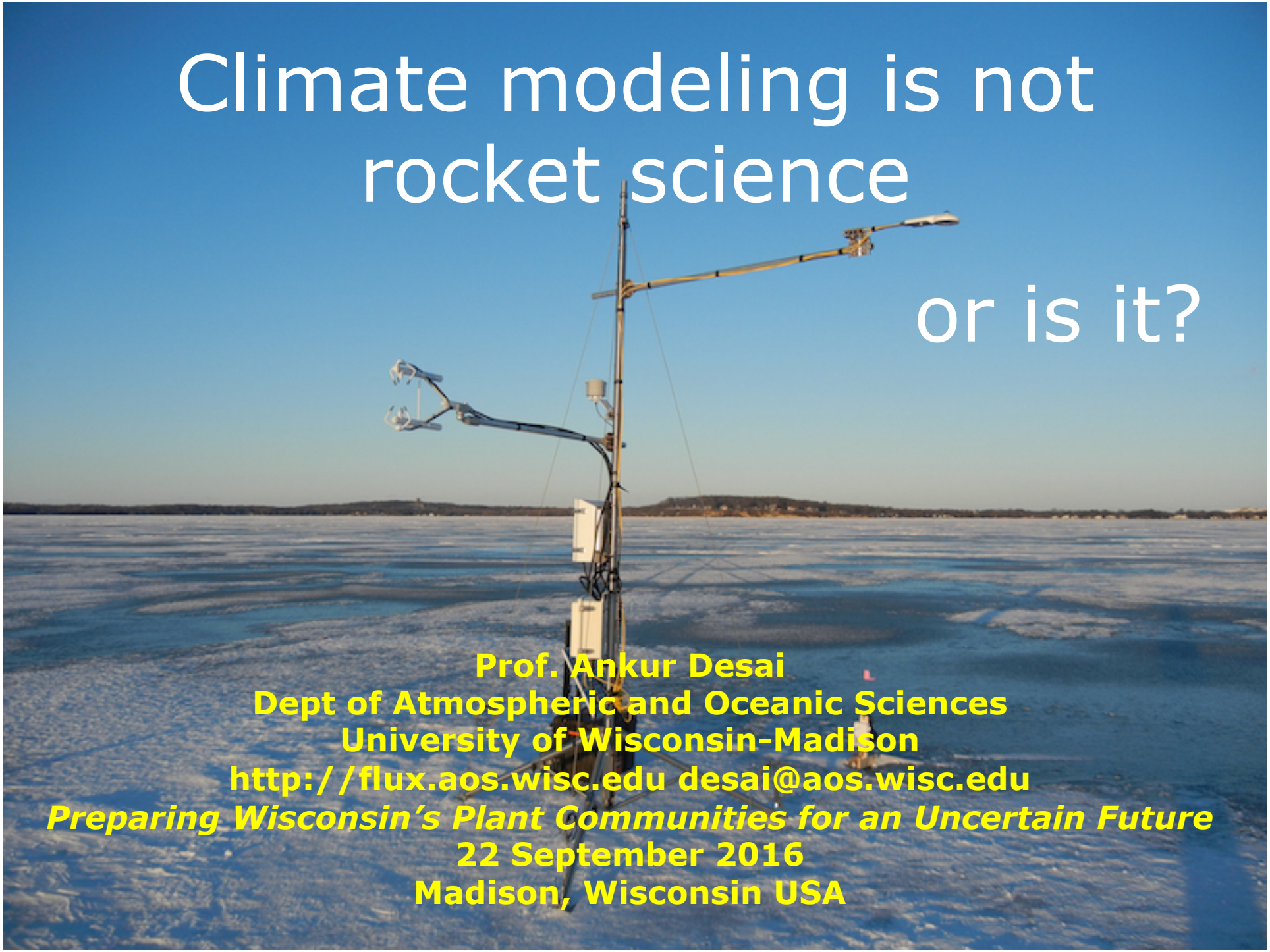
Climate modeling is not rocket science

or is it?



