Variable Importance for Prediction of Damaging Straight-line Thunderstorm Winds

Ryan Lagerquist

Master's work at the University of Oklahoma

Committee members: Amy McGovern, Travis Smith, Michael Richman





Variable Importance for Damaging Straight-line Storm Winds Section 1: Introduction

- In an average year in the U.S., thunderstorms cause over 100 deaths and \$10 billion of damage^[1].
- Most of this damage is caused by straight-line winds^[2].
- Near-surface winds are non-linearly related to many environmental factors.
- Difficult for human forecasters and physical models to predict.
- Recent studies have successfully used machine learning to predict other thunderstorm-related hazards:
 - Tornadoes^[3, 4, 5]
 - Hail^[4, 6]
 - Lightning^[7]
 - Aviation turbulence^[5, 8]



Variable Importance for Damaging Straight-line Storm Winds Section 1: Introduction

- Goal: develop a machine-learning system to predict damaging straight-line winds in real time.
- Research to operations.
- For each storm cell, we predict damaging straight-line winds at 3 buffer distances and 5 lead times:
 - 0, 5, 10 km
 - 0-15, 15-30, 30-45, 45-60, 60-90 minutes
- Our system ran during the Spring 2016 Hazardous Weather Testbed (May 2 June 3) at the Storm Prediction Center in Norman OK.

Variable Importance for Damaging Straight-line Storm Winds Section 1: Introduction



Variable Importance for Damaging Straight-line Storm Winds Section 2: Input Data

Data Type	Sources	Resolution (if applicable)	Time Period
Radar grids	Multi-year Reanalysis of Remotely Sensed Storms (MYRORSS ^[9])	1 km / 5 minutes	2000-11 (no 2009)
Model soundings	Rapid Update Cycle (RUC ^[10])	13 or 20 km / 1 hour	Apr 1994 – Apr 2012
Surface wind observations	Meteorological Assimilation Data Ingest System (MADIS ^[11]) Oklahoma Mesonet ^[12] One-minute METARs ^[13] National Weather Service local storm reports ^[14]		Jul 2001 – present 1994-present 2000-present 1955-present

- Radar grids and model soundings were used to create predictors for the "event" (storm cell produces winds ≥ 50 kt).
- Surface wind obs were used as "verification data," to determine when and where the event occurred.

Variable Importance for Damaging Straight-line Storm Winds Section 2: Input Data

- Radar grids and model soundings were used to create predictors.
- Surface wind obs were used as verification data, to determine when and where the "event" occurred.
- "Event" = storm cell produces wind ≥ 50 kt.
- We used 804 training days (those with complete data and ≥ 30 severe-wind reports).
- For these 804 days we used all storm cells in the CONUS.



Variable Importance for Damaging Straight-line Storm Winds Section 3: Storm Identification and Tracking

- Identification and real-time tracking is done by w2segmotionII^[15] and w2besttrack^[16].
- Identification is based on -10 °C reflectivity field, with a minimum storm-cell size of 50 km².
- To connect storm objects, real-time tracking algorithms (like w2segmotionII) may look only into the past.
- However, post-event tracking algorithms (like w2besttrack) may look into both the past and future.
- w2besttrack "corrects" the output from w2segmotionII, resulting in longer storm tracks.



Blue = storm objects before t_c

Green = storm objects after t

Technical Note

- "Storm cell" = a single thunderstorm, or a single updraft-downdraft pair, consistent with common usage.
- "Storm object" = one storm cell at one time step.
- "Storm track" = succession of storm objects linked in time (presumably all snapshots of the same storm cell).



Variable Importance for Damaging Straight-line Storm Winds Section 4: Linkage Wind Observations to Storm Cells

- Causal attribution (which storm cells are responsible for which wind observations?).
- Procedure is described below, for a single wind observation *W*.
 - 1. If W does not occur at a radar-scan time, interpolate storm objects (along their respective tracks) to same time as W.
 - 2. Find storm object (*S*) with nearest polygon edge. Let the parent track be *S**.
 - 3. If *S* is within 10 km, link *W* to all objects in track *S*^{*}. Otherwise, do not link *W* at all.
- This is where tracking becomes important.
- Allows us to say that, *e.g.*, storm cell at 1830 UTC eventually produced severe winds at 2000 UTC.



Black line = storm track Green polygon = first storm object Red polygon = last storm object Purple diamonds = wind obs linked to track

- 4 types of predictors for each storm object:
 - Radar statistics
 - Storm motion (speed and direction)
 - Shape parameters (describe outline of storm object)
 - Sounding parameters (from interpolated RUC soundings)

- 11 stats are calculated for 12 radar variables, using only values inside the storm object.
- This is done for both raw values and gradients.
- This leads to 264 (11 x 12 x 2) predictors.

Radar Variables	Stats Calculated for Each
Low-level (0—2-km) azimuthal shear	0 th percentile (minimum)
Mid-level (3—6-km) azimuthal shear	5 th percentile
18-dBZ echo top	25 th percentile
50-dBZ echo top	50 th percentile (median)
Max estimated hail size	75 th percentile
-20 °C reflectivity	95 th percentile
-10 °C reflectivity	100 th percentile (max)
0 °C reflectivity	Mean (1 st moment)
Composite reflectivity	Standard deviation (~ 2 nd moment)
Lowest-altitude reflectivity	Skewness (~ 3 rd moment)
Severe-hail index (SHI)	Kurtosis (~ 4 th moment)
Vertically integrated liquid (VIL)	

- Shape parameters:
 - Area
 - Bending energy
 - Compactness
 - Curvature
 - Eccentricity
 - Extent
 - Orientation
 - Solidity
- Params involving curvature are calculated on smoothed outline.



Red polygon = raw storm object Blue polygon = smoothed object Grey dots = radar pixels in storm object

- 97 sounding parameters (see Appendix C) were calculated with SHARPpy^[17].
- Types of sounding parameters:
 - Wind shear over various layers
 - Mean wind over various layers
 - Mean storm-relative wind over various layers
 - Moisture variables (precipitable water, mean RH over various layers, etc.)
 - Heights of critical levels (LCL, LFC, equilibrium level, etc.)
 - Thermodynamic indices (CAPE, CIN, lapse rates, etc.)
 - Other indices (EHI, microburst index, winddamage index, etc.)
- 431 predictors overall (after decomposing vectors into magnitude, sin, cos).



