Ecological Conditions of US National Parks: Enabling Decision Support Through Monitoring, Analysis, and Forecasting

Sponsored by:

NASA Applications Program: Decision Support through Earth-Sun Science Research Results Project

and

NPS I&M Program

Validation

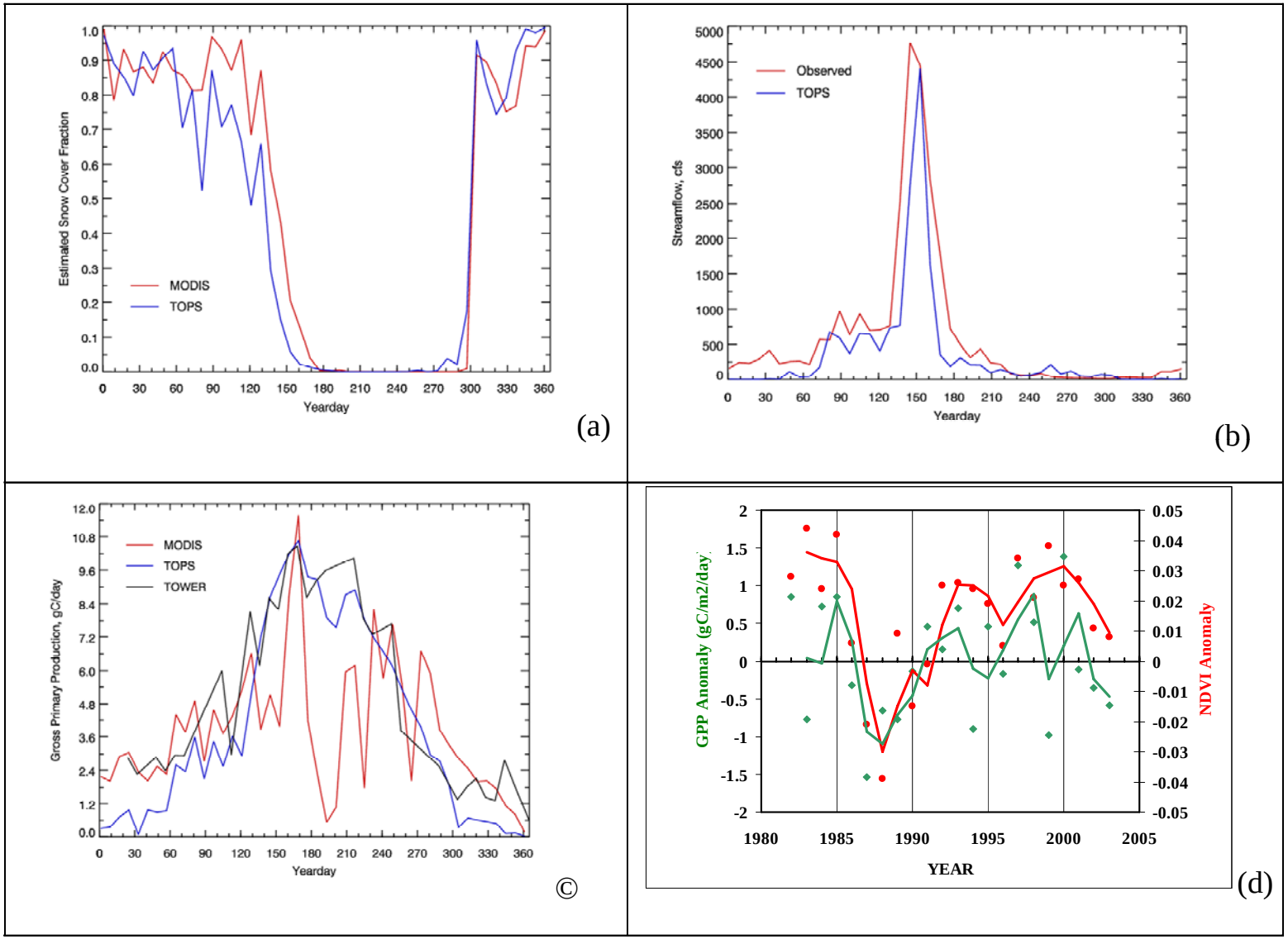
- In many cases, indicators derived from satellite data and ecosystem models may be useful for the NPS I&M program because they provide information that is difficult to obtain on the ground, or for which in situ data is not consistently available

- As a result, there are also often limited local, long-term ground datasets available for use in validation of data from satellites and ecosystem models

