Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume

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Abstract

In recent decades the frequency of extreme rainfall has increased in New Jersey and across the Northeast. These changes affect the magnitudes of the published extreme rainfall statistics that are used in engineering design specifications, environmental and stormwater regulations, and resiliency planning. The current extreme rainfall values used in New Jersey are based on a data record ending in 2000. With 20 years of additional precipitation data now available, this report assesses the magnitude by which design rainfall extremes have changed in the state.

Across the state, the majority of stations have seen an increase in 2-, 5-, 10-, 25-, 50- and 100-year recurrence interval daily rainfall since 2000. These positive changes occur at over 75% of the stations. At more than half of the stations, extreme precipitation amounts are 2.5% higher now than they were in 2000. The changes are consistent for durations ranging from 1 to 20 days. Similar changes are also noted for hourly data. The hourly changes closely match the changes noted for daily data, indicating that when considering the most extreme events, recent increases in extreme precipitation are similar across a wide range of durations from hourly to multi-day.

There is no indication of a strong spatial pattern in the observed changes in extreme rainfall. Rather the increases and decreases are scattered throughout the study domain. It appears that the occurrence of new rainfall events exceeding the previous maximum and multiple new events in the upper decile of the rainfall extreme time series drive the observed changes in the extreme rainfall return period amounts.

1. Introduction

Historical climate records for observing sites in the Northeastern United States have been characterized by significant increases in extreme precipitation since the mid-to-late 20th century (DeGaetano, 2009; Groisman, 1992; Heineman, 2012; Kunkel et al., 1999; Kunkel, 2003). This has raised practical concerns about use of an assumed stationary historical record to design infrastructure with a lifetime that extends well into the future. For example, DeGaetano (2009) reports that rainfall amounts once considered 1-in-100-year events based on the data record available from 1950-1978, occur as often as once every 67 years based on data observed across the Northeast from 1978-2008. This problem is exacerbated by climate model projections suggesting that the frequency and magnitude of extreme precipitation will continue to increase throughout the twenty-first century (e.g., Walsh et al. 2014; Donat et al., 2016; Ning et al., 2015; Sun et al., 2016).

Despite these established trends in extreme rainfall, recent flooding disasters and the range of climate-related risks and vulnerabilities associated with extreme rainfall, design standards and regulations in New Jersey currently utilize climate data from NOAA Atlas 14. The data used in this publication end in 2000. (Bonnin et al., 2006). Given the observed trends in extreme rainfall, particularly across the Northeastern United States, it is unclear how the inclusion of 19 additional years of rainfall data have affected the rainfall extremes reported in Atlas 14. Since several locations in New Jersey and surrounding states have experienced record rainfall events since 2000, or at least rainfall events that are among the highest in the pre-2000 record, it is likely that the Atlas 14 values underestimate the rainfall extremes that factor in the more recent years of data. This work documents these changes and proposes adjustments to the Atlas 14 rainfall extremes to better align them with the more recent climate record.

2. Data

Daily Cooperative Observer Network stations within the area extending from 41.7°N to 37.5°N and 76.0°W to 72.5°W were identified. From these locations, a set of 55 base sites was retained based on the following criteria: 1) inclusion in NOAA Atlas 14 Volume 2 or Volume 10 (Bonnin et al., 2006; Perica et al., 2019) 2) a data record that extends from at least 1950 through 2019 and 3) less than 5% of daily precipitation missing. Similarly, a larger set of regional stations was retained that included the base stations and additional sites having at least 20 years of record after 1980. For all sites, daily rainfall observations and flags were extracted from the Applied Climate Information System (ACIS) and reflect the values in the GHCN on January13, 2021.

Similar criteria were used to select hourly observing stations. These sites were extracted from one of three databases 1) NOAA National Centers for Environmental Information (NCEI) COOP-Hourly Precipitation Data (HPD) Version 2 (NCEI, 2018) for stations with available records after 2014; 2) NCEI's Hourly Precipitation Dataset (HPD), known historically as DSI-3240 (NCDC 2003) for stations with records ending prior to 2014 and 3) NCEI Surface Data Hourly Global (DS3505) for National Weather Service Automated Surface Observing System stations. Nine base hourly stations were available within the study region.

Using the daily (hourly) rainfall data, partial duration rainfall series (PDS) were formulated for the base and regional stations. Partial duration series comprise the n largest independent rainfall values in a n year data record and thus represent a block-maxima approach to extreme value analysis. Separate PDS were developed for 1-, 2-, 3-, 7-, and 10-day and 1-, 2-, 3-, 6-, 12-, 24- and 48-hour precipitation accumulations. Daily precipitation values flagged as

"accumulated" were retained if the accumulation period was less than or equal to the indicated duration. For example a value that represented a 2-day accumulation was excluded from the 1-day PDS, but was included as part of the 2-or-greater-day PDS. When multiple PDS members occurred within a 14-day window, the smaller value was excluded from the PDS, to satisfy the requirement that PDS members were independent. This time interval was selected to approximate the time scale of unique synoptic weather patterns. The temporal independence for hourly data was a function of duration, ranging from 24 hrs for durations ≤ 3hrs to 336 hrs (14 days) for durations ≥24 hrs. Events in the 6 hr and 12 hr duration PDS were required to be separated by more than 48, and 168 hrs (7 days), respectively.

For each station, an array of 29 PDS was generated such that the shortest PDS included data from 1950-1990 and the longest was based on data from 1950-2019. In each case, the PDS contained *n* values where *n* was defined as the total number of non-missing precipitation values divided by the total number of days (hours) in the relevant period of record rounded to an integer.

3. Methods

a. Computation of recurrence interval rainfall amounts

Using the array of 29 PDS at each station, rainfall amounts corresponding to recurrence probabilities of 50%, 20%, 10%, 4%, 2% and 1% (i.e. 2-, 5-, 10- 25-, 50- and 100-year storms) were computed by simulating the methodology used in NOAA Atlas 14 (Bonnin et al., 2006; Perica et al., 2019). First, the python lmoments package (https://pypi.org/project/lmoments/) was used to fit the generalized extreme value (GEV) distribution to each station's 29 PDS using

the methods of Hosking (1990). Although not the only valid theoretical distribution for estimating extreme rainfall probabilities, the use of the GEV has been standard practice in prior extreme rainfall analyses (Papalexiou and Koutsoyiannis, 2013). Then given the L-moments estimates for the GEV parameters, the lmoments library method was used to obtain the specified quantiles of the GEV distribution.

In addition, the regional L-moments procedure used in NOAA Atlas 14 Vol 10 (Perica et al., 2019) was adapted. Although the majority of sites lied outside the regional covered by this atlas, the difference in methodology employed to develop regions in the later atlas was assumed to be an improvement over the earlier implementation. A maximum of 20 neighboring stations, identified from the previous set of regional stations, formed a region around each base station. Sample lmoments were obtained for each regional station using the lmoments library samlmu routine and a weighted average of the higher order moments computed based on the length of each station's PDS. These weighted averages along with the base station's location parameter were then used to obtain GEV parameters and quantiles.

Although this did not exactly replicate the Atlas 14 methodology, the differences between the resulting ARI rainfall amounts and those given by Atlas 14 were generally small (less than 5%) with the most values also generally falling within the published Atlas 14 confidence intervals (Fig 1 and 2). While percent differences tend to be higher for the longer recurrence intervals, there does not appear to be a consistent geographic pattern of differences. However, it should be noted that the computed values for stations in New York always fall within the Atlas 14 confidence intervals, despite differences that are of the same magnitude as those for station in the other states. This results from a change in the methodology used to regionalize stations and compute confidence intervals between NOAA Atlas Volume 2 and

NOAA Atlas Volume 10, which covered New York. The methodology used in the earlier Volume 2 resulted in narrower confidence interval widths.

Often when the computed annual recurrence interval ARI rainfall amounts exceeded the Atlas 14 values by >20%, the cause of the difference was related to the length of the period of record used in Atlas 14. For example, in Figure 1c, the >20% difference occurred at Wilmington Porter Reservoir in Delaware, at which the Atlas 14 rainfall record begins in 1933. The PDS values that occurred prior to 1950 are systematically less, with only 2 of the potential 17 PDS years (12%) recording rainfall >3.65 in (the 1-day 5-year storm) whereas in the period from 1950-2000, 17 of the 51 years (33%) record rainfall exceeding this value. As subsequent analyses were based on differences in (ARI) rainfall amounts between the longer (1950-2019) and shorter (1950-2000) PDS periods, it was important to adapt a consistent methodology through time. Likewise, unlike Atlas 14, a fixed starting year was chosen to maximize the available number of base stations and also to avoid between-station differences arising due to differences in the length of the earlier period as highlighted by the Delaware example.

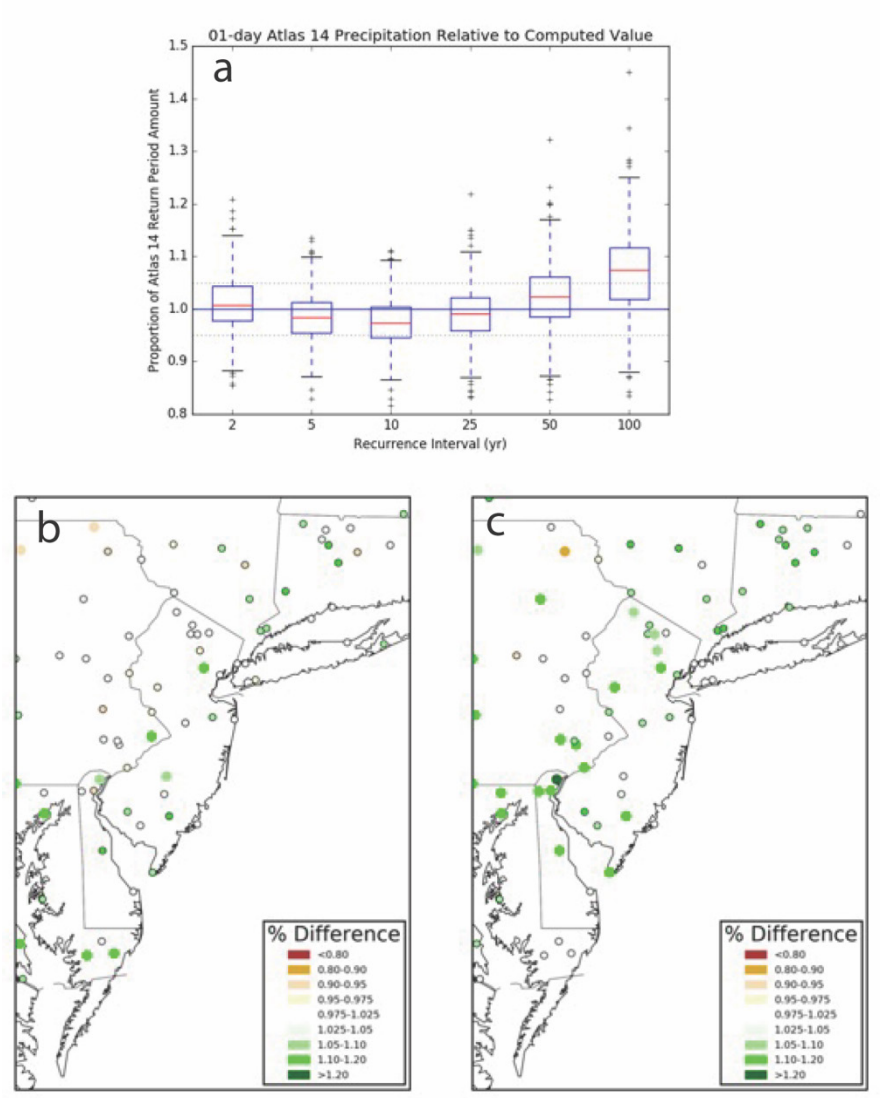

Figure 1. Ratios between 1-day (converted to 24-hour) Atlas 14 and project computed ARI rainfall amounts. In a) boxplots show ratios for all recurrence intervals across all stations in the study domain (Fig. 1b) with the horizontal dotted lines denoting a ± 5% difference between the values. Station-specific ratios are shown for the b) 2-year and c) 100-year ARI amounts. The slightly smaller station markers outlined in black indicate computed values that fall within the published Atlas 14 confidence interval.

