

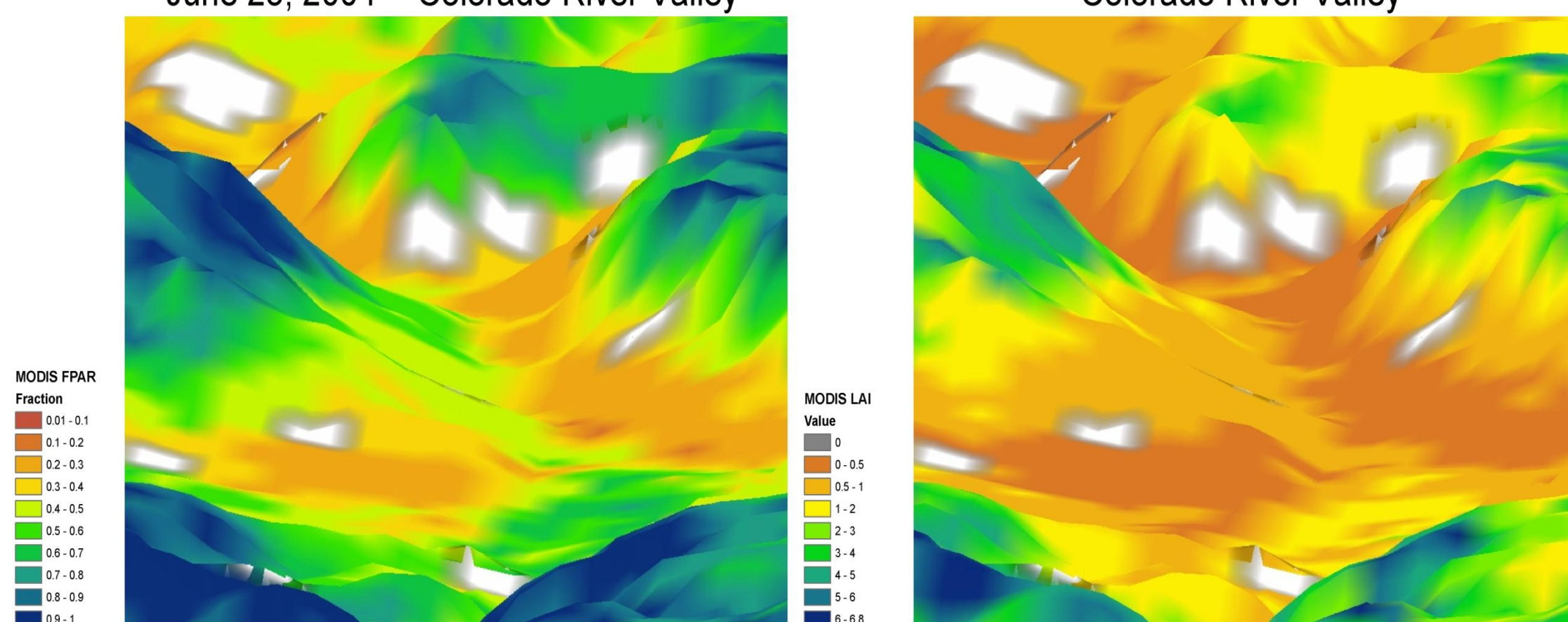


INTRODUCTION

The management of western natural resources and wildlife conservation efforts are currently hampered by inadequate consideration of climate change and a lack of supporting information and data. In order to assist resource managers to evaluate vulnerabilities and to strengthen conservation efforts, we have developed a downscaled climate data set at temporal and spatial scales more suitable for management planning. This approach should also strengthen decision making on ecosystem services, natural resources, and biodiversity at regional and state levels.

