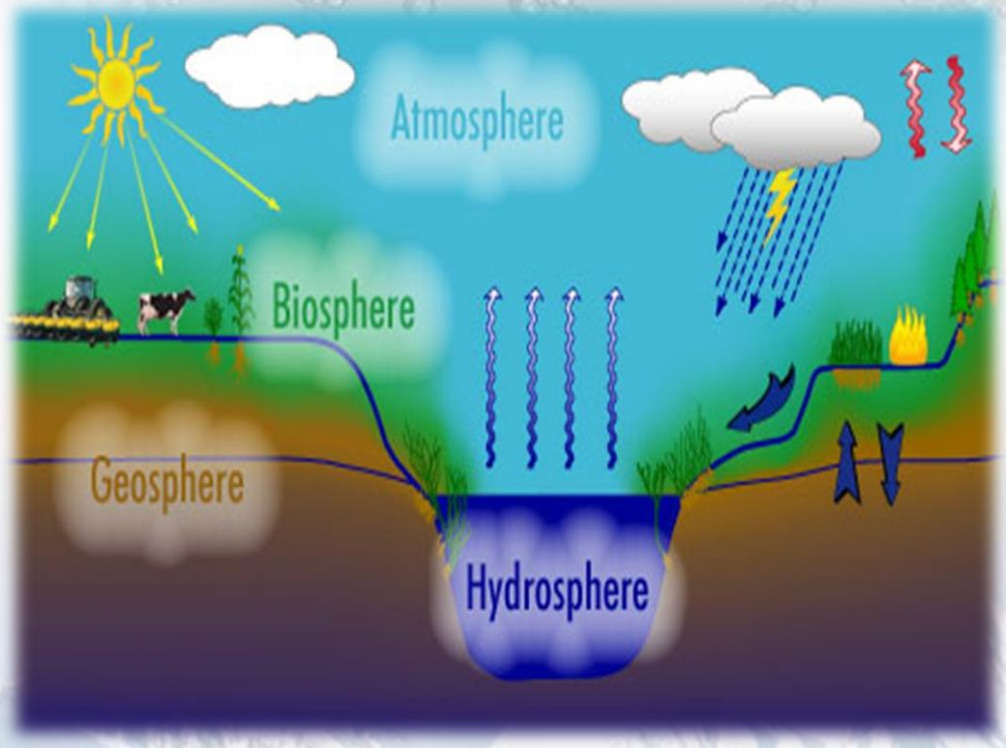
Nature *and* Humans

Josh

Natural Systems and Human Systems

- Natural Systems are the interactions across the four main earth systems
- Humans are a part of the biosphere and our practices drastically influence natural systems
- Great Acceleration of human caused problems to the natural world over the last few hundred years.
- Acceptance and paradigm shift beginning about a half century ago



A “Concrete” Example

I affect all four parts of earth:

- I am the product of human expansion across the biosphere
- I affect components of the biosphere aside from humans; such as fish, birds and deer. How they migrate, live, eat, drink by changing their habitat
- I change the geomorphic and geologic evolution that hinder processes such as sediment load or incision
- I am made from parts of the geosphere
  - Just the process of taking these parts from the geosphere and making them into the substance that created me accounts for 5% of total emissions into the atmosphere
- I change cycles of the hydrosphere that mesh with the atmosphere
- I change the atmosphere by emitting harmful pollutants produced from eutrophication or algal blooms

I am not the result of seven billion beavers with bulldozers.

What am I?

DAM

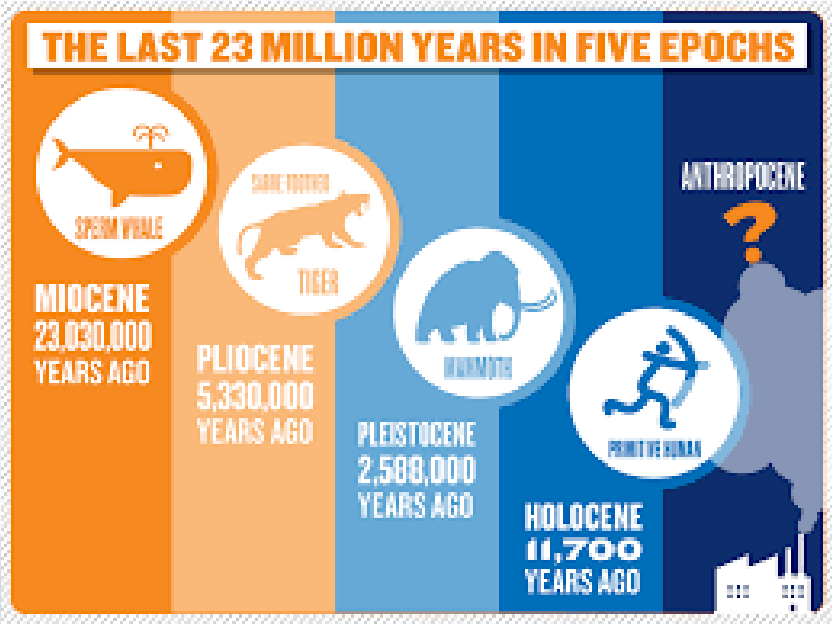
Holocene or Anthropocene

Holocene: 11,700 years ago (domestication, land clearing, resource usage . etc.)