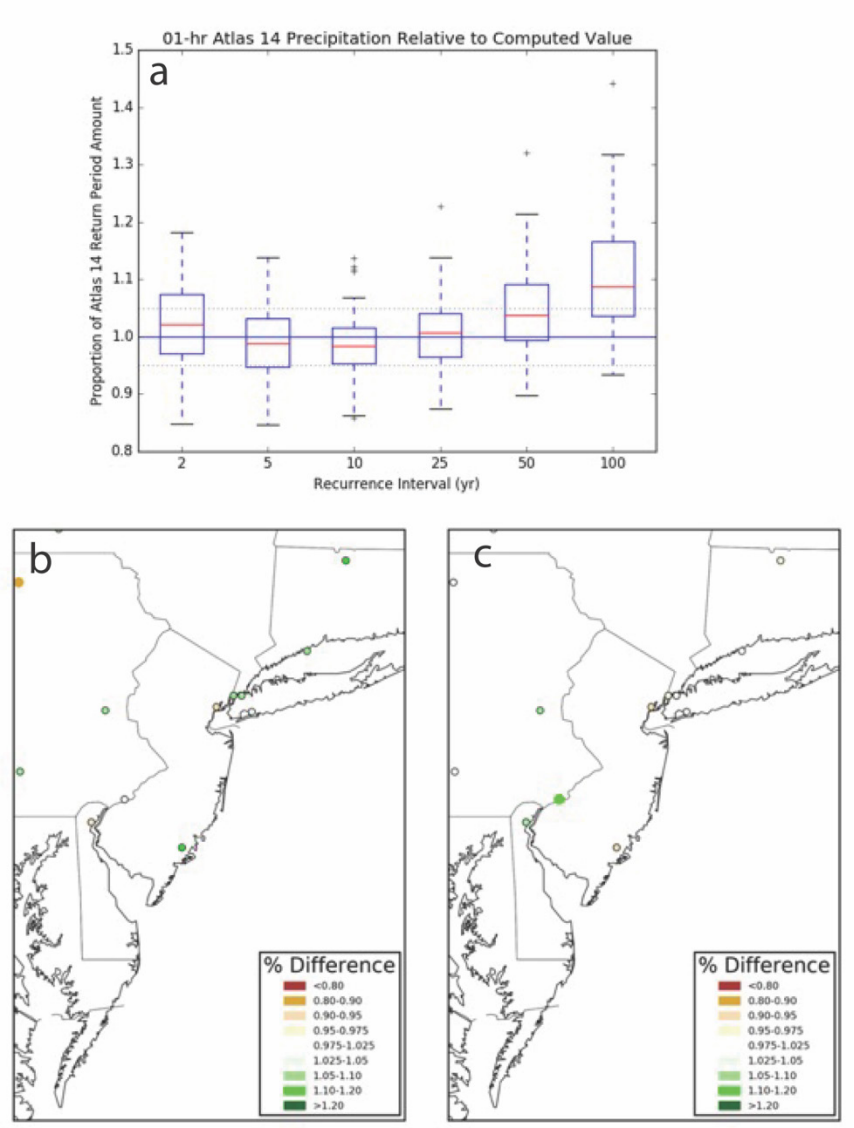

Figure 2. Ratios between 1-hour (converted to 60 minute) Atlas 14 and project computed ARI rainfall amounts. In a) boxplots show ratios for all recurrence intervals across all stations in the study domain (Fig. 1b) with the horizontal dotted lines denoting a ± 5% difference between the values. Station-specific ratios are shown for the b) 2-year and c) 100-year ARI amounts. The slightly smaller station markers outlined in black indicate computed values that fall within the published Atlas 14 confidence interval.

b. Post-2000 rainfall extreme differences

Given the ARI rainfall amounts for each duration, a percent difference was computed such that

$$\Delta P_{2000} = P(d,r)_n / P\ (d,r)_{2000,}$$

where P is the precipitation amount corresponding to duration *d* and return interval *r* and *n*, as well as 2000, represents the ending year of the partial duration series. When the value of *n* is 2019, ΔP_{2000} compares the most recent PDS to that corresponding to the end of the period of record used in Atlas 14.

The significance of ΔP_{2000} was assessed using a resampling analysis. For ARI amounts computed using non-regional L-moments, the GEV parameters fit to the base station's 1950-2019 PDS were used to randomly generate 1000 PDS using the random variates method in the scipy.stats genextreme library. For each random (unsorted) PDS, the L-moments procedure was used to fit new GEV parameters using all 70 values in the randomly generated PDS and a second set of GEV parameters based on only 50 of the random PDS values. This was intended to simulate the difference between the current PDS available at a station and that available in 2000. Quantiles were computed from these two GEV distributions and differenced giving a set of 1000 random ΔP_{2000} values from which the 1-tailed probability of obtaining the observed ΔP_{2000} value was determined.

Two similar procedures were used to obtain randomized ΔP_{2000} distributions for the regional L-moments results. In both cases, the GEV parameters obtained from the regional L-moments analysis of the observed PDS (as opposed to those obtained solely for the base station) were used to generate the 1000 random PDS. In the first method, the original weighted regional L-moments were used to obtain new GEV parameters from the randomized PDS which were

ultimately used to construct the randomized ΔP_{2000} distribution. Thus, while 1000 randomized PDS were generated, only the L-moments location parameter varied in each simulation. Alternately in the second method, random PDS were also generated for each of the regional stations allowing different regionally weighted higher order L-moments parameters to be used in each random simulation. There are trade-offs to each method. The first likely underestimates the variation of the random ΔP_{2000} distribution. The second does not account for any potential autocorrelation in the neighboring PDS. Nonetheless there was not a systematic difference in the observed ΔP_{2000} probabilities for one approach compared to the other.

4. Results

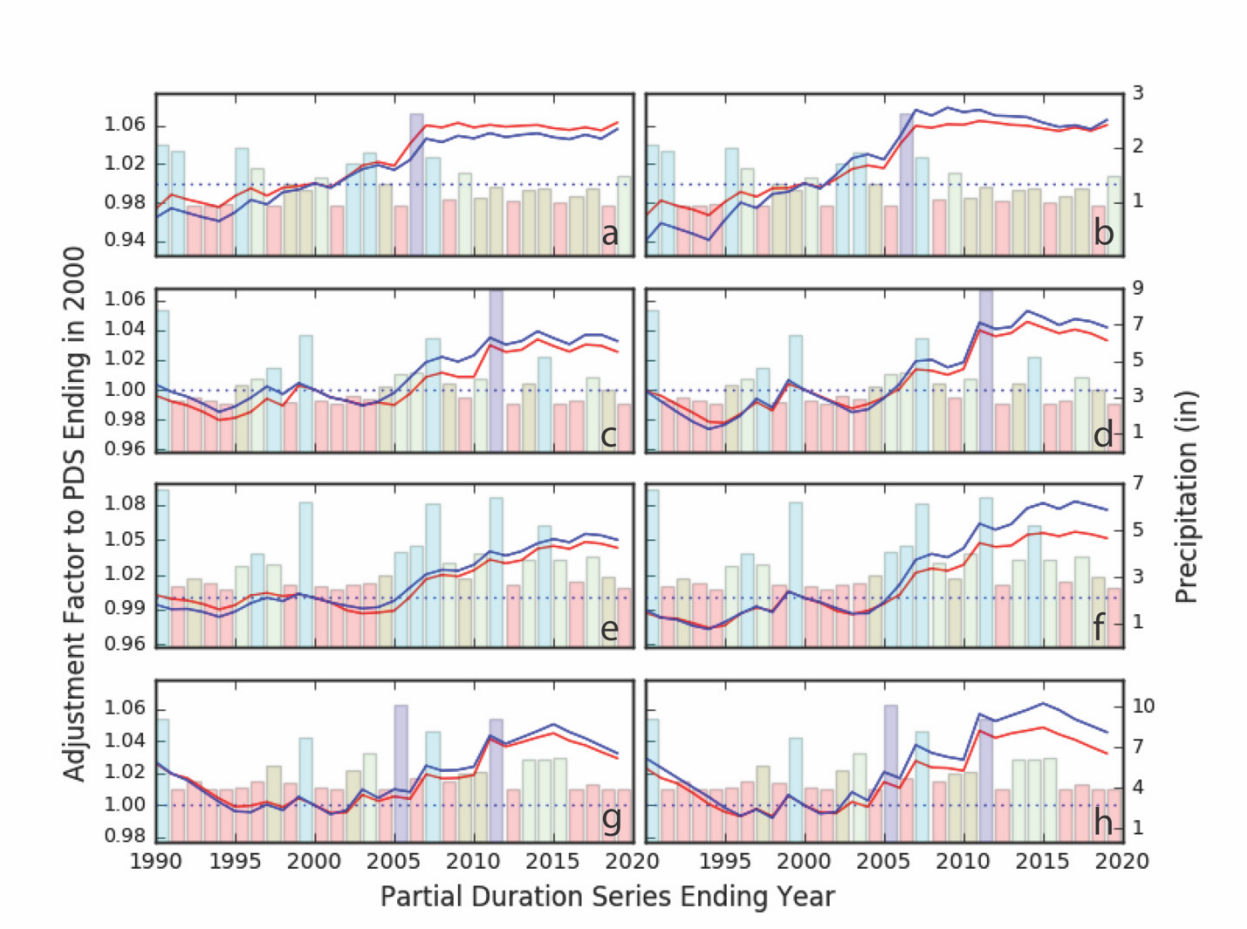

Figure 3. ΔP_{2000} for 1-hr (a-b), 24-hr (c-d), 1-day (e-f) and 7-day (g-h) 2-year (a, c, e, g) and 100-year (b, d, f, h) ARI interval rainfall amounts based on PDS ending in the specified years (the value of n in Eq. 1) based on data for Newark, NJ. The red line is the RI amounts based on the regional L-moments analysis and the blue line represents the L-moments fit to only the Newark data. The bars show the largest new rainfall amount that is added to the PDS each year. Purple bars indicate the new value is the maximum in the PDS, while light blue, green and brown bars indicate new values >90th percentile, between the 75th and 90th percentile and between the 50th and 75th percentile of the PDS, respectively. Red bars are values falling below the median.

Figure 4. As in Figure 3, but for Atlantic City International Airport (hourly data) and Atlantic City Marina (daily values).

