

# Enhancing Climate Prediction Information by Capturing Where People Aren't Looking

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Utah State University, USA

Enhancing Climate Prediction Information  
by Capturing **Where People Aren't Looking**

- **Processes of extremes** (can blame it to GW?)
- **Sources of predictability** (can or can't forecast?)
- **Education** (ready for a new discipline ?)

One solution to

# Enhancing Climate Prediction Information

by Capturing Where People Aren't Looking

lies in



Higher Education 2.0

# Enhancing Climate Prediction Information

Build Bachelor & Master Degrees for

**Meteorologist (BS) vs.**

- **Climate Forecaster (Ph.D.)**
- **Climate Communicator (?)**

# (1) Climate Prediction Information

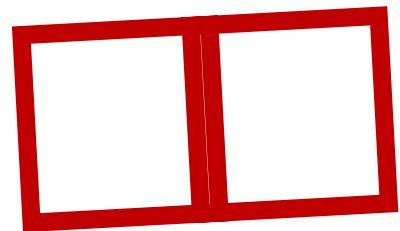
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(2)



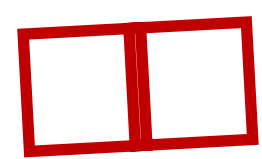
## Weather

Immediate, can feel



## Climate

Delayed, mixed feeling



## Change

Extrapolated

Information

perception

# Weather

I know what I need

Information

# Climate

Not sure what I need

User

# Change

Think what I will need

# Weather

Don't care what you need

Information

# Climate

What is it that you need?

Provider

# Change

Whatever you need...

Weather

Information

User



Provider

Climate

What is it that you need?

Change

6 - 10 of 90 days | All 90 da

Next month

Next next month

Next year

Next decade

SAT  
AUG 18



88°/74°F

Partly sunny;  
humid



88°/74°

A stray morning  
thunderstorm

More



87°/74°

Partly sunny, a  
stray shower

More



87°/74°

Clouds and sun;  
humid

More



89°/74°

A little afternoon  
rain

More

Information

Climate  
Prediction  
?

# VISION AND RESEARCH STRATEGIES FOR THE

## NEXT DECADE

*S2S forecasts will be as widely used a decade from now as weather forecasts are today*

Forecast Period	Icon	Temperature Range	Description
Next month	Sunny with a cloud	88°/74°	A stray morning thunderstorm
Next next month	Partly sunny with a cloud	87°/74°	Partly sunny, a stray shower
Next year	Sunny with a cloud	87°/74°	Clouds and sun; humid
Next decade	Cloudy with rain	89°/74°	A little afternoon rain

**NEXT GENERATION EARTH SYSTEM PREDICTION**

STRATEGIES FOR SUBSEASONAL TO SEASONAL FORECASTS

The National Academies of  
SCIENCES • ENGINEERING • MEDICINE

2016

# *Climate Forecast*



(1)

# Climate Projections Information



(1)

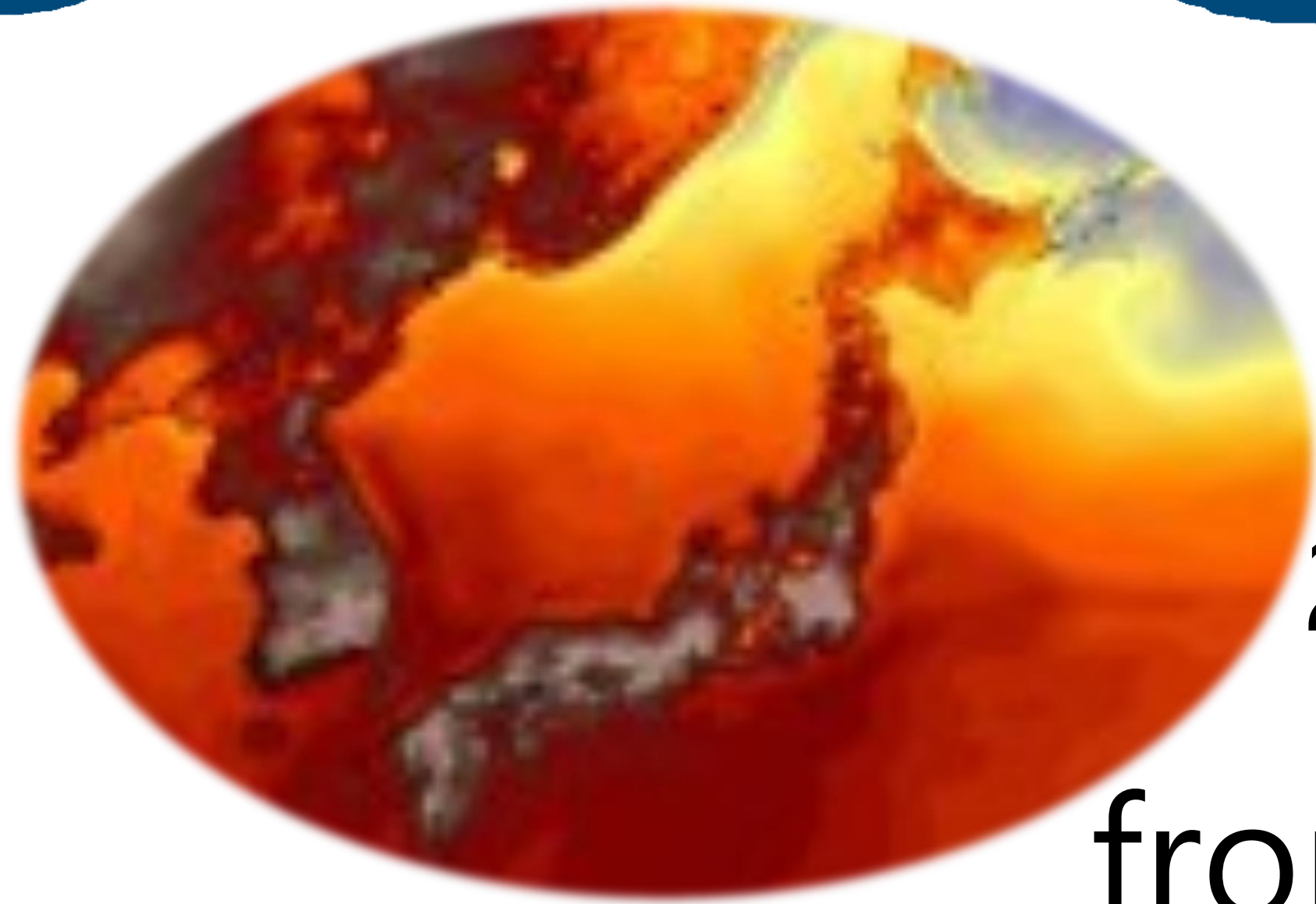
## Climate Prediction

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**Timescale** (weeks, season, decade)

**Content** (beyond El Niño/ENSO)

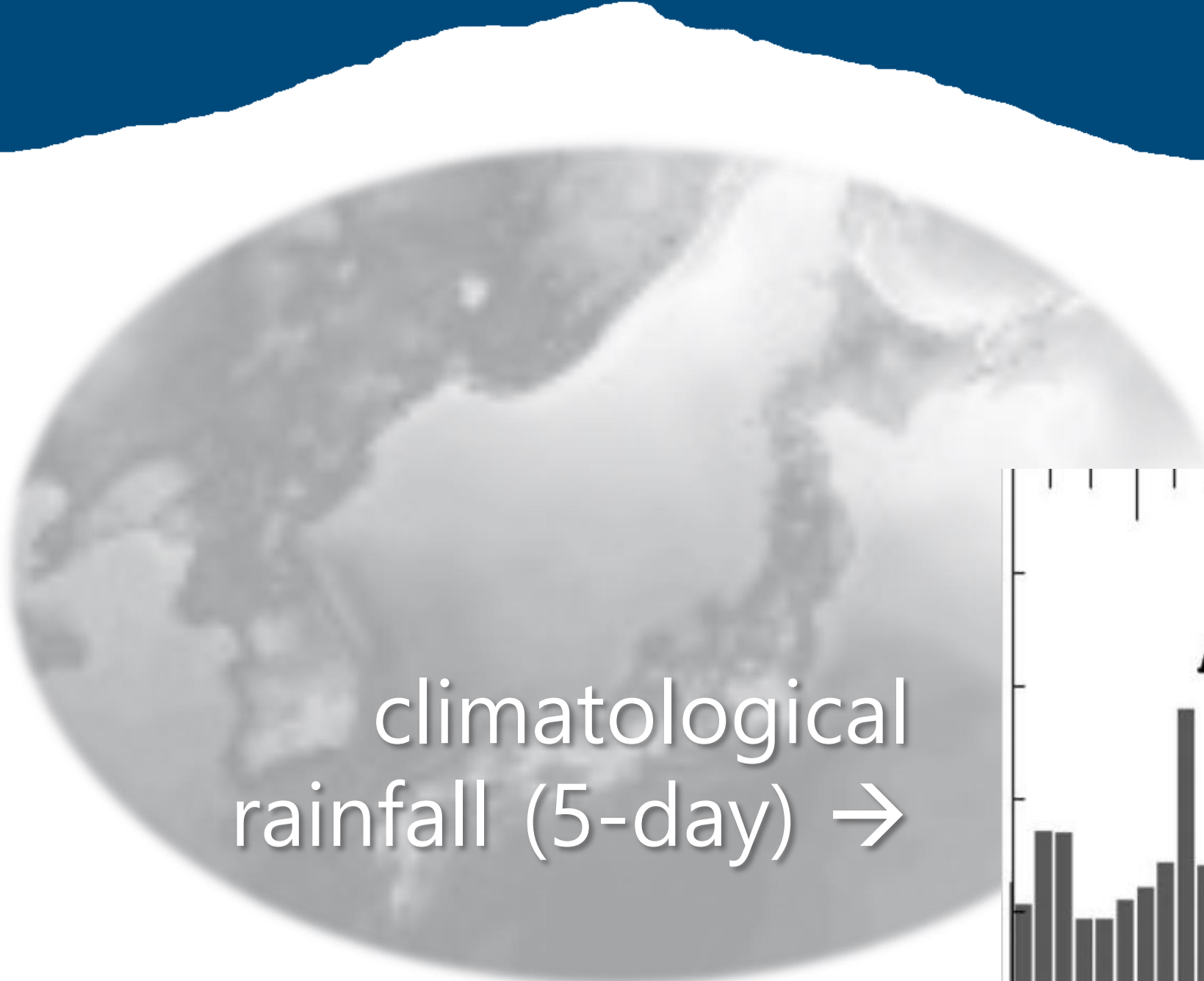
**Extremes** (unexpected)



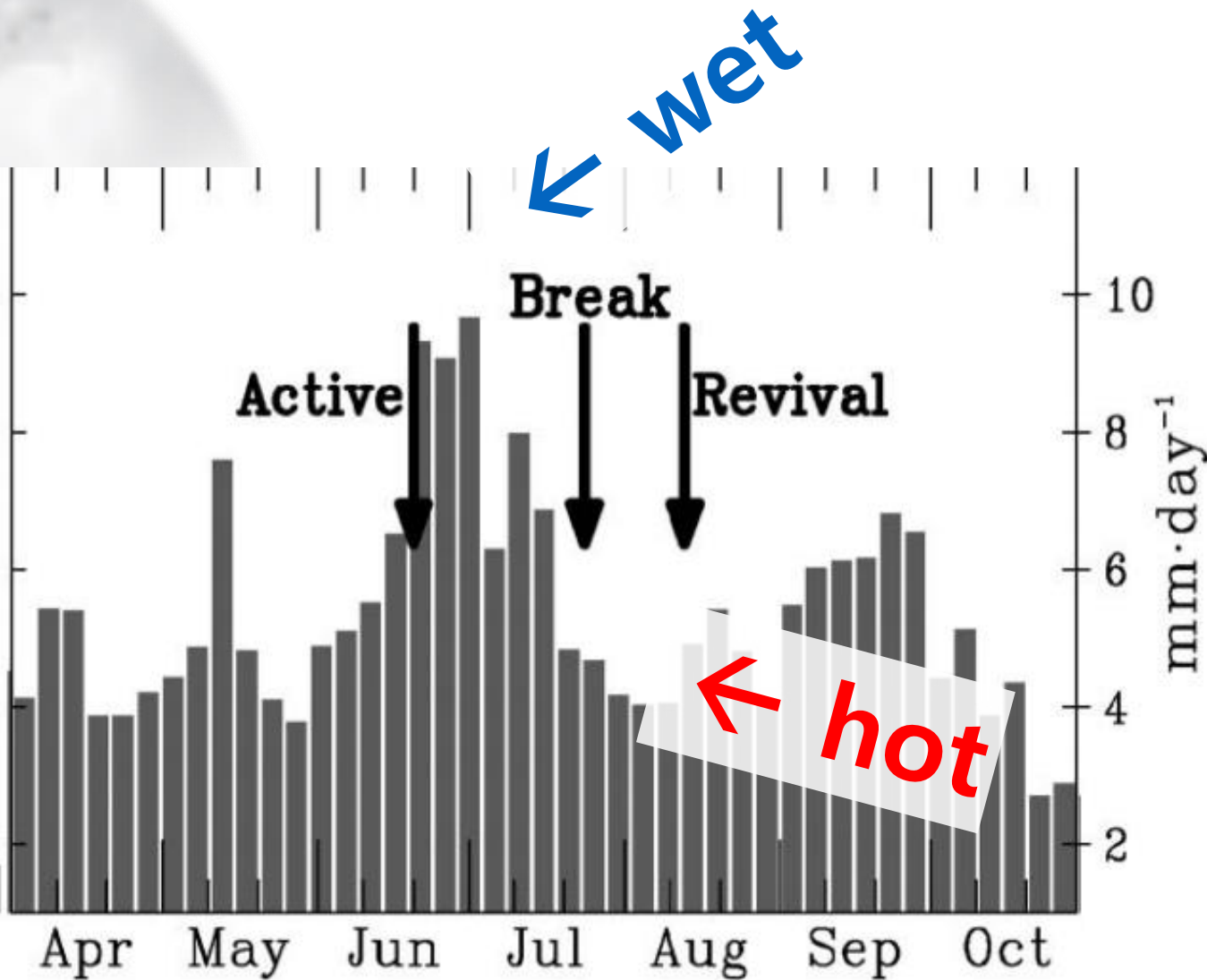
2018 Korea & Japan:  
from flood to heat

