Briefing on Climate Adaptation

Interagency Climate Adaptation Team

Minnesota Environmental Quality Board

November 20, 2013

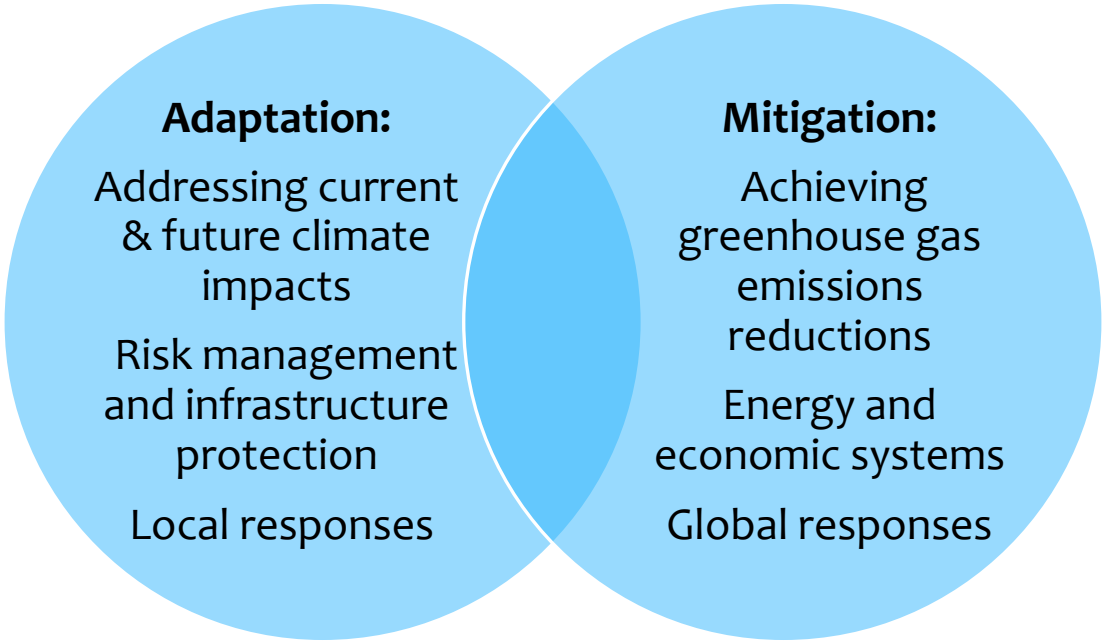
Overview

* Introduction
* Presentation by Dr. Mark Seeley
* Agency presentations from Interagency Climate Adaptation Team
* Opportunities for Interagency Action
* Questions/Discussion

Adaptation/Mitigation

* *Adaptation:* Developing/implementing strategies, initiatives and measures to help human and natural systems address climate change impacts
* *Mitigation:* Reducing greenhouse gas emissions to limit magnitude or progression of climate change

Adaptation/Mitigation



Complementary Strategies

* *2013 Draft National Climate Assessment:*

Research indicates that both mitigation and adaptation are needed in order to minimize the damages from climate change and to adapt to the pace and ultimate magnitude of the changes that occur.

http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-chap28-adaptation.pdf

Minnesota: Interagency Climate Adaptation Team (ICAT)

* Started in 2009
* Agriculture, BWSR, Commerce, Health, Metropolitan Council, Natural Resources, Pollution Control, Public Safety, Transportation
* Initiated by agencies

2013 ICAT Accomplishments

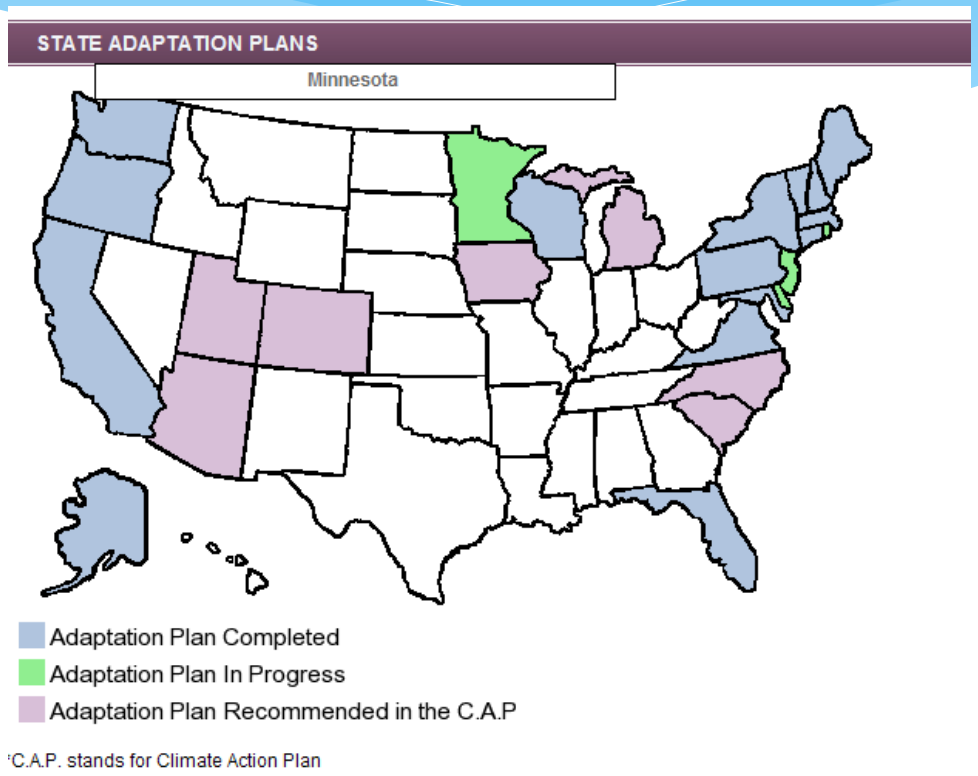
* 2013 ICAT report
* Presentation to 2013 Legislature
* Identified agency collaboration opportunities
* Information sharing, presentations, and updates

2013 ICAT Report

* Describes climate trends affecting MN
* Characterizes climate impacts
* Summarizes activities by agencies
* Presents opportunities for interagency action
* Underscores urgency and complexity of issue

Adaptation in other states

- Adaptation planning in other states
- Coastal states
- Varying models



Source: http://www.c2es.org/us-states-regions/policy-maps/adaptation

Other state efforts

- 2012 NRDC summary report


NRDC ISSUE BRIEF

APRIL 2012 IB:12-03-A

Ready or Not: An Evaluation of State Climate and Water Preparedness Planning

AUTHOR
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Natural Resources Defense Council

PROJECT DESIGN AND DEVELOPMENT
Steve Fleischli
Natural Resources Defense Council

CONTRIBUTING AUTHOR
Jenna Schroeder

Source: http://www.nrdc.org/water/readiness/files/Water-Readiness-issue-brief.pdf

Other state efforts

- Wisconsin Initiative on Climate Change Impacts (WICCI)

Source: http://www.wicci.wisc.edu/

Climate Trends in Minnesota

Dr. Mark Seeley
Extension Climatologist/Meteorologist
Dept of Soil, Water, and Climate
University of Minnesota

MN Environmental Quality Board

November 20, 2013

St Paul, MN

UNIVERSITY OF MINNESOTA | EXTENSION
Driven to Discover℠

"Science for adaptation starts with understanding decision-making processes and information needs, determining where the vulnerabilities are, and then moves to [climate trend analysis] climate modeling..[and] tracks whether adaptation is effective," Richard Moss, DOE (*Science, Nov, 2013)*

