Climatic and Ecological Conditions in the Klamath Basin of Southern Oregon and Northern California: Projections for the Future

A Collaborative Effort by:

National Center for Conservation Science & Policy

CLI Climate Leadership Initiative
Institute for a Sustainable Environment
University of Oregon

The MAPSS Team at the USDA Forest Service
Pacific Northwest Research Station

INTRODUCTION

The Klamath Basin is rich in history, culture, and biological diversity. This region is home to numerous relict species – species that survived in place while most others were forced to move or go extinct in response to a changing climate and glacial retreat over the last 20,000+ years. Recent climatic changes are already causing ecological changes in the Basin, and in the coming decades, change is expected to accelerate. However, our understanding of the trajectory and specifics of change is still quite limited.

We initiated this project to explore the possible future conditions of the Klamath Basin and bring this information to local communities, resource managers, and decision makers. Our assessment brings global climate models to the local scale to help guide the planning process.

Climatologists created complex models to determine how climatic conditions may change in the future. These models vary in their level of detail and assumptions, making the output highly variable and future scenarios uncertain. However, taken as a group, climate models present a range of possible future conditions that are more likely to occur than continued historical conditions.

Most climate models are created at the global scale, but are difficult to apply at local or regional scales. For resource managers and policymakers

to make decisions at these finer scales, they need information about how climate change will impact the local area.

The MAPSS (Mapped Atmosphere-Plant-Soil System) Team at the U.S. Forest Service Pacific Northwest Research Station has adjusted global model results to local and regional scales. This report presents some of the projected results for the Klamath Basin.

DEFINITIONS

Climate projection
A model-derived estimate of the future climate.

Climate prediction or forecast
A projection that is highly certain, based on agreement among multiple models.

Scenario
A coherent and plausible description of a possible future state. A scenario may be developed using climate projections as the basis, but additional information, including baseline conditions and decision pathways, is needed to develop a scenario.

MODELS AND THEIR LIMITATIONS

From the multitude of models reviewed by the International Panel on Climate Change (IPCC), the MAPSS Team chose three global climate models that represented a range of projections for temperature and other climate variables. These three models are Hadley (HADCM), MIROC, and CSIRO. While the specific inputs are beyond the scope of this report, they include such variables as greenhouse gas emissions, air and ocean currents, ice and snow cover, plant growth, particulate matter, and many others.

Model outputs were converted to local scales using local data on recent temperature and precipitation patterns. The climate model results were applied to a vegetation model (MC1) to provide information on possible future vegetation types, wildfire frequency, and runoff.

The utility of the model results presented in this report is to help communities picture what the conditions and landscape may look like in the future and what the

HOW CERTAIN ARE WE?

HIGH CERTAINTY:

Higher temperatures – Greater concentrations of greenhouse gases trap more heat. Measured warming tracks model projections.

Lower snowpack – Higher temperatures lead to precipitation as rain instead of snow; accumulated snow will melt earlier.

Shifting distributions of plants & animals – Relationships between species distributions and climate are well documented.

MEDIUM CERTAINTY:

More frequent storms – Storms will be regionally variable.

Changes in precipitation – Current models show wide disagreement on precipitation patterns, but the model projections converge in some locations.

LOW CERTAINTY:

Changes in vegetation – Vegetation may take decades or centuries to keep pace with changes in climate.

Changes in runoff– Current models of runoff are unsophisticated and based on historical conditions. Uncertainty in precipitation, land use, and shifting vegetation also contribute to the uncertainty in runoff patterns.

Wildfire patterns – Many uncertain components, including vegetation, tree pests and disease, and precipitation will impact fire patterns.

magnitude and direction of changes might be. Because the model outputs vary in their degree of uncertainty, they are considered projections rather than predictions. Some model output, such as temperature, has greater certainty than other output, such as vegetation type or runoff (see box, previous page). **We urge the reader to keep in mind that these model results are presented to explore the types of changes we may see, but that actual conditions may be quite different from those depicted.**

The uncertainty associated with projections of specific future conditions should not be used as a reason for inaction on climate change. The likelihood that future conditions will resemble historic conditions is very low, so managers and policy makers are encouraged to begin to plan for an era of change, even if the trajectory of such change is uncertain.

GLOBAL CLIMATE CHANGE PROJECTIONS

The IPCC concluded in 2007[1] that the evidence was "unequivocal" that the Earth's atmosphere and oceans are warming primarily due to human activities including the emission of CO_2, methane, and other greenhouse gases, along with land conversion and deforestation. The IPCC emission scenario used in this assessment was the "business-as-usual" trajectory that assumes that most nations fail to act individually or collectively to lower emissions. The current growth in emissions actually exceeds the assumed growth in this modeled scenario, meaning that these results may underestimate changing climate conditions.

