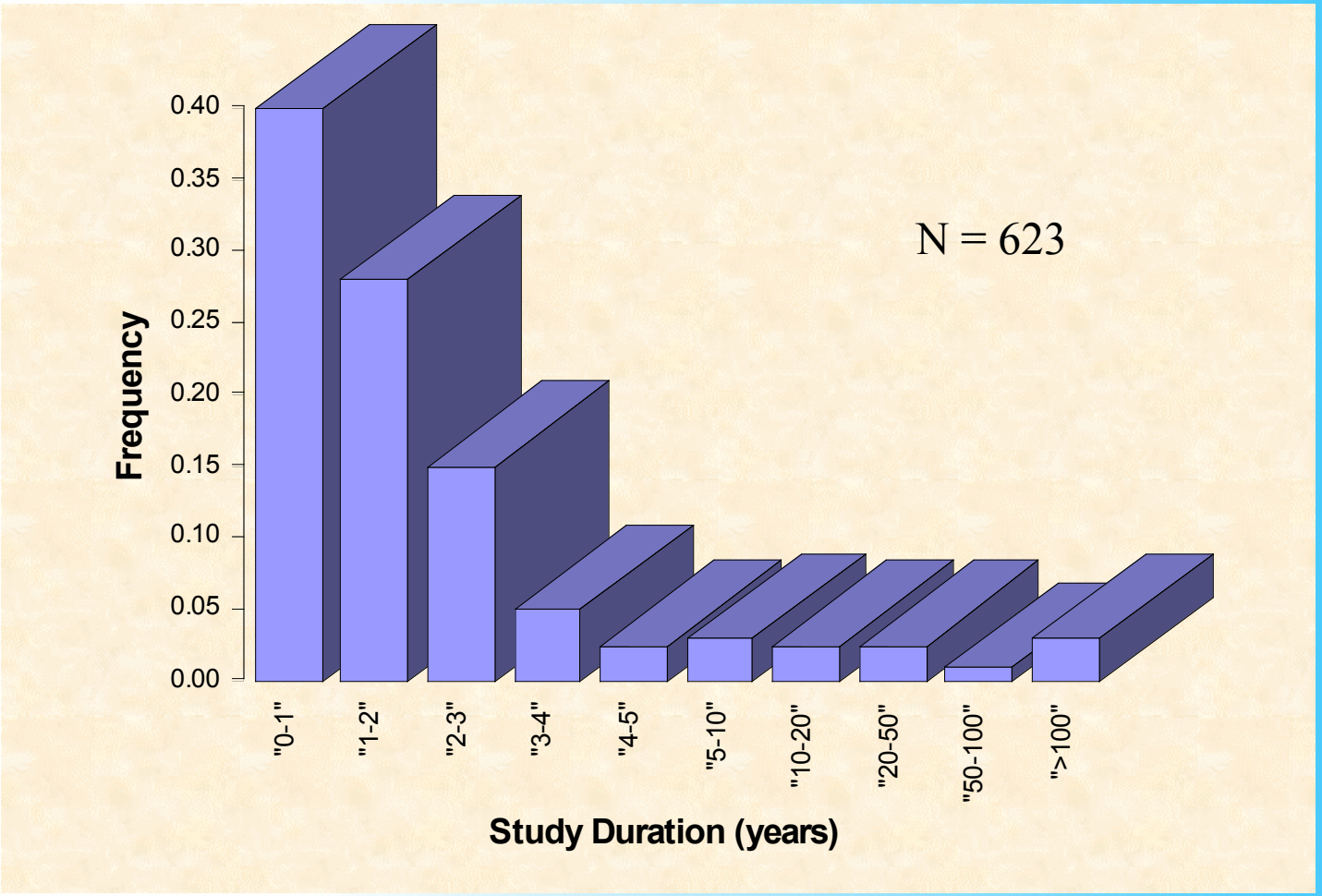
Niwot Ridge
Long-Term Ecological Research Site

Long-term ecological research (LTER): the challenge of converting long term monitoring into science

Mark Williams, University of Colorado

High-elevation areas are important bellwethers of global change: we need long-term research

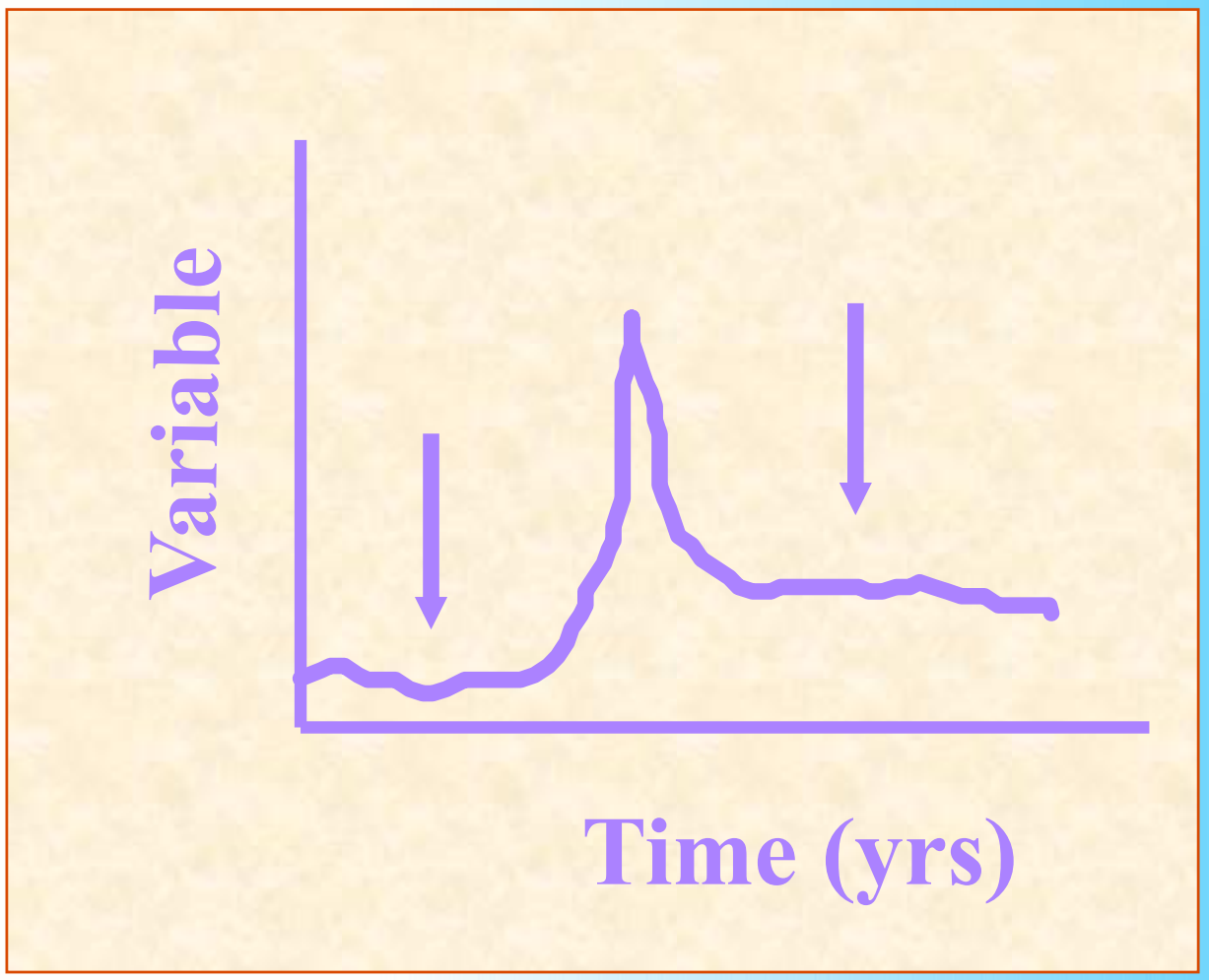
Duration of all observational and experimental studies



Eighty percent of studies in the ecological literature last less than three years

From Tilman, D. 1989. Ecological experimentation: strengths and conceptual problems. pp. 136-157. In Likens, G.E. (ed). Long-Term Studies in Ecology. Springer-Verlag, New York.