Changing Minnesota Climate Features

Consequences/Implications

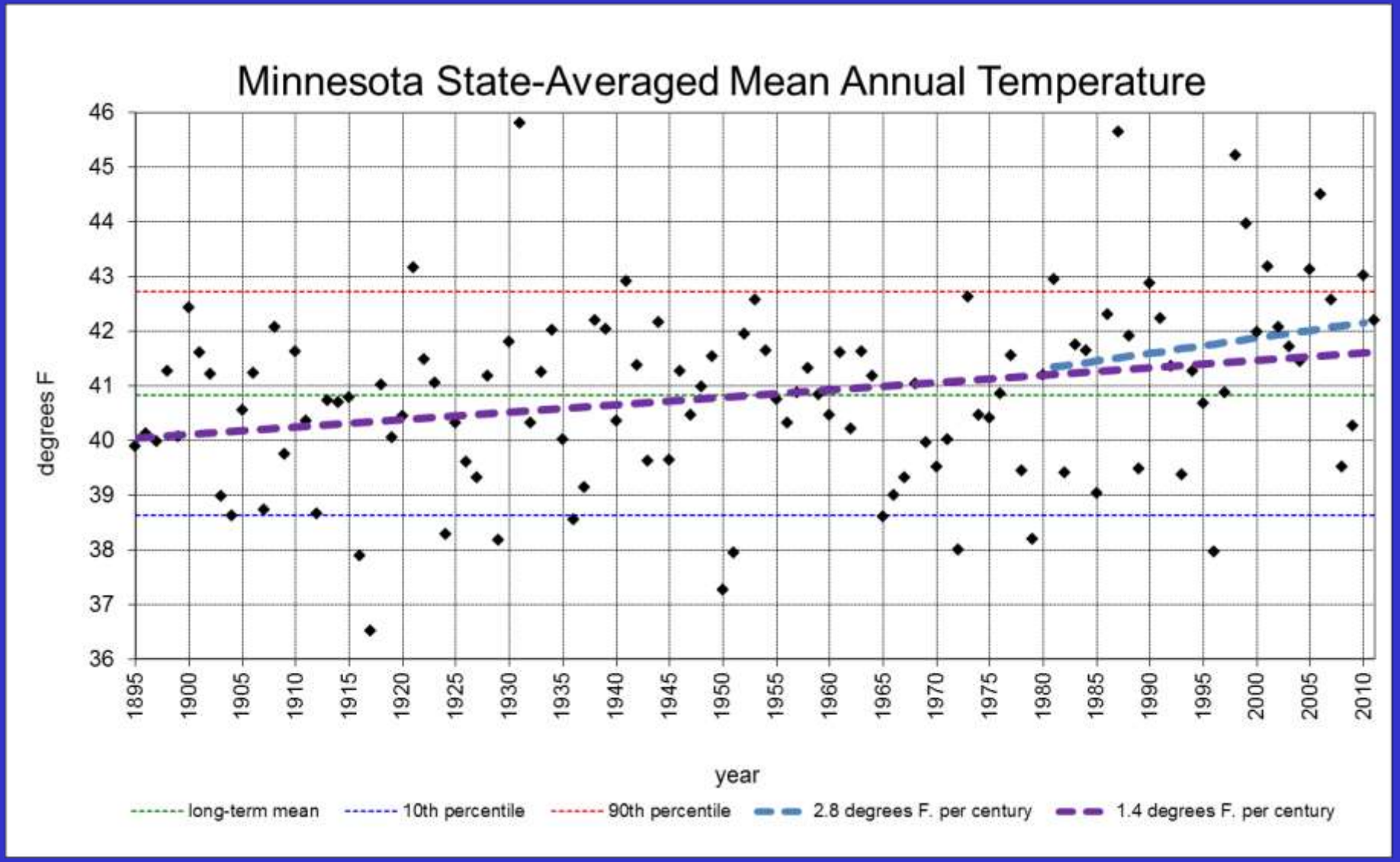
Comment on Extremes

RECENT SIGNIFICANT CLIMATE TRENDS IN MINNESOTA AND THE WESTERN GREAT LAKES

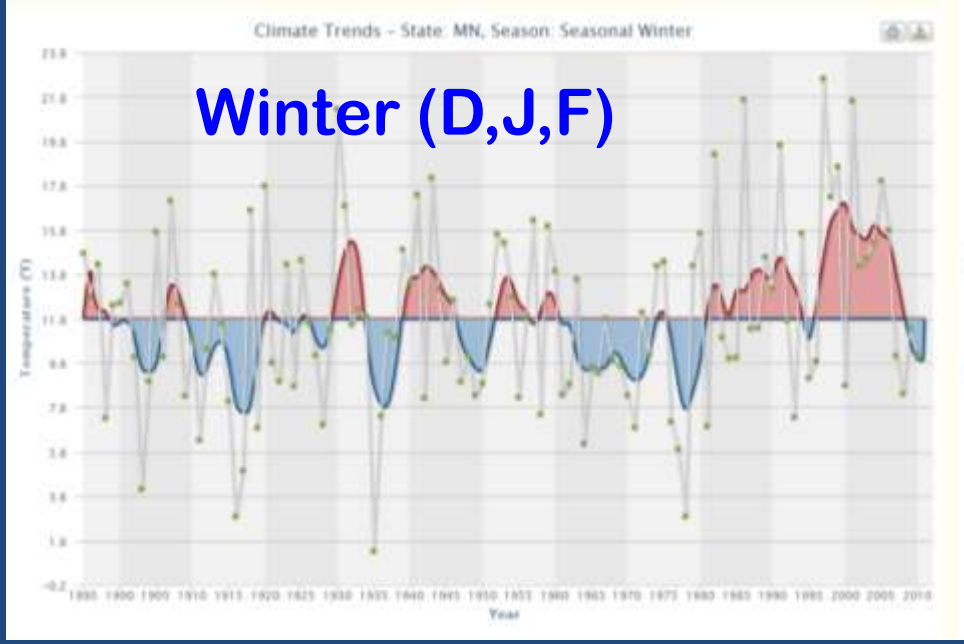
- *TEMPERATURE*: WARM WINTERS AND HIGHER MINIMUM TEMPERATURES

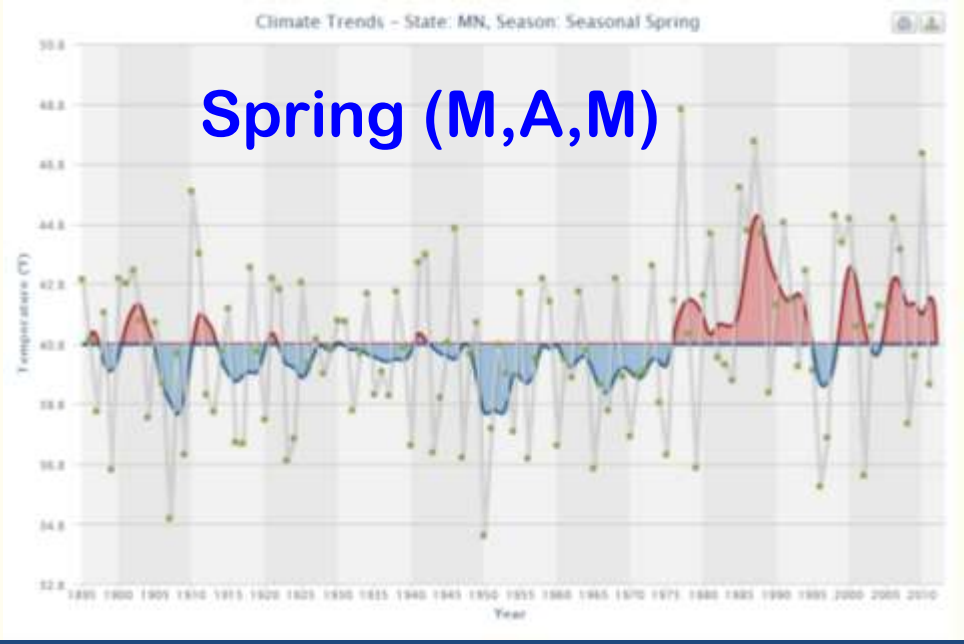
- *DEWPOINTS*: GREATER FREQUENCY OF TROPICAL-LIKE ATMOSPHERIC WATER VAPOR

- *MOISTURE*: AMPLIFIED PRECIPITATION SIGNAL, THUNDERSTORM CONTRIBUTION

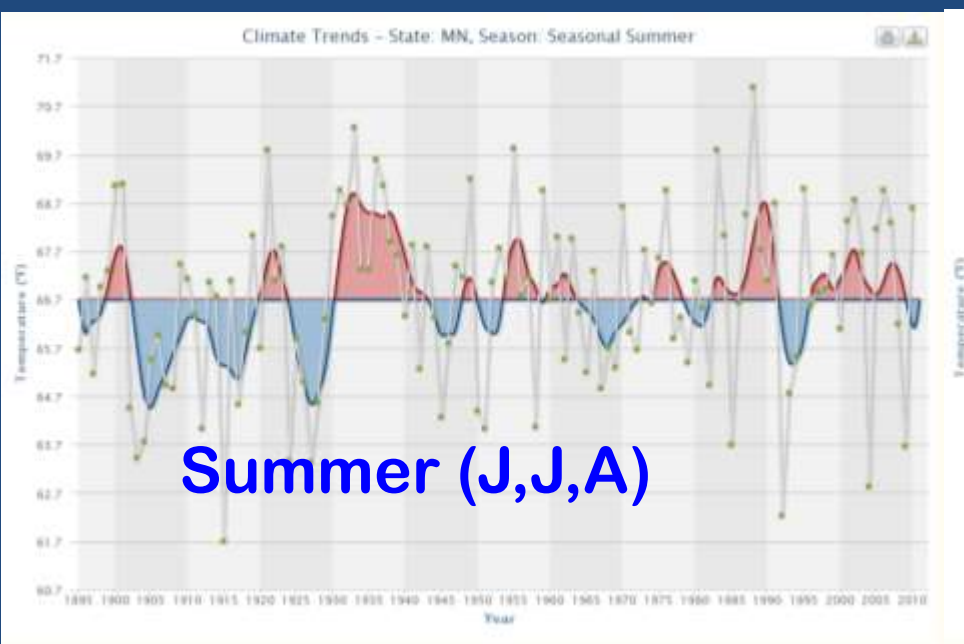


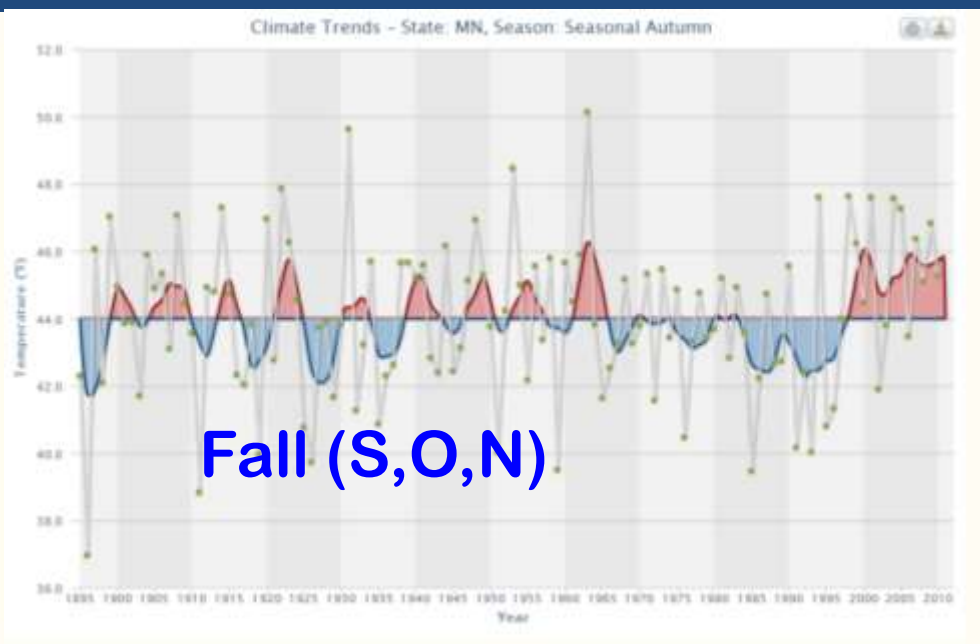
Temp trend is upward and more frequently above the 90th percentile