Anthropocene: Essentially the shift away from the Holocene to a new age which has been widely accepted by most scientists

- Medical and technological advances led to more humans, creating a need for space and energy

- At this point almost 90% of all land surface on earth has been altered by humans in some way

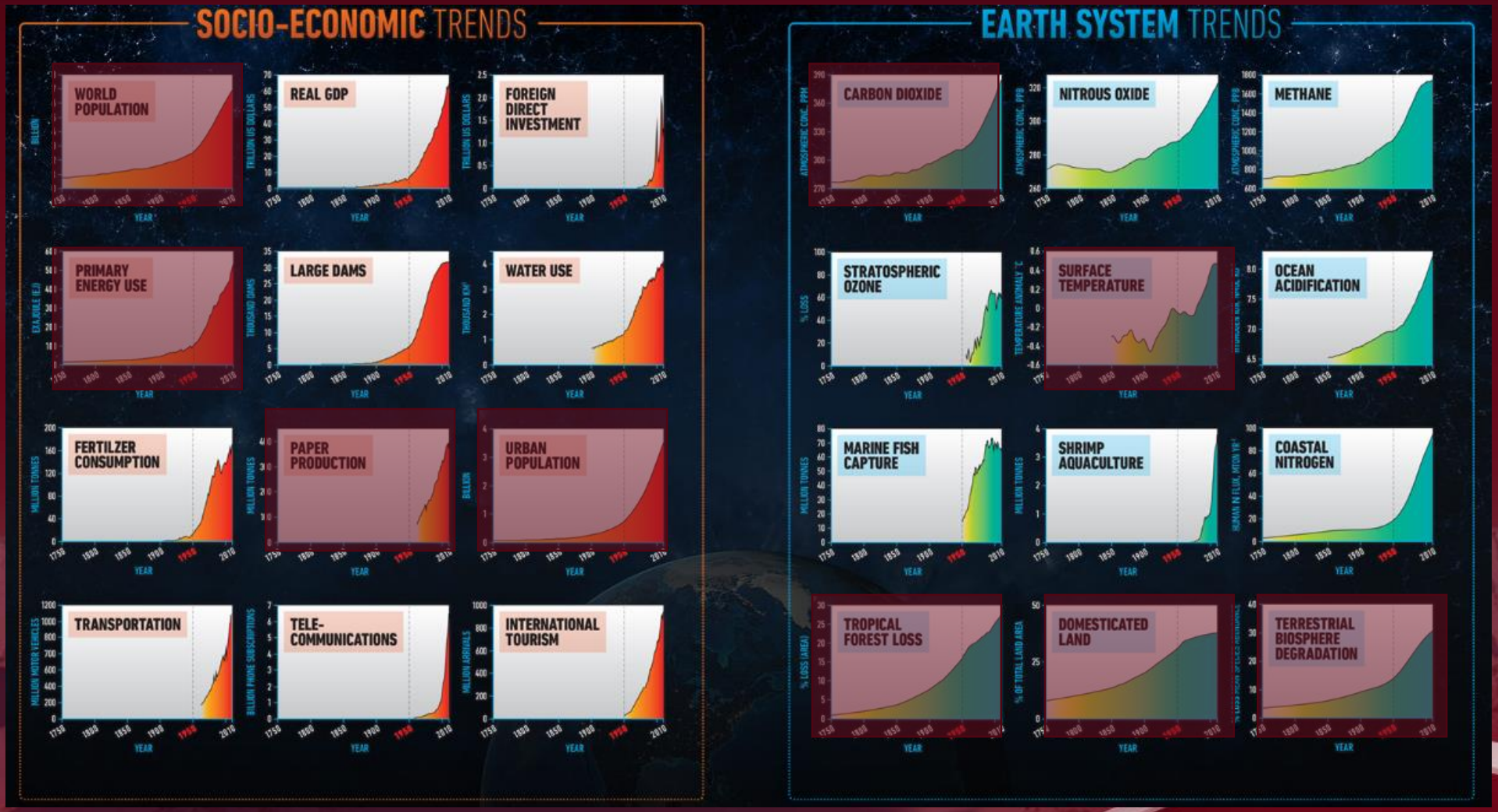


From the time beginning around Holocene epoch, if it were a calendar, than the industrial age occurred about a week ago and the Great Acceleration occurred about a day ago.

I will discuss this phenomena on the next slide.

But first, a cheesy metaphor…

The Great Acceleration



The Great Acceleration

As you are probably already aware, there are some systems that are described as Earth's "Achilles heels". Here is a list of some key 'tipping points' we are in danger of passing in a near future. Even small human induced climate changes could push these vital parts of the planet over the edge. They represent areas whose condition decisively affects the entire planet and have irreversible effects on the global environment.

High Latitudes (poles) include:
Arctic Sea-Ice- Arctic albedo, rising temperatures and ecosystem loss

Greenland Ice Sheet- 6% of freshwater, if melted, would end up in our oceans causing sea level rise

West Antarctic Ice Sheet- more melt and more sea level rise

Boreal forest- increased vulnerability to disease and increased water stress with temperature rise

Low and Mid-Latitudes (equator):
Amazon Rainforest- changing precipitation patterns may result in drier seasons and degradation of soil composition. Half of the biomass from the world's largest forest and carbon sequester could be lost in a few decades.

ENSO- major changes in weather. Drought in Indonesia and Australia and heavy rain on the west coast of South America. Climate change may increase severity over time.

