Modeling the Severity of Drought Events

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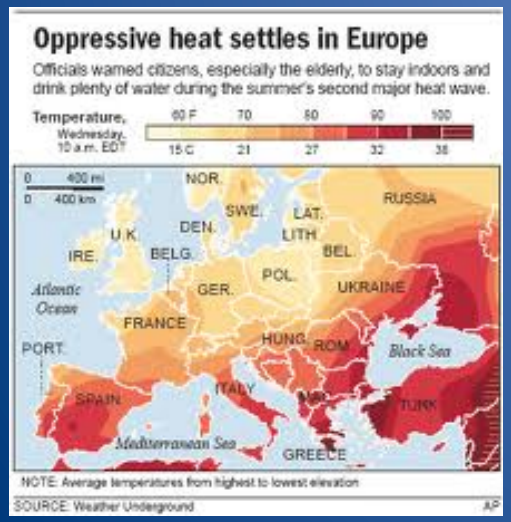
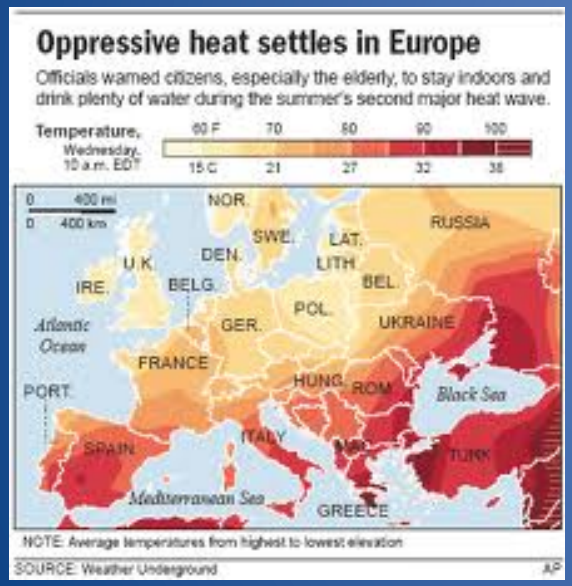
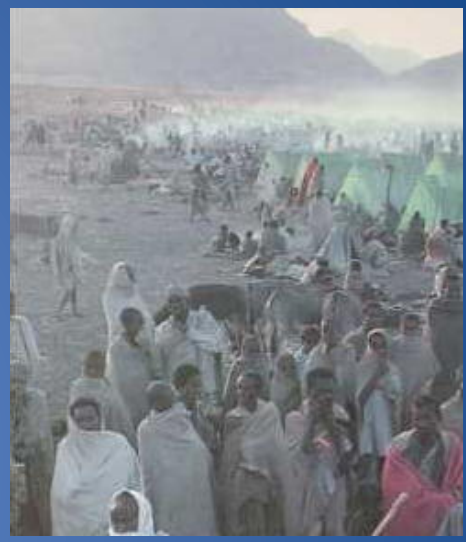


Droughts are Important Ecological and Environmental Events

- Drought inhibits photosynthesis and increases respiration, decreasing carbon sequestration.
- Droughts are predicted to increase in severity and duration as a result of global warming.



The 2003 heat wave in Europe changed the ecosystem from a carbon sink to a source. Ciais, et al, (*Science, 2005)*



The Sahel Drought (late 1960's to early 1980s) killed 100,000 people

The Haymann fire, caused (in part) by the 2002 Rocky Mountain drought, caused $40 million in damage.

Do Land Surface/Atmosphere Models Correctly Predict Droughts?

- We speculate that models overpredict the severity and duration of droughts—real ecosystems recover more quickly than modeled ecosystems.
- We are testing this hypothesis by looking at particular drought events:
  - Rocky Mountain drought of 2002
  - Southeastern US drought of 2007
  - Amazon basin drought of 2005

