The Maritime Influence on Diurnal Temperature Range in the Chesapeake Bay Area

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ABSTRACT: This study analyzes the influence of the Atlantic Ocean and Chesapeake Bay on the diurnal temperature range (DTR) reported by nearby weather stations. Coastal locations reported the smallest DTRs and DTR fluctuations, and DTR increased with distance from the ocean. Month of the year and airmass type also proved to be significant predictors of DTR. All locations showed a bimodal annual DTR pattern with peaks during the transitional seasons and experienced the greatest DTR during dry and/or warm air masses. Proximity to the ocean had the largest (smallest) influence on DTR during dry (moist) air masses with extreme (moderate) temperatures. Seasonally, the proximity to the ocean had the strongest impact on DTR during early–middle spring. A multiple regression model using distance from water, month, and airmass type explains over 30% of DTR variability in the area ($p < 0.01$). Airmass type has the largest influence on DTR, and changes in both air mass and month impacted the DTR of continental locations more than coastal locations. Land use, cloud cover, and wind speed/direction are additional variables that could account for differences not explained by the model.

KEYWORDS: Continentality; Air mass; Temperature range; Microclimate

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1. Introduction

The climate of a location depends in part on its continentality. Any combination of factors (i.e., distance to sea, elevation, latitude, and circulation patterns) that minimize the maritime influence on a location’s weather and climate increases its degree of continentality. A continental climate is minimally impacted by a water body and characterized by extreme seasonal shifts in temperature (colder winters and hotter summers), with an annual temperature range (ATR) typically greater than 15.6°C (McBoyle and Steiner 1972). This “thermal continentality” is also seen on a daily basis (Mikolaskova 2009), as continental locations experience higher maximum temperatures $T_{\text{max}}$ and lower minimum temperatures $T_{\text{min}}$ than their maritime counterparts. This results in a greater diurnal temperature range (DTR). Continental locations have additional climatic characteristics resulting from lack of a dependable moisture source, including seasonal precipitation, often highlighted by a summer maximum from convective storms (McBoyle and Steiner 1972). Coastal locations may also be affected by a sea breeze, which causes a variety of weather changes when it penetrates inland, including an increase in humidity and cloud cover and occasional precipitation (Simpson 1994).

The purpose of this study is to analyze the temperature variability within an area that is likely to experience DTR moderation by both the Atlantic Ocean and Chesapeake Bay. DTR has gained attention from climatologists because it has been identified as an important climatic factor to consider in anthropogenic climate change research (Barganza et al. 2004). In recent decades, DTR has decreased across the United States (Kalnay and Cai 2003) and across the world (Barganza et al. 2004). This has been attributed to an increase in nighttime temperatures and the associated increase in $T_{\text{min}}$ (Kalnay and Cai 2003). To understand the climate change signal in DTR data, we must first understand the factors that are responsible for DTR variability on a daily and seasonal time scale. This paper is one of the first to analyze in detail the relationship between DTR and continentality. Generally, the climate of a maritime location is moderated by the temperature and moisture content of a nearby water source, causing a lag between radiation fluctuations and changes in air temperature (Prescott and Collins 1951) and a smaller ATR and DTR than more continental locations (Mikolaskova 2009).

1.1. Continentality indices

Continentality indices have been utilized to characterize locations by their degree of continentality. Van den Dool and Konnen (Van den Dool and Konnen 1982) create a simple physical model showing that the degree of maritime influence at a location can be partly prescribed by the lag of temperature extremes in the winter and summer. McBoyle and Steiner (McBoyle and Steiner 1972) note that the summer/winter precipitation ratio and humidity are also useful in creating a continentality index.

Continentality indices are regionally specific, as the spatial influence of continentality on ATR and DTR varies. The degree of thermal continentality is highly correlated with latitude because of insolation differences (Mikolaskova 2009), is dependent upon wind patterns (Hela 1952), and is correlated to prevailing airmass
Therefore, maritime influence varies regionally and seasonally and is also dependent on presiding weather type.