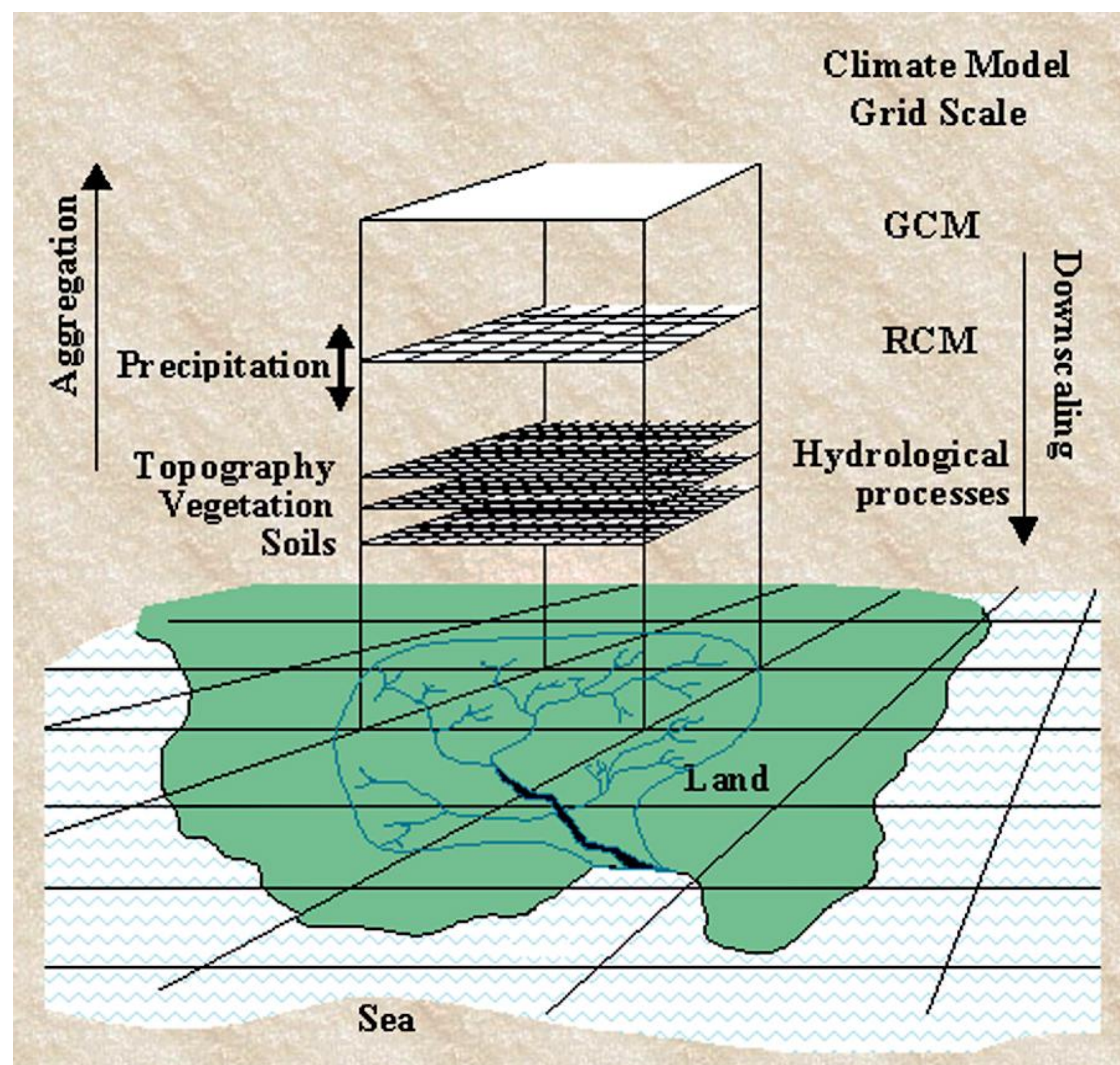
MODIS Fraction of Photosynthetically Active Radiation (FPAR)
June 25, 2004 -- Colorado River Valley

MODIS Leaf Area Index (LAI)
June 25, 2004
Colorado River Valley



Especially in complex terrain, the need for hi-resolution climate data resolved to capture the topographic features of valleys and ridgetops are critical to evaluation of natural resource impacts to climate changes. The MODIS satellite data for Fractional Photosynthetically Active Radiation (FPAR) and Leaf Area Index (LAI) demonstrate the sensitivity of biophysical and ecosystem characteristics to topographic features.

Currently, detailed downscaling projections (i.e., 1-km daily climate projections to 2050) are not available for the region. These projections have been developed through a partnership between the Heinz Center, the National Center for Atmospheric Research, University of Colorado and Colorado State University.