- Goal is to predict severe winds for each storm cell at 3 buffer distances (0, 5, 10 km) and 5 lead times (0-15, 15-30, 30-45, 45-60, 60-90 minutes).
- Procedure is described below for a single storm object S, buffer distance d, lead time [t_{min}, t_{max}].
 - Label = 1 if S has a wind observation \geq 50 kt within buffer distance d and lead time $[t_{min}, t_{max}]$.
 - Label = 0 otherwise.
- Label = predictand for machine learning.
- Thus, machine-learning task is binary classification.

Variable Importance for Damaging Straight-line Storm Winds Section 7: Machine-learning Methods

- We used gradientboosted trees^[18] (GBT) as the base model.
- Then used isotonic regression^[19] to calibrate GBT probabilities.
- Gradient-boosting is a way of ensembling decision trees, similar to random forest.
- Difference is that GB focuses learning on difficult examples, which usually leads to better performance.



Sample decision tree. Follow right branch if answer to question is "yes".

Variable Importance for Damaging Straight-line Storm Winds Section 7: Machine-learning Methods

- Receiver operating characteristic (ROC) and reliability curves shown for 0-15 minutes (easiest lead time).
- Areas under curve (AUCs) all > 0.9 (excellent^[20, 21, 22]).
- 0-km and 5-km models near perfect reliability (x = y); 10-km model underforecasts.



Variable Importance for Damaging Straight-line Storm Winds Section 7: Machine-learning Methods

- ROC and reliability shown below for 60-90 minutes (hardest lead time).
- AUCs are all > 0.8 (good) or > 0.9 (excellent).
- Near perfect reliability, except 5-km and 10-km at upper end.
- More forecast evaluation in Appendix A.



- We used two methods:
 - J-measure ranking (JMR^[22])
 - Sequential forward selection (SFS^[23])
- JMR is a data-driven method (selects variables based on their relationships in the dataset).
- SFS is a model-driven method (selects variables based on how they affect model performance).
- Methods independent of each other.
- Methods independent for each buffer distance and lead time.
- Bootstrapped data 25 times for each buffer distance and lead time.
- We will show results only for 5 km and 30-45 minutes (median values).
- Results were similar for other combinations (see Appendix B).

- *J*-measure is basically the difference between two PDFs.
- In our case, difference between PDF of predictor variable when label = 0 and label = 1.

$$J = \sum_{k=1}^{10} \left[p(x = x_k \mid y=0) - p(x = x_k \mid y=1) \right] \log_2 \left[\frac{p(x = x_k \mid y=0)}{p(x = x_k \mid y=1)} \right]$$

- p(x | y=0) and p(x | y=1) are distributions of predictor variable x for non-severe and severe-wind-producing storms, respectively.
- J is large when distributions are very different.
- Suggests that x is an important predictor.



• Top 20 of 431 predictors shown below.

Top 20 J-measures (BEFORE controlling for linear correlation).		Top 20 J-measures (AFTER controlling for linear correlation).		
-10 °C reflectivity, mean	2.14	-10 °C reflectivity, mean	2.	0
-20 °C reflectivity, mean	2.12	-20 °C reflectivity, mean	2.	0
-10 °C reflectivity, 50th percentile	2.09	-10 °C reflectivity, 50th percentile	1	9
-20 °C reflectivity, 50th percentile	2.07	-20 °C reflectivity, 50th percentile	1.	0
-20 °C reflectivity, 75th percentile	2.04	-20 °C reflectivity, 75th percentile	1.	. /
-10 °C reflectivity. 25th percentile	2.02	-10 °C reflectivity. 25th percentile	1.	6
-20 °C reflectivity, 25th percentile	2.00	-20 °C reflectivity, 25th percentile	1.	5
-10 °C reflectivity. 75th percentile	1.97	Lapse rate from 850-500 mb	1.	4
-20° C reflectivity, 95th percentile	1.95	Vertical-totals index	1.	3
-20° C reflectivity, 100th percentile	1.93	Magnitude of shear from 0-6 km AGL	1.	2
50-dBZ echo top, mean	1.90	Magnitude of shear from 0-8 km AG	1.	1
-20° C reflectivity. 5th percentile	1.88	Fosherg fire-weather index	1.	0
VII mean	1.85	Comp reflectivity, 95th-percentile gradient	0.	.9
VIL 50th percentile	1.83	Supercell composite parameter for left-mover	0.	8
10° C reflectivity. Of the percentile	1.81	Storm relative belicity for left mover	0.	.79
-10 C reflectivity, 95th percentile	1.78		0.	6
SU-dBZ echo top, /Sth percentile	1.76	-10 C reflectivity, mean gradient	0.	.5
VIL, 75th percentile	1.73	0 C reflectivity, mean gradient	0.	.5
50-dBZ echo top, 50th percentile	1.71	0 C reflectivity, 25th-percentile gradient	0.	.4
0 C reflectivity, mean	1.69	Comp reflectivity, 100th-percentile gradient	0	3
VIL, 25th percentile	1 66	Sine of shear from 0-1 km AGL	0	2

- Colour fill is *J*-measure (averaged over 25 bootstrap replicates).
- Even after controlling for linear correlation, top 7 variables are statistics on -10 C° or -20 °C reflectivity.
- Probably an artifact of storm ID (based on -10 °C reflectivity).

- SFS is a model-driven method, so has underlying machine-learning model.
- We used logistic regression (fast and good for binary classification).
- SFS starts with 0 variables (constant model), then adds one at a time.
- Stops when the last 10 variables have not improved performance (AUC).

- Graph below shows how many times (out of 25) each variable was included in the final model.
- Similarities between JMR and SFS:
 - Fosberg fire-weather index
 - Lapse rates
 - Magnitude of deep-layer shear
 - Mean -10 °C reflectivity
 - Sine (related to v-component) of 0 —1-km shear
 - Vertical-totals index
- Severe-wind probability increases with all of these.