1.2. Diurnal temperature range variability

A number of variables impact the DTR of a location on a given day. Moisture has been found to play a large role for several reasons. Cloud cover significantly decreases the DTR (Sun et al. 2006) and, along with soil moisture and precipitation (Dai et al. 1999), clouds can cause a 25%–50% reduction in DTR. Scheitlin and Dixon (Scheitlin and Dixon 2010) note that moist air masses cause significantly smaller DTRs across a region compared to dry air masses, regardless of the temperature of the airmass. The significant impact of moisture on DTR supports the consensus that areas with different levels of continentality will experience variations in DTR due to moisture availability.

Land use is also an important determinant of DTR on a given day. Urban heat islands cause cities to have smaller DTRs than other land-use types (Gallo 1996). Deforestation for agriculture also decreases the DTR, because enhanced evapotranspirational cooling in the irrigated cropland results in a decrease in $T_{\text{max}}$ (Bonan 2001). Forests experience greater DTRs than both urban and agricultural areas (Scheitlin and Dixon 2010).

Regardless of land-use type, a similar DTR pattern is seen annually across the eastern United States. The pattern is characterized by two DTR peaks in the spring and fall and DTR minimums in the summer and winter (Leathers et al. 1998; Durre and Wallace 2001a; Durre and Wallace 2001b; Sun et al. 2006; Scheitlin and Dixon 2010). The cause of the transition-season peaks are not completely understood but are likely related to moisture in some capacity, possibly due to seasonal changes in evapotranspiration rates (Durre and Wallace 2001b) or seasonal changes in airmass frequency (Scheitlin and Dixon 2010).

The goal of this study is to investigate the maritime influence on DTR in the Chesapeake Bay area. More specifically, this study is an initial attempt to differentiate between the impacts of the Chesapeake Bay and Atlantic Ocean on nearby temperature with respect to time of year, air mass, and degree of continentality. The next section details the data and methods used to complete the analyses. This is followed by a discussion of the results and then a summary and concluding remarks.

2. Data and methods

To analyze the influence of the Chesapeake Bay and Atlantic Ocean on nearby climate, a study area is chosen that includes land directly adjacent to the water sources and then reaches inland. The study area is bounded by a rectangle encompassing the southern half of the Delmarva Peninsula up to the Delaware border and then west approximately halfway through Virginia (see Figure 1). The study area size is set to include continentality differences, while minimizing the influence of other factors known to influence climate and the degree of continentality, such as latitude and elevation.

Observation locations of the U.S. Historical Climatology Network (USHCN) are plotted in Figure 1. The stations were chosen because they have data available from
1 January to 31 December 2011, are located at less than 150 m above mean sea level, and are in an area with a population density of less than 3000 people per square mile. This results in 28 stations that are then grouped according to their location relative to the ocean and bay. “Near Atlantic” locations (group A) are those on the Delmarva Peninsula (eight stations). “Near Chesapeake Bay” locations (group B) are those nearest the western shore of the bay (seven stations). “Continental” locations (group C) are relatively removed from either water source as shown in Figure 1 (six stations). Finally, “distant continental” locations (group D) are farther removed from either water source (seven stations). Daily $T_{\text{max}}$ and $T_{\text{min}}$ data from each location are obtained from the National Climatic Data Center (NCDC) for the calendar year of 2011, and the DTR is calculated for each day by subtracting $T_{\text{min}}$ from $T_{\text{max}}$.

The presiding air mass is characterized using the spatial synoptic classification (SSC). The SSC is a classification scheme that summarizes the ambient weather conditions for locations across the United States, Canada, and parts of Europe. The weather type is classified as dry polar (DP), dry moderate (DM), dry tropical (DT), moist polar (MP), moist moderate (MM), moist tropical (MT), and transitional (Trans). The original SSC system is explained in Kalkstein et al. (Kalkstein et al. 1996) and an expansion of the system is detailed in Sheridan (Sheridan 2002). For this study it is assumed that the entirety of the study area is being influenced by a single air mass, and the daily SSC is obtained for Richmond, Virginia (mapped in Figure 1).

