Frost and Freeze Data and Impacts to the Agriculture, Construction and Transportation Industry

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Air-Freezing Index to Estimate Frost Depth

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Air-Freezing Index (AFI)

Measure of the combined magnitude and duration of air temperatures above and below the freezing point

- Common index used to estimate a depth of frost penetration
- Daily mean air temperatures are used to generate seasonal values
- Season begins August 1st and ends July 31st the following year
Importance

Research has shown that up to one-third of the U.S. gross domestic product (GDP) is reliant on accurate weather and climate information.

• Including:
  – Construction Industry
  – Agricultural Producers
  – Hydrologists
  – Ecologists
Calculating AFI

- Daily departures are accumulated and plotted to create a seasonal curve.
- Seasonal AFI value is the difference between the highest and lowest inflection points.

Example:

Data gathered from NCDC for 1976-1977 year. Station’s COOP ID – 310301; located at – 35.6°, -82.53°
Calculating AFI

**Charleston City, SC**
- High: 5092
- Low: 5078
- AFI = 14

**Asheville, NC**
- High: 3365
- Low: 3147
- AFI = 218

**Kansas City Intl. Airport, MO**
- High: 3336
- Low: 2614
- AFI = 722

**Ithaca Cornell University, NY**
- High: 2180
- Low: 1009
- AFI = 1171
AFI to Frost Depth

Seasonal AFI values were calculated for all stations for two Climate Normals periods
• 1951-1980 & 1981-2010 (29 values/station/period)

Weibull distribution used to generate return period values

<table>
<thead>
<tr>
<th>STATION</th>
<th>1.1YR</th>
<th>1.2YR</th>
<th>2YR</th>
<th>2.5YR</th>
<th>3.3YR</th>
<th>5YR</th>
<th>10YR</th>
<th>20YR</th>
<th>25YR</th>
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<td>9</td>
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<td>14</td>
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<td>22</td>
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<td>Asheville, NC</td>
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<td>33</td>
<td>71</td>
<td>85</td>
<td>103</td>
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<td>1285</td>
<td>1346</td>
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</table>

100-Year return used to estimate maximum frost depth

<table>
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<tr>
<th>STATION</th>
<th>100YR</th>
<th>FROST DEPTH (CM)</th>
<th>FROST DEPTH (IN)</th>
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<tbody>
<tr>
<td>Charleston City, SC</td>
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<td>9.34</td>
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<td>150.36</td>
<td>59.20</td>
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</table>
AFI to Frost Depth

AFI is converted to frost depth using Brown (1964) formula
Frost Depth

Sites:
• 5,599 stations
• 60-year continuous data record (1950-2010)
Results:
• Reduction - ~73% of stations
• Increase - ~23% of stations
Changes in Frost Depth

Frost Depth Value Change
1951-1980 to 1981-2010
Trend:
• R2 is not significant
• 60-year record shows a decreasing trend over the period (1950-2010)
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Product

NCDC Data Governance process

• Climate Normals: Supplemental Normals
  – Seasonal AFI values, return period values, & frost depth estimates
  – AFI & frost depth maps

• Availability – closer to the end of the year (October)
References


Thank You!

Any Questions?

• Contact: rocky.bilotta@noaa.gov