**Extremes** (unexpected)

# East Asian summer monsoon lifecycle



climatological rainfall (5-day) →



**Extremes** ( ↑ what's expected)

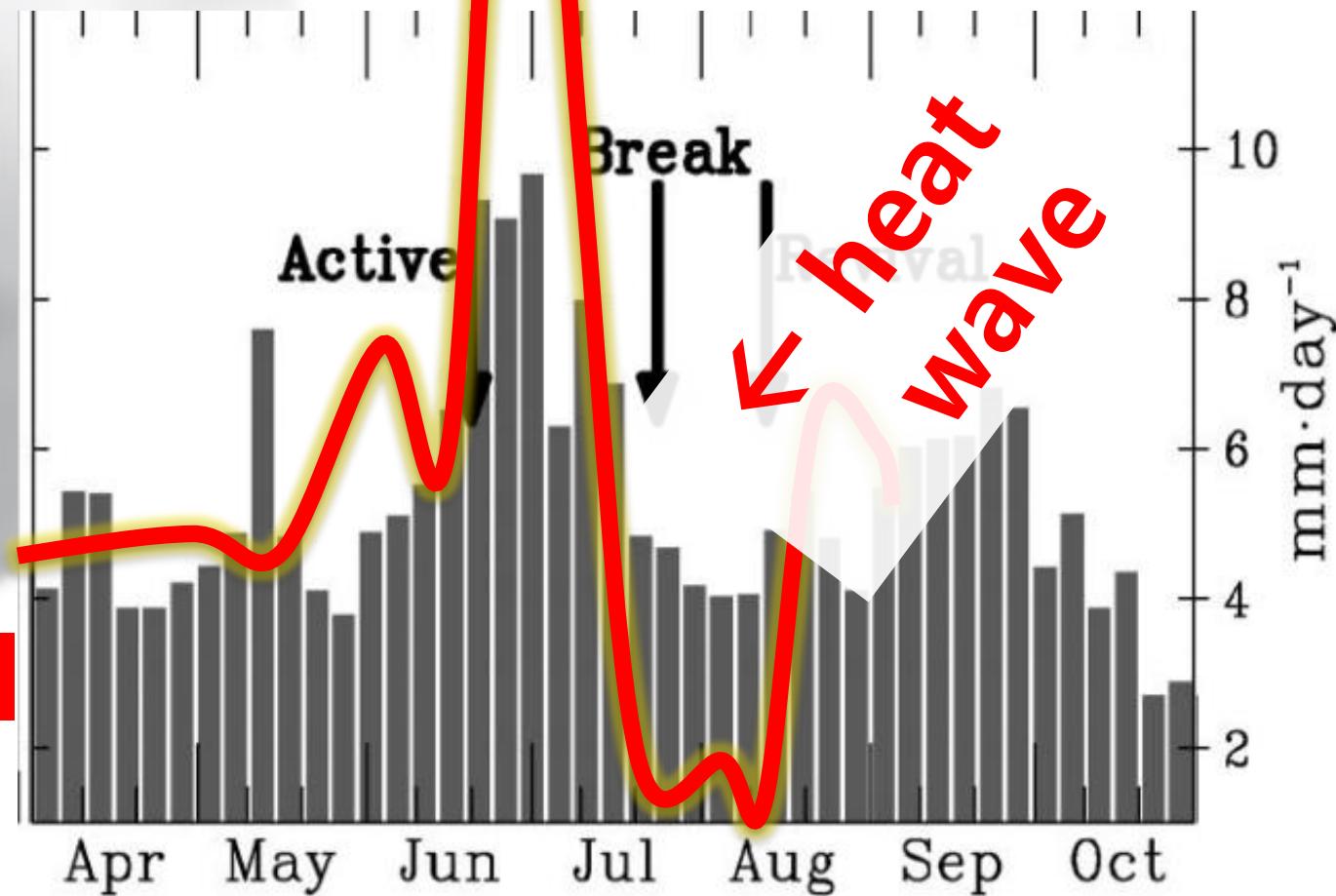
East Asian summer monsoon lifecycle **boosted?**

← **flood**

← **heat wave**

climatological rainfall (5-day) →

**2018 rainfall**

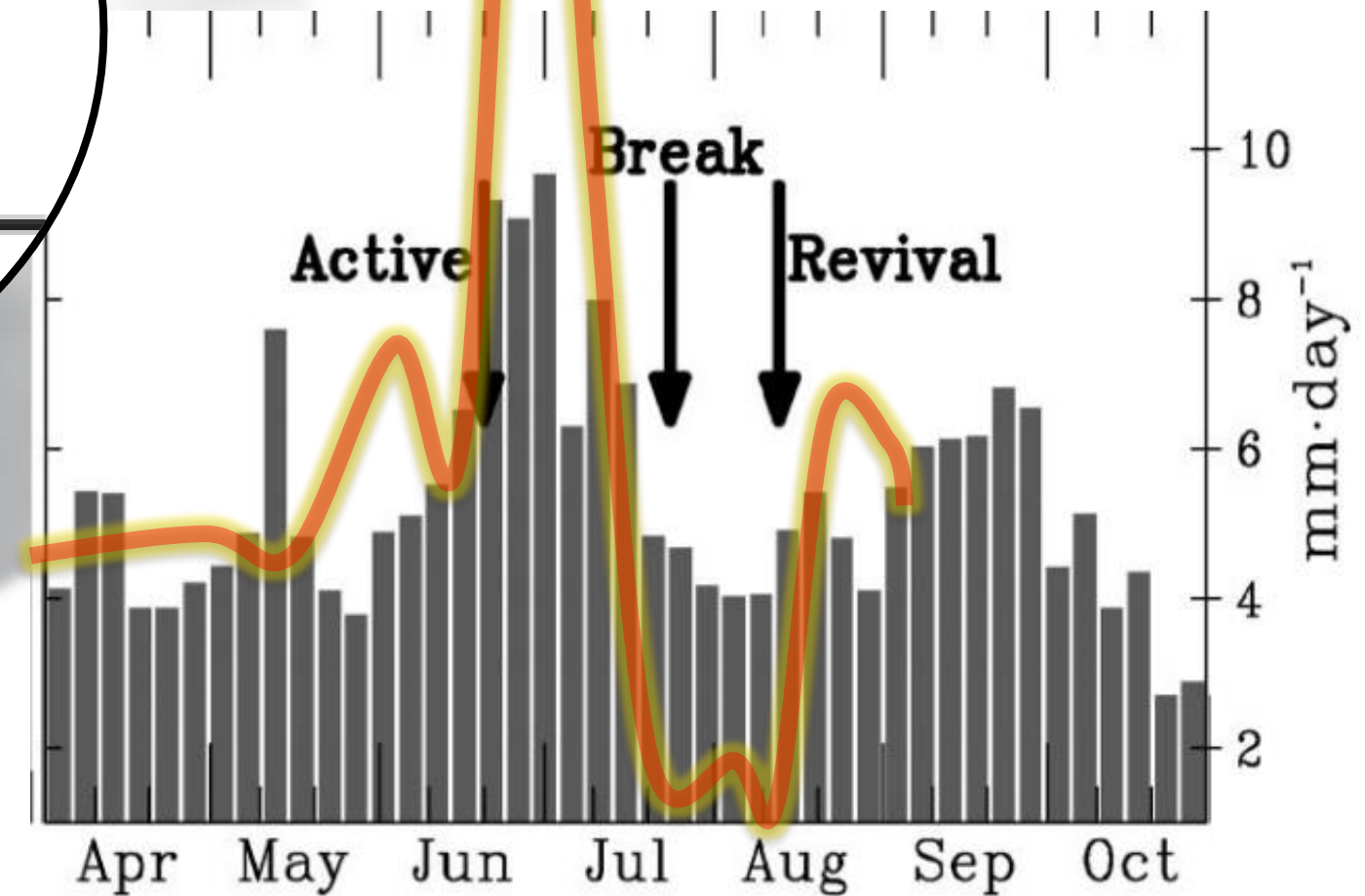


**Extremes** (that's unexpected)

East Asian summer monsoon lifecycle **boosted?**

CMIP5 projection  
(RCP8.5)

- - - future



**Extremes** (or is it so unexpected?)

(1) Climate Prediction Information

(2)

**Goal:**

(1)  $\approx$  (2)

# How does the U.S. do it?



Drought Information System (NIDIS)

+ River Forecasting Centers

Climate Prediction Center

Hydrological Prediction Center

Storm Prediction Center

National Water Center

How does the U.S. do  
it?



Product development should be driven by consumers – rather than **scientists** or **donor agencies** assuming what data might be useful or what climate impacts are of most concern.

Storm Prediction Center

- Webber and Donner (2017)

**Require bottom-up forecast development. But  
can only afford top-down forecast development.**

**said Chief of the Operations Branch**

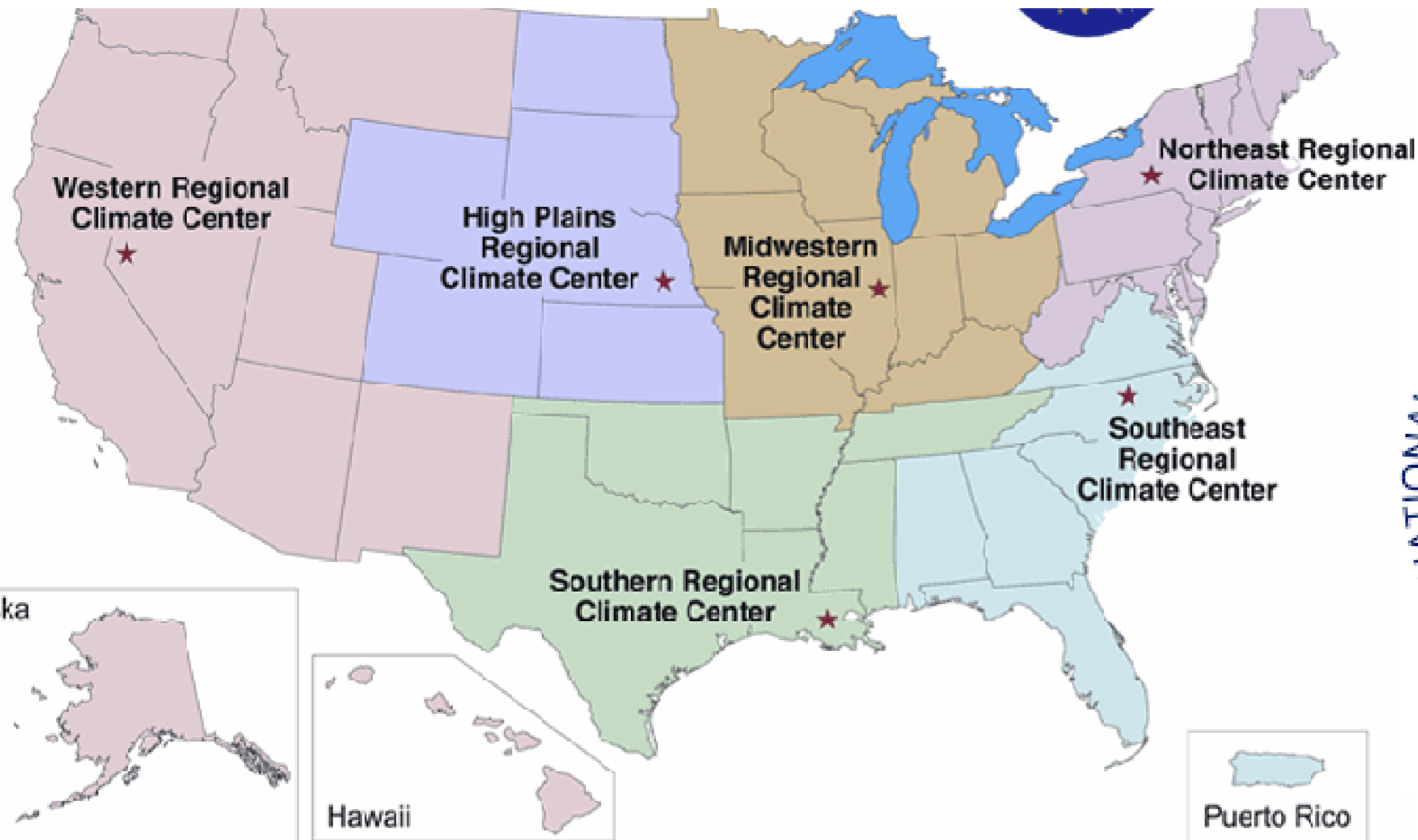
A map of the United States showing the outlines of the states and a grid of latitude and longitude lines. Five colored squares are placed on the map: a blue square in the central US, a yellow square in the central US, a purple square in the central US, a green square in the Northeast, and a red square in the Northeast. A red arc is drawn in the upper right quadrant of the map.

