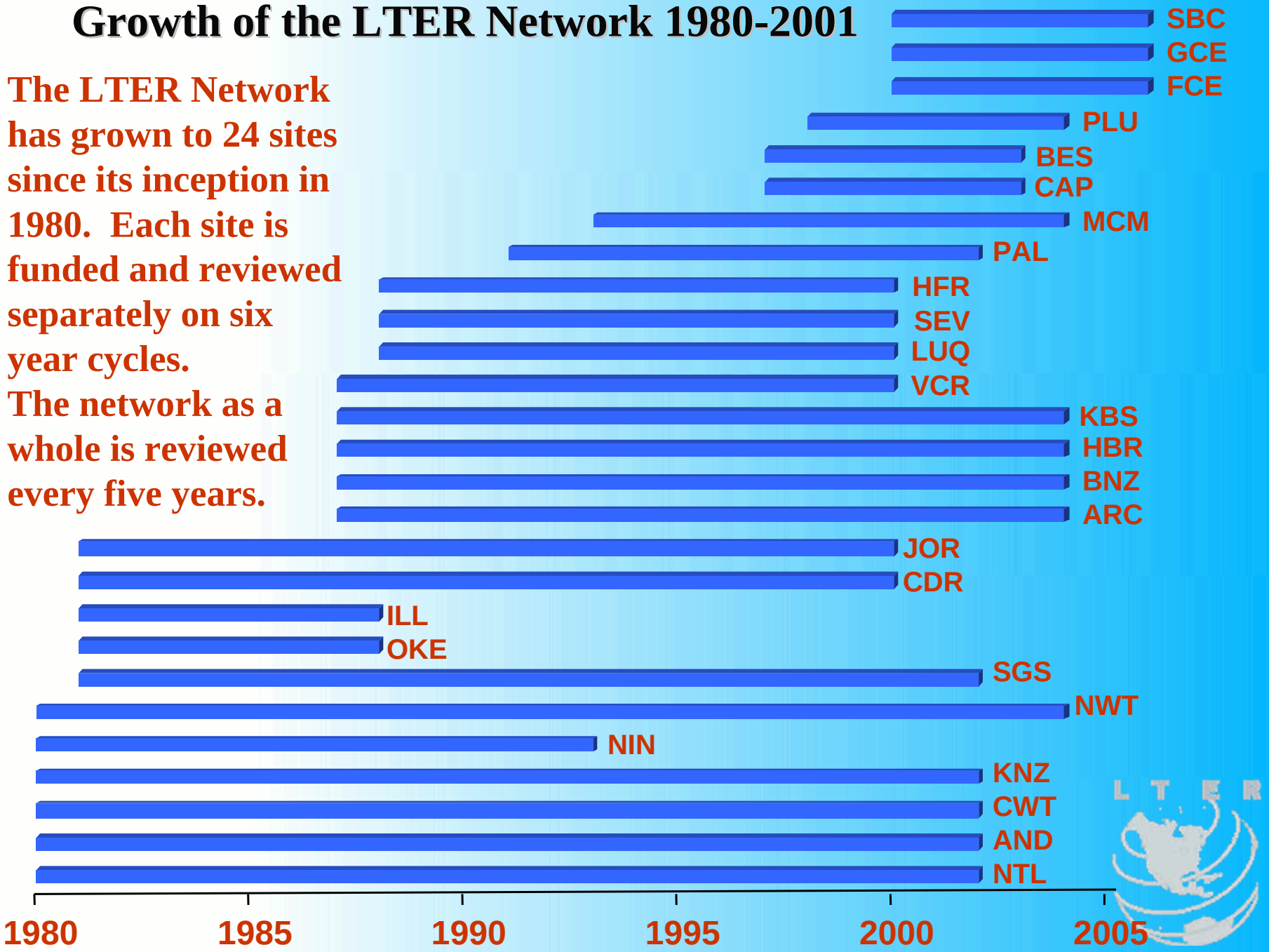
- **Science—*Addressing important questions and issues***
- **Leadership—*Setting the standard for network-level science***
- **Education and Training—*Facing New directions***
- **Multi and interdisciplinary efforts—*Broadening Horizons of Network Research***
- **Outreach—*Putting LTER knowledge in reach of land management and policy decision makers***

24 sites comprise the LTER Network ranging from Alaska near the arctic circle to Antarctica.



Growth of the LTER Network 1980-2001

The LTER Network has grown to 24 sites since its inception in 1980. Each site is funded and reviewed separately on six year cycles.
The network as a whole is reviewed every five years.



Partnerships with the San Diego Super Computer Center and the National Partnership for Advanced Computational Infrastrucutre

The LTER-hyper-SRB project is to design and implement a collections management system for the LTER hyperspectral data products. This system is being built using the NPACI resources available at SDSC, specifically, the high performance storage system (HPSS), the metadata catalog (MCAT), and the storage resource broker (SRB).

In the past 4 years the Network has grown from:

- *18 to 24 Sites*
- *270 to more than 400 PIs*
- *720 to 1114 Scientists*
- *25% to 35% women*

LTER Site Profiles (1995-1998)

	Averages per site	
	1995	1998
Number of PIs	15	18.3
Ave. $/PI (x1000)	27	30.8
No. of Institutions	6.1	6.5
Effective Overhead Rate (%)	20	22
% spent on Infrastructure	21	21.4
% spent on Local Economy	56	64.8
Graduate Students	17	17.7
Undergraduate Students	15	17.4
LTER leveraged resources	2.1	2.4
Non-PI scientists at the site	25	34.6

LTER is Increasing the number and regularity of Network-level cross-site science and synthetic activities

Annual Science Theme Meetings

- **1995 - Biodiversity and Net Primary Productivity**
- **1996 – Scaling up to Regional-level Investigations**
- **1997 - Climate Dynamics and Ecological Processes**
- **1998 - Social and Economic Integration into LTER 1999 - Disturbance and Recruitment Dynamics**
- **2000 -**
- **2001 - Terrestrial - Aquatic Interactions**

LTER All-Scientists Meetings

Through "Special Sessions" at Ecological Society of America Annual Meetings, LTER has developed a mechanism for conducting synthetic activities:

•1999-"Planning for Serendipity", and "Research in a North American Regional LTER Network"
•2000-"LTER All Scientist Meeting"
•2001- "Integration of the natural and social sciences at LTER sites," "Scalable information systems," "Integration of Research on Biogeochemical Cycles at LTER Sites," and "GCTE/LTER Collaboration on Removal Experiments on the Role of Biodiversity in Ecosystem Functioning"

Standing Committees form smaller closer communication groups, which increase the involvement of site scientists in Network activities and Cross-site efforts

- Climate
- Publications
- Education*
- Social/Economic Integration*
- Information Management
- Technology
- Synthesis
- Graduate Student

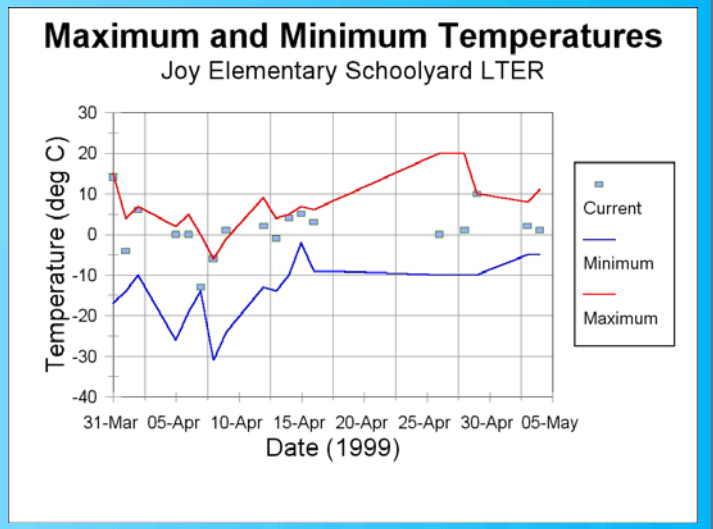
*recent additions

Education - Schoolyard LTER

Supplemental funding enhances LTER site k-12 outreach and education programs…

LTER Scientists interact regularly with hundreds of K-12 schoolteachers and thousands of students…

Education - Schoolyard LTER



PLANT	PLOT 1 control	PLOT 2 control	PLOT 3 restored	PLOT 4 restored
PANICUM SP	1750	1600	27	3
HELENIUM SP	89	29	6	2
SOLIDAGO SP	20	27	0	2
CORNUS SP	5	10	4*	9*

** The dogwoods were planted as part of the restoration project.*

Four estuarine sites recently added broaden scale of cross-site comparisons…

Santa Barbara Coastal Ecosystem LTER

Georgia Coastal Ecosystem LTER

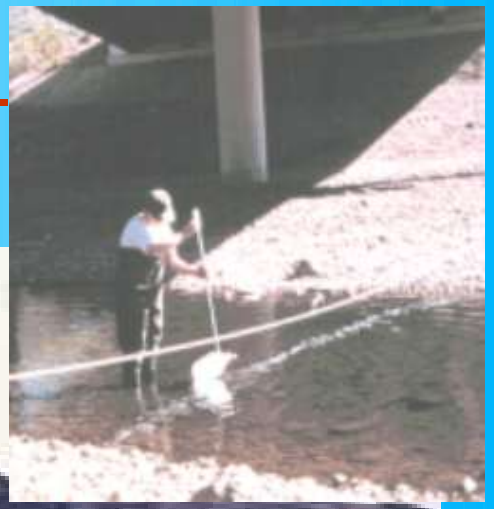
Florida Coastal Ecosystem LTER

Plum Island Ecosystem LTER

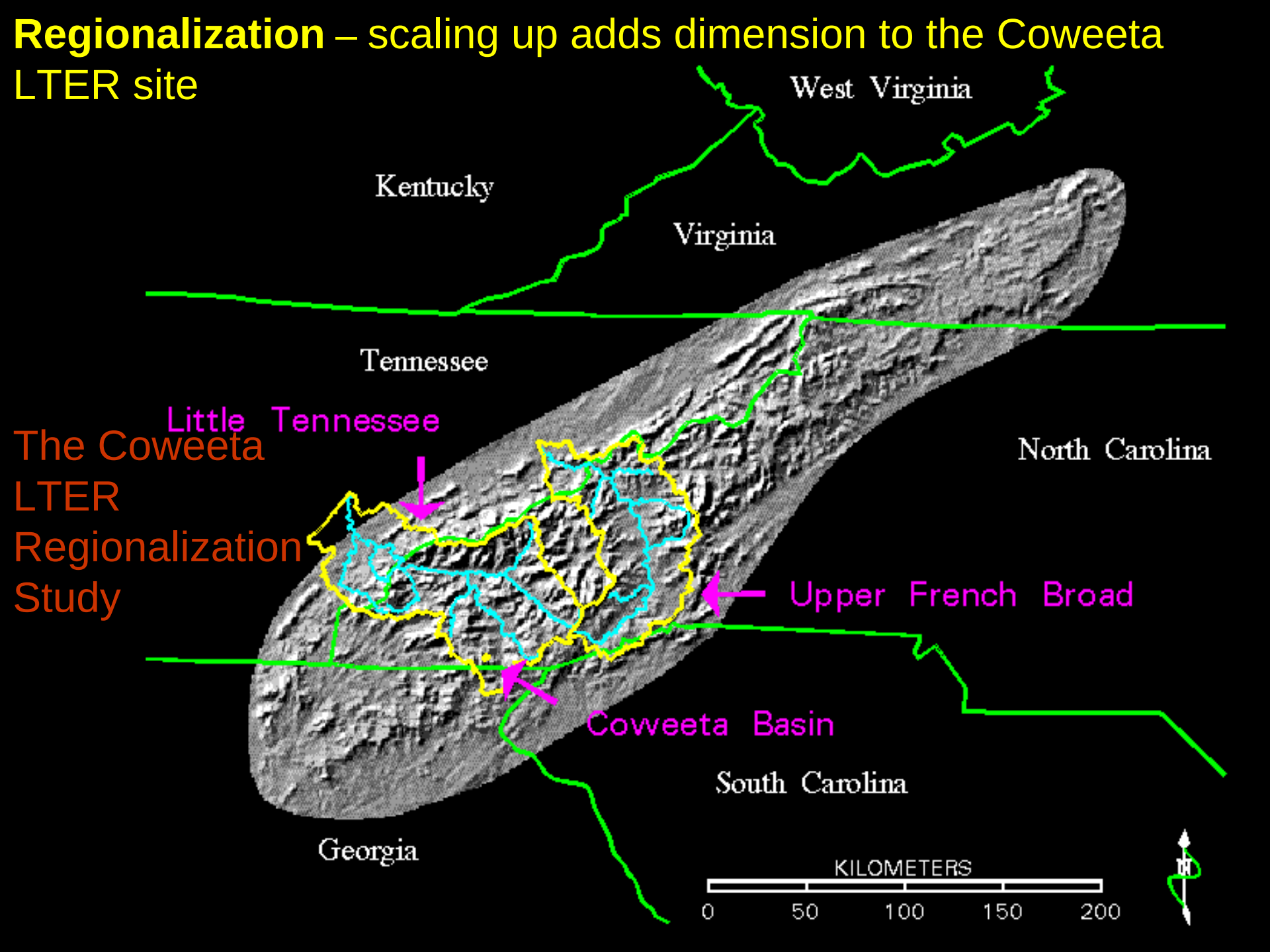
Two new sites added in 1998 expand the scope to include multidisciplinary studies of human dominated ecosystems

