باسمه تعالی

مروری بر یک مقاله پراستناد تغییر اقلیم

بهار ۱۳۹۸

- Bonan G.B. (2008) Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests, SCIENCE VOL 320, 1444-1449

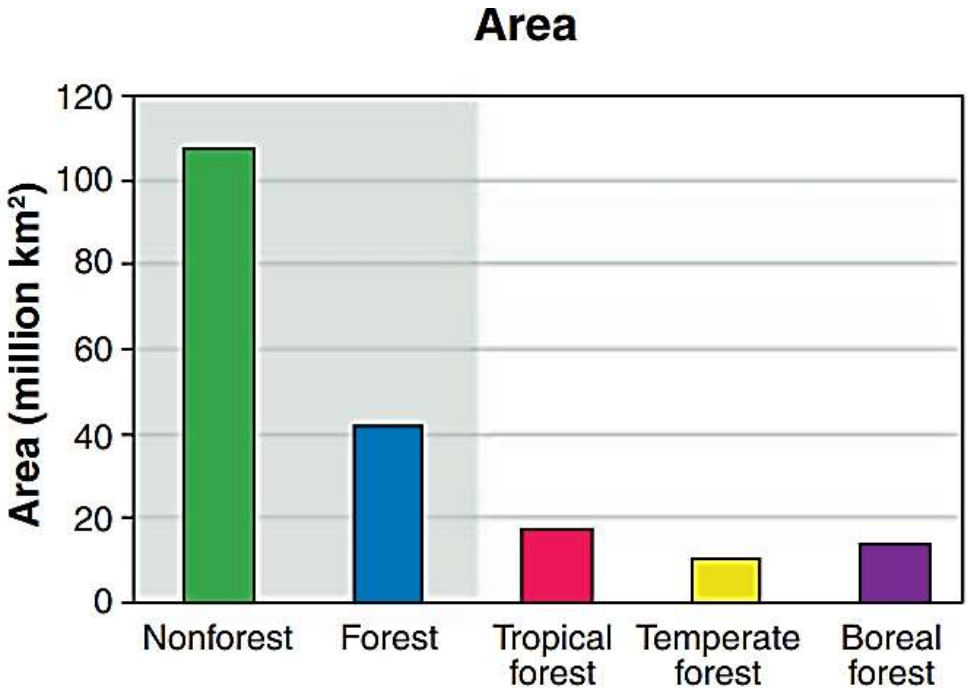
Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

- The world's forests influence climate through physical, chemical, and biological processes that affect planetary energetics, the hydrologic cycle, and atmospheric composition.
- These complex and nonlinear forest-atmosphere interactions can dampen or amplify anthropogenic climate change.
- Tropical, temperate, and boreal reforestation and afforestation attenuate global warming through carbon sequestration. Biogeophysical feedbacks can enhance or diminish this negative climate forcing.
- Tropical forests mitigate warming through evaporative cooling, but the low albedo of boreal forests is a positive climate forcing. The evaporative effect of temperate forests is unclear. The net climate forcing from these and other processes is not known.
- Forests are under tremendous pressure from global change. Interdisciplinary science that integrates knowledge of the many interacting climate services of forests with the impacts of global change is necessary to identify and understand as yet unexplored feedbacks in the Earth system and the potential of forests to mitigate climate change

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

- **جنگل‌های جهان از طریق فرآیندهای فیزیکی، شیمیایی و زیستی موجب تاثیرات سیاره‌ای، چرخه آب و ترکیب اتمسفر می شوند که به نوبه خود بر آب و هوا تاثیر می‌گذارند. مجموعه اثرات متقابل جنگل – اتمسفر نیز می‌تواند باعث کاهش یا تقویت تغییرات آب و هوایی انسان‌محور شود.**
- **جنگلکاری در هر یک از مناطق اقلیمی استوایی، معتدل و یا قطبی منجر به تضعیف گرم شدن جهانی هوای کره زمین از راه ترسیب کربن می‌شود (بازخورد منفی).**
- **بازخوردهای بیوژئوفیزیکی مثبت می‌تواند این اثر منفی را افزایش داده یا تضعیف کند.**
- **جنگل‌های استوایی نقش خنک‌کنندگی تبخیری دارند (بازخورد منفی).**
- **جنگل های قطبی به خاطر کاهش دادن آلبدو (میزان پرتو بازتابش شده از زمین) اثر گرم کنندگی (بازخورد مثبت) دارند.**
- **اثر جنگل‌های معتدل بر دما واضح نیست. مشخص نیست که آیا تبخیرو تعرق و سایر فرایندهای آب و هوایی در این جنگلها خنک کننده خالص هستند یا خیر. جنگل‌ها تحت تأثیر فشار عظیم ناشی از تغییرات اقلیمی هستند.**
- **نیاز به دانش بین رشته ای داریم تا اندرکنش بین پارامترهای مختلف اقلیمی اثرگذار بر جنگل شناخته شود. در آن صورت شناخت گوشه های کشف نشده در سیستم زمین و پتانسیل جنگل‌ها برای کاهش تغییرات اقلیمی راحت تر خواهد بود**

