

Understanding Earth Surface Processes: A Landscape Perspective

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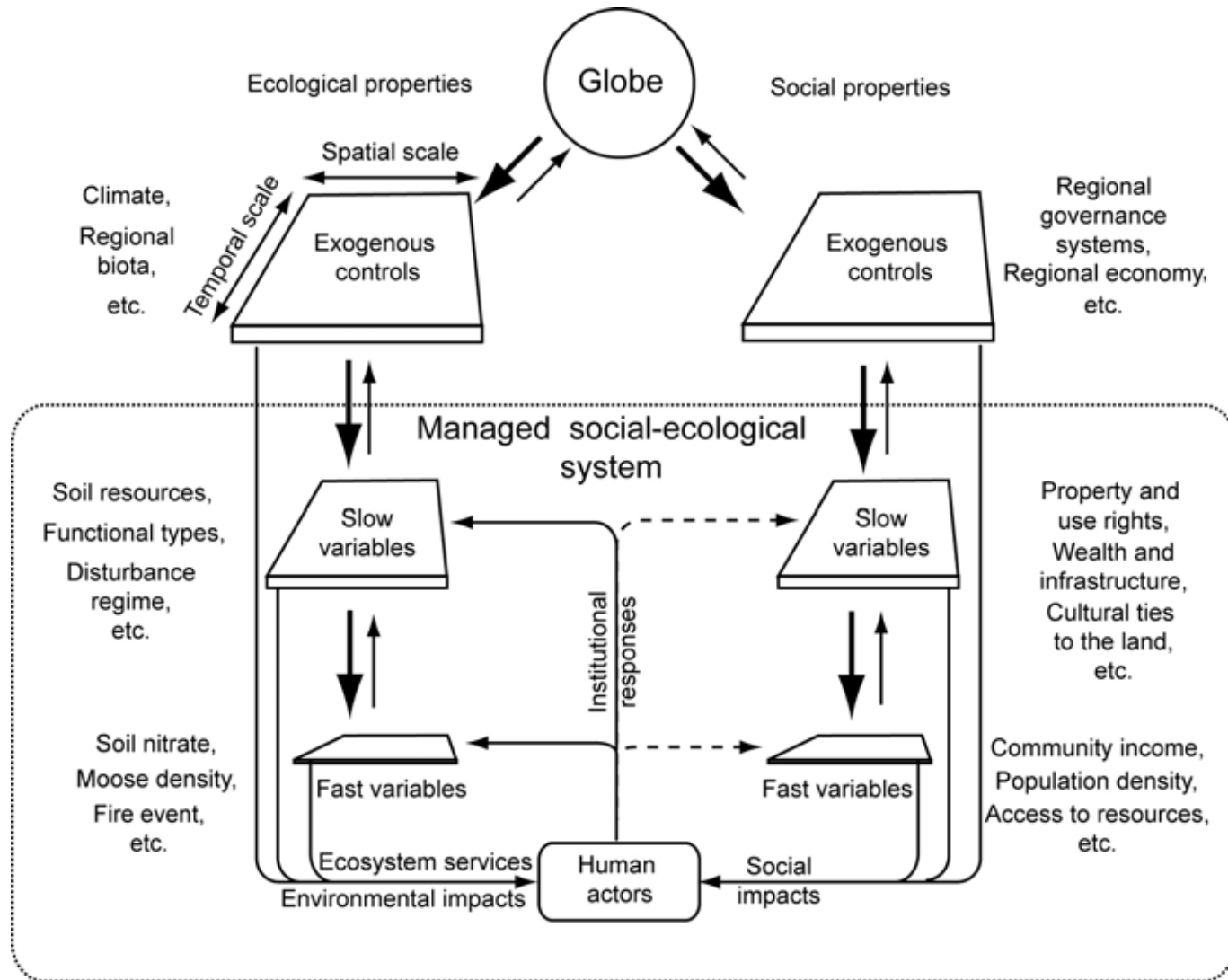
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What are the critical earth surface processes?