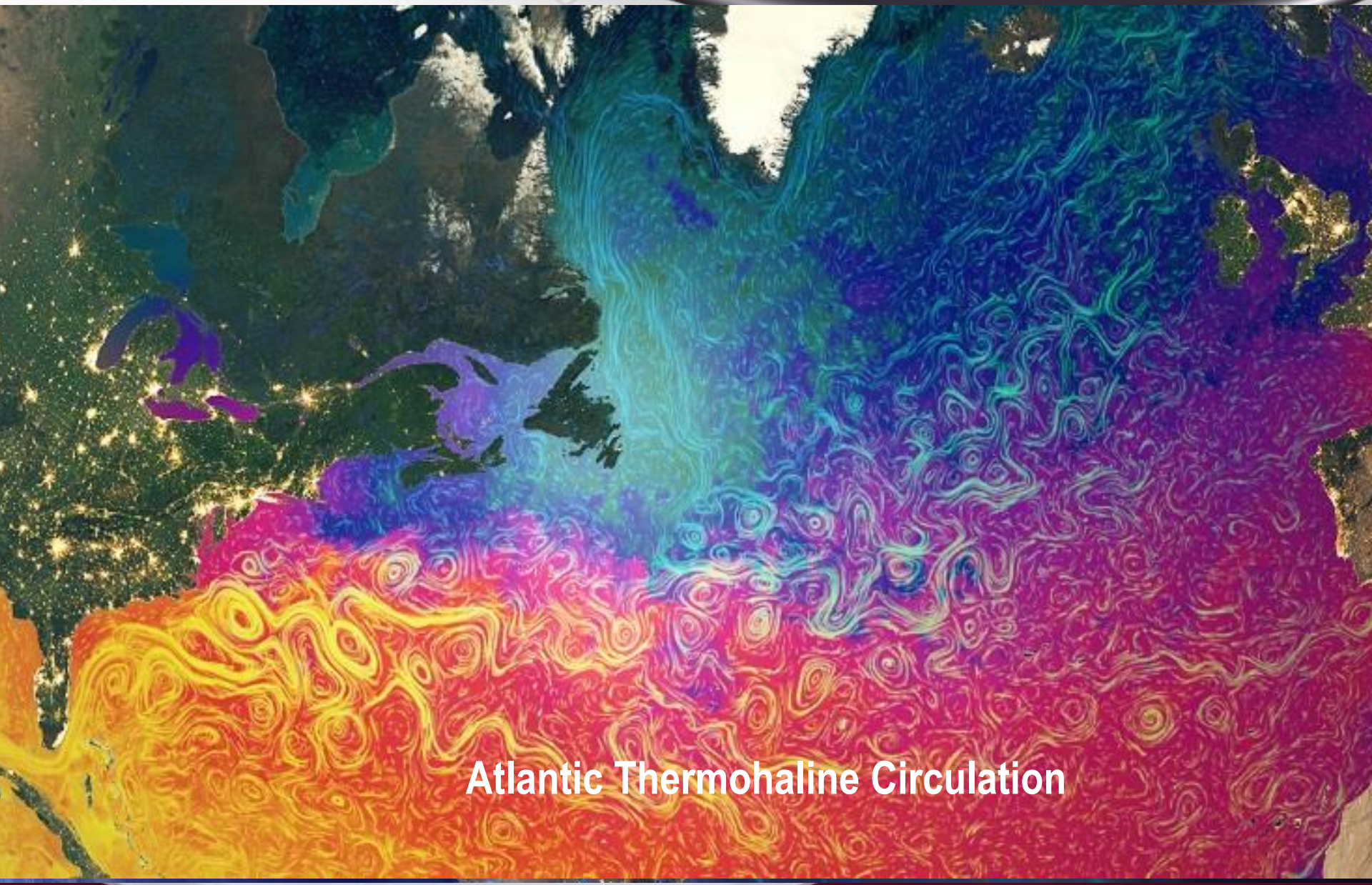
Indian-Summer- may result in more severe rainfall and warmer air that can carry more water. Drastic fluctuations of seasonal patterns.

Sahel-West Africa Monsoons- drying of the Sahel as droughts increase

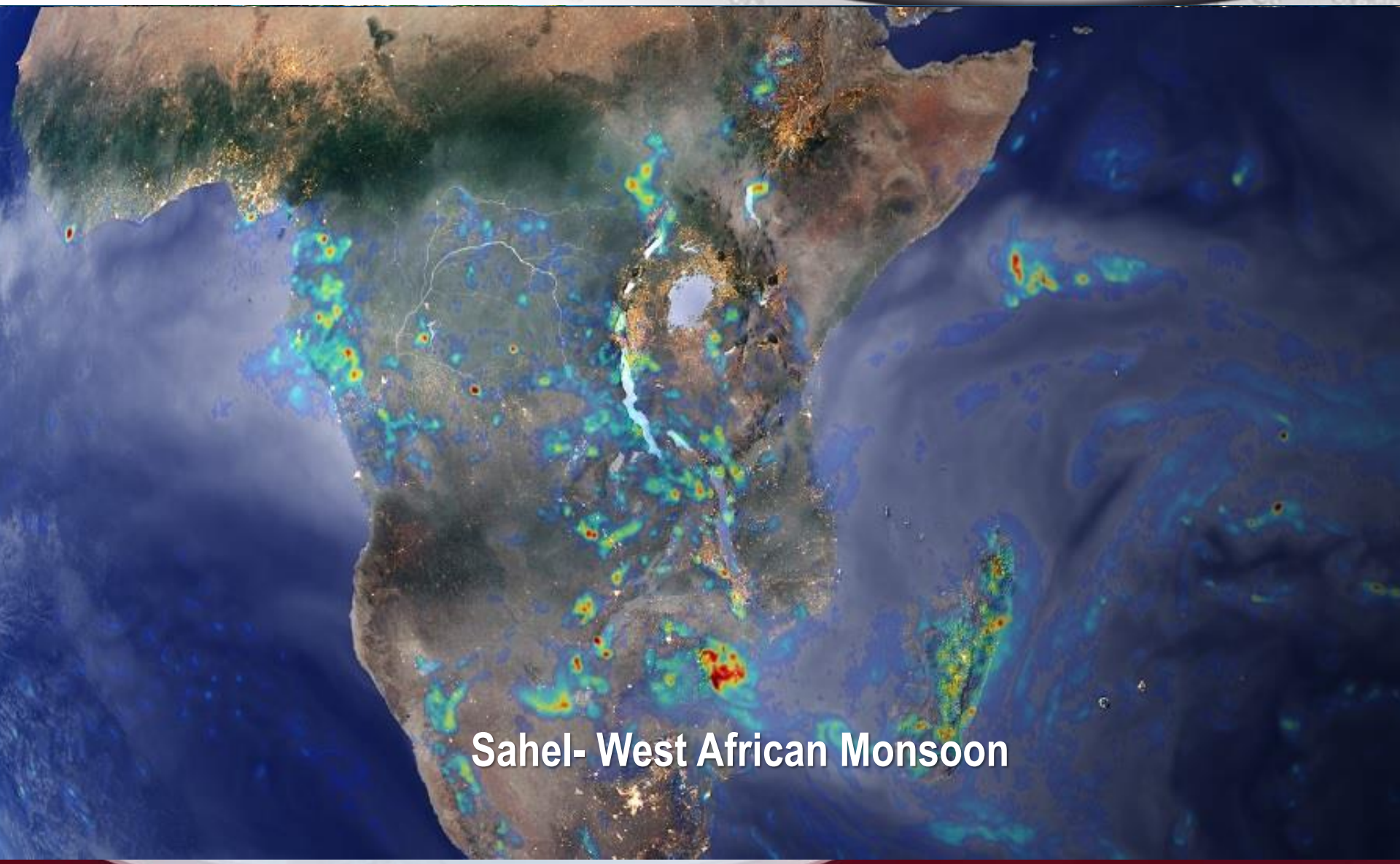
ATC- warming of oceans, changing ocean salinity and currents

