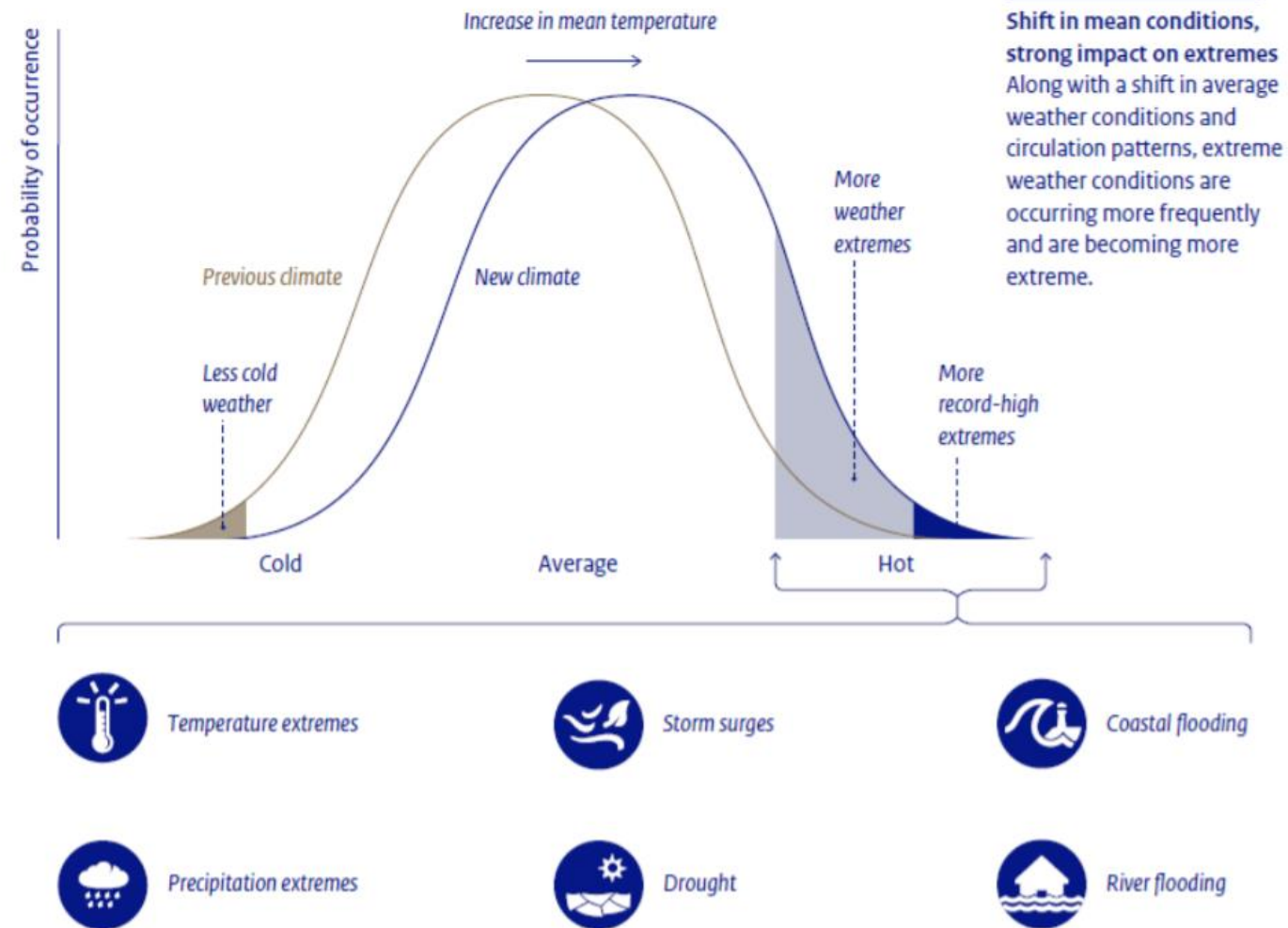


Smart Water Management Tools Based on Integrated flood and Drought management

Mehdi Rahnema



Source: Ligtoet W. et al. (2018), The Geography of Future Water Challenges, The Hague: PBL Netherlands Environmental Assessment Agency

Review Water Resources Schema: Climate change is hydrologic change

More intense storms with more flooding and extreme winds

Less precipitation in some areas, more in other areas. Greater interannual variability

More rain and less snow. Snow melts sooner in Spring

More evapotranspiration. Drier vegetation and soils. More frequent and severe droughts. Increased wildfires and area burned. Reduced stream flows.

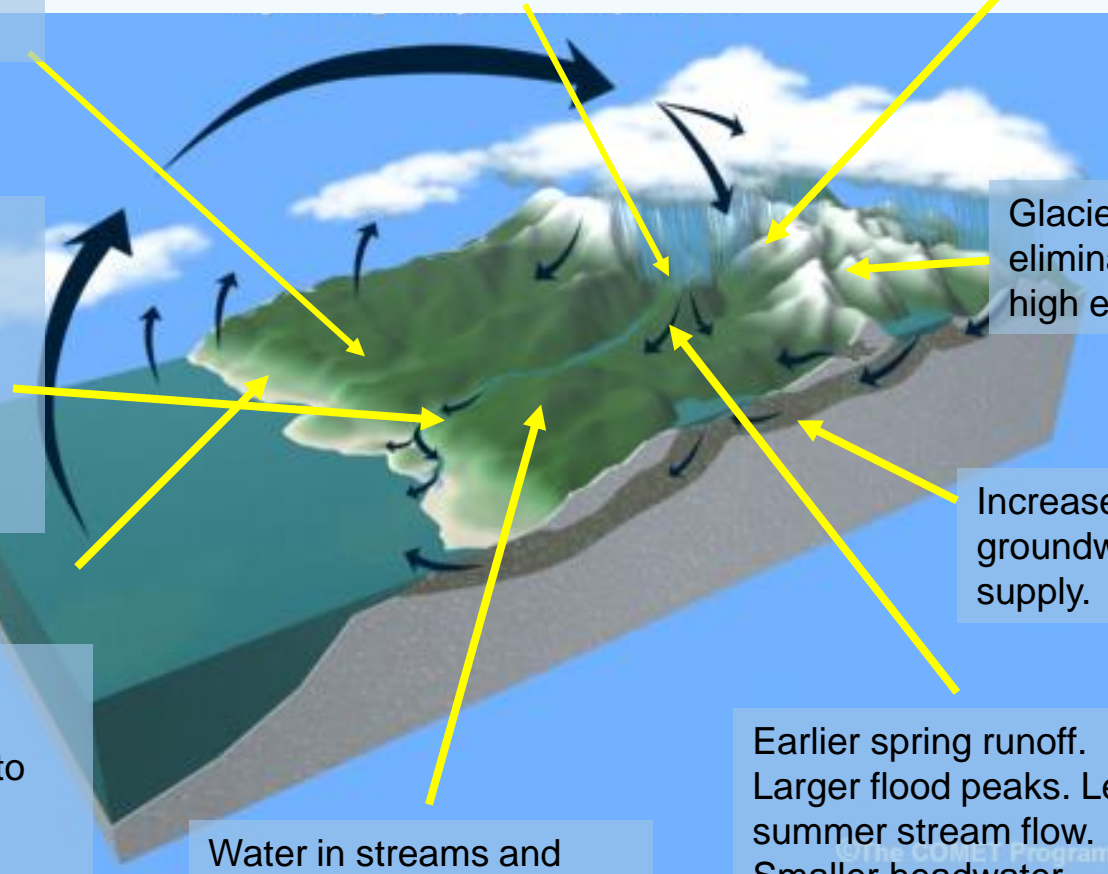
Glaciers are reduced or eliminated. Increased high elevation erosion.

Increased reliance on groundwater for basic supply.

Sea level rises. More coastal erosion. Saltwater intrusion into coastal freshwater aquifers. Sea water acidification.

Water in streams and lakes becomes warmer.

Earlier spring runoff. Larger flood peaks. Less summer stream flow. Smaller headwater stream networks



Climate change impacts on water resources

Climate change amplifies risks we already face, and have faced for many years:

- Drought
- Flood
- Water supply shortages and distribution
- Poor water quality
- Disrupted watershed processes
- And so on

Climate Change increases the risks, problems and stakes



Potential climate change impacts to water

- Less snow, more rain
- Increased winter flooding
- Less snowpack
- Earlier snowmelt
- Lower summer streamflows
- Increased stream and lake temperature
- Increased risk to aquatic ecosystems and fish species



Potential climate change impacts

- Longer, warmer growing seasons
- Increased and decreased forest growth and ecosystem productivity
- Warming surface waters
- Intense droughts
- Longer and more severe fire seasons
- Increased insect and disease



For Example: Drought intensity and severity is expected to increase



What solution do we have?

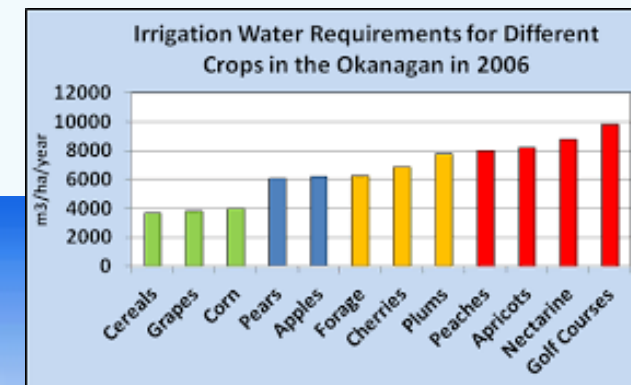
Short-term Monitoring and Forecasting



Sacramento river flooding, California



Irrigation requirements



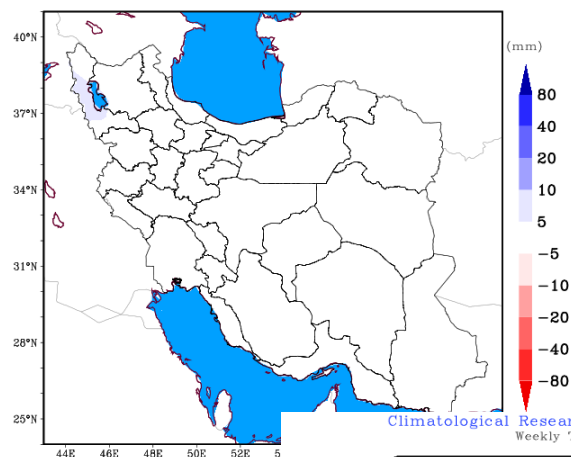
Based on weather forecasts, conditioned on historical ecosystem state hours to days

Mid-term/Seasonal Forecasts of water resources, temrature, fire risk, phenology

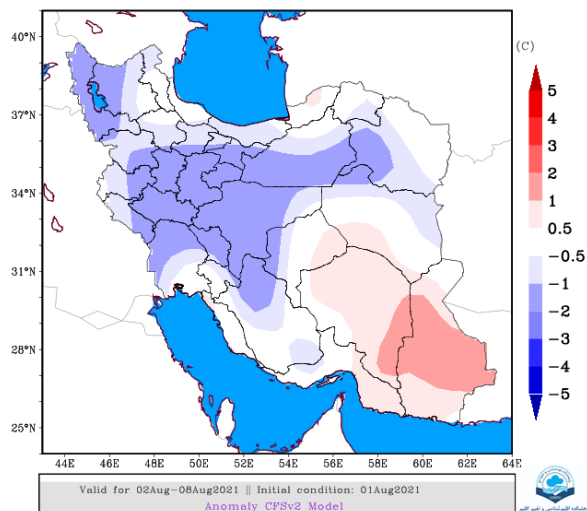
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و علوم جو



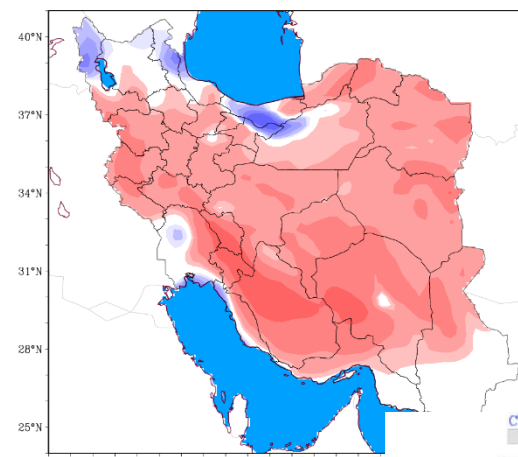
Climatological Research Institute (CRI) Weekly Forecast
Weekly Precipitation Anomaly(mm)



