MRI Newsletter 4: Climate Science in the American West

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MRI Newsletter 4: Climate Science in the American West

The Mountain Research Initiative promotes global change research in mountain regions throughout the world. In this edition of its Newsletter, MRI introduces readers to CIRMOUNT—the Consortium for Integrated Climate Research in Western North American Mountains—a regional project with roots in the American West but congruent with the MRI program.

CIRMOUNT is a collaborative, open consortium dedicated to understanding the climates and ecosystems of western North American mountains. CIRMOUNT's goals are to measure and understand climate-driven changes in the unique landscapes that define western North American mountains, and to respond to the needs and challenges of western society regarding mountain resources affected by climate change.

Mountain ecosystems of the western United States are complex, and include grass, shrub, and forestlands at middle elevations, cold desert and alpine biomes in the upper tree-line zone, and tundra ecosystems above the timberline. The alpine ecosystem within the cordilleran region that extends from North America into Central America is the only one that exists in all different climatic zones, from the equator to the polar region. This environment is among the most sensitive to climatic changes occurring on a global scale (see also MRI Newsletter 3, *MRD* 24.2, pp 176–177, May 2004). The alpine zones consist of glaciers, snow, permafrost, frozen ground (landscape-scale frozen ground structures important for water archiving), liquid water, and the uppermost limits of vegetation and other complex life forms.

The stratified, altitudinally controlled vegetation belts found on mountain slopes are analogous to the different latitudinally controlled climatic zones, but these condensed vertical gradients support unique hotspots of biodiversity and provide vital corridors for endemic mountain species. High relief, steep gradients, and "isolated island" effects in high summit zones make mountain ecosystems vulnerable to slight changes in temperature and extreme precipitation events.

The mountain regions of the western United States may be especially vulnerable to changes in climate and to the ensuing changes in snowpack, stream flow, ecosystem functioning, and other impacts on human and natural systems. The current sustained and severe drought in the western United States has highlighted the region's sensitivity to climate and other environmental changes. Recent decades have shown a tendency towards decline in spring snowpack and earlier runoff in many watersheds. The role of mountains in providing life-sustaining water to downstream ecosystems and communities means that climatic and other environmental changes in the mountains of the West will have a large local to national impact.

CIRMOUNT seeks to fill important gaps in research, monitoring, and application in mountain climate science in western North America. Critical gaps exist in *geographic coverage* of climate and climate-related research across western North America. Some regions—specifically areas within ranges—are well studied, while others are blank maps on the intellectual terrain. For example, the Cascade Mountains are a focus of climate-related research, while most of the Great Basin ranges are little studied. More commonly gaps exist in *disciplinary coverage* within ranges and across ranges. For example, while the Sierra Nevada is a focus of intense study in hydrology and tree-ring research, the range is poorly monitored climatically: out of 404 meteorological stations in the National Oceanic and Atmospheric Administration (NOAA) Coop System for California, only 6 are above 2500 m, 3 above 2750 m, and the highest is at only 2941 m, although the range itself tops out at 4400 m. And while the mountains of the Colorado Plateau region have been well studied for insect and pathogen effects on forest health and mortality, the Sierra Nevada has not received such attention despite repeated episodes of forest death.

Nearly universal across western North America is a *lack of attention to climate change issues in natural resource management and policy*. With increased extremes and decreased predictability of climate events expected in a warming world, the challenges of maintaining a flow of goods and services to an increasingly demanding human society will be staggering, but this has not been addressed in most mountain resource management circles. The overall *lack of integrated research studies and lack of science application to management* in western North American mountains constitute the biggest challenge to coordination and the greatest potential for gain. From climate monitoring to research and applications, improving integration will be a key measure of CIRMOUNT's success.

Physical and ecological scientists from different state and federal agencies working on western United States mountain climate and ecosystems formed a working group to promote greater understanding of the physical processes affecting western mountains and their ecosystems, and to promote better communication of scientific findings to policy and decision makers. The Mountain Climate Sciences Symposium (MCSS) at Lake Tahoe in May 2004 was the first major event sponsored by this group, and served to publicly launch CIRMOUNT.

The MCSS was a remarkably successful meeting, both in providing an overview of global change-related research in western mountains and in energizing the commu-

nity of researchers. The full set of presentations is available at the MCSS web site (http://www.fs.fed.us/psw/mcss/mcss2.shtml).

