



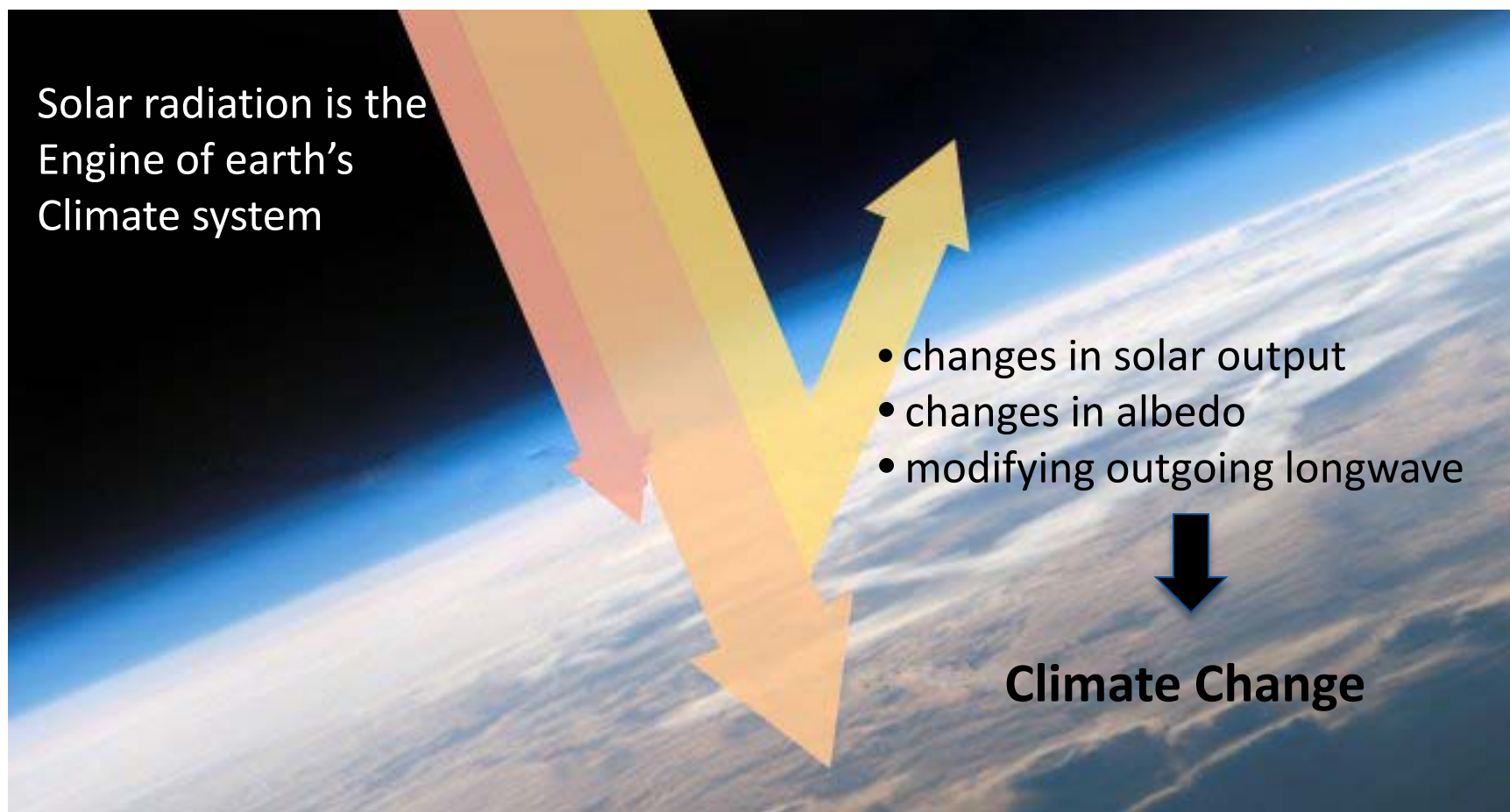
The Surface Energy Budget

*NOAA climate research for understanding
land surface processes and climate feedbacks*

