Introducing prognostic beetle and prognostic timber harvest modules to the CLM

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photo P. Buotte

USDA | NIFA

Overview

Beetle module

- CLM Modifications
- Sample output

Timber harvest module

- CLM Modifications
- Challenges

Focus on the technical aspects of the work

The beetle module
Modifications to clm4_5_16_r241

1. Started from Polly Buotte's prescribed beetle set-up which
   - Reads annual mortality from the same file as harvest
   - Applies this mortality in one timestep every year
   - Represents "snags" of 3-6 stages in new C & N pools

2. Prognostic beetle code **calculates** this annual mortality

3. Prognostic beetle module requires climate variables
   - Oct-Sep precipitation
   - Sep-Nov mean air temperature
   - Apr-July mean air temperature
   - Dec, Jan, Feb avgs of daily min air temperature

   I used clm's accumulMod tool for this

The beetle module
Modifications to clm4_5_16_r241

4. Calculates number of beetles attacking lodgepole pine per grid cell

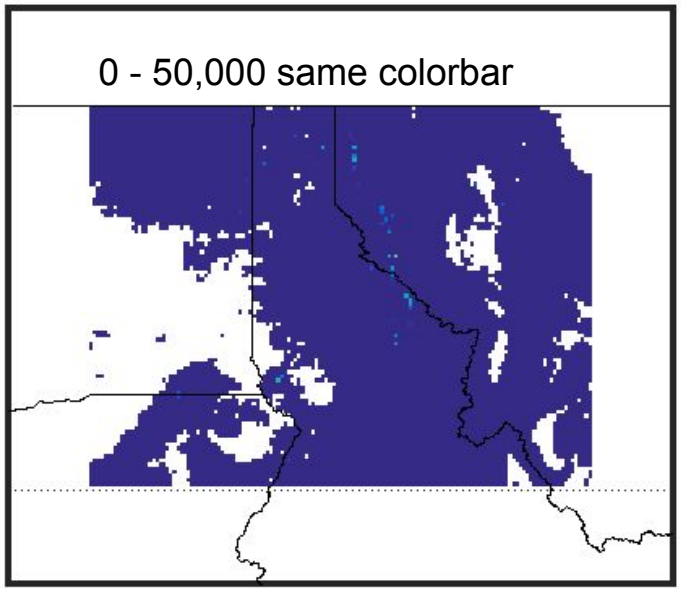
5. Calculates number of beetles dispersing to neighboring grid cells with lodgepole pine

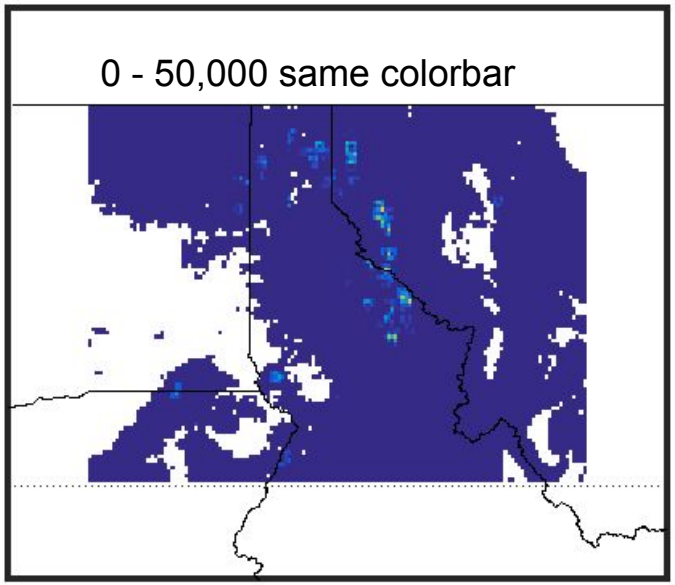
6. Dispersal algorithm requires sharing with all cores
   - numbers of dispersing beetles
   - neighbors with lodgepole pine

   call mpi_allreduce (thank you Bill Sacks!)