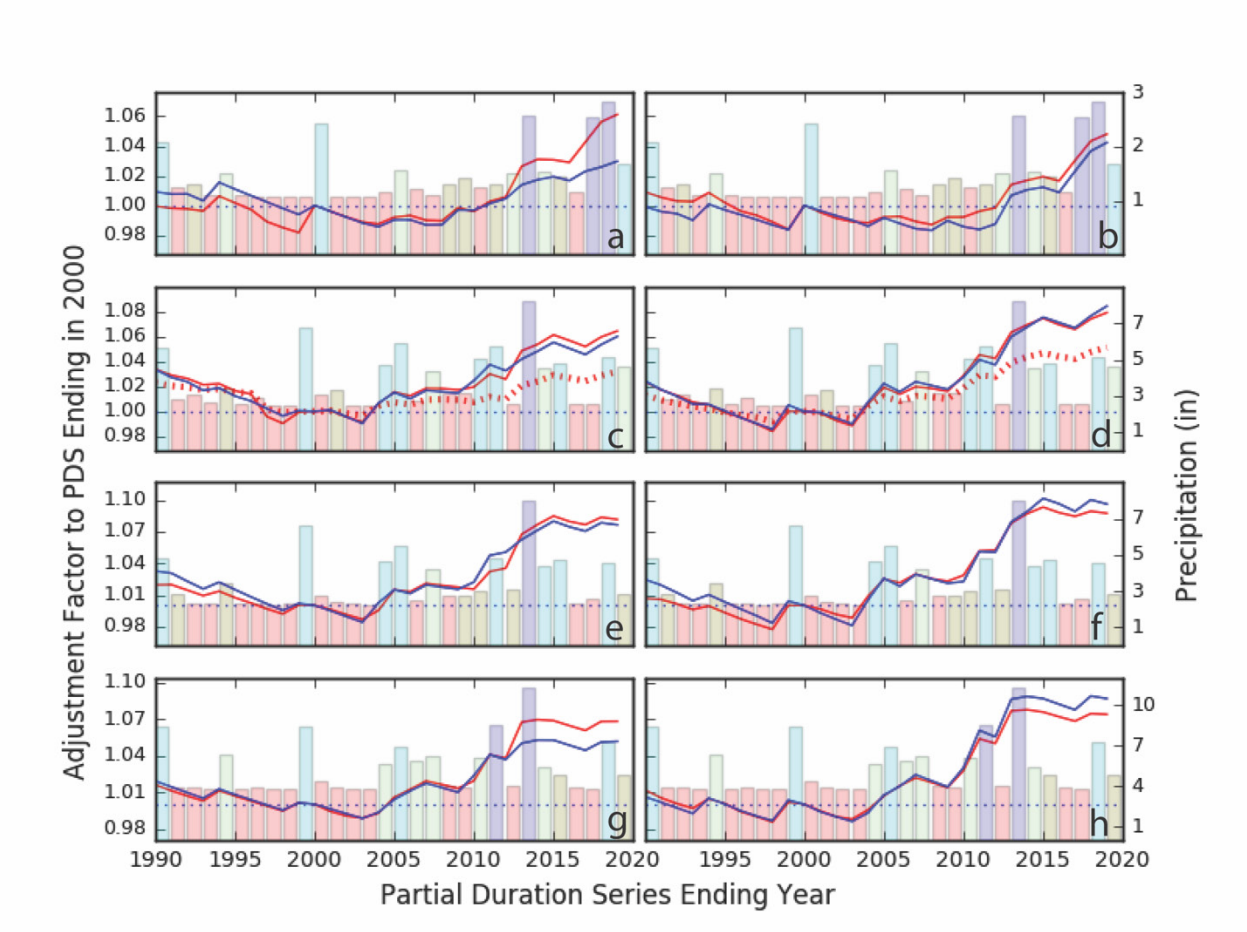

Figure 5. As in Figure 3, but for Philadelphia PA. The dotted red line shows RI amounts based on the regional L-moments analysis of the full Philadelphia record which starts in 1900.

Figures 3-5 illustrate several time series of ΔP_{2000}. In all cases, the ΔP_{2000} corresponding to the year 2000 is 1.00 by definition. Values greater than 1.00 indicate an increase in rainfall intensity for a particular recurrence interval as data beyond 2000 is considered. At Newark (Fig. 3), there is little difference between the ΔP_{2000} values computed using regional versus single station L-moments based on the hourly data record and for 2-year RI using the daily record. This is not the case for the 100-year RI using daily rainfall. Here, the single-station ΔP_{2000} values increase at a faster rate than the regional ΔP_{2000} values. In Figures 3a-d, the influence of experiencing a new

PDS maximum is apparent. In 2005 the maximum hourly rainfall increases by nearly 0.5 inches, this causes both the 2-year and 100-year ΔP_{2000} for hourly rainfall to increase by 3-4%. Similarly in 2011, the maximum 24-hr PDS value increases by nearly 1 inch resulting in an analogous increase in ΔP_{2000}. After both of these rises, ΔP_{2000} remains constant, as the new additions to the PDS are of smaller magnitude with the larger additions generally occurring at a similar frequency before and after 2000. This is not the case with 1-day rainfall (Fig. 3e-f). In these cases, from 2005 through 20016, there is a prevalence of new PDS values within the upper quartile of the PDS. This results in a steady increase through the period, as opposed to an abrupt rise as was the case with the hourly data. The hour-based values are higher since this represents rainfall in any 24-hour period, whereas daily rainfall is limited to a particular 24-hr interval (midnight to midnight in the case of Newark).

Although the data for Atlantic City in Figure 4, shows many similarities to the Newark ΔP_{2000} series, this station experiences a decline in ΔP_{2000} from the late 1990s through 2005, particularly in the hourly record. This general pattern is also evident, but to a lesser degree at Philadelphia (Fig. 5). The decline in ΔP_{2000} results from the combination of a lengthening PDS series, with the new additions frequently falling in the lower half of the distribution and consistently below the 75^{th} percentile.

Figure 4 also illustrates the difference in behavior of the ΔP_{2000} values based on regional and single-station L-moments. Overall, the two measures of ΔP_{2000} behave similarly showing the same general pattern of increases and decreases. Typically, but not always, when based only on the station data, ΔP_{2000} tends to be more variable, showing a greater response to large precipitation events but also declining more quickly when the PDS lengthens with the new

events confined to the lower half of the distribution. However, this generalization is often tempered by the coincident occurrence (or non-occurrence) of large rainfall events at the regional set of stations.

Figure 5 shows how ΔP_{2000} is affected by the starting date of the PDS. At Philadelphia, although ΔP_{2000} increases in the post 2000 period when the full 1900-2019 record is used, its change is moderated compared to that based on a 1950 starting date. This is not a consistent response among stations with records that start prior 1950, as it is influenced by the magnitude of the individual rainfall events included in the PDS from the pre-1950 period. At Philadelphia, the largest 31 daily rainfall events in the 120-year PDS occur in the post 1949 period. Furthermore, only 9 of the 120 PDS values occurred prior to 1950, hence the full-record RI amounts fall below those based on the 1950-2019 values.

Figure 6 shows ΔP_{2000} boxplots for different recurrence intervals and daily durations. There has been a general increase in extreme rainfall in 1950-2019 relative to 1950-2000 as indicated by the medians of majority of the boxplots exceeding $\Delta P_{2000} = 1.00$. The height of each boxplot represents the variation in ΔP_{2000} across the 74 stations shown in Figure 1. The general patterns of ΔP_{2000} relative to recurrence interval and duration are similar. Notably the between-station variance of ΔP_{2000} tends to increase with duration and recurrence interval. This results from both the very localized nature of the most extreme rainfall and the uncertainty inherent to representing the far-right tail (most extreme values) of the GEV distribution. Changes are most consistent for 1-day and 20-day duration events. For these durations, more than 75% of the stations show an increase, with the exception of 50% RI 20-day rainfall. For 1-day rainfall the increase through the 20-year period is typically between 0 and 5%. The typical increases for 20-day rainfall are larger, with the median increase >5% for the 100- and 50-yr RI and all stations

indicating an increase with some increases in excess of 10%. For shorter recurrence intervals the 1-day and 20-day increases are similar.

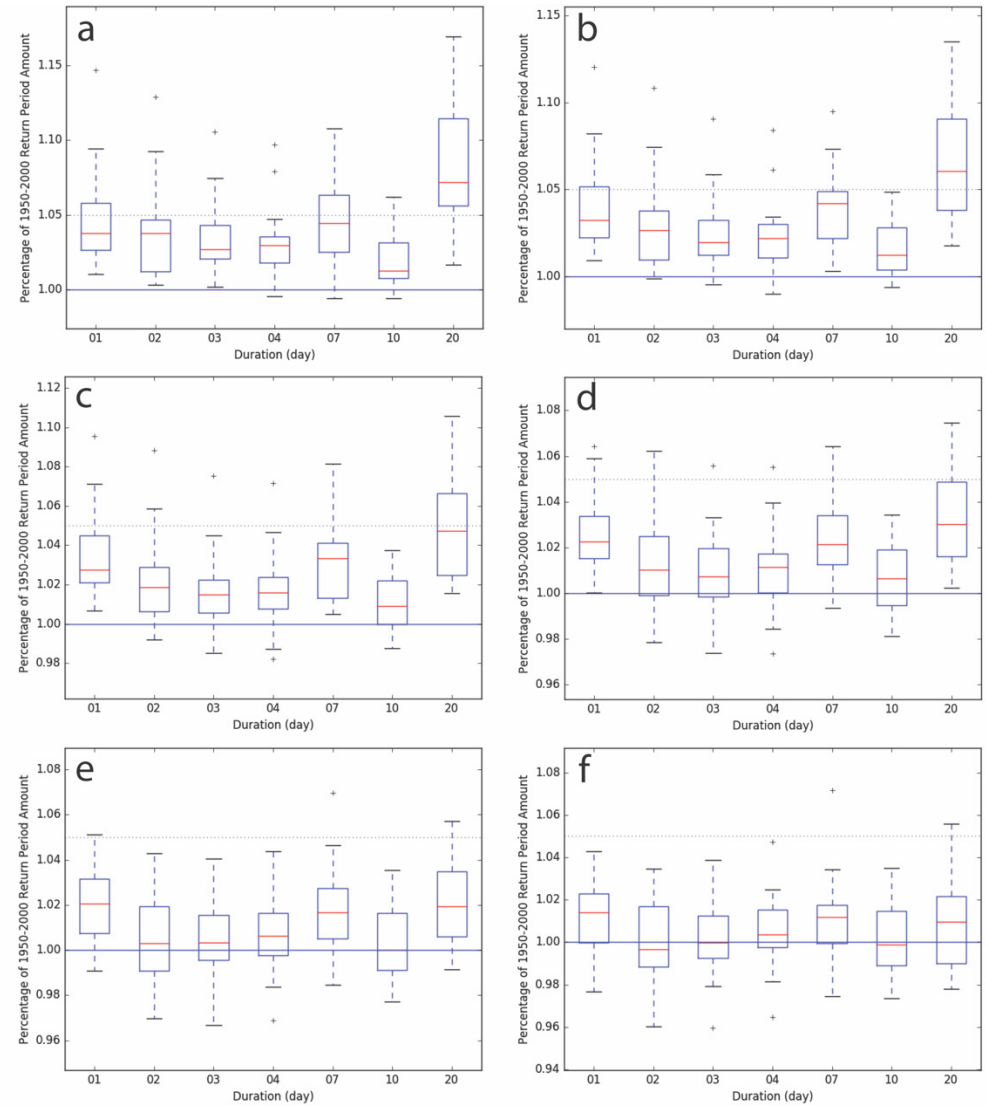

Figure 6. Boxplots showing the ratios of daily RI precipitation amounts for different durations computed using the 1950-2019 PDS to those based on a 1950-2000 PDS. Boxplots show for the a) 100-; b) 50-; c) 25-; d) 10-; e) 5-; and f) 2-year storms across stations in New Jersey.

Spatial differences in daily ΔP_{2000} are shown in Figure 7. There is not a very consistent pattern to the changes. Stations farther inland over Pennsylvania tend to have increases of 1-5% for the 2-

year RI and are among the stations with the highest increases for 100-year RI ΔP_{2000}. Stations from northeastern New Jersey into New York and Connecticut, have the largest decreases in 1-day 100-year ΔP_{2000} with decreases between 0 and 5%, while 1-day 2-year ΔP_{2000} are generally positive in this region. In terms of the 20-day duration, the spatial pattern for the 2-year RI is similar to that for the 1-day duration with the largest increases inland over Pennsylvania. The general decreases in 20-day 2-yr, ΔP_{2000}, however are more in line with the 1-day 100-yr values. Twenty-day 100-year ΔP_{2000} shows large region-wide changes consistent with Figure 6, with some indication of smaller increases to the northeast.

