CLIMATE CHANGE WORKSHOP HANDBOOK

PHASE 1 STUDIES

WEST VALLEY DEMONSTRATION PROJECT

West Valley, New York

August 2, 2012

Prepared for:
U.S. Department of Energy
New York State Energy Research and Development Authority
Ashford Office Complex
9030 Route 219
West Valley, NY

Prepared by:

Enviro Compliance Solutions Inc.
1571 Parkway Loop, Suite B
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Prepared under:
Environmental Management Consolidated Business Center
U.S. Department of Energy
Contract Number DE-EM0001602/0920/11/105680

HANDBOOK

WEST VALLEY CLIMATE CHANGE WORKSHOP

Ashford Office Complex, Room C-1
9030 Route 219, West Valley, NY

Thursday, August 02, 2012

SECTION | **CONTENTS**

SECTION 1
AGENDA

AGENDA
WEST VALLEY CLIMATE CHANGE WORKSHOP

Ashford Office Complex, Room C-1
9030 Route 219, West Valley, NY

Thursday, August 2, 2012

TIME		DURATION (hr:min)	ACTIVITY	SPEAKER / FACILITATOR / MODERATOR
8:30 AM	**9:00 AM**	**0:30**	**Sign In**	-
9:00 AM	9:10 AM	0:10	Welcome	Bryan Bower (DOE)
9:10 AM	9:20 AM	0:10	Workshop Format and Procedures	Facilitator (ECS)
9:20 AM	9:30 AM	0:10	Climate Scientist Introduction	Moderator (ECS)
9:30 AM	9:50 AM	0:20	**Presentation 1 - *The Paleoclimate Perspective***	Dr. Vas Petrenko (Scientist)
9:50 AM	10:00 AM	0:10	Question & Answer	Facilitator (ECS)
10:00 AM	10:20 AM	0:20	**Presentation 2 - *Human Influences on Climate***	Dr. Xuebin Zhang (Scientist)
10:20 AM	10:30 AM	0:10	Question & Answer	Facilitator (ECS)
10:30 AM	**10:45 AM**	**0:15**	**Break**	-
10:45 AM	11:05 AM	0:20	**Presentation 3 - *Estimates of Current and Future Probable Maximum Precipitation***	Dr. Ken Kunkel (Scientist)
11:05 AM	11:15 AM	0:10	Question & Answer	Facilitator (ECS)
11:15 AM	11:35 AM	0:20	**Presentation 4 - *Variability in Local Rainfall Intensity and Rainfall Distribution Parameters***	Dr. Art DeGaetano (Scientist)
11:35 AM	11:45 AM	0:10	Question & Answer	Facilitator (ECS)
11:45 AM	**1:00 PM**	**1:15**	**LUNCH**	-
1:00 PM	1:10 PM	0:10	Panelist Discussion Format	Facilitator (ECS)
1:10 PM	2:55 PM	1:45	Panel Discussion - Questions for Scientists & Discussion with Public Stakeholders	Scientists/Moderator (ECS)
2:55 PM	**3:00 PM**	**0:05**	**Adjournment**	Bryan Bower (DOE)

DOE = US Department of Energy
NYSERDA = New York State Energy Research and Development Authority
ECS = Enviro Compliance Solutions, Inc.
Facilitator = Bill Logue (ECS)
Moderator = Dan Herlihy (ECS)

SECTION 2

OVERVIEW

OVERVIEW

The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) requested the assistance of Climate Scientists to participate in this Climate Change Workshop in order to share their ideas on climate change topics as they relate to the decommissioning and/or long-term stewardship of the West Valley Demonstration Project (WVDP) and the Western New York Nuclear Service Center (WNYNSC) (see Appendix A).

WVDP and WNYNSC documents can be reviewed at www.westvalleyphaseonestudies.org.

WELCOME

DOE and NYSERDA are pleased to host this Climate Change Workshop at the request of WVDP public stakeholders. The purpose of this workshop is to educate and inform DOE, NYSERDA and public stakeholders on the latest science regarding climate and climate change, and to address the following Foundation Questions.

Foundation Questions

- What are the climate change issues that should be considered in WVDP Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?
- How may these climate change issues be evaluated during Phase 2 Decisionmaking for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

The workshop will be facilitated and moderated by Enviro Compliance Solutions, Inc. (ECS). DOE and NYSERDA look forward to an educational, informative and productive workshop.

FORMAT & PROCEDURES

The Ground Rules addressing interaction among workshop participants, presenters, facilitator and moderator during the workshop will be the same as those adopted for WVDP Quarterly Public Meetings (QPMs). These rules are provided in the Appendix B. Acronyms and abbreviations that may be used from time-to-time during the workshop are provided in Appendix C.

Presentations

Following introductory remarks by DOE, NYSERDA and ECS, each of four Climate Scientists will give a 20-minute slide presentation in their specific research area of interest. These presentations are intended to be educational and informative. Each Climate Scientist will conclude their presentation with their thoughts and perspectives regarding climate issues that may be relevant to Phase 1 Studies and Phase 2 Decisionmaking (i.e. Foundation Questions).

Questions and Answers

Prior to each presentation, index cards will be distributed to workshop participants. Using index cards, workshop participants are encouraged to prepare written questions regarding climate issues introduced during the presentation that may be relevant to Phase 1 Studies and Phase 2 Decsionmaking. ECS will then compile these written questions by subject (during lunch) so that questions can be addressed in an orderly fashion by the panel of Climate Scientist during the afternoon portion of the workshop. Notwithstanding, ten minutes are set aside following each

20-minute presentation so that Climate Scientists can answer general questions (verbal - not written) regarding the research topics introduced during their presentation.

Panel Discussion

The afternoon portion of the workshop will be devoted to Foundation Questions. The ECS moderator will read the written questions (from index cards) so that the panel of Climate Scientists can address them sequentially. If desired, public stakeholders and the panel of Climate Scientists can further discuss a particular issue, raised by the question, in an open forum in keeping with the adopted Ground Rules (Appendix A). ECS will moderate open discussions to allow sufficient time to address all written questions.

ADJOURNMENT

After the Panel Discussion, DOE and NYSERDA will offer closing remarks regarding the Climate Change Workshop.

GUIDANCE DOCUMENT

Following the workshop, ECS will conference with Climate Scientists to prepare a written guidance document that includes: 1) a summary of issues addressed during the workshop, and 2) the Climate Scientists' thoughts, observations, and recommendations for a path forward to help DOE, NYSERDA and Subject Matter Experts (SMEs) address the topic of climate within the scope of Phase 1 Studies.

SECTION 3

CLIMATE SCIENTIST BIOGRAPHIES

CLIMATE SCIENTIST BIOGRAPHIES

Climate Scientists were recommended by public stakeholders (Dr. Ray Vaughn), DOE and NYSERDA based on unique qualifications and research interests. Below is a brief biographical sketch for the four Climate Scientists participating in the workshop. The biographies are presented in the order that the Climate Scientist will present their research interests (see Agenda).

Dr. Vasilii Petrenko

Dr. Vasilii Petrenko received a Bachelor's Degree in Chemistry (Physics minor) from the University of New Hampshire, a Master of Education in Science Teaching from Harvard University, and a PHD in Earth Sciences from the University of California at San Diego. He is currently an Assistant Professor in Earth and Environmental Sciences at the University of Rochester, New York.

Prior to his current assignment, Dr. Vasilii Petrenko was a Science Teacher at the International School of Düsseldorf, Düsseldorf, Germany, and The Rivers School in Weston, Massachusetts, Staff Research Associate and Postdoctoral Fellow at Scripps Institution of Oceanography at the University of California at San Diego, and a National Oceanic and Atmospheric Administration (NOAA) Climate and Global Change Postdoctoral Fellow and Postdoctoral Scholar at the Institute of Arctic and Alpine Research (INSTAAR) at the University of Colorado at Boulder.

Dr. Vasilii Petrenko's research interests include understanding natural and anthropogenic climate and environmental change, particularly from the perspective of atmospheric composition and chemistry. Dr. Petrenko is specifically interested in examining the records of past atmospheric composition obtained from ice cores, to better understand the relationship between climate and greenhouse and reactive trace gases (i.e. methane and carbon monoxide).

Dr. Xuebin Zhang

Dr. Xuebin Zhang has Bachelor and Master Degrees in Engineering Hydrology, and a PhD in Physics (Climate Science). He is a Research Scientist with the Climate Research Division of Environment Canada. He is also an Adjunct Professor with the Department of Math and Statistics at York University in Toronto, Canada. He is a co-Chair of the Joint World Meteorological Organization Commission for Climatology, World Climate Research Program, and the Joint Commission of Oceanography Expert Team for Climate Change Detection and Indices, and a member of the Committee for Climate Variability and Change of the American Meteorological Society. He is a Lead Author for the Intergovernmental Panel on Climate Change (IPCC) Special Report on climate extremes, and a Lead Author for the IPCC fifth assessment Working Group I report.

His research interests include observed changes in climate, detection of climate changes and attribution to causes, and projected future climate.

Dr. Kenneth Kunkel

Dr. Kenneth Kunkel received a Bachelor of Science Degree in Physics from Southern Illinois University-Edwardsville, and Master of Science and PhD in Meteorology from the University of Wisconsin-Madison. He is a Research Professor in the Department of Marine, Earth, and Atmospheric Sciences of North Carolina State University, and Lead Scientist for Assessments with the National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute for Climate and Satellites at the National Climatic Data Center in Asheville, North Carolina.

Prior to his current assignment, Dr. Kenneth Kunkel served as Executive Director of the Division of Atmospheric Sciences of the Desert Research Institute where he managed a group of about 120 atmospheric scientists, support staff, and graduate students. From 1982 to 1988, he served as the New Mexico State Climatologist and as Associate Professor at New Mexico State University, and performed research on atmospheric optical phenomena as a Research Meteorologist with the Atmospheric Sciences Laboratory at the White Sands Missile Range. From 1988 to 2008, he served in a variety of positions with the Illinois State Water Survey, including Interim Director of the Survey, Director of the Center for Atmospheric Sciences, and Director of the Midwestern Regional Climate Center.

Dr. Kenneth Kunkel has performed research on a wide range of atmospheric science topics. Recent research has focused on climate variability, extremes, and change. He has published about 100 articles in peer-reviewed scientific journals, nine book chapters, and one book, and is a lead author on a recent report of the U.S. Climate Change Science Program, entitled: *Weather and Climate Extremes in a Changing Climate and Climate Change Models: An Assessment of Strengths and Limitations*. He has served on numerous climate advisory and review panels.

Dr. Arthur DeGaetano

Dr. Arthur DeGaetano received Bachelor and Master Degrees, and a PhD in Applied Climatology from Rutger's University, New Jersey. He is currently Associate Chair of the Department of Earth and Atmospheric Sciences, and a Professor of Meteorology and Climate Change at Cornell University, New York. He also directs the Northeast Regional Climate Center (NRCC), which is one of six federal centers that provide climate data, data products and decision tools to regional stakeholders.

Prior to his arrival at Cornell in 1991, Dr. Arthur DeGaetano was an Assistant Professor with the Meteorology Department at the South Dakota School of Mines and Technology in Rapid City, and served as the Research Climatologist for the NRCC.

Dr. DeGaetano's research focus is Applied Climatology, which involves the development of methods and data sets that can produce climatological information for use by decision-makers in a variety of fields. His work centers mainly on the impacts and adaptations that result from climate change. He serves as a climate editor for the Bulletin of the American Meteorological Society, and is an associate editor for the Journal of Applied Meteorology and Climatology.

SECTION 4

PRESENTATIONS

INTRODUCTION

West Valley
Climate Change Workshop

Moderated By

ECS

August 2, 2012

Climate Change Workshop

AGENDA

09:00-09:30	Introduction & Objective
09:30-10:30	Scientist Presentations with Q&A
10:30-10:45	Break
10:45-11:45	Scientist Presentations with Q&A
11:45-01:00	LUNCH
01:00-03:00	Questions for Scientist Panel & Discussion

Post-Workshop Written Summary of Guidance
(to be uploaded to Phase I Website)

Ground Rules

- Basic courtesies to presenters and other participants
  - Please: Listen, learn, inquire, be respectful, stay on topic and within timeframes
  - Please do not: interrupt, personally attack or dominate
- Silence and mute phones
- Please identify yourselves when speaking
- Participation by phone/web

Feedback & Comment Opportunities

- **Clarification Questions** – about 10 minutes after each presentation
- **Index Cards** – follow-up questions for Panel Discussion
- **Comment Cards** – comments for presenters to consider when writing guidance for the agencies
- **Q&A with Panel** – afternoon 1:00 – 3:00
- **Joint Email** - Moira.N.Maloney@wv.doe.gov & LMG@nyserda.org

Climate Scientist Panel

Scientist	Research Focus
Dr. Vasilii Petrenko - Assistant Professor Dept. of Earth & Environmental Sciences University of Rochester	Natural/Anthropogenic changes Atmospheric chemistry Gradual earth warming
Dr. Xuebin Zhang – Research Scientist Climate Research Division Environment Canada	Climate trends & variability Climate extremes Global/Regional scale
Dr. Ken Kunkel – Research Professor Dept. of Marine, Earth, and Atmospheric Sciences, No. Carolina State University	Climate variability and change Historic climate variations 19th Century to present.
Dr. Art DeGaetano – Prof/Associate Chair Dept. of Earth & Atmospheric Sciences Cornell University	Document climate variations Improve climate data quality Assess climate impacts

PHASE 1 STUDIES

Foundation Questions

1. What are the climate change issues that should be considered in Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?

2. How may these climate change issues be evaluated during Phase 2 Decision Making for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

PRESENTATION 1

THE PALEOCLIMATE PERSPECTIVE

By Dr. Vasilii Petrenko

THE PALEOCLIMATE PERSPECTIVE

By: Vasilii Petrenko, Dept. of Earth and Environmental Sciences, Univ. of Rochester, NY

PRESENTATION SUMMARY

The purpose of this presentation is to give a brief general overview of Paleoclimate with a focus on past climate events that can provide some insights into possible future climate change. The largest climate fluctuations in recent geologic history have been the glacial-interglacial cycles (ice ages). The West Valley site was covered by an ice sheet during the last major glaciation, until about 18 thousand years ago. The glacial (cold) periods were characterized by globally much more ice and colder temperatures. Ice core records show that current greenhouse gas concentrations are much higher than at any time during the last 800 thousand years, and for this reason it is extremely unlikely that another glacial period would occur anytime in the next 100 thousand years.

Climate change has been very abrupt at times in the past. Abrupt climate change could be disastrous because it leaves very little time to adapt to changing conditions. Greenland ice cores have recorded abrupt warming events as large as 18˚F that happened in as little as 20 years. These kind of abrupt warming events have only happened during the cold glacial periods and are unlikely today. The same ice cores have also recorded relatively rapid cooling events, typically of a few degrees F. These events occurred because large influxes of glacial melt water slowed down the warm water current flowing into the North Atlantic. It is possible for this kind of event to occur today as Greenland melting accelerates.

The last time that the Earth was significantly warmer than today was during the previous warm interglacial period, between about 130 and 116 thousand years ago. Climate records from this period could in principle provide insights into the future of West Valley. Unfortunately, most local climate records from that period would have been erased or altered by advance of the last ice sheet. But records from just beyond the southern-most extent of the ice sheet may be worth examining.

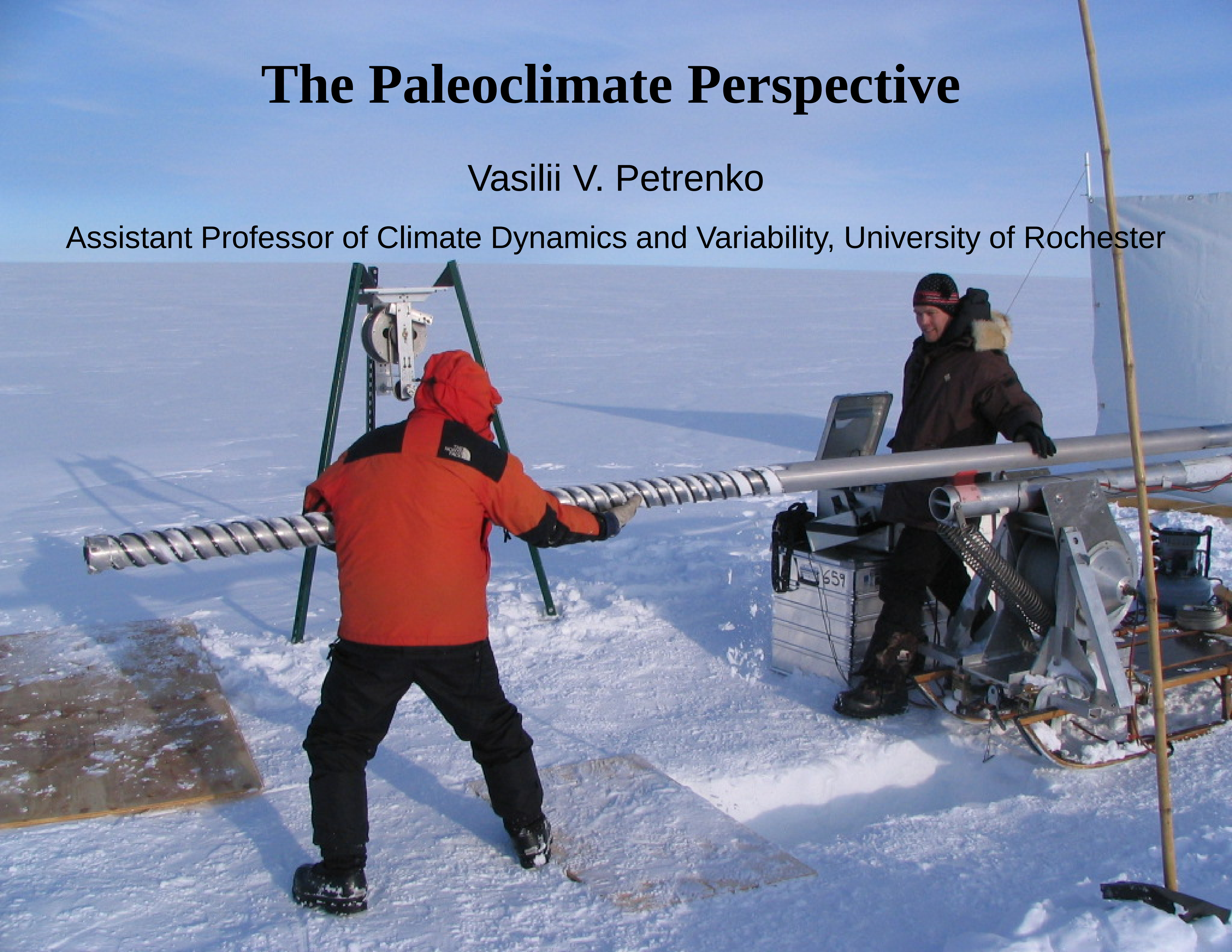
There have also been periods in Earth history when the climate was much warmer than today, with no land ice and warm oceans even in the high Arctic. One such period was the mid-Cretaceous about 100 million years ago. The most likely explanation for extreme warmth at this time was high CO2.

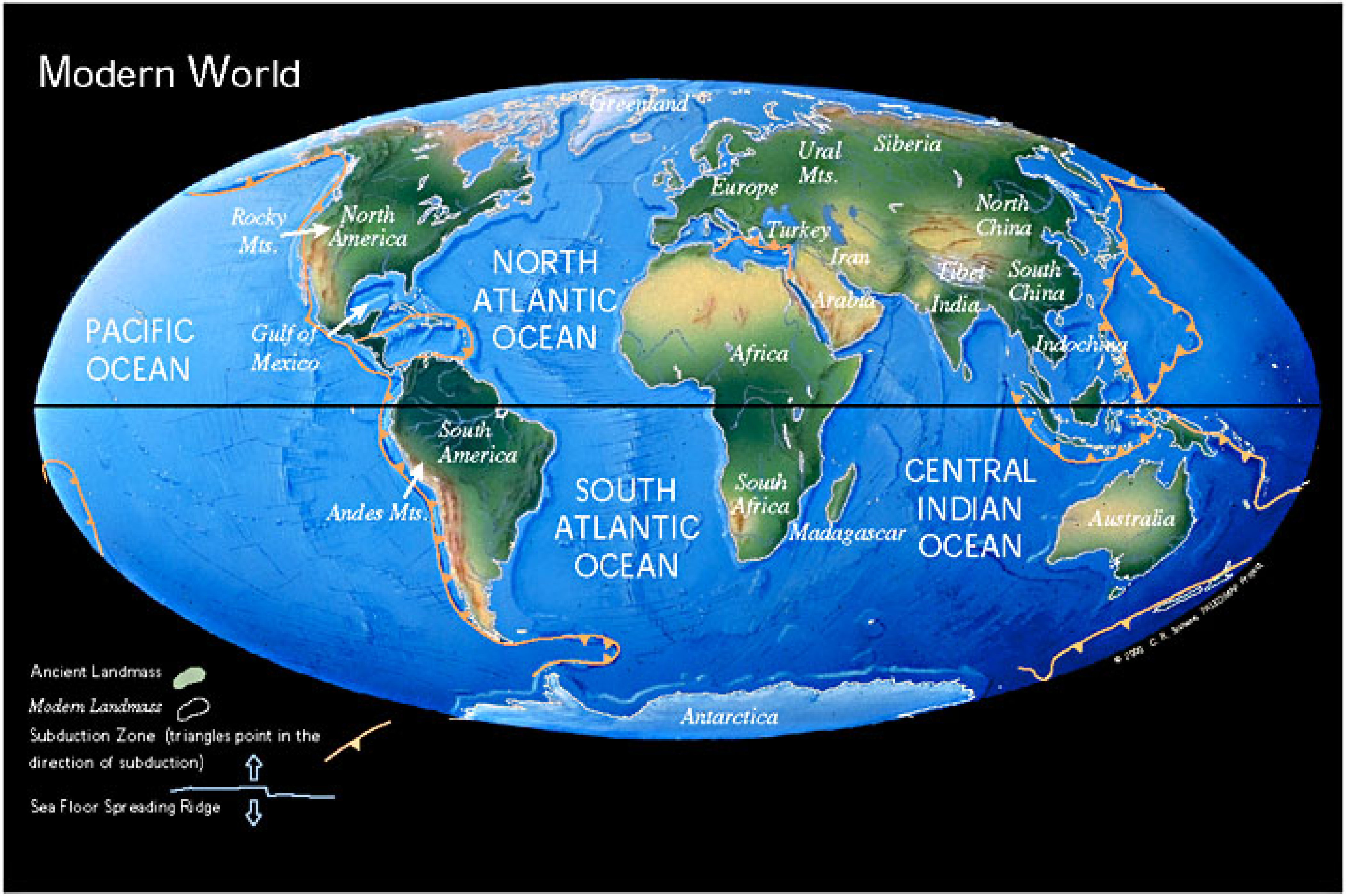
Possibly the best analog to the current global warming that we know about happened about 55 million years ago. This event is known as the Paleocene-Eocene Thermal Maximum (PETM). During this event, a very large amount of carbon was released into the ocean-atmosphere system, causing widespread ocean acidification. Temperatures that were already warm rose further by about 9˚F in the low latitudes and about 16˚F in the high latitudes. This warming and carbon release seems to have been slower than what we are seeing today, and took about 1 to 10 thousand years. It took the climate system 100 thousand years or more to recover from this event.

