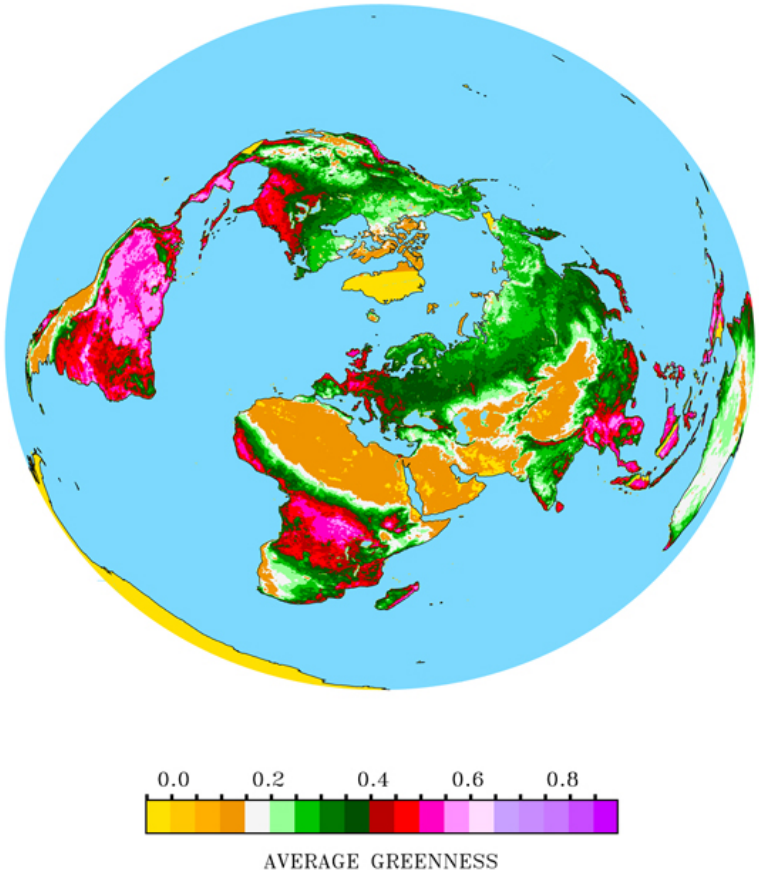
Synergistic use of MODIS and Landsat data for mapping global forest carbon fluxes



Ramakrishna Nemani, NASA ARC

Richard Waring, Oregon State U.

Randy Wynne, Virginia Tech

Weile Wang, NASA NPP

Jennifer Dungan, NASA ARC

Ranga Myneni, Boston U.

Cristina Milesi, CSU Monterey Bay

outline

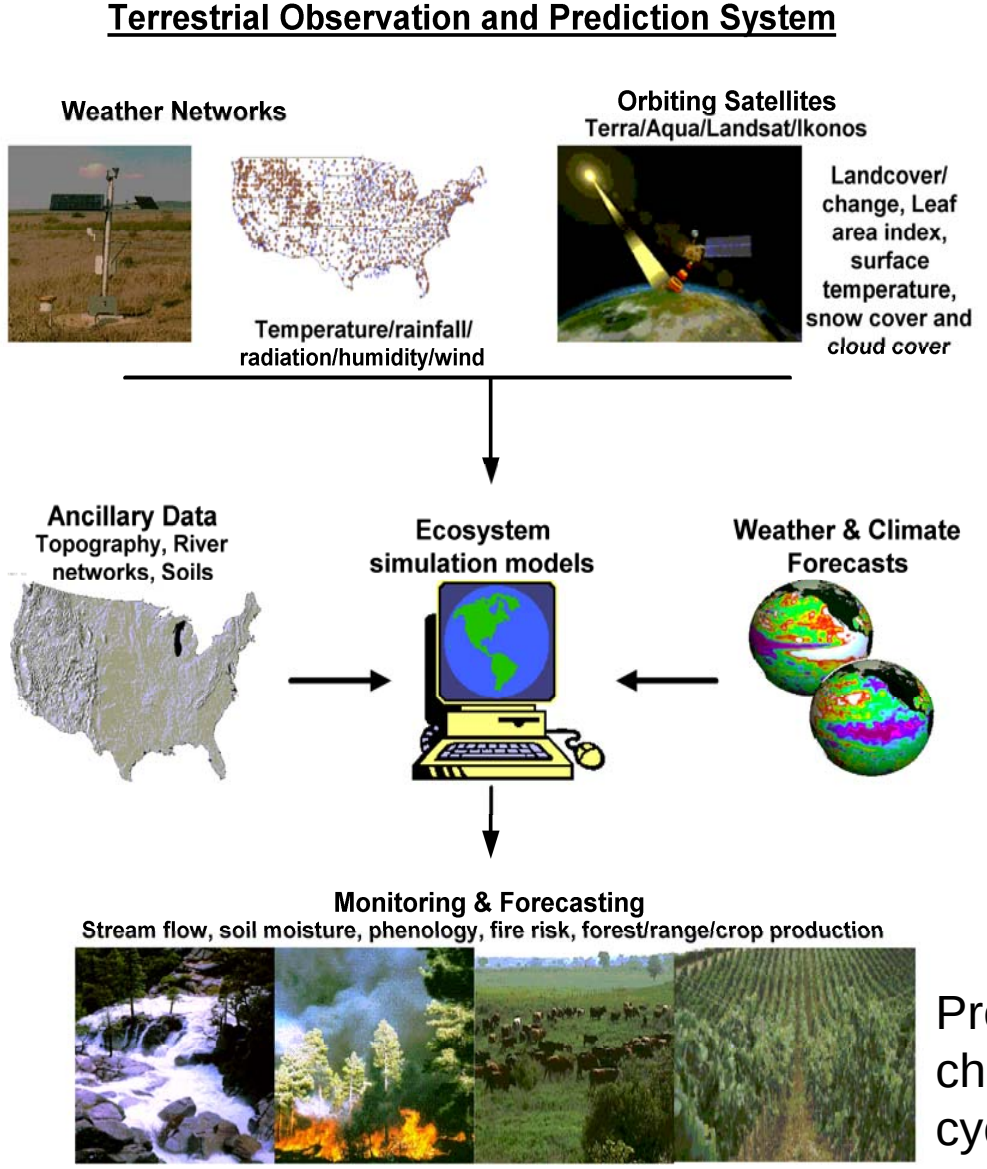
1. Integration of satellite data with modeling

- **Description of the Terrestrial Observation and Prediction System (TOPS)**
- **A brief review of current TOPS applications**
- **Potential for integrating Landsat data**

2. Mapping global forest carbon fluxes

- **Motivation**
- **Approach**
- **Key assumptions**
- **Prototype activities**
- **Global mapping with Google academic computing**

