Are Plants Using Less Water These Days?

Prof. Ankur Desai
Dept of Atmospheric and Oceanic Sciences
University of Wisconsin-Madison
http://flux.aos.wisc.edu desai@aos.wisc.edu
water@uw
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Madison, Wisconsin USA

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LETTERS

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

Kimberly A. Novick[1]*, Darren L. Ficklin[2], Paul C. Stoy[3], A. Christopher Oishi[6], Shirley A. Papuga[7], Peter D. Bla
Russell L. Scott[11], Lixin Wang[12] and Richard P. Phillips[13]

Plant responses to increasing CO_2 reduce estimates of climate impacts on drought severity

Abigail L. S. Swann[a,b,1], Forrest M. Hoffman[c,d], Charles D. Koven[e], and James T. Randerson[f]

nature plants

PUBLISHED: 5

Intensifying drought eliminates the expected benefits of elevated carbon dioxide for soybean

Sharon B. Gray[1†], Orla Dermody[1], Stephanie P. Klein[1†], Anna M. Locke[1†], Justin M. McGrath[1], Rachel
E. Paul[1], David M. Ro
A. Ainsworth[1,2], Carl

Geophysical Research Letters

RESEARCH LETTER

10.1002/2017GL072759

Key Points:

- Base flow is consistently declining along the Australian east coast

CO_2-vegetation feedbacks and other climate changes implicated in reducing base flow

Ralph Trancoso[1,2], Joshua R. Larsen[1,3], Tim R. McVicar[4,5], Stuart R. Phinn[1] and Clive A. McAlpine[1]

Warm spring reduced carbon cycle impact of the 2012 US summer drought

Sebastian Wolf[a,b,1], Trevor F. Keenan[c,2], Joshua B. Fisher[d], Dennis D. Baldocchi[a], Ankur R. Desai[e], Andrew D. Richardson[f], Russell L. Scott[g], Beverly E. Law[h], Marcy E. Litvak[i], Nathaniel A. Brunsell[j], Wouter Peters[k,l], and Ingrid T. van der Laan-Luijkx[k]

Global Change Biology (2016), doi: 10.1111/gcb.13428

Well are they?

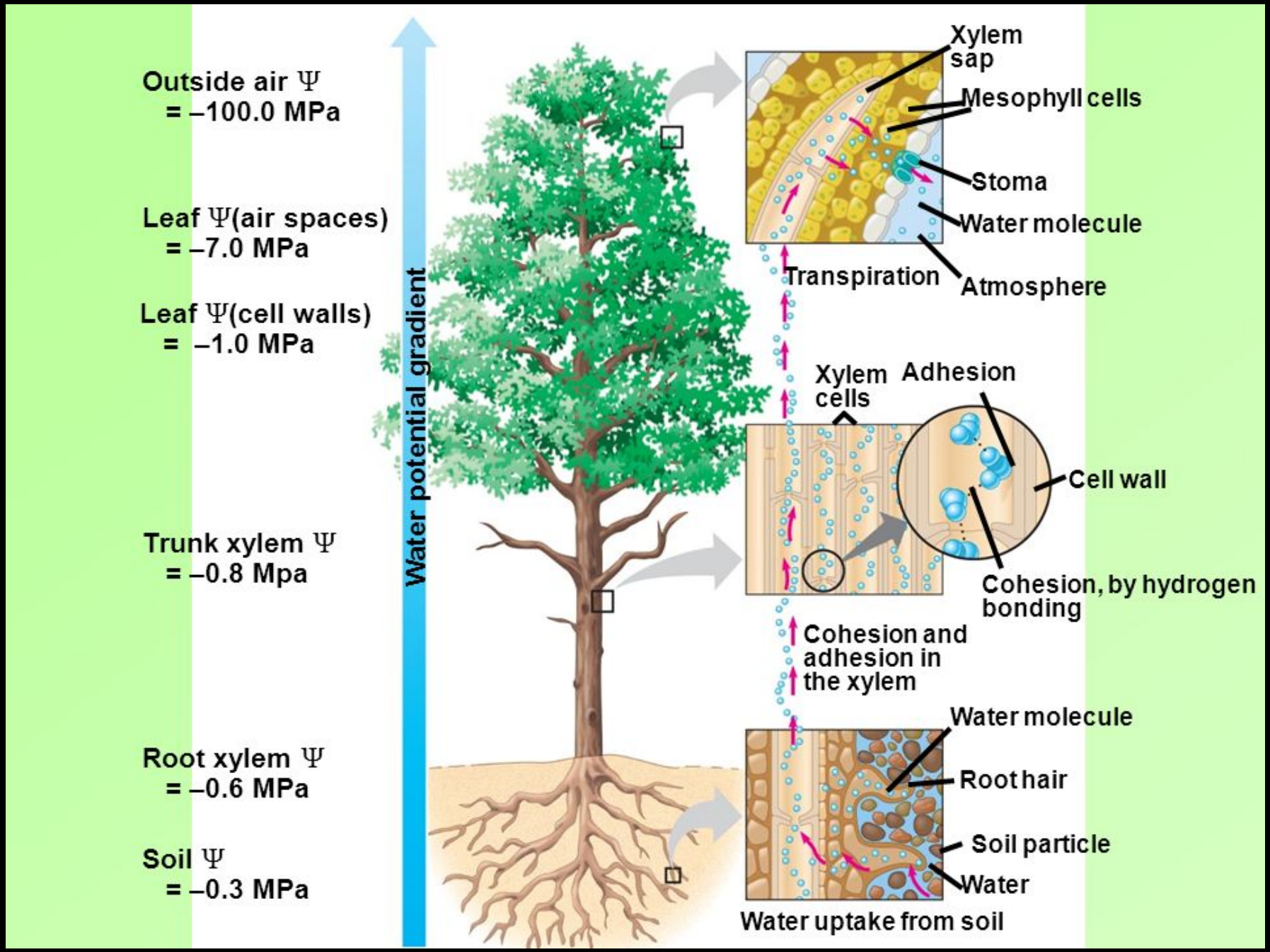
Relationships between individual-tree mortality and water-balance variables indicate positive trends in water stress-induced tree mortality across North America

RNER A. KURZ[2] and NICHOLAS C. COOPS[1]