Seasonal Temperature Trends in MN





Amplified trends in average winter minimum temperatures International Falls, MN

Period of Record	Ave Min Temp in Deg. F
1951 - 1980	Jan -12.5
1961 - 1990	Jan -9.9
1971 - 2000	Jan -8.4
1981 - 2010	Jan -6.6
1951 - 1980	Feb -6.1
1961 - 1990	Feb -4.0
1971 - 2000	Feb -0.7
1981 - 2010	Feb -1.3
1951 - 1980	Mar 7.8
1961 - 1990	Mar 11.4
1971 – 2000	Mar 12.3
1981 - 2010	Mar 12.5

Trends in mean monthly temperatures at Willmar 1971-2000 normals vs 1981-2010 normals (F)

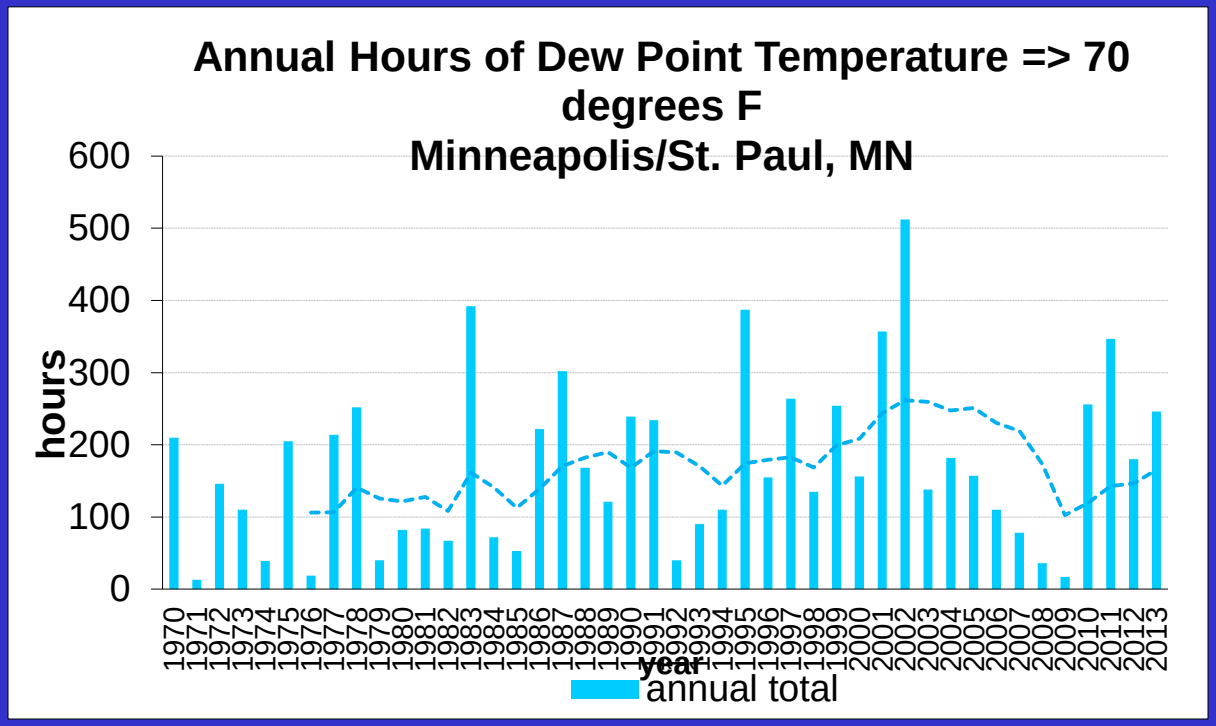
Month	Min Change	Max Change	Mean Change
January	+3.4	+1.5	+2.9
February	+0.8	+0.9	+0.8
March	+0.9	+1.2	+1.0
April	+0.7	+1.5	+1.1
May	+0.1	-0.1	NC
June	+0.5	+0.2	+0.3
July	+0.7	+0.5	+0.6
August	+0.4	+0.7	+0.5
September	+0.9	+1.0	+0.9
October	+0.5	+0.5	+0.5
November	+1.3	+2.3	+1.7
December	+2.1	+1.7	+1.8

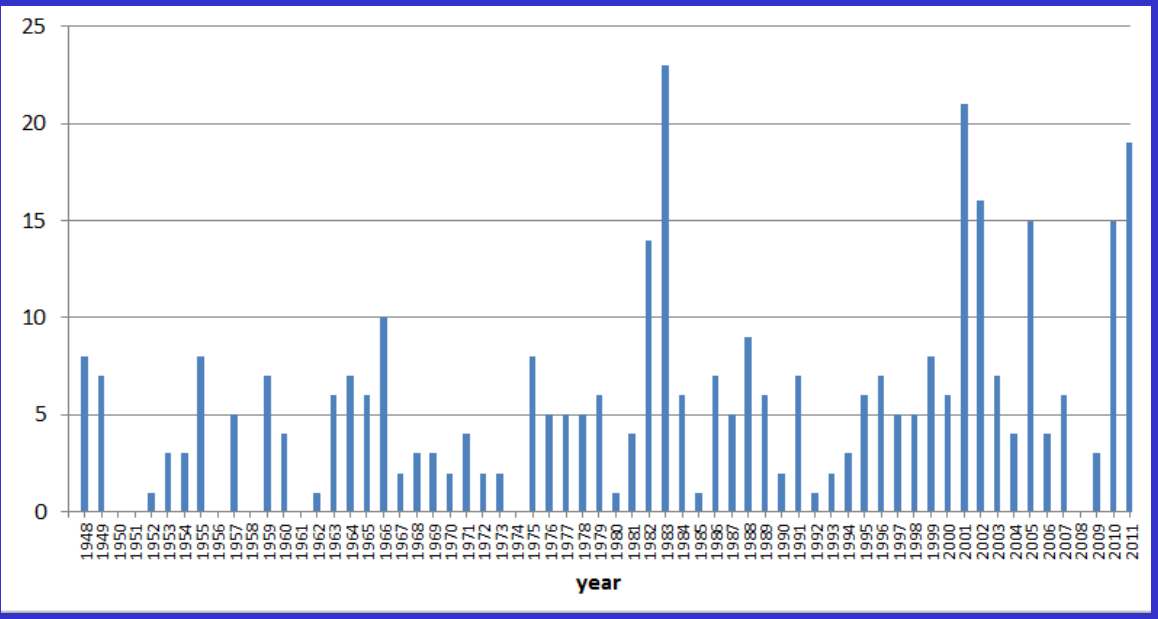
Consequences of Warm Winters and Higher Minimum Temperatures

- Change in depth and duration of soil and lake freezing
- More rapid breakdown of crop residues
- Later fall nitrogen applications (soil temp too high)
- Change in Plant Hardiness Zones
- Change in survival rates and distributions of insect pests, plant diseases, and soil microbes
- Reduced energy use for heating (fewer HDD)
- Increased number of freeze/thaw cycles (damaged roads)
- Change in animal migration, hibernation, and foraging
- Longer exposure times to mold and allergens

Trend in episodes of dewpoints of 70 F or higher (tropical air masses)

Latitude 45 degrees





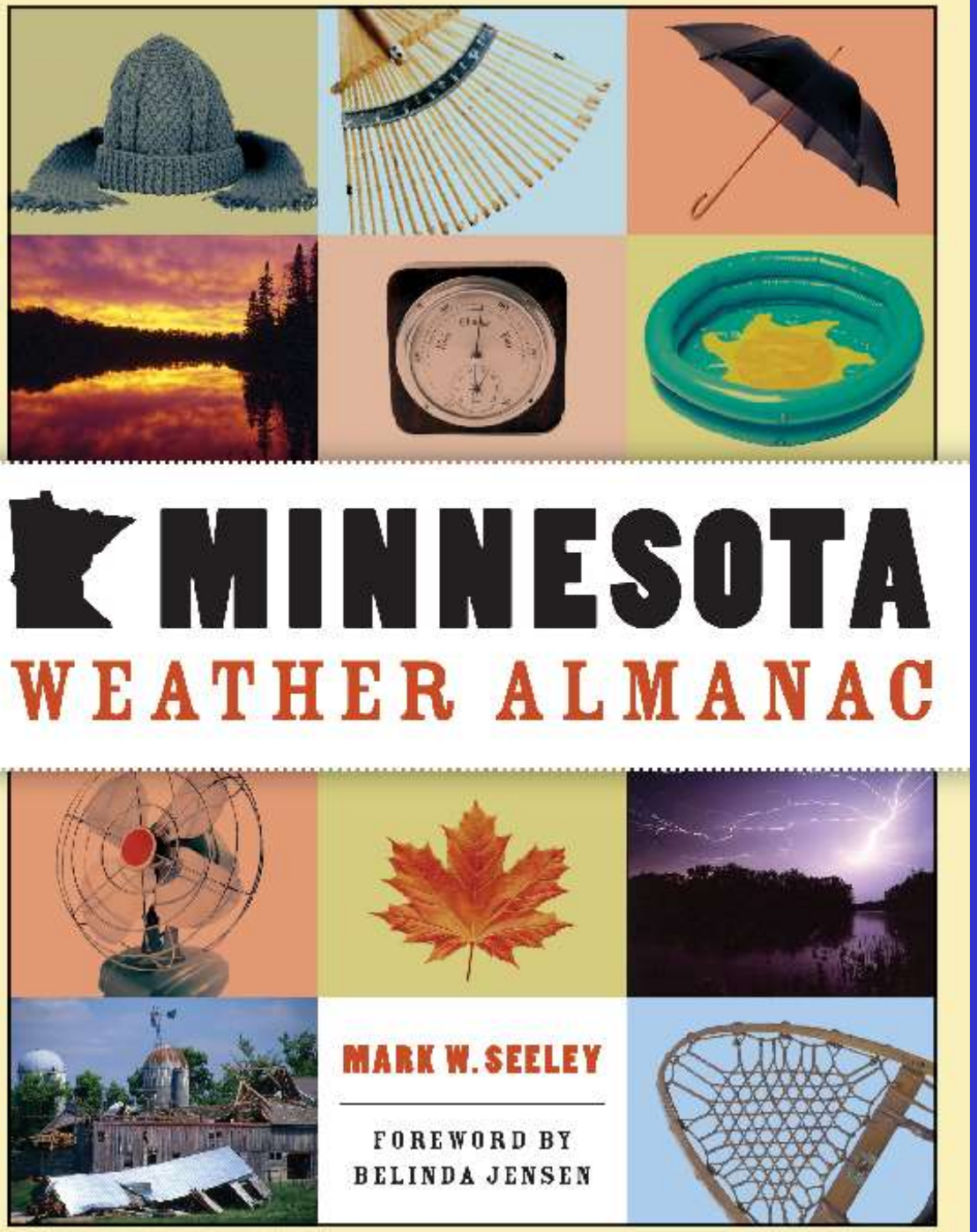
Hours with dewpoints of 70 degrees F or higher at Voyageurs National Park

