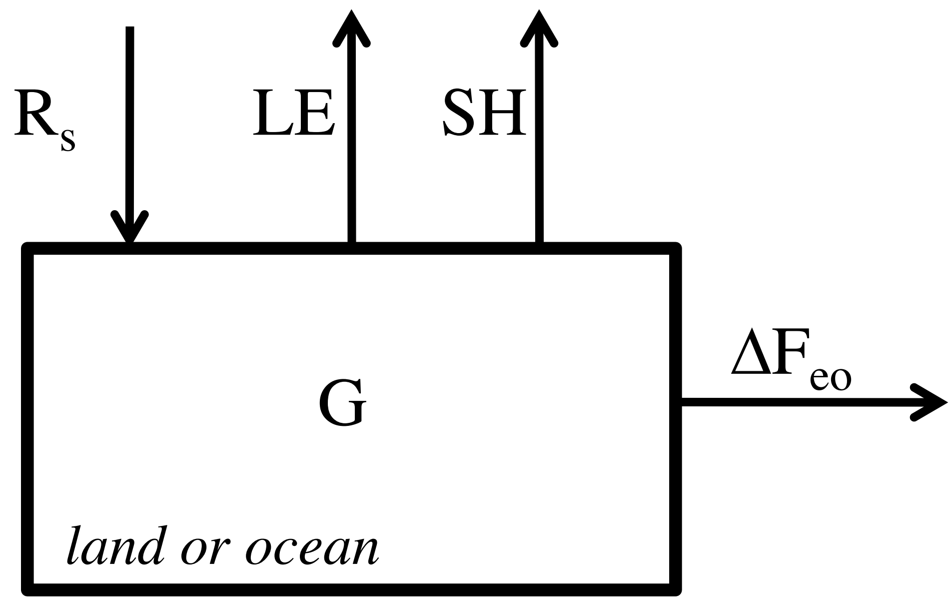
Plants and the terrestrial surface energy balance

Or: Why you should take AOS520

Ankur R Desai

Energy Balance of the Surface

- Apply first law of thermo to the surface (as opposed to atmosphere)
- G = Storage = d(Surface Energy)/dt = dE_s/dt
- R_N = Net Radiation
  = SW-LW
- LE = Latent
- SH = Sensible
- ΔF_{eo} = Transport