- Alternatives include use of related parameters, evaluation of patterns in multiple related indicators, and reliance on regional- to national-scale analyses

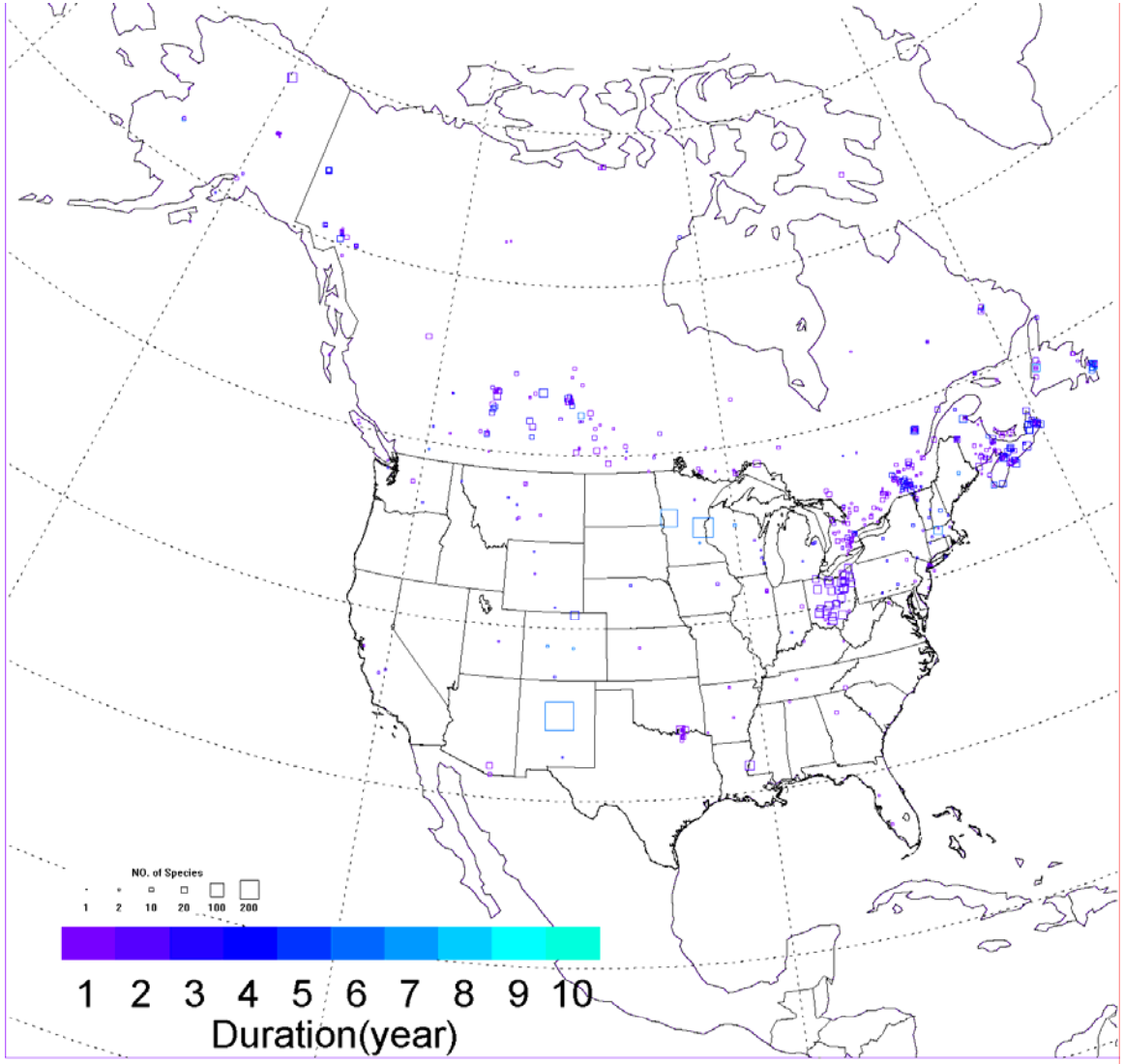
- Where available, patterns in data sets from in situ monitoring network can be used to determine whether trends in related datasets are consistent, even if the parameters are not identical (e.g., tree mortality rates (plot), maximum NDVI (satellite), and gross primary production (model))