Notice anything? Climate and forests are key elements to all of these and tie into the exponential spike I just mentioned. I will discuss these two topics momentarily

Other global threats reaching a tipping point



Other global threats reaching a tipping point



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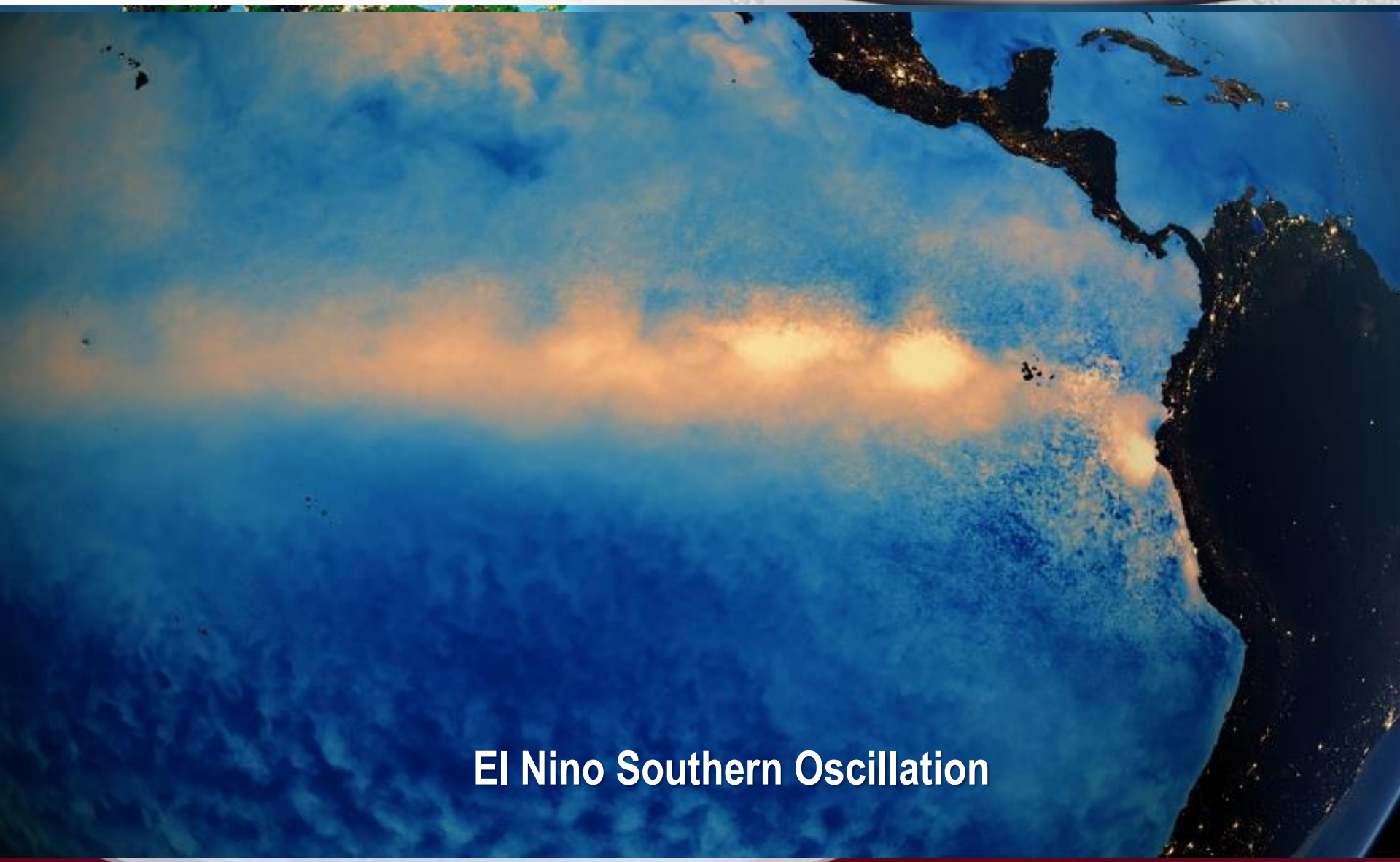

