

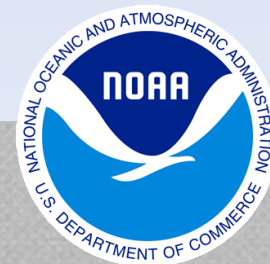
Frost and Freeze Data and Impacts to the Agriculture, Construction and Transportation Industry



Rocky Bilotta

Air-Freezing Index to Estimate Frost
Depth

March 21, 2013



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

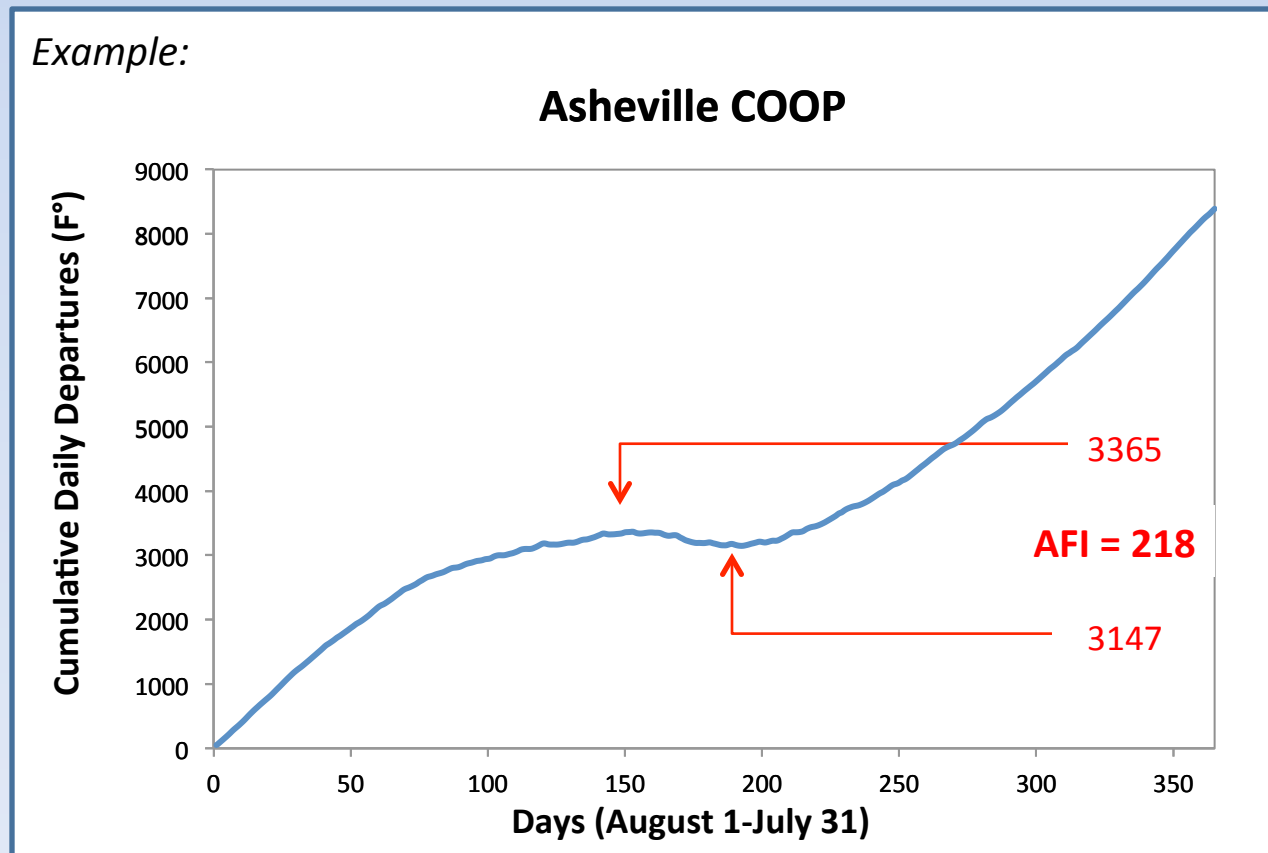
Research has shown that up to one-third of the U.S. gross domestic product (GDP) is reliant on accurate weather and climate information.