Model Validation Using Multiple Parameters Related to Gross Primary Productivity



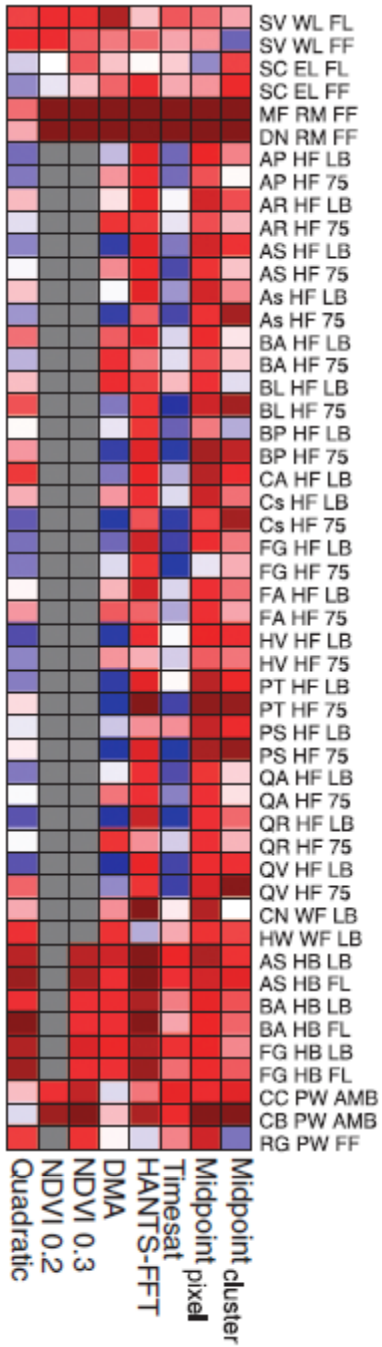
TOPS simulations using observed climatic data over Yosemite capture seasonal changes in (a) snowcover, (b) streamflow, and (c) gross primary production, shown here for 2003. Tower-based GPP are from near-by Blodgett National Forest. (d) TOPS-derived annual GPP also tracks interannual variability in photosynthetic capacity observed from AVHRR satellite data (actual simulations and observations are represented by points, while the lines correspond to moving averages). Nemani et al., 2008, RSE 113:1497-1509.

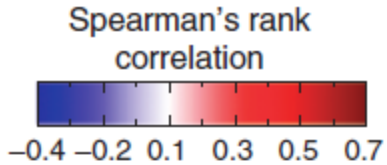
Long-term Phenology Measurements Lacking in Western US



Ground phenology records since 2001. Boxes show: location (center of box); number of species (box size); number of years observed at each site since 2001 (box color.)

Comparison of SOS Estimates from Multiple Methods Against Surface Observations





Species codes: AP, *Acer pensylvanicum*; AR *Acer rubrum*; AS, *Acer saccharum*; As, *Amelanchier* species; BA, *Betula alleghaniensis*; BL, *Betula lenta*; BP, *Betula popilofolia*; CA, *Cornus alternifolia*; CB, *Clintonia borealis*; CC, *Cornus canadensis*; CN, coniferous trees; Cs, *Crataegus* species; DN, *Delphinium nuttallianum*; FA, *Fraxinus americana*; FG, *Fagus grandifolia*; GA,HV, *Hamamelis virginia*; HW, hardwood trees; MF, *Mertensia fusiformis*; PS, *Prunus serotina*; PT, *Populus tremuloides*; RG QA, *Quercus alba*; QR, *Quercus rubra*; QV, *Quercus velutina*; SC, *Syringa chinensis*; SV, *Syringa vulgaris*; RG, *Ranunculus glaberrimus*.

Site/network codes: EL, eastern lilac; HB, Hubbard Brook; HF, Harvard Forest; PW, Plantwatch; RM, Rocky Mountain Biological Laboratory; WF, Howland Forest; WL, western lilac.

Phenological stage: AMB, anthesis/middle bloom; FF, first flowers expanding; FL, first leaf; LB, leaf budburst; 75, 75% of full leaf expansion.

Fig. 10 Spearman's rank correlation coefficients between ground-measured phenology and SOS estimates for the corresponding years and location. Shown are records of at least 10 years in duration. Blue colors indicate negative correlations; red colors positive correlations; gray indicates missing SOS estimates. Each column shows one SOS method; each row shows one ground record. Text to the right of the colored panels shows species, site or network, and phenological stage (see in-figure text for code explanations). For EL, PW, and WL comparisons are based on annual averages at multiple locations; otherwise comparisons are for individual sites. PAT and Gaussian methods not shown as they were implemented at the ecoregion, not pixel, level.