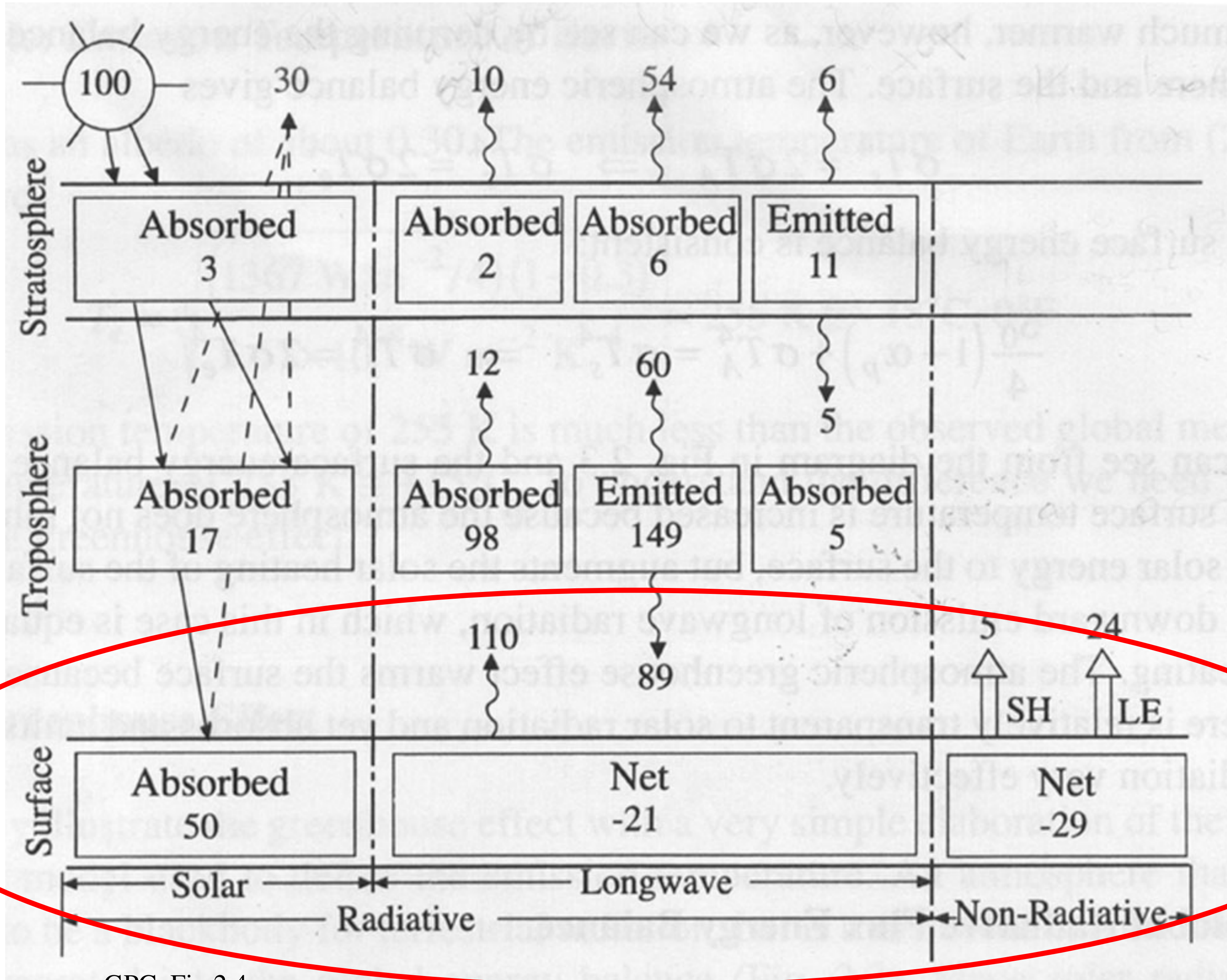


BALANCE EQUATION

$$G = R_N - LE - SH - \Delta F_{eo}$$

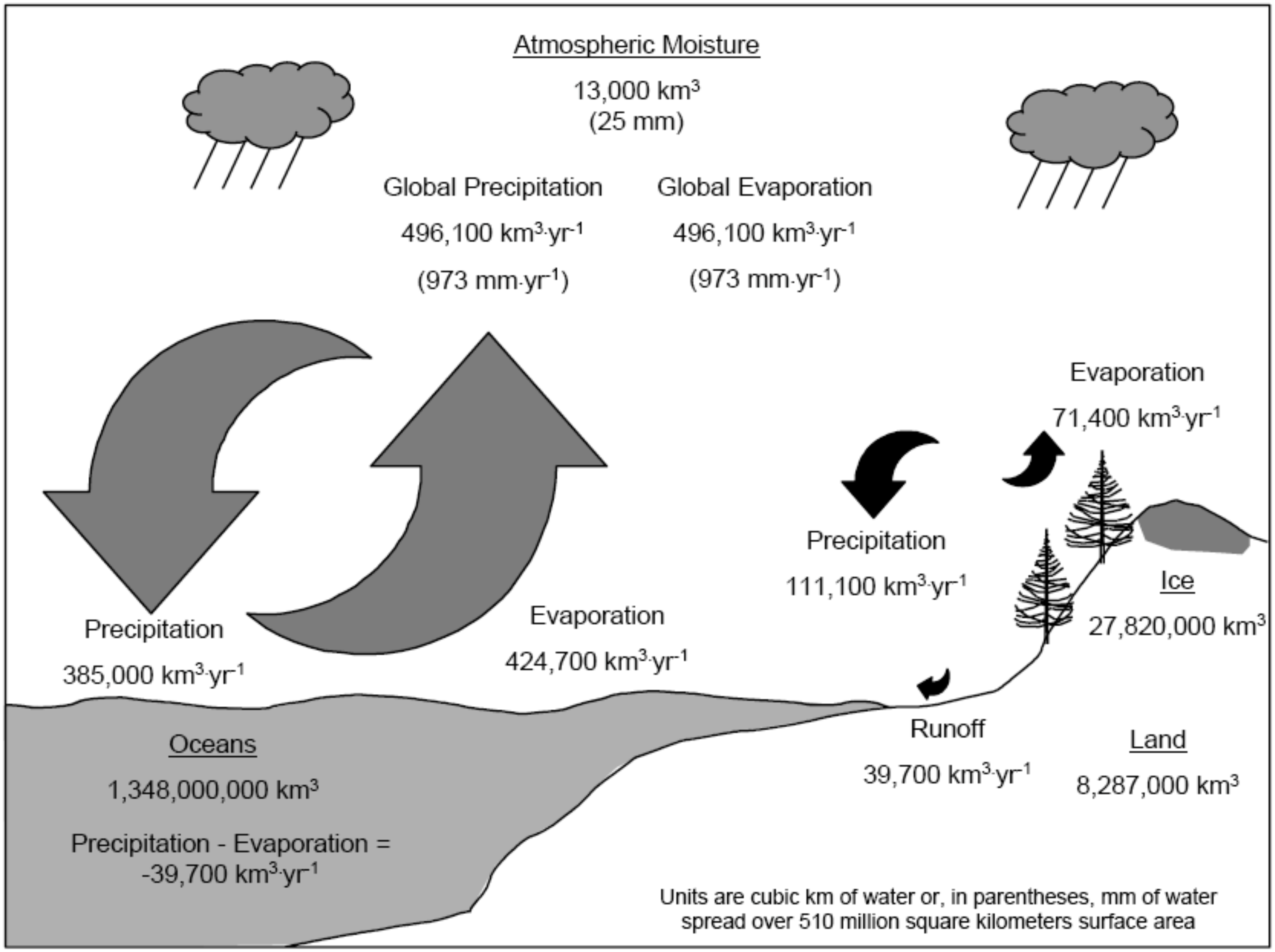
Global Energy Flow

100 = 342 W/m^2

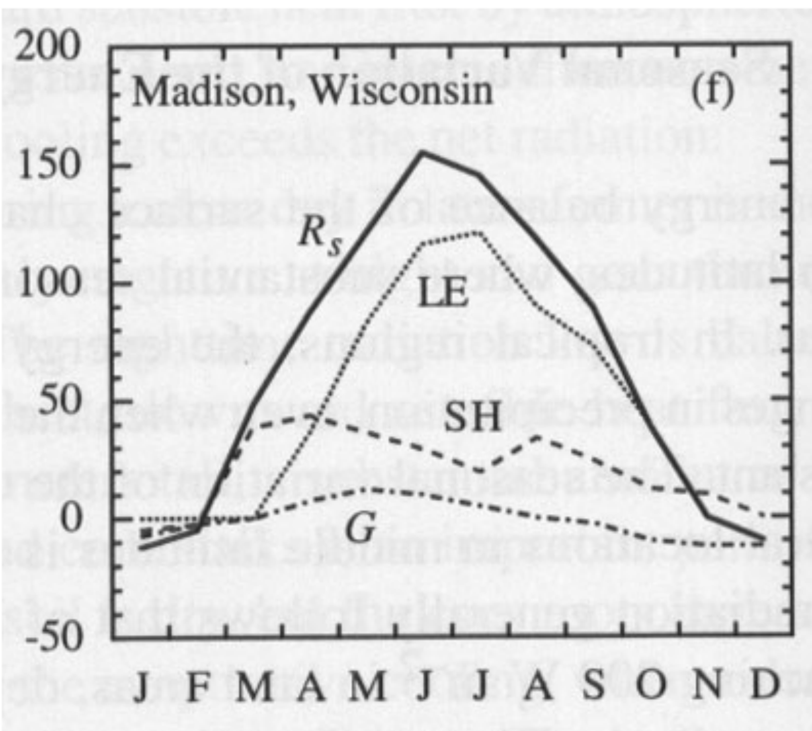


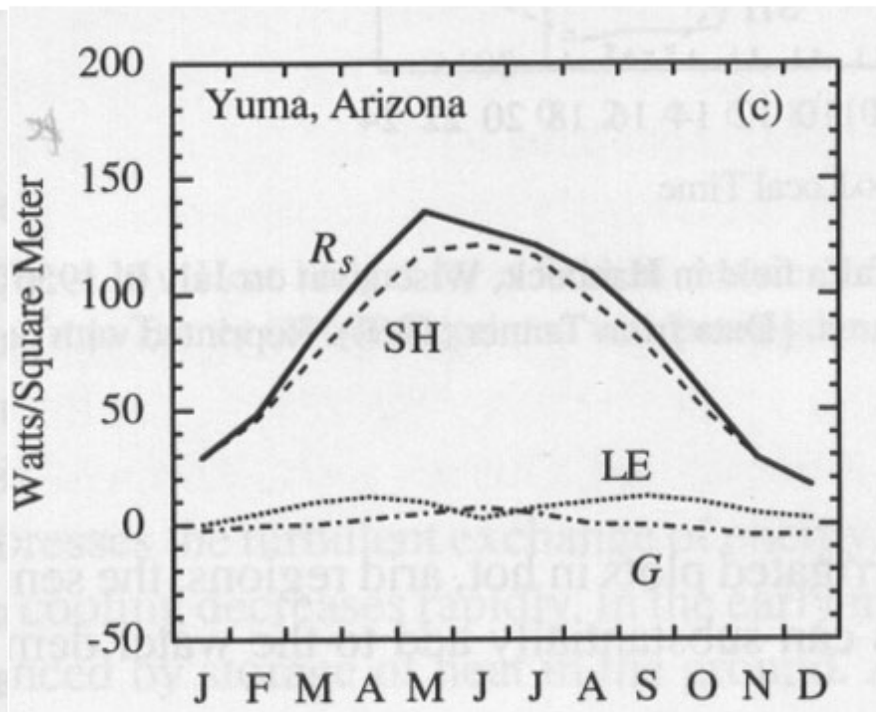
GPC, Fig 2.4

Hydrology: Global



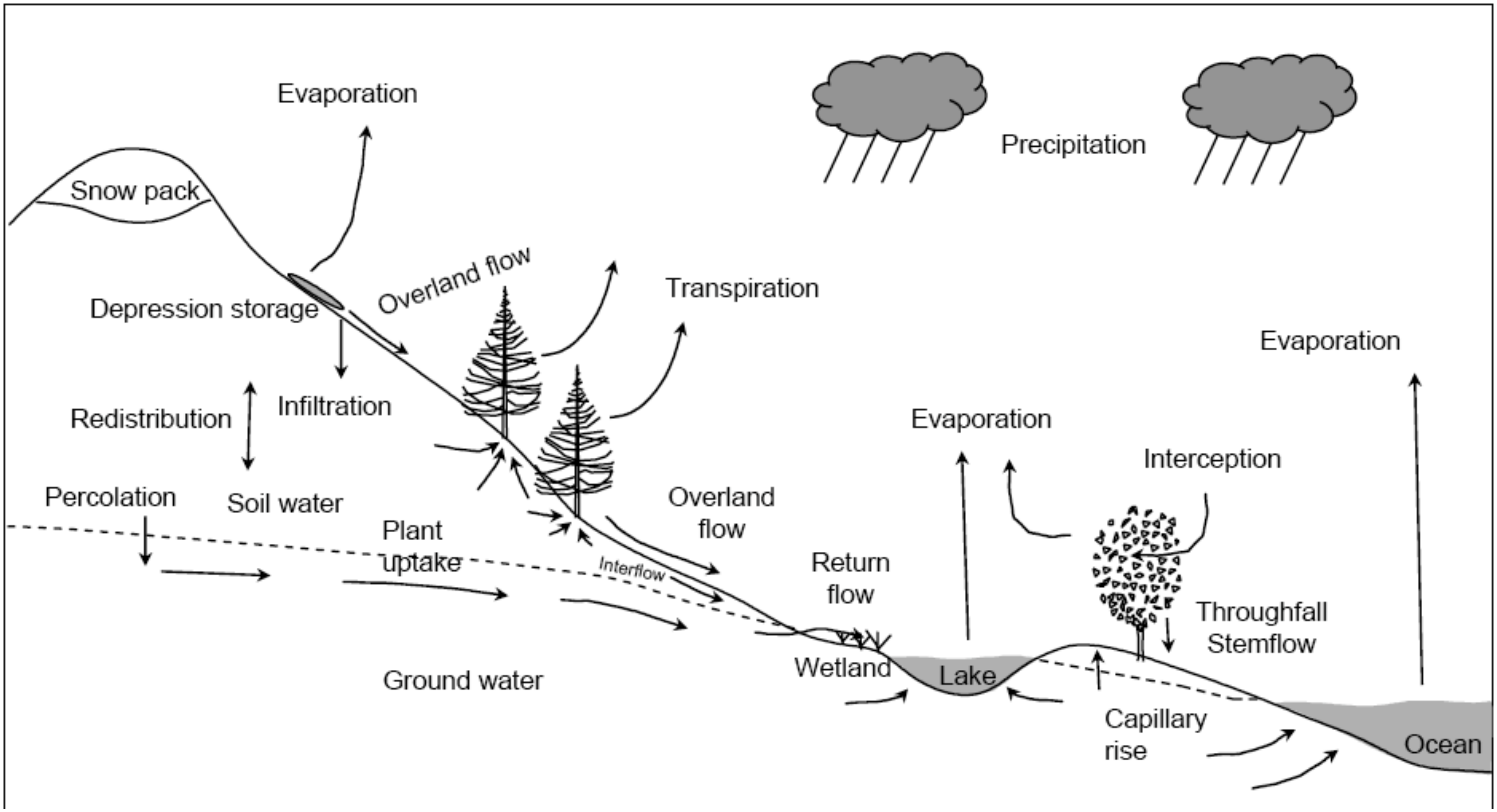
Seasonal:
Madison vs. Arizona desert
$G = R_N - LE - SH - \Delta F_{eo}$



