Climate Normals and Climate Change

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What Are Normals?

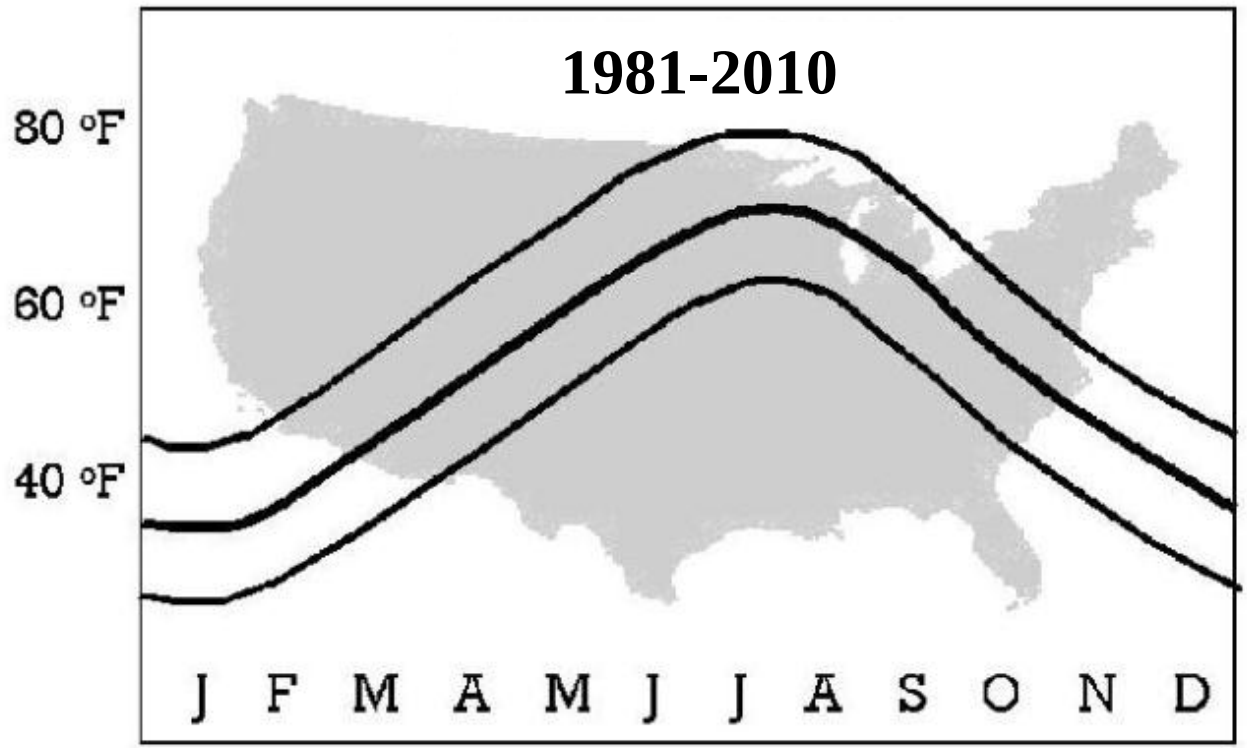
- Generic meaning: Long-term averages
  - Typically computed for a 30-year period
  - One the most fundamental attributes of local climate
  - "Normal" and "climatology" as interchangeable terms
- U.S. meaning: A popular NOAA/NCDC product
  - Congressional mandate (Organic Act, 1890):

    "… to record the climatic conditions of the United States."
  - Updated once per decade

How Are They Used?

- Used in many sectors
  - Builders, insurers, and engineers (planning/risk management)
  - Energy companies (to predict demand)
  - Regulators (to set utility rates)
  - Farmers (crop selection and planting schedules)
  - TV (weather segments, improve ratings)
- Also used by government
  - NWS (put current events in historical perspective)
  - NCDC (climate monitoring)

United States Climate Normals



1981-2010 Station Portfolio

Normals Period	Temperature Stations	Precipitation Stations
1921-1950	388	388
1931-1960	3656	3656
1941-1970	3145	4928
1951-1980	3349	5506
1961-1990	4775	6662
1971-2000	5556	7926
1981-2010	7501	9307

Also, hourly normals for 262 first-order stations. Elements include temperature, dew point, wind, degree hours, heat index, wind chill...

1981-2010 Product Portfolio

Category	Parameter	Daily	Monthly	Seasonal	Annual
Averages	Temperature	✓	✓	✓	✓
	Degree Days	✓	✓	✓	✓
	Precipitation	*	✓	✓	✓
	Snowfall	*	✓	✓	✓
Standard Deviations	Temperature	✓	✓		
Frequencies of threshold exceedance	Temperature		✓	✓	✓
	Precipitation	✓	✓	✓	✓
	Snowfall	✓	✓	✓	✓
	Snow Depth	✓	✓	✓	✓
Percentiles	Precipitation	✓	✓		
	Snowfall	✓	✓		
	Snow Depth	✓			