White et al. 2009, GCB doi: 10.1111/j.1365-2486.2009.01910.x

Comparison of SOS Estimates from Multiple Methods Against Surface Observations

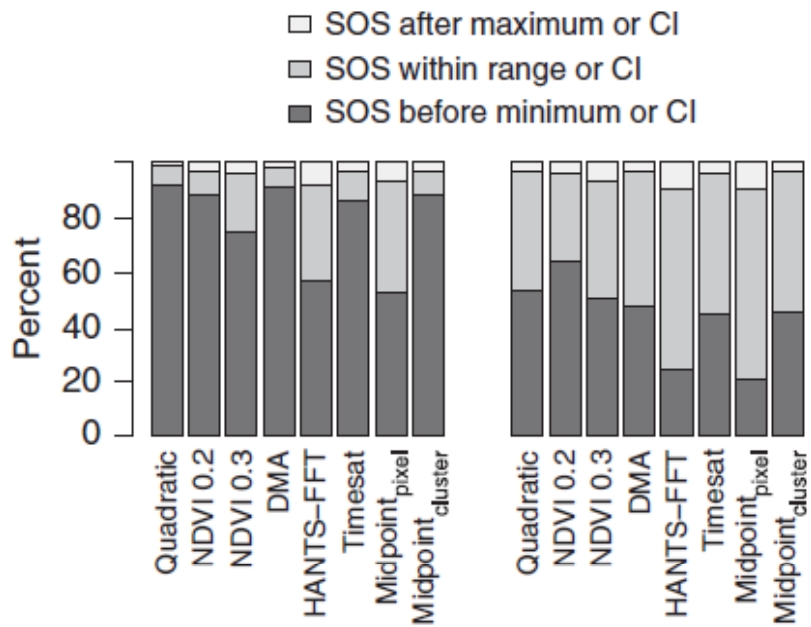


Fig. 11 Comparison of SOS methods against ground data. For each 8 km pixel containing at least two ground observations within a year (any species or phenological event), the range and 90% confidence interval (CI) were constructed for the ground observations; SOS estimates were then categorized as before the minimum or CI, within the range or CI, or after the maximum or CI. Comparisons are range in the left panel and CI in the right panel. All ground data for which valid satellite retrievals existed (ranging from a low of 1848 pixel-year records for NDVI 0.2 to a high of 3046 for HANTS-FFT) were used – a separate assessment was conducted using only pixel-year records found in all eight methods but results were consistent and are not shown. PAT and Gaussian methods not shown as they were implemented at the ecoregion, not pixel, level.