Baltimore Ecosystem Study

Central Arizona - Phoenix

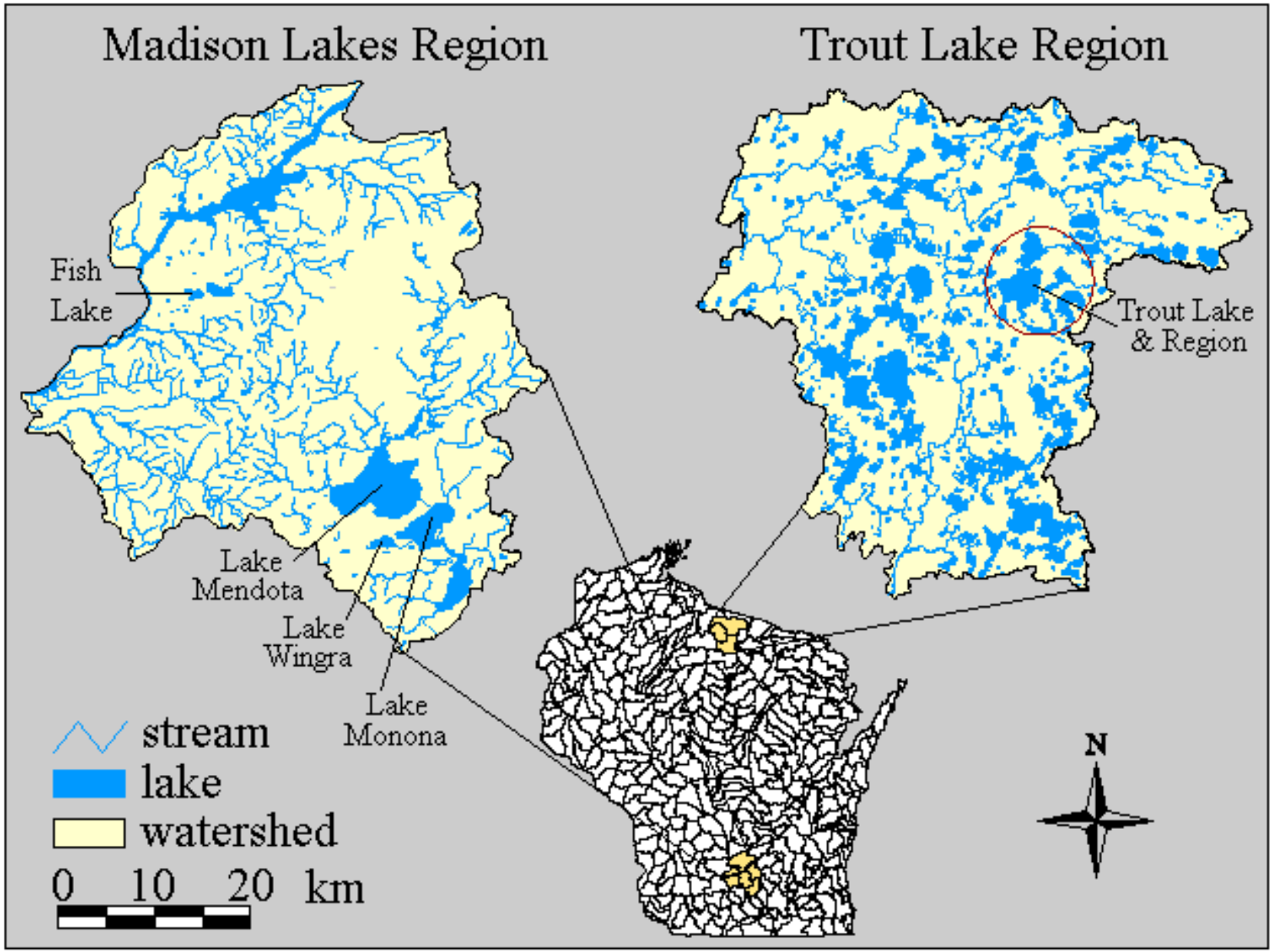


Regionalization – scaling up adds dimension to the Coweeta LTER site



The Coweeta LTER Regionalization Study

Regionalization – scaling up adds dimension to the North Temperate Lakes LTER Site



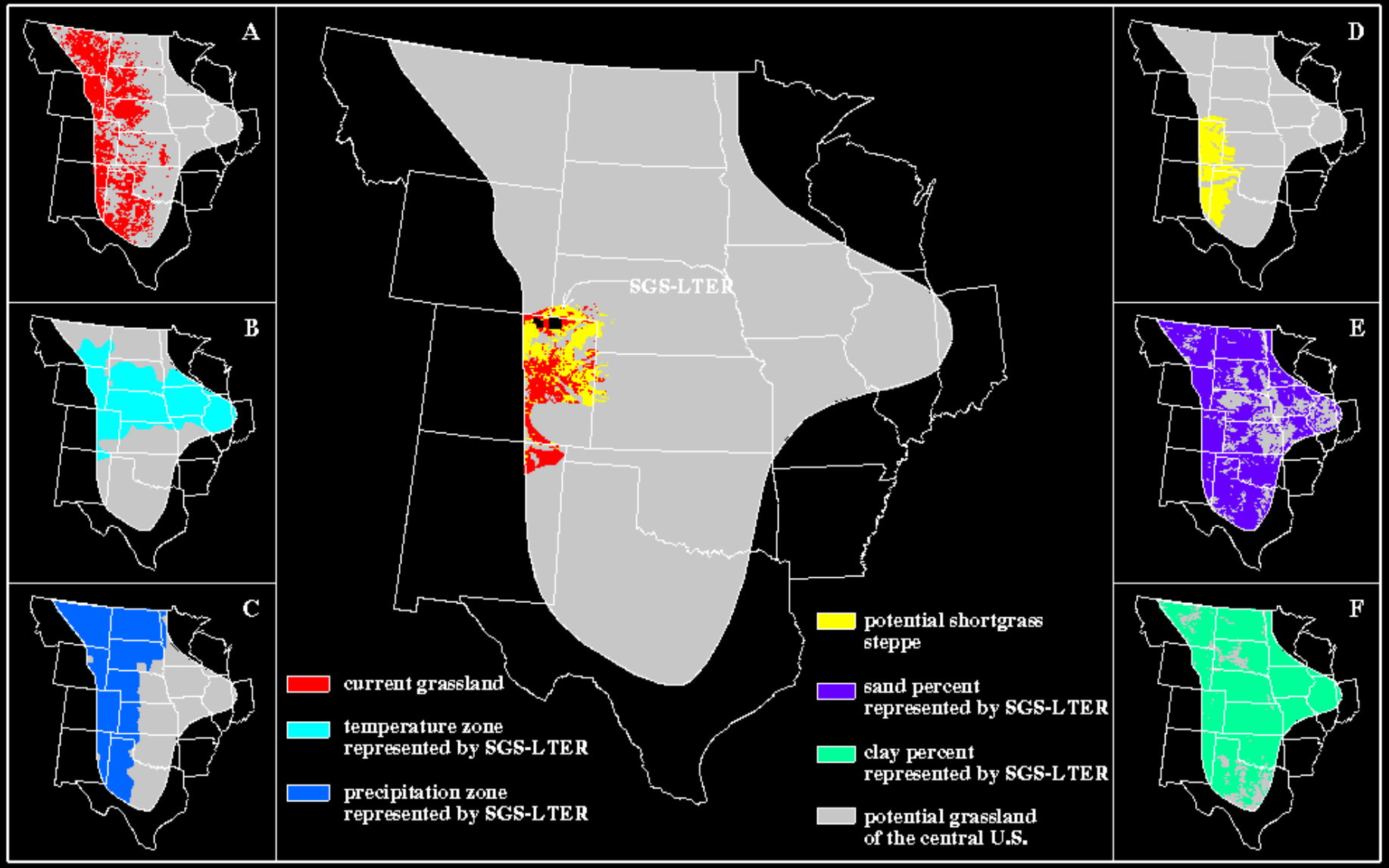
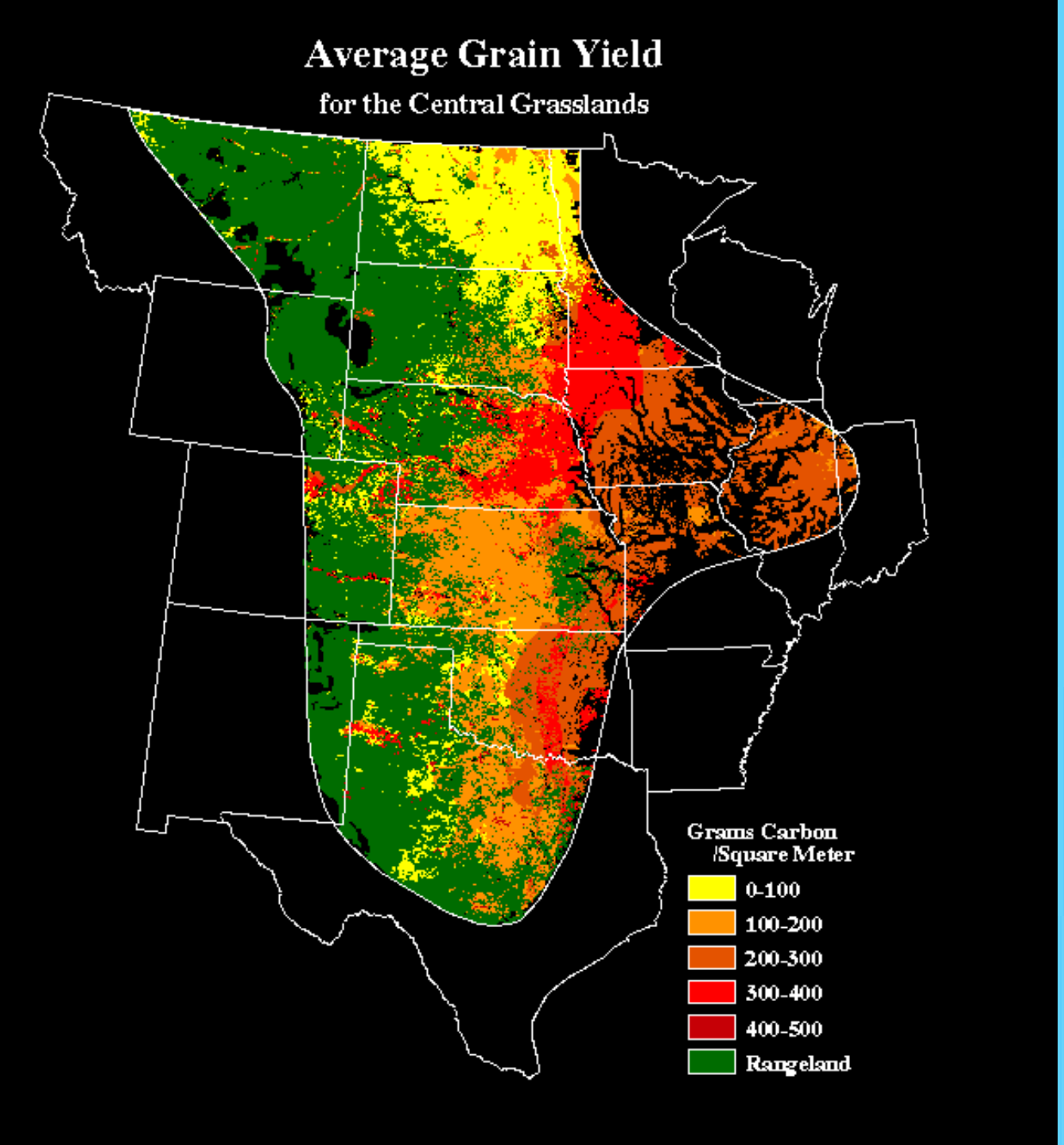