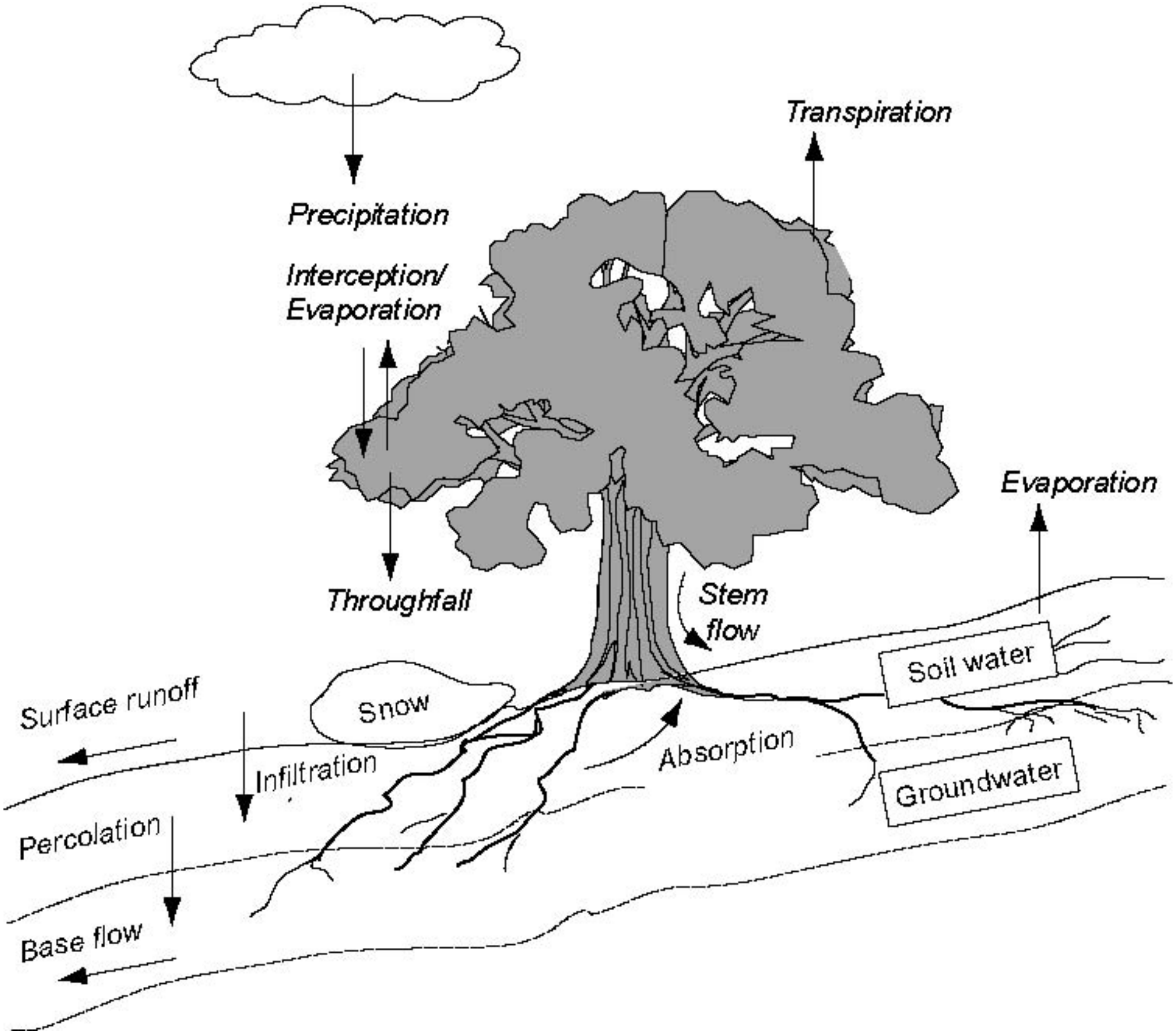


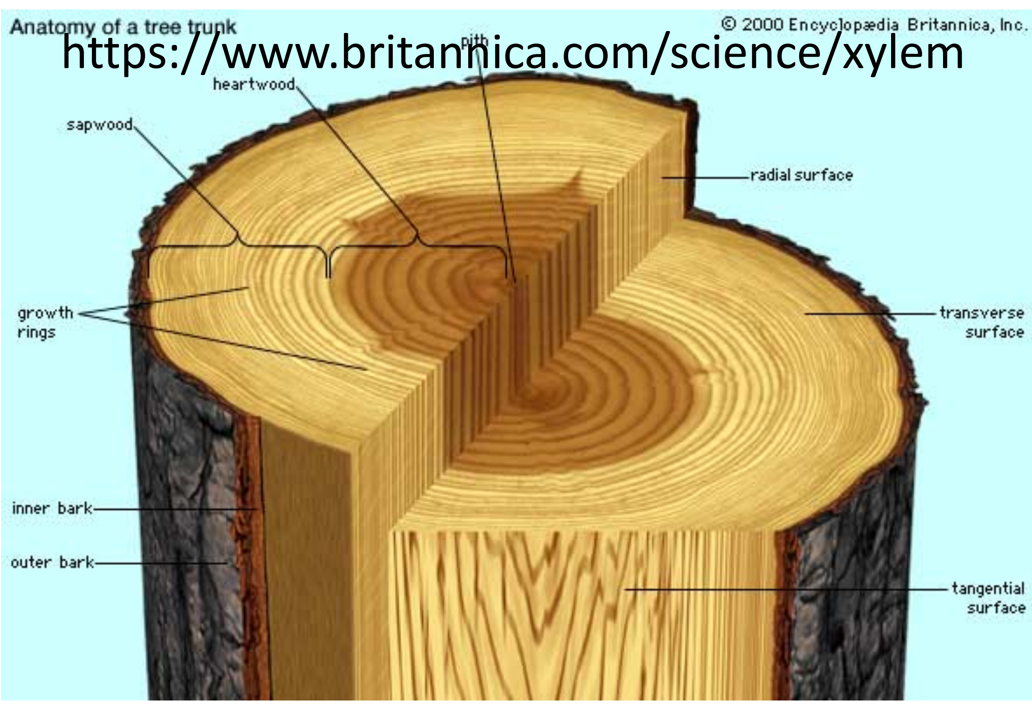
GPC, Fig 4.16 (c,f)