Schematic figure of statistical downscaling scheme

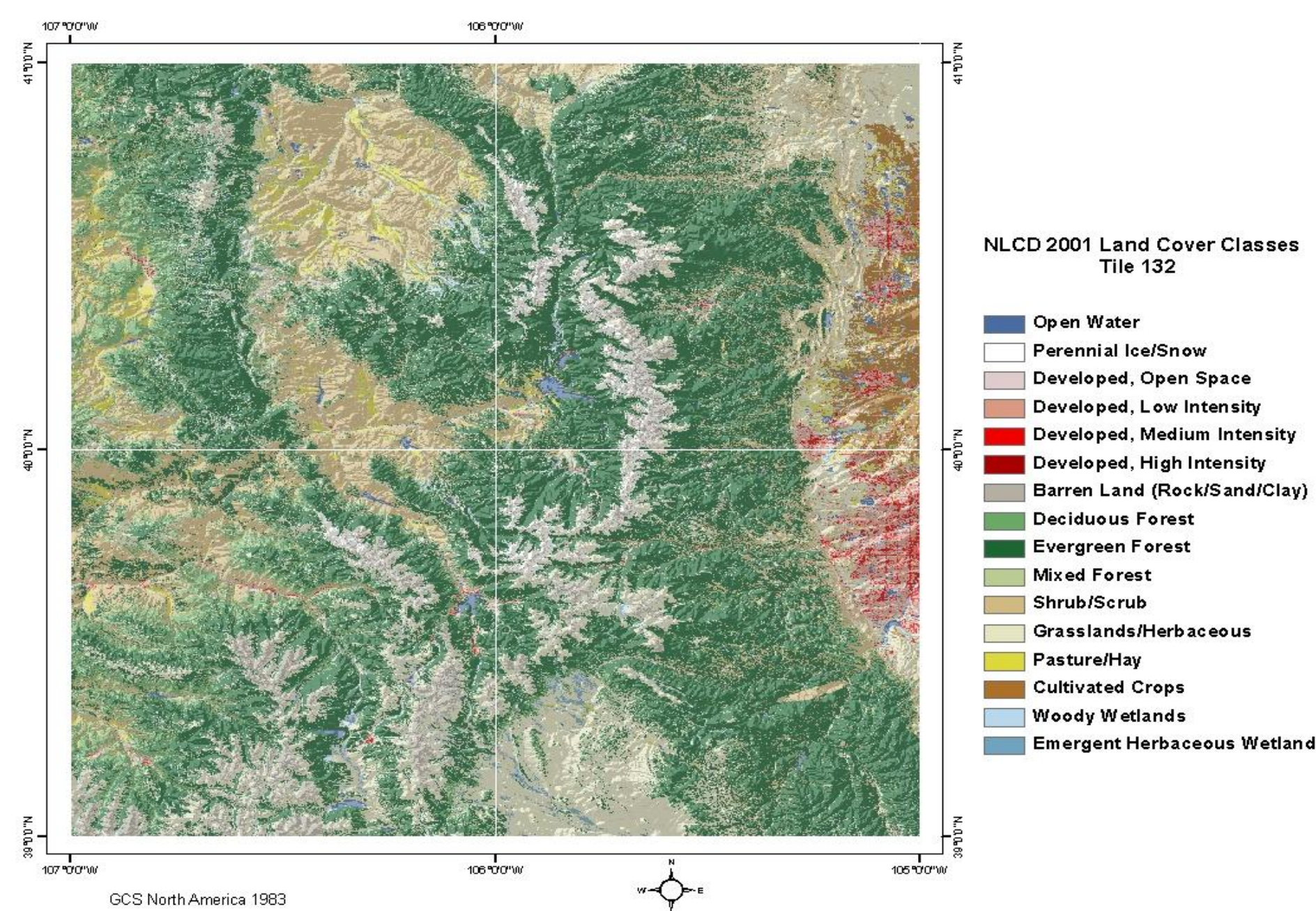
Downscaled climate information has the potential to provide a better basis to respond to the increased likelihood of drought, fires, invasive species, change in snowpack and associated effects on water availability. However, it is equally important to work closely with decision makers and resource managers from local, state, and federal levels to further develop their skill in using climate change information.

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METHODOLOGY

Use of "statistical or empirical downscaling" techniques provide useful climate information which are not available from current GCM scenarios to evaluate impacts on important local and regional resources to make assessment of possible action plans to deal with climate change.