Figure 2.6: Realm of Inference for the SGS-LTER Site. The center map shows results of an analysis to determine the area within the shortgrass steppe that the SGS-LTER site represents. Maps used in this analysis (following methods of Burke and Lauenroth 1992) are: (A) current grassland (Land Use Land Cover, 1982) (B) mean annual temperature ranging from 6.64 to 11.64 degrees Celcius, and (C) mean annual precipitation ranging from 100 to 600 mm (CLIMATEDATA, 1910-[illegible]) potential shortgrass steppe (Küchler, 1975); (D) clay ranging from 5 to 40 percent and (E) sand ranging from 20 to 80 percent (Weld County Soil Survey 1981)(STATSGO, 1994). By intersecting temperature, precipitation, sand percent, clay percent, and potential shortgrass steppe vegetation, the realm of inference for the SGS-LTER site is defined. As seen in the center map, the SGS-LTER site (black), current (red) and potential (yellow) grassland fall within this area.

Regionalization - scaling up adds dimension to the Shortgrass Steppe LTER Site



Modeled Average Grain Yield for the Central Grasslands

Short Grass Steppe LTER

REGIONAL SCALE ANALYSIS AND ASSESSMENT

1999 STAR Grants for Research

(This RFP was a direct result of EPA representatives attending the 1996 LTER Network Science Meeting on Regionalization at Harvard Forest LTER site – please see http://www.lternet.edu/hfr/research/region/intro.htm)

Background:
Regional Scale Analyses

Ecologists have learned a great deal about systems and how they function by long-term studies of individual locations. Research conducted at the Long-Term Ecological Research (LTER) sites (funded primarily by the National Science Foundation) is outstanding among the many examples of these types of studies. A lingering question, however, from studies of this nature is the extent to which the findings from the single site can be extrapolated to broader areas. Determining the "representativeness" of the site is one approach toward creating regional scale analyses from site studies. Knowledge of the important system drivers at the site is generally needed along with a knowledge of how those drivers are distributed over broader geographic areas containing apparently similar types of systems.

LTER serves an important role in facilitating cross-site synthesis

The power of the LTER Network approach to science is the ability to compare similar processes (e.g., primary production or decomposition of organic matter) under different ecological conditions. As a result, LTER scientists are able to understand how fundamental ecological processes operate at different rates and in different ways under different environmental conditions.

Cross-site publications and multiple-site authorships

Oxford - LTER Synthsis Series

Published:

- **Konza/Tallgrass Prairie**
- **Soil Methods**
- **Alpine Ecosystems/Niwot Ridge**

Under Contract:

- **Short Grass Steppe**
- **Jornada**

In Final Stages:

- **Drylands Biodiversity**
- **North Temperate Lakes**
- **Virginia Coast**
- **Kellogg Biological Station**
- **Sevilleta**
- **Harvard Forest**
- **Toolik Lake**
- **Luquillo**

Other Site Volumes:

- **Hubbard Brook**
- **McMurdo**
- **Palmer**

LTER Demonstrates a commitment to Broadening the Scale of Ecological Research through Participation with Ecological Research Networks

- ILTER = GTOS, GT-NET
- FLUXNET
- NERR
- USDA Forest Service and /UVB monitoring network
- Organization of Biological Field Stations
- San Diego Supercomputer Center

The LTER Network Has lead the scientific community away from the traditional research and its

- Short Term Studies (1-2 years)
- Small Scale Studies (1 m^2)
- Single Scale Studies
- 1-2 Species Studies
- Few Variable Studies
- Single Discipline Studies
- Inadequate Information Mgmt.

The LTER Network recognizes that modern ecological science must be…

- **Complex - many interacting factors are involved in ecological processes**
- **Dynamic - varies over time in complex ways**
- **Spatially variable - exhibits different patterns at different scales**
- **Biologically diverse - complex assemblages of thousands of species**

and

- **Interdisciplinary research is essential**

LTER Science Involves Comprehensive Site Research That Integrates …

Many **Temporal Scales**

and

Many Spatial Scales

and

Complex Species Assemblages

and

Multiple Disciplines

and

Archives the Data for Future Scientists!

The LTER Message:

Long-term research sites stimulate intensive activities by many individuals from many disciplines working on common areas that facilitates integration of information.

The LTER SITE BECOMES A RESEARCH PLATFORM

(ENVIRONMENTAL OBSERVATORY)

Long Term Ecological Research Sites are excellent research platforms for performing international activities

- ILTER
- GTOS
- DIVERSITAS, IBOY
- IGBP,GCTE
- NoLimits

Global Terrestrial Observing System (GTOS) - Microsoft Internet Explorer

File Edit View Go Favorites Help

Address http://www.fao.org/gtos/Home.htm Links

GTOS

Global Terrestrial Observing System

About GTOS: *Français* *Español*

About GTOS
Background information: what is GTOS, what are the objectives...

How does it work?
GTOS structure, collaboration with GC

GT-Net
Global Terrestrial Observing Network: scope, structure, activities...

News
Programme support, GTOS meetings,

TEMS meta-database
Information about registered sites through the Terrestrial Ecosystem Monitoring Sites meta-database...

Documents
On line access to GTOS publications..

Links
Interesting environmental links on the Web...

Please register!
...to receive notices on GTOS develop

Internet zone

Demonstration Project

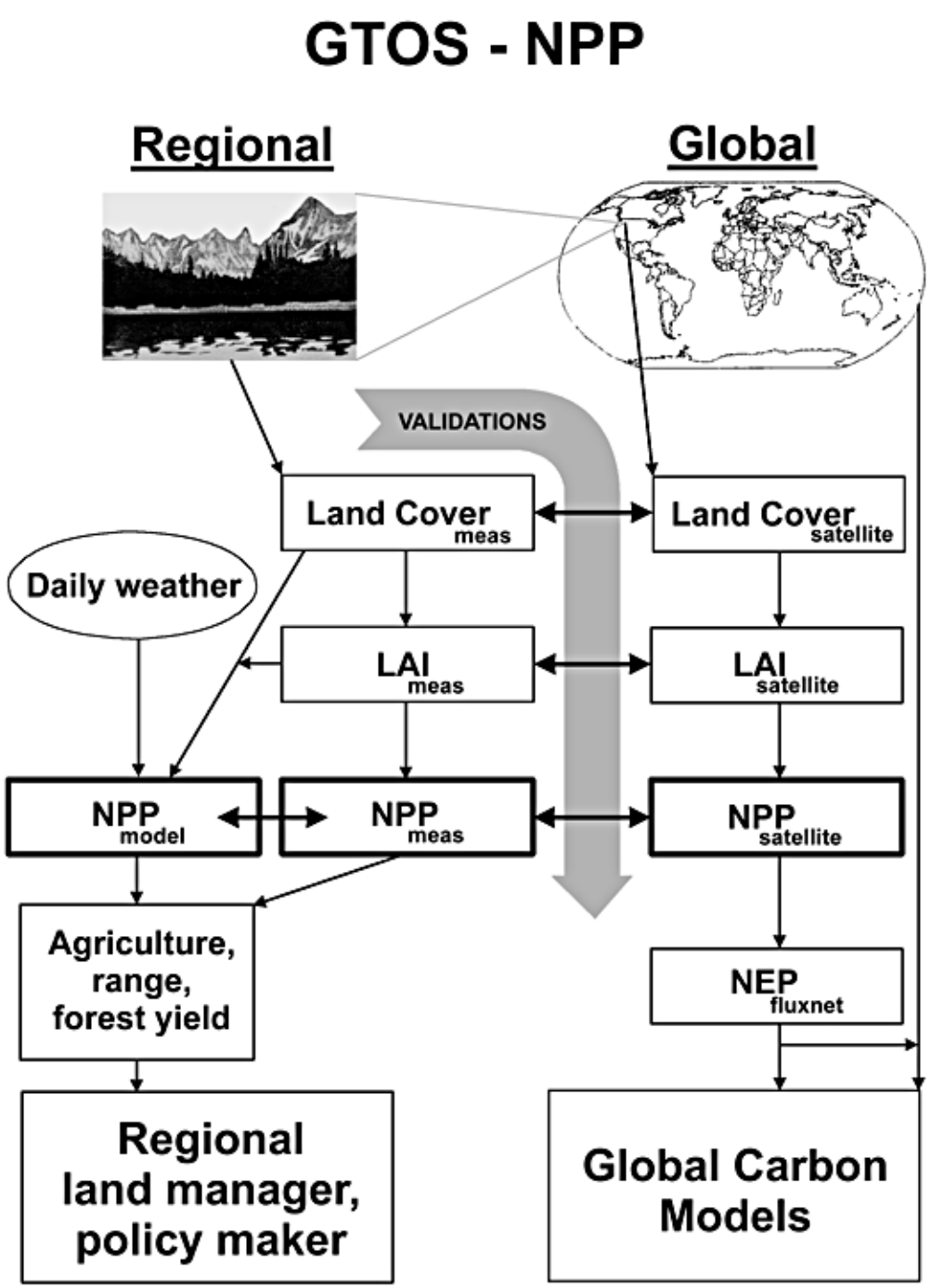
GT-NET

GLOBAL TERRESTRIAL OBSERVING SYSTEM

NASA / MODIS

♦The GT-Net will undertake projects which demonstrate the effectiveness of linking existing networks by generating data sets which are useful in studying global change.