Hydrology: Terrestrial

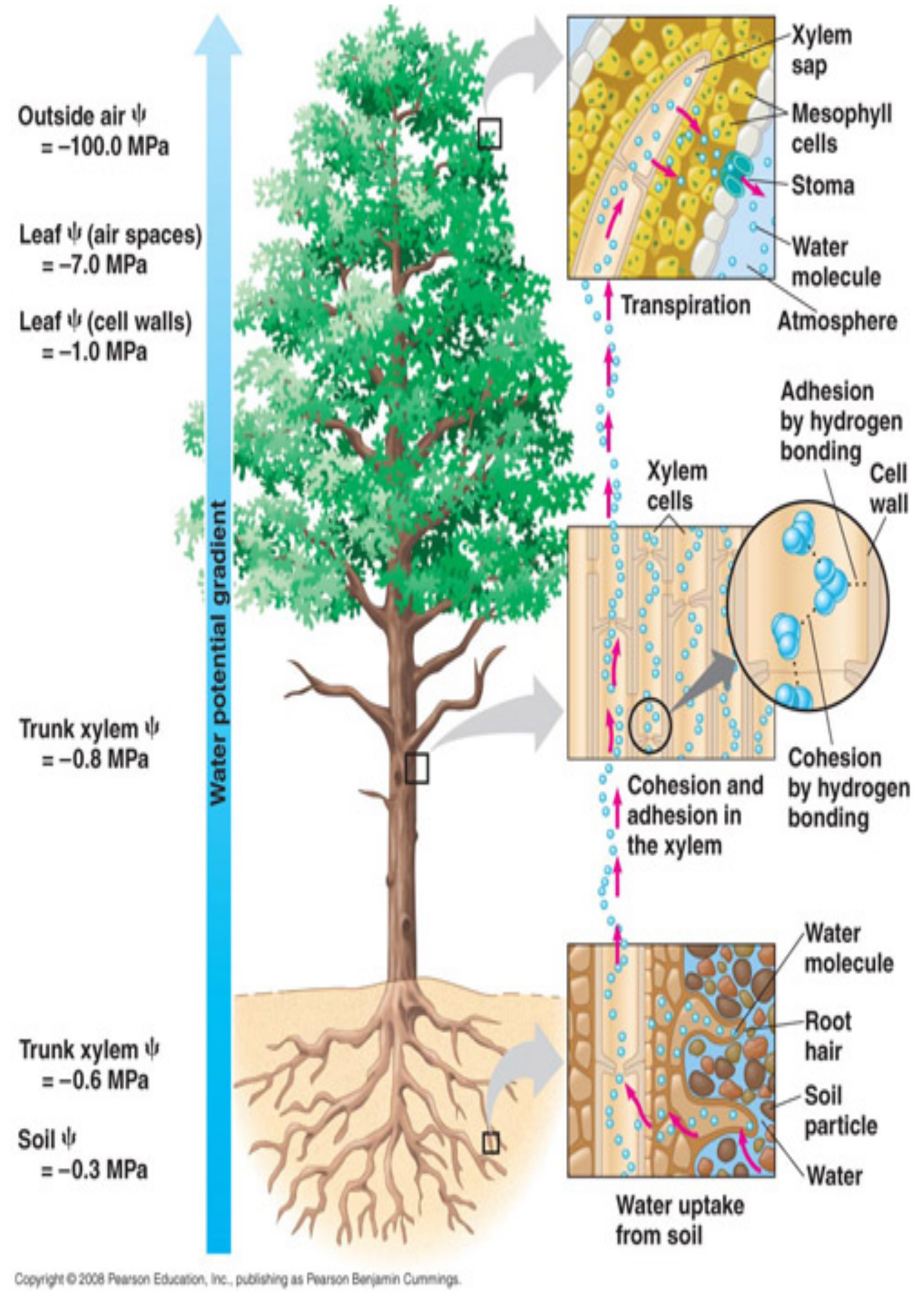


Hydrology: Canopy





https://www.britannica.com/science/xylem



http://www.bio.miami.edu/dana/pix/xylem_sap_ascent.jpg

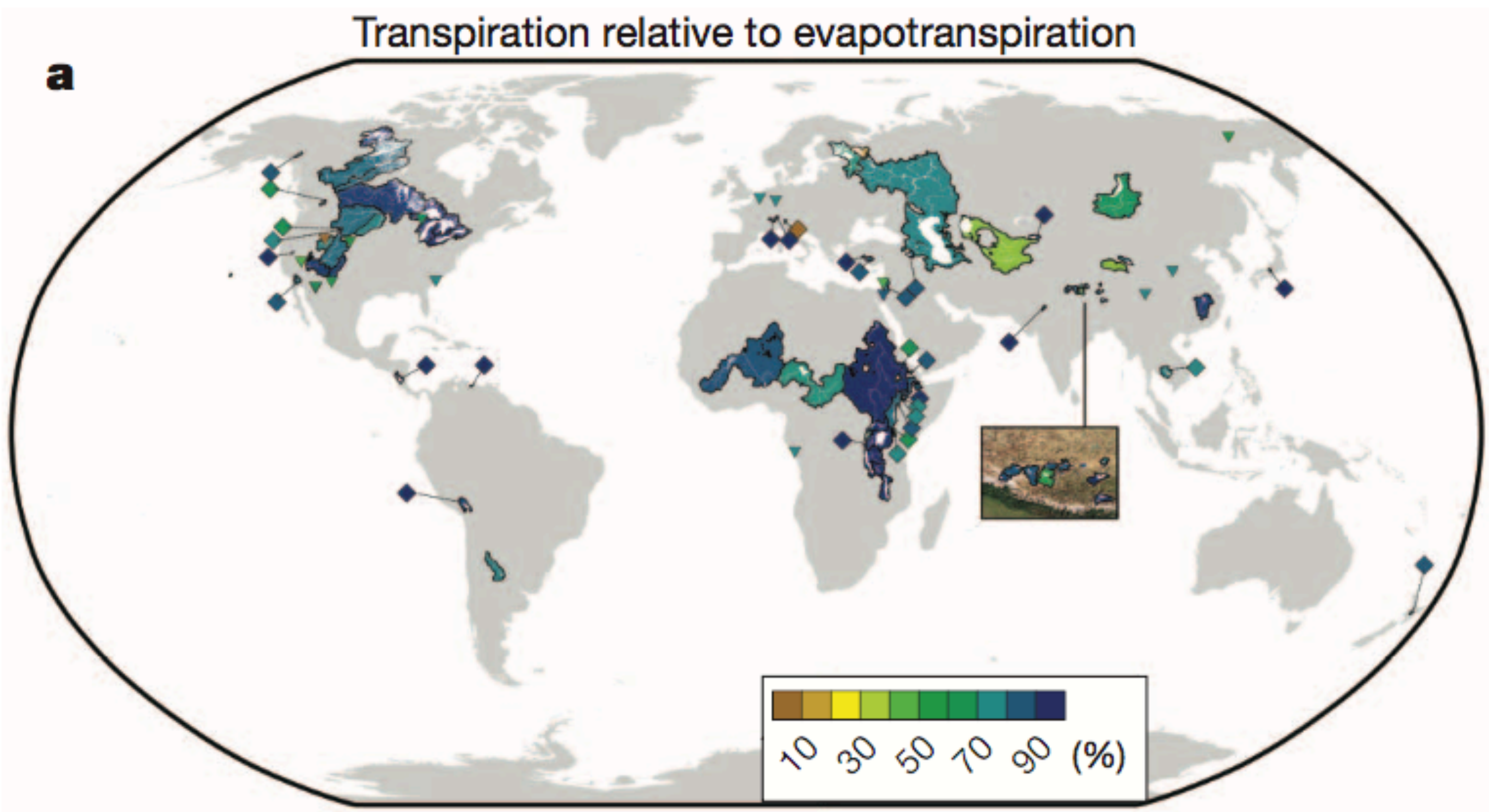
Litvak et al., in press

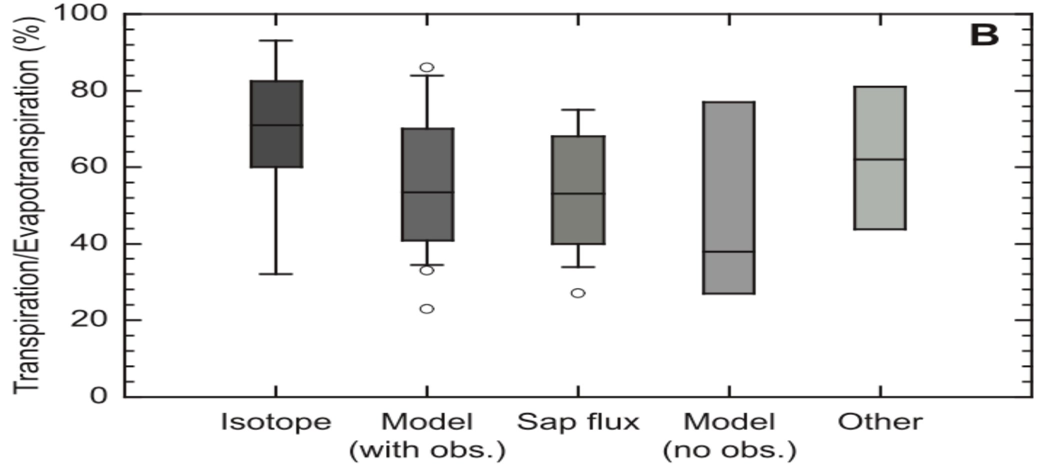
LETTER

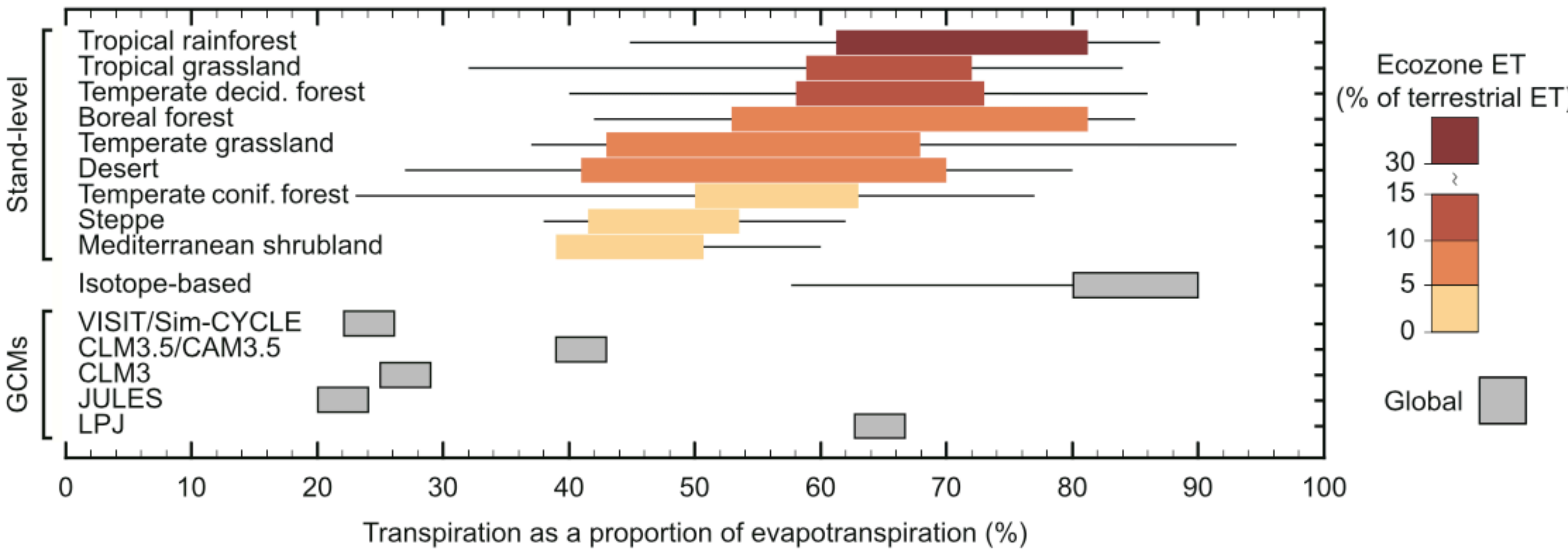
doi:10.1038/nature11983

Terrestrial water fluxes dominated by transpiration

Scott Jasechko[1], Zachary D. Sharp[1], John J. Gibson[2,3], S. Jean Birks[2,4], Yi Yi[2,3] & Peter J. Fawcett[1]





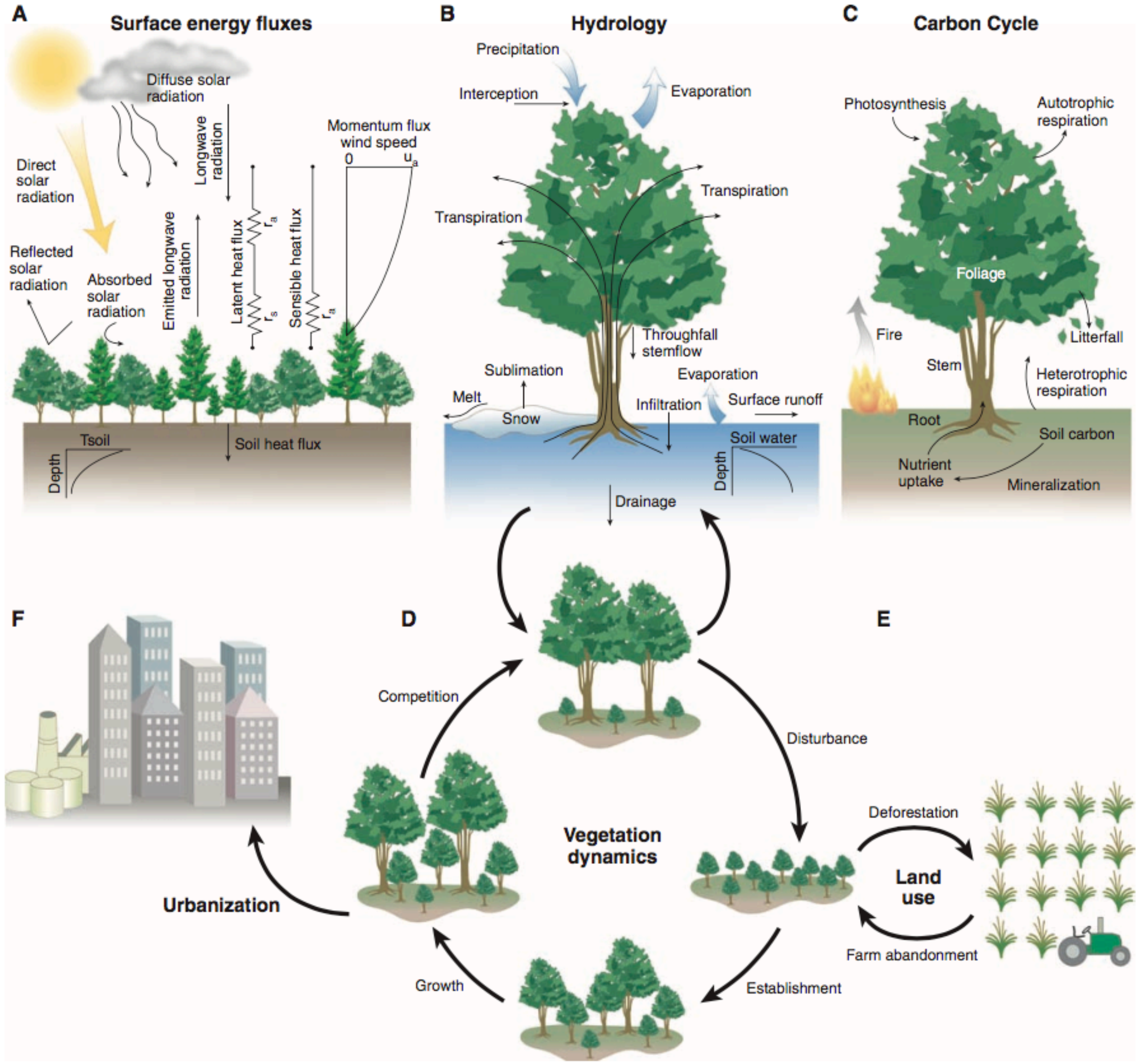


Short communication

Transpiration in the global water cycle

William H. Schlesinger[a,*], Scott Jasechko[b]