The analysis techniques used in this study include descriptive statistics, $t$ tests, a multiple regression model, and a three-way analysis of variance (ANOVA) with the ultimate goal of analyzing the influence of location relative to a water source, presiding SSC, and month on DTR. The analysis techniques are described in more detail below, along with a discussion of the results.

Figure 1. Locations of the weather stations used in this study. Stations are grouped based on their location: near Atlantic (A), near Chesapeake Bay (B), continental (C), and distant continental (D). The black point denotes Richmond, Virginia, the location of the spatial synoptic classification designation used in this study.
3. Results and discussion

3.1. Annual DTR pattern

First, the annual DTR fluctuation is observed. Time of year is important to consider in temperature studies for several reasons. In addition to its obvious influence on insolation (and thereby temperature), there are seasonal differences in evapotranspiration that could greatly affect DTR (Durre and Wallace 2001b). The frequency of airmass types also changes seasonally (Sheridan 2003). This is relevant to this study because humid air masses have been shown to cause smaller DTRs than dry air masses, while polar air masses have been shown to cause smaller DTRs than tropical air masses (Scheitlin and Dixon 2010).

A plot of the mean monthly DTRs (Figure 2) shows that all four station groups experience a somewhat bimodal DTR pattern. The spring and fall (winter and summer) DTR maximums (minimums) have been noted in prior research in different study areas (Durre and Wallace 2001a; Durre and Wallace 2001b; Sun et al. 2006; Scheitlin and Dixon 2010). Durre and Wallace (Durre and Wallace 2001b) suggest the reasoning may be a seasonal shift in evapotranspirational cooling; however, Scheitlin and Dixon (Scheitlin and Dixon 2010) show that the bimodal pattern is seen regardless of land-use type and therefore may be related to shifts in airmass frequency. The DTR peaks seen here are slightly off from the time scale seen in much of the previous literature, likely because of differences in latitude and continentality of the study areas. The stronger winter minimum and weaker
summer minimum are characteristic of the latitude of the study area (Durre and Wallace 2001b).

A general linear model using month (expressed as a factor) as a predictor of DTR only explains 8.0% of the DTR variability seen in the study area ($p < 0.05$). The model residuals are distributed unevenly by station group, suggesting that the model needs to account for distance from water (see Figure 3). Specifically, group A is being overpredicted, meaning the observed DTR of coastal locations is less than the model is predicting. Group D is being underpredicted, meaning the observed DTR of the locations farther from the water is greater than the model is predicting. The model, being only based on month, is not accounting for the temperature moderation of the coastal locations (group A) and the greater DTR of more distant locations (group D).

The DTR means for each group are listed in Table 1. The smallest annual DTR of 10.00°C is experienced by group A, and the mean annual group DTR increases with distance from the ocean (group B: 10.60°C; group C: 11.72°C; group D: 13.18°C). This result suggests that the ocean is moderating daily and seasonal temperatures as would be expected. The annual DTR rank (group A < group B < group C < group D) is present each month, with the only exception being in December, when group B reported an insignificantly smaller DTR than group A ($p < 0.01$). The $t$ tests show that all of the mean annual group DTRs are significantly different ($p < 0.01$) from each other. Annually, the greatest DTR difference in adjacent groups occurs between groups D and C (1.46°C) and then between groups B and C (1.12°C). Stations nearest to the ocean and bay (groups A and B) are the most similar, with only 0.60°C DTR difference.