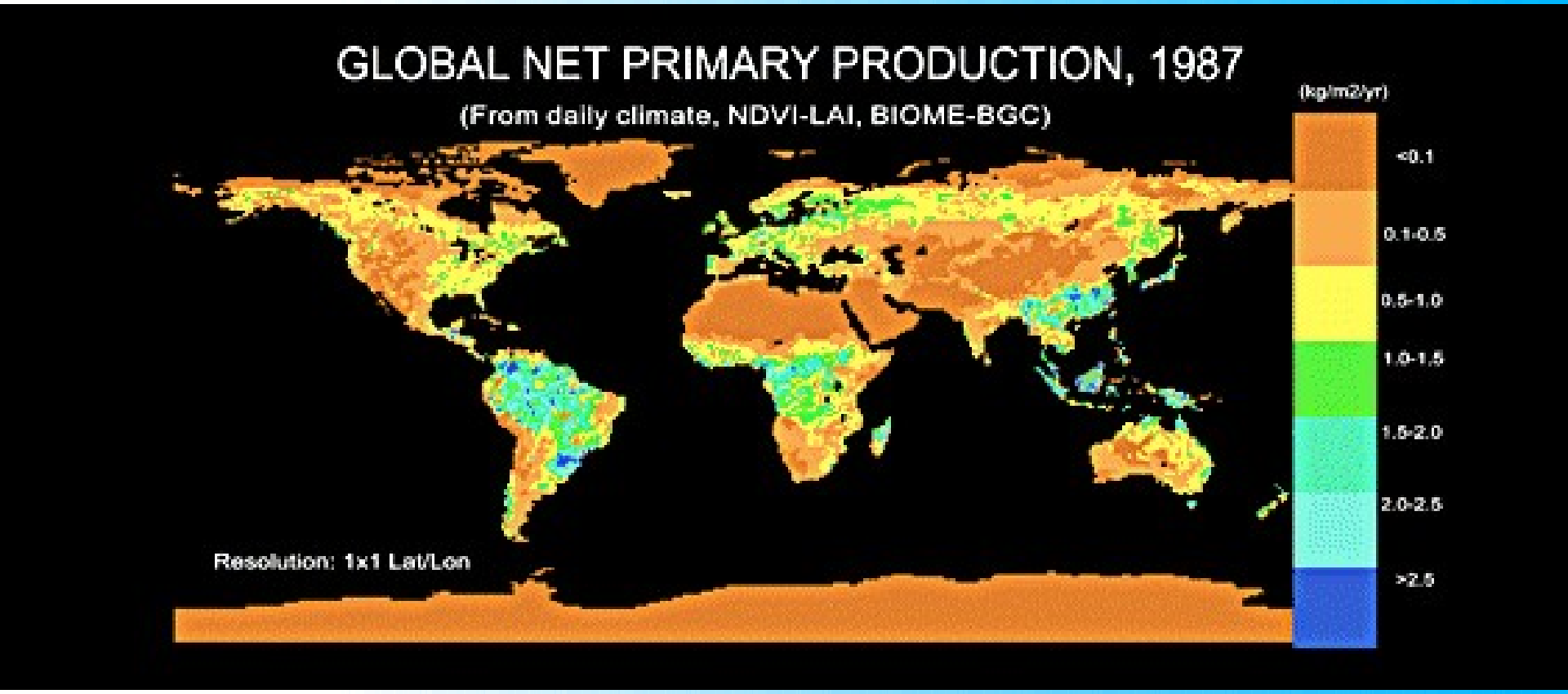
♦This will serve as a test bed for collaboration among networks and sites, including data sharing and exchange, and obtaining the experience needed for a further development of the global terrestrial network.



A measurement flow diagram for the GTOS-NPP project.

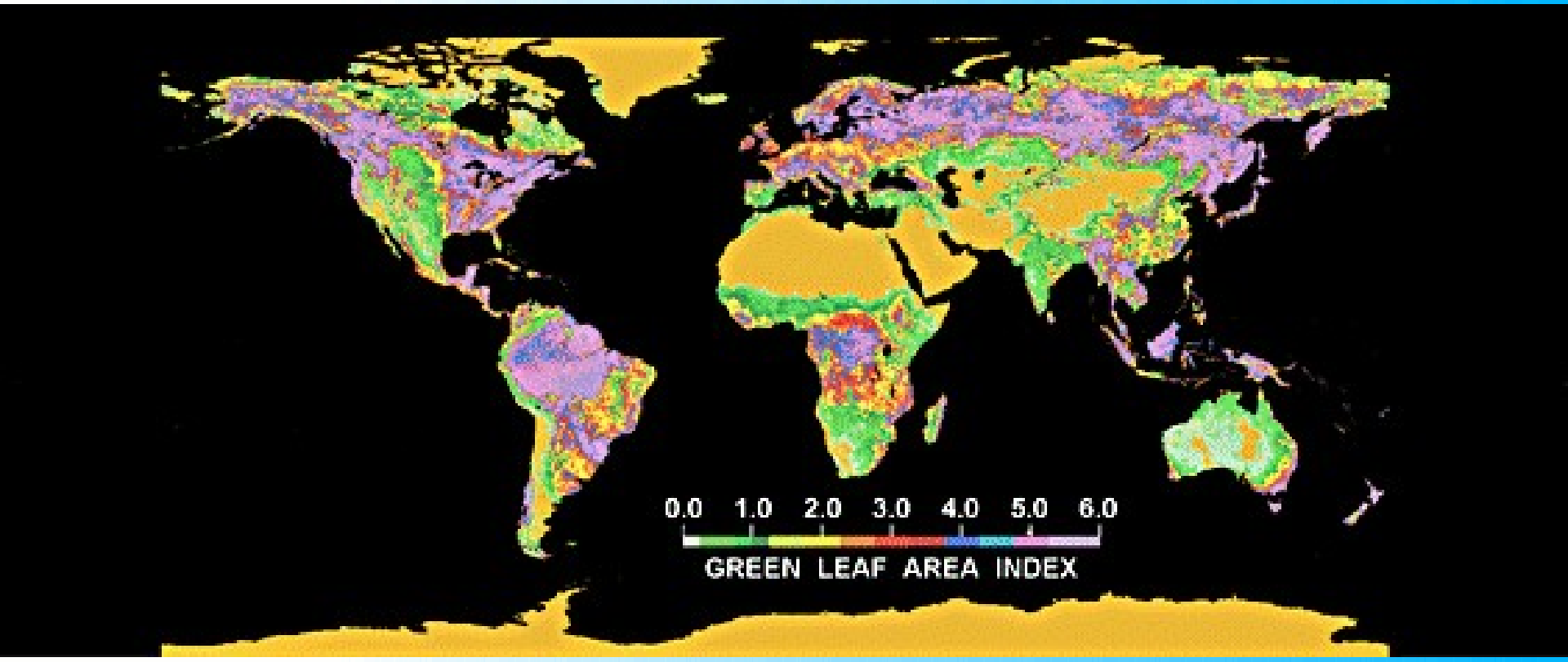
Critical vegetation variables of LC, LAI and NPP are measured at the EOS-MODIS and regional scales, and used to validate the global satellite based estimates. FLUXNET based NEP measurements provide a separate validation, and translation of the carbon budget based NPP to commodity yields (with local weather data if available) allows local utility of the NPP data by resource managers.

An example of global Net Primary Production (NPP) that will be produced from the Earth Observing System (EOS) every 8 days at 1 km.



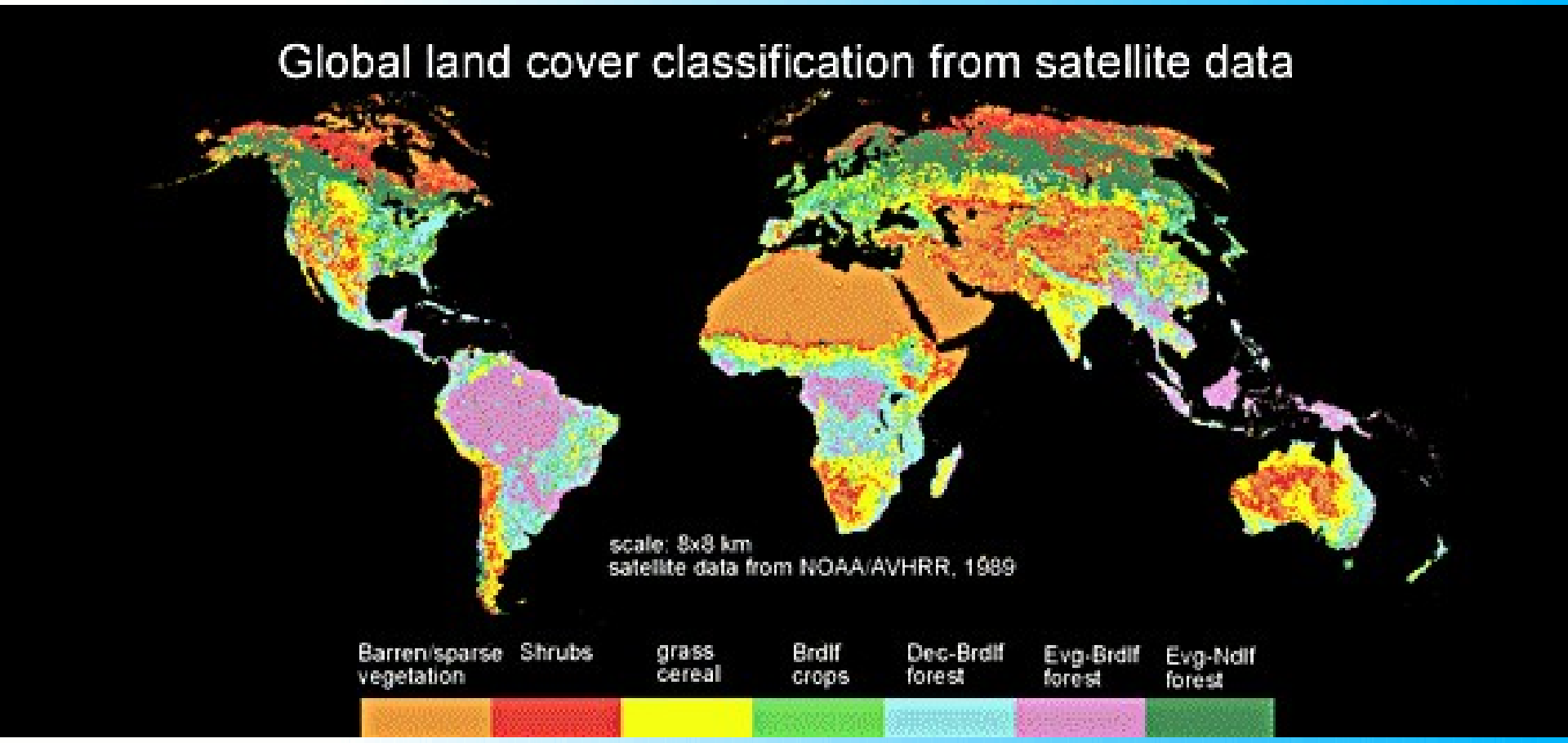
These data will be invaluable for scaling of ecological research and land management, but first need global field validation. (see Running et al., 1994, and Justice et al., 1998 for details).

An example of global Leaf Area Index (LAI) that will be produced from the Earth Observing System (EOS) every 8 days at 1 km.



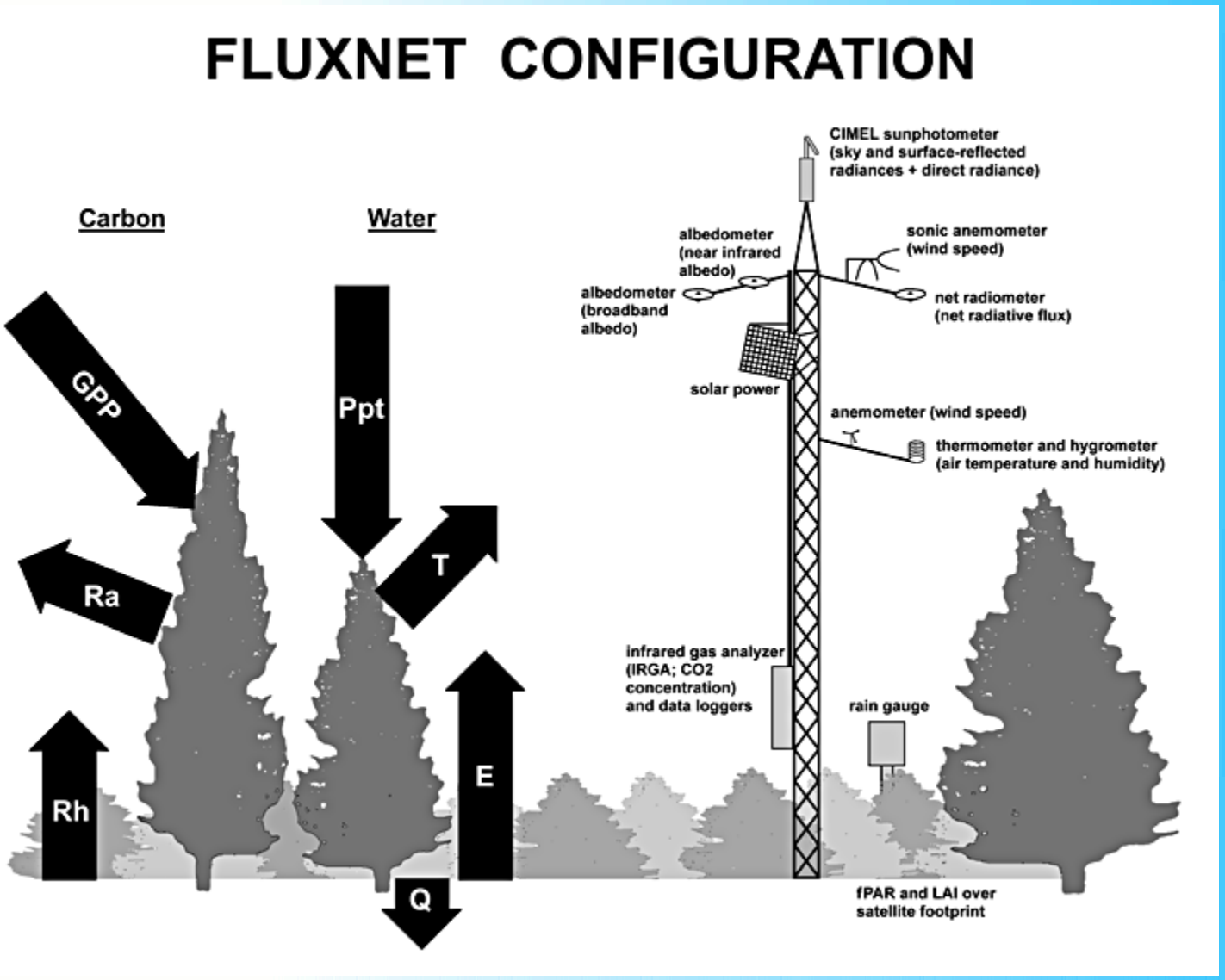
These data will be invaluable for scaling of ecological research and land management, but first need global field validation. (see Running et al., 1994, and Justice et al., 1998 for details).