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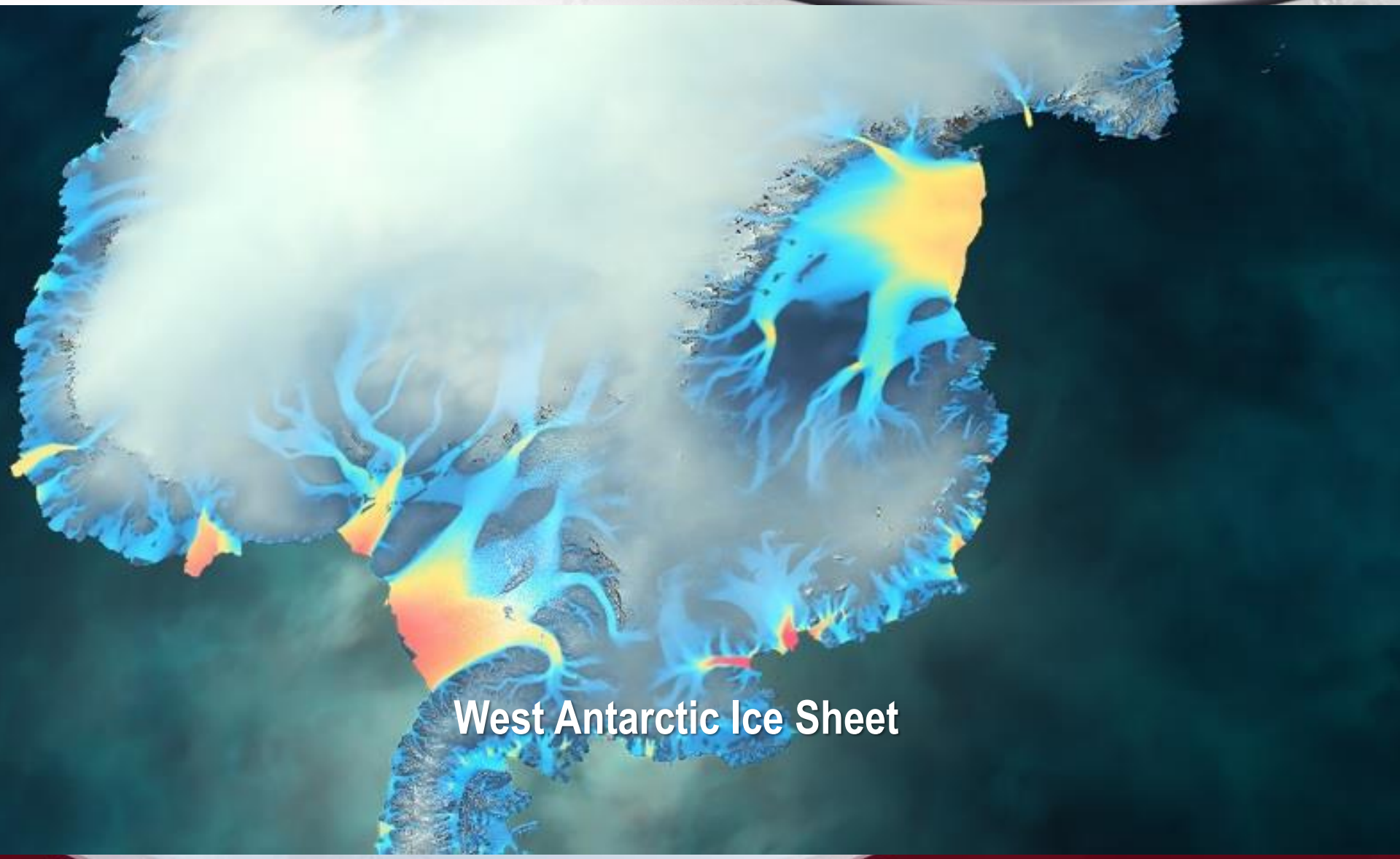


Other global threats reaching a tipping point

How we can approach these threats?

Need for resilience thinking and conservationist thinking which means monitoring the vulnerability from disturbances and interacting systems between humans and nature

A set of principles to build resilience in socio-ecological systems:

- Maintain diversity
- Interdisciplinary connections
- Conservative management
- Education those who do not understand the treats
- Consider all research, large or small scale
- Government acceptance and cooperation by broadening their understanding of the full problem

Example:

Threat-analysis including human and climate-growth relationships for the tulip-poplar in cove forests of the southern Appalachian mountains.

My NSF research preproposal which I will talk about in a couple weeks is a small scale example

How we can approach these threats?

Need for residence thinking and conservationist thinking which means monitoring the vulnerability from disturbances and interacting systems between humans and nature

Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. A resilience thinking approach tries to investigate how these interacting systems of people and nature – or social-ecological systems – can best be managed to ensure a sustainable and resilient supply of the essential ecosystem services on which humanity depends. This is a set of seven principles that are considered crucial for building resilience in social-ecological systems.

Other needs include:

Need for interdisciplinary integration of knowledge across multidisciplinary fields. This has really increased since around the turn of the century

Need for sustainable management of connectivity and focus on maintaining diversity

Limiting alteration of disturbance regimes and which requires the fostering of complex system thinking

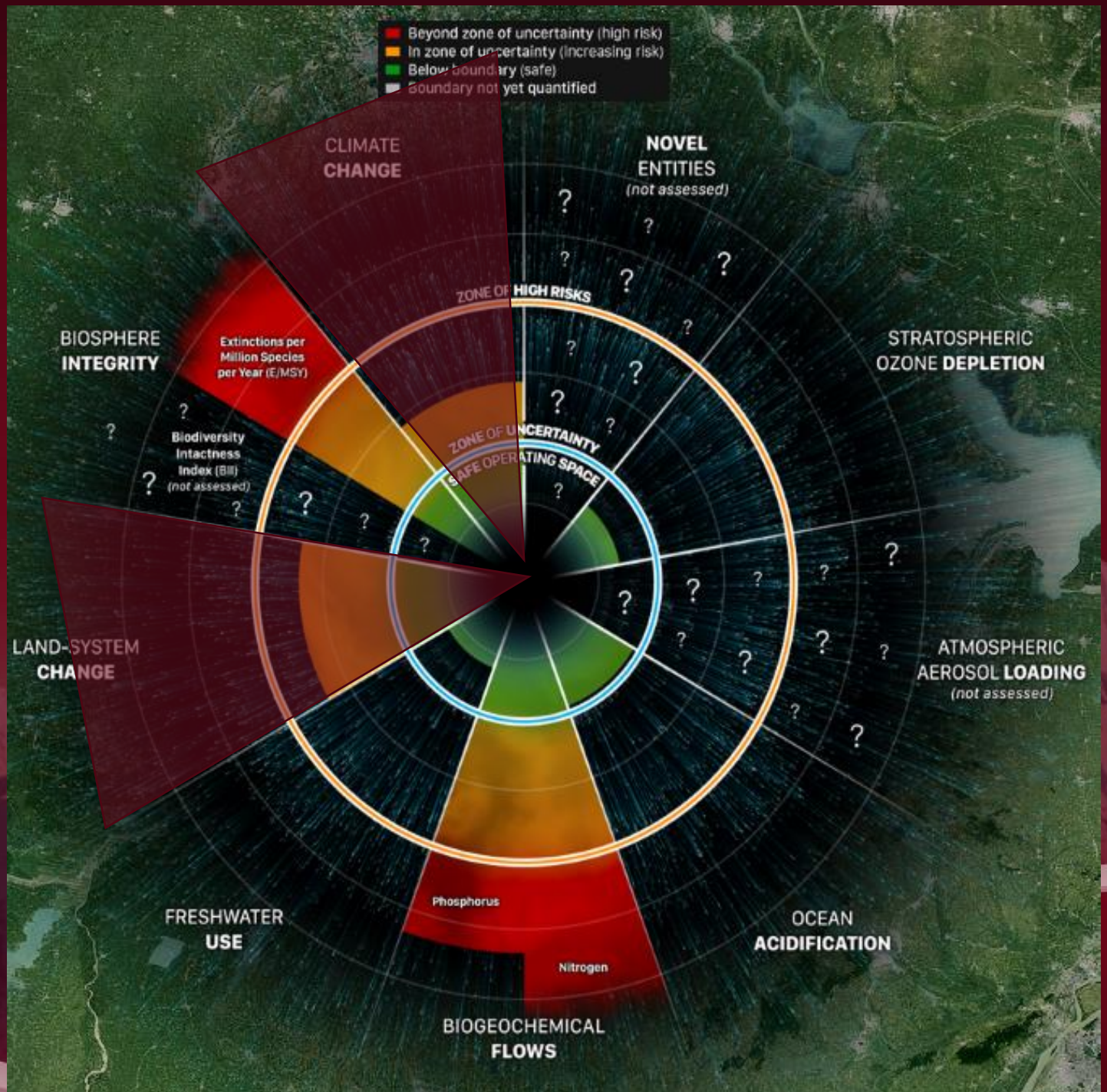
Educate the masses while encouraging learning and acceptance of ideas across different fields

