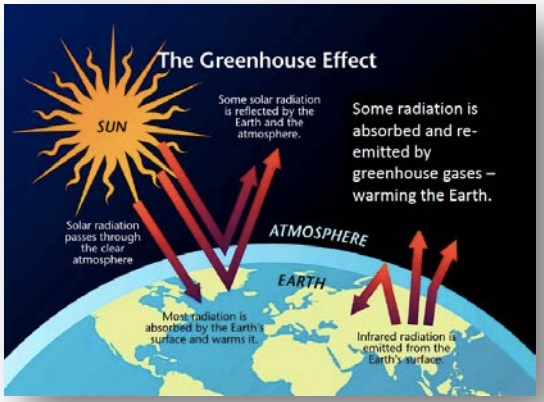
Climate Change Science Institute Overview

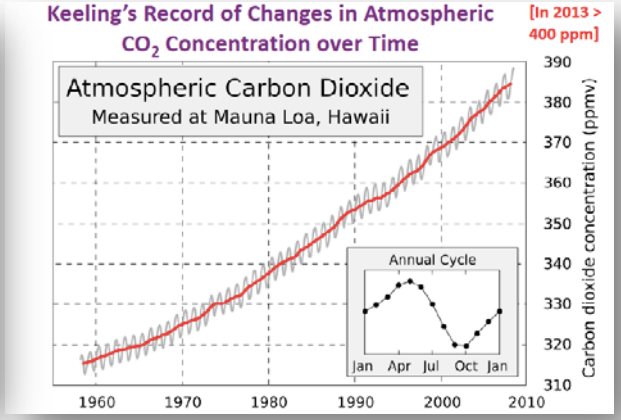
Jack D. Fellows
Climate Change Science Institute Director
fellowsjd@ornl.gov

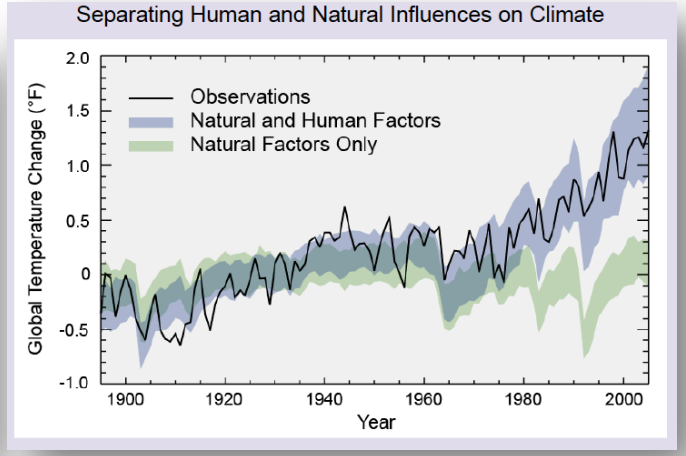
ORNL is managed by UT-Battelle
for the US Department of Energy

CLIMATE CHANGE SCIENCE INSTITUTE
OAK RIDGE NATIONAL LABORATORY

The Climate Change Challenge







1. The climate became stable enough for sustainable agriculture ~10,000 years ago.
2. Global greenhouse gas emissions and rates continue to grow.
3. The 1.5 degree Fahrenheit warming over the past 100 years is 10X faster than the past 800,000 years, consistent with all climate change indicators, and can't be explained with only natural forces.
4. Warming could be 6-9 degrees Fahrenheit by 2100…resulting in new weather-related extremes.
5. Need tools and information to understand extremes, their impact on human and natural land-energy-water systems, and maintain a stable climate.

