PHYSICAL SCIENCES REPORT, PART 1:
BACKGROUND, MOTIVATION, AND INITIAL EVALUATION OF FUTURE CONDITIONS IN CAMPTON.

S. Miller
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The Fourth National Climate Assessment (Reidmiller *et al.* 2018) includes a chapter on expected climate change in the Northeast United States for the duration of the 21st Century. This report states that "[b]y 2035, and under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6° F (2 °C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone." Reidmiller *et al.* (2018) also state that the instrumental record over the past several decades indicates that "more intense precipitation events have [already] increased the risk of some types of inland floods, particularly in valleys, where people, infrastructure, and agriculture tend to be concentrated. With little redundancy in their infrastructure and, therefore, limited economic resilience, many rural communities have limited ability to cope with climate-related changes."

In addition to economic challenges, the changes in regional climate already observed and the projected changes in climate over the next 80 years increases stresses on human health and well-being. Reidmiller *et al.* (2018) state that "[t]he changing climate of the Northeast…lead[s] to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, higher risk of infectious diseases, lower quality of life, and increased costs associated with healthcare utilization. Health impacts of climate change vary across people and communities of the Northeast and depend on social, socioeconomic, demographic, and societal factors; community adaptation efforts; and underlying individual vulnerability."

While some individuals and organized groups have tried to claim that the climatic changes observed over the past century are entirely natural, this assertion is not supported by direct and rigorous scientific investigation. The Intergovernmental Panel on Climate Change Fifth Assessment (2014) states plainly that "[h]uman influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems" (IPCC 2014).

Several professional organizations, representing the community of climate scientists across the globe, have also made their positions on climate change quite clear. For example, the U.S. National Academies of Sciences states that "[s]cientists have known for some time, from multiple lines of evidence, that humans are changing Earth's climate, primarily through greenhouse gas emissions… The evidence is clear and compelling. Earth's atmosphere and oceans are warming, the magnitude and frequency of extreme climate and weather events are increasing, and sea level is rising along our coasts. Climate change is [already] having significant effects on infrastructure, agriculture, fisheries, public health, and the ecosystems that support society. It is also changing the environment in ways that affect the distribution, diversity, and long-term survival of species of plants, animals, and other forms of life on Earth" (NAS 2020). Another example is the American Geophysical Union, which states that this warrants "immediate and coordinated actions to limit and adapt to human-caused climate change…to protect human and ecological health, economic well-being, and global security" (AGU 2019). Thus, climate change represents not only the primary effects of increasing mean temperatures and changes in precipitation patterns (detailed below), but also creates a plethora of secondary effects involving the health and well-being of humans, their communities, and wildlife.

Waiting for regional climate change to reach crisis levels before taking adaptation measures is not a cost-effective strategy. This is akin to waiting for a building to catch fire before purchasing an insurance policy or hiring a fire department. To this end, Vogel *et al.* (2016) detail climate change adaptation efforts already underway in 17 different communities across the United States (ranging in size from small towns to large cities, such as Boston). One such community is Dover, New Hampshire, which has adopted a highly-detailed and proactive adaptation plan as part of the city's 2018 master plan (Peterman and Coauthors 2018). Vogel *et al.* (2016) includes the following summary recommendations for community-level adaptation, based on an integration of the best practices already in use.

Communities should:

- *Start getting ready now.*
- *Look for co-benefits, cross-sector leveraging, and opportunities to "piggyback" climate adaptation onto other relevant community issues.*
- *Employ commonly used policy tools to mainstream adaptation.*
- *Build flexibility into policies, projects, and programs.*
- *Consider both the needs and capabilities of more vulnerable populations.*
- *Creative outreach and community engagement efforts build community support.*
- *Take prudent risks and adjust over time.*
- *Consider the local (cultural) context.*
- *Provide leadership.*
- *Work with partners.*

For a detailed review of Vogel *et al.* (2016), including further discussion of the underlying climate science and the implications for community development objectives, see Miller (2019).