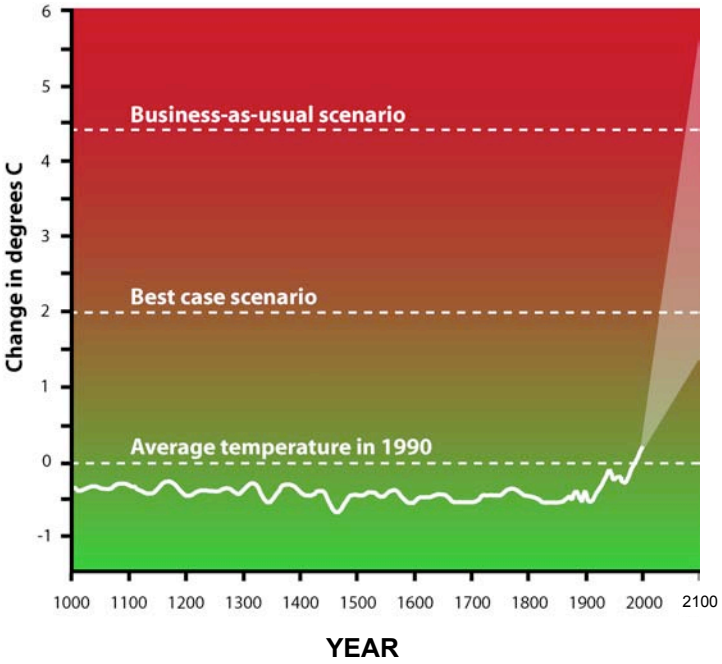


Figure 1. The last 1000 years in global mean temperature, in comparison to projected temperature for 2100. Drastic cuts in greenhouse gas emissions would lead to an increase of about 2ºC by 2100 while the current trajectory will lead to an increase closer to 4.5º C and as high as 6º C (adapted from IPCC 2007)

[1] IPCC 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

KLAMATH BASIN CLIMATE PROJECTIONS

Variables modeled using HADCM, CSIRO, and MIROC, the vegetation model (MC1), and our stream flow calculations include temperature, precipitation, vegetation type and distribution, percent of the landscape burned, and annual runoff. These variables were calculated based on historical data for making baseline comparisons, and were projected out to 2100. Again, these projections are uncertain, but they represent a likely range of possible future conditions in the Klamath Basin. As climate change plays out, surprises and unforeseen chains of cause-and-effect are likely.

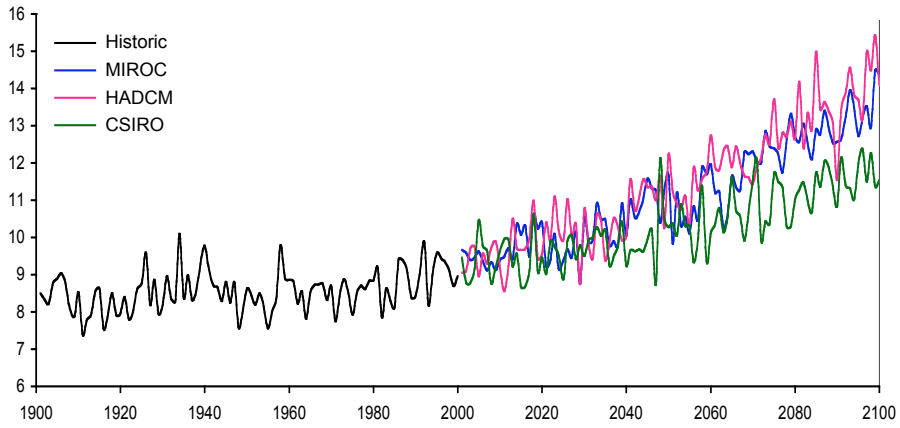


Figure 1. Mean annual temperature (ºC) across the Klamath Basin from 1901 to 2000 (measured historical) and projected through 2100 using three global climate models adjusted for local conditions and topography.

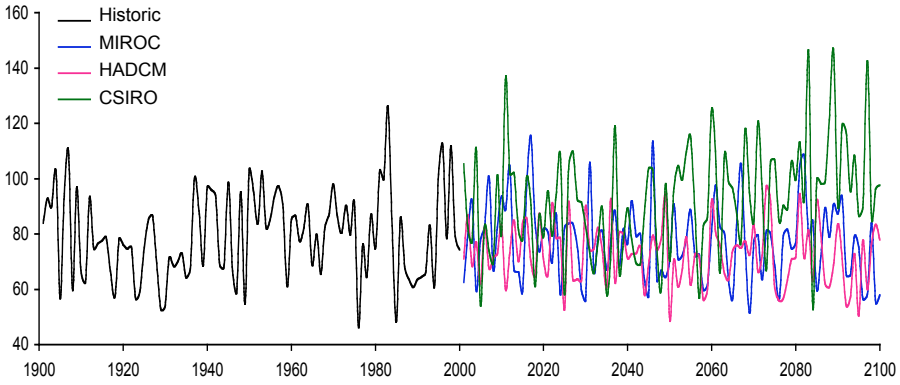


Figure 2. Mean annual precipitation (mm) across the Klamath Basin from 1901 to 2000 (measured historical) and projected through 2100 using three global climate models adjusted for local conditions and topography.