- 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:

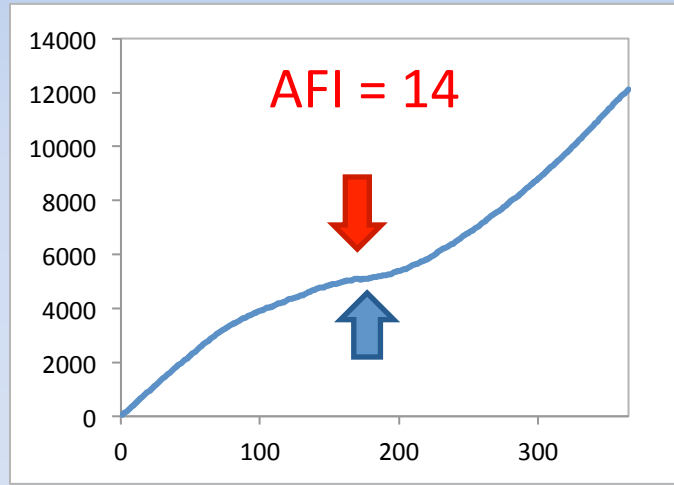


Data gathered from NCDC for 1976-1977 year. Station's COOP ID – 310301; located at – 35.6°, -82.53°

Calculating AFI

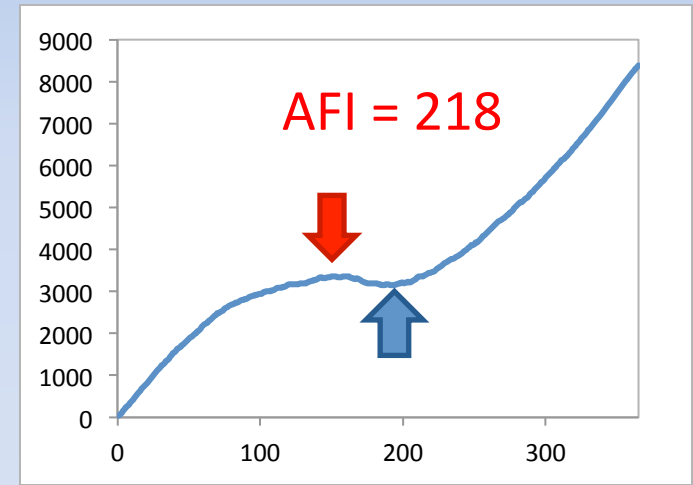
Charleston City, SC

High:
5092
Low:
5078



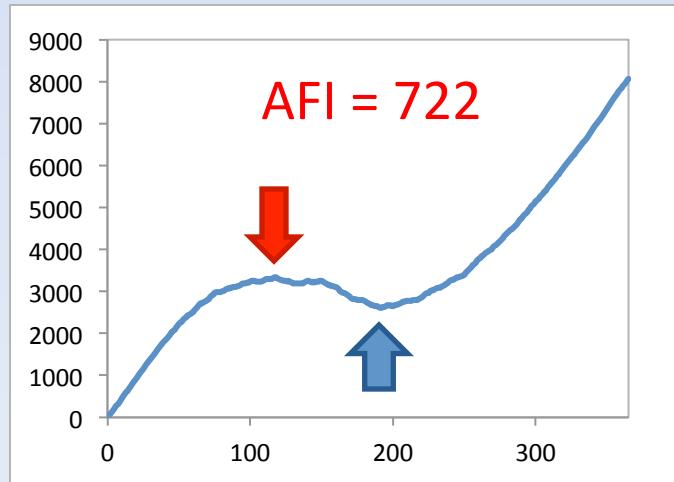
Asheville, NC

High:
3365
Low:
3147



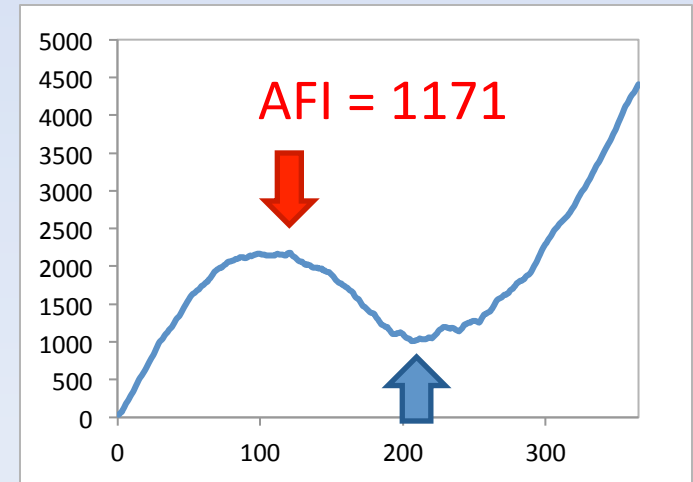
Kansas City Intl. Airport, MO

High:
3336
Low:
2614



Ithaca Cornell University, NY

High:
2180
Low:
1009



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

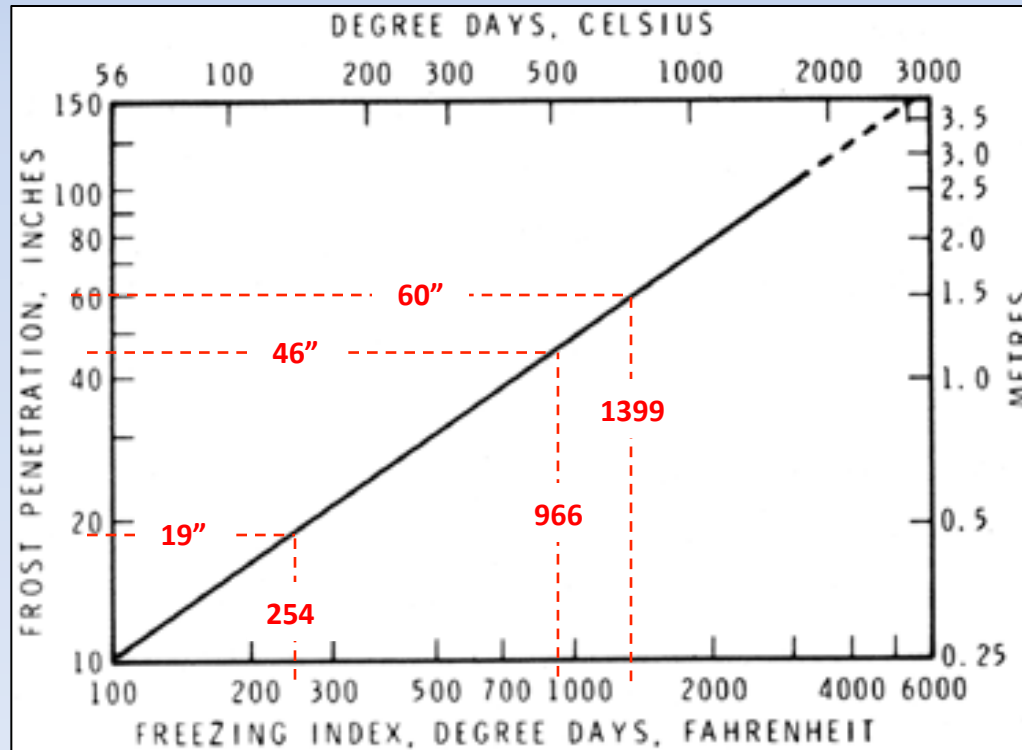
STATION	1.1YR	1.2YR	2YR	2.5YR	3.3YR	5YR	10YR	20YR	25YR	50YR	100YR
Charleston City, SC	0	1	2	3	4	6	9	13	14	18	22
Asheville, NC	20	33	71	85	103	125	159	190	199	227	254
Kansas City Intl. AP, MO	182	253	418	473	534	607	711	799	825	899	966
Ithaca Cornell Univ., NY	572	683	893	954	1018	1090	1187	1263	1285	1346	1399

100-Year return used to estimate maximum frost depth

STATION	100YR	FROST DEPTH (CM)	FROST DEPTH (IN)
Charleston City, SC	22	9.34	3.68
Asheville, NC	254	47.92	18.86
Kansas City Intl. AP, MO	966	117.38	46.21
Ithaca Cornell Univ., NY	1399	150.36	59.20