Only 10 percent of studies capture unusual events



Unusual events reset systems. Short-term studies initiated before and after a rare event are viewing different system states.

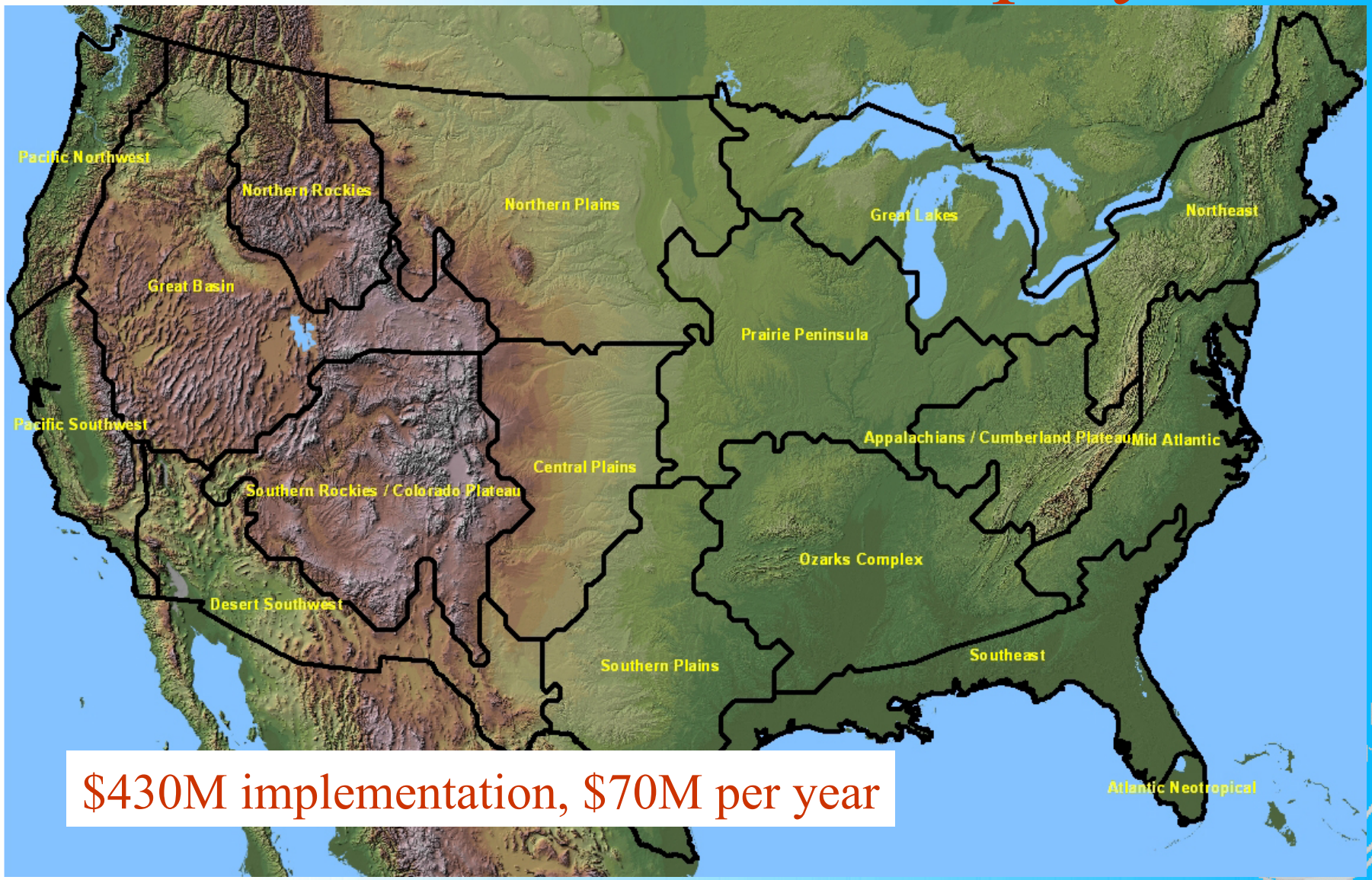
Advantages of long-term research

- Slow processes or transients
- Episodic or infrequent events
- Trends
- Multi-factor responses
- Processes with major time lags
- Leverage of experiments with long-term data
- Sites become research platforms
  - Attract other research projects/funding

How the program works

- 26 sites
- $820,000 per year per LTER site
- $940,000 per year starting 2011
- Grants are for 6 years
- Rigorous renewal process
- One LTER site discontinued after 30 years in 2010
- LTER network office provides coordination

NEON Domains and Deployment



$430M implementation, $70M per year

Critical Zone Observatories: new program

National CZO Program

BOULDER CREEK CRITICAL ZONE OBSERVATORY

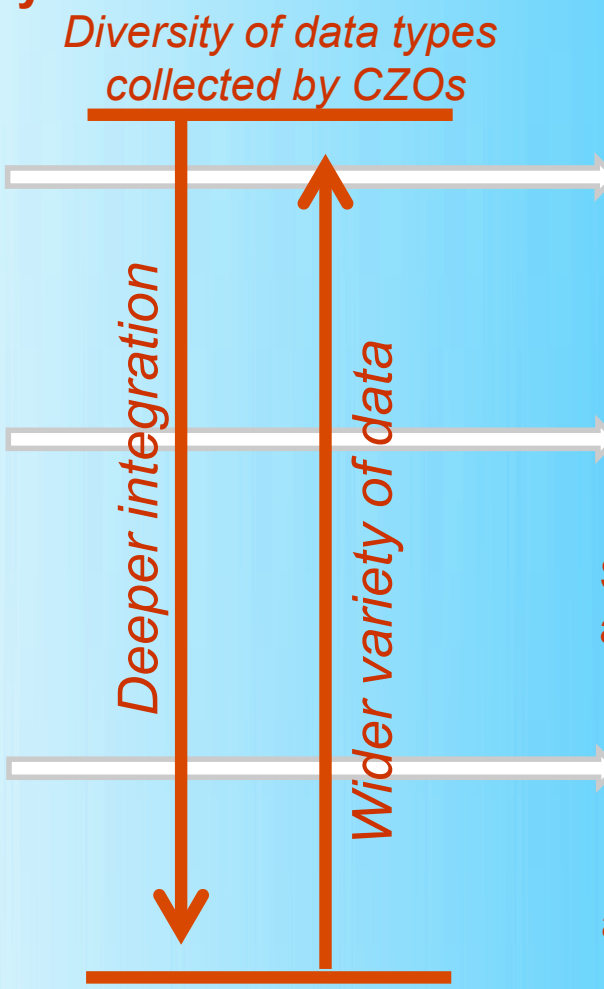
Levels of interoperability

Find and retrieve CZO resources: files and file collections, services, documents - by CZO thematic category and type

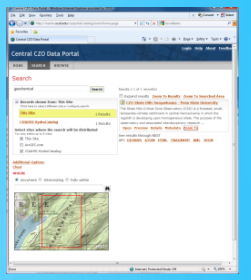
Data available in compatible semantics: ontologies, controlled vocabularies

Data available via standard service interfaces (e.g. WFS, SOS) but different information models