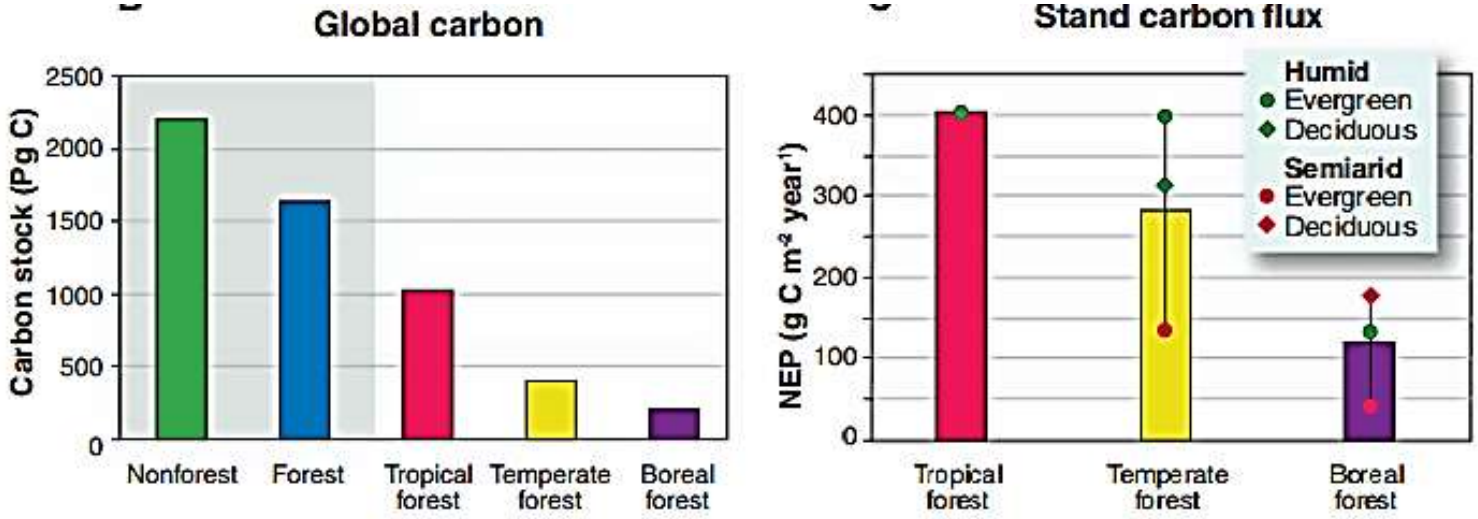
Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



- مساحت جنگل ها بالای ۴۲ میلیون کیلومتر مربع (حدود ۳۰ درصد مساحت سطح زمین) است.

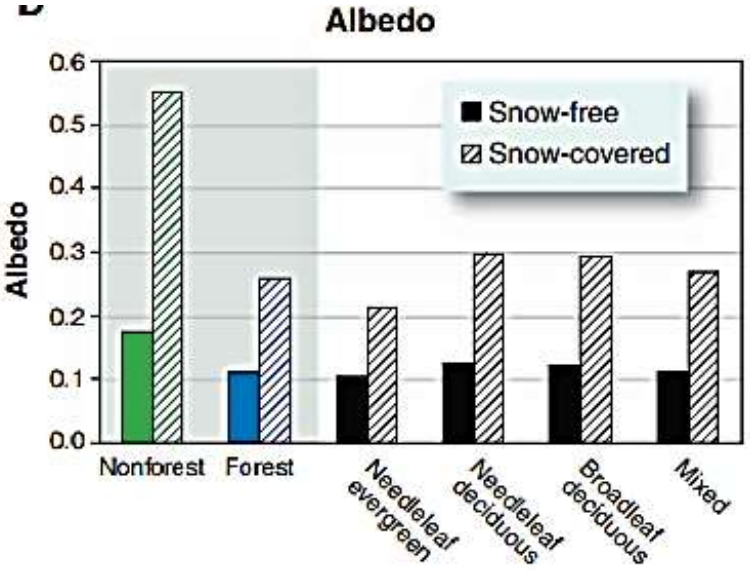
- برخی از کارکردهای جنگل:
- اثرات اقلیمی از طریق تبادل انرژی، آب، دی اکسید کربن و سایر ترکیبات با جو زمین
- پناهگاه حیات وحش و عامل مهم تنوع زیستی
- تأمین غذا، گیاهان دارویی و محصولات جنگلی (مانند چوب)
- تنظیم چرخه هیدرولوژی
- حفاظت از خاک
- استفاده تفریحی و تأمین نیازهای روحی انسان

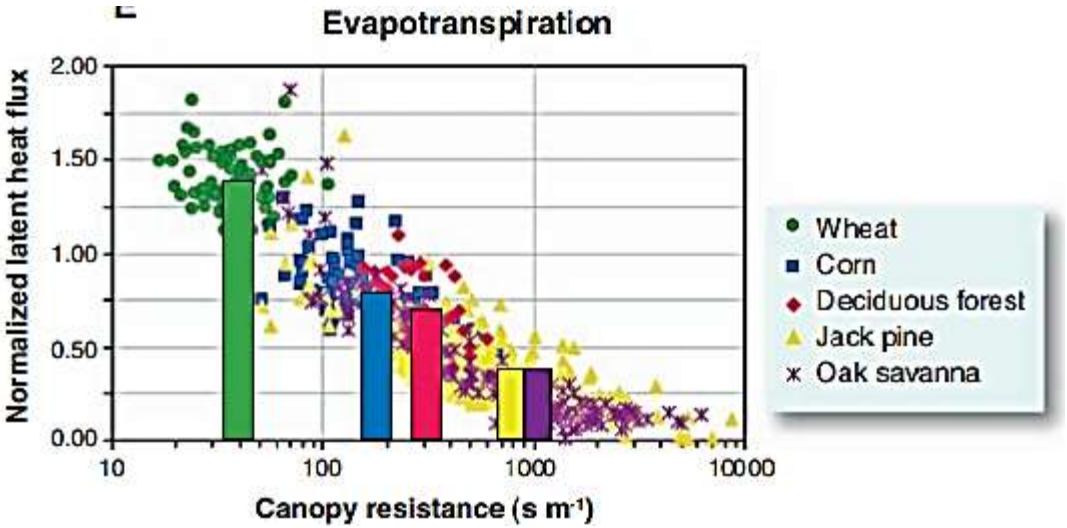
Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



- **برخی از کارکردهای جنگل:**
- **ذخیره ۴۵ درصد کربن زمین (شکل سمت چپ)**
- **توانایی ترسیب کربن سالانه با مقادیر بسیار بالا (شکل سمت راست)**
- **در سال ۱۹۹۰ جنگل ها ۳۳ درصد کربن تولید شده توسط انسان را ذخیره کردند.**