	Ton 20 variables from SES	
t k Alexandra a Bessel		
	-10 C reflectivity, mean	25
	Vertical-totals index	25
	Lapse rate from 0-3 km AGL	24
	Fosberg fire-weather index	23
	Speed of motion	20
	Precipitable water	22
	Sine of shear from 0-1 km AGL	21
	Downdraft CAPE	20
	Magnitude of shear from 0-6 km AGL	20
	Sine of bulk Richardson number (BRN) shear	19
	Significant-severe parameter	18
	Height of -10 $^{\circ}$ C	17
	K-index	1/
	MCS-maintenance probability	16
	SHERB parameter	15
	Derecho composite parameter	1/
	Effective-layer depth	14
	Magnitude of mean LCL-EL wind	13
	CAPE	12
	Boundary-layer depth	11

Variable Importance for Damaging Straight-line Storm Winds Conclusions

- Used machine learning to predict severe winds (\geq 50 kt) for each storm cell.
- Three buffer distances: 0, 5, 10 km around storm cell.
- Five lead times: 0-15, 15-30, 30-45, 45-60, 60-90 minutes.
- Good AUC and reliability achieved for all buffers and lead times.
- *J*-measure ranking and sequential feature selection used to estimate variable importance.
- Methods show strong agreement, except for stats on -10 °C and -20 °C reflectivity (probably artifact of storm ID).
- Variable importance allows straight-line wind threat to be linked to climate models, which do not explicitly resolve convection.

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• ROC curves for each lead time are shown on the following pages.











• Reliability curves for each lead time are shown on the following pages.










- Performance diagrams^[24] for each lead time are shown on the following pages.
- Colour fill is critical success index (CSI); dashed lines are frequency bias.











• J-measure results for buffer distance of 0 km and lead time of [0, 15] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	3 04	Top 20 J-measures (AFTER controlling for linear correlation).	3.04
-10 °C reflectivity, mean	3.04	-10 °C reflectivity, mean	2.90
-10 °C reflectivity, 50th percentile	2.02	-10 °C reflectivity, 50th percentile	2.30
-20 °C reflectivity, mean	2.90	-20 [°] C reflectivity, mean	2.70
-20 °C reflectivity, 50th percentile	2.95	-20 °C reflectivity, 50th percentile	2.01
-10 °C reflectivity, 75th percentile	2.92	Lapse rate from 850-500 mb	2.47
-20 °C reflectivity, 75th percentile	2.09	Vertical-totals index	2.5
-10 °C reflectivity, 25th percentile	2.00	Lowest-altitude reflectivity, 5th percentile	2.13
-20 °C reflectivity, 95th percentile	2.05	-10 °C reflectivity, 25th-percentile gradient	2.04
-20 °C reflectivity, 25th percentile	2.00	Magnitude of effective bulk wind difference	1.90
-20 °C reflectivity, 100th percentile	2.70	-10 °C reflectivity, mean gradient	1.70
-10 °C reflectivity, 95th percentile	2.75	Fosberg fire-weather index	1.02
50-dBZ echo top, mean	2.72	-20 [°] C reflectivity, mean gradient	1.47
VIL, mean	2.09	Mid-level azimuthal shear, 5th percentile	1.5
50-dBZ echo top, 75th percentile	2.00	Low-level azimuthal shear, 25th percentile	1.13
-10 °C reflectivity, 100th percentile	2.03	Supercell composite parameter for left-mover	1.02
VIL, 75th percentile	2.00	Convective temperature	0.91
VIL, 50th percentile	2.57	Cosine of mean storm-relative wind from 0-1 km AC	0.70
50-dBZ echo top, 95th percentile	2.54	Cosine of mean storm-relative wind from 0-2 km AC	
Comp reflectivity, mean	2.51	Effective-layer depth	0.40
VIL, 95th percentile	2.40	Energy-helicity index for left-mover	0.54

• SFS results for buffer distance of 0 km and lead time of [0, 15] minutes.

Top 20 variables from SFS.	
Speed of motion	
-10 [°] C reflectivity, mean	25
Vertical-totals index	24
Magnitude of mean boundary-layer wind	23
Significant-severe parameter	25
Significant-hail parameter	22
Lapse rate from 0-3 km AGL	21
Lapse rate from 850-500 mb	20
Surface relative humidity	20
Magnitude of mean LCL-EL wind	19
Fosberg fire-weather index	18
Precipitable water	17
Cosine of mean LCL-EL storm-relative wind	1/
K-index	16
MCS-maintenance probability	15
Lowest-altitude reflectivity, standard deviation of g	nt 1/
SWEAT index	14
Sine of shear from 0-3 km AGL	13
Lowest-altitude reflectivity, 95th-percentile gradien	12
Area	11

• J-measure results for buffer distance of 0 km and lead time of [15, 30] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	2 89	Top 20 J-measures (AFTER controlling for linear correlation).	2 89
-10 °C reflectivity, mean	2.05	-10 °C reflectivity, mean	2.05
-10 °C reflectivity, 50th percentile	2.00	-10 °C reflectivity, 50th percentile	2.70
-10 °C reflectivity, 75th percentile	2.05	-10 °C reflectivity, 75th percentile	2.02
-20 °C reflectivity, mean	2.00	-20 °C reflectivity, 75th percentile	2.40
-20 °C reflectivity, 75th percentile	2.77	Lapse rate from 850-500 mb	2.55
-20 °C reflectivity, 50th percentile	2.74	Vertical-totals index	
-20 °C reflectivity, 95th percentile	2.71	Lapse rate from 3-6 km AGL	2.07
-10 °C reflectivity, 95th percentile	2.00	Lapse rate from 700-500 mb	1.94
-20 °C reflectivity, 100th percentile	2.05	Magnitude of effective bulk wind difference	1.60
-10 °C reflectivity, 25th percentile	2.02	Lowest-altitude reflectivity, 5th percentile	1.00
-20 °C reflectivity, 25th percentile	2.59	Low-level azimuthal shear, 25th percentile	1.33
-10 °C reflectivity, 100th percentile	2.50	Convective temperature	1.59
50-dBZ echo top, mean	2.55	Supercell composite parameter for left-mover	1.23
50-dBZ echo top, 95th percentile	2.30	Mid-level azimuthal shear, 5th percentile	1.11
VIL, mean	2.47	Effective-layer depth	0.90
50-dBZ echo top, 100th percentile	2.44	Low-level azimuthal shear, 5th percentile	0.04
50-dBZ echo top, 75th percentile	2.41	Cosine of mean storm-relative wind from 0-2 km AG	0.70
VIL, 75th percentile	2.30	Sine of shear from 0-1 km AGL	0.57
VIL, 95th percentile	2.33	Cosine of mean effective-layer storm-relative wind	0.45
VIL, 100th percentile	2.52	Cosine of mean wind from 0-8 km AGL	0.29

