

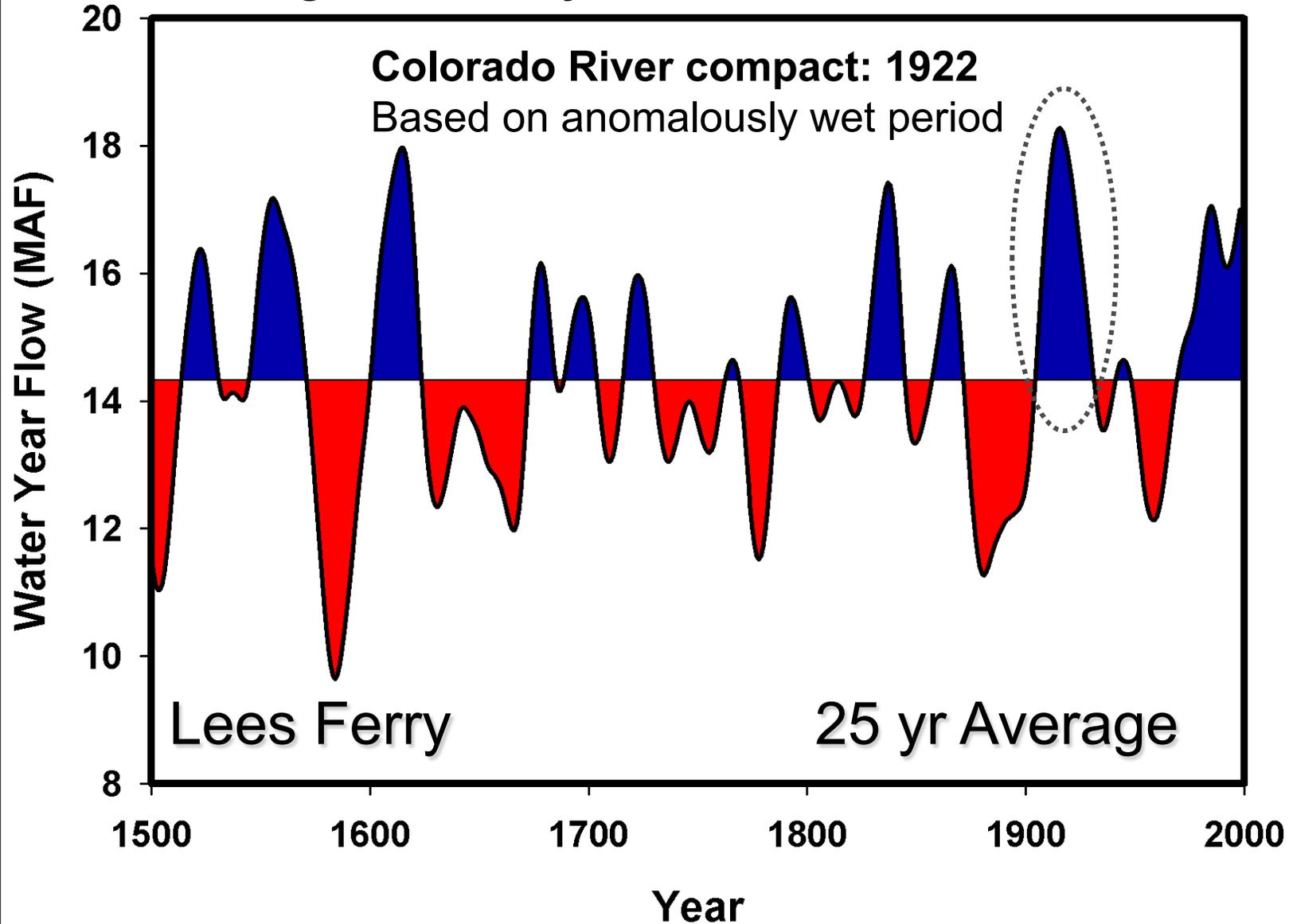


NORTH CENTRAL
**CLIMATE
SCIENCE**
CENTER

Overview and Potential Interaction with CMMAP

Jeff Morisette
14th CMMAP Team Meeting
January 22-24, 2013
Boulder CO

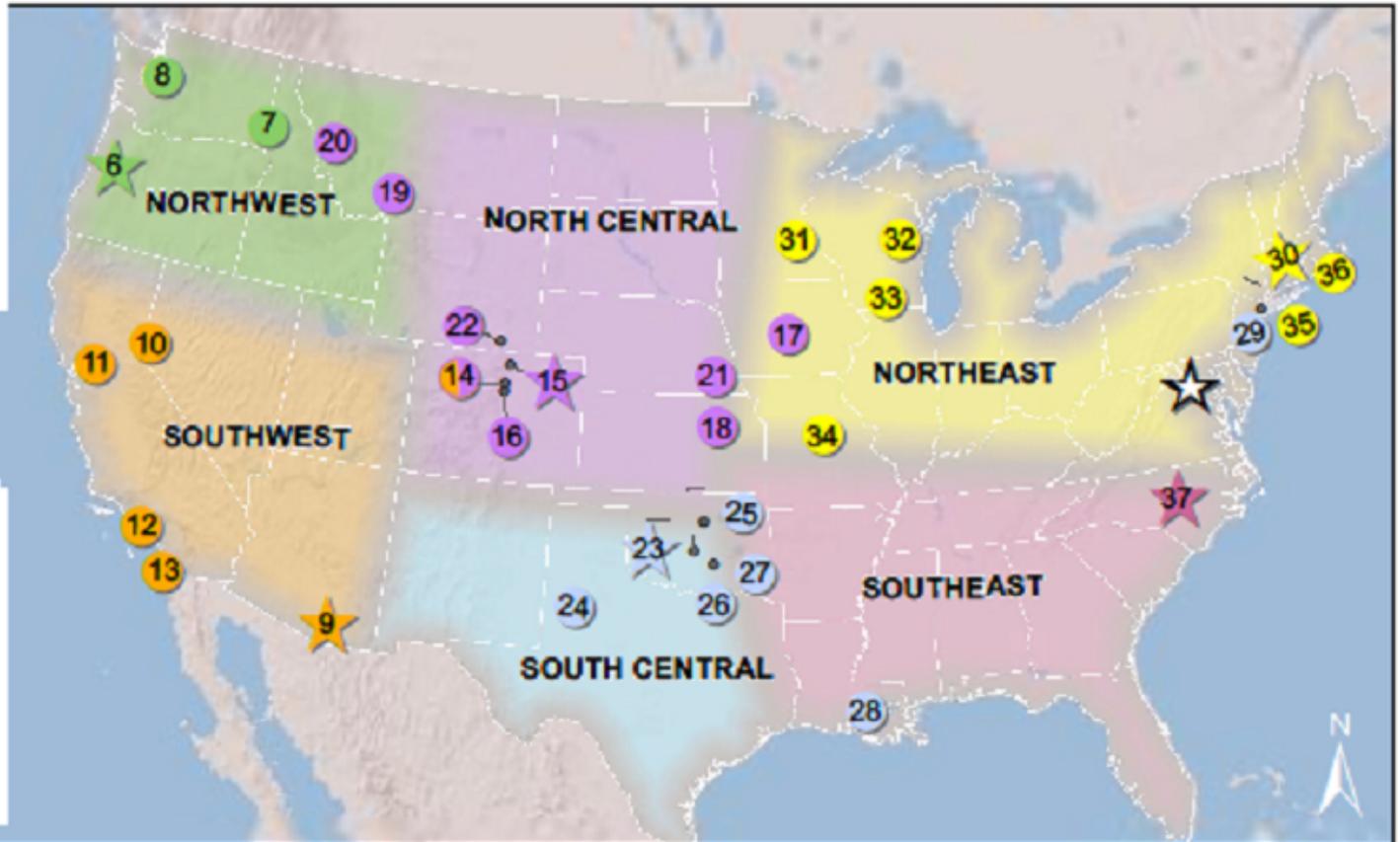
Long-term History of Colorado River Climate



Slide courtesy of Dr. Steve Gray, DOI Alaska Climate Science Center, based on Woodhouse, Gray, and Meko (2006). *Water Resources Research* 42:W05415

