Ecological Forecasting

using the

TERRESTRIAL OBSERVATION and PREDICTION SYSTEM (TOPS)

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NASA/Ames Research Center

Where do we fit into agency goals..

NASA Earth Science Questions:

How is the global earth system changing?

What are the primary forcings of the earth system?

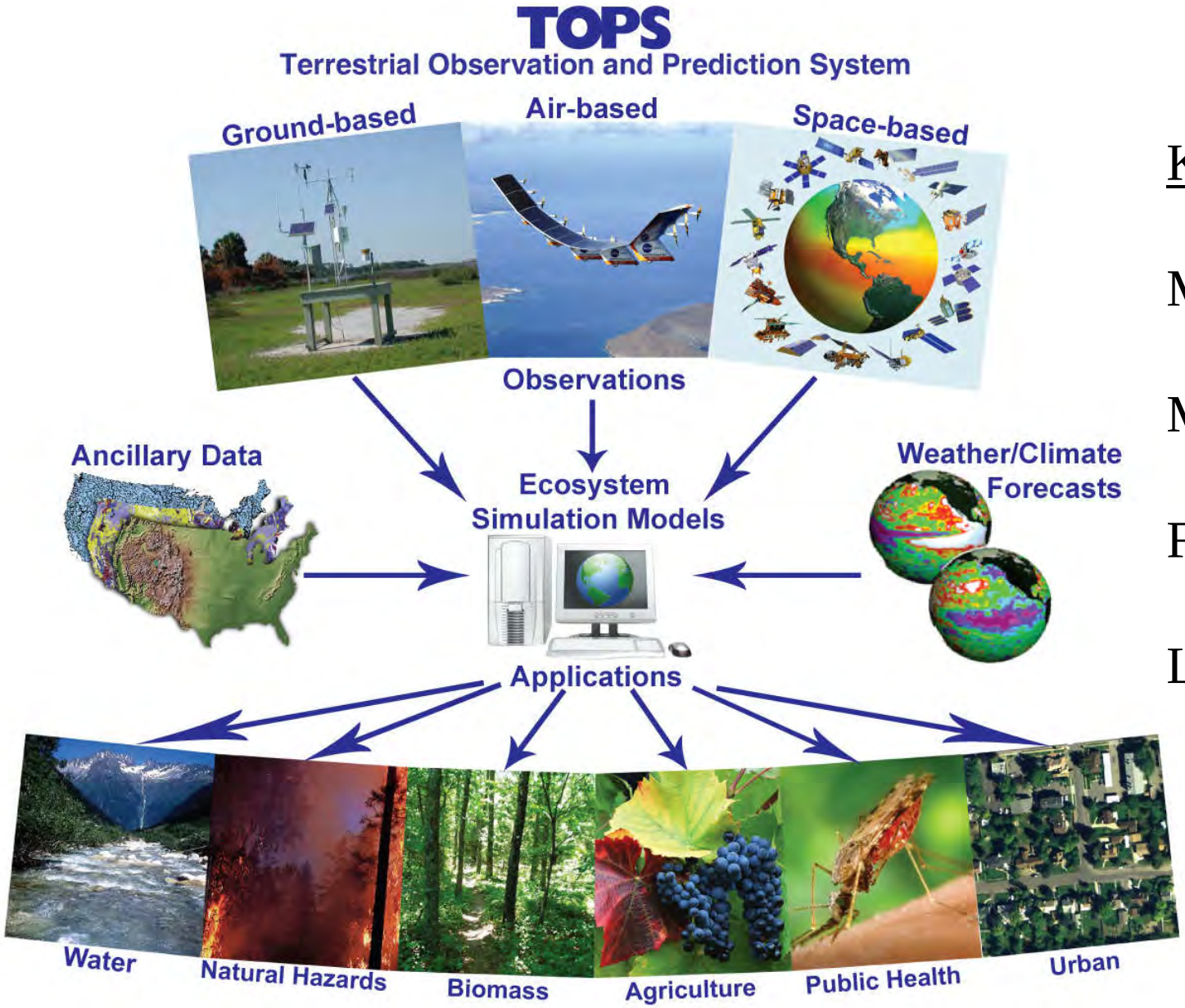
How does the earth system respond to natural and human-induced changes?

What are the consequences of change in the earth system to human civilization?

How will the earth system change in the future?

We have been developing TOPS, an integrated data and modeling system, for ***monitoring, modeling and forecasting*** *ecosystem states and function.*

TOPS – Concept



Key elements:

Monitoring

Modeling

Forecasting

Local to Global

Nemani et al., RSE, 2008

Daily Weather Surfaces 1KM

Raw data

Gridded Products

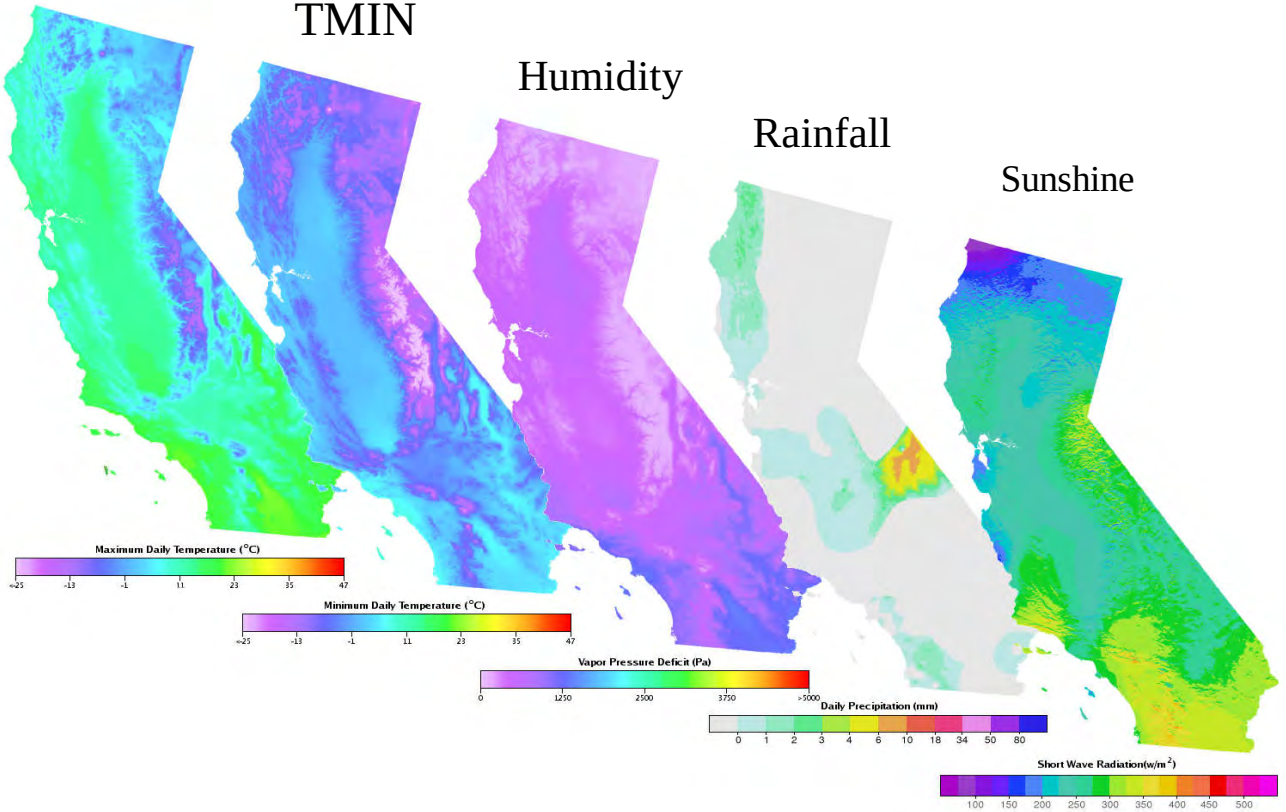
TMAX

TMIN

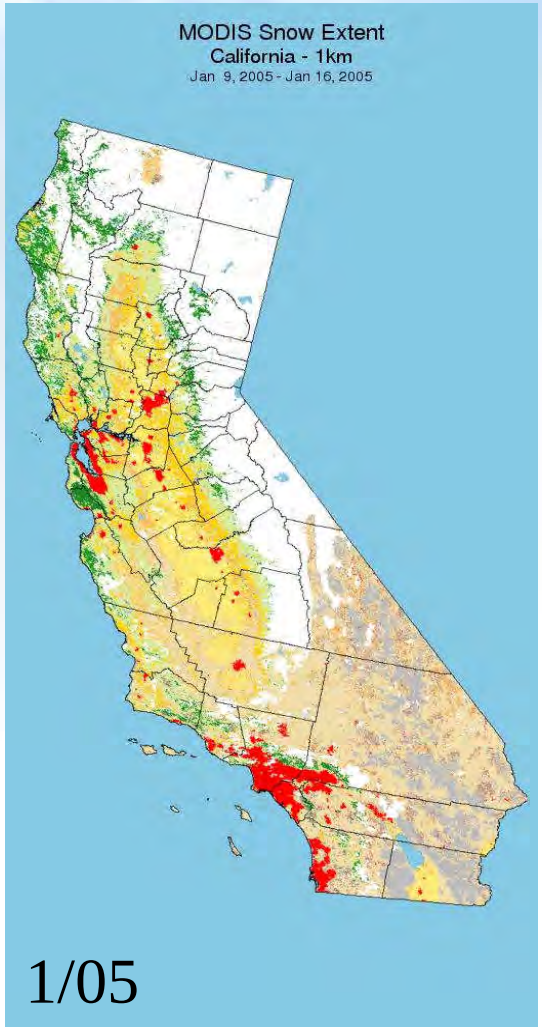
Humidity

Rainfall

Sunshine



Satellite data



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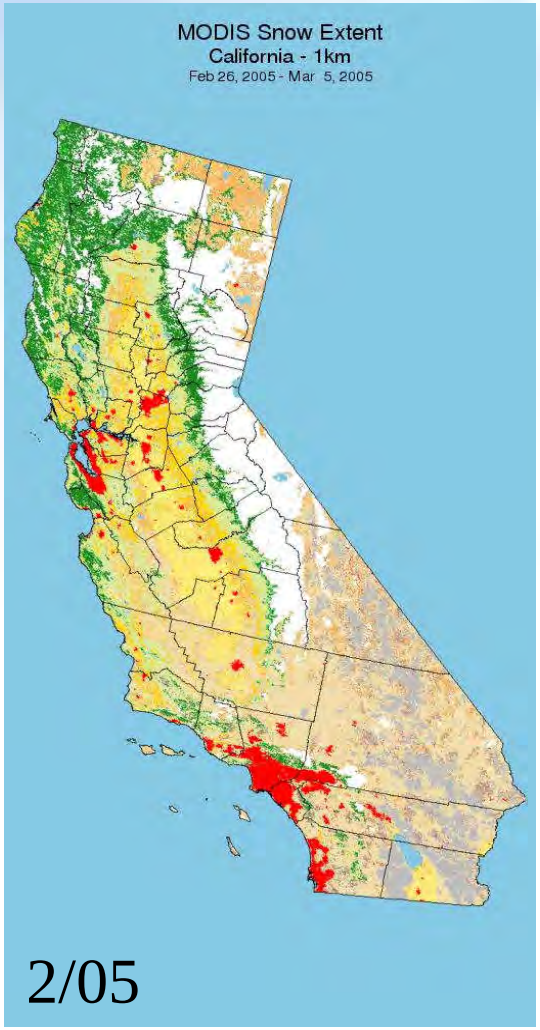