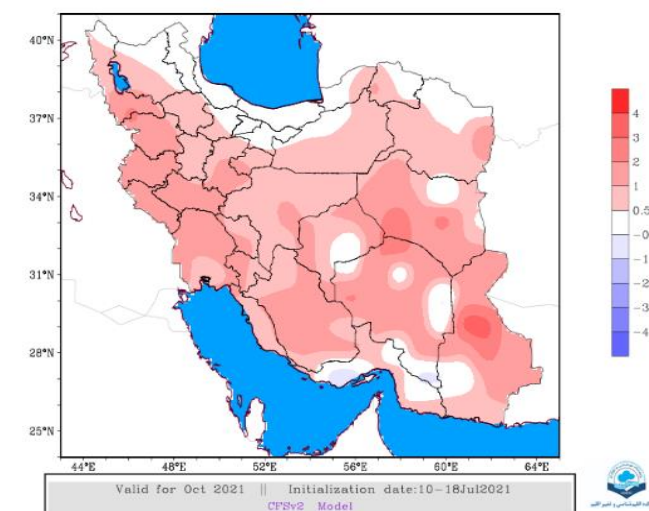
Climatological Research Institute (CRI) Weekly Forecast
Weekly Temperature Anomaly(C)



Climatological Research Institute (CRI) Monthly Forecast
Monthly Precipitation Anomaly(mm) | Issued 19Jul2021

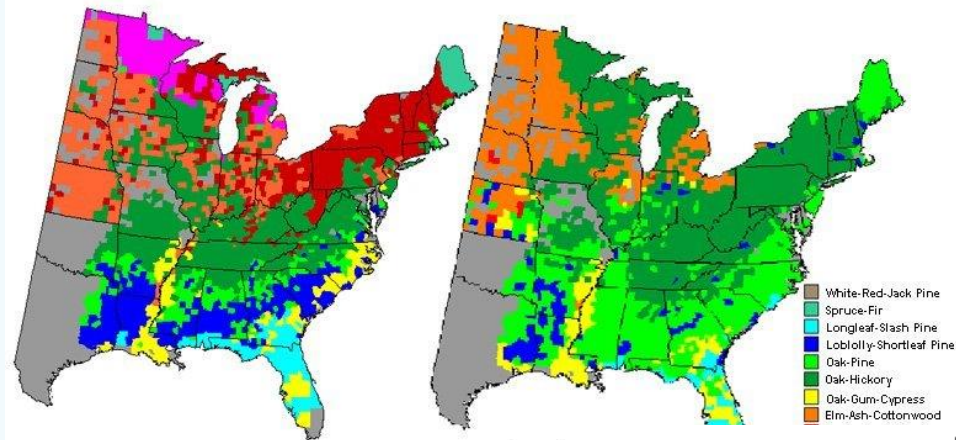


Climatological Research Institute (CRI) Monthly Forecast
Monthly Temperature Anomaly(C)



Weeks to months

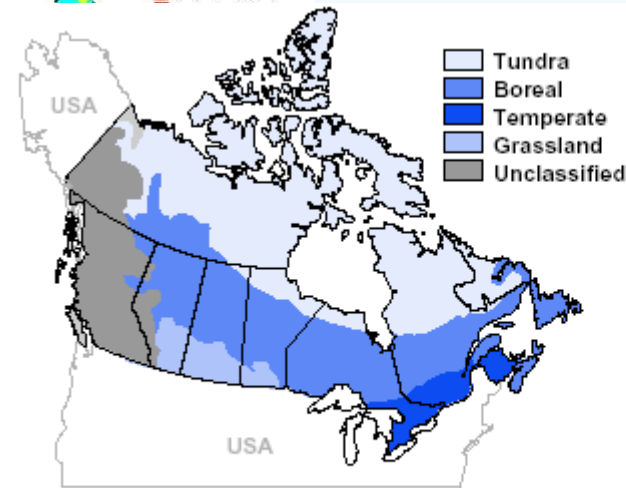
Long-term Projected changes



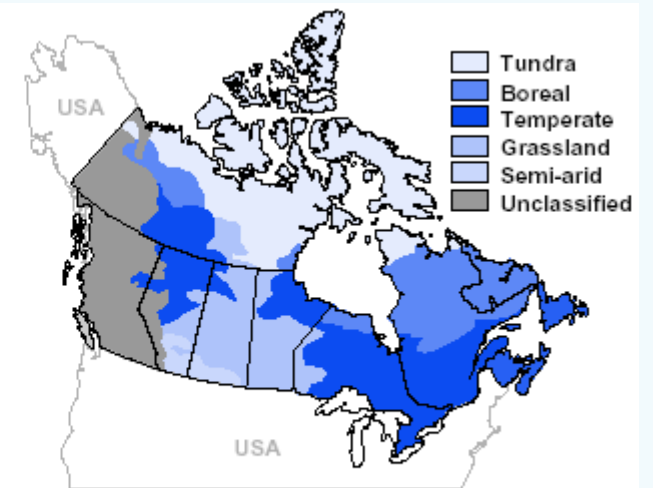
Dominant Forest Type
Current

Predicted Fore
(Average of 5 Clim)

Based on GCM outputs
Decades to centuries



Present day

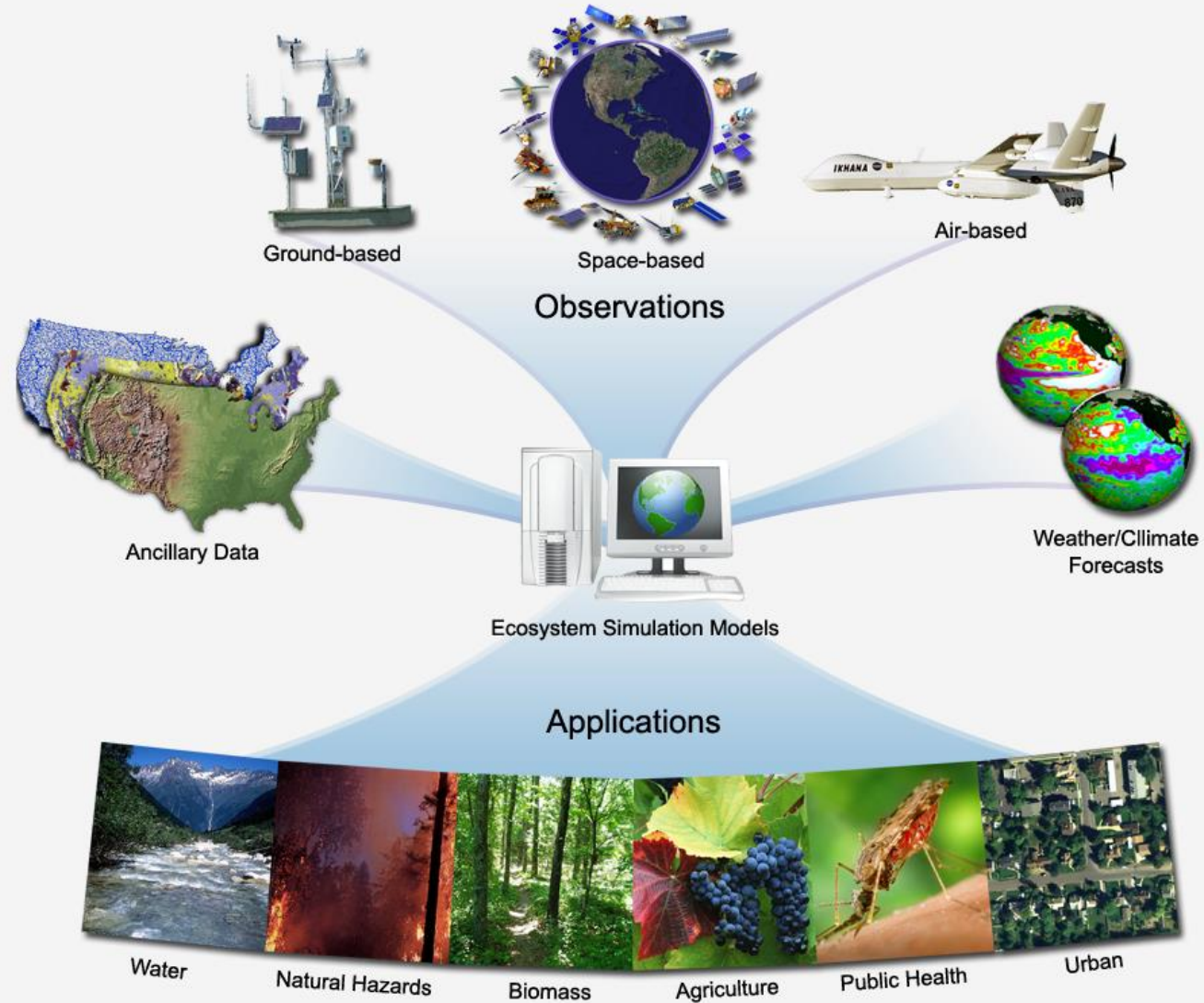


Doubled-CO₂ climate

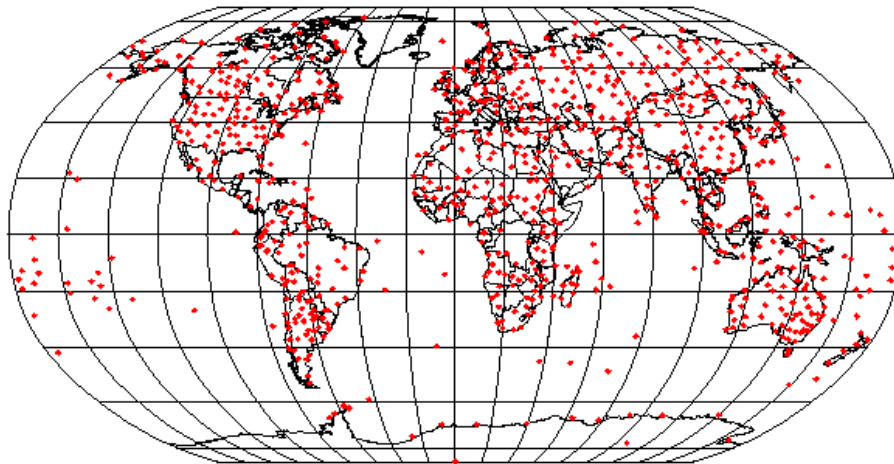
SOURCE: Rizzo 1990.

What tools do we need?