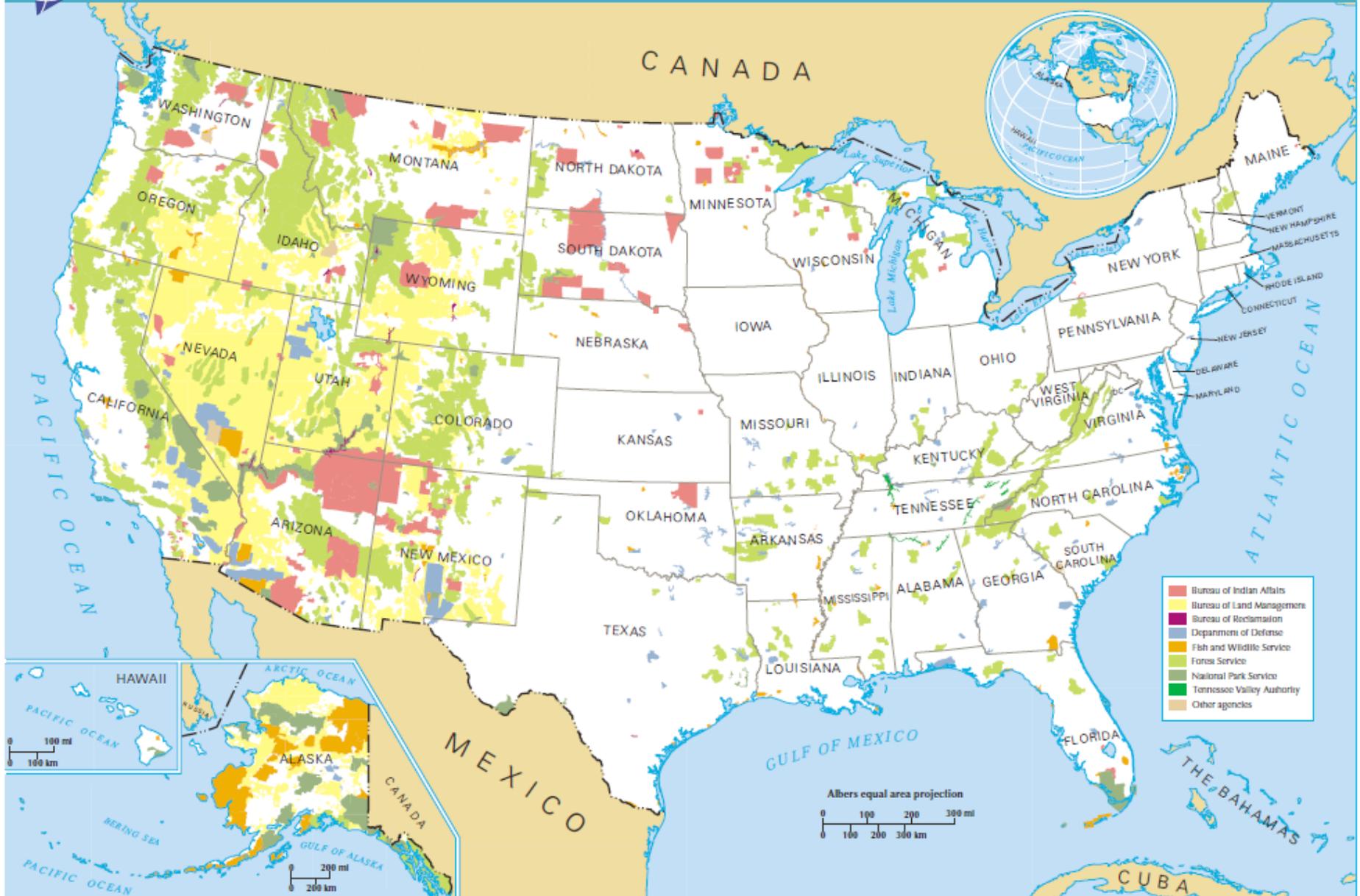
DOI Secretarial Order 3289



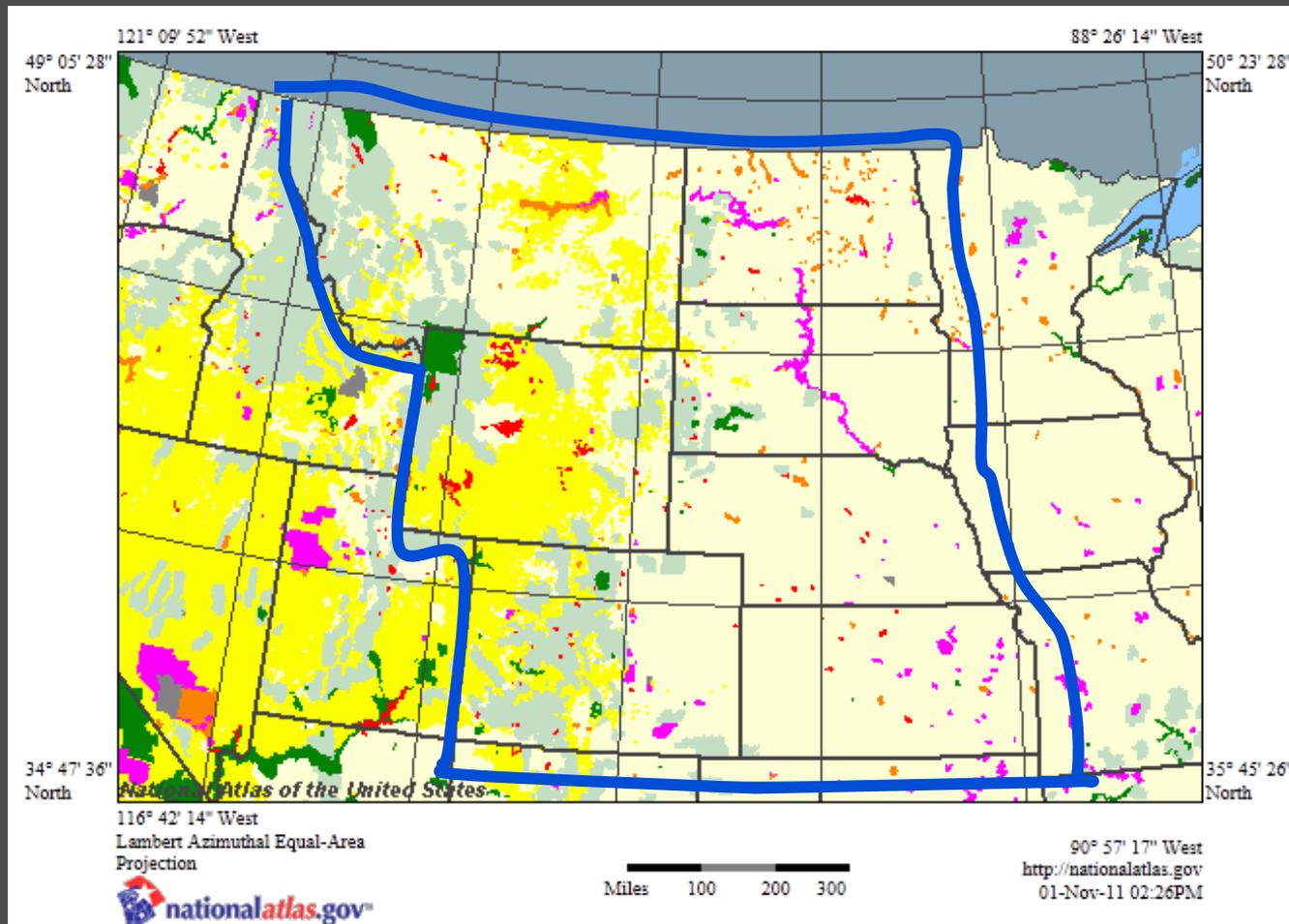




FEDERAL LANDS AND INDIAN RESERVATIONS



North Central CSC domain

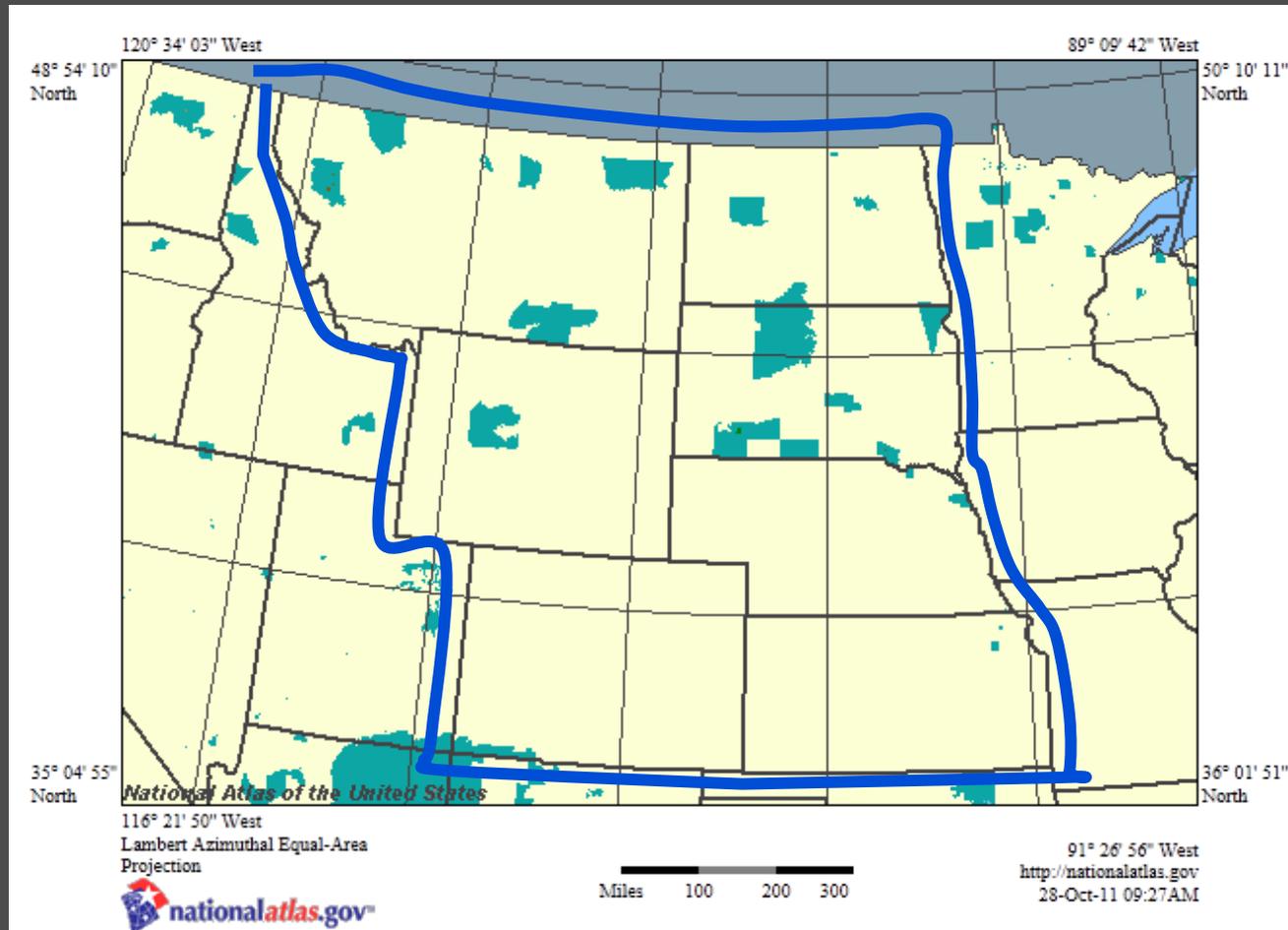


Federal Lands

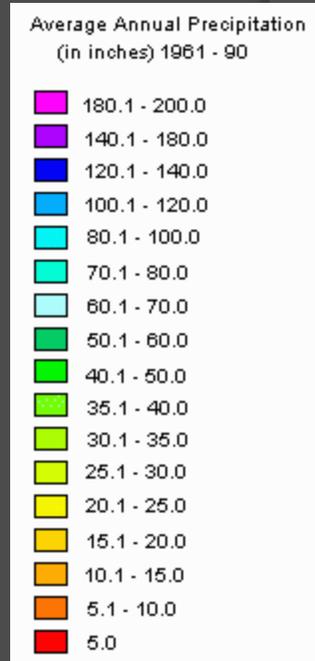
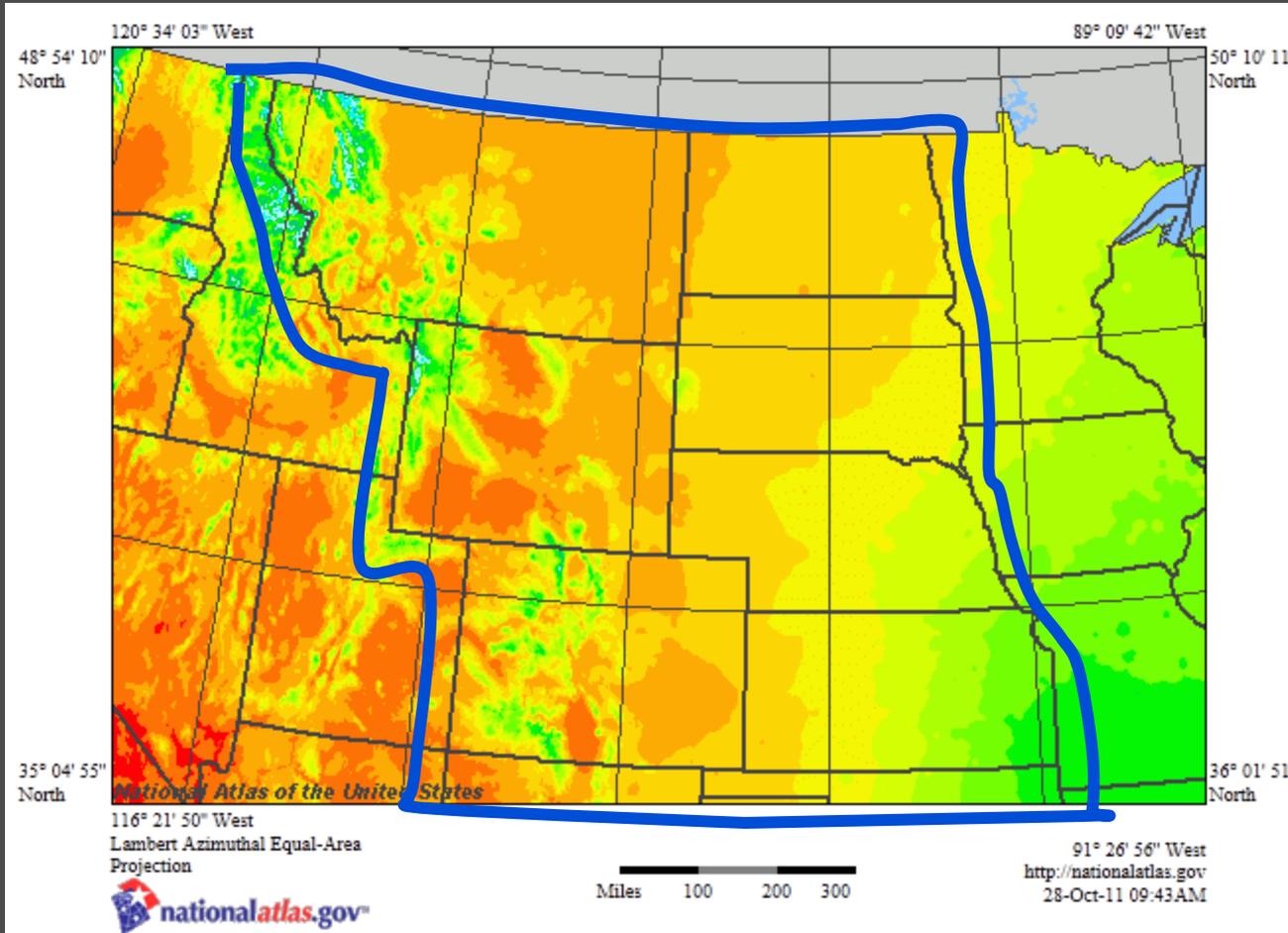
Source: [U. S. Geological Survey](http://nationalatlas.gov)