Latitude 48.5 degrees

Frequencies of July tropical dew points (70 F or higher) and associated Heat Index values for the Twin Cities since 1945

Year	Hours with DP of 70 F or greater	Range of Heat Index Values (F)	
1949	223	98 - 112	
1987	223	98 - 104	
1955	206	98 - 113	
1999	192	98 – 115	(*123)
1957	192	99 – 114	
2001	182	98 - 110	
1977	160	100 - 108	
1983	157	102 - 110	
1995	110	98 - 116	
2002	305	98 – 109	
2004	108	98 - 105	
2011	243	98 – 118	(**134)
2012	186	99 - 117	

**statewide high Heat Index; ** North America high Heat Index*



Historical Minnesota Heat Waves:

Red denotes dewpoint driven

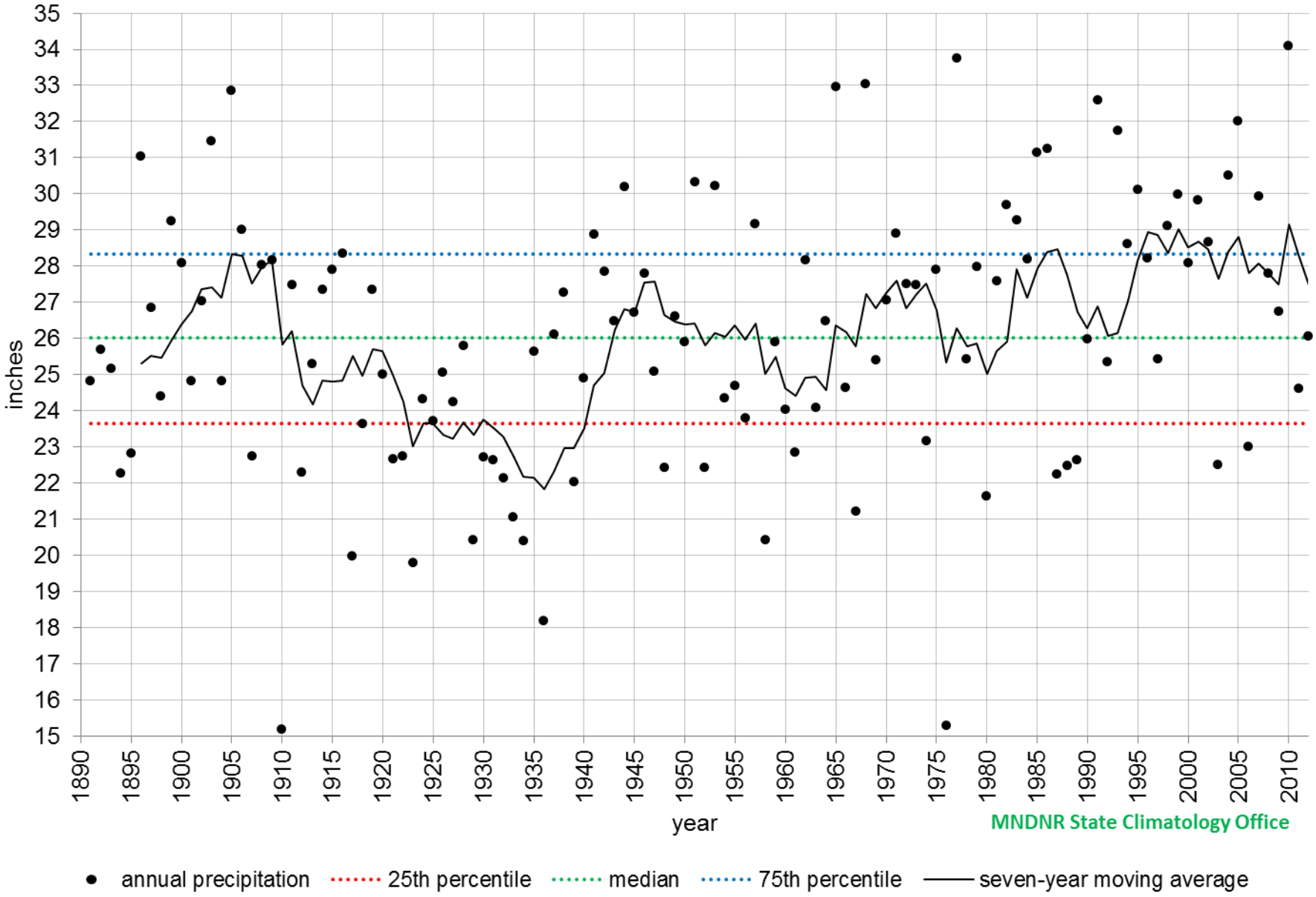
1883, 1894, 1901, 1910, 1917, 1921, 1931, 1933, 1934, 1936, 1937, 1947, 1948, 1949, 1955, 1957, 1959, 1964, 1976, 1977, 1983, 1988, 1995, 1999, 2001, 2005, 2006, 2007, 2010, 2011, 2012, 2013

(pattern is episodic but increasing in frequency)

Consequences of Increased Frequency in Tropical-like Dew Points

- Geographic and seasonal dynamics of pathogen, insect, parasitic, and microorganism populations
- Change in aquatic habitats, algae blooms
- Increased workload in heat related health care (exposure differentials, MS, COPD, Obesity)
- Increased stress on livestock (change in ration, water, reduced milk production and reproduction problems)
- Adjustment in late spring and early fall school systems
- Increased demand for air conditioning/cooling systems

Minnesota State-Averaged Annual Precipitation

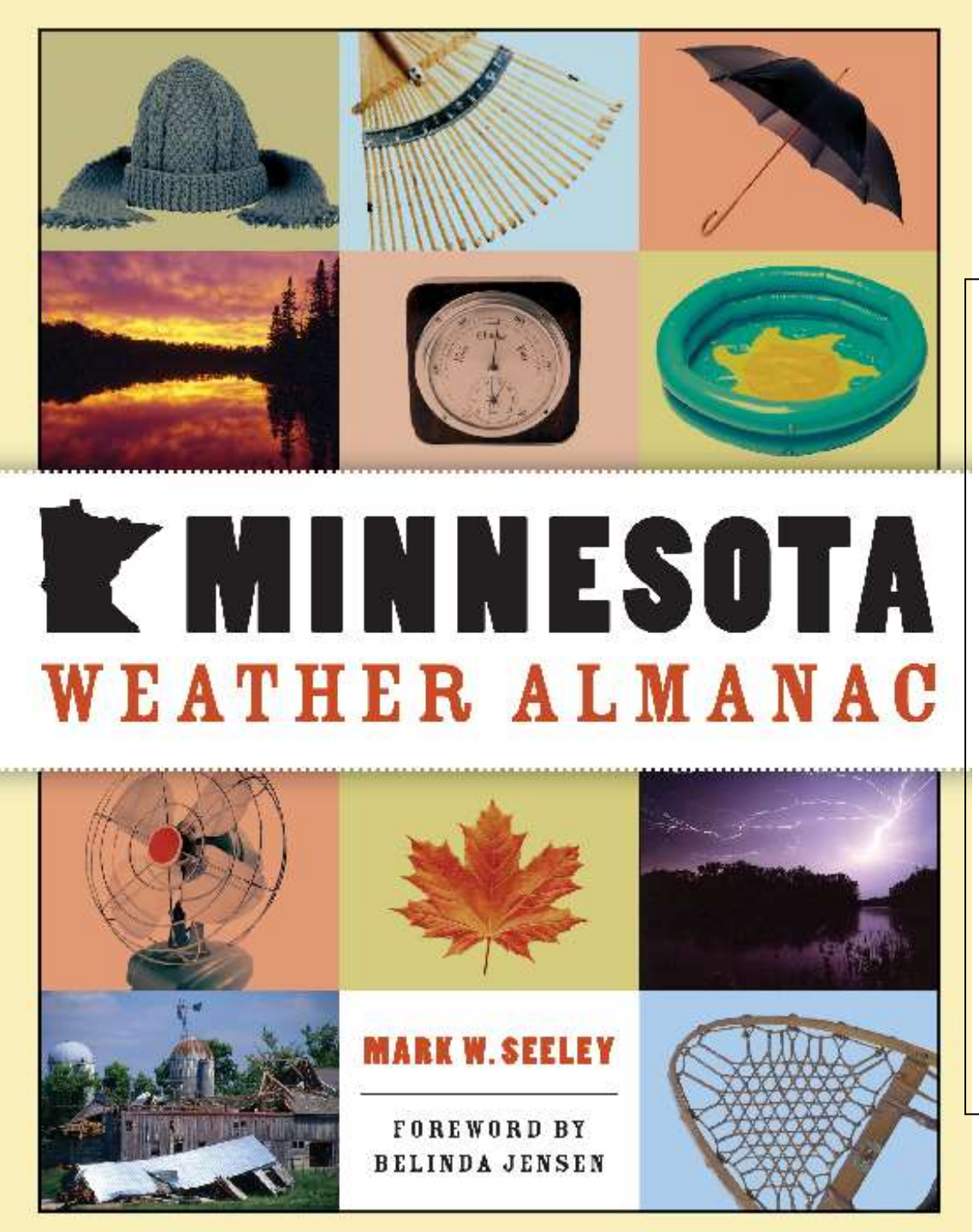


Change in Annual Precipitation
"Normals" at Brainerd, MN

PERIOD	AMOUNT (IN.)
1921-1950	23.03"
1931-1960	24.68"
1941-1970	25.59"
1951-1980	26.02"
1961-1990	26.40"
1971-2000	27.55"
1981-2010	28.38"