Global Change Biology (2017) **23**, 1140–1151, doi: 10.1111/gcb.13439

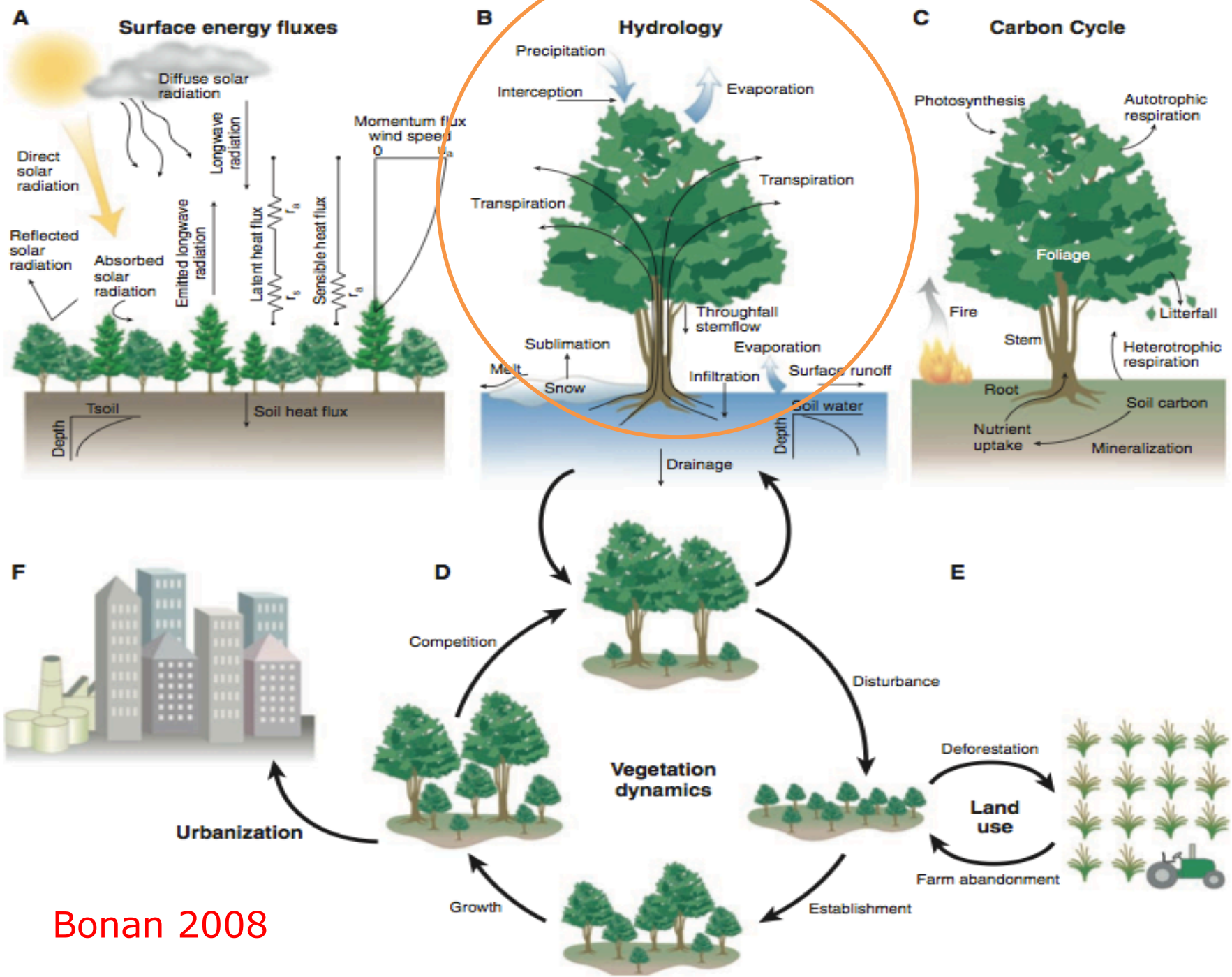
Stomatal response to humidity and CO_2 implicated in recent decline in US evaporation

ANGELA J. RIGDEN and GUIDO D. SALVUCCI
Department of Earth and Environment, Boston University, 675 Commonwealth Ave., Boston, MA 02215, USA