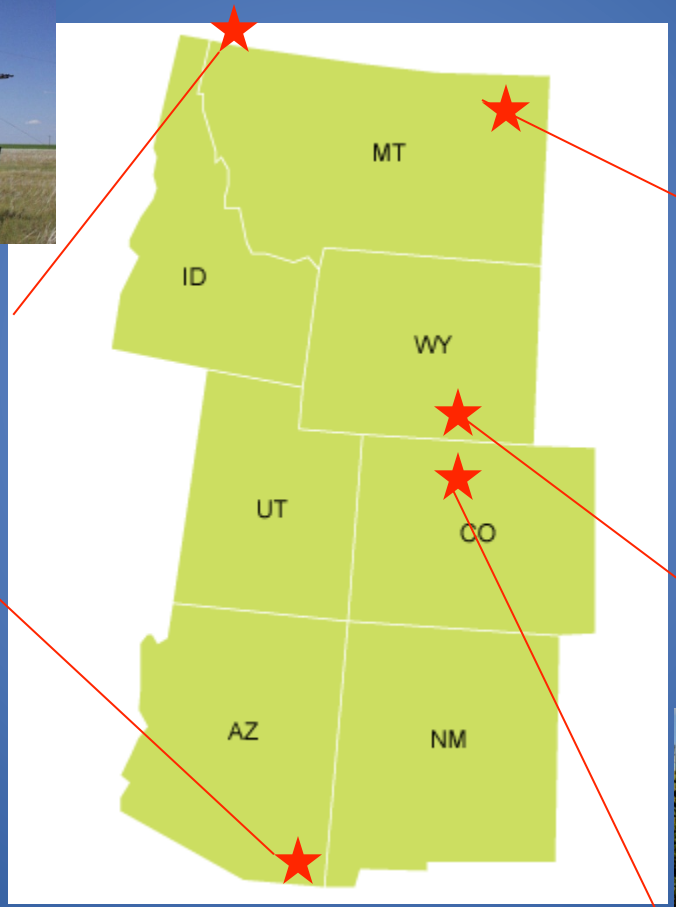
1.Collect data from a variety of sources (weather, flux towers, satellites, crop data).

- Data on forest activity from the US Forest Service Forest Inventory and Analysis National Program , which conducts inventories of all national forest lands.
- Climate data from the Earth Systems Research Laboratory of the National Atmospheric and Oceanic Administration.
- Energy, water vapor, and CO_2 fluxes from the FLUXNET network of eddy covariance towers .
- Radiation and vegetation data from Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instrument .
- Crop productivity data from the National Agricultural Statistics Service (NASS) of the US Department of Agriculture .