23 percent increase since 1921-1950 period

Extremes: 13.16" in 1976, 37.45" in 1986



Measurable Attributes of Precipitation

Quantity

Type (liquid,frozen)

Intensity *(9-15")*

Frequency *(74-145 days)*

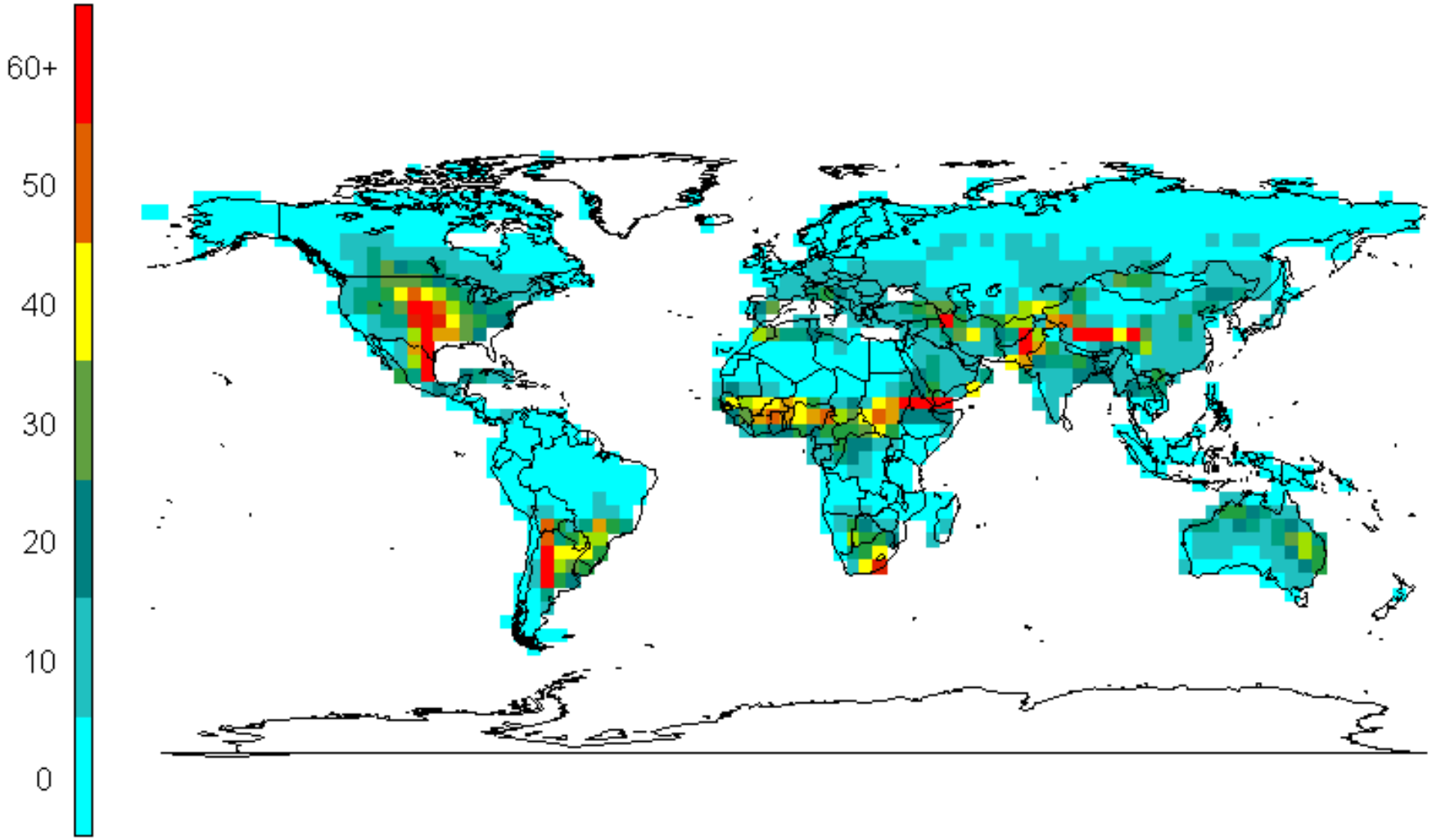
Duration *(10 days)*

Seasonality *(shifting)*

Landscape relationship

(interception, absorption, runoff, evaporation)

Days per Year with Favorable Severe Parameters



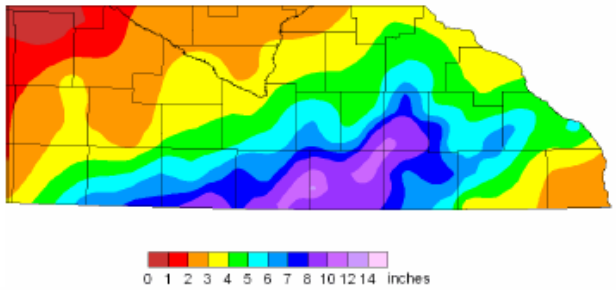
from Brooks et al, NOAA-SSL, 2012

Shift in Precipitation Recurrence Intervals

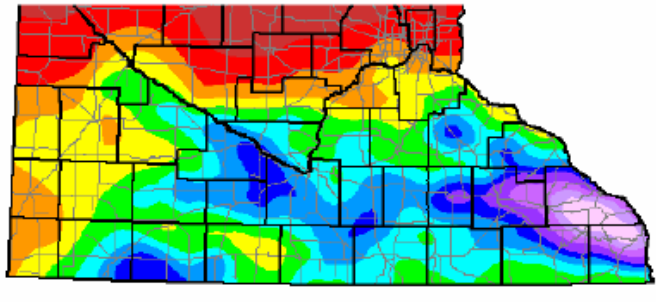
Three one thousand year events since 2004

***'1000-yr (approx.) events'* in Southern Minnesota in the last decade.**

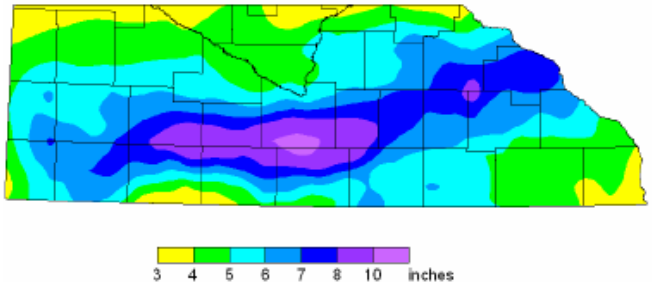
September 14-15, 2004



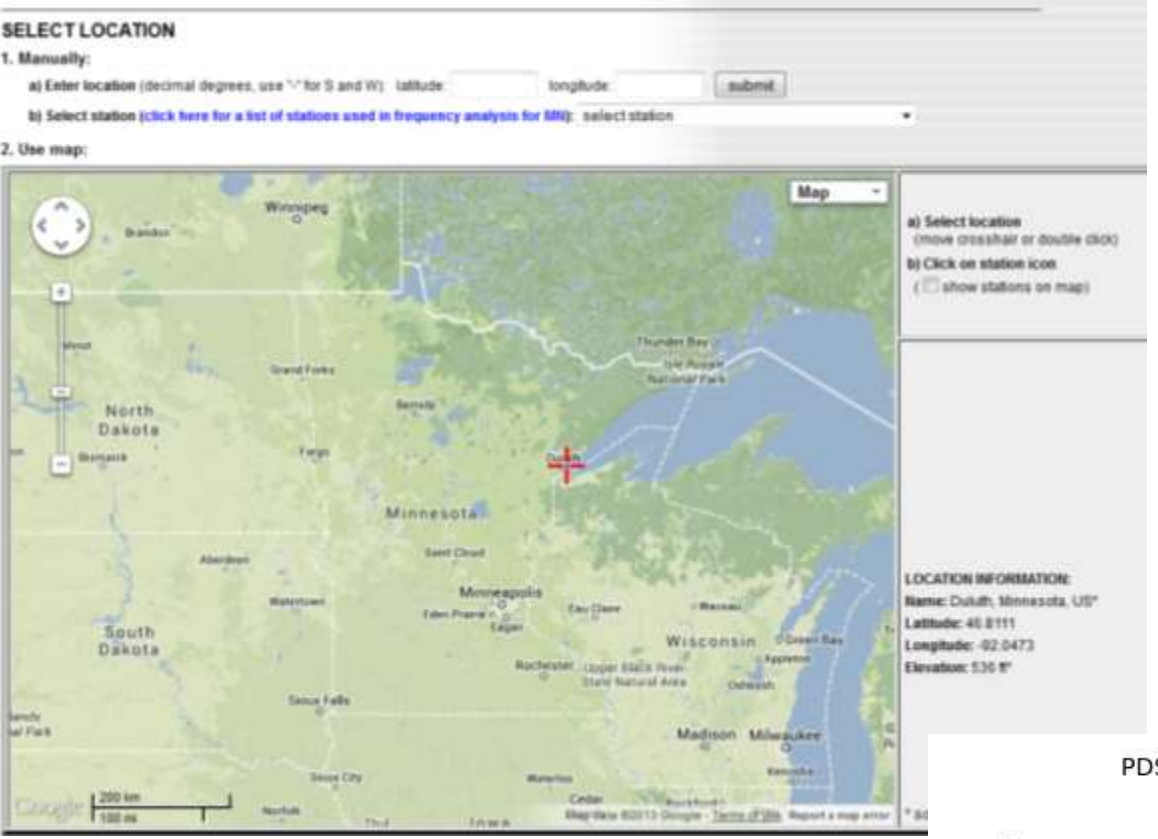
August 18 through August 20 (8:00 AM CDT), 2007