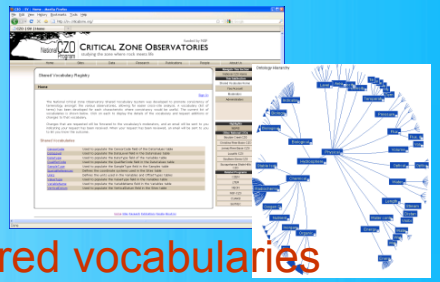
Compatibility at the level of domain information models and databases



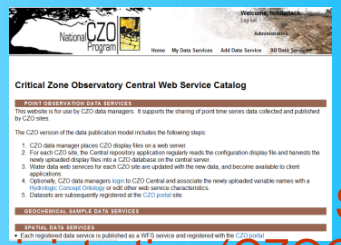
System components



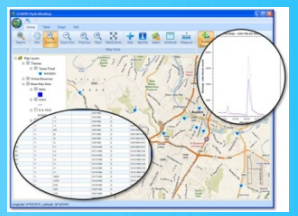
Data discovery portal



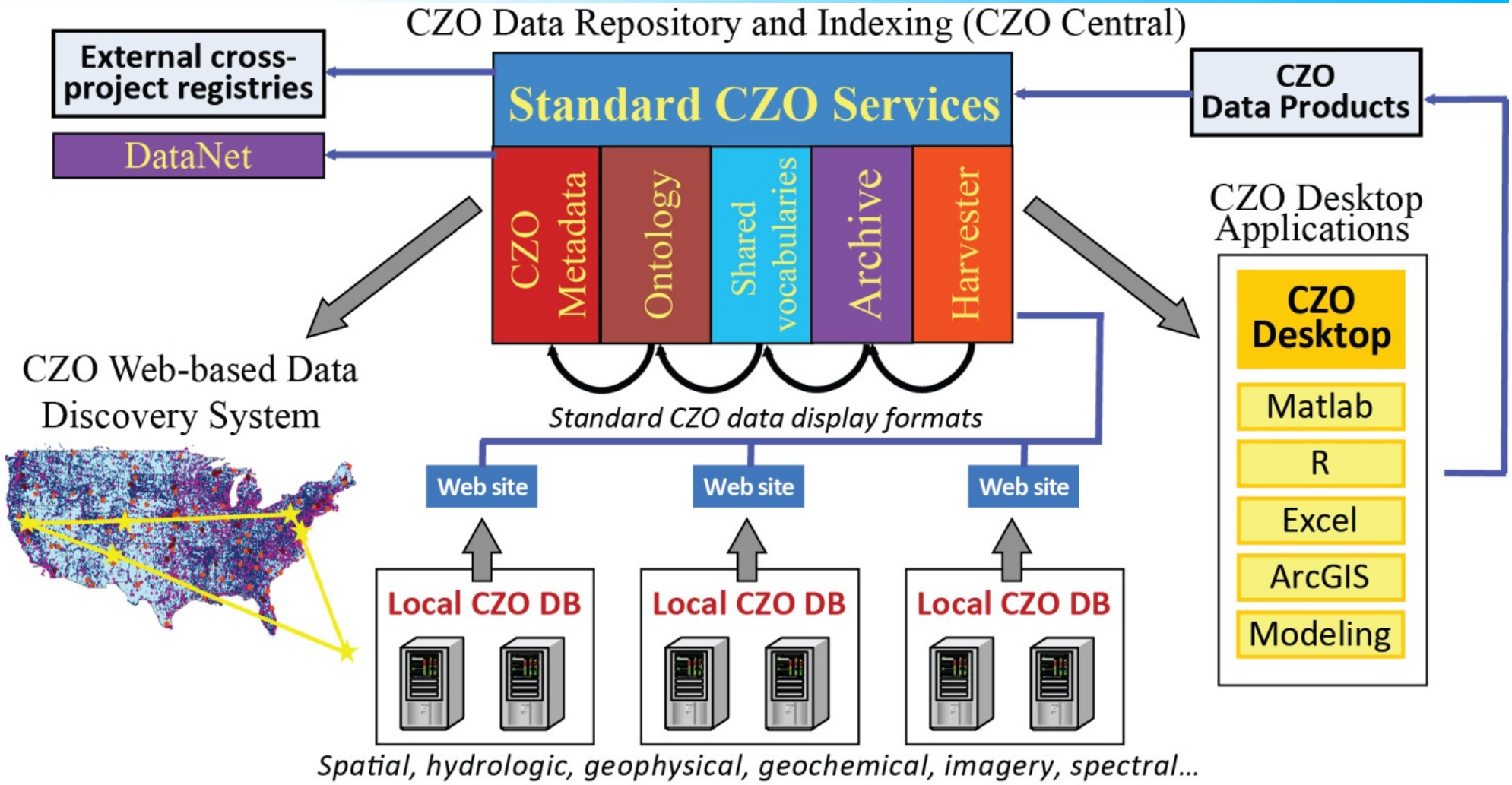
Shared vocabularies and ontology management

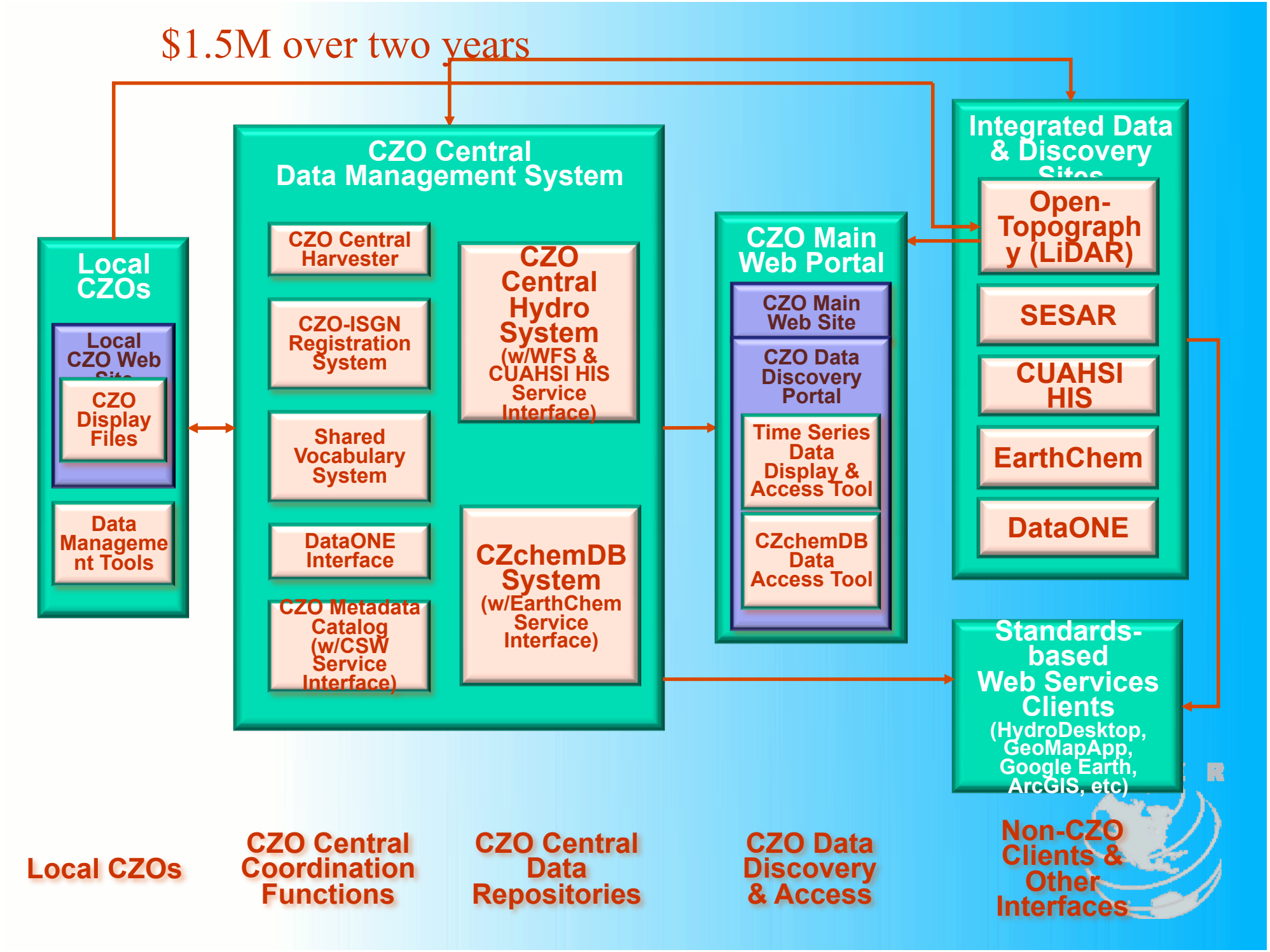


Service administration (CZOCentral)