**Climate Prediction Center**

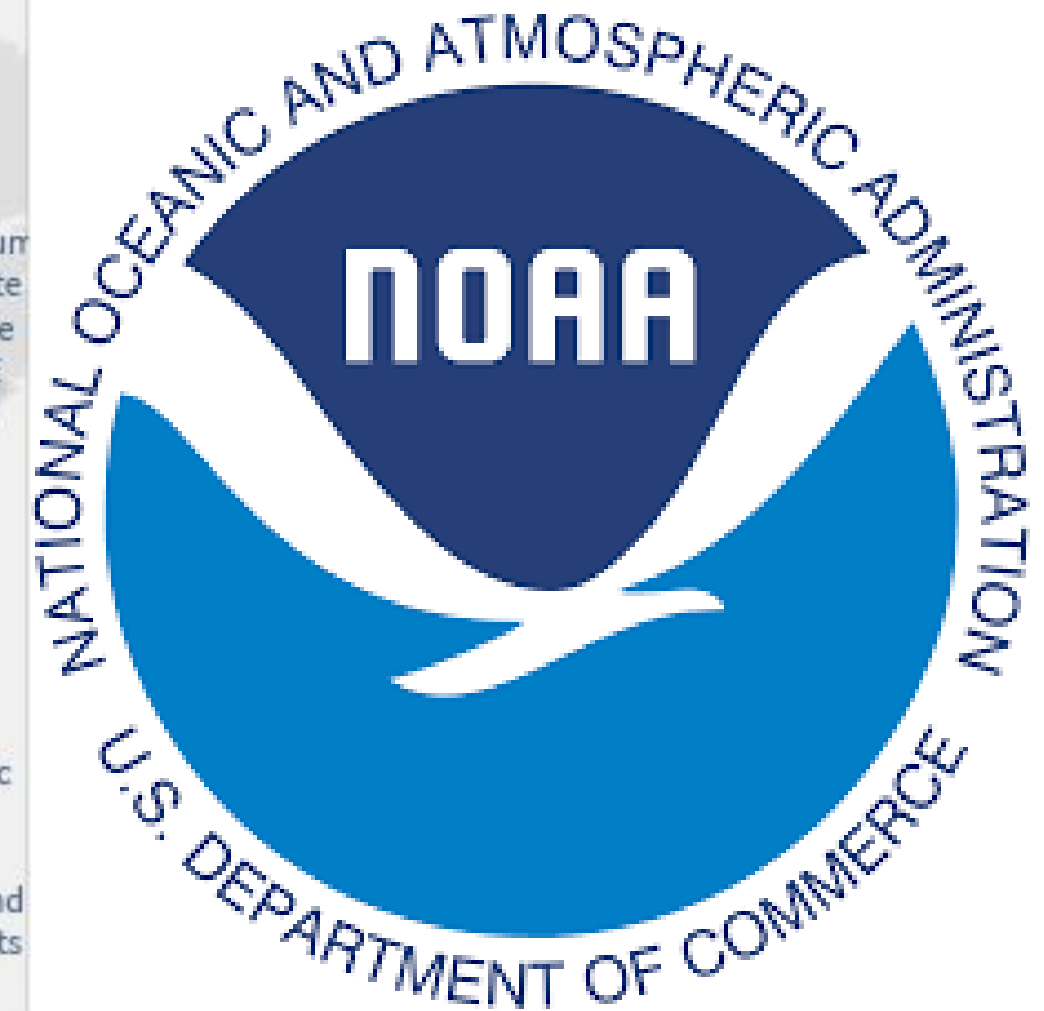
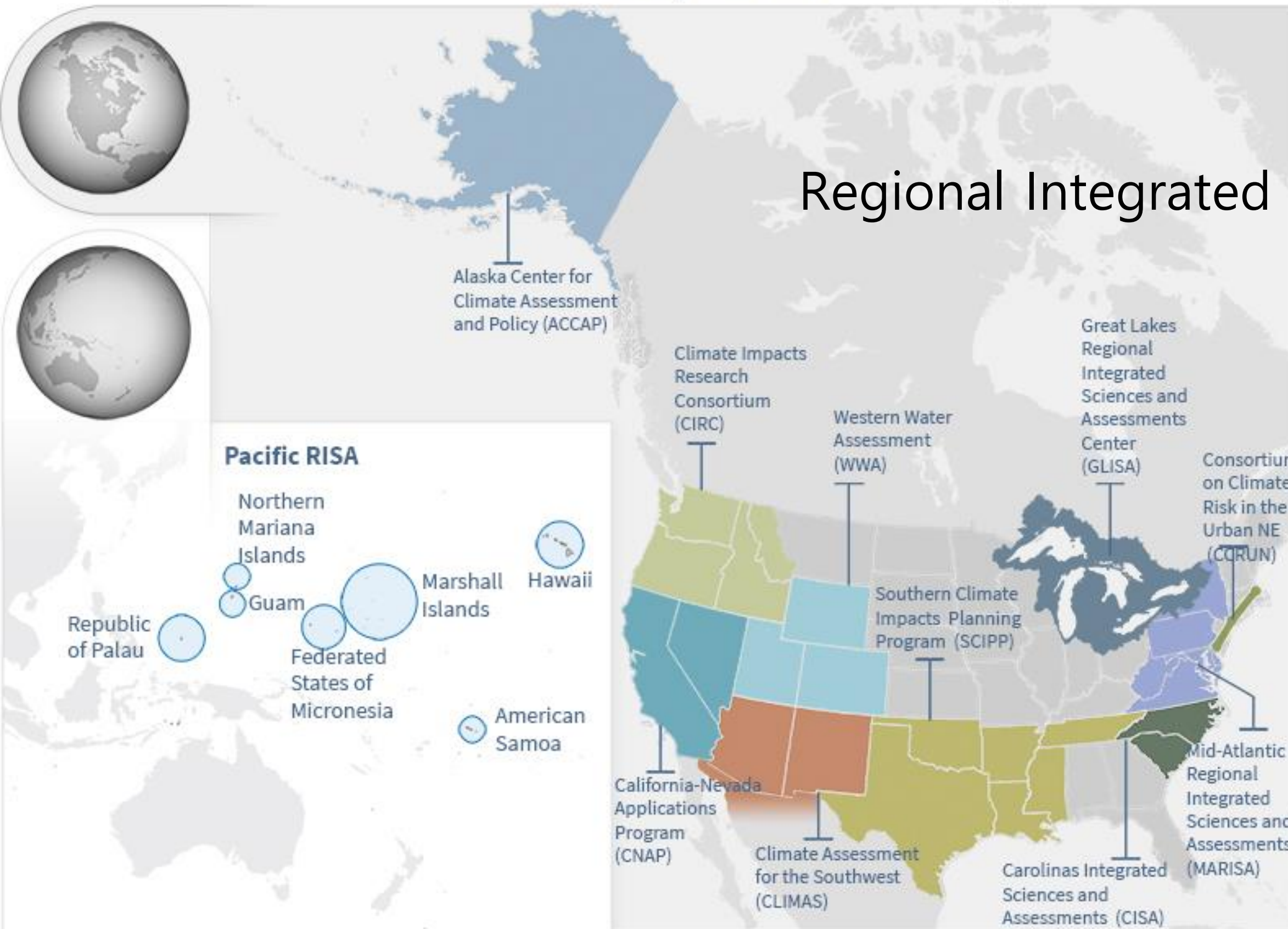
**...for it's impossible for government entities to meet everyone's different needs!**



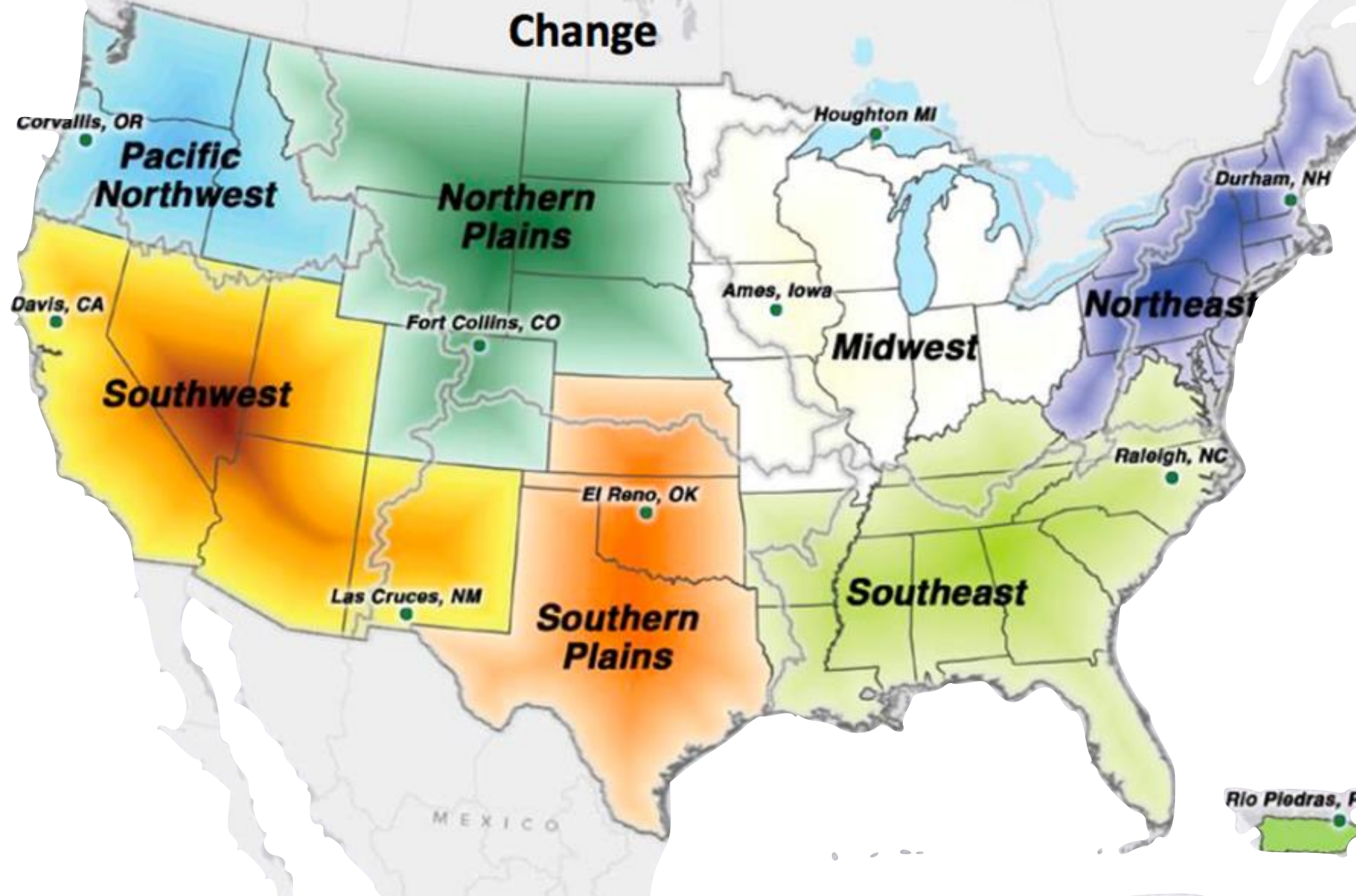
Still, the gov needs regional “centers” to handle and deliver climate information.



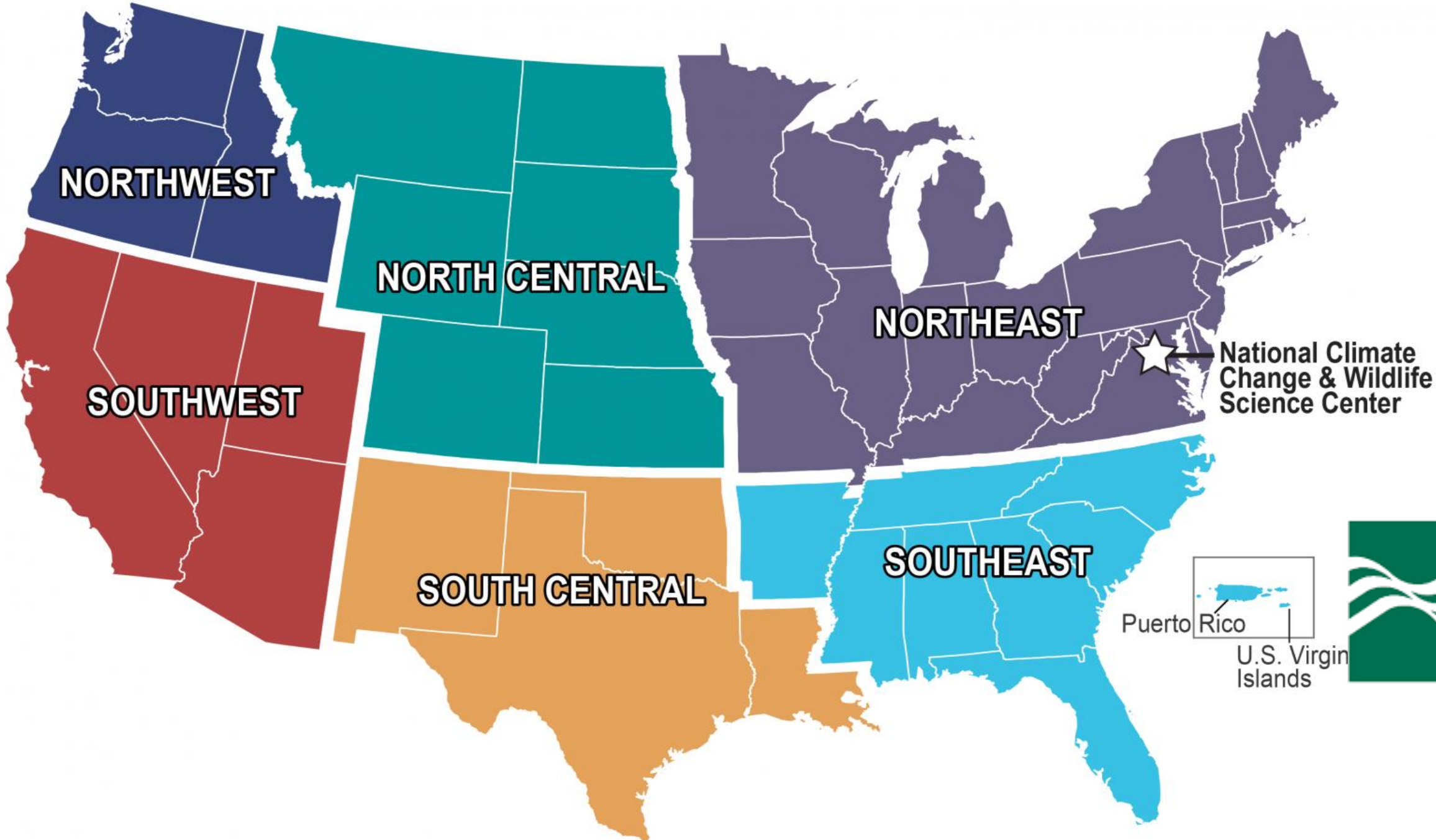
# Regional Integrated Sciences and Assessments