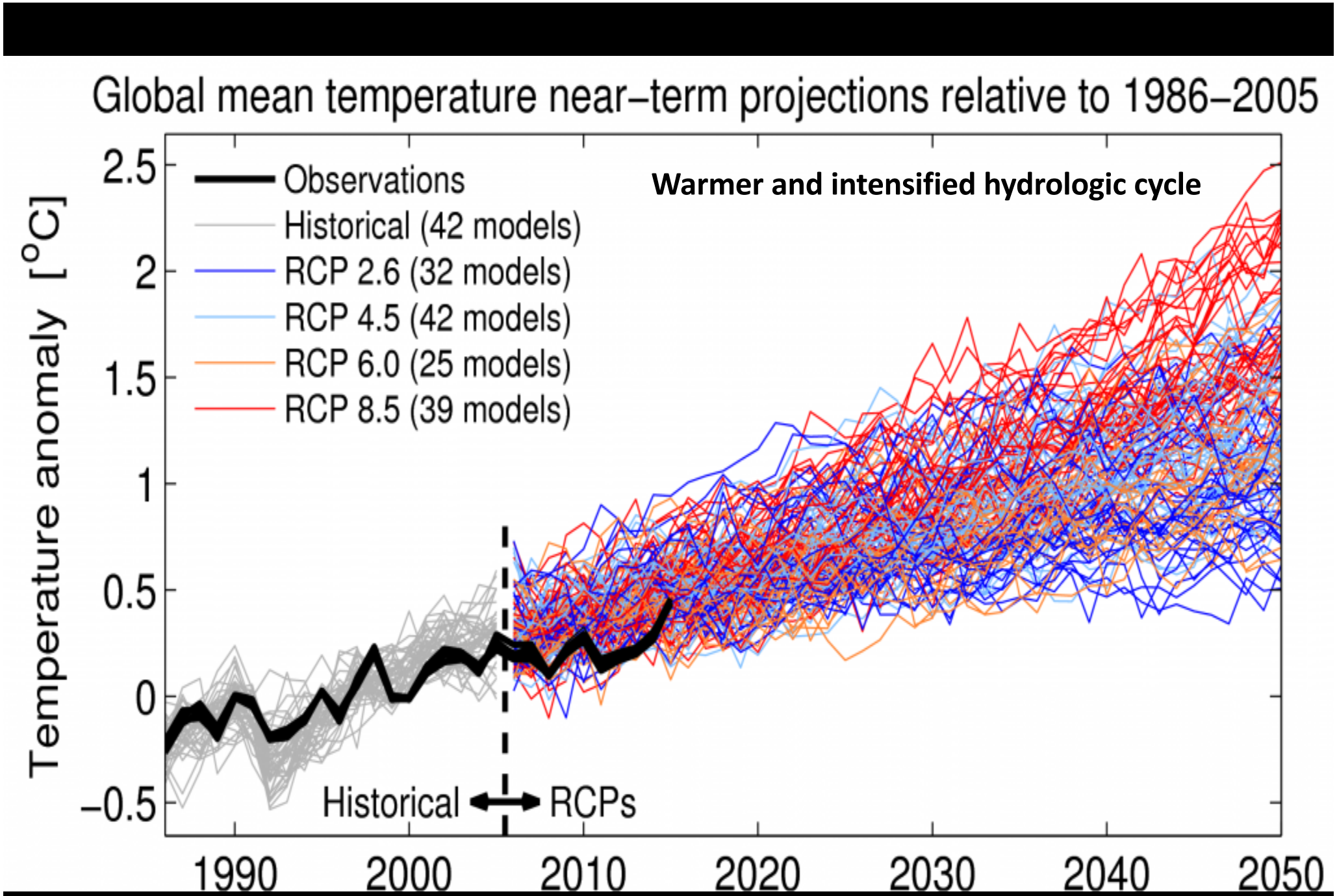


https://www.emaze.com/@AWQQLQIL/Transpiration

Forests in Flux

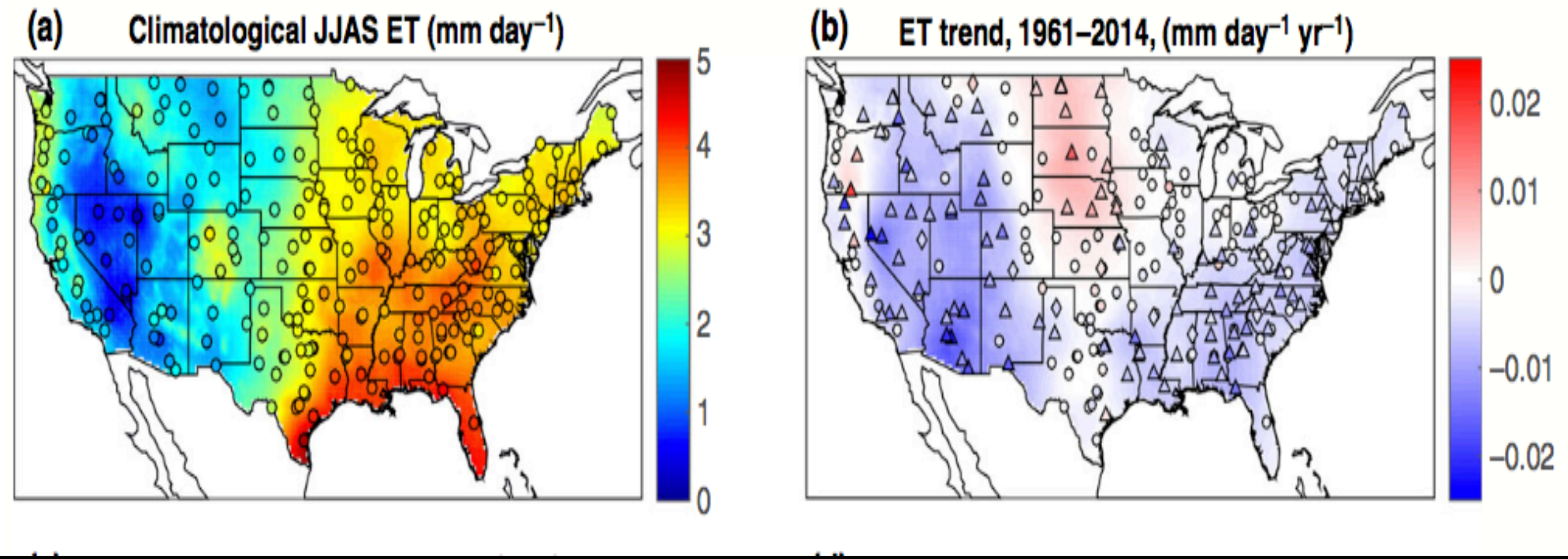


Bonan 2008



http://www.climate-lab-book.ac.uk/comparing-cmip5-observations/