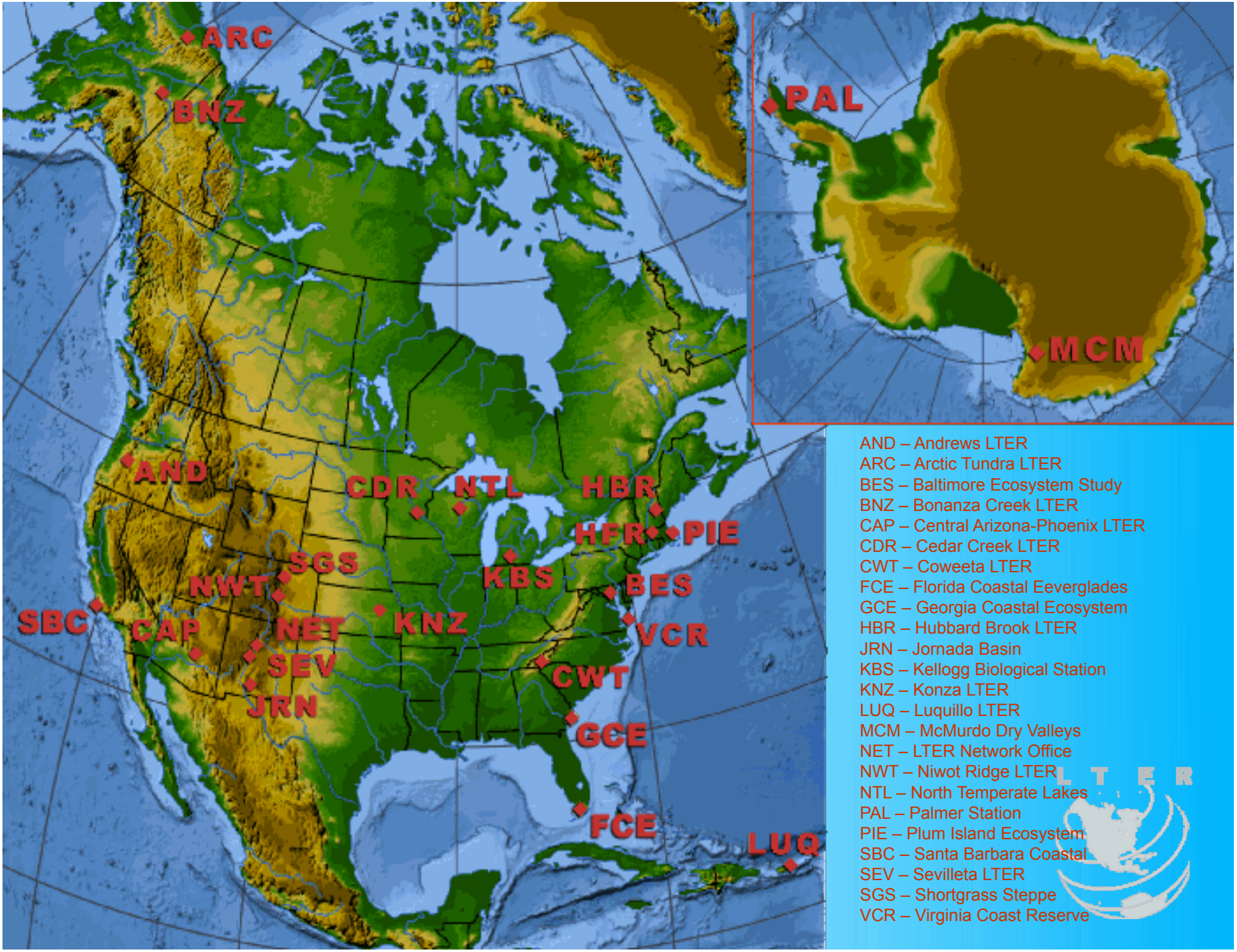
Data analysis clients


CZO Data Repository and Indexing (CZO Central)
External cross-project registries
DataNet
Standard CZO Services
CZO Metadata
Ontology
Shared vocabularies
Archive
Harvester
CZO Data Products
CZO Desktop Applications
CZO Desktop
Matlab
R
Excel
ArcGIS
Modeling
CZO Web-based Data Discovery System
Standard CZO data display formats
Web site
Web site
Web site
Local CZO DB
Local CZO DB
Local CZO DB
Spatial, hydrologic, geophysical, geochemical, imagery, spectral…


$1.5M over two years
Local CZOs
Local CZO Web Site
CZO Display Files
Data Management Tools
CZO Central Data Management System
CZO Central Harvester
CZO-ISGN Registration System
Shared Vocabulary System
DataONE Interface
CZO Metadata Catalog (w/CSW Service Interface)
CZO Central Hydro System (w/WFS & CUAHSI HIS Service Interface)
CZchemDB System (w/EarthChem Service Interface)
CZO Main Web Portal
CZO Main Web Site
CZO Data Discovery Portal
Time Series Data Display & Access Tool
CZchemDB Data Access Tool
Integrated Data & Discovery Sites
Open-Topography (LiDAR)
SESAR
CUAHSI HIS
EarthChem
DataONE
Standards-based Web Services Clients (HydroDesktop, GeoMapApp, Google Earth, ArcGIS, etc)
Local CZOs
CZO Central Coordination Functions
CZO Central Data Repositories
CZO Data Discovery & Access
Non-CZO Clients & Other Interfaces

LTER

The Long Term Ecological Research Network


ARC
BNZ
PAL
MCM
AND
CDR
NTL
HBR
HFR
PIE
SGS
KBS
NWT
BES
SBC
CAP
NET
KNZ
VCR
SEV
CWT
JRN
GCE
FCE
LUQ
AND – Andrews LTER
ARC – Arctic Tundra LTER
BES – Baltimore Ecosystem Study
BNZ – Bonanza Creek LTER
CAP – Central Arizona-Phoenix LTER
CDR – Cedar Creek LTER
CWT – Coweeta LTER
FCE – Florida Coastal Eeverglades
GCE – Georgia Coastal Ecosystem
HBR – Hubbard Brook LTER
JRN – Jornada Basin
KBS – Kellogg Biological Station
KNZ – Konza LTER
LUQ – Luquillo LTER
MCM – McMurdo Dry Valleys
NET – LTER Network Office
NWT – Niwot Ridge LTER
NTL – North Temperate Lakes
PAL – Palmer Station
PIE – Plum Island Ecosystem
SBC – Santa Barbara Coastal
SEV – Sevilleta LTER
SGS – Shortgrass Steppe
VCR – Virginia Coast Reserve
L T E R

