Why complexity?
Desai et al., 2010, JGR-G
Ecosystem Ecology

• Ecosystem: Bounded ecological system of organisms (biotic) and their environment (abiotic) that interact or function together

• Structure and function of ecosystems
  – Structure: organization: physical, community, diversity
  – Function: Energy, carbon, nutrient cycling

• Biomes: Climatically or geographically defined area of ecologically similar conditions
  – Leading to dominance of certain types of ecosystems that have evolved to succeed (successfully reproduce) within a particular climate or geographic niche
In regions having the ranges indicated within the red dashed lines, other factors—such as seasonality of drought, fire, and grazing—strongly affect which biome is present.
a) Global ecosystem

How does carbon loss from plowed soils influence global climate?

b) Watershed

How does deforestation influence the water supply to neighboring towns?

c) Forest ecosystem

How does acid rain influence forest productivity?

d) Endolithic ecosystem

What are the biological controls over rock weathering?
Nemani, 2003, Science
Why terrain?
Precipitation in the US
Rain Shadow
Slope winds

(a) Downslope Wind
- Height: 10-40 m
- Temperature: -4°C
- Wind: 1-3 m, 1-4 m/s

(b) Upslope Wind
- Height: 50-150 m
- Temperature: +4°C
- Wind: 10-20 m, 1-5 m/s
Canopy + Terrain
Cold Air Damming
Waves and Rotors

- Lenticular clouds
- Lee wave region
- Cap cloud
- Roll clouds
- Rotors
Monsoon Flow

- Strong solar radiation
- Low pressure
- Hot land surface
- Summer monsoon
- High pressure: cooler ocean
Monsoon Flow

Weak solar radiation

High pressure

Cold land surface

Low pressure: warmer ocean

Winter monsoon
http://redbuttecanyon.net/ecology.html
Western US Closeup
• Desai et al., 2011 JGR-G
500 hPa heights
Does complexity matter?

• Depends on the question you are asking

• Here we are interested in questions about scaling magnitudes of fluxes and processes/drivers

• We investigated the global scale problem and then spent time in the field and lab to understand methods for scaling, sampling, and modeling with chambers, towers, remote sensing, Bayesian inverse methods, and climate models in complex terrain at plot (chambers, greenhouse, spectral) to ecosystem (flux towers) to landscape scale (airborne, models)
Know thy site*

*Ray Leuning
Know thy scale
Know thy bottom-up and top-down methods, observation tools, model assumptions, and experiments
Be a scientist!
Thanks!