While it is not the purpose of this report to repeat the extensive content of the Reidmiller *et al.* (2018), the many peer-reviewed scientific publications referenced by their report, or the other documents referenced here, this section will attempt to summarize the expected climatic changes relative to Campton, located in central New Hampshire, for the period beginning in 2020 and ending in approximately 2040. Later sections of this report will address several secondary effects of the expected changes in temperature and precipitation during this period.

Insensitivity to emissions scenario. Bryan *et al.* (2015), in their literature review, state that warming of the climate will continue through the 21st Century, even if all anthropogenic greenhouse gas (GHG) emissions were to cease immediately. This is the result of the long residence time of carbon dioxide in Earth's atmosphere, which is on the order of 1000 years.

With continuing emissions, the amount of warming beyond mid-century is dependent on the emissions scenario (Nakicenovic *et al.* 2000), but prior to that, particularly in the period from 2020 through 2040, the differences between the amount of warming under different emissions scenarios is small. Figure 1 (below), reproduced from Bryan *et al.* (2015), shows the expected mean temperature in Maine through the 21st Century for the winter and summer seasons. (Their research domain included a large portion of the northeastern United States, and they use Maine to demonstrate the expected warming in New England.) The figure clearly shows that the differences in warming associated with different GHG emission scenarios do not become important until the very end of this report's period of interest.

Bryan *et al.* (2015) report similar results for precipitation: Changes in regional precipitation totals, in inches of liquid equivalent per day, are relatively insensitive to assumptions about emissions until after the end of our period of interest.