A data-Modeling framework



Monitoring

Modeling

Forecasting

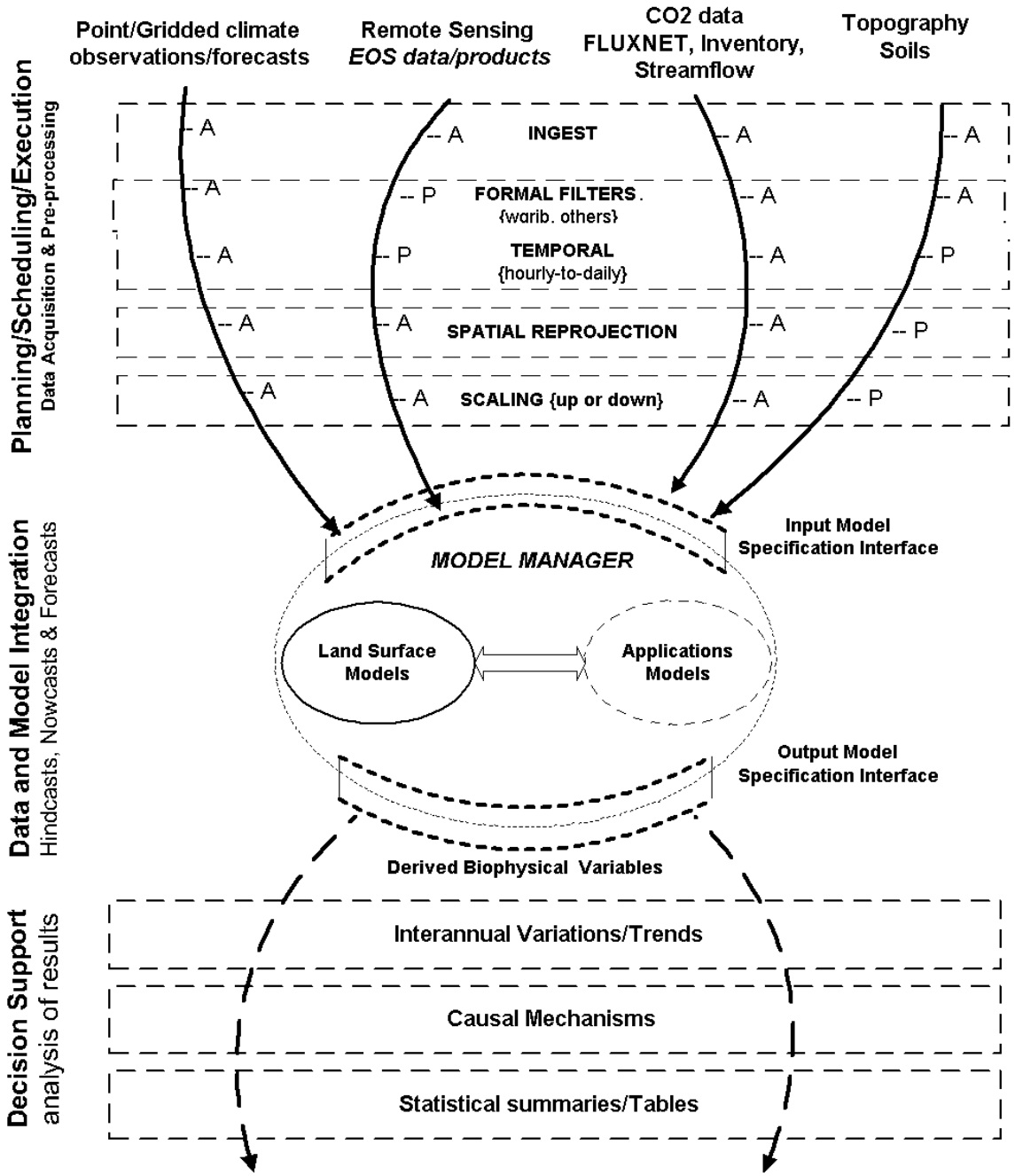
Multiple scales

Predictions are based on changes in biogeochemical cycles

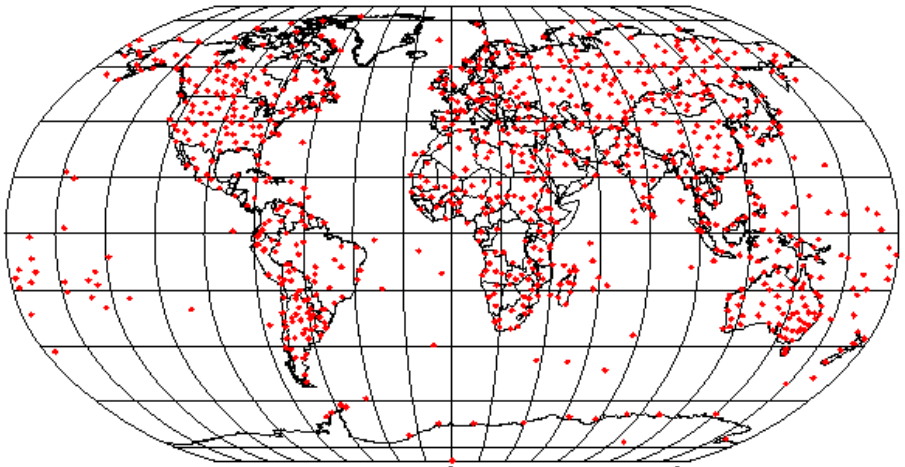
Nemani et al., 2003, EOM

White & Nemani, 2004, CJRS

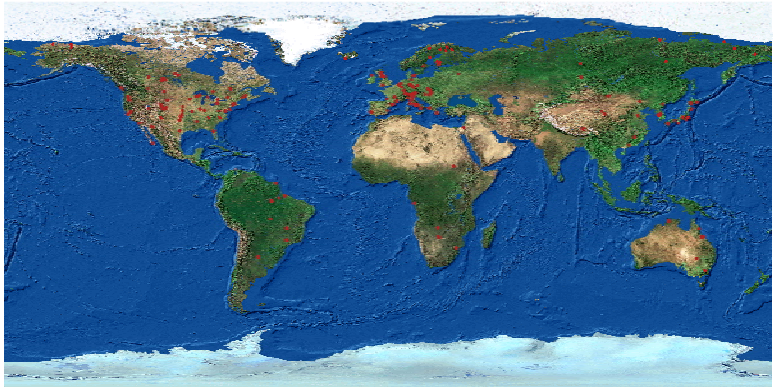
Data – Model Integration in TOPS



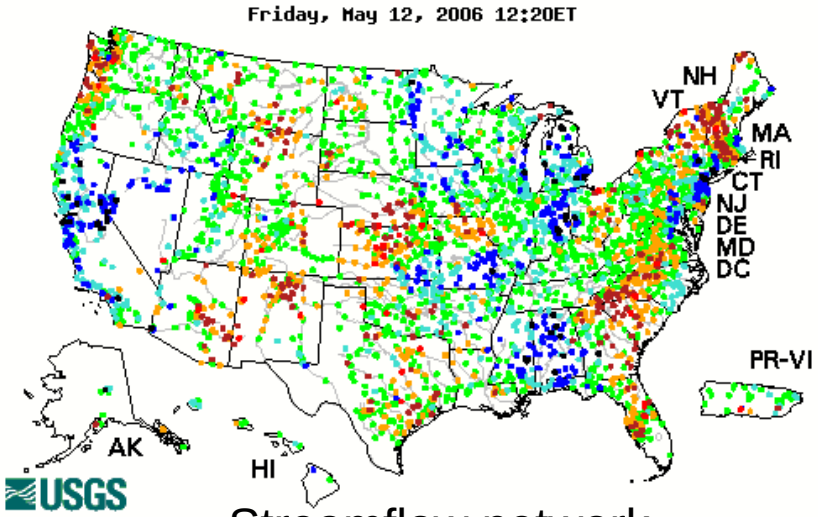
Access to a variety of observing networks