Chicago Midway Airport

Variable	J	F	M	A	M	J	J	A	S	O	N	D	Ann
Tmax	31.5	35.8	46.8	59.2	70.2	79.9	84.2	82.1	75.3	62.8	48.6	35.3	**59.4**
Tavg	24.8	28.7	38.8	50.4	60.9	71.0	75.9	74.1	66.4	54.2	41.5	29.0	**51.4**
Tmin	18.2	21.7	30.9	41.7	51.6	62.1	67.5	66.2	57.5	45.7	34.5	22.7	**43.5**
DTR	13.3	14.0	15.9	17.5	18.6	17.8	16.7	15.9	17.8	17.1	14.1	12.6	**16.0**
Precipitation	2.06	1.94	2.72	3.64	4.13	4.06	4.01	3.99	3.31	3.24	3.42	2.57	**39.09**
Snowfall	11.5	9.1	5.4	1.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3	8.7	**37.1**
HDD	1245	1015	812	448	188	31	1	4	77	349	704	1116	**5989**
CDD	0	0	1	12	61	210	338	288	119	16	0	0	**1045**

Chicago Midway Airport

Variable	J	F	M	A	M	J	J	A	S	O	N	D	Ann
Days on which Tmax ≥ 90°F	0	0	0	0	0.6	3.1	6.3	3.8	1.2	0	0	0	**15.1**
Days on which Tmax ≥ 70°F	0	0.1	1.5	5.5	15.2	25.8	30.2	29.9	21.2	7.8	1.0	0	**138.2**
Days on which Tmax ≥ 50°F	1.4	2.9	10.6	23.5	30.5	30.0	31.0	31.0	30.0	28.1	13.1	2.9	**235.0**
Days on which Tmin ≤ 50°F	31.0	28.0	30.1	25.8	14.6	1.3	0	0.2	5.0	21.8	28.2	30.8	**216.8**
Days on which Tmin ≤ 32°F	27.1	23.2	17.2	3.3	0.1	0	0	0	0	1.1	12.0	24.3	**108.3**
Days on which Tmin ≤ 0°F	3.0	1.1	0	0	0	0	0	0	0	0	0	1.1	**5.2**