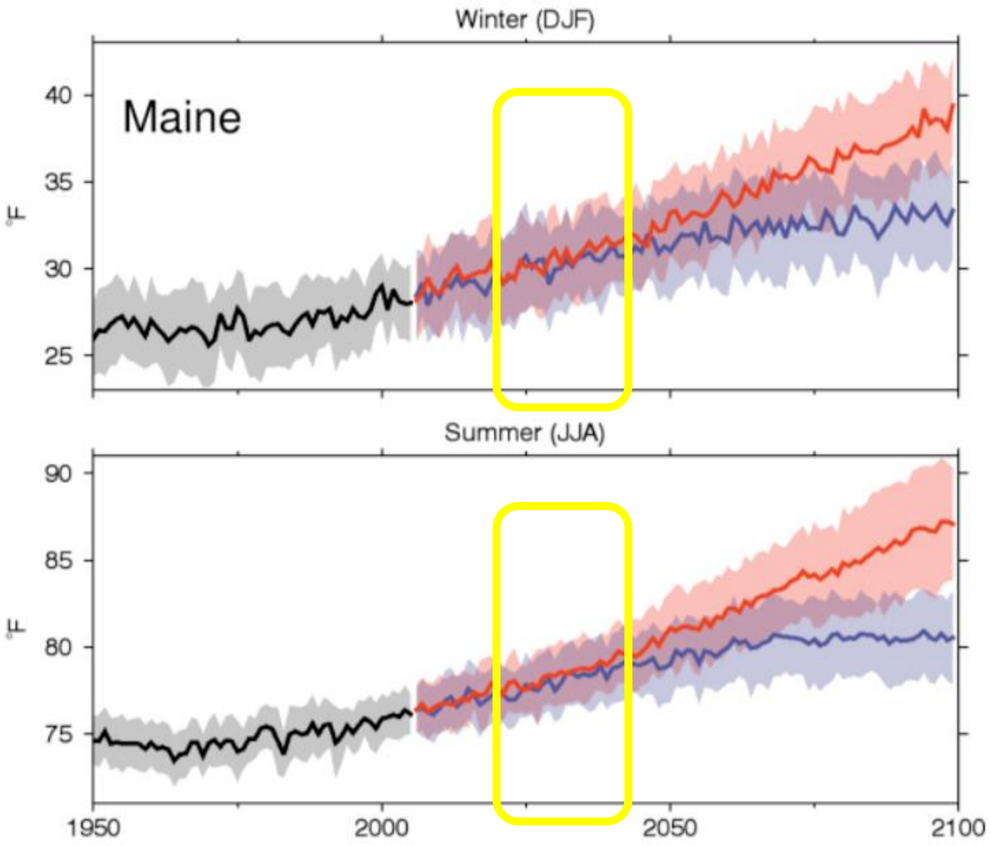

Fig. 1: Average seasonal temperatures in the Northeast United States, under different emission scenarios. Horizontal axis is year; vertical axis is temperature. Red and blue lines represent high and low emission scenarios, respectively, from a 33-member ensemble of global climate models, downscaled to 800-meter horizontal resolution. Black line corresponds to historical (observed) data. Upper panel: Meteorological Winter (DJF); Lower panel: Meteorological Summer (JJA). Period of interest in this report (2020 - 2040) is indicated by the yellow boxes. (Reproduced from Bryan *et al.* 2015.)

Expected changes in temperature. Bryan *et al.* (2015) state that (based on historical information) annual temperatures in the Northeast have increased by an average of 0.16 °F (0.09 °C) per decade from 1895 through 2011, and that warming has been more pronounced during the winter (0.24 °F/0.13 °C per decade) than the rest of the year during this period. Thibeault and Seth (2014) further state that the historical record indicates that *minimum* temperatures in the Northeast are warming more rapidly than *maximum* temperatures, consistent with observed changes seen around the world.

Scherer and Diffenbaugh (2014) utilized a multi-member ensemble of global climate models to evaluate the changes in temperature in different regions of the United States expected with climate change. They computed Baseline (BL) median temperatures at each gridpoint, along with the distribution of daily median temperature values about the average daily median temperature. This was accomplished for both annual and seasonal values, based on the historical observations of temperature for the 30-yr period beginning in 1980 and ending in 2009. Next, they define two metrics (both of which are illustrated in Figure 2):

- *Permanent Exceedance (PE)*: The *minimum* value of the new daily median temperature distribution in a region is equal to the *average* daily median value of the old BL temperature distribution. In a warming climate, this benchmark would occur first.

- *New Normal (NN)*: The *average* value of the new daily median temperature distribution in a region is equal to the *maximum* daily median value of the old BL temperature distribution. In a warming climate, this benchmark would occur after PE.

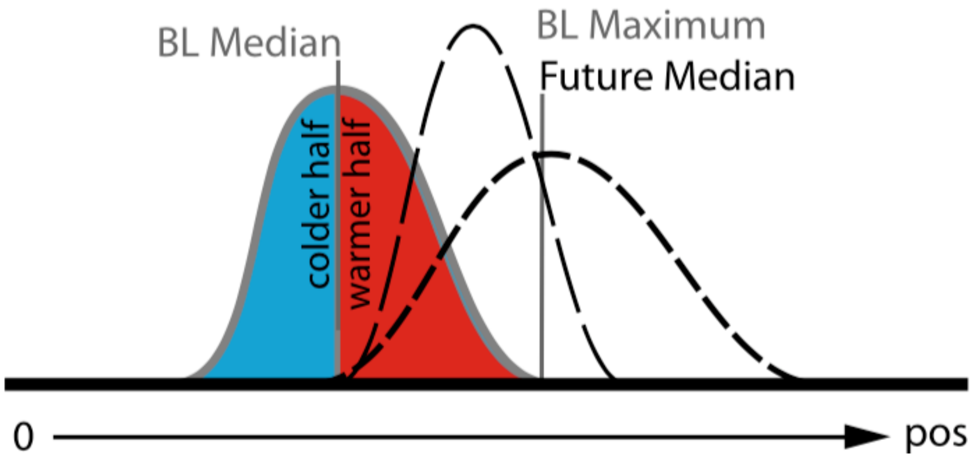

Fig. 2: Increases in median temperature, and distribution about the median. BL = Baseline (median and distribution; 1980 – 2009). Thin dashed line = Permanent Exceedance (PE). Heavy dashed line = New Normal (NN). (Adapted from Scherer and Diffenbaugh 2014.)

