

Regional Climate Change Effects Report



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“Past Performance does not guarantee future returns”



- **Past weather patterns/climate no longer a good guide to the future**
- **Cannot assume that future rates of change will match the past**
- **At the same time, cannot say for sure how large future change will be**
 - Ability of scientists to project future climate conditions is expected to advance over the next 3-5 years, produce narrower ranges & better information

Regional Climate Change Effects Report



Three sections

- **Report**
- **Regional maps (Appendix B)**
- **Climate Effects Typology (Appendix C)**

Received assistance from Climate experts:

- **NOAA, USGS, DOE**

Regional Climate Change Effects Report

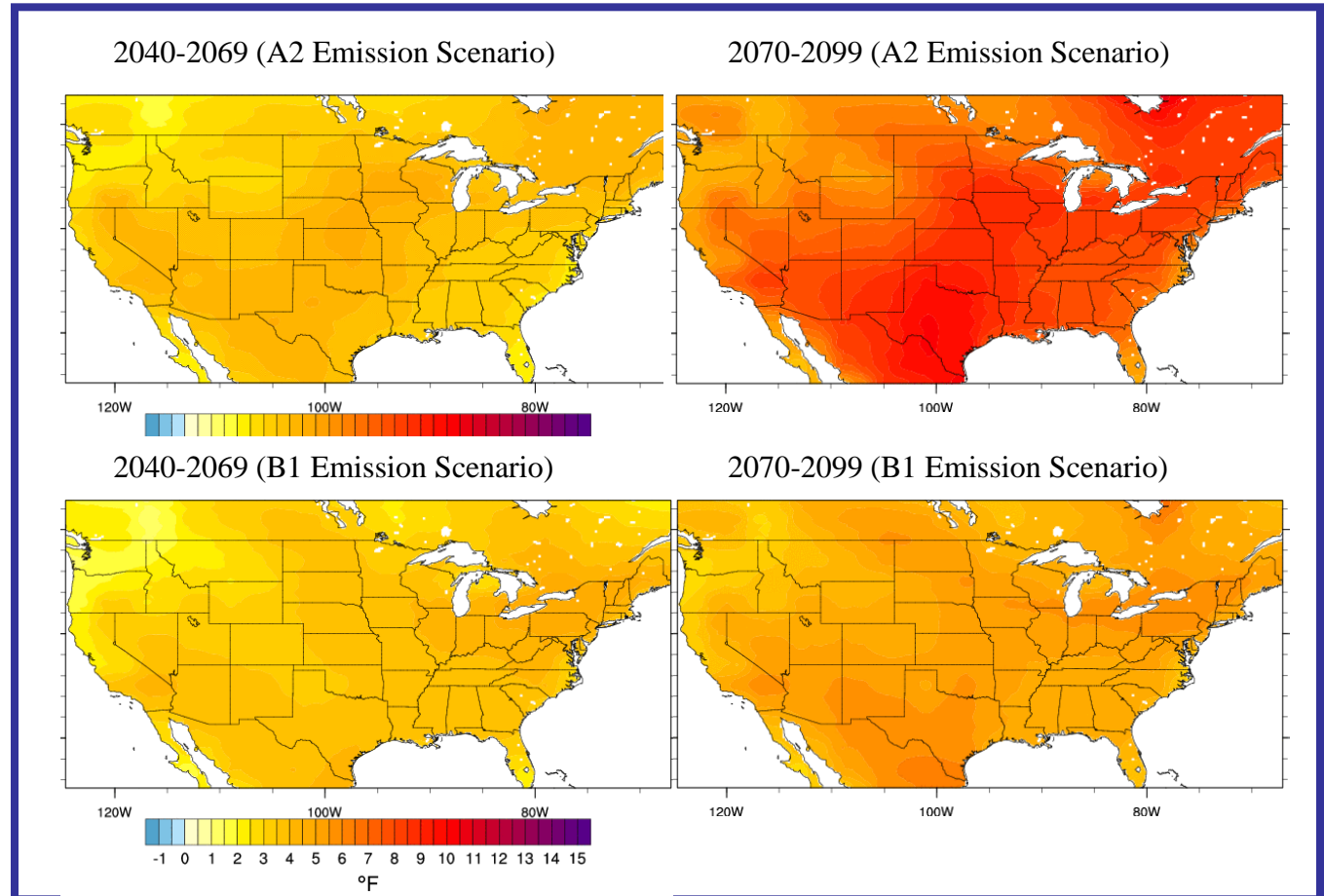


- **Synthesizes information on climate change projections from multiple studies, for transportation decision makers**
- **Snapshot: Summarizes recent science**
 - Science is progressing, expect information to improve over next 3-5 years
- **Regional focus**
 - Also includes information at other scales, including down-scaled temperature data
- **Projected *changes* by region:**
 - Annual, Seasonal Temperature (change in °F)
 - Seasonal Precipitation (% change)
 - Where information exists:
 - Sea level rise, Storm activity

Projections of Temperature Change



- **US: Average annual temp projected to rise by 4 to 11°F by 2100**
- **Variations of warming around the globe (greatest warming over land, higher latitudes)**



