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# Climatic drivers of tree mortality patterns in temperate and tropical montane forests: using networks of forest inventory data

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We have developed new methods for large climate–forest gradients analysis using field-sampled and forest inventory data. Using data on tree locations within plots to fit spatially-explicit "neighborhoods", we model tree growth and mortality as a function of (1) climate, (2) soils, (3) intrinsic plant properties (principally species and size), (4) local competitive interactions for a target tree based on the size, species and distances of neighboring trees, and (5) site conditions. The modeling framework allows for testing interactions with changes mortality by climate, fire and insects. For example, with this approach we can control for the effects of local variation in plant size, competitive status, and site from the effects of climate factors. USDA Forest Service FIA plots and CloudNet data provide growth and mortality data in the USA and tropical mountains respectively, as the increase in diameter for an individual tree and/or its survivorship status between measurement intervals (cause of mortality is reported, including fire and insects). A key hypothesis is that inertia in species composition under climate change will be strongly dependent on background rates of canopy tree mortality and key agents of canopy tree mortality: fire, and pests and pathogens. The net effect of these agents may accelerate or retard the rate of change in both composition and function in forest ecosystems under climate change, depending on the nature of the mortality regime.
Model runs will focus on fire-beetle-climate interactions. There is a rich literature in the USA on fire regimes, insect outbreaks and climate triggers to set modeling scenarios (e.g. Veblen et al. 2003, Brown & Wu 2005). Modeled fire regimes will be community-specific with simulations of stand-replacing fires in higher elevations, and regular surface fires in lower elevations. Fire regimes will then be systematically altered to explore the effects of different regimes, including fire suppression. Insect modeling will focus on the region's most important vectors – e.g. mountain pine beetle, western spruce budworm, white pine blister rust, and Douglas fir bark beetle – and will involve 3 main steps: (1) estimating the probability of colonization of a stand as a function of long-distance dispersal from infested plots, host presence, and habitat and climatic constraints per FIA and published data; (2) characterizing the local spread between host trees within stands. This local dispersal will be evaluated as both a deterministic diffusion process and as a stochastic function of distance, and be flexible enough to accommodate other predictor variables such as density dependence; (3) characterizing the impact of infestation on fecundity, growth, and survival. For some insects (e.g. mountain pine beetle), mortality occurs rapidly in nearly all trees if attacked, but is limited to trees of a minimum size (e.g. Pelz & Smith 2012). In white pine blister rust, the effects are slow declines in growth, fecundity, and eventual mortality (Keane & Arno 1993). By removing adult trees, however, disturbance and mortality events rapidly accelerate the effects of climate change, particularly when the event (e.g. fire, insects) is highly selective in species and tree sizes.