September 22-23, 2010

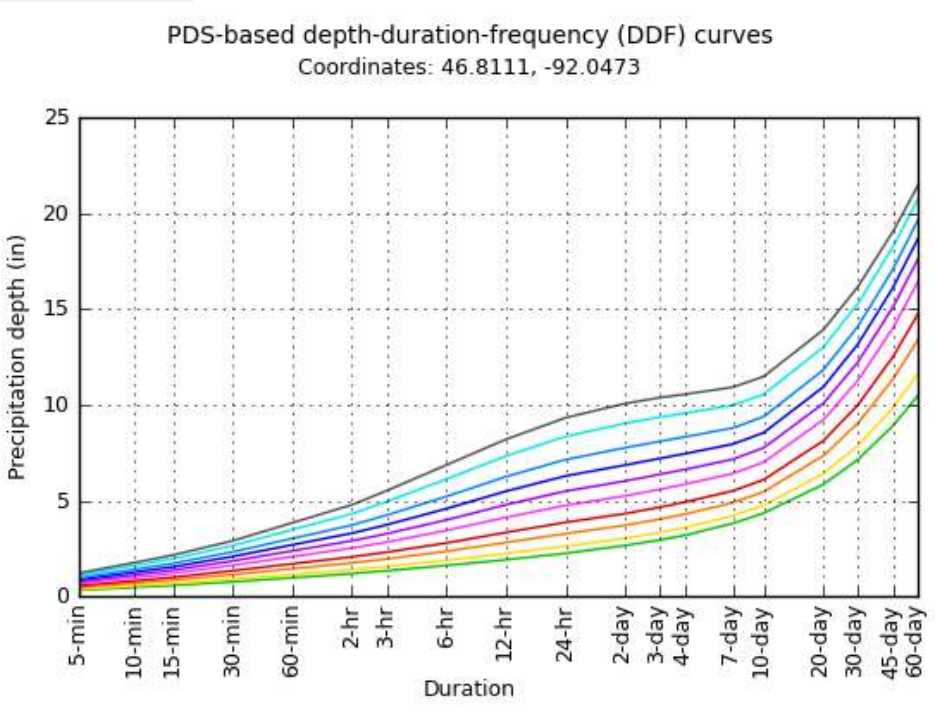


A 'by-eye' estimate of the total area covered by 10" of rain over the 7 years of 2004-2010 appears to be near 1400 sq. mi. or about 200 sq. mi per year. Given that the area of the southern 3 layers of counties looks to be approximately 20000 sq. mi. the areal fraction of the southern three counties covered by 10" per year appears to be approximately 1/100; i.e. at the rate of coverage for the last 7 years an area equal to the whole southern three county area could be covered in about 100 years.



Access to NOAA-Atlas 14 On the Web is cursor-based graphical and tabular access to the most current data base from NCDC

WEB SITE:
http://www.dnr.state.mn.us/climate/noaa_atlas_14.html

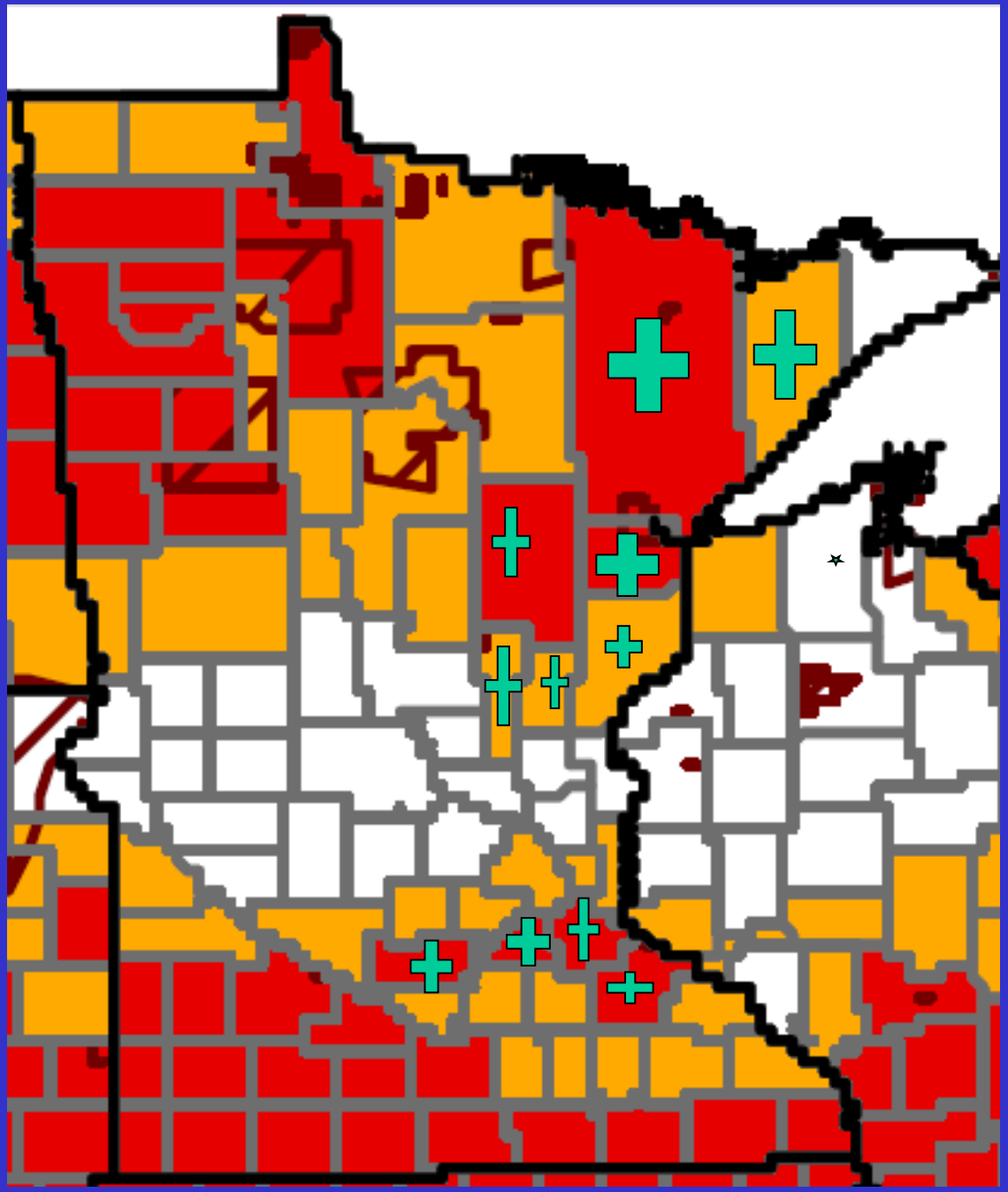


PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.337 (0.297-0.388)	0.412 (0.362-0.475)	0.536 (0.470-0.618)	0.640 (0.558-0.741)	0.786 (0.661-0.935)	0.900 (0.740-1.08)	1.02 (0.807-1.25)	1.14 (0.864-1.42)	1.29 (0.948-1.66)	1.42 (1.01-1.84)
10-min	0.494 (0.435-0.569)	0.603 (0.531-0.695)	0.784 (0.688-0.906)	0.937 (0.817-1.08)	1.15 (0.968-1.37)	1.32 (1.08-1.58)	1.49 (1.18-1.82)	1.66 (1.26-2.08)	1.90 (1.39-2.43)	2.08 (1.48-2.69)
15-min	0.602 (0.531-0.694)	0.736 (0.647-0.848)	0.957 (0.838-1.10)	1.14 (0.996-1.32)	1.40 (1.18-1.67)	1.61 (1.32-1.93)	1.81 (1.44-2.22)	2.03 (1.54-2.54)	2.31 (1.69-2.96)	2.53 (1.81-3.28)
30-min	0.812 (0.715-0.935)	0.999 (0.879-1.15)	1.31 (1.15-1.51)	1.57 (1.37-1.82)	1.93 (1.63-2.30)	2.21 (1.82-2.66)	2.50 (1.99-3.06)	2.79 (2.13-3.50)	3.19 (2.33-4.08)	3.48 (2.48-4.51)
60-min	0.997 (0.878-1.15)	1.25 (1.10-1.44)	1.67 (1.46-1.92)	2.02 (1.76-2.34)	2.51 (2.11-2.99)	2.90 (2.38-3.49)	3.29 (2.61-4.04)	3.70 (2.81-4.63)	4.24 (3.10-5.43)	4.66 (3.32-6.04)
2-hr	1.18 (1.05-1.35)	1.50 (1.32-1.71)	2.02 (1.78-2.32)	2.47 (2.16-2.84)	3.09 (2.62-3.66)	3.58 (2.96-4.28)	4.08 (3.27-4.98)	4.60 (3.53-5.73)	5.30 (3.92-6.74)	5.84 (4.20-7.51)
3-hr	1.29 (1.15-1.47)	1.64 (1.45-1.87)	2.22 (1.96-2.54)	2.72 (2.39-3.12)	3.43 (2.92-4.05)	3.99 (3.32-4.76)	4.57 (3.67-5.55)	5.17 (3.99-6.42)	5.99 (4.45-7.59)	6.63 (4.80-8.49)
6-hr	1.54 (1.38-1.75)	1.91 (1.70-2.16)	2.53 (2.25-2.87)	3.08 (2.72-3.51)	3.88 (3.34-4.58)	4.53 (3.80-5.38)	5.21 (4.23-6.31)	5.93 (4.63-7.33)	6.93 (5.21-8.74)	7.72 (5.65-9.81)
12-hr	1.89 (1.69-2.12)	2.22 (1.99-2.49)	2.81 (2.51-3.16)	3.34 (2.97-3.78)	4.15 (3.61-4.88)	4.83 (4.09-5.72)	5.56 (4.56-6.70)	6.34 (5.01-7.80)	7.46 (5.67-9.36)	8.36 (6.17-10.5)
24-hr	2.23 (2.01-2.48)	2.55 (2.30-2.85)	3.14 (2.82-3.52)	3.69 (3.29-4.14)	4.51 (3.95-5.27)	5.21 (4.45-6.13)	5.96 (4.94-7.14)	6.79 (5.41-8.29)	7.96 (6.11-9.92)	8.91 (6.65-11.1)
2-day	2.51 (2.28-2.79)	2.91 (2.63-3.23)	3.61 (3.25-4.01)	4.23 (3.79-4.71)	5.14 (4.52-5.94)	5.91 (5.07-6.87)	6.71 (5.58-7.95)	7.57 (6.07-9.15)	8.78 (6.80-10.8)	9.74 (7.35-12.1)
3-day	2.74 (2.49-3.03)	3.17 (2.87-3.50)	3.91 (3.53-4.32)	4.56 (4.11-5.07)	5.53 (4.87-6.35)	6.33 (5.45-7.33)	7.17 (5.99-8.45)	8.06 (6.50-9.70)	9.32 (7.26-11.4)	10.3 (7.83-12.8)
4-day	2.95 (2.69-3.25)	3.39 (3.08-3.73)	4.15 (3.77-4.58)	4.83 (4.36-5.35)	5.82 (5.14-6.66)	6.64 (5.73-7.66)	7.50 (6.29-8.81)	8.42 (6.81-10.1)	9.70 (7.58-11.9)	10.7 (8.16-13.2)
7-day	3.51 (3.20-3.84)	3.99 (3.64-4.37)	4.81 (4.38-5.28)	5.53 (5.01-6.08)	6.56 (5.80-7.43)	7.39 (6.41-8.45)	8.25 (6.96-9.62)	9.16 (7.46-10.9)	10.4 (8.20-12.6)	11.4 (8.77-14.0)
10-day	4.01 (3.68-4.38)	4.54 (4.15-4.95)	5.41 (4.94-5.91)	6.15 (5.59-6.75)	7.21 (6.39-8.12)	8.05 (7.00-9.15)	8.91 (7.53-10.3)	9.81 (8.01-11.6)	11.0 (8.72-13.3)	12.0 (9.26-14.6)
20-day	5.50 (5.07-5.95)	6.13 (5.64-6.64)	7.16 (6.57-7.77)	8.01 (7.32-8.72)	9.17 (8.15-10.2)	10.1 (8.79-11.3)	11.0 (9.31-12.5)	11.9 (9.74-13.8)	13.0 (10.4-15.6)	13.9 (10.9-16.9)
30-day	6.73 (6.22-7.25)	7.48 (6.90-8.06)	8.68 (7.99-9.38)	9.64 (8.84-10.5)	10.9 (9.74-12.1)	11.9 (10.4-13.3)	12.8 (11.0-14.6)	13.8 (11.4-16.0)	15.0 (12.0-17.7)	15.8 (12.4-19.1)
45-day	8.26 (7.66-8.87)	9.20 (8.52-9.88)	10.7 (9.85-11.5)	11.8 (10.9-12.8)	13.3 (11.9-14.6)	14.4 (12.7-16.0)	15.4 (13.2-17.4)	16.4 (13.6-18.9)	17.6 (14.2-20.7)	18.5 (14.6-22.1)
60-day	9.56 (8.88-10.2)	10.7 (9.91-11.4)	12.4 (11.5-13.3)	13.8 (12.7-14.8)	15.5 (13.8-16.8)	16.7 (14.7-18.4)	17.8 (15.2-20.0)	18.8 (15.6-21.6)	20.0 (16.2-23.5)	20.9 (16.6-24.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Rainfall Recurrence Table for Alexandria, MN