The Paleoclimate Perspective

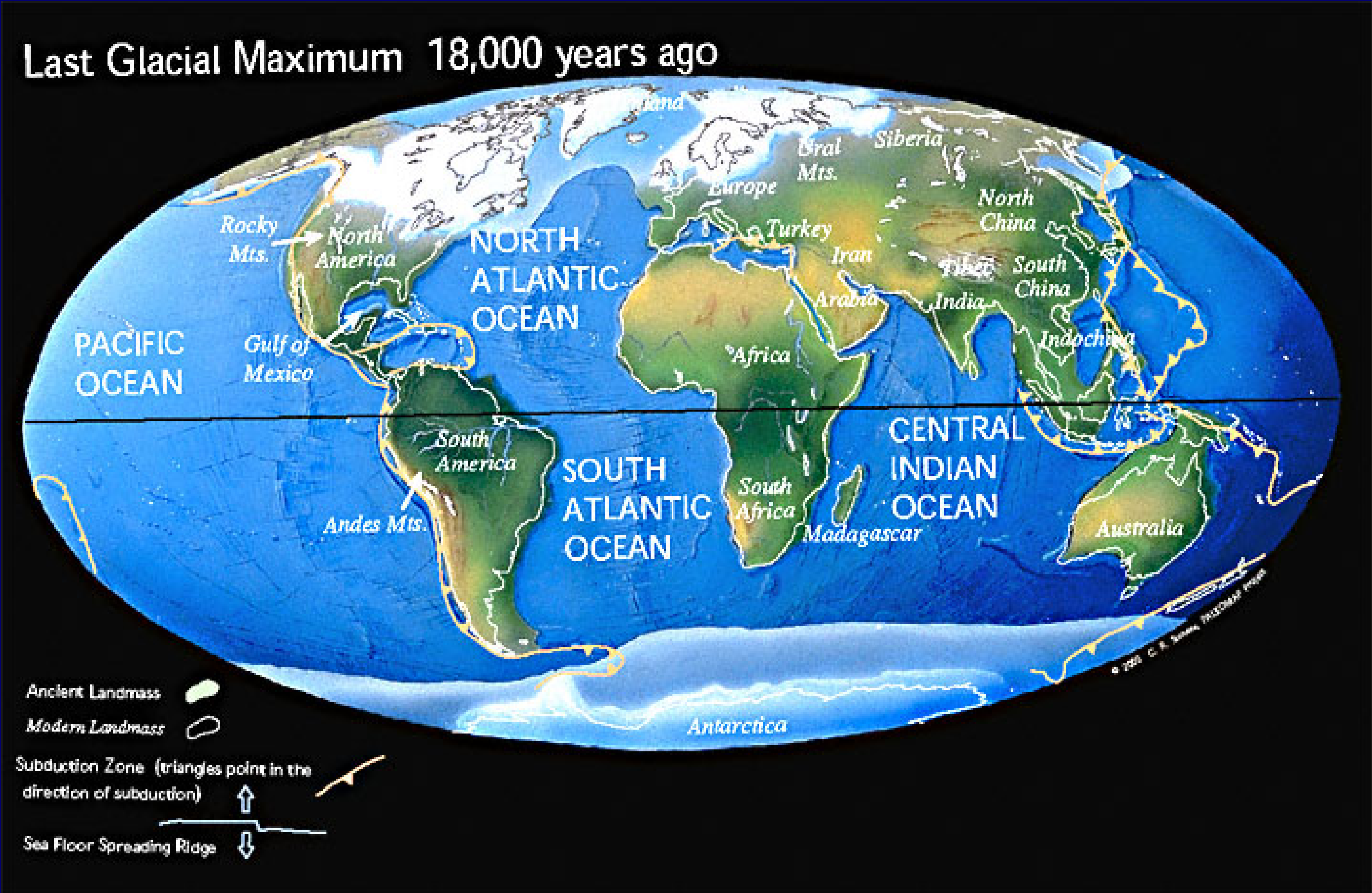
Vasilii V. Petrenko

Assistant Professor of Climate Dynamics and Variability, University of Rochester



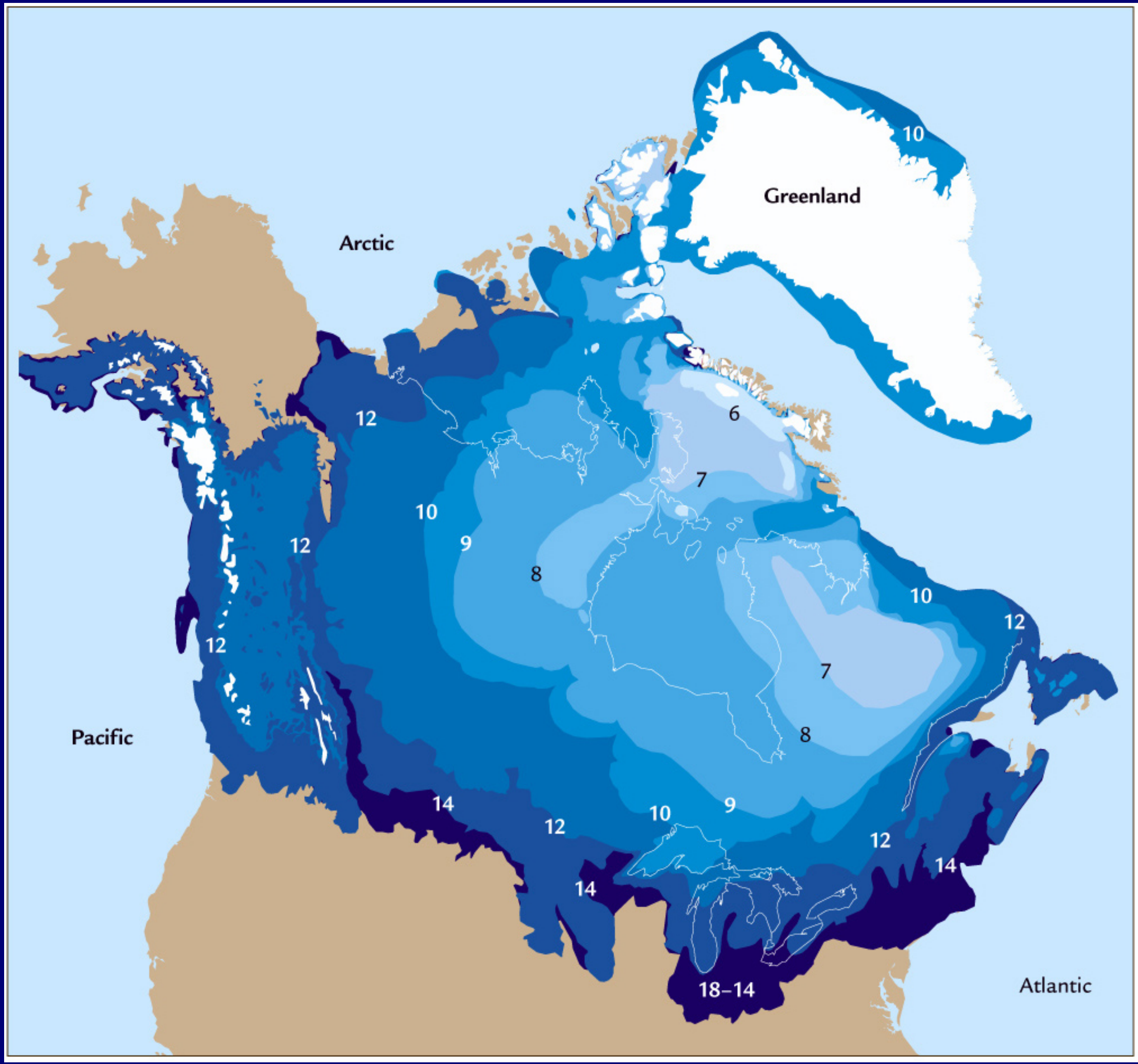


Scotese, C. R., 2001. Atlas of Earth History, Volume 1, Paleogeography,PALEOMAP Project, Arlington, Texas, 52 pp.



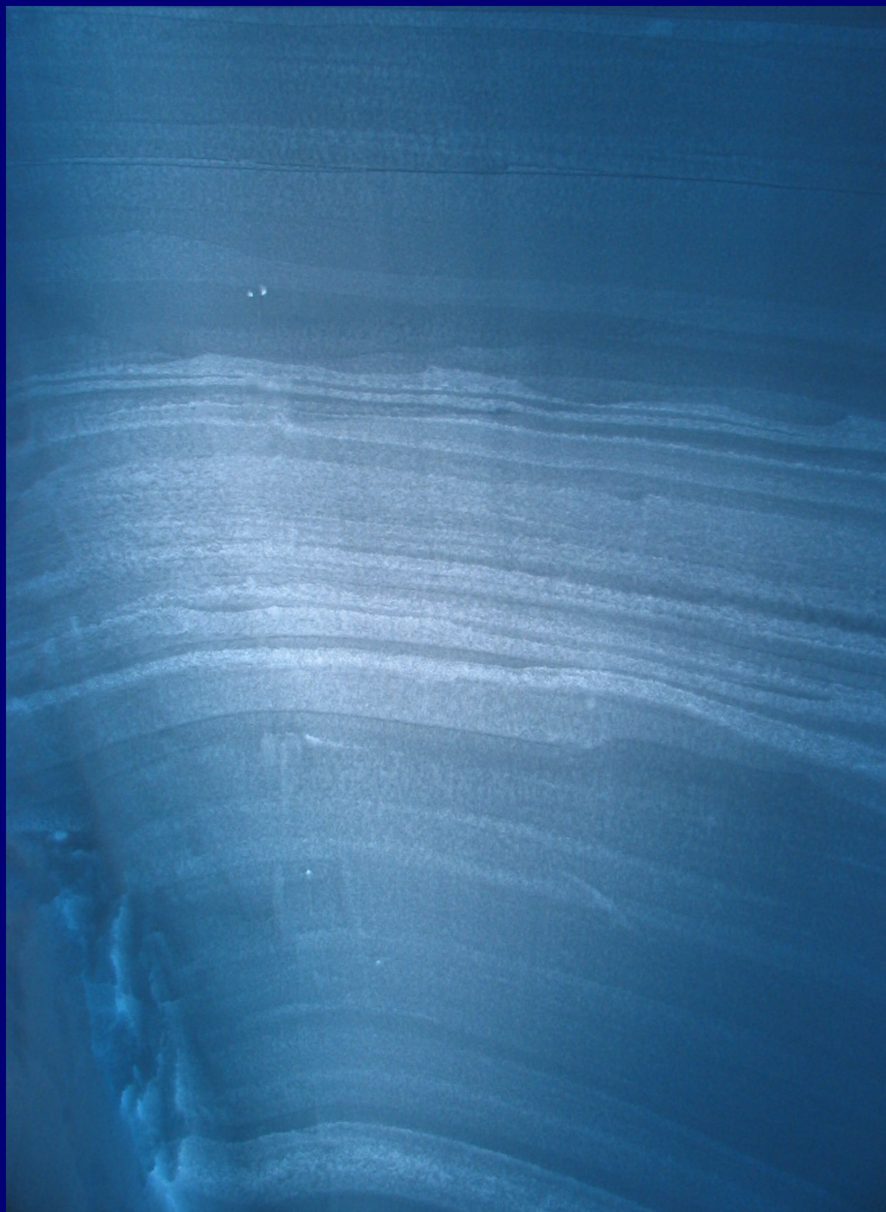
Scotese, C. R., 2001. Atlas of Earth History, Volume 1, Paleogeography,PALEOMAP Project, Arlington, Texas, 52 pp.

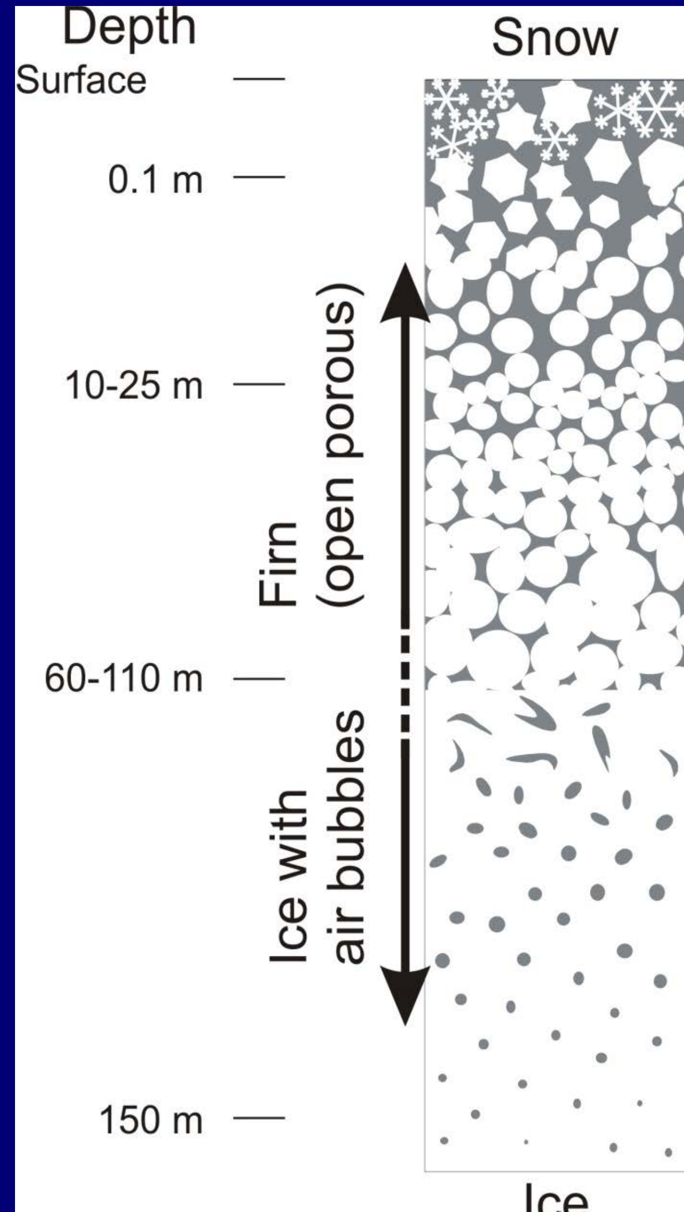
RETREAT OF THE LAST NORTH AMERICAN ICE SHEET



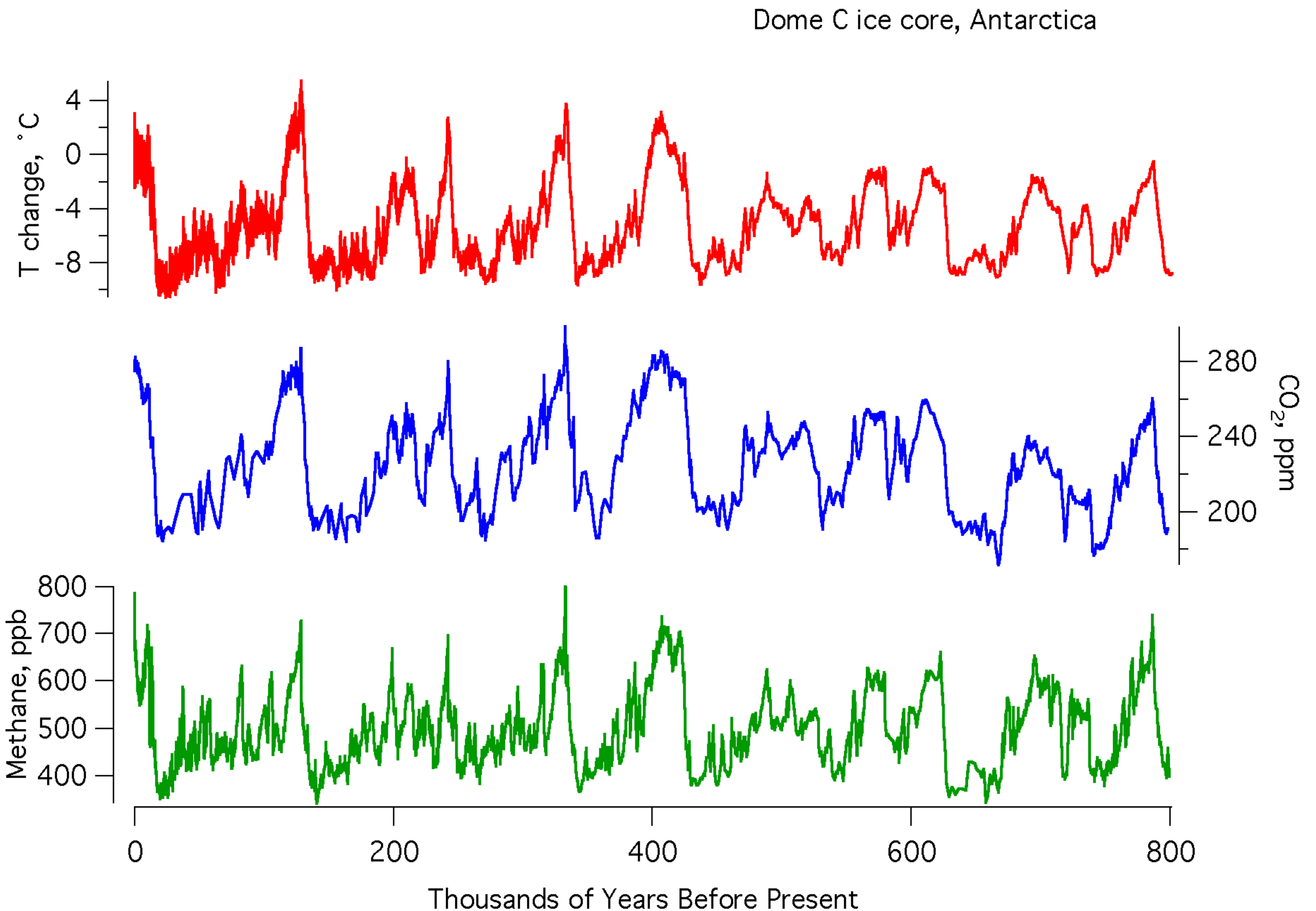
Ruddiman, W.F., 2007. “Earth’s Climate: Past and Future”, 2nd ed., 388 pp., W.H. Freeman, New York.

ICE CORES AS A SOURCE OF PAST CLIMATE RECORDS

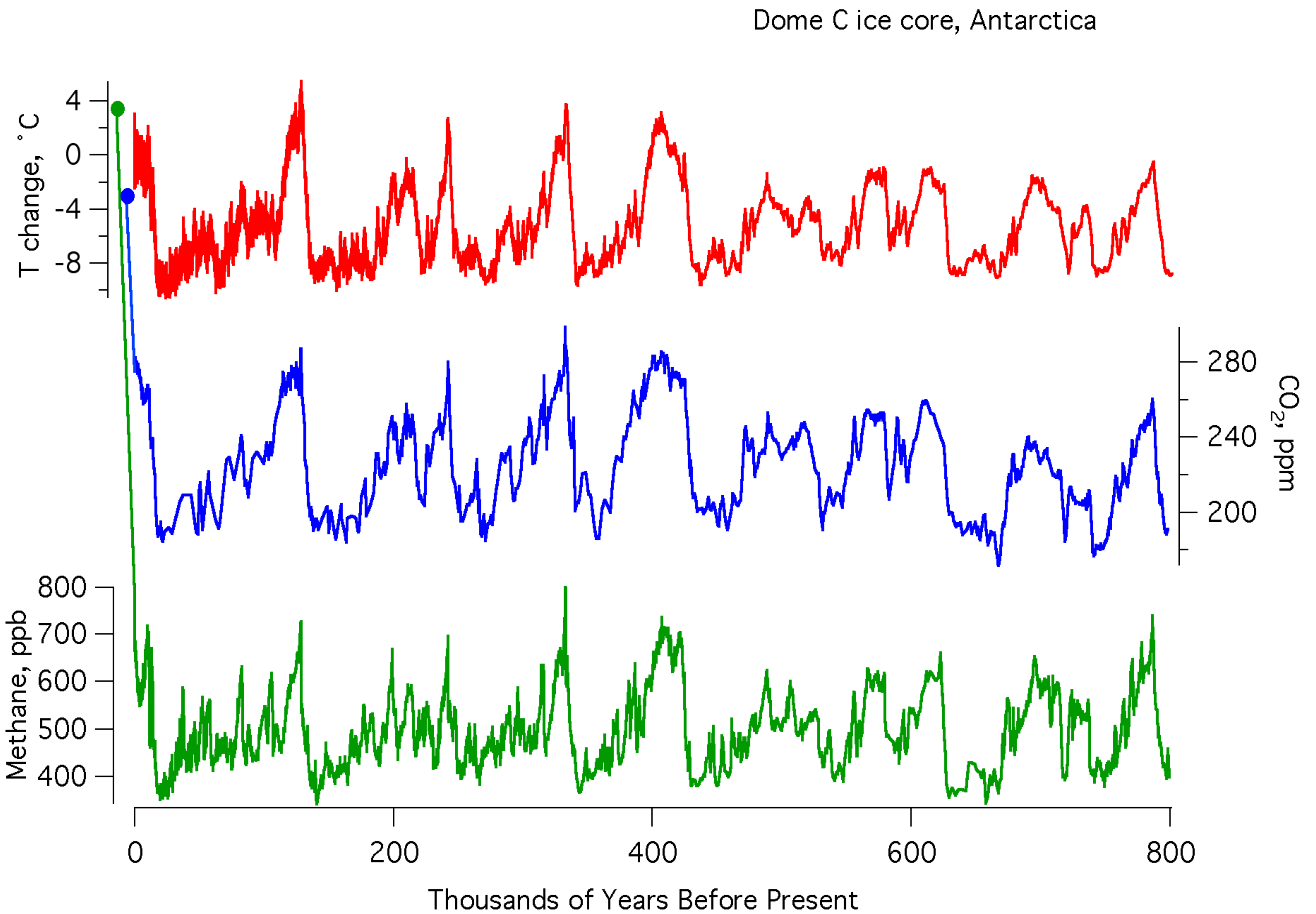




Center for Ice and Climate, U Copenhagen

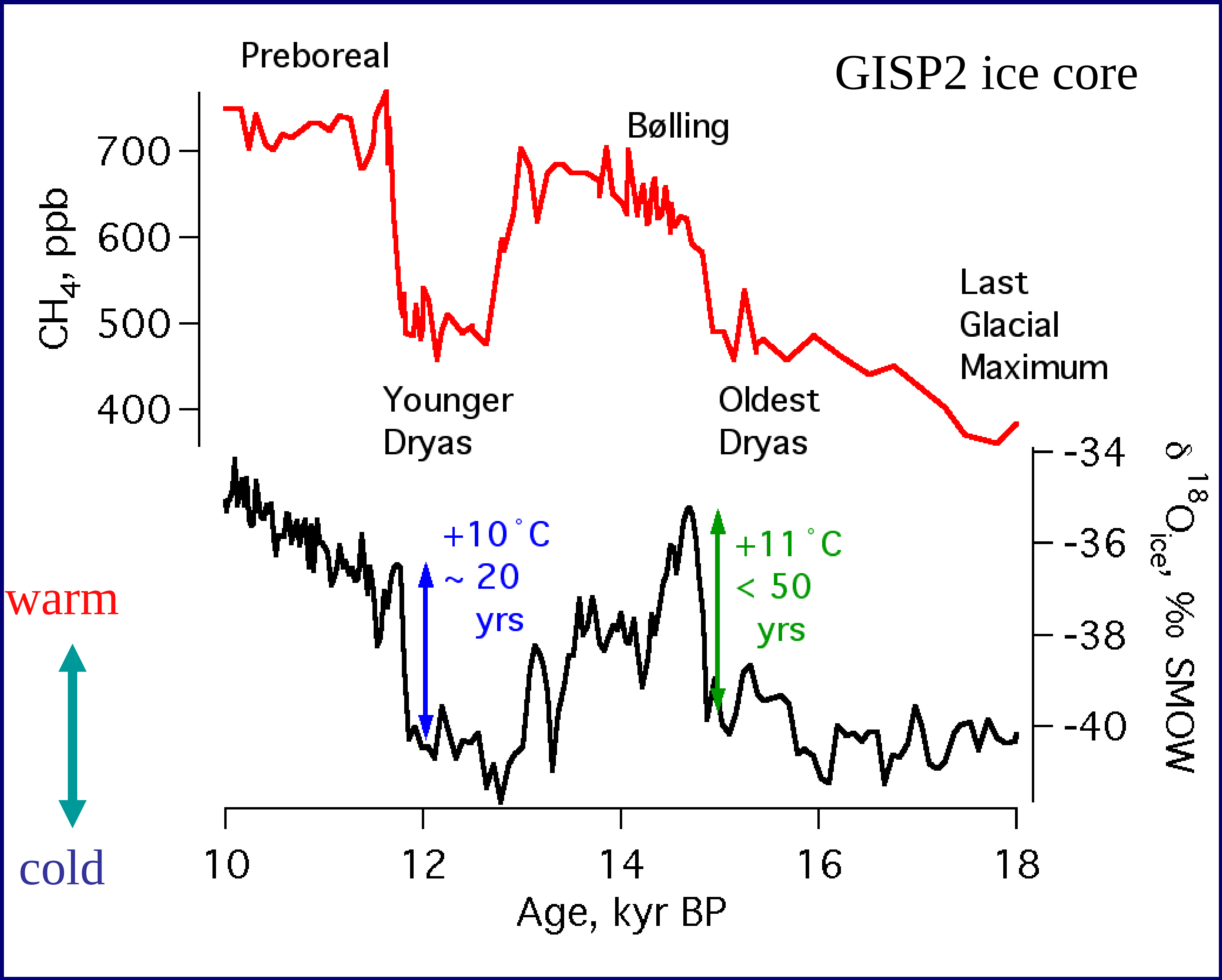


Data are from: Jouzel et al., 2007, Science, 5839, v. 317, p. 793; Luthi et al., 2008, Nature, v. 453, p.379;
Loulergue et al., 2008, Nature, v. 453, p. 383;



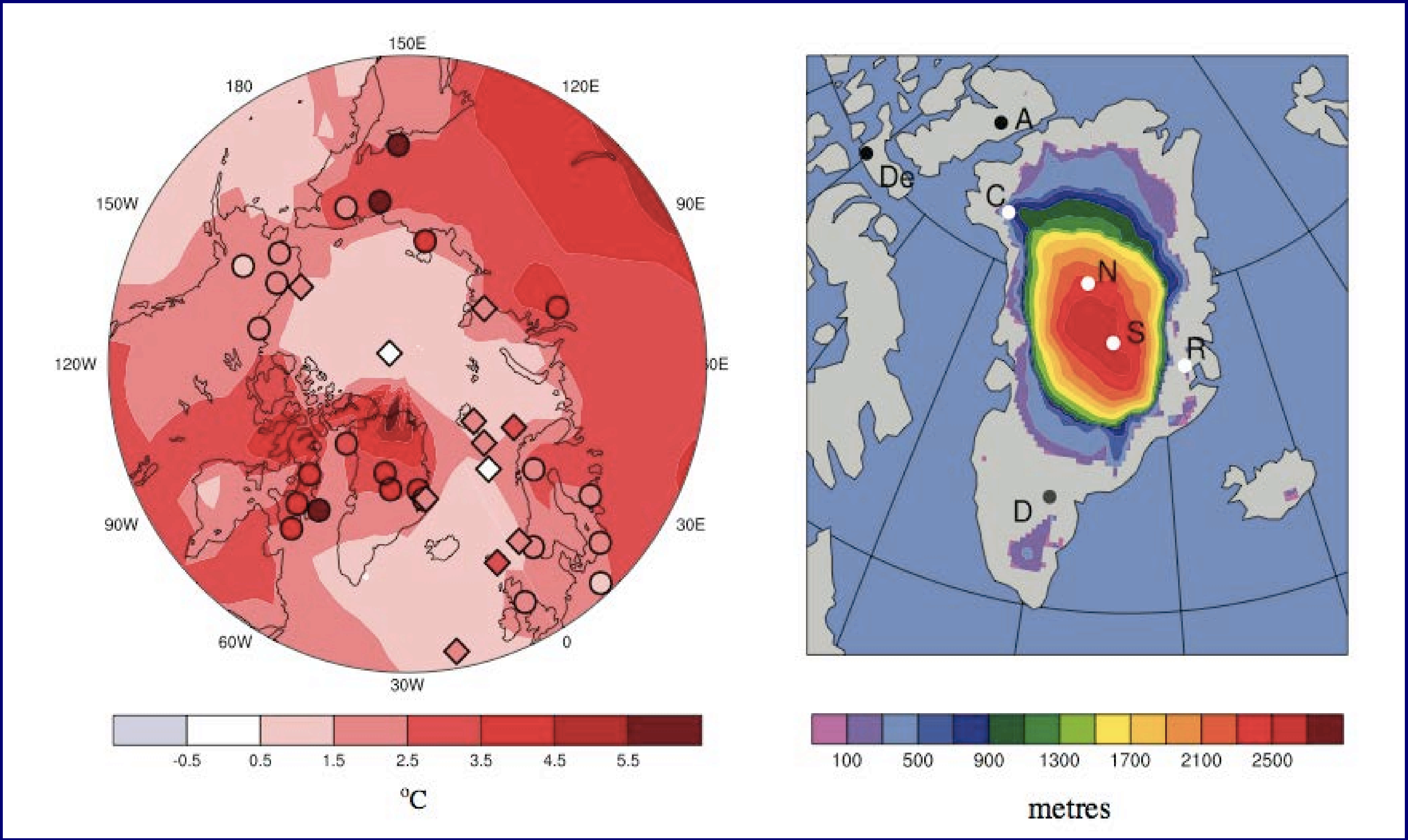
Data are from: Jouzel et al., 2007, Science, 5839, v. 317, p. 793; Luthi et al., 2008, Nature, v. 453, p.379; Loulergue et al., 2008, Nature, v. 453, p. 383;

ABRUPT CLIMATE CHANGE



CH_4 data are from Brook et al., 2000, Glob. Biogeochem. Cycles; $d^{18}O$ data are from Grootes and Stuiver, 1997, J. Geophys. Res.