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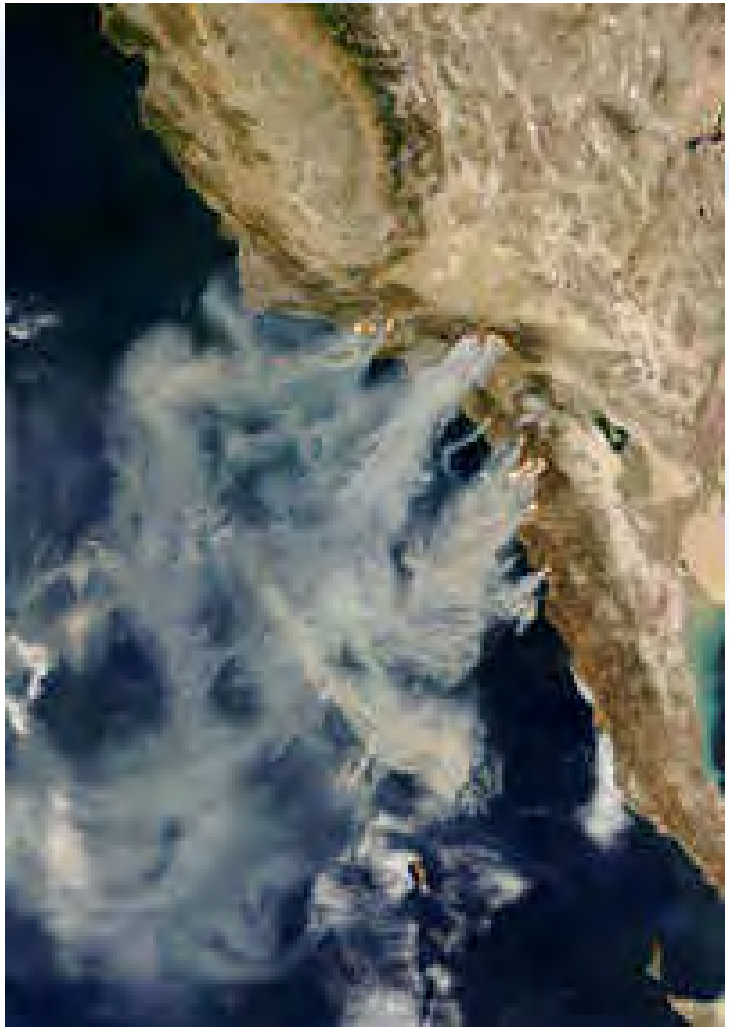
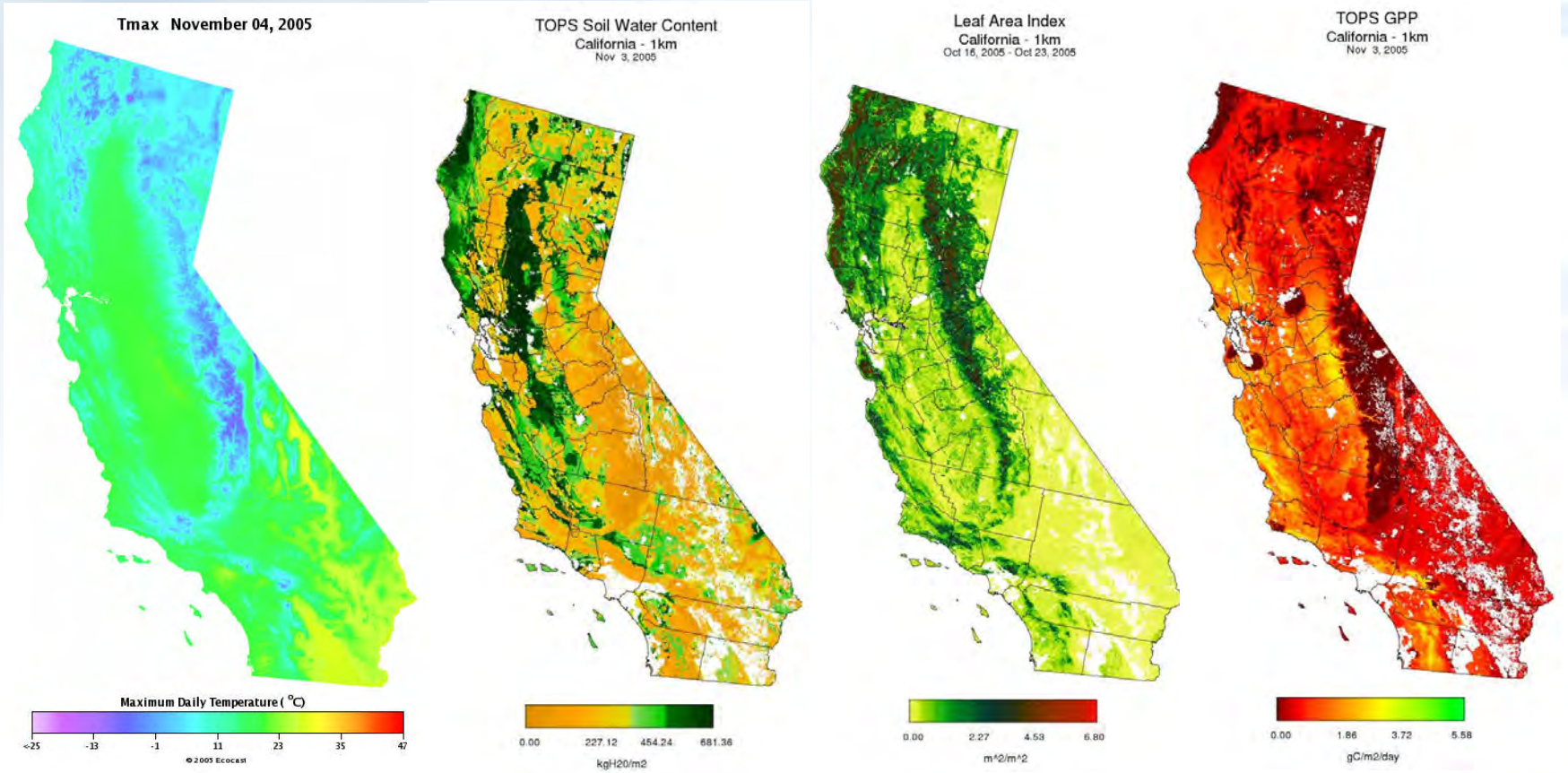


Daily Nowcasts: California

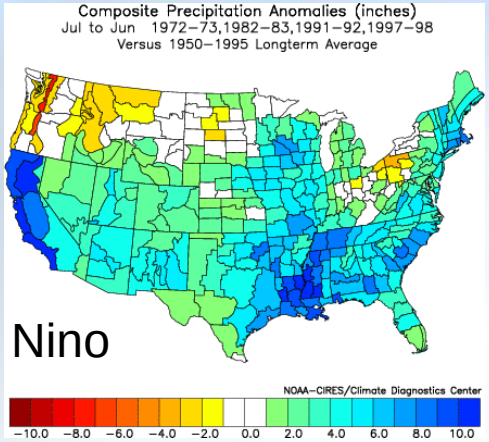
Meteorology **Hydrology** **Vegetation** **Ecosystem**



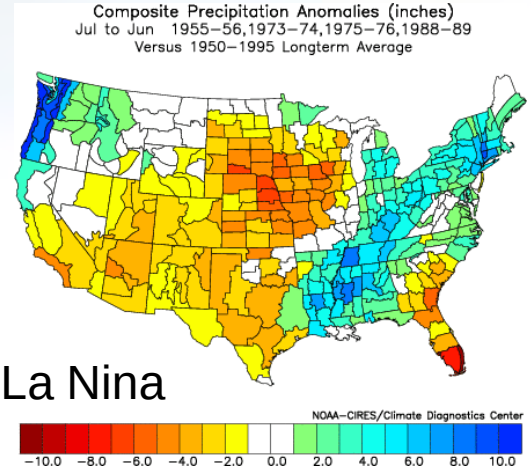
Seasonal Forecasts of water resources, fire risk, phenology

