

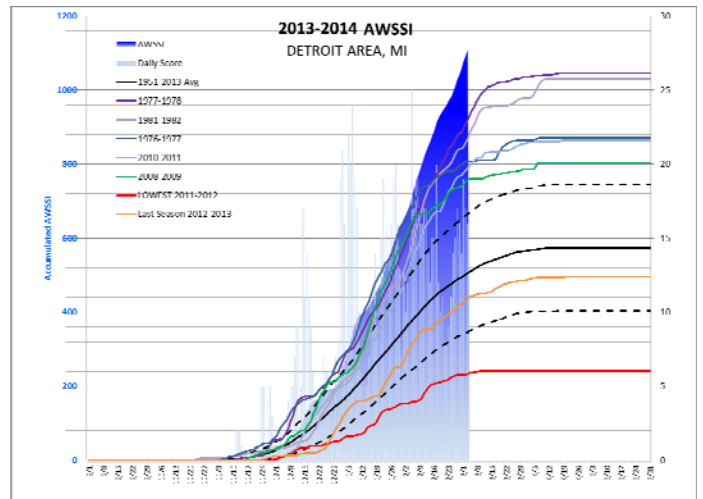


The Accumulated Winter Season Severity Index

Winter seasons have significant societal impacts across all sectors ranging from direct human health and mortality to commerce, transportation, and education. The question “How severe was this winter?” does not have a simple answer. At the very least, the severity of a winter is related to the intensity and persistence of cold weather, the frequency and amount of snow, and the amount and persistence of snow on the ground. The Accumulated Winter Season Severity Index (AWSSI) is being developed to objectively quantify and describe the relative severity of the winter season.

Goals of the AWSSI

- * Objectively index winter conditions
- * Use commonly available data—max/min temperature, snowfall, and snow depth or precipitation.
- * Create a historical database of AWSSI for any location with daily temperature, snow, and precipitation data.
- * Allow comparisons of season to season severity at one location in the context of the climatology of that location or between locations.
- * Use as a baseline to scale subjective impacts such as those to snow removal, commerce, and transportation.
- * Apply to multiple users and their needs.



How the AWSSI Accumulates

The AWSSI is not limited to meteorological winter (December-February) but is intended to capture winter weather from its earliest occurrence to its last. The winter season begins when the first of any one of the following instances occurs:

First measurable snowfall (≥ 0.1 inch)

- * Maximum temperature at or below 32°F
- * December 1

The winter season ends at the last occurrence of any of the following:

- * Last measurable snowfall (≥ 0.1 inch)
- * Last day with 1 inch of snow on the ground
- * Last day with a maximum temperature of 32°F or lower
- * February 28/29