Scherer and Diffenbaugh (2014) report the following relevant findings for the Northeast:

- For maximum daily temperatures, PE is expected by 2030. This means that the new *lowest* daily maximum temperature will be equal to the *median* daily maximum temperature in the historical BL period by then.

- They also expect NN for daily maximum temperatures by 2040, the end of our period of interest. This means that the new *median* daily maximum temperature will be equal to the *maximum* daily maximum in the historical BL period of 1980 - 2009.

Both of these benchmarks indicate a significant upward daily shift in daily high temperatures, and both fall within the high-confidence, emissions-independent period discussed in Bryan *et al.* (2015). This means that both PE by 2030 and NN by 2040 can be taken with high confidence, and that we can expect an increase in the incidence of heat waves and the resulting toll on human health in Campton within 20 years.

Karmalkar and Bradley (2017) also used downscaled global model simulations to estimate regional warming in the United States. Their work utilized a threshold-based approach, producing the amount of warming (in degrees Celsius) by period. They find that, while all regions of the contiguous United States are warming faster than the global rate, the Northeast region is warming the fastest. Relevant to this report's period of interest, Karmalkar and Bradley (2017) report that the Northeast will warm by 5.4 °F (3 °C) by 2039, relative to pre-industrial times, while the rest of the world warms by an average of 3.6 °F (2 °C). This is somewhat higher than the Northeast warming estimate reported in Bryan *et al.* (2015), which is 3.6° F (2 °C) by 2035.

Fan *et al.* (2015) used an ensemble of regional climate models, forced by global climate models, as part of the North American Regional Climate Change Assessment Program (NARCCAP), to develop projections of future temperature and precipitation changes in the Northeast United States[1]. They based their work on a baseline period of historical observations spanning the years 1961 – 1990, and report that, by the period beginning in 2041 (the end of this report's period of interest) and ending in 2070:

- Ensemble-average temperature increases in *winter* in the Northeast will be 5.8 °F (3.2 °C).
- Ensemble-average temperature increases in *summer* in the Northeast will be 4.5 °F (2.5 °C), with increased variability.

In both cases, the projected increases in temperature far exceed the estimated natural variability in the region. Thibeault and Seth (2014) also reported that Northeast winters will become milder (warmer), and summers hotter, displaying statistically significant shifts outside their current ranges. This echoes the findings of Scherer and Diffenbaugh (2014) for the period 2020 – 2039. Thibeault and Seth (2014), looking further out to the period between 2041 and 2070, found that the resulting warm summer extremes are "likely to impact human populations vulnerable to extreme heat, e.g. young children, the elderly, and people with respiratory illnesses…"

Identifying the historical warming trend. Fryeburg, Maine (ICAO[2] identifier KIZG) has an airport weather station, called an AWOS[3], that records surface weather conditions as often as once every 20 minutes. KIZG is located at 43.99 °N, 70.95°W, at an elevation of 135 meters above sea level (mASL). Plymouth, New Hampshire (K1P1) is located at 43.78 °N, 71.75 °W, at an elevation of 157 mASL. The great-circle distance between these two stations is 68.12 kilometers (42.35 statute miles). Given the short distance between these two stations, their similarity in elevation and other physical geographic factors, and the fact that both stations are in the same U.S. Department of Agriculture Plant Hardiness/Climate zone (5a), it was assumed that KIZG is a reasonable proxy for K1P1.

While K1P1 is relatively close to Campton, it only became operational as recently as 2007. The data from KIZG go back considerably further, and are easily obtainable via the Plymouth State Weather Center database[4]. Given the readily available data for KIZG, and its climatological similarity to K1P1, the

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[1] Their results are valid for the period beyond which the emission scenario is irrelevant (Bryan *et al.* 2015). They assume the A2 emissions scenario, which, according to NARCCAP, "is at the higher end of the SRES emissions scenarios (but not the highest)" (UCAR 2000). For more about the Special Report on Emissions Scenarios (SRES), see Nakicenovic *et al.* (2000).