THE LAST TIME THE WORLD WAS SIGNIFICANTLY WARMER: THE PREVIOUS INTERGLACIAL



IPCC Working Group I report, 2007

100 Myr AGO: A MUCH WARMER WORLD

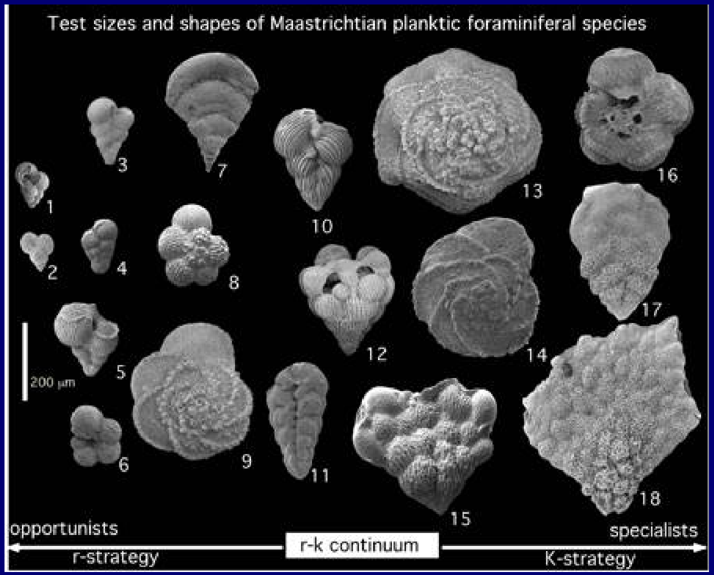
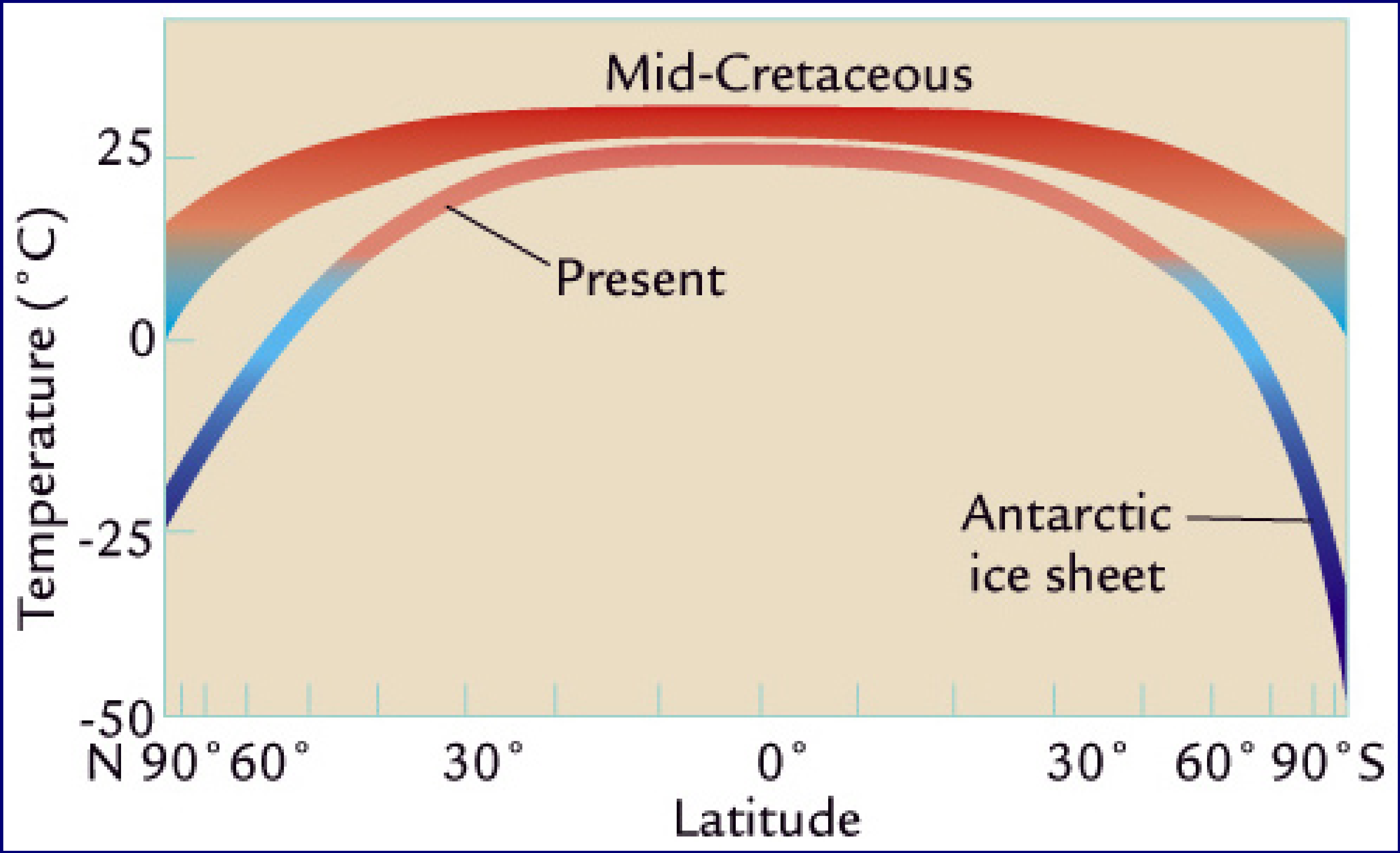


Image:http://geoweb.princeton.edu/people/keller/Deccan_Volc_2.html

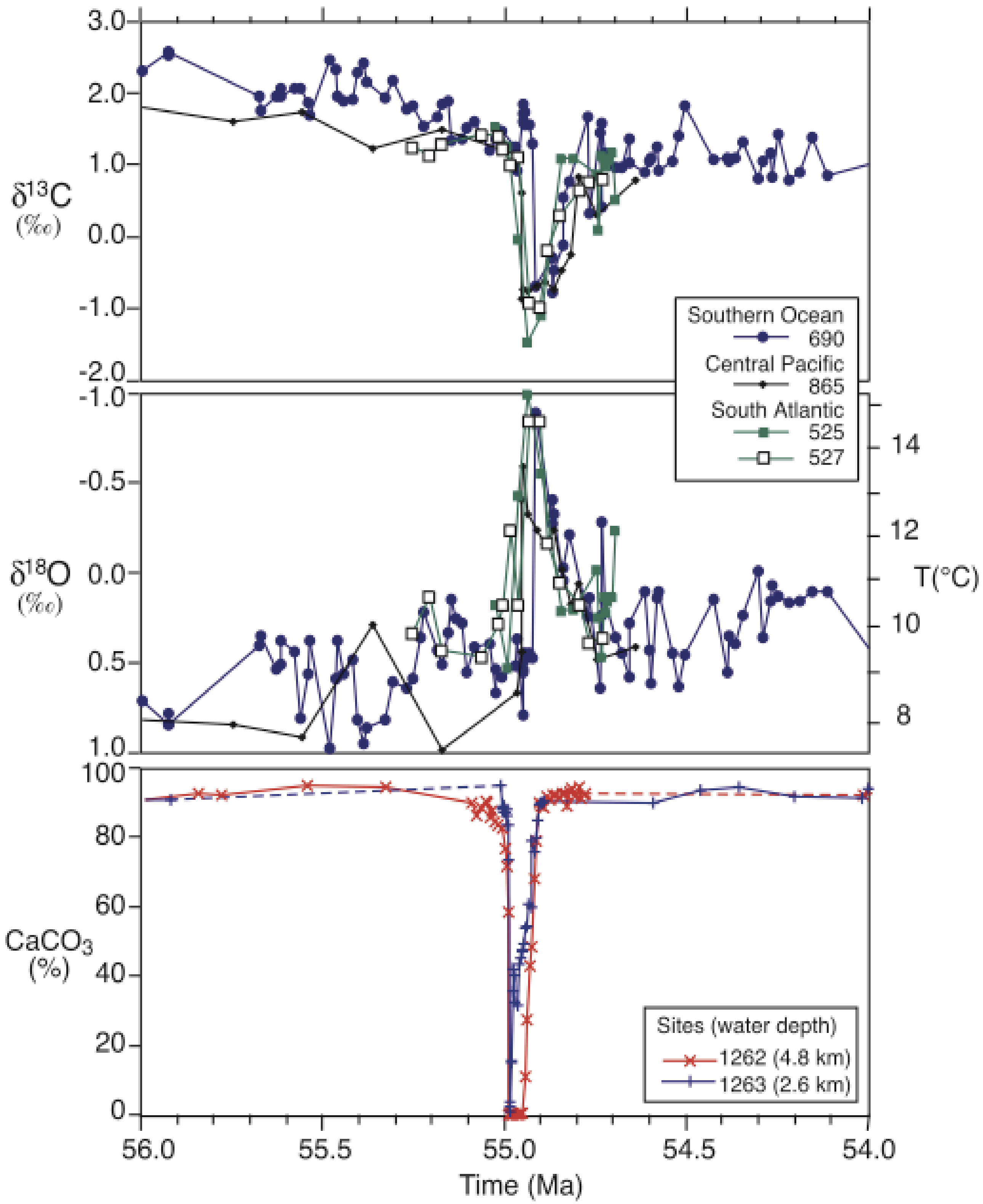
Ruddiman, W.F., 2007. “Earth’s Climate: Past and Future”, 2nd ed., 388 pp., W.H. Freeman, New York.

Image:http://palaeoblog.blogspot.com/2007_04_01_archive.html

RECONSTRUCTED TEMPERATURE DISTRIBUTION



Ruddiman, W.F., 2007. “Earth’s Climate: Past and Future”, 2nd ed., 388 pp., W.H. Freeman, New York.



PALEOCENE - EOCENE THERMAL MAXIMUM (55 Myr)

Very large input of CO_2 into the ocean - atmosphere system

~ 5˚C Warming at low latitudes

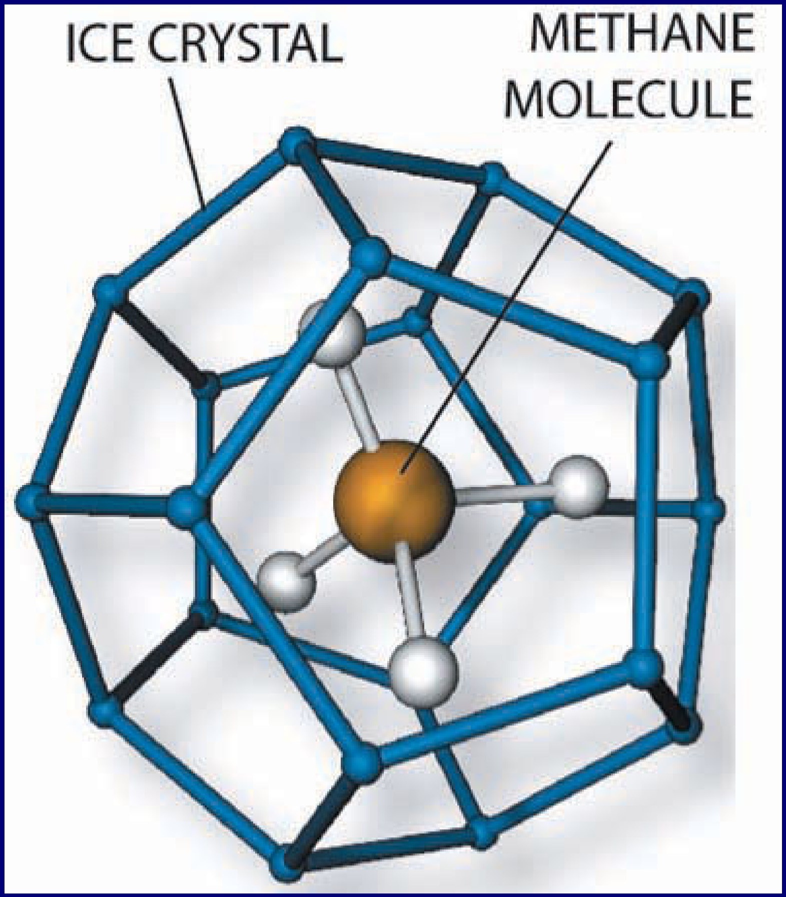
~ 9˚C warming at high latitudes

Warming took 1 - 10 kyr

Recovery took ~ 100 kyr

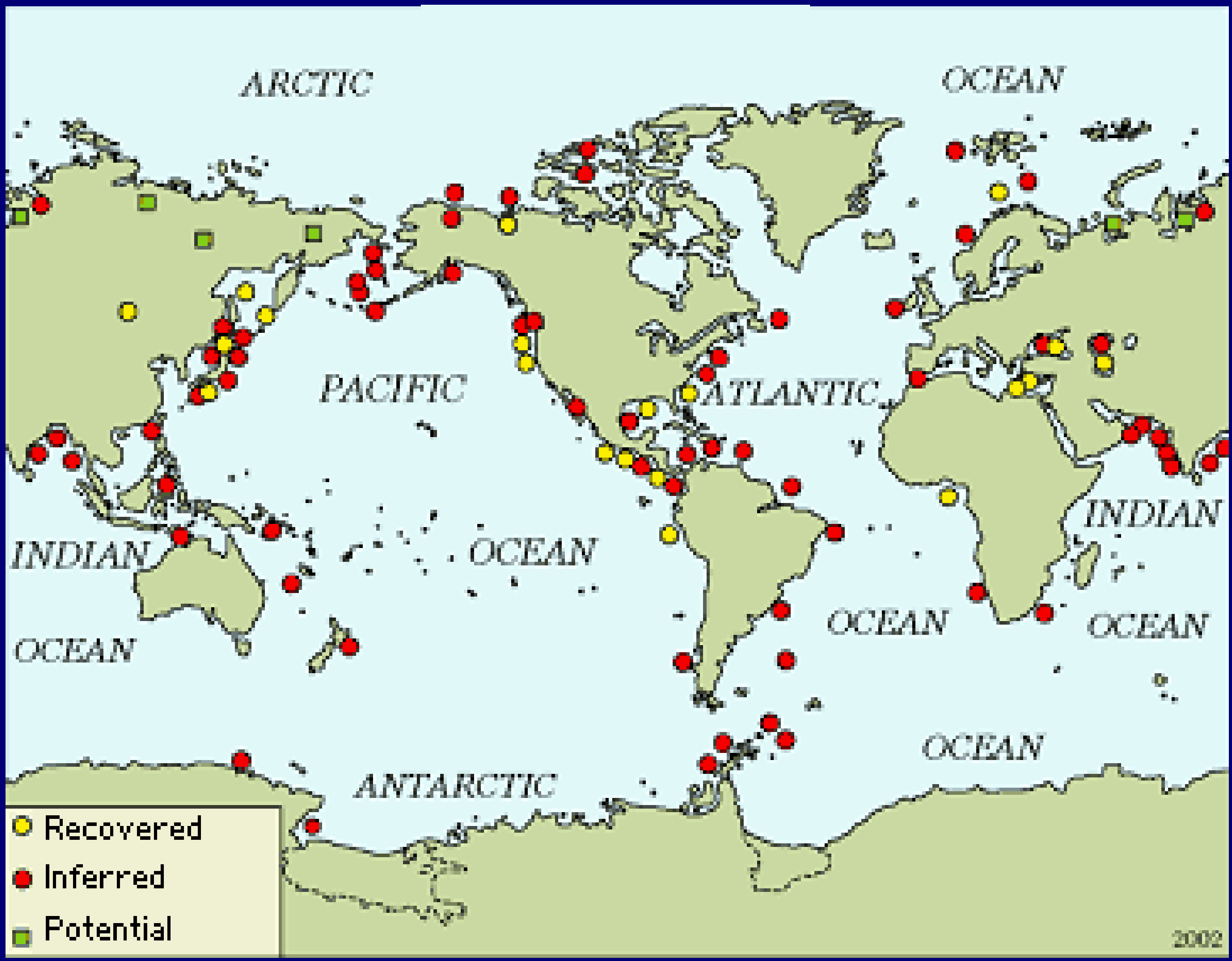
IPCC Working Group I report, 2007

POSSIBLE CAUSE: METHANE HYDRATES



https://depts.washington.edu/nwst/publish/stories/2006-fall/2006-fall-earthsciences-2-Methane_Molecule.jpg

METHANE HYDRATES



http://geology.usgs.gov/connections/images/mms_images/world_hydrates.gif

PHASE 1 STUDIES

Foundation Questions

What are the climate change issues that should be considered in Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?

How may these climate change issues be evaluated during Phase 2 Decision Making for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

PRESENTATION 2

HUMAN INFLUENCES ON CLIMATE

By Dr. Xuebin Zhang

HUMAN INFLUENCES ON CLIMATE

By: Xuebin Zhang, Climate Research Division, Environment Canada

PRESENTATION SUMMARY

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Temperature data for Earth as a whole show an increase of about 1.4°F. All of the 10 warmest years in the global temperature records up to 2011 have occurred since 1997. Associated with this warming are changes in precipitation and other elements of the climate system. They include for example increase in high latitudes and decrease in extra-tropics in precipitation, increase in amount of moisture in the atmosphere, decrease in coldest temperatures, increase in hottest temperature, and increase in heavy precipitation in a large part of the world.

Many factors drive climate change. Climate varies naturally from one year to another and from one decade to another. Natural factors, which are not part of earth climate system, such as solar activities that change the amount of solar energy reaching the earth atmosphere and volcanic activities that affect the amount of solar energy being absorbed by the atmosphere, also influence the climate. Human factors that include the use of fossil fuel and changes in land surface affect the climate. It is clear from extensive scientific evidence that the dominant cause of the rapid change in climate over the past half century is the increase in the amount of greenhouse gases as a result of human activities.

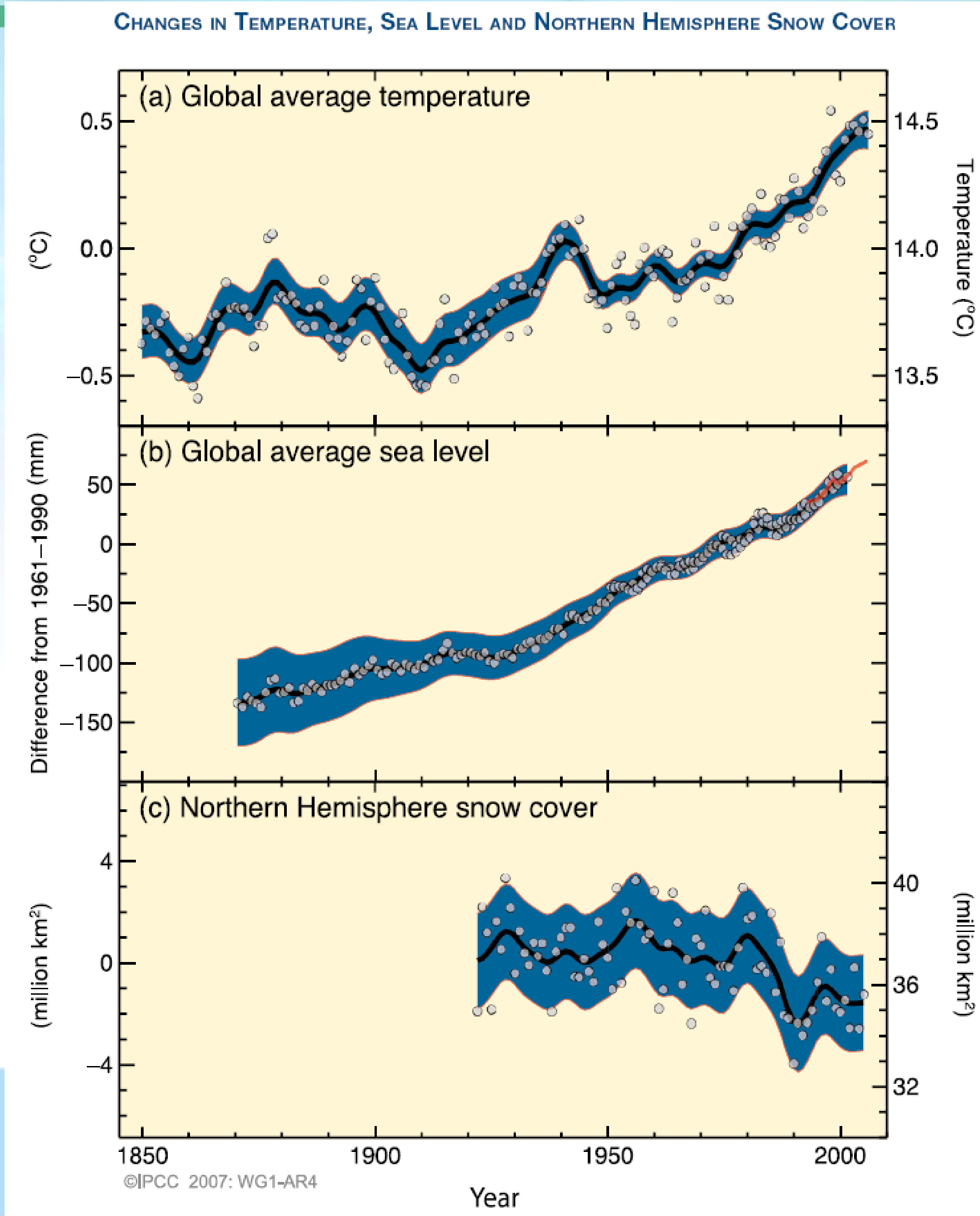
This talk presents some scientific evidence of anthropogenic influence on temperature at the global and regional scales, and on total and extreme precipitation at the hemispheric and global scale.

Human Influences on Climate

Xuebin Zhang
Climate Research Division
Science and Technology Branch

Global warming

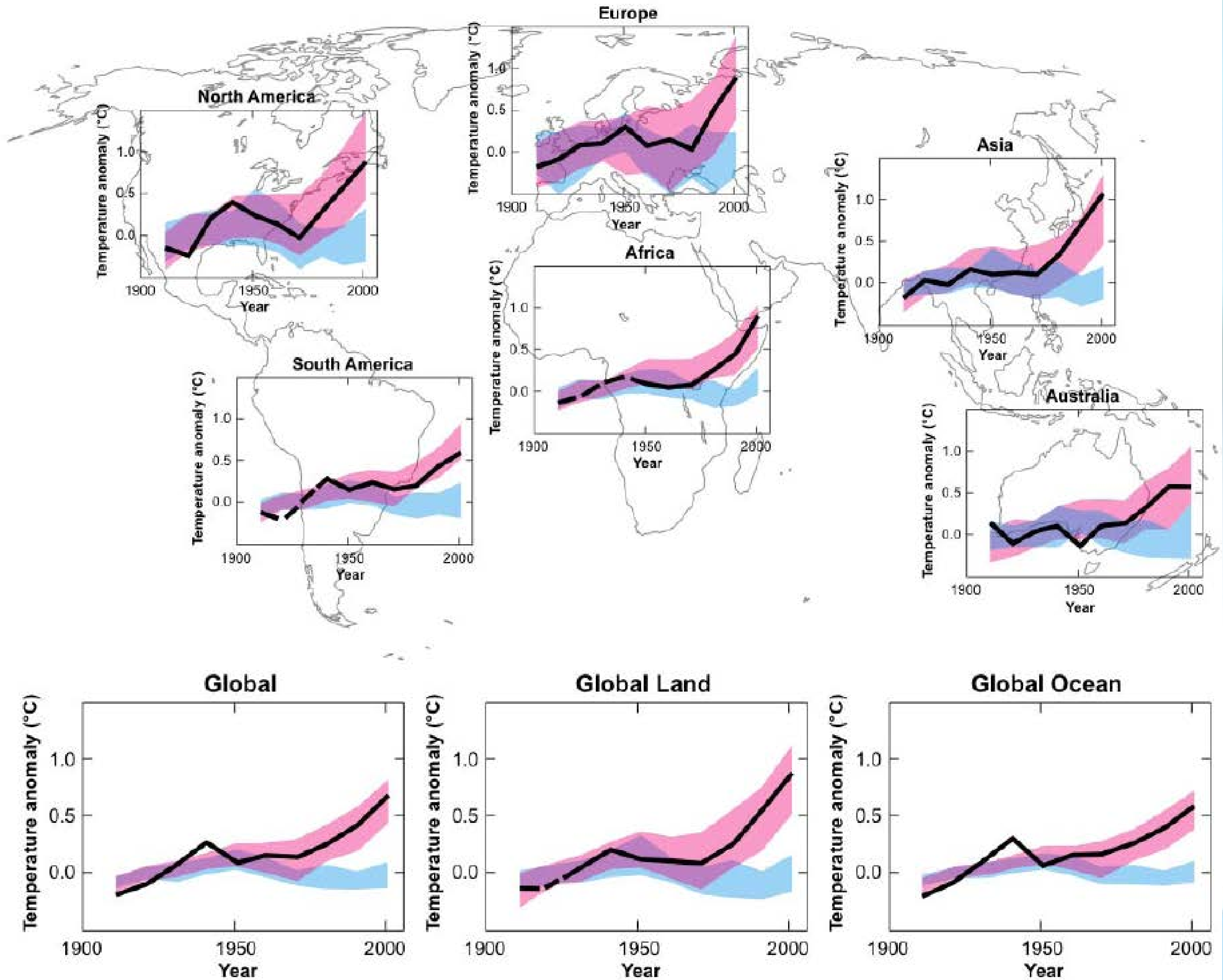
- Warming of the climate system is unequivocal.
- Global average surface temperature increased 1.4F over the period 1901-2010
- All of the 10 warmest years in the global temperature records up to 2011 have occurred since 1997



Environment Canada Environnement Canada

Continental warming

- It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent except Antarctica
- Climate models do not simulate observed change without anthropogenic forcing