Prof. Ankur Desai
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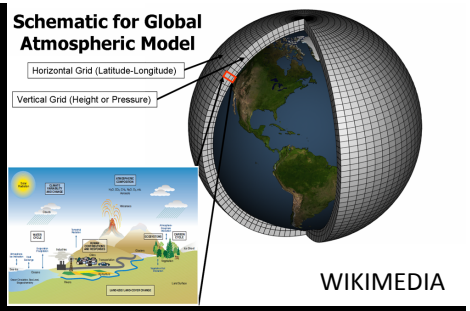
Preparing Wisconsin's Plant Communities for an Uncertain Future

22 September 2016
Madison, Wisconsin USA

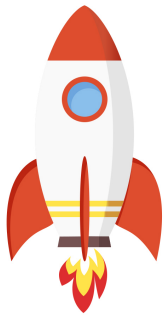


WIKIMEDIA

PROJECTION

≠

PREDICTION



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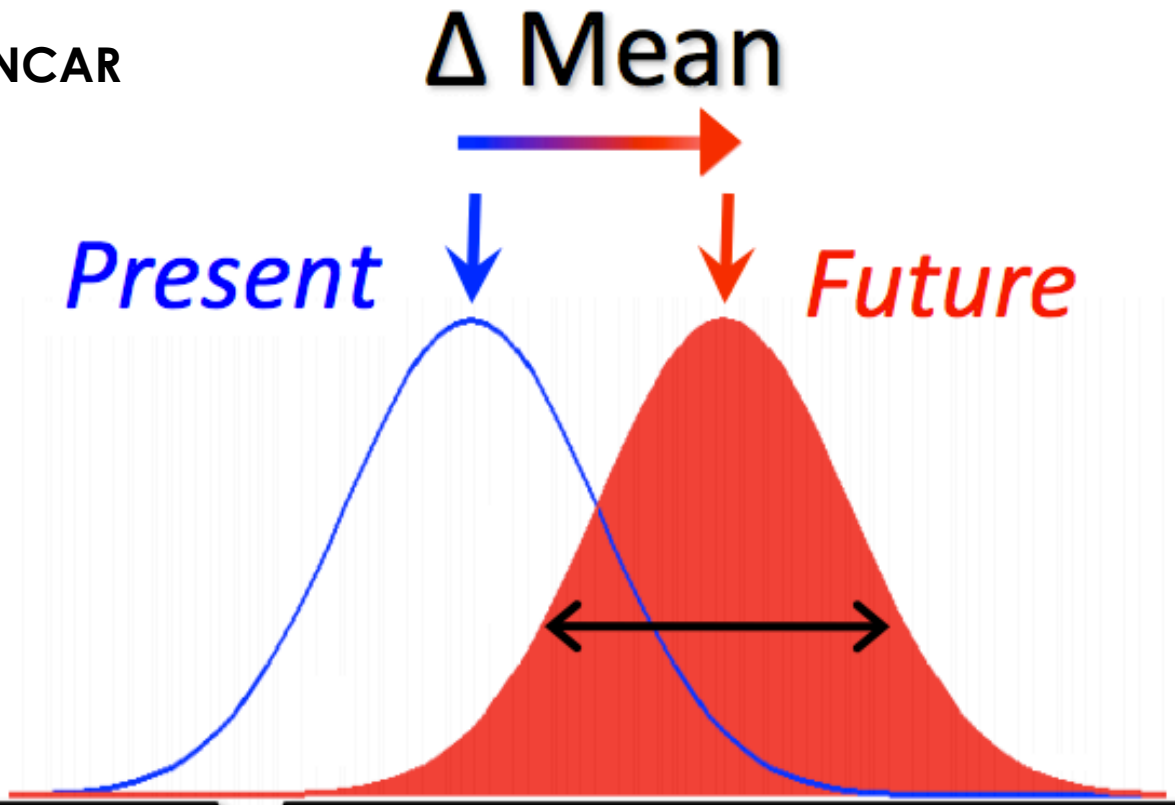