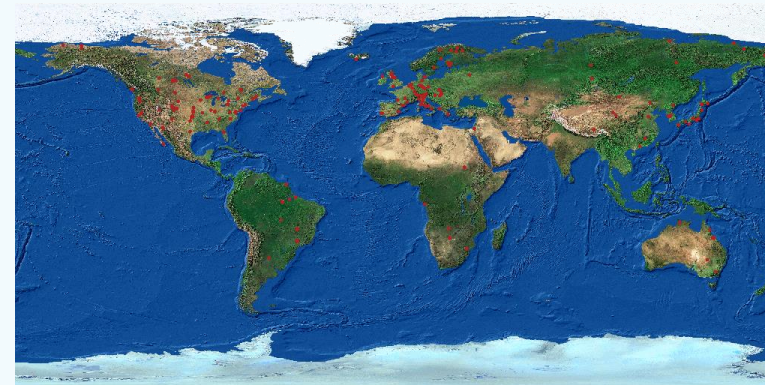
Terrestrial Observation and Prediction System



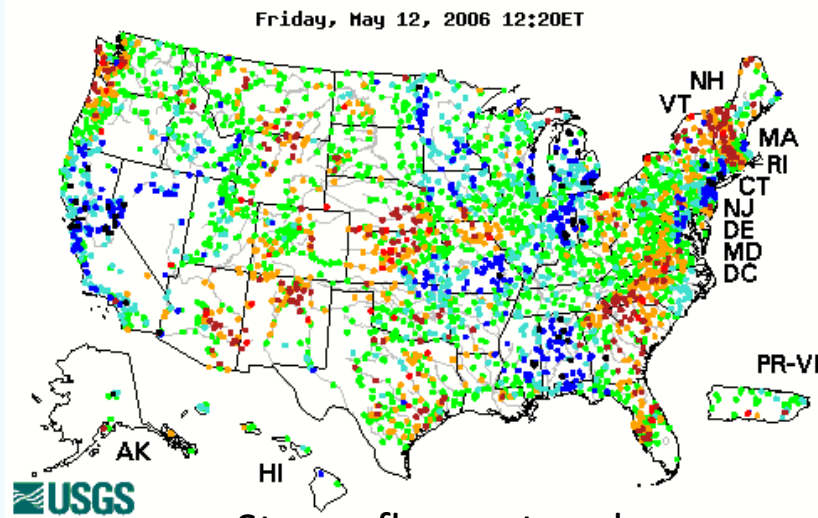
Access to a variety of observing networks



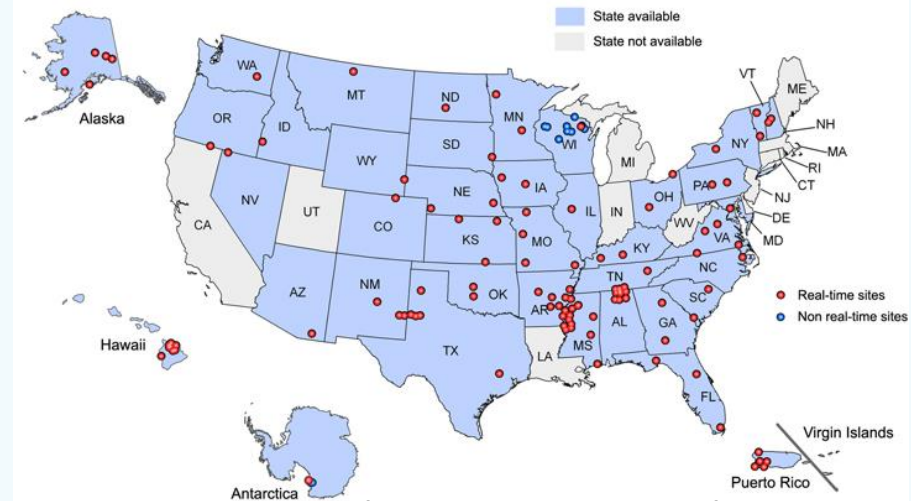
Weather network



Fluxnet



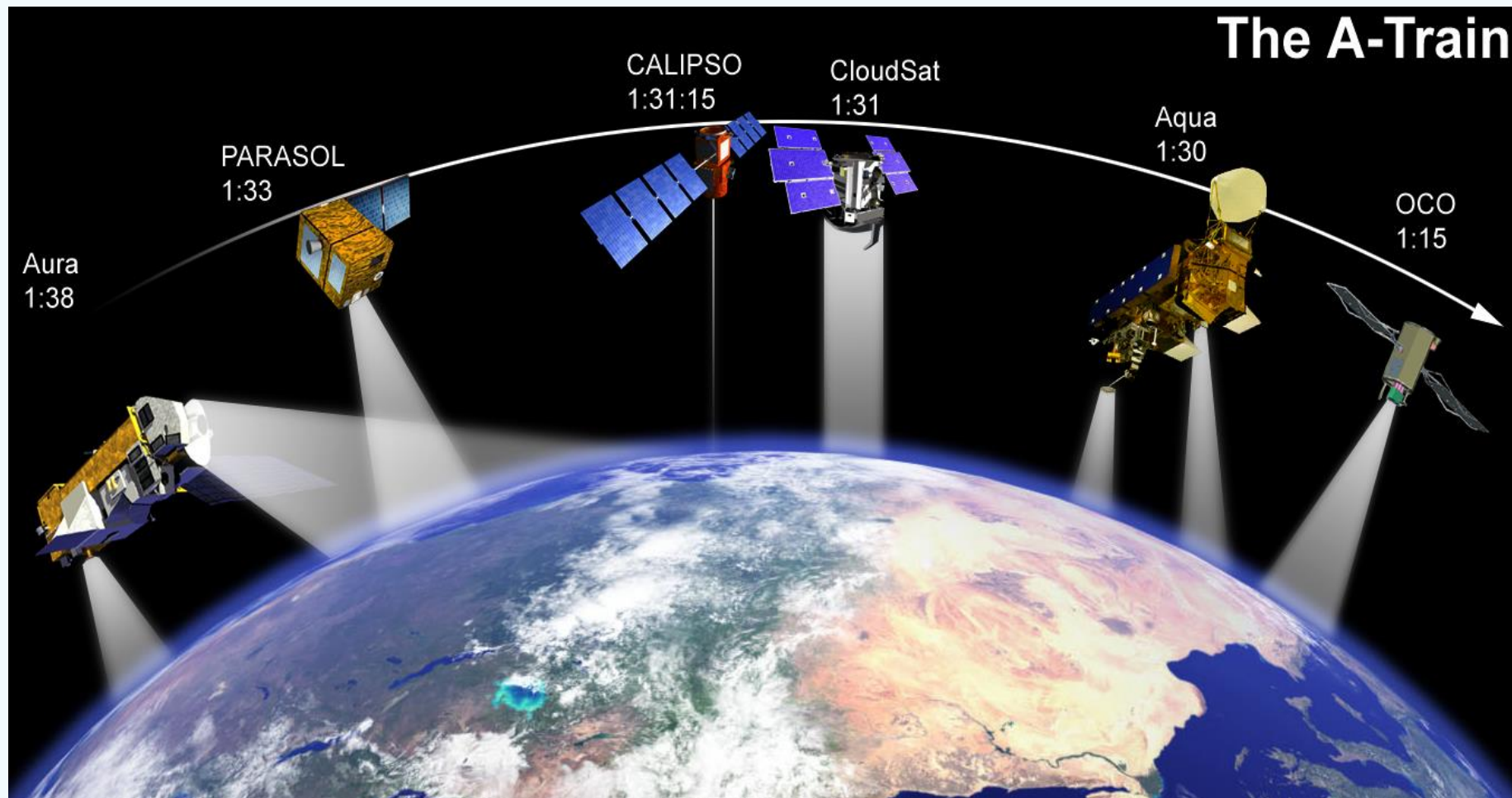
Streamflow network



Soil moisture network

Access to a variety of remote sensing platforms

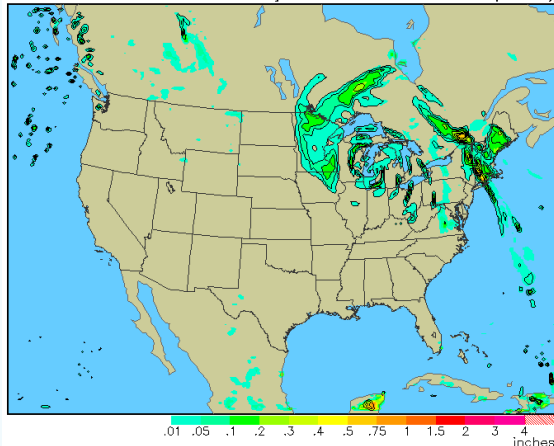
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و علوم جو



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

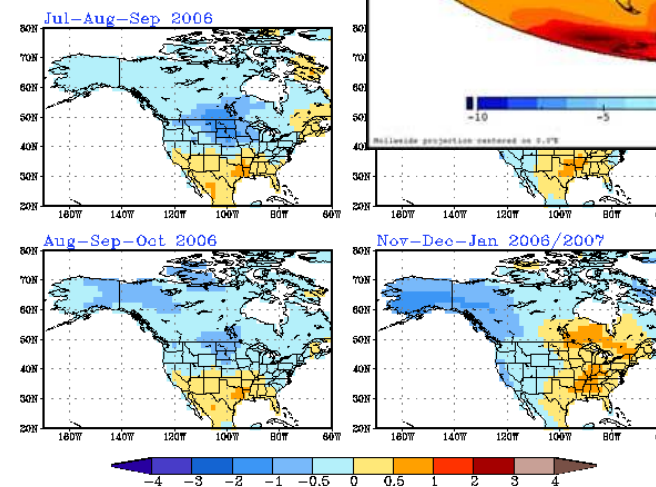
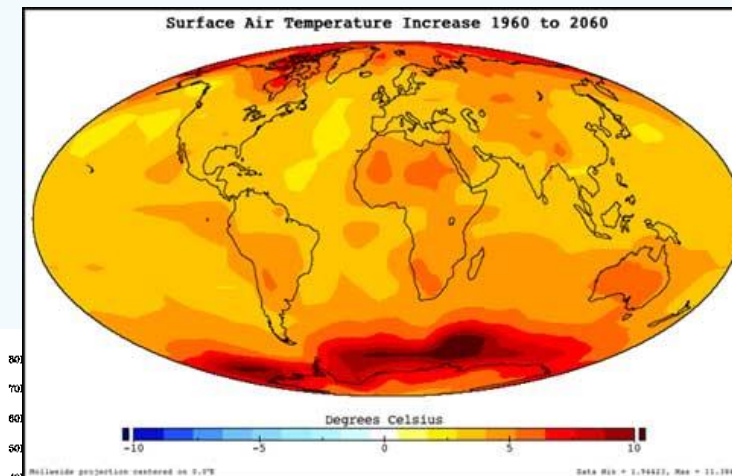
Ability to work across different time and space scales

3-hr accum precip (total-shaded; nonconvect-solid)
12 Hour forecast valid 0300 UTC Sat 13 May 2006 RUC (15x 12 May)