- Instantaneous fluxes
- Slow variables that govern these fluxes
- Altered controls over slow variables and fluxes
 - Especially human actions

If exogenous controls change substantially, social-ecological systems will inevitably change



What are critical earth surface processes?

- Instantaneous fluxes
 - Land-atmosphere fluxes
 - Water, energy, trace gases
 - Land-ocean fluxes
 - Water, nutrient runoff
 - Fish harvest that alters marine foodwebs
 - Redistribution
 - e.g., latitudinal ocean heat transport
 - Urban-rural food and waste transport

What are critical earth surface processes?

- Instantaneous fluxes
- Slow variables that govern these fluxes
 - Δ Cryosphere (sea ice and snow cover)
 - Δ Disturbance regime (wildfire)
 - Δ Land use
 - Δ Intensity of land/ocean use

**Annual area burned in W. North
America has doubled
in last 40 years**



**Fire slows the warming
of climate**

**More solar radiation
reflected**

**Less heat transferred
to atmosphere**



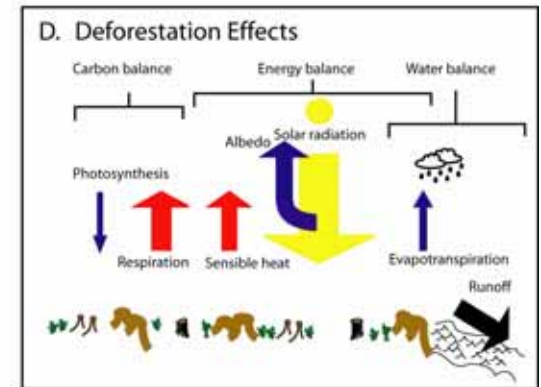
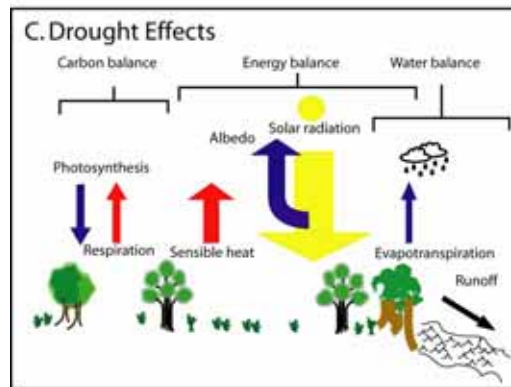
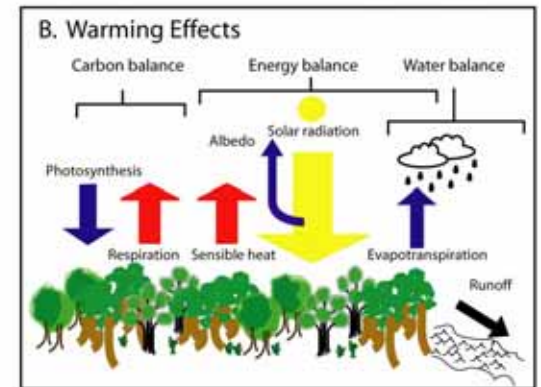
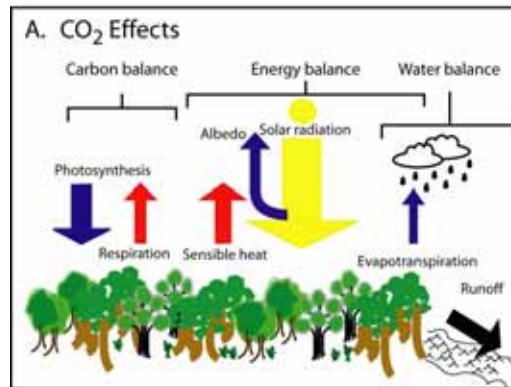
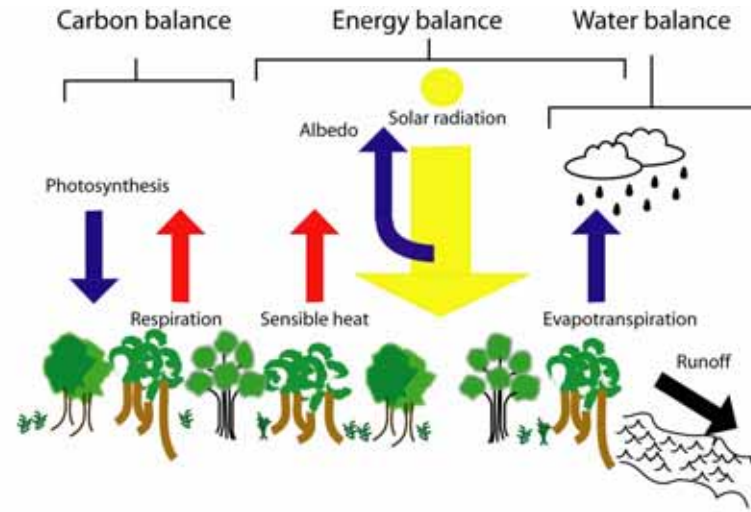
What are critical earth surface processes?