[a] *Cary Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, United States*
[b] *Department of Earth and Planetary Sciences, University of New Mexico Albuquerque, NM 87131, United States*

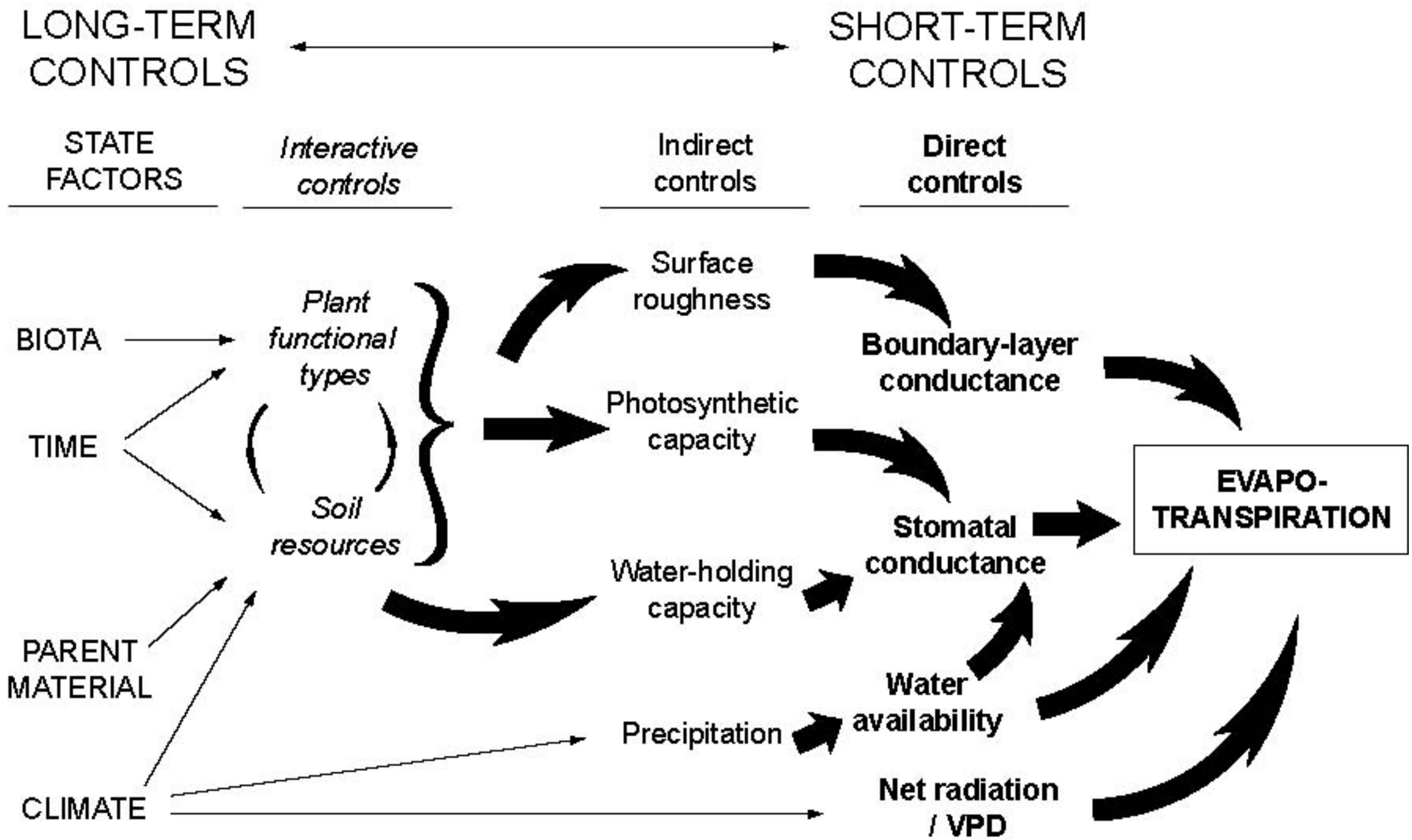


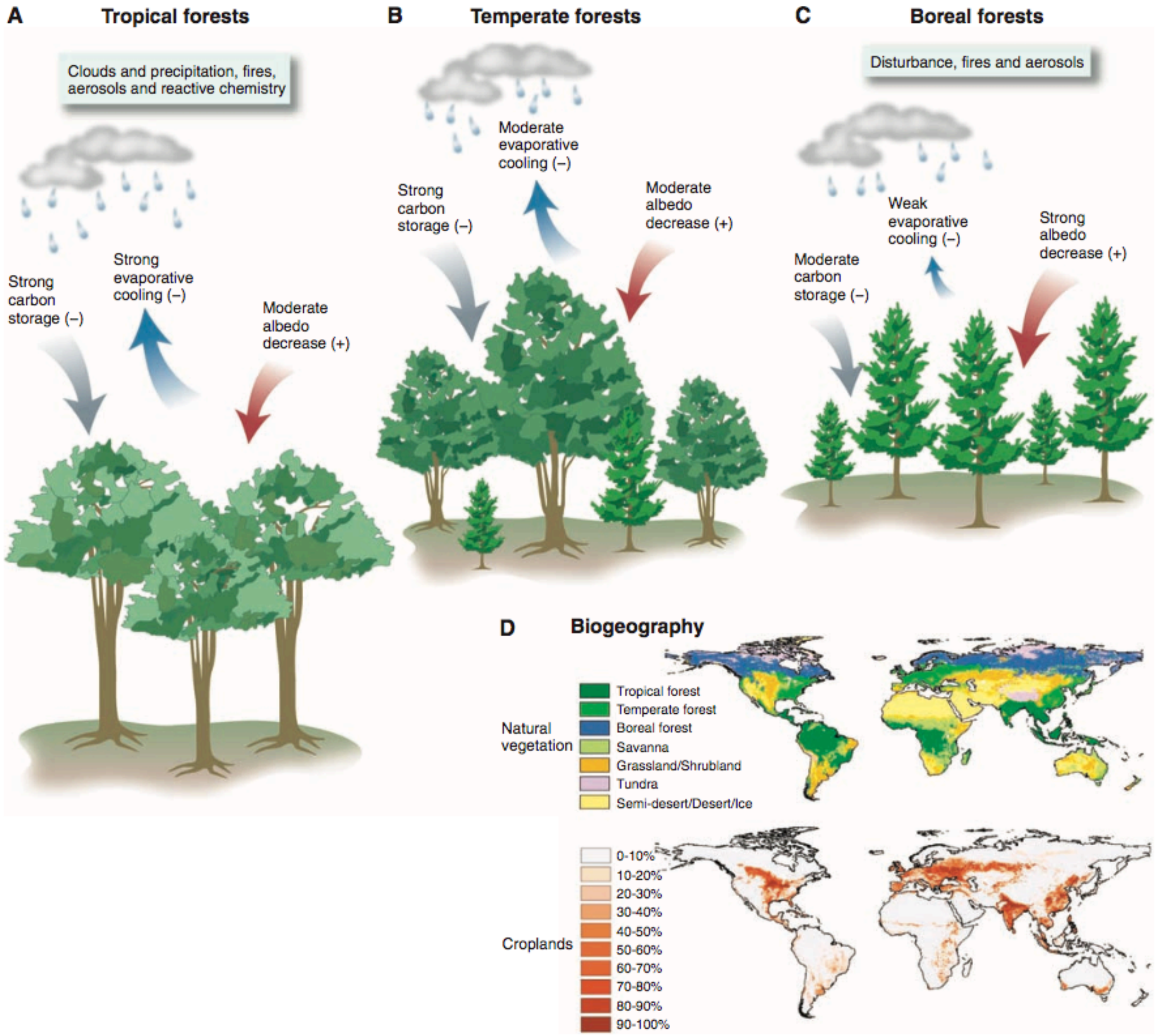
Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests

Gordon B. Bonan, *et al.*

Science **320**, 1444 (2008);
DOI: 10.1126/science.1155121

Chapin et al., 2011





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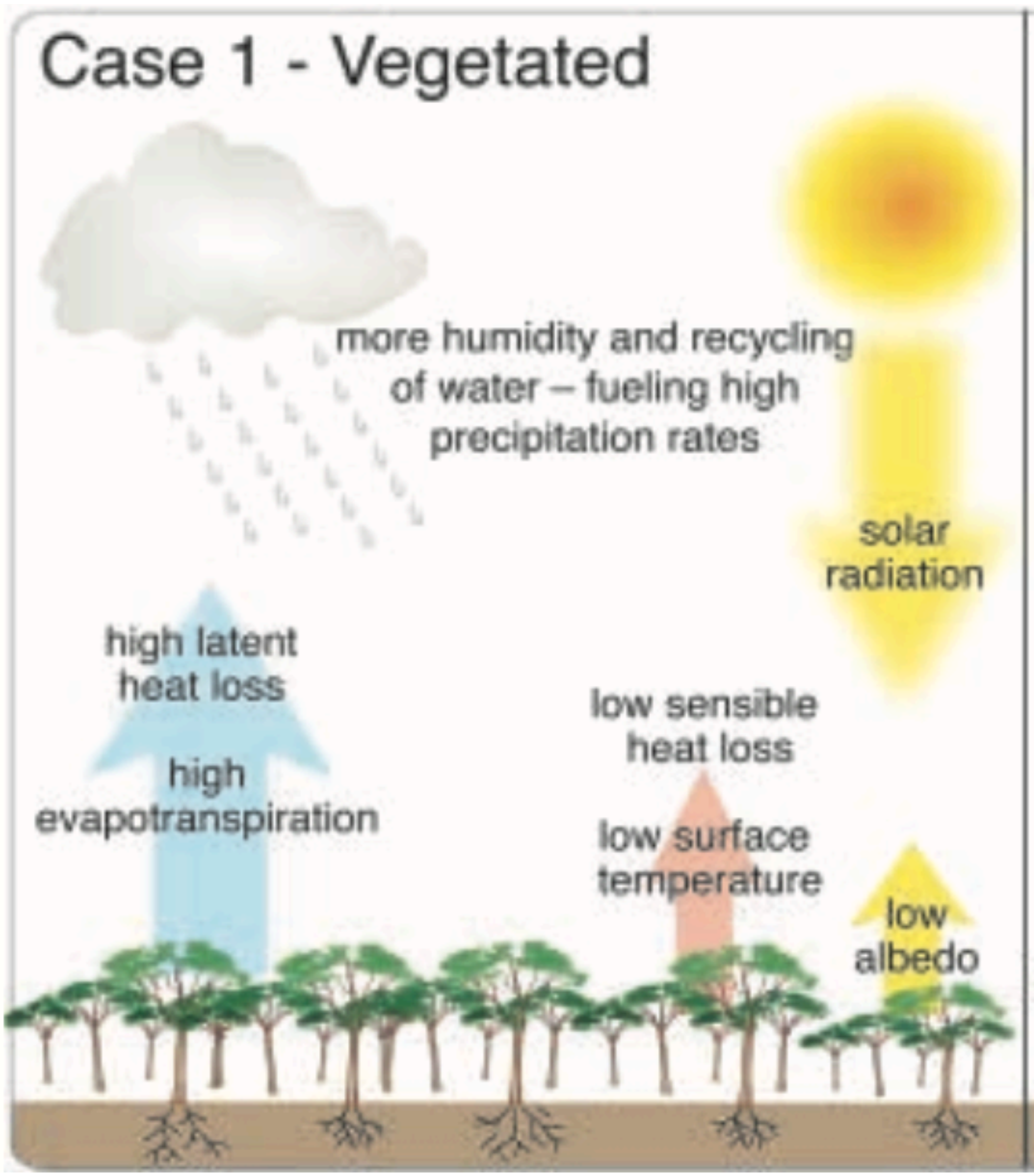
Green surprise? How terrestrial ecosystems could affect earth's climate

Jonathan A Foley[1], Marcos Heil Costa[2], Christine Delire[1], Navin Ramankutty[1], and Peter Snyder[1]



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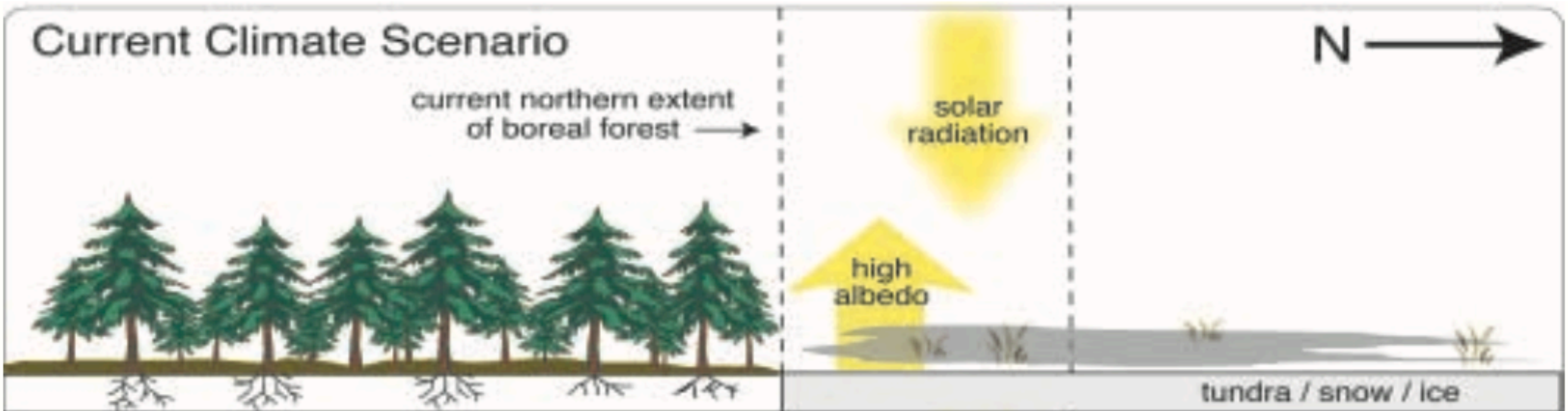

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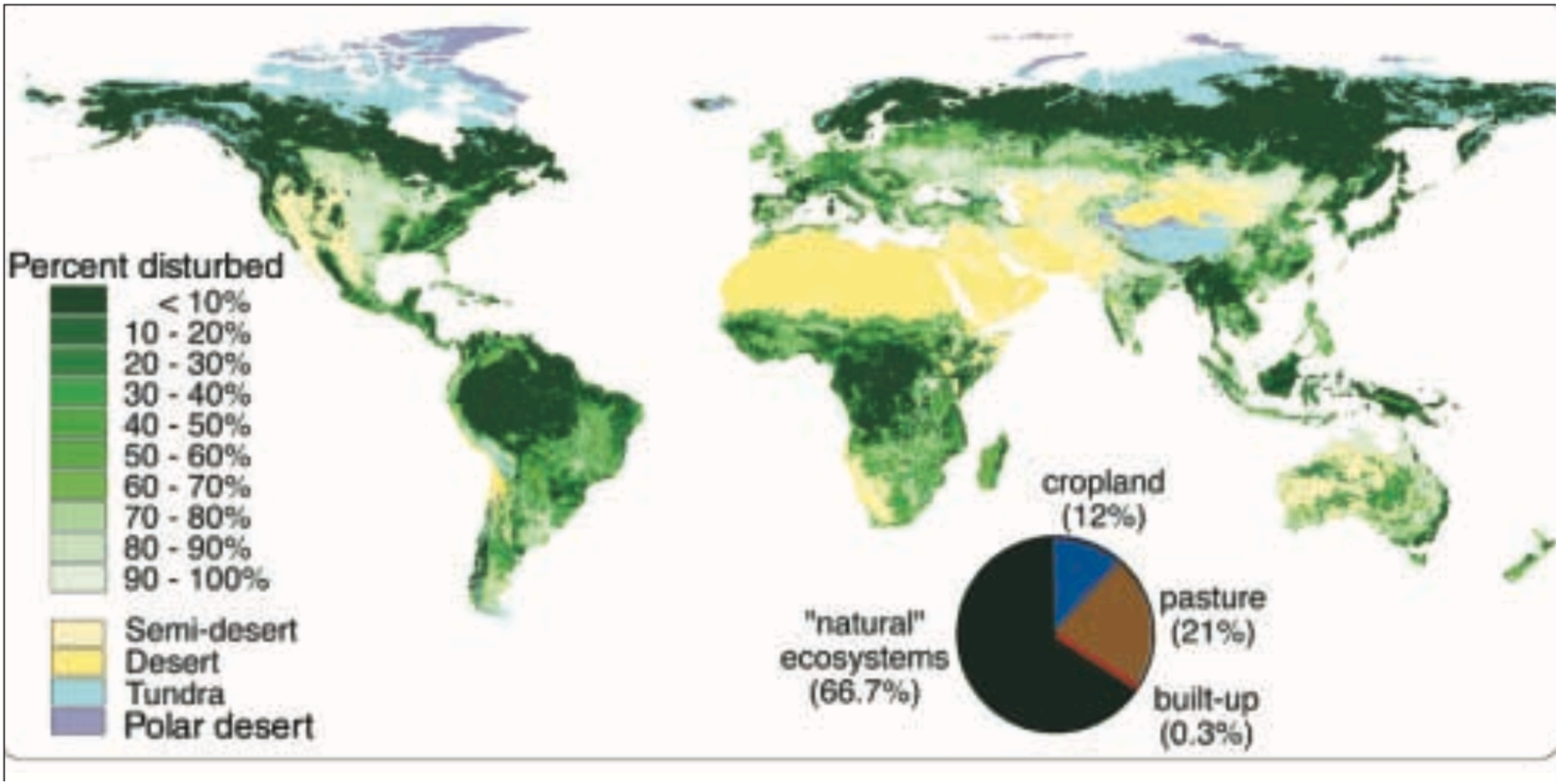
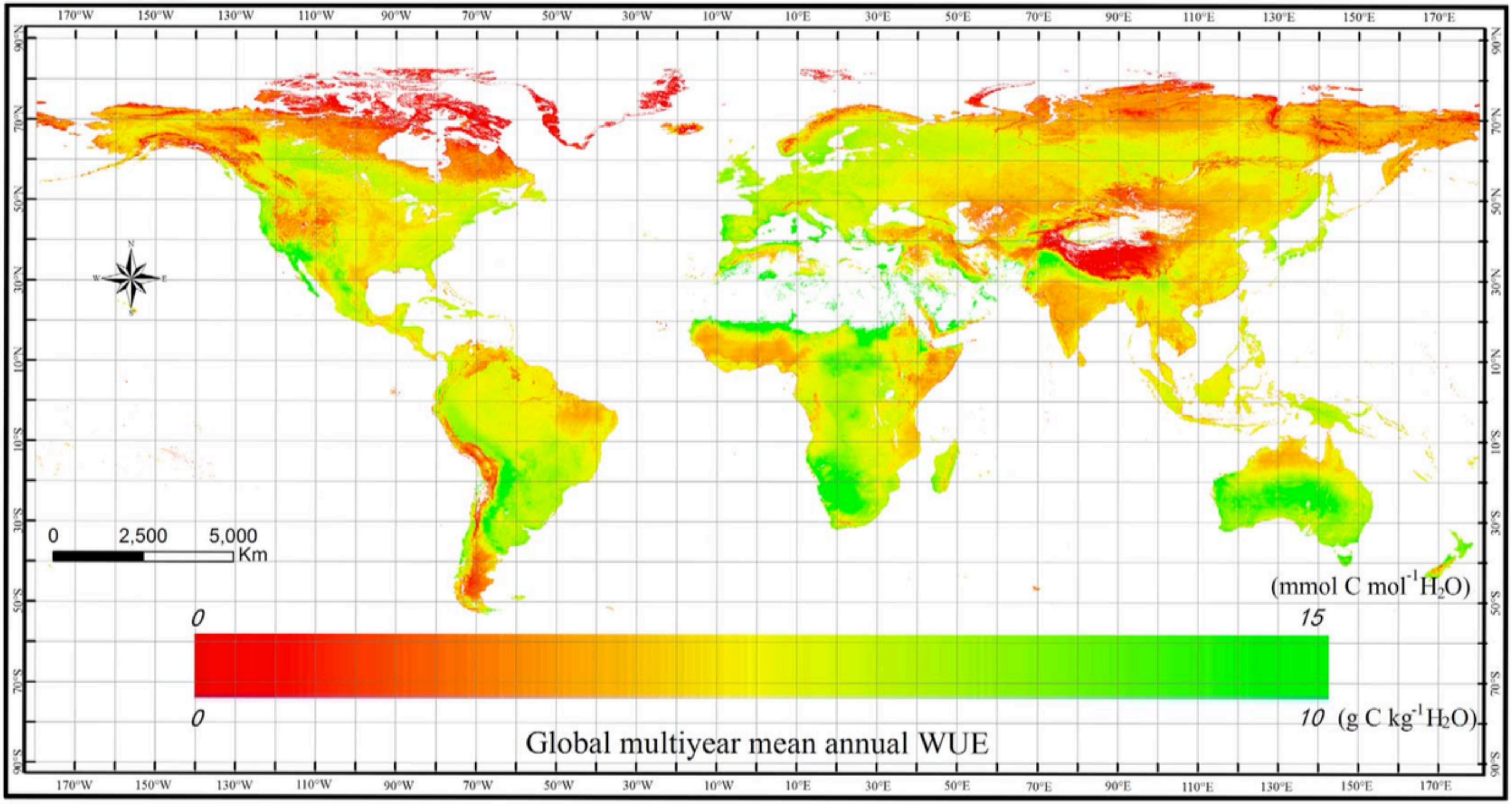