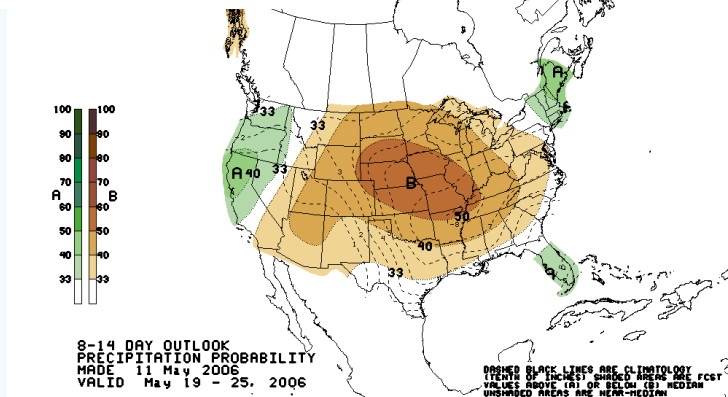
Hours

Years/Decades



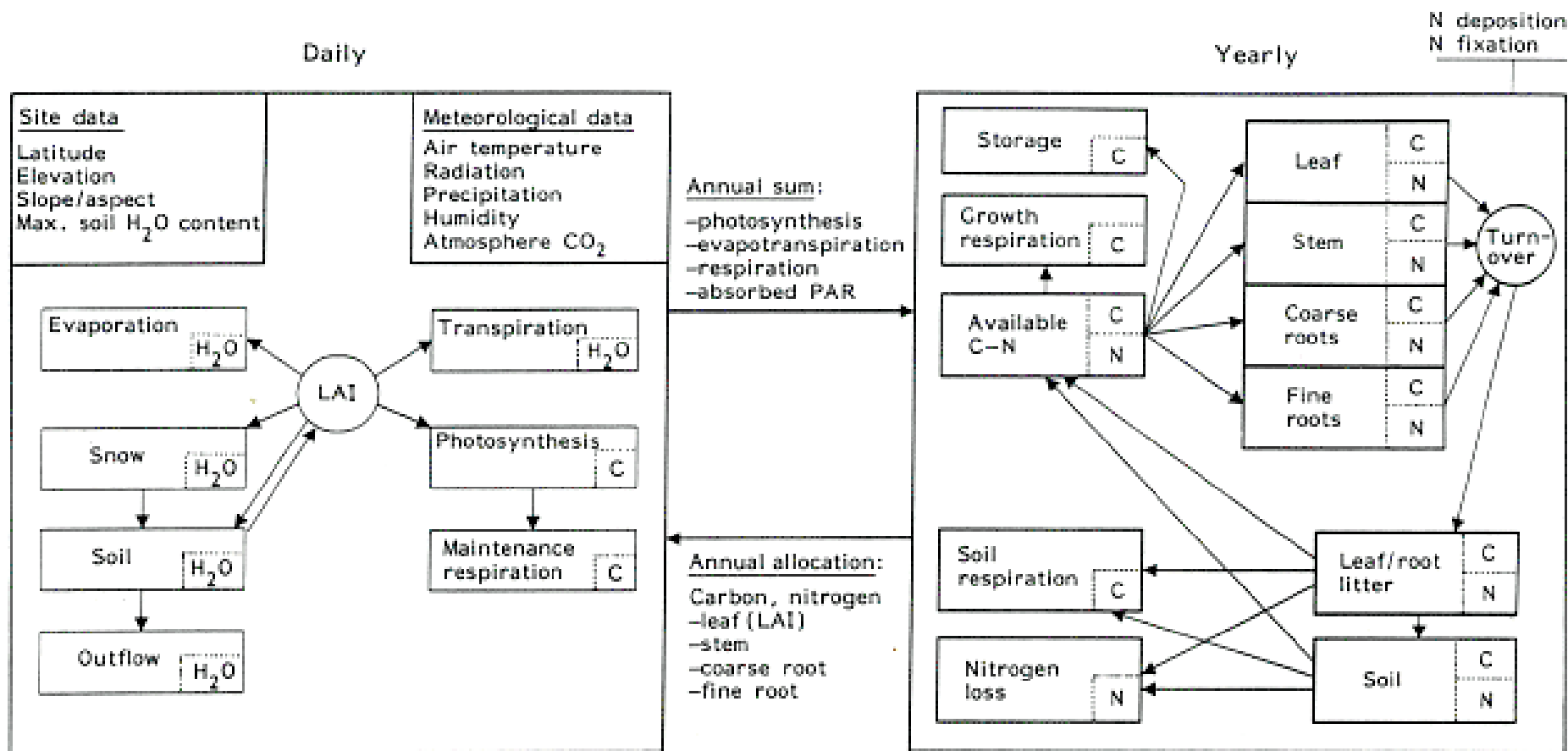
Weeks/Months

Days



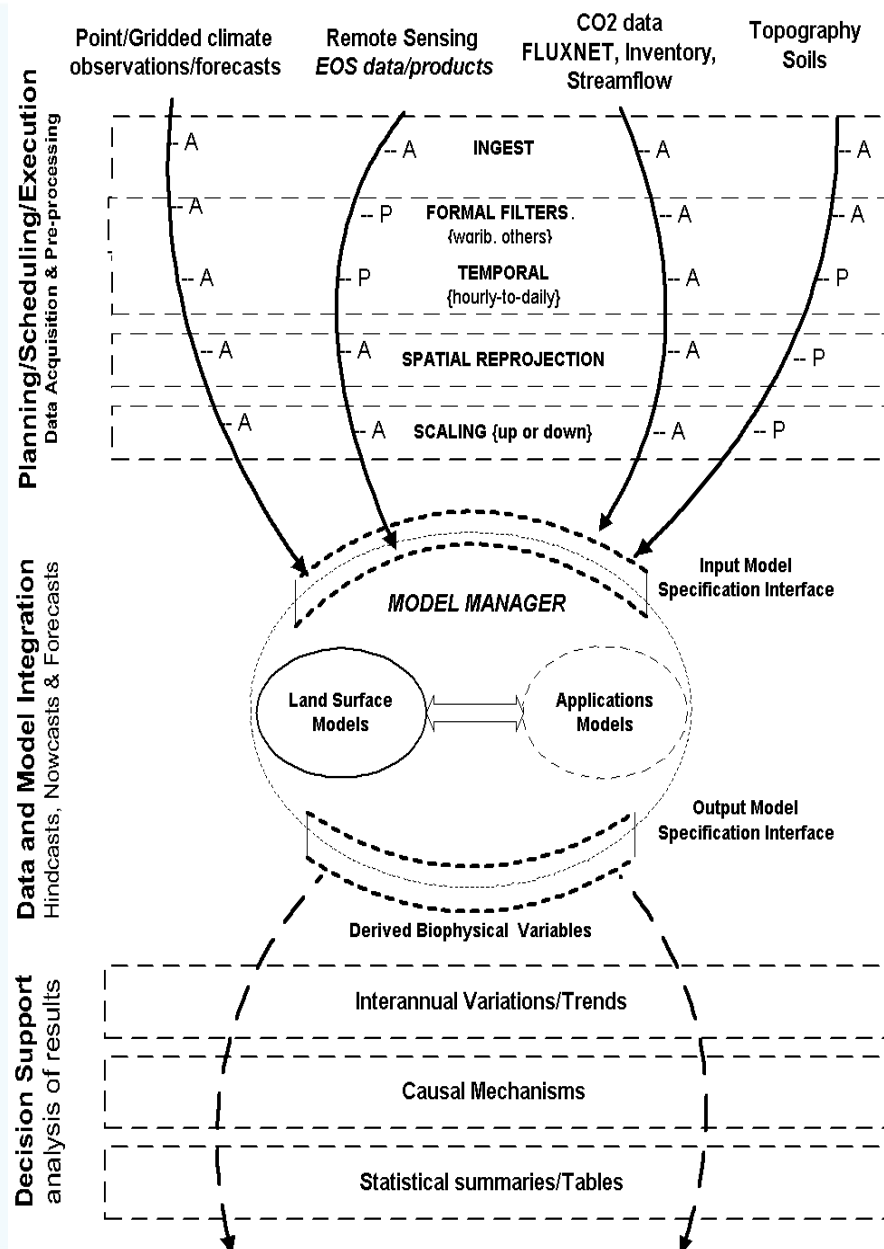
Weather/Climate Forecasts at various lead times downscaling

Ability to integrate a variety of models



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

Prognostic/diagnostic models

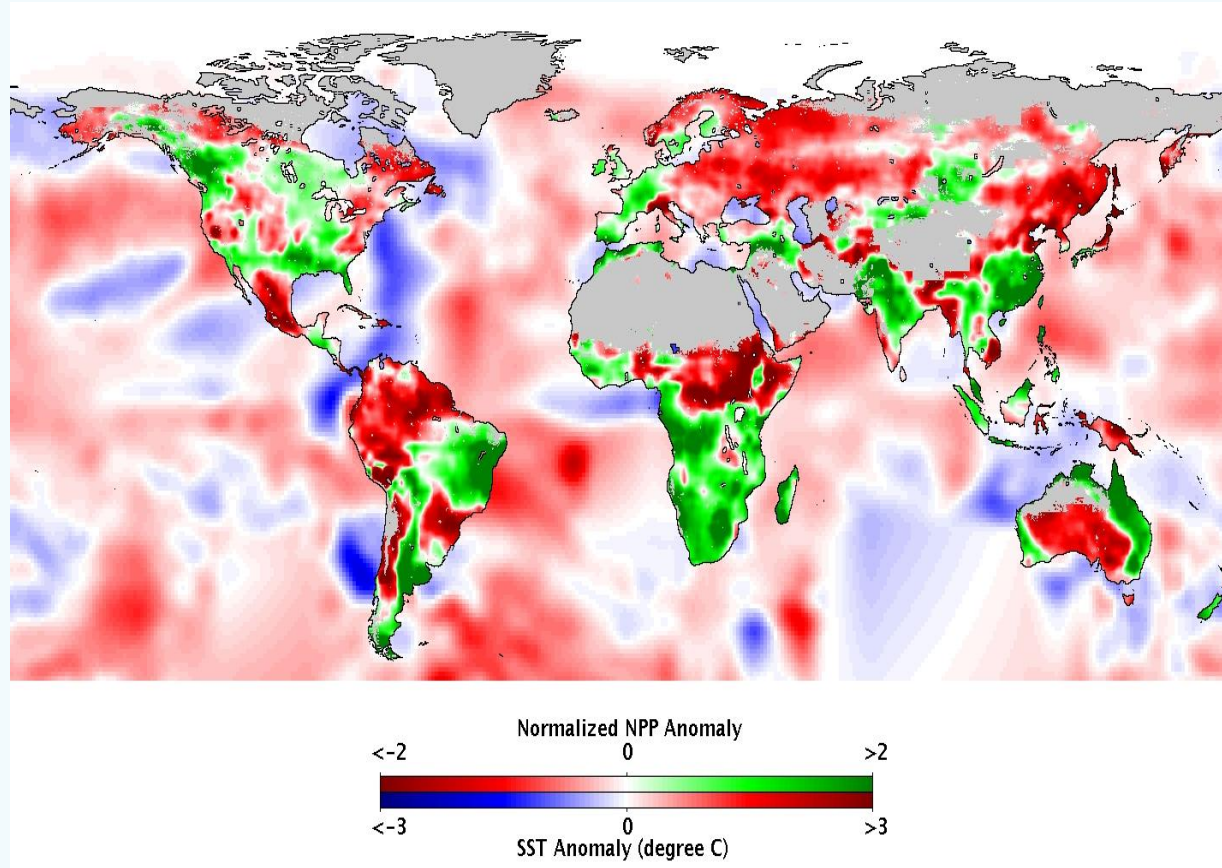


Data – Model Integration

Near realtime monitoring of global NPP anomalies

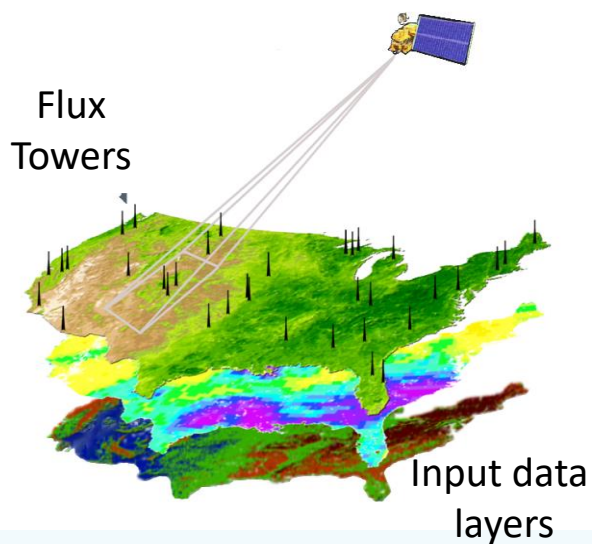
Mapping changes in global net primary production

near real-time depiction of the droughts in the Amazon and Horn of Africa, May 2005



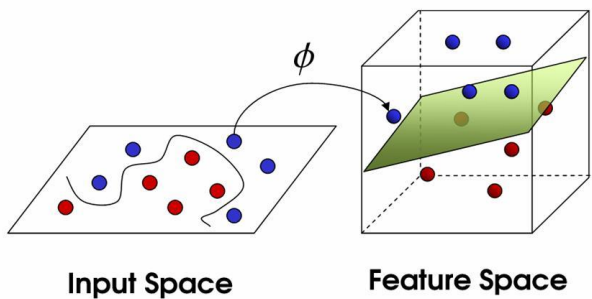
Running et al., 2004, Bioscience, 54:547-560