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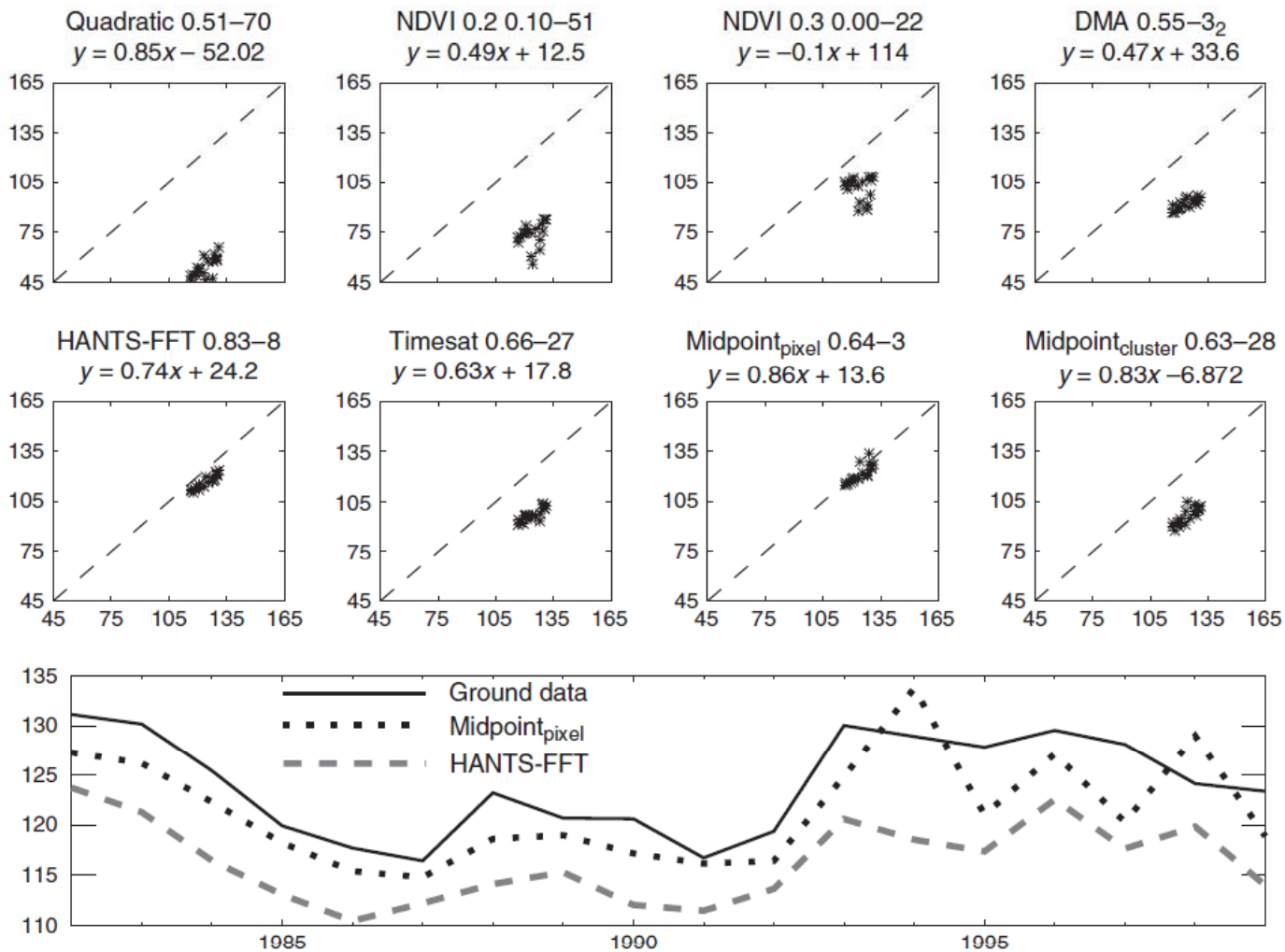

Fig. 12 Comparison of 1982–1999 ground observed phenology and SOS (post-1999 data not used due to very limited ground data availability). Analysis is for all pixel-years containing at least two ground observations of any species and any phenological stage and only for pixel-years present for all SOS methods. Ground data were first averaged to pixel-year and then for all of North America. Small panel titles are: SOS method, R^2, and bias (in days) on the first line and the reduced major axis linear model on the second line. The bottom panel shows the ground data and the two SOS methods with bias close to zero, slope near one, and high R^2. All Spearman's Rank Correlations showed no trends in SOS or ground phenology ($P > 0.05$). Analysis conducted only for those pixels present for all SOS methods.

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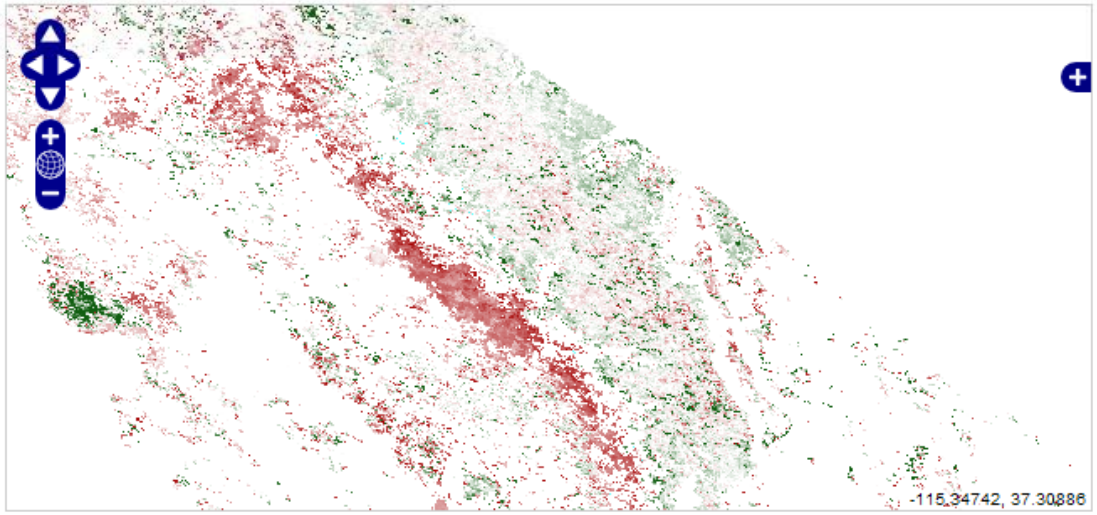