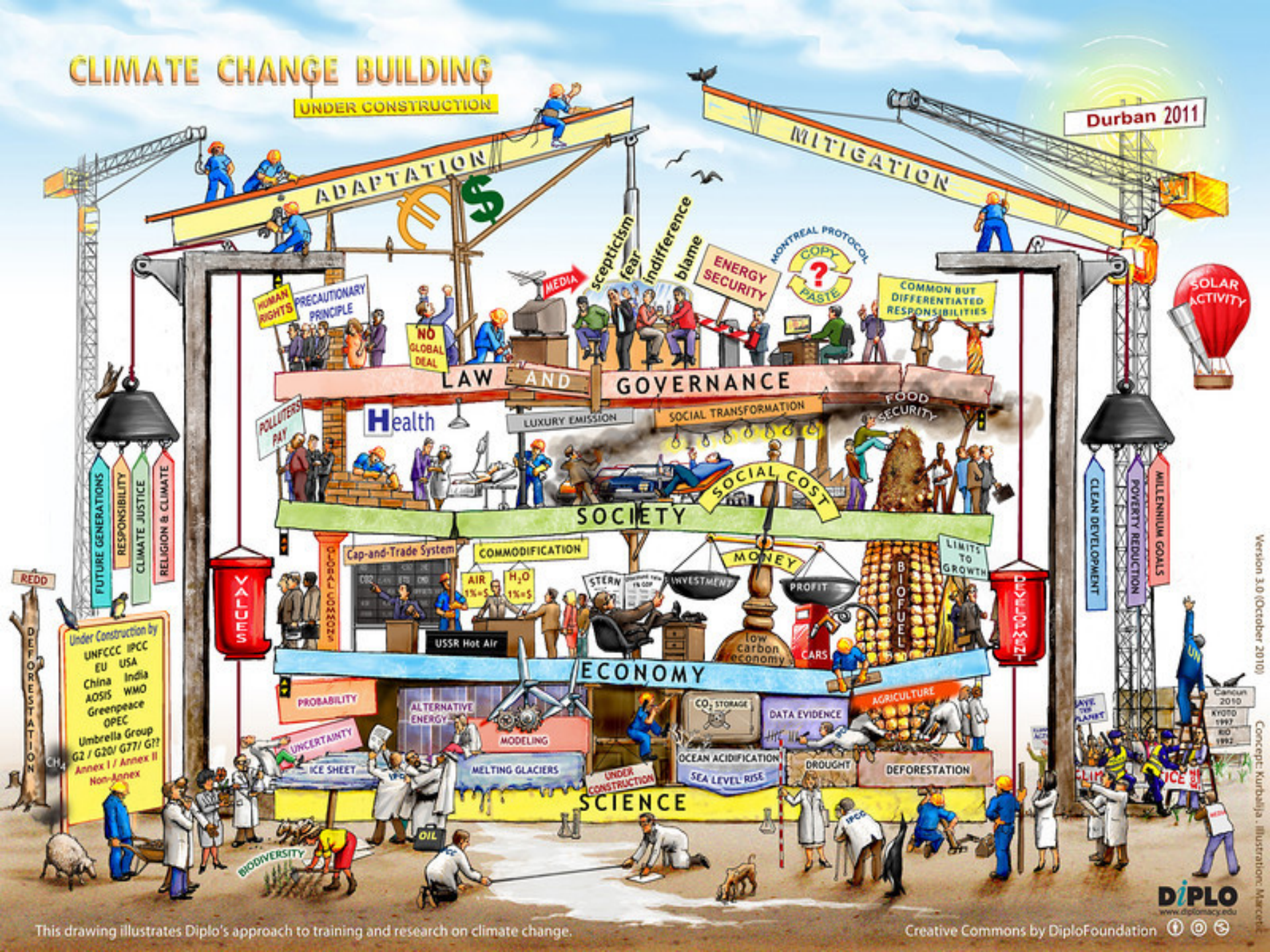
Extreme Events Come in All Forms and Timescales

Challenge: 12 orders of magnitude scales of motion -- from planetary to micrometer scales.