Confidence

$$\frac{\Delta \text{ Mean}}{\text{Uncertainty}}$$

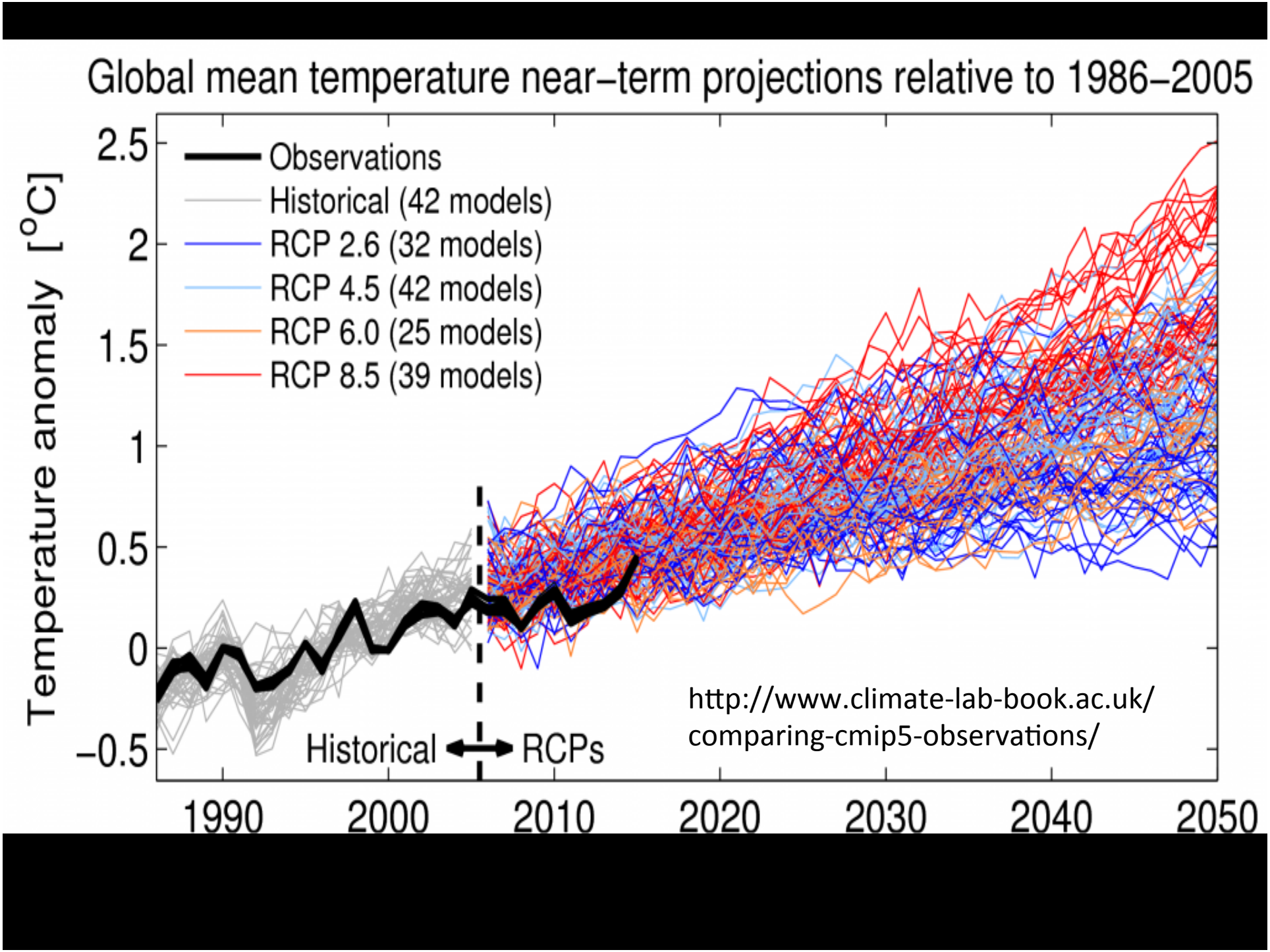
Uncertainty

- Radiative forcing scenario
- Model formulation
- Internal variability

Sources of Uncertainty

- Climate model physics (which model)
- Experiment (which factors, focus)
- Forcing (which emission scenarios)
- Initial conditions (which ensemble)
- Spatial downscaling (what resolution)
- Temporal downscaling (what timestep)
- Vegetation model (what parameters)

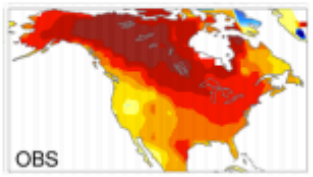
Without other information*, a priori*, all combinations are equally likely