How is water-use efficiency of terrestrial ecosystems distributed and changing on Earth?

Xuguang Tang[1], Hengpeng Li[1], Ankur R. Desai[2], Zoltan Nagy[3], Juhua Luo[1], Thomas E. Kolb[4], Albert Olioso[5], Xibao Xu[1], Li Yao[6], Werner Kutsch[7,8], Kim Pilegaard[9], Barbara Köstner[10] & Christof Ammann[11]



Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise

Trevor F. Keenan[1], David Y. Hollinger[2], Gil Bohrer[3], Danilo Dragoni[4], J. William Munger[5], Hans Peter Schmid[6] & Andrew D. Richardson[1]

$$A = g_s(c_a - c_i)$$

$$E = 1.6 g_s(v_i - v_a)$$

$$W_e = \frac{A_e}{E_e}$$

$$\Delta W_{ei} = \Delta(c_a - C_i)/1.6$$

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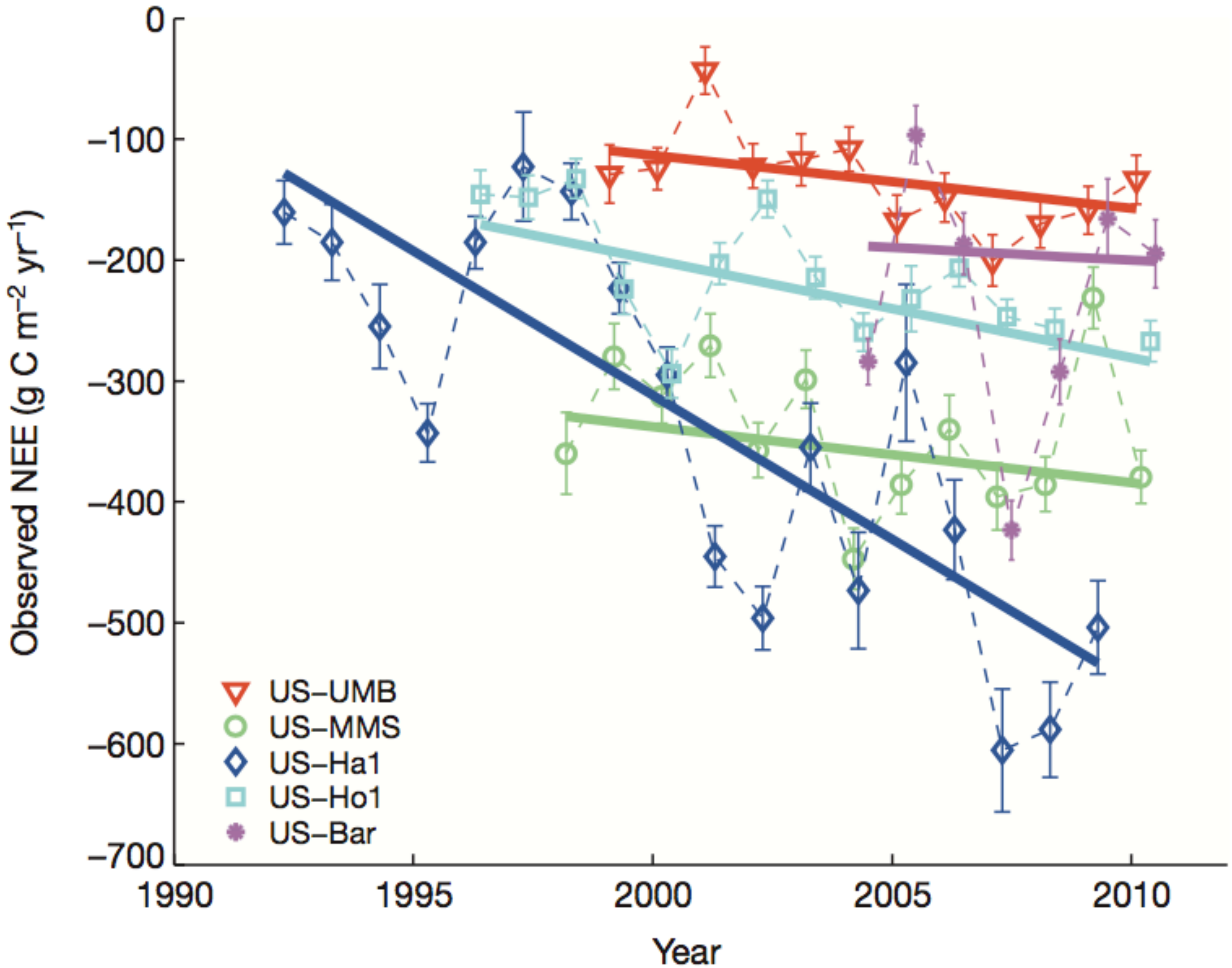

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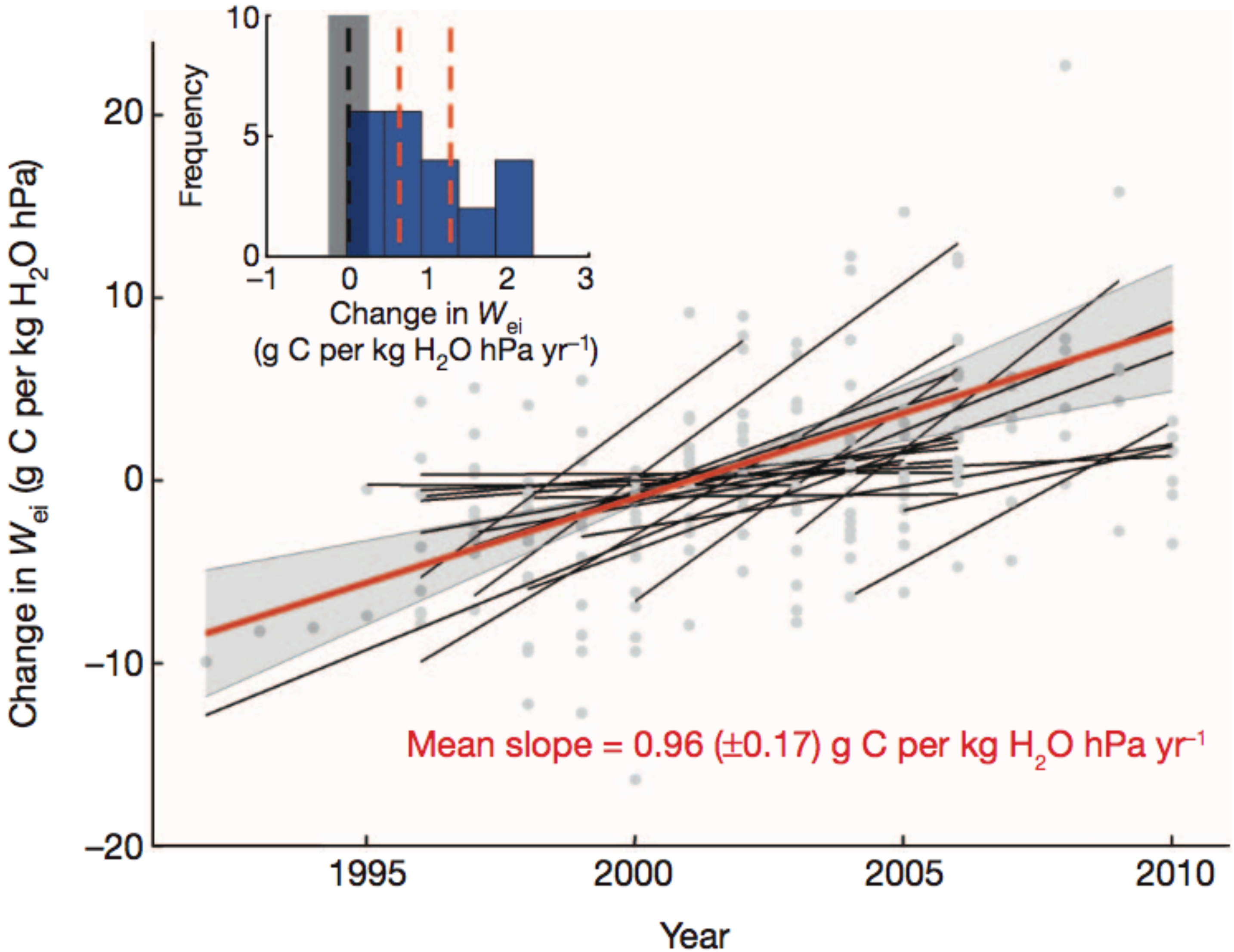