- Bureau of Land Management
- Bureau of Reclamation
- Department of Defense
- Forest Service
- Fish and Wildlife Service
- National Park Service
- Tennessee Valley Authority
- Other

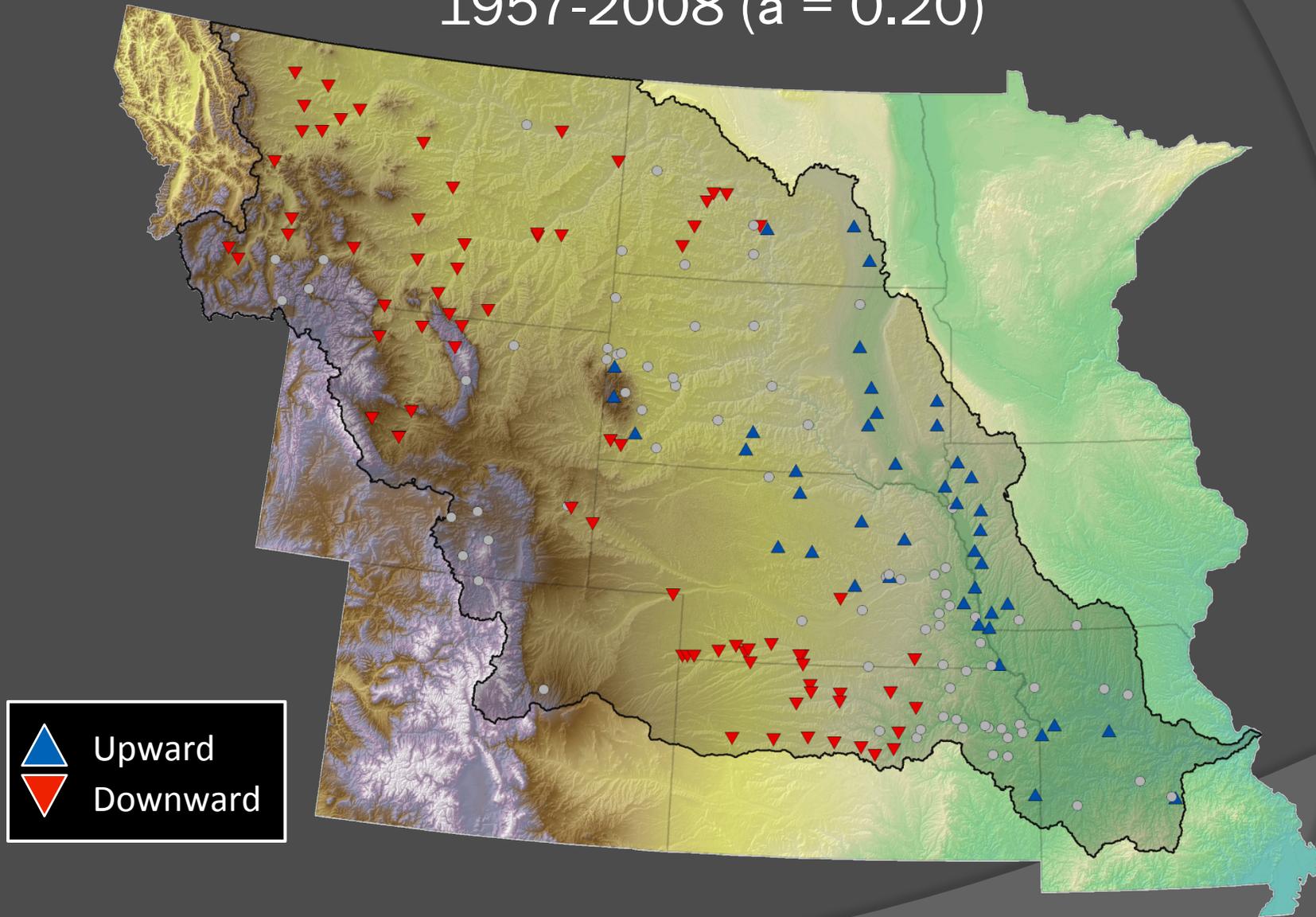
Native American Lands



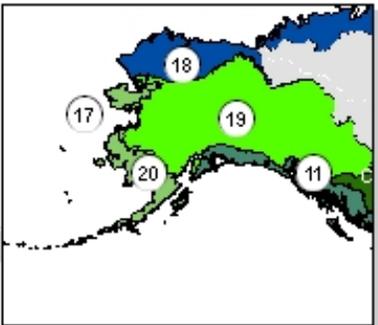
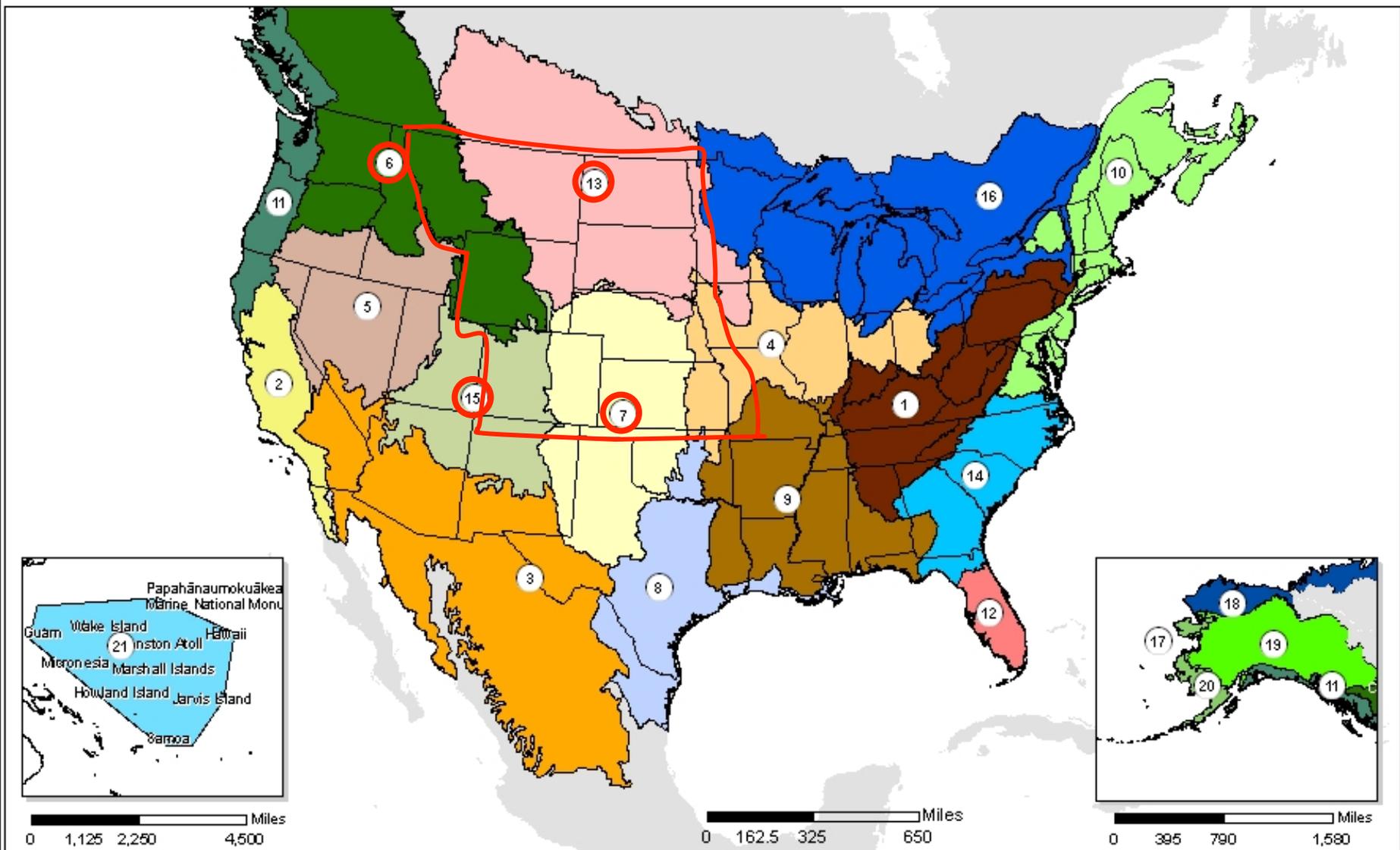
Average Annual Precipitation 1961-1990