MN Counties designated for federal disaster assistance in 2012

All are associated with drought except those with + which designates for flood or severe storm

Possible Implications of Changes in Precipitation Quantity and Character

- Altered irrigation, drainage, runoff, sediment, and shoreline management
- Change in storm sewer runoff design
- Modified fisheries management in aquatic habitat
- Mitigation of soil erosion
- Mitigation of flooding potential
- Impact on insurance claims
- Impact on winter tourism season

2010 Minnesota Tornadoes

48 on June 17, 2010

OPERATIONAL EF SCALE	
EF Number	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Kittson, Roseau, Lake of the Woods, Marshall, Pennington, Red Lake, Polk, Clearwater, Beltrami, Koochiching, St. Louis, Itasca, Norman, Mahnomen, Hubbard, Clay, Becker, Cass, Aitkin, Carlton, Wilkin, Otter Tail, Wadena, Crow Wing, Pine, Grant, Douglas, Todd, Morrison, Mille Lacs, Kanabec, Traverse, Stevens, Pope, Stearns, Benton, Isanti, Chisago, Big Stone, Swift, Sherburne, Anoka, Kandiyohi, Meeker, Wright, Lac qui Parle, Chippewa, Hennepin, Ramsey, Washington, Yellow Medicine, Renville, McLeod, Carver, Sibley, Dakota, Lincoln, Lyon, Redwood, Nicollet, Le Sueur, Rice, Goodhue, Brown, Wabasha, Pipestone, Murray, Cottonwood, Watonwan, Blue Earth, Waseca, Steele, Dodge, Olmsted, Winona, Rock, Nobles, Jackson, Martin, Faribault, Freeborn, Mower, Fillmore, Houston

Tornado Enhanced Fujita Intensity Rating

- = EF4 (4)
- = EF3 (4)
- = EF2 (8)
- = EF1 (31)
- = EF0 (66)

Total = 113

First ever EF-5 Tornado in Canada, (Elie, Manitoba) June 22, 2007

First 4 inch thunderstorm rainfall Churchill, Manitoba, Aug 24, 2010

Located at nearly 59 degrees N. latitude, Churchill, Manitoba reported their first ever 4.12 inch thunderstorm rainfall on August 24, 2010! Previous record was 2.45 inches.

ICAT Member Presentations

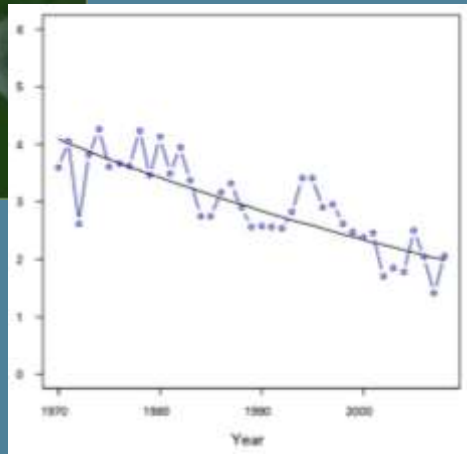
* Natural Resources
* Health
* Agriculture
* Pollution Control
* Commerce
* Water and Soil Resources
* Transportation
* Metropolitan Council
* Public Safety/Homeland Security and Emergency Management

Managing Natural Resources in a Changing Climate

Minnesota DNR

Projected shift in prairie-forest border (Frelich and Reich 2010)

Cisco decline since 1970s



Building Resilience

Building Capacity

- Climate change teams
- Foundational information
- Adaptation strategy development
- Workshops

Taking Action

- Planning
- Landscape/watershed projects
- Site projects
- Monitoring

Current and Future Needs

- ✓ Accelerate efforts to conserve and restore the quality, size, and connectivity of Minnesota‘s natural lands and waters
- ✓ Integrate adaptation strategies broadly into planning and on-the-ground management
- ✓ Expand partnerships and build new collaborations across jurisdictions
- ✓ Monitor, Evaluate, and Adapt

Preparing for Climate Change: ICAT Report Findings

Kristin Raab, MPH, MLA
MN Climate & Health Program Director
Minnesota Department of Health

Minnesota Environmental Quality Board

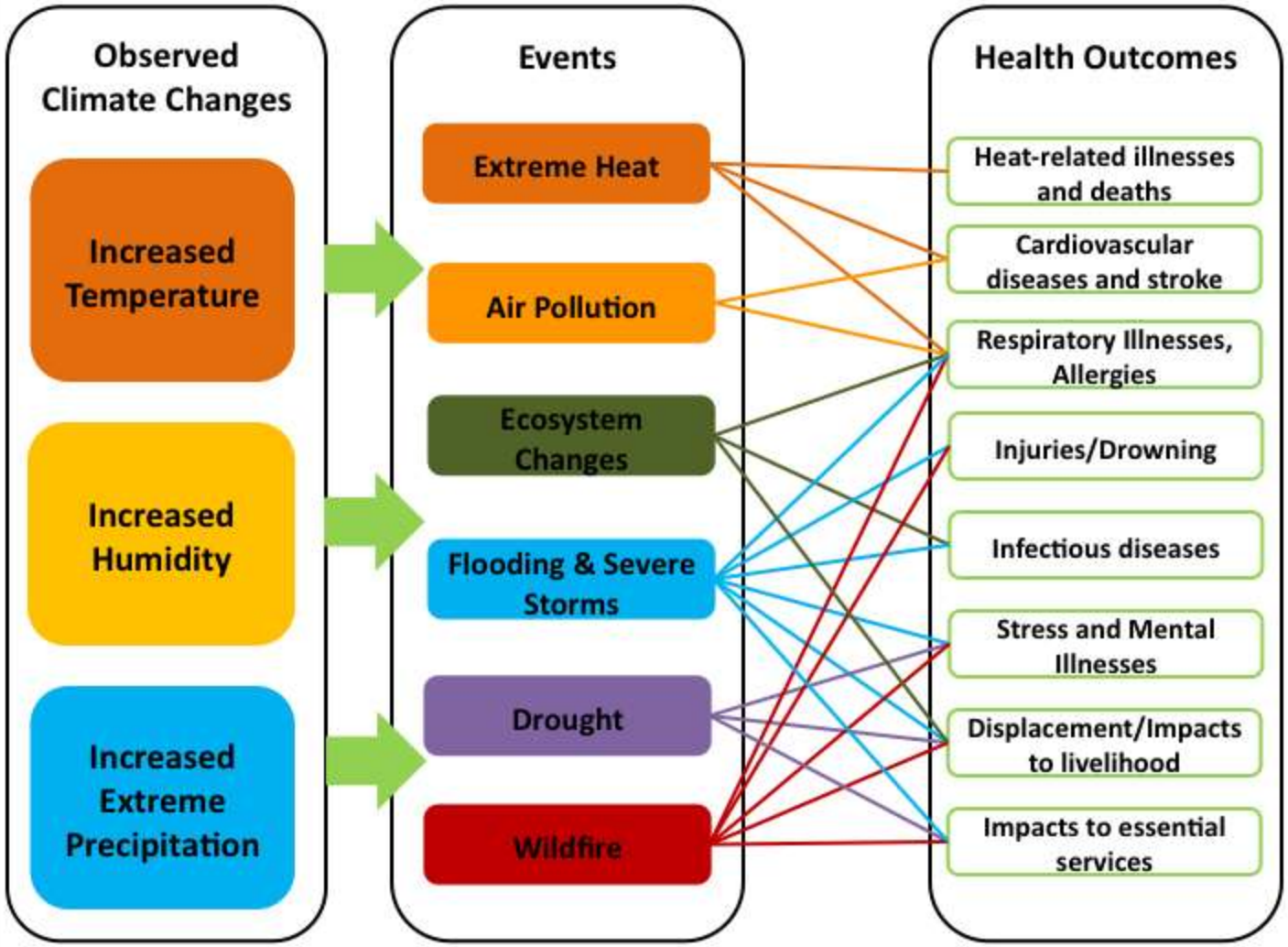
November 20, 2013

MINNESOTA MDH DEPARTMENT OF HEALTH

MN Climate & Health Program
Environmental Impacts Analysis Unit
625 Robert Street North
Saint Paul, Minnesota 55164