An example of global Landcover (LC that will be produced from the Earth Observing System (EOS) every 8 days at 1 km.

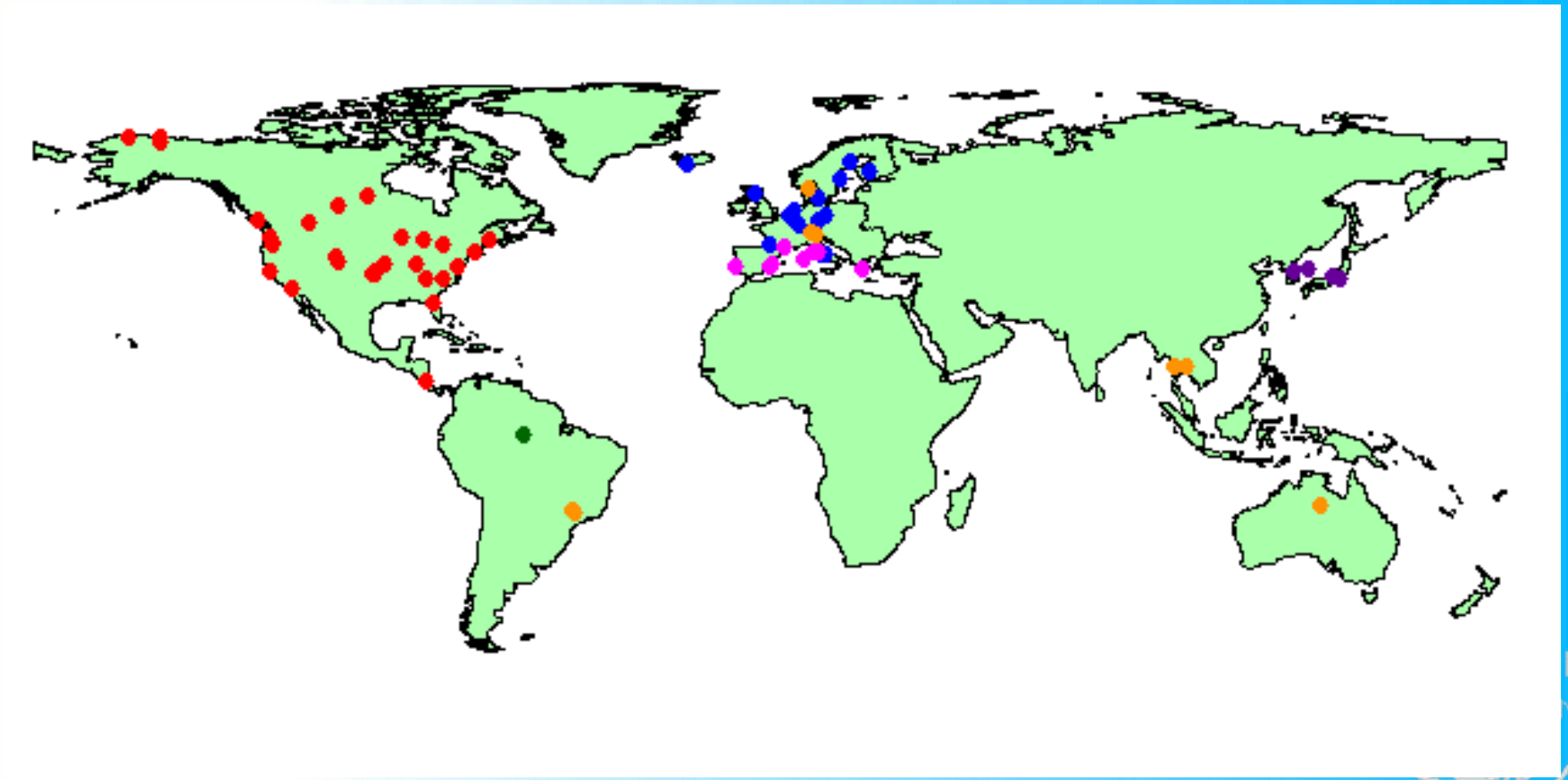


These data will be invaluable for scaling of ecological research and land management, but first need global field validation. (see Running et al., 1994, and Justice et al., 1998 for details).

A generalized FLUXNET tower configuration diagram showing key carbon and water fluxes measured. Atmospheric optical measurements, automated surface spectral measurements, flask sampling and stable isotope sampling can all be accommodated into this framework.



FLUXNET: Integrating Worldwide CO2 Flux Measurements

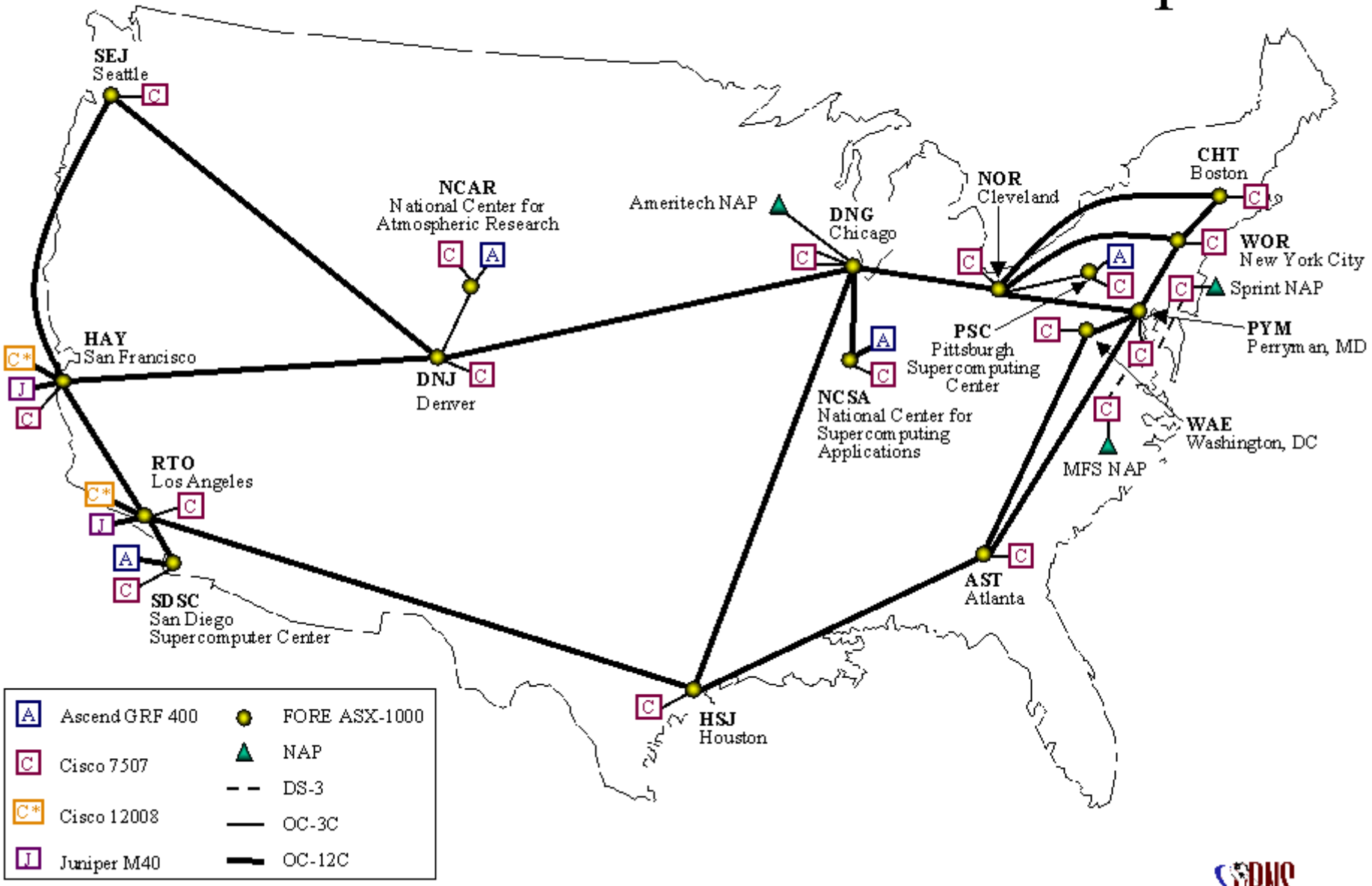


DIVERSITAS Participation

Knowledge and Distributed Intelligence (KDI)

"… will link the biocollections and species databases of the systematic community (more than 15 million digitized records), the ecosystem databases of the ecological community, and the geospatial, computational and analytical tools at SDSC. This research will be performed in collaboration with the U.S. Long Term Ecological Research (LTER) Network and the National Center for Ecological Analysis and Synthesis (NCEAS)."