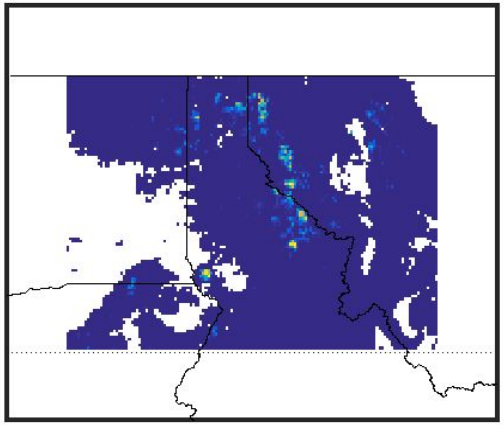
Sample Output from Subset Region

Out-dispersing 2010 (beetles/yr) In-dispersing 2010

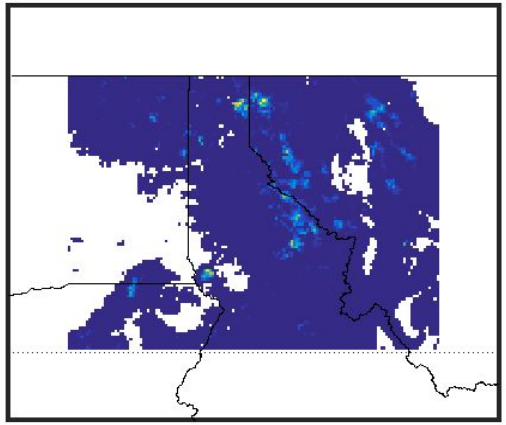




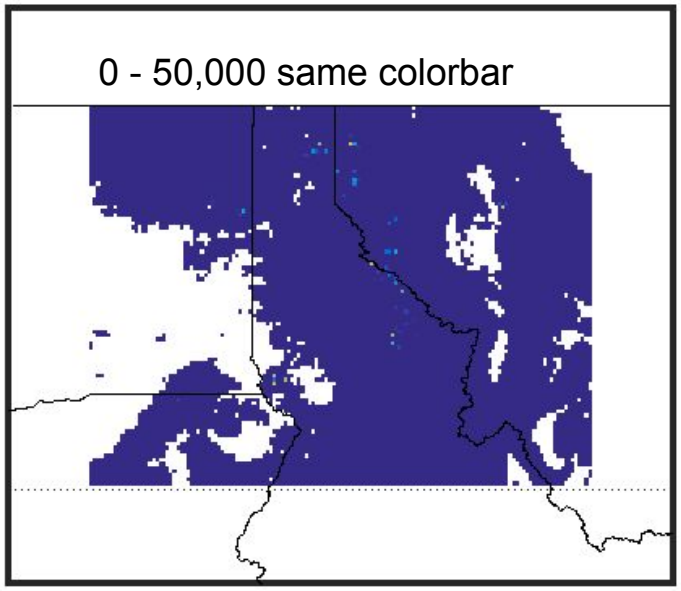
BEETLE_MORT_RATE /yr years: 2010-2010

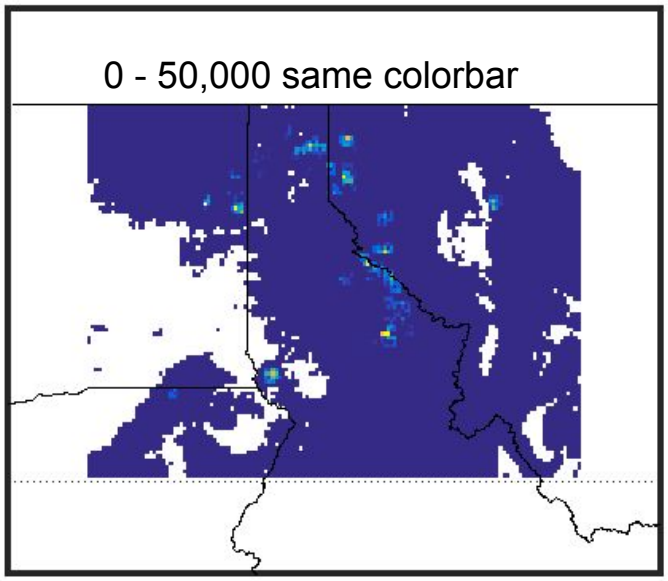