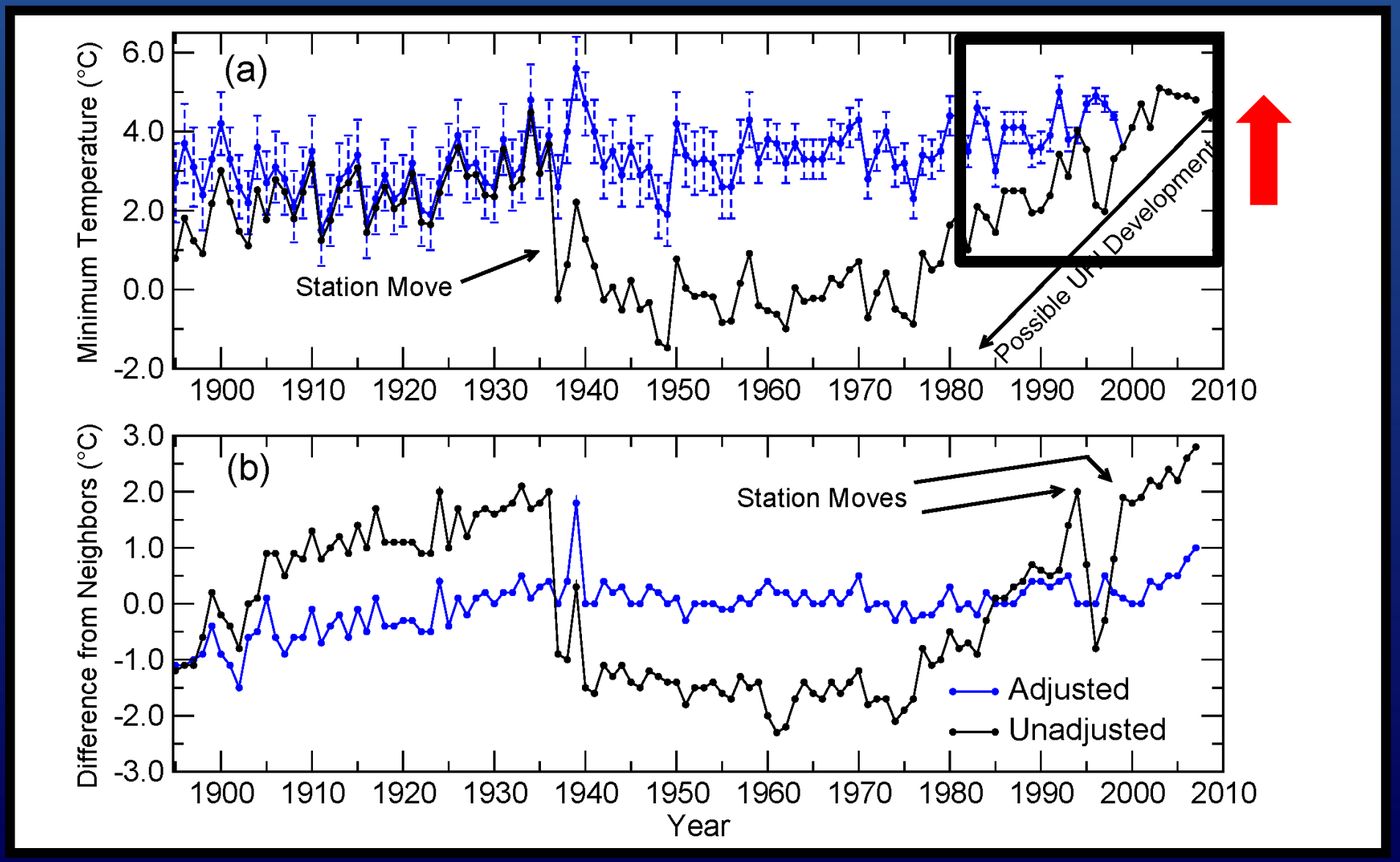
Chicago Midway Airport

Variable	J	F	M	A	M	J	J	A	S	O	N	D	Ann
Days on which Prec ≥ 0.01"	10.7	8.8	11.2	11.1	11.4	10.3	9.9	9.0	8.2	10.2	11.2	11.1	**123.1**
Days on which Prec ≥ 0.1"	5.0	4.5	6.1	7.1	7.6	6.5	6.5	6.3	5.3	6.1	6.2	5.3	**72.5**
Days on which Prec ≥ 0.5"	1.2	1.1	1.7	2.5	2.8	2.7	2.8	2.7	2.1	2.2	2.2	1.4	**25.4**