What's needed for long-term research

- Secure and consistent base funding for:
  - Instrumentation
  - Monitoring (climate, veg, discharge)
  - Field/instrument technician
  - Data manager
  - Scientific lead (1-2 months)

Different way of doing science

- Expand beyond the idea of independent investigators
  - Still room for individual scientists
  - Site leads need to think beyond individual projects
  - Cultural change
  - Not everyone will be comfortable with this
- Drop the “eco” in long-term ecological research
  - Long-term environmental research

Getting a program going

- Need a brand (incredibly important)
  - LTER, GMBA, whatever
- Legacy data
- Data needs to be publicly and easily available
- Peer-reviewed publications
- Face-time with funding agencies, politicians

Information management is the key to a successful long-term site

For the Sites

Long-term studies depend on databases to retain project history

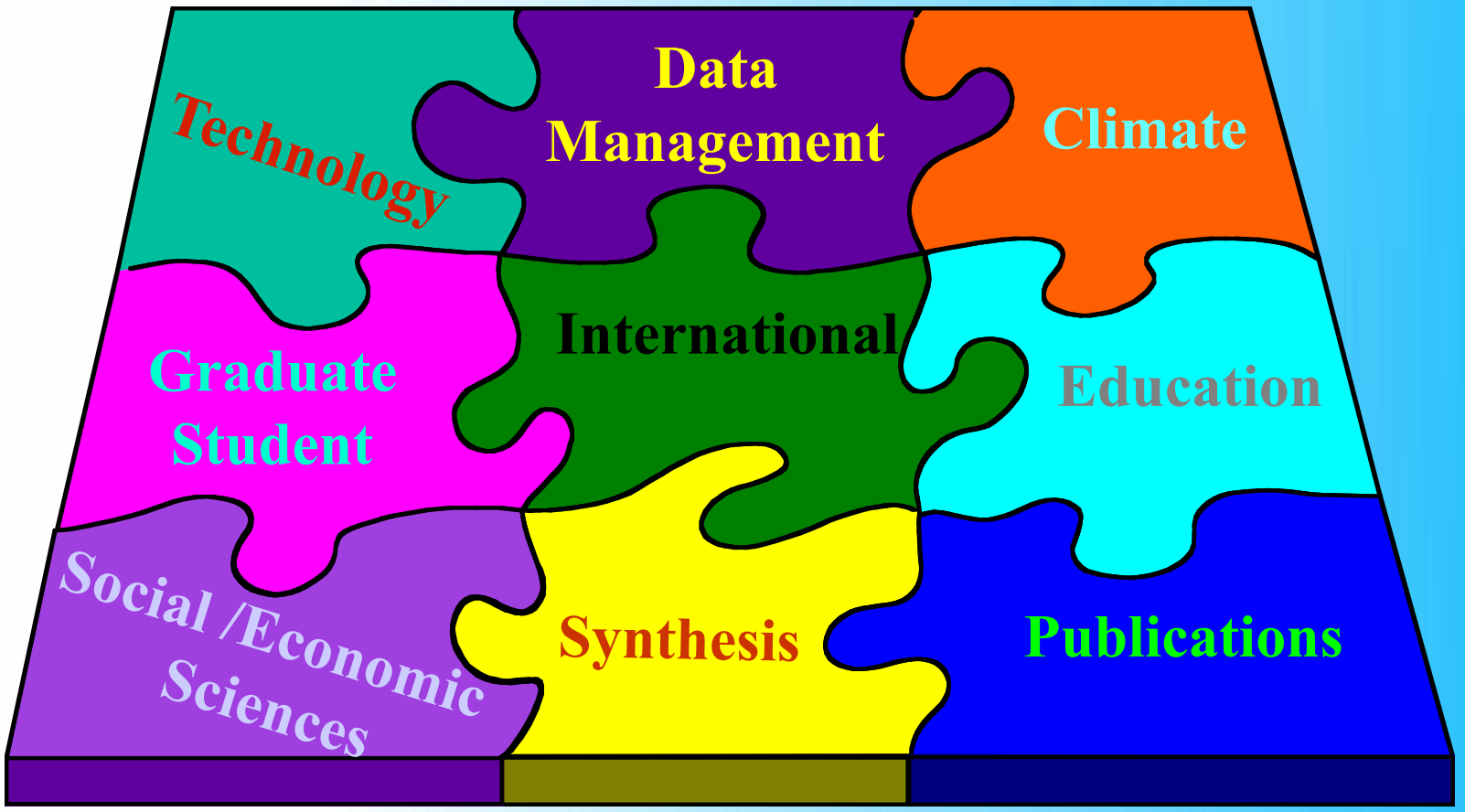
For the Network

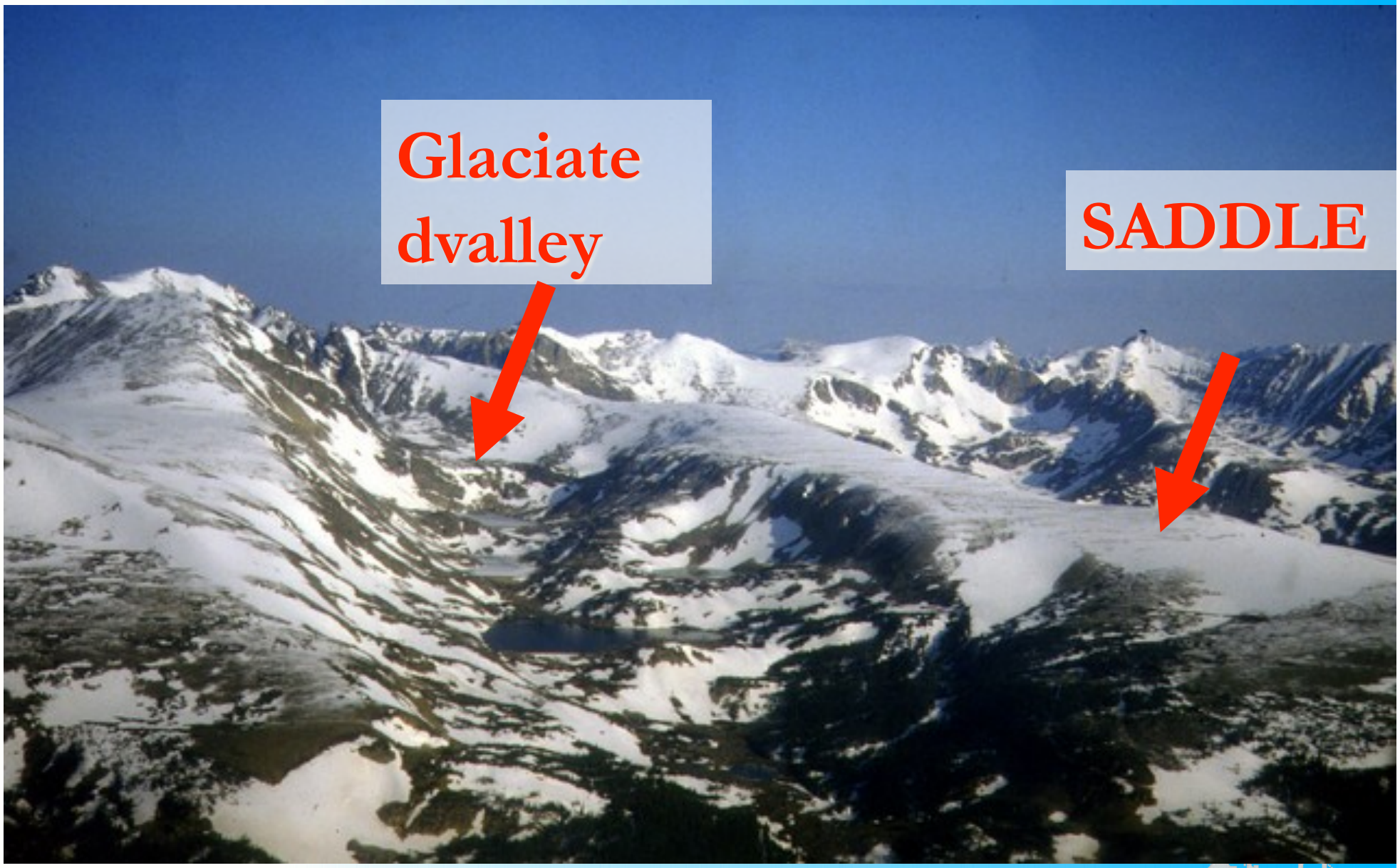
Cross-site studies require communication and integration of data