![Figure 3. Residuals of a linear model predicting DTR using month as the independent variable. Residual values are shown as box plots based on station group (A, B, C, and D). The line in the center of each box plot denotes the median. If the width of the median notch does not overlap the median notch of another plot, there is strong evidence that they are significantly different. The whiskers extend to the most extreme data point that is no more than 1.5 times the interquartile range from the box. The points are considered outliers.](image)
3.2. Monthly DTR variability

Coastal locations (group A) experience not only the smallest mean annual DTR but also the smallest annual fluctuation in DTR. The largest DTR difference for group A is 3.72°C, which is between January (7.94°C) and February (11.66°C) (see Table 1). The largest monthly DTR difference increases with distance from the ocean. Differences within consecutive months are, on average, greatest between January and February, but interestingly group D exhibits the smallest intragroup difference between these months, in spite of having the largest annual shift in DTR (from 10.17°C in September to 15.42°C in November). Most of the significant differences between consecutive months occur August through February, with more gradual monthly shifts during the rest of the year (February through August).

3.3. Monthly variability in marine influence

The DTR differences between station groups vary monthly, but there is a significant difference between the DTR of groups A and D during every month of the year (Table 2). The greatest differences occurred in the transition seasons, which is usually the climatic maximum of monthly DTR means (see Figure 2). The greatest total DTR differences occurred in March, November, and April: each of which reported over a 4°C total difference in DTR across the study area (between groups A and D). During March and April there is also the largest difference between groups A and B (1.34°C and 1.53°C), with the difference being double the average annual difference between the two groups (0.61°C). It is obvious that during the early–middle spring, proximity to the ocean has a strong impact on DTR. Between February and March the DTR of all groups dropped, but the amount of the decrease lessened with distance from ocean and the group D decrease was small and insignificant ($p < 0.01$).

During the month of November the study area reported its second-greatest DTR difference (4.63°C), but this high fall DTR variability has a few differing characteristics from its spring counterpart. First, the fall difference (November) is more
short lived than that of the spring (March and April). Second, unlike during the spring where groups A and B experienced notable DTR differences, the difference between groups A and B in November is insignificant. If these results are due solely to thermal continentality, the water bodies demonstrate a greater spatial influence in the fall than spring. Third, the spring DTR differences are spread more evenly across space, while during the fall, once the maritime influence on temperature begins to wane, the isotherms are more tightly packed, causing cooler temperatures more quickly as distance from the ocean increases. A final difference in the spring and fall seasons is the catalyst of DTR variability. The spring differences between groups were instigated by a drop in DTR that decreased with distance from the ocean, but the highlight of the fall differences is a significant increase in DTR in the most continental locations and smaller increases near the ocean.

The annual and monthly differences in DTR across station groups (Table 2) and the residuals in Figure 3 provide sufficient evidence that the station’s distance to the water (as defined by its group designation) should be included in the linear model predicting DTR. A multiple regression model is created in which month and group designations (both expressed as factors) are the independent variables. Adding station group to the model increased the previous \( R^2 \) value of 0.08 to an adjusted \( R^2 \) value of 0.168 (\( p < 0.01 \)), accounting for an additional 8.8% of explanation of the DTR variability in the study area. The residuals for this model are shown in Figure 4, separated by SSC. The patterns of over- and underprediction between SSC types based on moisture content and temperature suggest that SSC should be included in the model.

### 3.4. Influence of air masses

Here, SSCs are used to analyze the impact of weather type (defined by airmass characteristics) on DTR and the role SSC plays in the strength of maritime influence. The transitional airmass classification indicates a changing weather pattern and can describe a variety of conditions; thus, it is not used in these analyses, except where indicated. Table 3 shows the mean DTR for each group separated by
SSC. All of the groups experienced their SSC DTRs in the same order: DT > DM > MT > DP > MM > MP, with the exception being group D, where MT and DP are reversed. The tropical air masses are associated with the greatest DTRs relative to their moisture range (dry or moist), and the polar air masses are associated with the smallest DTRs relative to their moisture range. The moist air masses are associated with smaller DTRs than their dry counterparts relative to their temperature (polar, moderate, or tropical). Therefore, the addition of moisture or the cooling of an air mass encourages a DTR decrease.