Days on which Prec ≥ 1"	0.2	0.2	0.3	0.9	1.0	1.3	1.0	1.3	0.7	0.8	0.8	0.5	**9.0**
Days on which Snowfall ≥ 0.1"	8.1	5.5	3.8	0.7	0.0	0.0	0.0	0.0	0.0	0.1	1.8	6.7	**26.7**
Days on which Snowfall ≥ 1"	3.7	2.8	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.6	**11.4**

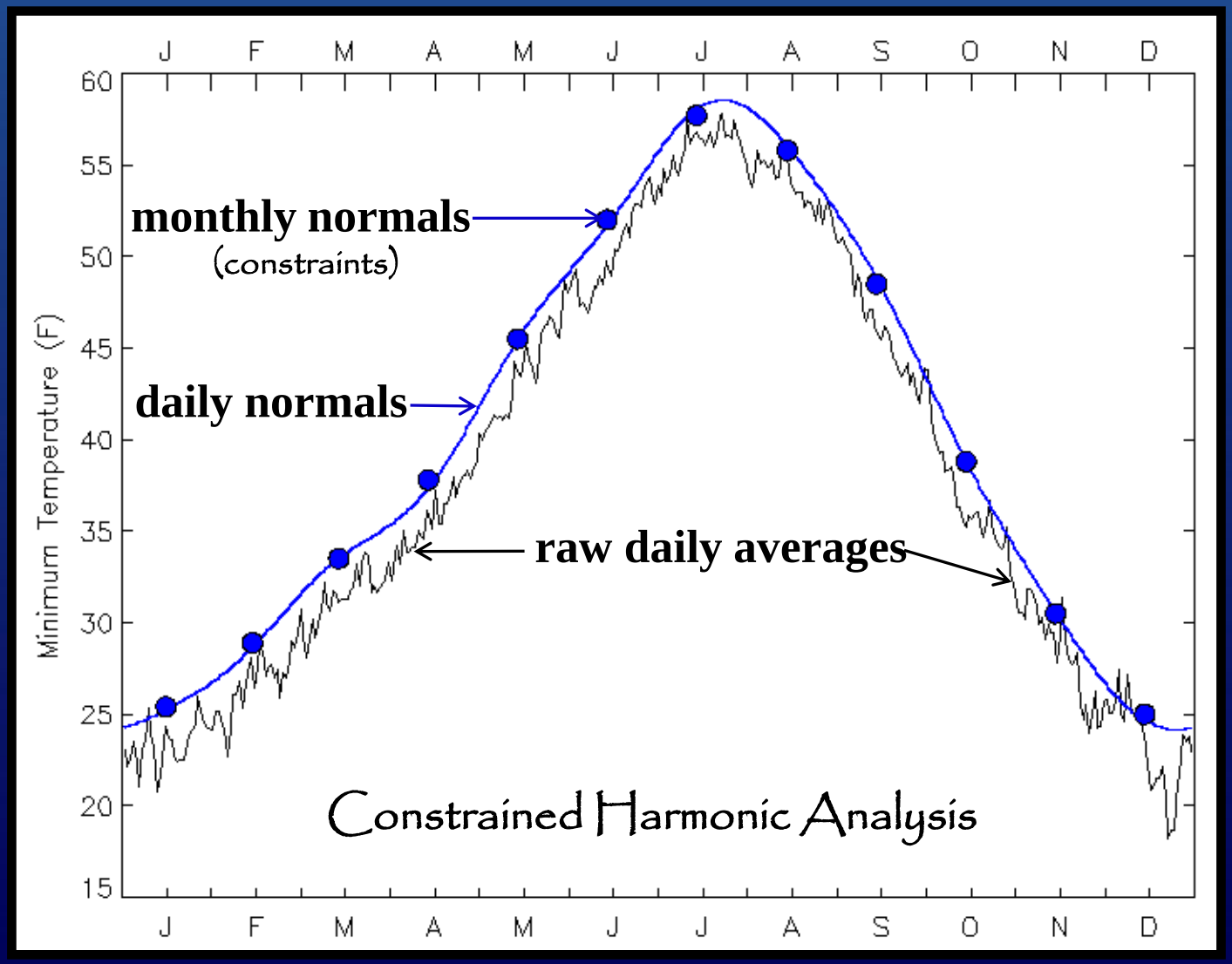
How Have They Changed over Time?