Chicago Area (IL)	ORDthr	Season	Start Date	End Date	Length(days)	TempScore	SnowScore	AWSSI
1974-1975	1974-11-13	1975-04-09	148	322 (0/0)	181 (0/0)	503		
1975-1976	1975-11-12	1976-05-02	173	332 (0/0)	239 (0/0)	571		
1976-1977	1976-10-27	1977-04-05	161	631 (0/0)	309 (0/0)	940		
1977-1978	1977-11-13	1978-04-20	159	617 (0/0)	536 (0/0)	1153		
1978-1979	1978-11-20	1979-03-26	127	604 (0/0)	779 (0/0)	1383		
1979-1980	1979-11-27	1980-04-15	141	413 (0/0)	164 (2/0)	577		
1980-1981	1980-11-18	1981-03-19	122	413 (0/0)	124 (0/0)	537		
1981-1982	1981-11-20	1982-04-10	142	624 (0/0)	292 (0/0)	916		
1982-1983	1982-11-04	1983-04-16	164	304 (0/0)	85 (0/0)	389		
1983-1984	1983-11-24	1984-04-03	132	578 (0/0)	247 (0/0)	825		
1984-1985	1984-12-01	1985-03-05	95	478 (0/0)	324 (0/0)	802		
1985-1986	1985-11-20	1986-04-15	147	538 (0/0)	119 (0/0)	657		
1986-1987	1986-11-11	1987-03-15	125	256 (0/0)	95 (0/0)	351		
1987-1988	1987-10-20	1988-03-30	163	438 (0/0)	217 (0/0)	655		
1988-1989	1988-11-06	1989-05-06	182	398 (0/0)	116 (0/0)	514		
1989-1990	1989-10-18	1990-04-11	176	390 (0/0)	155 (0/0)	545		
1990-1991	1990-12-01	1991-03-31	121	345 (0/0)	114 (0/0)	459		
1991-1992	1991-11-02	1992-04-02	153	311 (0/0)	116 (0/0)	427		
1992-1993	1992-10-20	1993-04-02	165	366 (0/0)	200 (0/0)	566		
1993-1994	1993-11-06	1994-03-06	121	473 (0/0)	266 (0/0)	739		
1994-1995	1994-12-01	1995-04-12	133	311 (0/0)	117 (0/0)	428		
1995-1996	1995-11-08	1996-03-26	140	496 (0/0)	87 (33/26)	583		
1996-1997	1996-11-10	1997-04-13	155	435 (0/0)	160 (37/87)	595		
1997-1998	1997-11-03	1998-03-15	133	218 (0/0)	124 (48/61)	342		
1998-1999	1998-11-08	1999-03-16	129	301 (0/0)	257 (1/54)	558		
1999-2000	1999-12-01	2000-04-06	130	288 (0/0)	156 (0/0)	444		
2000-2001	2000-11-16	2001-04-16	152	500 (0/0)	390 (0/0)	890		
2001-2002	2001-12-01	2002-04-04	125	245 (0/0)	129 (1/32)	374		
2002-2003	2002-11-17	2003-04-08	143	445 (0/0)	96 (0/0)	541		
2003-2004	2003-11-24	2004-03-18	116	354 (0/0)	162 (0/0)	516		
2004-2005	2004-11-24	2005-03-25	122	313 (0/0)	183 (0/0)	496		
2005-2006	2005-11-16	2006-03-24	129	296 (0/0)	140 (0/0)	436		
2006-2007	2006-10-12	2007-04-12	183	388 (0/0)	171 (0/0)	559		
2007-2008	2007-11-21	2008-03-28	129	412 (0/0)	273 (1/2)	685		
2008-2009	2008-11-16	2009-04-06	142	515 (0/0)	311 (0/0)	826		
2009-2010	2009-12-01	2010-03-20	110	333 (0/0)	276 (0/0)	609		
2010-2011	2010-11-26	2011-04-18	144	431 (0/0)	323 (1/2)	754		
2011-2012	2011-12-01	2012-03-04	95	166 (0/0)	68 (0/0)	234		
2012-2013	2012-11-24	2013-04-19	147	313 (0/0)	126 (0/0)	439		

An example of output for Chicago. Numbers in parentheses are the number of missing values for max/min and snowfall/snow depth in the season.

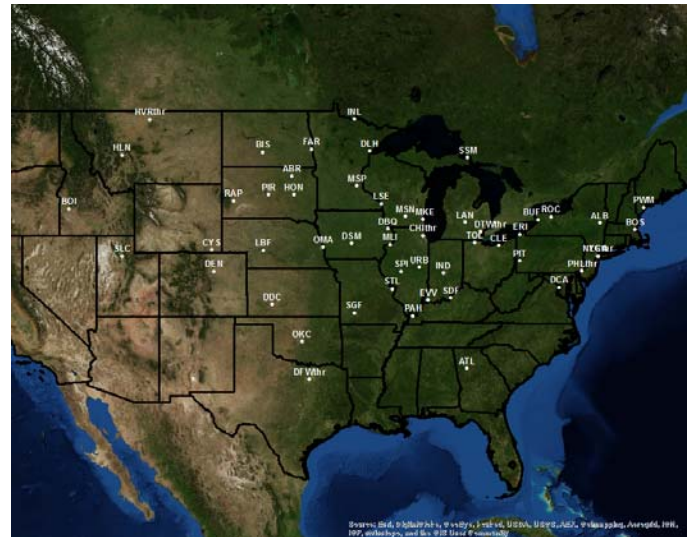
Daily scores are calculated based on scores assigned to temperature, snowfall, and snow depth thresholds. The daily scores are accumulated through the winter season, allowing a running total of winter severity in the midst of a season as well as a final, cumulative value characterizing the full season. Accumulations of the temperature and snow components of the index are computed separately and then added together for the total index. This allows comparison of the relative contribution of each to the total score.