[2] ICAO = International Civil Aviation Organization

[3] AWOS = Automated Weather Observation System

[4] The Plymouth State Weather Center obtains its base data via a NOAAPort satellite downlink from the National Oceanic and Atmospheric Administration.

following historical statistics (Table 1) are presented for Fryeberg to represent the range of temperature conditions in Campton. The period represented by these statistics begins on 01 January 1999 0000 EST, and ends on 31 December 2019 2300 EST, a period of approximately 21 years (184,080 hours).

Table 1: Bulk temperature statistics for Fryeburg, Maine (KIZG), for 21-yr record of hourly temperatures. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis). Average range is defined as average daily maximum – average daily minimum.

	Average Daily Minimum	Average Daily Median	Average Daily Maximum	Average Range
Annual	33.71 (0.95)	45.64 (7.58)	56.30 (13.50)	22.59 (12.55)
Winter[5]	11.36 (-11.41)	23.50 (-4.72)	32.50 (0.28)	21.14 (11.69)
Summer[6]	54.97 (12.76)	67.01 (19.45)	78.67 (25.93)	23.70 (13.17)

The 21-yr time series of temperature at KIZG was divided into two periods. The first 11 years selected for comparison with Scherer and Diffenbaugh (2014), discussed below; and the second half for comparison to the first.

- The first period spans the period beginning on 01 January 1999 0000 UTC, and ending on 31 December 2009 2300 EST, and includes hourly observations of temperature for 96,432 hours (11 years). Bulk statistics for this period are shown in Table 2.

- The second period spans the period beginning on 01 January 2010 0000 UTC, and ending on 31 December 2019 EST UTC, and includes hourly observations of temperature for 87,648 hours (10 years). Bulk statistics for this period are shown in Table 3.

Table 2: Bulk temperature statistics for Fryeburg, Maine (KIZG), for 11-yr period ending December, 2009. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis). Average range is defined as average daily maximum – average daily minimum.

	Average Daily Minimum	Average Daily Median	Average Daily Maximum	Average Range
Annual	33.21 (0.67)	45.14 (7.30)	55.92 (13.29)	22.71 (12.62)
Winter	10.49 (-11.95)	22.68 (-5.18)	32.05 (0.03)	21.56 (11.98)
Summer	54.84 (12.69)	66.54 (19.19)	78.21 (25.67)	23.37 (12.98)

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[5] Meteorological winter, defined as December, January, and February (DJF).
[6] Meteorological summer, defined as June, July, and August (JJA).

Table 3: Bulk temperature statistics for Fryeburg, Maine (KIZG), for 10-yr period ending December, 2019. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis). Average range is defined as average daily maximum – average daily minimum.

	Average Daily Minimum	Average Daily Median	Average Daily Maximum	Average Range
Annual	34.29 (1.27)	46.99 (8.33)	56.73 (13.74)	22.44 (12.47)
Winter	12.54 (-10.81)	24.42 (-4.21)	33.01 (0.56)	20.47 (11.37)
Summer	55.13 (12.85)	67.53 (19.74)	79.20 (26.22)	24.07 (13.37)

Comparing the results shown in Table 3 to those shown in Table 2, it is clear that, by every measure, the climate in Fryeburg warmed. Table 4 summarizes the differences between the values in Tables 2 and 3, with positive numbers indicating that the values in Table 3 are greater than the values in Table 2. Table 4 indicates average winter minimum temperatures have increased by about twice as much as average annual minimum temperatures, and about six times as much as average summer minimum temperatures, which is in agreement with Fan *et al.'s* (2015) projections that winter is warming at a greater rate than summer. The average range in the summer also increased (while the annual and winter ranges decreased), which is also in good agreement with Fan *et al.* (2015).

Table 4: Differences between bulk temperature statistics for Fryeburg, Maine (KIZG), for the two periods shown in Tables 2 and 3. Positive numbers indicate that the values in Table 3 are greater than those in Table 2. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis).