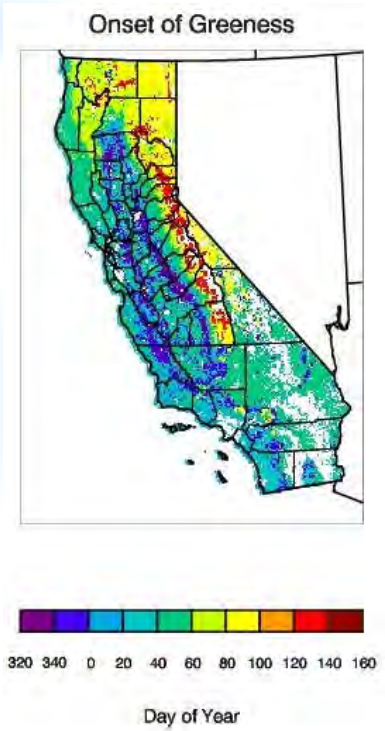
ENSO-Rainfall over U.S

El Nino



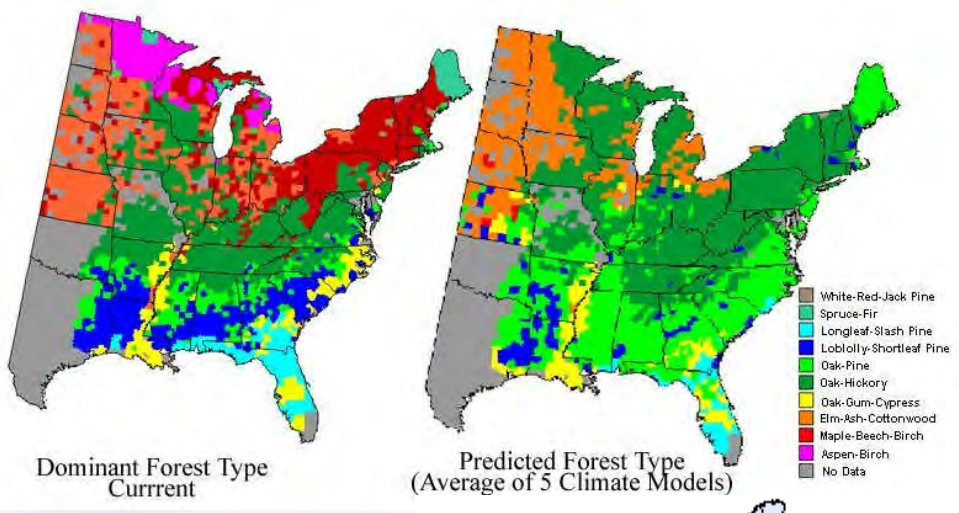
La Nina



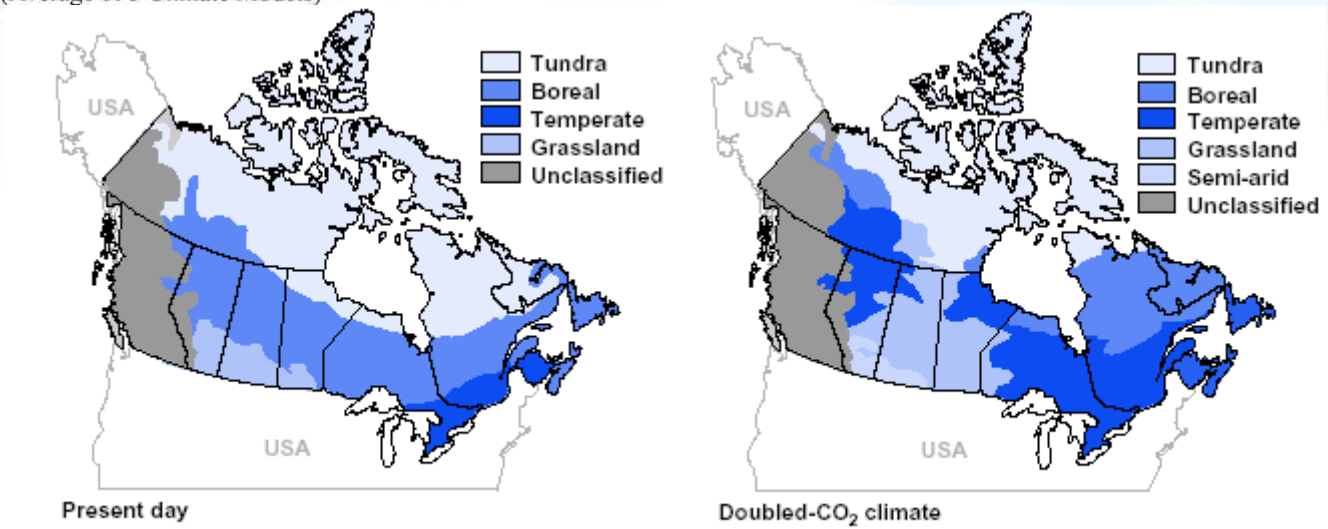


Based on ENSO forecasts
Weeks to months

Long-term Projected Changes



Based on GCM outputs
Decades to centuries

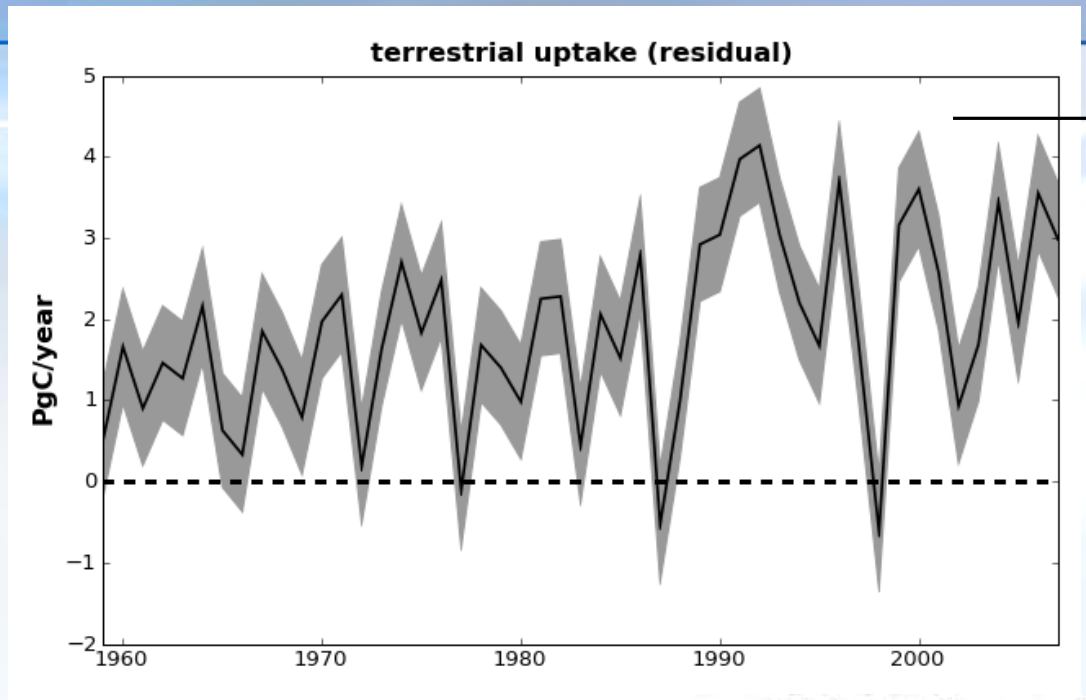


SOURCE: Rizzo 1990.

TOPS Research

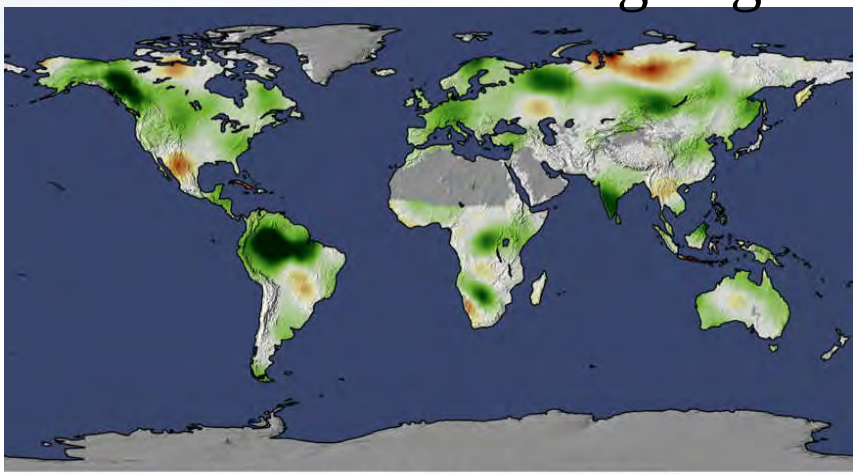
- Global carbon cycling
- Food Security
- Climate Change
- Earth Science Missions

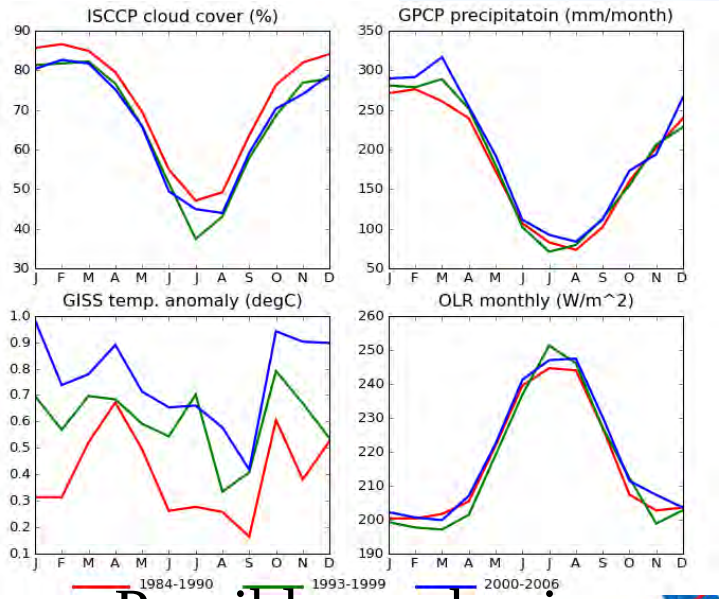
Global carbon cycling



Increased Uptake since the 1990s

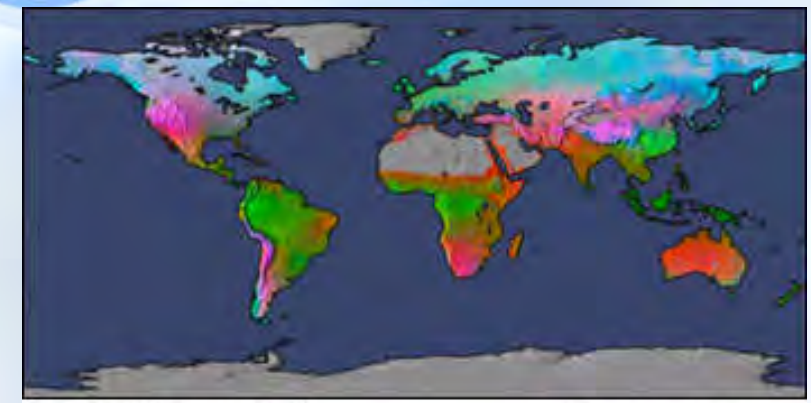
Where is the carbon going?