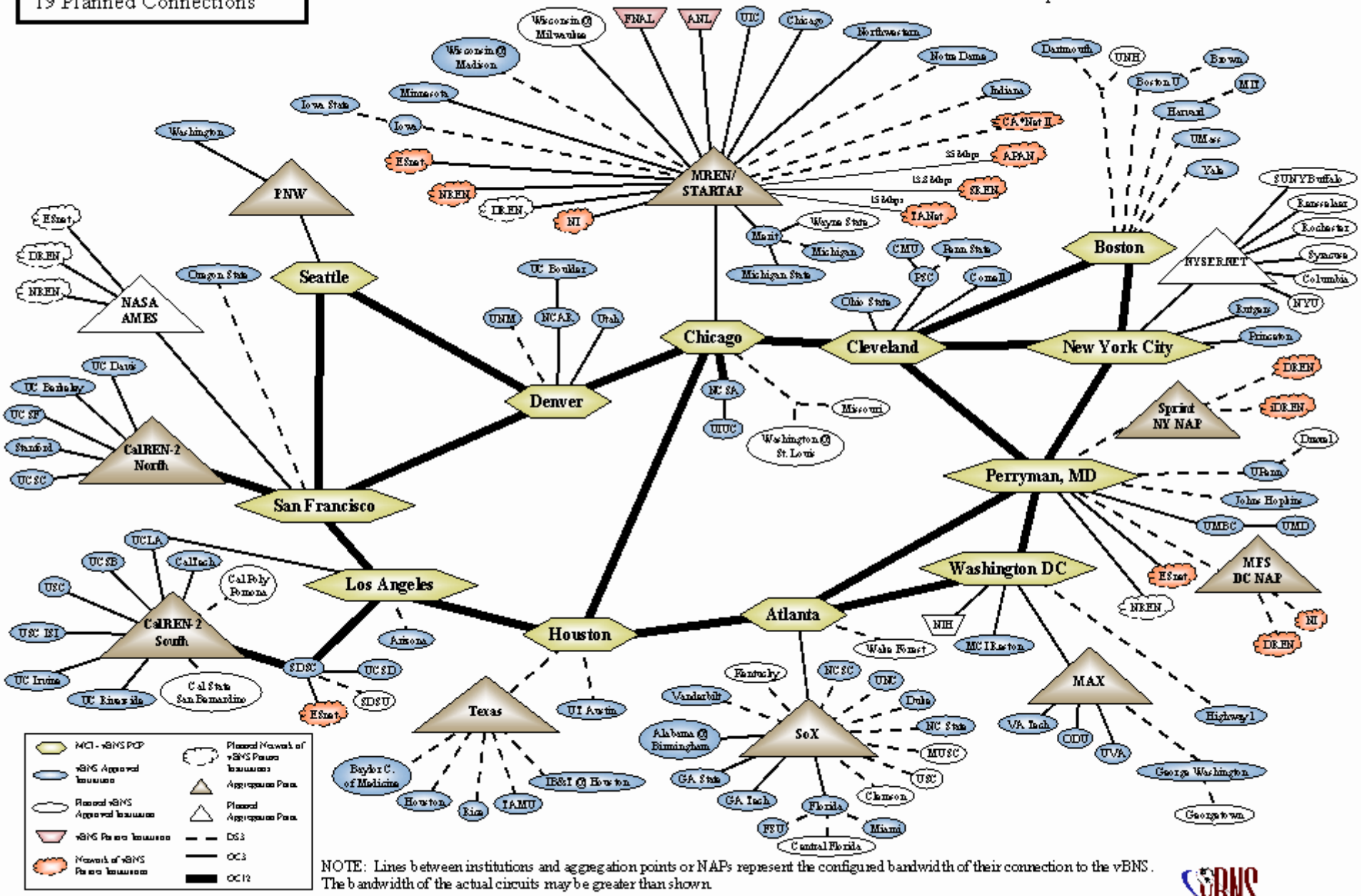
vBNS Backbone Network Map



74 Operational Connections
19 Planned Connections

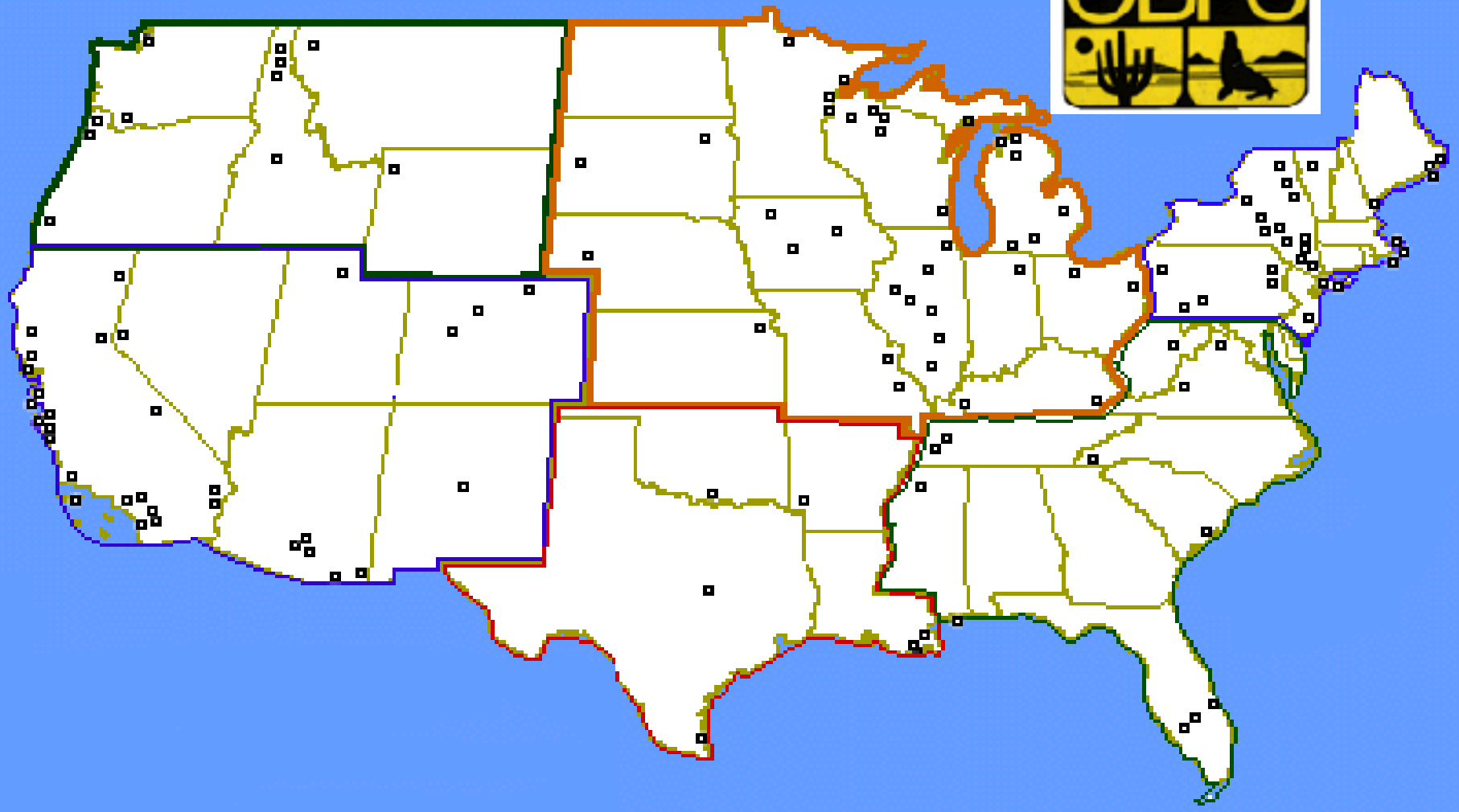
vBNS Logical Network Map

Last Updated 12/04/98

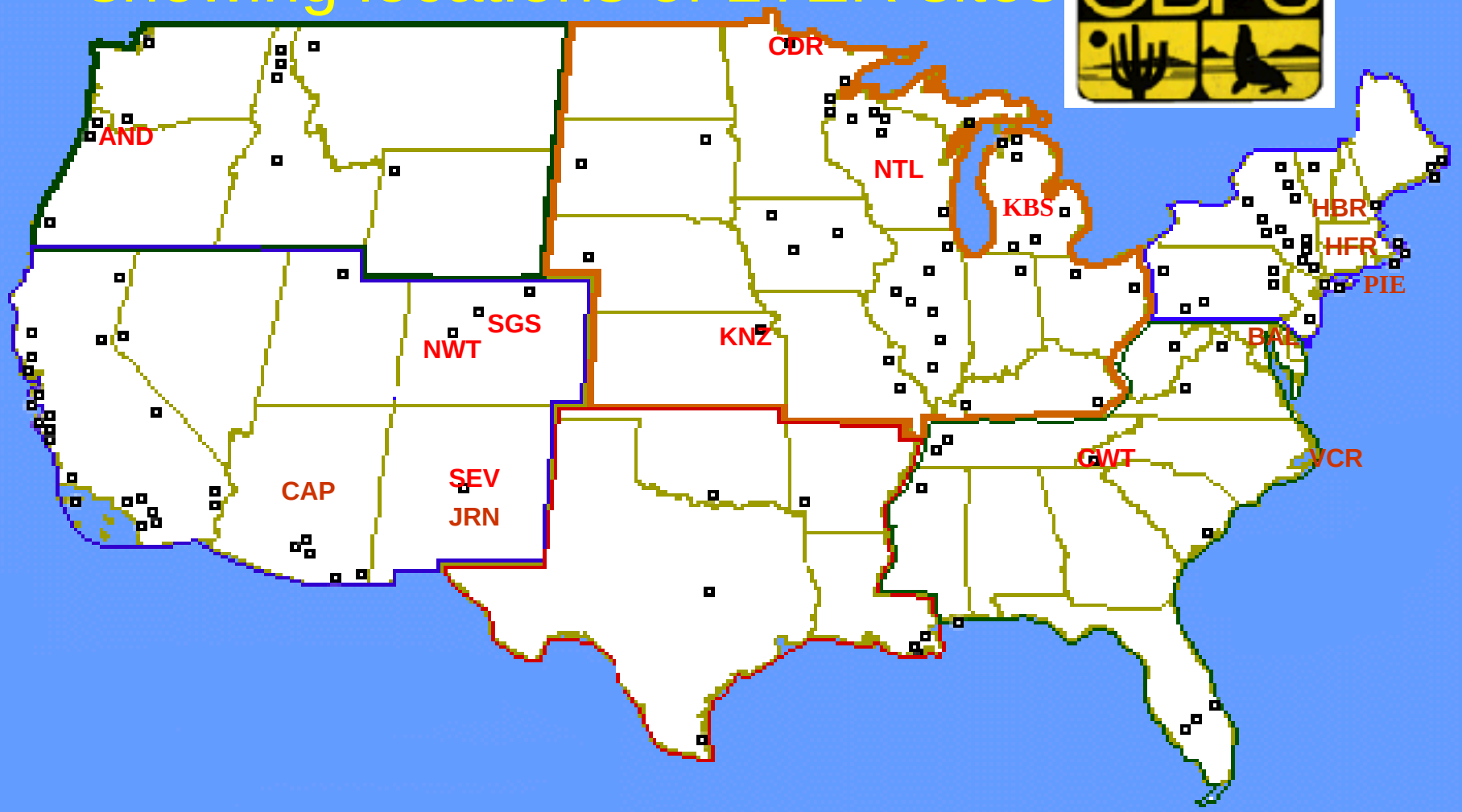


NOTE: Lines between institutions and aggregation points or NAPs represent the configured bandwidth of their connection to the vBNS. The bandwidth of the actual circuits may be greater than shown.