Environment Canada Environnement Canada

Fig. SPM-4 / FAQ 9.2, Fig. 1

Changes in surface specific humidity

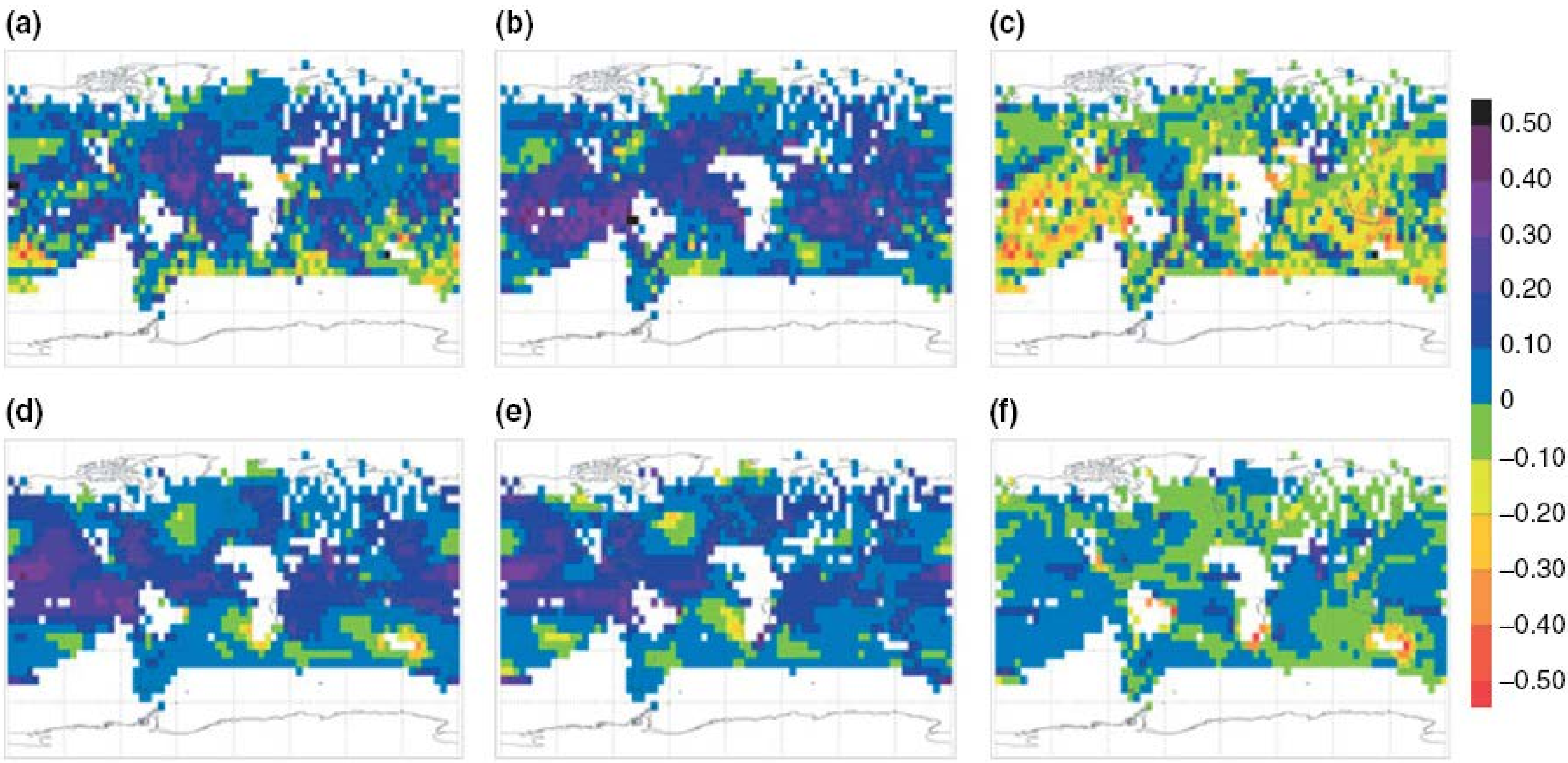
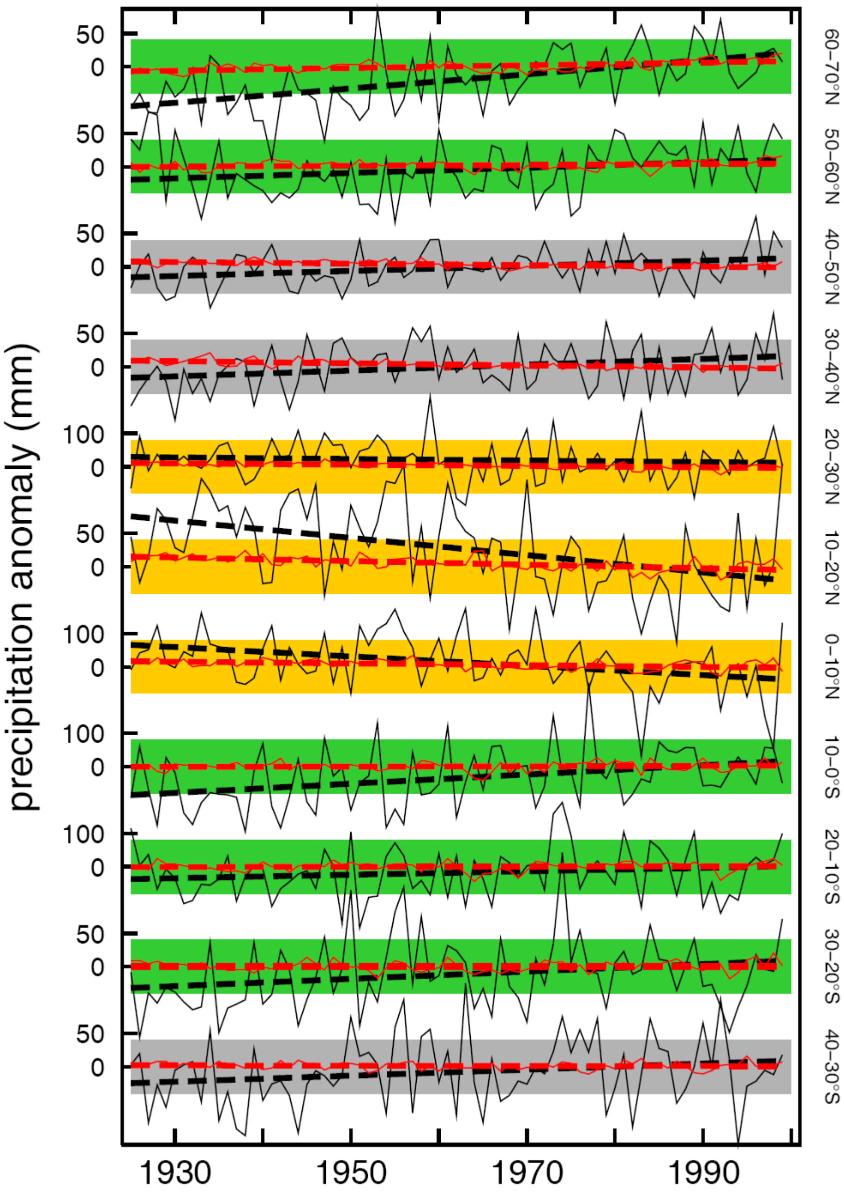
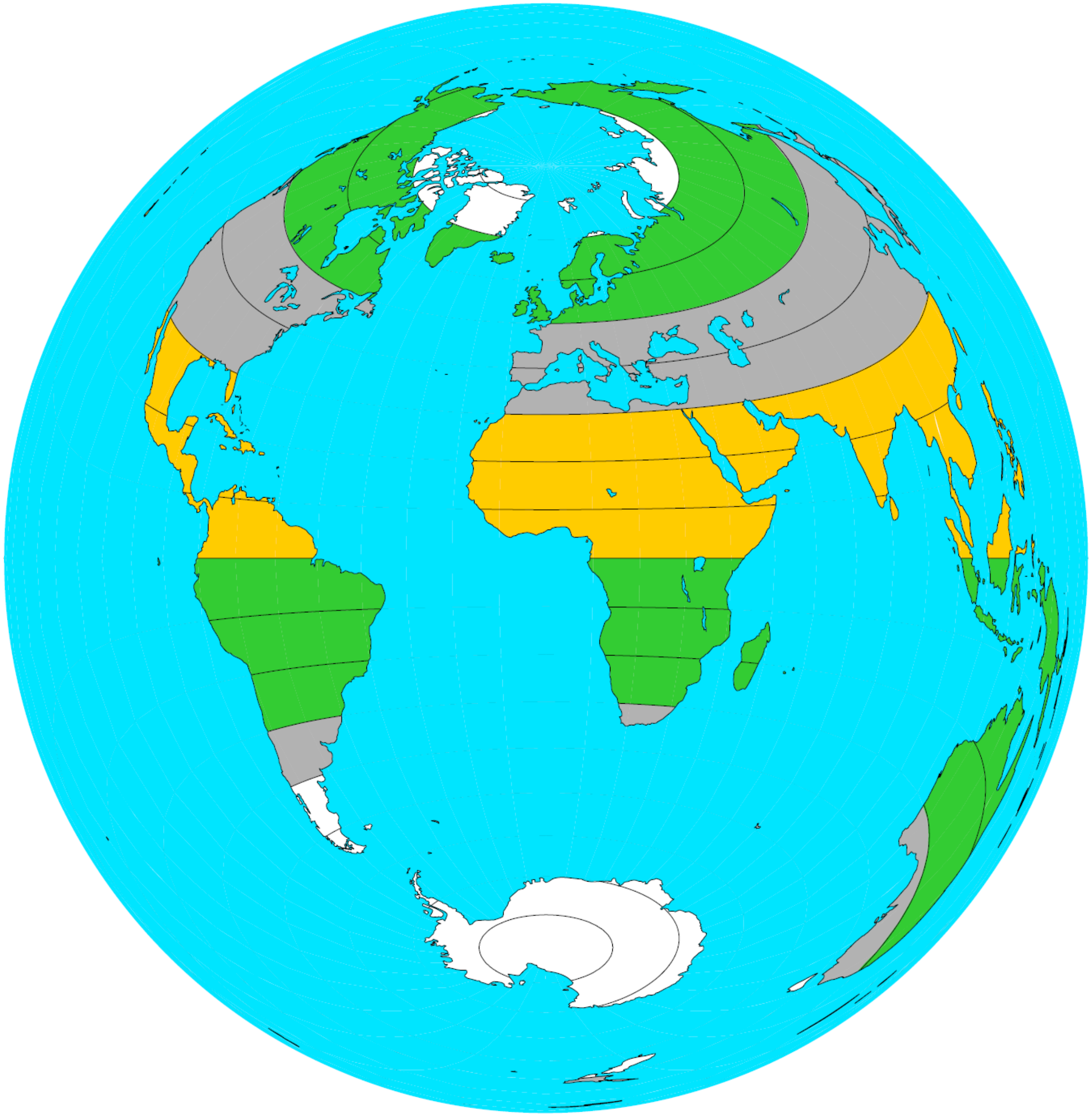


FIGURE 6 | Observed (top row) and simulated (bottom row) trends in specific humidity over the period 1973–1999 in grams per kilogram per decade. Observed specific humidity trends (a) and the sum of trends simulated in response to anthropogenic and natural forcings (d) are compared with trends calculated from observed (b) and simulated (e) temperature changes under the assumption of constant relative humidity; the residual actual trend minus temperature induced trend is shown in (c) and (f). Adapted from Willett et al.[47]

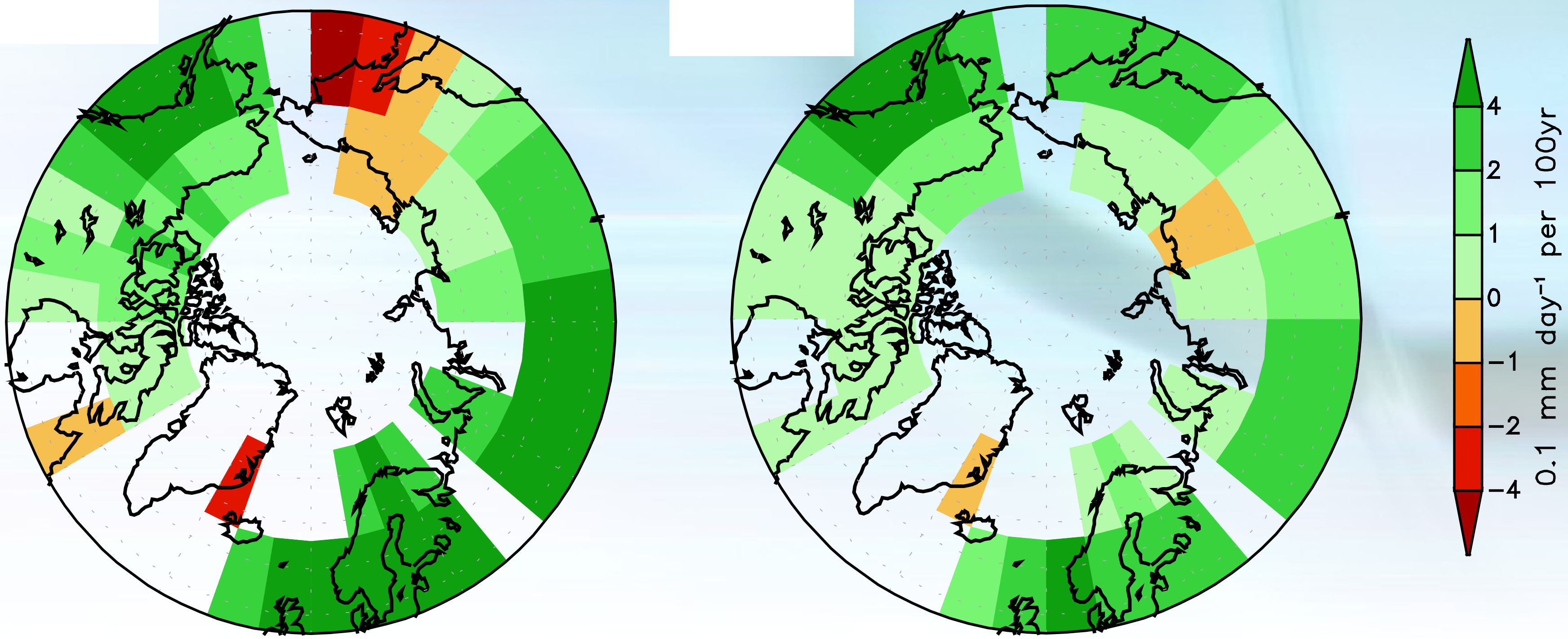
Observed and ALL trends (1925-1999)





Zhang et al (2007)

Precipitation Trends for 1950–99

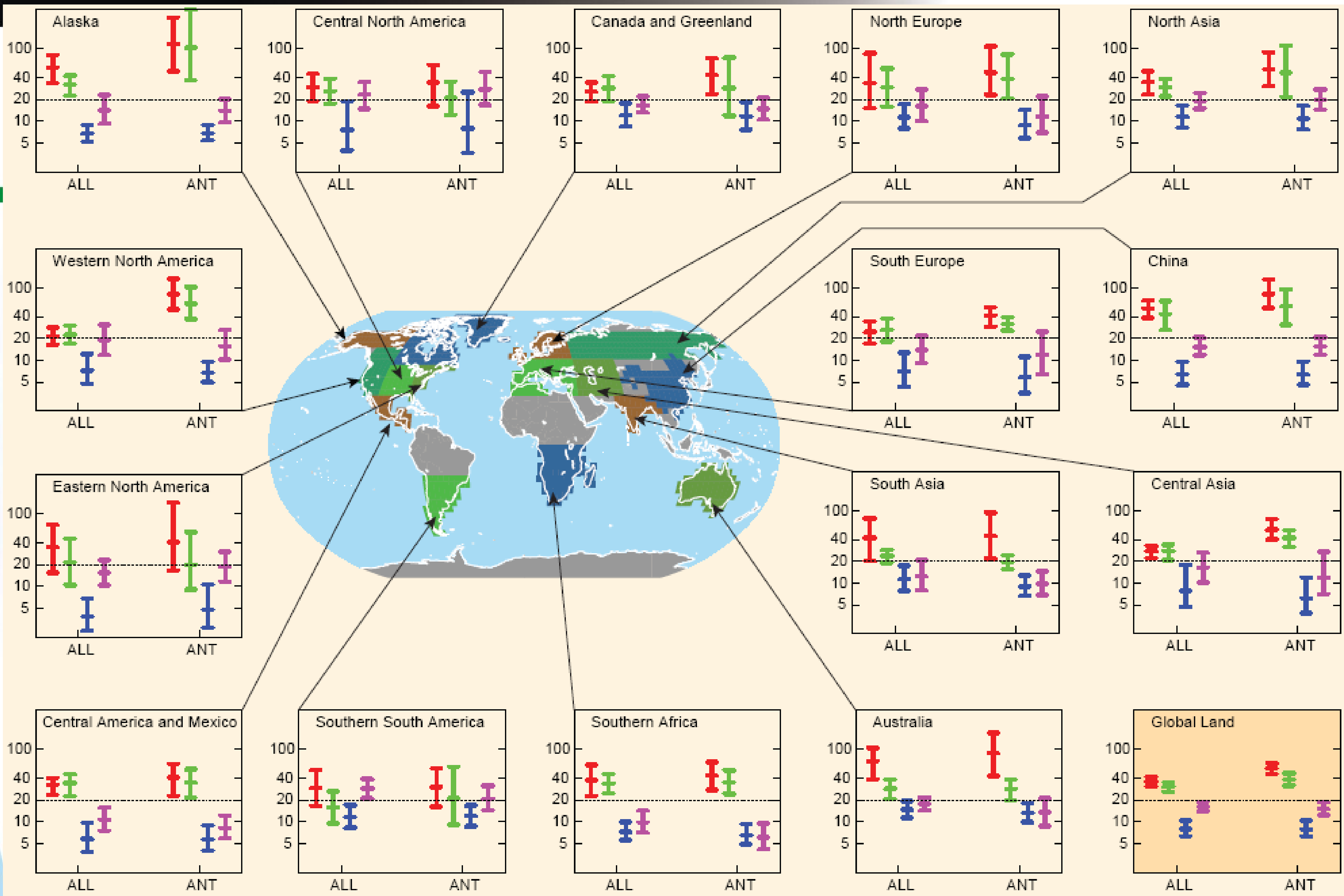


Observations

Multi–model mean (ANT)

- Overall increasing trends
- Exception: Easternmost part of Eurasia

- Increasing everywhere
- consistent with future predictions
- Weaker amplitude than observed



igure 3-2 | Estimated return periods (years) and their 5 and 95% uncertainty limits for 1960s 20-year return values of annual extreme daily temperatures in the 1990s climate see text for more details). ANT refers to model simulated responses with only anthropogenic forcing and ALL is both natural and anthropogenic forcing. Error bars are for annual ninimum daily minimum temperature (red: TNn), annual minimum daily maximum temperature (green: TXn), annual maximum daily minimum temperature (blue: TNx), and annual naximum daily maximum temperature (pink: TXx), respectively. Grey areas have insufficient data. Source: Zwiers et al., (2011).

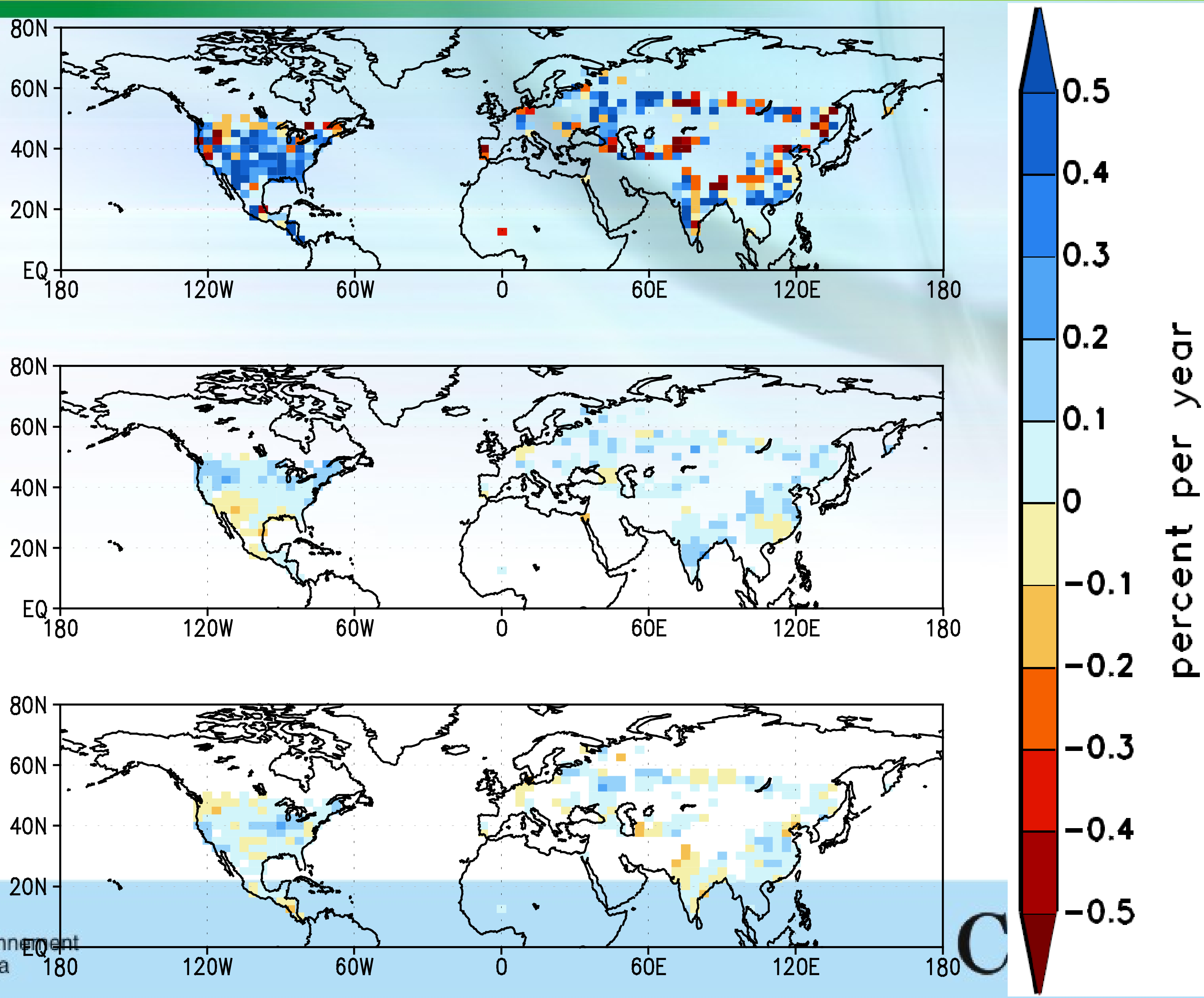
Trends in probability of maximum 1-day precipitation (1951-1999)

OBS

Models

ANT

ALL



Conclusion

- The warming is unequivocal
- The warming is largely the result of human activities
- Human influences can also be detected on other aspects of the climate, including extreme temperatures, precipitation totals, and extreme precipitation

PHASE 1 STUDIES

Foundation Questions

What are the climate change issues that should be considered in Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?

How may these climate change issues be evaluated during Phase 2 Decision Making for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

Thank you!

PRESENTATION 3

ESTIMATES OF CURRENT AND FUTURE PROBABLE MAXIMUM PRECIPITATION

By Dr. Kenneth E. Kunkel

ESTIMATES OF CURRENT AND FUTURE PROBABLE MAXIMUM PRECIPITATION

By: Kenneth E. Kunkel, Dept. of Marine, Earth, and Atmospheric Sciences, NC State University

PRESENTATION SUMMARY

Probable Maximum Precipitation (PMP) is the theoretically greatest amount of rain that can fall at a particular location. PMP values are used in the design of long-lived structures with lifetimes of many decades, such as dams, where failure would be catastrophic. Climate change is an unavoidable consideration on those time scales.

The method for estimation of PMP values has changed little over the last 30 to 40 years. The basic approach is to consider the factors that contribute to heavy rain and then estimate the potential rainfall if all of those factors were simultaneously maximized. Precipitation forms when air rises, the air cools, and water condenses. One key factor in estimating PMP is the maximum speed of rising air in the atmosphere. A second key factor is the amount of water vapor in the atmosphere. There are no direct measurements of the speed of rising air. Historical extremely heavy rain storms, which have to be accompanied by very high rising air speeds, are used as indirect measures of these speeds. By contrast, there are direct measurements of atmospheric water vapor and these are used in estimates of PMP.

On timescales of decades to centuries and beyond, there is reason to believe that PMP values will change because of potential changes in atmospheric water vapor content. The amount of water vapor that the atmosphere can hold is directly related to temperature. In fact, the maximum amount of water vapor is about double at 80°F compared to 60°F. As the globe warms in response to increasing greenhouse gas concentrations, it is virtually certain that maximum water vapor will increase. It is not known whether there could be future changes in the other important factors that enter into PMP that would counteract the potential increases due to increases in the water vapor component.

Estimates of Current and Future Probable Maximum Precipitation

Kenneth E. Kunkel
Department of Marine, Earth, and Atmospheric Sciences
North Carolina State University

Probable Maximum Precipitation (PMP)

- Definition: Theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin at a particular time of year

Usages and Considerations

- PMP values are used in the design of long-lived (decades to century) runoff-control structures where failure is unacceptable, e.g. dams
- Climate change is an unavoidable consideration on those time scales

Usages and Considerations

- This is even more critical for the WVDP as multi-century time scales are involved, increasing the chances that human influences on climate will take place
- Can any statements be made about future changes in PMP?