Missouri River Basin Streamflow Trends 1957-2008 ($\alpha = 0.20$)



Mark T Anderson, USGS



Miles
 0 1,125 2,250 4,500

Miles
 0 162.5 325 650

Miles
 0 395 790 1,580

- | | | | |
|---|-----------------------------------|-------------------------------------|----------------------------------|
| 1. Appalachian | 7. Great Plains | 13. Plains and Prairie Potholes | 19. Northwestern Interior Forest |
| 2. California | 8. Gulf Coast Prairie | 14. South Atlantic | 20. Western Alaska |
| 3. Desert | 9. Gulf Coastal Plains and Ozarks | 15. Southern Rockies | 21. Pacific Islands |
| 4. Eastern Tallgrass Prairie and Big Rivers | 10. North Atlantic | 16. Upper Midwest and Great Lakes | Unclassified |
| 5. Great Basin | 11. North Pacific | 17. Aleutian and Bering Sea Islands | |
| 6. Great Northern | 12. Peninsular Florida | 18. Arctic | |

Crossing the Valley of Death

Science

Climate modeling

Basic biology and ecology

Guidelines

- Strong research program
- Healthy infrastructure and transition
- Strong interface with user community
- Continuous evaluation process



Climate Science Centers

Landscape Conservation Cooperatives



Applications

Management plans and actions



Research to Operations in Weather Satellites and Numerical Weather Prediction, 2000. National Academy Press.

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North Central Climate Science Center University Consortium



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UNIVERSITY CONSORTIUM

Establish foundational infrastructure

Introduce SAC, NCUC, and USGS constituents

Initiate ReVAMP concept

PRIMERS AND GUIDE DOCS

SCIENCE DELIVERY

Utilize ReVAMP infrastructure and common modeling framework
Including interaction with NCTC

Configure and maintain ReVAMP infrastructure
and common modeling framework

ADAPTATION AND MITIGATION

FOUNDATIONAL SCIENCE AREAS

IMPACTS



Including the NCCP Pilot...and potential follow-on

CLIMATE DRIVERS

NC CSC SCIENCE AGENDA/STRATEGIC PLAN

NCCWSC SCIENCE AGENDA AND IMPLEMENTATION PLAN

NCCWSC DATA MANAGEMENT PLAN

YEAR 1

YEAR 2

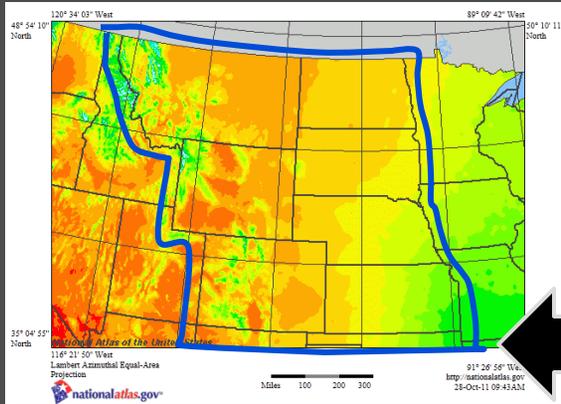
YEAR 3

YEAR 4

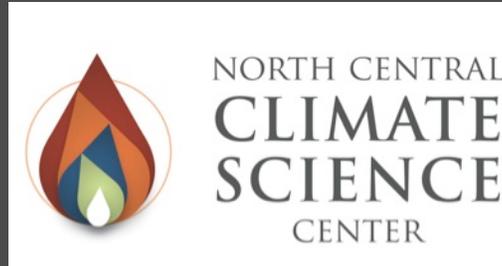
YEAR 5



STRATEGIC PLANNING MEETING REPORT: BASELINE OF NEEDS AND CAPACITY



Climate and climate derivatives



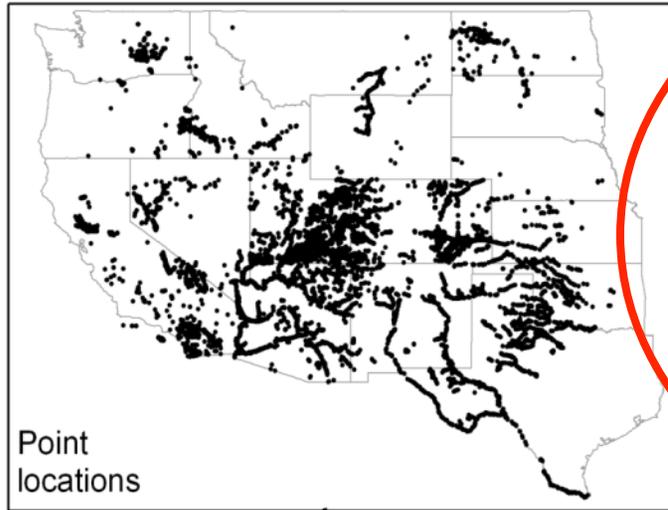
**Vulnerability*
Assessment &
Ecological
Response
Modeling**



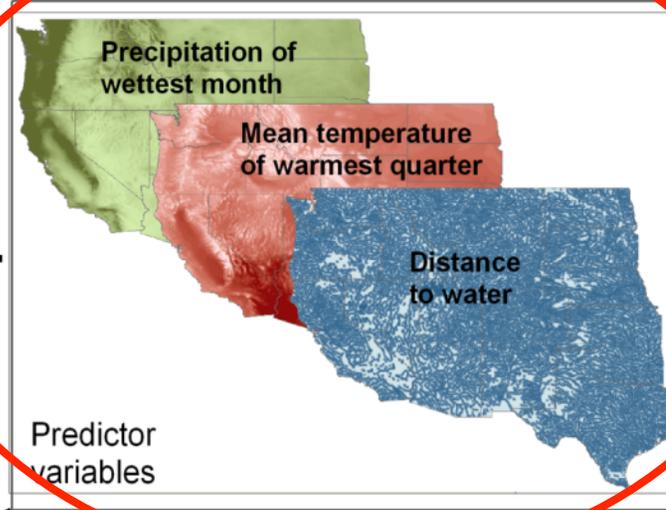
DOI Management Objectives/Goals

* can also consider opportunity assessment

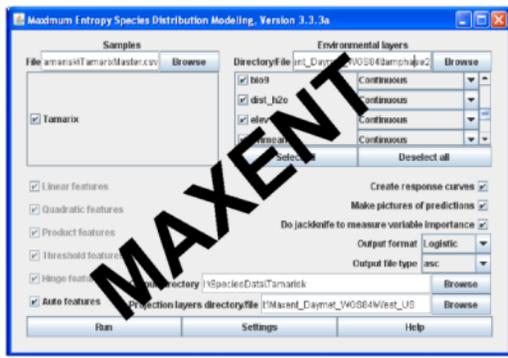
Species Distribution Modeling



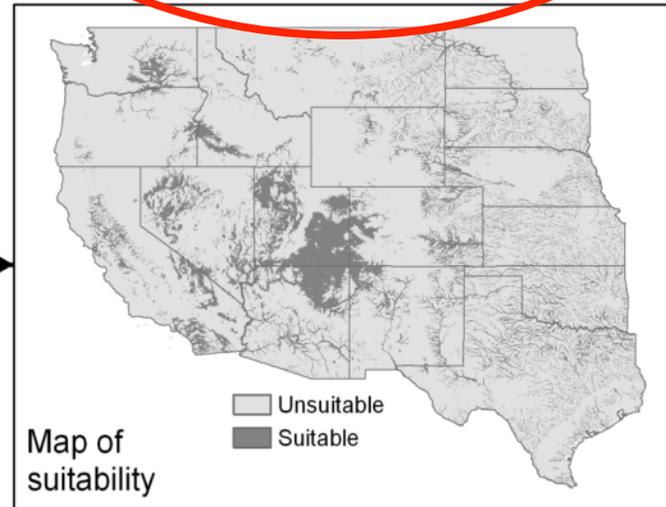
+



Suitability = f(Distance to water, mean temperature of warmest quarter, Precipitation of wettest month, etc.)