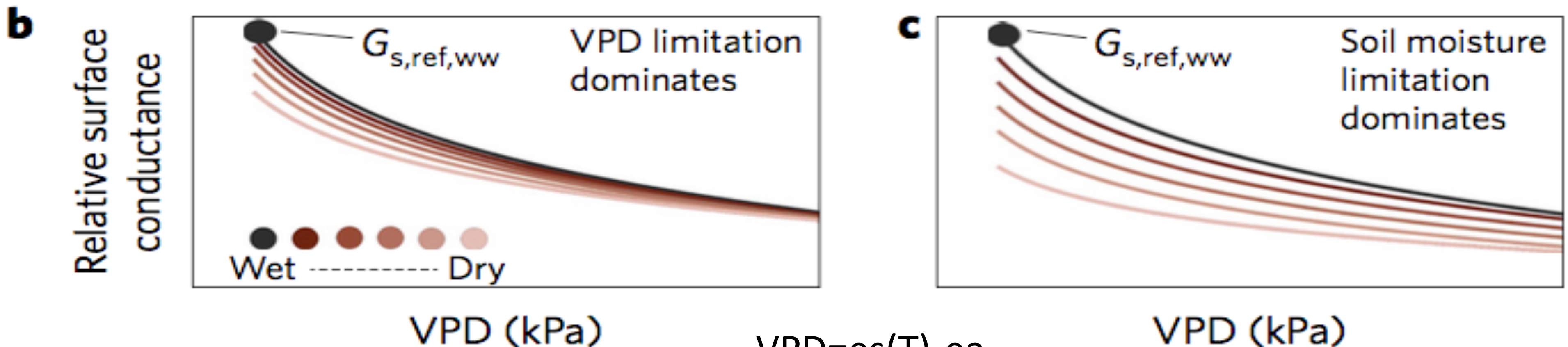
nature climate change

LETTERS

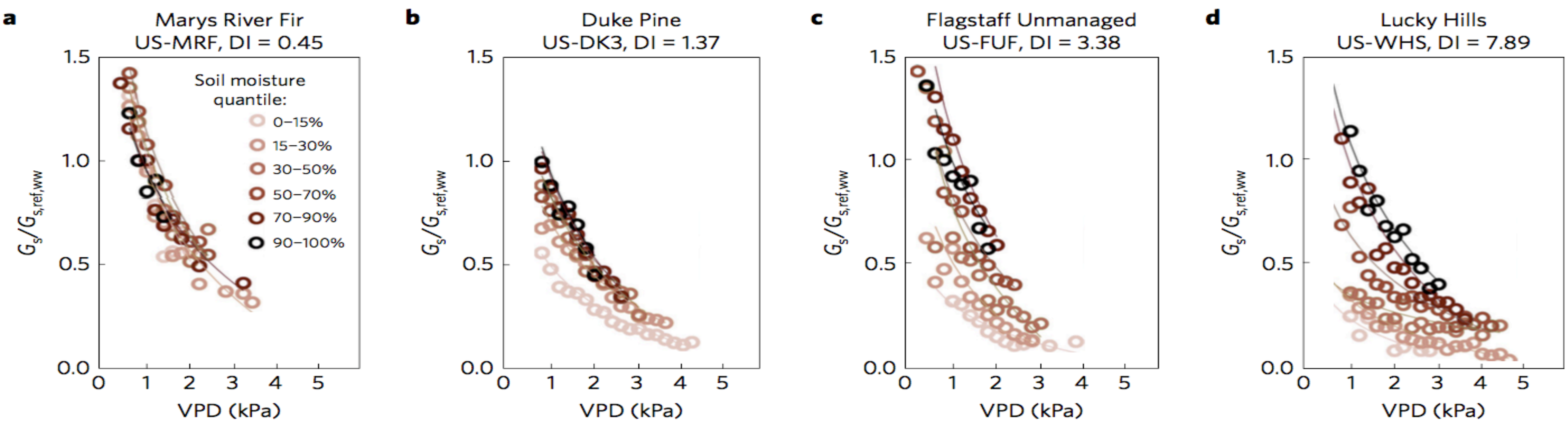
PUBLISHED ONLINE: 5 SEPTEMBER 2016 | DOI: 10.1038/NCLIMATE3114

The increasing importance of atmospheric demand for ecosystem water and carbon fluxes

Kimberly A. Novick[1*], Darren L. Ficklin[2], Paul C. Stoy[3], Christopher A. Williams[4], Gil Bohrer[5], A. Christopher Oishi[6], Shirley A. Papuga[7], Peter D. Blanken[8], Asko Noormets[9], Benjamin N. Sulman[10], Russell L. Scott[11], Lixin Wang[12] and Richard P. Phillips[13]



VPD=es(T)-ea



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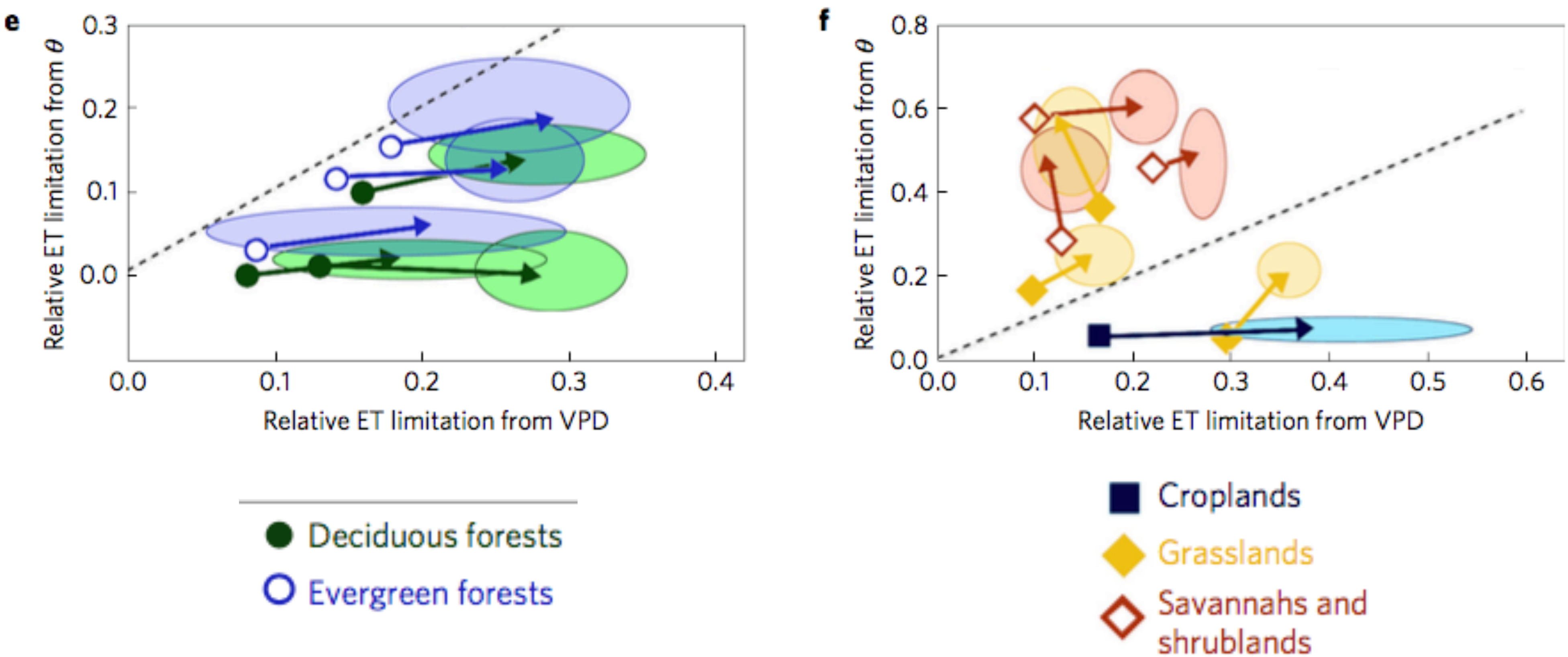

Major points

- Terrestrial evapotranspiration (ET, aka latent heat flux) is dominated by transpiration (T)
- T is biologically regulated, function of species specific adaptations to climate, soils, competition
- Stomata regulate input of CO_2 and release of H_2O, plants limit cavitation in xylem while maximizing growth/reproduction
- As a result, biological primary productivity and T are tightly linked, can be tracked by water use efficiency (WUE)
- Any changes to plant biogeochemistry (such as CO_2 fertilization) influence plant water loss, but is also regulated by atmospheric demand (VPD), soil moisture, plant acclimation
- Regional and global surface energy balance influenced by these processes, leading to net changes in sensible and latent heating of atmosphere, albedo, and hence local and regional meteorology
- Take AOS 520: Bioclimatology to learn more!