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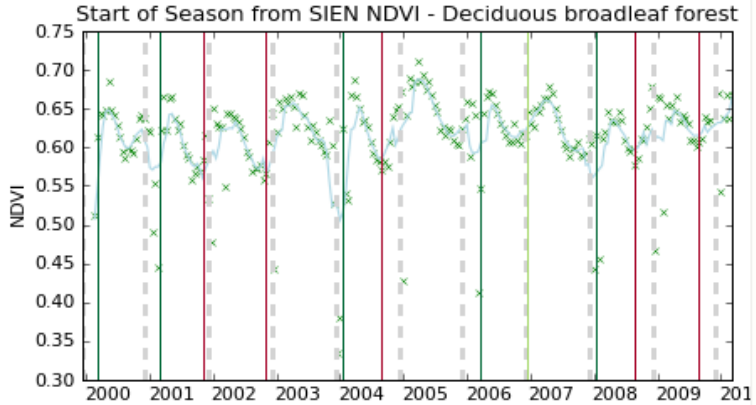
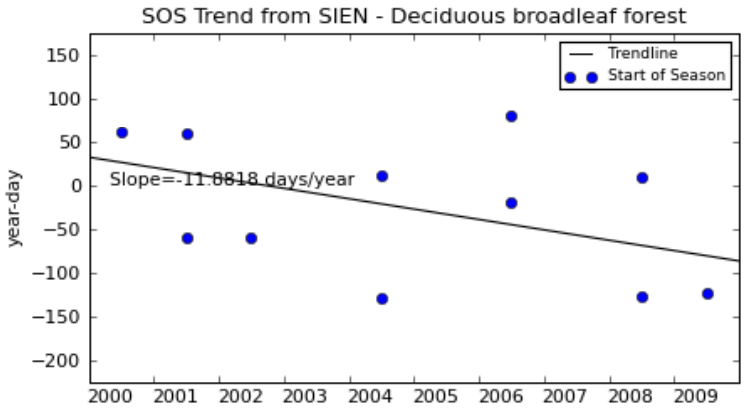
Region SIEN_Deciduous_broadleaf_forest



Year 2005

SIEN Start of Season

Region	Start of Season	anomaly (days)
PACE	12 May '05	43
Evergreen needleleaf forest	01 May '05	25
Deciduous broadleaf forest	24 Aug '04	-103
Mixed forests	18 Feb '05	-11
Closed shrublands	08 Mar '05	4
Open shrublands	12 Jun '05	75
Woody savannas	06 Nov '04	-119
Savannas	31 Dec '05	25



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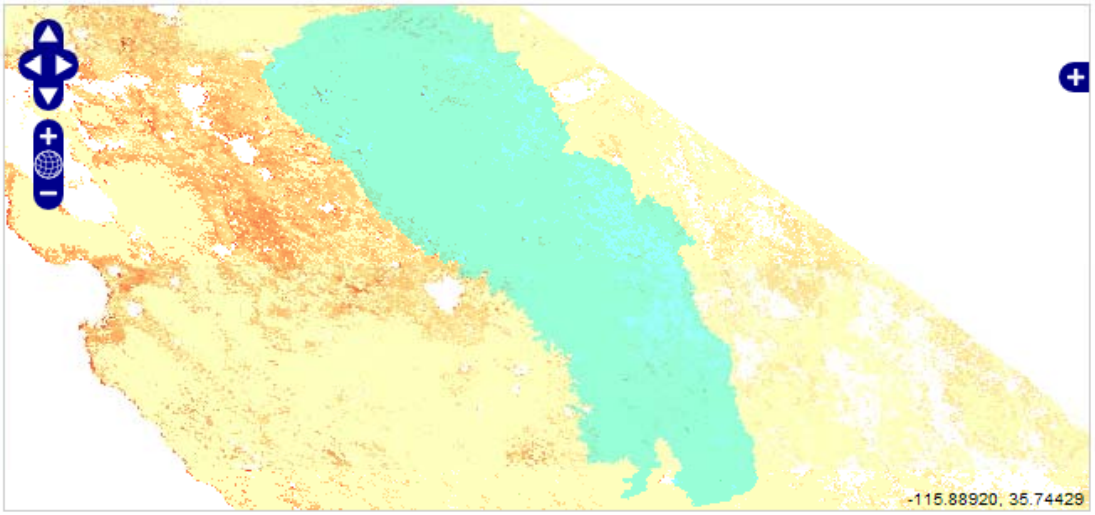