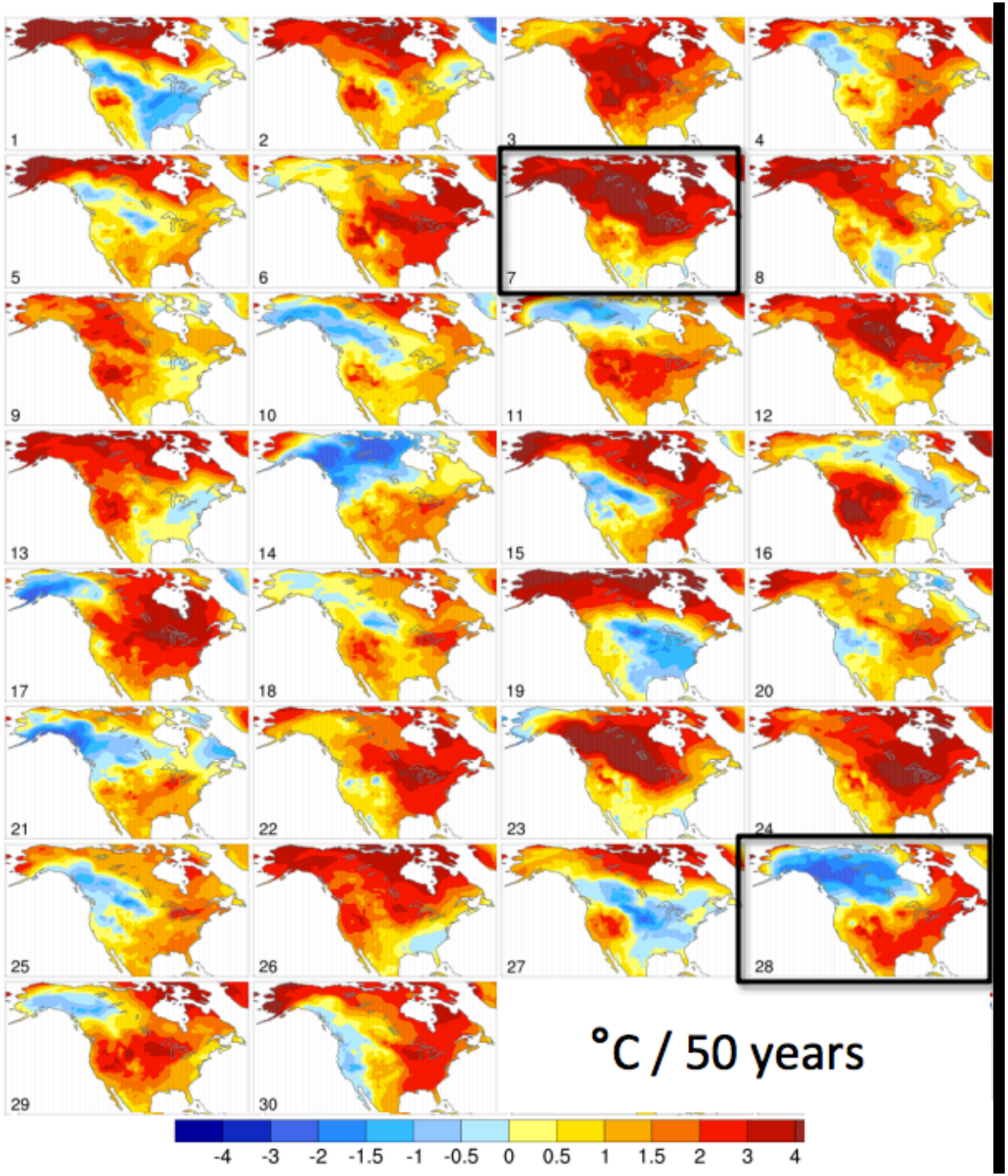

Global mean temperature near–term projections relative to 1986–2005
Temperature anomaly [°C]
2.5
2
1.5
1
0.5
0
–0.5
Observations
Historical (42 models)
RCP 2.6 (32 models)
RCP 4.5 (42 models)
RCP 6.0 (25 models)
RCP 8.5 (39 models)
Historical
RCPs
http://www.climate-lab-book.ac.uk/comparing-cmip5-observations/
1990
2000
2010
2020
2030
2040
2050