Increased acceptance of the risks by all people and informed of the best actions needed. Be involved in helping the developing world “catch up” without making the mistakes that generations before have made

Bridge the gap between science and policy making and present solutions that lead to a better balance among the prosperity of the planet and its people.

Small scale:

My research idea includes this idea when monitoring the tulip-tree in Appalachia. A so called resilient species that is a key carbon sequester in the eastern US and only found elsewhere in eastern China. Soil composition is susceptible to variations coming from rising temperatures and precipitation changes. Better connectivity among decision makers, the establishment of permanent long-term monitoring plots and sustainable agreement with land developers and timber companies purchasing private lands.


Beyond zone of uncertainty (high risk)
In zone of uncertainty (increasing risk)
Below boundary (safe)
Boundary not yet quantified
CLIMATE CHANGE
NOVEL ENTITIES
(not assessed)
ZONE OF HIGH RISKS
BIOSPHERE INTEGRITY
Extinctions per Million Species per Year (E/MSY)
Biodiversity Intactness Index (BII)
(not assessed)
STRATOSPHERIC OZONE DEPLETION
ZONE OF UNCERTAINTY
SAFE OPERATING SPACE
LAND-SYSTEM CHANGE
ATMOSPHERIC AEROSOL LOADING
(not assessed)
FRESHWATER USE
Phosphorus
Nitrogen
OCEAN ACIDIFICATION
BIOGEOCHEMICAL FLOWS

Novel entities- radioactive or toxic compounds, GMOs, micro-plastics. Long time in environment.
Aerosol loading- mike?
Ocean acidification- Coral Reefs dying from chemical changes in the oceans ph levels. Essentially what we are doing to our atmosphere
Biogeochemical flows- Agricultural usage of nitrogen and phosphates on what we eat and what is absorbed our environment

Two that I will focus on in a minute when discussing the article include:
Significant amount of landscape change including forest to farmland and permanent forest loss to development. Loss of biodiversity

Extreme loss of biodiversity in the last 50 years. Bio In^2 is how one species affects another's population. This change is mostly due to landscape and climate change.
Climate change is directly due to fossil fuel burning and other human activites

Deforestation- Land lost to development or for agricultural purposes (cattle grazing)
Climate change- increased greenhouse gas emissions and ozone depleting CFC's
Population Increase =
Need for energy = burning of fossil fuels/building dams = carbon emissions = rising temperatures
Need for food (agricultural land) & need for land and timber to build = deforestation
Loss of trees (permanently) = less carbon storage potential = more carbon
More carbon emissions and fewer carbon sequesters equals an exponential increase

Discussion

Does your research over-lap between humans and natural systems?

- In other words, is your research topic heavily influenced by human practices? Because it likely is in some way.

What glaring biotic and abiotic factors are at play and at risk?

How does that research relate to the “bigger picture”?

Deforestation and Climate Change

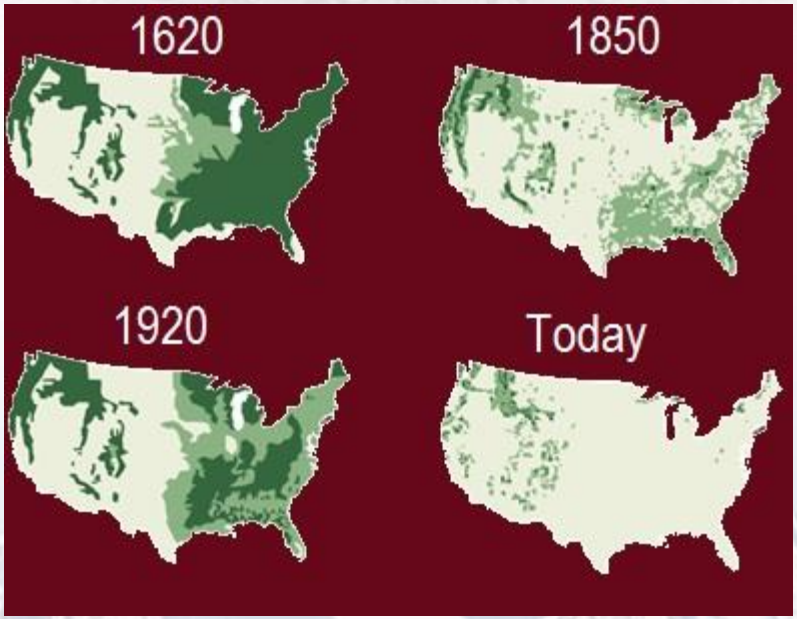
Natural System: Trees grow and die over their lifetime by using carbon captured from the atmosphere to breathe (+)

Human System: Deforestation, logging, mining, urban/residential sprawl, etc. (-)

Natural System: Climate fluctuations over millions of years (+)

Human System: Climate fluctuations over a few generations from energy consumption (-)

These two human systems change the “natural processes” between natural carbon output and uptake by increasing output and decreasing uptake potential.