• SFS results for buffer distance of 0 km and lead time of [15, 30] minutes.

Top 20 variables from SFS.	
-10 °C reflectivity, mean	0.5
Speed of motion	25
Vertical-totals index	24
Lapse rate from 0-3 km AGL	23
Surface relative humidity	25
Height of -10 °C	22
MCS-maintenance probability	21
Sine of shear from 0-1 km AGL	20
Significant-severe parameter	20
Magnitude of shear from 0-6 km AGL	19
Lowest-altitude reflectivity, skewness	18
Sine of maximum boundary-layer wind	17
Magnitude of mean boundary-layer wind	17
Mid-level azimuthal shear, 50th percentile	16
-10 °C reflectivity, 100th percentile	15
Sine of bulk Richardson number (BRN) shear	14
Precipitable water	10
Fosberg fire-weather index	13
Significant-hail parameter	12
SHERB parameter	11

• *J*-measure results for buffer distance of 0 km and lead time of [30, 45] minutes.

-10 °C reflectivity, mean2.32-10 °C reflectivity, S0th percentile2.24-20 °C reflectivity, 50th percentile2.29-10 °C reflectivity, 50th percentile2.13-20 °C reflectivity, 95th percentile2.26-20 °C reflectivity, 55th percentile2.03-20 °C reflectivity, 95th percentile2.23-20 °C reflectivity, 75th percentile1.92-10 °C reflectivity, 75th percentile2.20-20 °C reflectivity, 75th percentile1.92-10 °C reflectivity, 75th percentile2.20-20 °C reflectivity, 75th percentile1.81-20 °C reflectivity, 95th percentile2.11-20 °C reflectivity, 50th percentile1.60-20 °C reflectivity, 95th percentile2.11-20 °C reflectivity, 100th percentile1.60-20 °C reflectivity, 95th percentile2.08Vertical-totals index1.29-10 °C reflectivity, 55th percentile2.02Magnitude of effective bulk wind difference1.17-10 °C reflectivity, 100th percentile2.02Magnitude of shear from 0-6 km AGL1.07-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-8 km AGL0.96-50 -dBZ echo top, 100th percentile1.93Fosberg fire-weather index0.75VIL, mean1.99Mid-level azimuthal shear, 5th percentile0.53VIL, 75th percentile1.81Low-level azimuthal shear, 25th percentile0.53VIL, 50th percentile1.81Low-level azimuthal shear, 25th percentile0.53VIL, 50th percentile1.81Low-level azimuthal shear, 25th percentile0.32<	Top 20 J-measures (BEFORE controlling for linear correlation).	2 35	Top 20 J-measures (AFTER controlling for linear correlation).	2 35
-10 °C reflectivity, 50th percentile2.29-10 °C reflectivity, 50th percentile2.13-20 °C reflectivity, 75th percentile2.26-20 °C reflectivity, 75th percentile2.03-20 °C reflectivity, 95th percentile2.23-20 °C reflectivity, 95th percentile1.92-10 °C reflectivity, 75th percentile2.20-20 °C reflectivity, 95th percentile1.81-20 °C reflectivity, mean2.17-20 °C reflectivity, 50th percentile1.81-20 °C reflectivity, 50th percentile2.14-20 °C reflectivity, 50th percentile1.60-20 °C reflectivity, 95th percentile2.14-20 °C reflectivity, 100th percentile1.49-10 °C reflectivity, 25th percentile2.05Vertical-totals index1.28-10 °C reflectivity, 25th percentile2.02Magnitude of shear from 0-6 km AGL1.07-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-8 km AGL0.96-10 °C reflectivity, 100th percentile1.93Lowest-altitude reflectivity, 5th percentile0.8550-dBZ echo top, 100th percentile1.90Mid-level azimuthal shear, 5th percentile0.85VIL, mean1.87Supercell composite parameter for left-mover0.53VIL, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.53VIL, 50th percentile1.81Energy-helicity index for left-mover0.53VIL, 95th percentile1.75Effective-layer depth0.32	-10 °C reflectivity, mean	2.33	-10 °C reflectivity, mean	2.33
-20 °C reflectivity, 75th percentile2.26-20 °C reflectivity, 75th percentile2.13-20 °C reflectivity, 95th percentile2.23-20 °C reflectivity, 95th percentile1.92-10 °C reflectivity, 75th percentile2.20-20 °C reflectivity, 75th percentile1.81-20 °C reflectivity, 75th percentile2.17-20 °C reflectivity, 75th percentile1.81-20 °C reflectivity, 50th percentile2.17-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 100th percentile2.14-20 °C reflectivity, 50th percentile1.60-20 °C reflectivity, 95th percentile2.11-20 °C reflectivity, 100th percentile1.49-10 °C reflectivity, 25th percentile2.05Vertical-totals index1.28-20 °C reflectivity, 25th percentile2.02Magnitude of shear from 0-8 km AGL1.07-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-8 km AGL0.9650-dBZ echo top, 100th percentile1.93Lowest-altitude reflectivity, 5th percentile0.8550-dBZ echo top, 95th percentile1.99Mid-level azimuthal shear, 5th percentile0.75VIL, mean1.87Supercell composite parameter for left-mover0.53VIL, 50th percentile1.81Low-level azimuthal shear, 25th percentile0.53VIL, 50th percentile1.75Effective-layer depth0.22	-10 °C reflectivity, 50th percentile	2.52	-10 °C reflectivity, 50th percentile	2.24