Probable Maximum Precipitation (PMP)

- Values of PMP (point) in western New York:
  - 6 hr: 24 inches
  - 12 hr: 28 inches
  - 24 hr: 30 inches
  - 48 hr: 33 inches
  - 72 hr: 34 inches

Sources of Guidance

- Historical trends
- Theoretical considerations
- Climate model simulations

PMP Considerations/Methods

- The estimation of PMP is based on **maximizing** the important atmospheric factors that determine extreme precipitation, including:
  - Upward motion
  - Moisture in the atmosphere

Upward Motion

- No satisfactory theoretical basis for assigning maximum values
- Solution has been to use observed storm rainfall as an indirect measure of maximum upward motion
- Example: Smethport PA: 24 inches in 6 hr (1942)

Moisture maximization

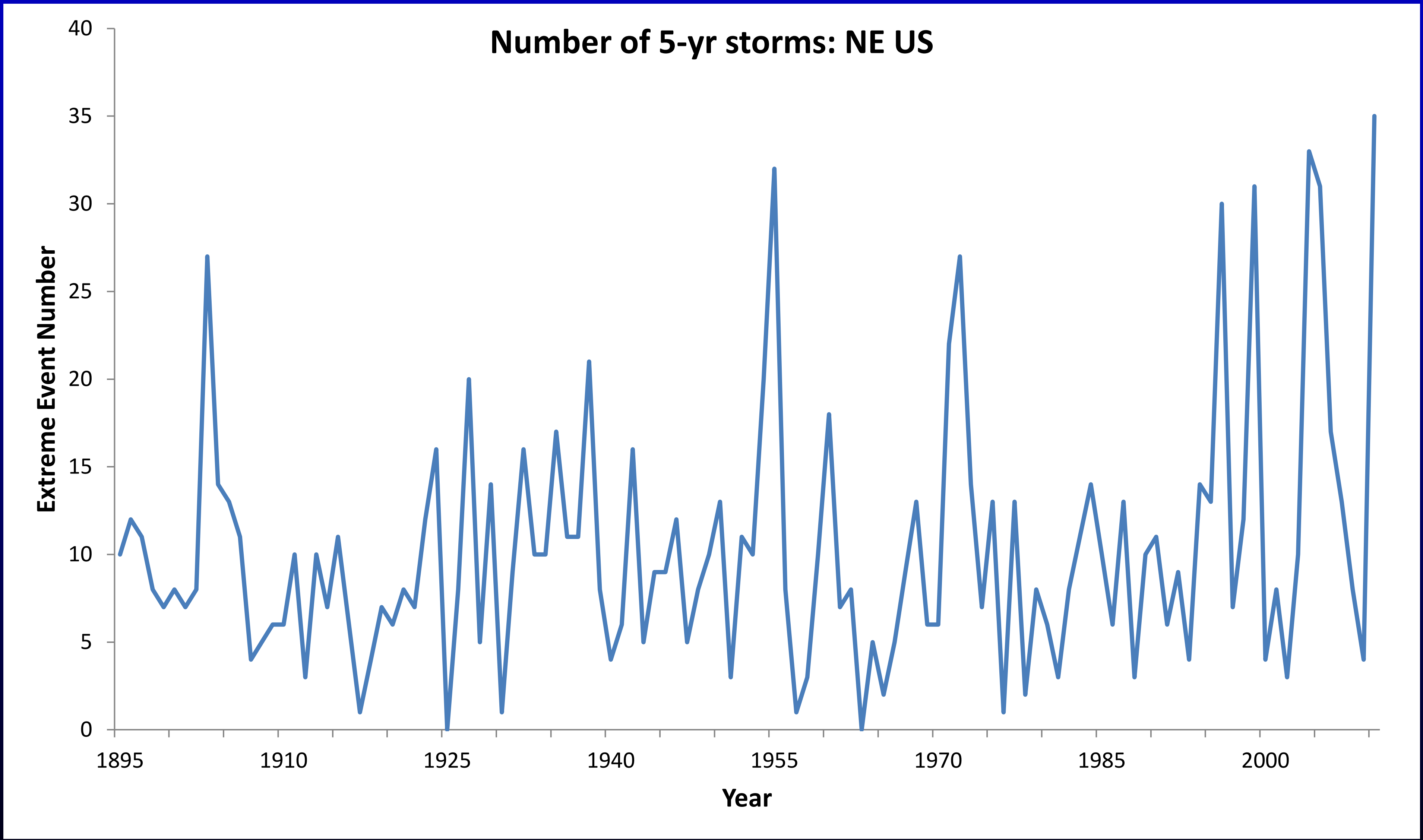
- Historical observations are used to determine the maximum atmospheric moisture that can occur in a given location

Moisture maximization

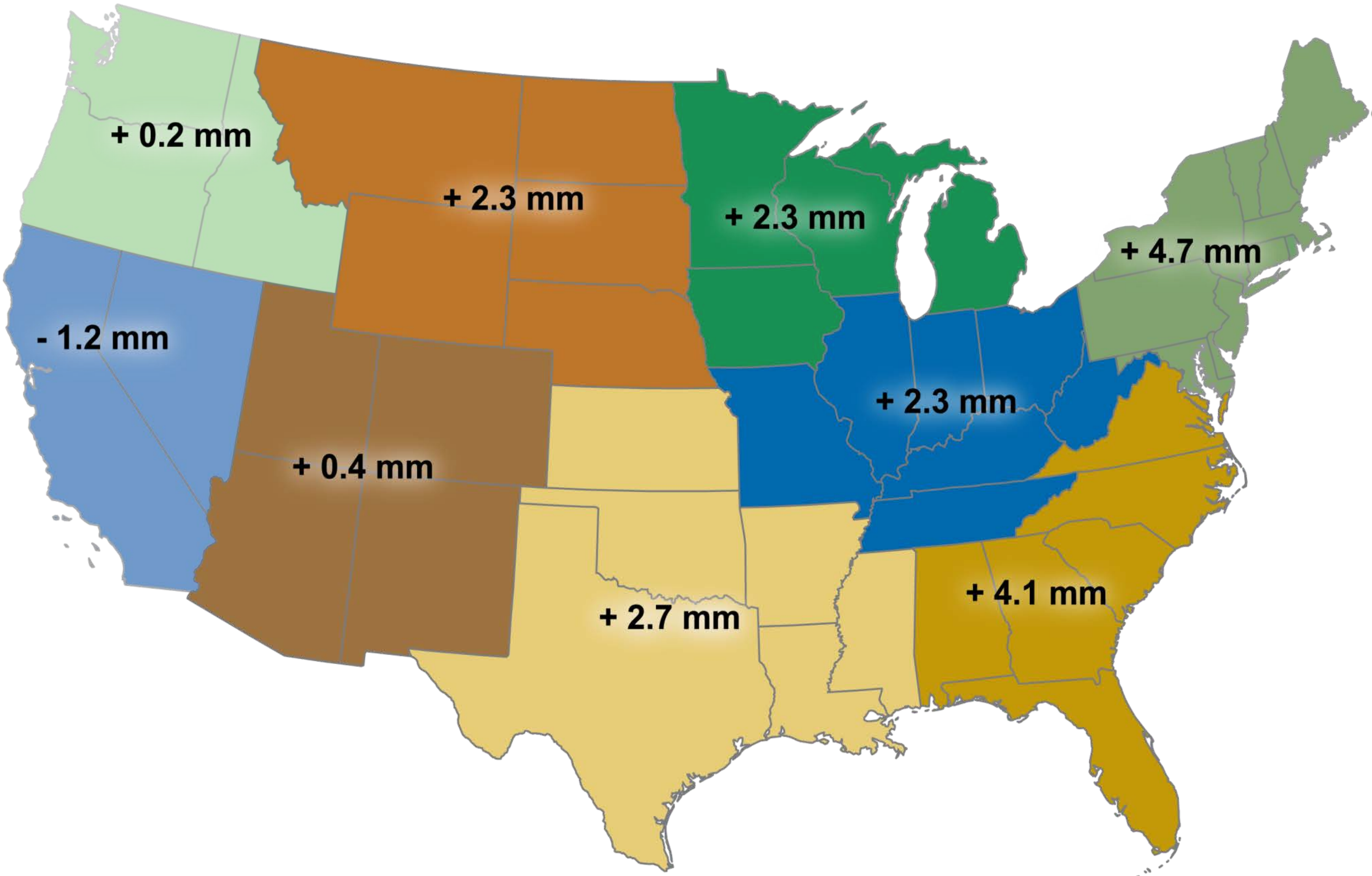
- The one factor that is likely to change due to global warming is moisture maximization due to warming oceans and increased evaporation
- We have seen intriguing evidence that recent extreme precipitation events have been increasing and the increased number of events has been accompanied by higher atmospheric water vapor

Changes in Number of Five Year Storms

Extreme Precipitation in NE US



Changes in Atmospheric Moisture Associated With Five Year Storms



Difference in extreme event precipitable water:
1982-2009 minus 1961-1981

Future Changes in Moisture

- I used data from climate models that simulate future climate conditions incorporating plausible changes in greenhouse gas concentrations

Climate Model Analysis

- I examined projections of moisture in seven climate models
- High emissions and low emissions scenarios

Changes in Maximum Moisture

	Low Emissions	High Emissions
2055	+10-15%	+15-20%
2085	+15-20%	+25-30%

Conclusions

- PMP estimates make direct use of climatological values of maximum atmospheric moisture content
- Intriguing evidence of recent upward trends
- Initial analysis of seven climate models indicates a consensus toward increasing maximum values of water vapor, in agreement with theoretical expectations
- Suggests a high risk of future PMP increases

PHASE 1 STUDIES

Foundation Questions

What are the climate change issues that should be considered in Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?

-Effects of climate change on the values of Probable Maximum Precipitation in western New York

How may these climate change issues be evaluated during Phase 2 Decision Making for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

-Re-evaluation of present climate values of PMP

-Analysis of climate model simulations of future changes in meteorological variables important to PMP

PRESENTATION 4

VARIABILITY IN LOCAL RAINFALL INTENSITY AND RAINFALL DISTRIBUTION PARAMETERS

By Dr. Art DeGaetano

VARIABILITY IN LOCAL RAINFALL INTENSITY AND RAINFALL DISTRIBUTION PARAMETERS

By: Art DeGaetano, Dept. of Earth and Atmospheric Science, Cornell University, NY

PRESENTATION SUMMARY

One of the most pronounced changes in the climate of the Northeastern United States over the last 50 years has been an increase in heavy rainfall. In general, there has been a marked increase in the number of daily rainfall events exceeding various greater-than-one-inch thresholds. Despite considerable station-to-station variation, on average across the region, the number of very heavy rainfall events (the largest 1% of all daily events) has increased by almost 75% since 1958. Most evidence points to a warming climate and the subsequent increase in atmospheric water vapor as playing a large role in this increase in heavy rain.

Engineering and hydrologic design relies on the past precipitation record to assure that, among other factors, flood-control systems, such as culverts and storm water systems are properly-sized to handle the runoff associated with heavy rain. Typically these analyses have assumed a stationary precipitation record; an assumption that appears to no longer be valid. In such analyses, a statistical distribution is typically fit to the observed record. This serves two purposes, smoothing the observed record and allowing extrapolation beyond the available data record. In many cases systems are designed to withstand the 100-year storm, but climate data records rarely cover this many years. Recent work has shown that across the Northeast, storms that were expected to occur on average once every 100 years (based on data from 1950-1979) now occur every 66 years. Similar decreases in the return frequency of the 50-year and 2-year storm are also noted.

In most cases, it is the intensity of rainfall that determines the magnitude of storm runoff, not the total daily amount. Less water will runoff from a slow “soaking” rain than from a downpour. Since different basins react differently to different rainfall intensities, a set of empirical rainfall distribution curves have been developed and are extensively used operationally. The same curves are used over large areas of the country, because the number of stations that reported hourly data was limited and observations of sub-hourly rainfall rare in the early 1960s when they were developed. More recent work to compare these curves with station-specific distributions computed with more recent data, indicate that the original curves capture the pattern of sub-daily rainfall intensities rather well. This agrees with recent work that shows little change in the peak hourly rainfall rate within the largest precipitation events.

Climate model projections allow scientists to assess whether these trends in heavy rainfall will continue through 2100. These models show that daily rainfall will continue to become more intense in the future. On average, western New York can expect as many as 20-25 more days with over 1 inch of rainfall in the period from 2041-2070 than it received in the 1980-2000 timeframe. It is less certain how the most extreme (e.g. > 4 inches) rainfall events will change, however these events are expected to increase in frequency as well. Thus, what is considered a 100-year storm today, will most likely occur more frequently in the future.

Finally, extreme rainfall is only one component of flooding in western NY. Many past floods, particularly on the largest rivers, have resulted from snowmelt or rain falling on a deep snowpack. Decreases in snow cover in the future may temper the risk of spring floods. Similarly longer growing seasons and drier summer soil conditions in the future could buffer a portion of the increase in rainfall. These competing factors complicate the assessment of future changes in flooding.

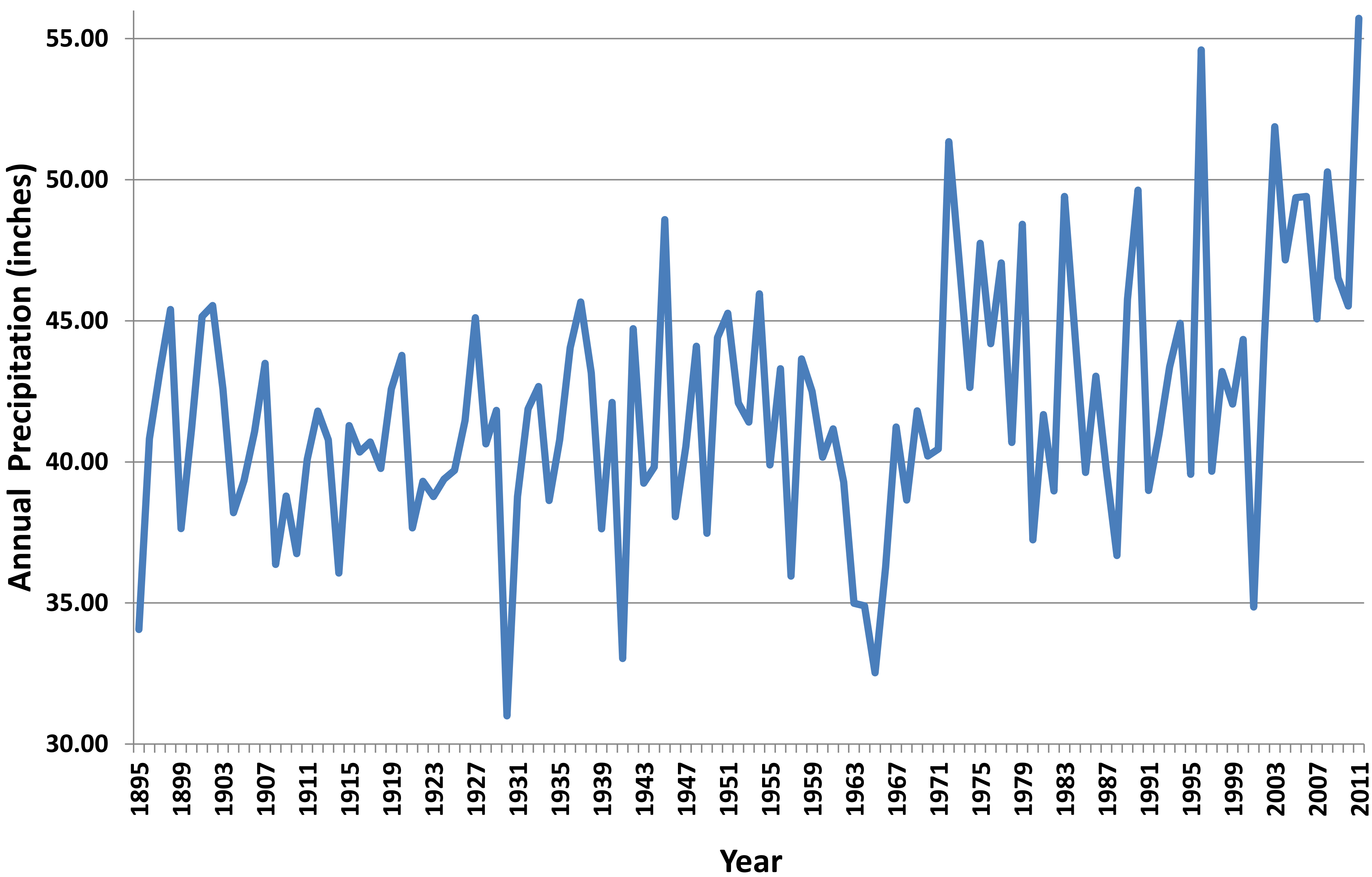
Variability in Local Rainfall Intensity and Rainfall Distribution Parameters

Art DeGaetano
Department of Earth & Atmospheric Science
Cornell University
Director, NOAA Northeast Regional Climate Center

August 2 , 2012

Cornell University

Northeast U.S. Average Annual Precipitation



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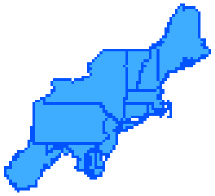
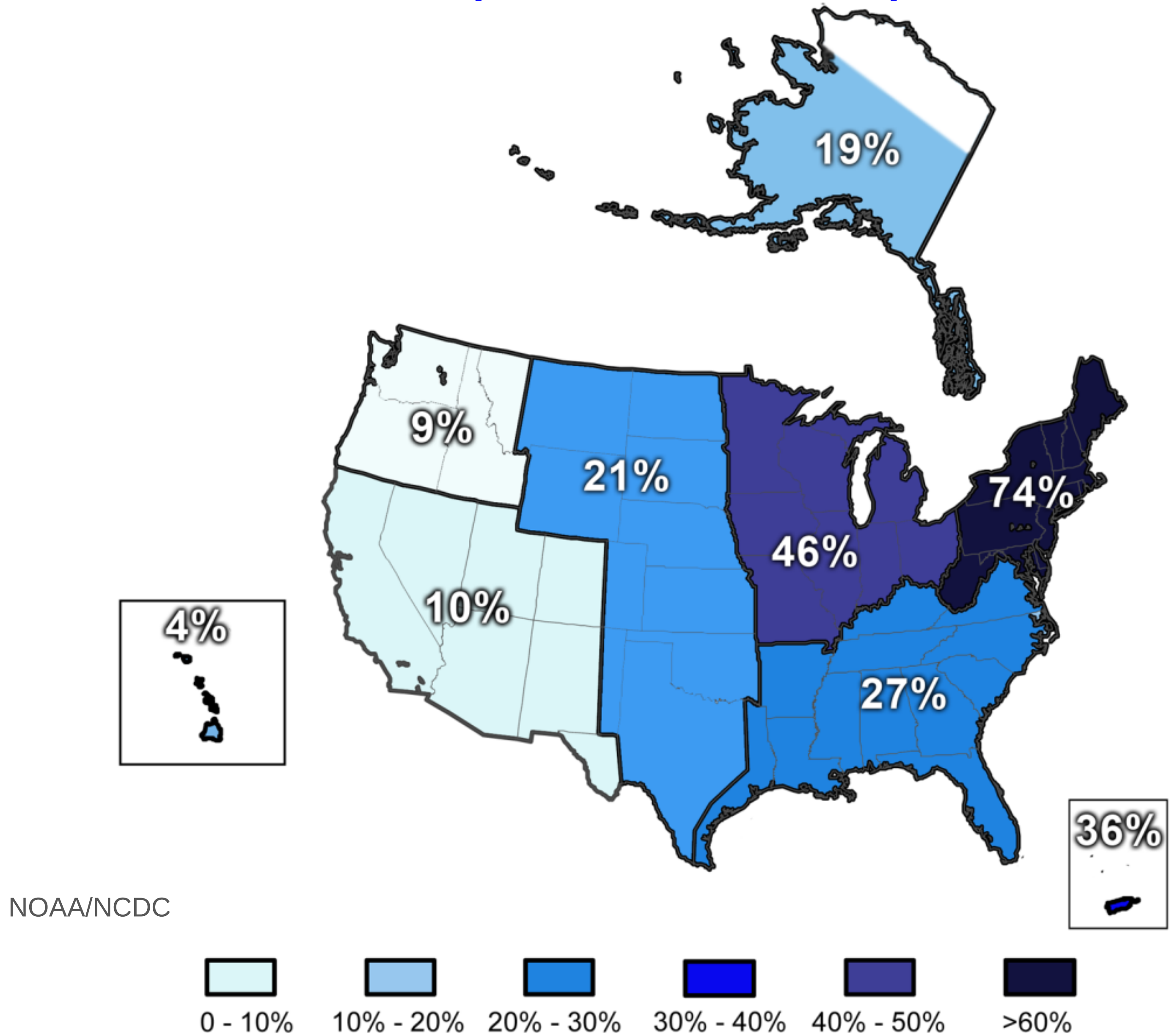
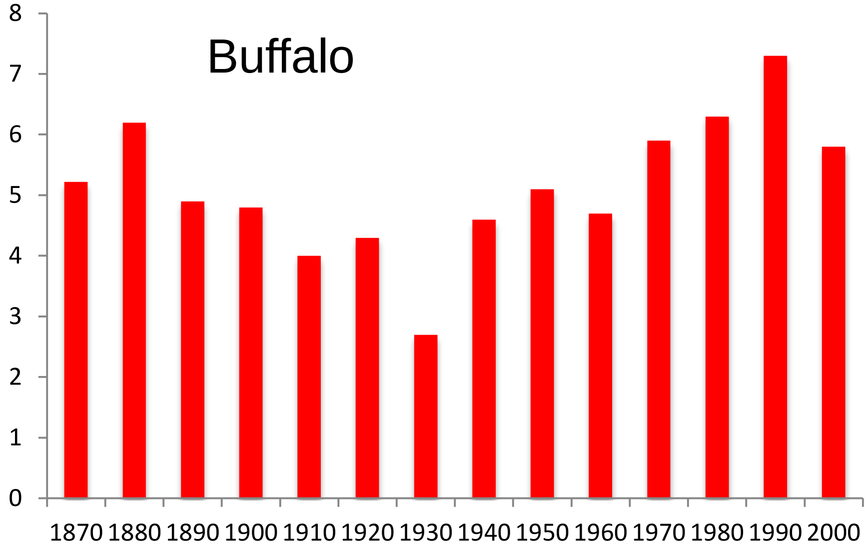
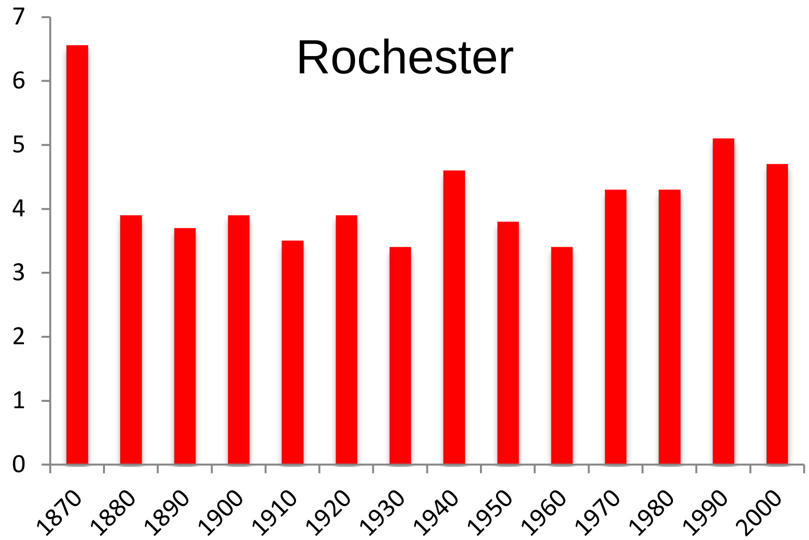


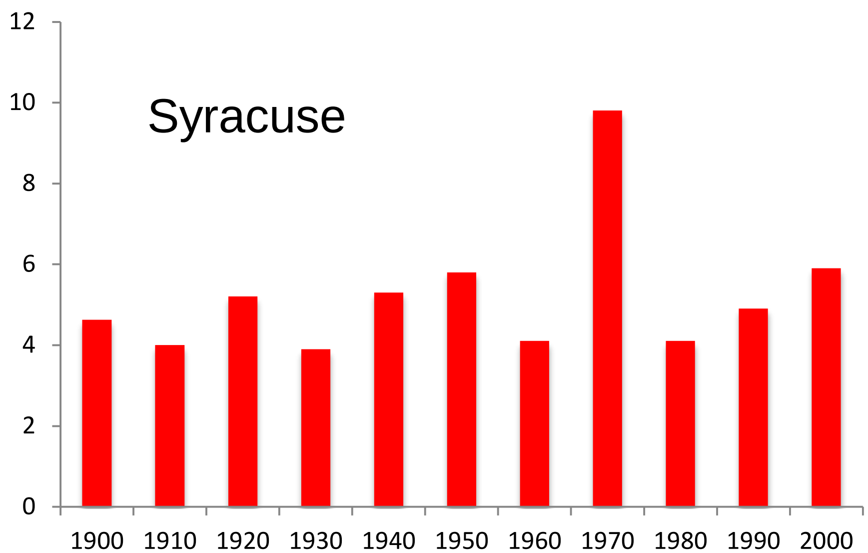
Observed Trends in 1-day Very Heavy Precipitation (1958 to 2010)