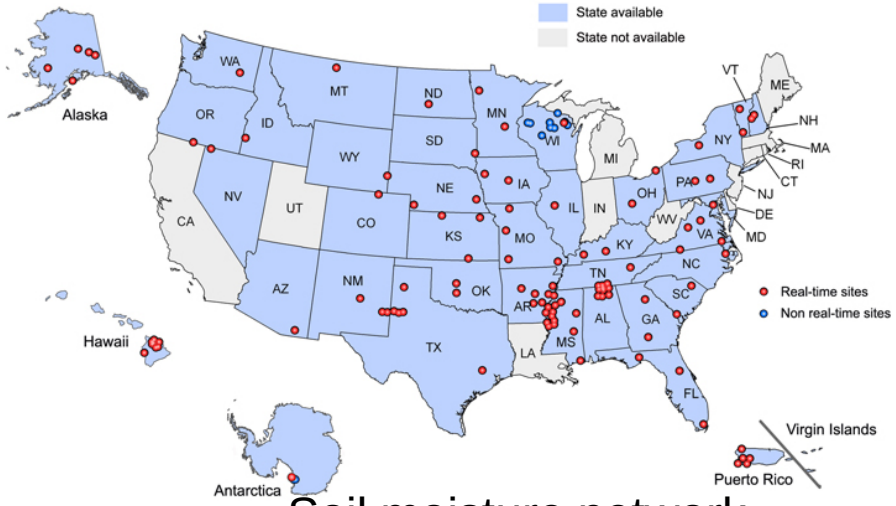
Weather network



Fluxnet

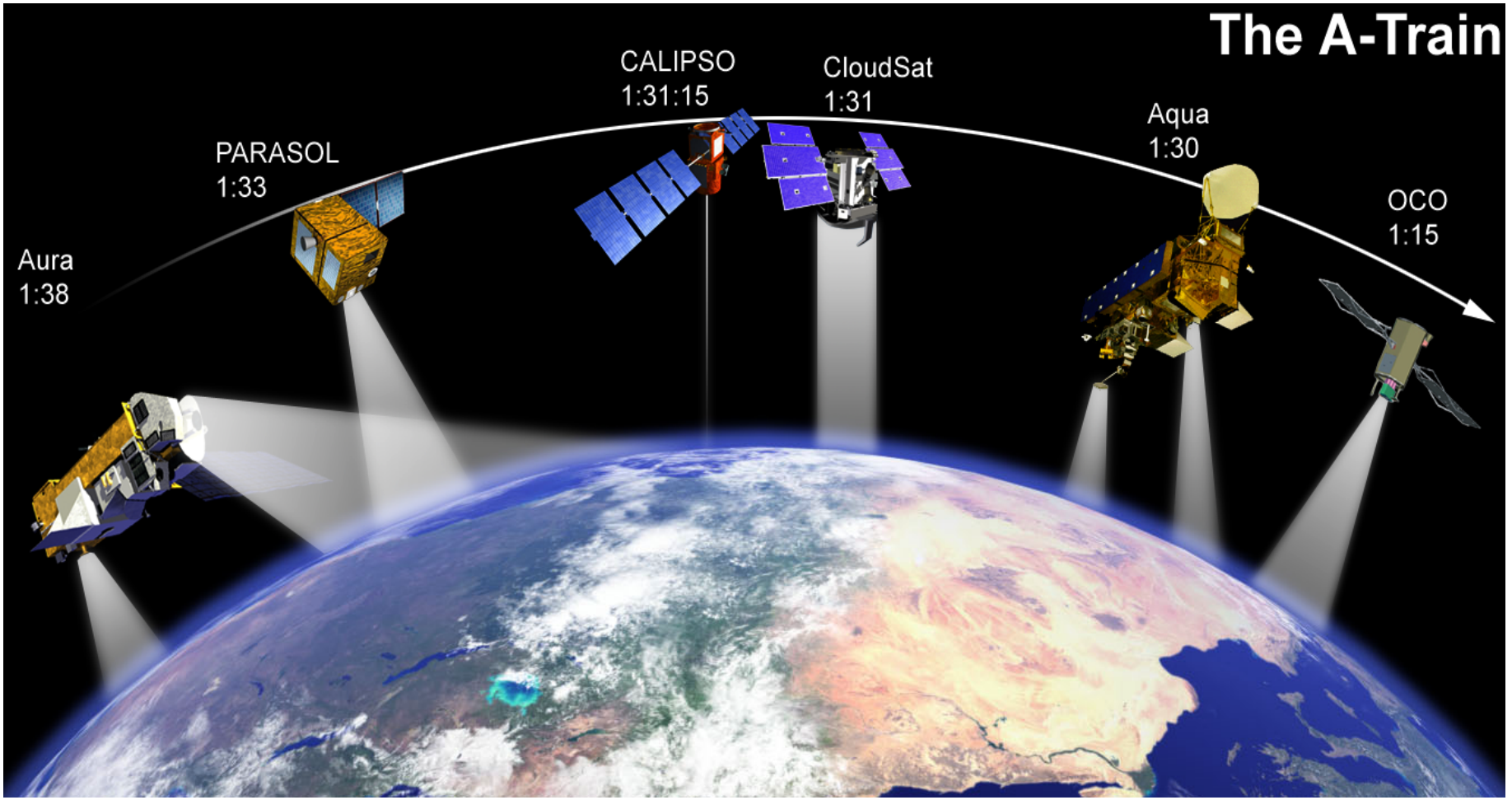


Streamflow network



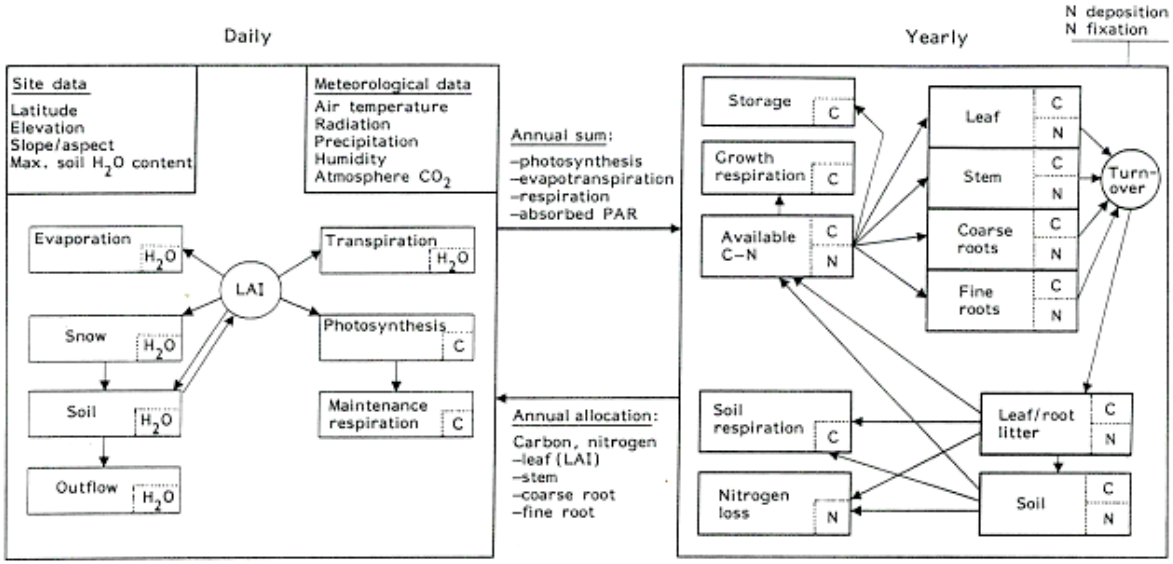
Soil moisture network

Access to a variety of remote sensing platforms



Integration across Platforms, Sensors, Products, DAACs *..Non-trivial*

Ability to integrate a variety of models

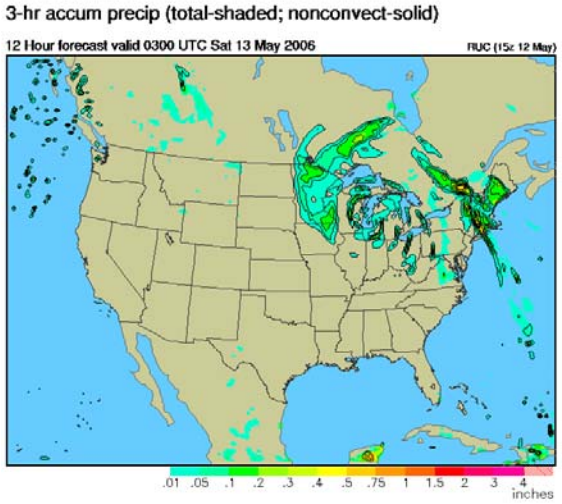


Biogeochemical Cycling
Crop growth/yield
Pest/Disease
Global carbon cycle

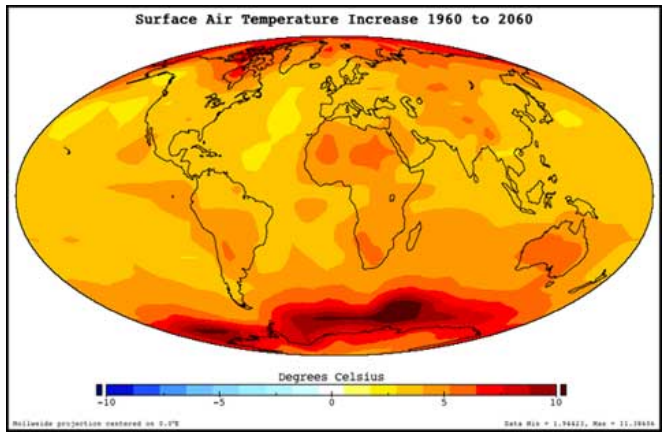
Prognostic/diagnostic models

Ability to work across different time and space scales

Hours

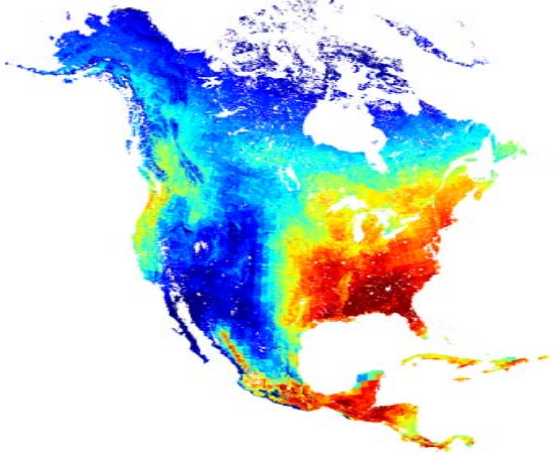


Decades



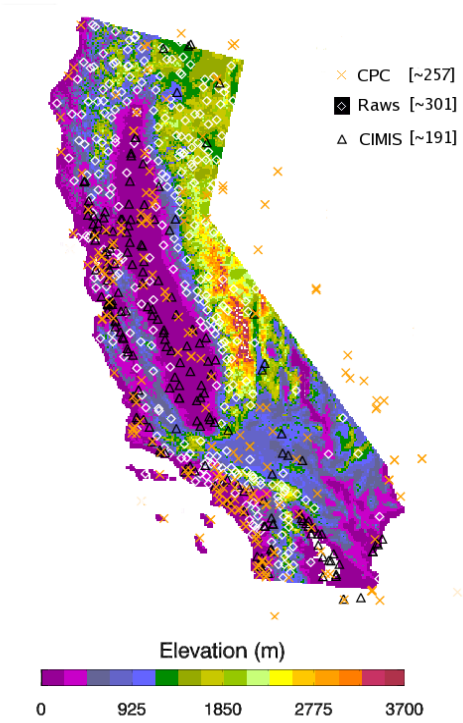
Vineyard water balance

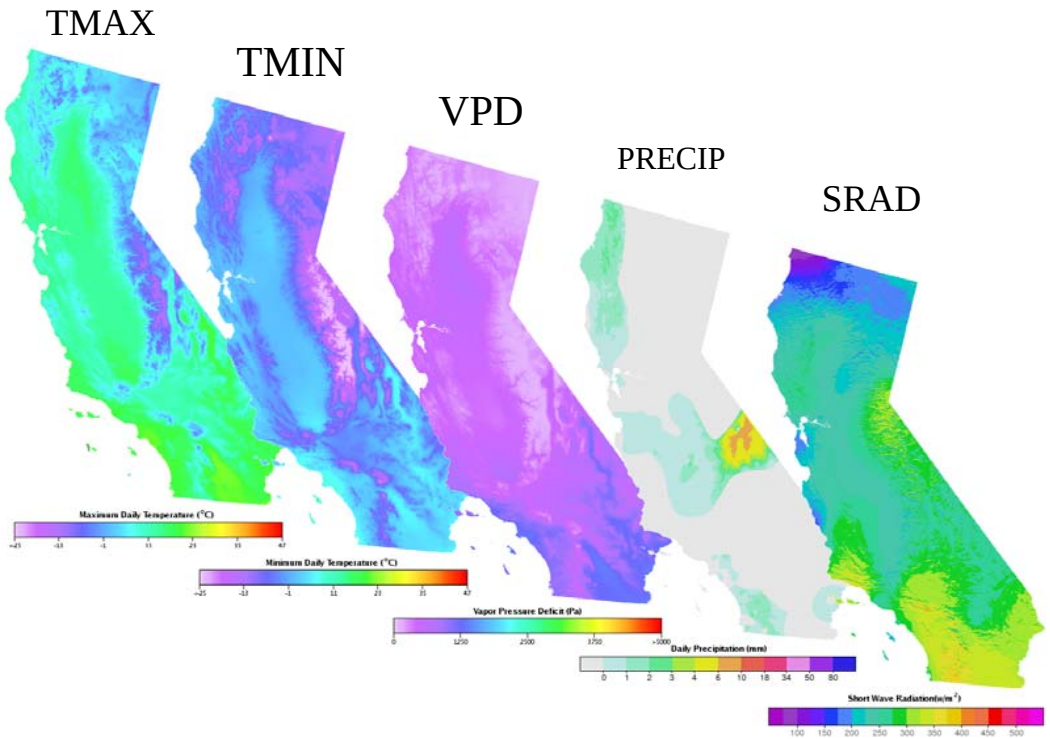
Continental Carbon Balance



Gridded Weather Surfaces for California

using nearly 700 weather stations daily



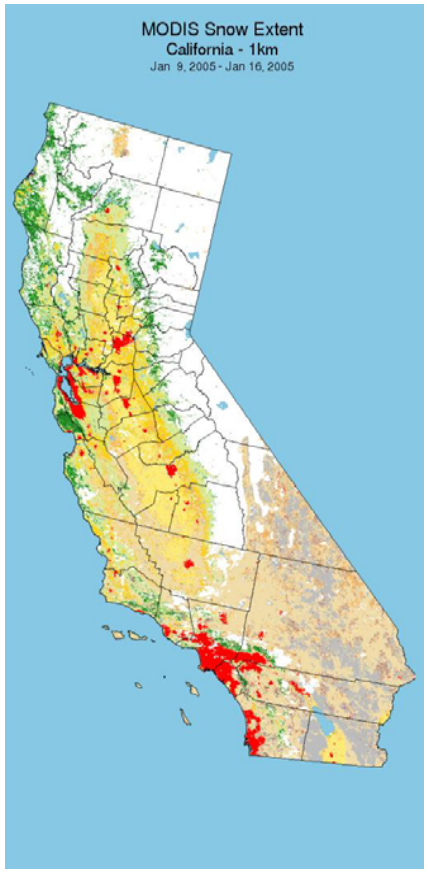


Weather networks often operated by different govt. agencies and/or private industry. Rarely integrated because they are intended for different audiences. We specialize in bringing them together to provide spatially continuous data.