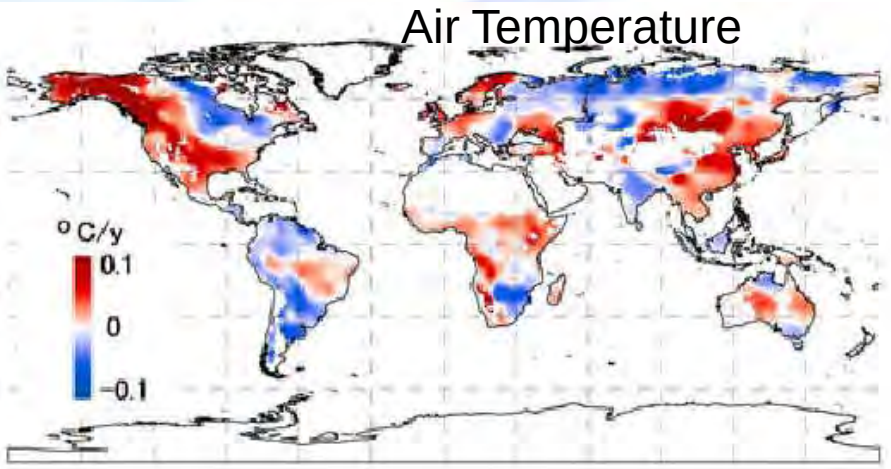


Possible mechanisms

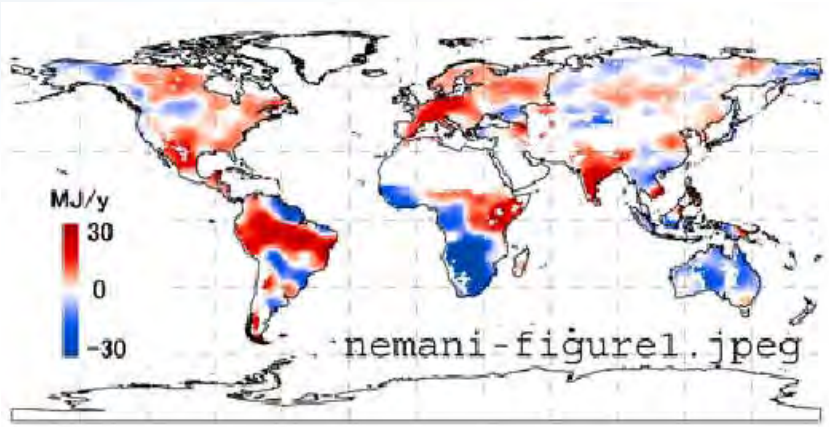
Changes in climate between 1982-1999 played a big role