**USDA Climate Hubs for Risk Adaptation and Mitigation to Climate Change**

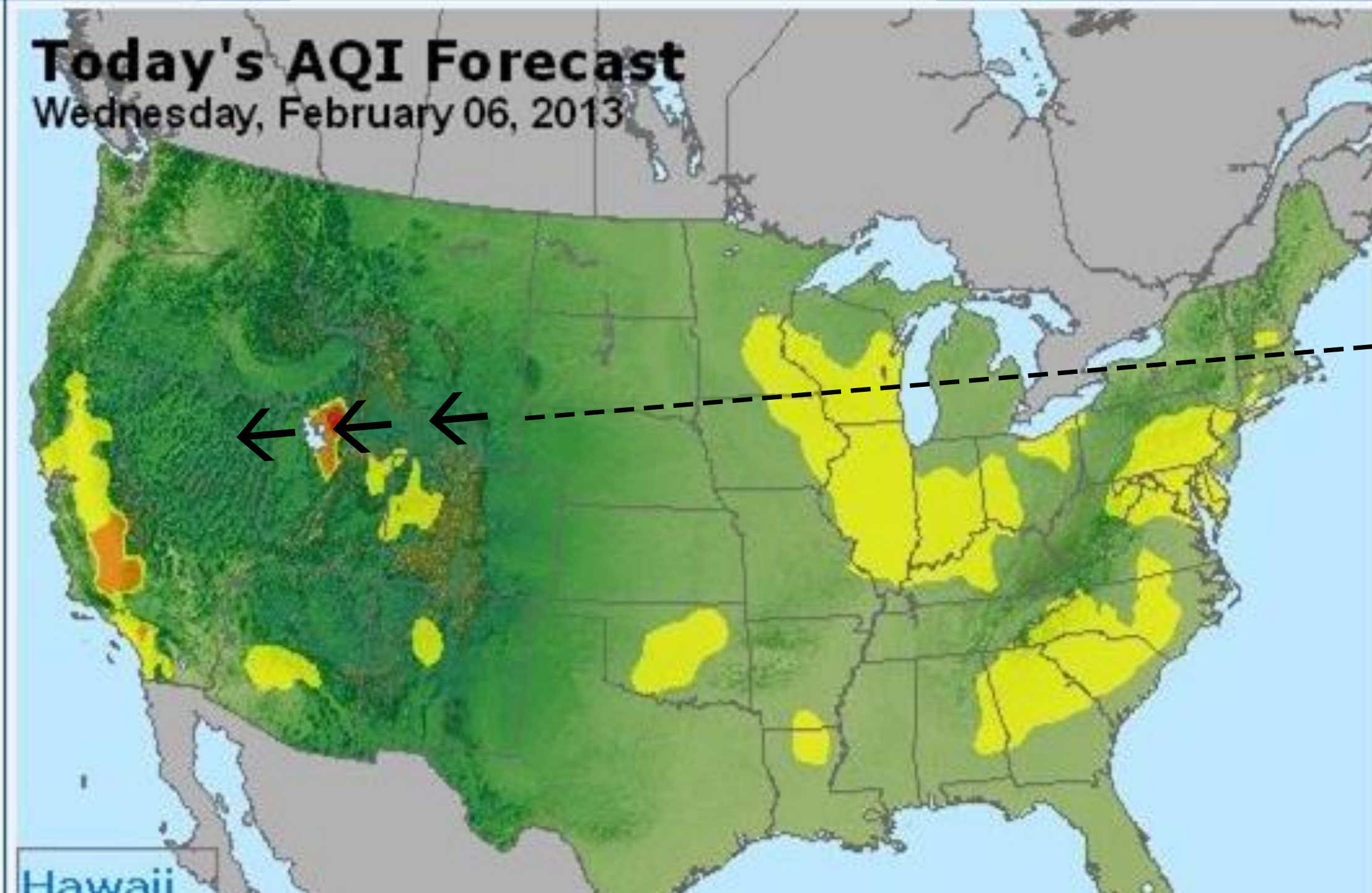


# Climate Science Centers



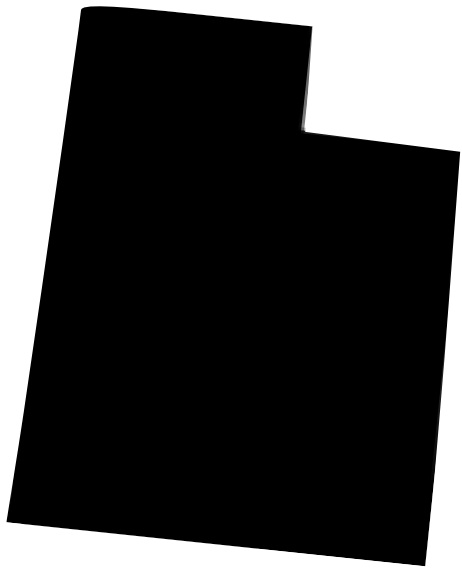
# Today's AQI Forecast

Wednesday, February 06, 2013



bad air quality!  
t...still not  
nough to  
meet user  
needs



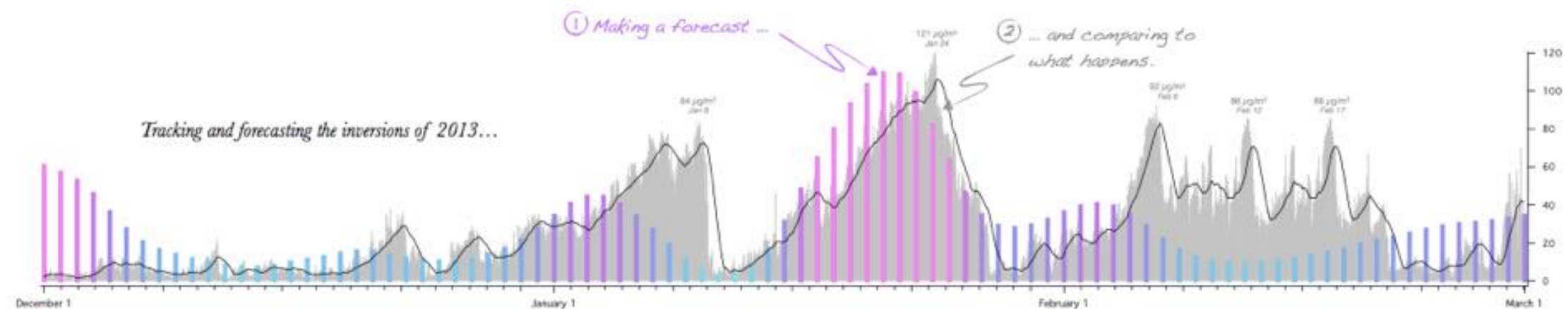


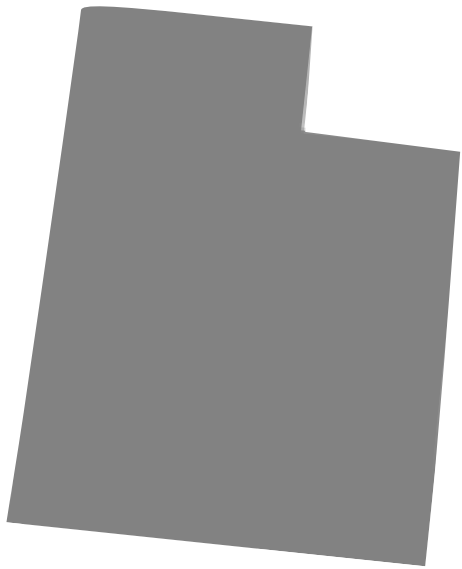
# Localized Forecasts

## Inversions ...



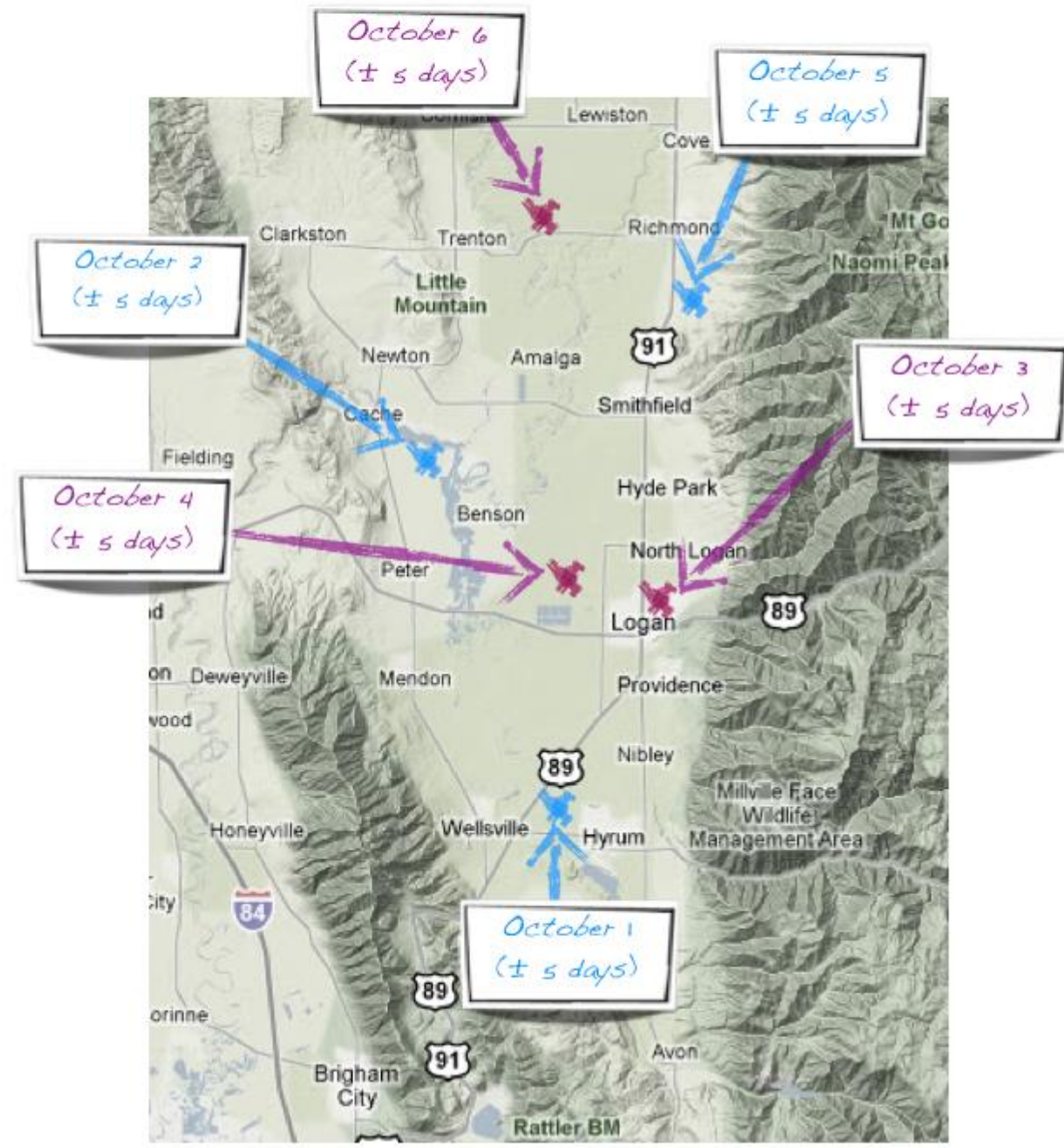
30-day forecasts



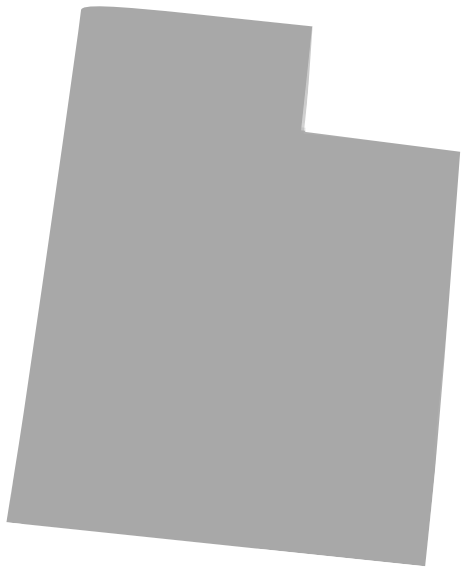


# Localized Forecasts

## First Freeze ...



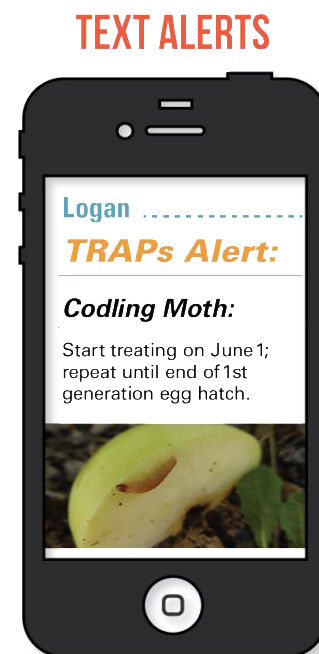
30-day forecasts

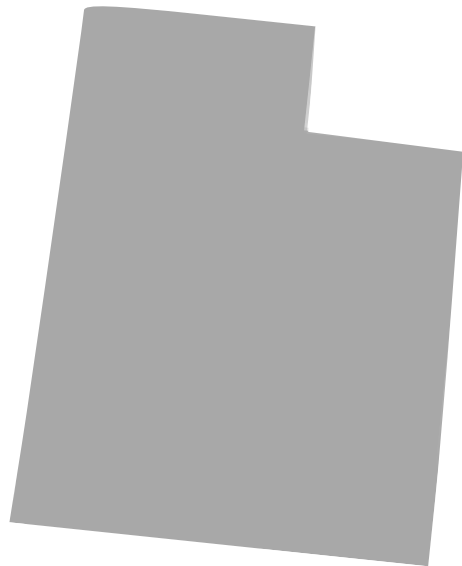


# Localized Forecasts



# Pest control Nowcasting





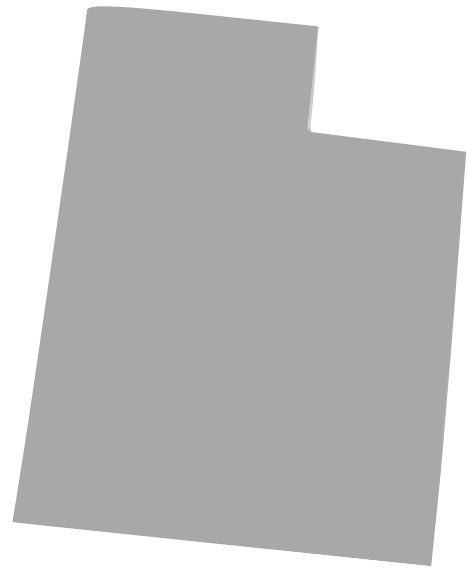
water level  
vs. zoning

Build it or not build it?



