DELAWARE CLIMATE PROJECTIONS: METHODS AND FINDINGS

Using statistical downscaling to develop statewide climate projection data

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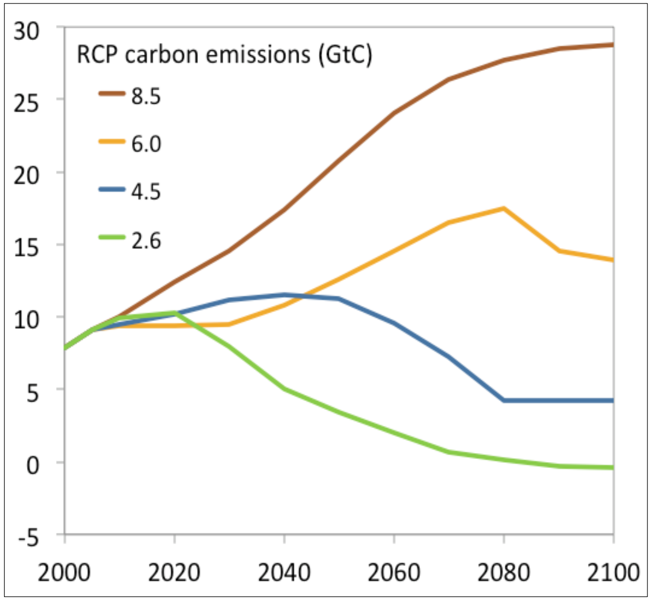
Choice of methodology and consultant

Drs. Katharine Hayhoe, Anne Stoner, and Rodica Gelca
ATMOS Research & Consulting

- Nationally-known atmospheric scientists
- Methodology used in downscaling projections for National Climate Assessment and other states/regions
- Use of both CMIP3 and CMIP5 global climate models
- Wide selection of climate indicators
- Coordination with state climatologist

Scenarios, Models, and Method



IPCC: 2010 Representative Concentration Pathways (RCP)

SCENARIOS

- We selected two scenarios: higher (RCP 8.5) and lower (RCP 4.5), for a time frame through 2100

MODELS

- Climate projections were based on simulations from four CMIP3 global climate models and nine CMIP5 global climate models

METHOD

- Statistical Asynchronous Regional Regression Model (ARRM)

Climate Indicators

- Analysis used observed weather data from 14 individual long-term weather stations in Delaware
- Indicators for temperature, precipitation, and secondary indicators - relative humidity, heat index, and potential evapotranspiration – 155 total
- Indicators generally grouped by averages and extremes

Climate Indicators

TEMPERATURE INDICATORS

Average Temperature Indicators:

- Maximum Temperatures
- Minimum Temperatures
- Average Temperatures
- Temperature Range

Extreme Temperature Indicators:

- Cold nights (min. $<20^{\circ}$F and $<32\ ^{\circ}$F)
- Hot days (max. > 90,95,100,105°F)
- Warm nights (min. > 80, 85, 90 $^{\circ}$F)
- Heat wave events of 4+ days

Other Temperature Indicators:

- Growing Season
- Energy-Related Temperature Indicators

PRECIPITATION INDICATORS

Average Precipitation Indicators:

- Average Precipitation
- Cumulative precipitation for 3-, 6-, and 12 Month averages

Extreme Precipitation Indicators:

- Precipitation Intensity
- Heavy precipitation days (> 0.5, 1,2,3,4,5,6,7,8 inches in 24 hours)
- Amount of precipitation in wettest events
- Dry Days, dry periods