relative to 1971-2000

USGCRP 2009

Projections of Precipitation Change

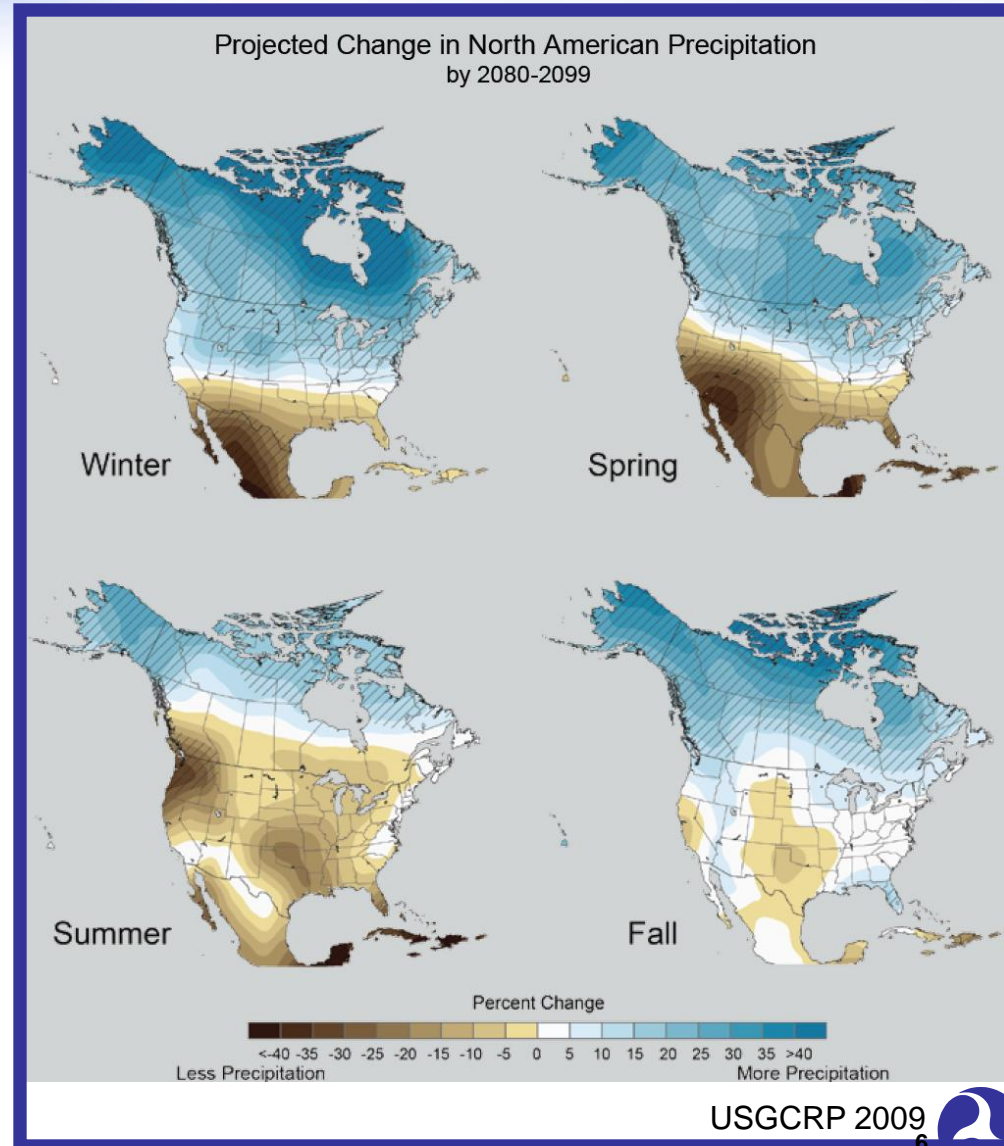


Seasonally

- Northward – significant increase in winter/spring precip (more as rain)
- Southward – significant reductions in winter/spring precip

Extreme Events

- Increase in frequency and intensity
- Decrease in light precip events
- Events with a 5% chance of occurring in a given year are projected by end of century:
 - 7 to 25% chance of occurring
 - Expected to be 10% to 25% heavier