Rocky Mountain FluxNet Sites

Lethbridge, CN

Fort Peck, MT

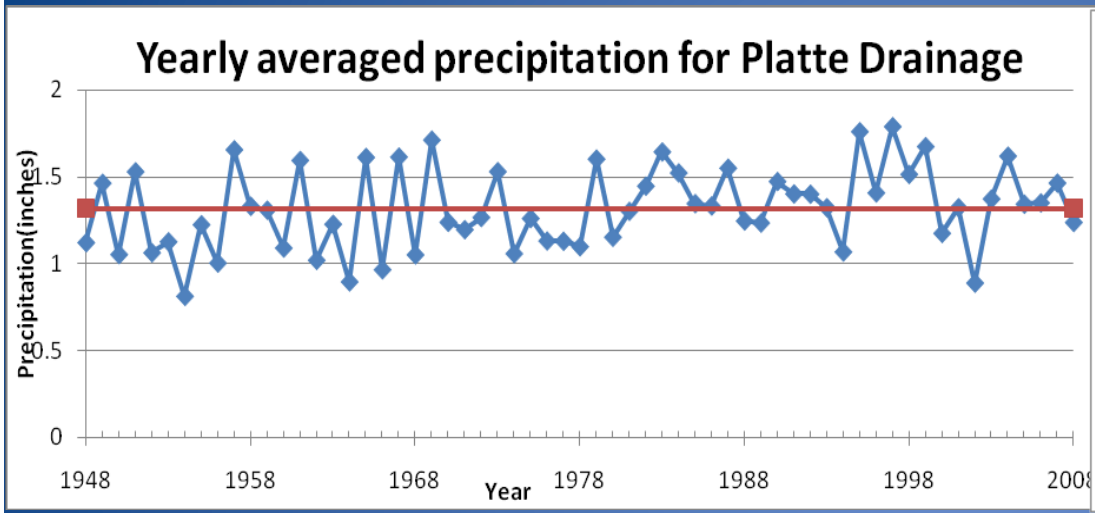


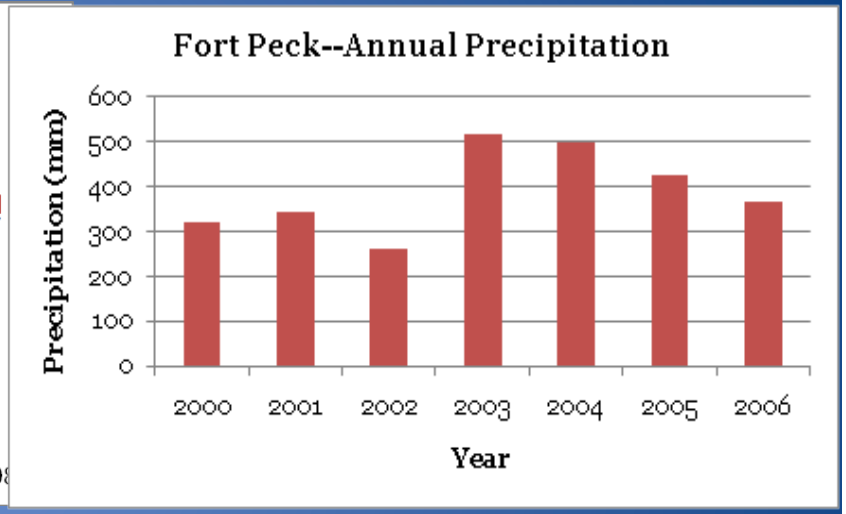
Glacier Lakes, WY

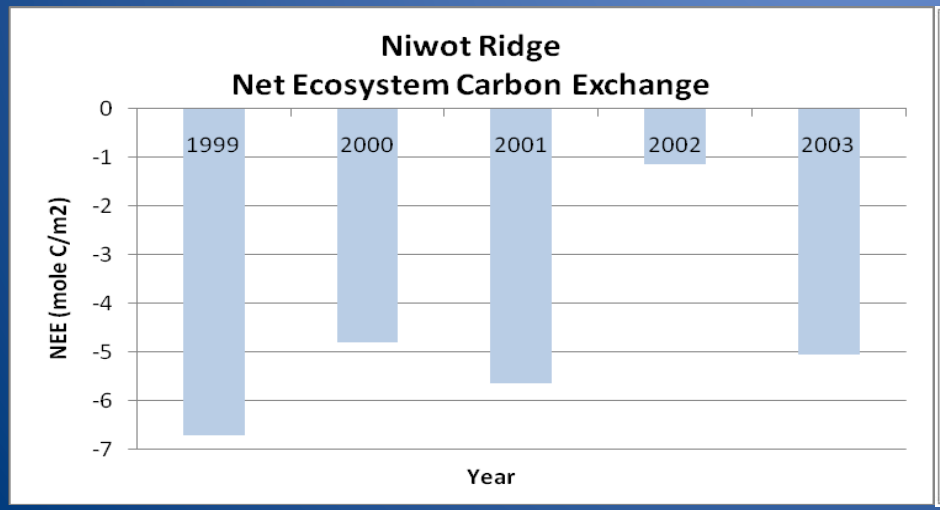
Audubon Research Ranch, AZ

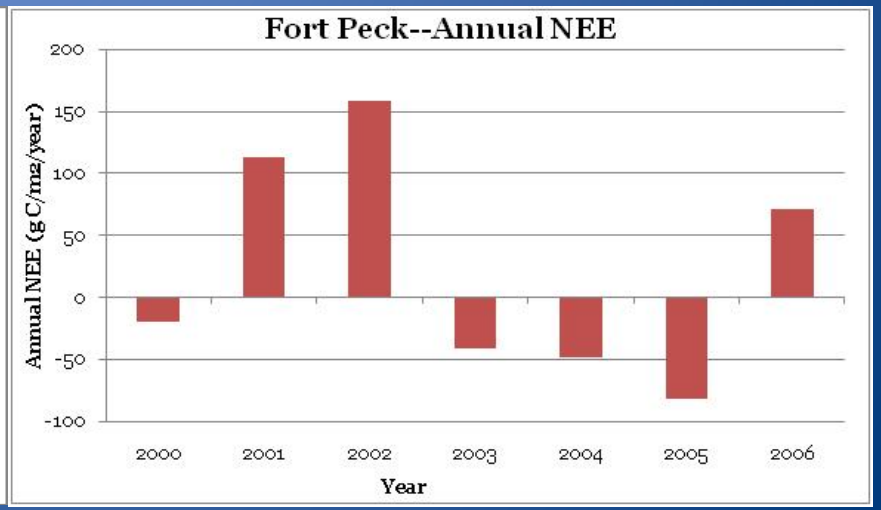
Niwot Ridge, CO

2. Define drought signature.

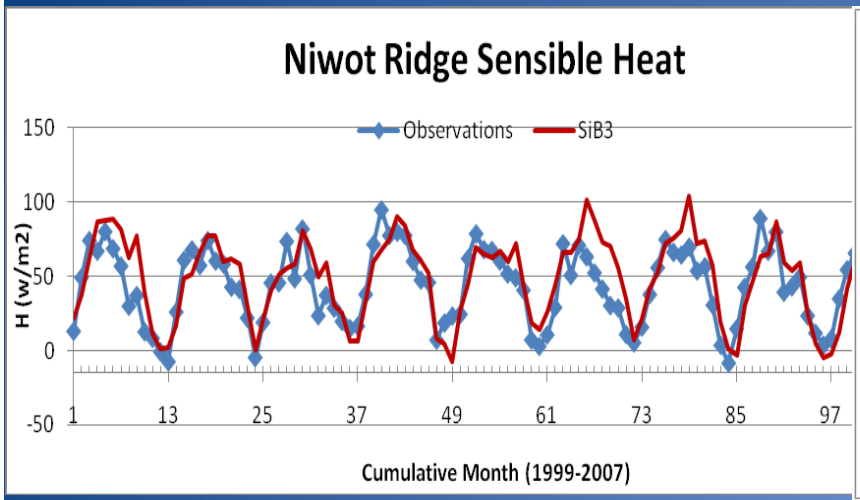


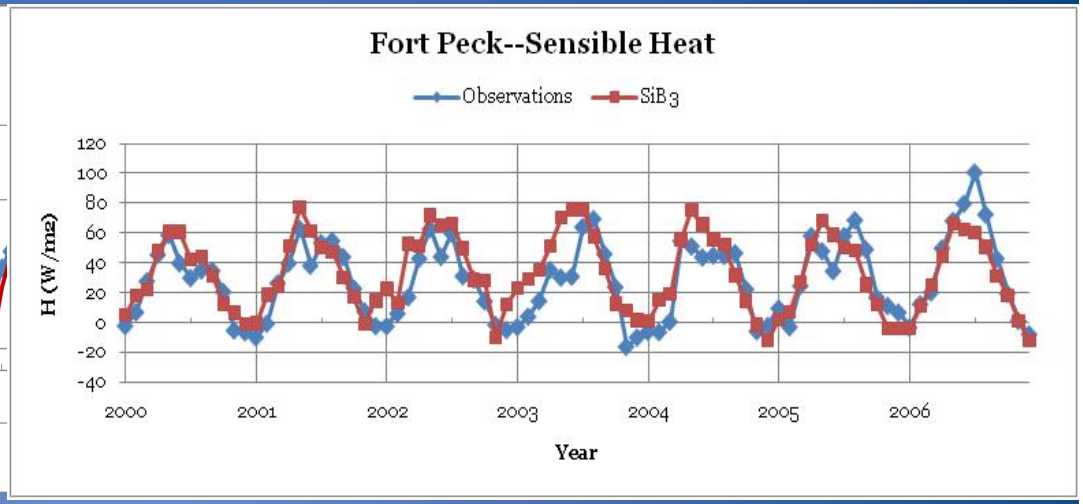


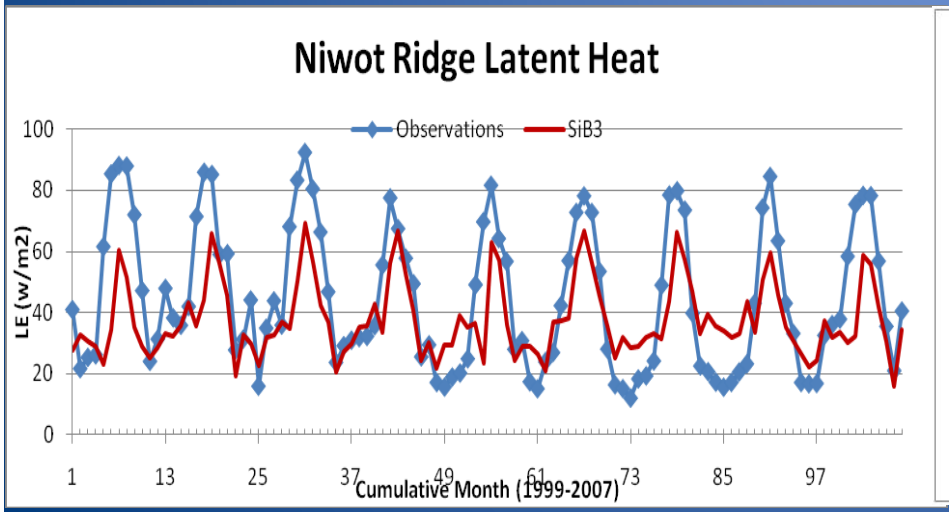