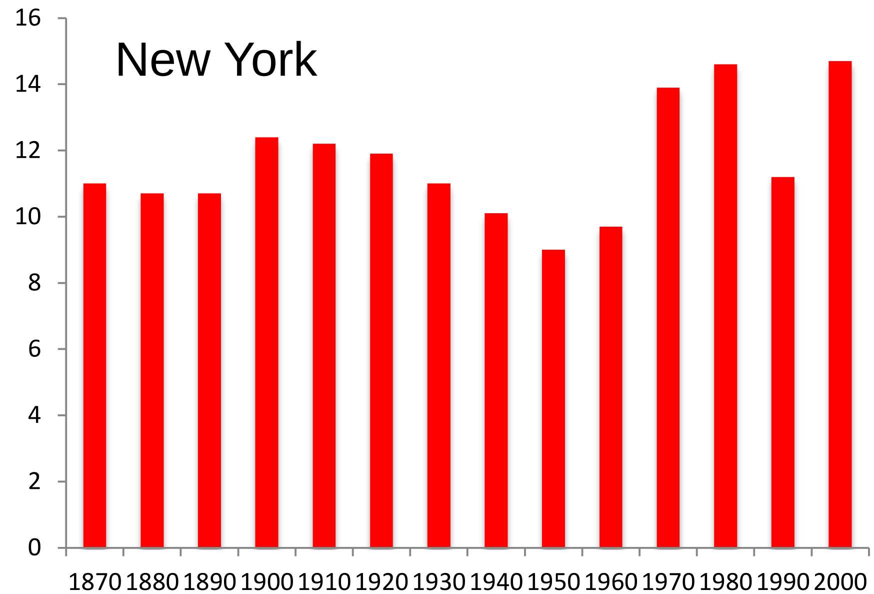


Days ≥ 1 inches rainfall









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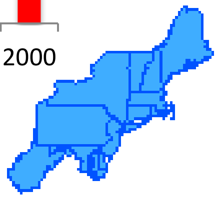
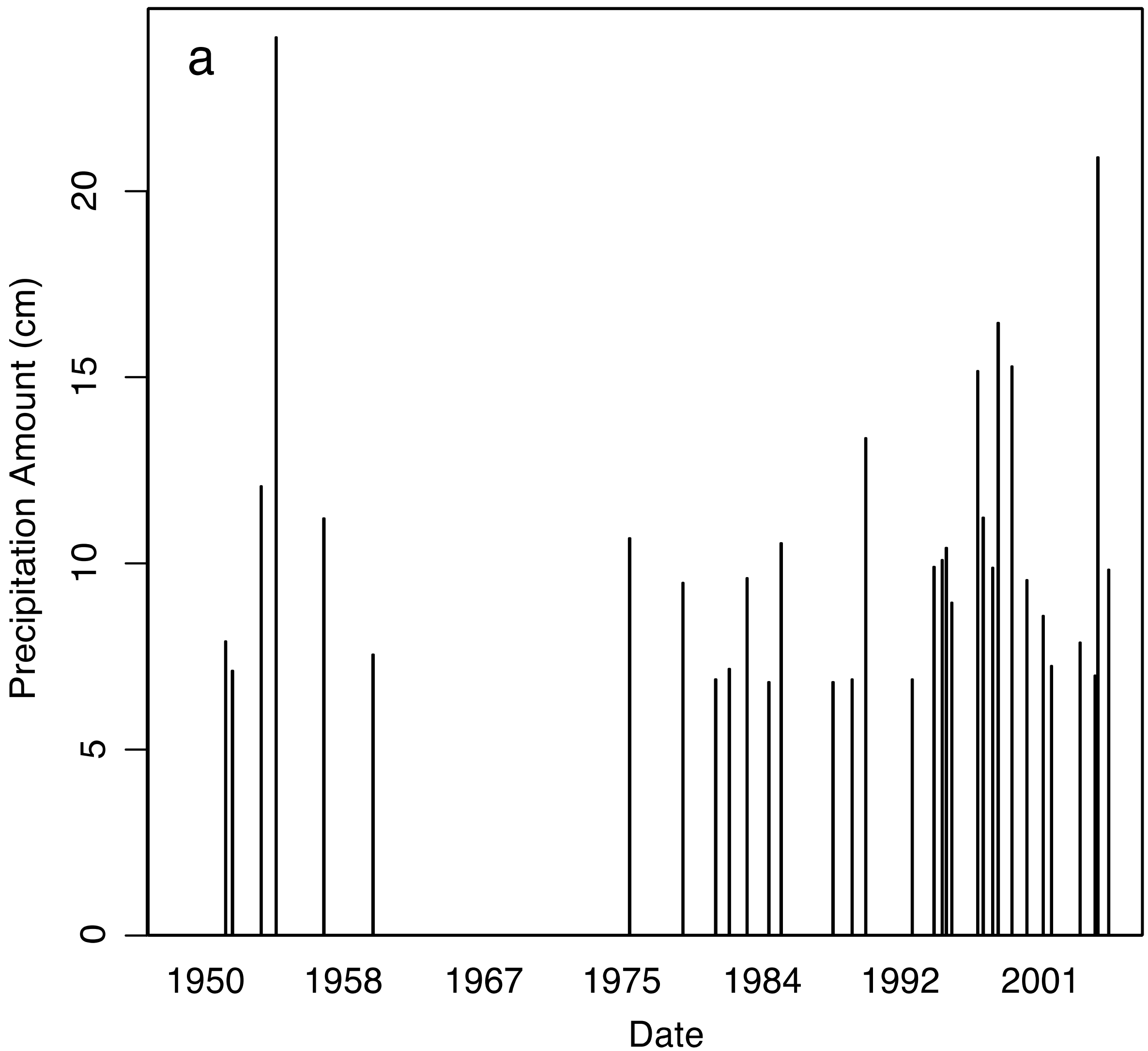


Date and Amount of the 10 Highest Precipitation Events



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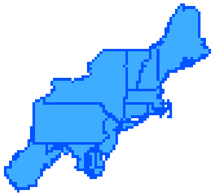
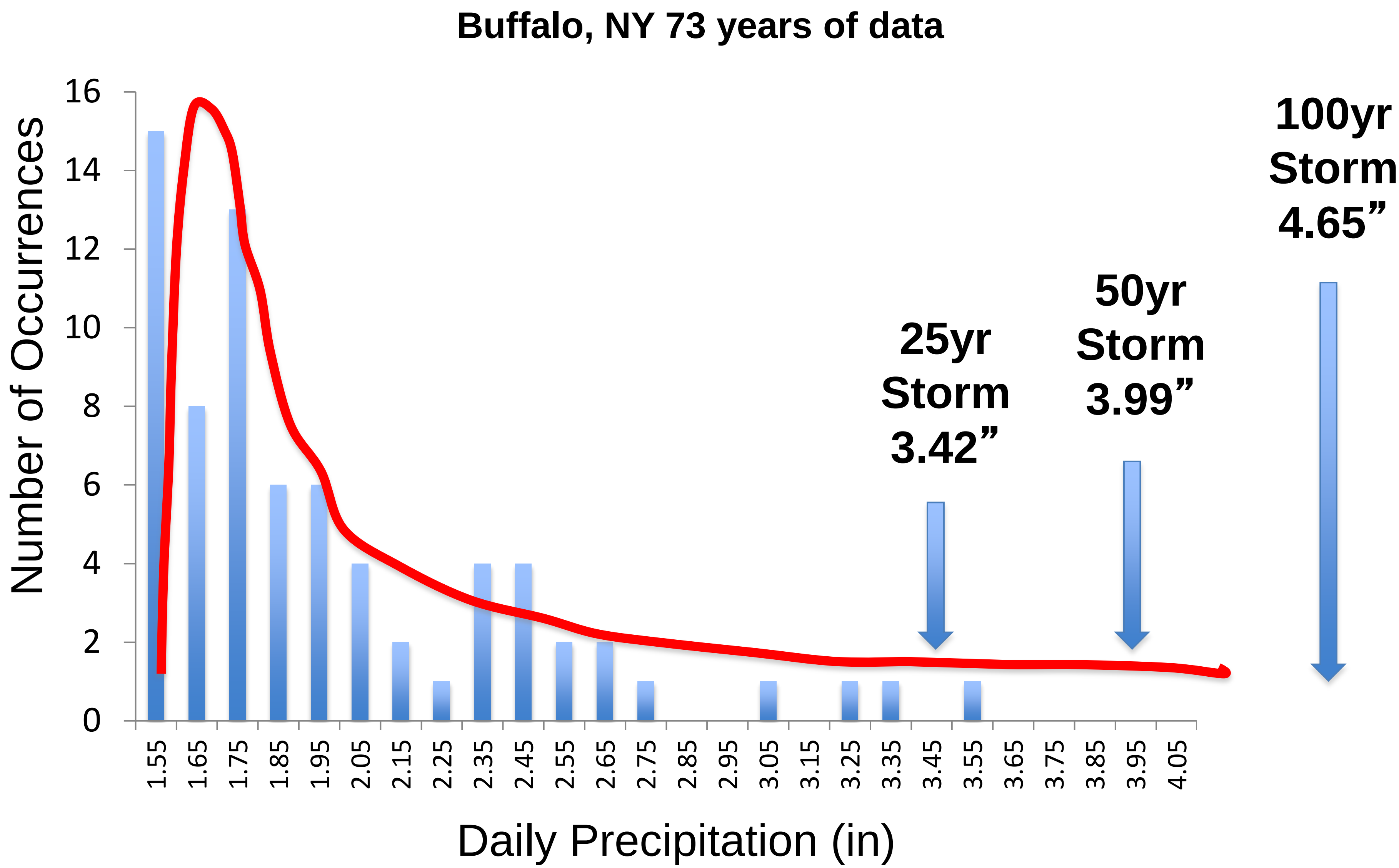
4 Representative Northeast Stations



Fitting the Distribution



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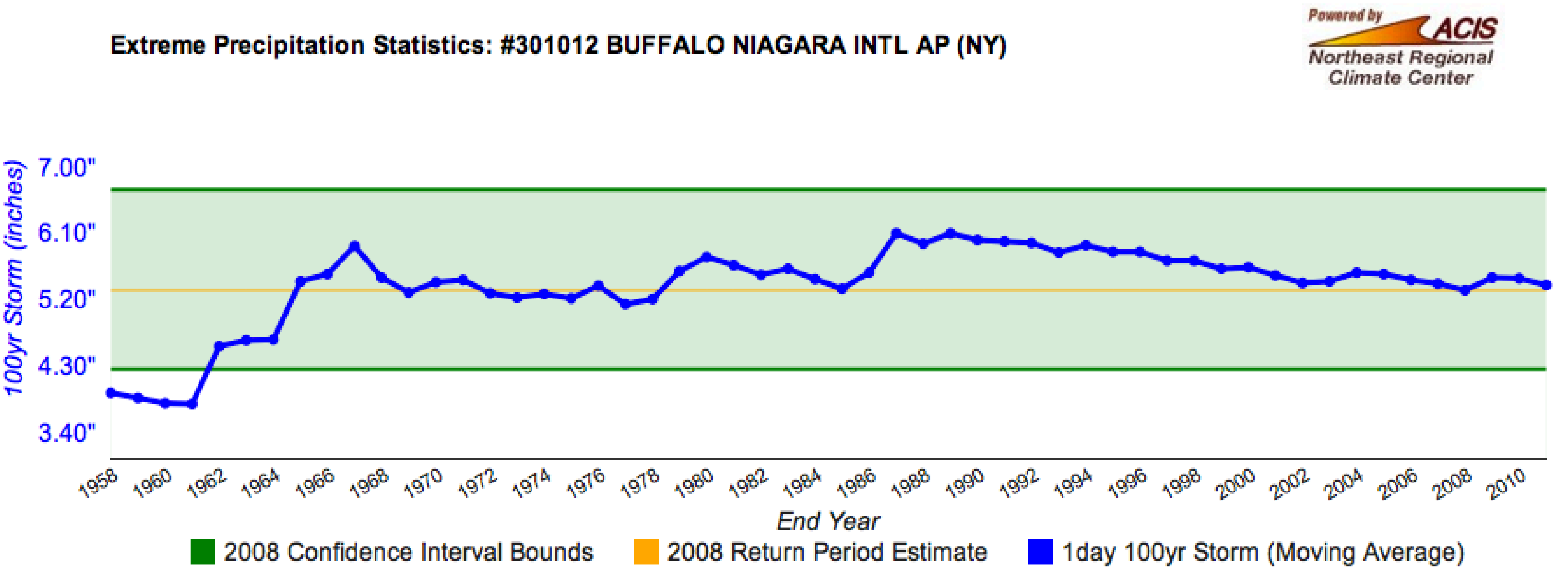
The 100-year Storm 1958 - 2011



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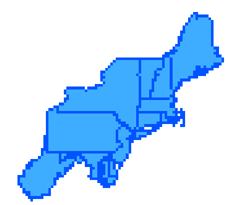
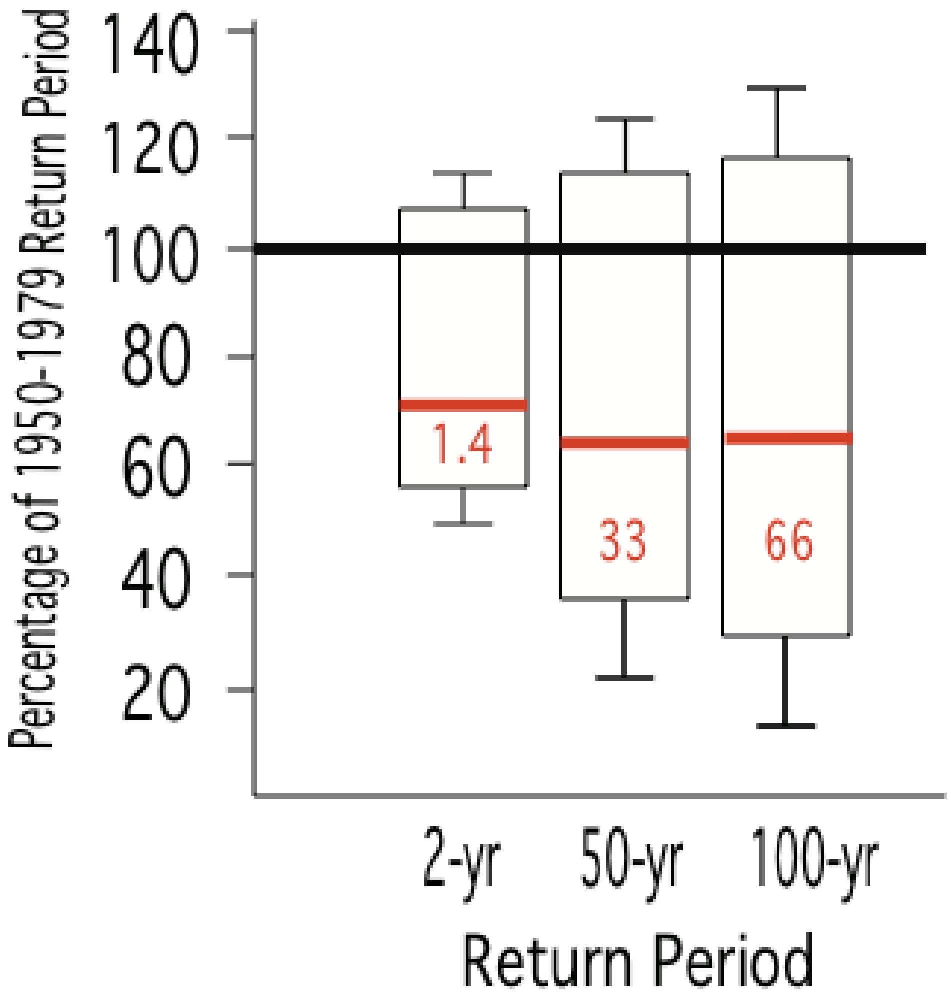


Extreme Rainfall 1950-79 vs 1980-2009



The 100-year storm has become the 66 year storm!

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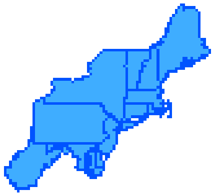
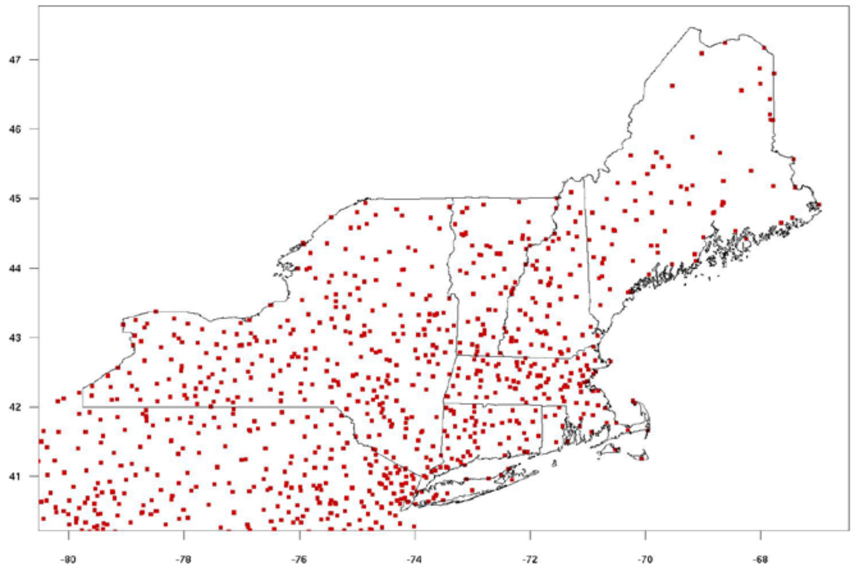
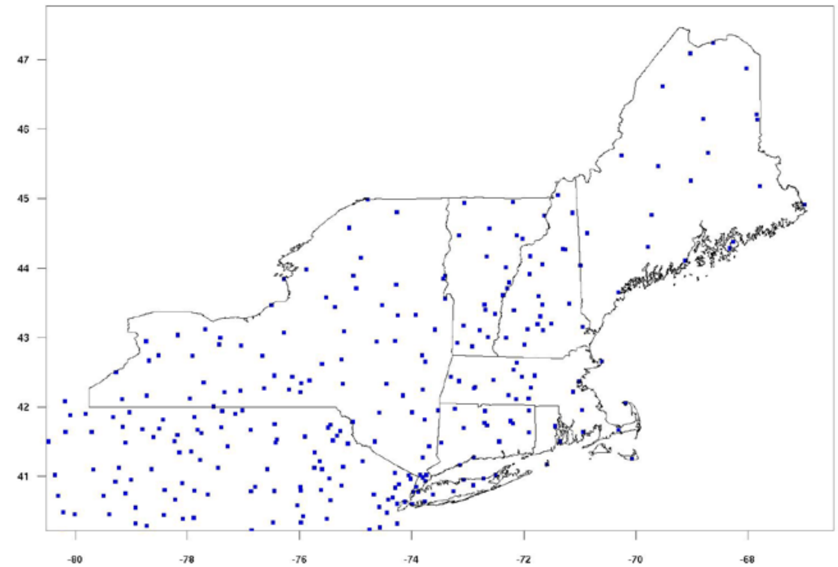


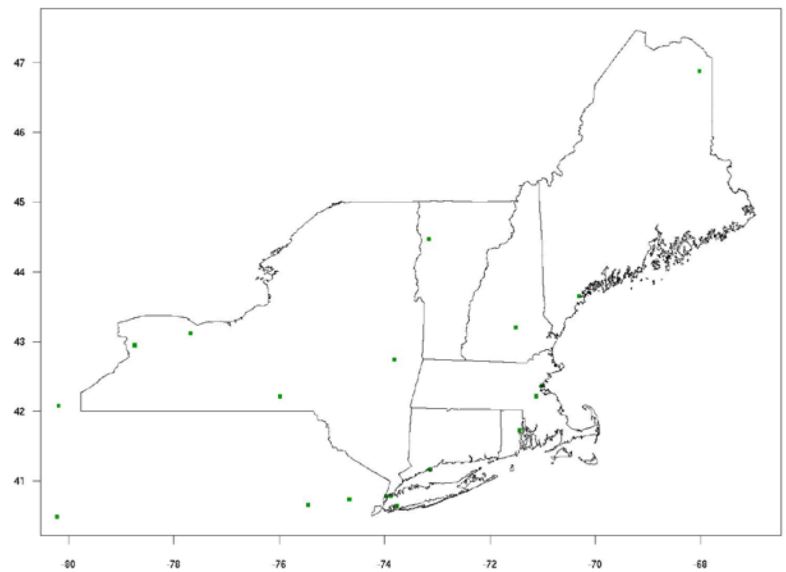
Daily Stations



Hourly Stations



Sub-hourly Stations



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Analysis of Sub-Hourly Data

For 100-year storm

24 hr / 1 day	1.13
60 min / 1 hr	1.16
30 min / 60 min	0.73
15 min / 60 min	0.51
10 min / 60 min	0.40
5 min / 60 min	0.27

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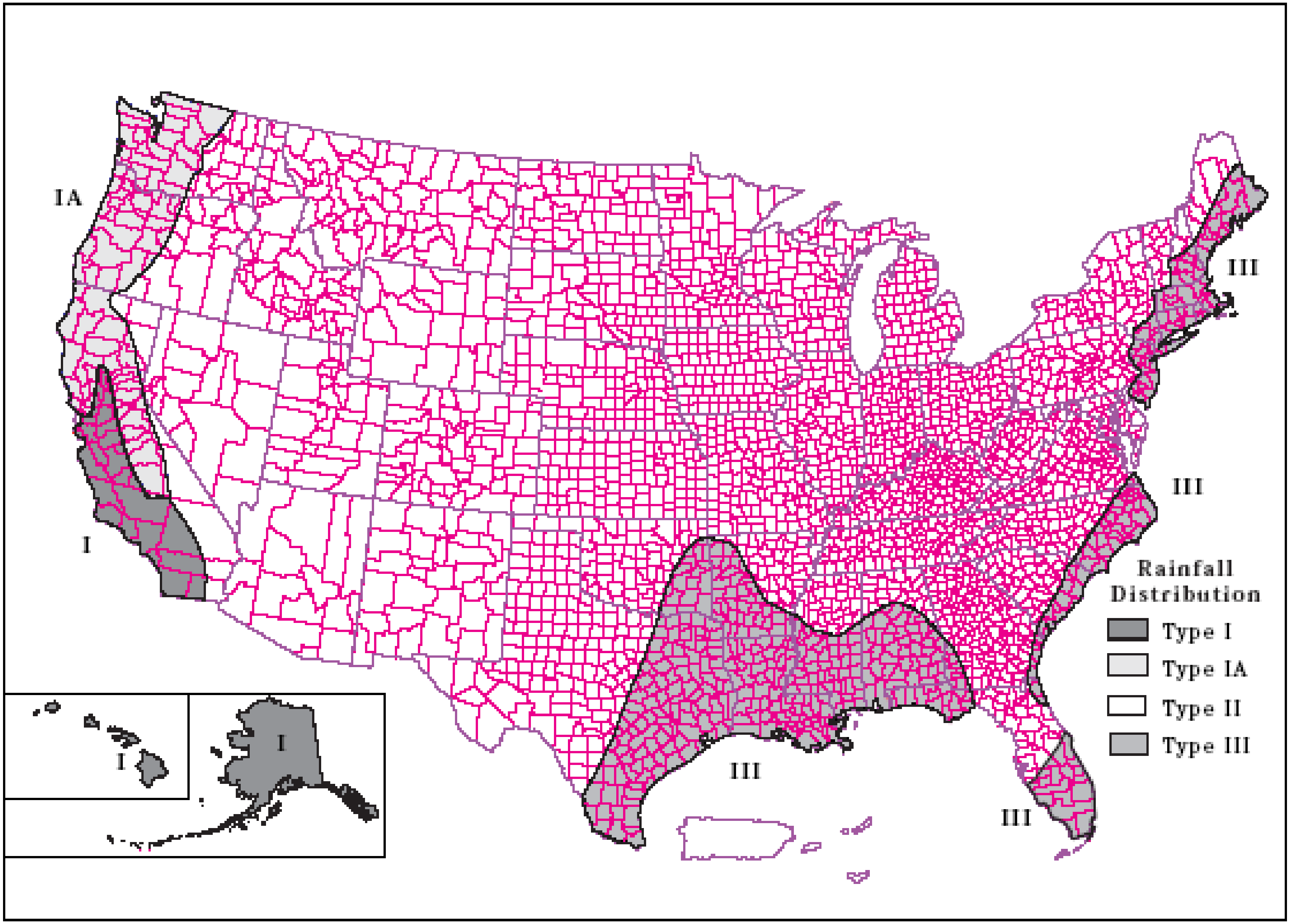
NRCS Rainfall Distributions
General Considerations

- Developed between 1960 and 1985
- Distribute 24-hour rainfall volume to times within storm
- Assumes that n-year sub-daily storm occurs within n-year 24 hour storm.
- Allows design storm to fit time of concentration of basin
- Enter into rainfall-runoff equations

Geographic Application



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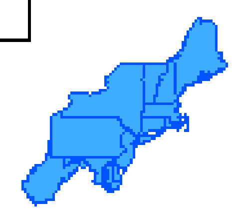
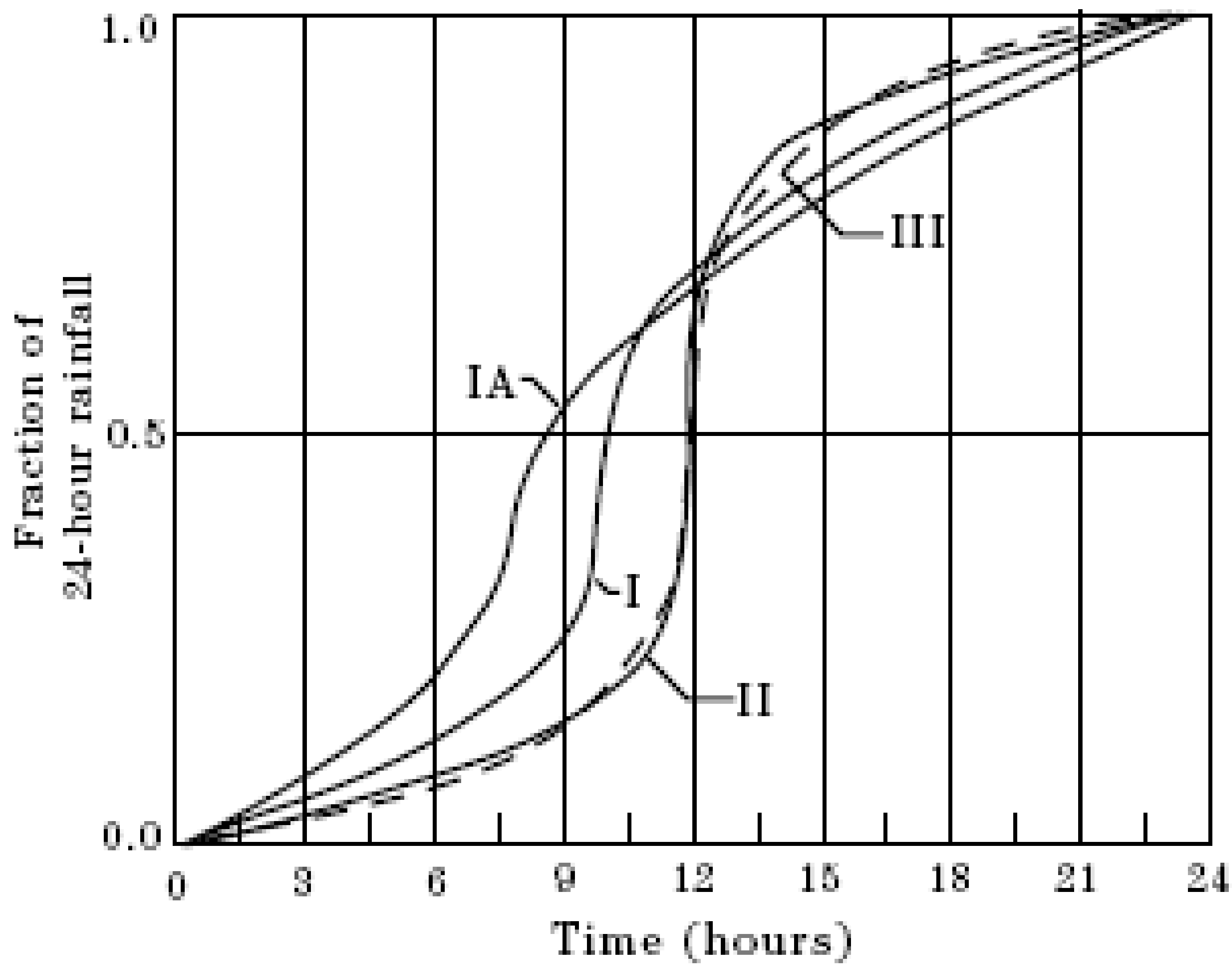


Standard Rainfall Distributions



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Developing a Distribution

- Determine ratios of x hour / 24 hour rainfall.
- Place the rainfall ratio for the shortest duration in the center of the distribution.
- Symmetrically place each larger duration to include the shorter durations.