Great Salt  
Lake flooding



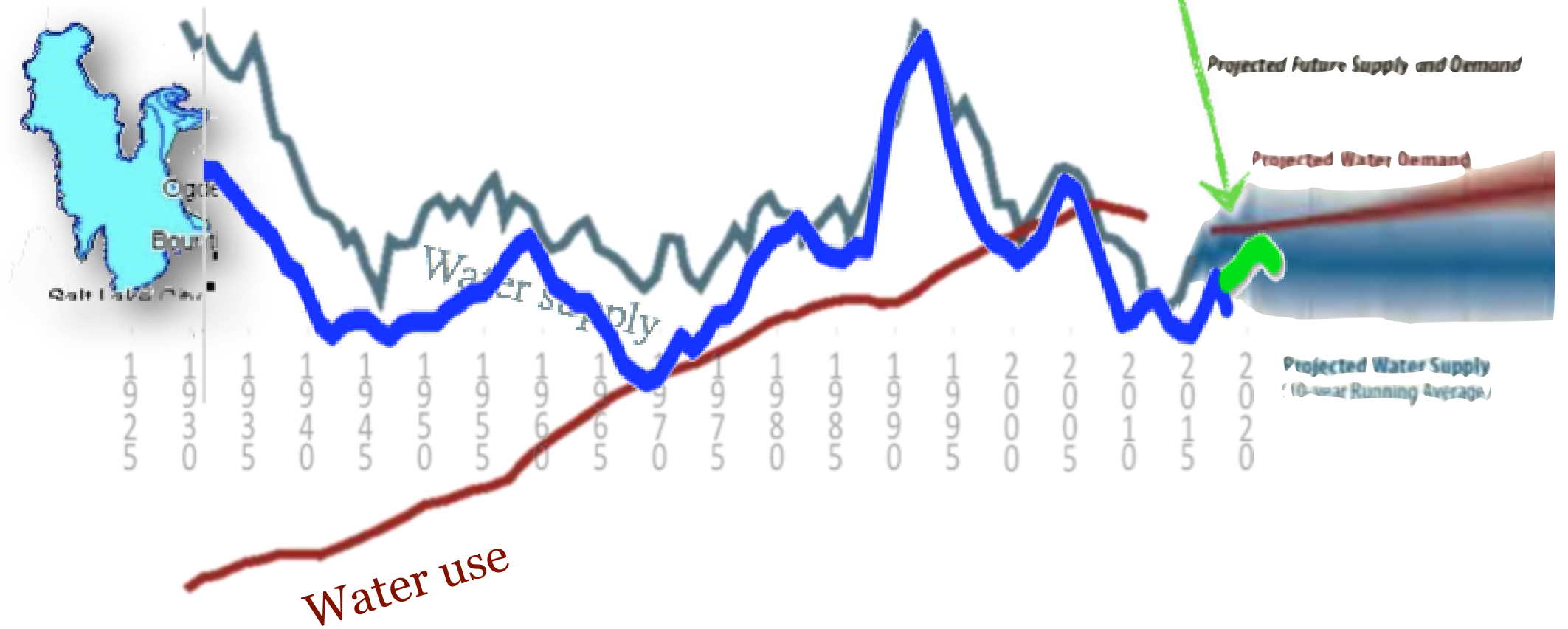


water supply

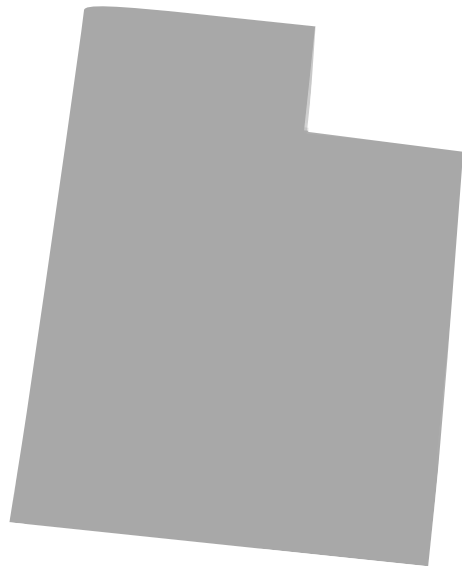
# Colorado River Water Supply

GSL water level

*forecast*



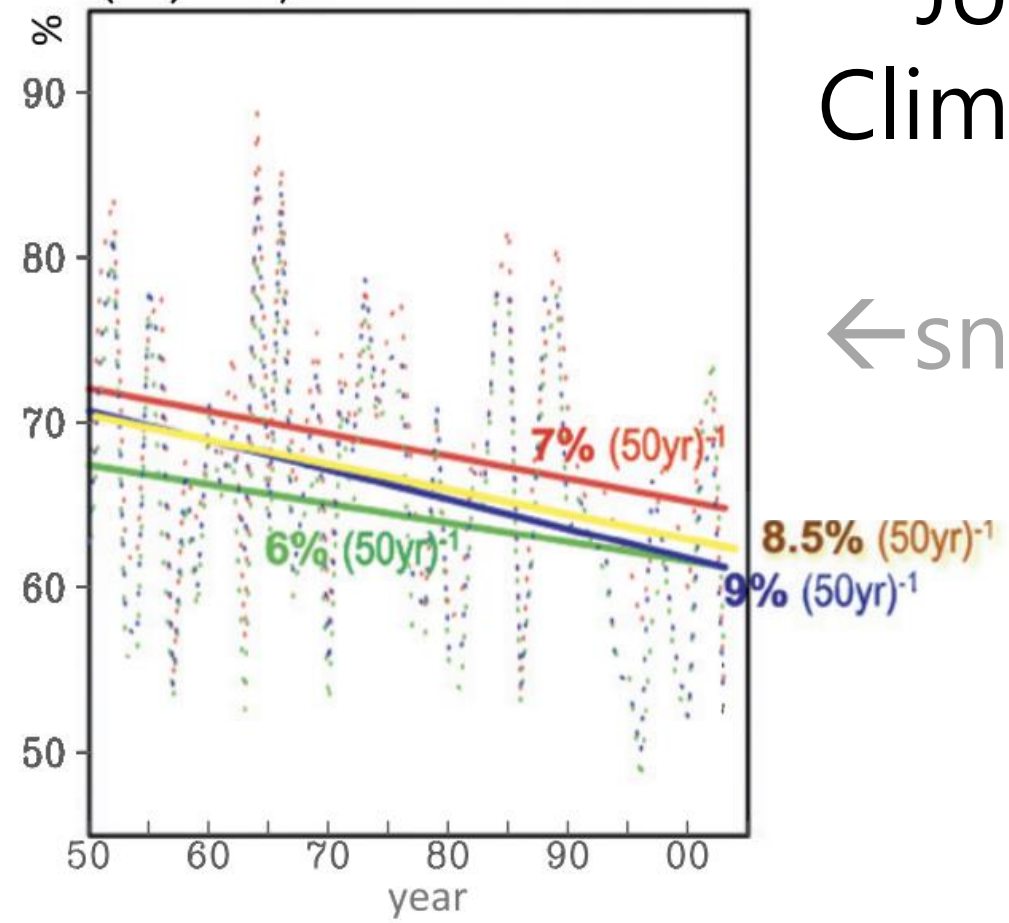
*J. Hydrometeorology (2011, 2018), J. Hydrology (2015)*



future fun?



(h) S/P

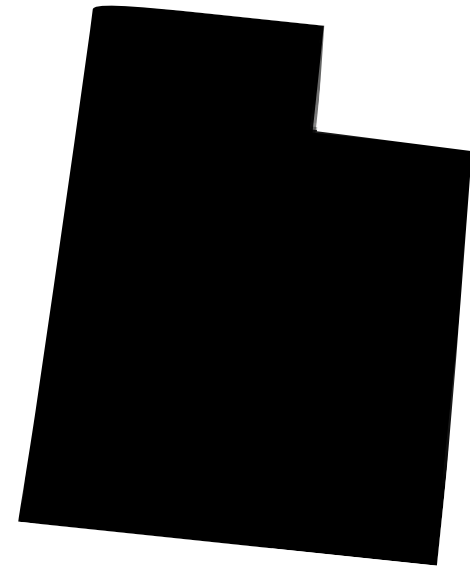


Journal of Climate (2012)

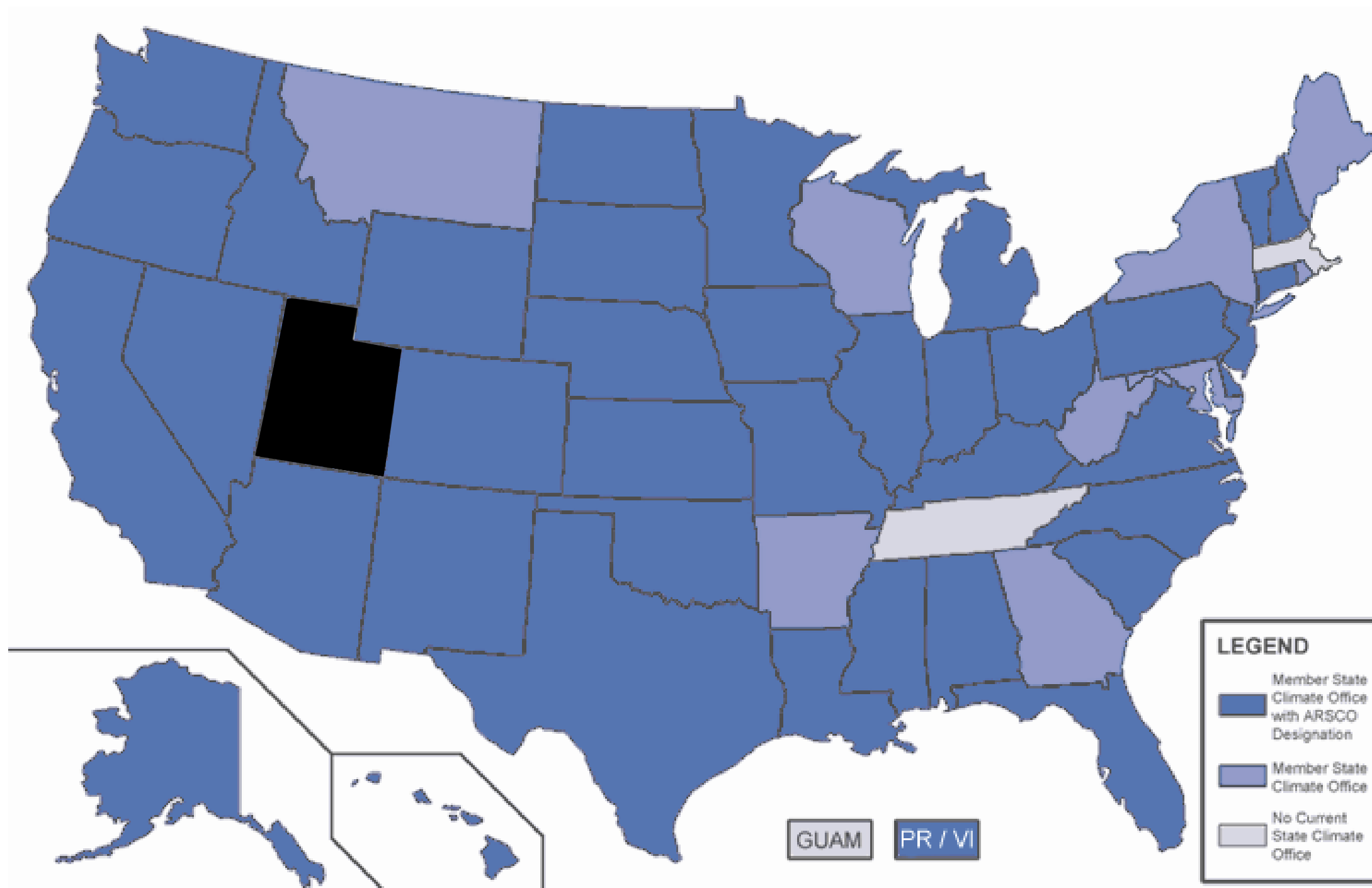
← snow/precip



© Alta Ski Area



**University extension:** its researchers and educators engage individuals and organizations in asking the challenging questions to discover science-based answers **that make a difference.**