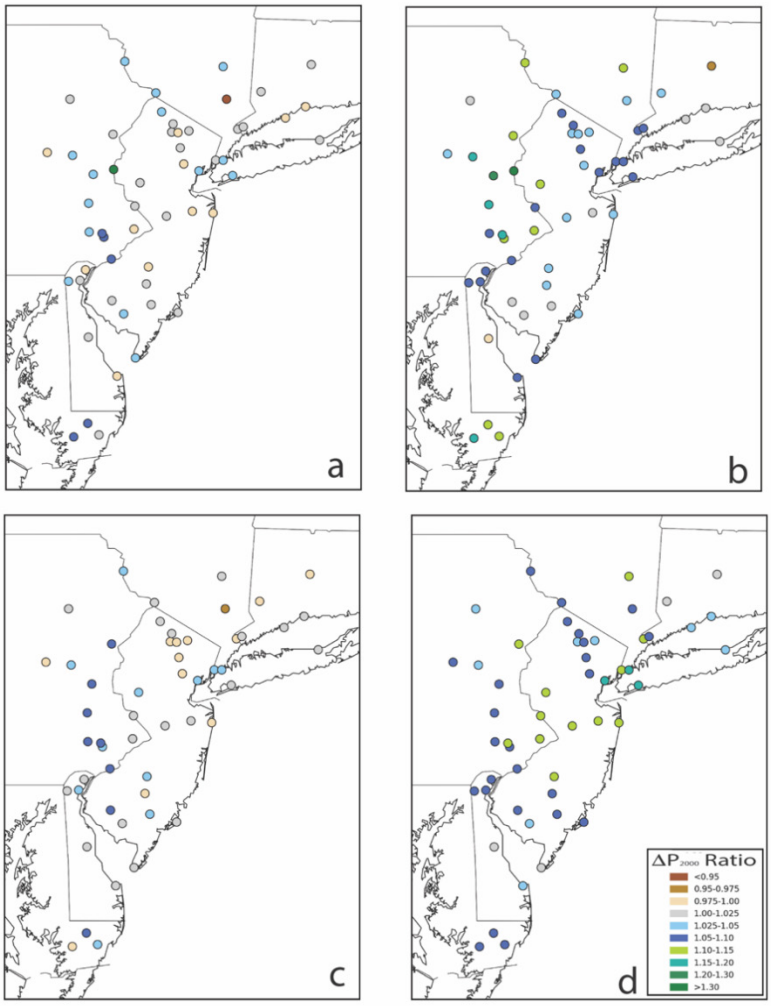

Figure 7 Station-specific a) 1-day 2-year; b) 1-day 100-year; c) 20-day 2-year; and d) 20-day 100-year RI rainfall amount ratios (1950-2019 PDS value divided by 1950-2000 PDS values).

In Figure 8 ΔP_{2000} boxplots are shown for hourly durations. Like the daily data, there has been a general increase in extreme rainfall based on the 1950-2019 PDS relative to that using 1950-2000, particularly for durations >12 hours and all durations for ARI ≥25-years. For longer recurrence intervals and durations shorter than 12 hours more of the stations experience a slight decrease in ΔP_{2000}. The largest increases in ARI rainfall are on the order of 5-10% and occur with the 100- and 50-year RI for 12-hour-or-greater durations. For shorter durations, the ΔP_{2000}

values for these ARIs are typically between 0.98 and 1.02, but the variation among stations increases with increasing duration. For more frequent ARIs, the majority of stations show increases in ΔP_{2000} in the range of 2-5%.

Given the small number of long-term hourly recording stations, clear spatial patterns in hourly ΔP_{2000} values are not evident (Fig. 9). For 1-hour durations, the cluster of stations in and around New York City have seen increases in 2-year RI events, while 100-year RI rainfall amounts have declined. For 24-hour durations, stations across the region have consistently shown increases in both 2-year and 100-year RI amounts, with the largest increases at stations in the New York metropolitan area, and in Pennsylvania at Philadelphia and Allentown.

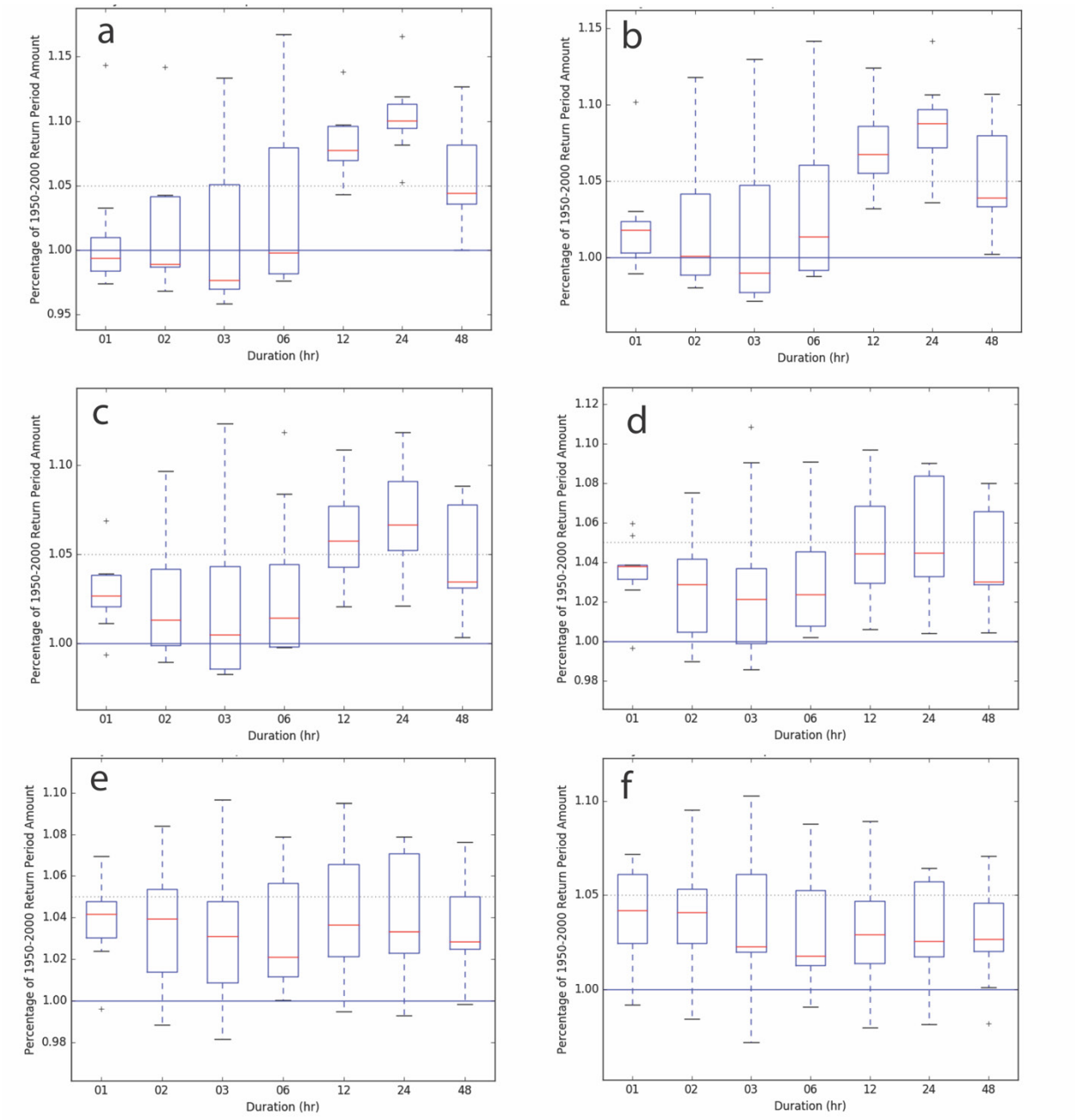

Figure 8 Boxplots showing the ratios of hourly RI precipitation amounts for different durations computed using the 1950-2019 PDS to those based on a 1950-2000 PDS. Boxplots shown for the a) 100-; b) 50-; c) 25-; d) 10-; e) 5-; and f) 2-year storms across stations in New Jersey.

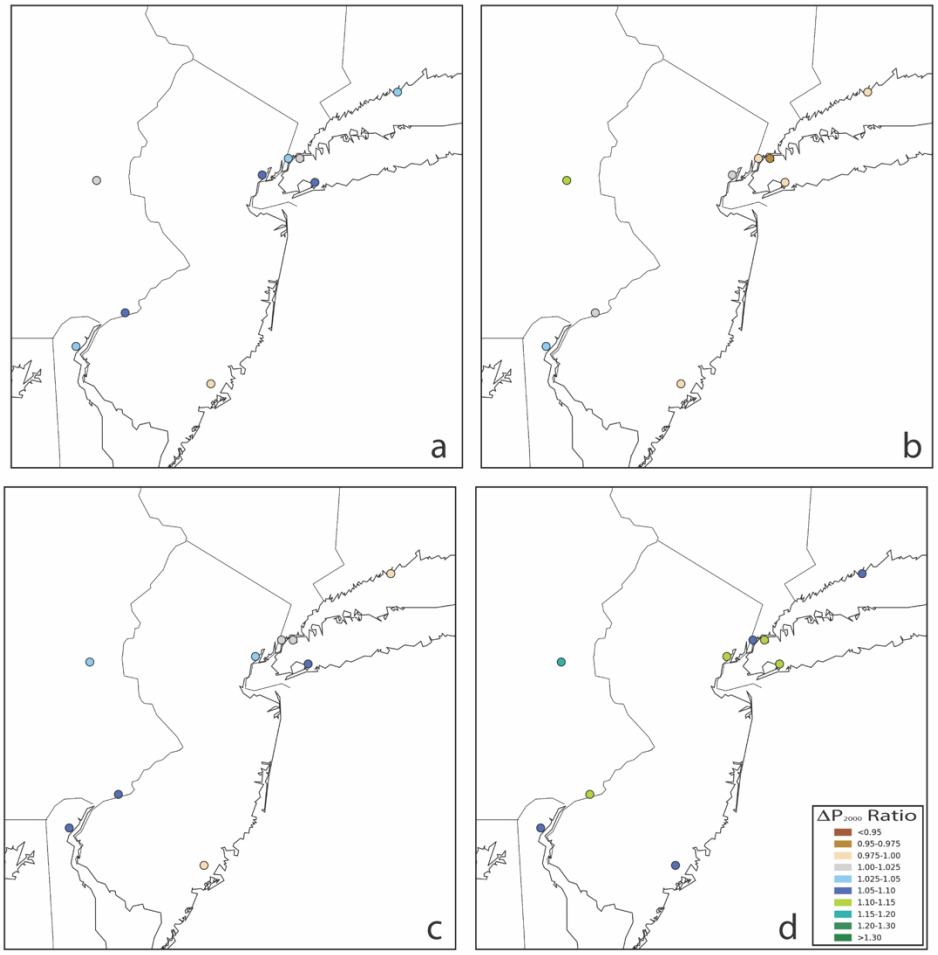

Figure 9 Station-specific a) 1-hour 2-year; b) 1-hour 100-year; c) 24-hour 2-year; and d) 24-hour 100-year RI rainfall amount ratios (1950-2019 PDS value divided by 1950-2000 PDS values).