AFI to Frost Depth

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

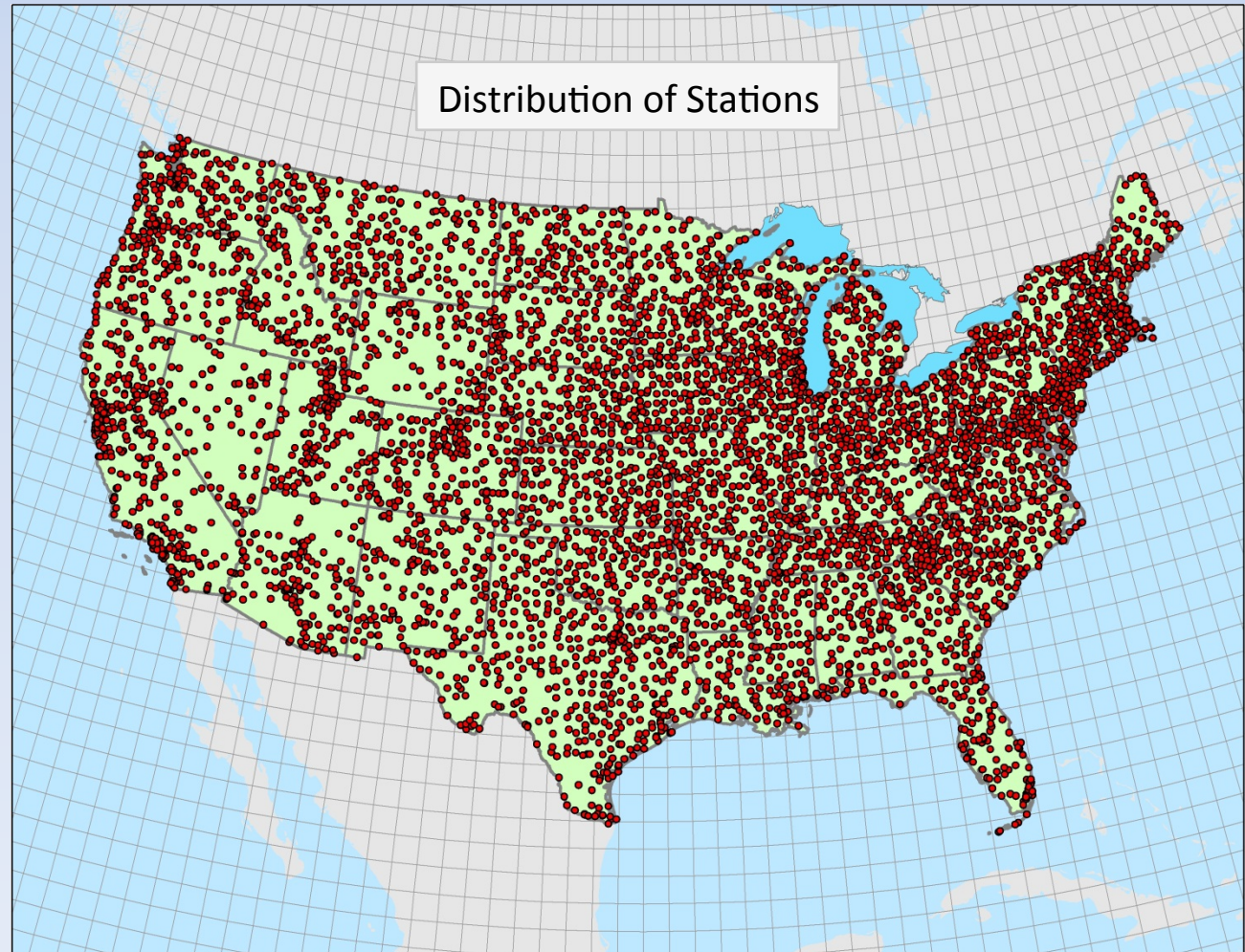