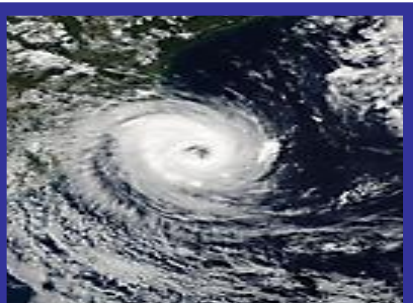
Projections of Tropical Storms & Hurricanes



General consensus today suggests projected global conditions by 2100:

- Average Intensity of these storms projected to increase by 2 to 11%
- Average Frequency decrease by 6 to 34%
- Higher resolution models suggest: Increase in frequency of most intense storms

Area of active research and debate



Projections of Sea Level Rise

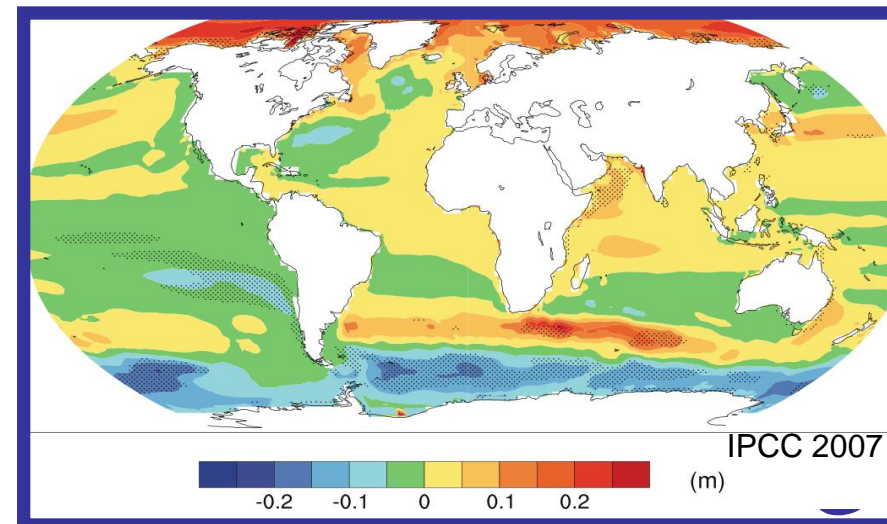


Study	Global Sea Level Rise, to 2100
IPCC (2007a)	7" to 23"
Newer studies	20" to 79"