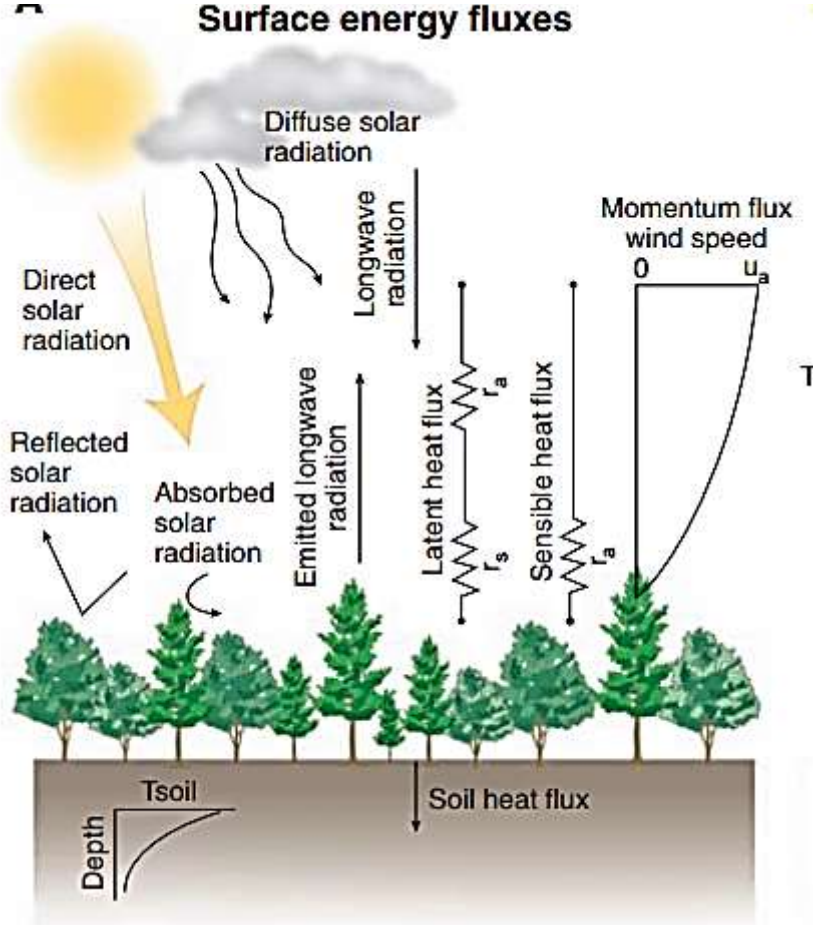
Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests





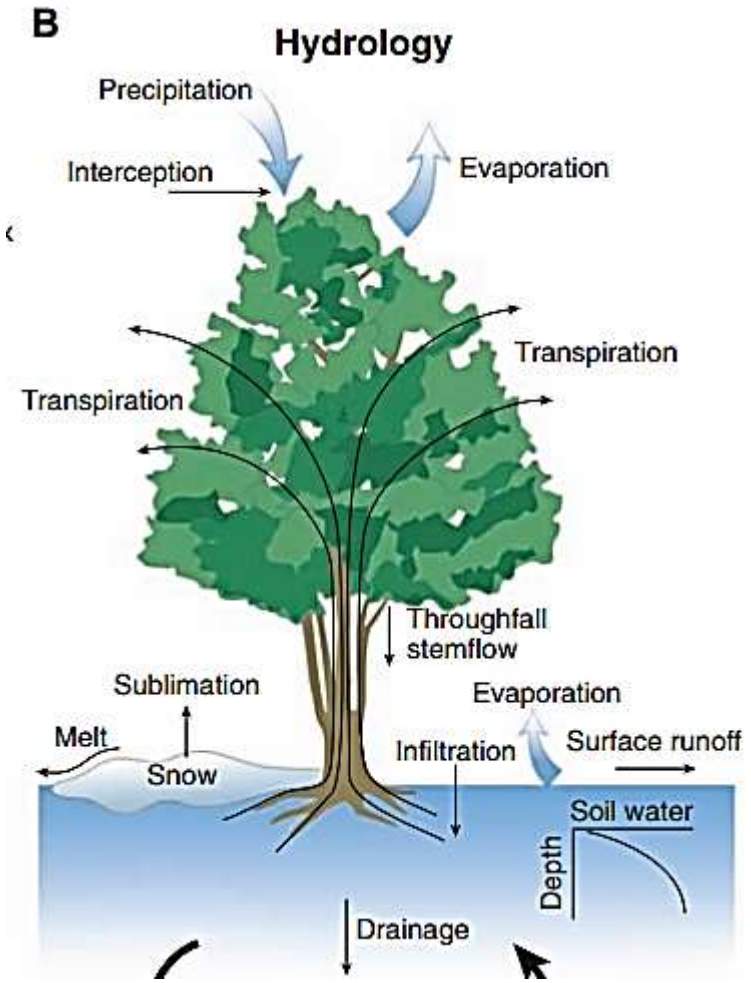
- **برخی از کارکردهای جنگل:**
- **جنگل ها ضریب آلبدوی پایین دارند و می توانند ضریب آلبدوی بالای برف را خنثی کنند. (شکل سمت چپ)**
- **نسبت تبخیر و تعرق به انرژی داده شده به سیستم، برای جنگل کمتر از گیاهان مزرعه مانند گندم و ذرت است. (شکل سمت راست)**

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



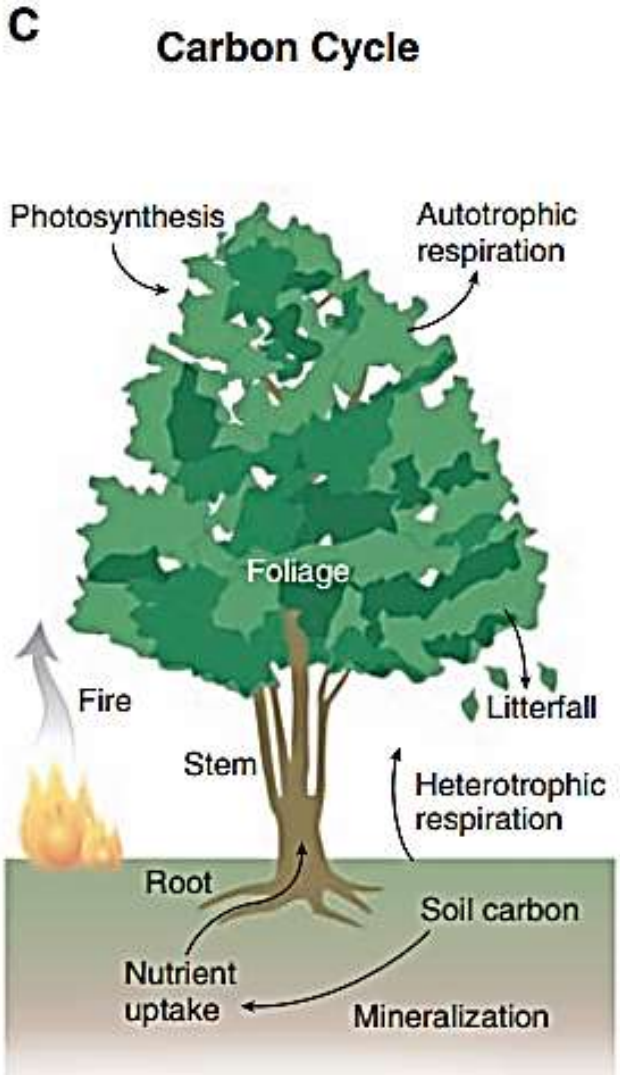
- در اواسط دهه ۱۹۸۰ نسل دوم مدل های اقلیمی قادر بودند چرخه هیدرولوژی و اثر پوشش گیاهی بر چرخه آب و انرژی را مدل نمایند.
- اثرات پوشش گیاهی در این مدلها شامل انتقال تابشی، فرایندهای آشفته درون و بالای پوشش گیاهی و اثرات فیزیکیو زیستی تبخیر و تعرق بود.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



