Tourism is a major economic driver for the Colorado Plateau states of Utah, Arizona, New Mexico, and Colorado. Yet despite the fundamental influence climate has on tourism services in the West, there is limited understanding of the relationship between climate and business operations and long-term sustainability. To address this relationship, participants from various agencies and interests in the region convened at a Climate and Tourism Workshop cohosted by the National Oceanic and Atmospheric Administration (NOAA)/University of Colorado Western Water Assessment, the Leeds School of Business Center for Sustainable Tourism, and the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. Representatives from the Arizona Golf Association, Vail Resort, Colorado River Water Conservation District, state parks, and others attended the two-day workshop, which was conducted in a participant-driven, open-discussion format.

Major session topics included climate trends and projections; impacts of climate variability and change on federal, state, local, and private tourism communities; and the development of plausible strategies to adapt to and mitigate the effects of climate change. Within each session, panel members provided insights from their respective industry experience or expertise, with time allocated for drawing comparative lessons. Key issues included improving the communication of uncertainties in estimating climate risks, and the importance of understanding variability in the context of climate change projections.

INDUSTRY SENSITIVE CLIMATE TRENDS AND PROJECTIONS. Wyoming State Climatologist Stephen Gray began the first session by introducing climate trends and projections for the Colorado Plateau, with a focus on physical characteristics that make the plateau particularly vulnerable to changes in climate. Gray emphasized that warmer temperatures (increasing evapotranspiration) coupled with a decrease in snowpack threatens surface water supplies, lowers winterkill of insects (such as the mountain pine beetle), and leads to a rise in wildfire prevalence and severity. Following Gray,
Linda Mearns of NCAR presented results showing that winters in North America could warm upward of 4°C, and that summers could warm 3°–5°C by the end of the twenty-first century. These summary predictions are based on 21 global circulation models (GCMs) and are consistent with results from the 2007 Intergovernmental Panel on Climate Change (IPCC) reports.

**CLIMATE IMPACTS ON TOURISM BUSINESSES AND LOCAL ECONOMIES.** Given this backdrop of climate trends and projections, participants discussed how climate impacts tourist business operations, nearby communities, and tourist travel behavior. They agreed that unfavorable climate conditions compel businesses to shorten traditional profit-making seasons, and in some cases raise prices or invest in alternative business activities to help cover economic losses. For example, prolonged periods of rainfall negatively influence tourist willingness to go whitewater rafting, camping, or golfing. Former Colorado State Parks Director Lyle Laverty noted that, “From a business standpoint, the prolonged rainfall during the month of September [2006] contributed to a $400,000 loss in revenue for state parks.” And, historically, below-average snowpack and streamflows lowers revenue generated by snow- and water-based recreation industries in comparison to wet years. Poor snowpack conditions in some years also increase operational expenses for snowmaking at ski resorts, contributing to increases in lift ticket prices. Considering the impact that seasonal climate variability already has on tourism, projected impacts tied to rising temperatures threaten long-term profit margins of many tourism industries on the Colorado Plateau.

Participants broadened the conversation to include discussions of how local communities dependent upon tourism are impacted by climate variability and change, both seasonally and annually. Examples of such communities include Moab and Park City, Utah; Taos, New Mexico; Sedona, Arizona; and Telluride and Steamboat Springs, Colorado. All are challenged in their efforts to retain stable business activity and permanent residents throughout the year. Several participants noted that real estate, particularly vacation or second homes, has become an important factor in local economies over the past twenty years to the extent that local residents are increasingly pressured economically to move away from resort centers because of rising real estate prices. It was then suggested that the future of resort economies in the face of a highly variable climate might lie in high-dollar residential and retirement communities.

Throughout the workshop, participants observed that public perceptions of climate conditions in destination locations are just as important as the actual conditions themselves. These perceptions play major roles in consumer choices. Further discussions identified potential industry and community-wide adaptive management and mitigation strategies.

**ADAPTATION AND MITIGATION STRATEGIES.** Suggestions from the group for adaptation and mitigation strategies included the following: 1) improved drought forecasting, especially in competitive regions; 2) the use of alternative and efficient energy technologies; 3) use of “green” business practices; 4) stronger partnerships with researchers, businesses, and local government; 5) diversification of tourism economies, especially in low-elevation regions; and 6) collaboration with the media. Participants mentioned that improved early warning systems for drought will increase in importance as tourism industries make tough business decisions in coming years. Continued expansion of snow-making operations by ski resorts and smaller, lighter boats for whitewater rafting are examples of adaptive technologies that can offset below-average snowpack or low-streamflow conditions. Industry flexibility and diversity in local economies offering “off season” alternative activities, such as climbing, jeep tours, or road biking, that take advantage of warm and dry conditions are already becoming important adaptations for regional tourism businesses. Use of “green” innovations, including wind power, energy-efficient fuel sources, or water-efficient technologies can provide communities and industries with ways to support ecofriendly activities that do not require large-scale investments or drastic changes in every-day business operations. Finally, working in close collaboration with the media and developing effective marketing campaigns is important in communicating accurate climate conditions and the impact on recreational pursuits to the general public.

**INFORMATION GAPS AND RESEARCH NEEDS.** Workshop participants identified a number of information gaps and noted that opportunities for research and business collaborations exist, but remain underdeveloped. Tourism industry representatives called for better communication and characterization of certainties and uncertainties in climate variability and change projections, as well as the development of climate-sensitive tourism indices catered toward...
local decision making. Ed Gowan, president of the Arizona Golf Association, recommended using confidence intervals for temperature and precipitation projections. Thus, instead of the projection of a 2°–5°C increase in temperatures by the end of the twenty-first century, a better hypothetical framing would be, for example, “A 2°C warming trend over the next 100 years is 60%–80% likely and a 3°C temperature increase is 40%–60% likely.”

Participants also agreed that the development of tourism–climate indices and corresponding threshold values are potentially useful in pinpointing at-risk industry practices. At present, climate change projections are produced at too large a scale and the benefits of downscaling in mountain environments are limited at best. Sarah Nicholls, a recreation expert at Michigan State University, summarized several previous studies that employed tourism–climate indices. A tourism–climatic index (TCI; Mieczkowski 1985) allows for the quantitative evaluation of climate for the purpose of general tourism activity (e.g., shopping, sightseeing) based on the notion of “human comfort.” Calculation of any TCI involves the combination of monthly climate variables, including daily maximum, minimum, and mean temperature, and relative humidity, precipitation, sunshine, and wind. The “climate suitability” for the location of a particular tourism activity is then rated on a scale from “ideal” to “impossible.” Nicholls also described three other approaches to tourism–climate research that focus on 1) the supply side (e.g., potential changes in season length or number of activity days), 2) the demand side (i.e., participation levels), and 3) analog studies, using past tourism activity during extreme events, such as droughts or wildfires, as being representative of future “norms” in the wake of a warming climate. Workshop participants suggested that the strengths and weaknesses of each method needed to be well understood for the potential development of new or revised approaches.

Finally, calls were made for an inclusive, easily accessible clearinghouse of up-to-date climate information catered toward tourism industry operations. Participants indicated that high-elevation ecosystem and riparian conditions, including streamflow and snowpack levels, and precipitation and temperature forecasts are used in every-day operations. However, such information is currently scattered among multiple outlets and is difficult to either assimilate or interpret. In summary, better communication and characterization of climate information would greatly assist industry professionals in every-day operations and long-term planning purposes.

The participants wrapped up the two-day interchange by noting that the partnerships formed from the workshop onward would be important steps in ensuring tourism industry adaptability on the Colorado Plateau.

REFERENCES