Recent trends in U.S. evapotranspiration show both, driven by changes in surface



Rigden and Salvucci, 2017

Plant transpiration ~60% of global terrestrial water flux (Wei et al., 2017)!

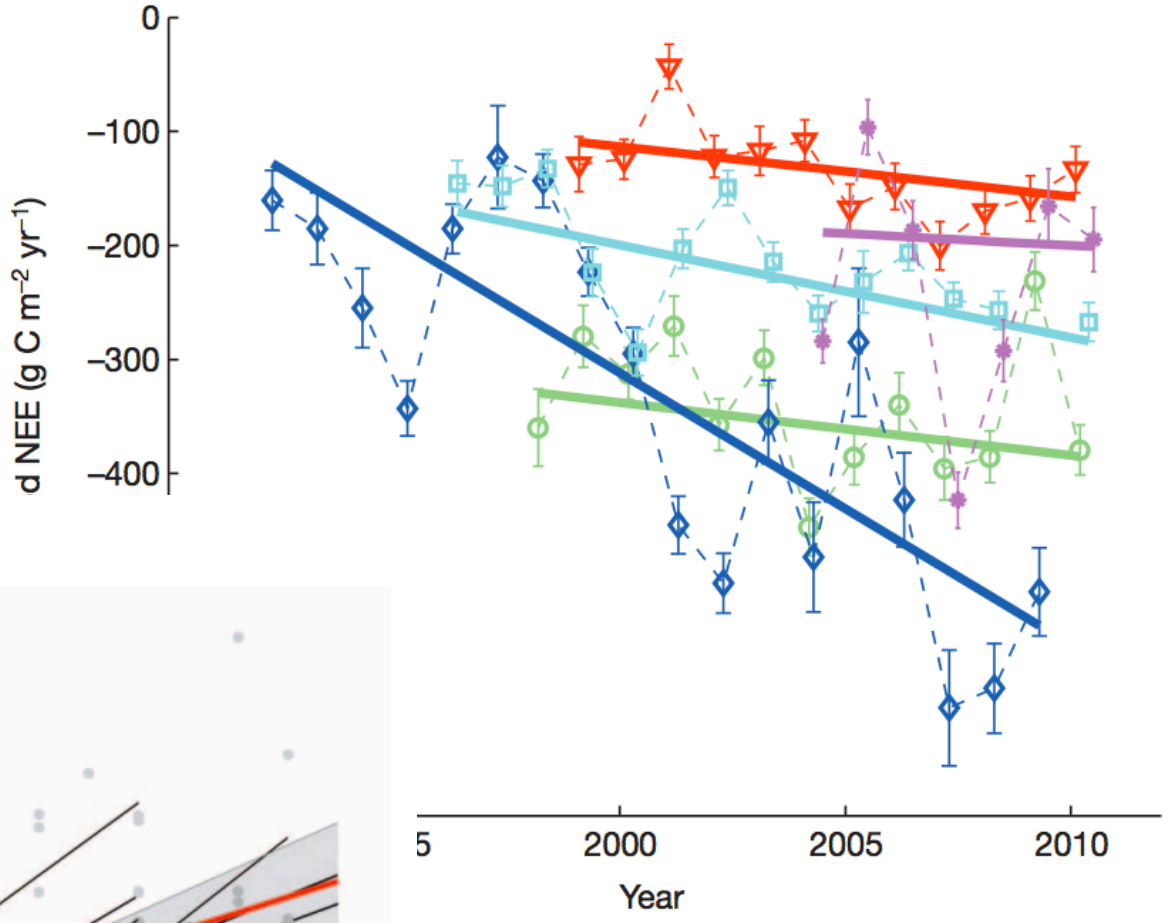
SO:

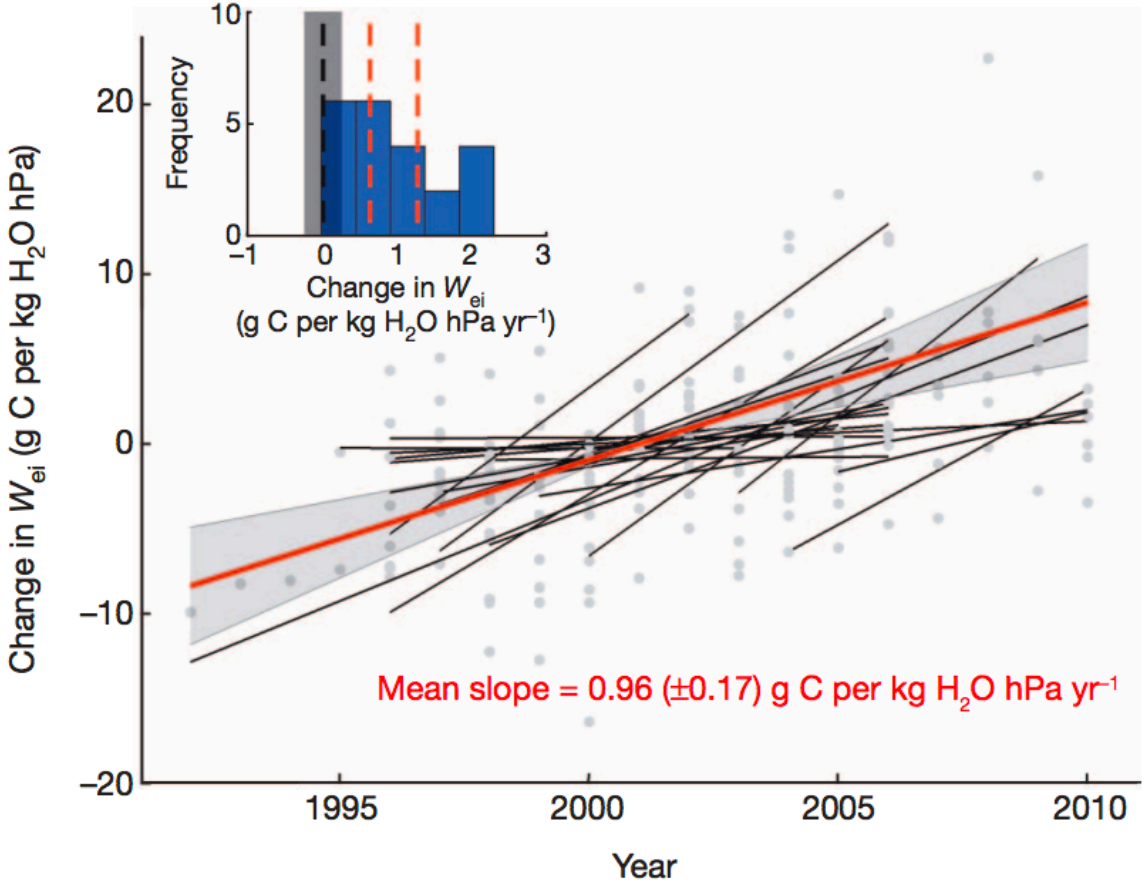
Are Plants Using Less Water These Days?

Or in the future?

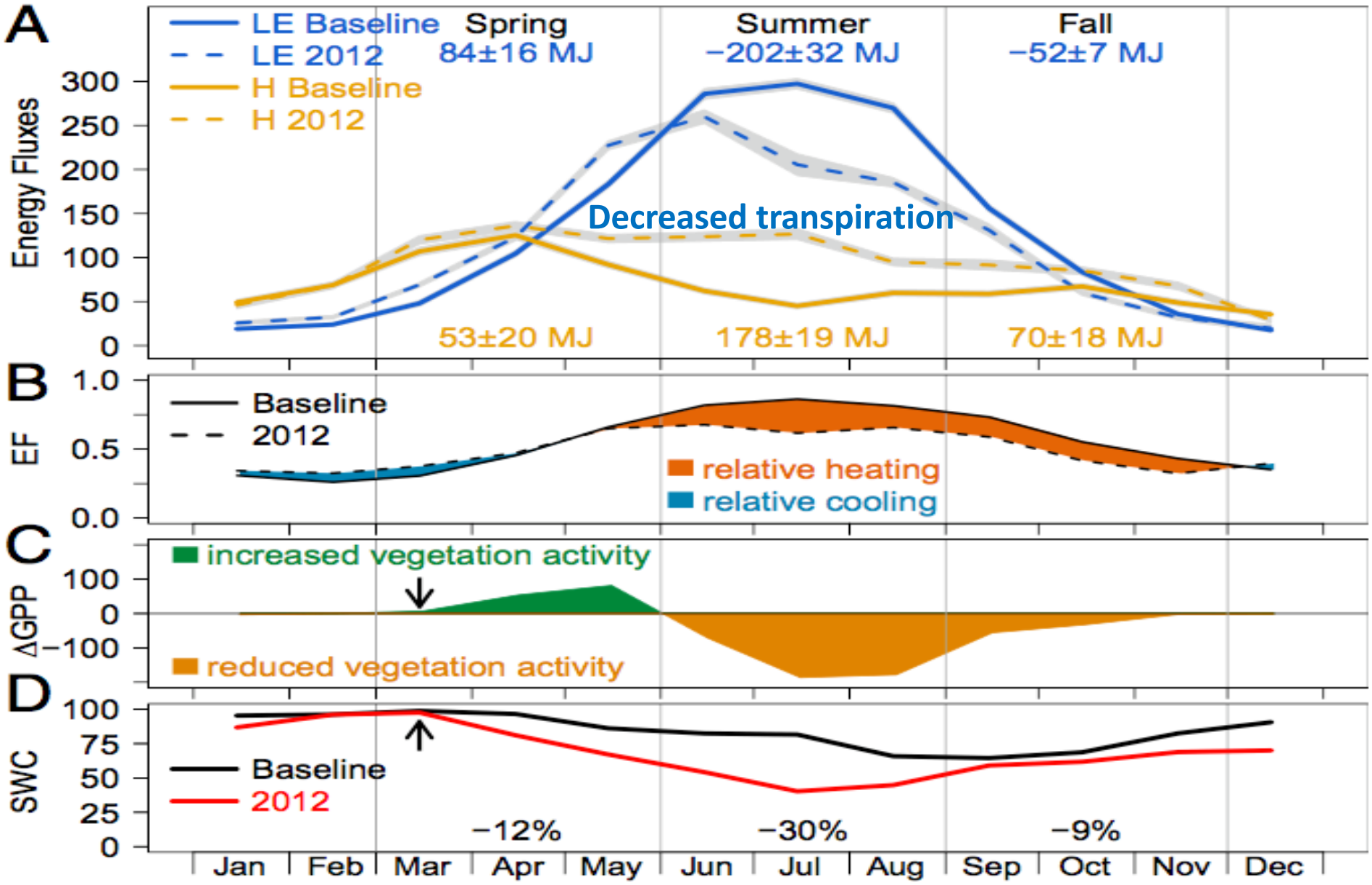
YES

- Higher CO_2 means less need to keep stomata open
  - Evidence: *Increasing water use efficiency*
- Increased atmospheric demand for moisture in warmer climates leads to stomatal closure
  - Evidence: *Higher vapor pressure deficit*
- Longer growing seasons lead to earlier depletion of plant available water
  - Evidence: *Soil moisture deficiency in summer*