Uncertainty, particularly in projecting the rate of melting of glaciers/ice sheets

Local sea level rise may differ from global estimates due to:

- Subsidence/uplift of land
- Sedimentation and erosion
- Ocean circulation
- Gravitationally induced changes
- Ocean density (ocean salinity and temp)

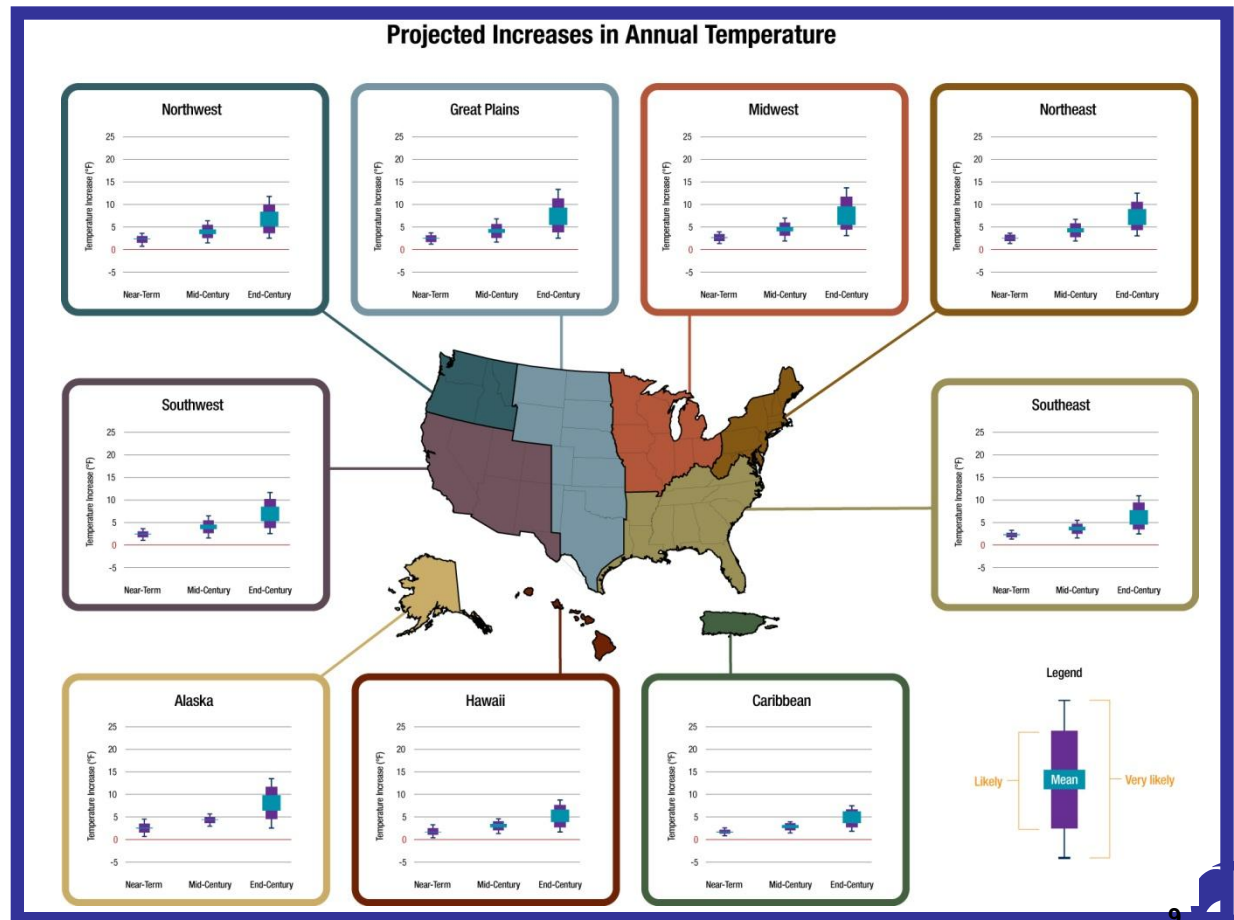


Projections of Regional Temperature, Precipitation changes



Projections of near-term, mid-term, end-of-century are provided for each region, based on USGCRP (2009) data