Flux Towers + Satellite data

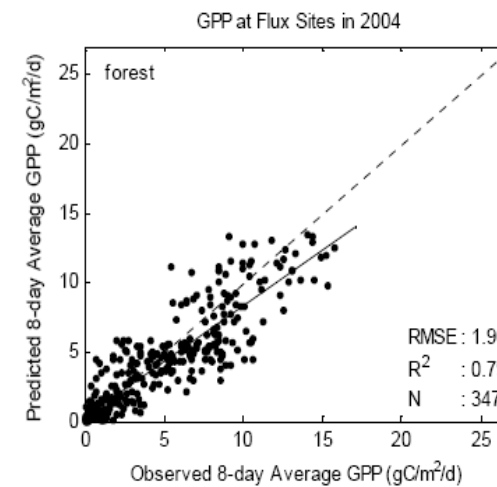
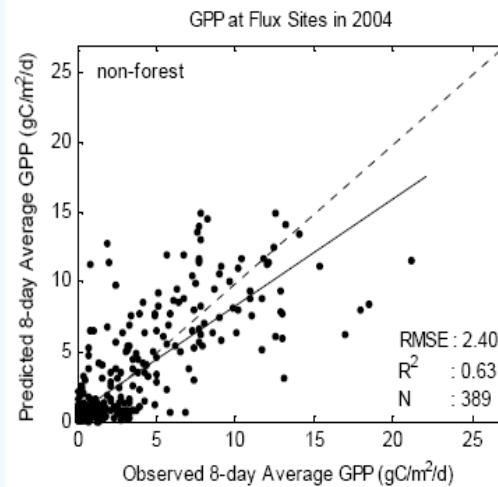


+

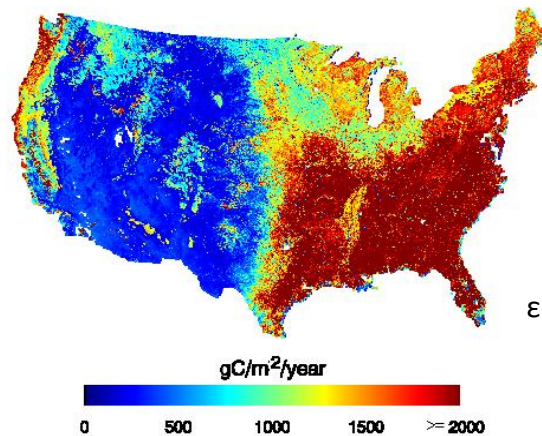
Support Vector Machine



Flux-GPP vs SVM-GPP

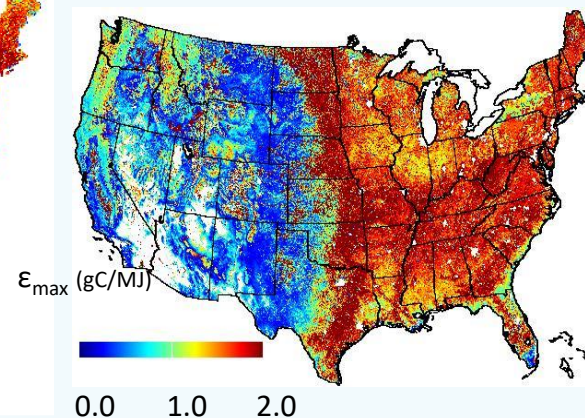


Annual GPP from SVM model



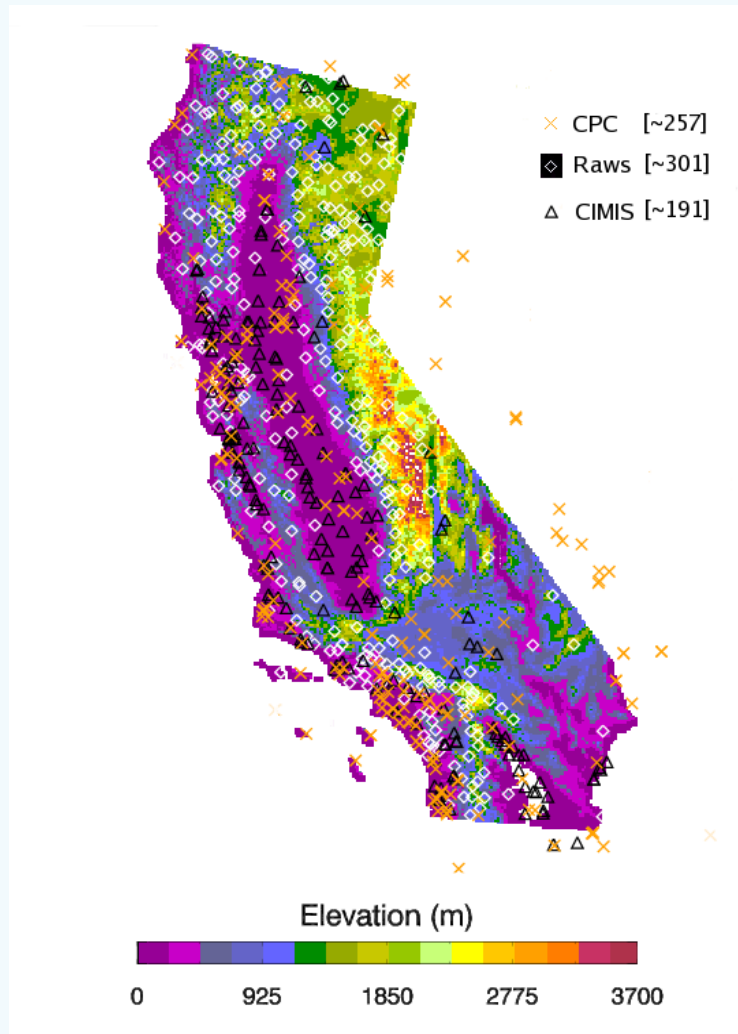
Maximum LUE

Inverted from annual GPP



[Yang et al., 2006]

Weather networks over California since 2000



Large geographic area, 265,000 km²
Population over 35M

Semi-arid climate
Irrigated orchards/crops

Urban/rural water conflicts
Energy shortage

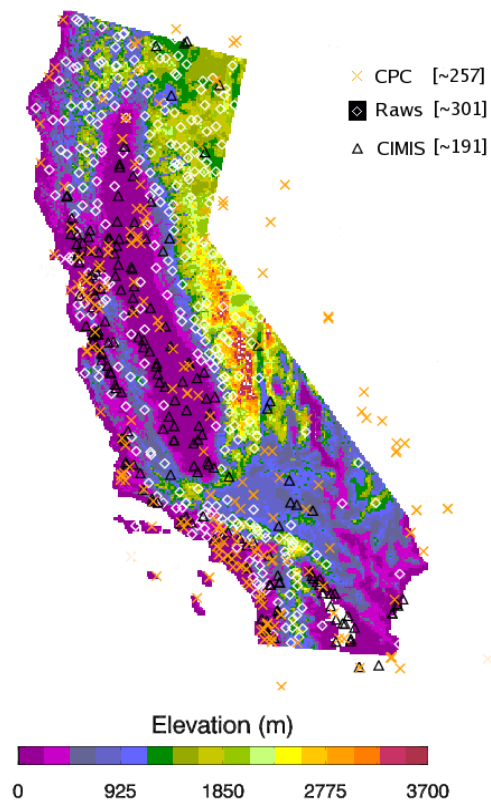
Weather networks often operated by different govt. agencies and/or private industry. Rarely integrated because they are intended for different audiences that should be specialize in bringing them together to provide spatially continuous data.

Daily Weather Surfaces 1KM

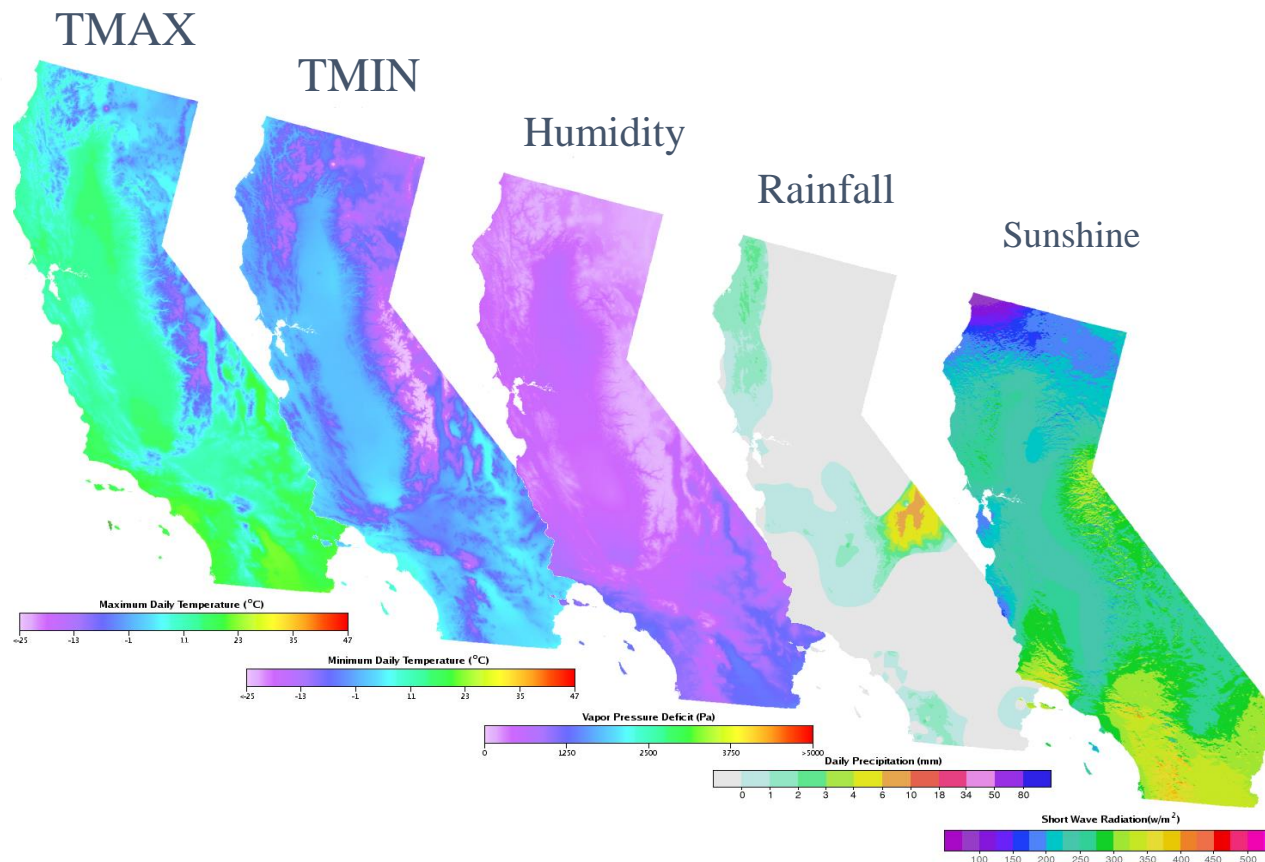
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و علوم جو