The pace of global change in the western mountains of the US as shown by presenters was startling. As Harald Bugmann stated during his closing synthesis, the worst-case scenarios that he and his students were projecting for the central Alps for the latter half of the 21st century are already occurring in the western mountains of the US: drought, extensive fires, forest dieback, and loss of snowpack.

A solid example of the plenary papers was one presented by Jesse Logan, a forest entomologist at the US Forest Service in Logan, Utah. One of his principal points was that increasing seasonal temperatures have released native forest pests in a way that allows them to act as invading species. Mountain pine beetles are endemic to pine forests west of the continental divide and have led to severe mortality in pines when climate conditions were conducive. Dr Logan and his colleagues have recently noted an expansion of mountain pine beetle north into British Columbia and Alberta where the species had previously not been seen.

The physical proximity of the mountain pine beetle to the pines in the boreal forests of Canada opens the possibility that the mountain pine beetle could expand eastward across the continent and eventually southward along the mountain and pine forests of the eastern US (Figure 1). It is thus conceivable that the mountain pine beetle could find its way to pine forests in eastern Texas that it heretofore had been unable to reach because of the pineless Great Plains. Of course, as Dr Logan points out, the impact of this potential expansion is unknown, as the mountain pine beetle would be encountering different climates along this route and competing with other beetles within their home ranges. What is clear is that climate change creates conditions that could lead to a cascade of ecological impacts on pine forests in North America.

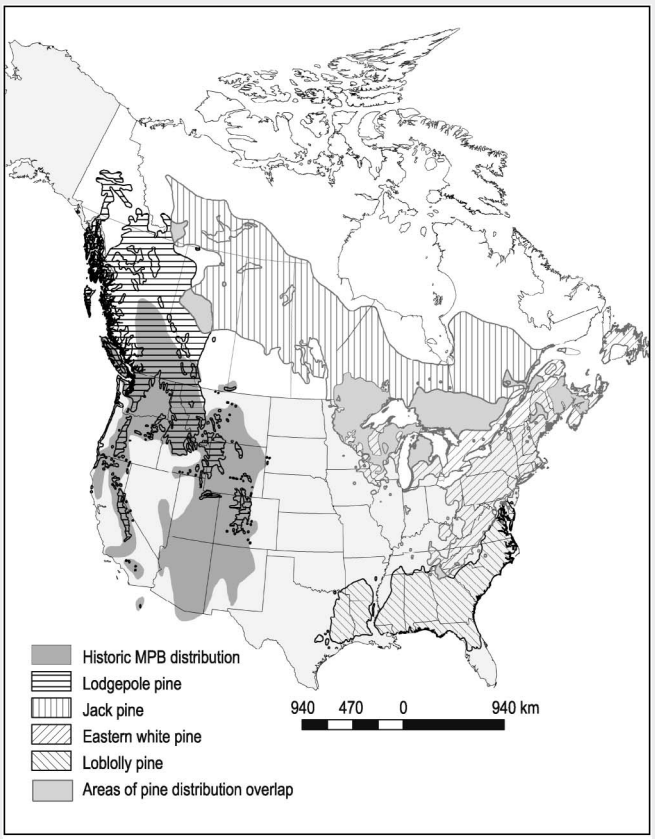

FIGURE 1 Climate change opens the possibility that the mountain pine beetle may be able to invade pine forests outside western North America. The hatched areas represent the ranges of different major pine species in North America. The outlined area in the West portrays the current range of the mountain pine beetle. As the beetle expands its range to the north, it will encounter a belt of pine forests that would allow its expansion to the east coast and then to the south, arriving finally in Texas, a destination it could not otherwise have achieved. (Map by Jesse Logan)

Following the MCSS, CIRMOUNT has laid out some key follow-up activities. First, it sponsored a special session at the American Geophysical Sciences Meeting (13–17 December 2004, San Francisco) on "Challenges to Mountain Water Resources and Ecosystems." Second, it has established MTNCLIM, an ongoing research symposium with its first meeting at Chico Hot Springs, Pray, Montana on 1–4 March 2005. MTNCLIM will be an open biennial research and management forum focused on the sciences related to climate and their interaction with physical, ecological, and social systems of western North American mountains. Third, CIRMOUNT has sponsored a North American Chapter of GLORIA. It will prepare publications and presentations to communicate results of early installations, actively encourage installation of additional sites, and promote use of baseline information in resource management. Finally, CIRMOUNT is committed to active participation and interaction with the Mountain Research Initiative. CIRMOUNT will be a key pilot regional program within the international MRI, and through MRI, will provide insight into the prerequisites and pitfalls of global change mountain science in service to sustainable mountain development.

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