Near-future forest vulnerability to drought and fire varies across the western United States

Background: Recent prolonged droughts and catastrophic wildfires in the western United States have raised concerns about the potential for forest mortality to impact forest structure, forest ecosystem services, and the economic vitality of communities in the coming decades.

Methods: The Community Land Model (CLM) was modified to represent 13 major forest types in the western US and used to determine forest vulnerability to mortality from drought and fire by the year 2049. Simulations were run at 4-km grid resolution, driven with climate projections from two general circulation models under one emissions scenario. Metrics of vulnerability were developed based on annual allocation to stem growth and net primary productivity.

Results:
• Simulated future fire vulnerability could be underestimated by 3% in the Sierra Nevada and overestimated by 3% in the Rocky Mountains.
• Water-limited forests in three specific regions will be the most vulnerable to future drought-related mortality.
• High carbon-density forests are projected to be the least vulnerable to either drought or fire.
• Differences in climate projections lead to only 1% of the domain with conflicting low and high vulnerability to fire.

Significance: These drought vulnerability metrics could be incorporated as probabilistic mortality rates in earth system models, enabling more robust estimates of the feedbacks between the land and atmosphere over the 21st century.

Vulnerability of forested areas during 2020–2049 to (a) drought, (b) fire, and (c) either drought or fire. Colors indicate agreement between CLM simulations with two climate projections, where one GCM low and one high (uncertain) = gray, both GCMs low = dark blue, one low one med = cyan, both medium = yellow, one medium one high = orange, and both high = magenta.