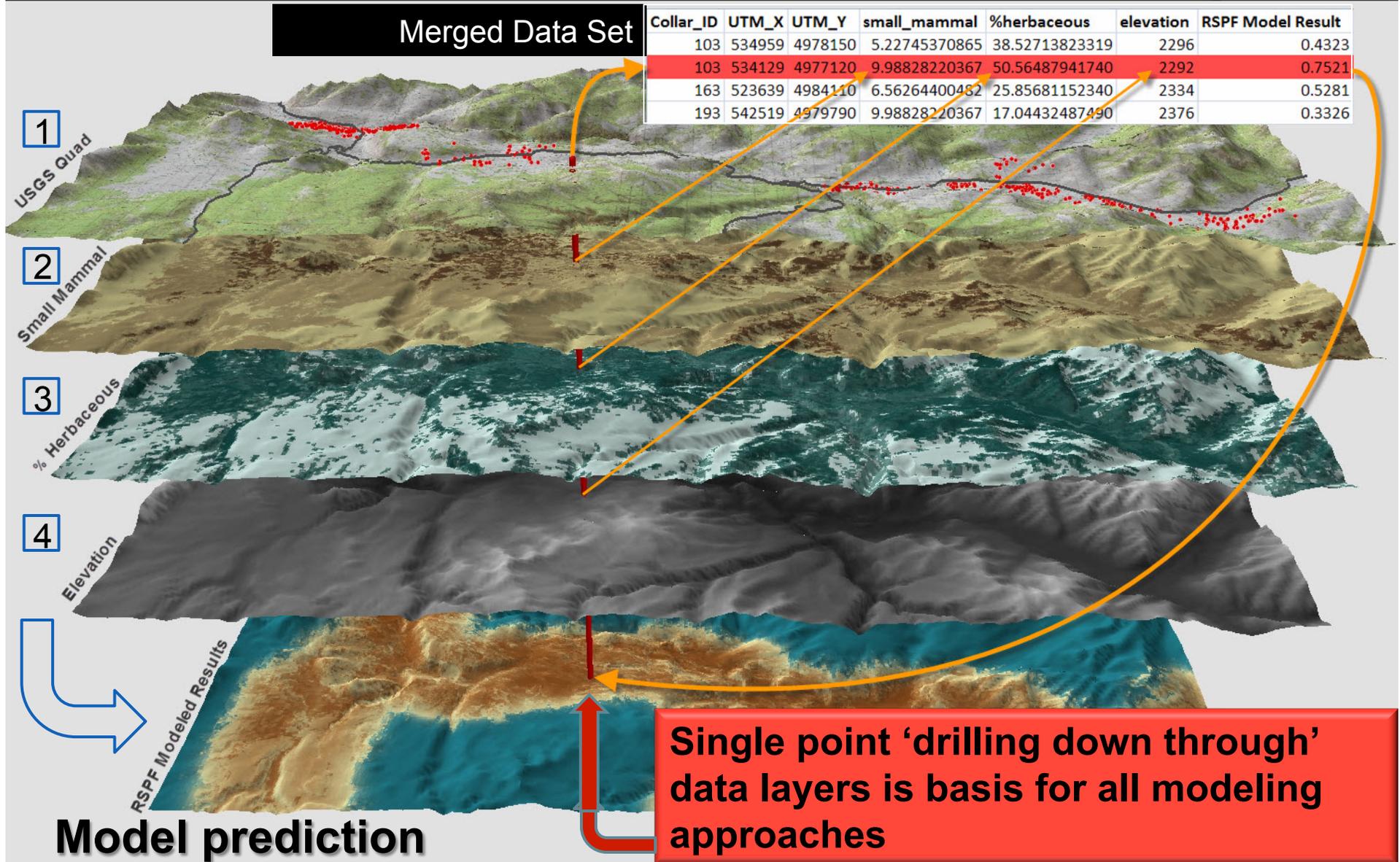


Model algorithm



Visual MDS and Model Output

Example: Resource Selection Analysis (RSF tool) courtesy of Bob Crabtree, YERC

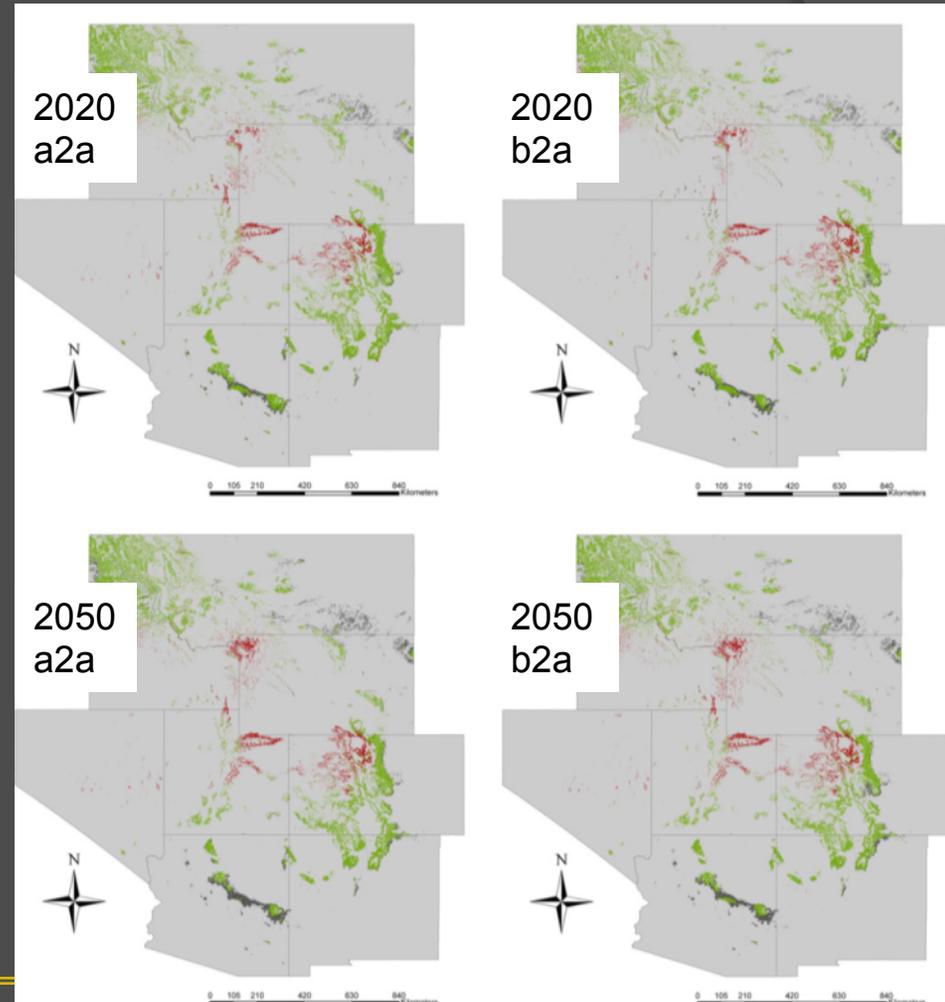
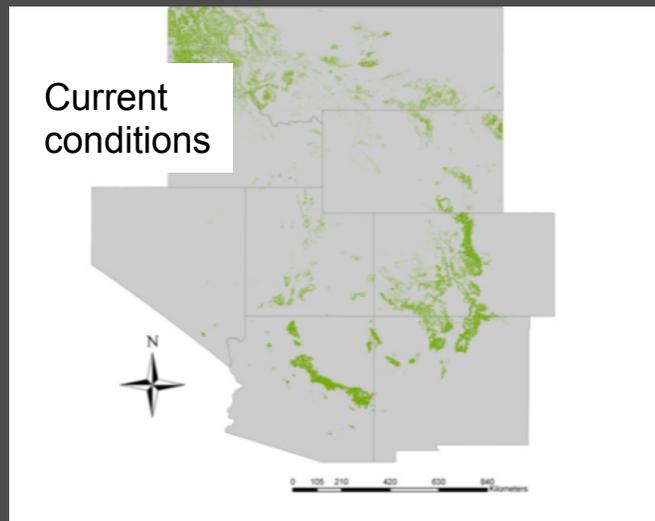


BioClim summaries

- BIO1 = Annual Mean Temperature
- BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
- BIO3 = Isothermality (BIO2/BIO7) (* 100)
- BIO4 = Temperature Seasonality (standard deviation *100)
- BIO5 = Max Temperature of Warmest Month
- BIO6 = Min Temperature of Coldest Month
- BIO7 = Temperature Annual Range (BIO5-BIO6)
- BIO8 = Mean Temperature of Wettest Quarter
- BIO9 = Mean Temperature of Driest Quarter
- BIO10 = Mean Temperature of Warmest Quarter
- BIO11 = Mean Temperature of Coldest Quarter
- BIO12 = Annual Precipitation
- BIO13 = Precipitation of Wettest Month
- BIO14 = Precipitation of Driest Month
- BIO15 = Precipitation Seasonality (Coefficient of Variation)
- BIO16 = Precipitation of Wettest Quarter
- BIO17 = Precipitation of Driest Quarter
- BIO18 = Precipitation of Warmest Quarter
- BIO19 = Precipitation of Coldest Quarter

Nix, H. 1986. A biogeographic analysis of Australian elapid snakes. Pages 4 - 15 in R. Longmore, editor. Atlas of Elapid snakes of Australia. Australian Government Publishing Service, Canberra.

Assessing the potential distribution of pine beetles under current and future climate scenarios



-  potential distribution extent under current climate conditions
-  distribution increases
-  distribution decreases

Evangelista PH, S Kumar, TJ Stohlgren, and NE Young 2011. Assessing forest vulnerability and the potential distribution of pine beetles under current and future climate scenarios in the Interior West of the US. *Forest Ecology and Management* 262: 307–316

Table 1

The top four predictors and their average (from 10 replicates) percent contribution reported from the Maxent model for the three bark beetles.