AWSSI Point Thresholds				
Points	Temperature (°F)		Snow (in)	
	Max	Min	Fall	Depth
1	25 to 32	25 to 32	0.1 to 0.9	1
2	20 to 24	20 to 24	1.0 to 1.9	2
3	15 to 19	15 to 19	2.0 to 2.9	3
4	10 to 14	10 to 14	3.0 to 3.9	4 to 5
5	5 to 9	5 to 9	-	6 to 8
6	0 to 4	0 to 4	4.0 to 4.9	9 to 11
7	-1 to -5	-1 to -5	5.0 to 5.9	12 to 14
8	-6 to -10	-6 to -10	-	15 to 17
9	-11 to -15	-11 to -15	6.0 to 6.9	18 to 23
10	-16 to -20	-16 to -20	7.0 to 7.9	24 to 35
11	-	-21 to -25	-	-
12	-	-	8.0 to 8.9	-
13	-	-	9.0 to 9.9	-
14	-	-	10.0 to 11.9	-
15	<-20	-26 to -35	-	36+
18	-	-	12.0 to 14.9	-
20	-	<-35	-	-
22	-	-	15.0 to 17.9	-
26	-	-	18.0 to 23.9	-
36	-	-	24.0 to 29.9	-
45	-	-	>=30.0	-

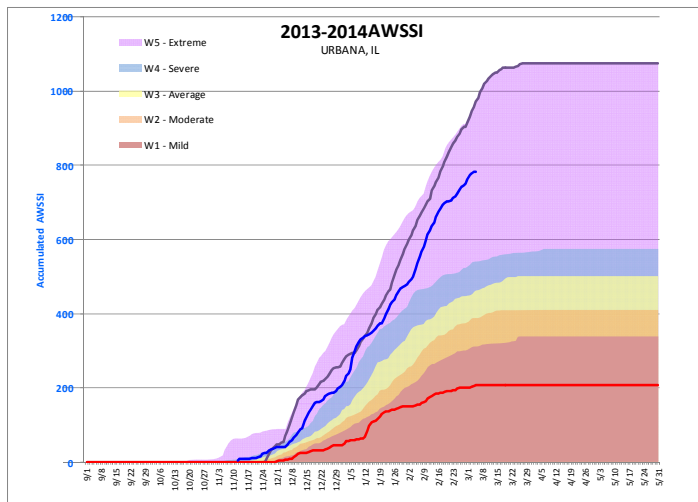
The AWSSI has been processed for 52 locations across the continental U.S. to provide a variety of locations in different climate regimes for analysis. The AWSSI is calculated for each season from 1950-1951 to 2012-2013. The seasonal data is then subject to quality control, and seasons missing data that would contribute 5% or more of the season's AWSSI are removed. Averages and standard deviations are calculated for running accumulations of daily temperature and snow scores as well as the total AWSSI.

Quintiles of AWSSI scores were determined for each location. Descriptive categories were assigned to each quintile as follows:

PERCENTILE	CATEGORY
20th	W1 - Mild
40th	W2 - Moderate
60th	W3 - Average
80th	W4 - Severe
99th	W5 - Extreme



Sites included in AWSSI analysis



Limitations

- * Does not include wind (e.g. wind chill, blowing snow)
- * Does not include mixed precipitation or freezing rain explicitly (a precip-only version of AWSSI may help address impacts of these events).
- * Thresholds have been set with impacts in mind and are subject to adjustment in the future as analysis continues.

Additional Work

The development of the AWSSI and analysis of results are ongoing. We hope to complete soon a version of the AWSSI that will use temperature and precipitation data to estimate snowfall and snow depth where that data is not available. This will allow us to look at historical winters (late 19th century) at locations for which that data may be available. There will also be work to identify temperature-dominant and snow/precipitation-dominant winter regimes, examine trends, teleconnections, other statistics by temperature and snow/precipitation, and eventually develop decision-support tools utilizing the AWSSI. By later this spring there will be an AWSSI web page on the MRCC web site, and before next winter we hope to have an interactive AWSSI product available for users on the MRCC web site.

For more information, please contact Barb Mayes Boustead (barbara.mayes@noaa.gov) at the National Weather Service or the Midwestern Regional Climate Center (mrcc@purdue.edu).