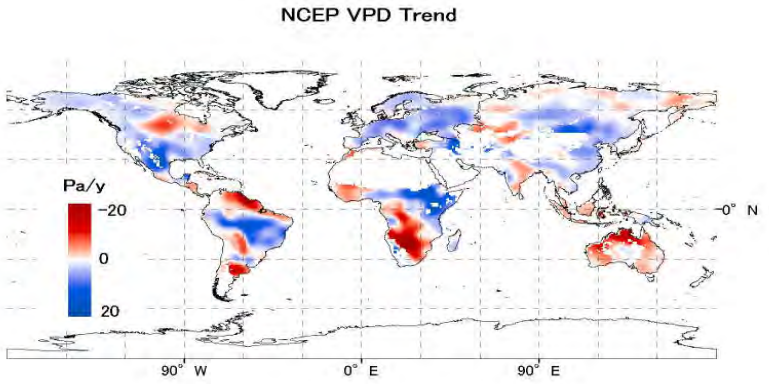
Air Temperature



Water

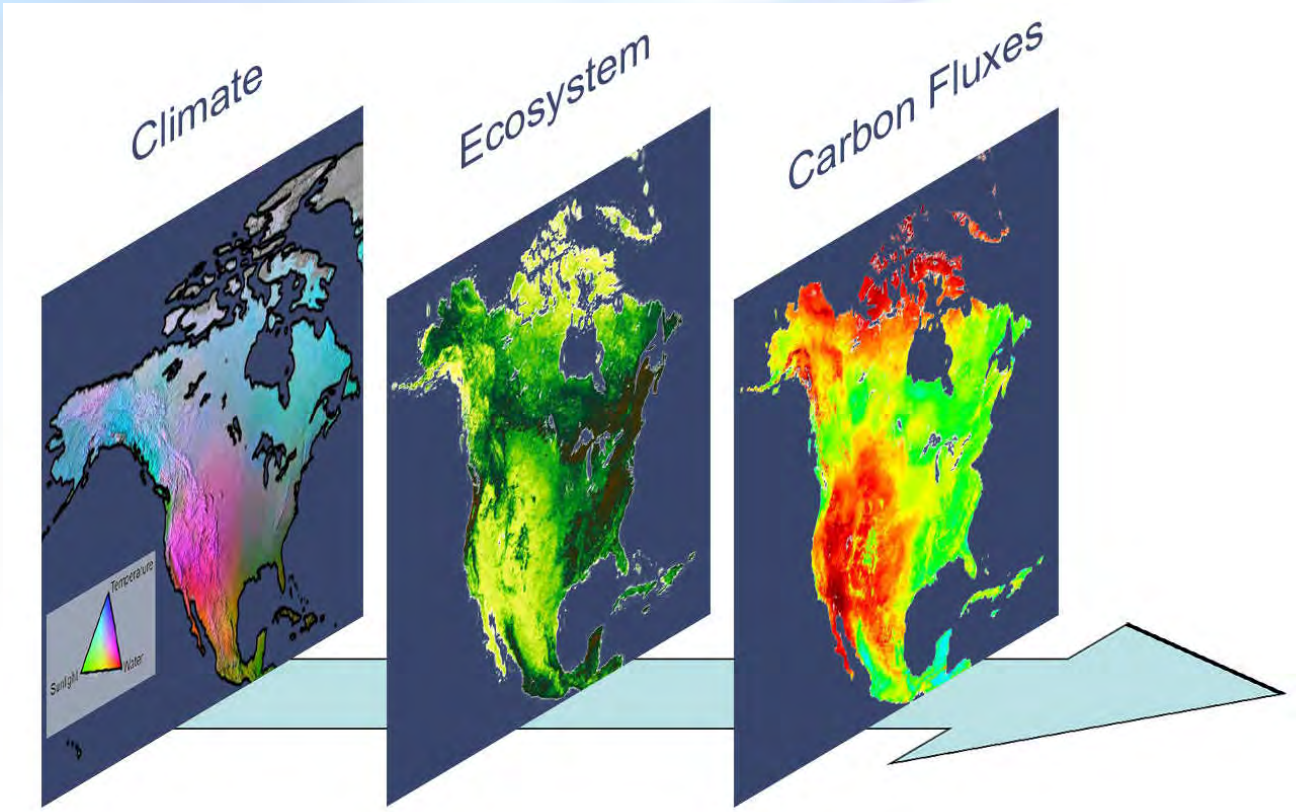


Sunlight



Ensemble Model Experiments using Columbia

- TOPS
- BGC
- CASA
- LPJ
- BEAMS
- SimCYCLE
- ⋮
- More

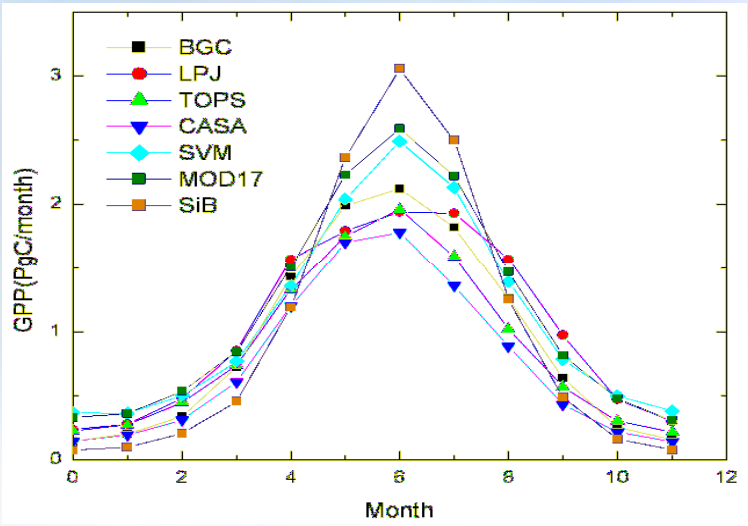


Similar to climate modeling, but for Carbon

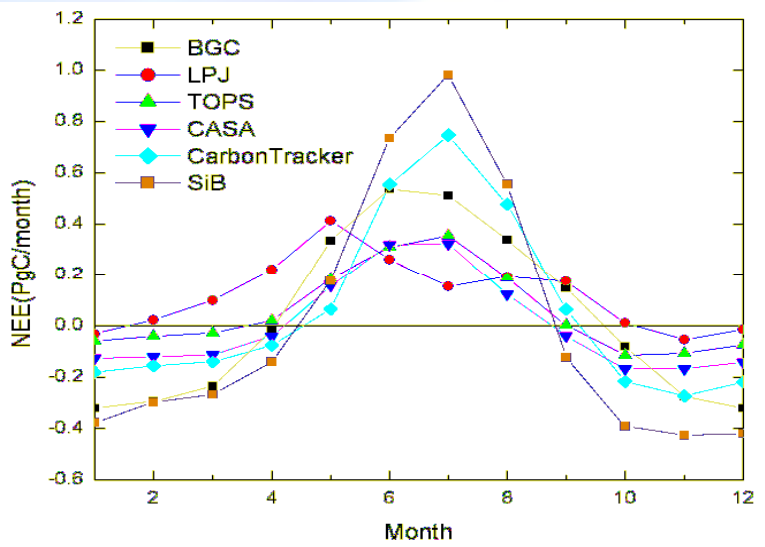
Wang, Michaelis, Dungan

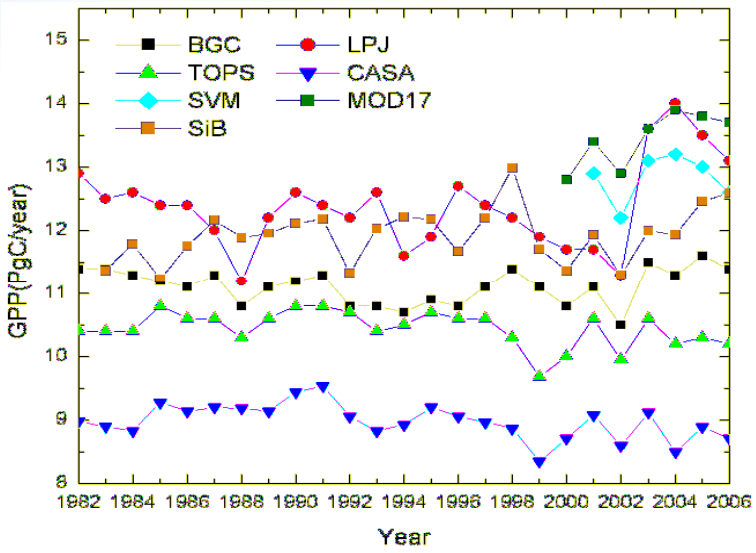
Uncertainties Among Ecosystem Models

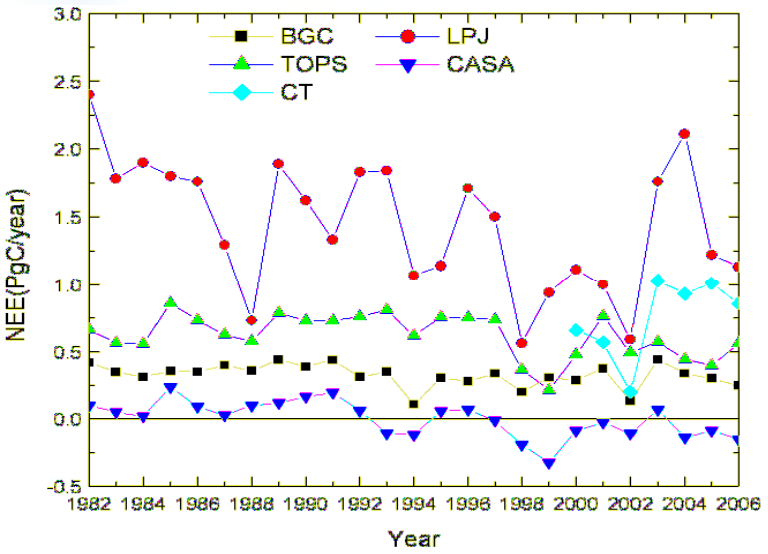
GPP



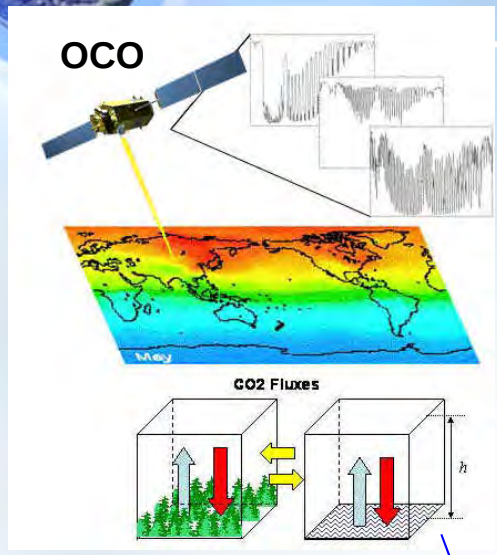
NEE







Carbon Accounting and Carbon Flux from Terrestrial Ecosystems

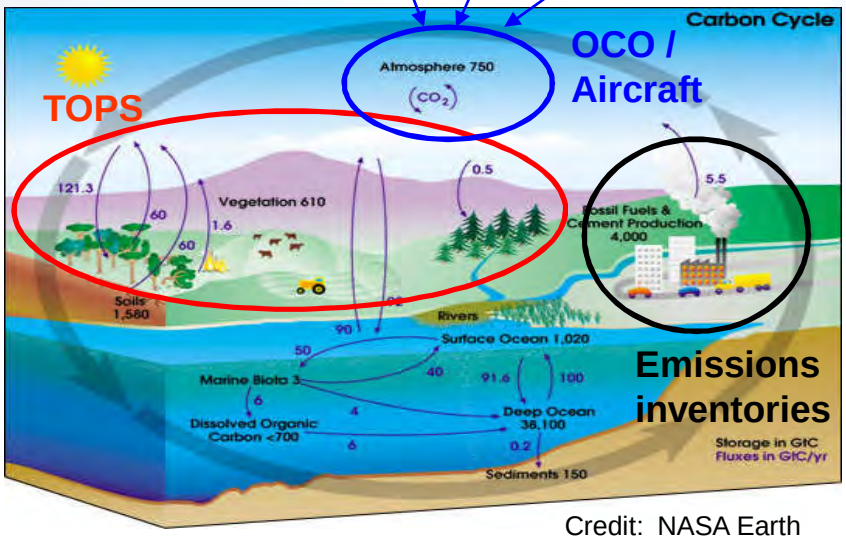


Credit: JPL

Alpha Jet

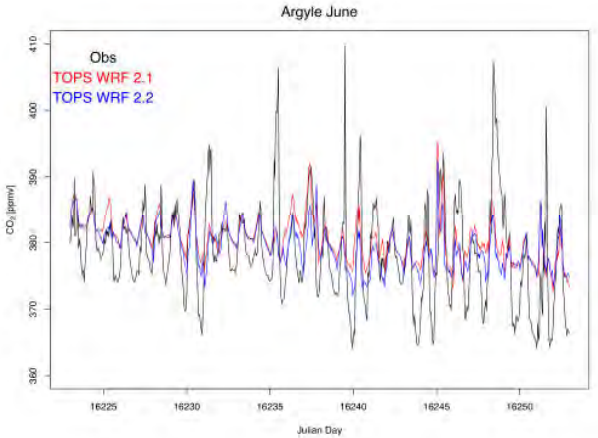
Credit: Adrian Pingstone

Altair

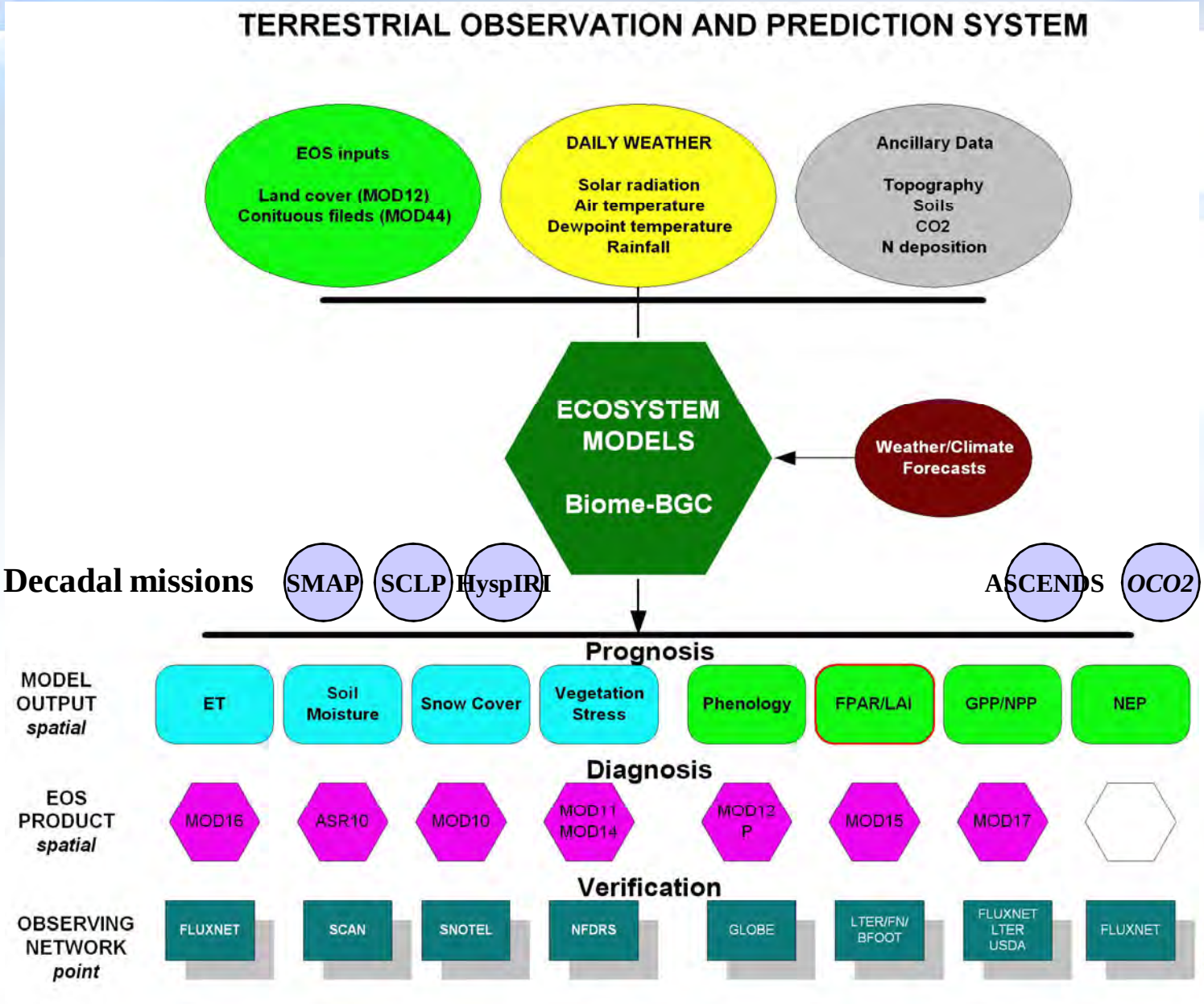


Credit: NASA Earth Science Enterprise

- Using measurements of atmospheric CO_2 concentrations from OCO, the NASA Altair UAV, or the Alpha jet, we can estimate local anthropogenic emissions by subtracting TOPS' estimated fluxes from natural ecosystems
- Estimates can be used to validate emissions inventories and identify unreported emission sources