Predictor variables	Contribution (%)
<i>Mountain pine beetle</i>	
Precipitation of the warmest quarter (Bio18)	65.3
Mean temperature of the warmest quarter (Bio10)	8.7
Precipitation seasonality (Bio15)	6.9
Precipitation of driest quarter (Bio17)	5.4
<i>Western pine beetle</i>	
Annual mean precipitation (Bio12)	39.5
Precipitation of wettest month (Bio13)	23.1
Precipitation of the wettest quarter (Bio16)	8.0
Precipitation seasonality (Bio15)	6.9
<i>Pine engraver beetle</i>	
Annual mean precipitation (Bio12)	37.8
Annual mean temperature (Bio1)	14.2
Precipitation of wettest month (Bio13)	13.0
Precipitation seasonality (Bio15)	10.6

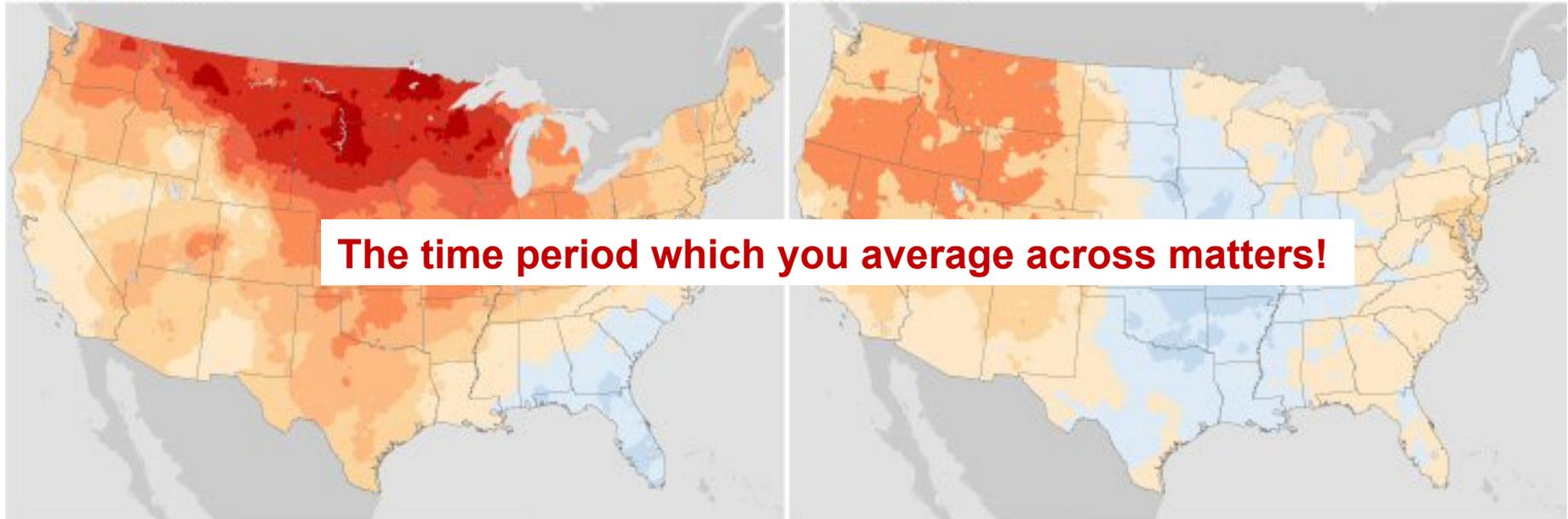
Evangelista PH, S Kumar, TJ Stohlgren, and NE Young 2011. Assessing forest vulnerability and the potential distribution of pine beetles under current and future climate scenarios in the Interior West of the US. *Forest Ecology and Management* 262: 307–316

Difference map:

Changes in U.S. Normal Temperatures (1981-2010 compared to 1971-2000)

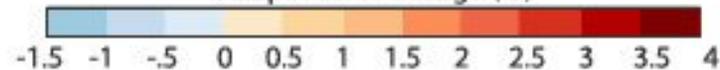
January minimums

July maximums



The time period which you average across matters!

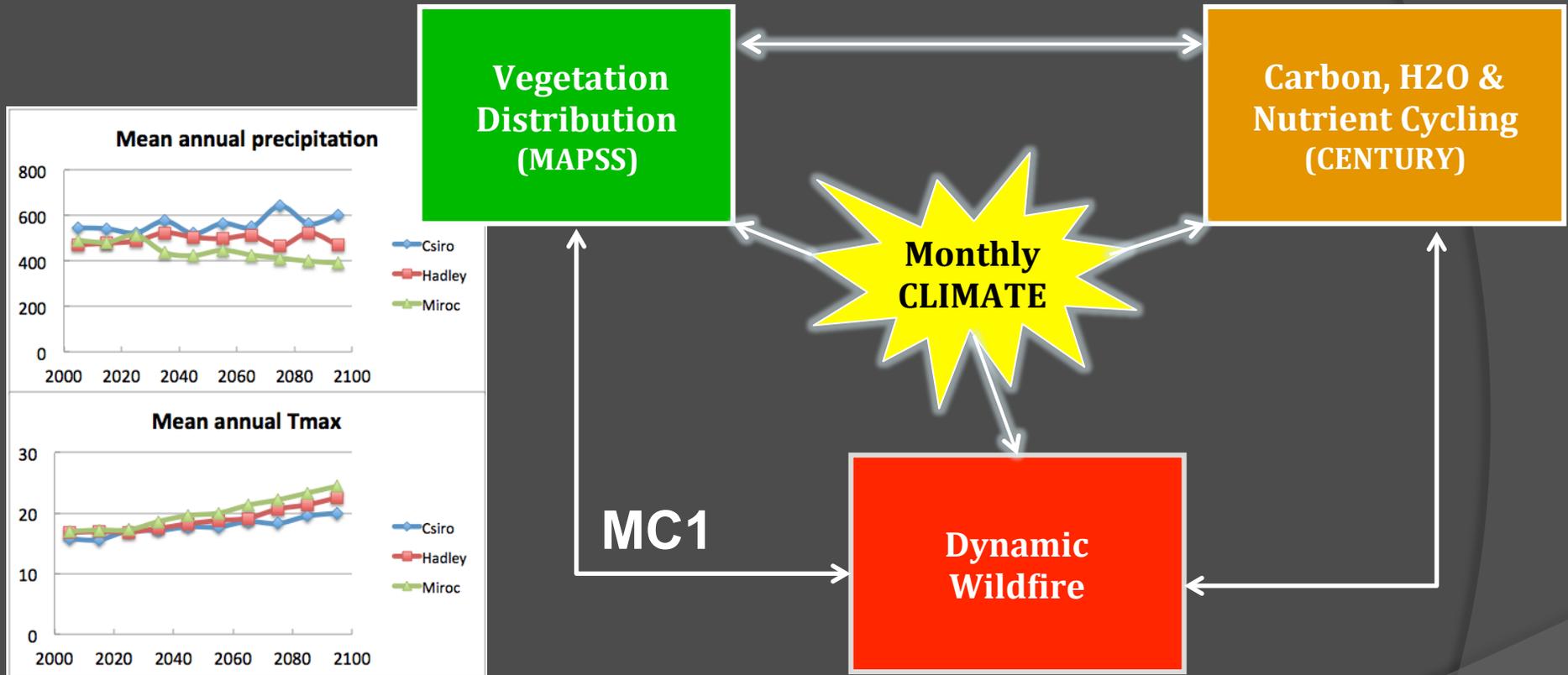
Temperature change (°F)



NOAA - http://www.noaanews.noaa.gov/stories2011/20110629_newnormals.html.

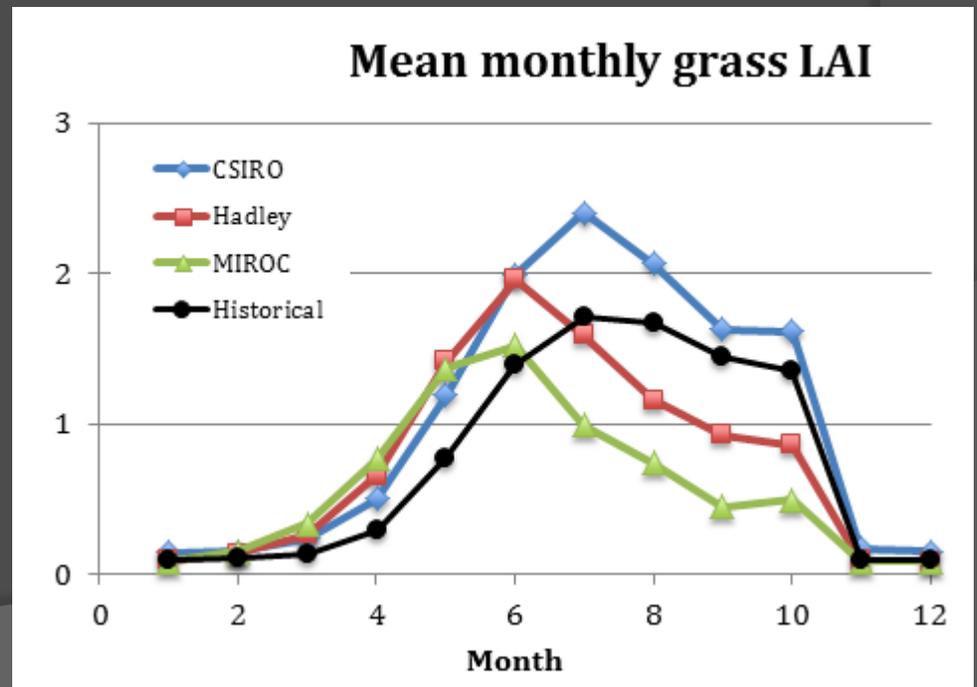
See also: "Perception of climate Change: The New Climate Dice", Hansen et al
http://www.columbia.edu/~jeh1/mailings/2012/20120105_PerceptionsAndDice.pdf

Climate Change Impacts at Wind Cave National Park (A. Symstad et al.)