CESM1 30-member ensemble

Internal variability

Observed





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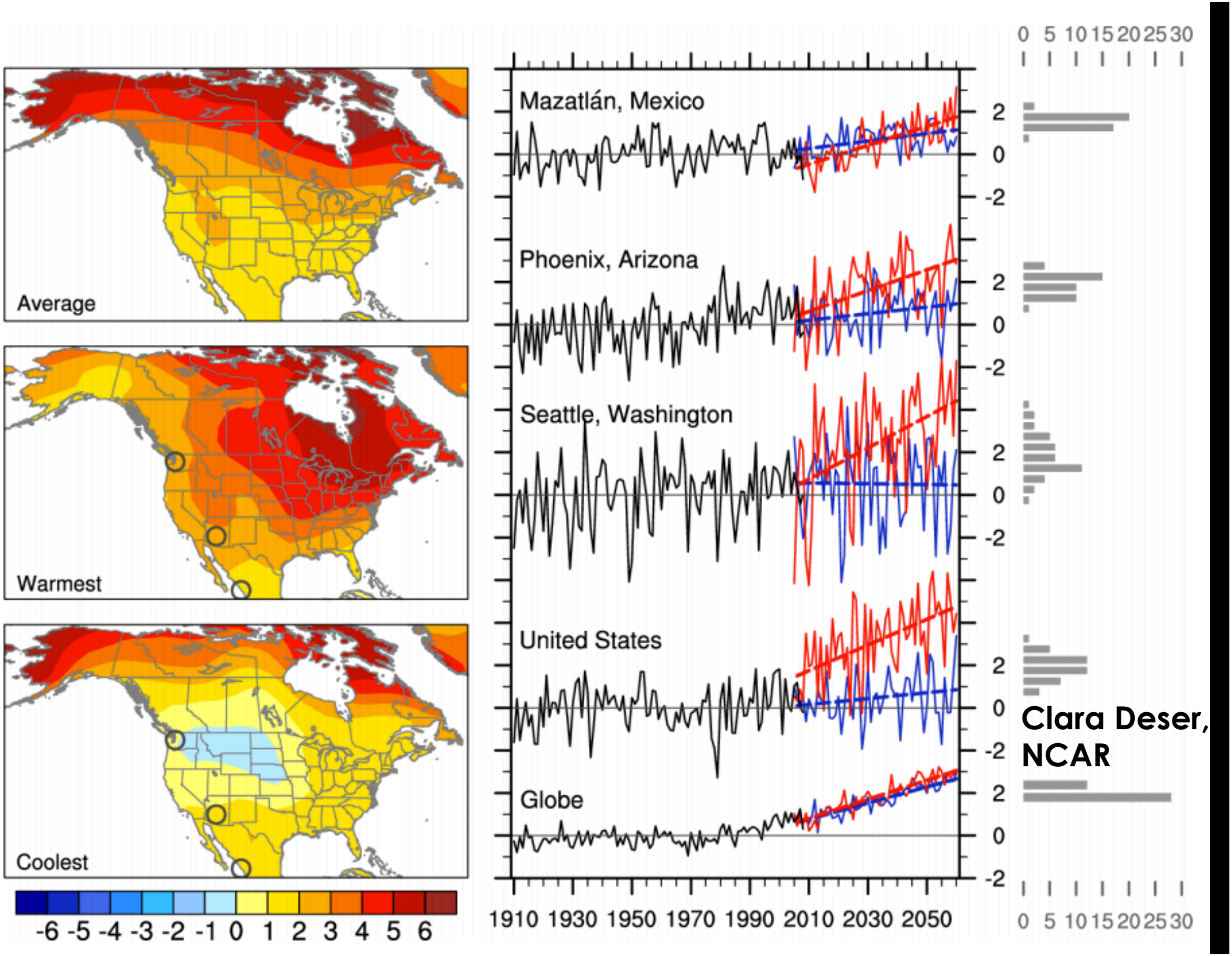
POP QUIZ