For the World

Integrated, multidisciplinary projects depend on databases to facilitate sharing of data

Long-term research as an integrated program

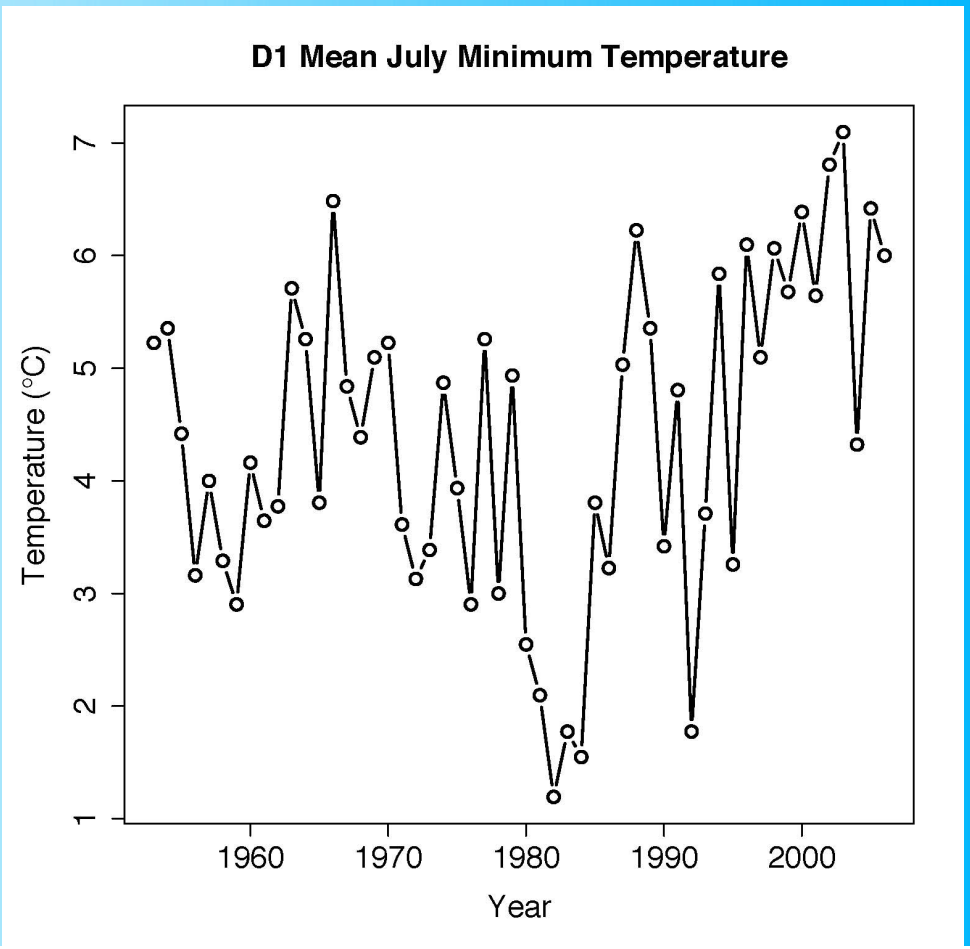




Niwot Ridge
Long-Term Ecological Research Site

External Drivers: Temperature

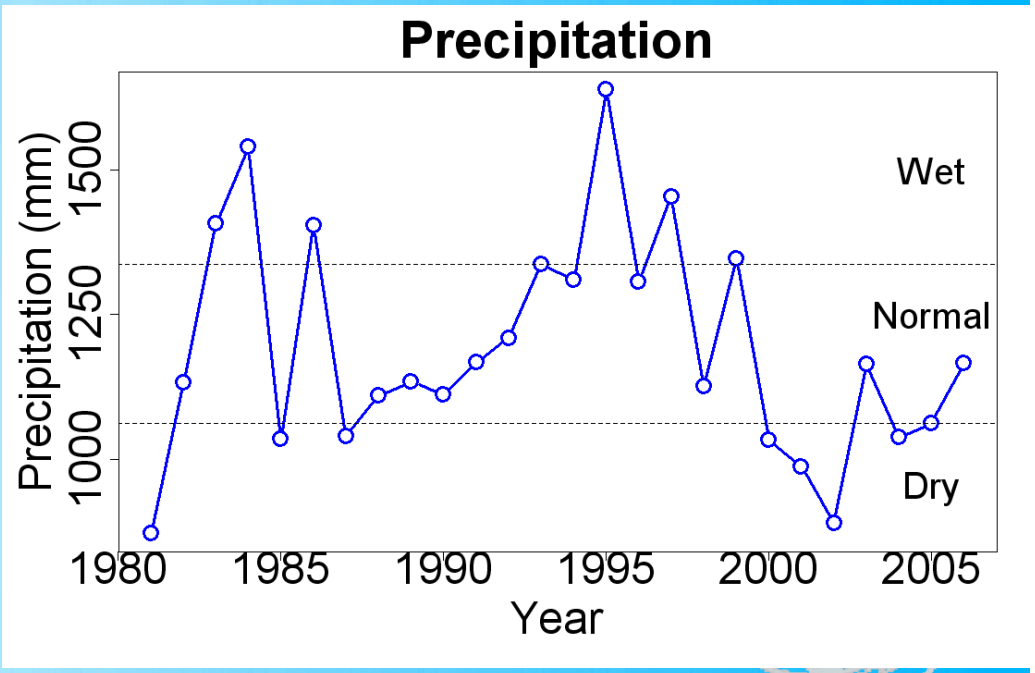
- Increasing air temperature since early 1980's
- Summer air temps warming fastest
- Earlier lake ice-out dates