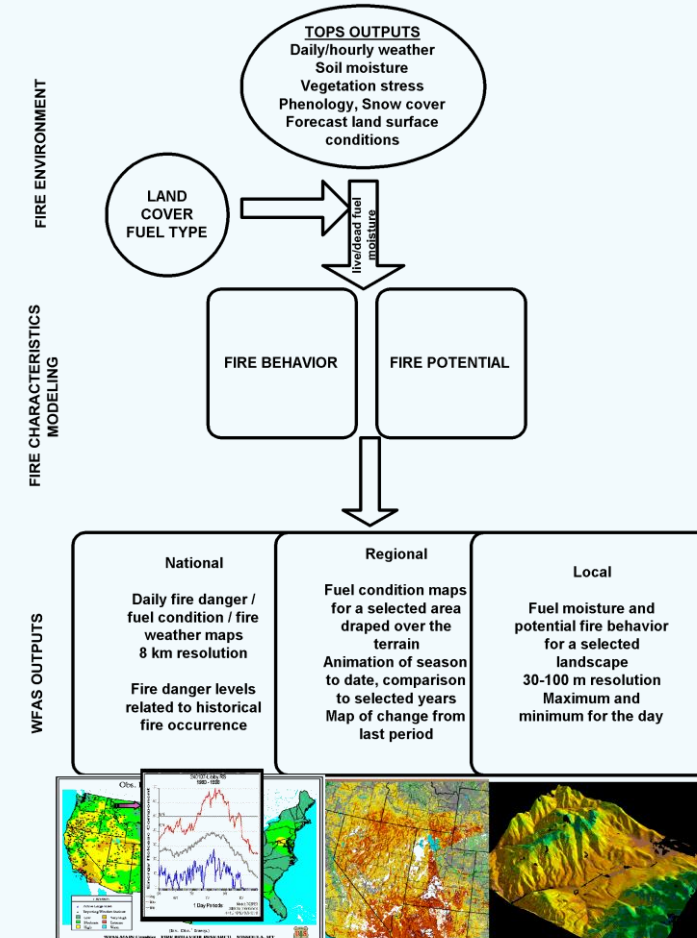
Raw data



Gridded Products



Wildfire Monitoring



Rapid Prototyping Concept MODIS/TOPS/RAMS

Irrigation Forecast for week of July 19-26, 2005

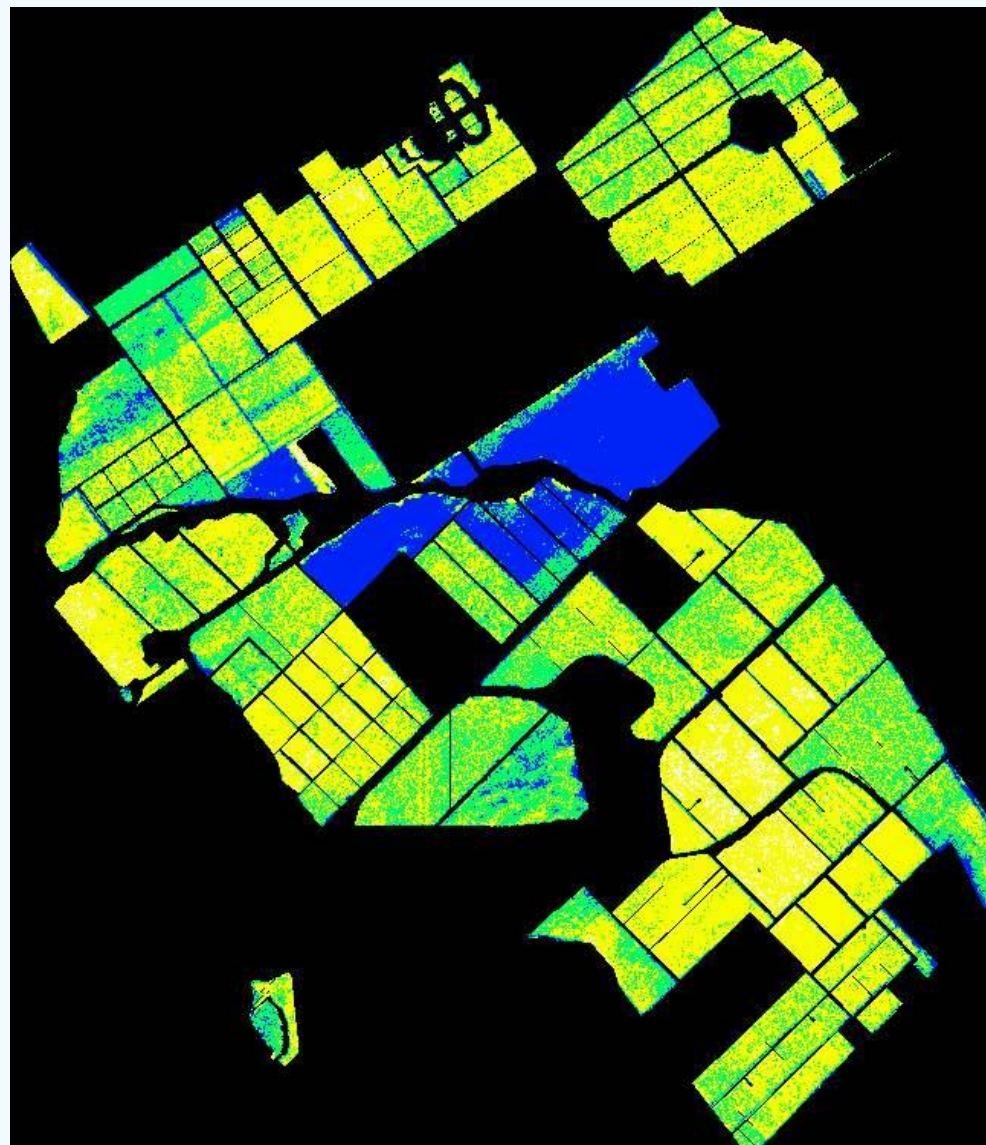
**Tokalon Vineyard,
Oakville, CA**

CIMIS Measured Weather Data
through July 18, 2005

NWS Forecast Weather Data
July 19-26, 2005



Forecast Irrigation (mm)

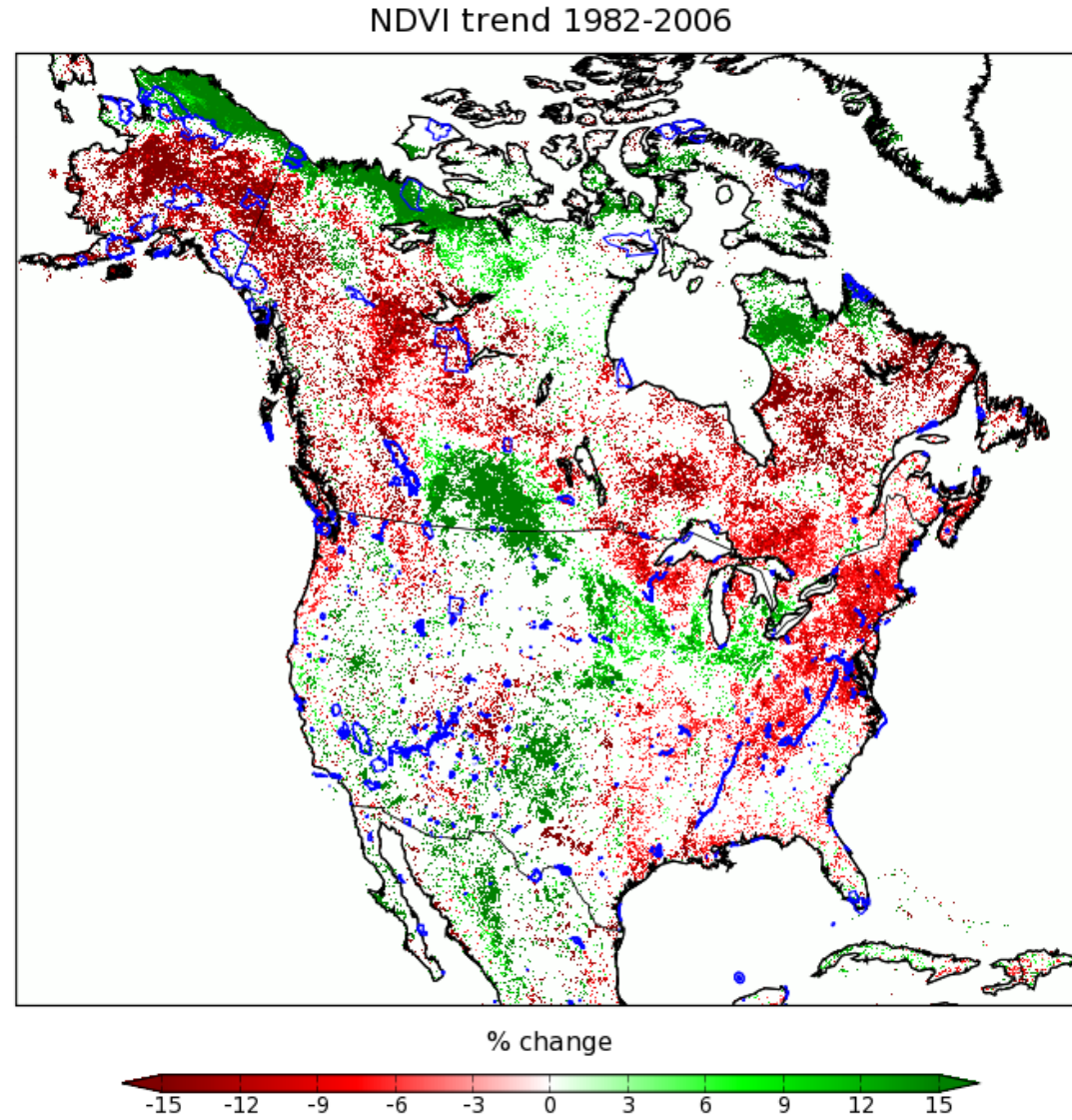


Why we need an integrated system?

- ***Understand the past***
- ***Manage the present***
- ***Prepare for the future***



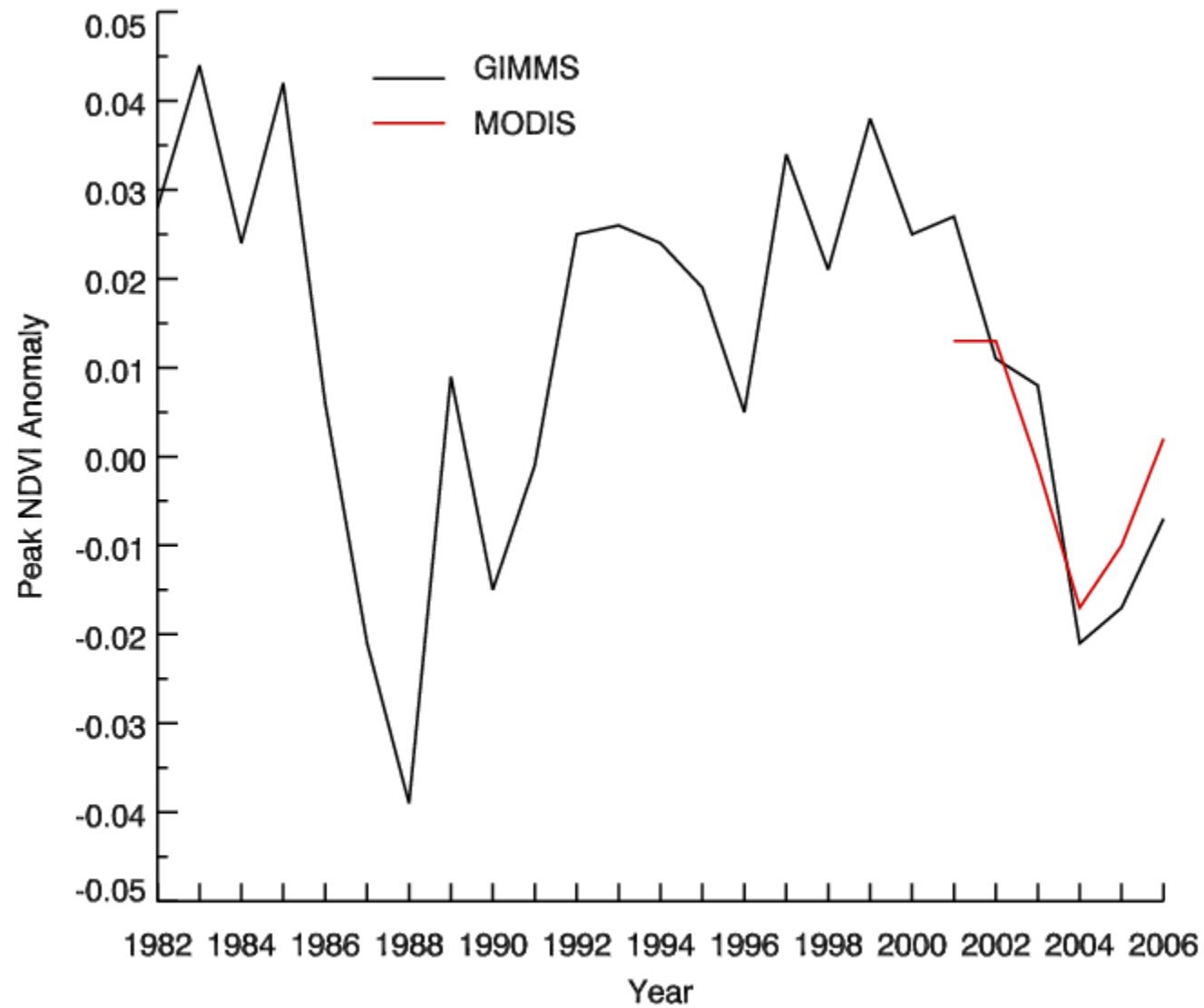
Vegetation index changes over continental scales