With regards to variability within a single group, group A experienced the least DTR differences due to SSC fluctuations, with a maximum difference of 4.93°C between DT and MP. With a constant moisture source located nearby, the DTR of group A did not increase substantially with the influx of a dry or polar air mass compared to the more continental locations. Interestingly, group D experienced smaller DTR variability between SSCs than groups B and C. The DTR of group D is consistently larger than all other groups and remains large regardless of SSC

### Table 3. Mean DTRs for each station based on SSC type. A bold number indicates that the mean of the station group is significantly different from the next group while under the influence of that particular air mass (p < 0.01). A bold number in D indicates that groups A and D are significantly different.

<table>
<thead>
<tr>
<th></th>
<th>A (°C)</th>
<th>B (°C)</th>
<th>C (°C)</th>
<th>D (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>11.39</td>
<td>11.99</td>
<td>13.54</td>
<td>13.33</td>
</tr>
<tr>
<td>DP</td>
<td>8.93</td>
<td>10.06</td>
<td>10.97</td>
<td>12.86</td>
</tr>
<tr>
<td>DT</td>
<td>11.68</td>
<td>12.26</td>
<td>14.07</td>
<td>15.25</td>
</tr>
<tr>
<td>MM</td>
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<td>8.25</td>
<td>8.72</td>
<td>10.31</td>
</tr>
<tr>
<td>MP</td>
<td>6.75</td>
<td>6.38</td>
<td>6.94</td>
<td>9.60</td>
</tr>
<tr>
<td>MT</td>
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<td>10.10</td>
<td>11.22</td>
<td>12.26</td>
</tr>
<tr>
<td>Trans</td>
<td>10.83</td>
<td>11.51</td>
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<td>12.61</td>
</tr>
</tbody>
</table>
fluctuation. The largest DTR variability due to SSC occurs in group C, with a
7.13°C difference between DT and MP. The main difference between the DTR
variability of groups C and D is that group C has an extremely low DTR during an
MP air mass (6.94°C) but then reaches a high maximum DTR during a DT air mass
(14.07°C). Meanwhile, group D has a high DTR during a DT air mass (15.25°C) but
does not have a similar low DTR during an MP air mass (9.60°C). The MM air
mass is also a time where the group C DTR remains low but the group D DTR is
high. Group C takes on the DTR characteristics of a maritime location during the
moist air masses but a more continental location when a dry air mass is in place.
There is an obvious border of maritime influence between groups C and D during a
time of moist air masses. During the dry air masses, the DTR differences are spread
more linearly across space.

The greatest variability among all groups occurred during DP, meaning on cold,
dry days there were the largest differences between the DTR across the study area.
The smallest variability among groups occurred during the DM and MM SSCs. This
means an air mass of moderate temperature is associated with smaller differences
between groups than one of warmer or cooler temperatures that accentuates the
maritime moderation. Within an air mass of similar temperature, adding moisture
decreases the DTR variability between groups, except for during moderate air
masses when moisture content does not play a large role. When the presiding air
mass is one of extreme temperatures, moisture aids in negating the differences be-
tween the more continental and maritime locations causing more similar DTRs.

Adding the SSC to the multiple regression model increases the model’s adjusted
$R^2$ value from 0.168 to 0.306 ($p < 0.01$). A linear model using only SSC to
explain DTR has an $R^2$ value of 0.172, making SSC the most influential
predictor, even compared to the combined prediction capabilities of continentality
and month.

### 3.5. Interaction between predictors

A three-way ANOVA provides additional insight on the relationship between
DTR variability and the three predictor variables (month, station group, and SSC).
The ANOVA tests for significant differences in DTR due to each individual vari-
able, as well as the interaction between two variables and the three-way interaction
between all three variables.