## State Climate Offices (state climatologists)



**Asian countries have similar extension entities,  
maybe smaller or fewer.**



# Asian countries

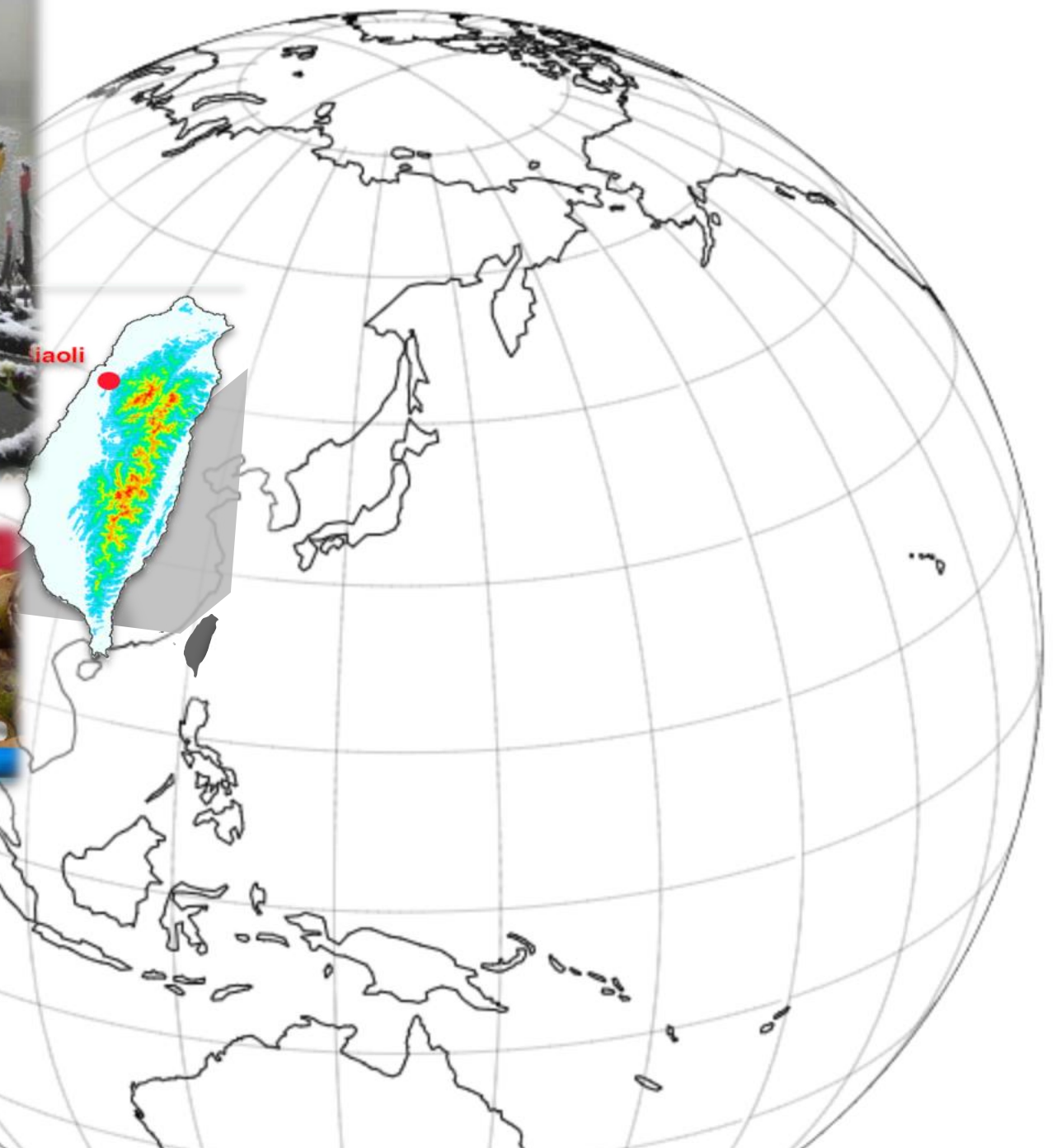
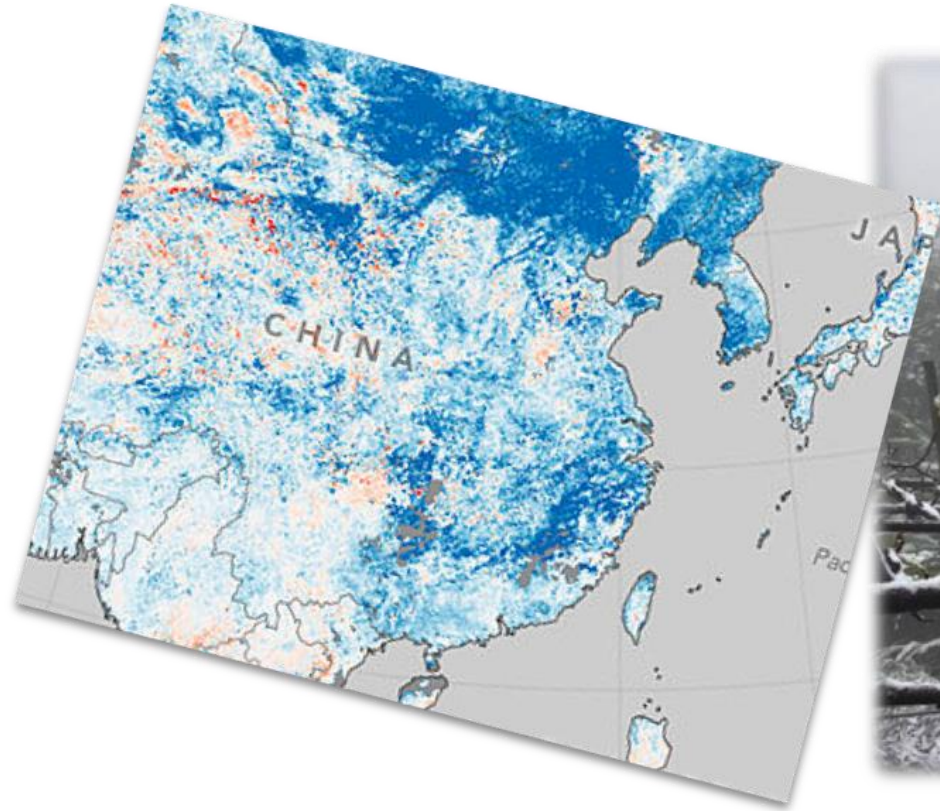
# extension entities

**Faculty who does everything  
other faculty members do**

*in the U.S.:  
Faculty who has specific  
roles (not evaluated by  
traditional research)*



# An example from Central Weather Bureau



Implications of the WNP:

Application of S2S forecasting



INTERNATIONAL JOURNAL OF CLIMATOLOGY  
*Int. J. Climatol.* (2017)  
Published online in Wiley Online Library  
(wileyonlinelibrary.com) DOI: 10.1002/joc.5194



**A seasonal prediction for the wet–cold spells leading to winter crop damage in northwestern Taiwan with a combined empirical–dynamical approach**

Parichart Promchote,<sup>a\*</sup> S.-Y. Simon Wang,<sup>a,b</sup> Yuan Shen,<sup>c</sup> Paul G. Johnson<sup>a</sup> and Ming-Hwi Yao<sup>d</sup>

<sup>a</sup> Department of Plants, Soils, and Climate, Utah State University, Logan, Utah, USA

<sup>b</sup> Utah Climate Center, Utah State University, Logan, Utah, USA

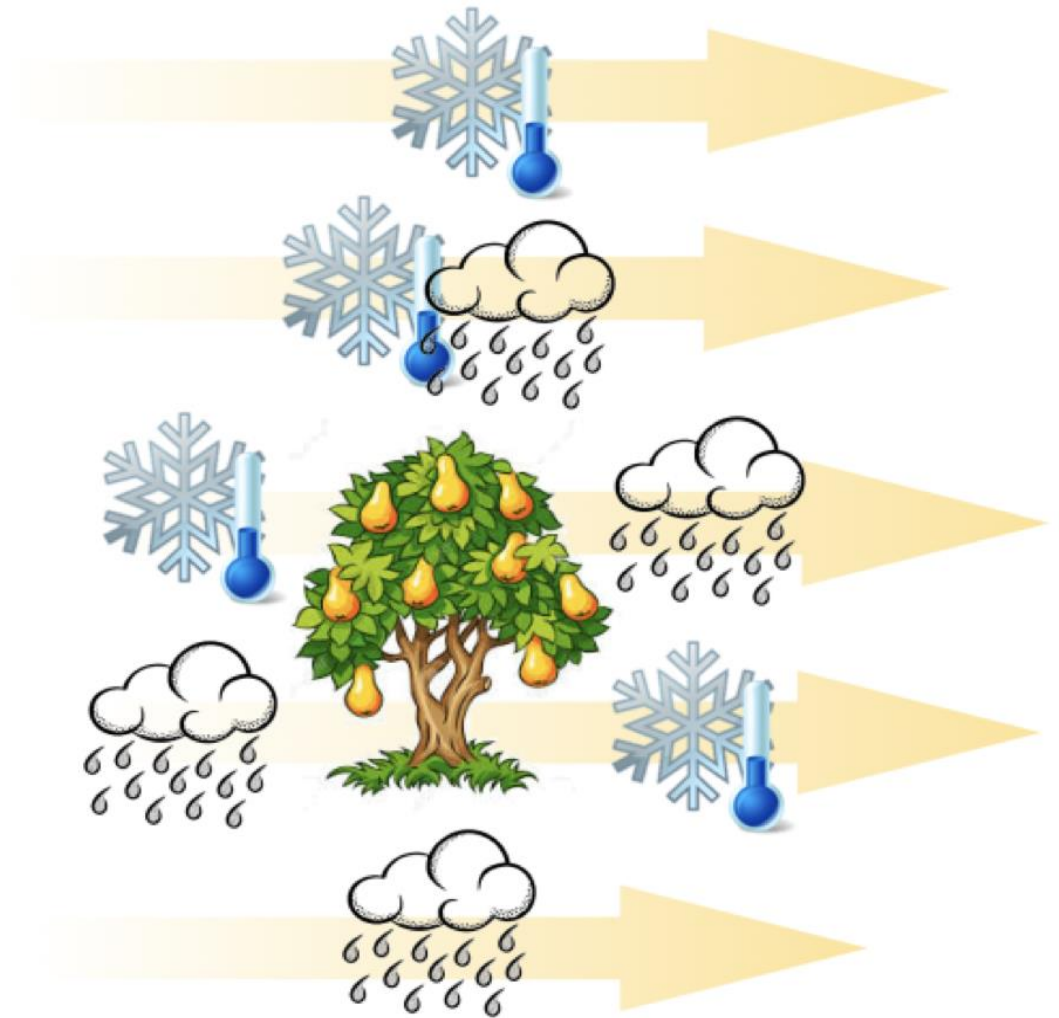
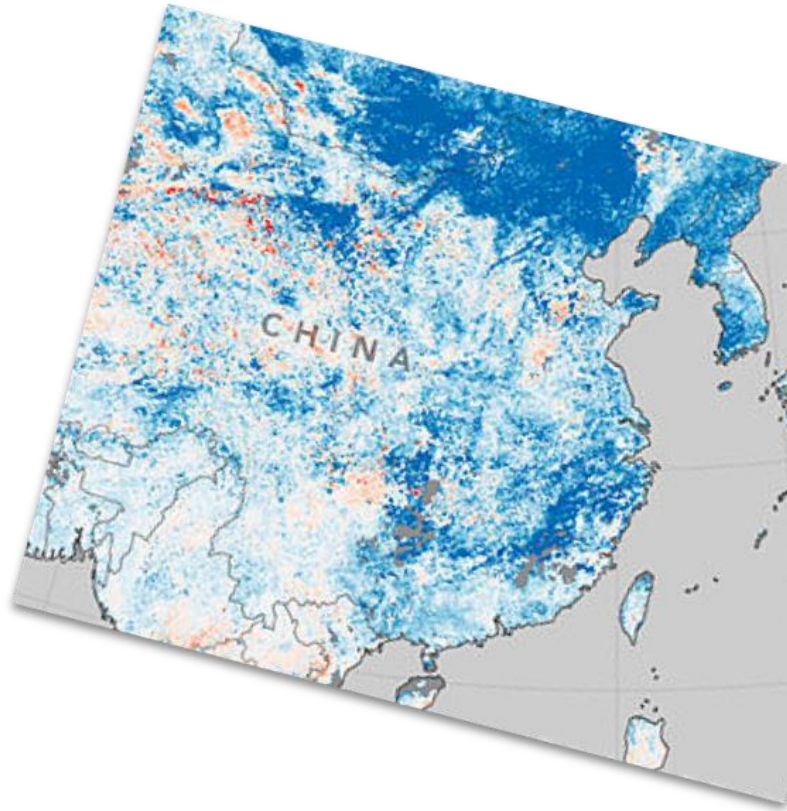
<sup>c</sup> Department of Soil and Environmental Sciences, National Chung Hsing University, Taichung, Taiwan

<sup>d</sup> Agricultural Engineering Division, Agricultural Research Institute, Taichung, Taiwan

# An example from Central Weather Bureau

Table 1. Abbreviations used to categorize weather events.

Weather event (abbreviation)	Description
Cold	Temperature $< 10^{\circ}\text{C}$
Dry-cold (DC)	Temperature $< 10^{\circ}\text{C}$ with no precipitation (0 mm) before, during, and after the cold day
Wet-before-cold (WBC)	Temperature $< 10^{\circ}\text{C}$ with precipitation $\geq 5$ mm in the previous day only
Wet-with-cold (WWC)	Temperature $< 10^{\circ}\text{C}$ and precipitation $\geq 5$ mm on same day only
Wet-after-cold (WAC)	Temperature $< 10^{\circ}\text{C}$ with precipitation $\geq 5$ mm on the following day only
Wet-cold (WC)	Temperature $< 10^{\circ}\text{C}$ with precipitation $\geq 5$ mm either before, during, or after the cold day



Forecast for damaging cold events 2 month ahead







*Int. J. Climatol. (2017)*



## RESEARCH LETTER

10.1002/2017GL073012

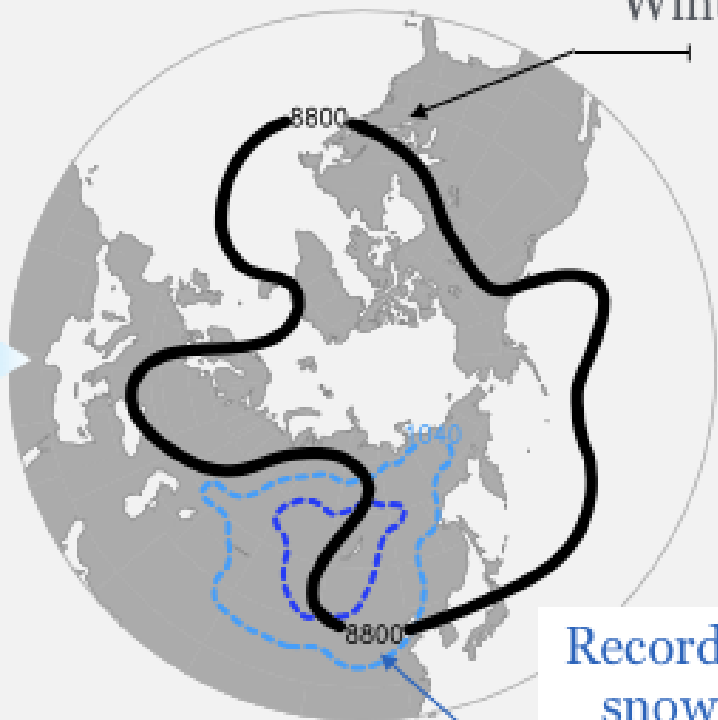
# Accelerated increase in the Arctic tropospheric warming events surpassing stratospheric warming events during winter

S.-Y. Simon Wang<sup>1,2</sup> , Yen-Heng Lin<sup>2</sup> , **Ming-Ying Lee<sup>3</sup> **, Jin-Ho Yoon<sup>4</sup> ,  
Jonathan D. D. Meyer<sup>1,2</sup> , and Philip J. Rasch<sup>5</sup> 

<sup>1</sup>Utah Climate Center, Utah State University, Logan, Utah, USA, <sup>2</sup>Department Plants, Soils and Climate, Utah State University, Logan, Utah, USA, **<sup>3</sup>Central Weather Bureau, Taipei, Taiwan,** <sup>4</sup>School of Earth Sciences and Environmental Engineering, Gwangju Institute of Science and Technology, Gwangju, South Korea, <sup>5</sup>Pacific Northwest National Laboratory, Richland,

21 Jan 2016

Winter Storm Jonas  
(Jan 22-24)