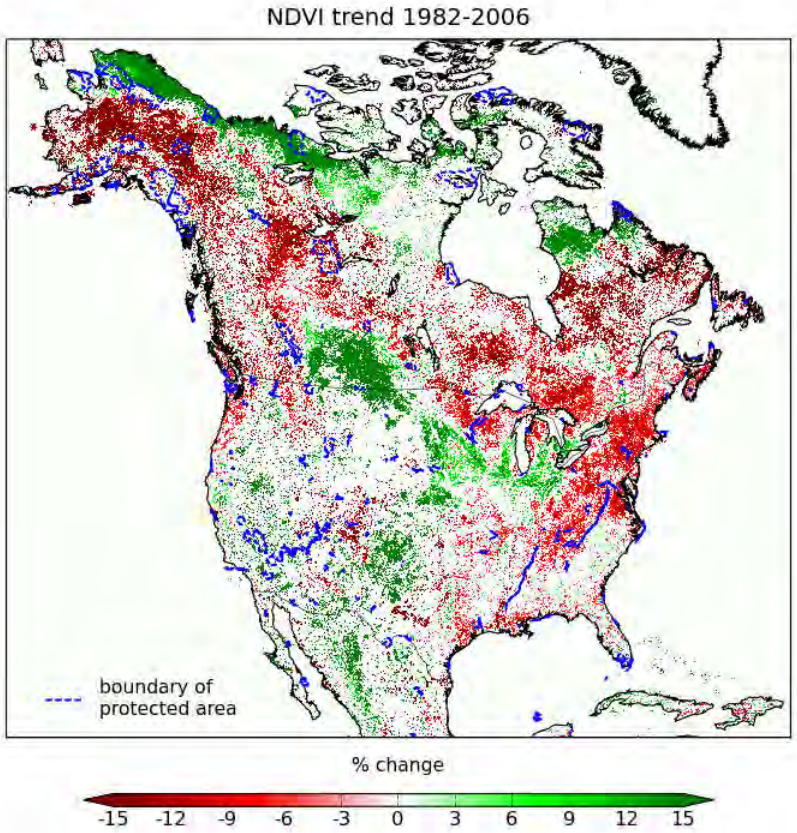
TOPS in support of NASA missions

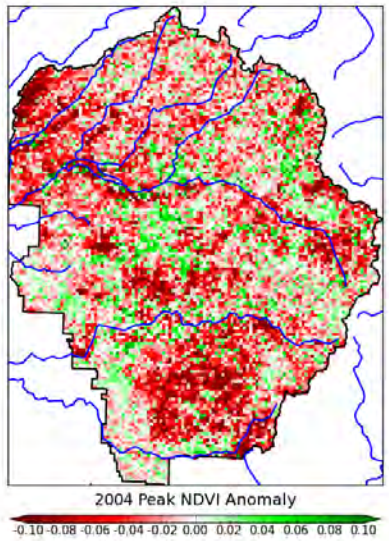


TOPS Applications

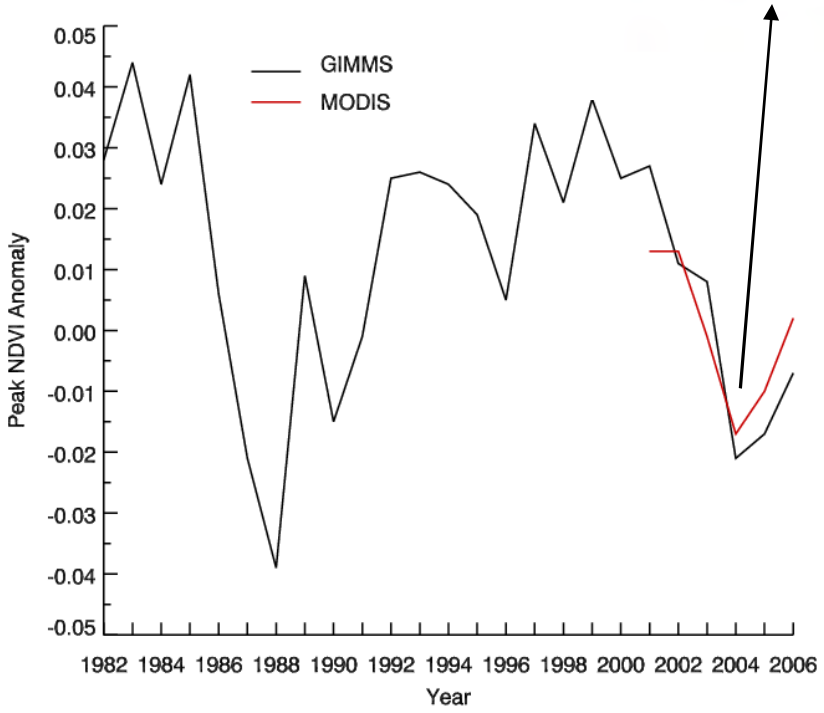
- Monitoring National Parks
- Public Health
- Fisheries
- Crop Insurance
- Coral Reef Health
- Irrigation Management

Protected area monitoring with TOPS



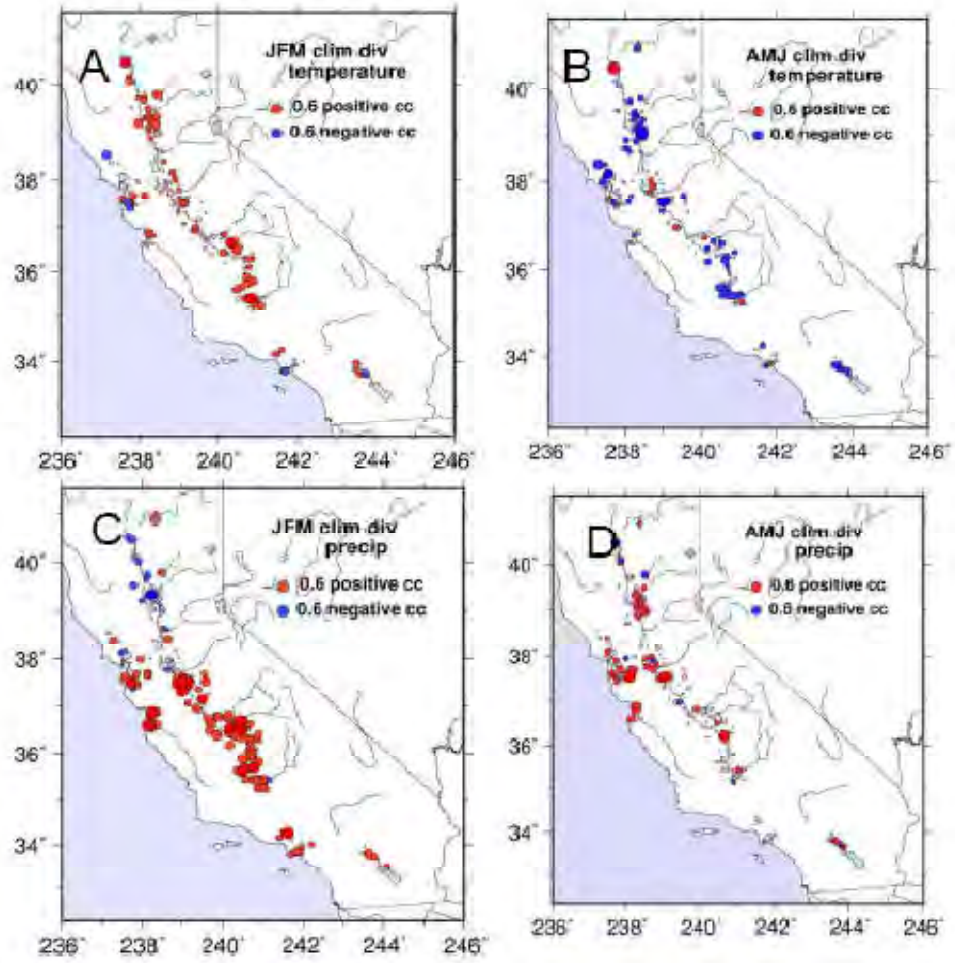


Yosemite National Park



Nemani et al., RSE, 2008

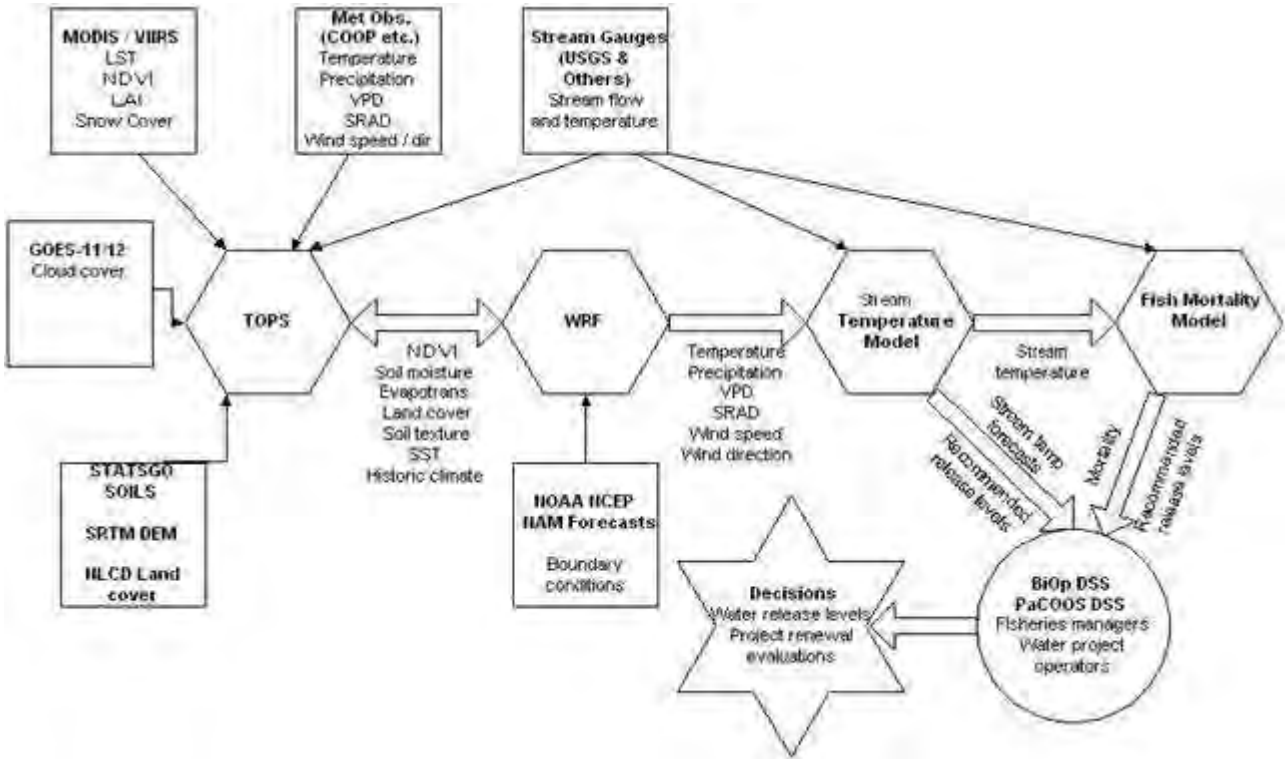
Using TOPS Data to Identify Drivers of Mosquito Abundance and Virus Transmission Risk in California and western U.S.