-20 °C reflectivity, 95th percentile2.20 2.23-20 °C reflectivity, 95th percentile2.09 1.92-10 °C reflectivity, 75th percentile2.20 2.20-10 °C reflectivity, 75th percentile1.81 1.81-20 °C reflectivity, 50th percentile2.17 2.14-20 °C reflectivity, 50th percentile1.71 1.60-20 °C reflectivity, 100th percentile2.14 2.11-20 °C reflectivity, 100th percentile1.60 1.49-10 °C reflectivity, 95th percentile2.08 2.08Vertical-totals index1.39 1.39-10 °C reflectivity, 25th percentile2.05 2.05Magnitude of effective bulk wind difference1.17 1.28 1.28-20 °C reflectivity, 100th percentile2.02 2.05Magnitude of shear from 0.6 km AGL1.07 1.07-50 -dBZ echo top, mean1.96 1.99Lowest-altitude reflectivity, 5th percentile0.96 0.85 0.75VIL, mean1.90 VIL, 75th percentile1.87 1.87 3.09 4.0420.75 4.84 4.00 4.840.96 0.43 4.043 4.042VIL, 50th percentile1.81 1.78 4.751.78 4.75 4.750.32 4.75	-20 °C reflectivity, 75th percentile	2.29	-20 °C reflectivity, 75th percentile	2.13
-10 °C reflectivity, 75th percentile2.23-10 °C reflectivity, 75th percentile1.81-20 °C reflectivity, mean2.17-20 °C reflectivity, mean1.71-20 °C reflectivity, 50th percentile2.14-20 °C reflectivity, 50th percentile1.60-20 °C reflectivity, 100th percentile2.11-20 °C reflectivity, 100th percentile1.49-10 °C reflectivity, 95th percentile2.08Vertical-totals index1.39-10 °C reflectivity, 25th percentile2.05Magnitude of effective bulk wind difference1.17-20 °C reflectivity, 100th percentile2.05Magnitude of shear from 0-6 km AGL1.07-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-8 km AGL0.9650-dBZ echo top, 100th percentile1.93Fosberg fire-weather index0.75VIL, mean1.87Supercell composite parameter for left-mover0.64VIL, 75th percentile1.81Low-level azimuthal shear, 25th percentile0.43VIL, 50th percentile1.81Energy-helicity index for left-mover0.32VIL, 95th percentile1.78Effective-layer depth0.32	-20 °C reflectivity, 95th percentile	2.20	-20 °C reflectivity, 95th percentile	2.05
-20 °C reflectivity, mean2.17-20 °C reflectivity, mean1.01-20 °C reflectivity, 50th percentile2.17-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 100th percentile2.14-20 °C reflectivity, 50th percentile1.60-20 °C reflectivity, 95th percentile2.11-20 °C reflectivity, 100th percentile1.49-10 °C reflectivity, 25th percentile2.08Vertical-totals index1.28-20 °C reflectivity, 25th percentile2.05Magnitude of effective bulk wind difference1.17-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-6 km AGL1.07-50 -dBZ echo top, mean1.96Lowest-altitude reflectivity, 5th percentile0.9650 -dBZ echo top, 100th percentile1.93Fosberg fire-weather index0.75VIL, mean1.87Supercell composite parameter for left-mover0.64VIL, 75th percentile1.81Energy-helicity index for left-mover0.53VIL, 95th percentile1.81Energy-helicity index for left-mover0.32VIL, 95th percentile1.75Effective-layer depth0.32	-10 °C reflectivity, 75th percentile	2.23	-10 °C reflectivity, 75th percentile	1.92
-20 °C reflectivity, 50th percentile2.1.1-20 °C reflectivity, 100th percentile2.14-20 °C reflectivity, 100th percentile1.60-10 °C reflectivity, 95th percentile2.11-10 °C reflectivity, 25th percentile2.08-20 °C reflectivity, 25th percentile2.08-20 °C reflectivity, 25th percentile2.05-20 °C reflectivity, 100th percentile1.39-10 °C reflectivity, 100th percentile2.02-20 °C reflectivity, 100th percentile1.99-20 °C reflectivity, 100th percentile1.90-20 °C reflectivity, 100th percentile1.93-20 °C reflectivity, 100th percentile1.93-20 °C reflectivity, 100th percentile0.96-20 °C reflectivity, 100th percentile0.96-20 °C reflectivity, 5th percentile0.96-20 °C reflectivity, 5th percentile0.96-20 °C reflectivity, 5th percentile0.75-20 °C reflectivity, 5th percentile1.87-20 °C reflectivity, 5th percentile0.53-20 °C reflectivity, 5th percentile1.81-20 °C	-20 [°] C reflectivity, mean	2.20	-20 °C reflectivity, mean	1.01
-20 °C reflectivity, 100th percentile2.14-20 °C reflectivity, 100th percentile1.09-10 °C reflectivity, 95th percentile2.08Lapse rate from 850-500 mb1.49-10 °C reflectivity, 25th percentile2.08Vertical-totals index1.39-20 °C reflectivity, 25th percentile2.05Magnitude of effective bulk wind difference1.17-10 °C reflectivity, 100th percentile2.02Magnitude of shear from 0-6 km AGL1.17-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-8 km AGL1.0750-dBZ echo top, mean1.96Lowest-altitude reflectivity, 5th percentile0.9650-dBZ echo top, 100th percentile1.93Fosberg fire-weather index0.75VIL, mean1.90Mid-level azimuthal shear, 5th percentile0.64VIL, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.5350-dBZ echo top, 75th percentile1.81Low-level azimuthal shear, 25th percentile0.43VIL, 50th percentile1.78Energy-helicity index for left-mover0.32VIL, 95th percentile1.751.750.22	-20 °C reflectivity, 50th percentile	2.17	-20 °C reflectivity, 50th percentile	1.71