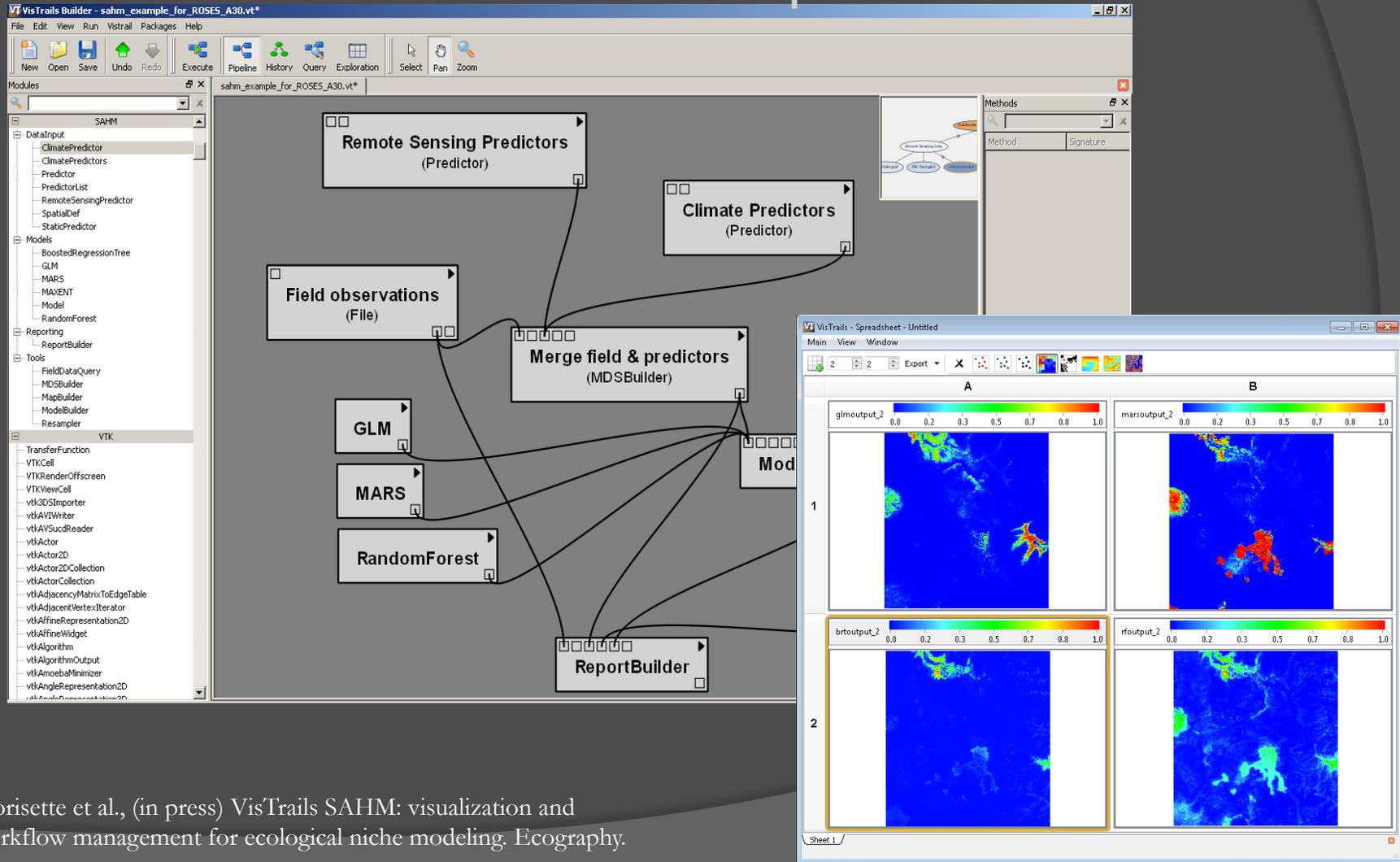
Summary of WCNP project – “Natural” Conditions

- High natural fire frequency prevents woody expansion.
- C4:C3 grass ratio increases with future warming.
- Increased WUE (CO₂ effect) mitigates warm and dry conditions.
- Production shifts to earlier in growing season.



VisTrails

...making our modeling transparent and repeatable.



Morisette et al., (in press) VisTrails SAHM: visualization and workflow management for ecological niche modeling. *Ecography*.

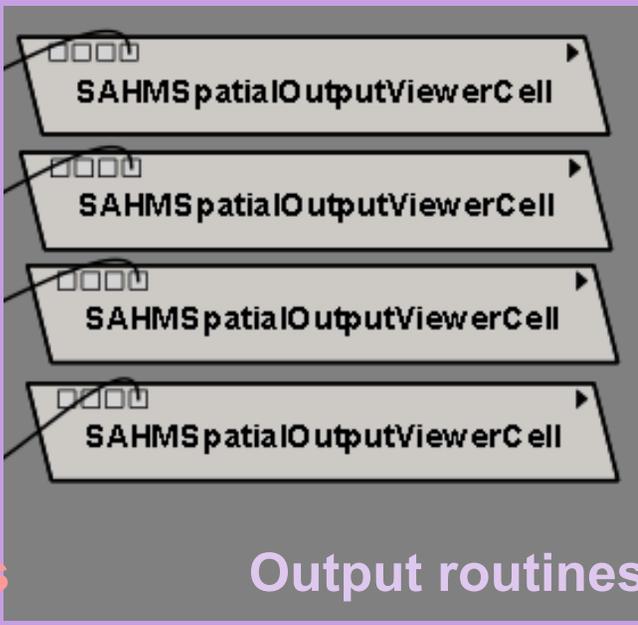
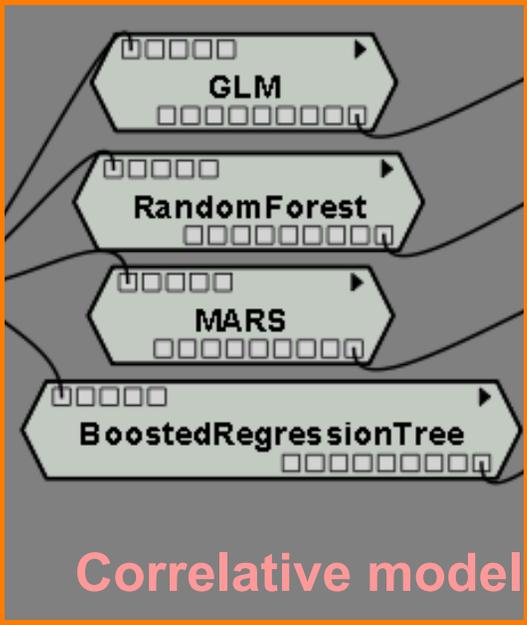
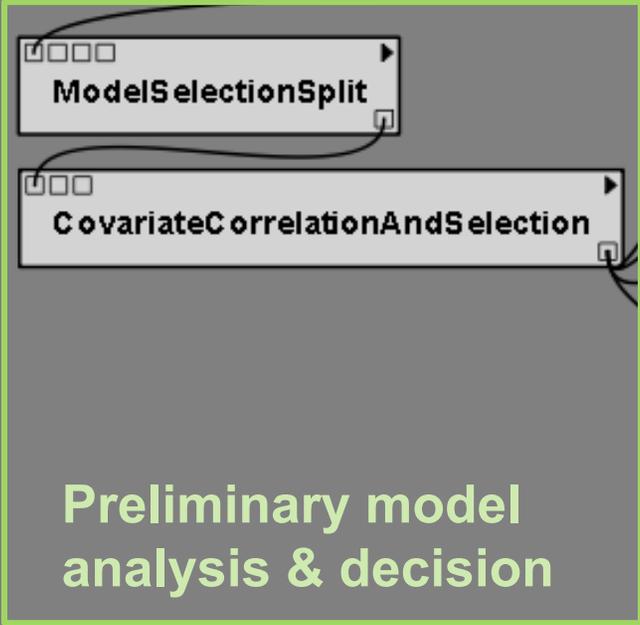
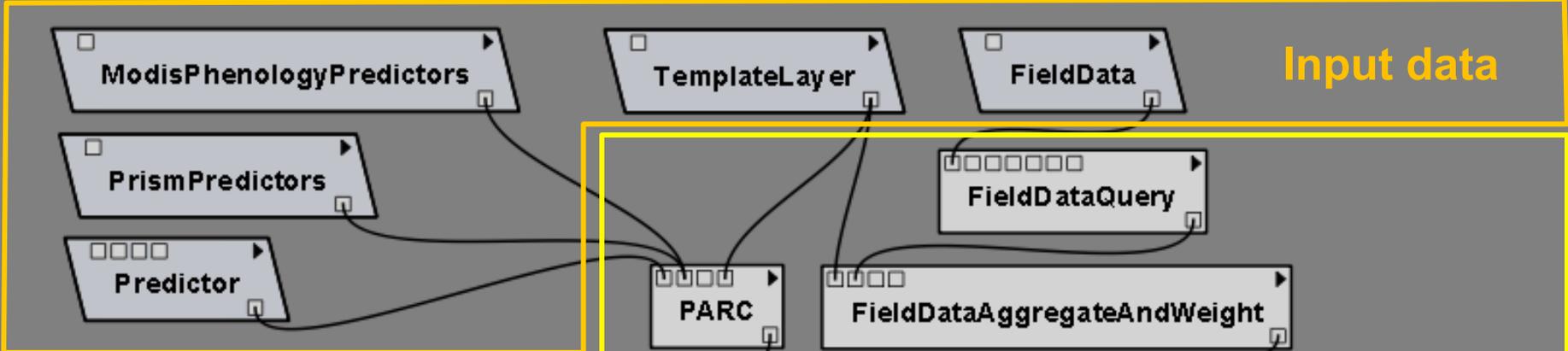
VisTrails



- Comprehensive **provenance infrastructure** (detailed history information on the steps followed and data derived in the course of an exploratory task, making all finding repeatable, important for FOYA, IQA, other court issues).
- First released in January 2007, VisTrails 2.0 was released in 2012
- The system has been downloaded over 35,000 times.
- VisTrails wiki has had over 1.5 million page views
- Google Analytics reports visitors from 65 different countries.
- VisTrails has been adopted in:
 - Ocean Sciences ([Baptista, et al. 2008](#), [Howe, et al. 2008](#)),
 - Psychiatry ([Anderson, et al. 2007](#)),
 - Astronomy ([Tohline, et al. 2009](#)),
 - Cosmology ([Anderson, et al. 2008](#)),
 - High-Energy Physics ([Dolgert, et al. 2008](#)), and
 - Quantum physics ([Bauer, et al. 2011](#), [Freedman, et al. 2012](#)).
 - Ultrascale Visualization - Climate Data Analysis Tools (UV-CDAT) <<http://uv-cdat.llnl.gov>>.
- VisTrails works through a graphical user interface where the user pulls pre-defined modules.

Freire, J., et al. 2006. Managing Rapidly-Evolving Scientific Workflows. - In: L. Moreau and I. Foster (eds), Springer Berlin / Heidelberg, pp. 10-18.