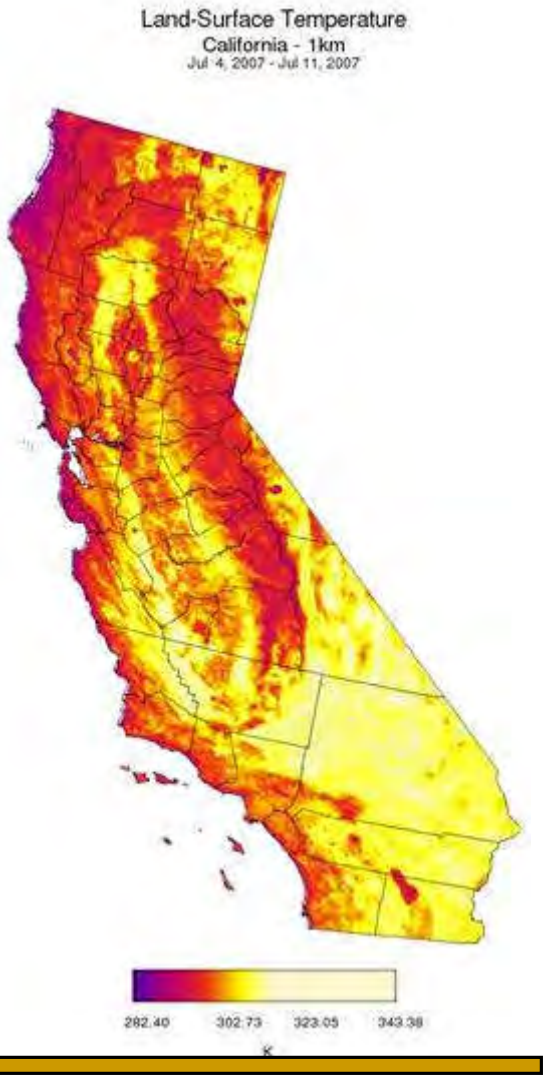


Correlations between temperatures and mosquito abundance in CA

These relationships are being used to develop predictive models.

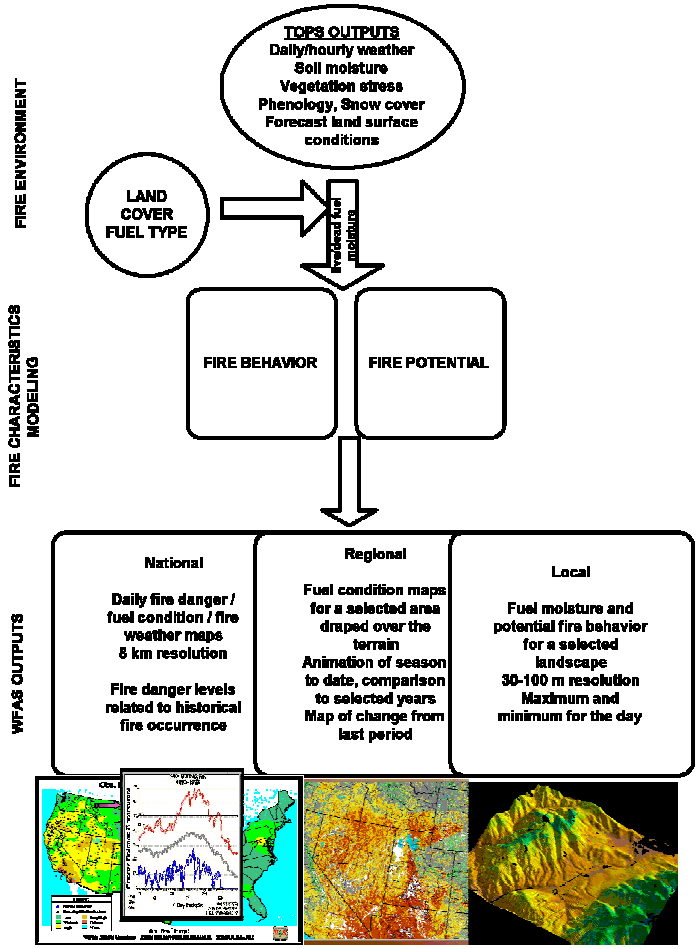
Future Application for NOAA Fisheries:
Forecasting Stream Temperature for Anadromous Fisheries Management





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.