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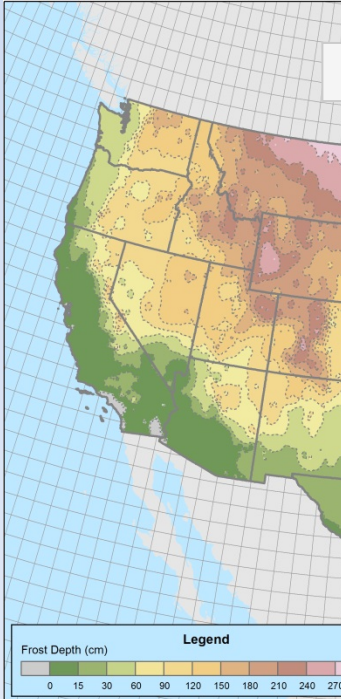
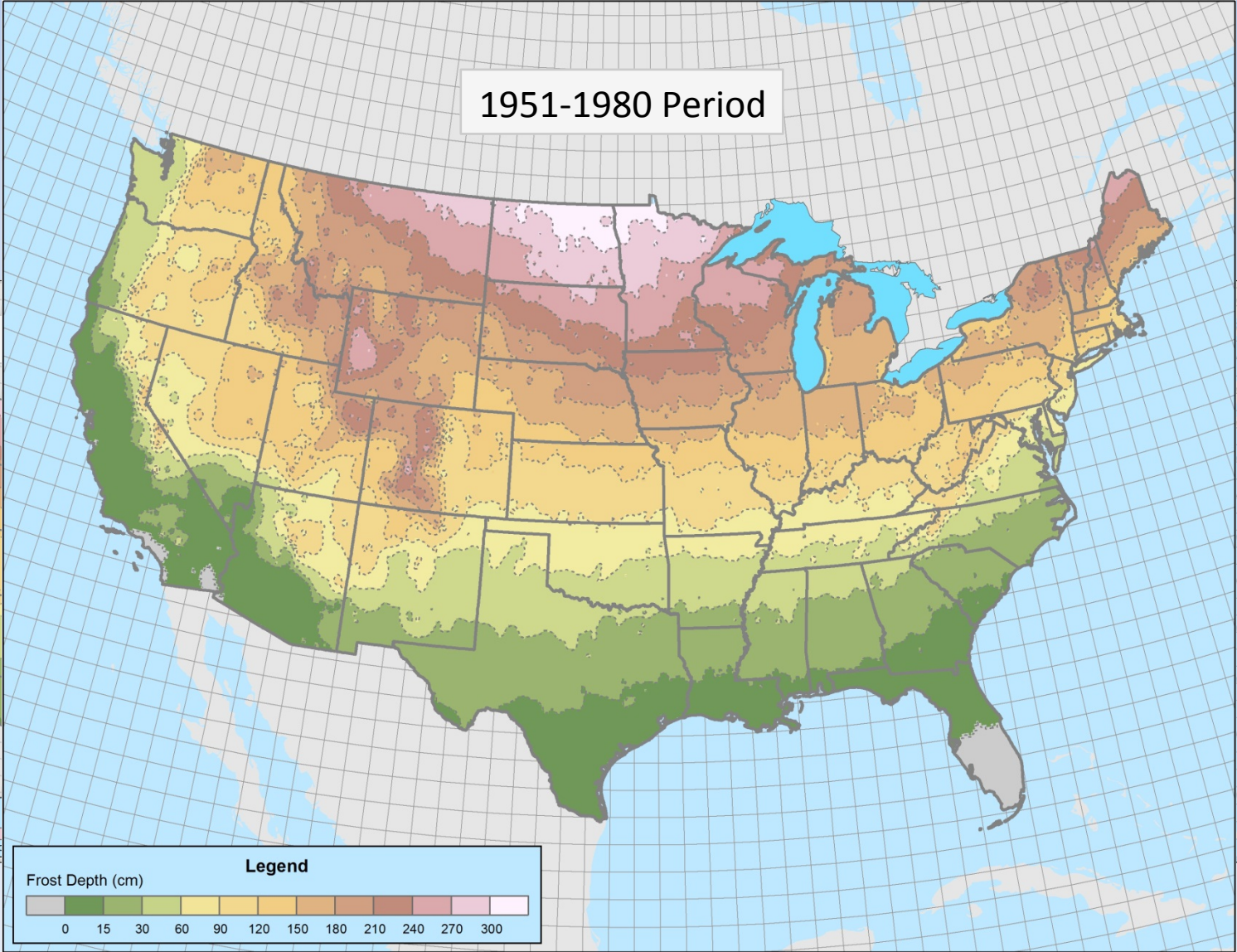
Frost Depth