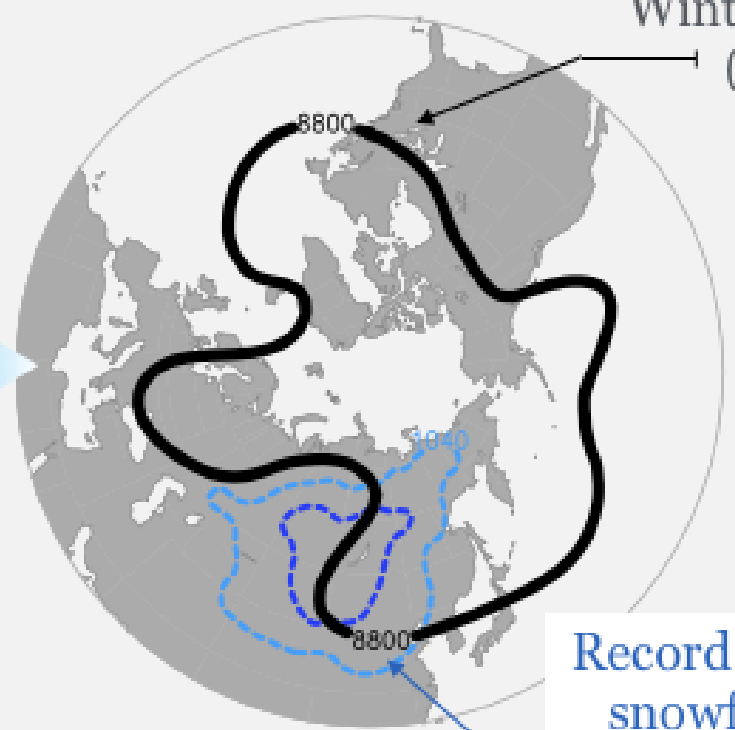


Record Siberian High and  
snowfall in subtropical  
Asia (Jan 24-26)

## Far-flung effect of Arctic warming (on cold East Asian winter)



21 Jan 2016



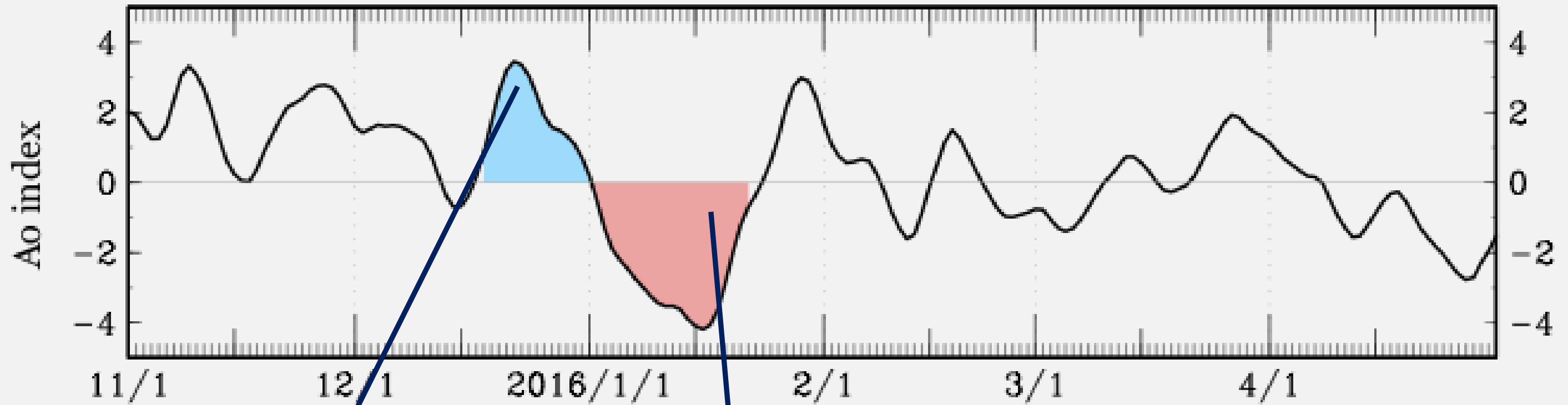
Record Siberian High and snowfall in subtropical Asia (Jan 24-26)

# East Asia cold snap kills 85 in Taiwan

ABS-CBN News  
Posted at 01/26/16 2



(a) AO (CPC)



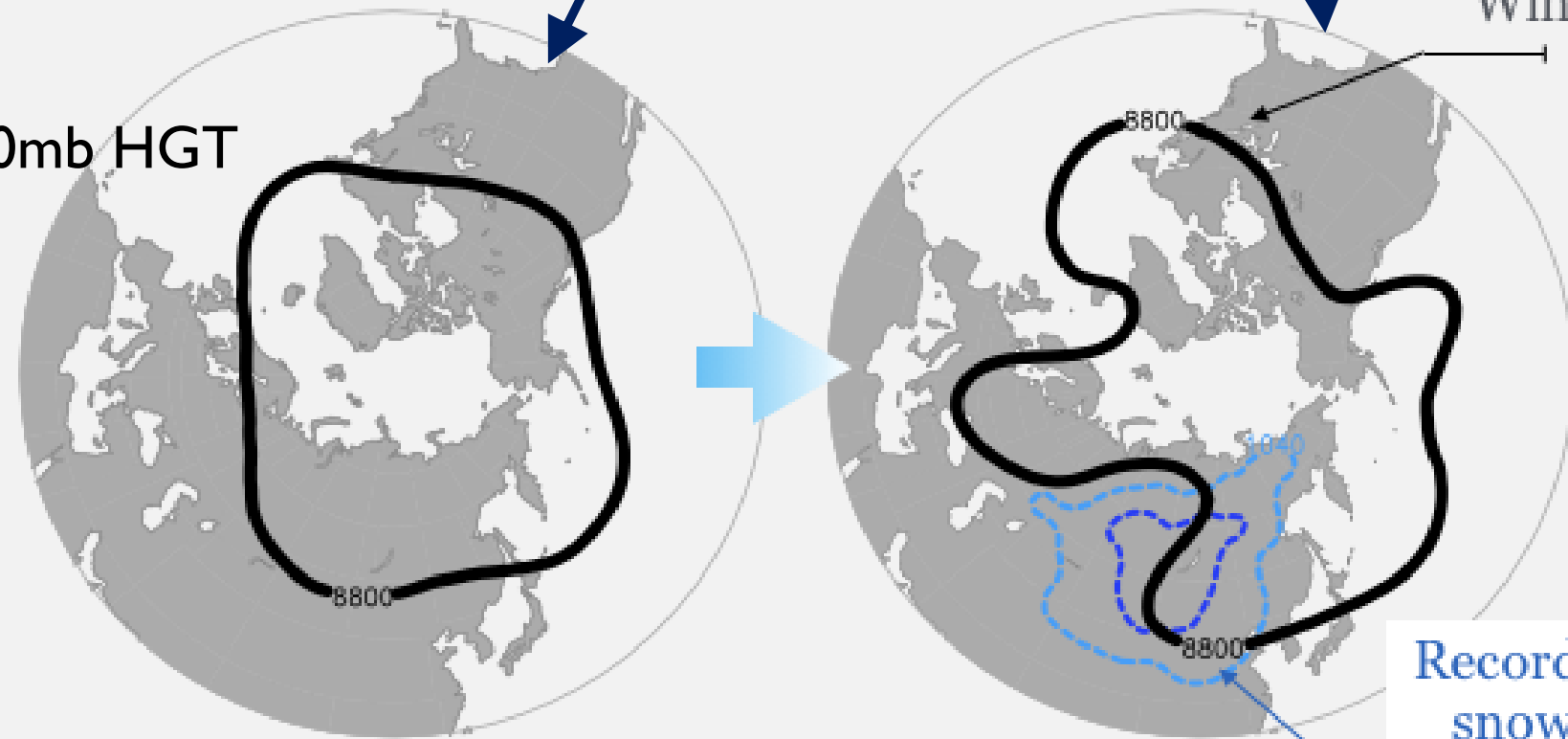
21 Dec 2015

21 Jan 2016

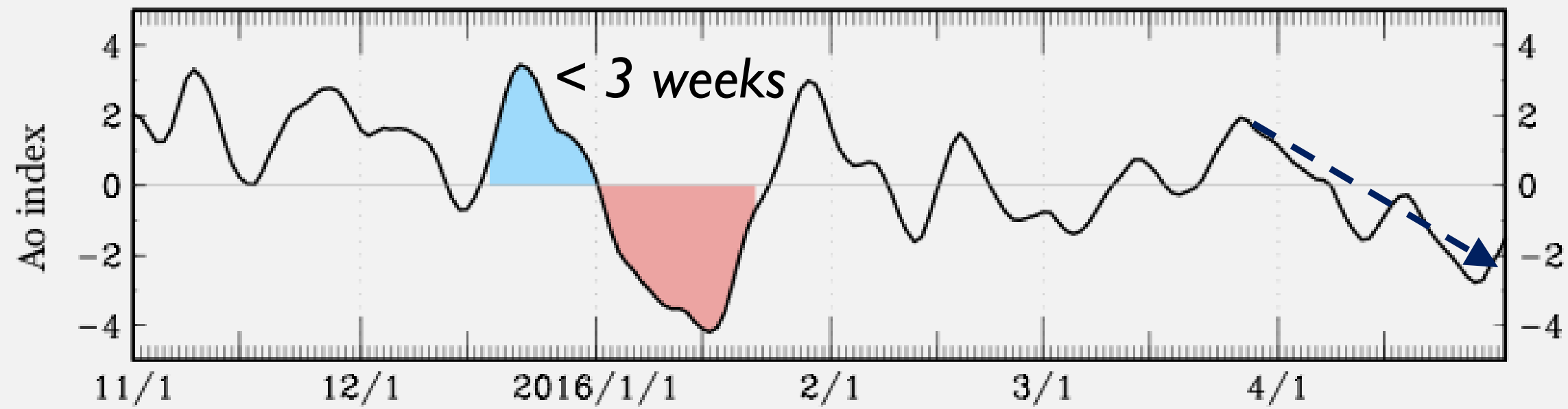
300mb HGT

Winter Storm Jonas  
(Jan 22-24)

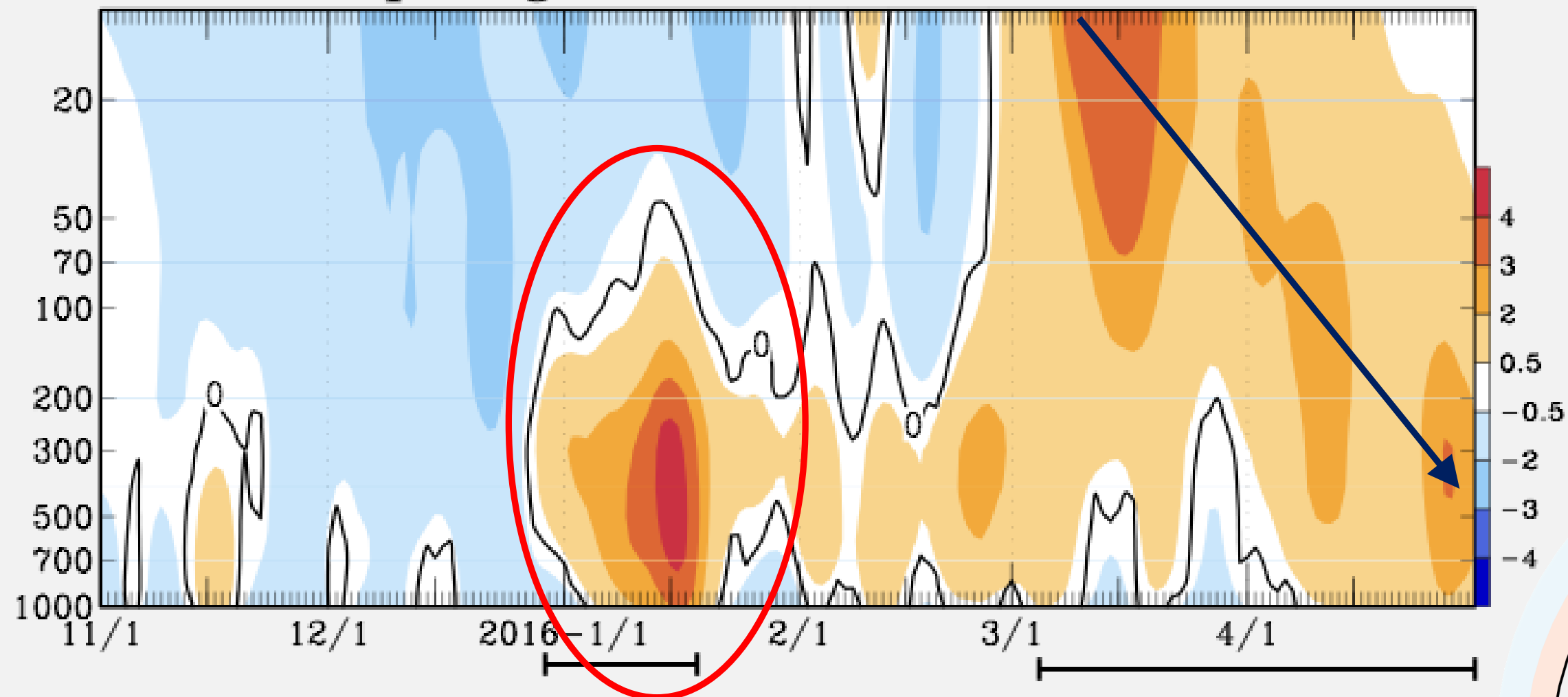
Record Siberian High and  
snowfall in subtropical  
Asia (Jan 24-26)



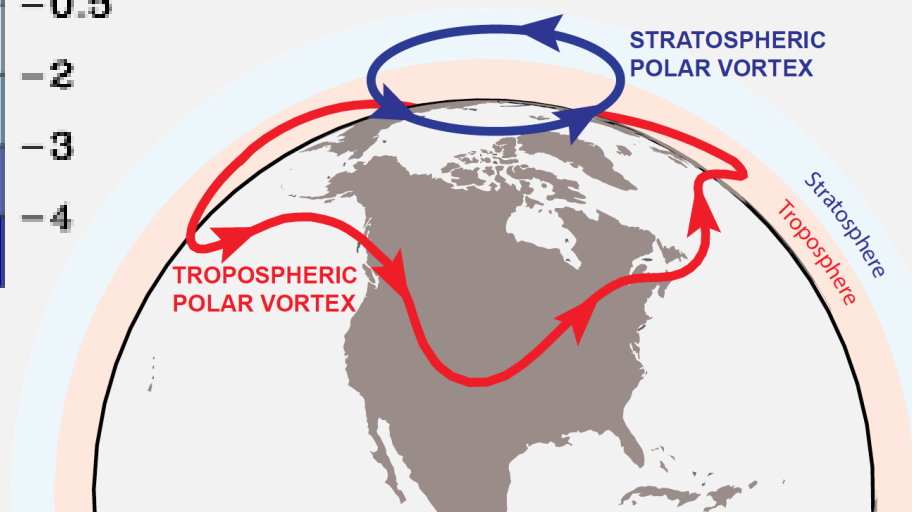
(a) AO (CPC)