maps come with cross-validation statistics

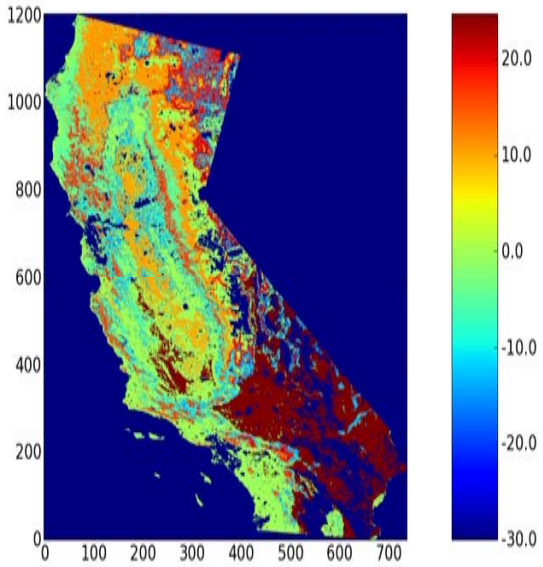
Daily satellite mapping of CA landscapes

SNOW COVER



VEGETATION DENSITY

VEGETATION PHENOLOGY

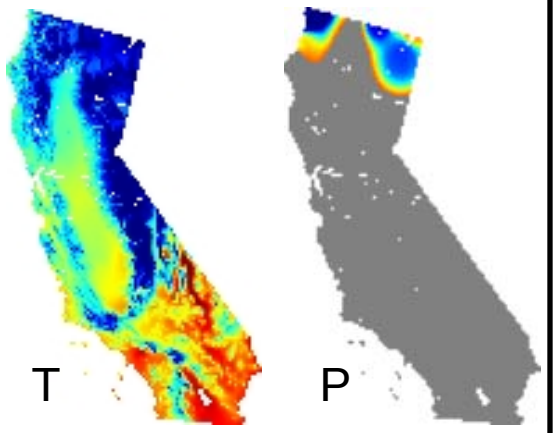


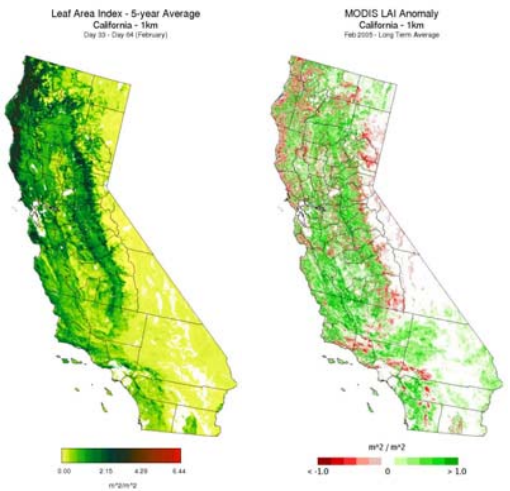
FIRE

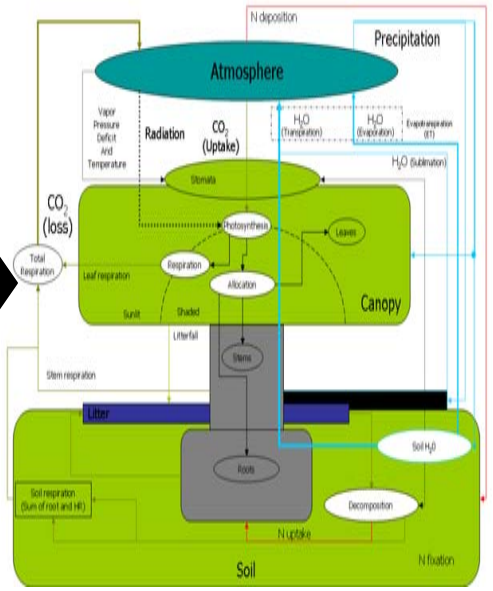
California : Ecological Daily Nowcast at 1km

[Feb/01/2006]

Climate + Satellite



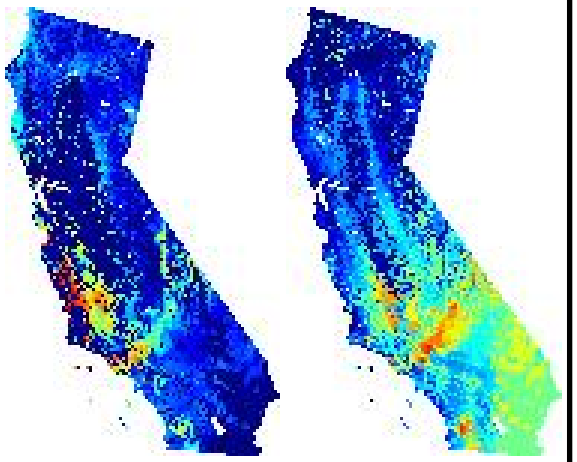




Biome-BGC

Simulation models

Carbon and water cycles



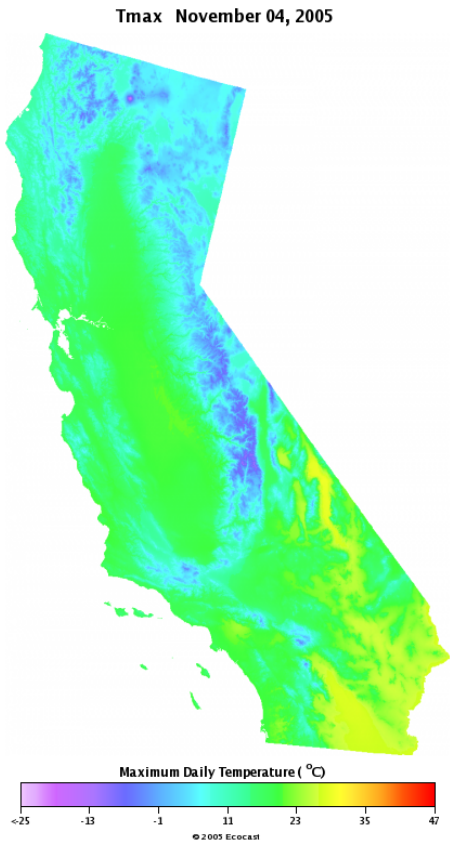
GPP (gC/m2/d)

ET (mm/d)