- 1981-2010 vs. 1971-2000
- There certainly are differences
- Climate change is the big player
- But there are non-climatic effects as well
  - Changes in station siting and instrumentation
  - Changes in Normals methodology

Data Rehabilitation: Reno, Nevada



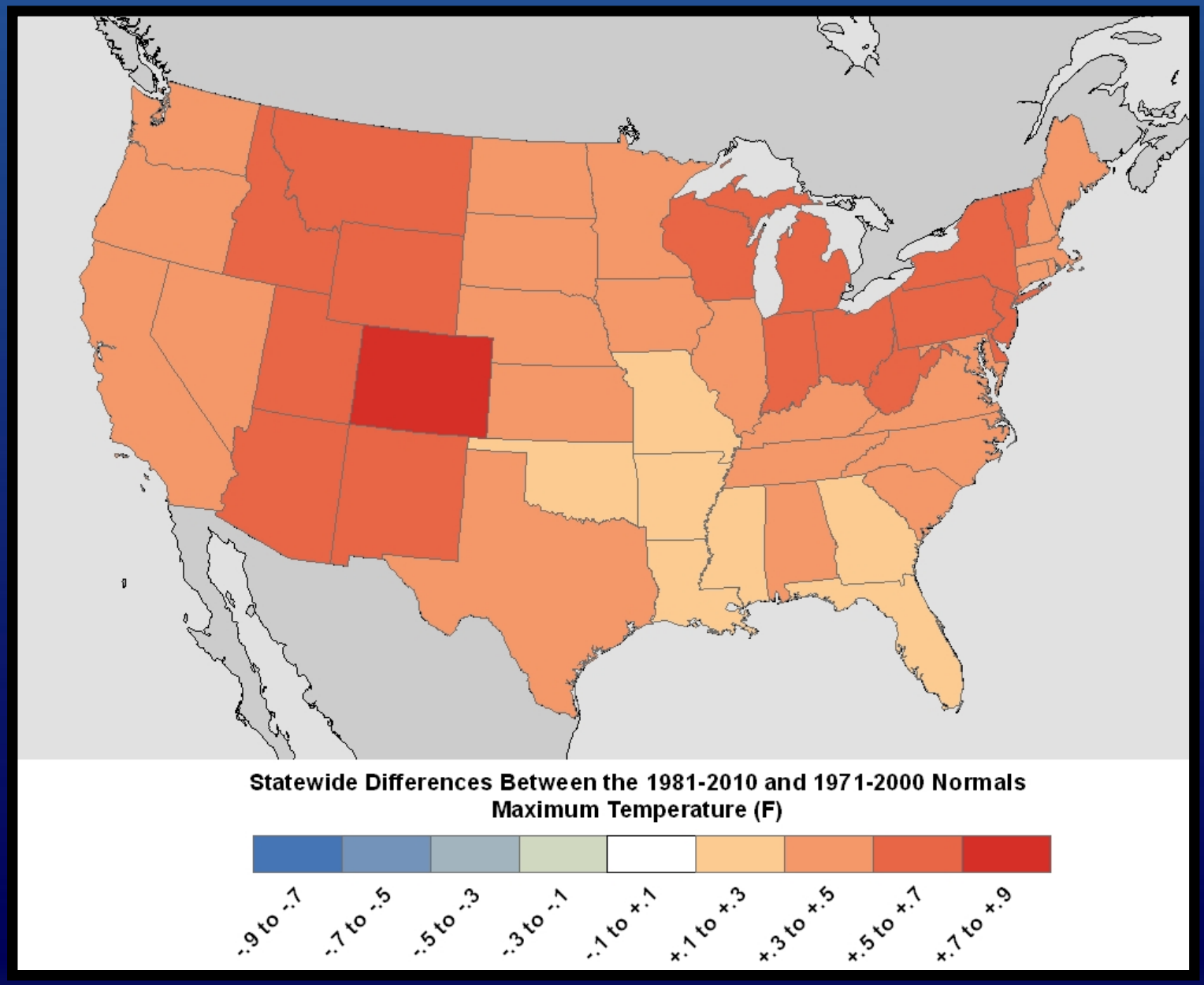
Data Rehabilitation: Reno, Nevada



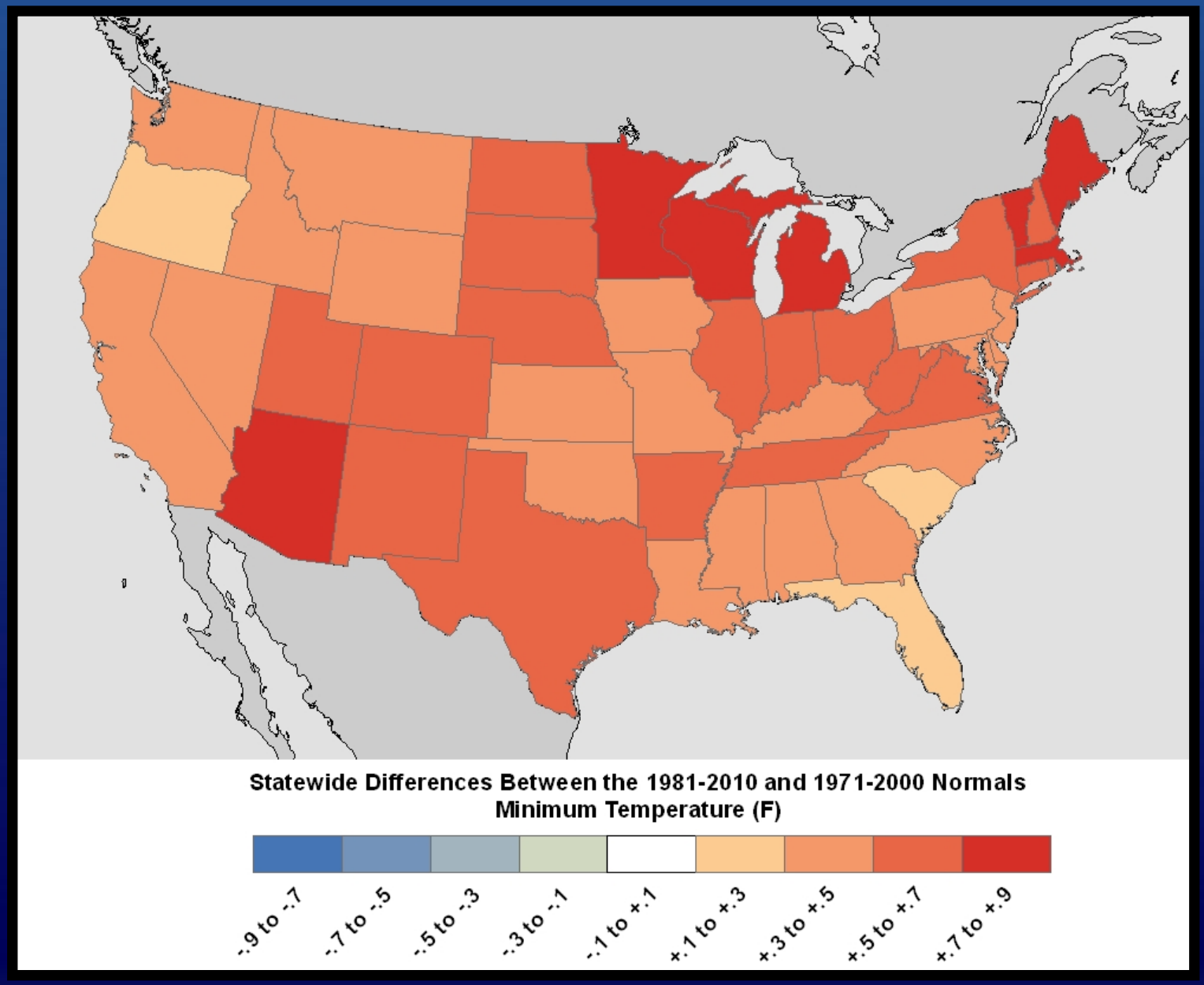
How Have They Changed over Time?

- Again, climate change is the big player
- Temperature
  - 1971-2000 Normals included the cooler ‘70s
  - 1981-2010 Normals dropped the ‘70s, added the warmer ‘00s
  - So the New Normals are warmer in most areas
- Precipitation
  - Changes are more complicated