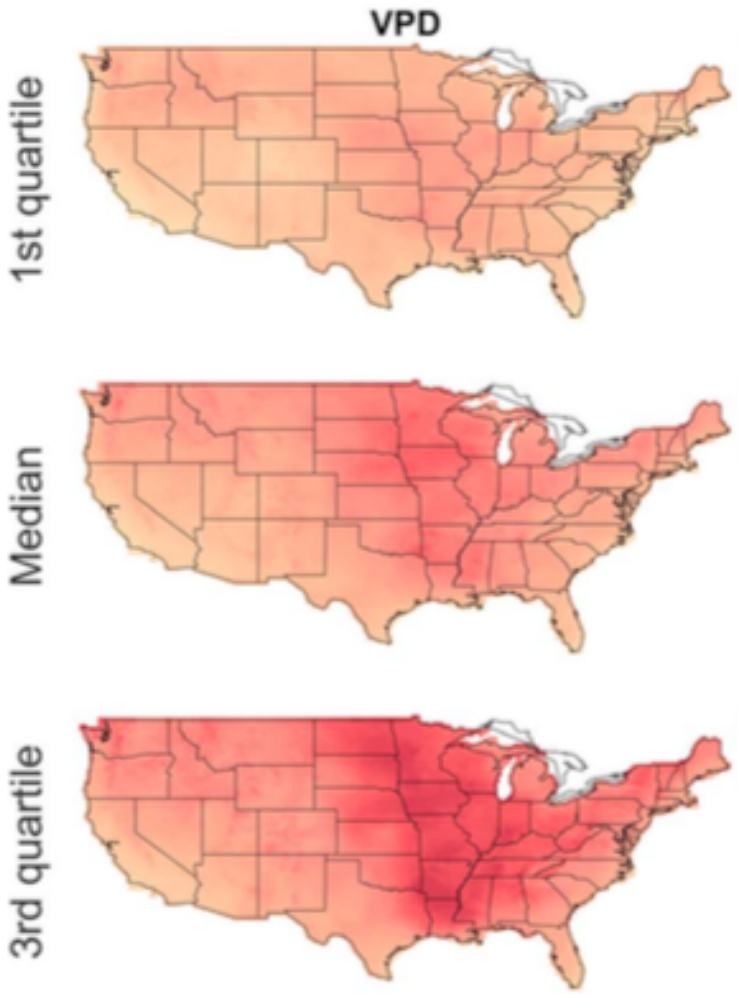


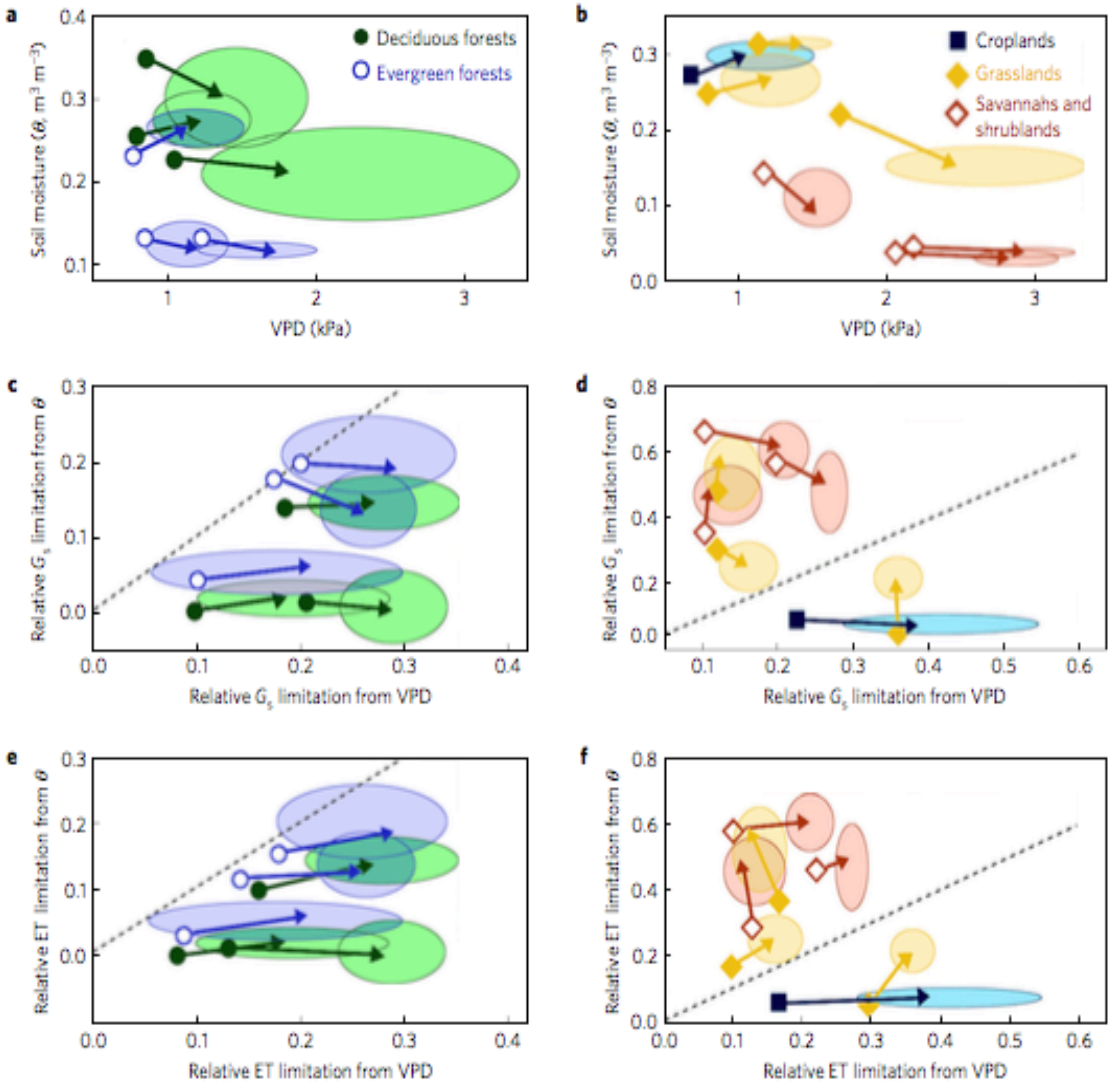


Keenan *et al* 2015



Wolf *et al.*, 2016



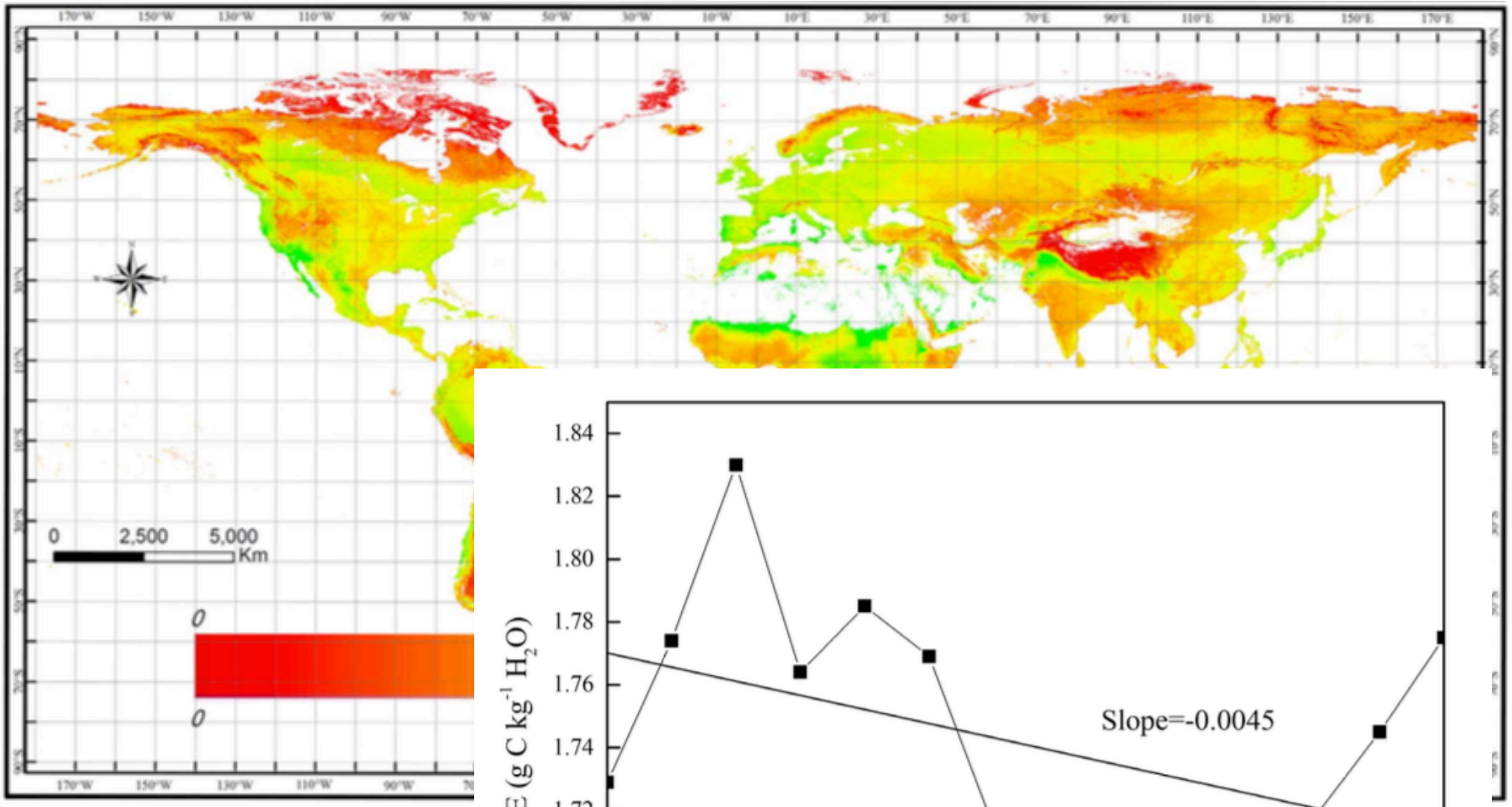


Ficklin and Novick, 2017

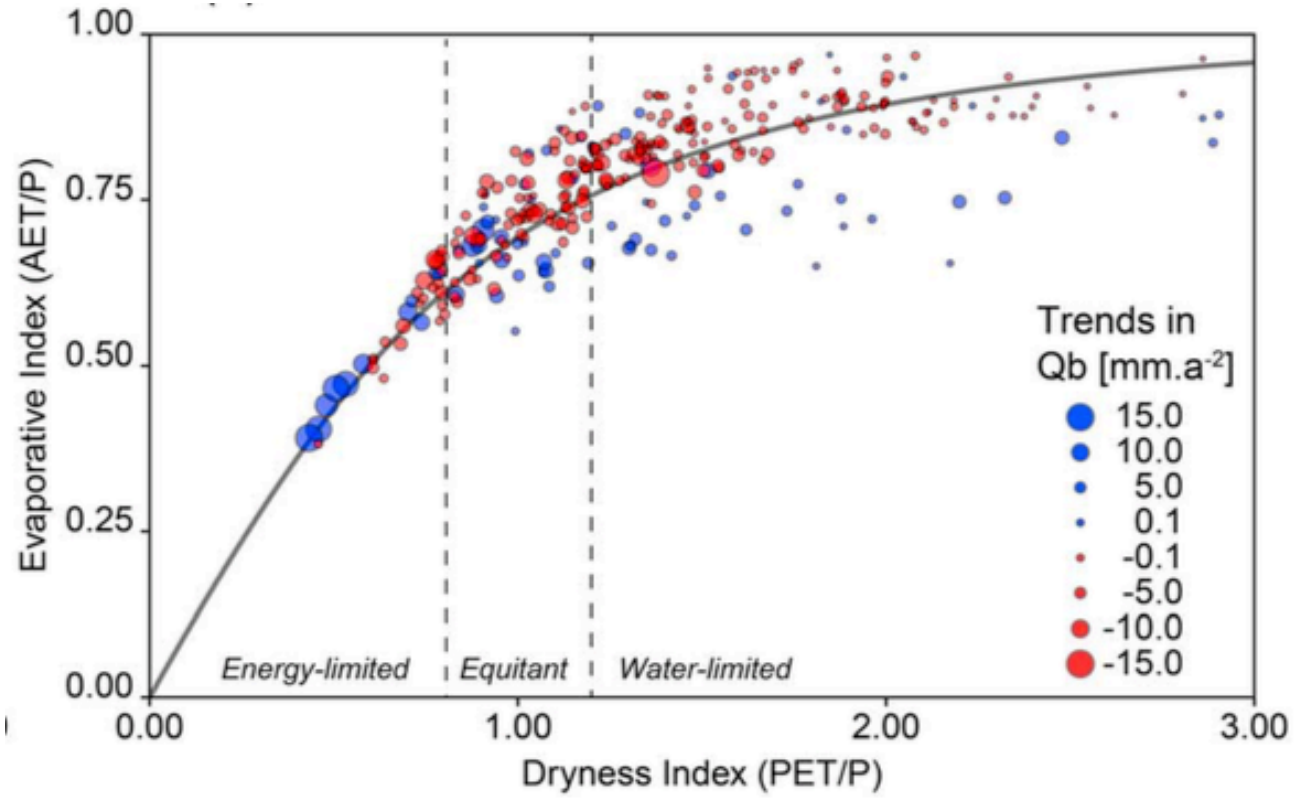
Novick *et al.*, 2016

NO

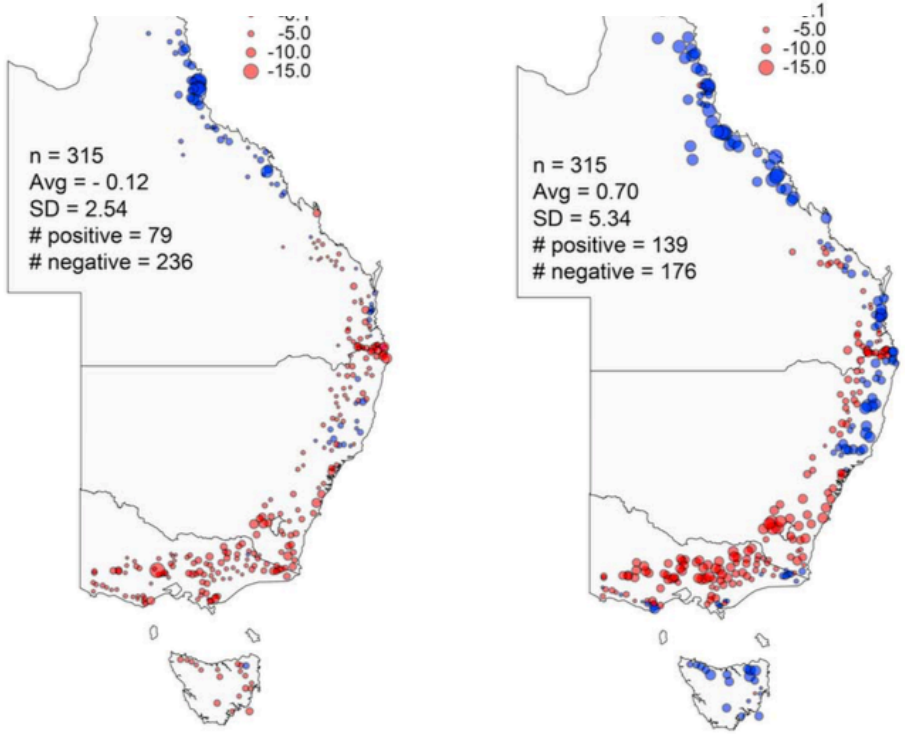
- Higher CO_2 fertilizes growth, plants trade water for carbon to maximize this, and as a result have limited change in stomatal response
  - Evidence: *Increased transpiration, reduced baseflow, decreases in water use efficiency*
- Longer growing seasons leads to longer actively transpiring period
  - Evidence: *Plant phenology shifts, earlier use of soil moisture*