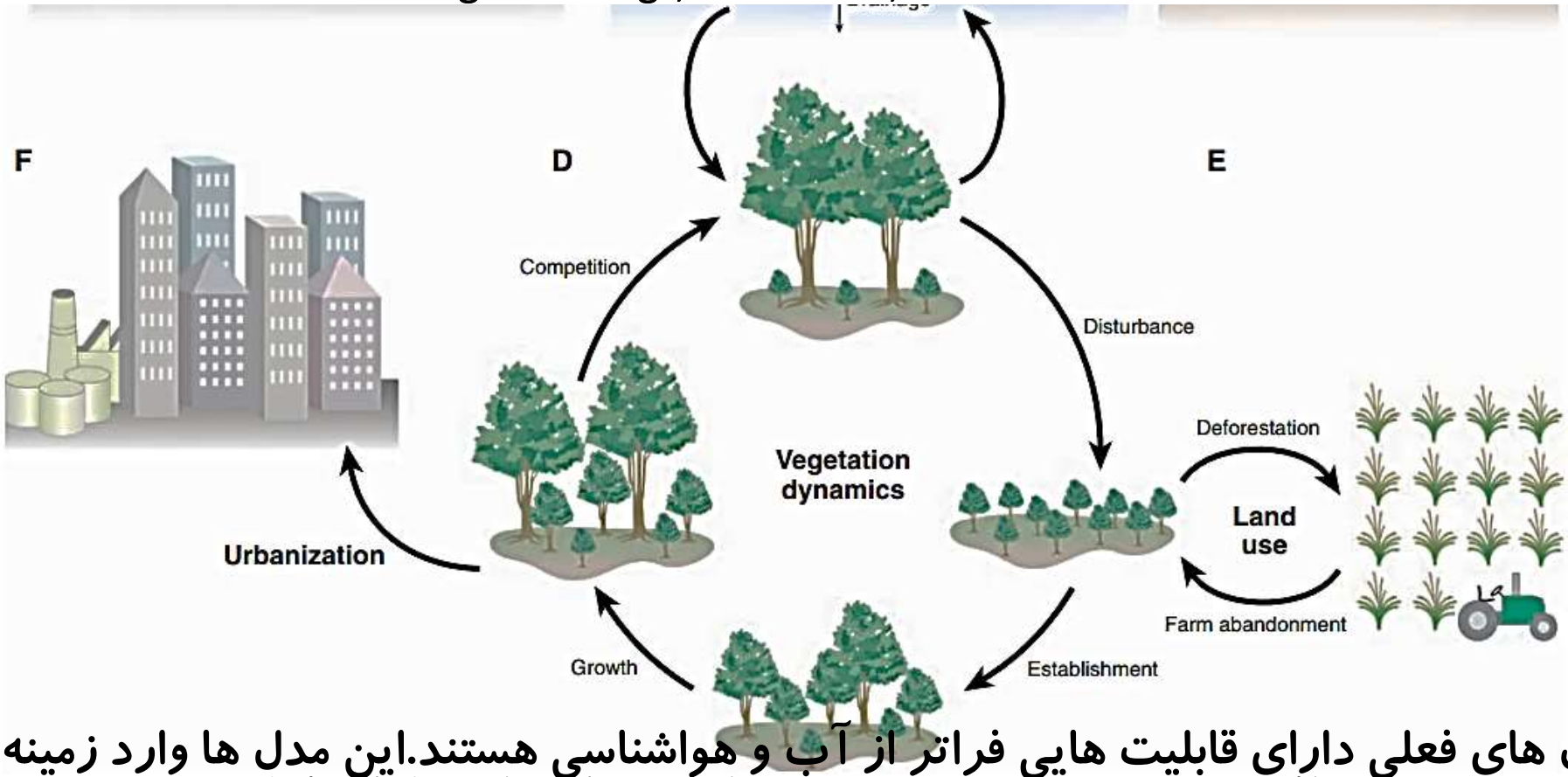
- **هم چنین در مدل های نسل دوم، پوشش برف، حرکت آب در خاک و اثرات پوشش گیاهی بر چرخه هیدرولوژی دیده شد.**

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



- در اواسط دهه ۱۹۹۰ مدل های نسل سوم اقلیم شناسی با لحاظ کردن تئوری فیزیولوژی گیاه، توانستند اثر زیستی تبخیر و تعرق را مدل کنند.
- بسیاری از مدلهای امروزی، چرخه کربن را مدل می کنند