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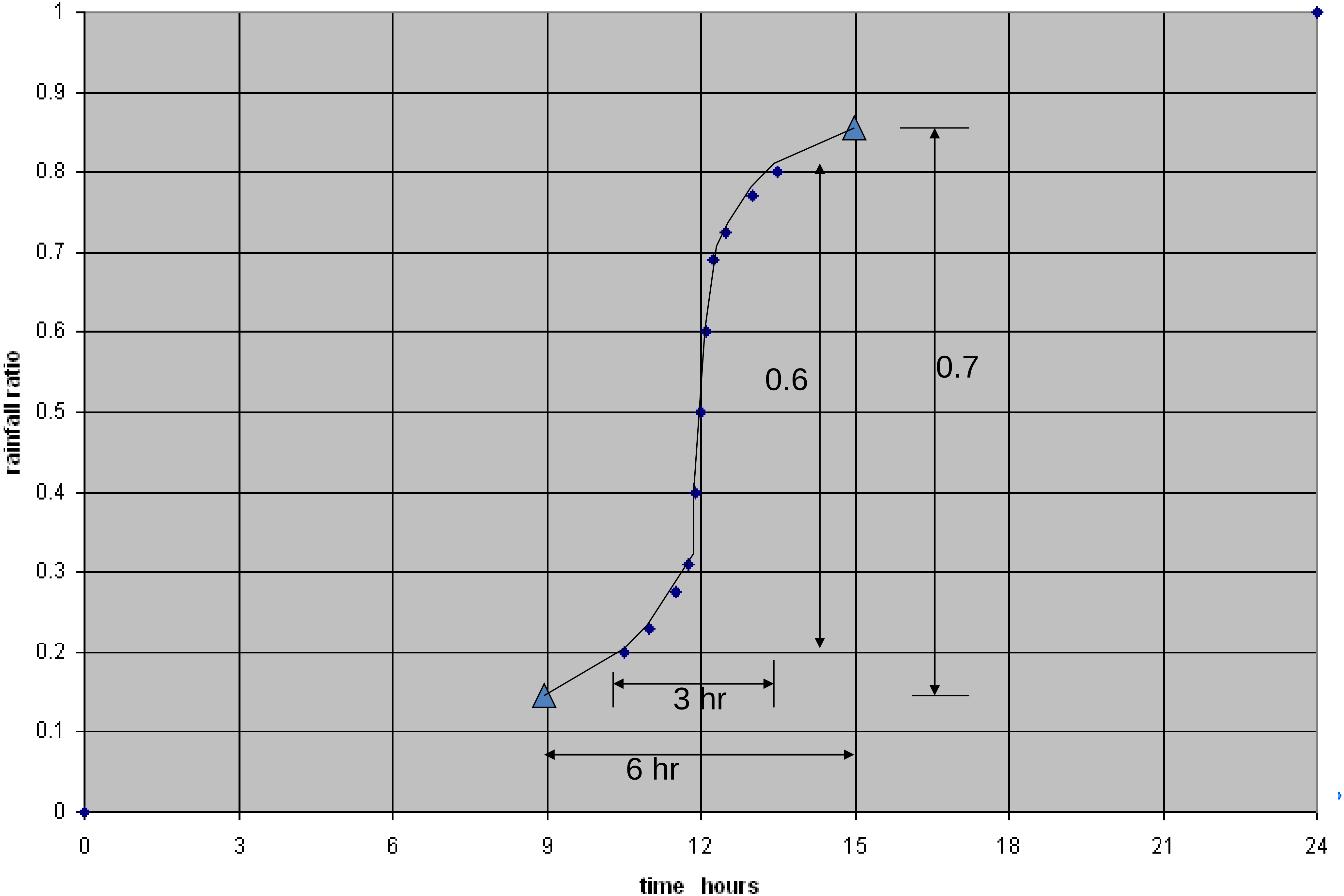
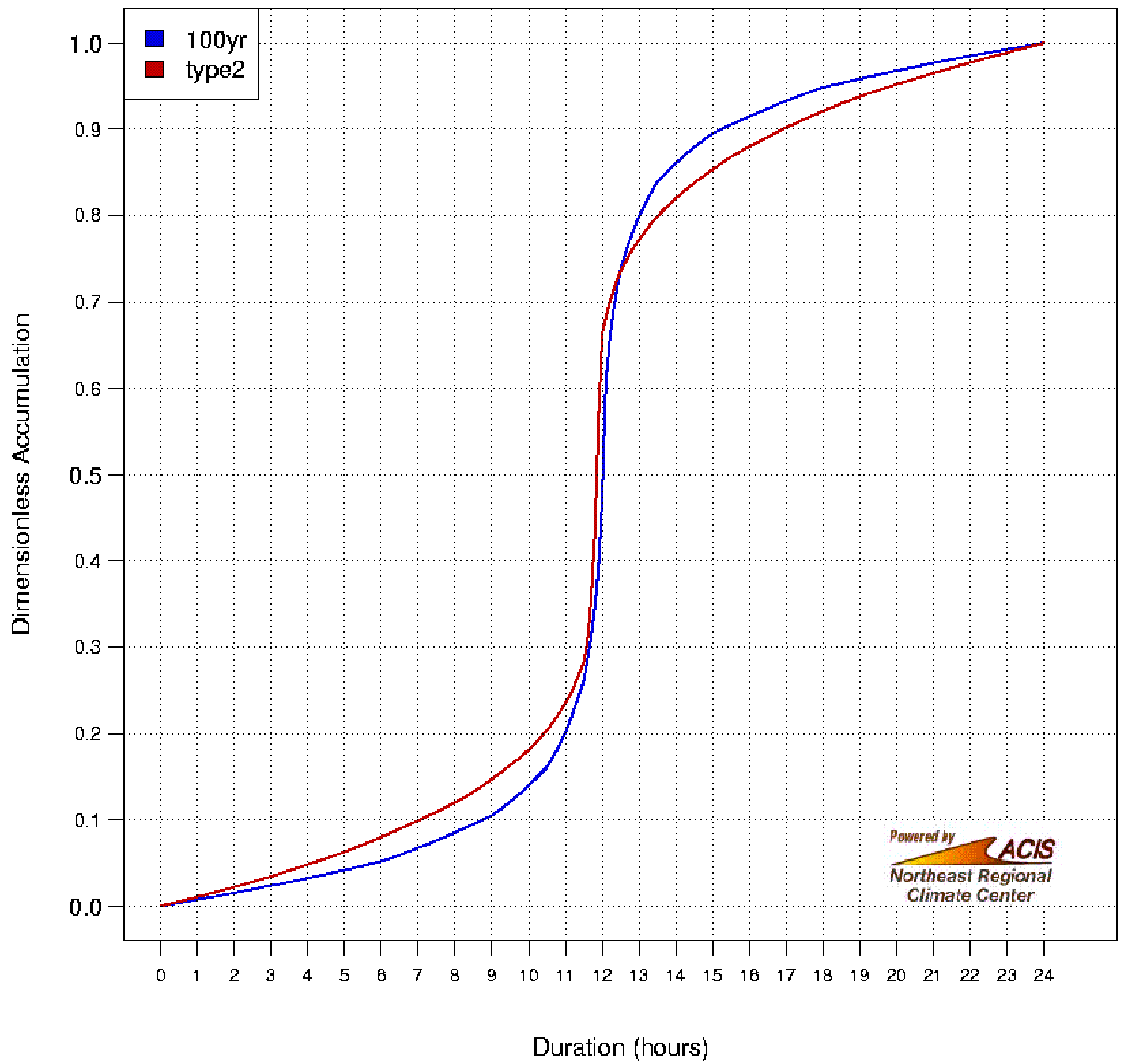
Example of a Nested Distribution



Precipitation Distribution
(42.405N, -78.612W) - 100yr/Type2 - Smoothed



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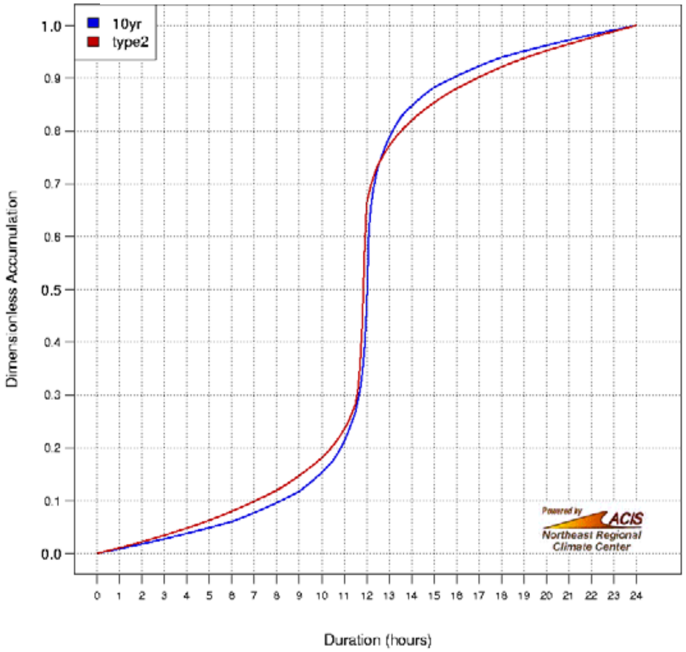
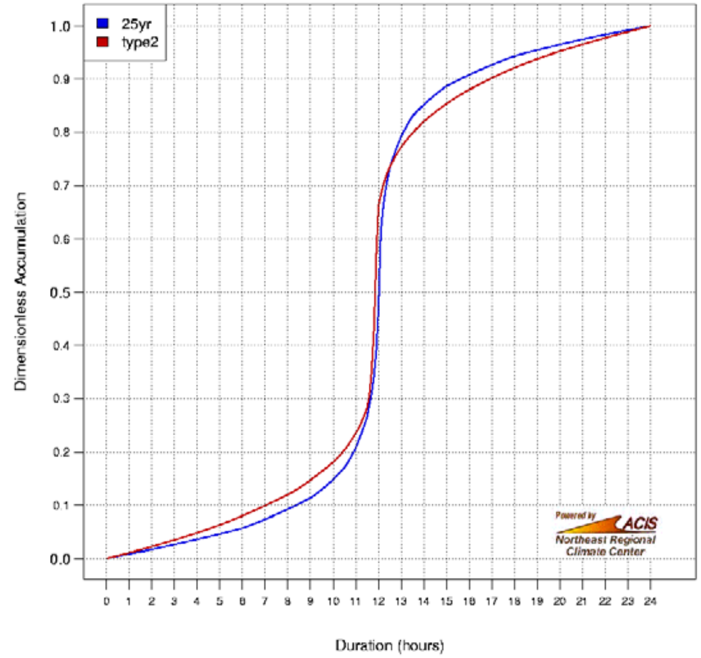
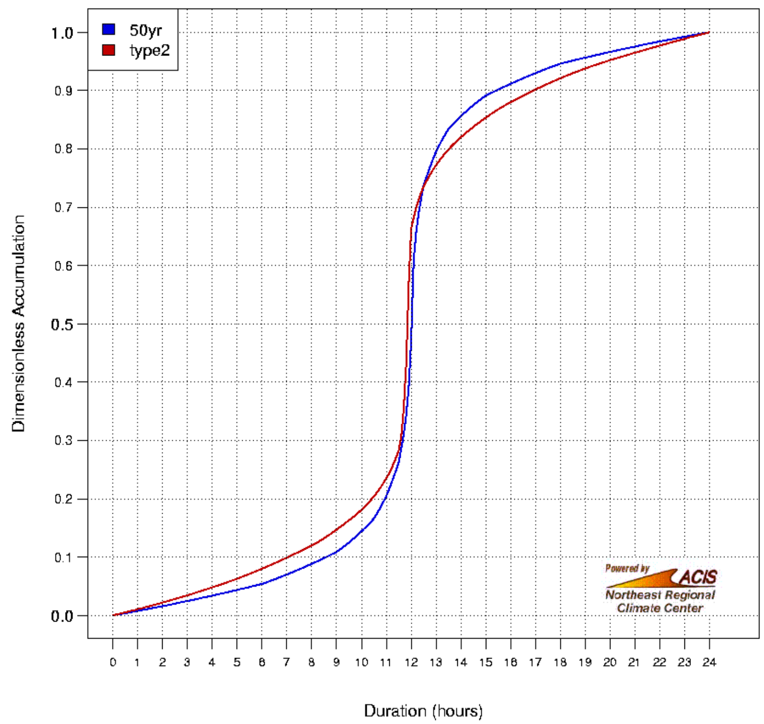
10-year



25-year



50-year



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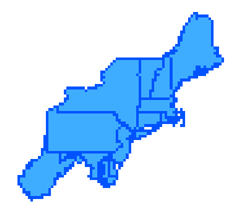
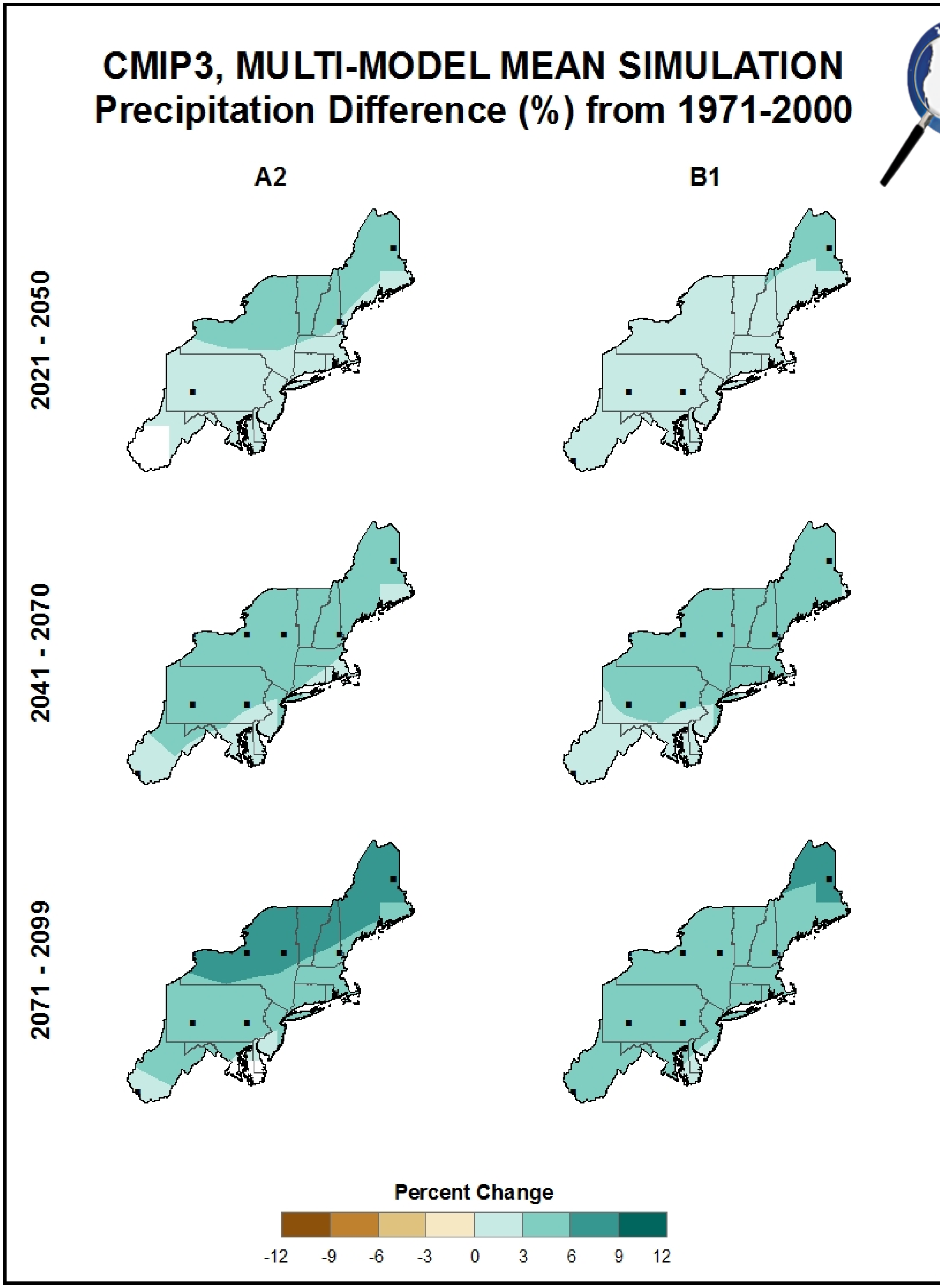


What about the Future??



U.S. Global Change Research Program

National Climate Assessment

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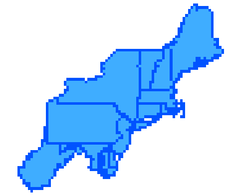
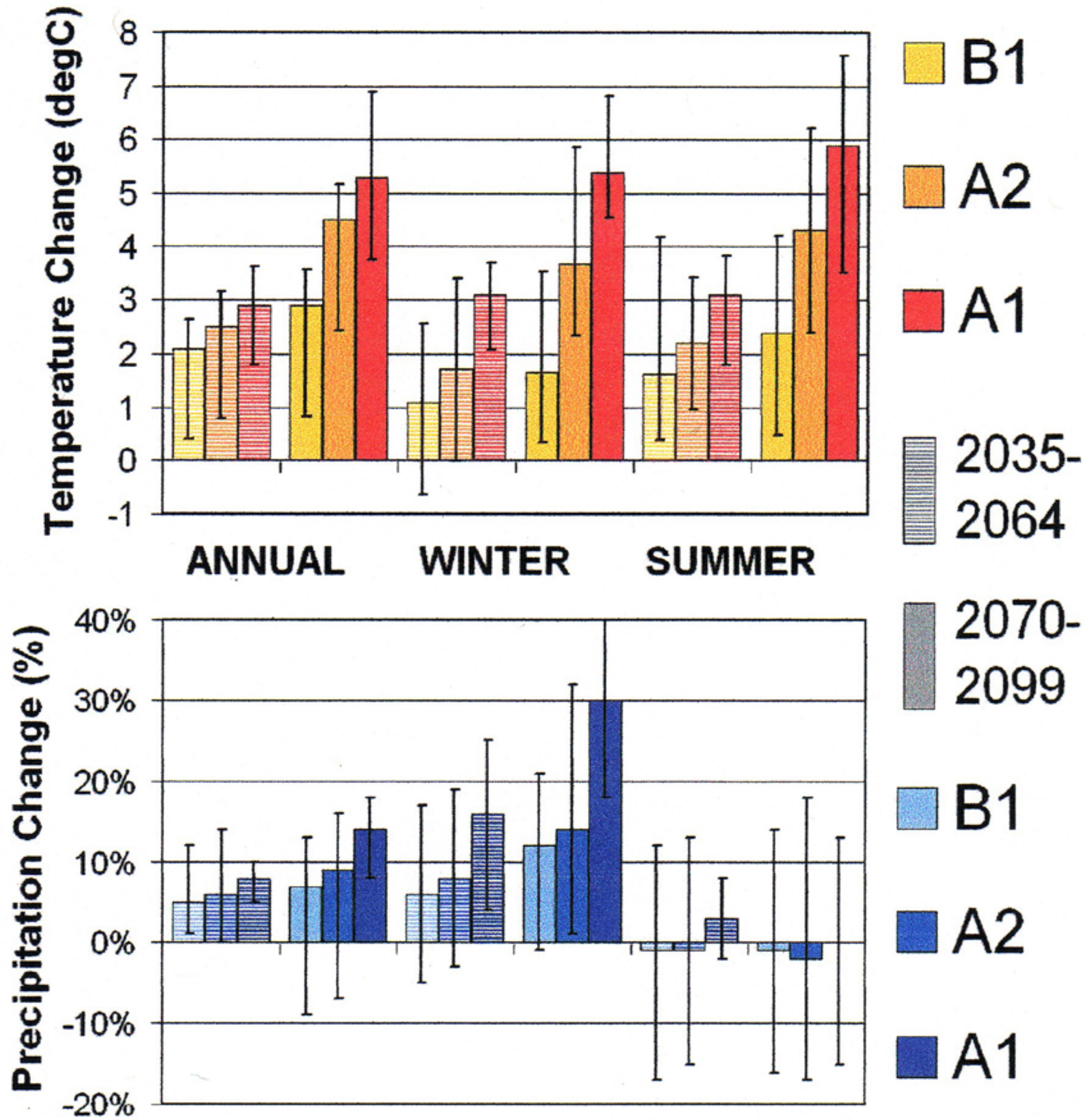


Seasonality



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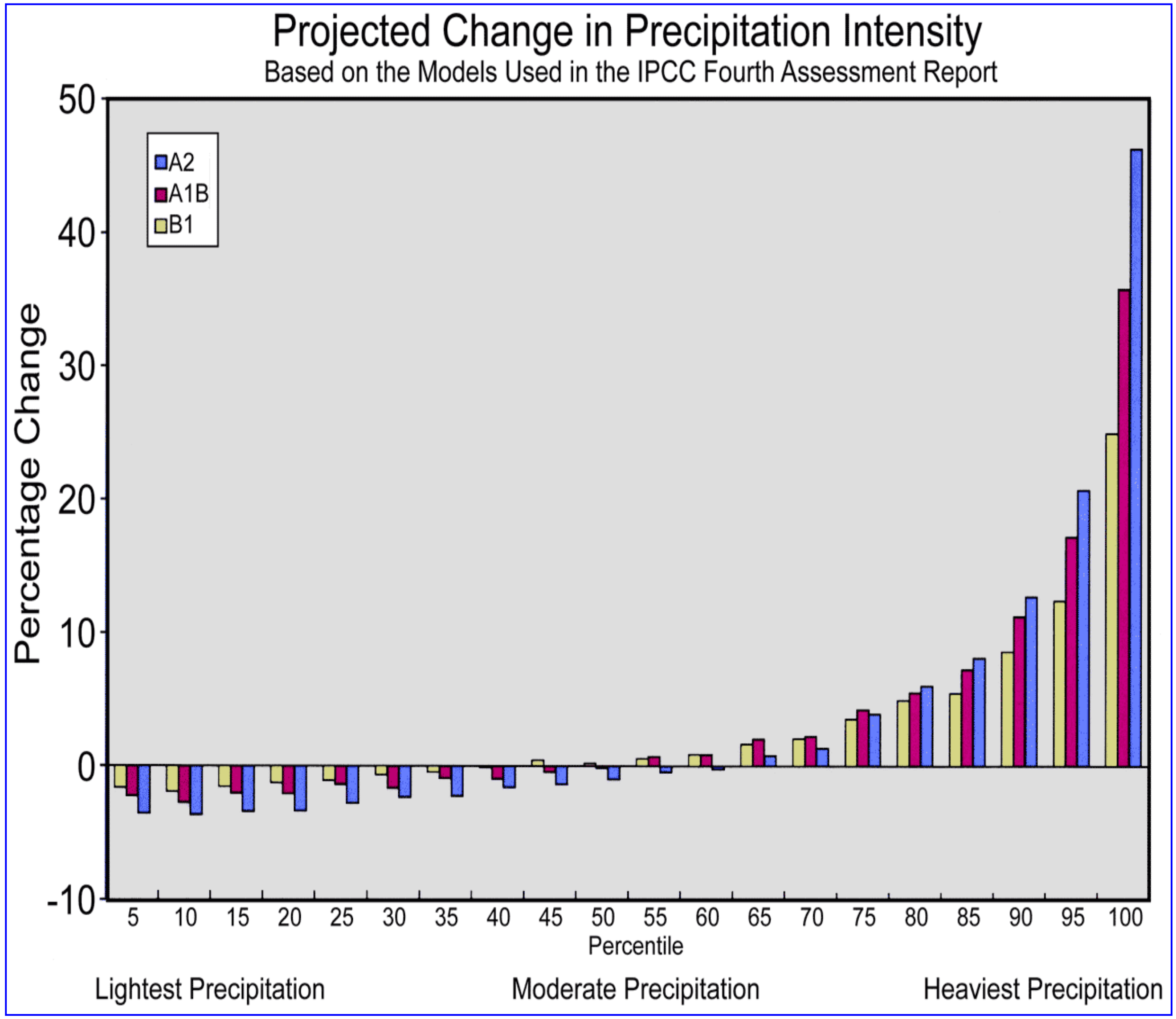
- Lightest precipitation decreases
- Heaviest precipitation increases strongly
- Higher emissions larger changes in extreme precip.