Freire, J. and Silva, C. T. 2012. Making Computations and Publications Reproducible with VisTrails. - Computing in Science & Engineering 14: 18-25



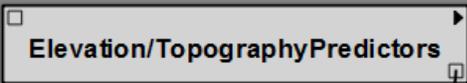
Input data

Preprocessing

Preliminary model analysis & decision

Correlative models

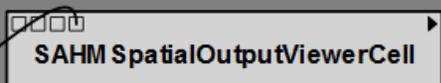
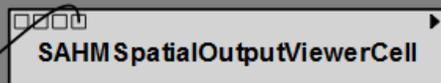
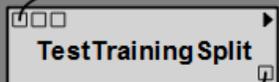
Output routines



ClimatePredictors Module Configuration

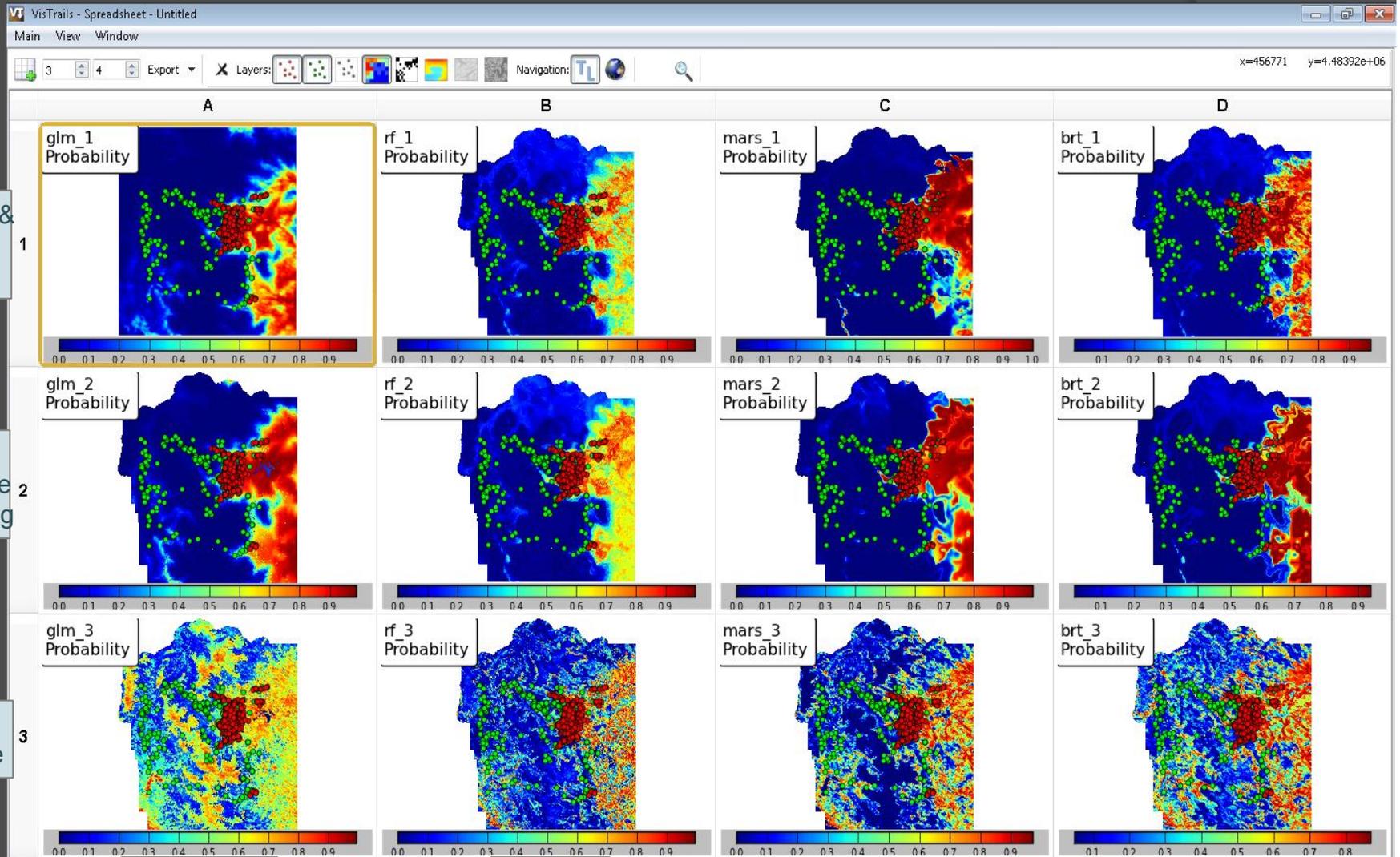
Include	Layer	Categorical
Daymet (1980-1997) Normals, 1km.		
WorldClim (1950-2000) Normals, 1km.		
PRISM (1971-2000) Normals, 800 m.		

OK Cancel Select All Switch Selection Query Add



VisTrails

Cheatgrass habitat in Rocky Mountain National Park



Climate &
Remote
Sensing

No
Remote
Sensing

No
Climate

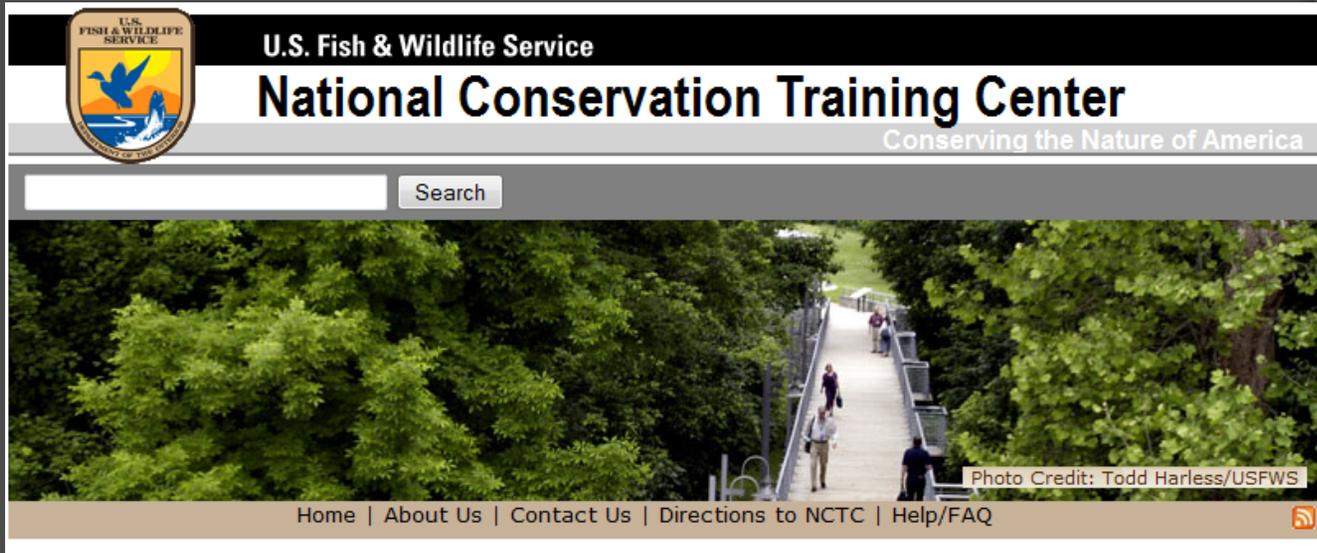
Generalized
Linear
Model

Random
Forest

Multivariate
Adaptive Regression
Splines

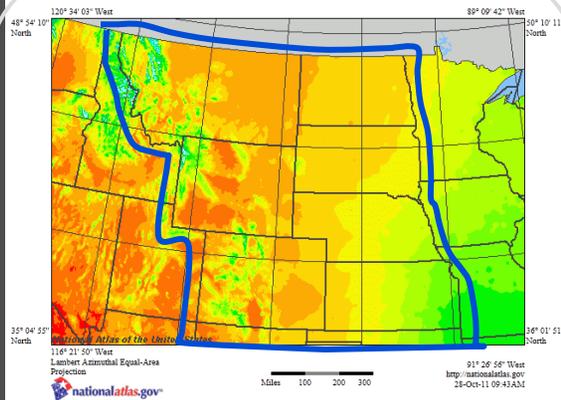
Boosted
Regression
Tree





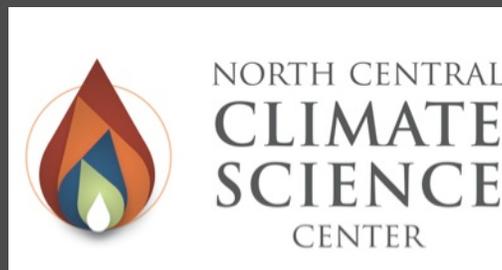
NC CSC connection with the Department of Interiors National Training Center

1. Stronger connection with NCTC, providing instructors
2. Provide Regional offerings of NCTC climate-related classes
3. Use NCTC as our “social network” or early adopters.
4. Bring NCTC case-studies to semester-long university courses of help with follow-up work at the NC CSC



Climate and climate derivatives

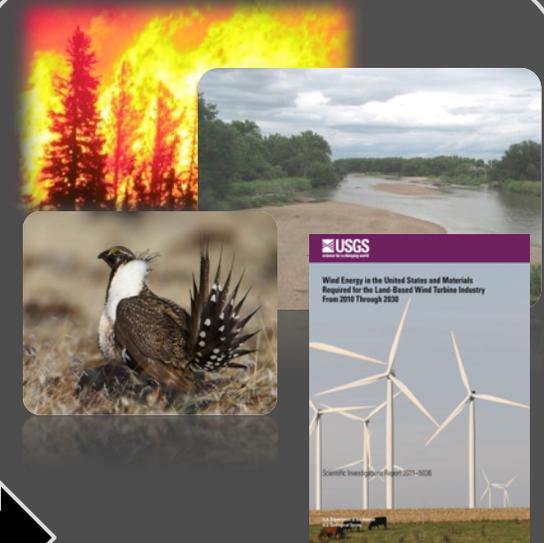
- CMIP3
- CMIP5
- Regional models
- Downscaled products
- Past and projected



Vulnerability* Assessment & Ecological Response Modeling

- Test sensitivity to
- Climate models
 - Emissions scenarios
 - Parameters used to construct the derivatives

Allow for alternative scenarios of non-climate forcings.



DOI Management Objectives/Goals

- Engage end-user early in the process
- Involve users through the vulnerability assessment process
- Utilize rigorous social science, recognizing cross-sectoral interactions
- Regional is scope

* can also consider opportunity assessment



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NCCWSC DATA MANAGEMENT PLAN

YEAR 1

YEAR 2

YEAR 3

YEAR 4

YEAR 5



STRATEGIC PLANNING MEETING REPORT: BASELINE OF NEEDS AND CAPACITY

NC CSC five year science plan, <http://pubs.usgs.gov/of/2012/1265/>