- Two emission scenarios (B1, A2)
- IPCC AR4 climate models
- Regionally processed
- Report also includes results of other studies

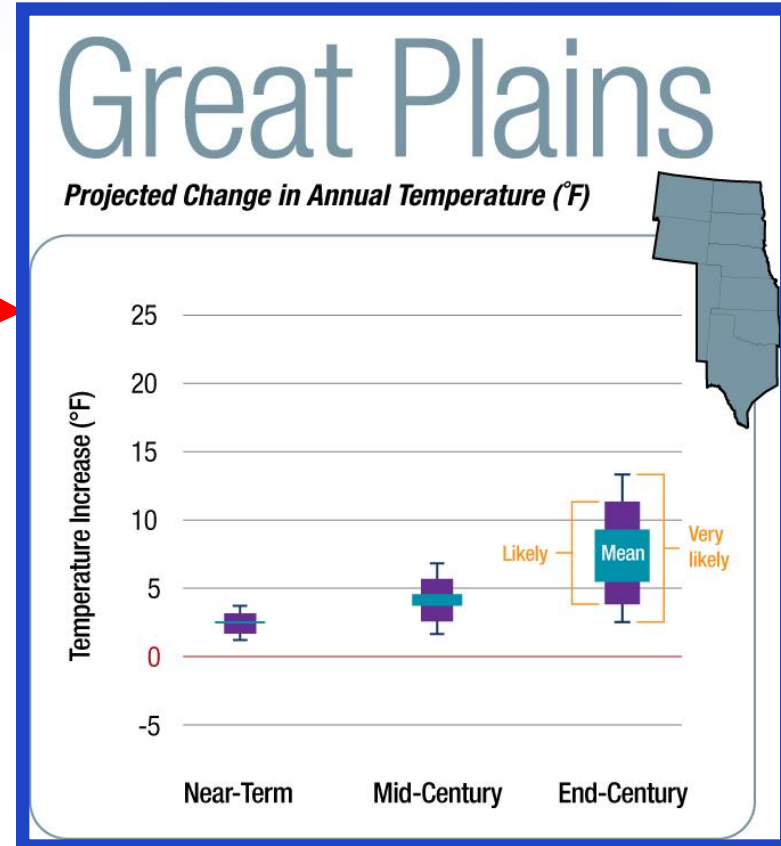


Example of Regional Temperature Change Great Plains



USGCRP data

Great Plains (Δ Temperature)		Near-term (°F)	Mid-century (°F)	End-of- century (°F)
Annual	Mean	2.4 – 2.5	3.8 – 4.7	5.4 – 9.2
	Likely	1.8 – 3.1	2.7 – 5.8	3.9 – 11.2
	Very Likely	1.1 – 3.8	1.6 – 6.9	2.5 – 13.2
Winter	Mean	2.2 – 2.5	3.6 – 4.3	5.3 – 8.3
	Likely	1.4 – 3.4	2.4 – 5.6	3.8 – 10.4
	Very Likely	0.6 – 4.2	1.2 – 6.9	2.2 – 12.5
Spring	Mean	1.9 – 2.2	3.4 – 4.0	4.8 – 8.0
	Likely	1.2 – 3.0	2.1 – 5.5	3.1 – 10.3
	Very Likely	0.5 – 3.9	0.8 – 6.9	1.3 – 12.7
Summer	Mean	2.7 – 2.9	4.3 – 5.6	5.8 – 10.6
	Likely	1.8 – 3.7	3.0 – 7.1	4.1 – 13.6
	Very Likely	0.8 – 4.6	1.7 – 8.7	2.4 – 16.6
Fall	Mean	2.4 – 2.5	3.8 – 4.7	5.5 – 9.6
	Likely	1.8 – 3.3	2.7 – 5.7	4.0 – 11.5
	Very Likely	1.1 – 4.0	1.6 – 6.7	2.4 – 13.5