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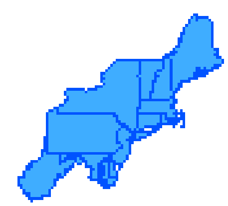

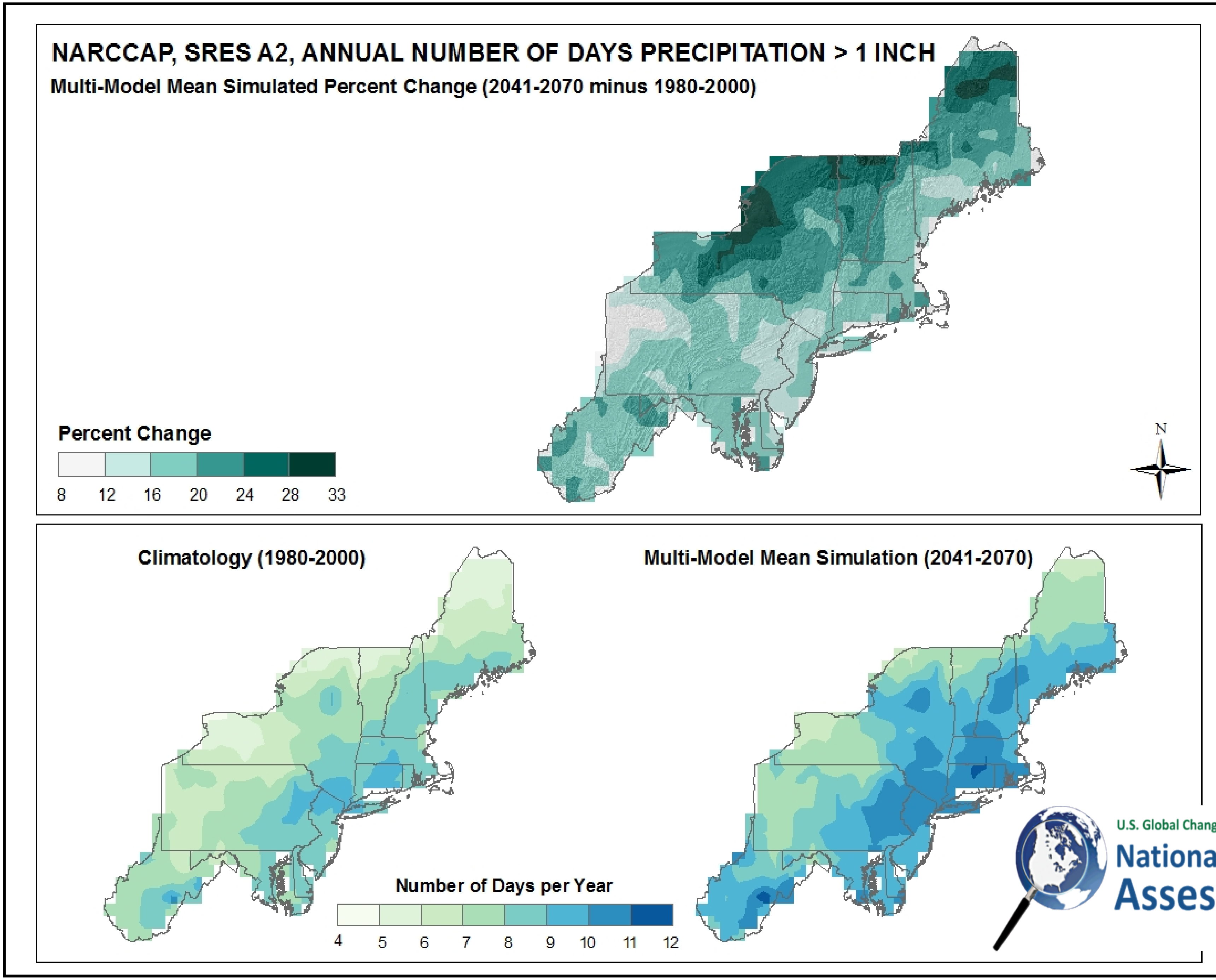

U.S. Global Change Research Program
National Climate Assessment

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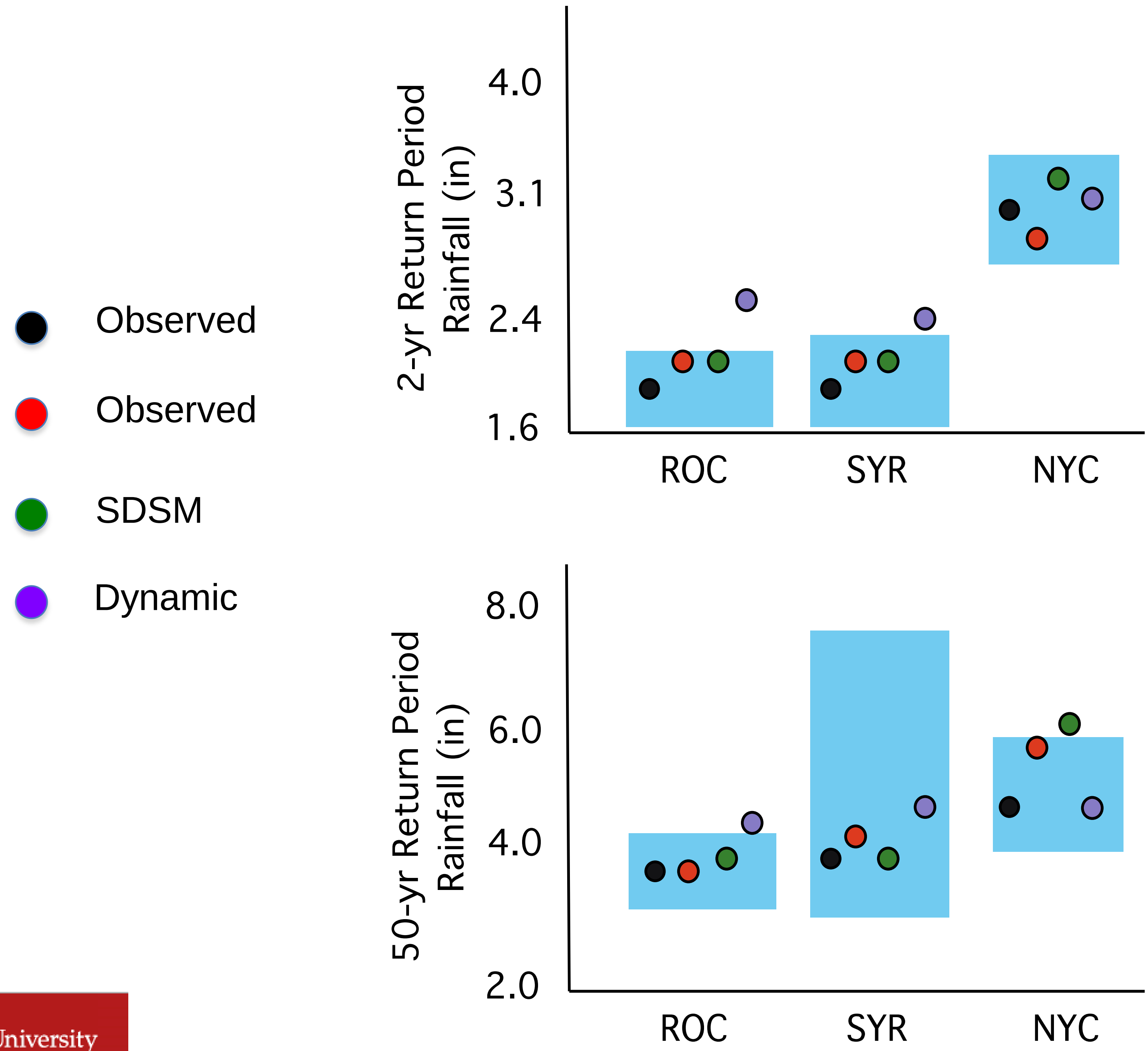
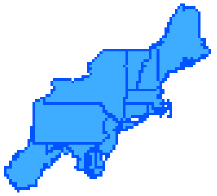
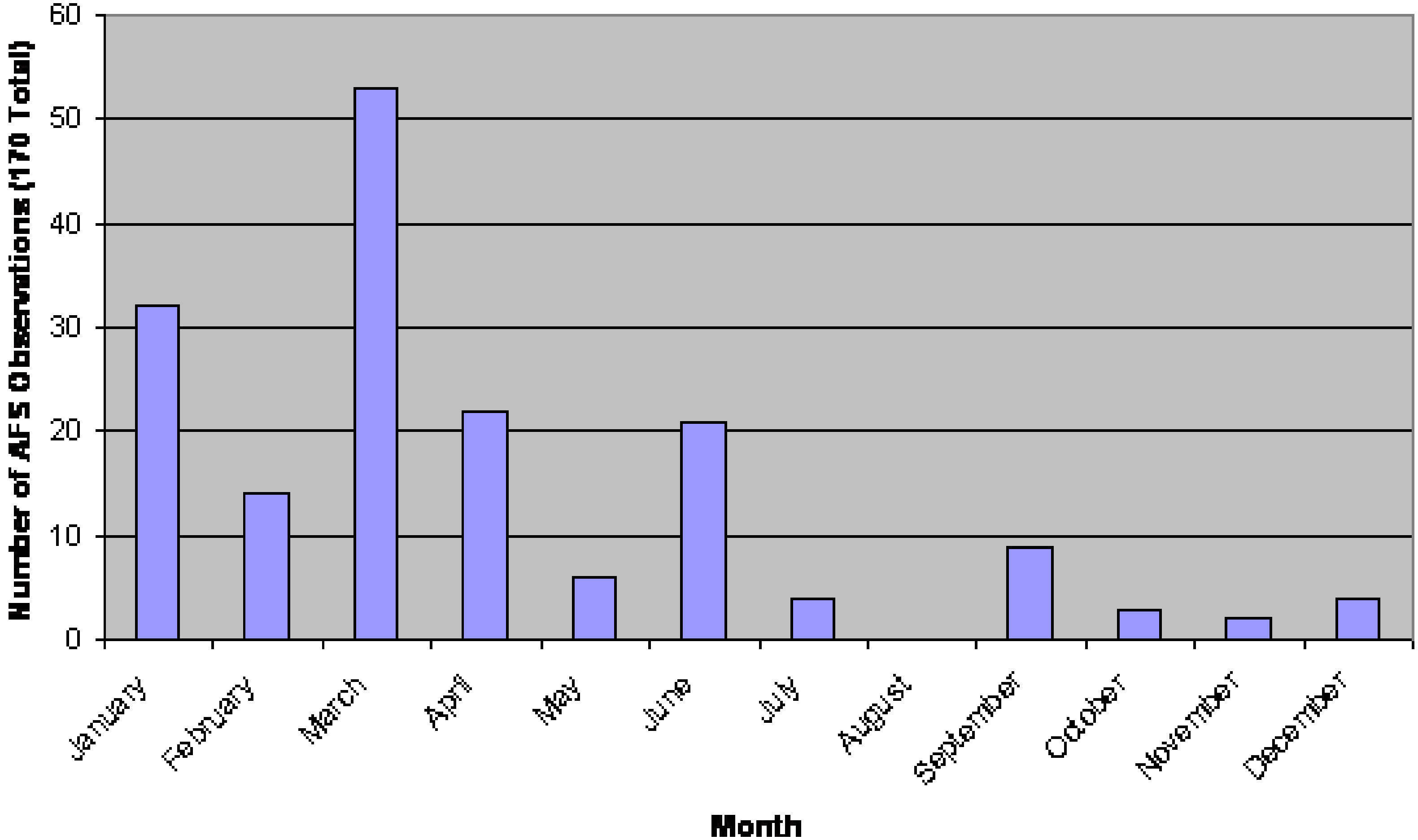
Downscaling Rainfall Return Periods

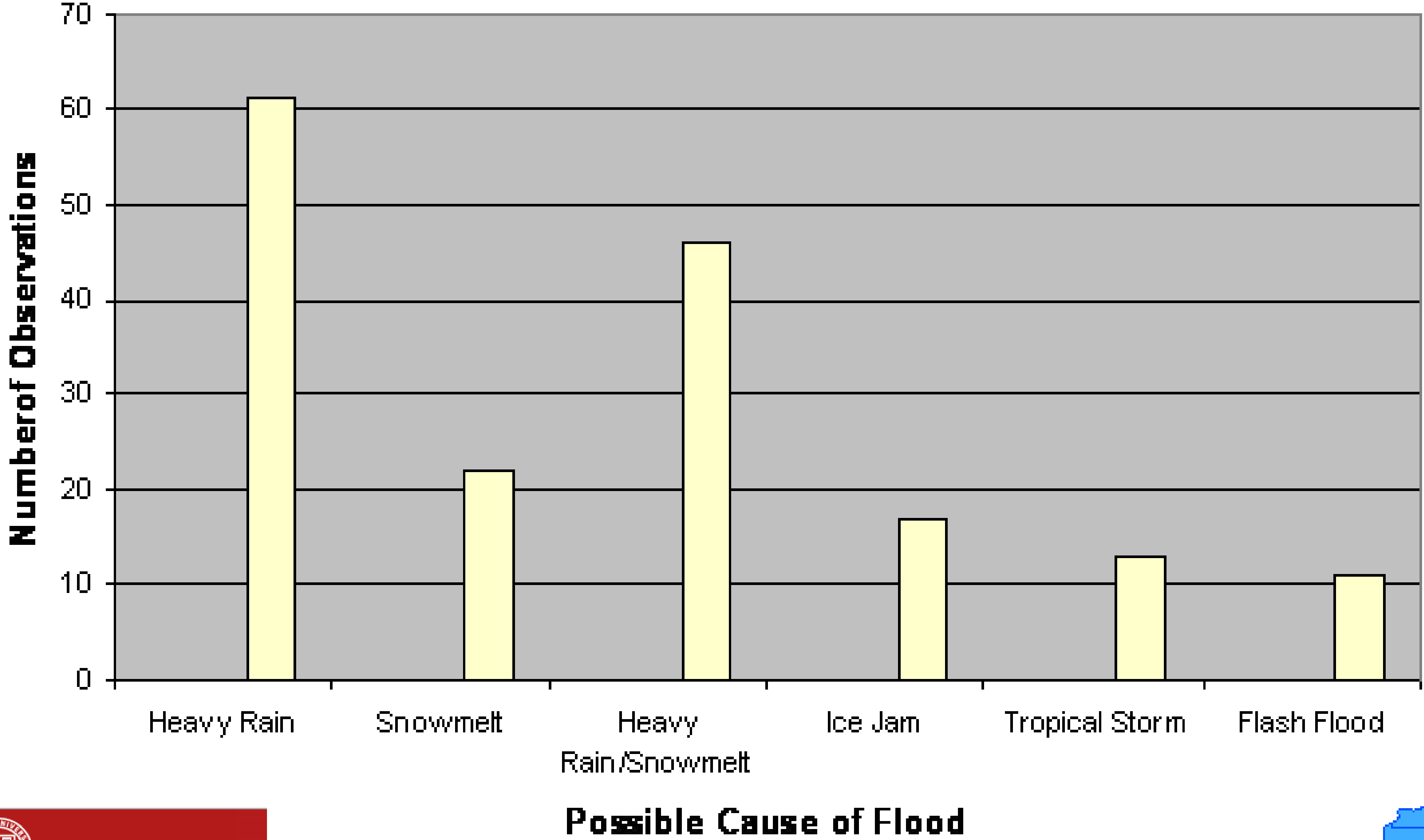




Causes of Floods in Western NY



Causes of Floods in Western NY



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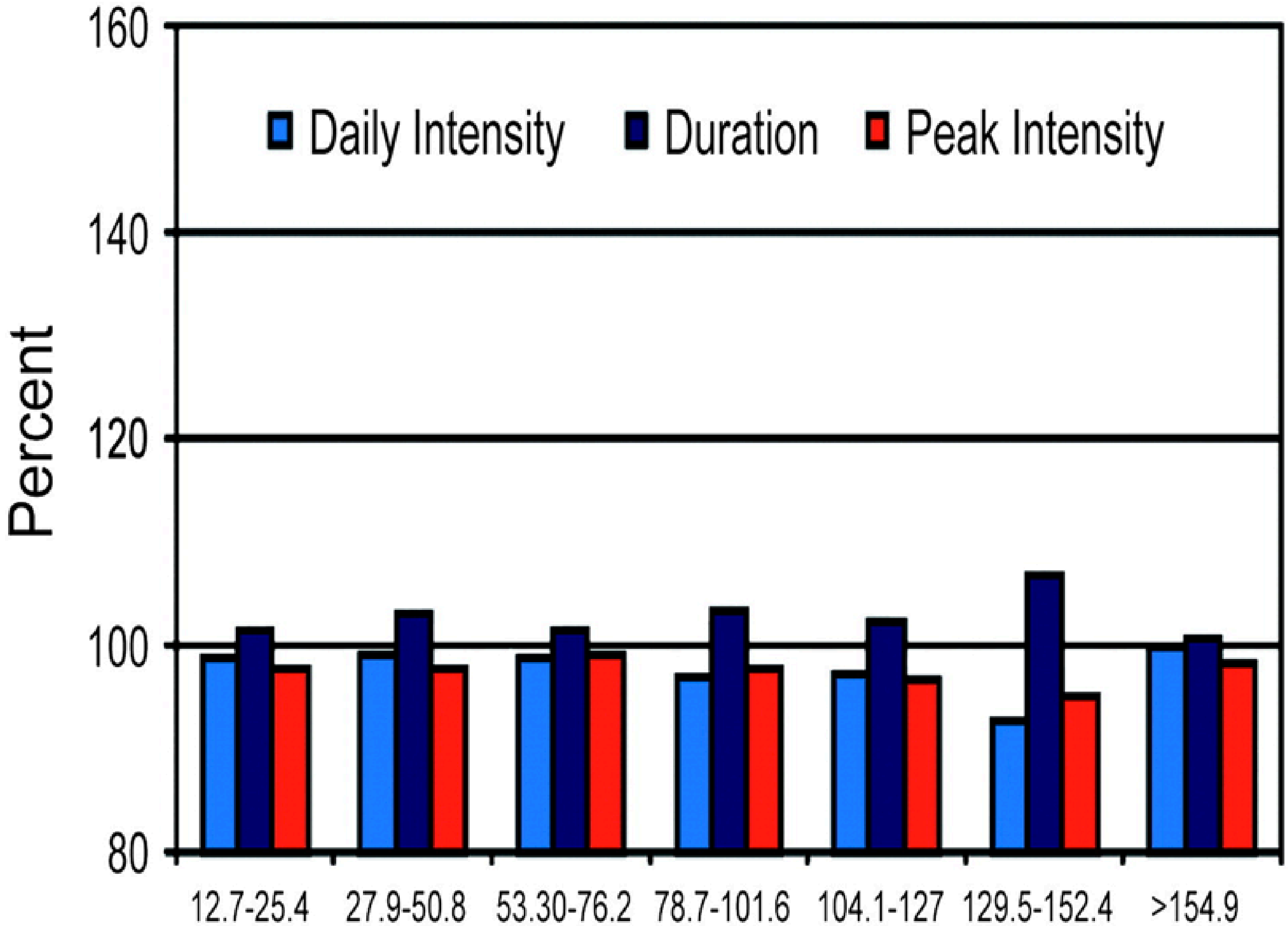
15-minute Storm Intensity

Winter	-1.3
Spring	1.3
Summer	0.3
Fall	-0.4

Percent change 1972 to 2002. None are significant

Michael A. Palecki[a], James R. Angel[b], and Steven E. Hollinger, 2005

Hourly Storm Intensity within Intense Storms



Groisman et al. 2012

Percent change 1979-2009/1948-1978

Little Difference

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Summary

- ✓ "Extreme" precipitation has increased in the Northeast and Globally

- ✓ Daily rainfall return periods have decrease by a factor of about 0.67 from 1950s to present

- ✓ "Extreme" precipitation increases are projected to continue in the 2000s

Summary

- ✓ Projections of future return periods are uncertain but show continued declines
- ✓ Factors other than precipitation affect flooding in western NY
- ✓ Little evidence of changes in factors that may affect distribution curves

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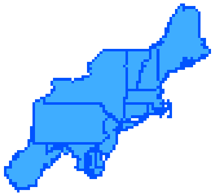

ECS

PHASE 1 STUDIES

Foundation Questions

What are the climate change issues that should be considered in Phase 1 Studies (i.e. soil erosion, engineered barriers, in-place closure)?

How may these climate change issues be evaluated during Phase 2 Decision Making for the decommissioning or long–term stewardship for the West Valley Demonstration Project (WDVP)?

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APPENDIX A

CLIMATE SCIENTIST SCOPE

Scope for

Workshop on Climate Change and Phase 1 Studies at the West Valley Demonstration Project and Western New York Nuclear Service Center

Background

The New York State Energy Research and Development Authority (NYSERDA) and the U.S. Department of Energy (DOE) recently selected Phased Decisionmaking as the path forward for Decommissioning and/or Long-Term Stewardship of the West Valley Demonstration Project and the Western New York Nuclear Service Center (WNYNSC). During Phase One of the Phased Decisionmaking Alternative, which will take about 10 years, NYSERDA and DOE (the agencies) plan to conduct scientific studies to facilitate interagency consensus to complete decommissioning of the facilities remaining at the WNYNSC after the completion of Phase 1 decommissioning. The agencies have agreed on a facilitated process for identifying, designing, and implementing potential Phase 1 Studies that involves input from Subject Matter Experts (SME), a four-member Independent Scientific Panel (ISP), regulatory agencies, and the public.

NYSERDA and DOE have identified a number of Potential Areas of Study (PAS) that will be considered by SME for further evaluation through specific studies. These include, but are not limited to:

- Soil erosion*.
- Groundwater flow and contaminant transport*.
- Catastrophic release of contamination and impact on Lake Erie*.
- Slope stability and slope failure*.
- Seismic hazard.
- Probabilistic vs. deterministic dose and risk analysis*.
- Alternate approaches to, costs of, and risks associated with complete waste and tank exhumation.
- Viability, cost, and benefit of partial exhumation of waste and removal of contamination.
- Exhumation uncertainties and benefit of pilot exhumation activities.
- In-place closure containment technologies*.
- Engineered barrier performance*.
- Additional characterization needs.
- Cost discounting and cost benefit analyses over long time periods.

*** indicates primary area of focus**

Climate change in both the near- and long-term may have significant impacts on the PAS listed above. DOE and NYSERDA have agreed to hold a public workshop on climate change in which scientific experts will share their ideas on climate change topics as they relate to the decommissioning and/or long-term stewardship of the West Valley Demonstration Project and the Western New York Nuclear Service Center.

Foundation Questions
The foundation questions are intended to convey the overall problem to be addressed by the workshop:

- What are the potential impacts of climate change on the Phase 1 PAS?
- How may these impacts be evaluated in order to help the agencies reach consensus on Phase 2 decisions?"

Objectives
The objectives of this workshop are to:

- Allow the agencies and stakeholders to exchange information with climate change experts.
- Explore a range of expert perspectives on climate change including paleoclimatology, as it may relate to the future of the West Valley site.
- Engage with stakeholders as to their concerns regarding climate change, as well as their expectations of how these concerns can be addressed by Phase 1 Studies.
- Identify climate change-related issues for further consideration by Subject Matter Experts as they evaluate the PAS.
- Identify strategies for implementation of climate change analyses in the Phase 1 Studies.
- Improve the agencies' and stakeholders' overall knowledge of the current scientific understanding of climate change issues.
- Identify and help understand how climate change science may be applied to the Phase 1 PAS and Phase 2 decisions.

Scope and Deliverables
Enviro Compliance Solutions, Inc. (ECS) will invite climate change experts to participate in the workshop, and will provide the experts with relevant background information on the West Valley site and the Phase 1 Studies process. At a minimum, each expert will be provided with:

- Forward (NYSERDA's View) of the Final Environmental Impact Statement (FEIS) and DOE's responses.
- FEIS Executive Summary.
- FEIS Appendix D - Overview of Performance Assessment Approach.
- FEIS Appendix E - Geohydrological Analysis.
- FEIS Appendix F - Erosion Studies.
- DOE's Record of Decision.
- NYSERDA's Findings Statement
- Phase 1 Studies Guidance.

Each expert will be asked to prepare a presentation (~20min) for the workshop with a focus on their specialty expertise on climate change, and their thoughts and perspectives on climate change as it may relate to the decommissioning and/or long-term stewardship of the West Valley Demonstration Project and the WNYNSC. The experts will travel to West Valley for a one-day workshop where they will give their presentation. Experts will also participate as members of a panel in a moderated question and answer session with agencies and stakeholders.

Following the workshop in coordination with ECS, each expert will be asked to provide ECS with a short written summary of their presentation. In an effort to facilitate interagency consensus, the expert panelists will be asked to collaborate with ECS as a group to deliver the group's thoughts, observations, and recommendations to the agencies with regard to addressing the topic of climate change through the Phase 1 Studies.

APPENDIX B

GROUND RULES

GROUND RULES

For Moderated Public Meetings

Phase 1 Studies

West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (WNYNSC)

- *Please turn cell phones off, or to vibrate.*
- *Please respect the time limitations of the meeting.*
- *One person will speak at a time.*
- *Please do not interrupt anyone who is speaking.*
- *Please avoid side conversations in the room.*
- *Please hold all questions and comments until the presentation is completed and the moderator begins the question/comment period.*
- *Please clearly state your name before asking a question or making a comment.*
- *It is the moderator's job to manage the order of stakeholder participation (questions/comments) during the meeting.*
- *Stakeholders at the meeting will be recognized first.*
- *Stakeholders at the meeting should raise hands to be recognized before speaking.*
- *Stakeholders on the telephone or participating in a web-based meeting will be recognized after all questions/comments from stakeholders at the meeting are processed.*
- *Stakeholders on the phone please place your telephones on mute unless you are recognized by the moderator to speak.*
- *Meeting notes will be taken; meeting summaries will be prepared and posted on the website following review and approval by DOE/NYSERDA. The meeting summaries will include a general summary of questions and responses, but will not include individual comments and responses.*

APPENDIX C

ACRONYMS AND ABBREVIATIONS

ACRONYMS and ABBREVIATIONS

A&PC	Analytical and process chemistry
ALARA	as low as is reasonably achievable
BCG	Biota Concentration Guide
BP	Before present
CDDL	Construction and Demolition Debris Landfill
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHILD	Channel-Hillslope Integrated Landscape Development
CFR	*Code of Federal Regulations*
CMS	Corrective Measures Study
dBA	decibels A-weighted
DCGL	Derived Concentration Guideline Limits
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	Environmental Assessment
EBWG	Engineered Barrier Working Group
ECL	Environmental Conservation Law
ECS	Enviro Compliance Solutions
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPRI/SOG	Electric Power Research Institute/Seismic Owners Group
EWG	Erosion Work Group
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FTE	full-time equivalent
GTCC	Greater-Than-Class C waste
HDPE	high density polyethylene
HEPA	high-efficiency particulate air
HIC	high-integrity container
HLW	High Level Radioactive Waste
HLWISF	High Level Radioactive Waste Interim Storage Facility
LCF	latent cancer fatality
LEM	Landscape evolution modeling
LiDAR	Light detection and ranging
LLW	low-level radioactive waste
LSA	Lag Storage Area
LWTS	Liquid Waste Treatment System
m	meter(s)
M&M	monitoring and maintenance
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MEI	maximally exposed individual

MLLW	mixed low-level radioactive waste
MMI	Modified Mercalli Intensity
NAAQS	National Ambient Air Quality Standards
NDA	NRC-licensed Disposal Area
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutant
NFA	no further action required
NFS	Nuclear Fuel Services, Inc.
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOL	New York State Department of Labor
NYSERDA	New York State Energy Research and Development Authority
OSL	Optical Stimulated Luminescence
PCB	polychlorinated biphenyl
PGA	peak horizontal ground acceleration
PM	particulate matter
PMF	probable maximum flood
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RFI	RCRA Facility Investigation
RH	remote-handled
ROD	Record of Decision
ROI	Region of Influence
SDA	State-Licensed Disposal Area
SEQR	State Environmental Quality Review Act
SME	Subject matter expert
SOW	Statement of Work
SPDES	State Pollutant Discharge Elimination System
STS	Supernatant Treatment System
SWMU	Solid Waste Management Unit
TAGM	Technical Assistance and Guidance Memorandum
TEDE	total effective dose equivalent
TRU	transuranic
TSCA	Toxic Substances Control Act
U-Pb	Uranium-lead
U.S.C.	United States Code
VRM	Visual Resource Management
WIPP	Waste Isolation Pilot Plant
WMA	Waste Management Area
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

WVNSCO	West Valley Nuclear Services Company, Inc.
°C	degrees Centigrade
°F	degrees Fahrenheit