Outputs include plant growth, irrigation demand, streamflow

Daily Nowcasts: California

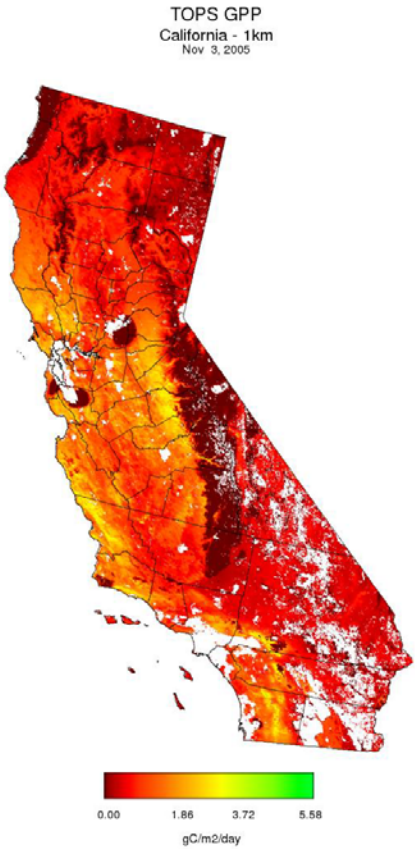
Meteorology



Hydrology

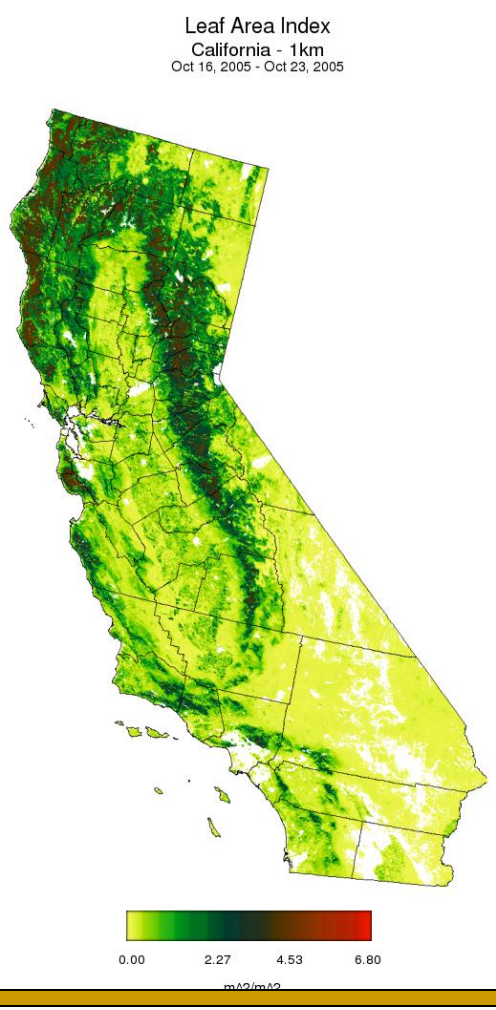
Vegetation

Ecosystem

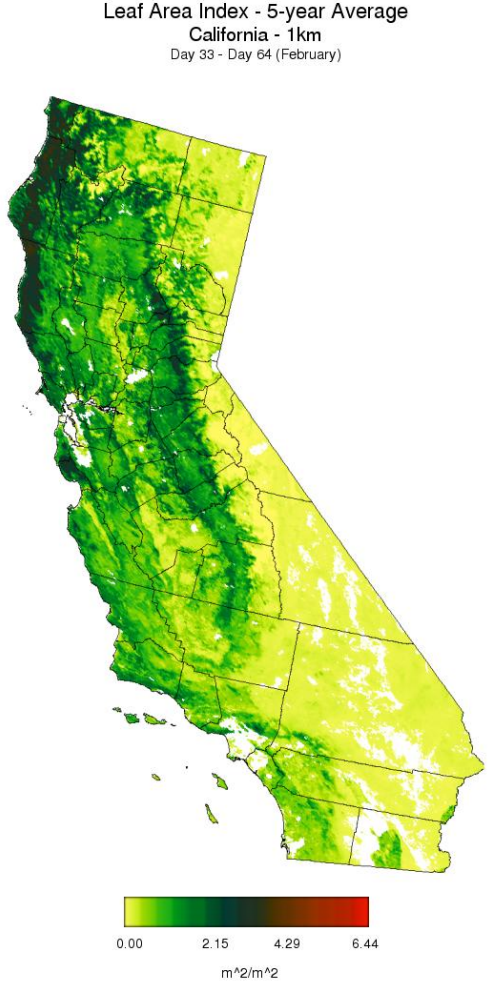


Weekly Ecocasts: California

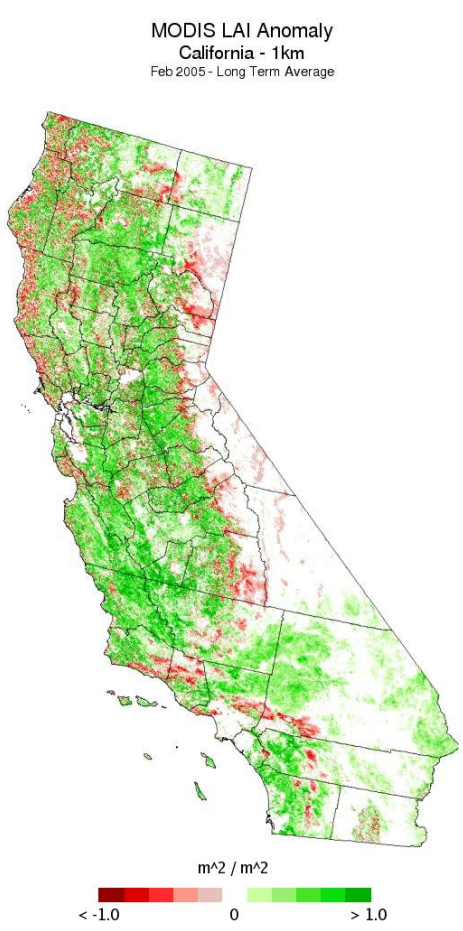
Current Data



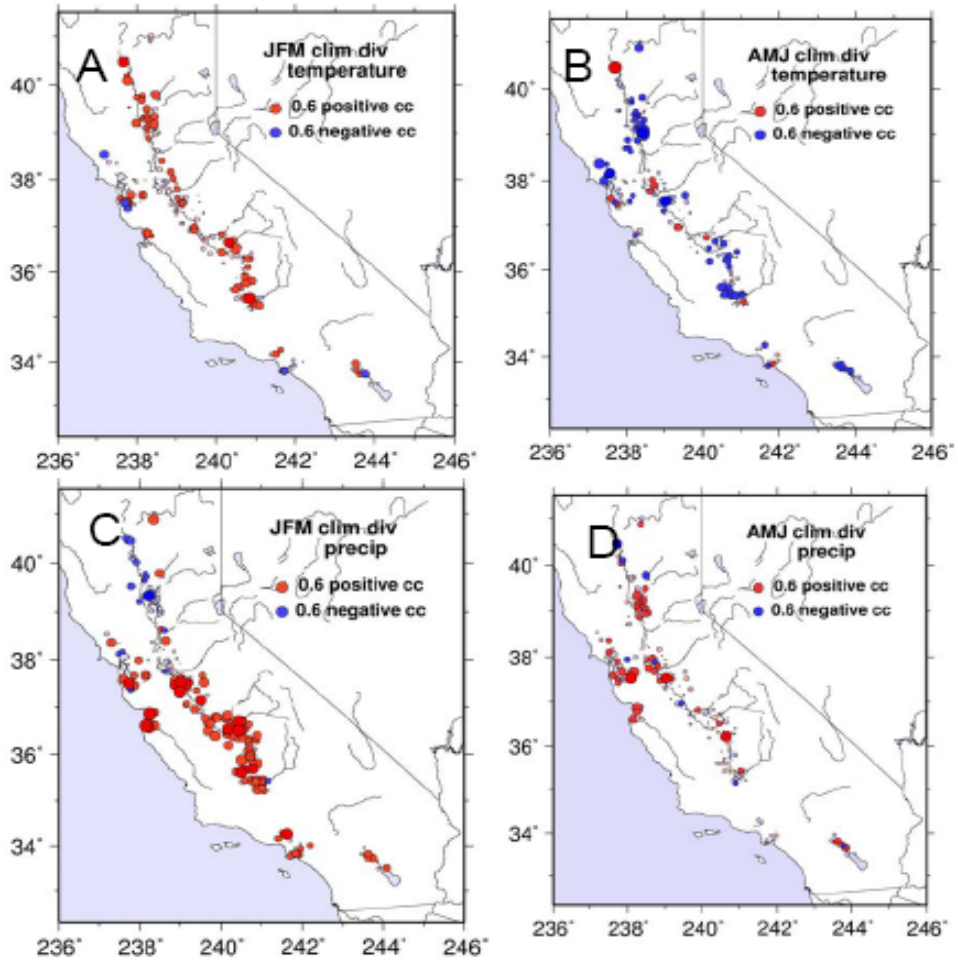
Historical Data



Anomaly Detection



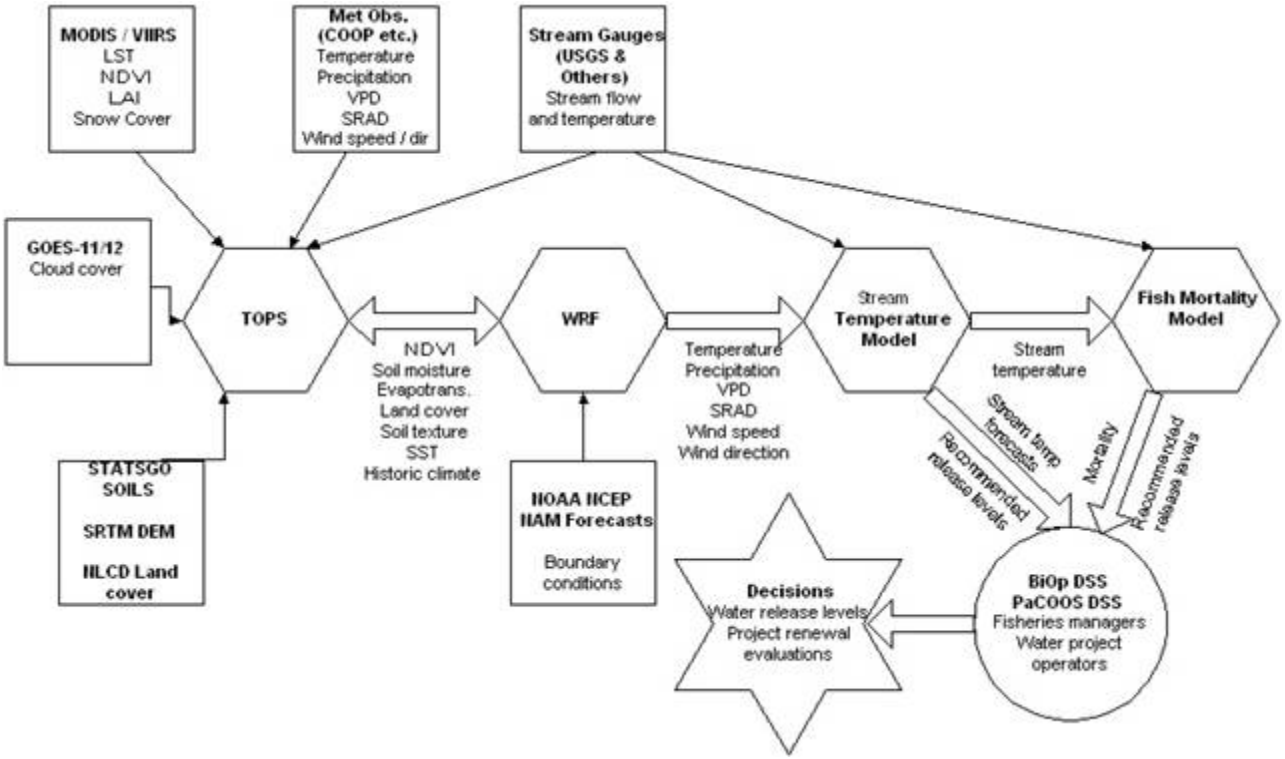
Using TOPS Data to Identify Drivers of Mosquito Abundance and Virus Transmission Risk in California and western U.S.

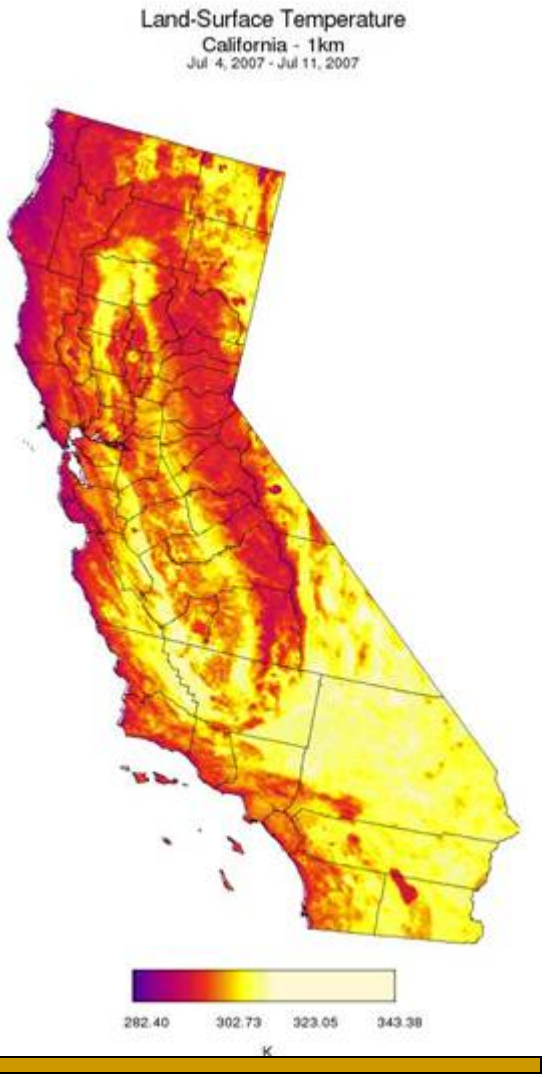


Correlations between temperatures and mosquito abundance in CA

These relationships are being used to develop predictive models.