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

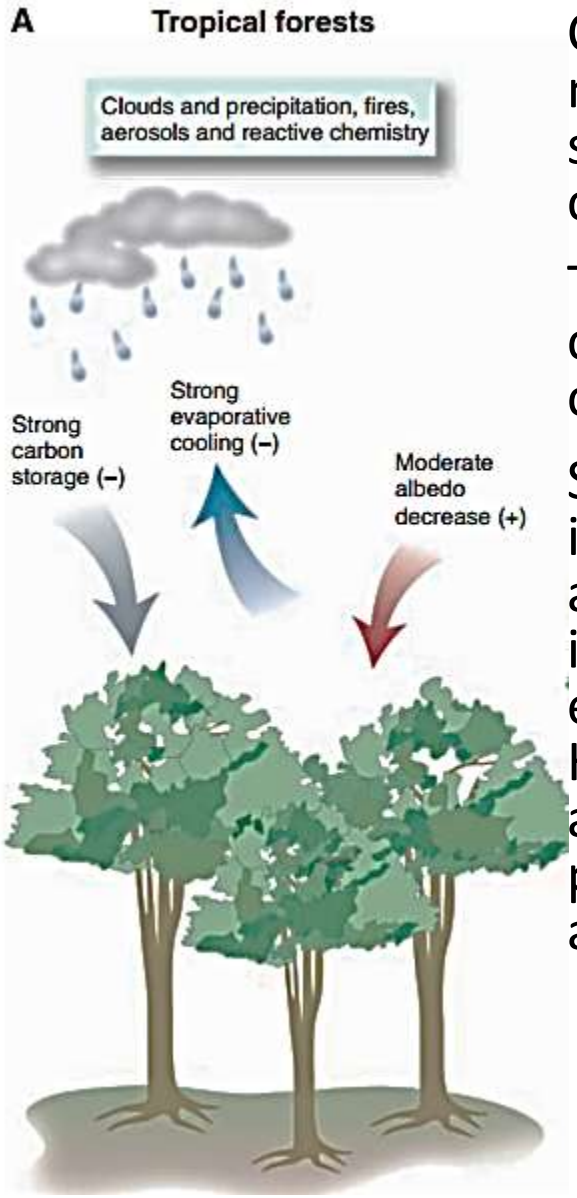


مدل های فعلی دارای قابلیت هایی فراتر از آب و هواشناسی هستند.این مدل ها وارد زمینه های زیست-جغرافی و زیست-زمین-شیمی شده اند. بسیاری از مدلهای فعلی پوشش گیاهی پویا (دینامیک) را مدل می کنند.

در مدلهای نوین، زیست کره و اتمسفر تشکیل یک سامانه جفت شده را می دهند که در آن تغییر در اقلیم منجر می شود به تغییر در اکوسیستم و زیست-جغرافی.

همانطور که تصویر بالا نشان می دهد، بسیاری از پوششهای گیاهی طبیعی تغییر کاربری به کشاورزی داده اند. بعضی از مدل ها کاربری زمین را هم در نظر می گیرند.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

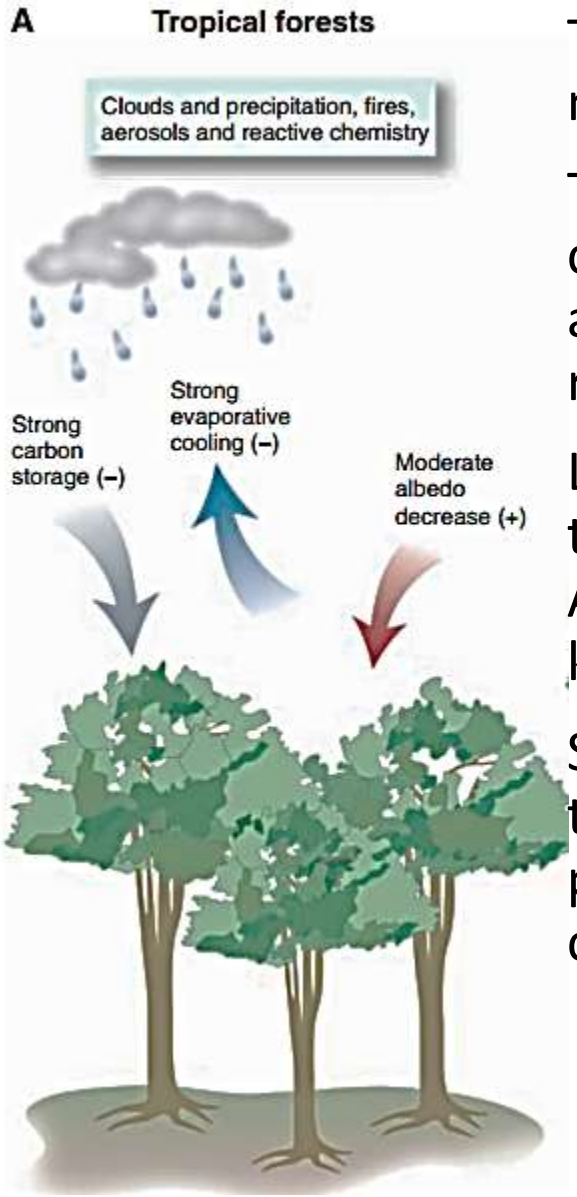


Climate model simulations show that tropical forests maintain high rates of evapotranspiration, decrease surface air temperature, and increase precipitation compared with pastureland.

The most studied region is Amazonia, where large-scale conversion of forest to pasture creates a warmer, drier climate.

Surface warming arising from the low albedo of forests is offset by strong evaporative cooling. Similar results are seen in tropical Africa and Asia, and the climatic influence of tropical forests may extend to the extratropics through atmospheric teleconnections. However, forest-atmosphere interactions are complex, and small-scale, heterogeneous deforestation may produce mesoscale circulations that enhance clouds and precipitation.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



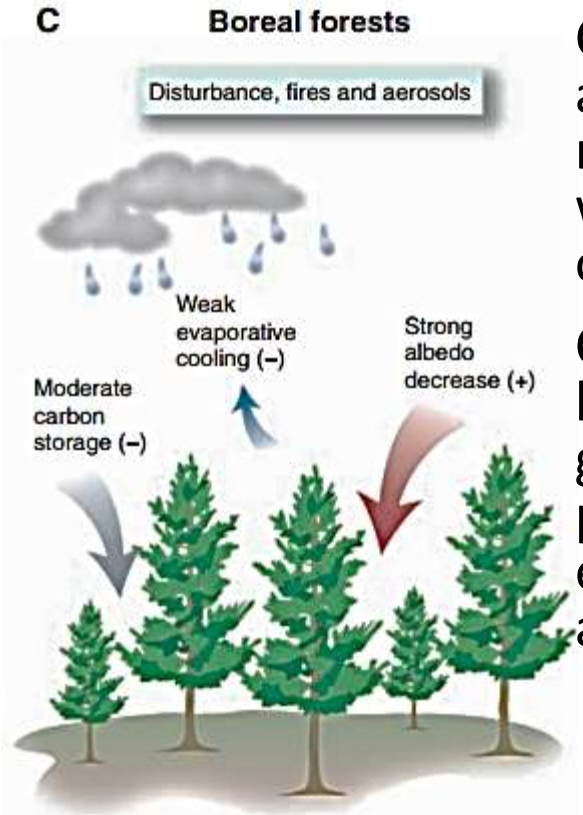
The future of tropical forests is at risk in a warmer, more populous 21st-century world.