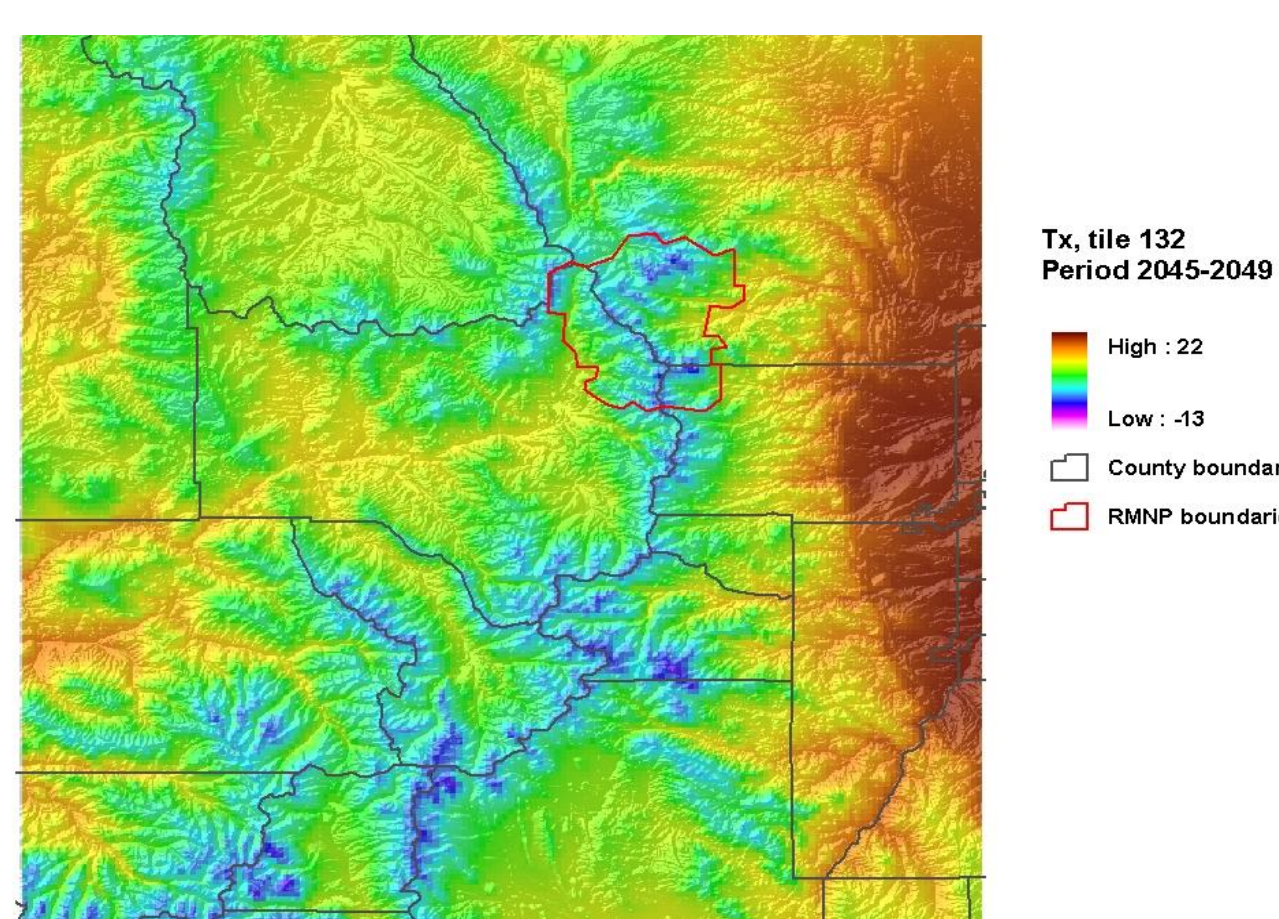
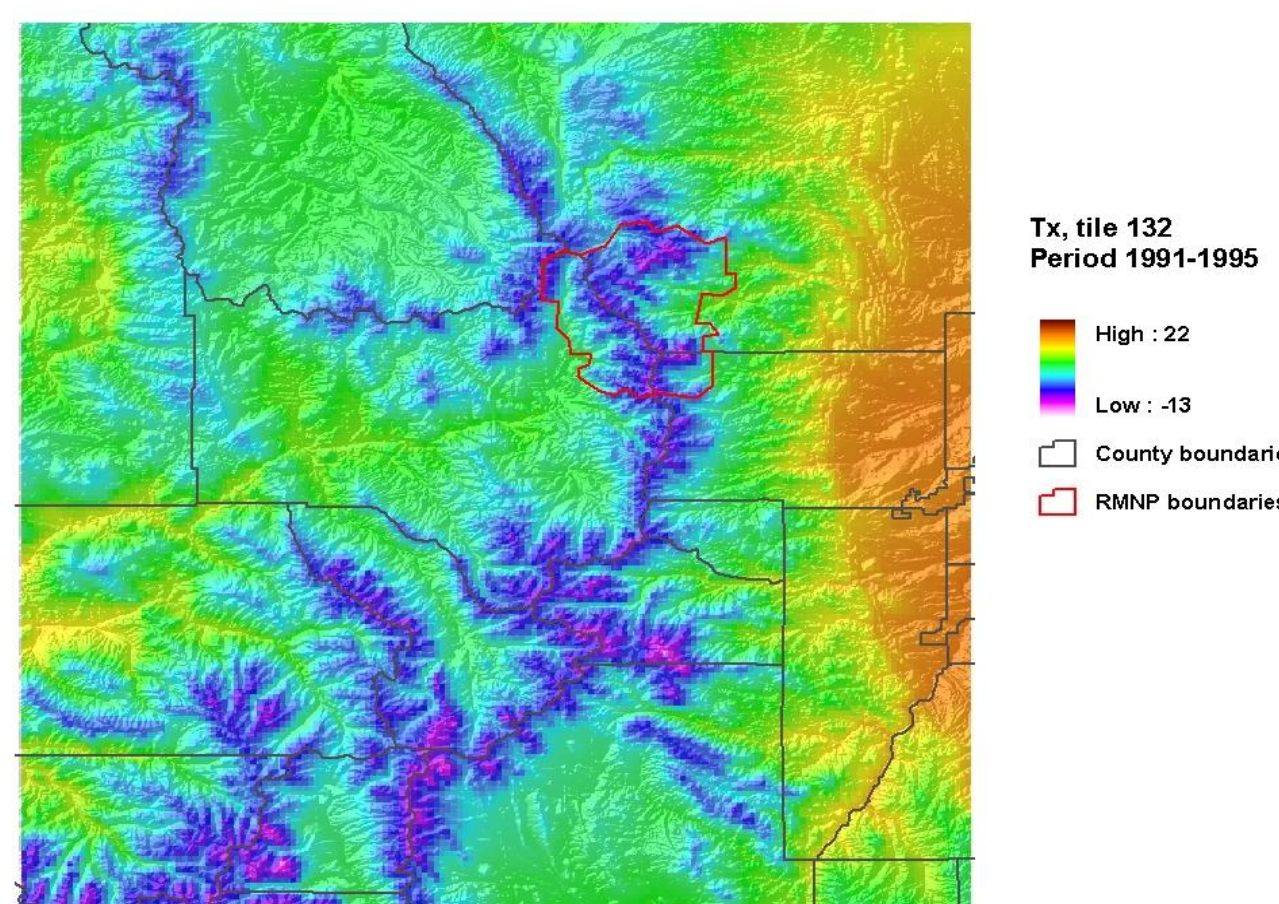
Statistical downscaling relies on the availability of two important data sets: (1) A multi-decadal weather data (e.g., 20 to 50 years) that include climate parameters and (2) GCM data sets for the same parameters for the same past time period (such data is already available at most modeling centers around the world). With these data, a statistical relationship can be established between the observational data from "local" weather stations and the estimate of past changes contained in the GCM for the same period in that region. Then, to project climatic conditions for some time in the future (say 2025-2050), the GCM can be run forward with the previously established statistical relationship for each of the weather station locations. The result is downscaled future climatic conditions for that region.