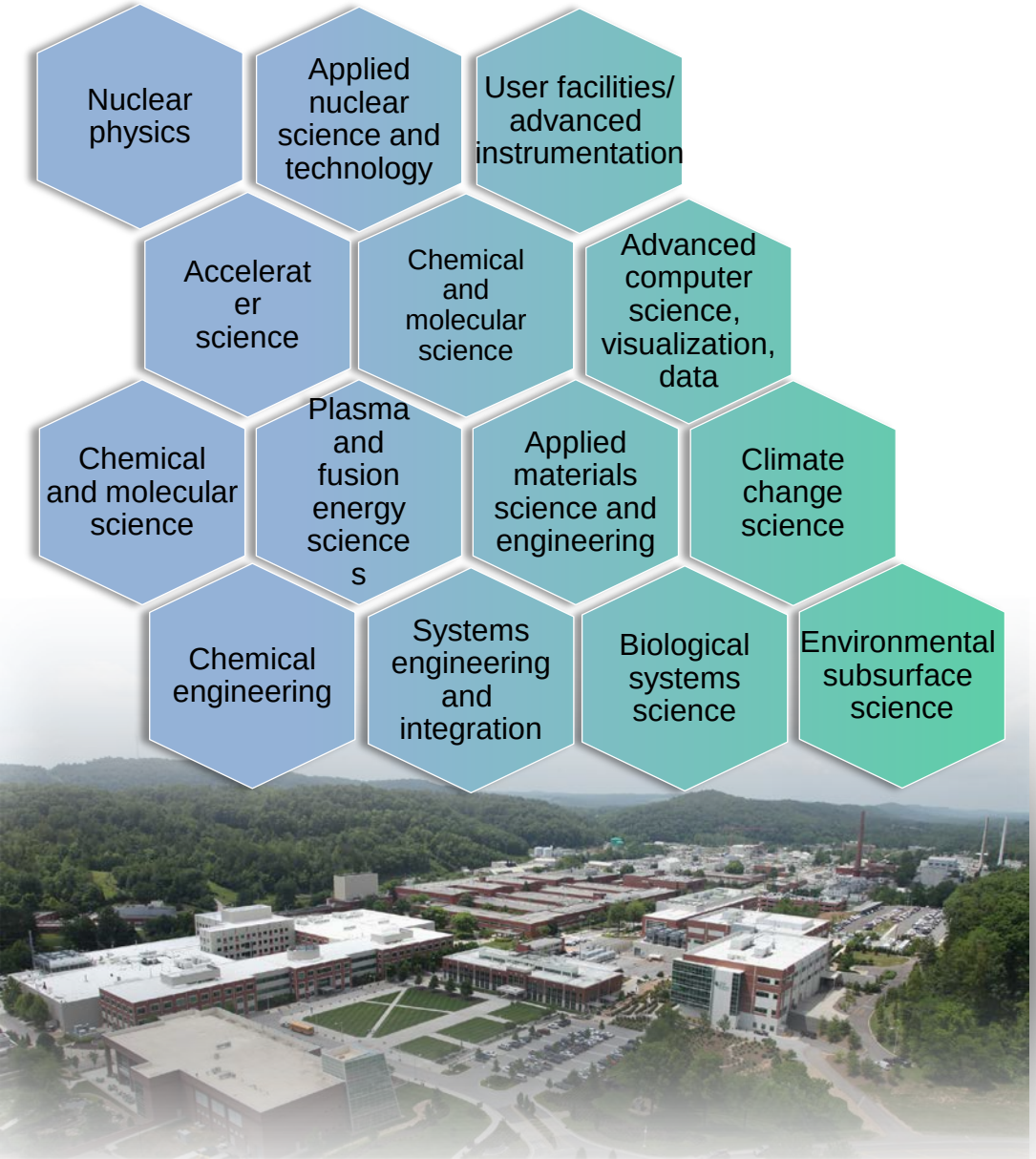
System Vulnerabilities to Extreme Events

Prepare, Respond, Recover

- **Energy.** Managing for different demand, heat waves, extreme events, etc.
- **Water Resources.** Management and maintenance of existing water supply systems, development of flood control systems and drought plans
- **Agriculture and food security.** Erosion control, dam construction (irrigation), optimizing planting/harvesting times, introduction of tolerant/resistant crops (to drought, insect/pests, etc.)
- **Human health.** Public health management reform, improved urban and housing design, improved disease/vector surveillance and monitoring
- **Terrestrial ecosystems.** Improvement of management systems (deforestation, reforestation,…), development/improvement of forest fire management plans
- **Coastal zones and marine ecosystems.** Better integrated coastal zone planning and management
- **Human-engineered systems.** Better planning for long-lived infrastructure investments