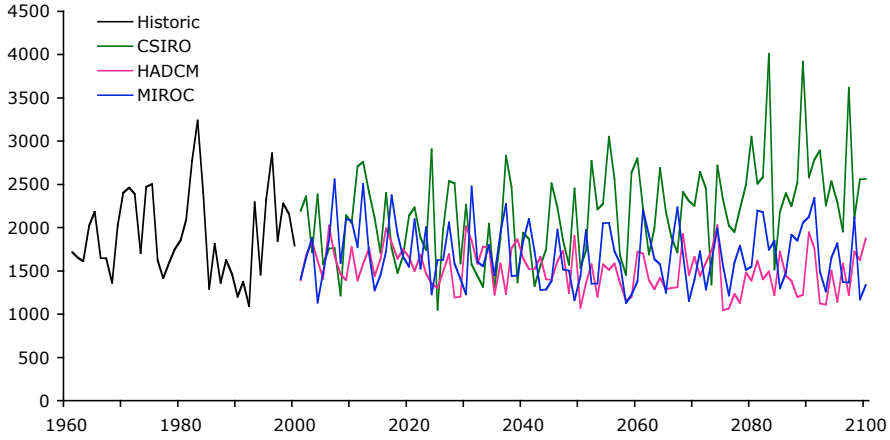


Figure 3. Mean annual runoff at Iron gate gaging station, in millions of cubic meters per year.

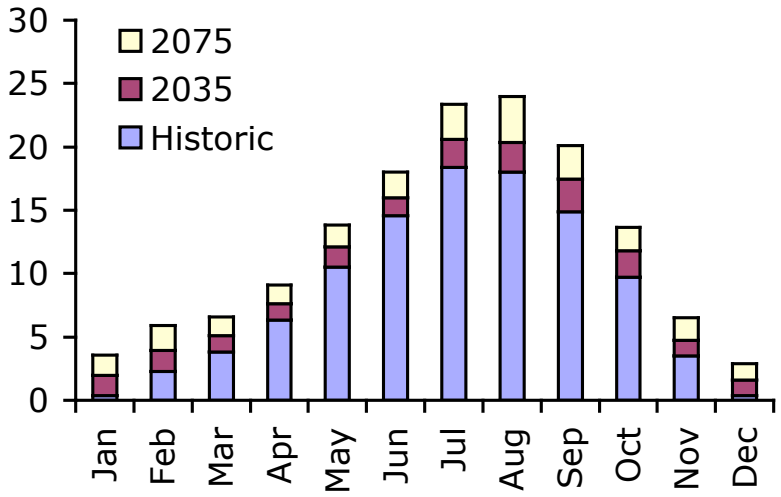


Figure 4. Monthly increases in temperature (ºC), based on a 10-year average with a midpoint in 2035 (red) and in 2075 (yellow), as compared to historic (light blue). Historic temperature data was averaged from 1961-1991. Because temperature change was similar across models, they were averaged together for this graph.

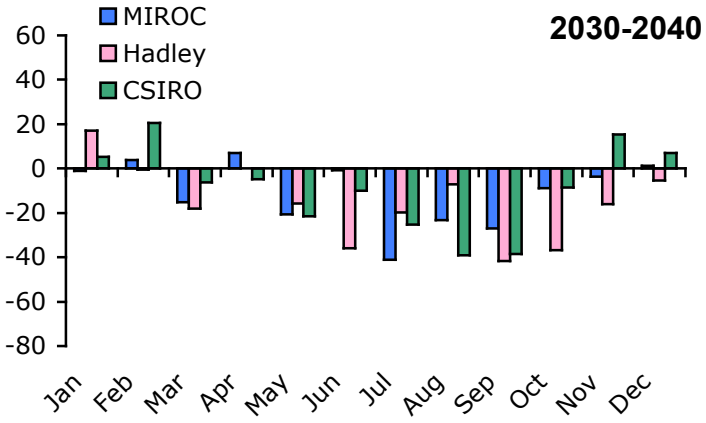


Figure 5. Monthly percent change in precipitation from historic (1961-1991) to a 10-year average centered around 2035. All three models show drier summers in the Klamath Basin by 2030-2040.