Changes in peak NDVI

understand the past

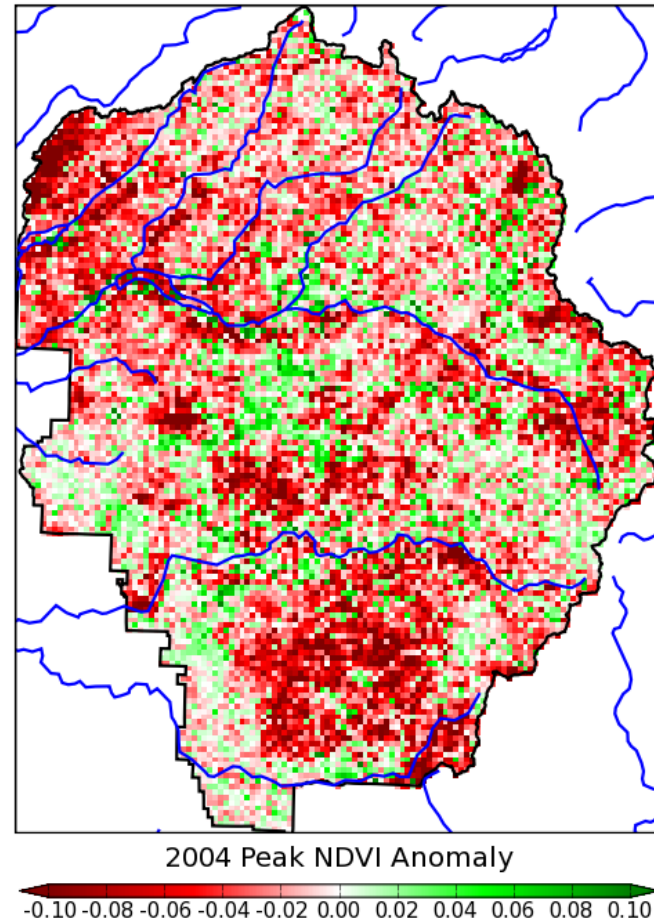
Interannual variability in NDVI over Yosemite National Park



Yosemite National Park

understand the past

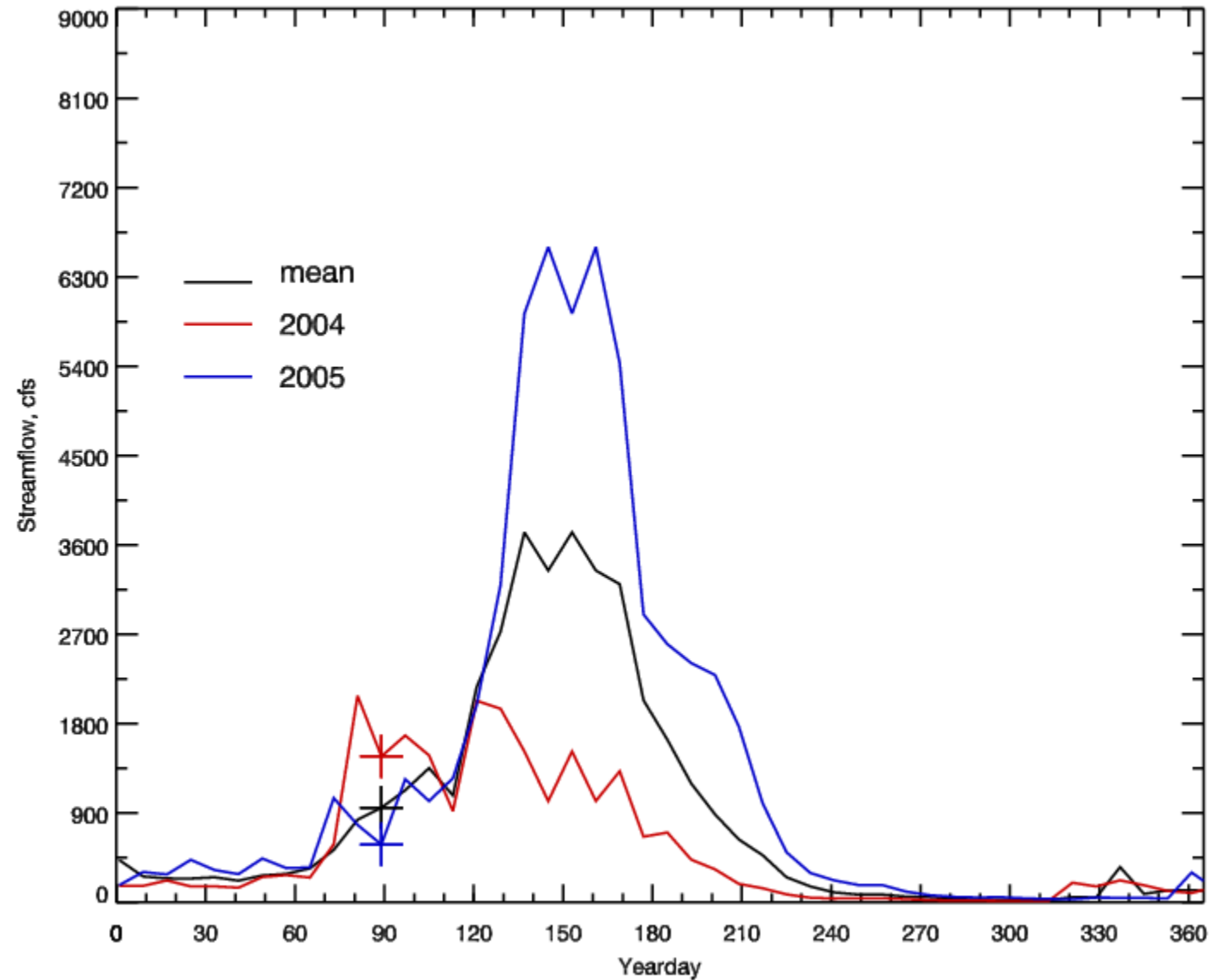
Watershed scale analysis of the anomalous 2004 using MODIS 250 data