5°C increase in 25 years

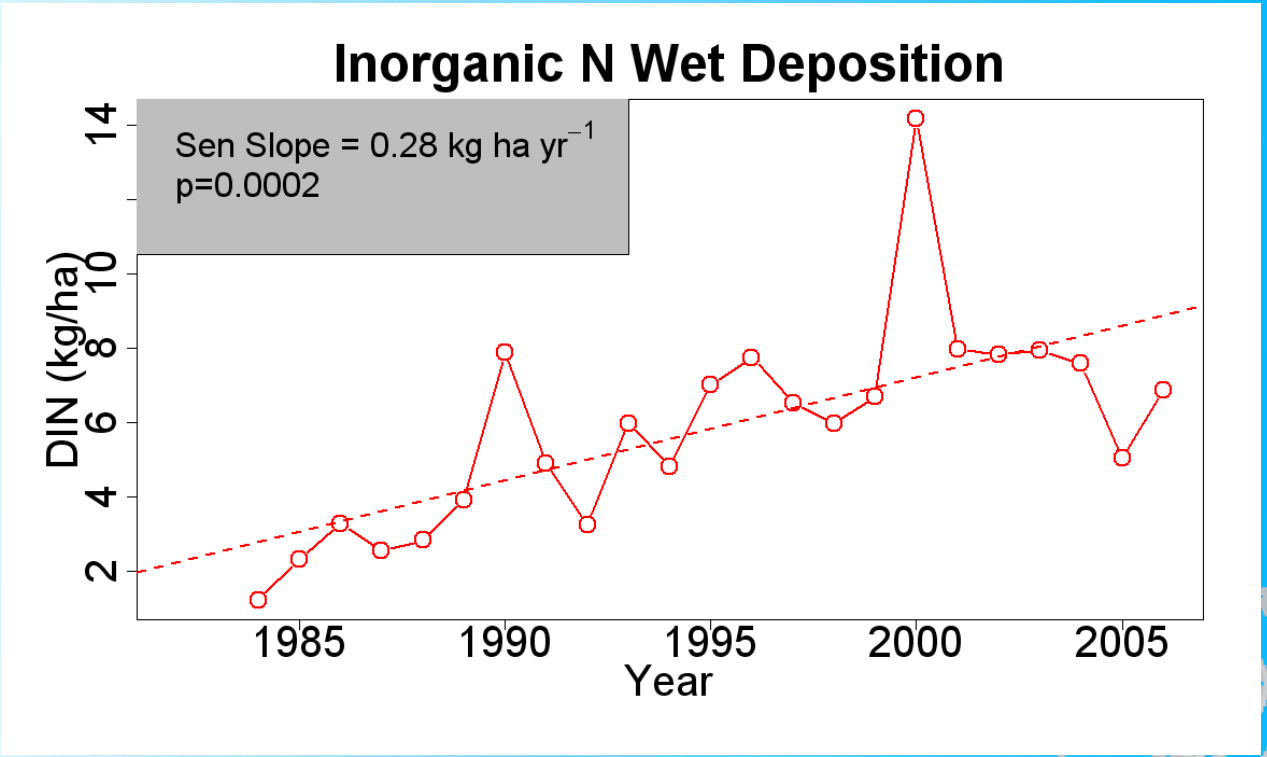
External Drivers: Precipitation

- Greater precipitation with increasing elevation
- Increases in the winter months (more snow)
- Summer drought starting in 2000

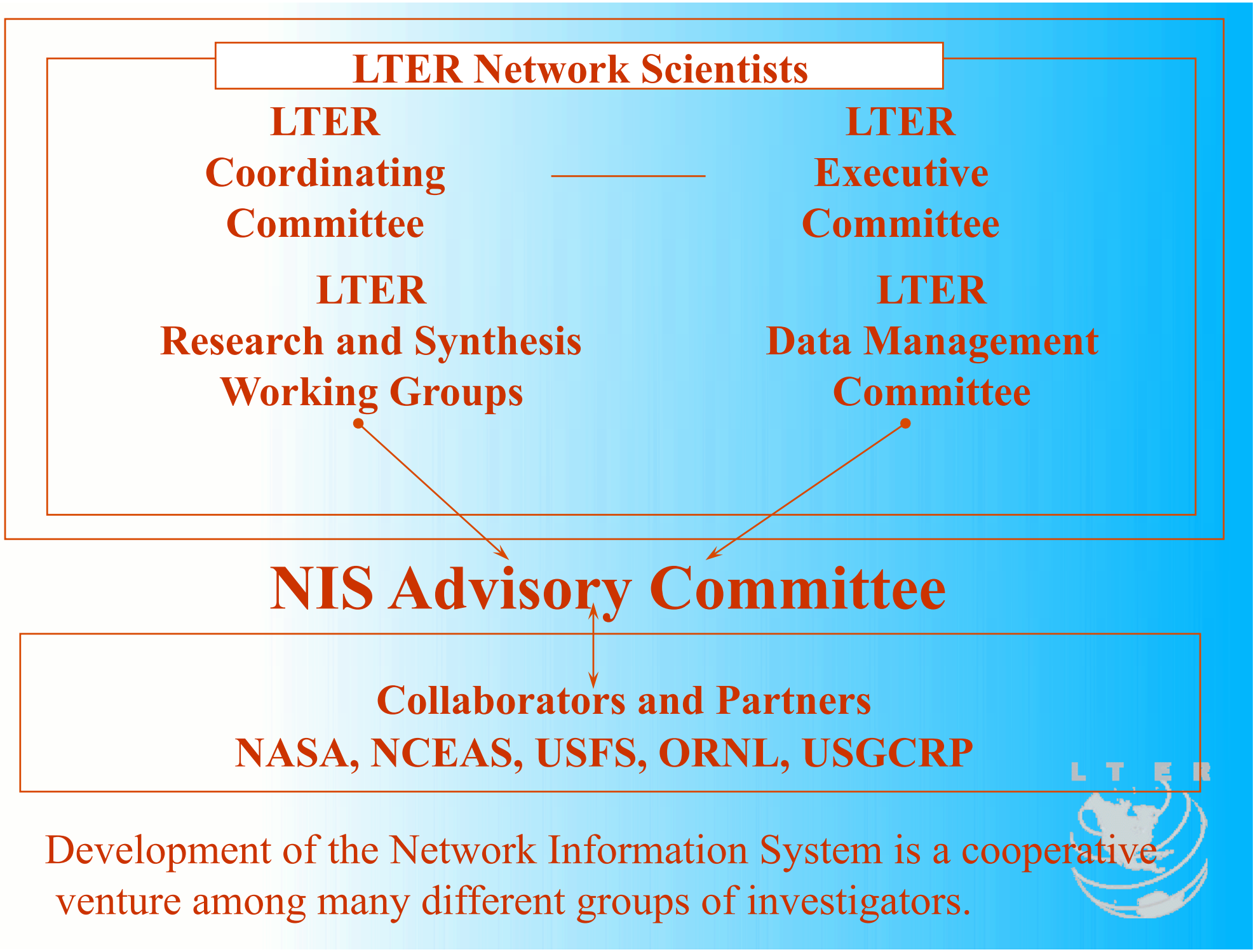


External Drivers: N deposition

- Increased rates of N deposition (wetfall)
- N loading increases, despite drought



QUESTIONS?



Development of the Network Information System is a cooperative venture among many different groups of investigators.

Partnership for Biodiversity Informatics

- Mission:
  - Conduct informatics research (i.e. the study and application of information technolgy) to advance knowledge discovery in systematics, ecology, and biodiversity.
- Goals
  - Enable research at the interactions between ecology and systematics
  - Enhance knowledge discovery through the management, shar
    and integration of data and information
    onst rative res ured dat
    ronm
  - Expand access to information and knowledge for research, resource management, policy decisions and education