-10 °C reflectivity, 95th percentile2.08Lapse rate from 850-500 mb1.39-10 °C reflectivity, 25th percentile2.05Vertical-totals index1.28-20 °C reflectivity, 25th percentile2.02Magnitude of effective bulk wind difference1.17-10 °C reflectivity, 100th percentile1.99Magnitude of shear from 0-6 km AGL1.1750-dBZ echo top, mean1.96Lowest-altitude reflectivity, 5th percentile0.9650-dBZ echo top, 100th percentile1.93Lowest-altitude reflectivity, 5th percentile0.8550-dBZ echo top, 95th percentile1.93Fosberg fire-weather index0.75VIL, mean1.87Supercell composite parameter for left-mover0.64VIL, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.53VIL, 50th percentile1.78Energy-helicity index for left-mover0.32VIL, 95th percentile1.78Effective-layer depth0.32	-20 °C reflectivity, 100th percentile	2.14	-20 °C reflectivity, 100th percentile	1.00
-10 °C reflectivity, 25th percentile2.08Vertical-totals index1.39-20 °C reflectivity, 25th percentile2.05Magnitude of effective bulk wind difference1.28-10 °C reflectivity, 100th percentile2.02Magnitude of shear from 0-6 km AGL1.1750-dBZ echo top, mean1.99Magnitude of shear from 0-8 km AGL0.9650-dBZ echo top, 100th percentile1.93Fosberg fire-weather index0.7550-dBZ echo top, 95th percentile1.87Supercell composite parameter for left-mover0.53VIL, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.43VIL, 95th percentile1.78Effective-layer depth0.32VIL, 95th percentile1.78Effective-layer depth0.32	-10 °C reflectivity, 95th percentile	2.11	Lapse rate from 850-500 mb	1.49
-20 °C reflectivity, 25th percentile2.03Magnitude of effective bulk wind difference1.26-10 °C reflectivity, 100th percentile2.02Magnitude of shear from 0.6 km AGL1.1750-dBZ echo top, mean1.99Magnitude of shear from 0.8 km AGL0.9650-dBZ echo top, 100th percentile1.93Lowest-altitude reflectivity, 5th percentile0.8550-dBZ echo top, 95th percentile1.90Fosberg fire-weather index0.75VIL, mean1.87Supercell composite parameter for left-mover0.5350-dBZ echo top, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.43VIL, 50th percentile1.78Energy-helicity index for left-mover0.32VIL, 95th percentile1.750.320.32	-10 °C reflectivity, 25th percentile	2.00	Vertical-totals index	1.39
-10 °C reflectivity, 100th percentile2.02Magnitude of shear from 0-6 km AGL1.1750-dBZ echo top, mean1.99Magnitude of shear from 0-8 km AGL0.9650-dBZ echo top, 100th percentile1.93Lowest-altitude reflectivity, 5th percentile0.8550-dBZ echo top, 95th percentile1.90Mid-level azimuthal shear, 5th percentile0.75VIL, mean1.87Supercell composite parameter for left-mover0.64VIL, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.5350-dBZ echo top, 75th percentile1.81Energy-helicity index for left-mover0.32VIL, 50th percentile1.78Effective-layer depth0.22	-20 °C reflectivity, 25th percentile	2.03	Magnitude of effective bulk wind difference	1.20
50-dBZ echo top, mean1.9950-dBZ echo top, 100th percentile1.9650-dBZ echo top, 95th percentile1.9650-dBZ echo top, 95th percentile1.93VIL, mean1.90VIL, 75th percentile1.8750-dBZ echo top, 75th percentile1.84Low-level azimuthal shear, 5th percentileVIL, 50th percentile1.81VIL, 95th percentile1.78VIL, 95th percentile1.75	-10 °C reflectivity, 100th percentile	1.02	Magnitude of shear from 0-6 km AGL	1.17
50-dBZ echo top, 100th percentile1.9050-dBZ echo top, 95th percentile1.9350-dBZ echo top, 95th percentile1.93VIL, mean1.90VIL, 75th percentile1.8750-dBZ echo top, 75th percentile1.84VIL, 50th percentile1.81VIL, 95th percentile1.75VIL, 95th percentile1.75	50-dBZ echo top, mean	1.99	Magnitude of shear from 0-8 km AGL	1.07
50-dBZ echo top, 95th percentile1.95Fosberg fire-weather index0.65VIL, mean1.90Mid-level azimuthal shear, 5th percentile0.64VIL, 75th percentile1.87Supercell composite parameter for left-mover0.6350-dBZ echo top, 75th percentile1.84Low-level azimuthal shear, 25th percentile0.63VIL, 50th percentile1.81Energy-helicity index for left-mover0.43VIL, 95th percentile1.75Effective-layer depth0.32	50-dBZ echo top, 100th percentile	1.90	Lowest-altitude reflectivity, 5th percentile	0.90
VIL, meanMid-level azimuthal shear, 5th percentile0.73VIL, 75th percentile1.87Supercell composite parameter for left-mover0.6450-dBZ echo top, 75th percentile1.81Low-level azimuthal shear, 25th percentile0.63VIL, 50th percentile1.78Energy-helicity index for left-mover0.32VIL, 95th percentile1.75Effective-layer depth0.32	50-dBZ echo top, 95th percentile	1.95	Fosberg fire-weather index	0.85
VIL, 75th percentile 50-dBZ echo top, 75th percentile VIL, 50th percentile VIL, 95th	VIL, mean	1.90	Mid-level azimuthal shear, 5th percentile	0.75
50-dBZ echo top, 75th percentile 1.04 Low-level azimuthal shear, 25th percentile 0.33 VIL, 50th percentile 1.81 Energy-helicity index for left-mover 0.43 VIL, 95th percentile 1.75 Effective-layer depth 0.22	VIL, 75th percentile	1.07	Supercell composite parameter for left-mover	0.04
VIL, 50th percentile VIL, 95th percentile 1.75 L 75 L 75 L 75 L 75 L 75 L 75 L 75 L	50-dBZ echo top, 75th percentile	1.04	Low-level azimuthal shear, 25th percentile	0.33
VIL, 95th percentile 1.76 Effective-layer depth 0.52	VIL, 50th percentile	1.01	Energy-helicity index for left-mover	0.43
	VIL, 95th percentile	1.70	Effective-layer depth	0.32