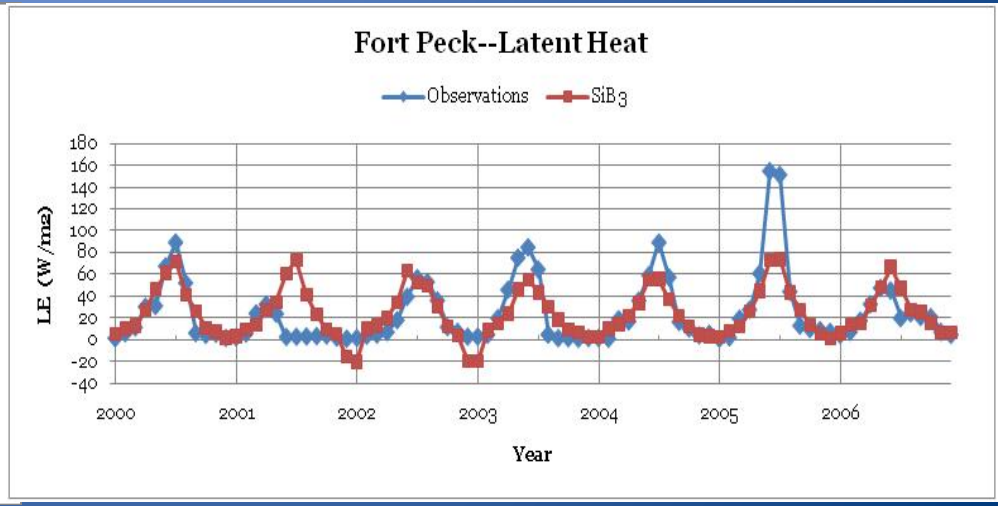


3. Compare data to model.

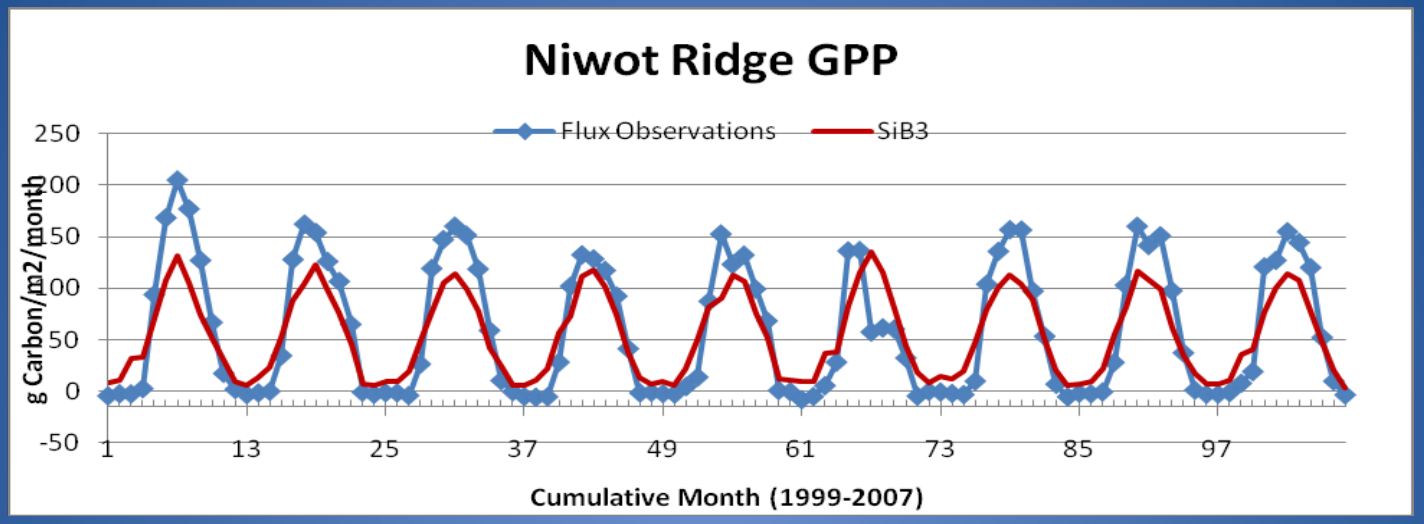


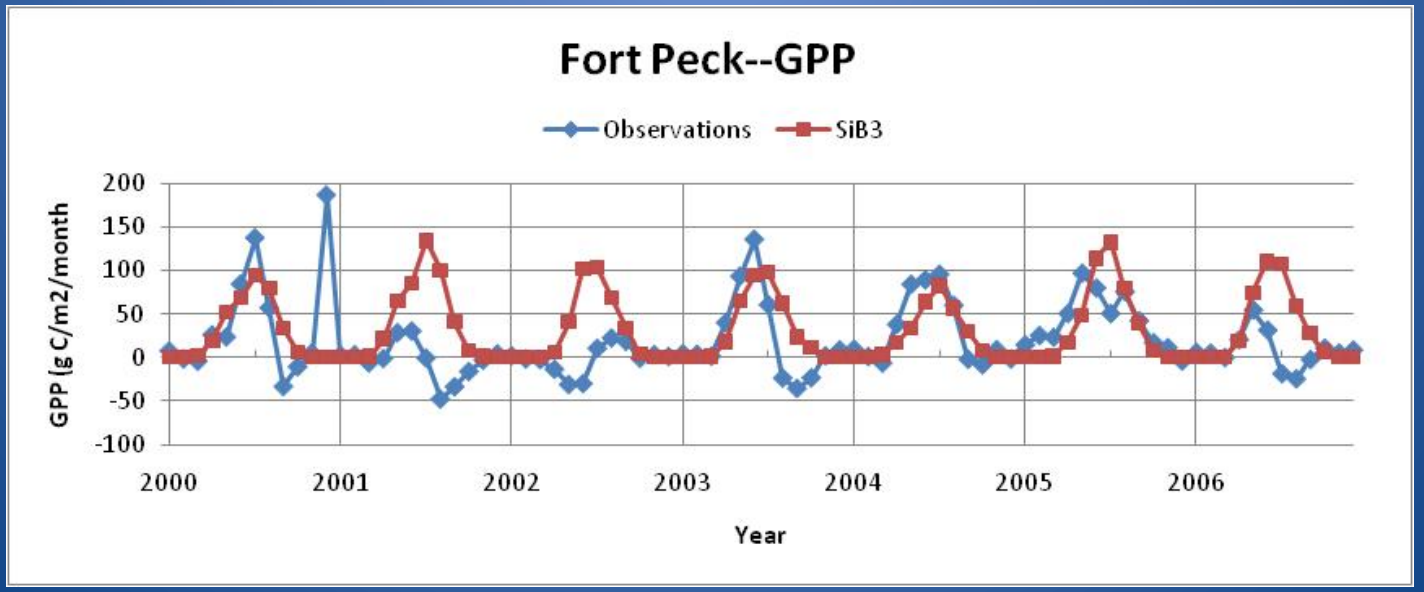






Gross Primary Productivity





Preliminary Conclusions

- Both Niwot Ridge and Fort Peck show clear climatological and ecological signatures of drought in 2002.
- At Niwot Ridge, 2002 was the second driest year since 1946; at Fort Peck 2002 followed two relatively dry years, but was followed by several wetter years.
- For both sites, net ecosystem exchange (NEE) was significantly reduced in 2002; for Fort Peck the ecosystem became a net carbon source.
- For both sites, the model does a better job of predicting sensible than latent heat, suggesting a possible issue with water handling.
- For both sites, the modeled Gross Primary Productivity (GPP) shows less inter-annual variation than the observations. The model fails to pick up the significant summer reductions in GPP.

References

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National Atmospheric and Oceanic Administration Earth Systems Research Laboratory (http://www.esrl.noaa.gov/psd/).

FLUXNET (http://daac.ornl.gov/FLUXNET/).

NASA Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instrument (http://modis.gsfc.nasa.gov/about/).

US Department of Agriculture National Agricultural Statistics Service (NASS) (http://www.nass.usda.gov/).