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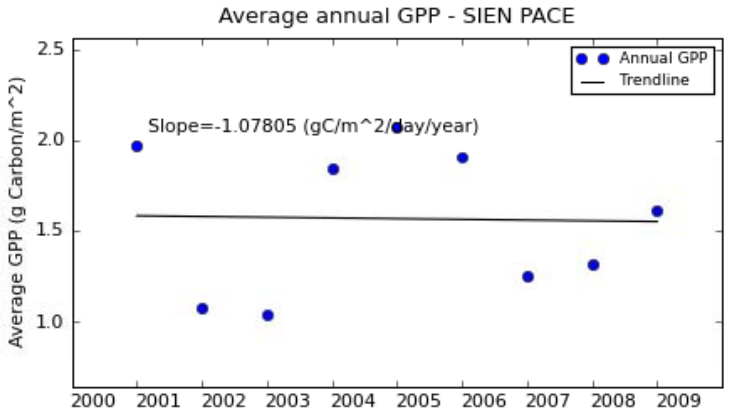
Region SIEN_PACE



Year 2009

2009 Cumulative GPP by Land Cover Type

Land Cover	Annual	Spring	Summer	Fall	Winter
PACE	1.6129	0.3897	0.2269	0.0669	0.9294
Evergreen_needleleaf_forest	2.1094	0.4915	0.3829	0.0936	1.1415
Deciduous_broadleaf_forest	2.0044	0.6045	0.1176	0.0872	1.1951
Mixed_forests	2.4356	0.6057	0.3441	0.1173	1.3685
Closed_shrublands	1.4578	0.4113	0.1514	0.0587	0.8364
Open_shrublands	1.0268	0.2200	0.1701	0.0456	0.5912
Woody_savannas	1.6009	0.4401	0.1382	0.0578	0.9649
Savannas	1.7676	0.4164	0.1061	0.0812	1.1639
Grasslands	0.9056	0.1726	0.2061	0.0277	0.4991

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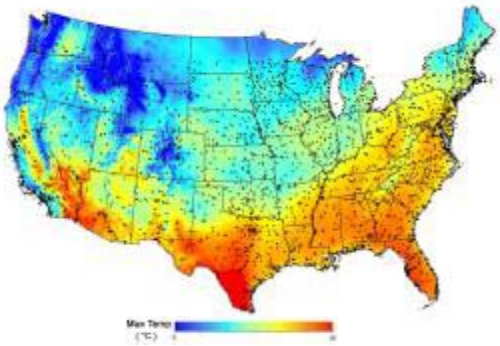
Additional Indicators in Development