Vegetation map for 10 km by 10 km tile for downscaling pilot study

Climate – Topographic – Vegetation Relationships

The downscaled climate data sets for the plains and mountain regions of northern Colorado provide a better representation of climate-vegetation patterns than available from GCM grids and even 10 km data sets.



Maps of mean annual daily maximum temperature averaged over 1991 to 1995 and over 2045 to 2049

The CCSM downscaled climate projections downscaled to 1 km resolution provides a closer geographic representation and indication of differential impact of future climate scenarios

APPLICATION OF DOWNSCALED DATA SETS

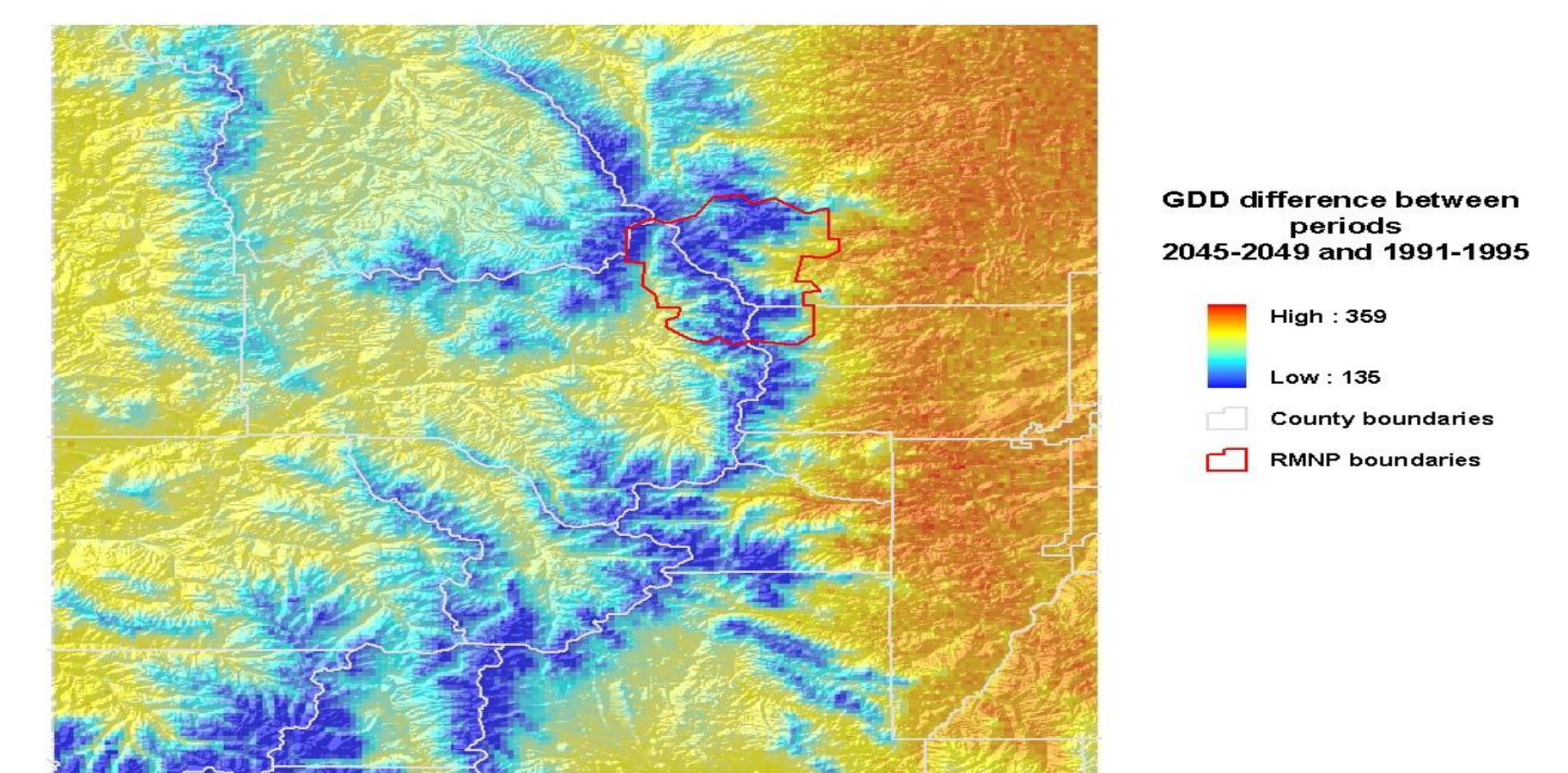
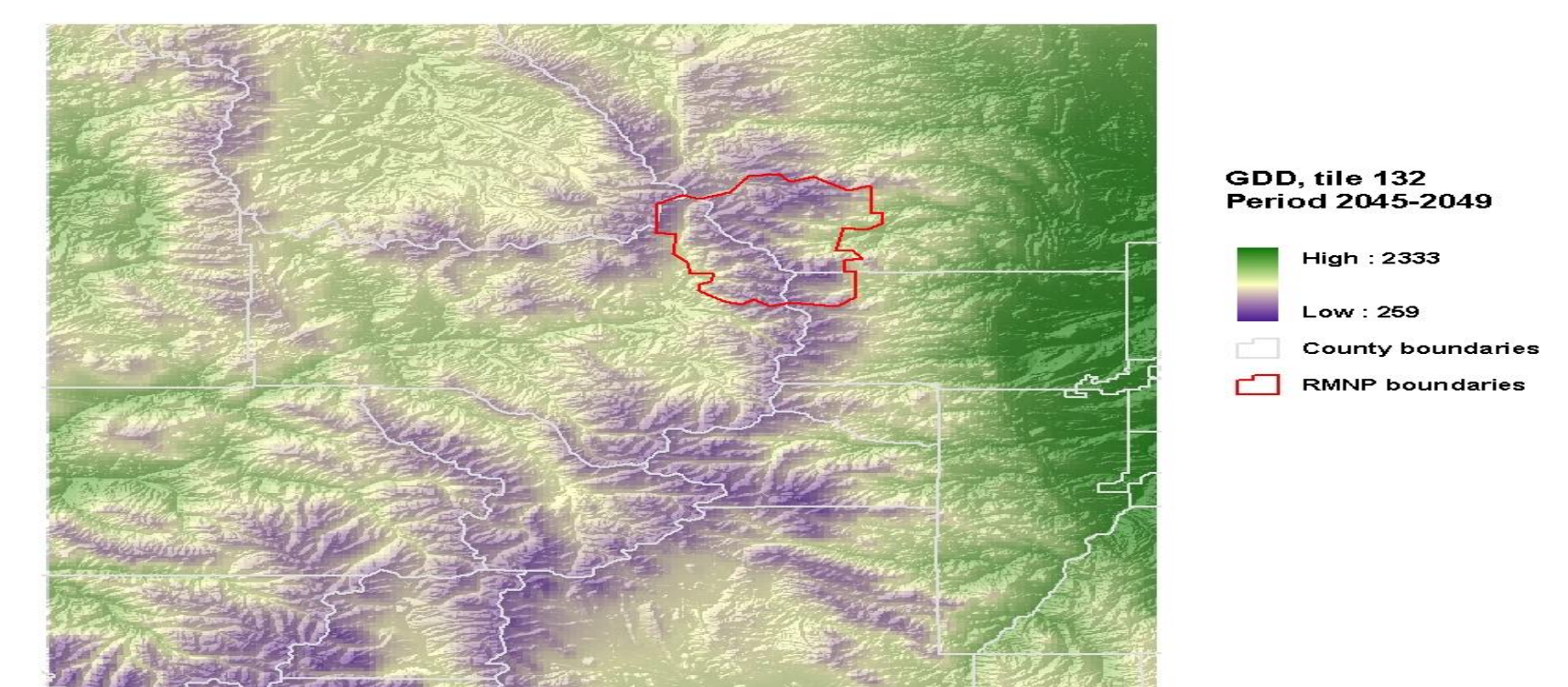
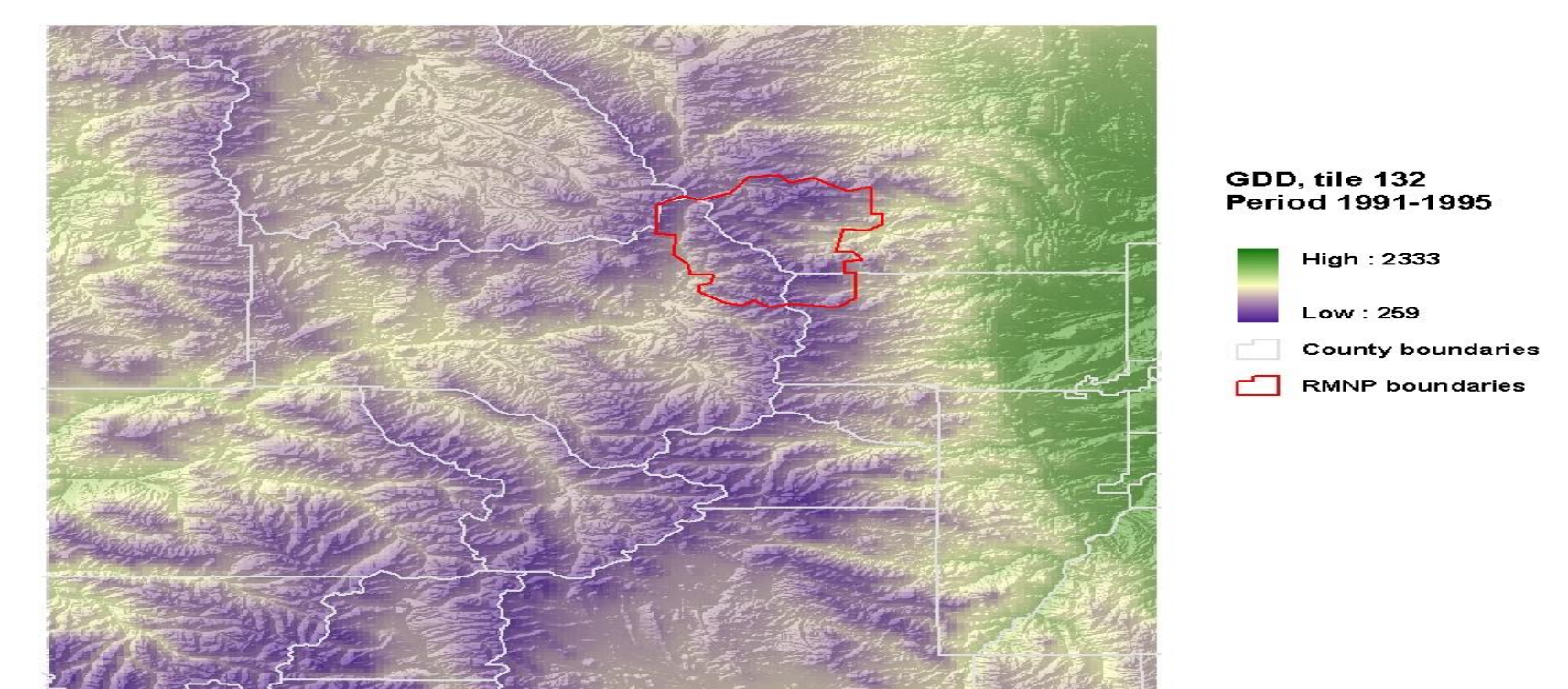
In addition to the production of downscaled climate records, it is necessary to also develop climate products that are readily useable to decision makers and to develop further skill sets in using this information for adaptation studies and assessment. Development of workshops to better design the climate information products which specific user communities needs should be planned for.