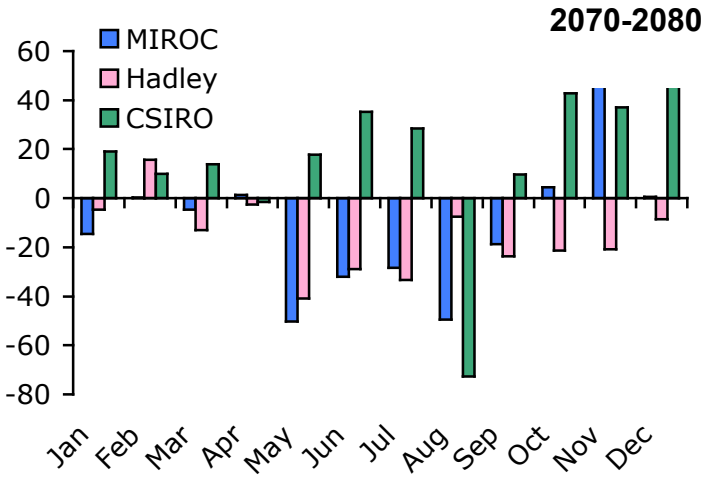
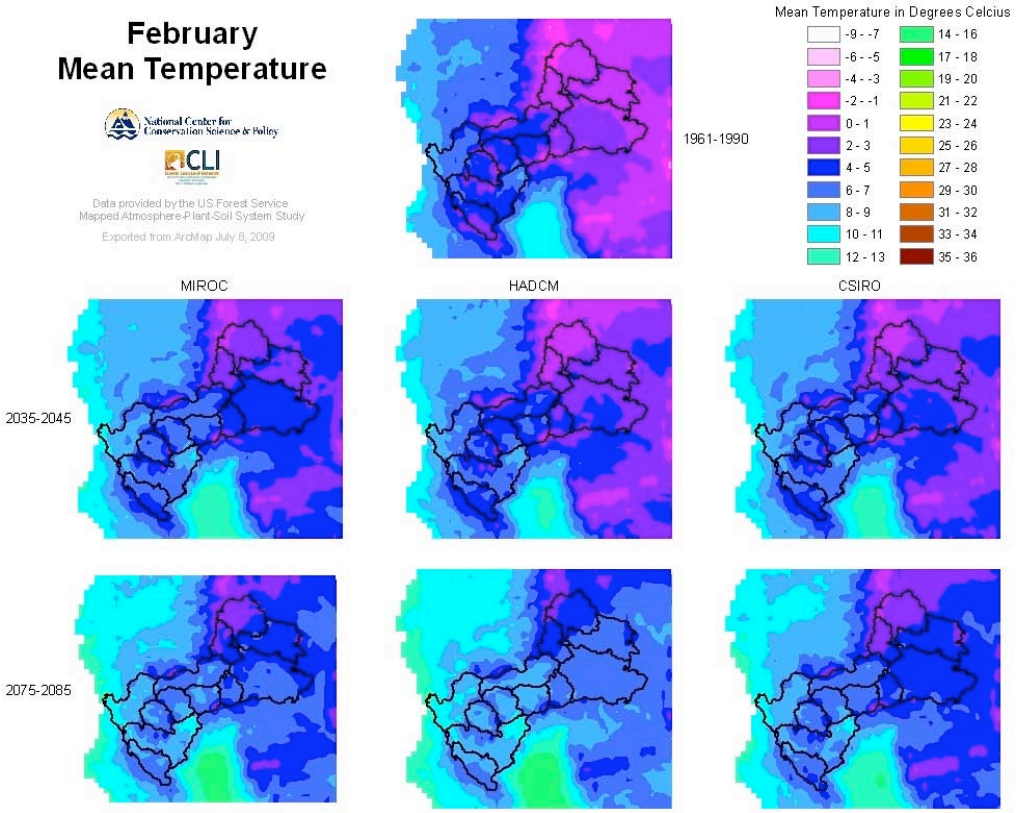
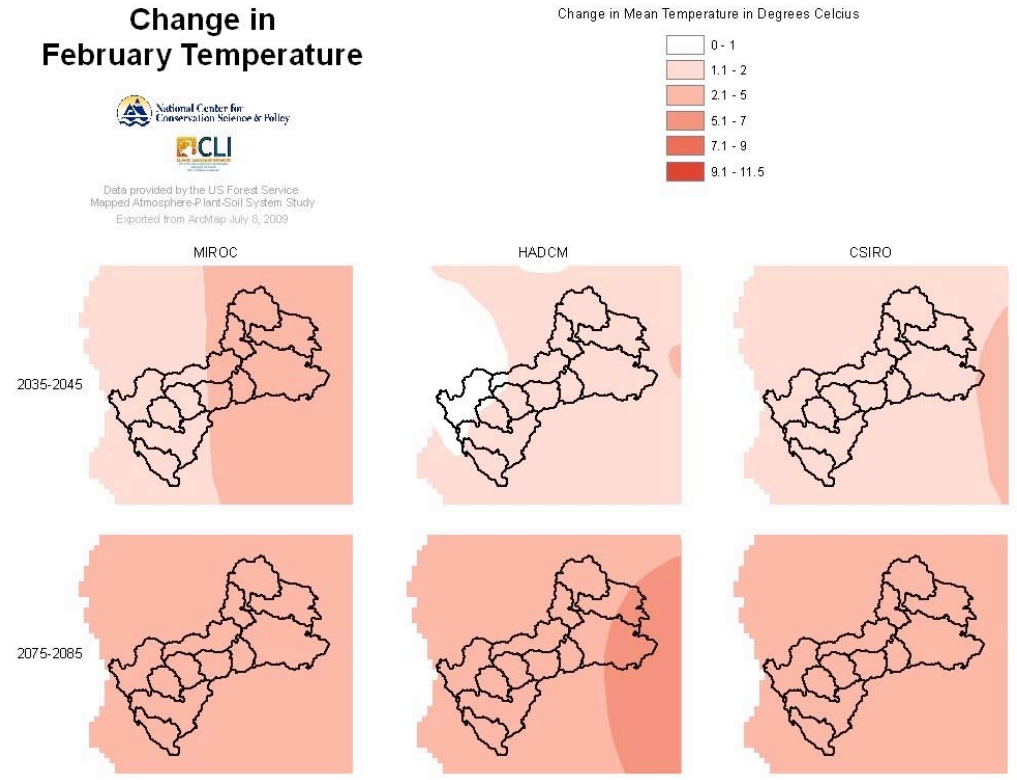
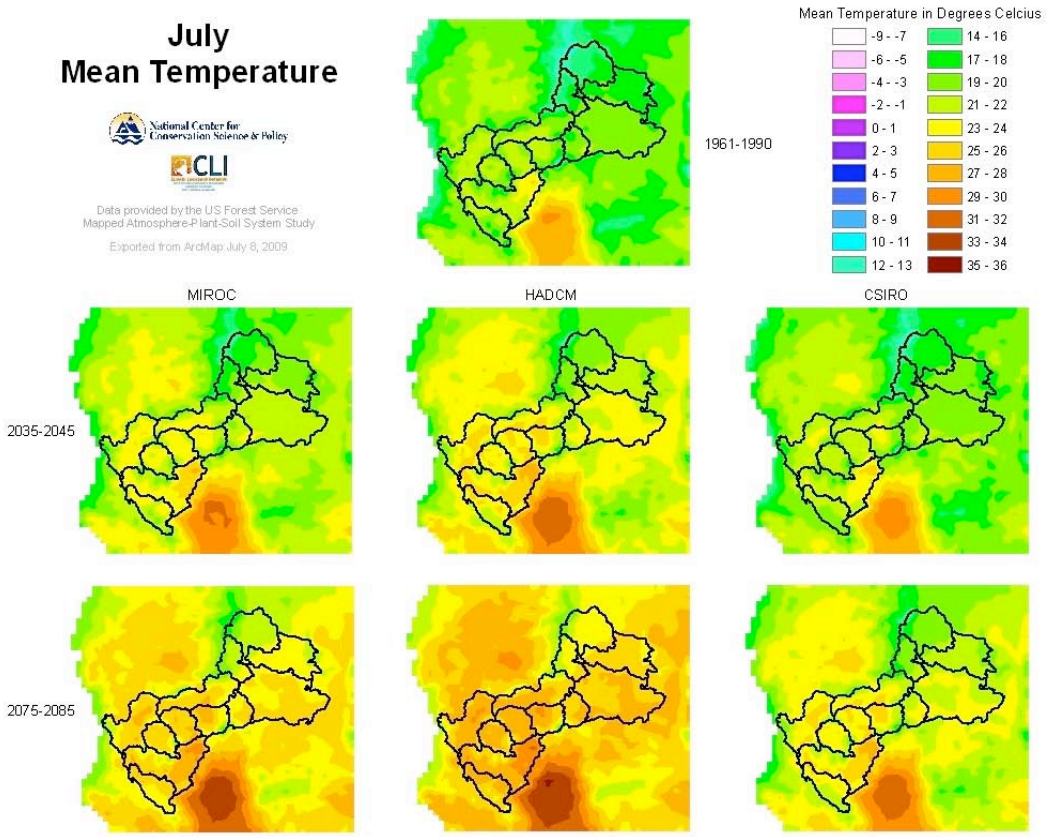