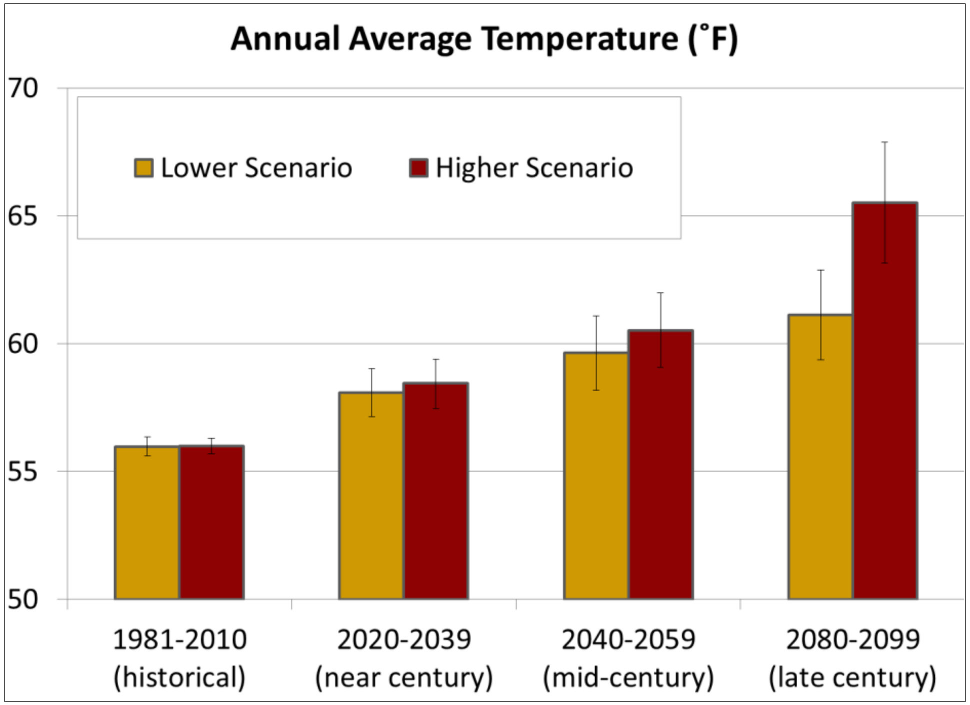
Humidity Hybrid Indicators

- Dewpoint Indicators
- Relative Humidity
- Heat Indices
- Potential Evapotranspiration

TEMPERATURE

AVERAGES AND EXTREMES

Averages: Continued increase in temperatures

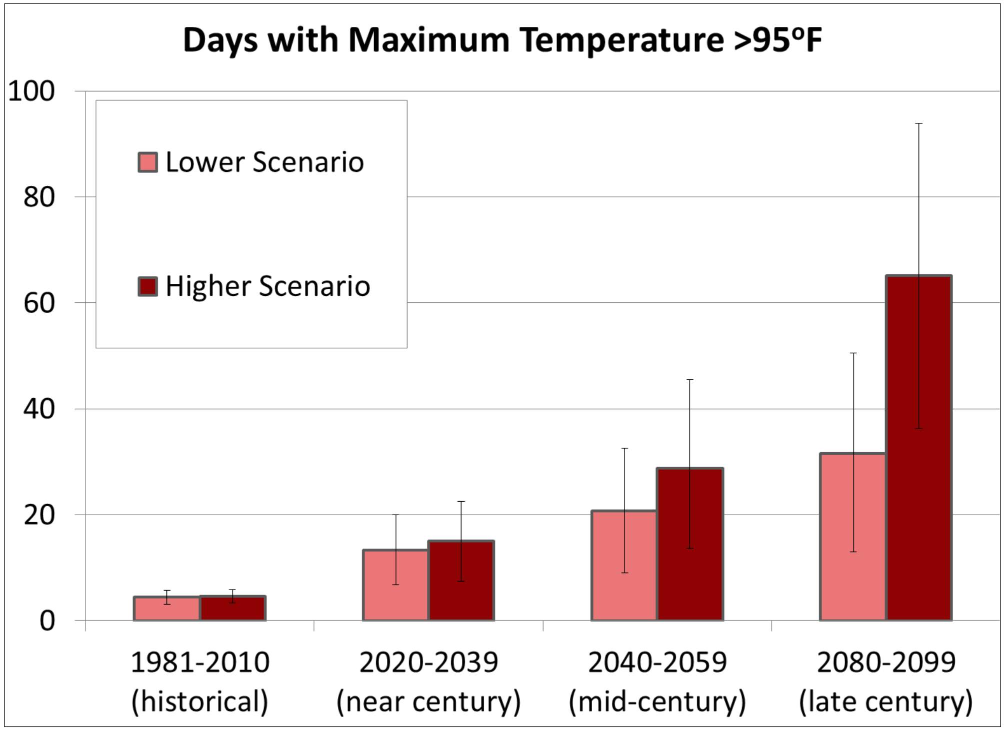


Source: Hayhoe, Stoner, Gelca (2013)

Annual and seasonal temperatures are projected to increase, with slightly greater increases in summer as compared to winter

Extremes: More days exceeding threshold values

Extreme heat days and heat waves are becoming more frequent; extreme cold, less frequent