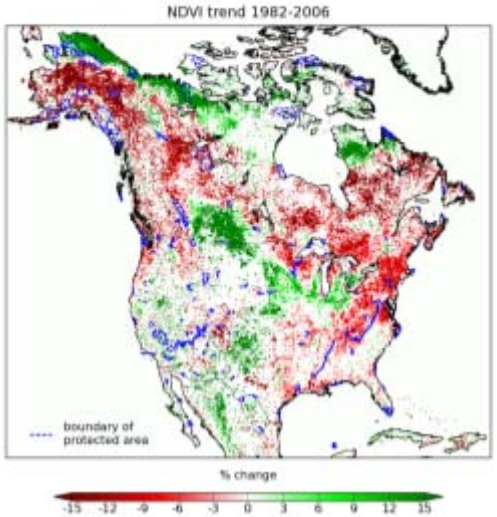
Climate

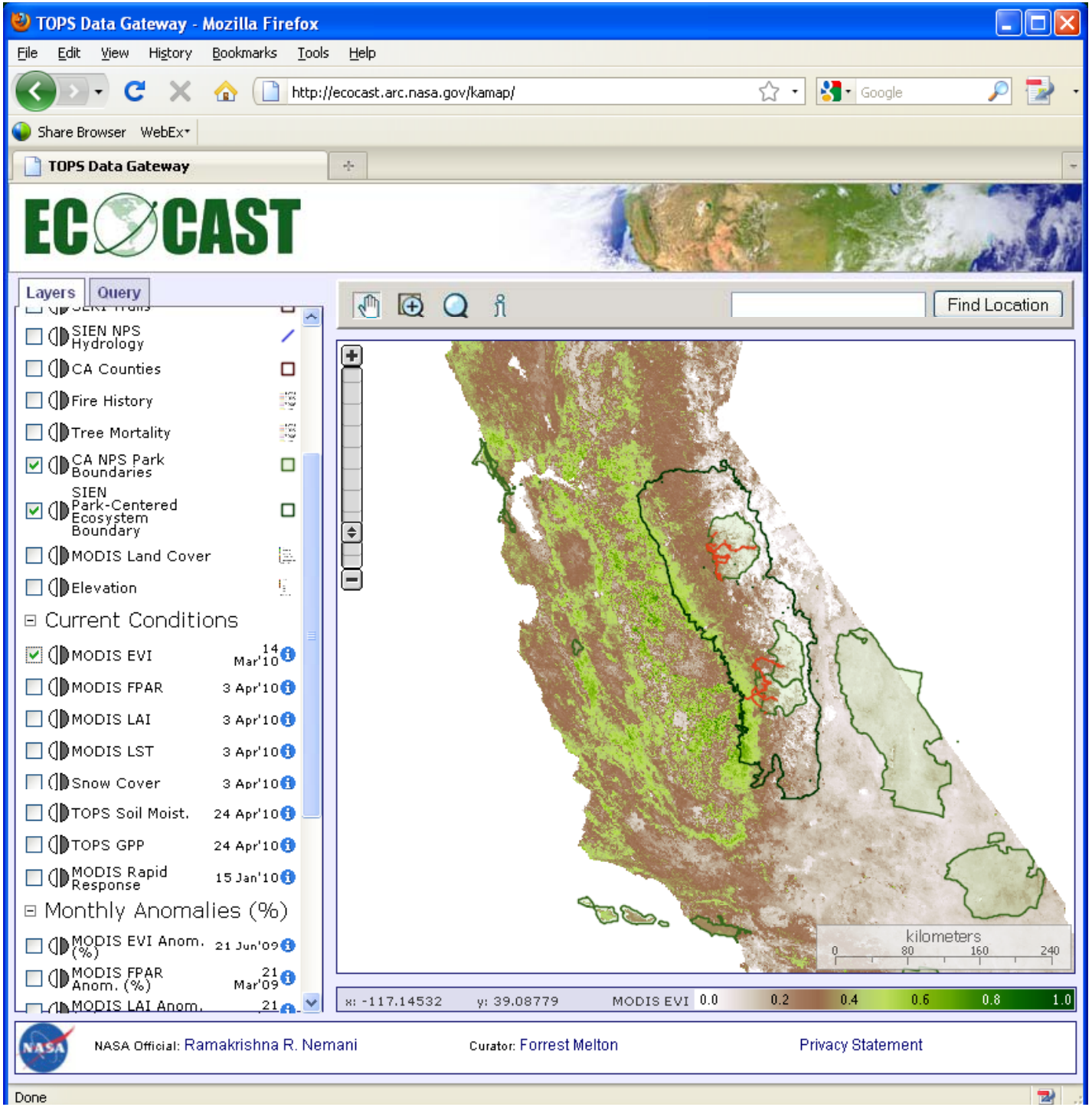
- Spatially continuous meteorological surfaces to supplement NPClime data products through visualization of spatial distribution of climate patterns
- Trend in average annual and seasonal max / min temperatures (maps, table)
- Anomaly map for 'snow-off' date
- Trend in % park with snow cover on Apr 1 (graph)



Landscape Dynamics

- Long-term trends in maximum NDVI (map)
- Current persistent monthly anomaly map from MODIS (with overlays of fire bounds / insect damage)
- Plot of percent of park experiencing anomaly month by month (graph)
- Annual land cover change maps from Kennedy et al., LandTrendr I&M Protocol

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Fire History
Tree Mortality
CA NPS Park Boundaries
SIEN Park-Centered Ecosystem Boundary
MODIS Land Cover
Elevation
Current Conditions
MODIS EVI 14 Mar'10
MODIS FPAR 3 Apr'10
MODIS LAI 3 Apr'10
MODIS LST 3 Apr'10
Snow Cover 3 Apr'10
TOPS Soil Moist. 24 Apr'10
TOPS GPP 24 Apr'10
MODIS Rapid Response 15 Jan'10
Monthly Anomalies (%)
MODIS EVI Anom. (%) 21 Jun'09
MODIS FPAR Anom. (%) 21 Mar'09
kilometers
0 80 160 240
x: -117.14532 y: 39.08779 MODIS EVI 0.0 0.2 0.4 0.6 0.8 1.0
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