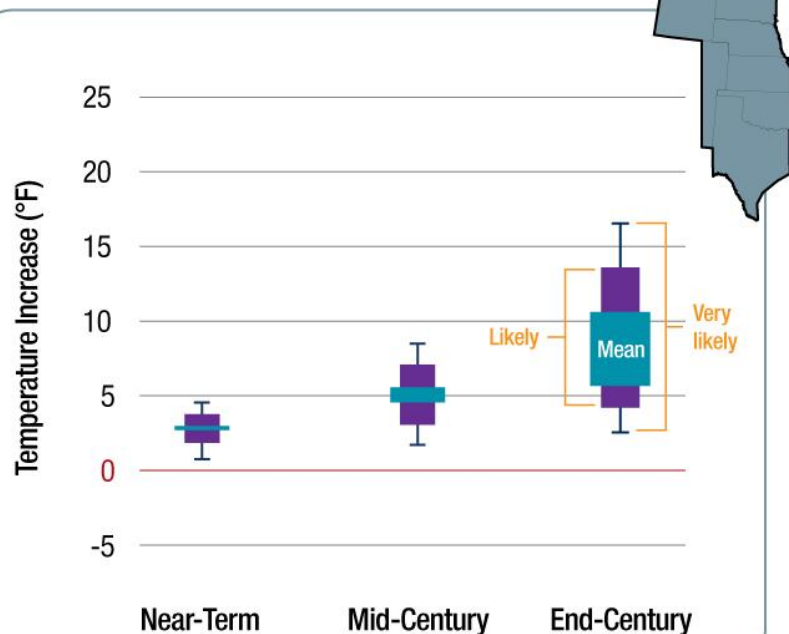
Collected Literature is also discussed in the text.

Regional Temperature Change, Great Plains



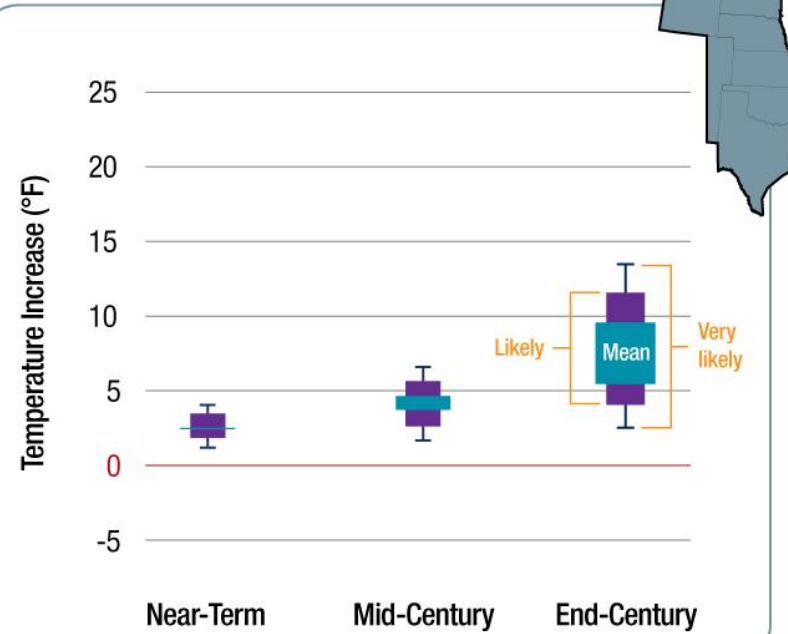
Great Plains

Projected Change in Summer Temperature (°F)