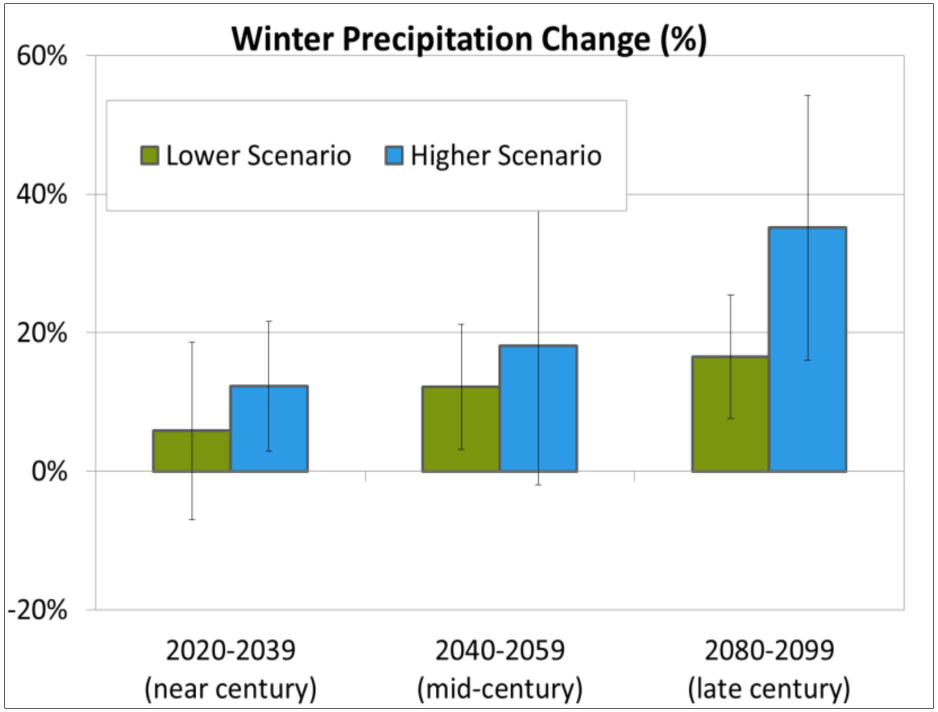


Source: Hayhoe, Stoner, Gelca (2013)

PRECIPITATION

AVERAGES AND EXTREMES

Averages: Annual precipitation increases

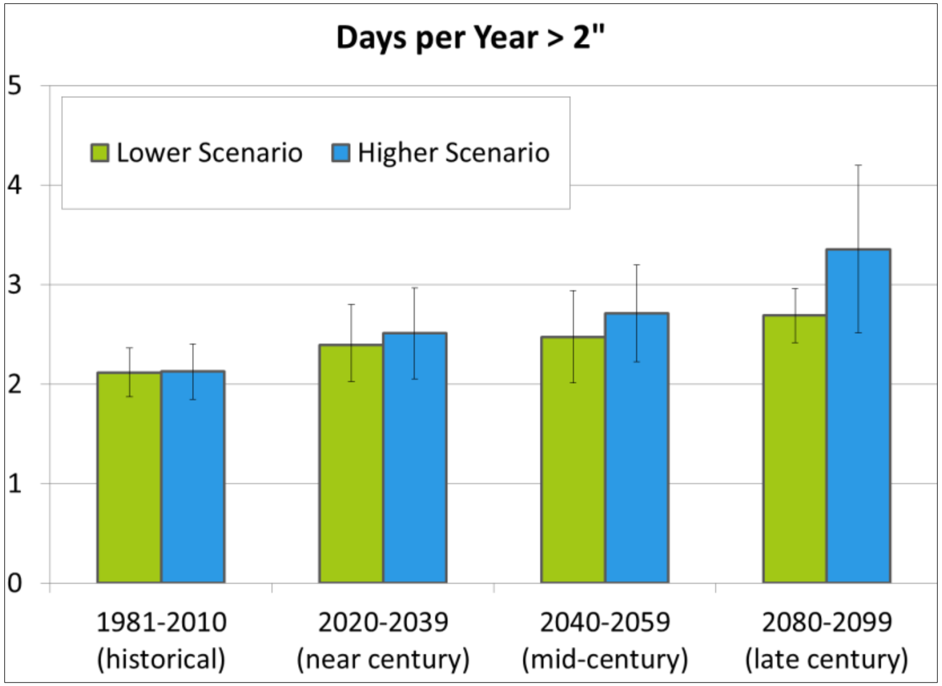


Source: Hayhoe, Stoner, Gelca (2013)

Annual precipitation projected to increase, mostly due to changes in winter and fall.

Extremes: Days of heavy precipitation increase

Heavy precipitation expected to become more frequent as precipitation becomes more intense.