TOPS products for NOAA Fisheries:
Forecasting Stream Temperature for Anadromous Fisheries Management





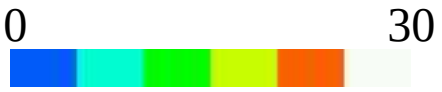
TOPS data and regional climate models will drive forecasts of steam temperature developed by NOAA Fisheries. Forecasts will be used in decision making related to water releases for management of habitat for endangered fish species.

Irrigation Forecast
for week of July 19-26, 2005

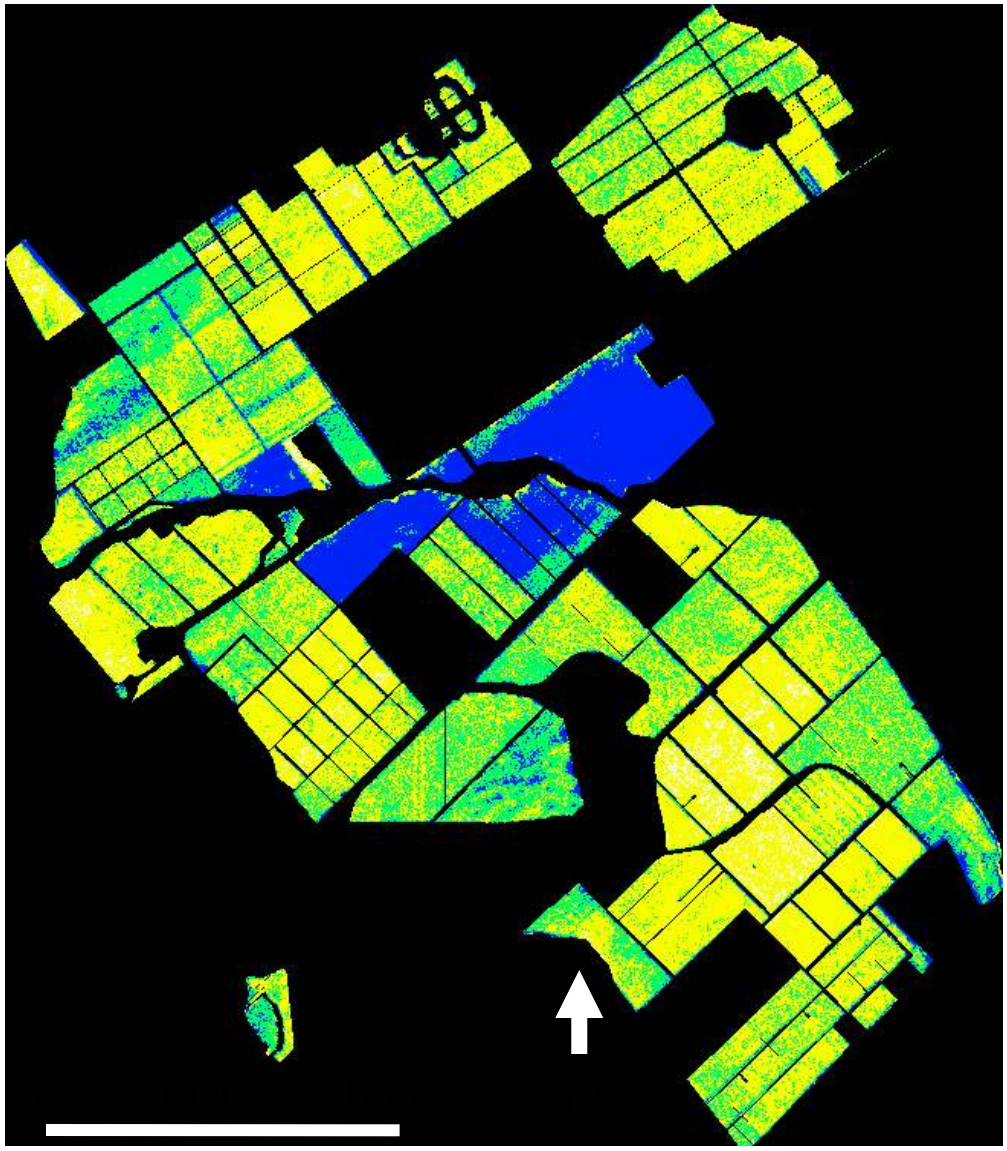
Tokalon Vineyard,
Oakville, CA

CIMIS Measured Weather Data
through July 18, 2005

NWS Forecast Weather Data
July 19-26, 2005



Forecast Irrigation (mm)



Mapping global forest carbon fluxes

Moving from pools to fluxes

Flux towers shedding light on carbon cycling

MODIS algorithms

Availability of global Landsat data

Access to computing resources

Strong interest from Google Earth

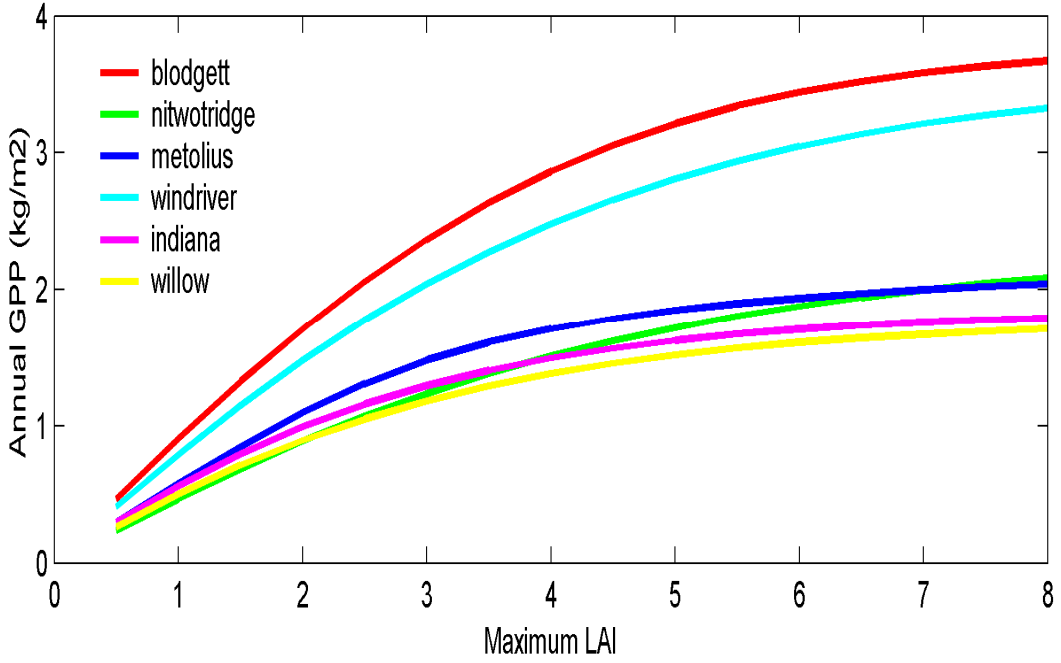
Education vs Science

- ***Not to convince scientists***
- ***Mainly to educate the public about climate change & Kyoto protocol***
- ***Great to show we can do it at 30m globally***

Assumptions

- ***Leaf Area Index can be used to scale carbon fluxes such as Gross Primary Production (GPP)***
- ***Ratio between GPP and NEP (Net Ecosystem Production) is fairly constant for mature stands***
- ***We can rely on remote sensing to map recent disturbances that deviate from a constant NEP/GPP ratio***

Climate and LAI interactions captured by BIOME-BGC

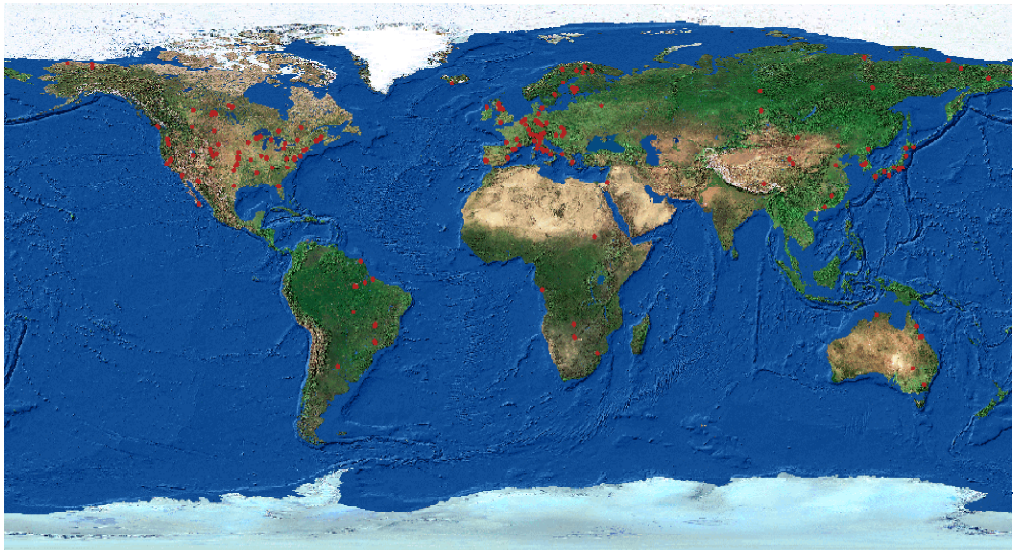


Relation between LAI and GPP depends on the climate

Standard MODIS LAI and GPP products are available at 1km

Landsat data have been widely used to estimate LAI (NDVI, SR, RSR)