When interpreting three-way ANOVA results, it is common practice to begin
with the most complex interaction first, which in this case is the three-way inter-
action between station group, SSC, and month. The interaction between all three
variables is not significant ($p = 0.86$), suggesting that, while all three variables are
significant in a multivariate regression model, it is not necessarily the interaction
between the three variables that is important.

With regards to the two-way interactions, the interactions between SSC and
month and between SSC and station group are significant ($p < 0.01$). This signifies
that the relationship between DTR and SSC varies between station group and
month. In other words, the impact that the station’s location relative to the water
has on DTR varies by air mass. An example of this discussed in section 3.4 is that
during a moist air mass the DTRs across station groups are more similar because all
stations have moisture present, not just those that are located close to the water.
Additionally, the significant interaction between SSC and month shows that the impact that time of year (month) has on DTR depends on the presiding air mass. The two-way interaction between month and station group is significant at the \( p < 0.05 \) level. While it is not as significant as the other two-way interactions, it shows that the impact that station group has on DTR varies by month. This would result from an independent variable whose monthly variability is different between station groups. For example, it could be related to land-use type and the changing of evapotranspiration rates between seasons at stations where there is deciduous vegetation (Durre and Wallace 2001b).

The individual ANOVA results reiterate that station group and SSC contribute to significant DTR differences \( (p < 0.01) \). Interestingly, the results suggest that month is not a significant variable \( (p = 0.06) \), which counters the \( t \) test results and regression model. The weaker relationship between month and DTR is likely because it is not the month itself that is impacting DTR but rather something that varies over time such as evapotranspiration rates, airmass frequency, or day length. Since month is a significant variable in the multivariate regression model, it indicates that there is a seasonal shift in DTR that is not explained by station group or SSC and is weakly represented by month. The model would be strengthened by testing other variables that experience seasonality in order to determine which of these is possibly being represented by month in the current model.

### 3.6. Additional considerations

The multiple regression model explains over 30% of DTR variability in the study area, using month, degree of continentality, and SSC as the independent variables. However, adding station name to the model increases the adjusted \( R^2 \) value to 0.384 (a nearly 8% increase), meaning there are additional station-specific variables that are not being accounted for in the model. One of these variables is likely land use, as Scheitlin and Dixon (Scheitlin and Dixon 2010) found that land-use type is a significant covariate for determining DTR (but not as significant as airmass type). This study area incorporates a range of land uses including agricultural and forested areas, as well as smaller urban areas, which all have differing impacts on DTR. The site of the observation station may also play a role. Elsner et al. (Elsner et al. 1996) speculate that a weather station with direct sky exposure reports an anonymously low \( T_{\text{min}} \) on calm, clear nights. Additional factors such as clouds and soil moisture can also play a role on DTR at specific locations. Adding elevation and latitude to the model does not increase its strength, so these variables were discounted with the careful creation of the study area.

The ANOVA results suggest that an important variable missing from this model is one with seasonality. Month proved to be a significant predictor of DTR, but month itself is not physically impacting air temperature. Instead, a variable (or multiple variables) operating with a degree of monthly variability is being represented by month in the model. In addition to some of the variables described in the previous paragraph, wind could be a missing component of the model that varies seasonally. Several studies have quantified the well-known seasonality of the land–sea breeze circulation in other locations (Steyn and Faulkner 1986; Zhu and Atkinson 2004; Lu et al. 2009; among others). Sumner (Sumner 1977) mentions the influence of airmass type on sea breeze inland penetration rates. Including wind
speed and direction in the model can determine sea breeze variability and its impact on DTR and also provide more information on the relationship between sea breeze strength and air mass.

The time scale used here may also be a weakness because it is too short to provide conclusive evidence of the suggested relationships between DTR and the selected variables. The brief time scale was chosen to provide a snapshot of the area while limiting large-scale changes due to climate change or land-use change. A larger time scale could be useful to make certain that the results presented here are not an anomaly.