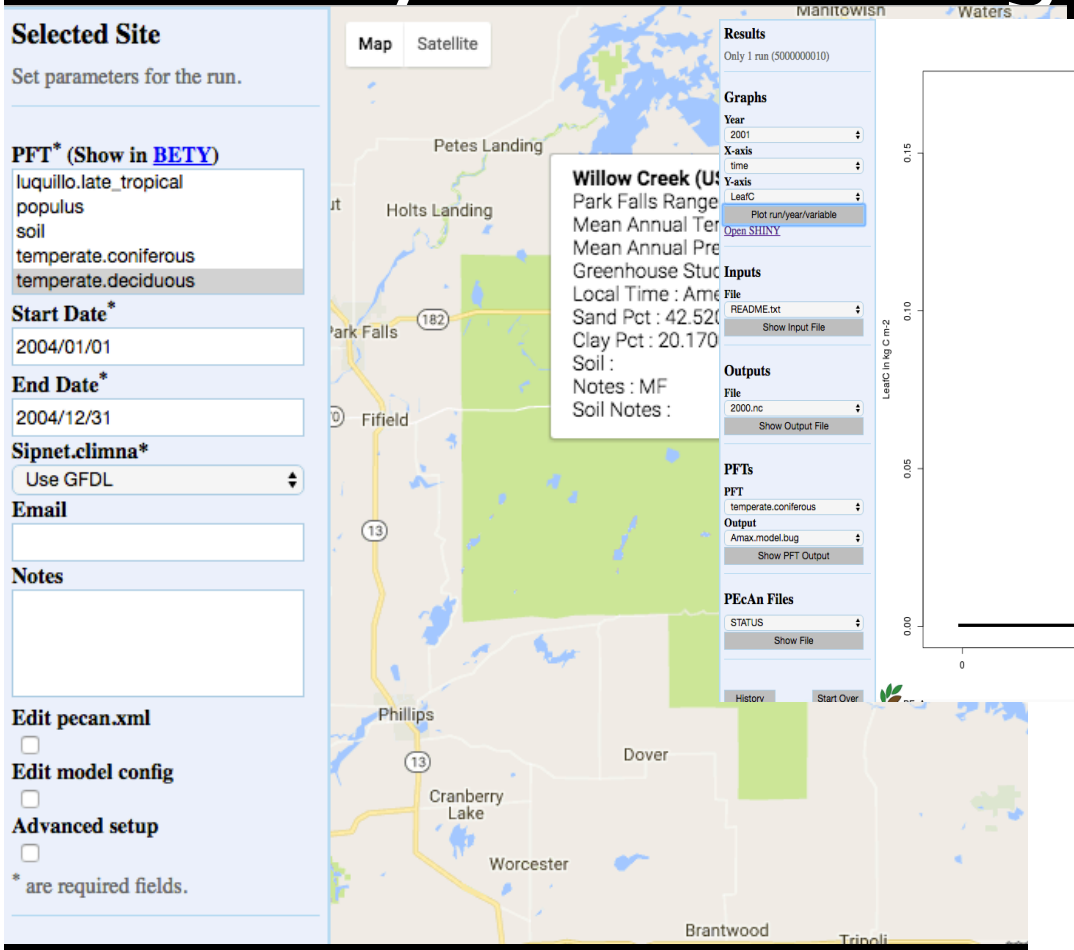
The smaller in spatial scale and the closer in time to present your analysis, the ***GREATER*** the uncertainty

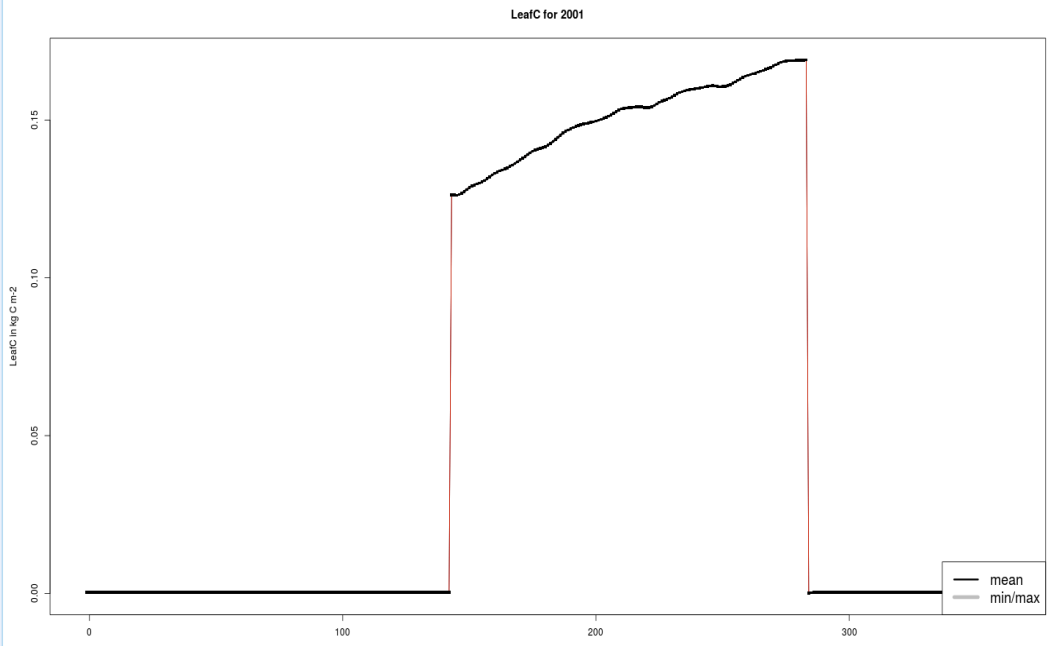

Average
Warmest
Coolest
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
Mazatlán, Mexico
Phoenix, Arizona
Seattle, Washington
United States
Globe
2
0
-2
1910 1930 1950 1970 1990 2010 2030 2050
0 5 10 15 20 25 30
Clara Deser, NCAR

