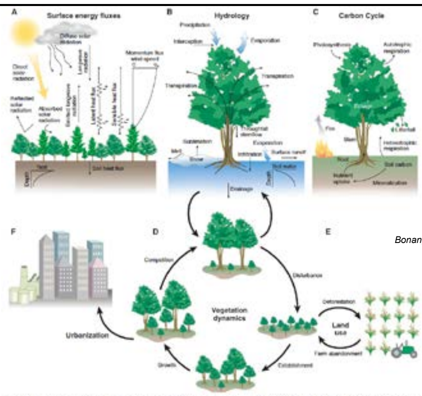
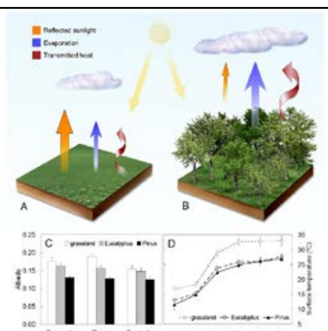
Topic 11: Feedbacks to climate change

11.2: Biogeophysical feedbacks

Climate Change Ecology
Geography 404
Jeff Hicke



Bonan, Science, 2008



Comparison of biogeophysical processes in grassland versus forest

Jackson et al., ERL, 2008

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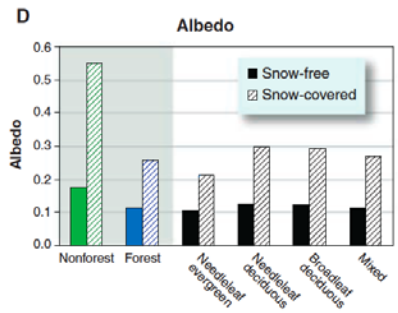

Bonan, Science, 2008

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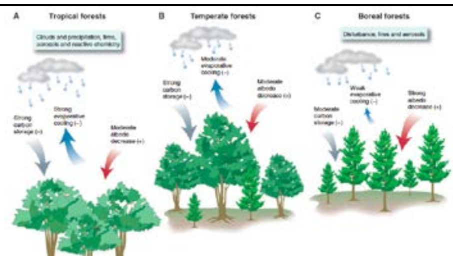

Comparison of biogeophysical processes in different forest types

Bonan, Science, 2008

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Global Change Biology

Global Change Biology (2011), doi: 10.1111/j.1365-2486.2011.02577.x

Radiative forcing of natural forest disturbances

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Illustrates biogeophysical versus biogeochemical effects of converting forest to other land cover types

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Change from brighter canopy to darker soil

O'Halloran et al., GCB, 2011

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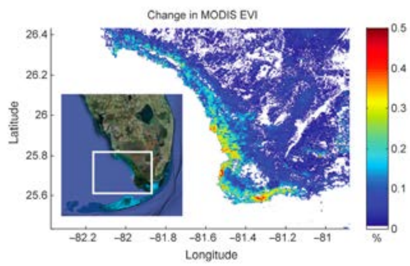
Changes in albedo (before – after hurricane)



O'Halloran et al., GCB, 2011

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Biogeochemical (carbon, NECB)
Biogeophysical (albedo)
Net

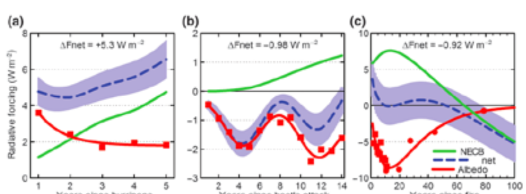

Fig. 5 Top of the atmosphere radiative forcing resulting from changes to albedo (data as red symbols; model fit as red line) and net ecosystem production (δNECB, green line) and the net of those two processes (dashed blue line) for (a) hurricane damage to a mangrove forest, (b) lodgepole pine mortality from mountain pine beetle, (c) stand replacing fire in coniferous forests in and Manitoba, Canada (squares = MODIS; circles = towers). Values of ΔF_{net} averaged over the period indicated in each panel are included. The radiative forcing from albedo changes and CO_2 release are on the same order of magnitude, and can either oppose in sign to reduce the net forcing (e.g., b, c), or combine constructively to enhance it (e.g., a).

O'Halloran et al., GCB, 2011

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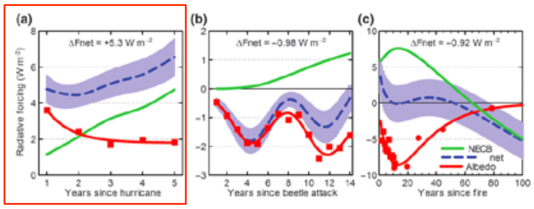

Main points
- hurricane: post-forest BGC and BGP (albedo) processes both act to warm surface
- net (BGC+BGP): warming (radiative forcing > 0)

O'Halloran et al., GCB, 2011

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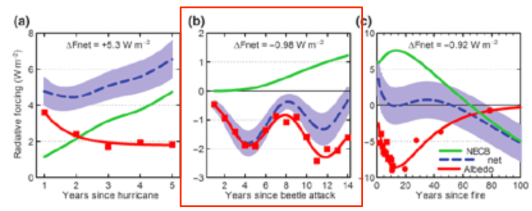

Main points
- beetle outbreak:
  - forest was darker; now, higher winter albedo cools surface
  - relatively weak C source
  - net (BGC+BGP): cools surface

O'Halloran et al., GCB, 2011

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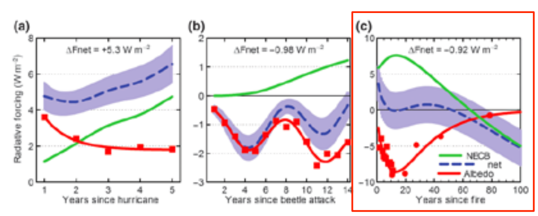

Main points
- fire:
  - forest was darker; now, higher winter albedo cools surface
  - relatively strong C source (warms surface)
  - net (BGC+BGP): warming or cooling depending on time since outbreak

O'Halloran et al., GCB, 2011

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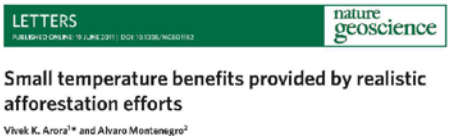
LETTERS
PUBLISHED ONLINE: 19 JUNE 2011 | DOI: 10.1038/NGEO1182
nature geoscience

Small temperature benefits provided by realistic afforestation efforts

Vivek K. Arora[1]* and Alvaro Montenegro[2]

- used general circulation model
- projected future change in temperature for multiple afforestation scenarios
  - 50% of cropland converted to forest in each of three regions as well as all regions
    - tropics
    - temperate
    - boreal
- metric: differences in warming in 2100 compared with run without land cover change
  - one run: carbon only
  - one run: biogeophysical changes only
  - one run: both

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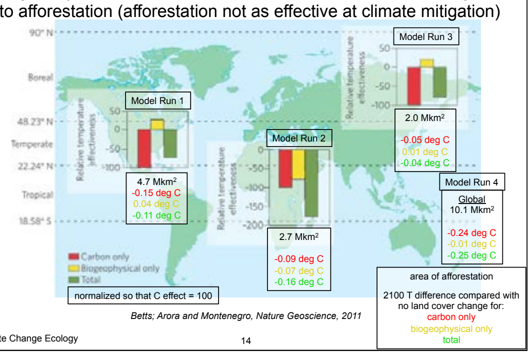
All runs: warming compared with today, but inclusion of biogeophysical impacts decreases reduction of future warming due to afforestation (afforestation not as effective at climate mitigation)



Betts; Arora and Montenegro, Nature Geoscience, 2011

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