Sites:

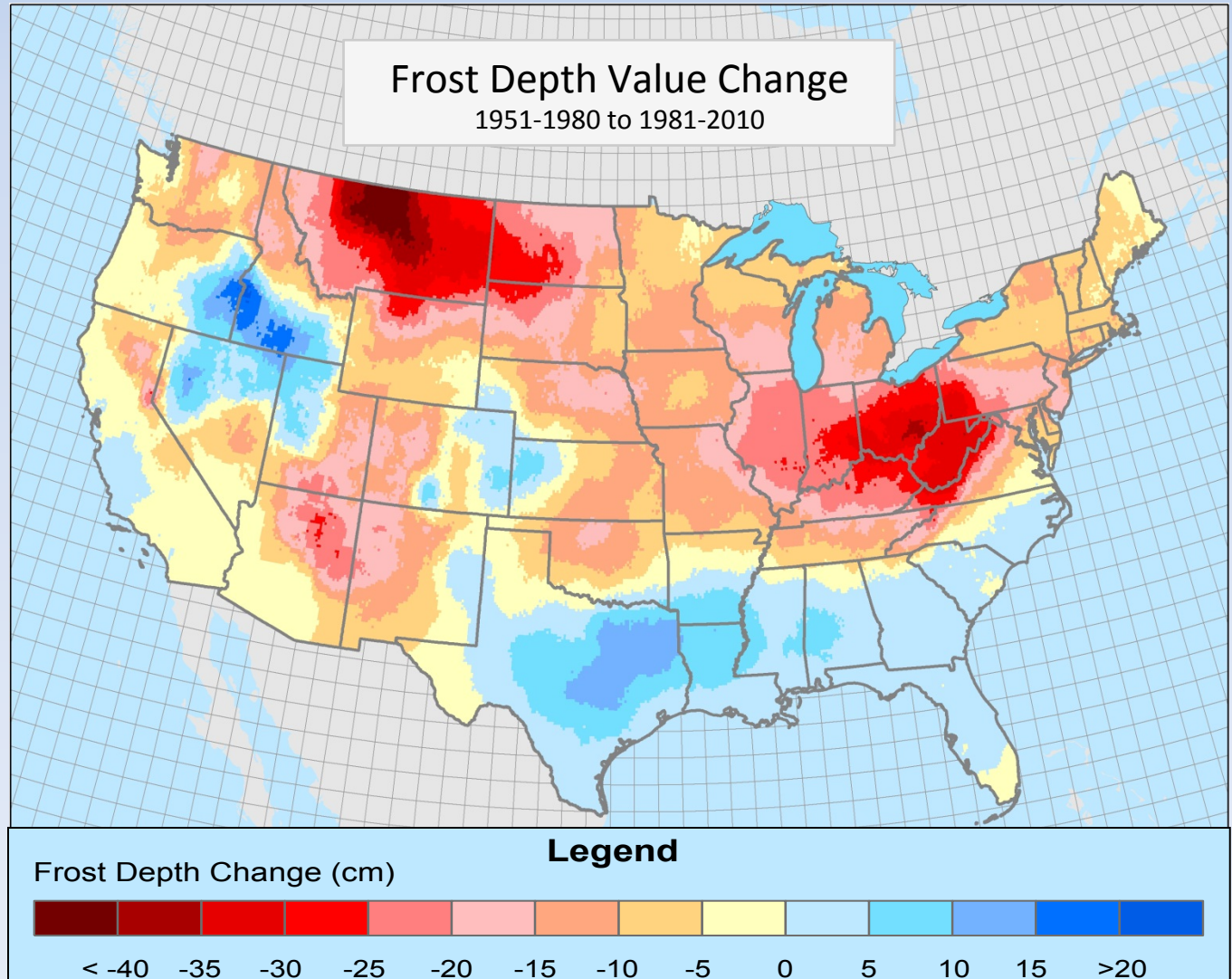
- 5,599 stations
- 60-year continuous data record (1950-2010)