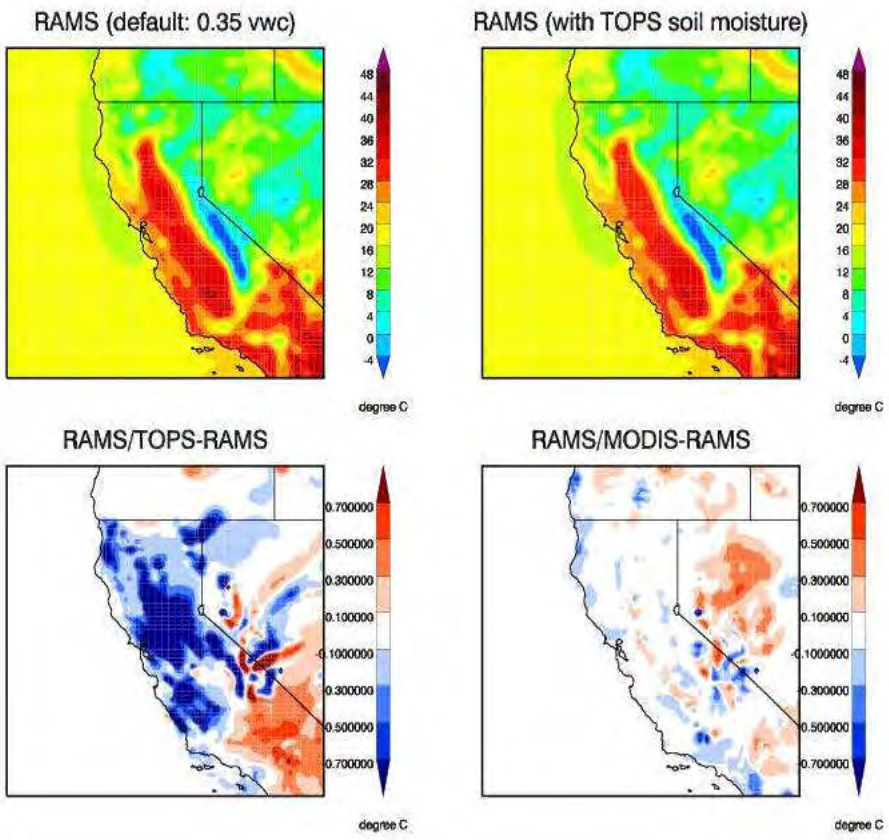
Wildfire Monitoring

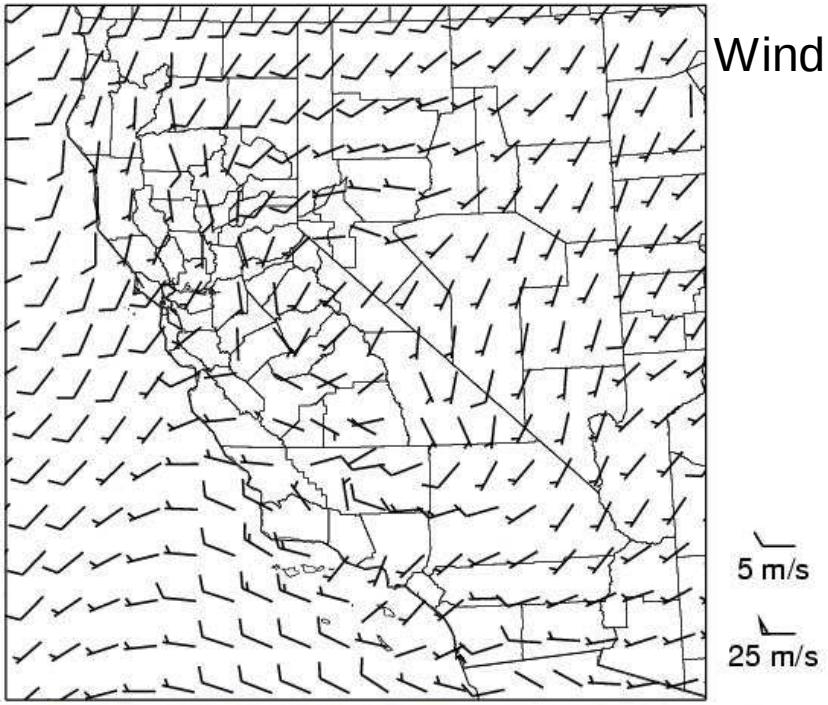


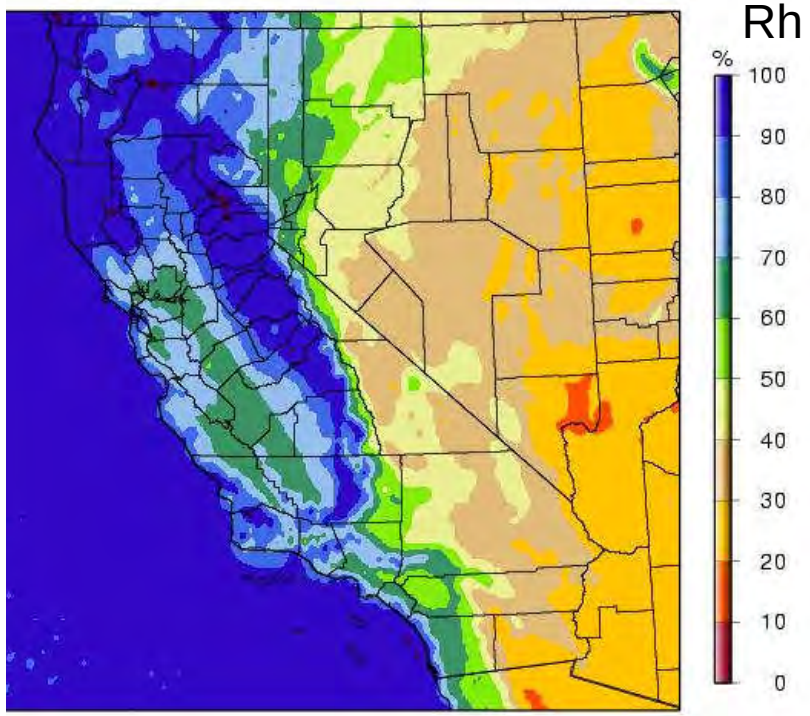
Rapid Prototyping Concept MODIS/TOPS/RAMS

TOPS/RAMS Simulations in support of small fires

20x20km around the fire
Rapid delivery (<30mts)
Ability to update







Irrigation Forecast for week of July 19-26, 2005

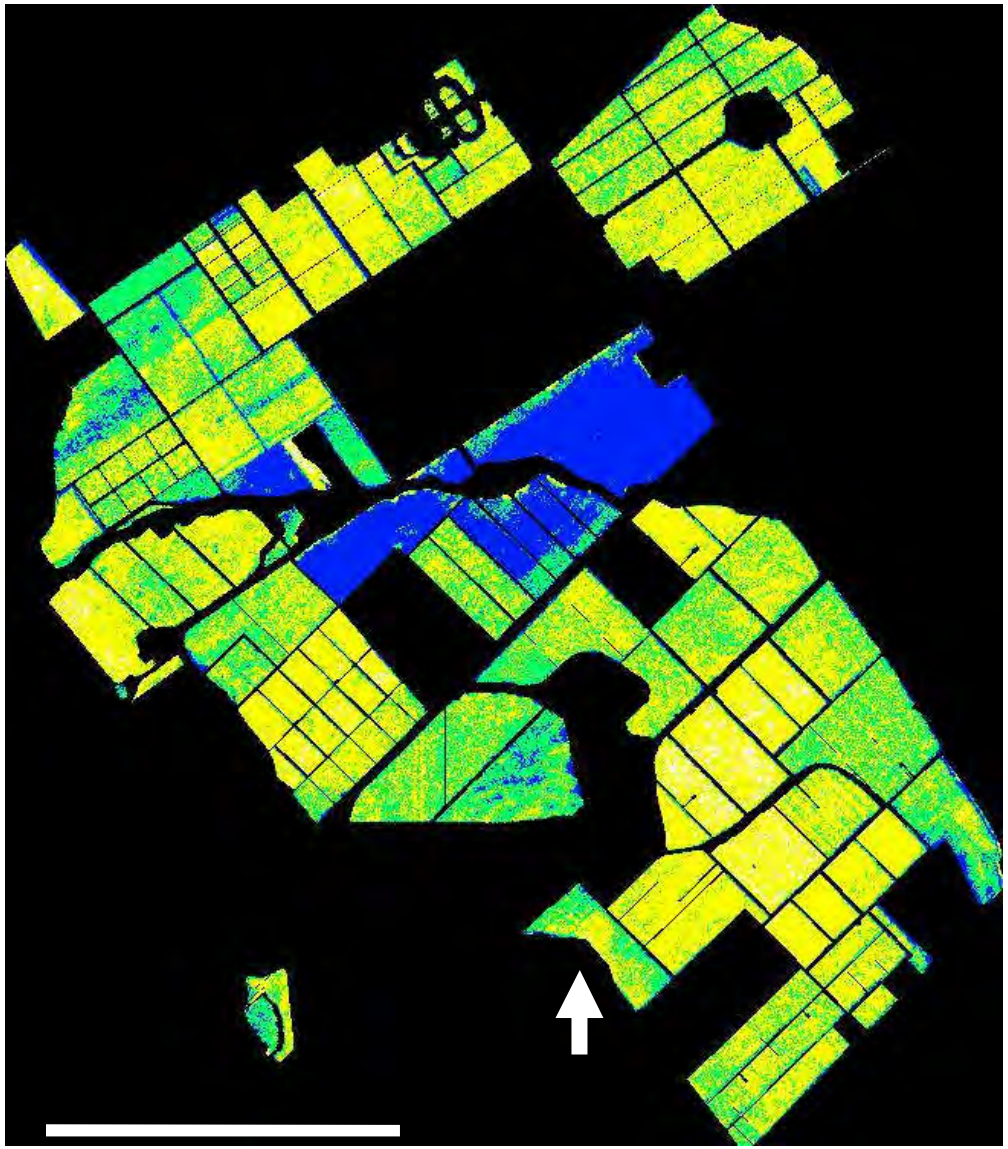
Tokalon Vineyard, Oakville, CA

CIMIS Measured Weather Data through July 18, 2005

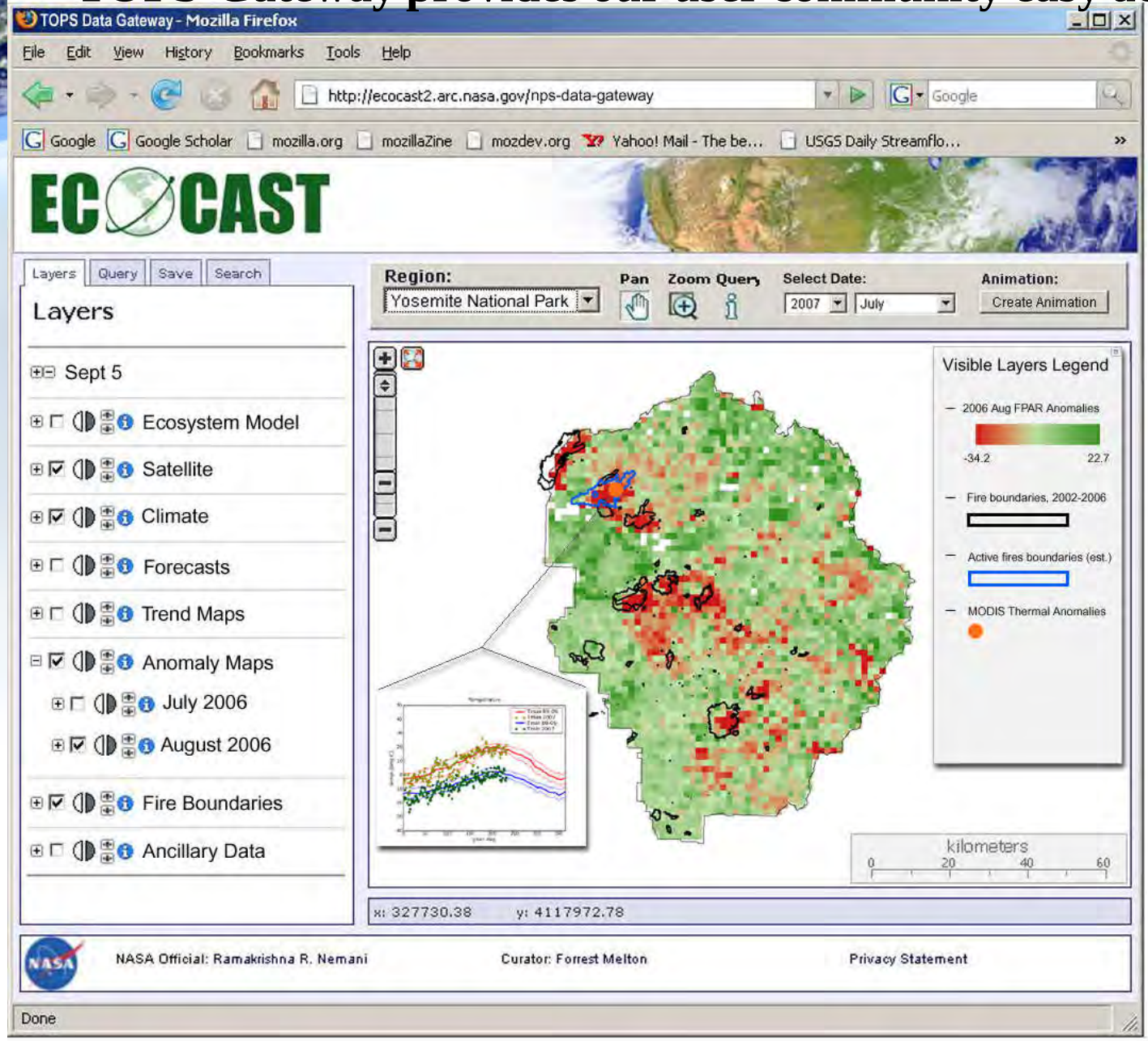
NWS Forecast Weather Data July 19-26, 2005

0 30

Forecast Irrigation (mm)



TOPS-Gateway provides our user community easy access to data



Funded by REASON,Melton/Hiatt

Summary

Potential exists for providing ecological forecasts of various lead times

Characterizing and communicating uncertainty remains a key issue

We need:

Improved in-situ monitoring networks.

Rapid access to satellite data.

Better linkages among models.

Comprehensive framework for data management

Improved delivery systems to decision makers