Tropical forests are vulnerable to a warmer, drier climate, which may exacerbate global warming through a positive feedback that decreases evaporative cooling, releases CO2, and initiates forest dieback.

Loss of natural forests worldwide in the tropics during the 1990s was as high as 152,000 km2/year, and Amazonian forests were cleared at a rate of ~25,000 km2/year.

Such land-use pressures are expected to continue in the future and may shift the Amazonian region to a permanently drier climate once a critical threshold of clearing is reached.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

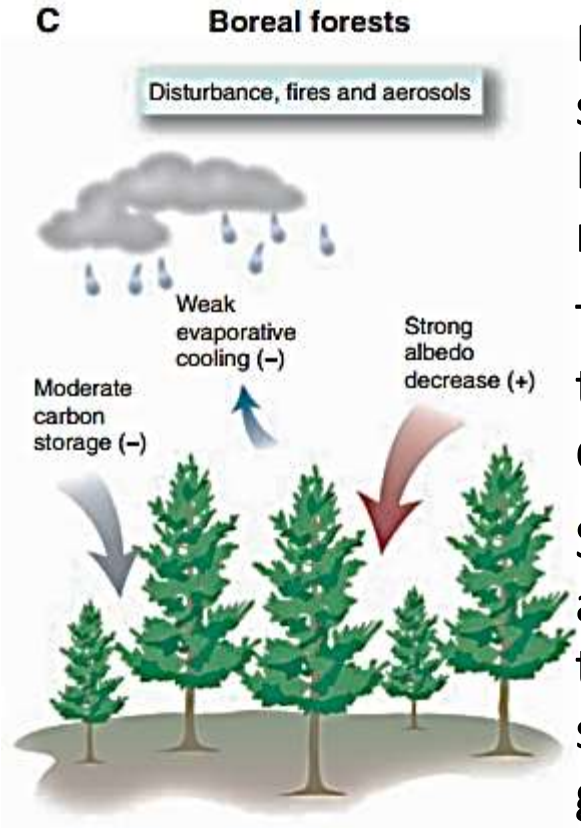


Climate model simulations show that the low surface albedo during the snow season, evident in local flux measurements and satellite-derived surface albedo, warms climate compared to when there is an absence of trees.

Consequently, the boreal forest has the greatest biogeophysical effect of all biomes on annual mean global temperature. Loss of boreal forest provides a positive feedback for glaciation, whereas forest expansion during the mid-Holocene 6000 years ago amplified warming.

Boreal forests differ in their partitioning of net radiation into sensible and latent heat fluxes. Conifer forests have low summer-time evaporative fraction (defined as the ratio of latent heat flux to available energy) compared with deciduous broadleaf forests, producing high rates of sensible heat exchange and deep atmospheric boundary layers.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

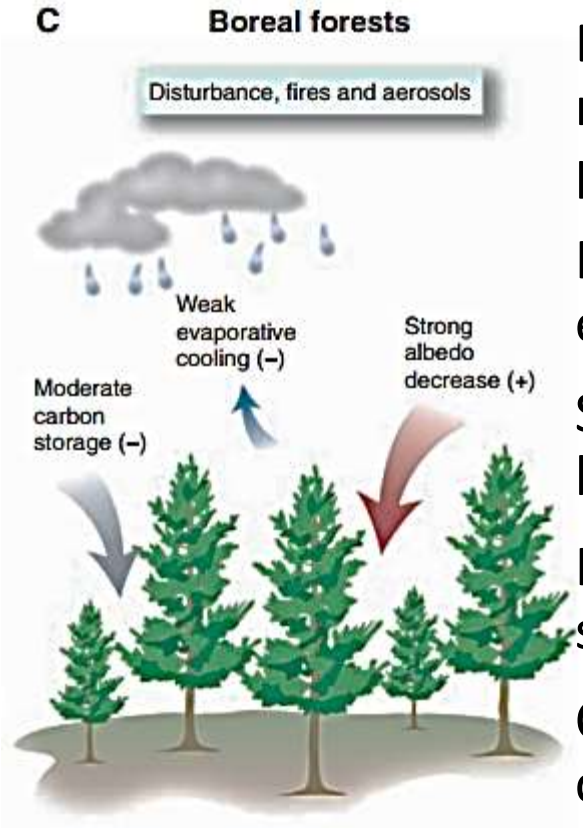


Boreal ecosystems store a large amount of carbon in soil, permafrost, and wetland and contribute to the Northern Hemisphere terrestrial carbon sink, although mature forests have low annual carbon gain.

The climate forcing from increased albedo may offset the forcing from carbon emission so that boreal deforestation cools climate.

Similar conclusions are drawn from comprehensive analysis of the climate forcing of boreal fires. The long-term forcing is a balance between postfire increase in surface albedo and the radiative forcing from greenhouse gases emitted during combustion.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



Boreal forests are vulnerable to global warming. Trees may expand into tundra, but die back along southern prairie ecotones.

In the main boreal forest, there may be loss of evergreen trees and a shift toward deciduous trees.