CLIMATE CHANGE BUILDING
UNDER CONSTRUCTION
ADAPTATION
MITIGATION
Durban 2011
scepticism
fear
indifference
blame
MEDIA
ENERGY SECURITY
MONTREAL PROTOCOL
COPY
?
PASTE
COMMON BUT DIFFERENTIATED RESPONSIBILITIES
SOLAR ACTIVITY
HUMAN RIGHTS
PRECAUTIONARY PRINCIPLE
NO GLOBAL DEAL
LAW AND GOVERNANCE
POLLUTERS PAY
Health
LUXURY EMISSION
SOCIAL TRANSFORMATION
FOOD SECURITY
SOCIAL COST
SOCIETY
FUTURE GENERATIONS
RESPONSIBILITY
CLIMATE JUSTICE
RELIGION & CLIMATE
VALUES
GLOBAL COMMONS
Cap-and-Trade System
COMMODIFICATION
AIR 1%=$
H2O 1%=$
USSR Hot Air
STERN
INVESTMENT
MONEY
PROFIT
low carbon economy
BIOFUEL
CARS
LIMITS TO GROWTH
DEVELOPMENT
CLEAN DEVELOPMENT
POVERTY REDUCTION
MILLENNIUM GOALS
REDD
DEFORESTATION
Under Construction by
UNFCCC IPCC
EU USA
China India
AOSIS WMO
Greenpeace
OPEC
Umbrella Group
G2 / G20/ G77/ G77
Annex I / Annex II
Non-Annex
ECONOMY
PROBABILITY
ALTERNATIVE ENERGY
MODELING
UNCERTAINTY
ICE SHEET
MELTING GLACIERS
CO2 STORAGE
DATA EVIDENCE
AGRICULTURE
OCEAN ACIDIFICATION
SEA LEVEL RISE
DROUGHT
DEFORESTATION
UNDER CONSTRUCTION
SCIENCE
BIODIVERSITY
OIL
Cancun 2010
KYOTO 1997
RIO 1992
Version 3.0 (October 2010)
Concept: Kurbalija - Illustration: Marcetic
DiPLO
www.diplomacy.edu
This drawing illustrates Diplo's approach to training and research on climate change.
Creative Commons by DiploFoundation

ORNL Scientific Strengths and Partnerships Enable the Climate Mission



DOE's Largest Science and Energy Lab

- $1.4B budget and 4,400 employees.
- Nation's most powerful scientific computing facility and broad research capability

Partnerships

- Projects with +200 universities and 70% of ORNL publications have universities coauthors
- 40 MOUs and 178 joint faculty appointments
- 3,000 research quests annually and many faculty and student research opportunities