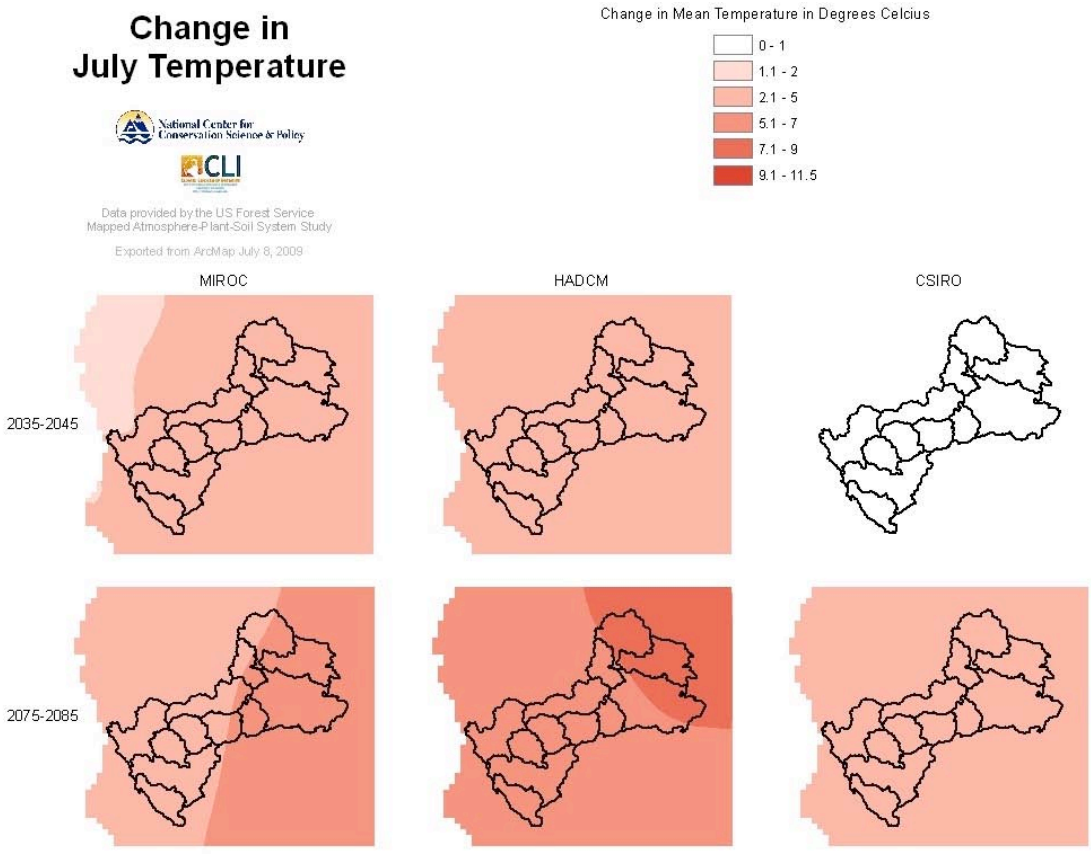
Figure 6. Monthly percent change in precipitation from historic (1961-1991) to a 10-year average centered around 2075. CSIRO indicates slightly wetter conditions while the other models indicate largely drier conditions year-round.