	Average Daily Minimum Change	Average Daily Median Change	Average Daily Maximum Change	Average Range Change
Annual	1.08 (0.60)	1.85 (1.03)	0.81 (0.45)	-0.27 (-0.15)
Winter	2.05 (1.14)	1.74 (0.97)	0.96 (0.53)	-1.09 (-0.61)
Summer	0.29 (0.16)	0.99 (0.55)	0.99 (0.55)	0.70 (0.39)

Estimating warming through 2040. Three methods were used to estimate temperature changes during the period of interest. The first used linear projections based on the baseline temperatures summarized in Table 3, and the 10-yr changes summarized in Table 4. Using this method, we find the following for our benchmark years:

- By 2030, annually-averaged daily *median* temperatures should increase by another 1.85 °F, to 48.84 °F. Average winter daily *median* temperatures should increase by another 1.74 °F, to 26.16 °F. Average summer daily *median* temperatures should increase by another 0.99 °F, to 68.52 °F.

- By 2040, annually-averaged daily *median* temperatures should increase to 50.69 °F. Winter daily *median* temperatures should increase to 27.90 °F, and summer daily *median* temperatures should increase to 69.51 °F.

Since the Fryeburg temperatures used as a baseline in this method cover a period of only 11 years, rather than the usual 30 (*e.g.* Scherer and Diffenbaugh 2014), and because the records are from the most recent (and therefore warmer) period, there is probably a warm bias in these projections, with a maximum magnitude on the order of about 1 °F.

The second method used Scherer and Diffenbaugh (2014)'s findings about PE and NN for daily maximum temperatures in the Northeast. Table 5 shows bulk statistics for daily maximum temperatures during the period beginning on 01 January 1999 0000 EST, and ending on 31 December 2009 2300 EST (96,432 hours), which we used as our baseline period. Note that this is the same period used to compute the contents of Table 2.

Table 5: Range of daily maximum temperatures for Fryeburg (KIZG) for the 11-yr period ending in December, 2009. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis).

	Minimum Daily Maximum	Median Daily Maximum	Maximum Daily Maximum	Range
Annual	-2.99 (-19.44)	55.99 (13.33)	99.00 (37.22)	101.99 (56.66)
Winter	-2.99 (-19.44)	32.00 (0.00)	69.01 (20.56)	72.00 (40.00)
Summer	48.99 (9.44)	79.00 (26.11)	99.00 (37.22)	50.01 (27.78)

Combining the results shown in Table 5 with Scherer and Diffenbaugh (2014), the following estimates were made for changes in daily *maximum* temperatures in 2030 and 2040:

- 2030: PE for daily maximum temperatures, meaning the new *lowest* daily maximum temperature will be equal to the *median* daily maximum temperature in the historical BL period. For winter, this means the new *lowest* daily *maximum* temperature will be 32 °F, and for summer, 79 °F.

- 2040: NN for daily maximum temperatures, meaning the new *median* daily maximum temperature will be equal to the *maximum* daily maximum in the historical BL period. For winter, this means the new *median* daily *maximum* temperature will be 69 °F, and for summer, 99 °F.

For the same reasons noted in the previous method, there is probably a warm bias in these projections, on the order of about 1 °F.

The third method was based Fan *et al.* (2015)'s ensemble-average model projections that winter temperatures in the Northeast will increase by 5.8 °F (3.2 °C) by the 2041-2070 timeframe, and that summer temperatures will increase by 4.5 °F (2.5 °C), with respect to the 1961-1990 baseline period. To complete this calculation, a record of temperatures recorded in Concord, New Hampshire (KCON) was obtained from Climatologist Barry Keim and his graduate student (Keim and Thompson 2020), and subjected to standard quality-control techniques. This record begins on 01 January 1961 at 0000 EST, and ends on 31 December 1990 at 1800 EST, representing a period of 262,968 hours. There is a three-year long period of missing data beginning in 1970 and ending in 1972. Records are hourly from 1961-1990, once every three hours from 1965-1969, and hourly again beginning in 1973. Concord was deemed a suitable proxy for Plymouth and Campton, because (a) it is 67.99 kilometers (42.15 statute miles) from Plymouth (about the same distance as Fryeburg from Plymouth), and (b) like Fryeburg, it is in the same U.S. Department of Agriculture Plant Hardiness/Climate zone as Plymouth and Campton (5a).