Although in the majority of cases ΔP_{2000} exceeds 1.0, indicating that rainfall extremes across NJ have primarily increased since the publication of NOAA Atlas 14, the magnitude of these changes is generally small. Across the region, the upper bound of the typical 90% confidence interval is generally 8-12% higher than the published rainfall amount regardless of RI or duration. Thus, except in a few cases, the values of ΔP_{2000} shown in Figures 7 and 9 are consistent with the expected variation in RI rainfall. While these confidence intervals express

the expected variation in RI rainfall given a specific PDS, they do not address the expected change in RI rainfall as additional years of data are included in the PDS. Figures 10 and 11 show that the general increase in RI rainfall amounts since 2000, are at many stations greater than would be expected to occur randomly, based on the resampling procedure outlined in section 3b. For 1-day rainfall the most significant changes occur at stations in eastern Pennsylvania and to a lesser extent northern NJ and the New York City area (Fig. 10). The greatest number of significant changes in NJ are associated with 10-year RI events. Few of the two-year changes attain significance at the 10% level, while for 10-year RI the change in stations across PA is significant at the 1 and 5% levels, while a group of stations in northern NJ and the New York City area have changes that are significant at the 5-10% level. The post-2000 change in the 100-year RI amounts is also significant at the 5-10% level at stations near New York City and in eastern Pennsylvania.

Using hourly rainfall data, the significance of ΔP_{2000} values for 1-hour and 24-hour durations is similar to that for the daily values. A significant change ($p < 0.10$) is noted in the 10-year ARI amount at all stations, except Atlantic City (Fig 11 c-d). For the 2-year ARI, more than half of the stations in the study region show a significant increase ($p <= 0.10$) based on the resampling procedure discuss in the previous section. For the 100-year ARI, all stations show a significant change based on the 24-hour duration, however only the change at Allentown, PA is significant based on a 1-hour rainfall duration.

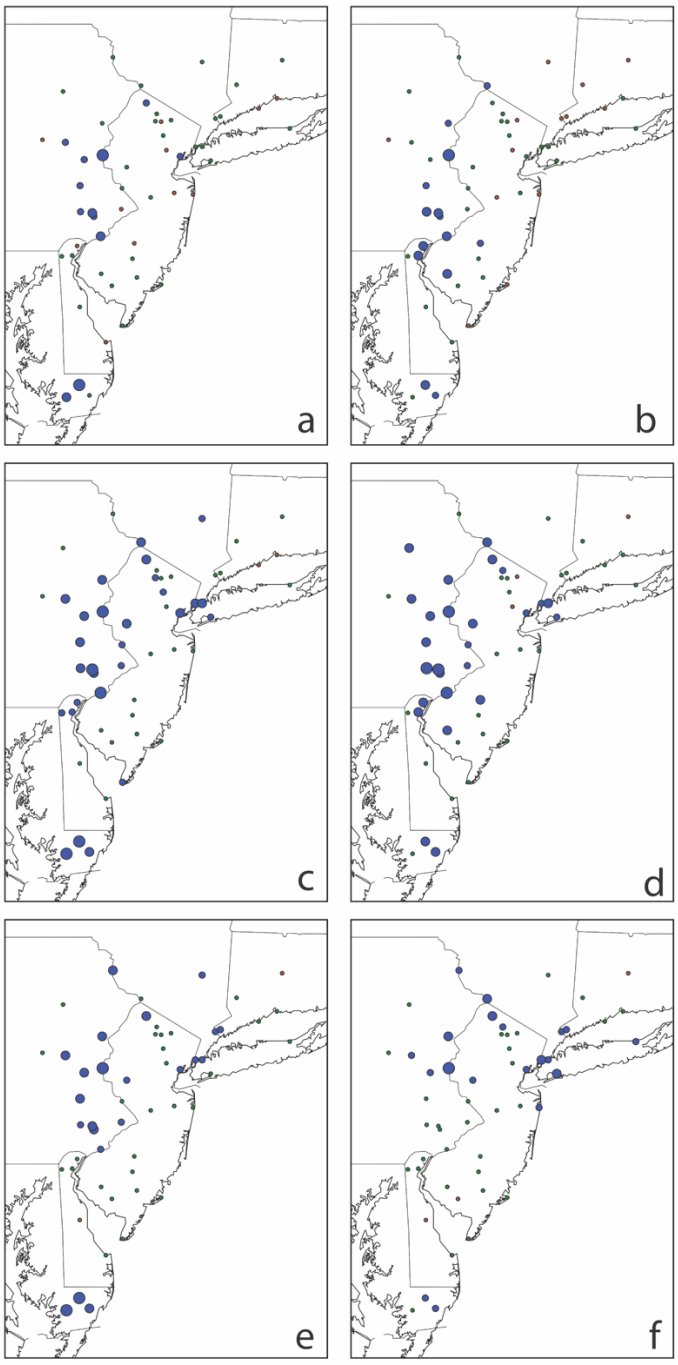

Figure 10. Significance of ΔP_{2000} for a) 2-year 1-day; b) 2-year 7-day; c) 10-year 1-day; d) 10-year 7-day; e) 100-year 1-day; and f) 100-year 7-day RI rainfall. Green (brown) circles indicate $\Delta P_{2000} > 1$ ($\Delta P_{2000} < 1$). Blue dots indicate statistical significance at the p = 0.10 (smallest dot), p = 0.05 and p = 0.01 (largest dot) levels.

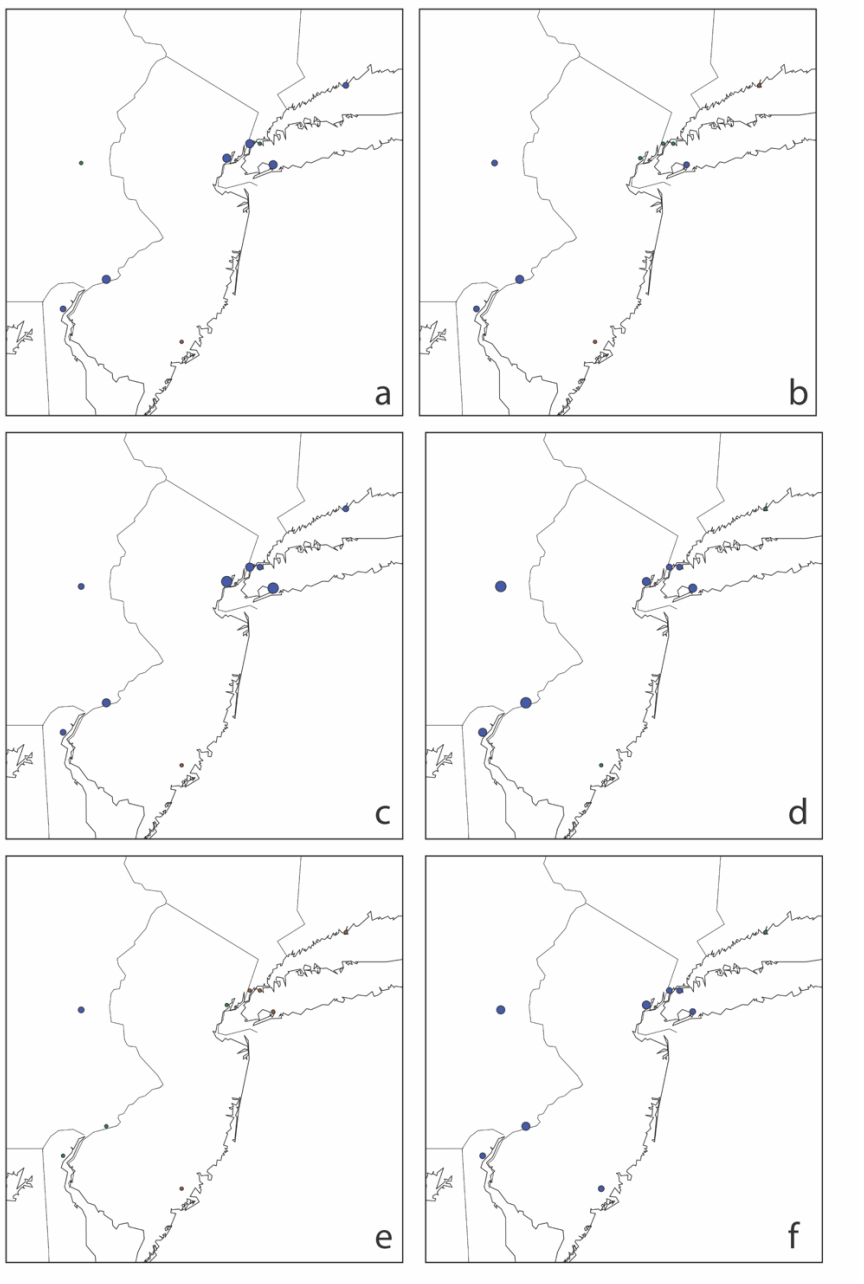

Figure 11. Significance of ΔP_{2000} for a) 2-year 1-hour; b) 2-year 24-hour; c) 10-year 1-hour; d) 10-year 24-hour; e) 100-year 1-hour; and f) 100-year 24-hour RI rainfall. Green (brown) circles indicate $\Delta P_{2000} > 1$ ($\Delta P_{2000} < 1$). Blue dots indicate statistical significance at the $p = 0.10$ (smallest dot size), $p = 0.05$ and $p = 0.01$ (largest dot size) levels.

5. Summary

Across New Jersey, the majority of stations with > 70-year-long daily precipitation records have seen an increase in 2-, 5-, 10-, 25-, 50- and 100-year recurrence interval rainfall since 2000. The positive changes occur at over 75% of the stations with changes exceeding 2.5% at more than half of the stations. These changes are consistent for all ARIs and for durations ranging from 1 to 20 days. Similar changes are also noted for hourly data, with over 75% of the observation sites experiencing increases and 50% of these increases exceeding 2.5%. These hourly changes closely match the changes noted for daily data, indicating that when considering the most extreme events, recent increases in extreme precipitation are similar across a wide range of duration from hourly to multi-day. Given that over 50% of the most extreme hourly rainfall events occur in conjunction with an extreme daily rainfall, this similarly is not surprising. Given that similar changes occur with rainfall durations as long as 20 days, which have much less overlap with hourly extremes, this may suggest that the mechanisms responsible for increases in the largest precipitation events may be independent of duration.

Across the region, there is not a strong spatial pattern in the observed changes in these recurrence interval rainfall amounts. Rather the increases and decreases are scattered throughout the study domain. In some locations, however, clusters of stations with predominate increases or decreases exist. This is an artifact of the spatial extent of specific rainfall events. Changes in extreme ARI rainfall are strongly affected by the occurrence of one or more events in the recent record that exceed the previous maximum rainfall within the partial duration series. Such events are likely to affect several adjacent stations leading to this clustering. Similarly neighboring stations that experienced the highest PDS events in the earlier part of their records, with few high PDS values in recent years, experience a consistent decrease in $\Delta P_{2019.}$ This highlights that it is

the occurrence of new rainfall events exceeding the previous PDS maximum or multiple new events in the upper decile of the PDS that apparently drive the observed changes in $\Delta P_{2019,}$ rather than simply an increase in rainfall events >99th percentile (e.g. like those used in Groisman et al., 2005) which are likely fall below the median PDS value.

Collectively the results give some insight into the appropriate frequency at which to update extreme rainfall atlases such as NOAA Atlas 14, particularly in regions where changes in extreme rainfall frequency are evident. Routine updates on a cycle of 20 to at most 30 years should be considered. Over this interval, increases in extreme rainfall have been experienced at over 75% of the stations in NJ, with the magnitude of change for the longest ARIs exceeding 10% at a quarter of the long-term stations in the state. Changes of this magnitude generally exceed the current Atlas 14 confidence bounds.