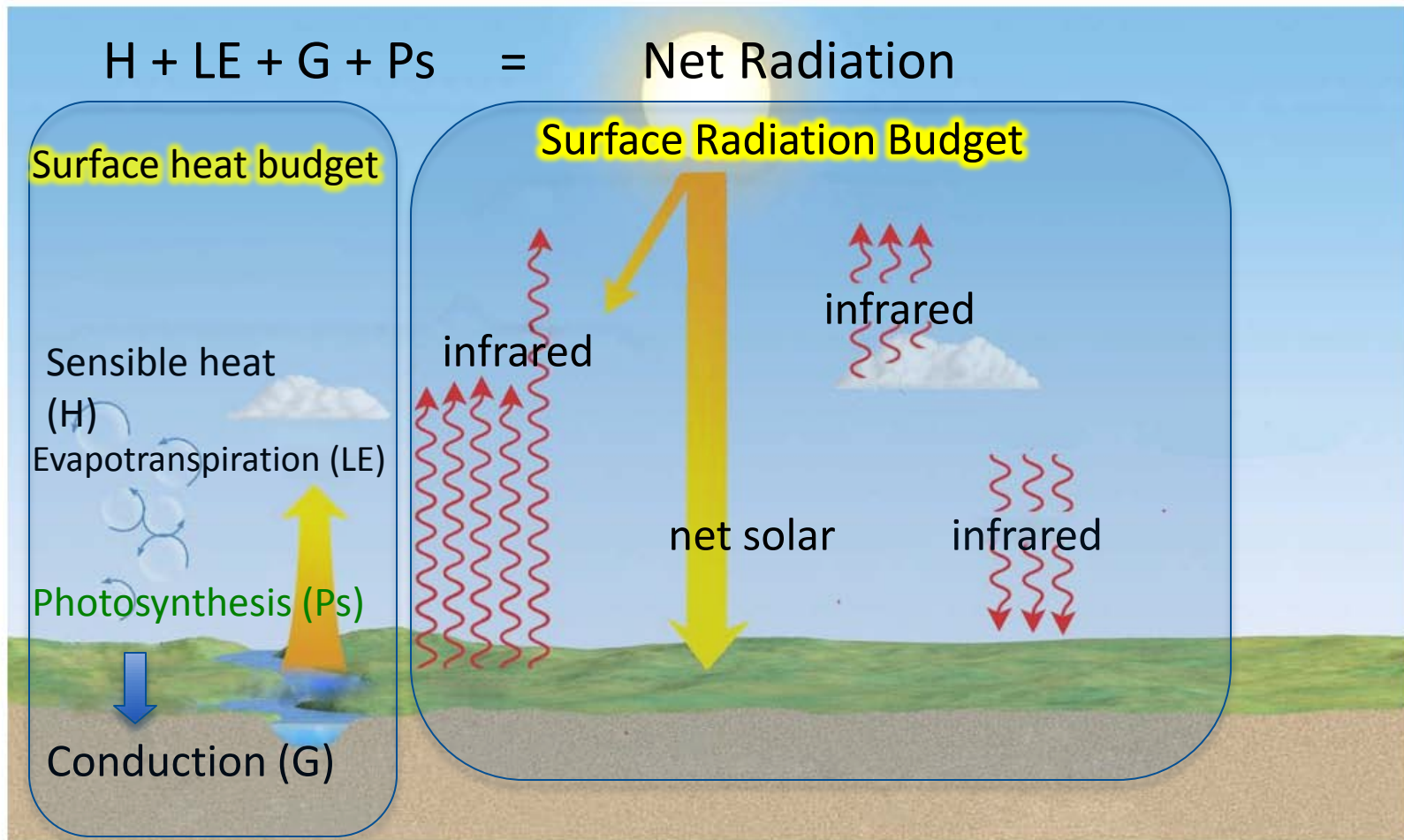
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Solar Radiation drives the climate system



The Surface Energy Budget





Research Goals

- Assessment of ecosystem annual carbon and water budgets
- Detection of land-surface feedbacks in response to changes in radiative forcing (albedo, Bowen ratio and changes in energy partitioning, growing season fluxes)
- Improved parameterization of land surface processes for incorporation into Land Surface Model (LSM) schemes, including NOAA's models suite.



Approach

Use micrometeorological measurement techniques to monitor the components of the surface energy budget (R_{net} , H , LE , G , P_s) for representative ecosystems in the major climate zones of the U.S.

R_{net} = Net Radiative flux

H = Sensible Heat Flux

LE = Evapotranspiration

G = Ground Heat flux

P_s = Photosynthesis

Why ARL?