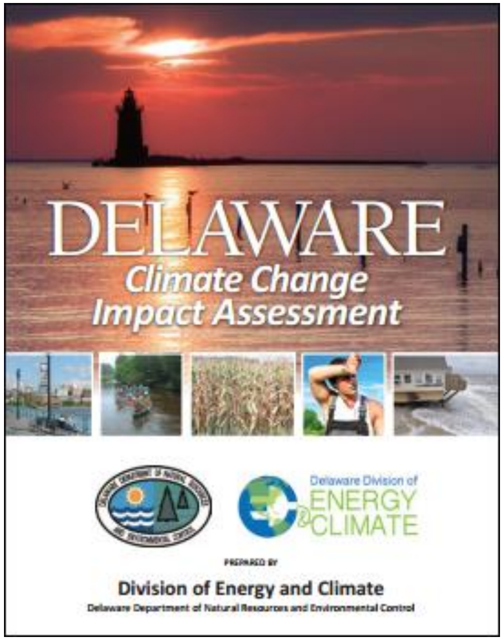


Source: Hayhoe, Stoner, Gelca (2013)

Making the data available

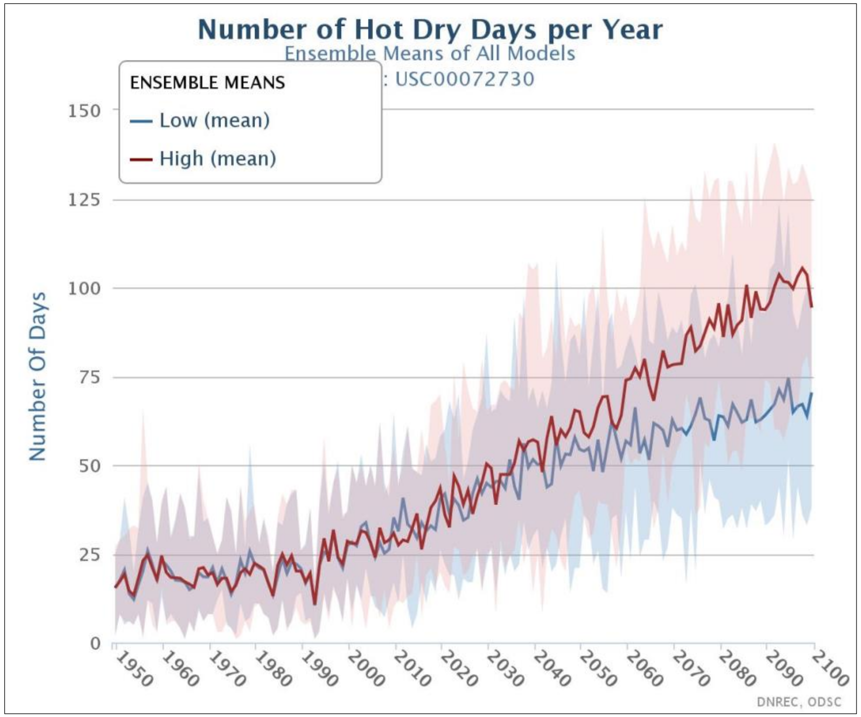
Delaware Climate Change Impact Assessment

http://www.dnrec.delaware.gov/energy/Pages/The-Delaware-Climate-Impact-Assessment.aspx



Delaware Climate Projections Portal

http://climate.udel.edu/declimateprojections/



Implications for Water Resources

Increased temperature		*Increased precipitation intensity*
Increased water demand for irrigation, power generation, and domestic use due to higher summer temperatures		Peak flows **exceeding capacity of wastewater and stormwater systems** during extreme rain events
Higher water temperatures, leading to reduced dissolved oxygen and poorer water quality		**Contaminated runoff and pollutant transport** due to more frequent flooding
		Changes in timing of seasonal flows, related to more precipitation falling as rain vs. snow

Implications for Nutrient Management

Increased temperatures		*Increased precipitation intensity*
Air quality impacts from ammonia release due to increased volatilization losses of ammonia-N.		Prolonged and intense periods of precipitation will **increase runoff of sediment** and nutrients to surface waters.
Reduced N use efficiency, due to increased volatilization of surface-applied ammonia-based fertilizers or poultry manures.		Extreme rain events increase the risk of **nutrient losses from overflow of manure storage facilities**.
Nitrate leaching from sandy soils as manure organic N will be converted to nitrate-N more quickly and completely in warmer soils.		Application of organic nutrient sources may be delayed or made more difficult in wet conditions following extreme rain events, and may lead to **increased nutrient losses**.