6. Acknowledgements

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7. References

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APPENDIX A

Adjustments to NOAA Atlas 14 daily recurrence interval precipitation amounts to reflect 1950-2019 data record by station

1-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	1.01	1.02	1.02	1.02	1.02	1.03	1.03
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	1.02	1.03	1.04	1.05	1.05	1.05	1.06
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1	1.01	1.02	1.03	1.03	1.05	1.06
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.98	0.99	1	1.01	1.01	1.02	1.03
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1.03	1.03	1.04	1.04	1.04	1.05	1.06
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	0.99	1.01	1.02	1.03	1.03	1.04	1.05
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.02	1.04	1.06	1.09	1.1	1.12	1.15
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	0.99	1	1	1.01	1.01	1.01	1.01
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1.01	1.01	1.02	1.02	1.02	1.02	1.03
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	1	1.01	1.01	1.02	1.02	1.02	1.03
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	0.99	1	1	1.01	1.01	1.02	1.03
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1.02	1.03	1.03	1.04	1.05	1.06	1.07
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	1	1	1.01	1.01	1.02	1.02	1.03
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	1.02	1.02	1.02	1.02	1.02	1.02	1.02
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.03	1.03	1.03	1.03	1.03	1.02	1.01
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.04	1.05	1.06	1.07	1.07	1.08	1.09
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1.02	1.03	1.03	1.04	1.04	1.04	1.05
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.02	1.03	1.03	1.03	1.02	1.02	1.01
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.04	1.05	1.05	1.06	1.06	1.07	1.08
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	1	1.01	1.02	1.03	1.03	1.04	1.04
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.03	1.04	1.04	1.05	1.05	1.06	1.06
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.04	1.04	1.05	1.06	1.06	1.07	1.08
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.02	1.03	1.04	1.05	1.05	1.07	1.08
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.03	1.03	1.04	1.04	1.04	1.05	1.05
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	1.03	1.04	1.05	1.06	1.07	1.09	1.11
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.01	1.01	1.02	1.02	1.02	1.02	1.02
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.95	0.97	0.98	1	1	1.02	1.03
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	1.01	1.02	1.03	1.04	1.04	1.05	1.07
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.04	1.08	1.12	1.15	1.16	1.2	1.24
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.06	1.08	1.09	1.1	1.11	1.12	1.14
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.01	1.04	1.07	1.09	1.1	1.13	1.15

USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1.04	1.07	1.09	1.11	1.12	1.14	1.16
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.03	1.04	1.06	1.07	1.08	1.1	1.12
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	0.99	1.01	1.03	1.05	1.06	1.08	1.1
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.08	1.1	1.12	1.13	1.14	1.16	1.18
USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.05	1.07	1.08	1.1	1.11	1.13	1.16
USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.08	1.09	1.09	1.09	1.09	1.09	1.09
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.05	1.06	1.07	1.08	1.08	1.09	1.1
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.99	1	1.01	1.02	1.03	1.04	1.05
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.02	1.03	1.03	1.03	1.03	1.02	1.02
USC00061762	CT	41.4002	-73.4212	DANBURY	1	1.01	1.01	1.02	1.02	1.02	1.03
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.99	1	1	1	1	1.01	1.01
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	0.99	0.99	1	1	1	1	1
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1.01	1.02	1.03	1.04	1.05	1.06
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	1.01	1.01	1.01	1	1	0.99	0.97
USC00072730	DE	39.1467	-75.5055	DOVER	1.01	1.01	1.01	1.01	1.01	1	0.99
USC00075320	DE	38.7841	-75.1581	LEWES	0.99	1.01	1.02	1.03	1.04	1.05	1.06
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1.03	1.04	1.05	1.05	1.05	1.05	1.06
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.02	1.04	1.05	1.06	1.06	1.06	1.06
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1	1.02	1.03	1.04	1.05	1.06	1.06
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1.08	1.09	1.1	1.12	1.12	1.14	1.16
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.1	1.1	1.1	1.11	1.12	1.13	1.15
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.02	1.04	1.06	1.08	1.08	1.1	1.13

2-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	0.99	0.99	1	1	1.01	1.01	1.02
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	1.01	1.01	1.01	1.02	1.02	1.03	1.04
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1	1	1.01	1.02	1.02	1.03	1.05
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.96	0.97	0.97	0.98	0.99	1	1.01
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1.01	1.02	1.02	1.03	1.03	1.04	1.04
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	1	1	1.01	1.01	1.02	1.03	1.04
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.02	1.04	1.06	1.07	1.08	1.09	1.11
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	1	1	1	1	1.01	1.01	1.02
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1	1	1	1.01	1.01	1.02	1.03
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	0.98	0.99	0.99	0.99	0.99	1	1
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.01	1.02	1.02	1.02	1.03	1.03	1.04
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1	1	1.01	1.02	1.02	1.03	1.04
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	0.99	0.99	0.99	1	1	1.01	1.02
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	0.99	1	1	1.01	1.01	1.01	1.02
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.01	1.01	1.01	1.01	1.01	1.01	1.01
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.04	1.03	1.03	1.04	1.04	1.04	1.05
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1	1	1	1.01	1.01	1.02	1.03
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.03	1.03	1.02	1.02	1.02	1.02	1.02
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.02	1.03	1.04	1.04	1.06	1.07
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.98	0.98	0.99	1	1	1.01	1.02
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.03	1.03	1.03	1.03	1.03	1.04	1.05
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.01	1.02	1.02	1.02	1.03	1.04
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.02	1.02	1.03	1.03	1.03	1.04	1.05
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.06	1.06	1.06	1.06	1.06	1.06	1.07
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	1	1	1.01	1.01	1.01	1.02	1.02
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.03	1.03	1.03	1.03	1.04	1.04	1.05
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.94	0.95	0.96	0.96	0.97	0.97	0.97
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.99	0.99	1	1	1.01	1.01	1.02
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.01	1.06	1.1	1.13	1.14	1.18	1.21
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.04	1.05	1.05	1.06	1.06	1.07	1.07
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.02	1.06	1.08	1.1	1.11	1.13	1.15
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1	1.04	1.07	1.09	1.1	1.13	1.16
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.04	1.05	1.06	1.07	1.08	1.09	1.1
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1	1.01	1.01	1.02	1.03	1.04	1.05
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.05	1.06	1.06	1.07	1.07	1.08	1.09

USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.06	1.07	1.08	1.09	1.09	1.1	1.11
USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.08	1.07	1.07	1.06	1.06	1.06	1.06
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.06	1.07	1.07	1.07	1.07	1.06	1.05
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.98	1	1.02	1.04	1.05	1.08	1.11
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.02	1.04	1.05	1.06	1.06	1.07	1.08
USC00061762	CT	41.4002	-73.4212	DANBURY	1	0.99	0.99	0.99	0.99	0.98	0.98
USC00061762	CT	41.4002	-73.4212	DANBURY	1	0.99	0.99	0.99	0.99	0.98	0.98
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.01	1	1	1	1	1	1
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.01	1	1	1	1	1	1
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1	1	1	1	1	1	1
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1	1	1	1	1	1	1
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1	1	1	1	1.01	1.01
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1	1	1	1	1.01	1.01
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.99	0.99	0.98	0.97	0.97	0.96	0.94
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.99	0.99	0.98	0.97	0.97	0.96	0.94
USC00072730	DE	39.1467	-75.5055	DOVER	0.99	0.99	0.99	0.99	0.99	0.99	0.99
USC00072730	DE	39.1467	-75.5055	DOVER	0.99	0.99	0.99	0.99	0.99	0.99	0.99
USC00075320	DE	38.7841	-75.1581	LEWES	1.01	1.02	1.03	1.03	1.04	1.05	1.06

3-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	0.99	0.99	1	1	1.01	1.01	1.02
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	1.01	1.01	1.01	1.02	1.02	1.03	1.04
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1	1	1.01	1.02	1.02	1.03	1.05
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.96	0.97	0.97	0.98	0.99	1	1.01
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1.01	1.02	1.02	1.03	1.03	1.04	1.04
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	1	1	1.01	1.01	1.02	1.03	1.04
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.02	1.04	1.06	1.07	1.08	1.09	1.11
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	1	1	1	1	1.01	1.01	1.02
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1	1	1	1.01	1.01	1.02	1.03
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	0.98	0.99	0.99	0.99	0.99	1	1
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.01	1.02	1.02	1.02	1.03	1.03	1.04
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1	1	1.01	1.02	1.02	1.03	1.04
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	0.99	0.99	0.99	1	1	1.01	1.02
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	0.99	1	1	1.01	1.01	1.01	1.02
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.01	1.01	1.01	1.01	1.01	1.01	1.01
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.04	1.03	1.03	1.04	1.04	1.04	1.05
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1	1	1	1.01	1.01	1.02	1.03
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.03	1.03	1.02	1.02	1.02	1.02	1.02
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.02	1.03	1.04	1.04	1.06	1.07
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.98	0.98	0.99	1	1	1.01	1.02
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.03	1.03	1.03	1.03	1.03	1.04	1.05
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.01	1.02	1.02	1.02	1.03	1.04
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.02	1.02	1.03	1.03	1.03	1.04	1.05
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.06	1.06	1.06	1.06	1.06	1.06	1.07
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	1	1	1.01	1.01	1.01	1.02	1.02
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.03	1.03	1.03	1.03	1.04	1.04	1.05
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.94	0.95	0.96	0.96	0.97	0.97	0.97
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.99	0.99	1	1	1.01	1.01	1.02
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.01	1.06	1.1	1.13	1.14	1.18	1.21
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.04	1.05	1.05	1.06	1.06	1.07	1.07
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.02	1.06	1.08	1.1	1.11	1.13	1.15
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1	1.04	1.07	1.09	1.1	1.13	1.16
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.04	1.05	1.06	1.07	1.08	1.09	1.1
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1	1.01	1.01	1.02	1.03	1.04	1.05
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.05	1.06	1.06	1.07	1.07	1.08	1.09
USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.06	1.07	1.08	1.09	1.09	1.1	1.11

USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.08	1.07	1.07	1.06	1.06	1.06	1.06
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.06	1.07	1.07	1.07	1.07	1.06	1.05
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.98	1	1.02	1.04	1.05	1.08	1.11
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.02	1.04	1.05	1.06	1.06	1.07	1.08
USC00061762	CT	41.4002	-73.4212	DANBURY	1	0.99	0.99	0.99	0.99	0.98	0.98
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.01	1	1	1	1	1	1
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1	1	1	1	1	1	1
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1	1	1	1	1.01	1.01
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.99	0.99	0.98	0.97	0.97	0.96	0.94
USC00072730	DE	39.1467	-75.5055	DOVER	0.99	0.99	0.99	0.99	0.99	0.99	0.99
USC00075320	DE	38.7841	-75.1581	LEWES	1.01	1.02	1.03	1.03	1.04	1.05	1.06
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1.01	1.02	1.03	1.04	1.04	1.04	1.05
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.04	1.04	1.04	1.04	1.04	1.04	1.04
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1.03	1.04	1.04	1.04	1.04	1.04	1.04
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1.05	1.07	1.09	1.1	1.11	1.13	1.15
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.05	1.06	1.08	1.09	1.09	1.11	1.13
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.05	1.07	1.08	1.1	1.1	1.12	1.14

4-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	0.99	0.99	1	1	1.01	1.01	1.02
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	1.01	1.01	1.01	1.02	1.02	1.02	1.03
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1	1.01	1.01	1.02	1.02	1.03	1.05
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.96	0.97	0.97	0.98	0.98	0.99	1
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1	1.01	1.01	1.02	1.02	1.03	1.03
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	1	1	1.01	1.01	1.01	1.02	1.03
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.02	1.04	1.06	1.07	1.07	1.08	1.1
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	0.99	0.99	0.99	1	1	1.01	1.02
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1.01	1.01	1.02	1.02	1.02	1.02	1.02
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	0.99	0.98	0.98	0.99	0.99	0.99	1
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.02	1.02	1.02	1.02	1.03	1.03	1.03
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1.01	1.01	1.01	1.02	1.02	1.03	1.05
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	1	1	1	1.01	1.01	1.02	1.03
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	1	1	1.01	1.01	1.01	1.01	1.01
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.02	1.02	1.01	1.01	1.01	1.01	1
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.02	1.02	1.02	1.02	1.02	1.03	1.04
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1	1	1.01	1.01	1.01	1.02	1.03
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.05	1.04	1.04	1.03	1.03	1.03	1.02
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.02	1.03	1.04	1.05	1.06	1.08
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.98	0.99	0.99	1	1	1.01	1.02
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.03	1.03	1.03	1.03	1.03	1.04	1.05
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.01	1.01	1.01	1.01	1.01	1.02	1.03
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.01	1.01	1.02	1.02	1.02	1.03	1.04
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.06	1.06	1.06	1.06	1.07	1.07	1.08
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	0.99	1	1	1.01	1.01	1.02	1.03
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.05	1.04	1.04	1.05	1.05	1.06	1.07
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.94	0.95	0.96	0.96	0.97	0.97	0.97
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.99	0.99	1	1	1	1.01	1.02
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.01	1.06	1.09	1.13	1.14	1.18	1.21
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.05	1.06	1.06	1.06	1.07	1.07	1.07
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.04	1.07	1.09	1.11	1.12	1.15	1.18
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1.01	1.05	1.07	1.1	1.11	1.14	1.17
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.06	1.07	1.08	1.09	1.1	1.11	1.13
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1	1.01	1.02	1.02	1.02	1.03	1.04
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.07	1.08	1.08	1.09	1.09	1.09	1.09
USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.05	1.06	1.07	1.08	1.09	1.1	1.12

USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.07	1.08	1.07	1.06	1.06	1.05	1.04
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.06	1.07	1.07	1.06	1.06	1.05	1.04
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.98	1	1.02	1.05	1.06	1.09	1.13
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.03	1.04	1.06	1.07	1.08	1.09	1.11
USC00061762	CT	41.4002	-73.4212	DANBURY	1	0.99	0.99	0.99	0.99	0.98	0.98
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1	1	1	1	1	1	1.01
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1	1	1	1	1	1	1.01
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	0.99	0.99	1	1	1	1	1.01
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	1	0.99	0.98	0.97	0.97	0.96	0.94
USC00072730	DE	39.1467	-75.5055	DOVER	1.01	1.01	1.01	1.01	1.01	1	1
USC00075320	DE	38.7841	-75.1581	LEWES	1.01	1.02	1.03	1.04	1.04	1.05	1.06
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1.01	1.03	1.04	1.04	1.04	1.05	1.05
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.04	1.05	1.05	1.05	1.05	1.04	1.03
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1.04	1.05	1.05	1.05	1.04	1.04	1.03
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1.06	1.07	1.09	1.1	1.11	1.12	1.14
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.04	1.05	1.07	1.08	1.08	1.1	1.11
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.06	1.07	1.08	1.09	1.1	1.11	1.13

7-Day Atlas 14 Adjustments

					Adjustment to Published Atlas 14 Recurrence Interval Amount						
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	0.99	1	1	1.01	1.01	1.01	1.02
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	1	1.01	1.02	1.03	1.03	1.04	1.05
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1.01	1.02	1.03	1.04	1.04	1.05	1.06
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.97	0.98	0.99	1	1.01	1.02	1.03
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1	1	1	1	1.01	1.01	1.01
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	1.01	1.02	1.02	1.03	1.03	1.04	1.06
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.02	1.05	1.06	1.08	1.08	1.09	1.11
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	1.01	1.01	1.02	1.03	1.03	1.05	1.06
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1	1.01	1.02	1.02	1.02	1.02	1.02
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	0.99	1	1	1.01	1.01	1.02	1.02
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.03	1.04	1.05	1.05	1.05	1.05	1.05
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1.02	1.03	1.03	1.04	1.04	1.04	1.04
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	1	1.01	1.02	1.03	1.03	1.05	1.07
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	1.01	1.02	1.02	1.02	1.02	1.03	1.03
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.01	1.02	1.02	1.01	1.01	1	0.99
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.03	1.03	1.04	1.05	1.05	1.06	1.08
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1.01	1.02	1.02	1.03	1.03	1.04	1.06
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.07	1.07	1.06	1.06	1.05	1.04	1.03
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.03	1.04	1.05	1.06	1.07	1.09
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.98	0.99	1	1.01	1.01	1.03	1.04
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.03	1.03	1.04	1.06	1.07	1.09	1.11
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.03	1.03	1.04	1.05	1.06	1.08	1.1
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.02	1.02	1.03	1.05	1.05	1.07	1.09
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.05	1.05	1.06	1.07	1.07	1.08	1.1
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	1	1.01	1.02	1.03	1.03	1.05	1.07
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.01	1.01	1.03	1.04	1.05	1.07	1.1
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.93	0.95	0.96	0.98	0.99	1.01	1.03
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.98	0.99	1	1.02	1.03	1.06	1.09
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.02	1.06	1.09	1.12	1.13	1.15	1.18
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.04	1.05	1.06	1.06	1.06	1.05	1.04
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.04	1.06	1.08	1.09	1.1	1.12	1.14
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1.01	1.04	1.06	1.08	1.08	1.1	1.12
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.02	1.04	1.05	1.06	1.07	1.08	1.1
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1.01	1.02	1.03	1.03	1.03	1.02	1.02
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.06	1.07	1.08	1.07	1.07	1.06	1.05

USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.04	1.06	1.07	1.07	1.07	1.07	1.07
USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.07	1.07	1.07	1.06	1.06	1.05	1.03
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.06	1.06	1.06	1.06	1.05	1.04	1.02
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.98	1	1.01	1.03	1.03	1.05	1.07
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.03	1.04	1.05	1.05	1.05	1.05	1.05
USC00061762	CT	41.4002	-73.4212	DANBURY	1	1	1	1.01	1.01	1.02	1.03
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1	1	1.01	1.02	1.02	1.04	1.05
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1	1	1.01	1.02	1.02	1.04	1.06
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	0.99	1	1.01	1.02	1.03	1.05	1.07
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.97	0.97	0.98	0.98	0.98	0.98	0.98
USC00072730	DE	39.1467	-75.5055	DOVER	1.03	1.02	1.02	1.01	1.01	1	0.99
USC00075320	DE	38.7841	-75.1581	LEWES	1.01	1.01	1.02	1.02	1.02	1.02	1.02
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1.02	1.03	1.03	1.03	1.03	1.03	1.02
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.05	1.06	1.05	1.04	1.04	1.02	1.01
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1.05	1.05	1.05	1.05	1.04	1.03	1.01
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1	1.02	1.03	1.04	1.05	1.06	1.07
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.05	1.05	1.06	1.06	1.06	1.06	1.07
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.04	1.05	1.06	1.06	1.06	1.07	1.08

10-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	0.99	0.99	0.99	1	1	1.01	1.02
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	0.99	0.99	0.99	1	1	1.01	1.01
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	0.99	0.99	0.99	1	1	1	1.01
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.97	0.98	0.98	0.99	0.99	0.99	1
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1	1	1	0.99	0.99	0.99	0.99
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	0.99	0.99	1	1	1	1	1.01
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.03	1.03	1.03	1.02	1.02	1.02	1.01
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	1	1	1.01	1.02	1.02	1.03	1.05
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1	1.01	1.01	1.01	1.01	1.02	1.03
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	0.99	0.99	0.99	1	1	1.01	1.01
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.03	1.03	1.03	1.04	1.04	1.04	1.05
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1	1.01	1.01	1.01	1.01	1.01	1.01
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	1	1	1.01	1.02	1.02	1.04	1.06
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	1.01	1.01	1.02	1.02	1.02	1.02	1.03
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.01	1.01	1.01	1.01	1.01	1	1
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.02	1.02	1.03	1.03	1.04	1.05	1.06
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	1	0.99	1	1	1	1	1
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.03	1.04	1.03	1.03	1.03	1.03	1.02
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.02	1.03	1.03	1.03	1.03	1.04
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.99	0.99	0.99	1	1	1	1.01
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.02	1.03	1.04	1.05	1.06	1.07	1.09
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.01	1.02	1.03	1.04	1.05	1.07	1.09
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1	1.01	1.02	1.03	1.03	1.05	1.07
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.01	1.01	1.01	1.02	1.02	1.02	1.03
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	0.99	1	1.01	1.02	1.03	1.04	1.06
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.02	1.02	1.03	1.04	1.04	1.05	1.06
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.94	0.96	0.97	0.99	0.99	1.01	1.03
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.98	0.99	1.01	1.02	1.03	1.05	1.08
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.03	1.04	1.05	1.06	1.06	1.06	1.07
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.04	1.05	1.05	1.05	1.05	1.04	1.03
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.05	1.05	1.05	1.05	1.05	1.06	1.06
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1.01	1.02	1.02	1.03	1.03	1.03	1.04
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.03	1.03	1.04	1.04	1.05	1.06	1.07
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1	1.01	1.02	1.02	1.02	1.02	1.02
USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.06	1.07	1.07	1.06	1.06	1.05	1.04

USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.04	1.05	1.05	1.06	1.06	1.06	1.06
USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.07	1.08	1.08	1.07	1.07	1.07	1.06
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.06	1.06	1.06	1.06	1.05	1.05	1.03
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.98	0.99	1	1.02	1.02	1.03	1.05
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.01	1.02	1.02	1.03	1.03	1.03	1.03
USC00061762	CT	41.4002	-73.4212	DANBURY	0.99	0.99	1	1	1	1.01	1.01
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1	1	1.01	1.01	1.02	1.02	1.03
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1.01	1.01	1.01	1.01	1.02	1.03	1.04
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1.01	1.02	1.03	1.03	1.05	1.06
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.98	0.98	0.98	0.98	0.98	0.98	0.97
USC00072730	DE	39.1467	-75.5055	DOVER	1.01	1.01	1.01	1	1	1	0.99
USC00075320	DE	38.7841	-75.1581	LEWES	1.01	1.01	1.01	1.01	1.01	1	1
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1.02	1.03	1.03	1.04	1.04	1.03	1.03
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.04	1.05	1.05	1.05	1.04	1.03	1.02
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1.03	1.04	1.04	1.04	1.04	1.03	1.02
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1	1.01	1.02	1.03	1.03	1.03	1.03
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.03	1.04	1.04	1.04	1.04	1.04	1.04
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.02	1.03	1.04	1.04	1.04	1.04	1.04