1951-1980 Period



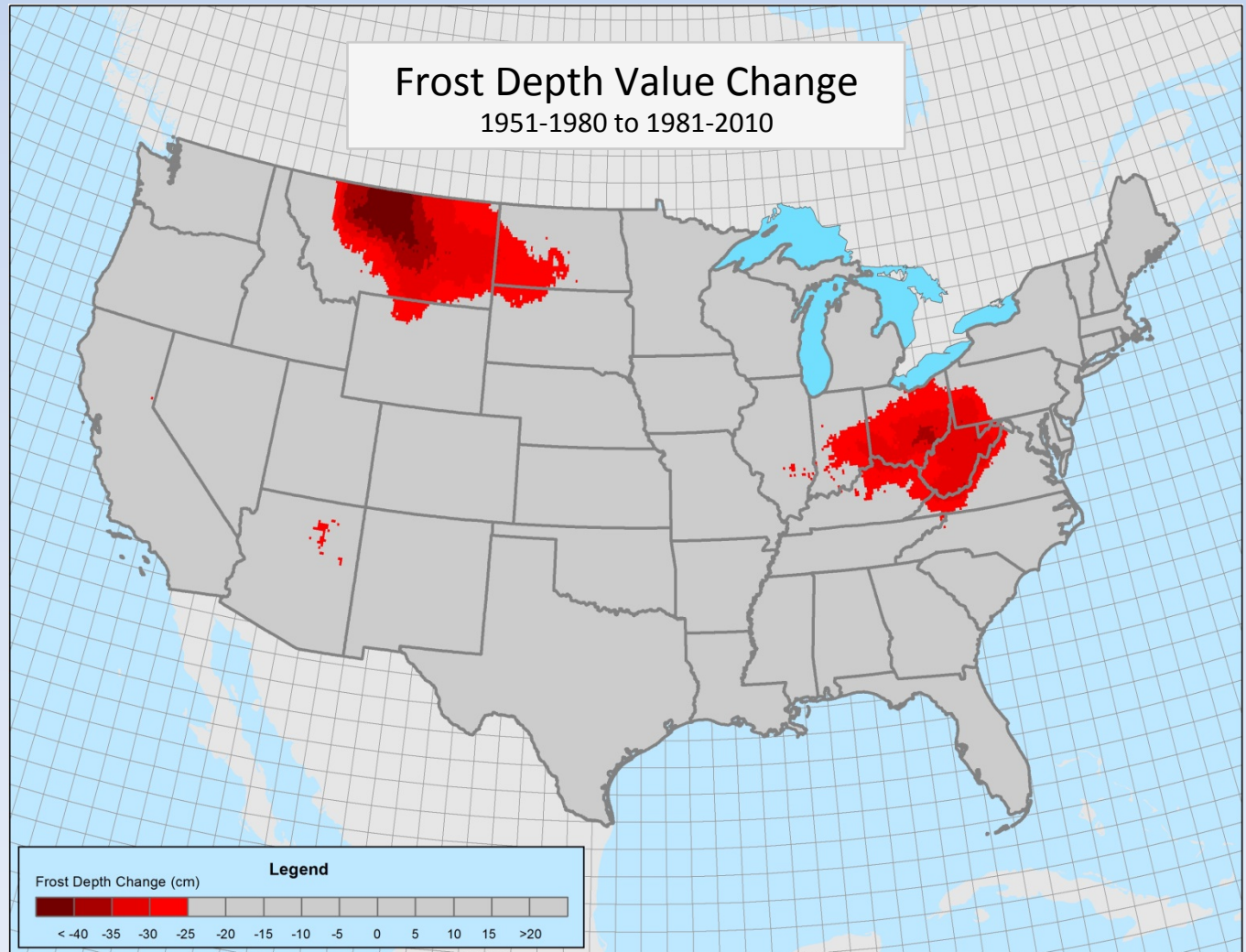
Changes in Frost Depth



Results:

- Reduction -
~73% of stations
- Increase -
~23% of stations

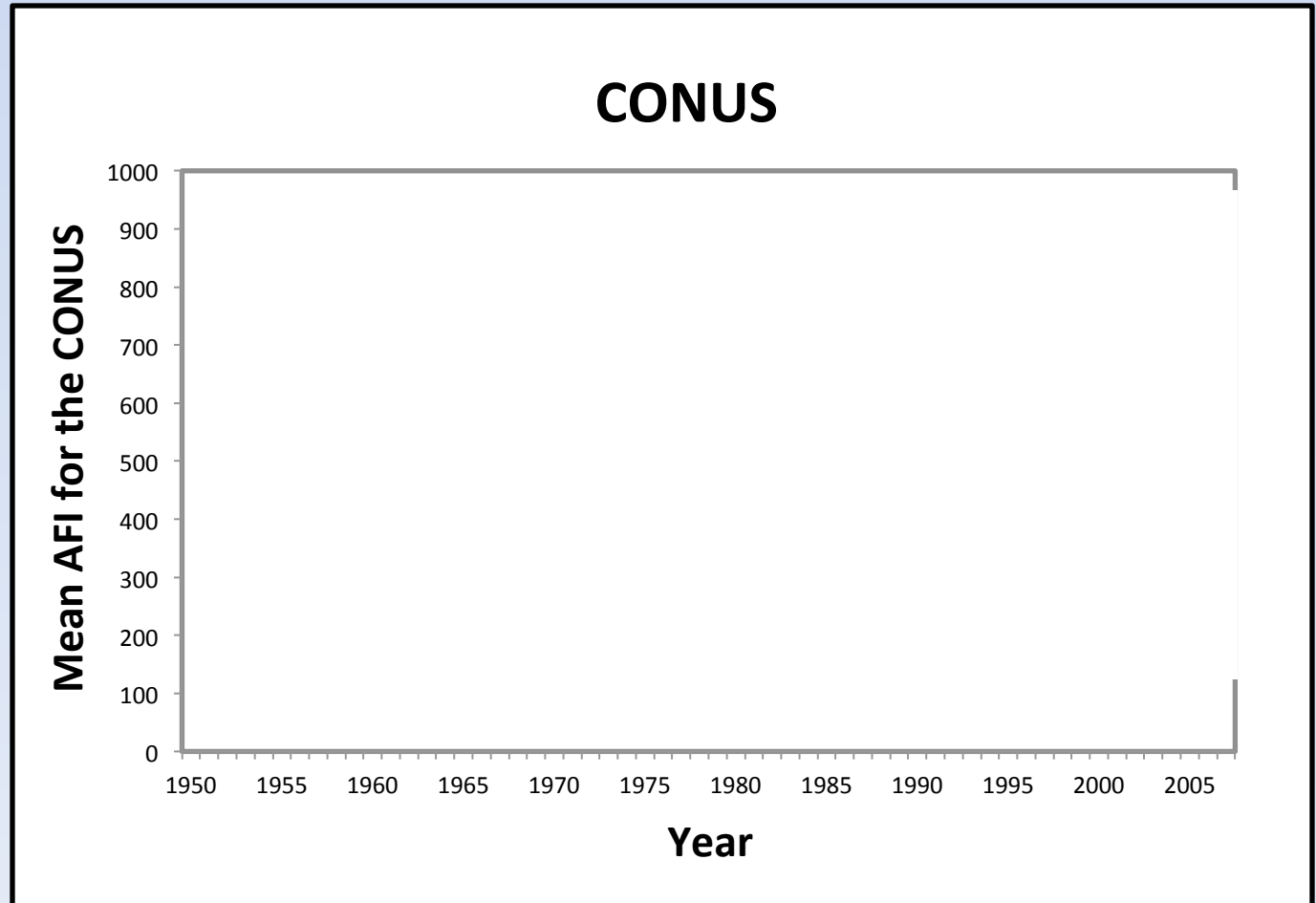
Changes in Frost Depth

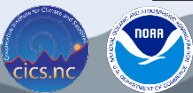
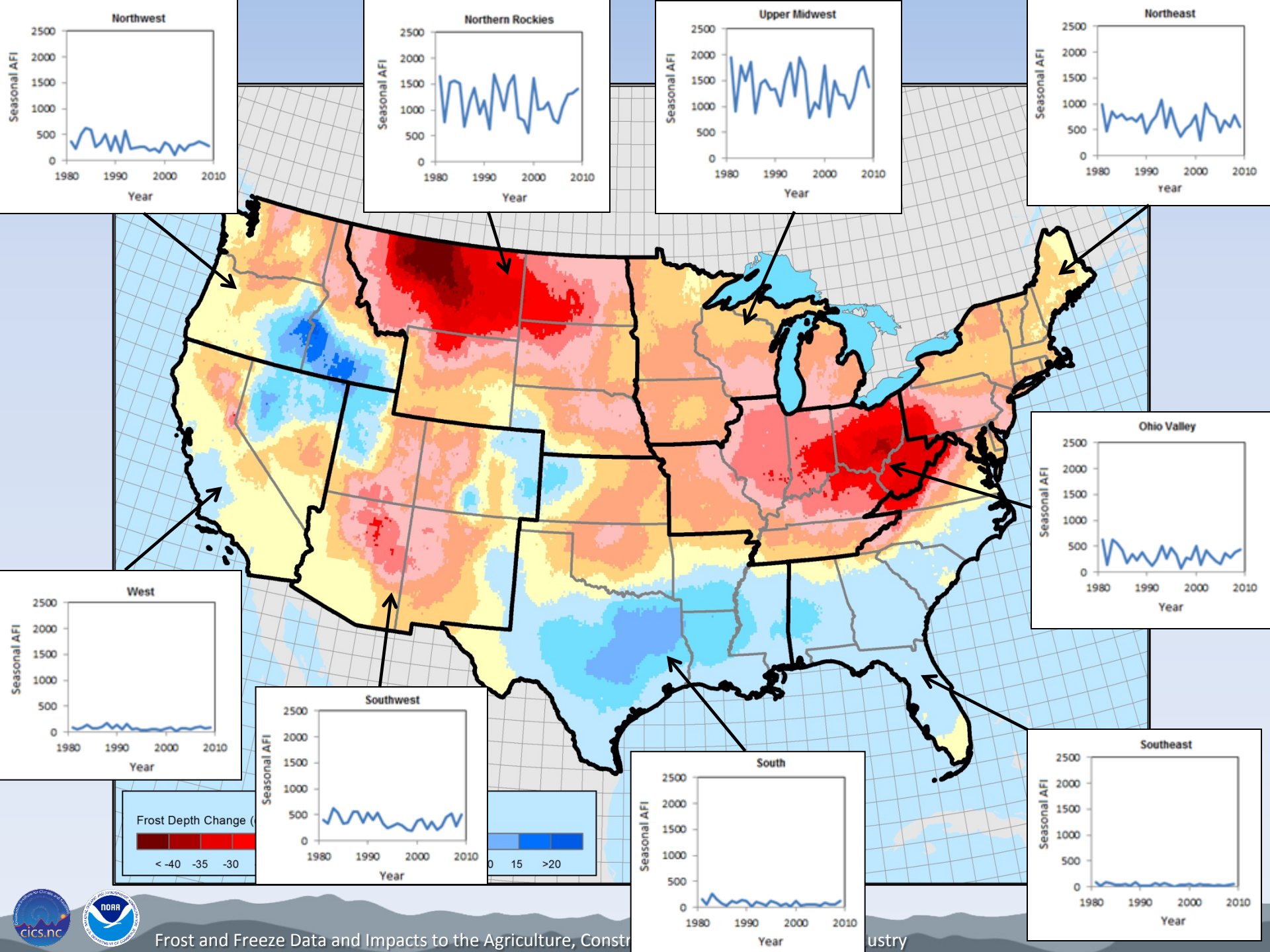


CONUS AFI Trend

Trend:

- R2 is not significant
- 60-year record shows a decreasing trend over the period (1950-2010)





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

Brown, W. G. 1964. Difficulties associated with predicting depth of freeze or thaw. *Can. Geotech. J.*, Vol. 1, No. 4, p. 215-226.

Steurer, P. M. 1989. Methods used to create an estimate of the 100-year return period of the air-freezing index. Frost-protected shallow foundation development program-Phase II final report, Appendix A, Prepared for the Society of the Plastics Industry, NAHB Res. Ctr., Upper Marlboro, Md.

Steurer, P. M. and J. H. Candrell. 1995. Comparison of methods used to create an estimate of the air-freezing index. *J. Cold Reg. Engrg.*, Vol. 9, No. (2), June 1995, pp. 64-74.

Trenberth, K. E., T. R. Karl, and T. W. Spence. 2002: The need for a systems approach to climate observations. *Bull. Amer. Meteor. Soc.*, 83, 1593–1602.

Thank You!

Any Questions?



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