Unlike Fryeburg, however, Concord is at a slightly lower latitude than Plymouth. This results in slightly warmer median and mean temperatures than Plymouth. Comparing more recent records for

Plymouth (K1P1) to Concord (KCON) (for the period between 2007 and 2020), there appears to be a difference in summer *median* temperature between KCON and K1P1 of about 1.98 °F, and a winter *median* difference of about 3.99 °F. In both cases, Concord was the warmer station. A similar comparison of *mean* temperatures indicates that KCON is about 2.54 °F warmer than K1P1 in summer, and 1.78 °F warmer in winter. Table 6 shows the median and mean seasonal temperatures derived from the 1961-1990 Concord record, and Table 7 shows estimated median and mean seasonal temperatures for Plymouth, based on the KCON-K1P1 warm biases noted.

Table 6: Seasonal median and median temperatures for Concord, New Hampshire, for the period 1961-1990. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis).

	Median Temperature	Mean Temperature
Winter	24.00 (-4.44)	22.67 (-5.81)
Summer	68.00 (20.00)	67.71 (19.84)

Table 7: Estimated seasonal median and median temperatures for Plymouth, New Hampshire, for the period 1961-1990, using bias-adjusted data from Concord. Values shown are in degrees Fahrenheit (degrees Celsius in parenthesis).

	Median Temperature	Mean Temperature
Winter	20.01 (-6.66)	20.89 (-6.17)
Summer	66.02 (18.90)	65.17 (18.43)

Combining the results shown in Table 7 with Fan *et al.* (2015), the following estimates were made for changes in seasonal *median* and *mean* temperatures in Plymouth and Campton during the period 2041-2070:

- Winter: *Median* seasonal temperature will increase to 25.81 °F; *Mean* seasonal temperature will increase to 26.69 °F.

- Summer: *Median* seasonal temperature will increase to 70.52 °F; *Mean* seasonal temperature will increase to 69.67 °F.

Expected changes in precipitation. Thibeault and Seth (2014) report that the Northeast has already become wetter, with more frequent extreme precipitation events, than during earlier periods in history. Using a 23-model ensemble, they found that this trend will continue through the 21st Century, with increases in precipitation due to more frequent, intense extreme precipitation events.

Thibeault and Seth (2014) focused their work on the end of our period of interest, with the same temporal window of 2041 – 2070. Compared to their baseline period of 1981 – 2010, they found that increases in total annual precipitation in the Northeast are strongly influenced by increases in *winter* wet extremes. "Projected increases in winter wet extremes are larger than for summer, [and] consistent with projected increases in mean winter precipitation are *triple those of summer*" [emphasis added].

Fan *et al.* (2015) also focused their work on the end of our period of interest, but used a baseline period of hourly precipitation beginning in 1961 and ending in 1990. Further, their results provide specific numbers we can work with to estimate seasonal precipitation amounts for the 30-year period beginning in 2041. Their results indicate a 21 – 23 percent *increase* in winter precipitation, and (unlike Thibeault and Seth (2014)) a 1.5 to 7.9 percent *decrease* in summer precipitation over the baseline period by 2041. Further, their results indicate an increase in the variability of winter precipitation totals of about 1.6 percent.