• SFS results for buffer distance of 0 km and lead time of [30, 45] minutes.

Top 20 variables from SFS.	
-10 °C reflectivity, mean	~-
Magnitude of shear from 0-6 km AGL	25
Speed of motion	24
Vertical-totals index	23
Lapse rate from 0-3 km AGL	25
Sine of shear from 0-1 km AGL	22
Fosberg fire-weather index	21
Surface relative humidity	20
Significant-severe parameter	20
CAPE from 0-3 km AGL	19
Mid-level azimuthal shear, 50th percentile	18
K-index	17
MCS-maintenance probability	1/
MESH, 25th-percentile gradient	16
CAPE	15
Height of -30 °C	14
SHERB parameter	17
Lifted index from surface – 300 mb	13
Sine of maximum boundary-layer wind	12
Sine of mean boundary-layer wind	11

• *J*-measure results for buffer distance of 0 km and lead time of [45, 60] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	2.03	Top 20 J-measures (AFTER controlling for linear correlation).	2 03
-10 °C reflectivity, 75th percentile	2.05	-10 °C reflectivity, 75th percentile	2.05
-10 °C reflectivity, mean	1 07	-10 °C reflectivity, mean	1.54
-10 °C reflectivity, 50th percentile	1.97	-10 °C reflectivity, 50th percentile	1.05
-10 °C reflectivity, 95th percentile	1.94	-10 °C reflectivity, 95th percentile	1.70
-20 °C reflectivity, 75th percentile	1.91	-20 °C reflectivity, 75th percentile	1.07
-20 °C reflectivity, 50th percentile	1.00	-20 °C reflectivity, 50th percentile	1.59
-20 °C reflectivity, 95th percentile	1.05	-20 °C reflectivity, 95th percentile	1.50
-20 °C reflectivity, mean	1.02	-20 °C reflectivity, mean	1.41
-10 °C reflectivity, 100th percentile	1.75	-10 °C reflectivity, 100th percentile	1.52
-20 °C reflectivity, 100th percentile	1.70	-20 °C reflectivity, 100th percentile	1.25
-20 °C reflectivity, 25th percentile	1.75	-20 °C reflectivity, 25th percentile	1.14
-10 °C reflectivity, 25th percentile	1.70	Vertical-totals index	1.05
50-dBZ echo top, mean	1.67	Lapse rate from 850-500 mb	0.90
50-dBZ echo top, 100th percentile	1.04	Magnitude of shear from 0-6 km AGL	0.07
VIL, mean	1.01	Magnitude of shear from 0-8 km AGL	0.78
50-dBZ echo top, 75th percentile	1.57	Magnitude of shear from 0-9 km AGL	0.09
50-dBZ echo top, 50th percentile	1.54	Fosberg fire-weather index	0.00
50-dBZ echo top, 95th percentile	1.51	Lowest-altitude reflectivity, 5th percentile	0.52
VIL, 50th percentile	1.40	Supercell composite parameter for left-mover	0.43
VIL, 75th percentile		Effective-layer depth	0.34
	/		

• SFS results for buffer distance of 0 km and lead time of [45, 60] minutes.

Top 20 variables from SFS.		
MCS-maintenance probability		
Fosberg fire-weather index		25
Magnitude of shear from 0-6 km AGL		24
-10 °C reflectivity, mean		23
Surface relative humidity		20
Vertical-totals index		22
Significant-severe parameter		21
Derecho composite parameter		20
-10 °C reflectivity, 100th percentile		20
K-index		19
Lapse rate from 0-3 km AGL		18
Sine of maximum boundary-layer wind		17
Cosine of shear from 0-8 km AGL		1/
Cosine of mean storm-relative wind from 0-1 km A	GL	16
SHERB parameter		15
Sine of bulk Richardson number (BRN) shear		14
MESH, 50th-percentile gradient		10
Mean relative humidity from 0-1 km AGL		13
Precipitable water		12
CAPE from 0-3 km AGL		11

• J-measure results for buffer distance of 0 km and lead time of [60, 90] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	154	Top 20 J-measures (AFTER controlling for linear correlation).	1 5	1
-10 °C reflectivity, 50th percentile	1.54	-10 °C reflectivity, 50th percentile	1.5	17
-20 °C reflectivity, mean	1.52	-20 [°] C reflectivity, mean	1.4	11
-20 °C reflectivity, 75th percentile	1.50	-20 °C reflectivity, 75th percentile	1.9	2 A
-20 °C reflectivity, 50th percentile	1.40	-20 [°] C reflectivity, 50th percentile	1.5	00
-10 [°] C reflectivity, mean	1.47	-10 [°] C reflectivity, mean	1.2	.0
-10 °C reflectivity, 75th percentile	1.45	-10 °C reflectivity, 75th percentile	1.2	. L
-20 °C reflectivity, 95th percentile	1.45	-20 °C reflectivity, 95th percentile	1.1	.5
-20 °C reflectivity, 100th percentile	1.41	-20 °C reflectivity, 100th percentile	1.0	19
-20 °C reflectivity, 25th percentile	1.40	-20 °C reflectivity, 25th percentile	1.0	
-10 °C reflectivity, 25th percentile	1.30	-10 °C reflectivity, 25th percentile	0.9	0
-10 °C reflectivity, 95th percentile	1.50	-10 °C reflectivity, 95th percentile	0.0	2
-10 °C reflectivity, 100th percentile	1.54	-10 °C reflectivity, 100th percentile	0.0	כי די
50-dBZ echo top, mean	1.55	Lapse rate from 850-500 mb	0.7	1
Comp reflectivity, mean	1.31	Vertical-totals index	0.7	0
50-dBZ echo top, 75th percentile	1.29	Magnitude of shear from 0-9 km AGL	0.0	-4
VIL, mean	1.28	Magnitude of mean LCL-EL wind	0.5	.1
-20 °C reflectivity, 5th percentile	1.20	Fosberg fire-weather index	0.5	
VIL, 50th percentile	1.24	Magnitude of shear from 0-3 km AGL	0.4	D
Comp reflectivity, 50th percentile	1.22	Cosine of mean storm-relative wind from 0-2 km A	G 0.3	ю N
MESH, 75th percentile	1.21	Cosine of mean effective-layer storm-relative wind	0.3)Z
				2

• SFS results for buffer distance of 0 km and lead time of [60, 90] minutes.