Seasonal Temperature across the Klamath Basin

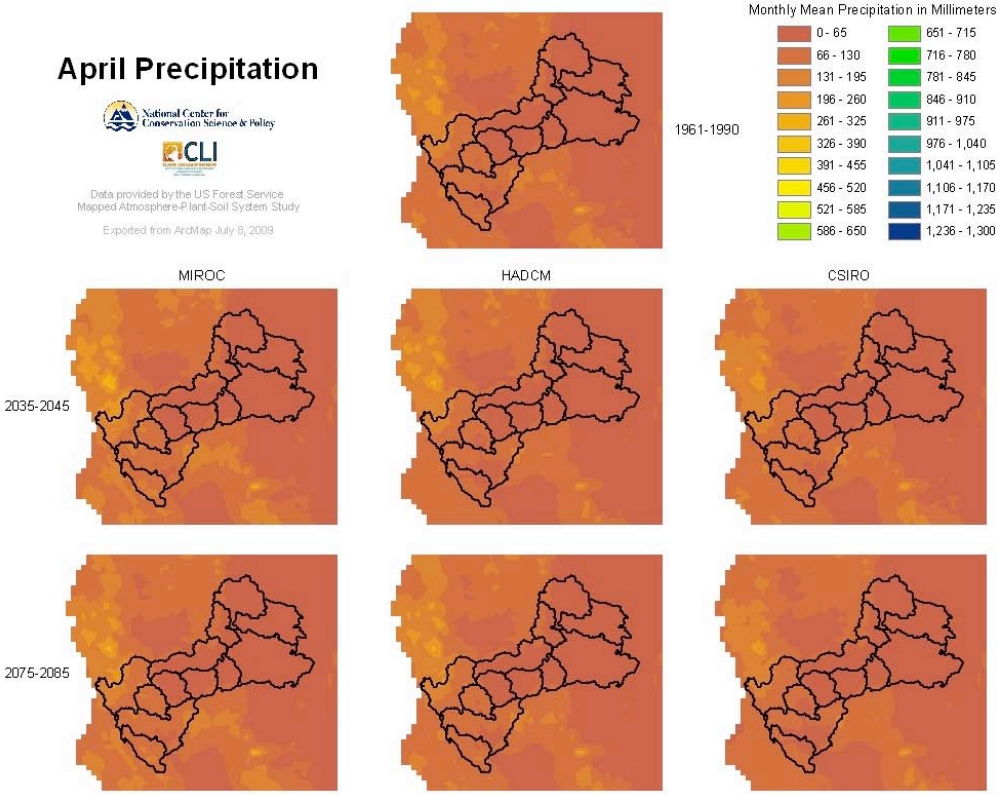