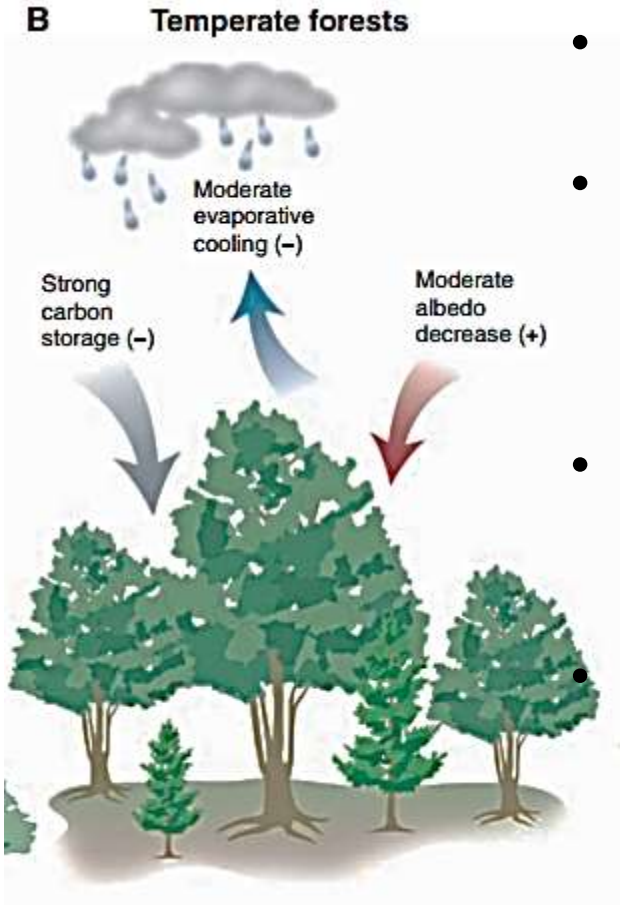
Siberian forests may collapse in some areas and become more evergreen in the north.

Increased disturbance from fire or insect outbreaks will shift the forest to a younger age class.

Climate forcing arising from younger stand age may be comparable to that arising from biome shifts.

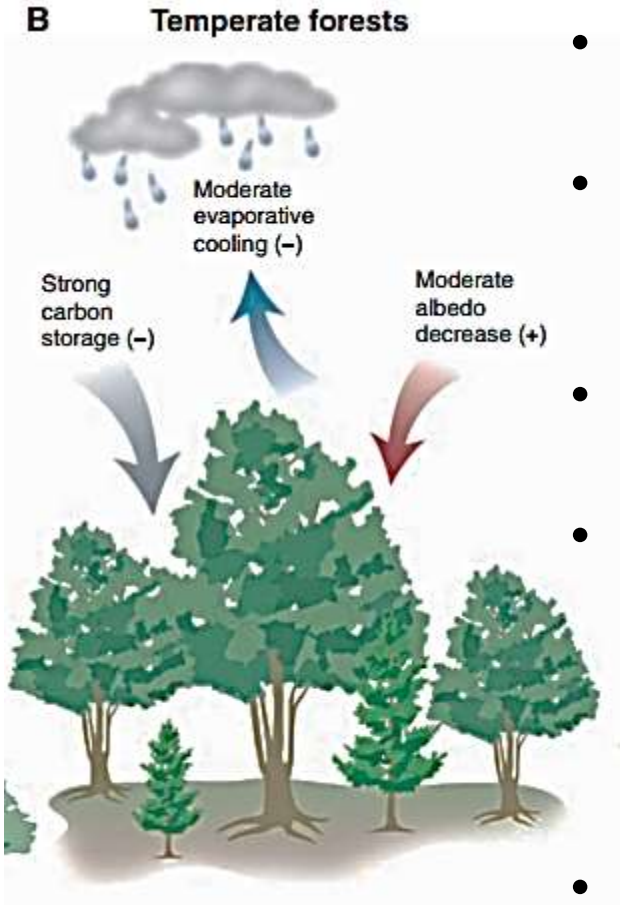
Averaged

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



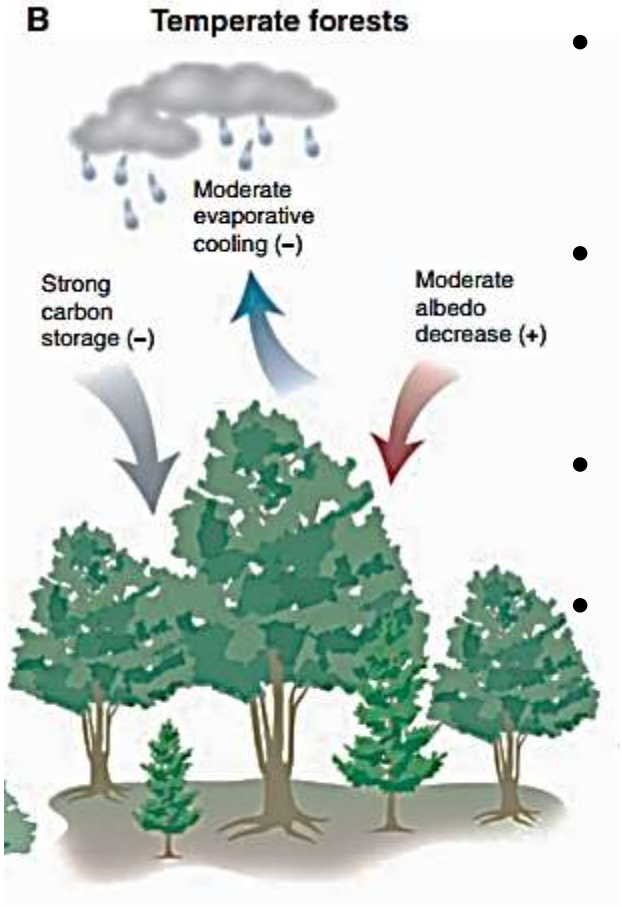
- Temperate forests hold ~20% of the world's plant biomass and ~10% of terrestrial carbon.
- Carbon sequestration rates of mature forests are high, but temperate forests in the United States historically have been carbon sources because of deforestation.
- Much of the temperate forests of the eastern United States, Europe, and eastern China have been cleared for agriculture.
- Croplands have a higher albedo than forests, and many climate model simulations find that trees warm surface air temperature relative to crops