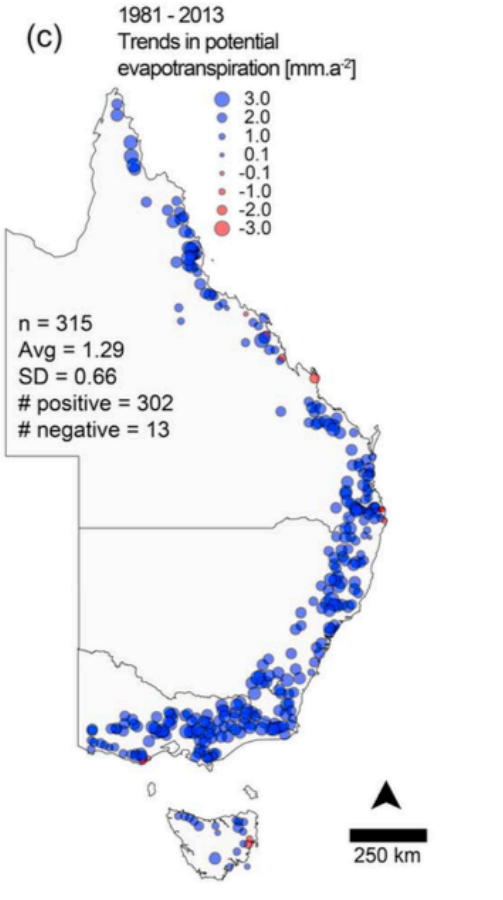


Tang *et al*., 2014



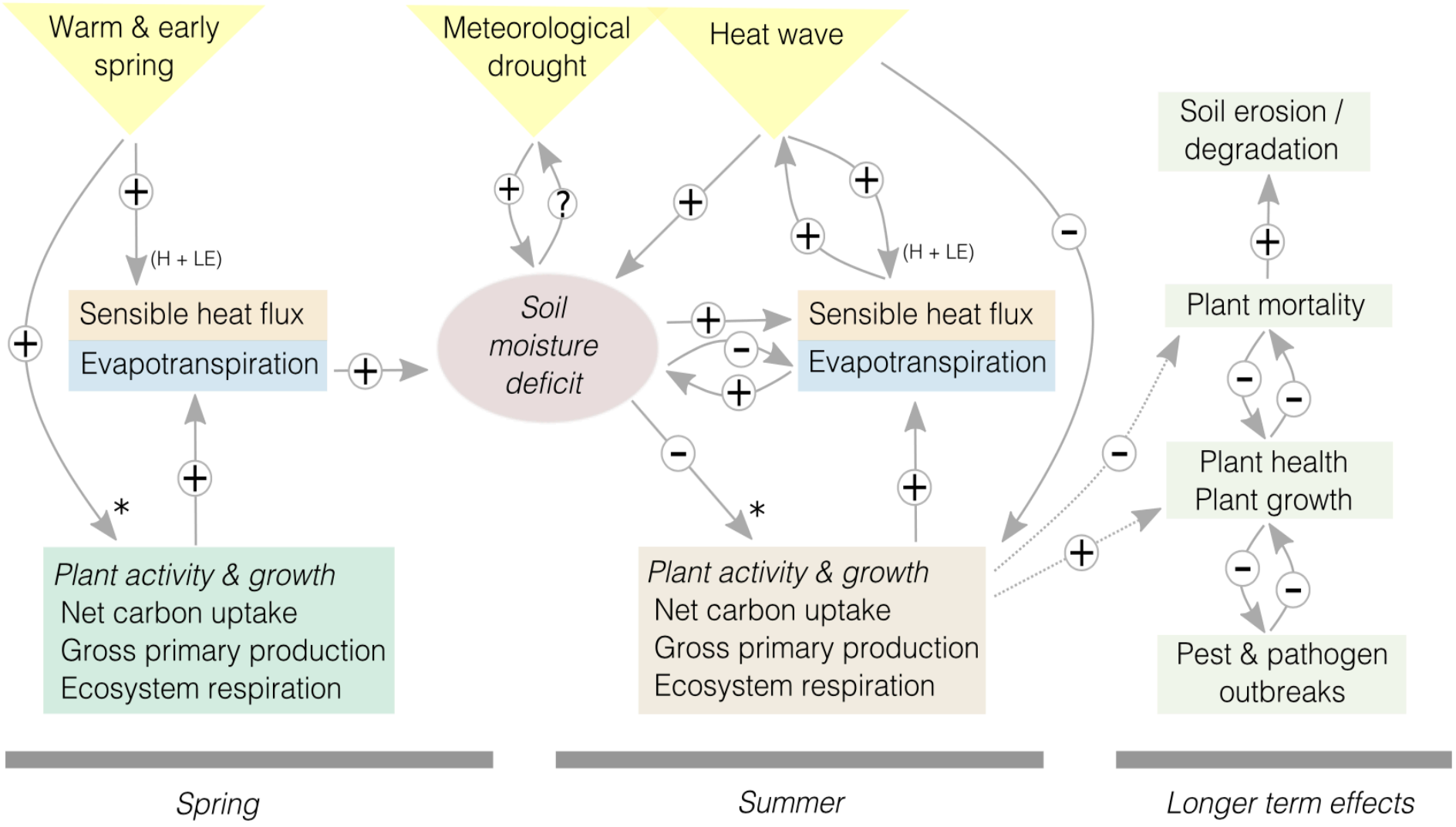
Trancoso *et al.*, 2017





Answer

- It depends
  - On plasticity of species response (isohydric/anisohydric continuum)
  - Either way, plant water use *will* change in response to intensifying hydrological cycles, which will influence global water budget and local land-atmosphere feedbacks
  - Implications for management of water for agriculture, forestry, drought
  - Multi-scale, long-term experiments and observations are needed (Ameriflux, NEON, LTER)



* Climate effects on ecosystem carbon fluxes are shown only in qualitative terms. Individual fluxes might be affected differently by climate extremes (see text).

Sippel *et al.*, 2016

Thanks!

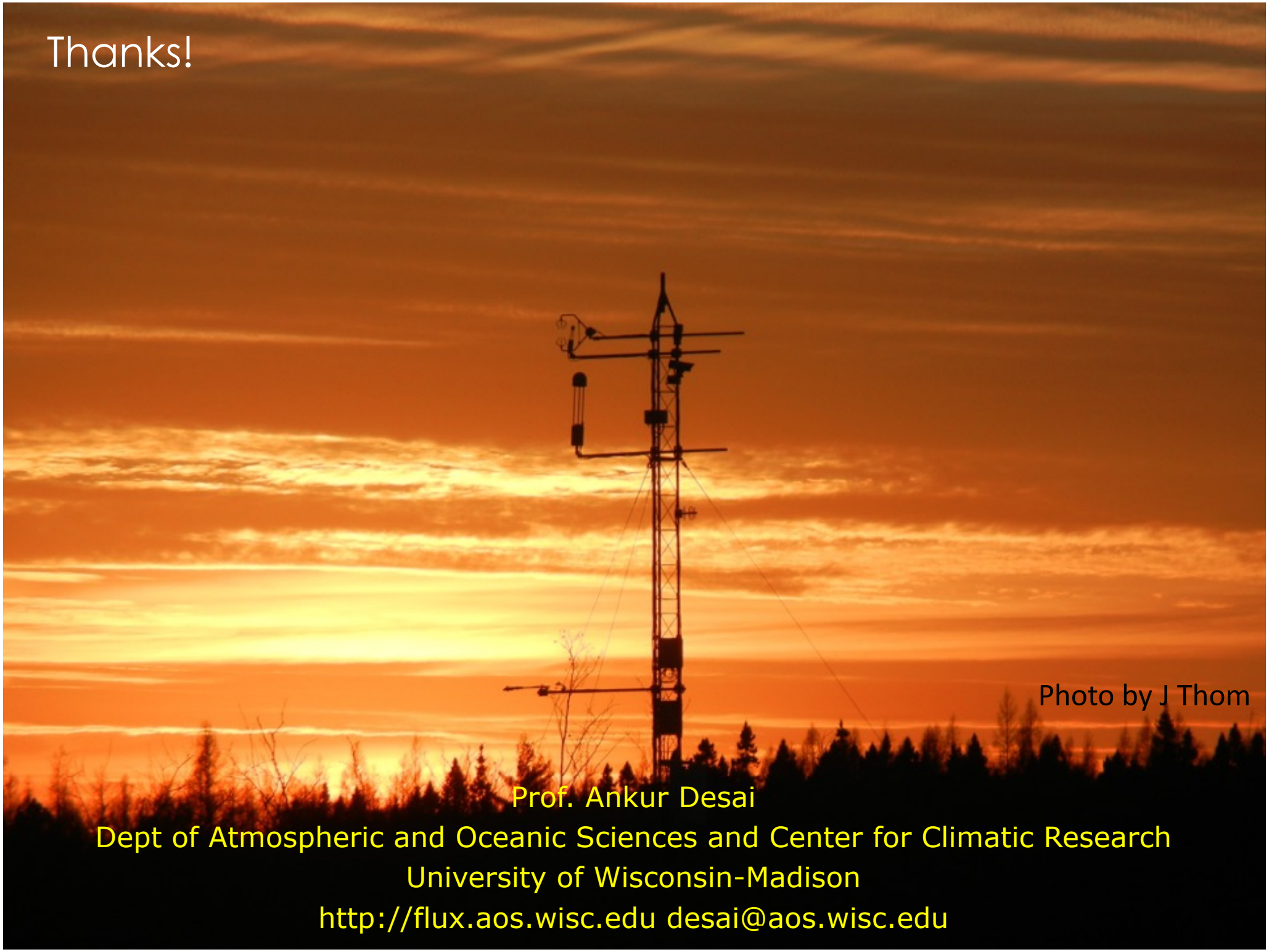


Photo by J Thom

Prof. Ankur Desai
Dept of Atmospheric and Oceanic Sciences and Center for Climatic Research
University of Wisconsin-Madison
http://flux.aos.wisc.edu desai@aos.wisc.edu