SNAG3C gC/m2 years: 2010-2010



Out-dispersing 2011 (beetles/yr) In-dispersing 2011





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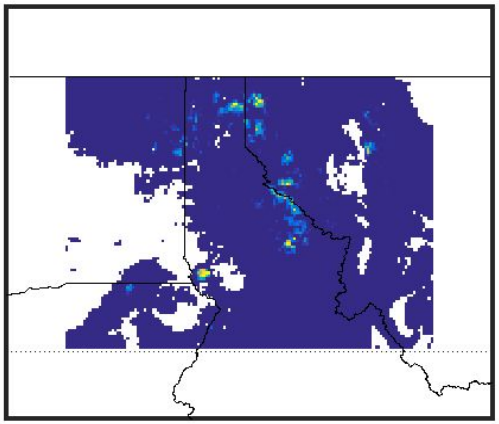
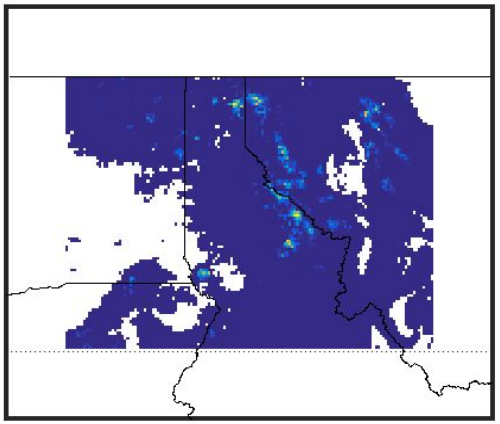
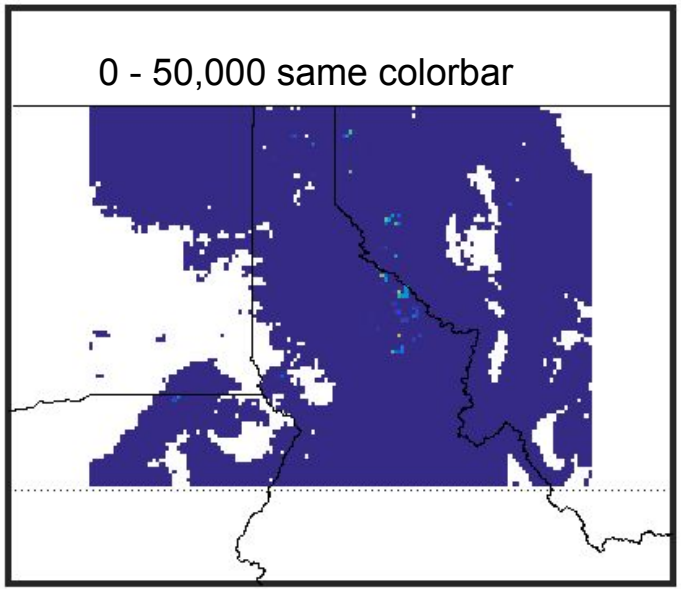
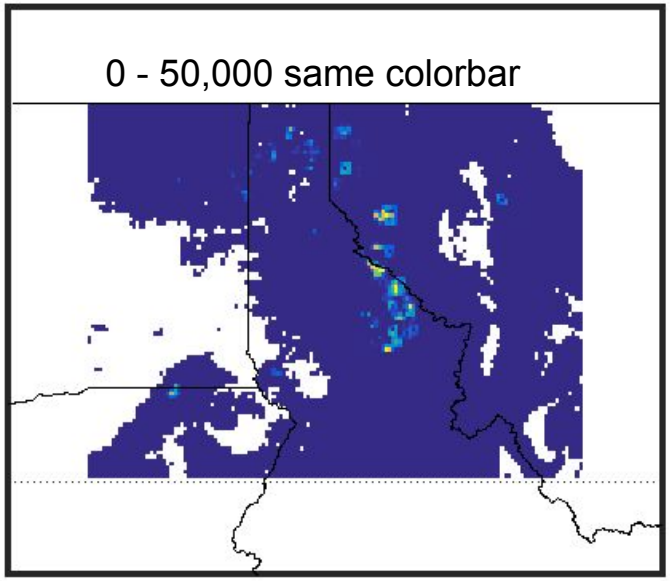