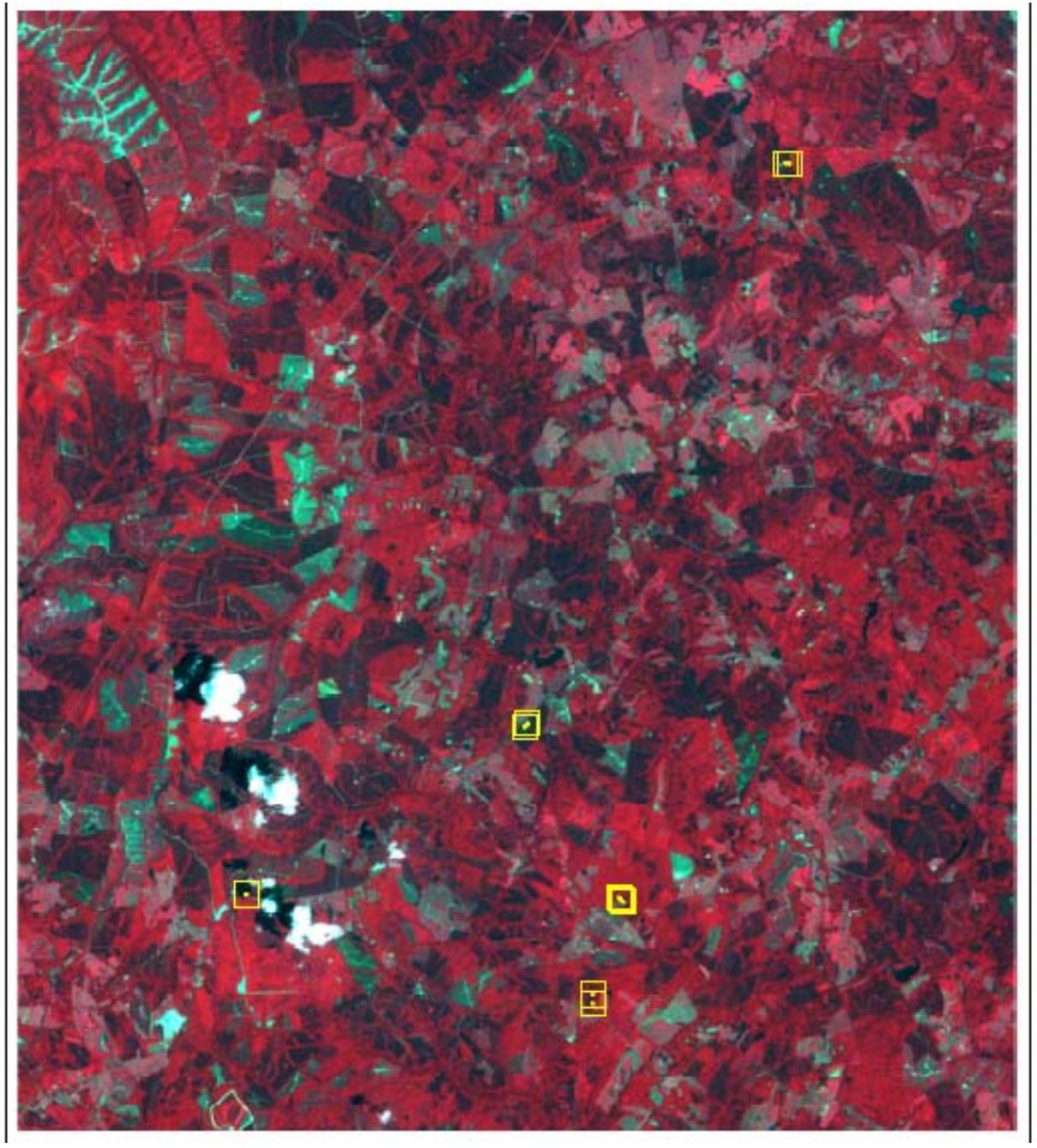
Fluxnet data are useful in simplifying carbon cycling



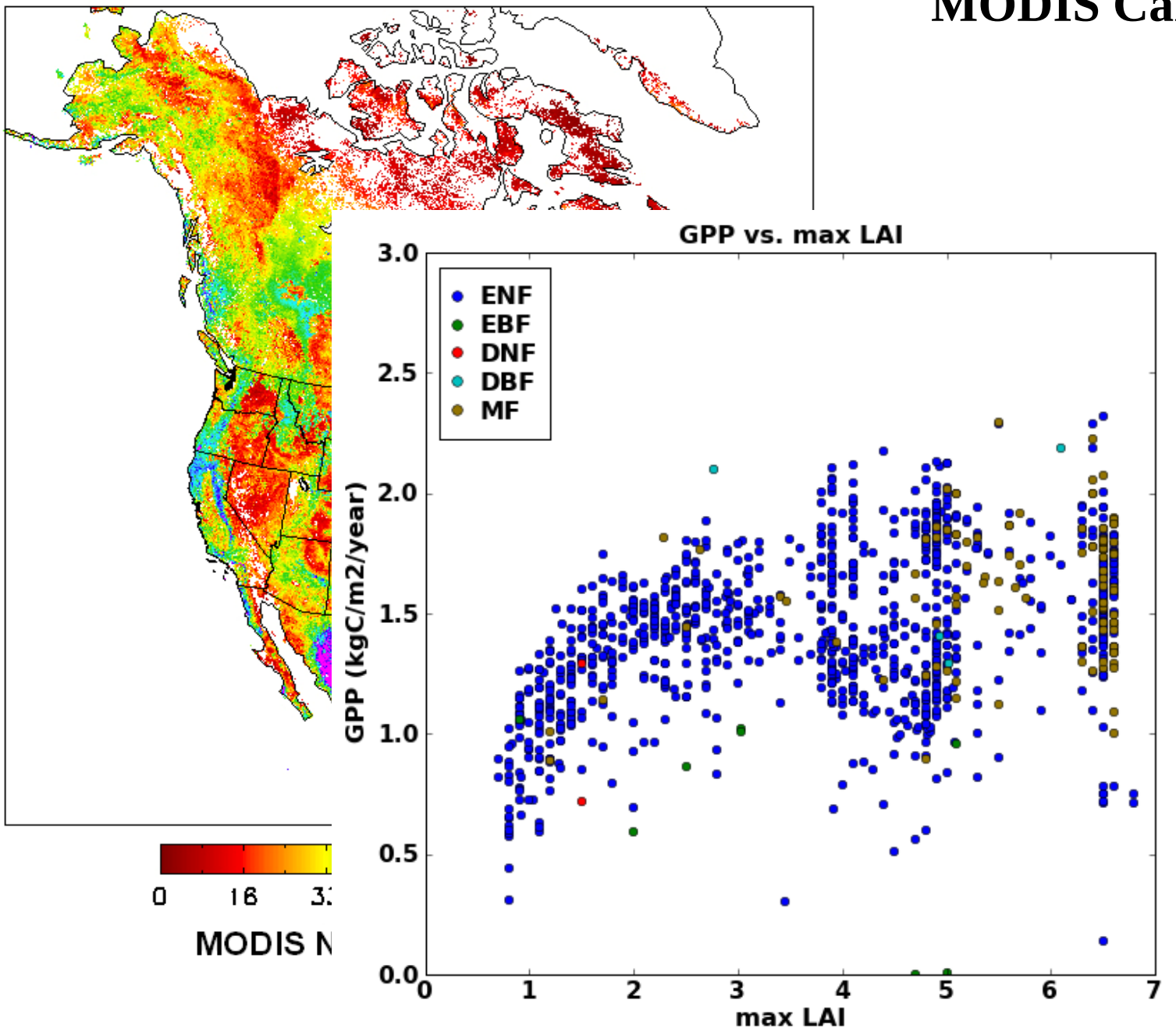
NEP/GPP ratio appears to be conservative, 0.25-0.30 for mature stands. Recently disturbed sites deviate from this, and are often large C sources (-0.8).

If we know, land cover, LAI and climate, GPP is relatively easy to estimate, Standard MODIS GPP algorithm does this globally at 1km.