- Instantaneous fluxes
- Slow variables that govern these fluxes
- Altered controls over slow variables
 - Increasing consumption
 - Trade globalization
 - Feedbacks from climate change
 - Melting sea ice, ocean acidification, saturation of terrestrial carbon sink
 - etc.

Three Significant Advances

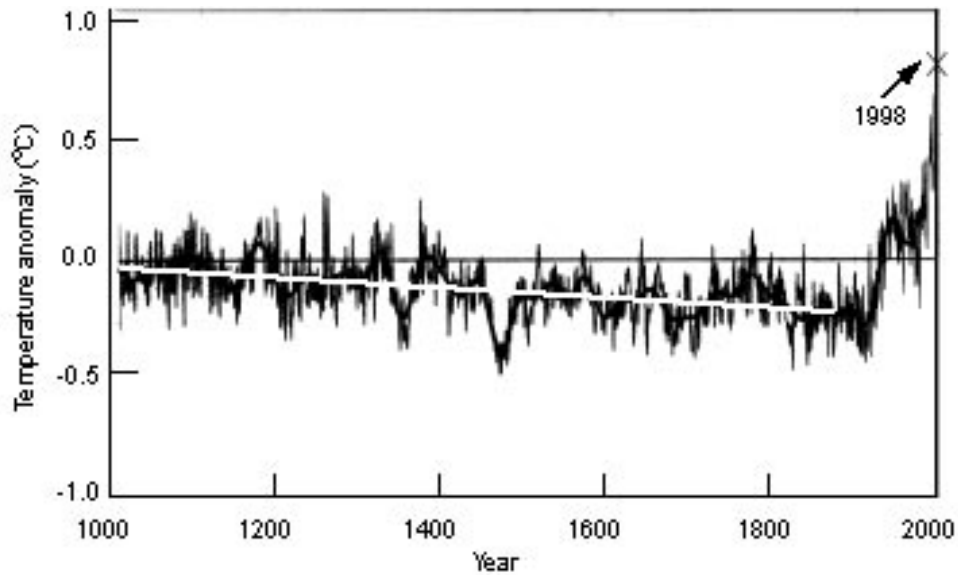
- Coupled nature of feedbacks
- Increased recognition of non-linearities, time lags, and hysteresis
- Recognition of human impacts on global system (Anthropocene Epoch)

Changes in land-atmosphere coupling



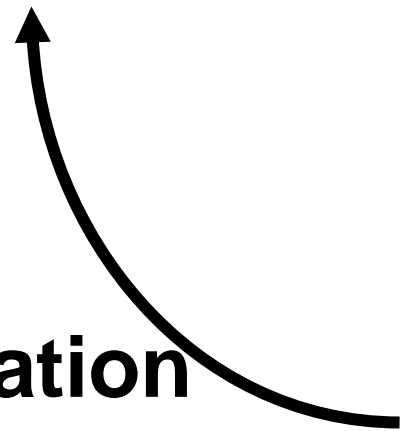
Four Key Challenges for 2020

- Quantify coupled climate feedbacks
- Boundary conditions for global tipping points
- Human actions as explicit component of global models
- Explicit analysis of cross-scale interactions

