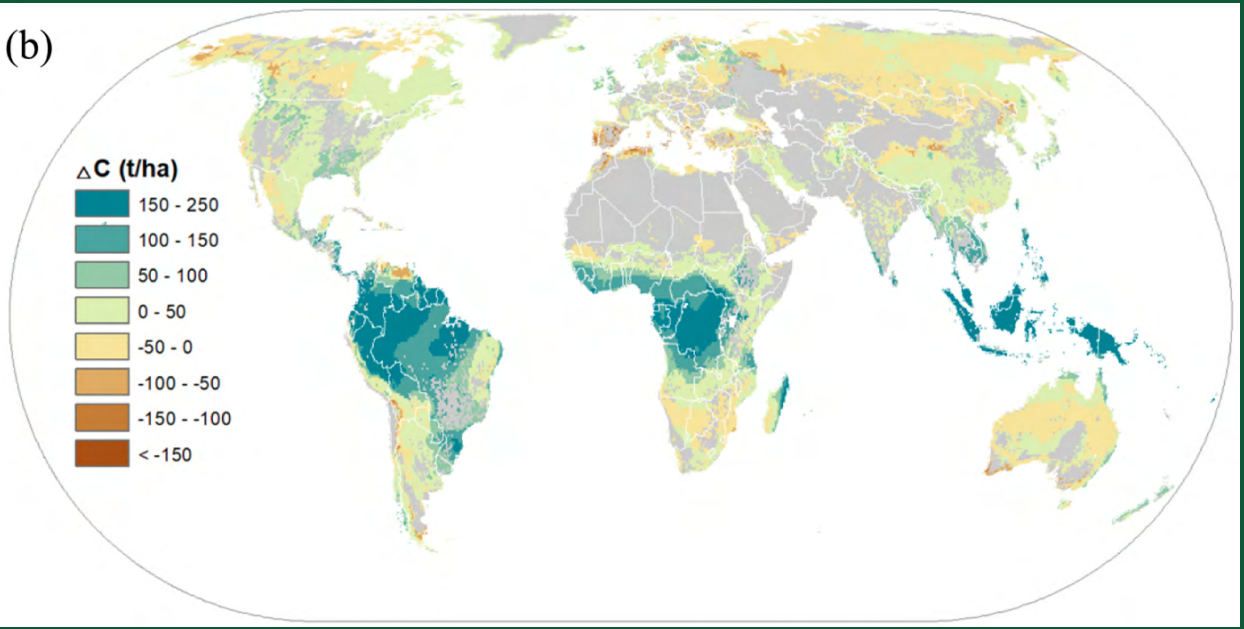
USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE
Western Wildland Environmental Threat Assessment Center

MC2

Dynamic Global Vegetation Model

The MC2 dynamic global vegetation model (DGVM) simulates ecosystem processes and their response to climate change. To do this, it represents the landscape as a grid and simulates how vegetation grows and responds to climate and wildfire in each grid cell at a monthly time step. MC2 is often used to study the long-term response of vegetation to climate change far into the future at regional and global scales. A report describing MC2's precursor, MC1, was originally published in 2001 (PNW-GTR-508), a collaboration among scientists at the Forest Service Pacific Northwest Research Station and universities.



Projected change in aboveground forest and woodland carbon stock by MC2 over the course of the 21st century in a high-warming scenario analogous to RCP 8.5

(Kim et al 2017, Golub et al. 2022)

Information MC2 Provides

MC2 provides information such as:

- Net primary productivity (NPP) of vegetation
- Vegetation type distribution (e.g., tundra, Mediterranean shrubland, etc.)
- Long-term wildfire occurrence and effects on vegetation
- Long-term vegetation-water interactions
- Carbon storage and dynamics

Scope and Scale

MC2 outputs can be used to create future projections of vegetation under climate change scenarios. Currently, future vegetation projections are available for the Pacific Northwest at 800-m resolution, the western United States at 4-km resolution, the conterminous United States at 6-km resolution, and globally at 0.5-degree resolution, from 1895 to 2100. MC2 simulates vegetation in terms of plant functional types (think broad ecosystems like tropical deciduous forest or taiga), and not in terms of individual species.

Examples of current MC2 work

Climate Change Vulnerability Assessments

MC2 outputs have been integrated into climate change vulnerability assessments for forests across the Pacific Northwest and California. This information helps managers anticipate and mitigate the impacts of climate change. So far, MC2 outputs have been incorporated into management plans for national forests and neighboring public lands in the Pacific Northwest and California, with more under way. Find full vulnerability assessments at WWETAC's website.

Southwest Climate-adapted Management

WWETAC researchers have been collaborating with forest managers in the southwestern United States to integrate future vegetation projections output by MC2 with a landscape state-and-transition model to create detailed projections of potential changes to the vegetation of Arizona and New Mexico.

Global Forest Economy

MC2 outputs have been integrated into forest economics models to project how climate change may alter forest products, forest markets, and forest management across the globe. For example, recent studies examined costs of forest carbon sequestration in the presence of climate change impacts (Golub et al. 2022), impacts of climate change on forests and markets (Tian et al. 2016), and how different climate scenarios might impact forest regions and mitigation benefits (Kim et al. 2017).

Hydrology Models

Future vegetation projections from MC2 have been integrated with the WaSSI hydrology model to project how water yield may change into the future under climate change scenarios.

Who Benefits From MC2?

The data MC2 produces is especially useful for land managers, who can use information from the model to explore how vegetation may change in response to climate change. Incorporating vegetation changes into climate change vulnerability assessments also allows managers to better plan for future conditions. When integrated with other models, MC2 helps advance the science of modeling various facets of ecosystem response to climate change.

To learn more about working with WWETAC to incorporate MC2 information into research, contact:
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WWETAC's Role

WWETAC supports the application of MC2 to national forests, research projects, and global studies. WWETAC also supports novel integration of MC2 output with other models, such as the STSim landscape dynamics model, the FSim wildfire model, and the WaSSI hydrology model.

Additional Information

- Kutschera, Ellynne; Kim, John B.; Pitts, G. Stephen; Drapek, Ray. 2023. What's past is prologue: Vegetation model calibration with and without future climate. Land. 12(6): 1121.
- Srivastava, Lorie; Hand, Michael; Kim, John; S nchez, Jos J.; Lupi, Frank; Garnache, Clo; Drapek, Raymond J.; Quinn, James F. 2020. How will climate change affect the provision and value of water from public lands in Southern California through the 21st century. Agricultural and Resource Economics Review. 49(1): 117-149.
- Kim, John B.; Kerns, Becky K.; Drapek, Raymond J.; Pitts, G. Stephen; Halofsky, Jessica E. 2018. Simulating vegetation response to climate change in the Blue Mountains with MC2 dynamic global vegetation model. Climate Services. 10: 20-32.
- GitHub link