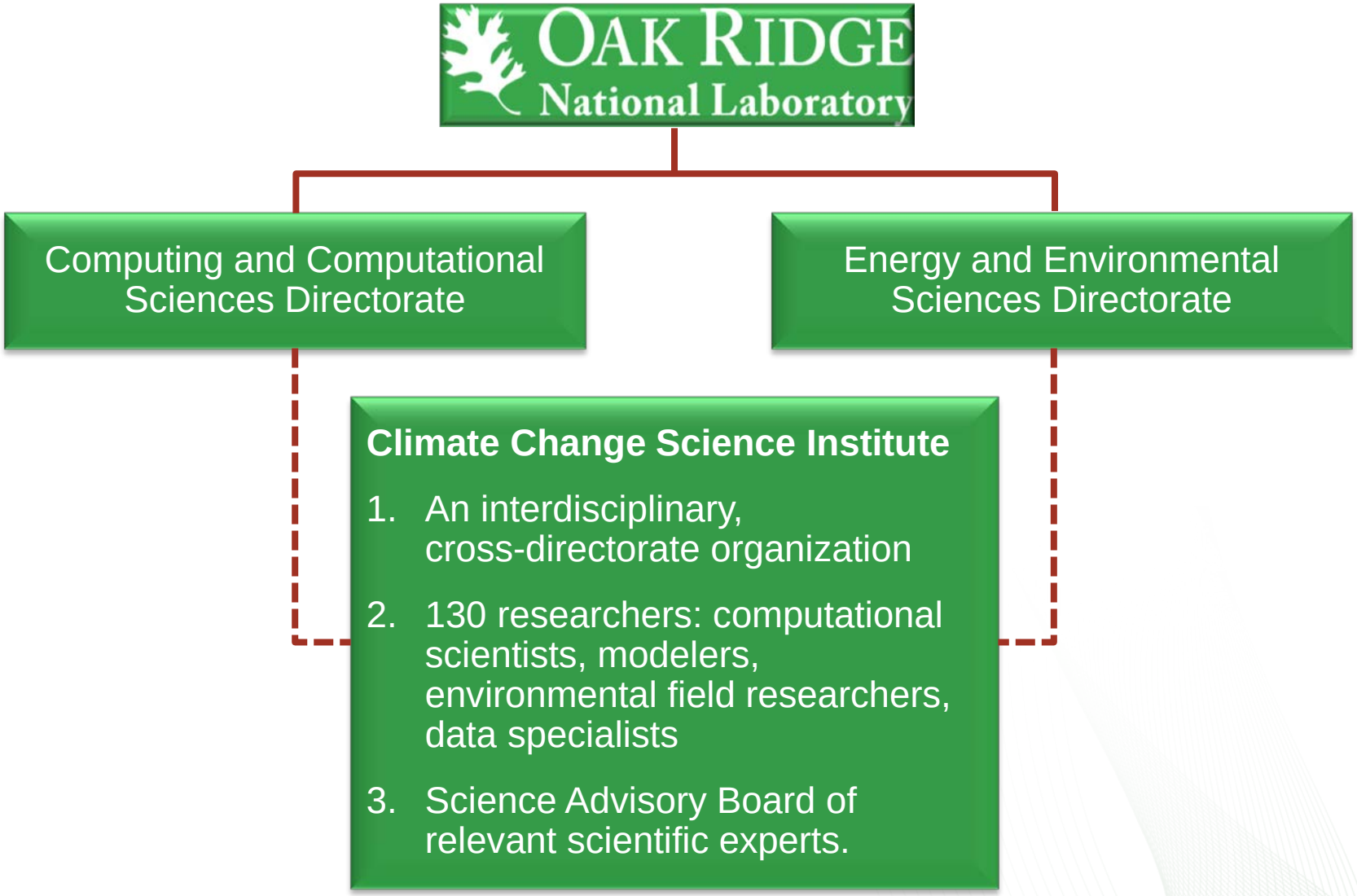
Climate Change Science Institute

Formed in 2009 to enhance the integration of ORNL's climate-related research programs.

Mission

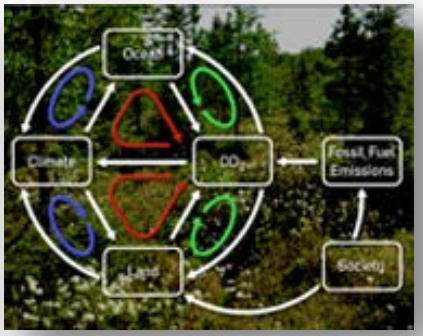
- Advance the understanding of the Earth system
- Describe the consequences of climate change
- Evaluate and inform policy on climate change responses

Organization



Scientific Themes

Earth System Modeling



Terrestrial Ecosystem and Carbon Cycle Science

Data Integration, Disseminatio nand Informatics

Impacts, Adaptation, and Vulnerability Science

CCSI Unique Features and Key Priorities

1. **Collocation.** Multidisciplinary staff collocated within a diverse national science lab with world-class supercomputers, measurement and analysis tools, and scientific expertise.

2. **Model-Data-Experiment Integration**. Improving multi-scale climate models and their uncertainty characterization by integrating models, long-term experiments, and data.

3. **Mission-Inspired Science**. Science driven by the need to better understand the impacts and consequences of climate change on land-energy-water human and natural systems.

Priorities: Creating the science, experiments, data, and community capacity needed to:

1. Improve predictive capabilities of Earth system and biogeochemical models.
2. Identify and understand how extreme events impact the resiliency of human and natural land-energy-water systems.
3. Participate in national and international climate assessments and policy analysis.
4. Develop useful climate adaptation and mitigation tools and information in collaboration with key stakeholders.

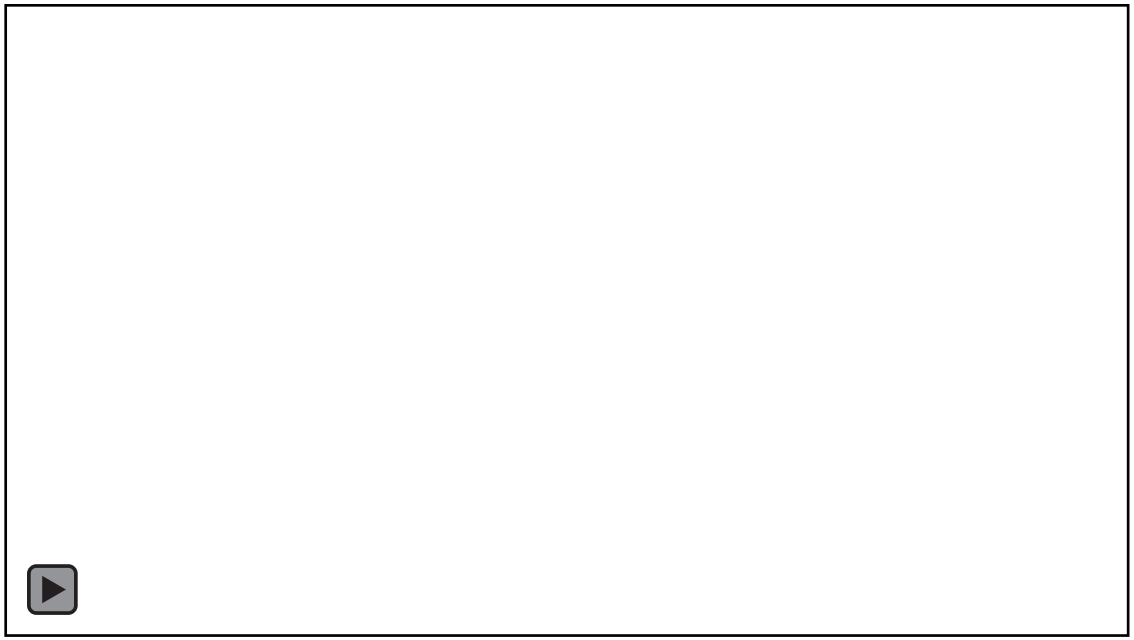
Data Integration, Dissemination, and Informatics