Great Plains

Projected Change in Fall Temperature (°F)

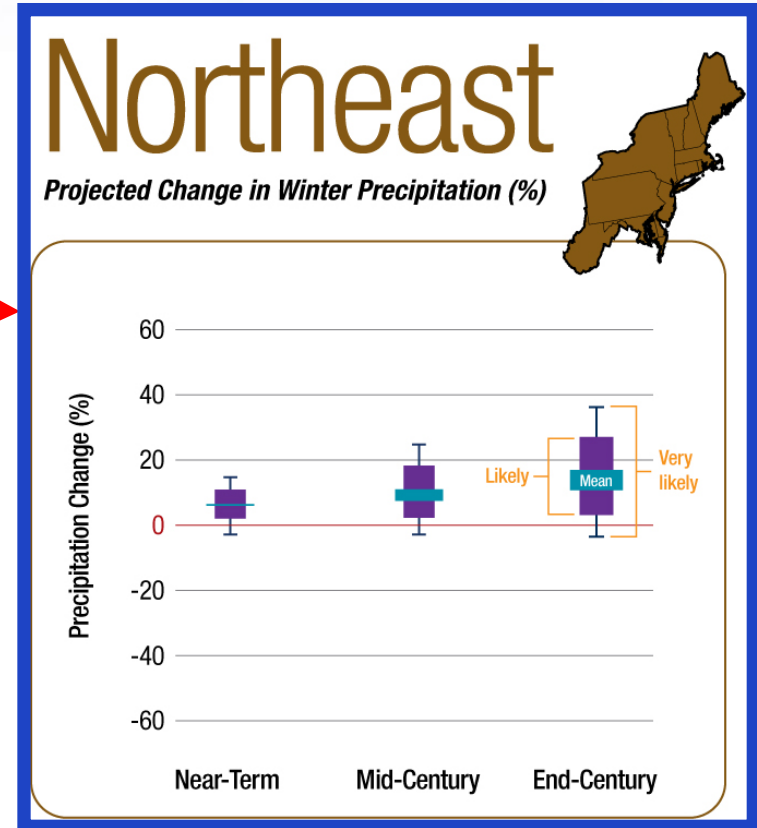


Example of Regional Precipitation Change Northeast



USGCRP data

Northeast (Δ Precipitation)		Near-term (%)	Mid-century (%)	End-of-century (%)
Winter	Mean	6	8 – 11	11 – 17
	Likely	2 – 11	2 – 18	4 – 27
	Very Likely	(2) – 15	(4) – 26	(4) – 36
Spring	Mean	3	5 – 6	9 – 11
	Likely	(2) – 7	0 – 12	1 – 21
	Very Likely	(7) – 12	(5) – 17	(9) – 31
Summer	Mean	2	1 – 2	(1) – 2
	Likely	(1) – 6	(6) – 7	(12) – 11
	Very Likely	(5) – 10	(12) – 14	(24) – 23
Fall	Mean	1 – 2	3	3 – 4
	Likely	(4) – 6	(3) – 9	(5) – 13
	Very Likely	(10) – 11	(9) – 16	(15) – 23



Collected Literature is discussed in the text:

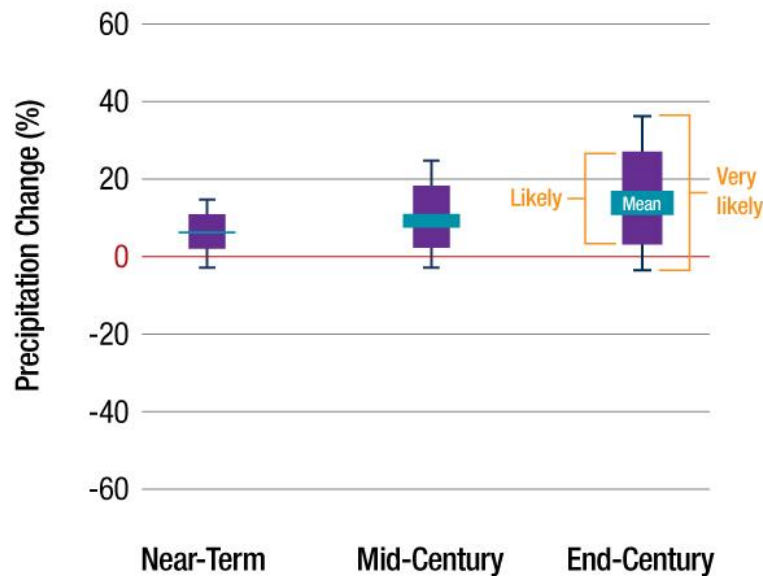
“By the end of the century, the intensity of any particular precipitation event is projected to increase, on average, by 12 to 13% (NECIA 2006). Additionally, the number of days in a given year with precipitation events of greater than two inches per day is projected to slightly increase by an additional 1.25 to 1.75 days per year (NECIA 2006).”

Regional Precipitation Change, Northeast



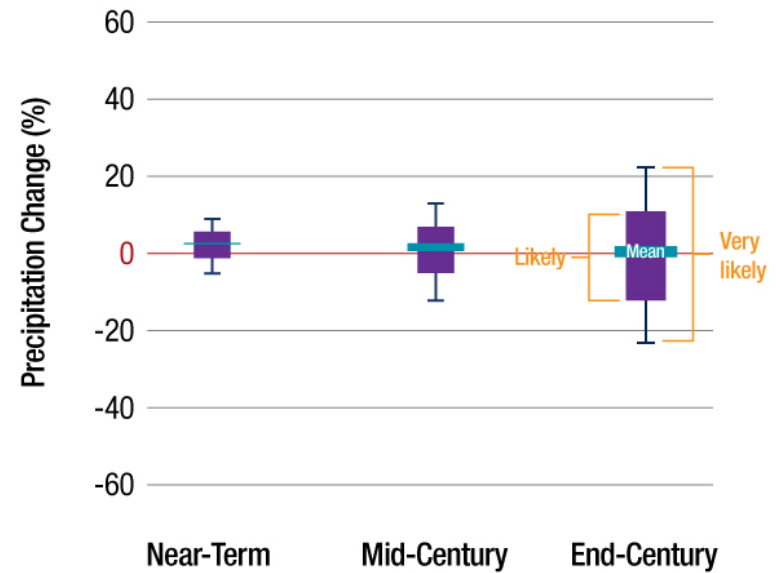
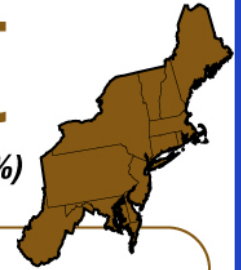
Northeast

Projected Change in Winter Precipitation (%)



Northeast

Projected Change in Summer Precipitation (%)



Ongoing / Future Research



Science agencies, academics, etc. (not FHWA, DOTs)

- **Comprehensive downscaled projections at the local level**
- **Inclusion of natural variability when considering uncertainty associated with these projections**
- **“All-inclusive” local sea level rise estimates**
- **Refining projections of precipitation (i.e., methodology for capturing precipitation events, including precip intensity/ duration/ frequency)**
- **Improve ability to project small scale events (e.g., local thunderstorms)**



How can this information be applied?



- **Can inform planning efforts**
 - Help understand which parts of the planning area may be susceptible to sea level rise, for example
 - Serves as a starting point for discussion of potential future changes
- **Can inform consideration of vulnerability of key assets**
 - Projections by definition are somewhat uncertain
 - Regional projections mask differences within a region
- **Some of the information is too broad / uncertain to make definitive decisions on projects**
- **Use of this information may vary by specialty (e.g., engineering, planning, etc.) and location**