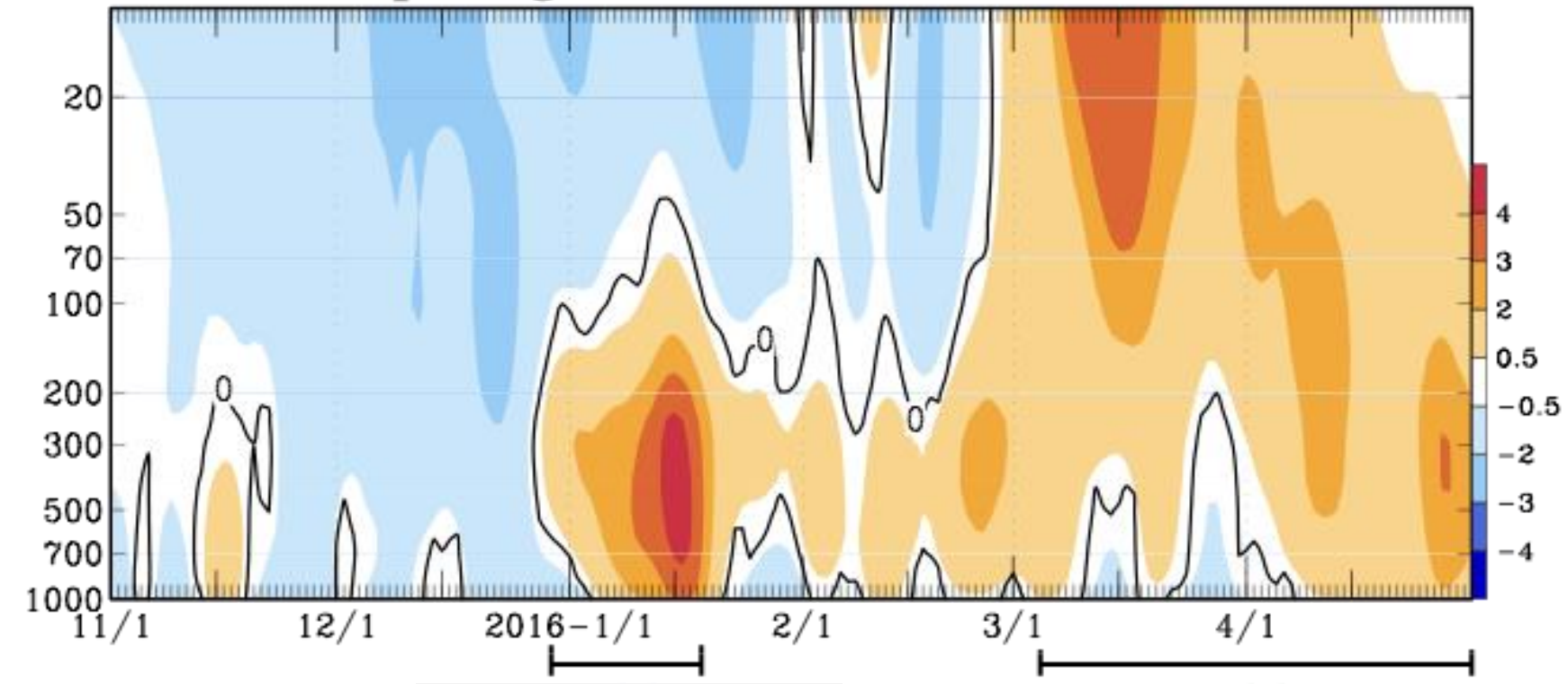
(b) Polar Cap Height



Waugh et al. (2016)

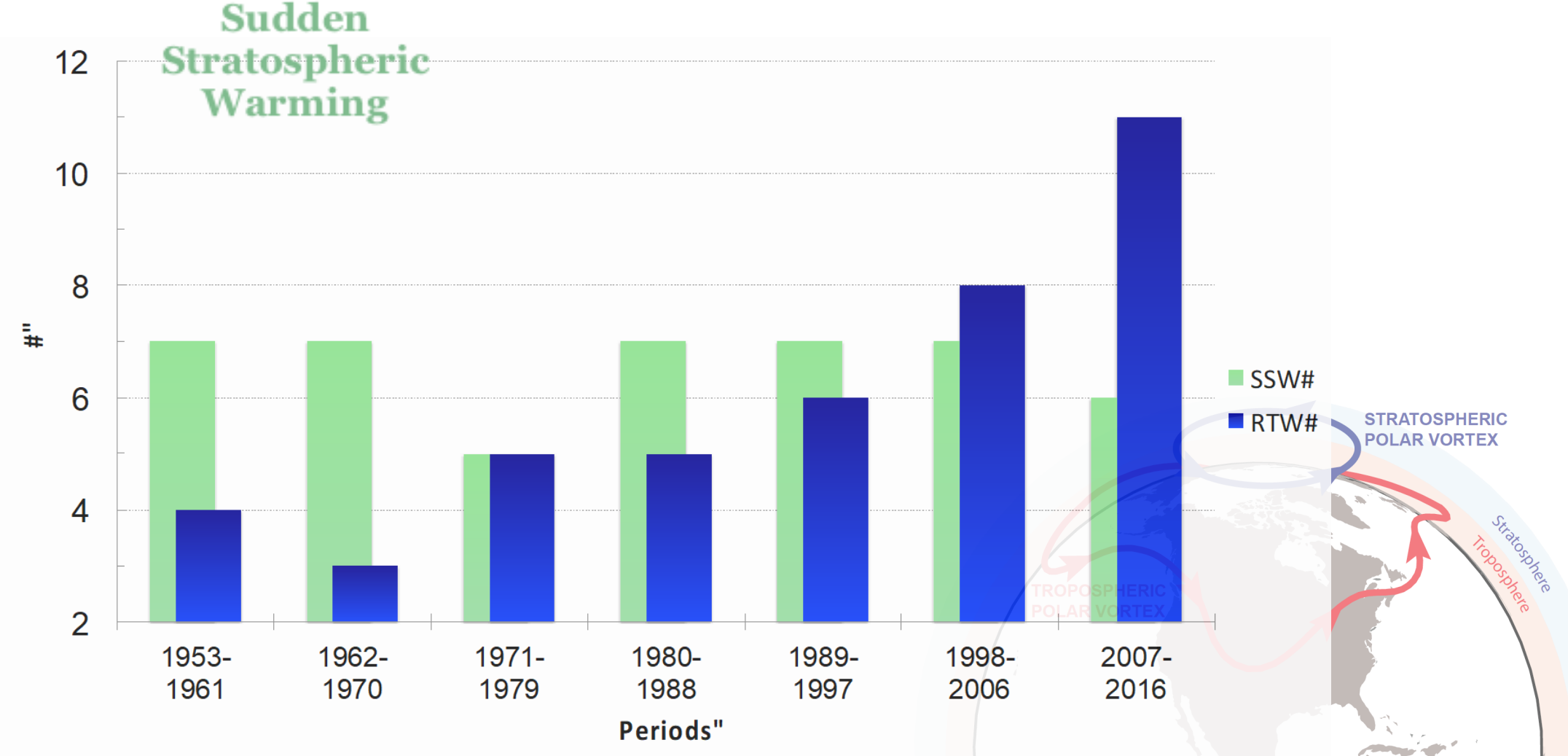


(b) Polar Cap Height

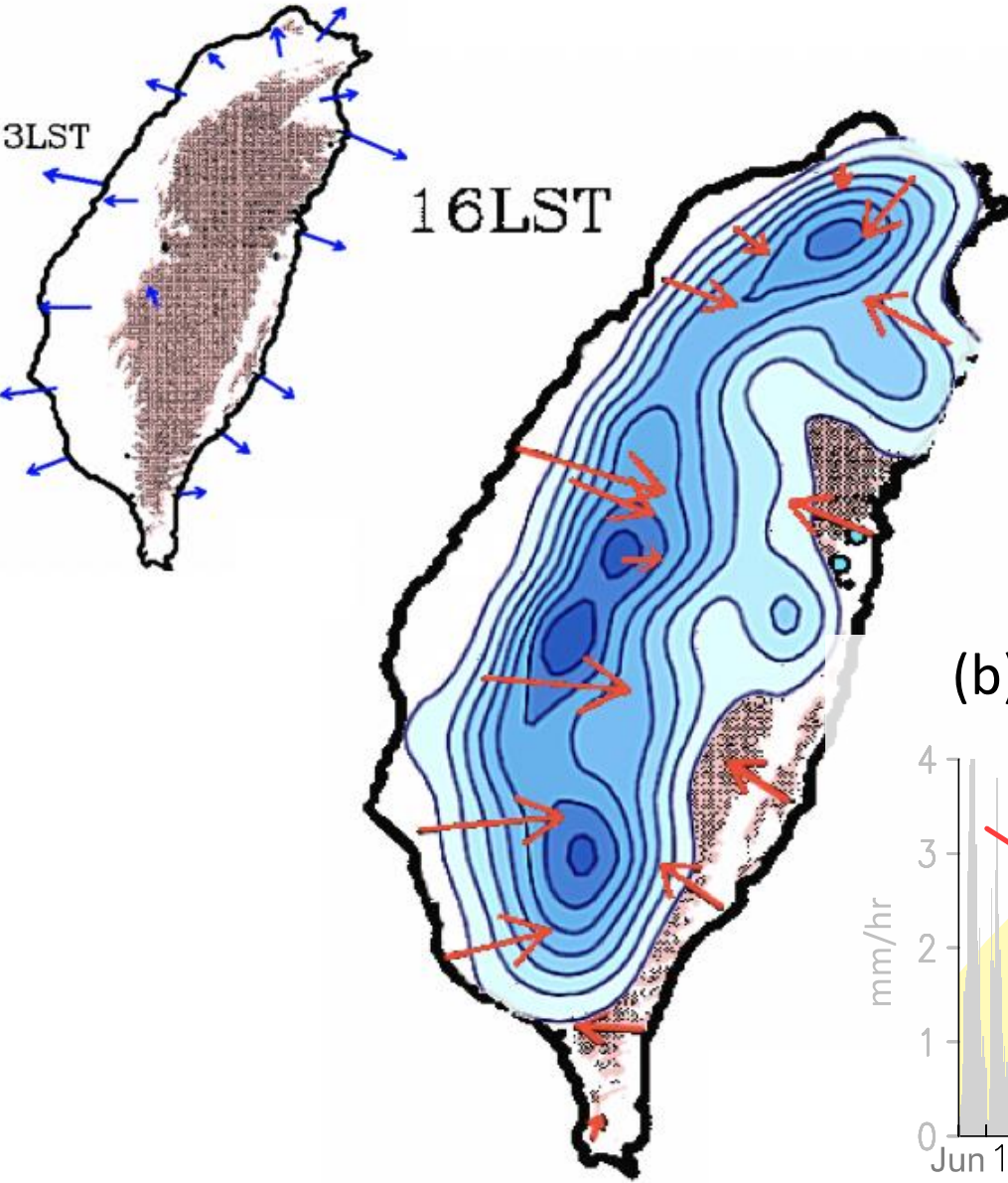


Since 1950, RTW cases have been increasing while SSWs remain flat

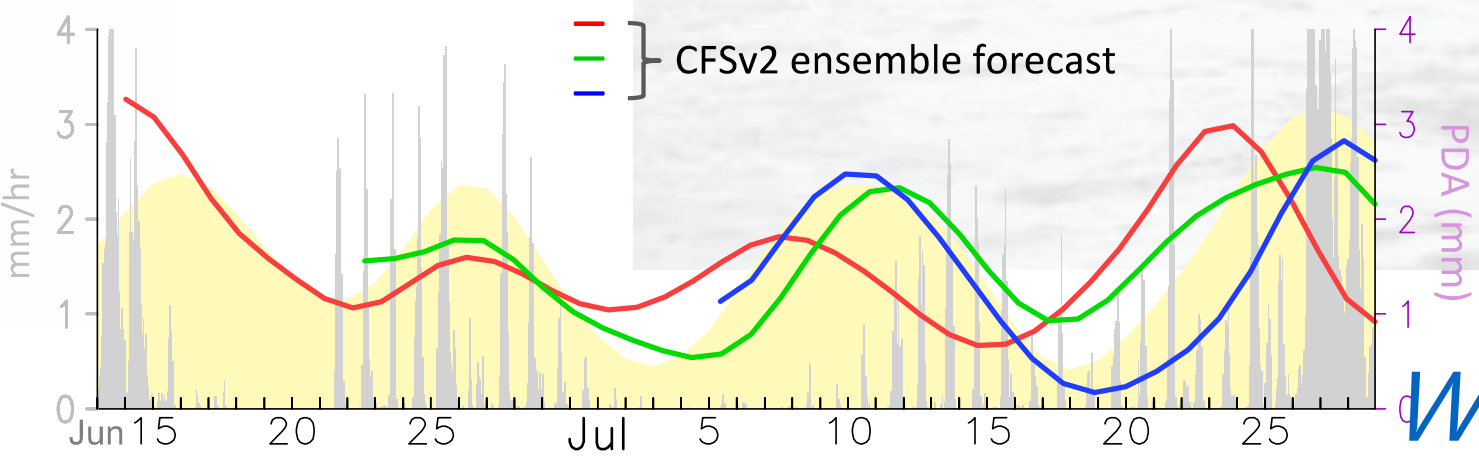
Increased RTW impacts extremes and challenges S2S prediction



# Central Weather Bureau



(b) Hourly precipitation and forecast: 2010



*Wea. Forecasting (2013)*

Forecast for diurnal episodes 3 weeks ahead of time

career opportunities

"boundary organizations"

Buizer et al. (2016 PNAS)

Climate Forecasts (S2S): public, private, & non-profit

**producers**

national centers

**translators**

**users**

rich & poor

economically valued met info

# Challenges ahead

A good translator:

- **Localized knowledge**
- **Meteorological professionalism**

*but people are  
trained differently!*

# Challenges ahead



Need to change education to produce a new discipline in climate prediction science



Producing a  
future  
generation  
with...

New degrees in

- **Climate Science**
- **Climate Communication**
- **Climate Informatics**

BS, MS, PhD

General Chemistry

Intro Calculus

General Physics

Freshman English

Linear Algebra

Solutions for the  
current  
generation

Colleges should add

- **Climate Change**
- **Climate Systems**

as gen-eds

Solutions in the  
mean time...

Engage in extension:  
create **extension**  
**climatologists**, but don't  
pressure them on  
*traditional* academic  
duties

Questions: [simon.wang@usu.edu](mailto:simon.wang@usu.edu)



*Thank you!*