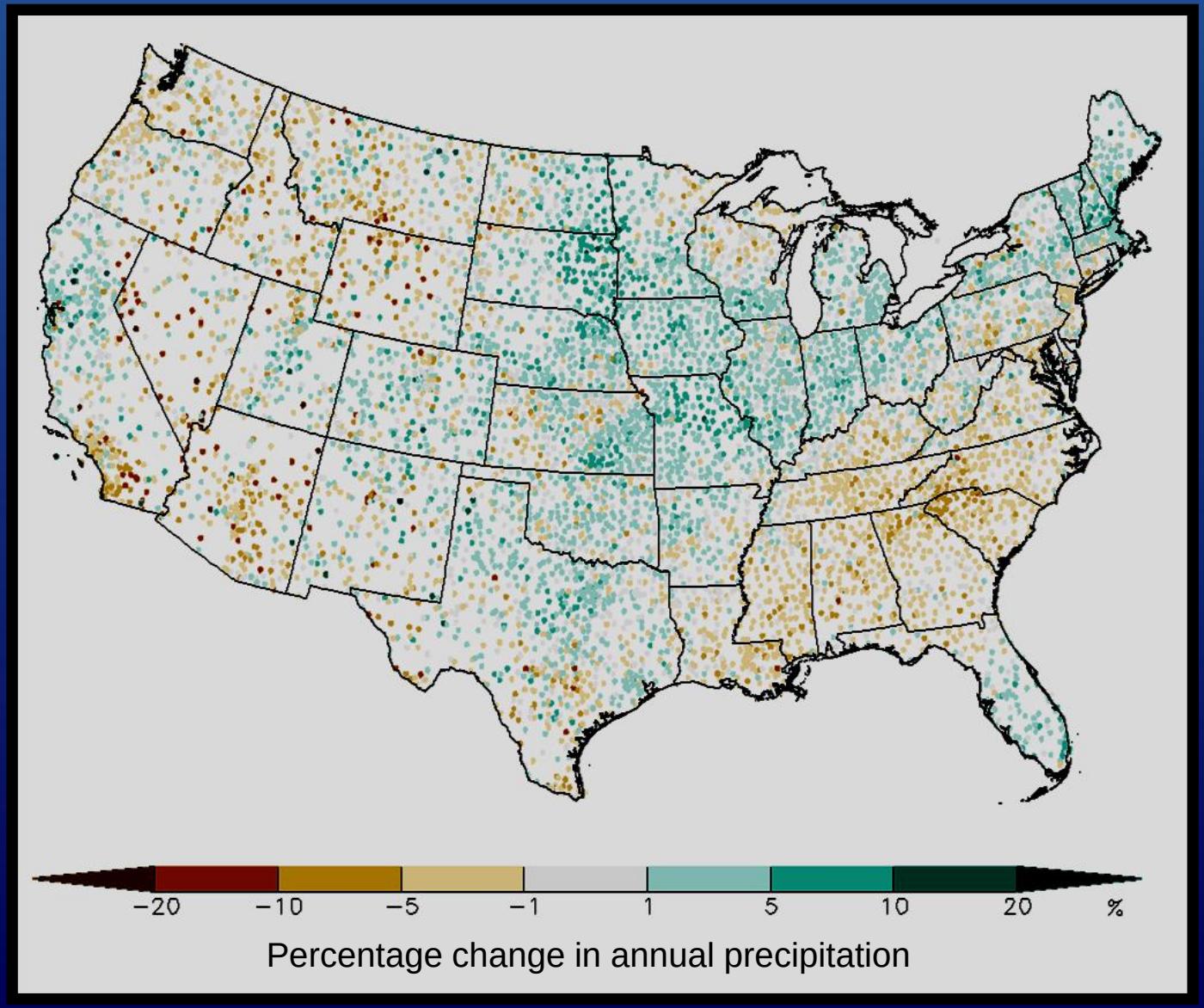
Maximum Temperature



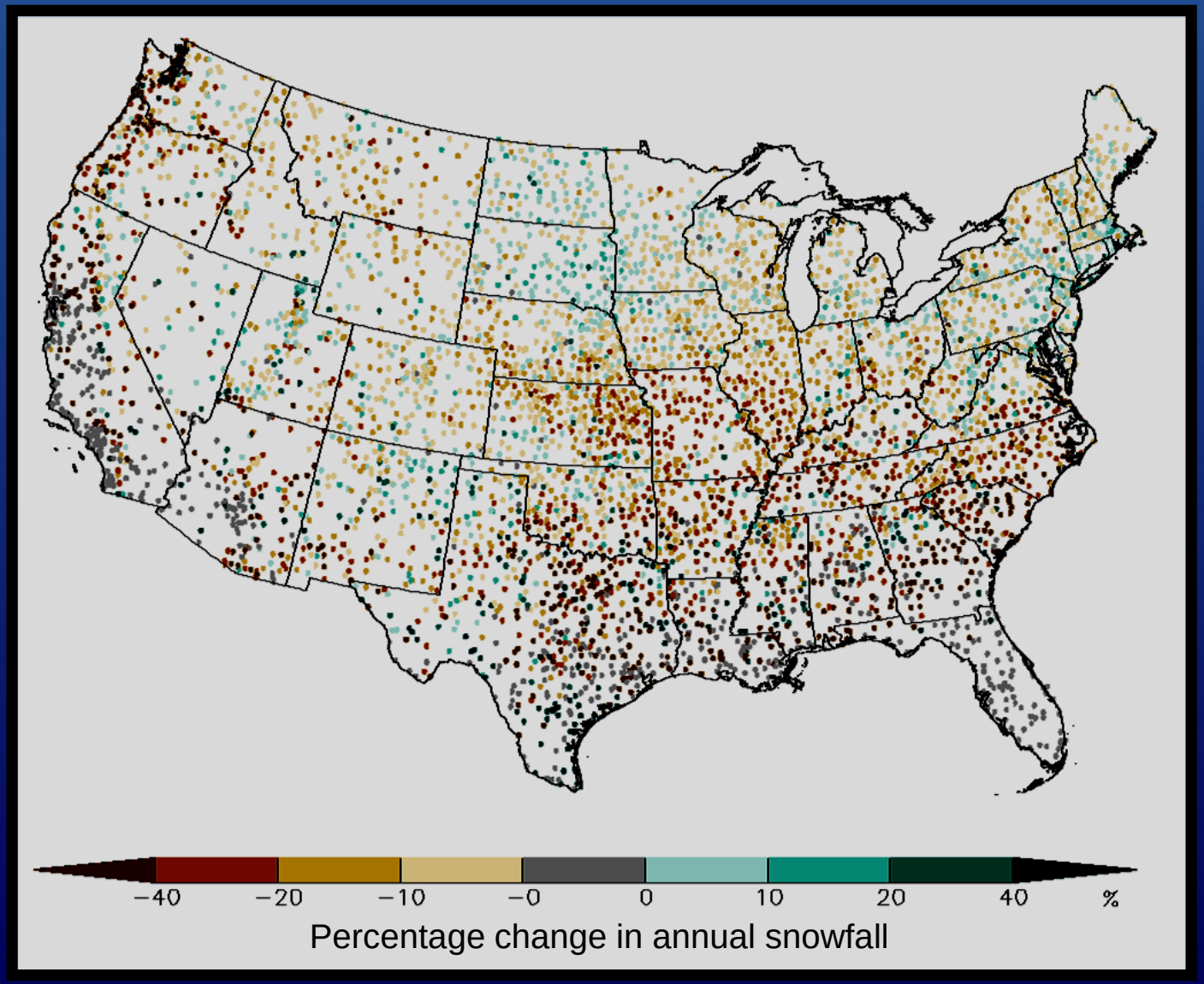
Minimum Temperature



Precipitation



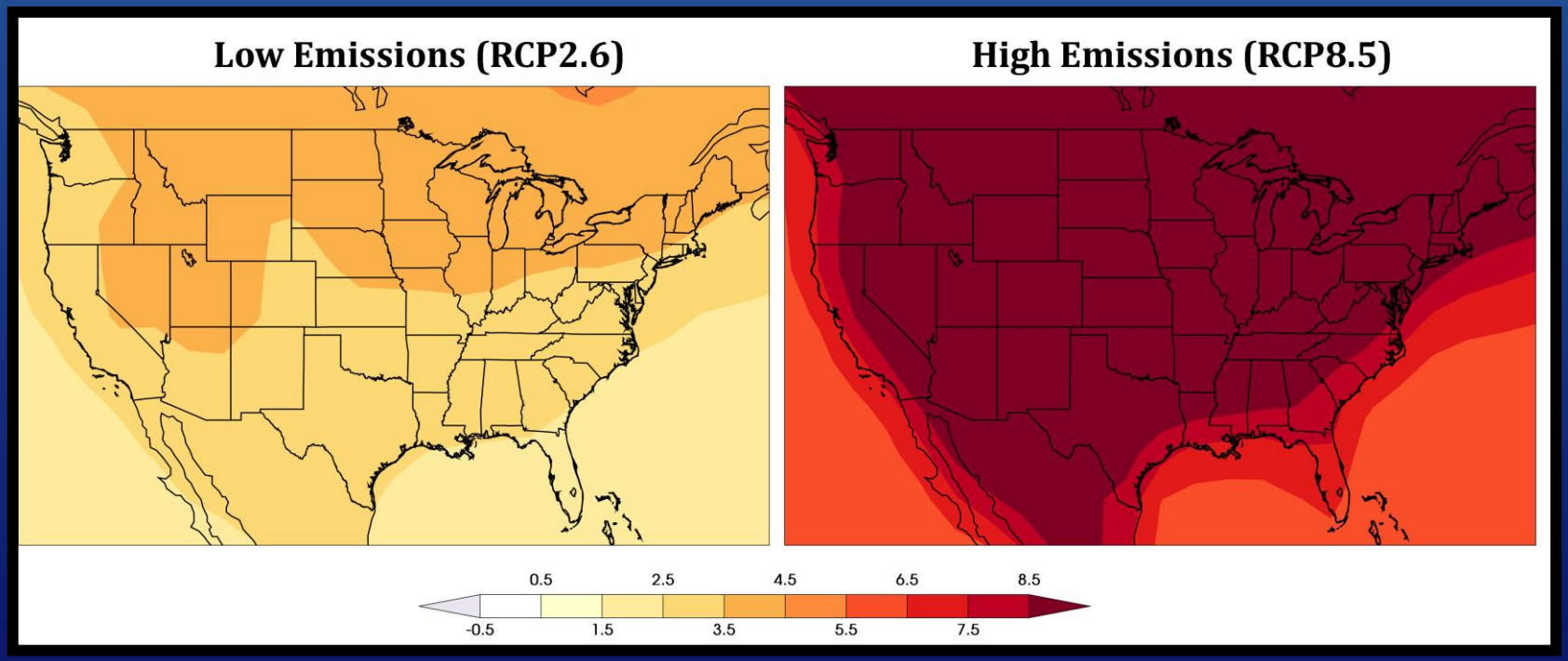
Snowfall



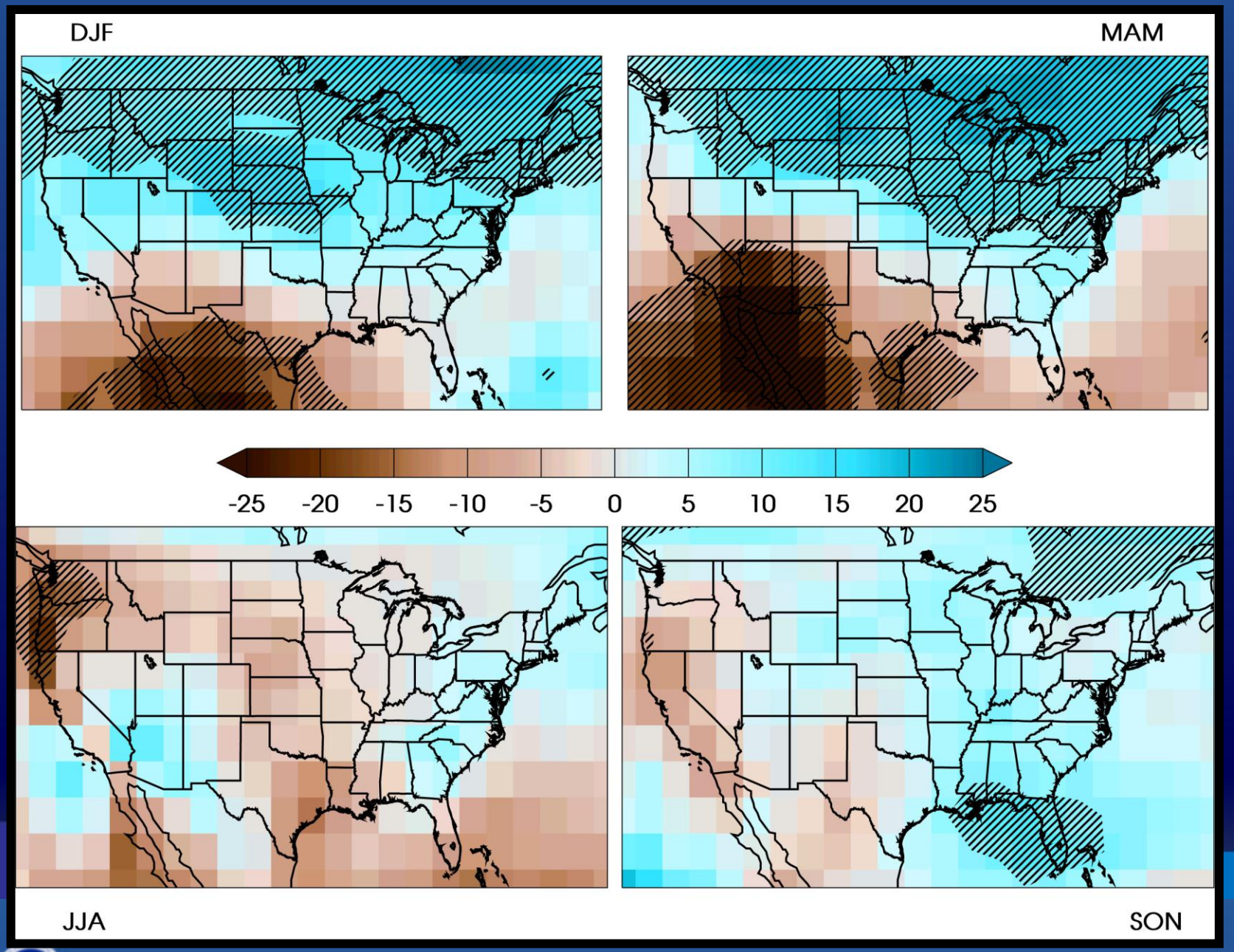
What about the Future?

- Temperature increases projected for most areas
- Changes in precipitation are also projected:
  - Increases in the north
  - Decreases in the south
  - More confidence in changes in winter and spring
- Are 30-year normals still sufficient for most users?

Future U.S. Temperature



Future U.S. Precipitation



Exploring Alternatives

- Rolling 30-year averages (vs. decadal releases)
- Shorter averaging periods (e.g., 10 years)
- Hinge-fit and other statistical approaches
- Normals informed by climate model projections
- Normals based upon other data sources (e.g., CDRs)
- Bottom line: engage users to determine their needs – e.g., Workshop on Alternative Climate Normals and Impacts to the Energy Industry (April 2012)

Remote Sensing CDRs and in situ Data

- Remote sensing and in situ data can compliment each other
- Differences in spatial and temporal resolution
- Combining or comparing climate variables
  - NDVI vs. temperature and precipitation
  - IR skin temperature vs. air temperature
- Extremes; rare events in space and time
- User engagement