4. Summary and conclusions

This study analyzes the influence of the Atlantic Ocean and Chesapeake Bay on the DTR of the surrounding area. Weather stations are grouped based on distance from the ocean, in order to determine the maritime influence on DTR while accounting for month and airmass type. All three variables (distance to ocean, month, and airmass type) are significant factors in a multiple regression model determining the DTR of a station.

The premise of thermal continentality is seen across the study area, with the smallest (largest) DTRs occurring at the stations nearest (farthest) from the ocean. The closest and farthest stations from the ocean reported significantly different DTRs for every month and airmass type (expressed by SSC). The stations nearest the ocean also reported the smallest annual fluctuations in DTR.

A similar annual DTR pattern is seen in all station groups, defined by DTR minimums in the winter and summer and maximums in the transition seasons (fall and spring). This is in accordance with previous research (Scheitlin and Dixon 2010), but the winter minimum is fairly short compared to other studies, as well as the late summer maximum. This suggests that all locations used here are probably experiencing some degree of marine influence. The transition seasons are also the time of the greatest differences between station groups, meaning the maritime influence is at its strongest. During the spring the maritime influence has greater temporal impact, lasting a couple of months, but in the fall it seems to have more spatial impact, causing the groups closest to the water to have very small differences.

Also agreeing with previous studies, there is a significant relationship between SSC and DTR. SSC explains more DTR variability than month and distance from the ocean combined. With one exception, all of the station groups experience their SSC mean DTRs in the following order: DT > DM > MT > DP > MM > MP. This shows that the addition of moisture or the cooling of an air mass encourages a DTR decrease. The DTR of the stations nearest the water fluctuated the least with a change in SSC, showing the strength of the maritime influence on coastal locations can overcome a large portion of the SSC influence. With a constant moisture source nearby, the coastal locations were not dependent on airmass moisture. The greatest differences between groups occurred during dry, cold air masses that allow for a large moisture gradient when the lack of evaporative energy hinders an influx of moisture farther inland. Conversely, adding moisture to an air mass negates the maritime influence and lessens DTR variability across space. Air masses with moderate temperatures are also associated with smaller differences between groups, while more extreme temperatures accentuate the maritime moderation of DTR.
Past studies have created continentality indices, which use a set of variables (e.g., distance from coast, humidity, precipitation characteristics, latitude, etc.) to designate the degree of continentality of a location. This study suggests that continentality, at a smaller scale, is relative to time of year and presiding weather conditions, and the strength and spatial spreading of the maritime influence on DTR depends on month and SSC. Location relative to a water body is an important consideration in a continentality index, but the importance of the location depends on the type of weather that is occurring. Some conditions highlight the maritime influence on DTR, while during other conditions (i.e., moist and/or moderate air masses) the maritime signal is lost except for at the most coastal locations. Therefore, a complete continentality index must shift according to the moisture and temperature conditions of the current air mass, as well as the time of year, in order to fully illustrate the variable degree of continentality of a location.

Using a combination of $t$ tests, a three-way ANOVA, and a multivariate regression model, it is obvious that two significant variables are only being partially accounted for. One of these varies by station and could possibly be land-use type (Scheitlin and Dixon 2010). The other variable is one that changes seasonally and is represented partially by month in the current model. This could be a number of variables, including wind speed/direction or evapotranspiration rates (Durre and Wallace 2001b).

This study provides insight on the influence of the Atlantic Ocean and Chesapeake Bay on nearby temperatures; however, it does not discern the different impacts between the two. Whether locations near the bay are impacted by the bay, the ocean, or a combination of both is yet to be answered. To fully understand the influence of the separate water bodies, an increase in the spatial frequency of observation stations will be necessary, especially on the Delmarva Peninsula, because it is located between the bay and the ocean. Humidity or dewpoint data would clarify the influence of moisture on DTR and identify the moisture gradient between the maritime and continental locations.

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References