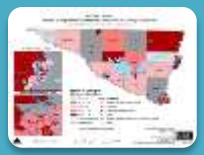
MN Climate & Health Program

Health Impacts

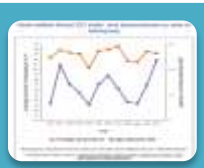


MDH's Key Activities

Education/Communication



Planning/Technical Assistance



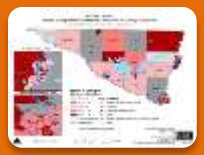
Tracking/Research

Policy Development/Review

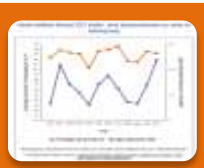
Collaboration

Next Steps/Challenges

Education/Communication



Planning/Technical Assistance



Tracking/Research

Policy Development/Review

Collaboration

MINNESOTA
DEPARTMENT OF
AGRICULTURE

www.mda.state.mn.us

Impacts on Agriculture

- Increasing temperature and extreme heat
- Drought

Image source: Every Life Secure

MINNESOTA DEPARTMENT OF AGRICULTURE

Impacts on Agriculture

- Extreme weather events
- Changing seasonality and longer term ecological changes

Image sources: Iowa State University Extension, USDA

MINNESOTA DEPARTMENT OF AGRICULTURE

MN Department of Agriculture Responses to Climate Impacts

- Encouraging best practices for conservation, sustainable use of water and soil resources, and fertilizer/pesticide use

MINNESOTA DEPARTMENT OF AGRICULTURE

MN Department of Agriculture Responses to Climate Impacts

- Supporting demonstration of sustainable agriculture practices
- Providing assistance related to extreme weather events

Image source: University of Minnesota Extension

MINNESOTA DEPARTMENT OF AGRICULTURE

MN Department of Agriculture Responses to Climate Impacts

- Preventing the spread and increasing awareness of pests and invasive species
- Monitoring and incident response to weather-related impacts from agricultural practices

MINNESOTA DEPARTMENT OF AGRICULTURE

Climate impacts

- Excessive stormwater runoff
- Untreated wastewater bypassing treatment plants
- Degraded air and water quality
- Large quantity of storm debris

Minnesota Pollution Control Agency

Actions and steps taken

- Minimal Impact Design Standards (MIDS) and new MS4 General Permit
- WW treatment permit review
- Adaptation opportunities through urban forestry
- Minnesota GreenStep Cities and Minnesota GreenCorps

Minnesota Pollution Control Agency

What more needs to be done?

- Involving residents in adaptation efforts
- Assisting local units of government
- Reducing nonpoint sources of air pollution
- Identifying integration opportunities through internal MPCA team

Minnesota Pollution Control Agency

Climate Adaptation: Minnesota Department of Commerce Division of Energy Resources

Deputy Commissioner Bill Grant

November 20, 2013
Environmental Quality Board

Minnesota Department of Commerce

Commerce Roles and Responsibilities

- Lead role in reducing GHG emissions from the energy sector
- Maintain state energy emergency plan
- Coordinate with energy utilities on restoration of service during and after emergencies
- Employ Consumer Response Team to assist with disaster recovery through our Insurance Division

Energy Emergency Planning

- Energy Assurance Plan, including emergency exercises
- Track duration, response, restoration and recovery time of energy supply disruptions
- Utility restoration of service coordination
- Monitor utility plans to assure reliability
- Monitor liquid fuel supplies to assure adequacy

Other Activities

- Consumer Response Team
  - Distribute insurance info; work with insurance companies on claim reporting
- Planning and data analysis
  - With PCA, produce annual report on GHG trends
  - Evaluate impacts of climate change on insurance investments through NAIC Climate Change and Global Warming Working Group

Climate impacts on BWSR activities

- Extreme weather patterns and disruption to natural cycles may decrease the ability of Minnesota landscapes to sustainably provide important environmental and economic benefits

Key action steps taken

- Wetland Restorations
- Soil Health Initiative
- Native Vegetation
- Multi-purpose Drainage Water Management
- Cooperative Weed Management
- Comprehensive local water management
- Disaster Response

Future Needs

- Continue protection of Minnesota wetlands
- Continue efforts to increase carbon sequestration in all parts of Minnesota
- Continue promotion of multi-functional plantings that increase landscape resiliency

MnDOT

Marilyn Jordahl Larson, P.E.
Office of Environmental Stewardship

Your Destination...Our Priority

MnDOT Climate Impacts

- Flooding–damage to highway & rail infrastructure
- Freeze/thaw cycles–pavement life cycle
- Higher low temps–icing conditions
- High heat–pavement & rail buckling, vehicles overheating, electrical system malfunctions, limitations on construction hours
- Drought– river navigability for barges
- Wildfires–road closures
- Roadside vegetation–new noxious weeds

MnDOT Key Actions

- FHWA Climate Vulnerability Assessment Project
- $50 million to mitigate flood prone highways
- Investigating pervious pavements
- Bridge Scour Plan of Action
- Bridge Office Flood Response Plan
- Manage invasive species
- Implement Complete Streets & Context Sensitive Solutions
- Research-drought tolerant sod & seed mixtures
- Incident Management Planning
- Inter-agency collaboration
- FHWA & AASHTO national committee participation

MnDOT Future Actions

- Continue development of a state-wide climate vulnerability assessment protocol
- Update Incident Management Plans-reflect lessons learned in recent floods
- Continue adaptation research efforts
- Encourage BMPs for emission reduction
- Continue to support a cooperative agreement with USGS for crest gage monitoring

Climate Change

- Impact on activities:
  - Drought: reduces water supply, degrades water quality, decreases park use
  - Extreme storms: might increase sewer overflows, wastes clean water for Minnesota, degrades water quality, might disrupt transit service, might limit park access

Current Council Initiatives

- *Thrive 2040 MSP* - planning
- Water supply - planning
- Wastewater - inflow/infiltration program
- Council facilities - stormwater management
- Regional parks – native planting and snow-making improvements

METROPOLITAN COUNCIL

Future Needs

- Lead by example – more!
- Collaborate and convene (with local governments)
  - E.g., grant program to educate public and communities
  - E.g., resources to develop more stormwater BMPs
- Partnering on demonstration projects

METROPOLITAN COUNCIL

Increased Frequency and Intensity of Severe Weather

- Torrential rains and flash flooding
- Tornadoes
- Drought and associated wildfires
- Ice storms with extended power outages

Effects on agency - limited resources with increased number of Presidentially declared disasters.

Agency Action Steps

- Include Climate Change & Adaptation in State All Hazard Mitigation Plan
- Provide Hazard Mitigation funding to locals to lessen effects of natural hazards
  - Acquisition of flood-prone homes
  - Community Tornado Safe Rooms
  - Retrofit electrical power lines (PNP)
  - Generators for Critical Facilities

Opportunities for Interagency and Collaborative Action

* 2013 ICAT report identifies seven priority areas for interagency action
* Some can be acted on with existing resources
* Others require additional funding or policy direction
* In some cases, collaboration with local partners will be key

Building resilience to extreme precipitation

* *Problem:* Observed climate trends for increasing extreme precipitation, and recent severe damage and costly recovery efforts
* *Opportunities:* Wide variety of actions can be implemented: green infrastructure, flood plain management, wetland restoration, urban forests, emergency response

Implementing best practices that achieve multiple benefits

* *Problem:* Degree of uncertainty about the future may result in inaction
* *Opportunities:* "No regrets" adaptation responses can build resilience as well as help to meet other environmental, health and economic goals

Examples: wetland restoration, stormwater best management practices, water conservation, white roofs, urban trees, wildfire protection planning, soil conservation and erosion prevention

Protecting human health

* *Problem:* Gaps remain in Minnesota's public health system for consequences of climate change
* *Opportunities*: Targeting climate assistance to vulnerable populations, evaluating climate change preparedness measures, assisting emergency managers, developing new tools and models to identify exposure thresholds

Strengthening existing ecosystems

* *Problem:* Ecosystems already face a wide variety of stresses (pollution, habitat loss, invasives), making them less resilient to climate change
* *Opportunities:* Strengthen ecosystems by: promoting soil and ecological health, better integrating climate change into water planning and management, climate smart management of wetlands and forests

Building partnerships with local governments

* *Problem:* Local governments have limited resources to maintain infrastructure, public health, environment, and economy
* *Opportunities:* Partnering with local governments on adaptation, including funding local adaptation efforts, technical assistance, education and information, support for local and regional planning

Quantifying climate impacts

* *Problem:* Limited data and analysis on climate trends and impacts
* *Opportunities:* Interagency research projects, including monitoring, trend analysis, cost and impact assessments, and vulnerability studies

Public and community outreach, education, and training

* *Problem:* Benefits of public and local stakeholder involvement have not been tapped
* *Opportunities:* Developing consistent core messages, case studies, campaigns across agencies, joint training, and tool kits

Discussion/Questions