Research Community Data Archives

- Carbon Dioxide Information and Analysis Center
- Atmospheric Radiation Measurement Archive
- NASA Distributed Active Archive

Address Data Management Challenges

- Integrating heterogeneous data.
- Supporting full data life cycle.
- Visualization of big data.



CO_2 emission (1751−2006)

Earth System Modeling

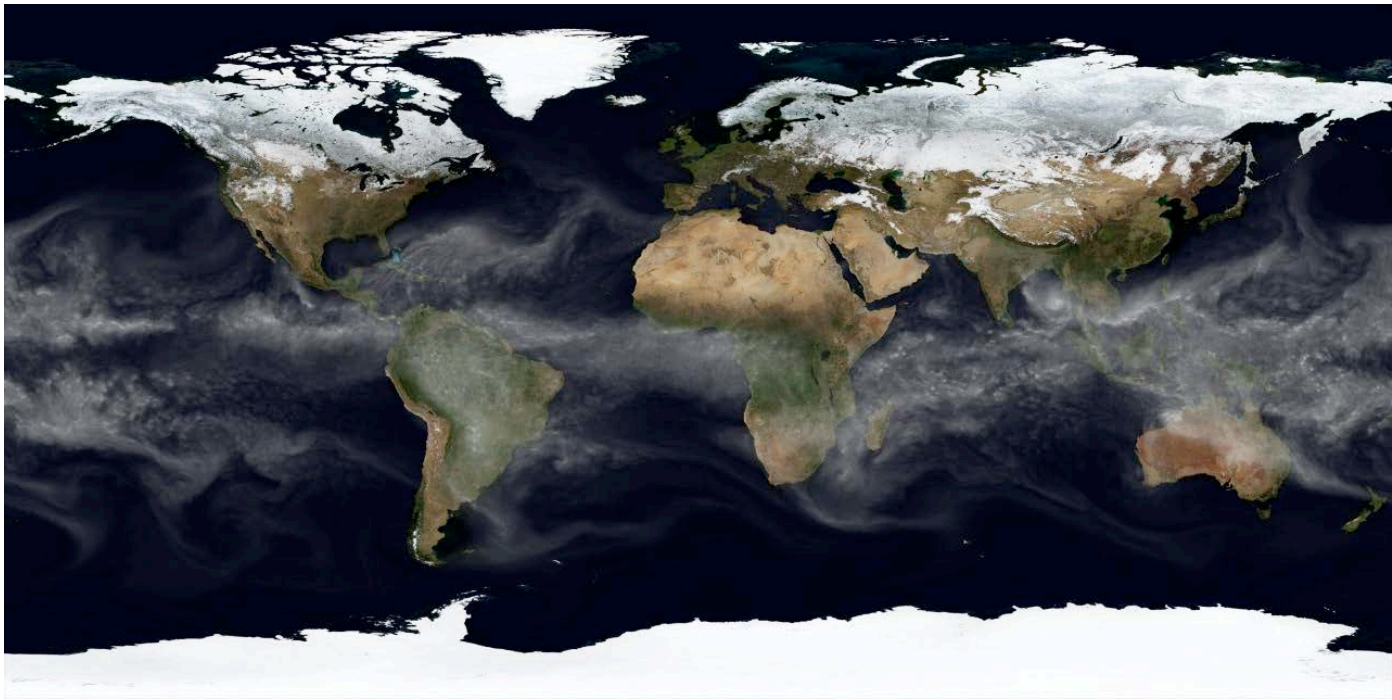
Scientific Discovery through Advanced Computing and Modeling

- Efficient computational schemes to model carbon and other ecosystem nutrients.
- High-resolution and downscaled models to investigate regional climate phenomena.
- Model ensemble analysis and uncertainty quantification.