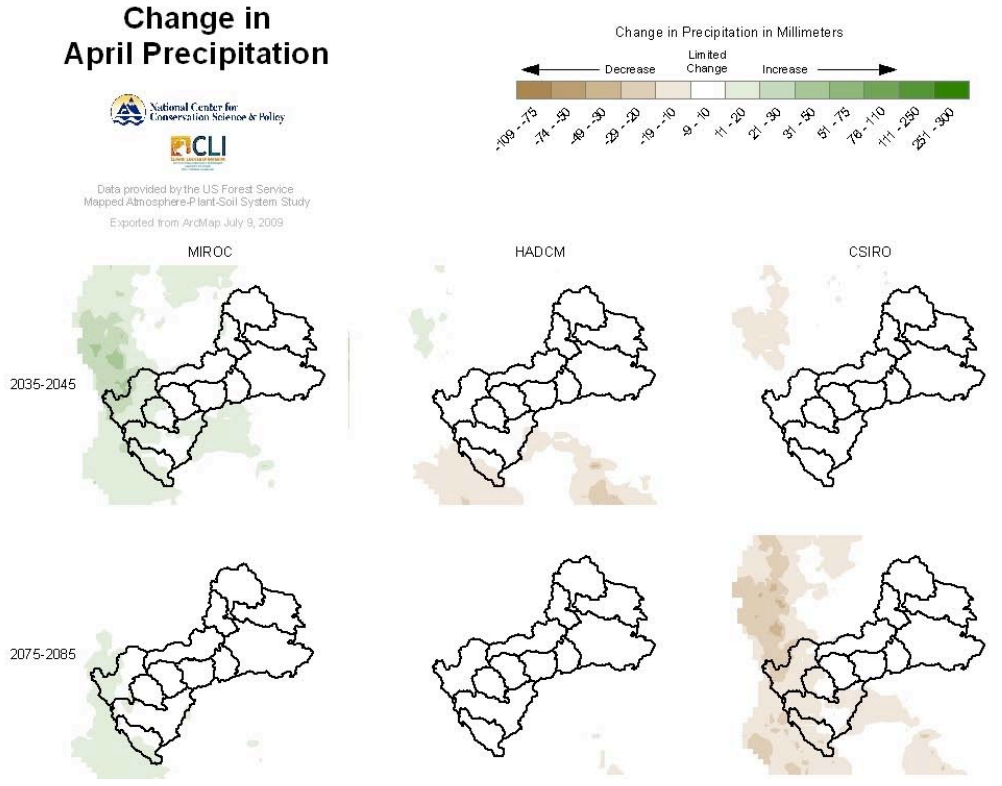


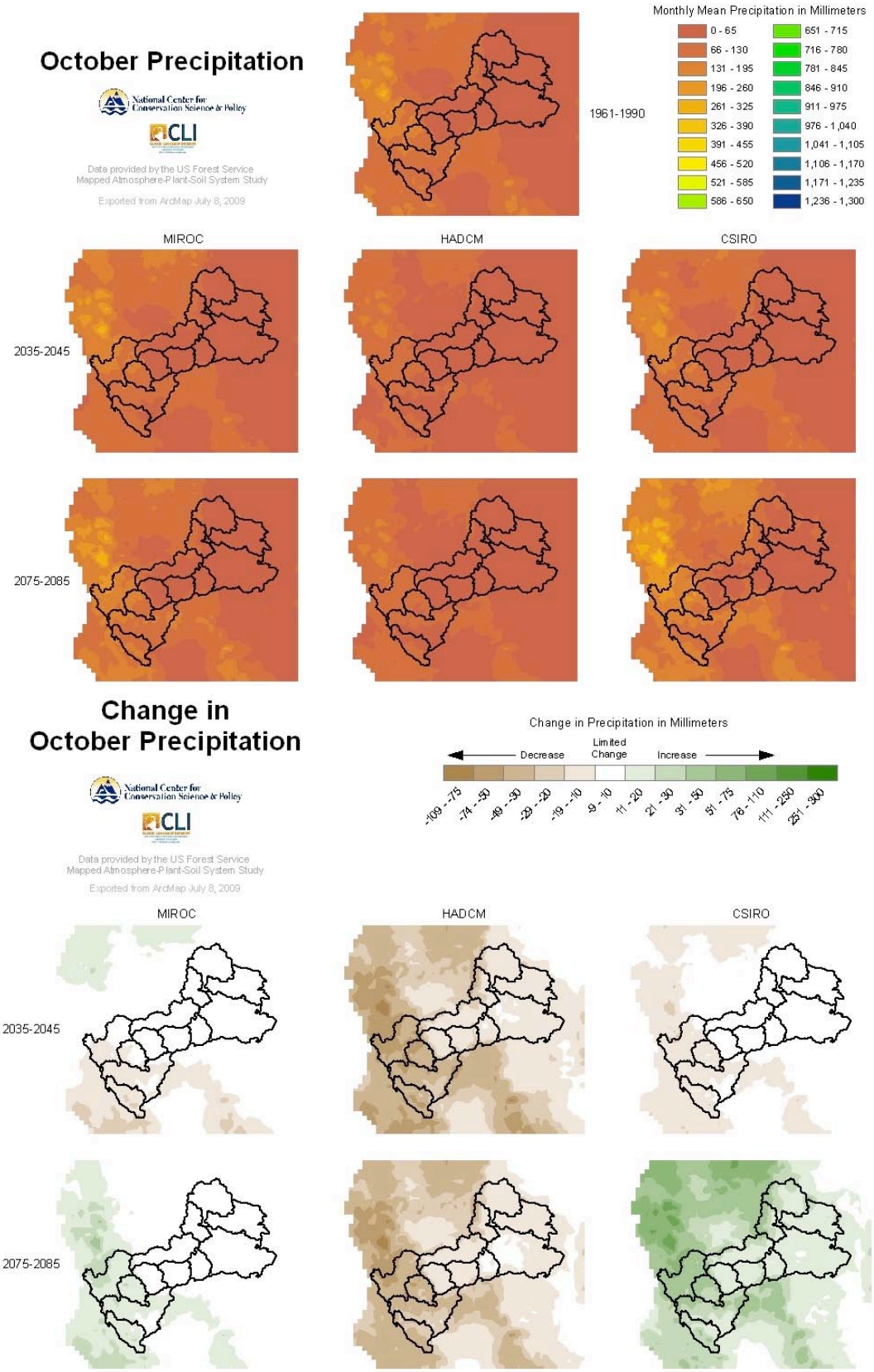
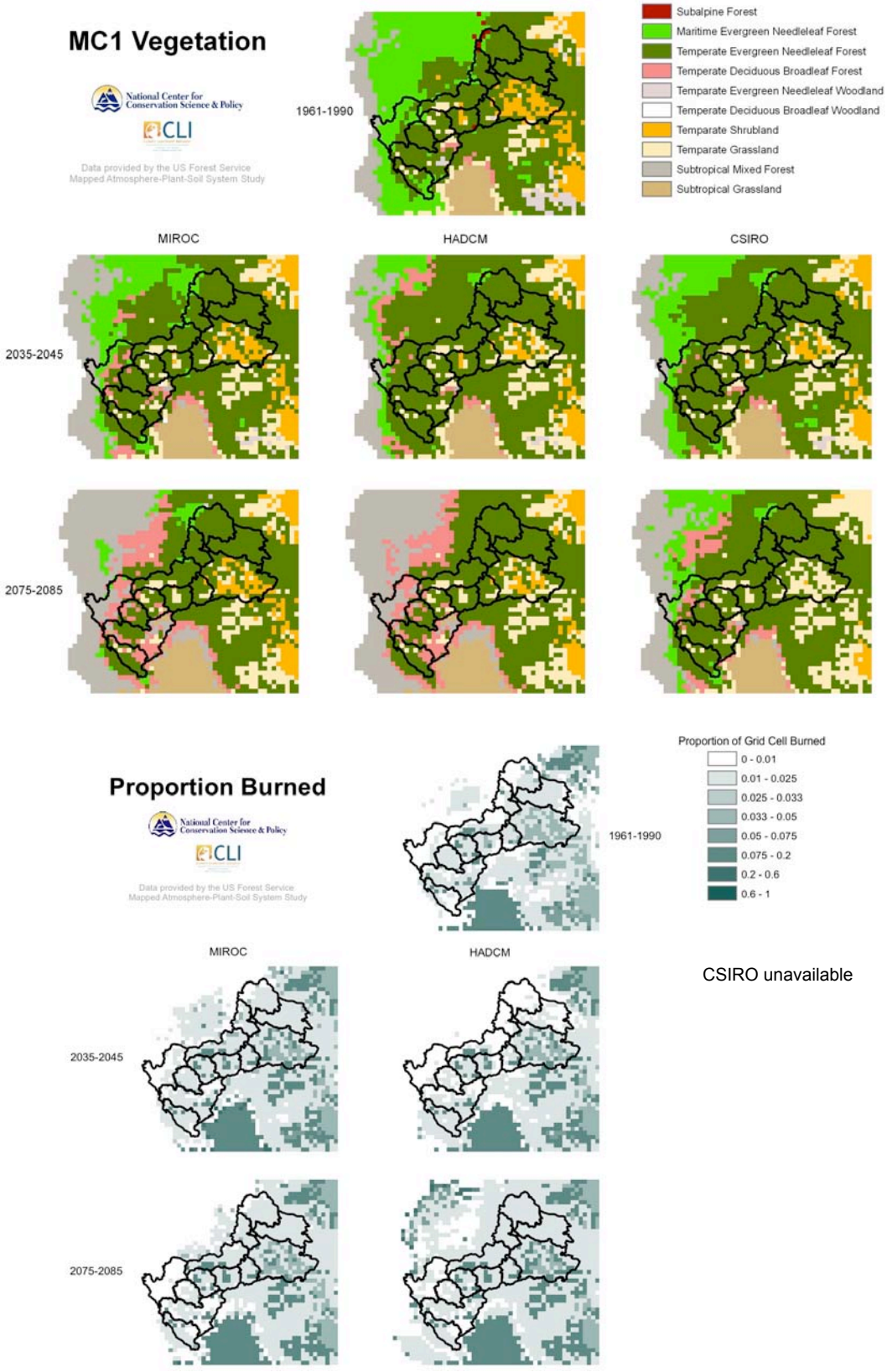