To apply these results, a database of hourly precipitation amounts in Concord, New Hampshire (KCON), beginning in 1960 and ending in 1999, was obtained from Keim and Thompson (2020). (Once again, Concord was used as a proxy for Plymouth and Campton because of the relatively short distance between them, because they are in the same USDA climate zone, and because a long record of hourly observations at Concord was easily available.) After merging the four separate 10-yr files, removing the extraneous data from both before and after the baseline period, and applying quality control procedures, winter and summer seasonal precipitation totals were computed for each year beginning in 1961 and ending in 1990, by summing the hourly amounts. Some interpolation was necessary to account for missing data, but was limited to 6-hr gaps (which were rare). The same three years were missing in this dataset as were missing in the parallel hourly temperature dataset used above (1970 – 1972). Note that, for much of the winter precipitation, the relevant numbers are for the liquid equivalent (or Snow Water Equivalent; SWE), obtained when snow is melted[7]. Table 8 shows the yearly results. The winter total for 1980 is suspiciously low and may be the result of degraded data. The rest of the seasonal totals shown seem reasonable, and correspond well with the usual annual total in Concord of about 40 inches liquid equivalent (USA Climate 2020). Bulk statistics computed from the seasonal precipitation totals in Table 8 are shown in Table 9.

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[7] An often used ratio is 10:1, meaning that every inch of snow contains a tenth of an inch of liquid. This is a very general rule and is not reliable. The real relationship is more complex, and heavily dependent on temperature. Snow falling in warmer temperatures may approximate a ratio of 10:1, but snowfall in very cold temperatures may correspond to a ratio as high as 100:1. The National Center for Environmental Information (NCEI), formerly known as the National Climatic Data Center (NCDC), has published a temperature-dependent conversion table, available here: https://www.ncdc.noaa.gov/sites/default/files/attachments/Estimating_the_Water_Equivalent_of_Snow.pdf

Table 8: Seasonal precipitation totals for Concord, New Hampshire, for the period 1961-1990. Values shown are in inches SWE. Winter = DJF; Summer = JJA.

Year	Winter Total	Summer Total
1961	6.28	8.83
1962	8.40	8.89
1963	5.99	6.90
1964	8.64	6.92
1965	5.40	7.62
1966	7.47	9.81
1967	8.38	10.68
1968	8.81	10.71
1969	11.31	13.83
1970	ND	ND
1971	ND	ND
1972	ND	ND
1973	11.94	12.82
1974	9.10	5.47
1975	9.62	11.49
1976	8.13	6.45
1977	8.49	6.93
1978	9.87	7.36
1979	12.46	7.65
1980	2.06	8.61
1981	12.41	11.79
1982	7.68	13.12
1983	11.46	6.54
1984	9.72	8.24
1985	4.59	8.39
1986	11.52	13.51
1987	4.57	12.37
1988	5.26	12.77
1989	3.72	11.43
1990	9.52	11.51

Table 9: Bulk statistics of annual seasonal precipitation totals in Concord, New Hampshire during the period 1961-1990. Values shown are in inches SWE.

Statistic	Winter	Summer
Max	12.46	13.83
Min	2.06	5.46
Mean	8.25	9.65
Median	8.49	8.89
Standard Deviation	2.78	2.54

Combining the results shown in Table 9 with those of Fan *et al.* (2015), we find that:

- Winter: Seasonal totals are expected to *increase* by 21 to 23 percent by 2041. This corresponds to maximum values of 15.08 to 15.32 inches, mean values of 9.98 to 10.15 inches, and median values of 10.27 to 10.44 inches. Variability in these totals, expressed in Table 9 as standard deviation, will increase by 1.6 percent to 2.82 inches.

- Summer: Seasonal totals are expected to *decrease* by 1.5 to 7.9 percent by 2041. This corresponds to maximum values between 12.74 and 13.62 inches, minimum values between 5.03 and 5.38 inches, mean values between 8.89 and 9.51 inches, and median values between 8.19 and 8.76 inches.

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Keim, B., and D. Thompson, 2020: Personal communications. Dr. Keim is a professor of geography at Louisiana State University in Baton Rouge, and the Louisiana State Climatologist. Mr. Thompson is his graduate student. Dr. Keim was the former New Hampshire State Climatologist, and the author's Ph.D. advisor at the University of New Hampshire, from 1999 through 2003.

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