SNAG3C gC/m2 years: 2011-2011

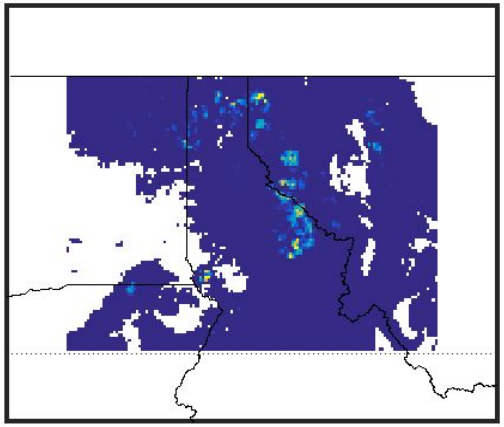


Out-dispersing 2012 (beetles/yr) In-dispersing 2012

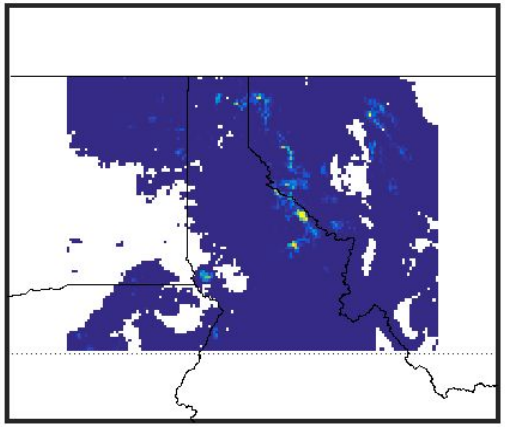




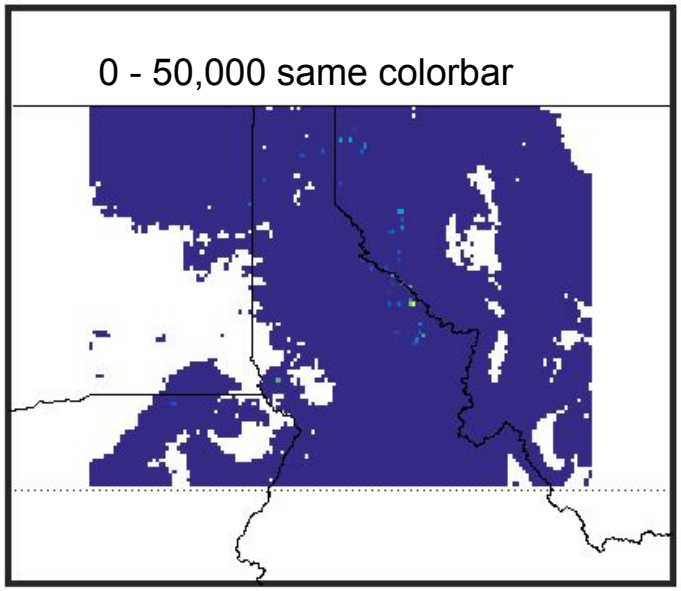
BEETLE_MORT_RATE /yr years: 2012-2012

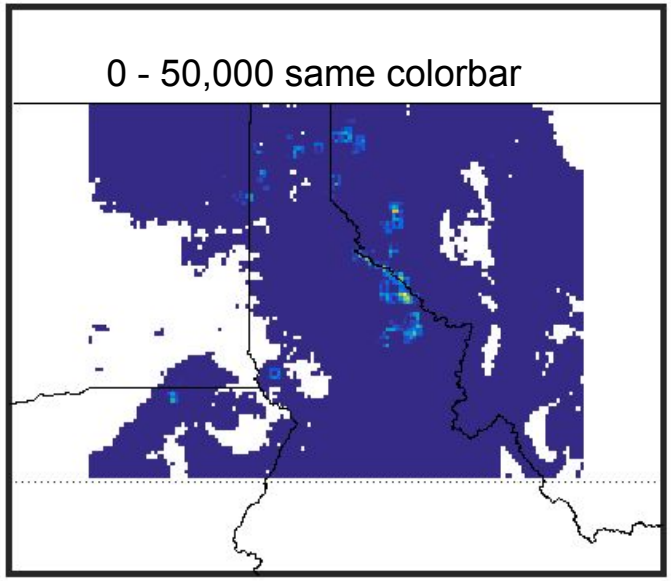


SNAG3C gC/m2 years: 2012-2012

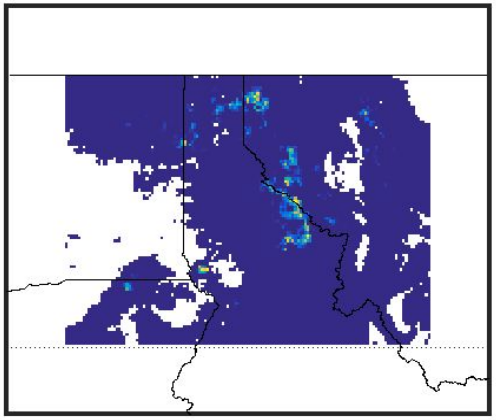


Out-dispersing 2013 (beetles/yr) In-dispersing 2013

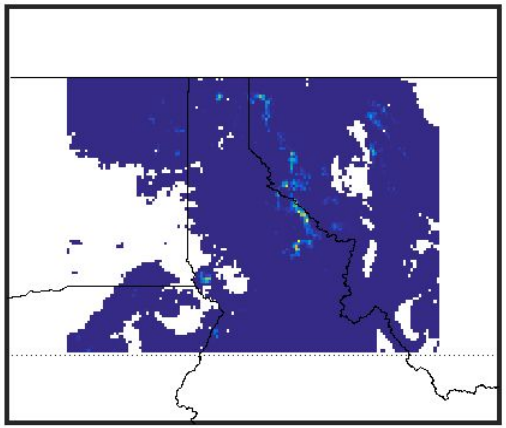




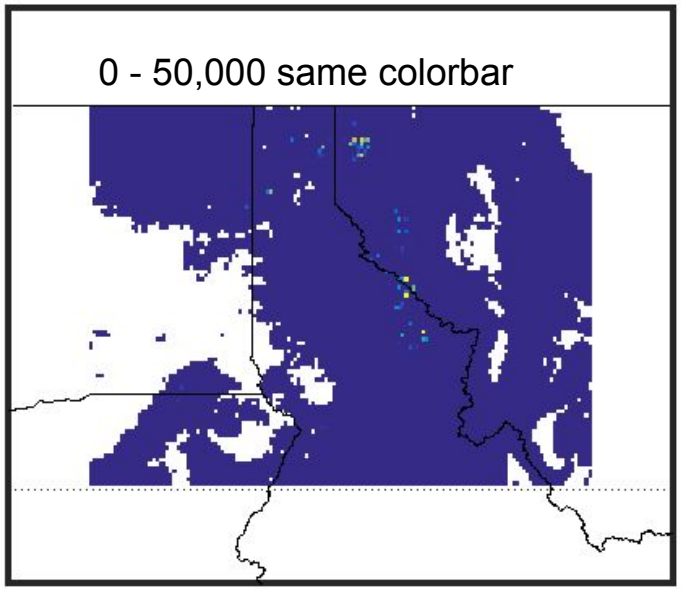
BEETLE_MORT_RATE /yr years: 2013-2013

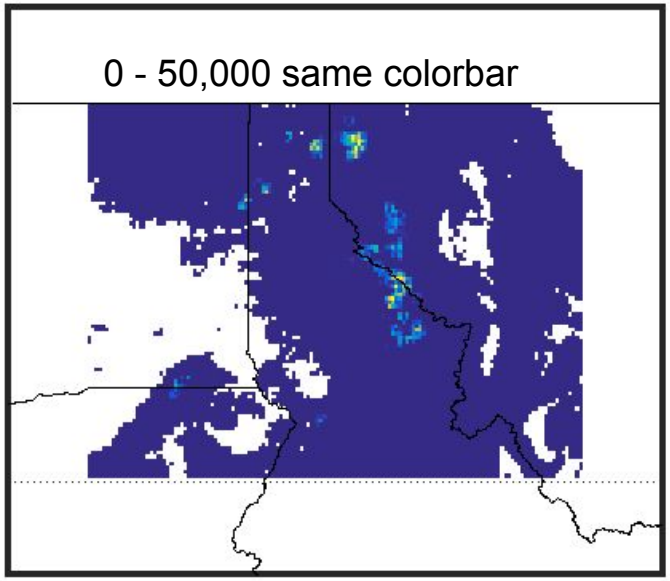


SNAG3C gC/m2 years: 2013-2013

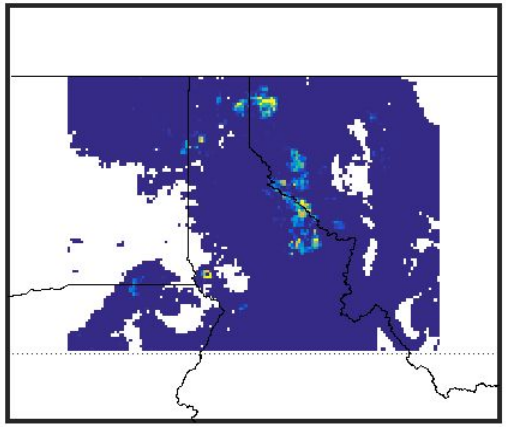


Out-dispersing 2014 (beetles/yr) In-dispersing 2014

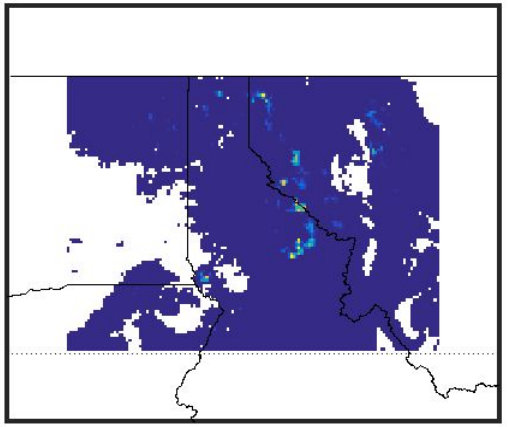




BEETLE_MORT_RATE /yr years: 2014-2014



SNAG3C gC/m2 years: 2014-2014



The prognostic timber harvest module
Modifications to clm4_5_6_r158

1. This is a **harvest economics** module that