Expertise in Air-surface Exchange



NAPAP

(National Acid Precitation Assessment Program)

Measurements of dry deposition using
Micrometeorological methods

Instrumentation Development

First long term flux measurements of
the surface energy budget and CO₂ were
made using open path analyzer developed
by ARL scientists and engineers

Initial sponsors of this work:
GEWEX (NOAA/NASA)
DOE, Terrestrial Carbon Program

Various types of measurements and platforms

Champaign, IL- cropland



Oak Ridge, TN - forest



Radiation and Heat Budgets



Surface Radiation Budget Station

- Incoming Solar and Thermal IR
- Upwelling Solar and Thermal IR
- PAR (incoming and upwelling)
(Photosynthetically Active Radiation)
- Surface "skin" temperature



Surface Heat Flux Station

- Evapotranspiration
- Sensible heat flux
- Ground heat flux
- CO₂ and Momentum Flux



Other Supporting Observations

- Soil moisture/temperature (5,10,20,50,100 cm)
- Barometric Pressure
- Wind, Air Temperature (1.5, 5, 10 m)
- Humidity
- Surface “skin” temperature
- Litter wetness, litter temperature
- Ground heat flux
- Leaf Area Index (LAI), canopy height, biomass
- Internet camera

Derived (NDVI, albedo, roughness length)

NDVI = Normalized Difference, spectral index

Additional observations



Annual cycle of forest canopy





Major Findings

Droughts that occur during the growing season, leads to net annual carbon emissions (Meyers, 2001)

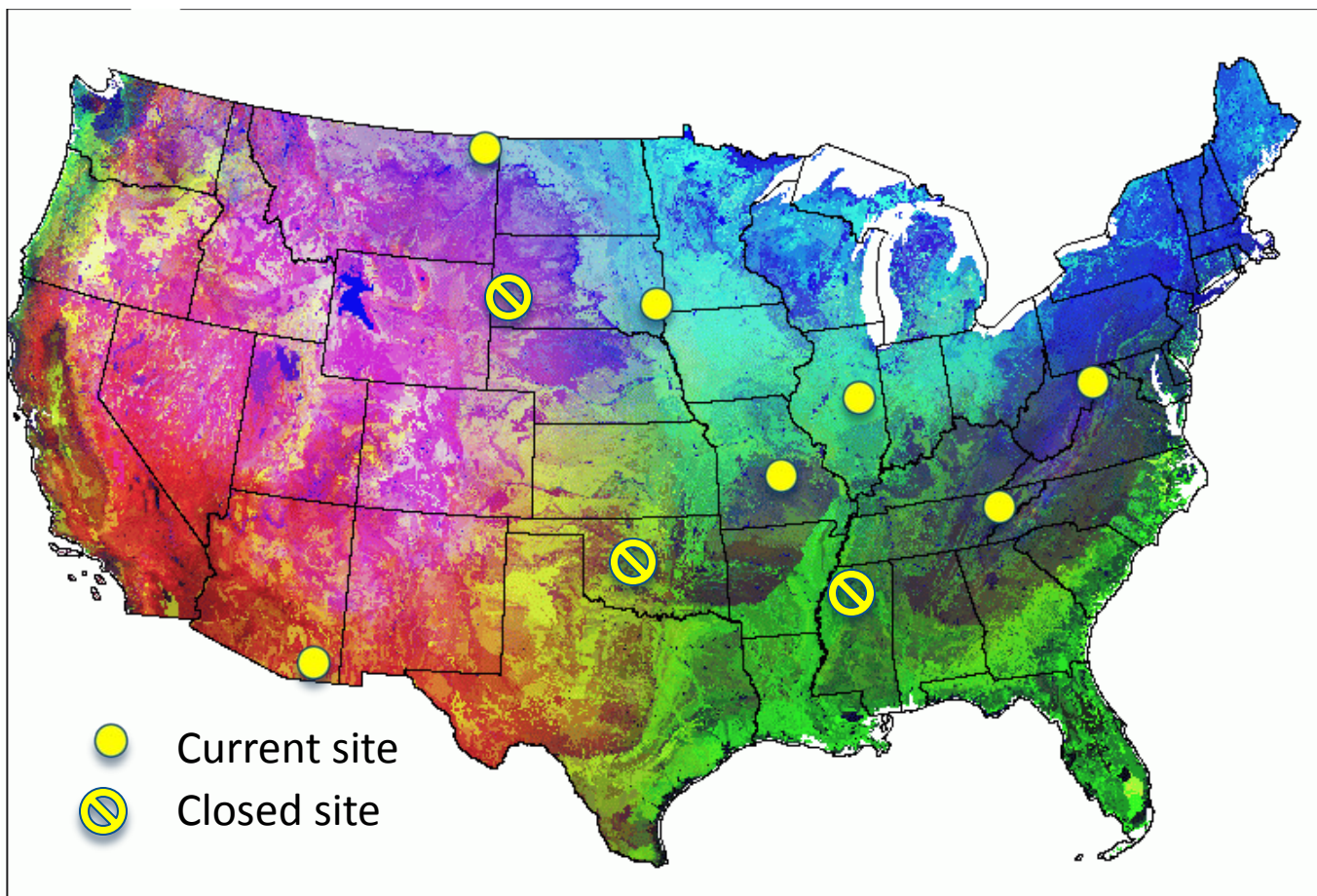
Mid-western corn/soybean ecosystems small carbon sink (Bernacchi, Hollinger, Meyers, 2005)