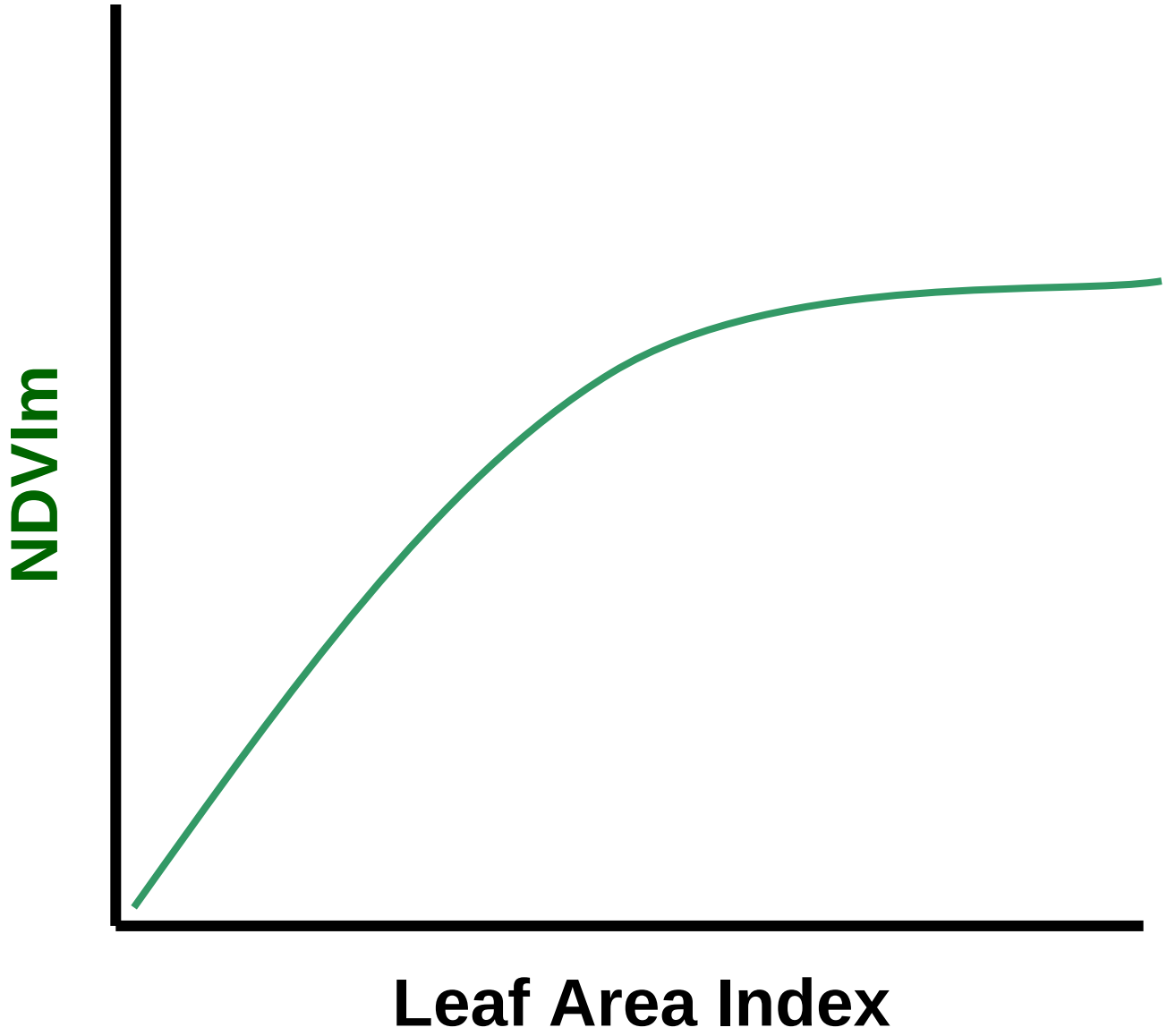
Managed Forests of Southeast



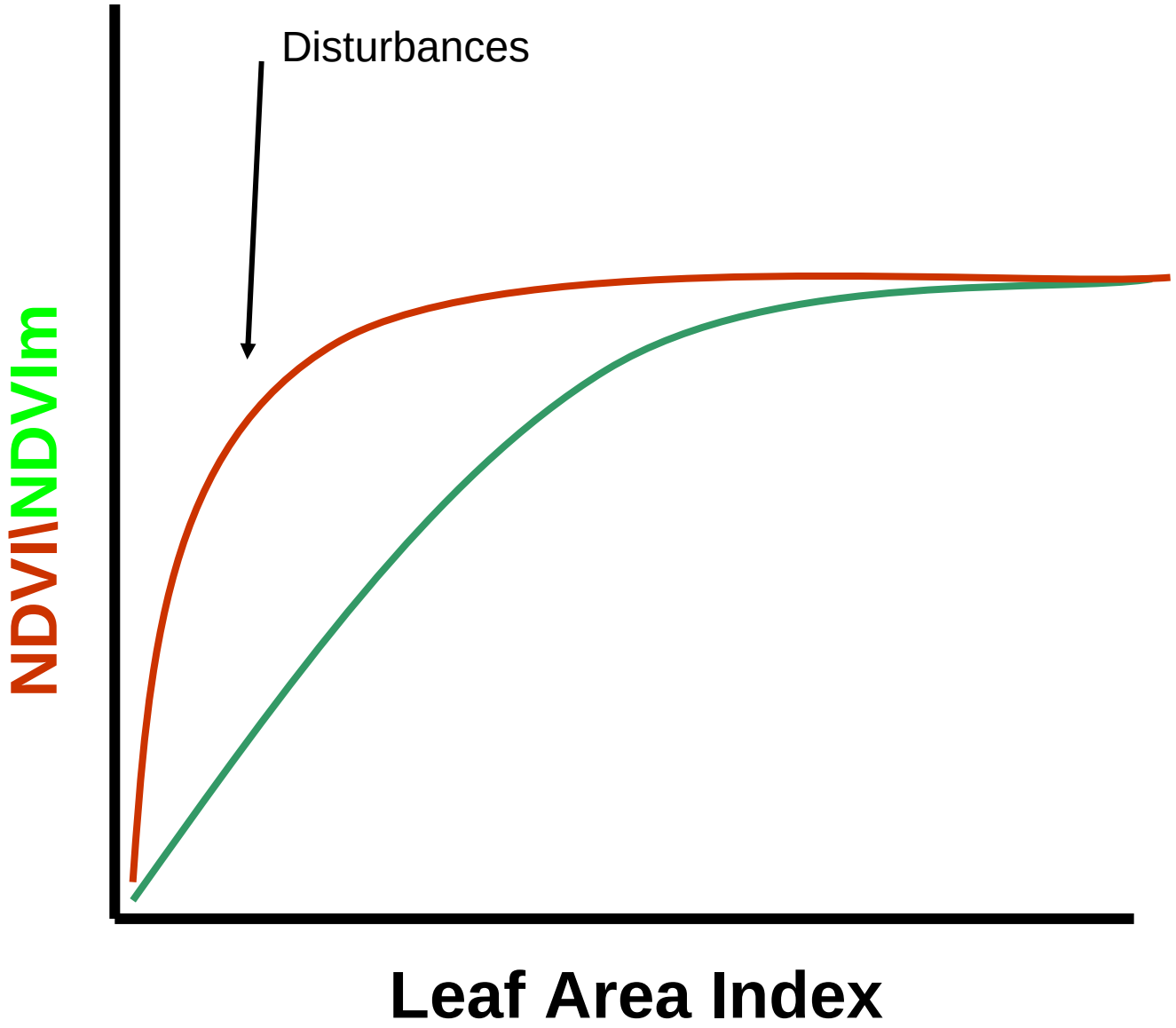
MODIS Carbon Fluxes



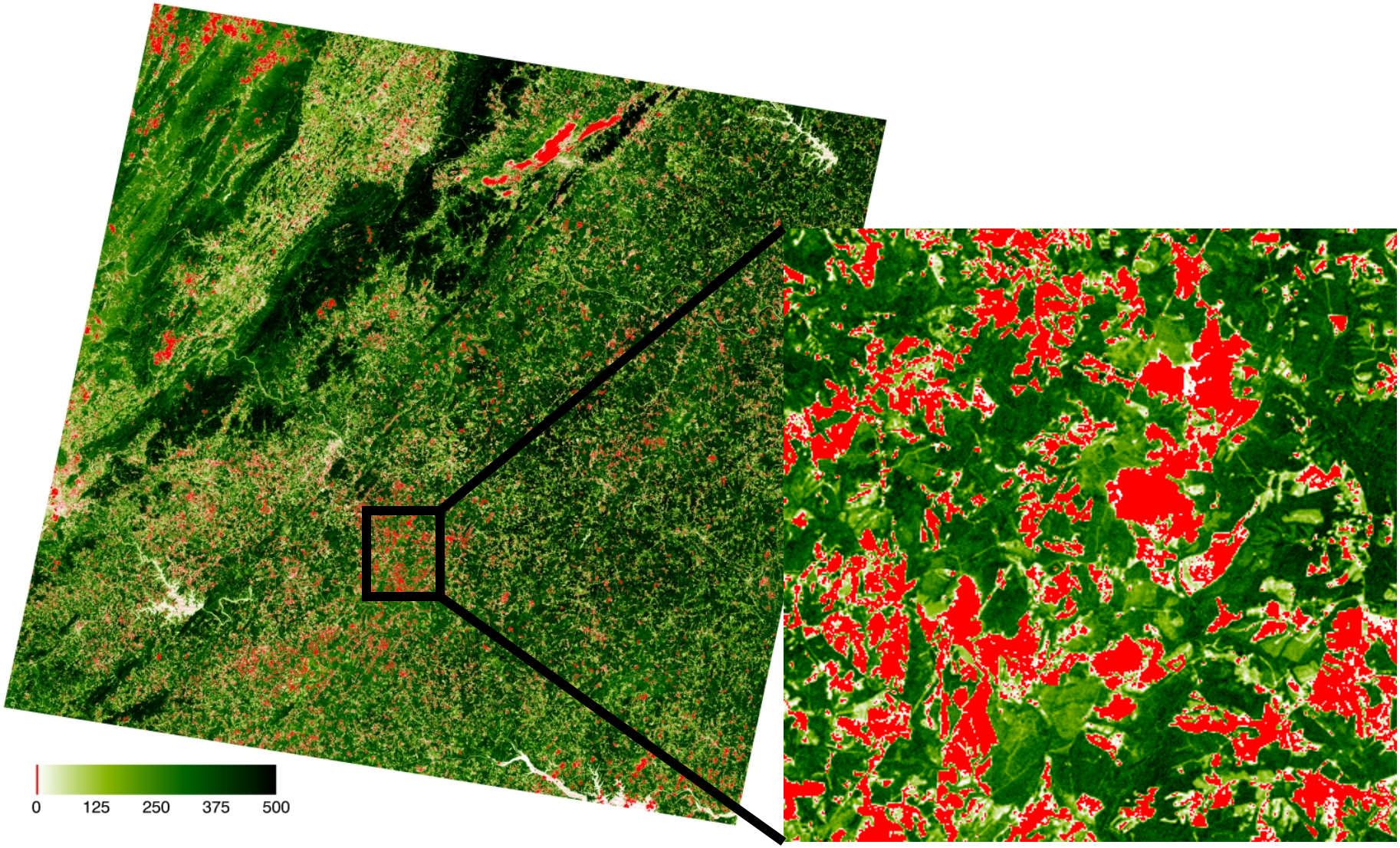
Mapping LAI from Thematic Mapper



Ability to map recent disturbances



Net Ecosystem Production



Global Mapping

- ***Google Academic Computing***
  1000 clusters, over 30,000 CPUs

Over 100 Pb of storage

A new layer on Google Earth

Summary

Exciting opportunities for integrating Landsat data into operational DSS

Lot of interest from private sector

We may have resources to routinely process global Landsat data sets

Collaboration with Google Earth opens new opportunities for validation