We computed growing degree days (GDD), as an example of derived variable used to assess changes in temperatures in seasonal context. The equation used set T_{cap} at 30, T_{base} at 5.5

$$GDD = (T_{max} + T_{min}) / 2 - T_{base};$$

T_{max} is set to T_{cap} when it exceeds T_{cap}

These figures below provide a demonstration of the spatial pattern of changes in GDD over the a region of plains and mountains in northern Colorado surround Rocky Mountain National Park. The bottom figure displays a 20 percent increase in plains region and approximately 50% increase in the GDD by 2050 in the mountain systems.



GDD estimates for 1991 to 1995 and 2045 to 2049 over a 10 km by 10 km tile. The bottom panel depicts the difference between the 2 averaged time periods

FUTURE APPLICATIONS

- **Ecological forecasting: identify thresholds and vulnerabilities.** Building on previous modeling efforts, we will provide forecasts of specific changes across the West and will emphasize the local and regional *vulnerabilities* of ecosystem components or processes to climate variability and change, *thresholds* at which specific forest or hydrologic ecosystems may experience state changes, and *uncertainties* associated with the forecasts.
- **Develop adaptation strategies.** Our studies and model results will provide scenarios of future ecosystem conditions, a necessary first step in identifying adaptation options. In collaboration with land managers and specific places, we will incorporate the results of our research to develop a range of tools and strategies for adapting to climate change and its effects, driven by the goal of maintaining critical ecosystem structures and functions, along with associated native biodiversity.