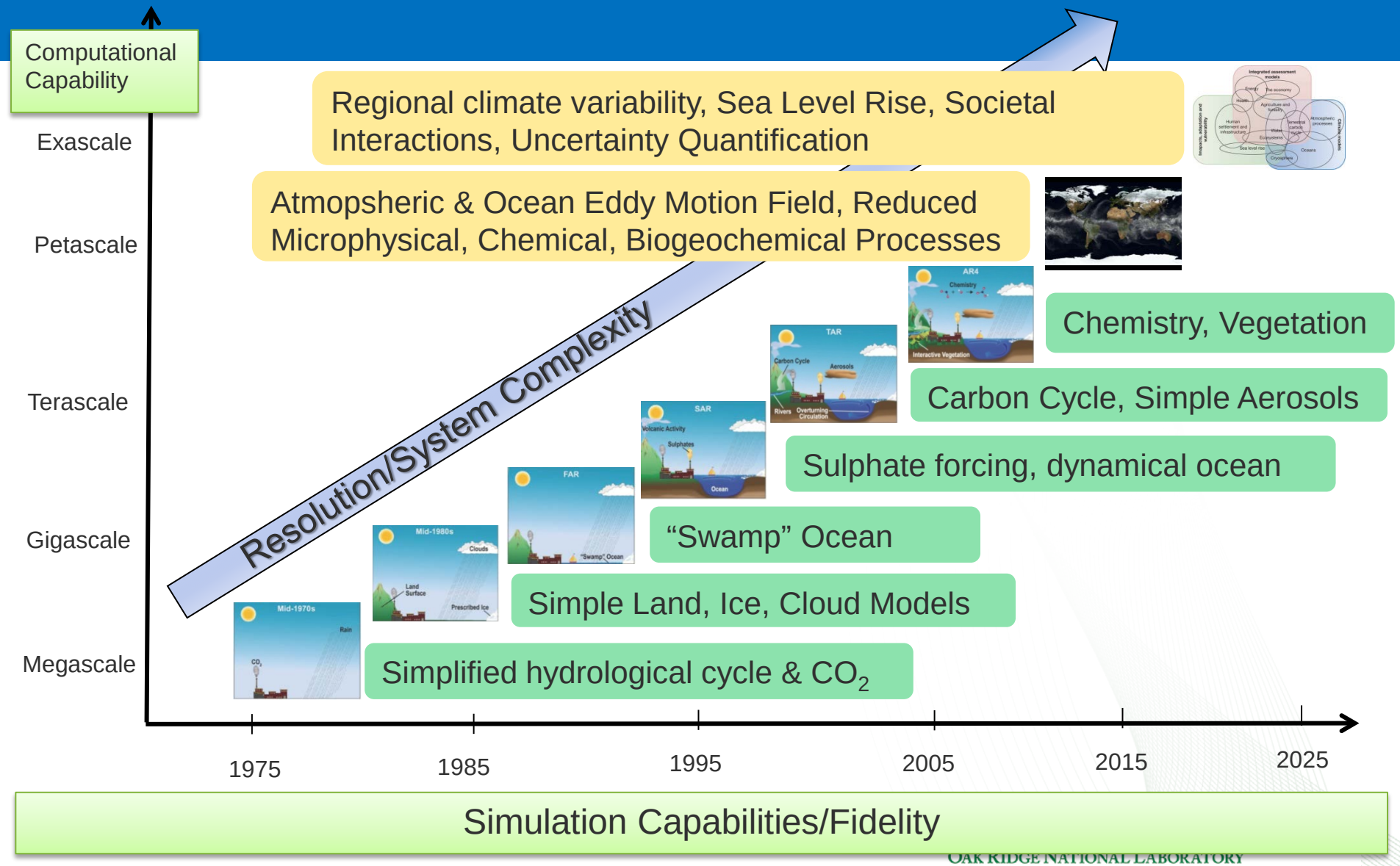
Supercomputers:

- +25 petaflops peak performance
- 10× faster than predecessor, same power and space requirements

Mesoscale column integrated water vapor (~37km)



Global Modeling Complexity has Evolved with Improvements in Computational Capabilities



Terrestrial Ecosystem and Carbon Cycle Science

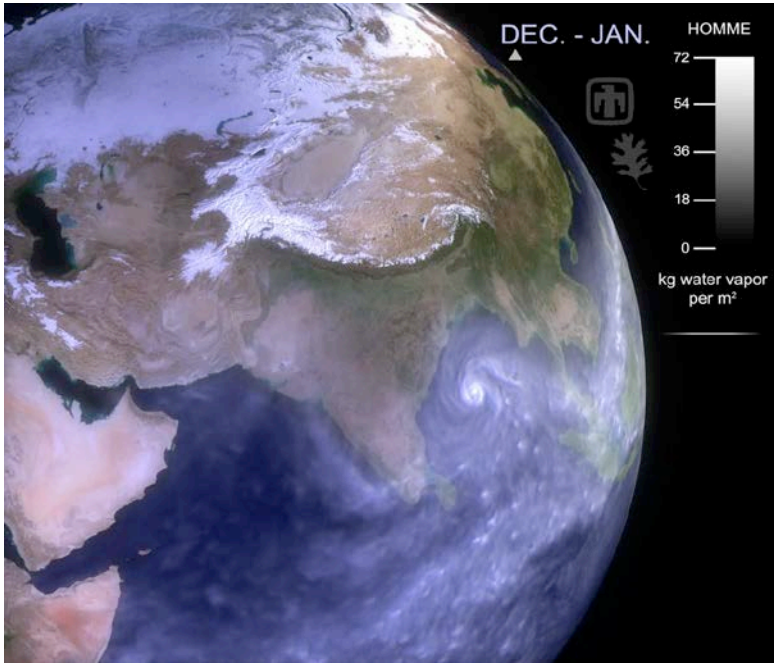
Integrating Modeling, Data, Observations, and Experiments

- Surface and subsurface observations.
- Land, carbon, and subsurface ecosystem modeling.
- Large-scale/Long-term experiments to examine ecosystems responses to climate change.

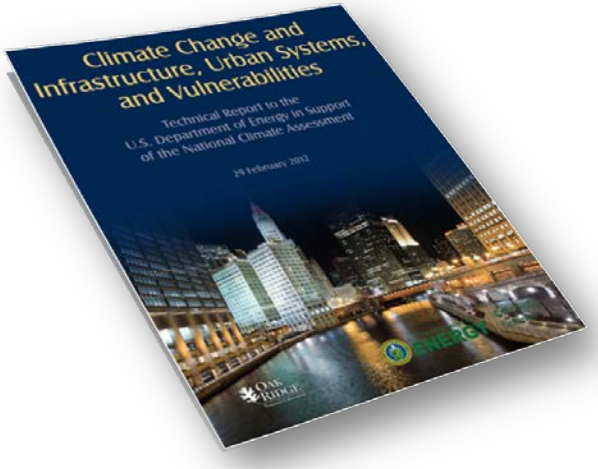
Impacts, Adaptation, and Vulnerability Science

Socio-Climatic Impact, Vulnerability, Risk, and Adaptation Assessments

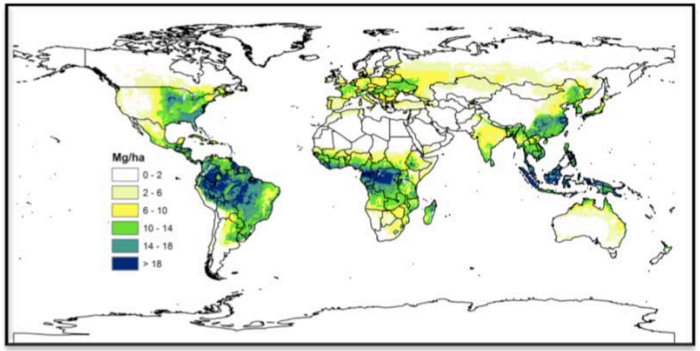
- Human settlements.
- Agriculture.
- Energy and water infrastructure.
- Knoxville Urban-Climate Adaptation Tool project.



LandScan global population data set



Modeling potential switchgrass yields using the EPIC agroecological model



Energy Awareness and Resiliency Standardized Services (EARSS)