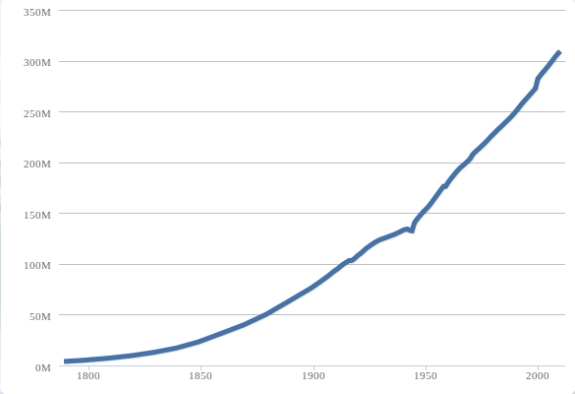


Map of Virgin Forests

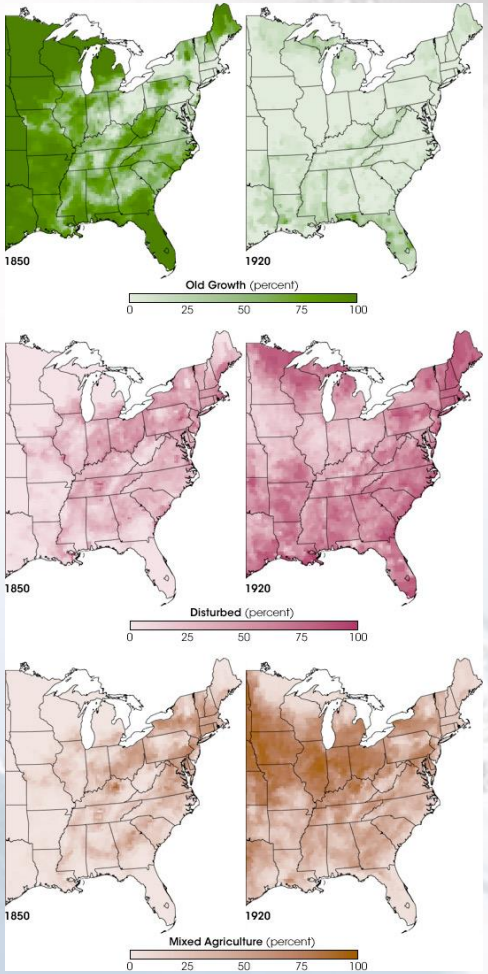
Losing Forest Canopy Cover and Height

	Forest Land	Urban Land
2011	24.4%	5.6%
2006	24.9%	5.5%
2001	25.7%	5.1%
1992	29.2%	2.8%
Change Over Two Decades	≈5% forest loss	≈3% developed land increase