SDSC

NATURAL HISTORY MUSEUM
BIODIVERSITY · RESEARCH · CENTER

NCEAS

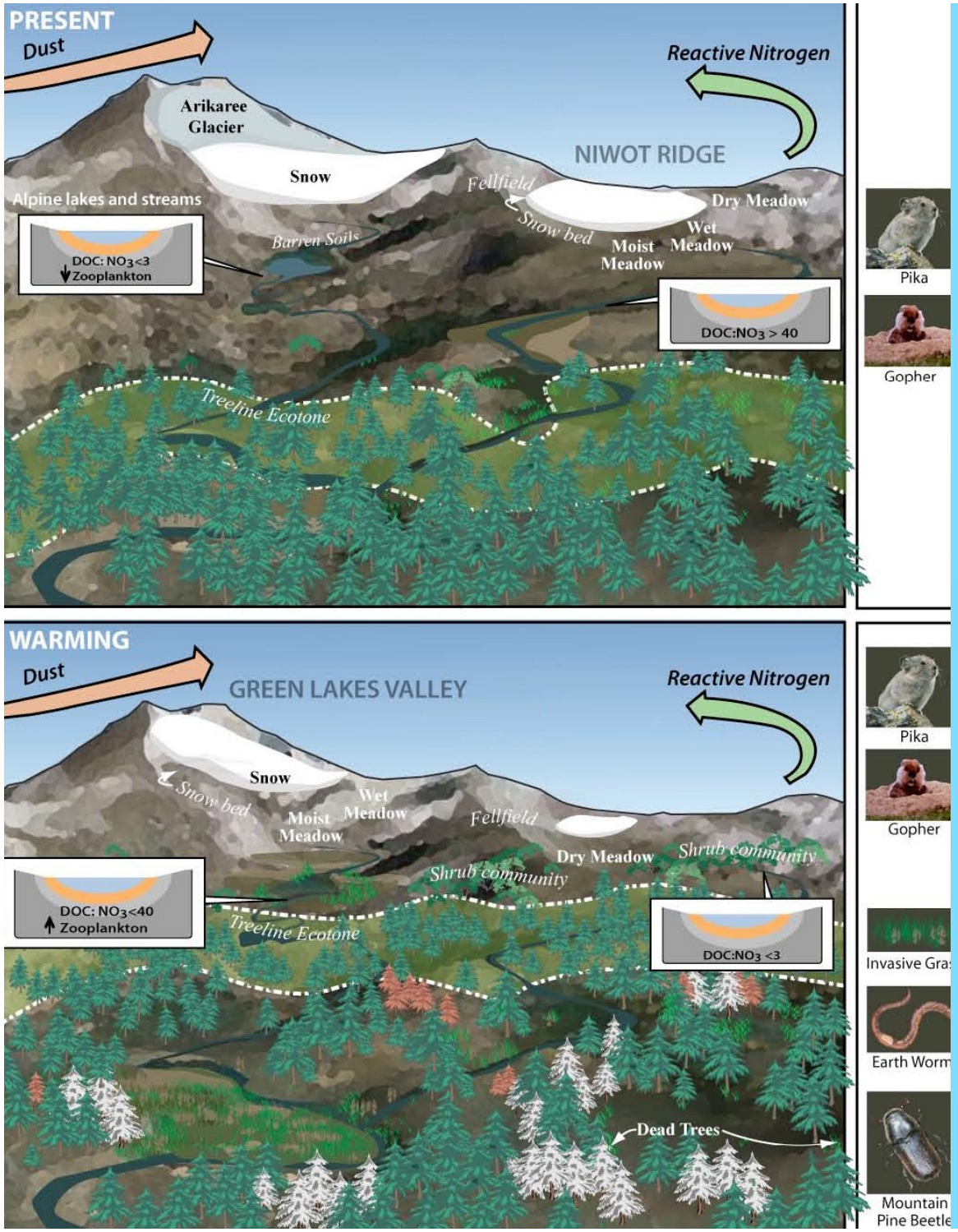
LTER
Long Term Ecological Research

L T E R

The Long Term Ecological Research Network

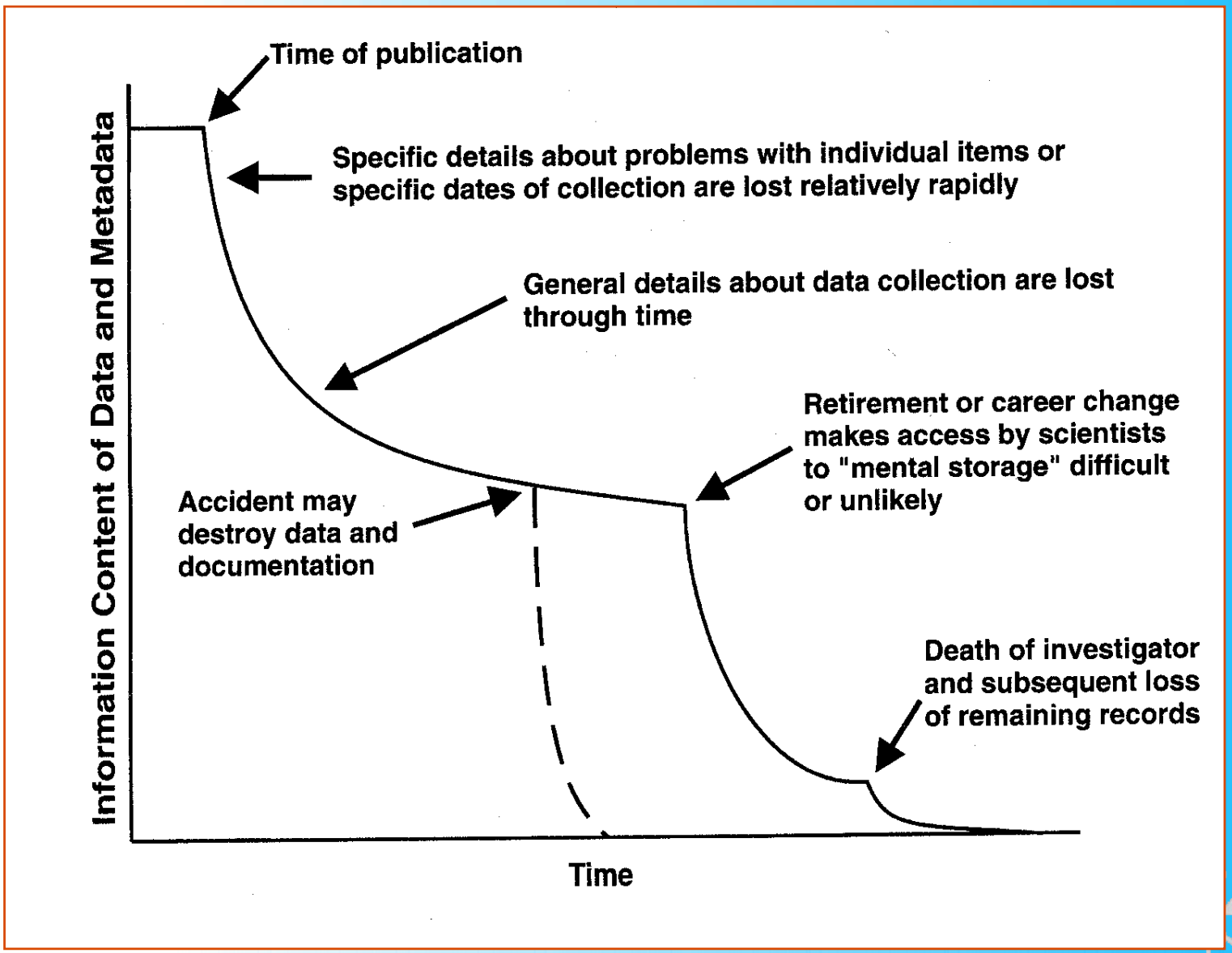
The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1200 scientists and students investigating ecological processes operating at long time scales and over broad spatial scales.

LTER was established in 1980 by the National Science Foundation to support research on long-term ecological phenomena in the United States. The network now consists of 24 sites representing diverse ecosystems and research emphases.


PRESENT
Dust
Reactive Nitrogen
Arikaree Glacier
NIWOT RIDGE
Snow
Fellfield
Snow bed
Dry Meadow
Wet Meadow
Moist Meadow
Alpine lakes and streams
Barren Soils
DOC: NO3<3
Zooplankton
DOC:NO3 > 40
Treeline Ecotone
WARMING
Dust
GREEN LAKES VALLEY
Reactive Nitrogen
Snow
Snow bed
Moist Meadow
Wet Meadow
Fellfield
Dry Meadow
Shrub community
Shrub community
DOC: NO3<40
Zooplankton
Treeline Ecotone
DOC:NO3 <3
Dead Trees
Pika
Gopher
Pika
Gopher
Invasive Gra
Earth Worm
Mountain Pine Beetle

L T E R

Information decay



Data loses value over time unless documented and archived.