Yosemite National Park

understand the past

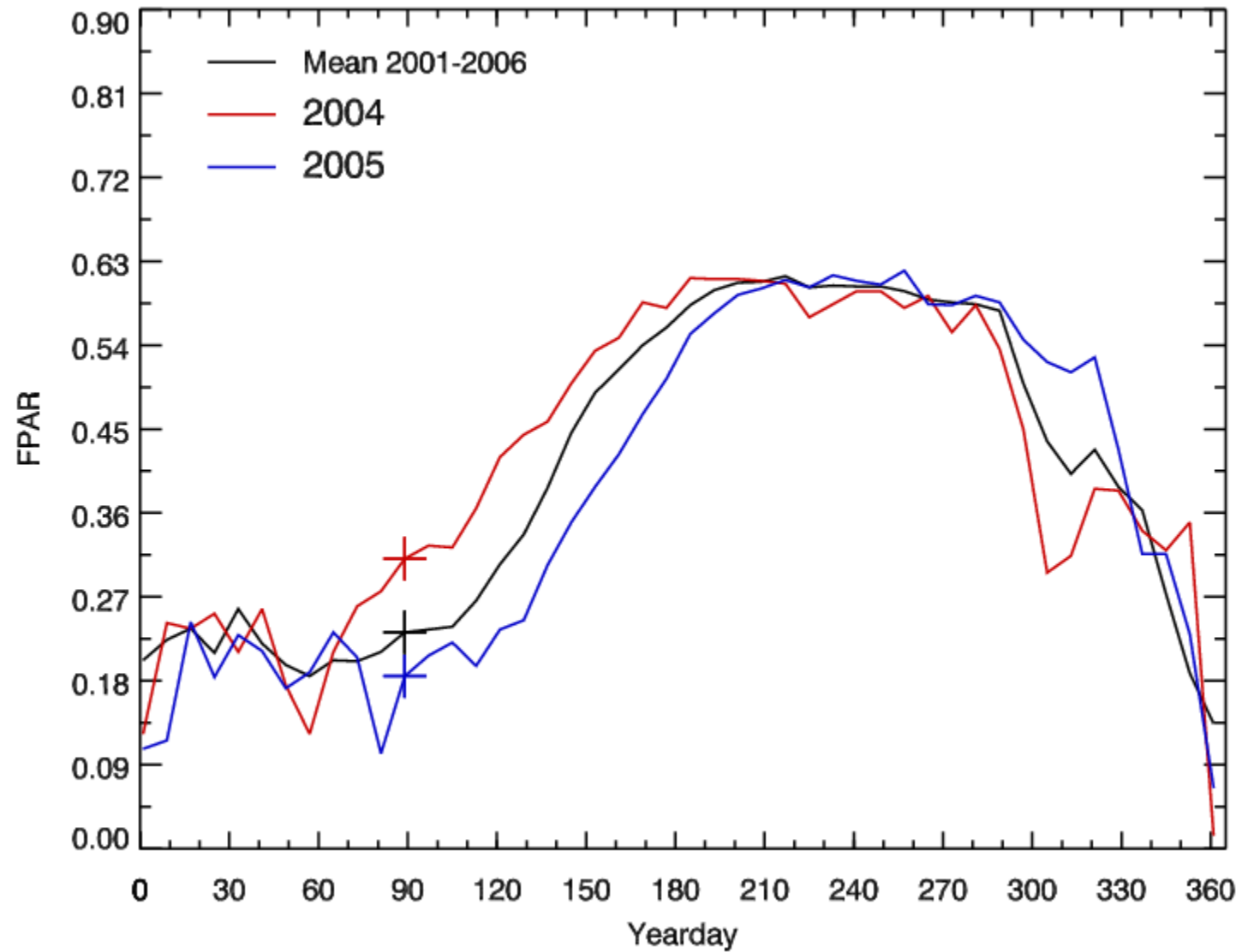
Monitoring stream flow



Yosemite National Park

monitor the present

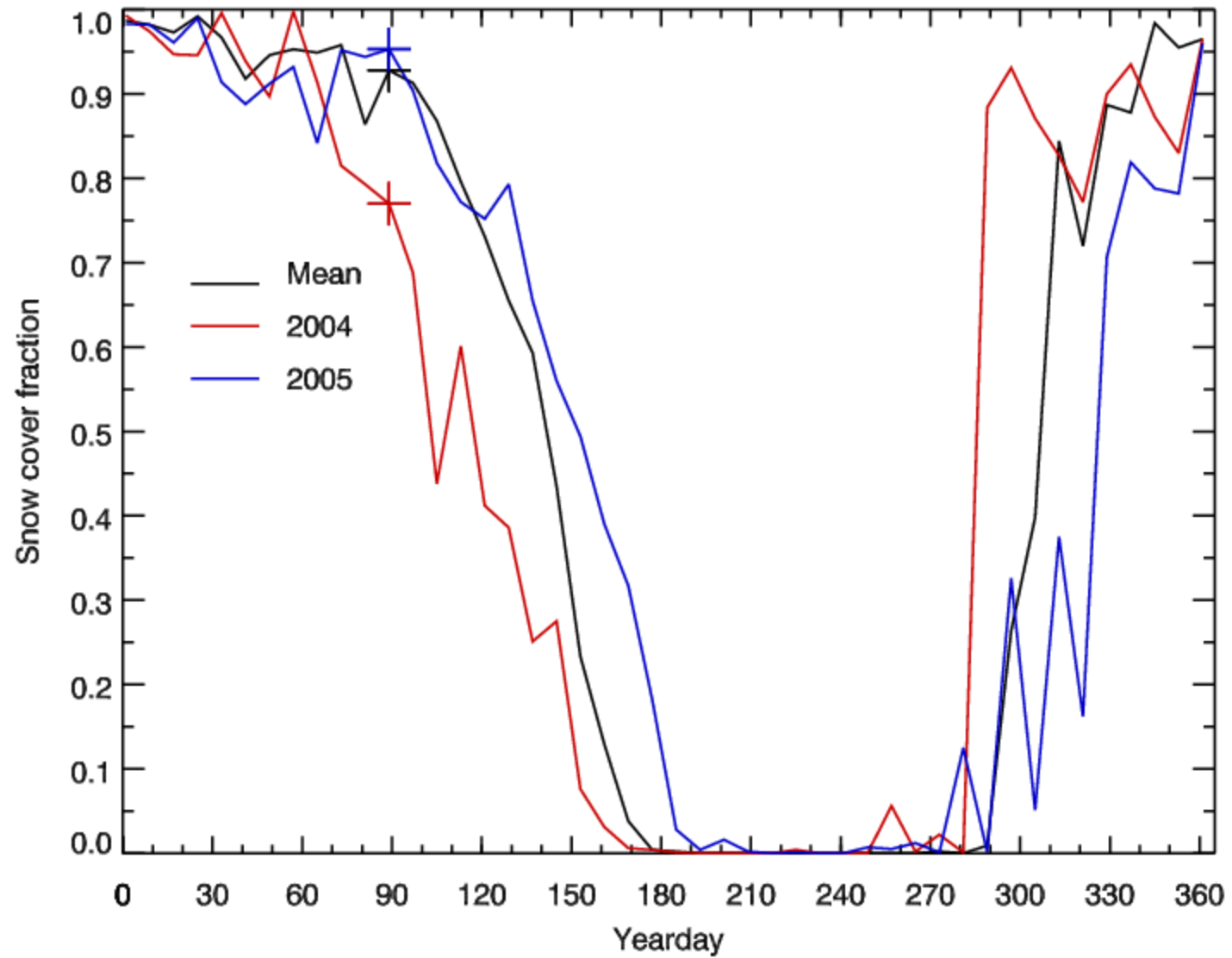
Vegetation monitoring using MODIS



Yosemite National Park

monitor the present

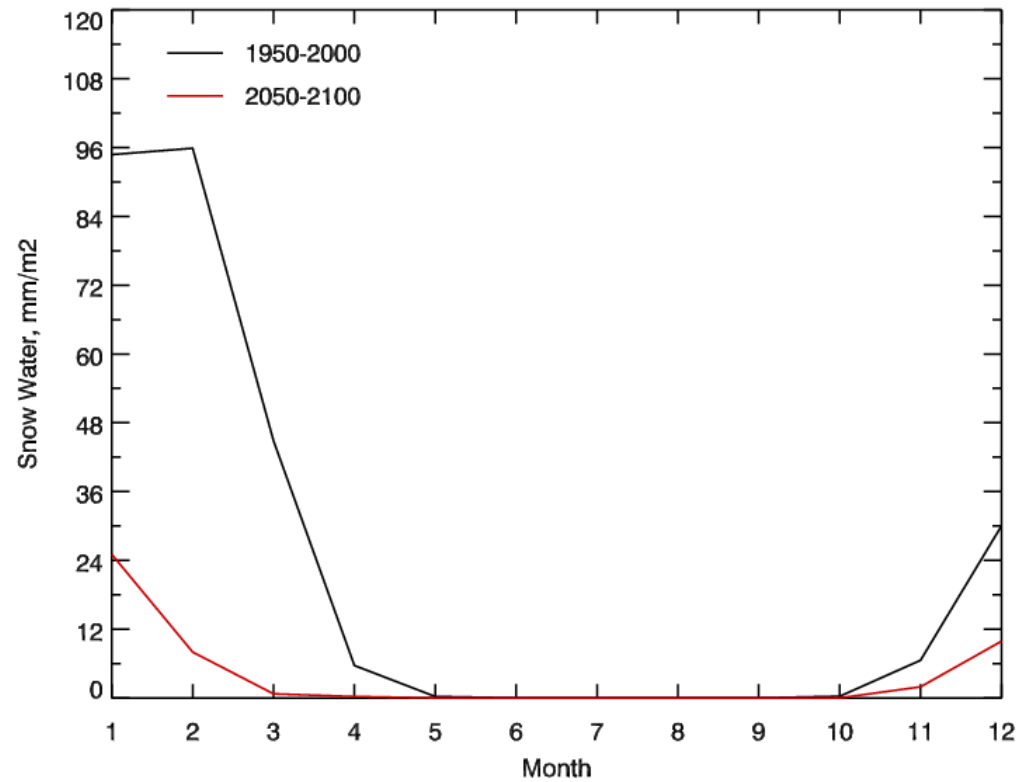
Snow monitoring using MODIS



Yosemite National Park

monitor the present

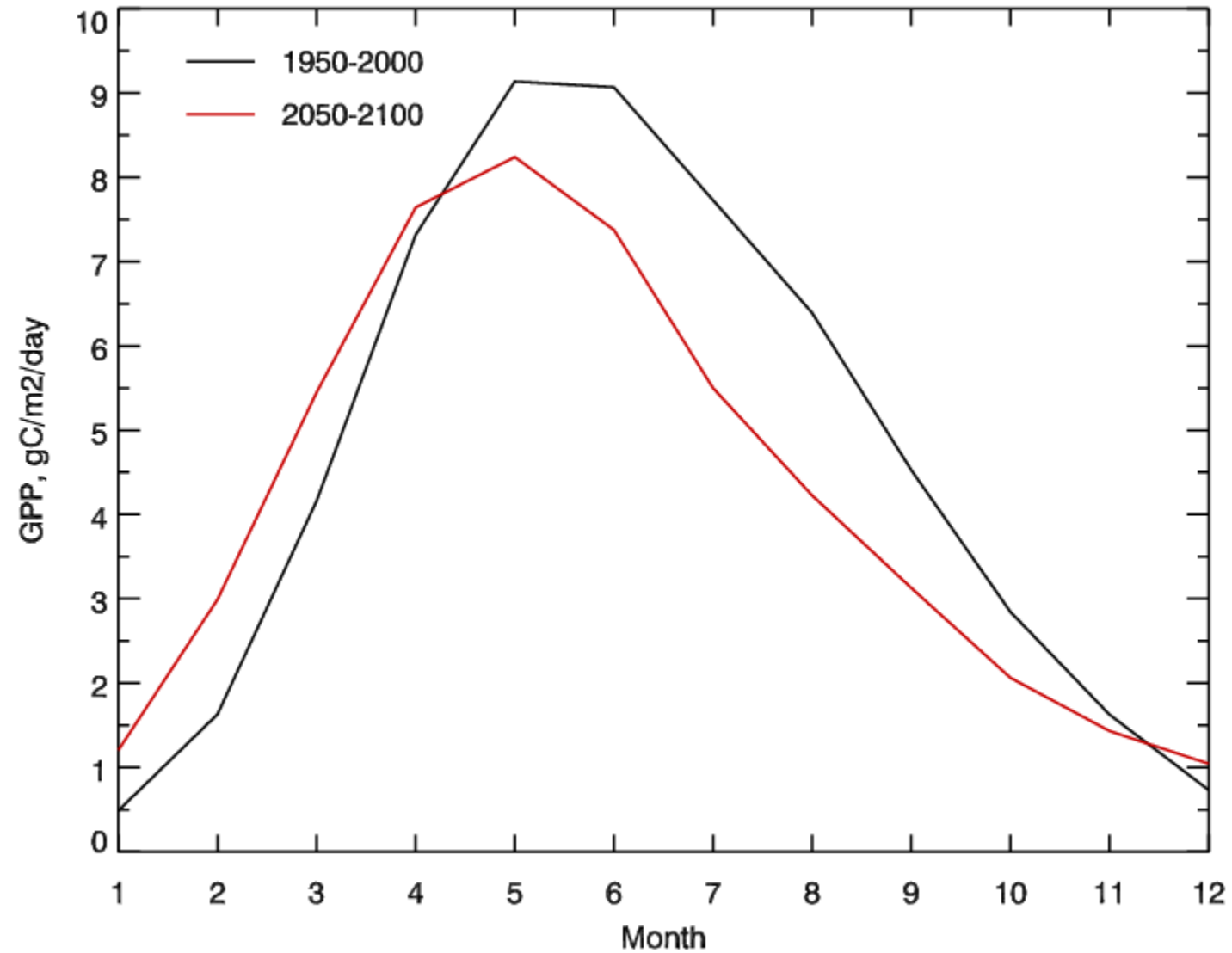
Impact of projected warming on Yosemite snow dynamics



Yosemite National Park

prepare for the future

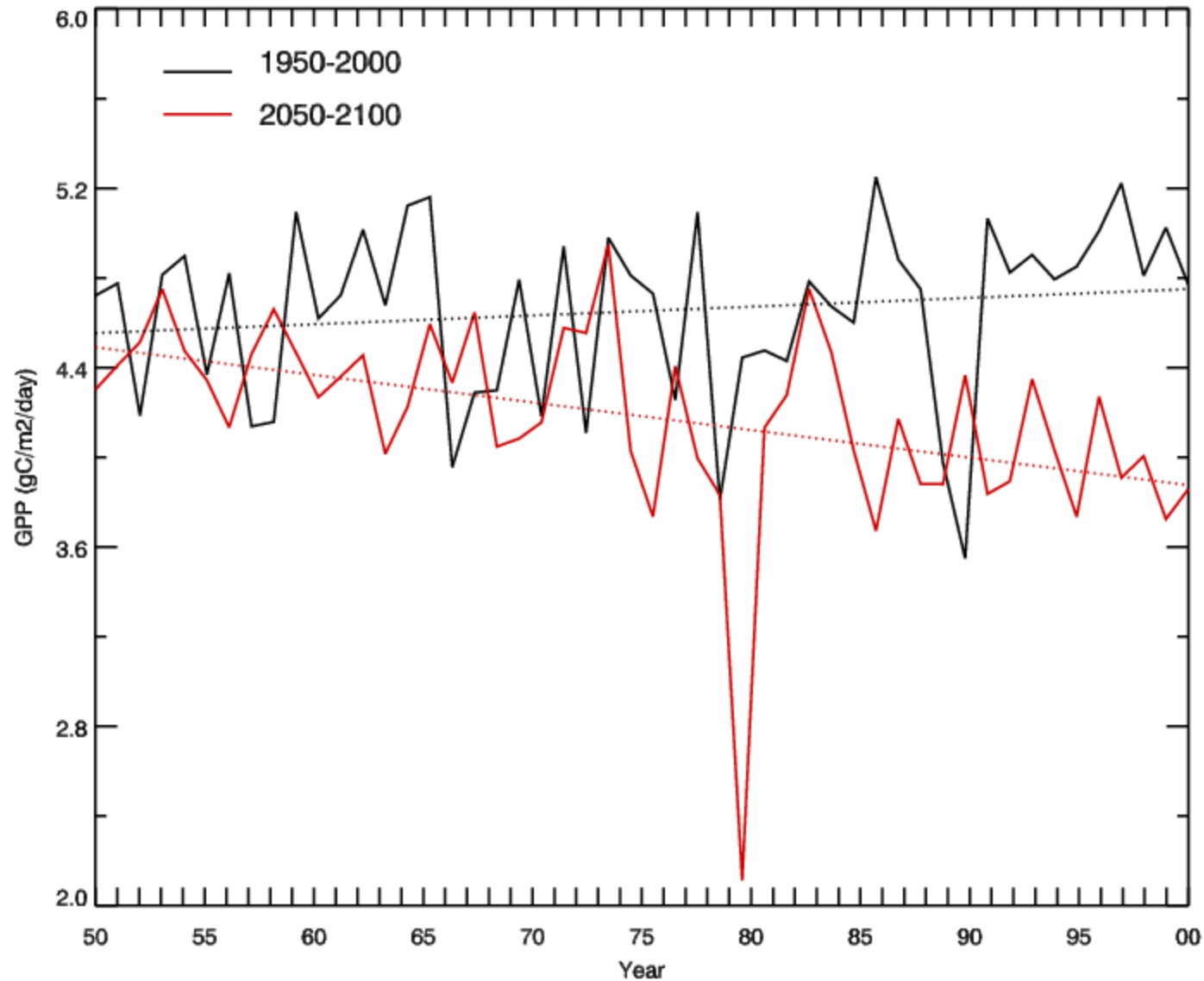
Growing season dynamics under climate change



Yosemite National Park

prepare for the future

Projected trends in vegetation productivity



Yosemite National Park

prepare for the future

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