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



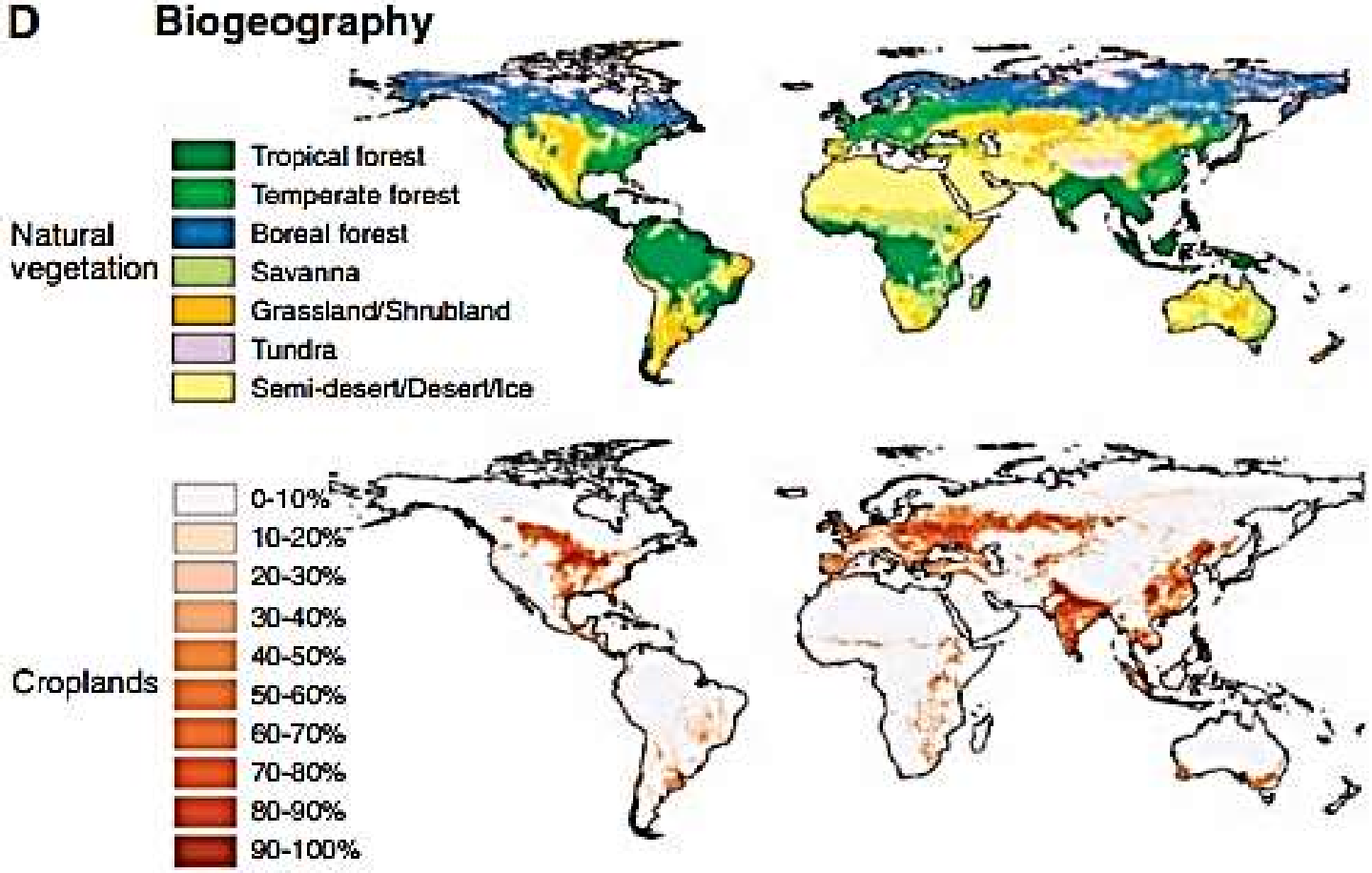
- The future of temperate forests and their climate services is highly uncertain.
- These forests face uncertain pressure from climate change, atmospheric CO2 increase, and anthropogenic nitrogen deposition.
- Change in the balance between deciduous and evergreen trees is likely in the future.
- Temperate forests are particularly vulnerable to human land use. The trend over the past several decades has been toward farm abandonment, reforestation, and woody encroachment from fire suppression.
- Meeting the needs of a growing global population could place greater pressures on these forests.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



- The present carbon sink in eastern United States forests is likely to decline as recovering forests mature.
- These forests face uncertain pressure from climate change, atmospheric CO2 increase, and anthropogenic nitrogen deposition.
- Change in the balance between deciduous and evergreen trees is likely in the future.
- Temperate forests are particularly vulnerable to human land use. The trend over the past several decades has been toward farm abandonment, reforestation, and woody encroachment from fire suppression.
- Meeting the needs of a growing global population could place greater pressures on these forests.

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests



Much of the natural vegetation of the world has been cleared for agriculture

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

Research Needs

- Through albedo, evapotranspiration, the carbon cycle, and other processes, forests can amplify or dampen climate change arising from anthropogenic greenhouse gas emission.
- Negative climate forcing in tropical forests from high rates of carbon accumulation augments strong evaporative cooling.
- The combined carbon cycle and biogeophysical effect of tropical forests may cool global climate, but their resilience to drought, their status as carbon sinks, interactions of fires, aerosols, and reactive gases with climate, and the effects of smallscale deforestation on clouds and precipitation are key unknowns.
- The climate forcing of boreal forests is less certain. Low surface albedo may outweigh carbon sequestration so that boreal forests warm global climate, but the net forcing from fire must also be considered, as well as effects of disturbance and stand age on surface fluxes.
- The climate benefit of temperate forests is most uncertain. Reforestation and afforestation may sequester carbon, but the albedo and evaporative forcings are moderate compared with other forests and the evaporative influence is unclear .

Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

- An integrated assessment of forest influences entails an evaluation beyond albedo, evapotranspiration, and carbon to include other greenhouse gases, biogenic aerosols, and reactive gases.
- The geographic impact of these processes varies, as does their time scale of climate forcing. Greenhouse gases are well mixed in the atmosphere and influence global climate; biogeophysical feedbacks have a regional impact. Biogeophysical processes influence climate more immediately than does the carbon cycle.
- Slow rates of carbon accumulation in boreal forest may in the short-term be offset by more rapid albedo effects. How forests attenuate or amplify climate change will vary with global warming.
- Vegetation masking of snow albedo becomes less important in a warmer world with less extensive snow cover.
- The evaporative cooling of forests declines if droughts become more common. The interrelatedness of climate change science, climate impacts on ecosystems, and climate change mitigation policy requires that these be studied together in an interdisciplinary framework to craft strong
- science in the service of humankind.