20-Day Atlas 14 Adjustments

Adjustment to Published Atlas 14 Recurrence Interval Amount

Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	20-year	25-year	50-year	100-year
USW00013724	NJ	39.3778	-74.4236	ATLANTIC CITY MARINA	1.02	1.02	1.03	1.04	1.05	1.06	1.08
USC00280907	NJ	40.8917	-74.3962	BOONTON 1 SE	0.98	0.99	1	1.02	1.02	1.04	1.06
USC00281327	NJ	41.1093	-74.4828	CANISTEAR RESERVOIR	1	1.01	1.02	1.03	1.03	1.04	1.06
USC00281335	NJ	40.7436	-74.3539	CANOE BROOK	0.99	1	1.02	1.03	1.04	1.05	1.07
USC00281351	NJ	38.9534	-74.9361	CAPE MAY 2 NW	1.01	1.02	1.02	1.02	1.02	1.02	1.02
USC00281582	NJ	41.03	-74.4248	CHARLOTTEBURG RESERVOIR	0.99	1	1.01	1.02	1.02	1.04	1.05
USC00283029	NJ	40.574	-74.8816	FLEMINGTON 5 NNW	1.04	1.06	1.07	1.08	1.09	1.1	1.12
USC00283181	NJ	40.3136	-74.2511	FREEHOLD-MARLBORO	1.02	1.04	1.05	1.07	1.08	1.11	1.14
USC00283662	NJ	39.6442	-74.8048	HAMMONTON 1 NE	1	1.01	1.02	1.03	1.04	1.05	1.07
USC00283951	NJ	40.2664	-74.5642	HIGHTSTOWN 2 W	1.01	1.02	1.04	1.06	1.07	1.09	1.11
USC00284229	NJ	39.7995	-74.7804	INDIAN MILLS 2 W	1.03	1.04	1.05	1.07	1.08	1.1	1.13
USC00284635	NJ	40.3596	-74.9446	LAMBERTVILLE	1.02	1.03	1.05	1.06	1.07	1.09	1.11
USC00284987	NJ	40.297	-74.0015	LONG BRANCH-OAKHURST	0.99	1.01	1.03	1.06	1.06	1.1	1.13
USC00285346	NJ	39.4504	-74.7472	MAYS LANDING 1 W	1.03	1.03	1.04	1.05	1.05	1.06	1.07
USW00013735	NJ	39.3662	-75.0778	MILLVILLE MUNICIPAL AIRPORT	1.01	1.01	1.02	1.02	1.03	1.03	1.03
USW00014734	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.04	1.06	1.07	1.1	1.11	1.14	1.17
USC00286460	NJ	41.0356	-74.5012	OAK RIDGE RESERVOIR	0.99	1	1	1.01	1.02	1.03	1.04
USC00281033	NJ	39.4871	-75.2201	SEABROOK FARMS	1.06	1.06	1.06	1.06	1.06	1.07	1.07
USC00288644	NJ	41.2184	-74.6207	SUSSEX 1 NW	1.02	1.02	1.03	1.04	1.05	1.06	1.08
USC00289187	NJ	41.0444	-74.2933	WANAQUE RAYMOND DAM	0.99	0.99	1	1.01	1.02	1.03	1.05
USW00094789	NY	40.6392	-73.764	JFK INTERNATIONAL AIRPORT	1.02	1.04	1.06	1.08	1.09	1.12	1.16
USW00014732	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.03	1.04	1.06	1.08	1.09	1.12	1.16
USW00094728	NY	40.779	-73.9693	NY CITY CENTRAL PARK	1.03	1.04	1.06	1.08	1.08	1.11	1.15
USC00306774	NY	41.3891	-74.6905	PORT JERVIS	1.01	1.02	1.02	1.03	1.04	1.05	1.07
USW00014757	NY	41.6257	-73.8816	POUGHKEEPSIE AIRPORT	1.01	1.01	1.03	1.04	1.05	1.07	1.1
USC00307134	NY	40.9624	-72.7161	RIVERHEAD RESEARCH FARM	1.02	1.02	1.03	1.03	1.03	1.04	1.05
USC00307742	NY	41.3325	-73.837	SHRUB OAK	0.97	0.98	1	1.01	1.02	1.04	1.06
USW00094745	NY	41.0624	-73.7046	WESTCHESTER CO AP	0.98	1	1.02	1.04	1.05	1.08	1.11
USW00014737	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.08	1.08	1.08	1.08	1.08	1.08	1.07
USC00361737	PA	40.0744	-75.3179	CONSHOHOCKEN	1.04	1.05	1.06	1.06	1.07	1.07	1.08
USC00368596	PA	41.0148	-75.2071	EAST STROUDSBURG	1.08	1.08	1.08	1.09	1.09	1.1	1.12
USC00364934	PA	40.8223	-75.6962	LEHIGHTON 1SSW	1.03	1.04	1.04	1.04	1.04	1.04	1.04
USC00365738	PA	41.6725	-75.0641	MILANVILLE	1.03	1.04	1.05	1.06	1.07	1.08	1.1
USC00366194	PA	40.1482	-74.953	NESHAMINY FALLS	1	1.02	1.03	1.05	1.06	1.08	1.1

USC00366370	PA	40.1097	-75.3371	NORRISTOWN	1.08	1.08	1.09	1.1	1.1	1.11	1.12
USC00366681	PA	40.3857	-75.5019	PALM 3 SE	1.05	1.07	1.08	1.08	1.08	1.09	1.09
USW00013739	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.07	1.07	1.07	1.08	1.08	1.08	1.08
USC00366927	PA	40.1211	-75.4942	PHOENIXVILLE 1 E	1.08	1.08	1.08	1.08	1.08	1.08	1.08
USC00368763	PA	40.8483	-75.9995	TAMAQUA 4 N DAM	0.99	1	1.01	1.03	1.03	1.04	1.05
USW00014777	PA	41.3336	-75.7269	WILKES-BARRE/SCRANTON INTERNATIONAL AIRPORT	1.02	1.02	1.02	1.03	1.03	1.04	1.04
USC00061762	CT	41.4002	-73.4212	DANBURY	0.99	0.99	0.99	1	1	1.01	1.02
USW00094702	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1	1	1.01	1.01	1.01	1.02	1.03
USW00014758	CT	41.2639	-72.8872	NEW HAVEN TWEED AP	1.02	1.02	1.02	1.02	1.03	1.03	1.04
USC00066655	CT	41.0825	-73.6386	PUTNAM LAKE	1	1.01	1.03	1.04	1.05	1.07	1.09
USC00067432	CT	41.6445	-72.8167	SHUTTLE MEADOW RESERVOIR	0.98	0.98	0.99	0.99	0.99	1	1.01
USC00072730	DE	39.1467	-75.5055	DOVER	1.01	1.01	1.01	1.01	1.01	1.01	1.01
USC00075320	DE	38.7841	-75.1581	LEWES	1.02	1.02	1.02	1.02	1.03	1.03	1.03
USC00076410	DE	39.6682	-75.7457	NEWARK AG FARM	1	1.02	1.03	1.04	1.04	1.05	1.06
USW00013781	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.04	1.05	1.06	1.06	1.06	1.07	1.08
USC00079605	DE	39.7739	-75.5414	WILMINGTON PORTER RES	1.02	1.03	1.04	1.05	1.05	1.06	1.07
USC00187330	MD	38.2122	-75.6822	PRINCESS ANNE	1	1.01	1.02	1.03	1.03	1.04	1.06
USW00093720	MD	38.3408	-75.5132	SALISBURY-WICOMICO REGIONAL AIRPORT	1.05	1.05	1.05	1.06	1.06	1.07	1.07
USC00188380	MD	38.2317	-75.3761	SNOW HILL 4 N	1.03	1.03	1.04	1.05	1.05	1.06	1.07

APPENDIX B

Adjustments to NOAA Atlas 14 hourly recurrence interval precipitation amounts to reflect 1950-2019 data record by station

1-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.06	1.06	1.05	1.04	1.04	1.02
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.00	1.00	0.99	0.99	0.99
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.03	1.03	1.02	1.01	0.99
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.04	1.04	1.04	1.03	1.02	1.00
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.07	1.06	1.04	1.04	1.02
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.02	1.02	1.04	1.06	1.07	1.10
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.06	1.05	1.04	1.03	1.03	1.02
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.04	1.04	1.04	1.03	1.02	1.01
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.05	1.04	1.03	1.03	1.03	1.03

2-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.05	1.04	1.03	1.02	1.01	1.00
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.98	0.99	0.99	0.99	0.99	0.99
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.01	1.00	0.99	0.99	0.98
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.04	1.02	1.01	1.00	1.00	0.99
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.05	1.04	1.02	1.02	1.00
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERAIRPORT	1.04	1.06	1.07	1.09	1.10	1.12
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.10	1.08	1.08	1.07	1.06	1.05
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.01	1.00	1.00	1.00	1.00	1.00
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.04	1.04	1.04	1.04	1.04	1.04

3-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.04	1.03	1.02	1.01	1.00	0.99
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.97	0.98	0.99	0.99	0.99	0.99
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.01	1.00	0.99	0.98	0.97
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.02	1.01	1.00	0.99	0.99	0.97
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.05	1.03	1.02	1.01	0.99
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTERNATIONAL AIRPORT	1.06	1.09	1.11	1.12	1.12	1.13
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.10	1.10	1.09	1.08	1.08	1.07
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.99	0.99	0.99	0.98	0.98	0.98
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.02	1.03	1.04	1.04	1.04	1.05

6-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.03	1.03	1.02	1.02	1.01	1.00
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.00	1.01	1.01	1.01	1.02
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.01	1.01	1.01	1.00	1.00	0.99
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.01	1.01	1.01	1.00	1.00	0.99
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.06	1.05	1.03	1.03	1.01
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.05	1.07	1.09	1.11	1.12	1.14
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.09	1.08	1.08	1.08	1.08	1.09
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.99	1.00	1.00	1.00	1.00	0.99
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.02	1.02	1.03	1.04	1.04	1.06

12-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.03	1.04	1.04	1.05	1.06	1.07
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.01	1.02	1.03	1.04	1.05
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.03	1.03	1.04	1.05	1.05	1.06
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.01	1.02	1.03	1.04	1.04	1.06
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.07	1.07	1.07	1.08	1.09
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.04	1.07	1.09	1.10	1.11	1.12
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.09	1.09	1.10	1.10	1.10	1.10
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.98	1.00	1.01	1.02	1.02	1.03
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.05	1.06	1.06	1.06	1.06	1.07

24-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.03	1.03	1.04	1.06	1.07	1.09
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.01	1.02	1.04	1.04	1.06
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.02	1.03	1.05	1.06	1.08
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.02	1.02	1.03	1.05	1.05	1.07
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.06	1.06	1.06	1.07	1.08	1.10
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.05	1.07	1.09	1.11	1.12	1.14
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.06	1.08	1.09	1.10	1.10	1.11
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.98	0.99	1.00	1.02	1.02	1.04
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.06	1.08	1.08	1.09	1.09	1.09

48-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.02	1.03	1.03	1.03	1.03	1.04
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.98	1.00	1.01	1.02	1.02	1.0
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.02	1.03	1.03	1.03	1.03	1.03
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.03	1.03	1.03	1.03	1.03	1.03
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.05	1.04	1.04	1.04	1.04	1.04
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.03	1.05	1.07	1.08	1.09	1.11
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.07	1.08	1.08	1.08	1.09	1.09
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.00	1.00	1.00	1.00	1.00	1.00
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.06	1.07	1.07	1.08	1.08	1.08

72-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.01	1.01	1.02	1.03	1.03	1.05
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.00	1.01	1.02	1.02	1.0
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.00	1.00	1.01	1.02	1.02	1.04
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.01	1.01	1.02	1.02	1.03	1.04
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.04	1.04	1.04	1.04	1.05	1.06
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.03	1.05	1.06	1.08	1.08	1.10
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.06	1.07	1.08	1.08	1.08	1.09
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	0.99	0.99	0.99	1.00	1.00	1.01
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.07	1.08	1.08	1.08	1.09	1.09

96-hour Duration

					Adjustment to Published Atlas 14 Recurrence Interval Amount					
Station ID	State	Latitude	Longitude	Station Name	2-year	5-year	10-year	25-year	50-year	100-year
286026	NJ	40.6825	-74.1694	NEWARK LIBERTY INTL AP	1.02	1.02	1.02	1.03	1.03	1.04
280311	NJ	39.4520	-74.5670	ATLANTIC CITY INTL AP	0.99	1.00	1.01	1.02	1.02	1.03
305811	NY	40.7794	-73.8804	LAGUARDIA AIRPORT	1.01	1.01	1.01	1.02	1.02	1.03
305801	NY	40.7790	-73.9693	NY CITY CENTRAL PARK	1.02	1.01	1.02	1.02	1.02	1.03
305803	NY	40.6392	-73.7640	JFK INTERNATIONAL AIRPORT	1.07	1.06	1.05	1.05	1.05	1.06
360106	PA	40.6499	-75.4477	ALLENTOWN LEHIGH VALLEY INTER AIRPORT	1.02	1.05	1.07	1.08	1.09	1.11
366889	PA	39.8733	-75.2268	PHILADELPHIA INTL AP	1.06	1.07	1.08	1.09	1.09	1.10
060806	CT	41.1642	-73.1267	IGOR I SIKORSKY MEMORIAL AIRPORT	1.00	0.99	0.99	1.00	1.00	1.00
079595	DE	39.6744	-75.6057	WILMINGTON NEW CASTLE CO AP	1.06	1.08	1.09	1.09	1.09	1.09