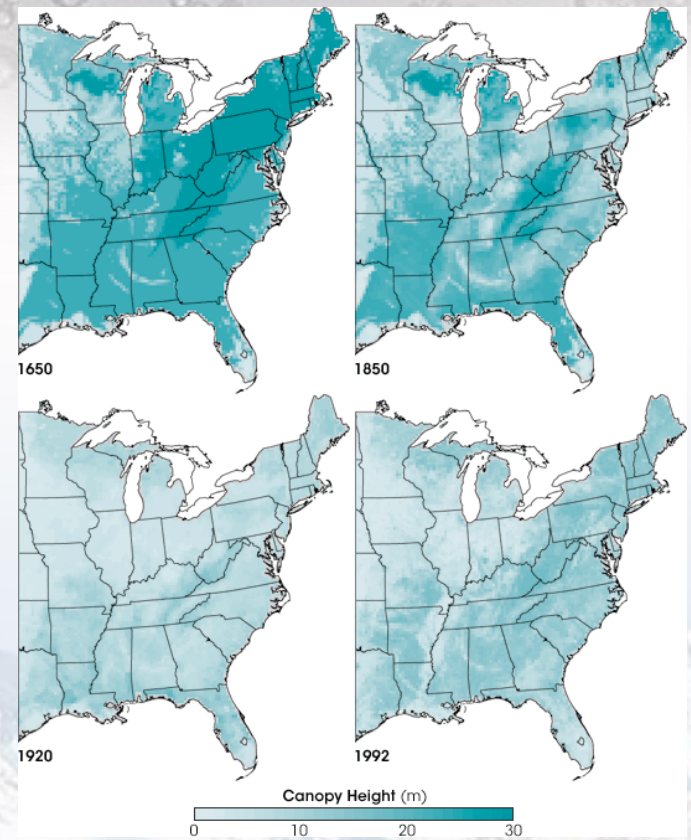
Land Change in US Over Two Decades



Population Change



Land Change



Loss of Old-Growth Since Settlement: Shorter and fewer trees

Article Assigned

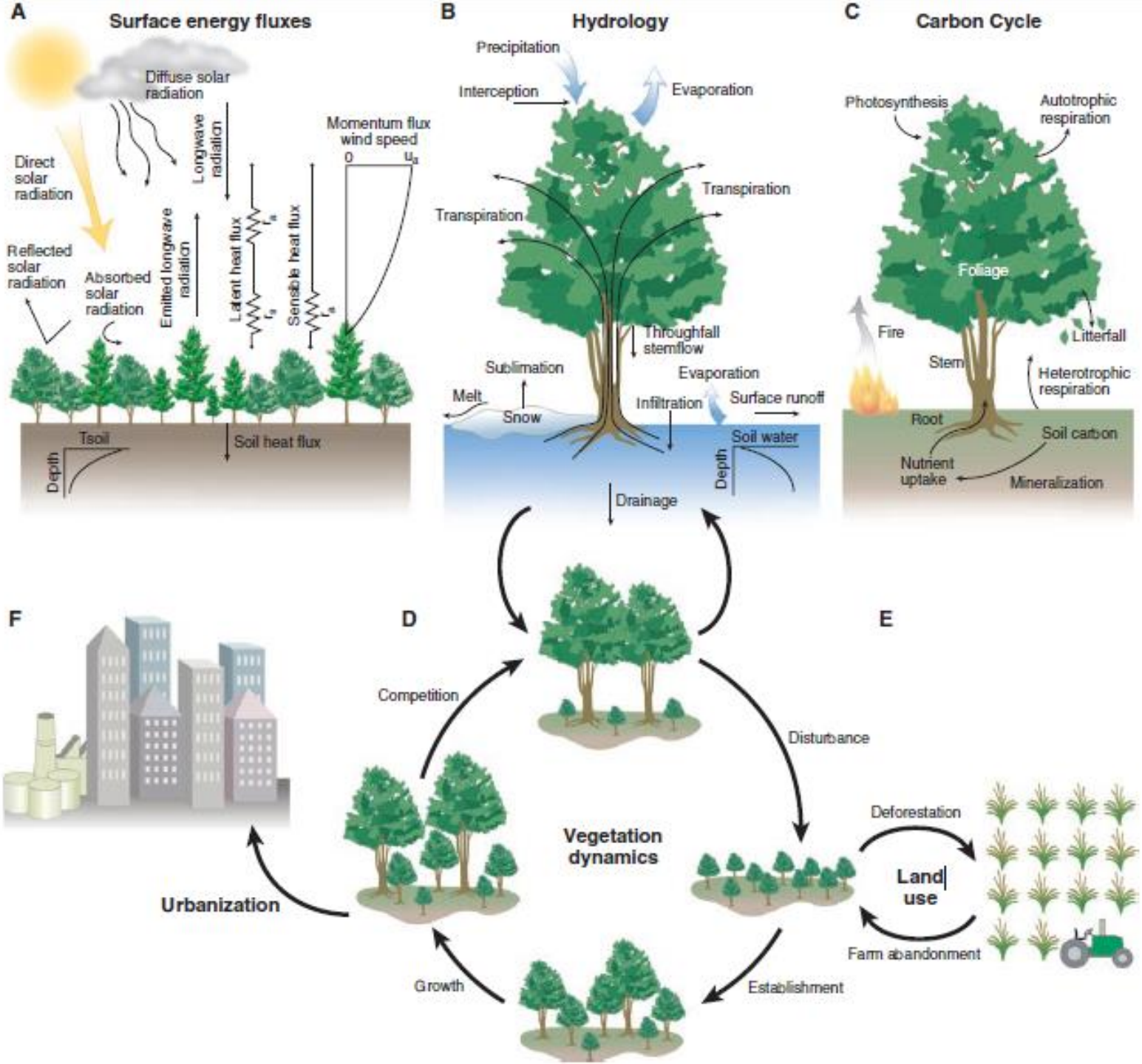
Bonan addresses three key concepts regarding forests and climate:

1. Forest = carbon storage.
2. Low albedo compared to other vegetation types
3. Pump a lot of water into atmosphere acting as a coolant

- *The 3 processes play out differently based on different climate zones and forest types*
- *Much of forested land has been converted to farmland, which is now known to be a large source of anthropocentric emissions*
- *Land needed for human development and agricultural land are primary reasons*

I. Very small scale experiments pumping heat and carbon dioxide around forested areas to measure response, using remote sensing to measure albedo, greenness and surface temperate then compare it at large spatial scales replicate those observations put into a computer model. Similar to what my presentation on spatial resolution tried to explain

II. The net effect of these competing processes is small globally but is large in temperate and high northern latitudes where the cooling due to an increase in surface albedo outweighs the warming due to land-use CO2 emission. Climate trends over the 21st century, too, should


A
Surface energy fluxes
Diffuse solar radiation
Direct solar radiation
Longwave radiation
Momentum flux wind speed
0
u_a
Reflected solar radiation
Absorbed solar radiation
Emitted longwave radiation
Latent heat flux
Sensible heat flux
Tsoil
Depth
Soil heat flux
B
Hydrology
Precipitation
Interception
Evaporation
Transpiration
Transpiration
Throughfall stemflow
Sublimation
Evaporation
Melt
Snow
Infiltration
Surface runoff
Soil water
Depth
Drainage
C
Carbon Cycle
Photosynthesis
Autotrophic respiration
Foliage
Fire
Litterfall
Stem
Heterotrophic respiration
Root
Soil carbon
Nutrient uptake
Mineralization
F
D
E
Competition
Disturbance
Deforestation
Vegetation dynamics
Land use
Urbanization
Farm abandonment
Growth
Establishment

The current generation of climate models treats the biosphere and atmosphere as a coupled system. Land surface parameterizations represent
the biogeophysics, biogeochemistry, and biogeography of terrestrial ecosystems. (A) Surface energy fluxes and (B) the hydrologic cycle. These are the core biogeophysical processes. Many models also include (C) the carbon cycle and (D) vegetation dynamics so that plant ecosystems respond to
climate change. Some models also include (E) land use and (F) urbanization to
represent human alteration of the biosphere.

Gordon Bonan

Biogeography/Bioclimatology

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M.S., Forest Resources, University of Georgia, 1984
B.A., Environmental Sciences, University of Virginia, 1982

- American Geophysical Union fellow -"For highly influential work on the coupling of terrestrial ecosystems with the atmosphere and feedbacks with climate change"
- Science Magazine publication "Forests in Flux" (essentially the one you read)
- Written numerous articles on linking climate to terrestrial ecosystems
  - Land use, land change, atmospheric sciences and climate change, biogeochemical fluctuations, human disturbance, "***experimentation with coupled models of Earth's biosphere, atmosphere, hydrosphere, and geosphere system***" – Bonan

Conclusion

Must safeguard ecosystems!

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