July
Mean Temperature
National Center for Conservation Science & Policy
CLI
Data provided by the US Forest Service
Mapped Atmosphere-Plant-Soil System Study
Exported from ArcMap July 8, 2009
1961-1990
Mean Temperature in Degrees Celcius
-9 - -7
-6 - -5
-4 - -3
-2 - -1
0 - 1
2 - 3
4 - 5
6 - 7
8 - 9
10 - 11
12 - 13
14 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
31 - 32
33 - 34
35 - 36
MIROC
HADCM
CSIRO
2035-2045
2075-2085


Change in
July Temperature
National Center for Conservation Science & Policy
CLI
Data provided by the US Forest Service
Mapped Atmosphere-Plant-Soil System Study
Exported from ArcMap July 8, 2009
Change in Mean Temperature in Degrees Celcius
0 - 1
1.1 - 2
2.1 - 5
5.1 - 7
7.1 - 9
9.1 - 11.5
MIROC
HADCM
CSIRO
2035-2045
2075-2085

Seasonal Precipitation across the Klamath Basin






October Precipitation
National Center for Conservation Science & Policy
CLI
Data provided by the US Forest Service
Mapped Atmosphere-Plant-Soil System Study
Exported from ArcMap July 8, 2009
1961-1990
Monthly Mean Precipitation in Millimeters
0 - 65
66 - 130
131 - 195
196 - 260
261 - 325
326 - 390
391 - 455
456 - 520
521 - 585
586 - 650
651 - 715
716 - 780
781 - 845
846 - 910
911 - 975
976 - 1,040
1,041 - 1,105
1,106 - 1,170
1,171 - 1,235
1,236 - 1,300
MIROC
HADCM
CSIRO
2035-2045
2075-2085
Change in October Precipitation
National Center for Conservation Science & Policy
CLI
Data provided by the US Forest Service
Mapped Atmosphere-Plant-Soil System Study
Exported from ArcMap July 8, 2009
Change in Precipitation in Millimeters
Decrease
Limited Change
Increase
-109 - -75
-74 - -50
-49 - -30
-29 - -20
-19 - -10
-9 - 10
11 - 20
21 - 30
31 - 50
51 - 75
76 - 110
111 - 250
251 - 300
MIROC
HADCM
CSIRO
2035-2045
2075-2085

Potential vegetation (actual vegetation will vary due to land use, dispersal rates, growth rates, ecological relationships, etc.)