Significance of ecosystem storage terms in closing the surface energy budget (Meyers and Hollinger, 2004)

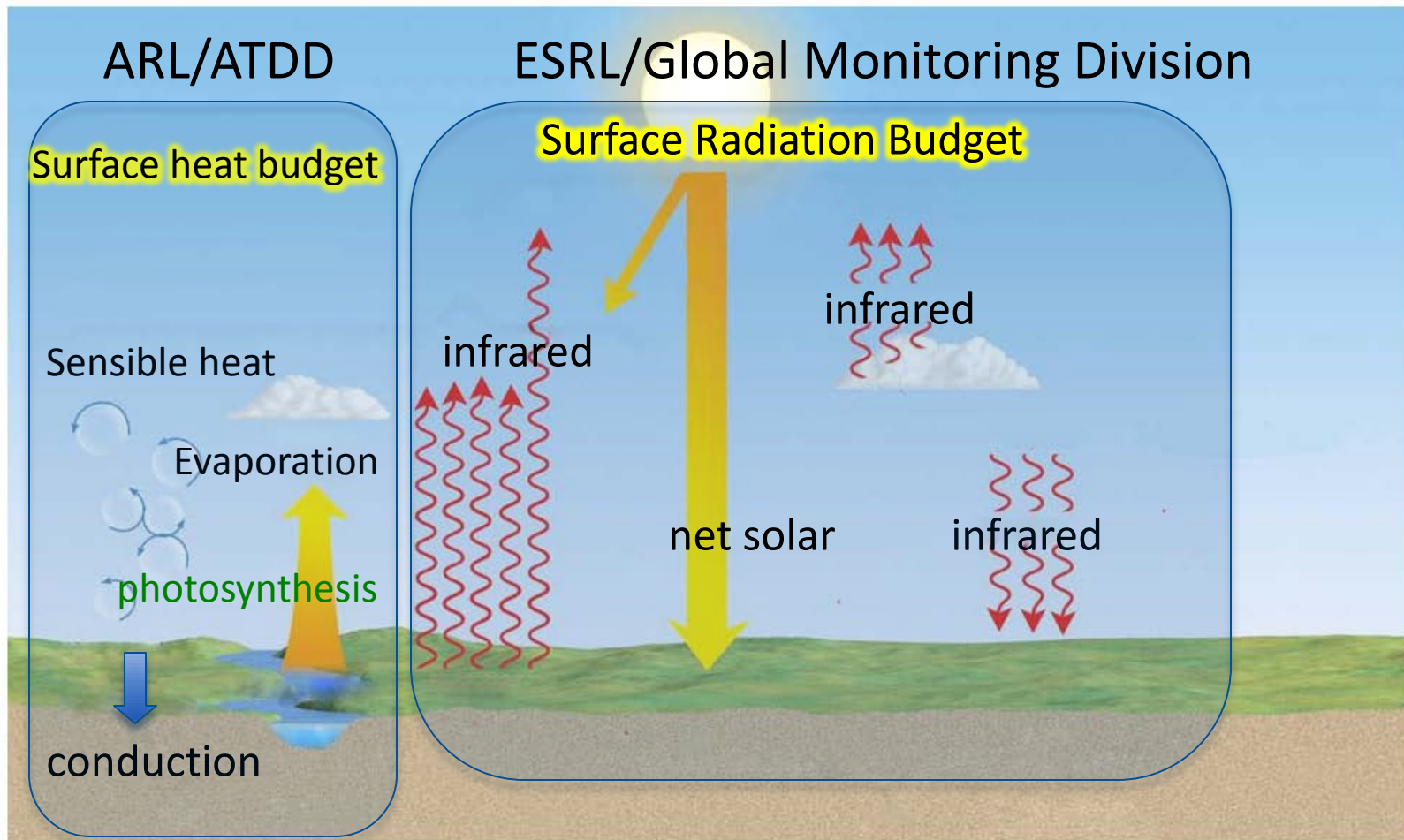
Demonstrated use in-situ broad-band Normalized Difference (NDVI) to track leaf area index (Wilson and Meyers, 2007)

Over 75% of annual evapotranspiration for semi-arid grasslands (AZ) occurs in just 3 months (Krishnan, Meyers, et al, 2011)