   - calculates relationships between harvest plots and lumber mills across the western US
   - requires reading a long list of inputs

2. Same template as for prognostic beetles
   - Calculate the mortality instead of reading from file
   - Share CLM's simulated biomass across cores

3. In addition
   - Read long list of inputs
   - Share inputs across cores

The prognostic timber harvest module
Modifications to clm4_5_6_r158

3. Inputs include
   - Lumber mill data, e.g.
     - location
     - capacity
     - product type
     - parameters for mill production functions
     - parameters for mill-level timber demand curves
   - Public/private land ownership information
   - Target harvest levels on specific public lands
   - Transport costs between harvest plots and mills
   - Transport costs between mills
   - Output market characteristics
   - Population & GDP from SSP5

The prognostic timber harvest module Challenges

1. Sharing the data correctly across all cores
2. Memory usage: in our 4x4-km^2 western US domain
   - ➔ lat rows = 429
   - ➔ lon columns = 549
   - ➔ number of mills = 421
   - ➔ matrix of 99^+ million elements
3. Was too much for yellowstone!
4. bigmem queue on geyser may have worked; too slow…
5. This work is on hold because the project expires in April, and I am already working on different tasks...

Summary

Forest Mortality, Economics, and Climate (FMEC)

Western forest vulnerability to

- drought
- fire
- beetles ...now with Jeff Hicke for evaluation

Impacts of economically driven timber harvest

- Can harvest reduce forest vulnerability?
- Can we identify harvest rates that maximize forest health
- vs. maximize forest productivity
- vs. maximize harvest sustainably?

FMEC project ending: if you are interested in following up with beetles and/or timber harvest let me know

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