Organization of Biological Field Stations - United States



rganization of Biological Field Stations - United States -showing locations of LTER sites

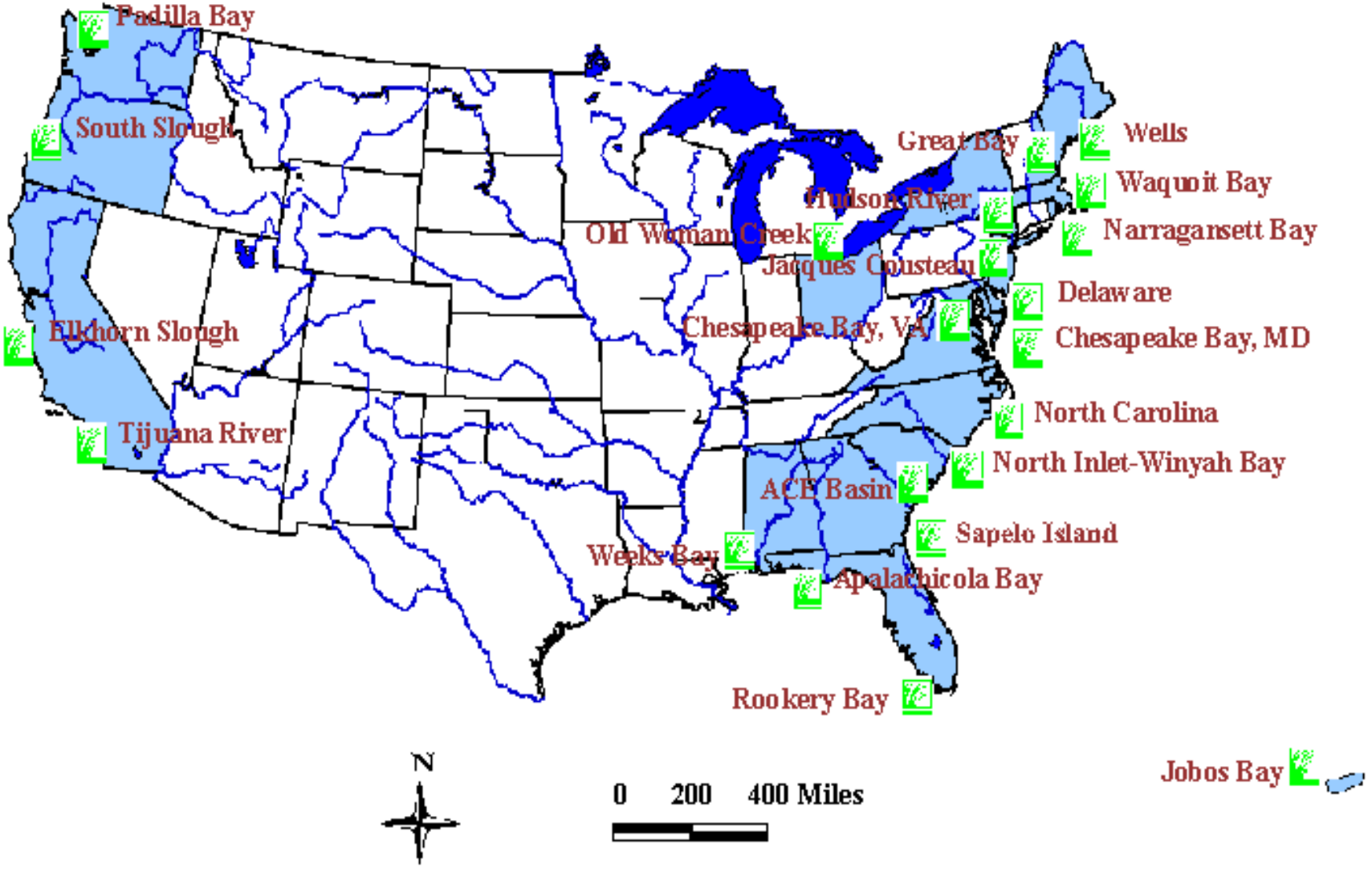


Six LTER Sites Utilize USDA Forest Service Land through an ongoing Memorandum of Understanding

- **HJ Andrews Experimental Forest**
- **Bonanza Creek**
- **Baltimore Ecosystem Study**
- **Coweeta**
- **Hubbard Brook**
- **Luquillo Experimental Forest**

LTER

NOAA's National Estuarine Research Reserves



The U.S. Department of the Interior

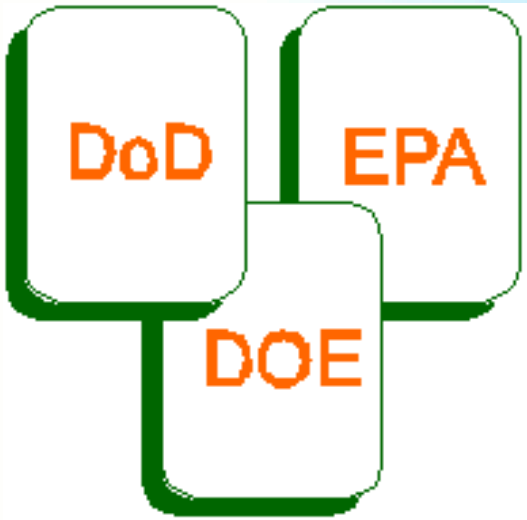
The National Park Service

ParkNet

Cooperative Ecosystem Studies Units

LTER

National Park System Units Selected for Prototype Experimental Monitoring of Natural Resources

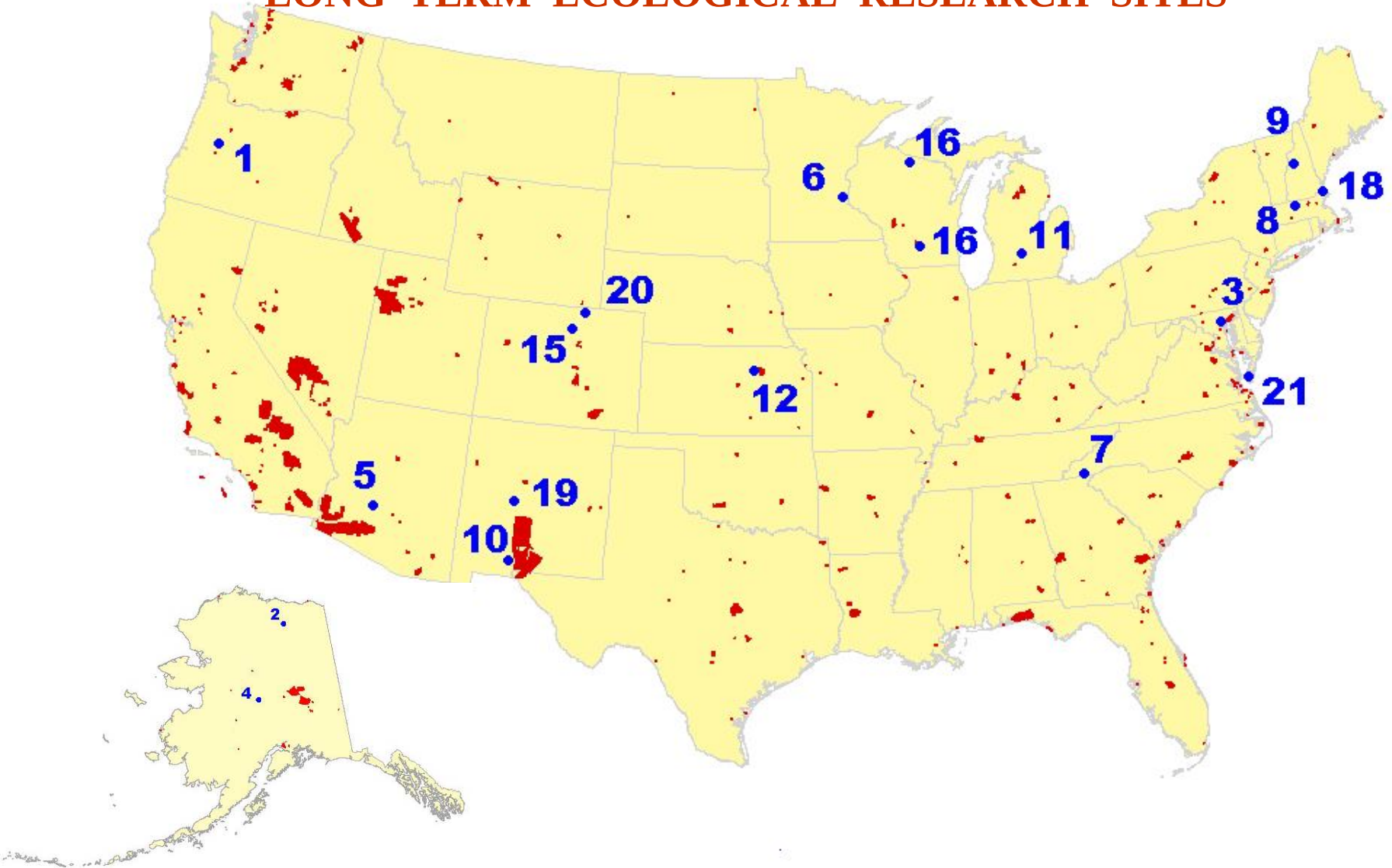


SERDP

Strategic Environmental Research and Development Program

Improving Mission Readiness Through Environmental Research

DEPARTMENT OF DEFENSE LANDS (> 640 ACRES)
AND
LONG TERM ECOLOGICAL RESEARCH SITES



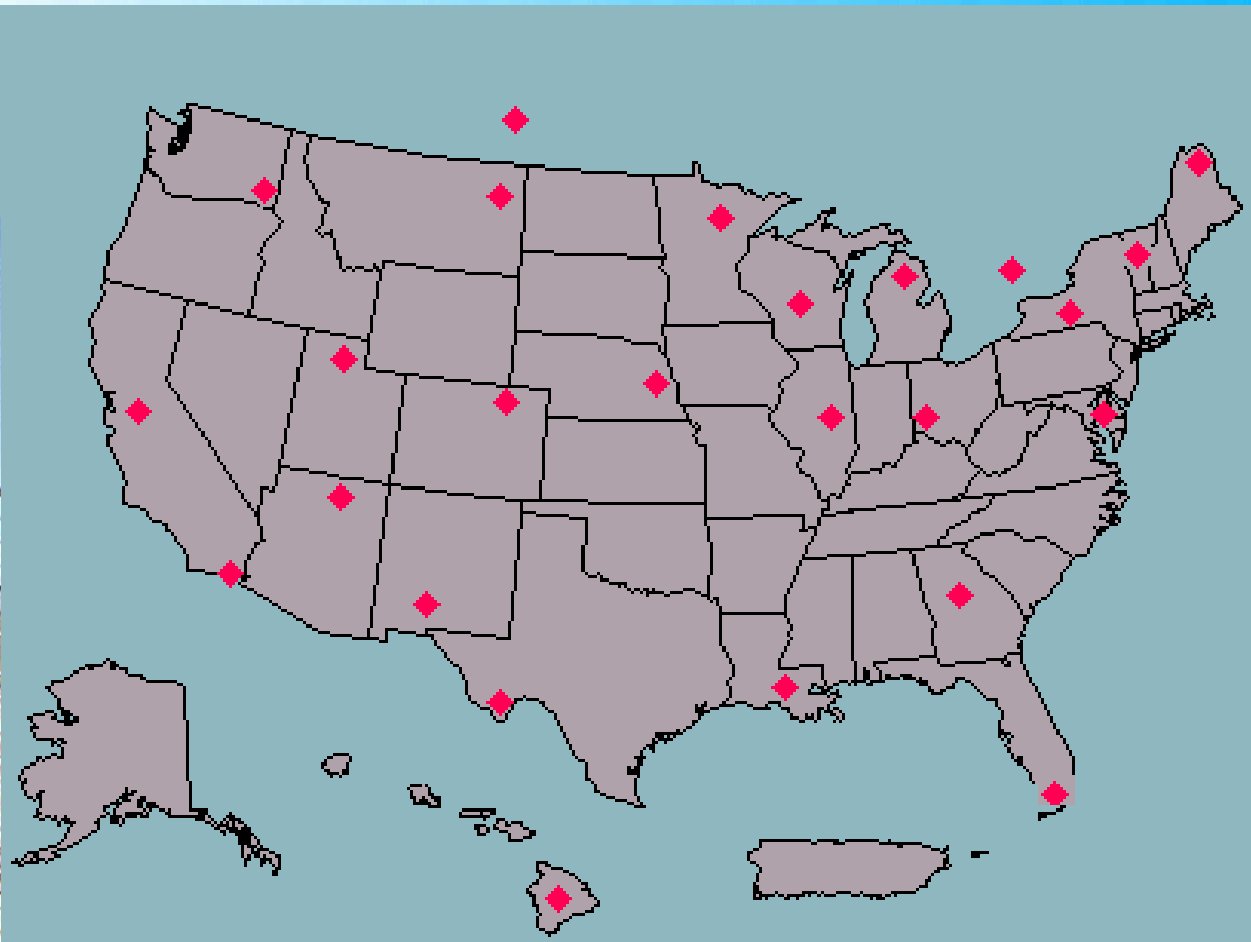
Global Fiducial Program

Archived, “classified”, satellite imagery for sites operated by different agencies.