Current Distribution of Sites

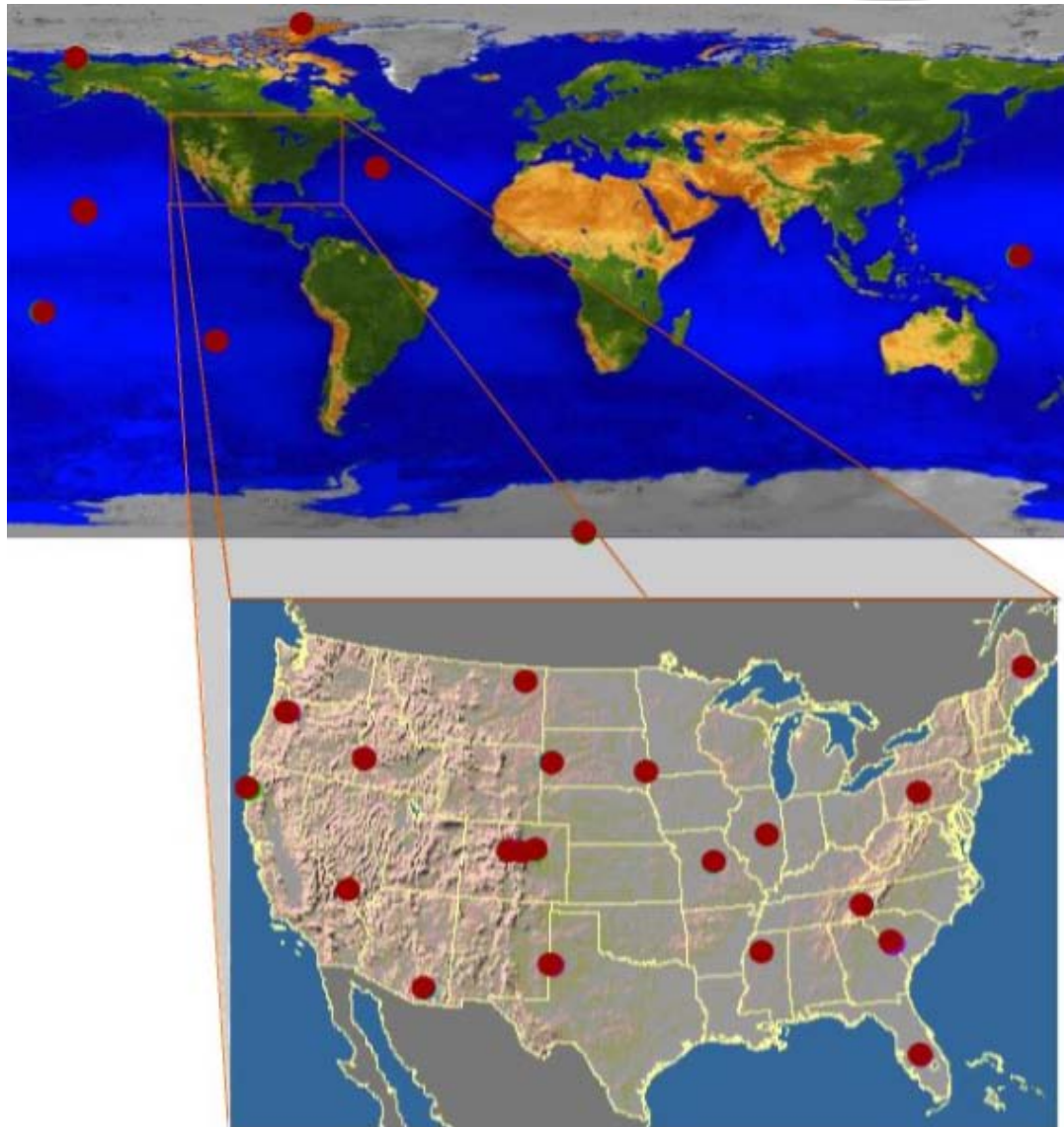


Plans: A Surface Energy Budget Network (SEBN)





The proposed NOAA SEBN Network





Benefits

Improved parameterizations of the land surface model physics that
Ultimately improves seasonal predictability of water resources

Better understanding of the critical land surface processes that
control the seasonal and annual water and carbon budgets for
various ecosystem types



Partners and Collaborations





Indicators of Success

NOAA sponsored sites constitute approximately 12% of the present AmeriFlux database

Bondville, IL is one of only 6 active AmeriFlux sites with records dating to 1996 and represents the longest continuous AmeriFlux record in an agricultural system.

Over 30 authored or co-authored publications (ARL Scientists) over the last 10 years, with over 200 publications that have used this data for assessments and synthesis activities.

Serve as technical experts for the National Science Foundation's NEON (National Ecological Observatory Network)