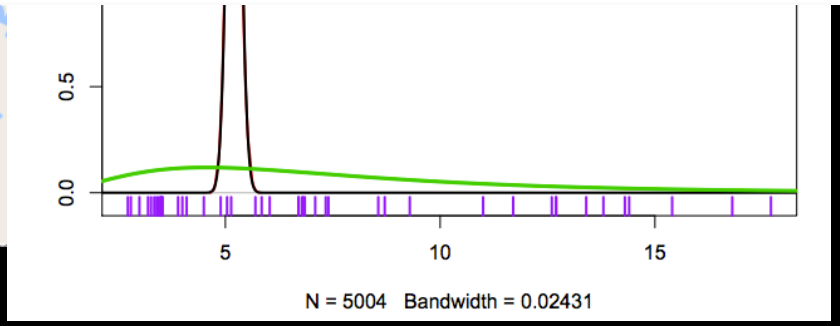
What is happening now?

- CMIP6 (Coupled Model Intercomparison Project) is conducting 20+ separate model experiments each involving up to 2 dozen climate models with multiple ensembles and a dozen emission scenarios to provide information for the IPCC 6th assessment by 2018 or so
  - Focus on specific sources of uncertainty, policy scenarios, new modeling developments (resolution, feedbacks)

New "cyberinfrastructure" for ecosystem change assessment







http://pecanproject.org (NSF Bioinformatics)

Dos and Don'ts in Climate Change Ecosystem Adaptation Application of Climate Models

- Do not pick just one model, one emission scenario, one downscaling method because that's what you can find
- Do not neglect internal climate variability
- Do think in terms of statistical probability for factors that matter to your system of interest (extremes, re-occurrence interval, thresholds)
- Do focus on **water, winter, and "black swans"**: Recent published literature shows a range of plant response to climate, but greatest effects in places where water cycle impacts physiology and demography, esp. with drought and snow, emergence of novel climates, and surprise disturbance regimes shifts

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]

nature plants
ARTICLES
PUBLISHED: 5 SEPTEMBER 2016 | ARTICLE NUMBER: 16132 | DOI: 10.1038/NPLANTS.2016.132

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. Rosenthal[1†], Ursula M. Ruiz-Vera[1], Matthew H. Siebers[1†], Reid Strellner[1], Elizabeth [illegible]g[1], Donald R. Ort[1,2] and Andrew D. B. Leakey[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]

Montane ecosystem productivity responds more to global circulation patterns than climatic trends

A R Desai[1,2], G Wohlfahrt[3,4], M J Zeeman[2], G Katata[2,5], W Eugster[6], L Montagnani[7,8], D Gia[illegible]
M Mauder[2] and H-P Schmid[2]

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

Temperate forest health in an era of emerging megadisturbance

Constance I. Millar[1*] and Nathan L. Stephenson[2]

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

ROBBIE A. HEMBER[1,2], WERNER A. KURZ[2] and NICHOLAS C. COOPS[1]

Beyond arctic and alpine: the influence of winter climate on temperate ecosystems

Laura M. Ladwig,[1,12] Zak R. Ratajczak,[2] Troy W. Ocheltree,[3] Katya A. Hafich,[4] Amber C. Churchill,[4,5] Sarah J. K. Frey,[6] Colin B. Fuss,[7] Clare E. Kazanski,[8] Juan D. Muñoz,[9] Matthew D. Petrie,[1] Andrew B. Reinmann[10] and Jane G. Smith[11]

nature climate change
LETTERS
PUBLISHED ONLINE: 19 SEPTEMBER 2016 | DOI: 10.1038/NCLIMATE3127

Mapping climatic mechanisms likely to favour the emergence of novel communities

Alejandro Ordonez[1*], John W. Williams[2,3] and Jens-Christian Svenning[1]