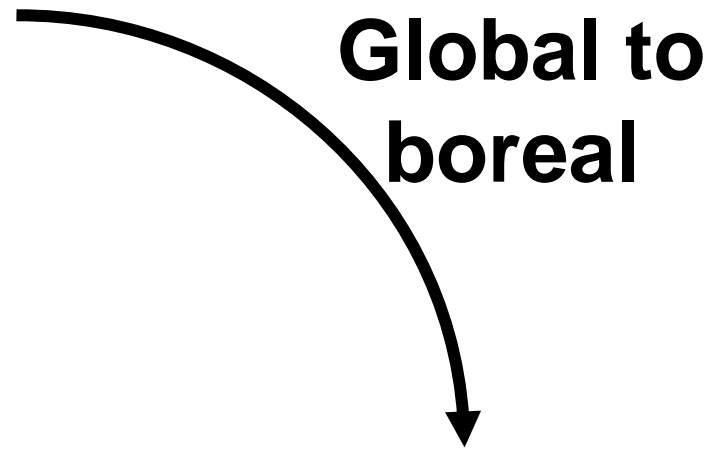


Mann et al.

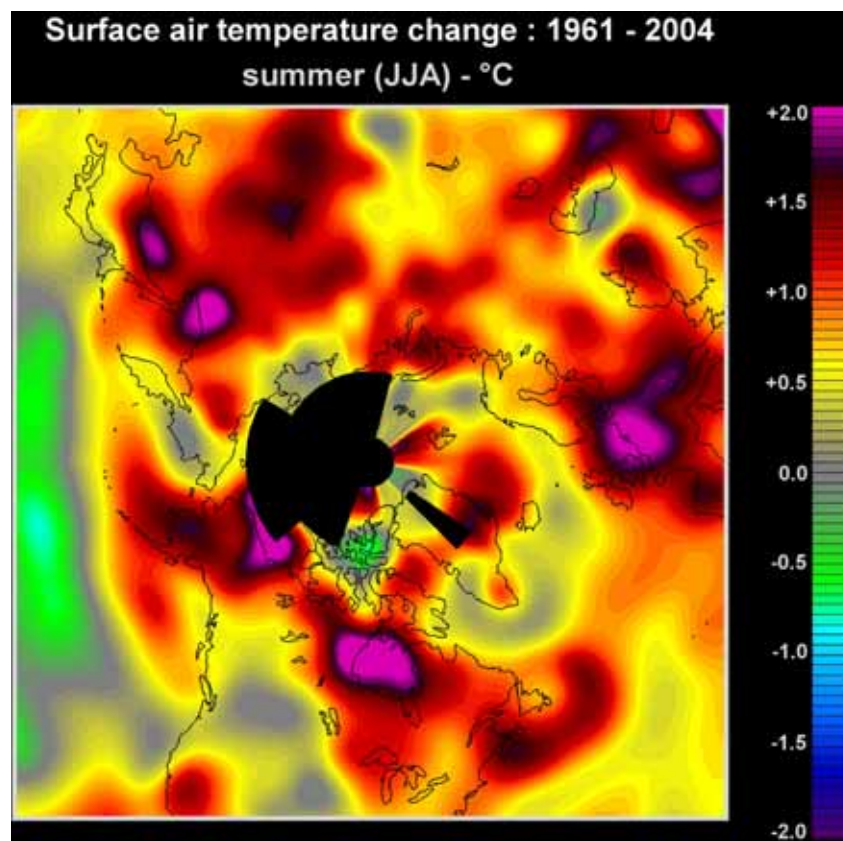
Polar amplification



Chapin et al. 2005



Global to boreal



**Thawing permafrost could increase CO₂/CH₄ release
(potential surprise:
more warming)**



Key collaborations needed

- Explicit incorporation of human dimensions in biophysical research
- Easy sharing of imagery, data, model projections, and model platforms
- Convey policy-relevant projections to policy makers *now*
 - Incorporate policy options in research design

Implementation mechanisms

- Supplement research awards that stimulate science implementation
- Insulate science priorities from political pressures
- Facilitate cross-agency co-funding of important research priorities