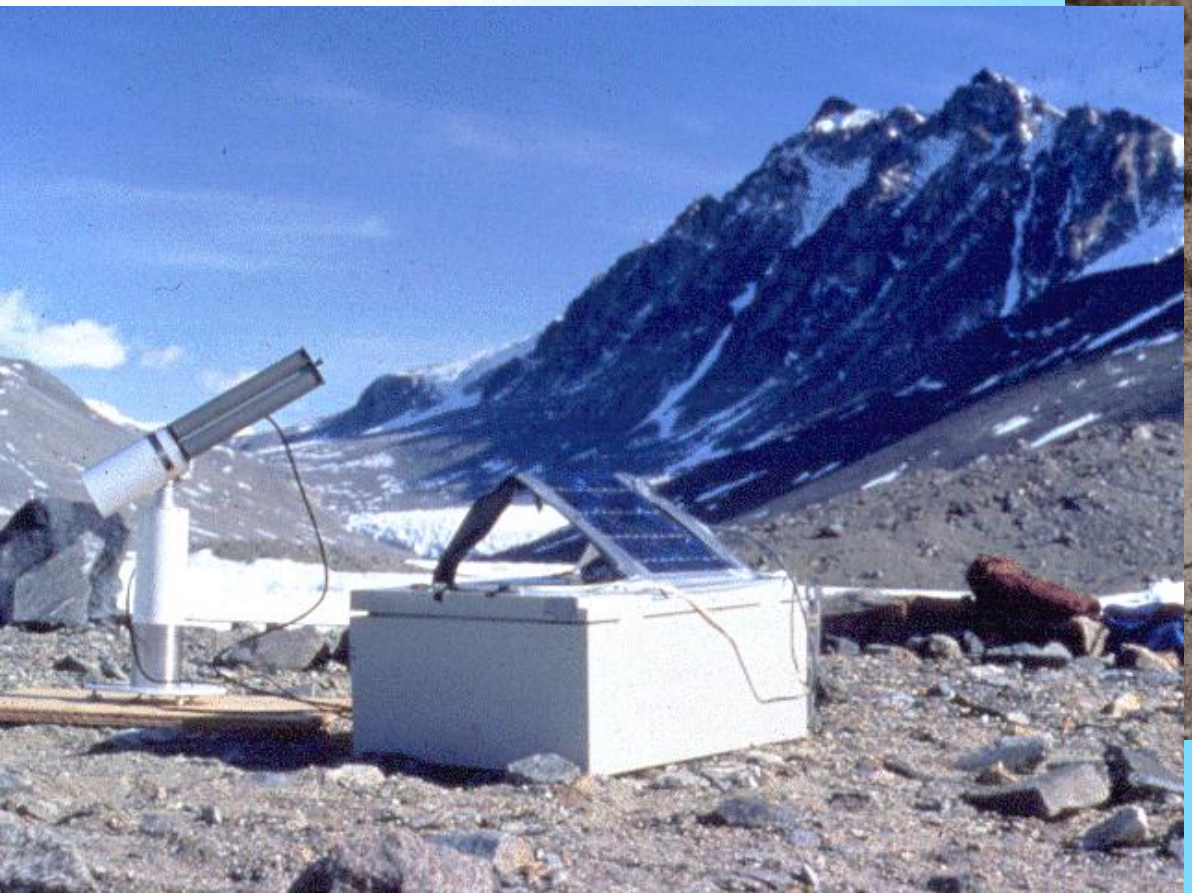
After expected declassification in the future, these sites will have a long-term record of phenomenal imagery!

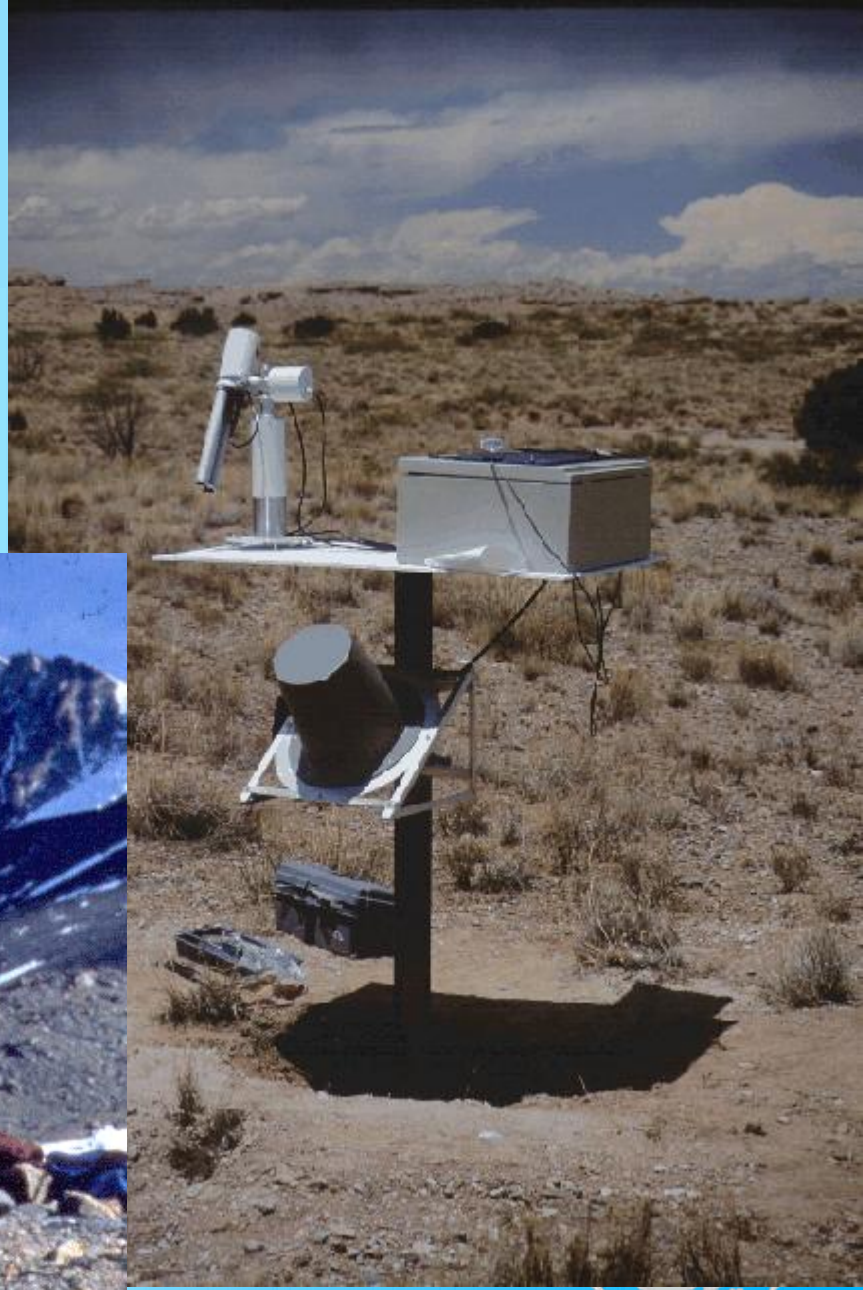
John Vande Castle of the Network Office has the secret clearance to monitor the acquisition of this imagery for LTER sites.

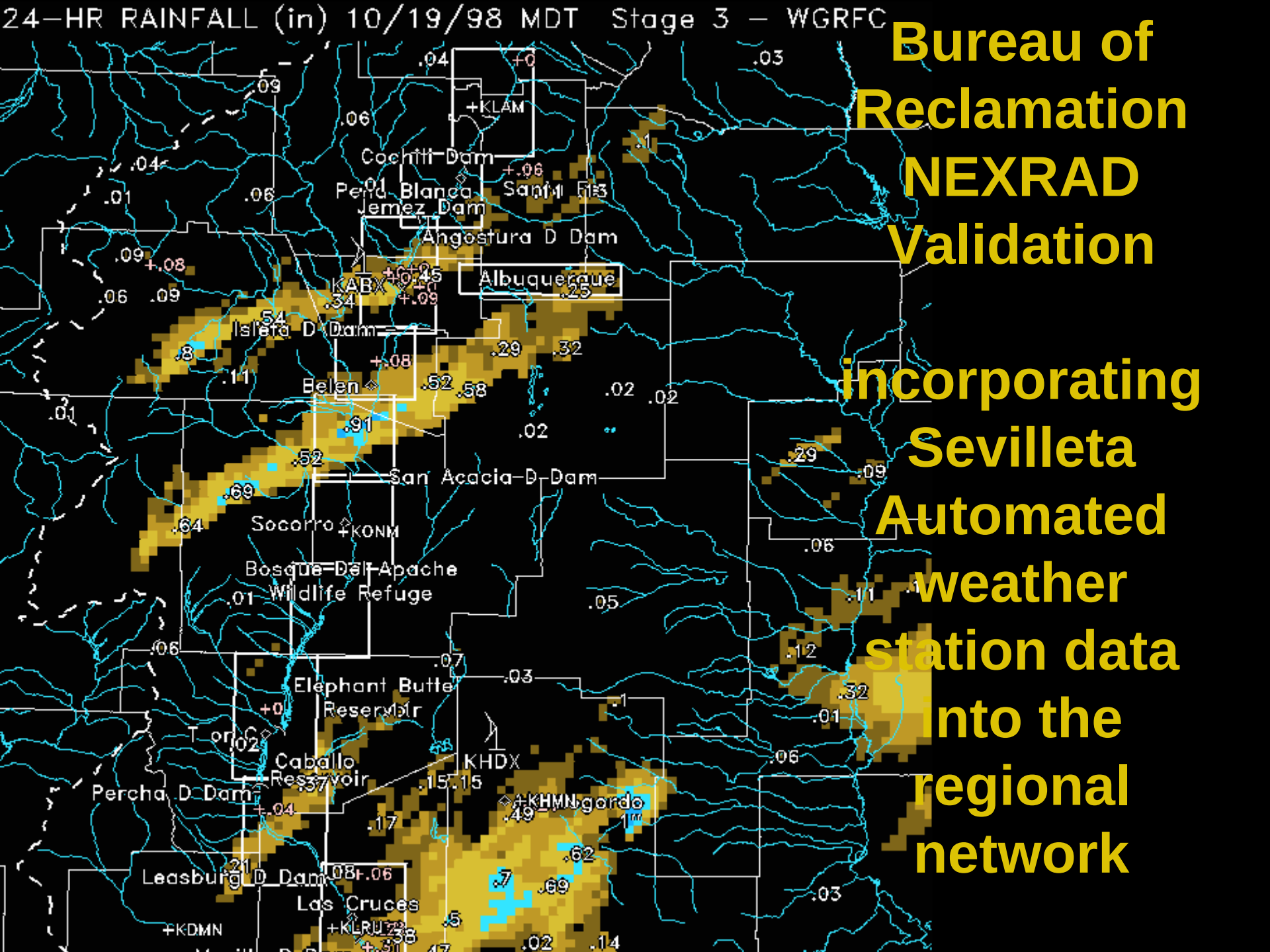
UVB Radiation Monitoring
National Network
USDA



Sun Photometer Network Collaboration with NASA






24-HR RAINFALL (in) 10/19/98 MDT Stage 3 - WGRFC
Cochiti Dam
Peña Blanca
Jemez Dam
Angostura D Dam
Albuquerque
KABX
Isleta D Dam
Belen
San Acacia D Dam
Socorro
KONM
Bosque Del Apache
Wildlife Refuge
Elephant Butte
Reservoir
Caballo
Reservoir
Percha D Dam
Leasburg D Dam
Las Cruces
KLRU
KDMN
KHDX
KHMN
Bureau of Reclamation NEXRAD Validation
incorporating Sevilleta Automated weather station data into the regional network

The LTER Network is becoming increasing recognized for:

- The *combination* of fundamental and applied research efforts
- The *infrastructure* allowing other research efforts, both independent and collaborative
- The *more than 1100 scientists* directly involved
- The academic+federal scientist team and interdisciplinary research
- The *participation* in agency monitoring, survey and research programs


L T E R

Entering the Century of the Environment: A New Social Contract for Science

Jane Lubchenco (Science 279:491-7)

"We believe the LTER Network can make a meaningful contribution to the Century of the Environment and the "Social Contract for Science"