Top 20 variables from SFS.		
Lapse rate from 0-3 km AGL		
Magnitude of shear from 0-6 km AGL		25
-10 °C reflectivity, mean		24
MCS-maintenance probability		23
Vertical-totals index		25
Magnitude of shear from 0-1 km AGL		22
Fosberg fire-weather index		21
CAPE from 0-3 km AGL		20
SHERB parameter		20
Sine of bulk Richardson number (BRN) shear		19
Magnitude of effective bulk wind difference		18
K-index		17
Lapse rate from 3-6 km AGL		1/
Cosine of mean effective-layer storm-relative wind		16
-10 °C reflectivity, 100th percentile		15
Significant-severe parameter		14
Surface relative humidity		17
Significant-hail parameter		13
Cosine of mean storm-relative wind from 9-11 km	'G	12
-20 °C reflectivity, mean		11

• J-measure results for buffer distance of 5 km and lead time of [0, 15] minutes.

-10 °C reflectivity, mean2.53-10 °C reflectivity, mean2.47-10 °C reflectivity, 25th percentile2.54-10 °C reflectivity, 25th percentile2.35-20 °C reflectivity, 50th percentile2.48-20 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.48-10 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.43-20 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.44-20 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 55th percentile2.43Lapse rate from 850-500 mb1.87-20 °C reflectivity, 75th percentile2.34Wertical-totals index1.75-20 °C reflectivity, 5th percentile2.34Magnitude of shear from 0.6 km AGL1.63-20 °C reflectivity, 5th percentile2.34Speed of motion1.63-20 °C reflectivity, 5th percentile2.32Magnitude of bulk Richardson number (BRN) shear1.40-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 95th-percentile gradient1.40-20 °C reflectivity, 95th percentile2.24Magnitude reflectivity, 95th-percentile gradient1.40-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 95th-percentile gradient1.04-20 °C reflectivity, 50th percentile2.23Comp reflectivity, 511.40-20 °C reflectivity, 50th percentile2.112.231.40-20 °C reflectivity, 95th percentile2.26Supercell composite parameter for left-mover1.	Top 20 J-measures (BEFORE controlling for linear correlation).	2 50	Top 20 J-measures (AFTER controlling for linear correlation).	2 50
-10 °C reflectivity, 25th percentile2.53-10 °C reflectivity, 25th percentile2.35-20 °C reflectivity, soth percentile2.51-20 °C reflectivity, mean2.23-10 °C reflectivity, 50th percentile2.48-20 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.45Lapse rate from 850-500 mb1.87-20 °C reflectivity, 75th percentile2.43Vertical-totals index1.75-10 °C reflectivity, 75th percentile2.34Magnitude of shear from 0-6 km AGL1.63-20 °C reflectivity, 75th percentile2.34Speed of motion1.52-20 °C reflectivity, 50th percentile2.34Speed of motion1.52-20 °C reflectivity, 50th percentile2.34Speed of motion1.63-20 °C reflectivity, 95th percentile2.34Speed of motion1.52-20 °C reflectivity, 95th percentile2.34Speed of motion1.52-20 °C reflectivity, 95th percentile2.34Speed of motion1.52-20 °C reflectivity, 95th percentile2.26Supercell composite parameter for left-mover1.40-20 °C reflectivity, 95th percentile2.26Supercell composite parameter for left-mover1.04-20 °C reflectivity, 95th percentile2.18Lowest-alitude reflectivity, standard deviation of gr1.063-10 °C reflectivity, 50th percentile2.12-20 °C reflectivity, standard deviation of gr1.068-10 °C reflectivity, 50th percentile2.18Lowest-alitude reflectivity, standard deviation of gr1.068-10 °C	-10 °C reflectivity, mean	2.55	-10 °C reflectivity, mean	2.55
-20 °C reflectivity, mean2.51-20 °C reflectivity, mean2.53-10 °C reflectivity, 50th percentile2.48-10 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.452.452.05 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 50th percentile2.432.432.232.11-20 °C reflectivity, 50th percentile2.432.431.87-20 °C reflectivity, 75th percentile2.43Vertical-totals index1.87-20 °C reflectivity, 75th percentile2.34Speed of motion1.62-20 °C reflectivity, 5th percentile2.34Magnitude of bulk Richardson number (BRN) shear1.40-20 °C reflectivity, 95th percentile2.23Fosberg fire-weather index1.40-20 °C reflectivity, 95th percentile2.24Magnitude of bulk Richardson number (BRN) shear1.40-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 95th-percentile gradient1.40-20 °C reflectivity, 95th percentile2.24Supercell composite parameter for left-mover1.40-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 100th-percentile gradient1.62-20 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr1.04-10 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr0.68-10 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr0.68-10 °C reflectivity, 50th percentile<	-10 °C reflectivity, 25th percentile	2.50	-10 °C reflectivity, 25th percentile	2.47
-10 °C reflectivity, 50th percentile251-10 °C reflectivity, 50th percentile251-20 °C reflectivity, 50th percentile248-20 °C reflectivity, 50th percentile199-20 °C reflectivity, 25th percentile243Lapse rate from 850-500 mb187-20 °C reflectivity, 75th percentile240Vertical-totals index175-10 °C reflectivity, 75th percentile240Nagnitude of shear from 0-6 km AGL163-20 °C reflectivity, 50th percentile241Speed of motion152-20 °C reflectivity, 50th percentile242Nagnitude of bulk Richardson number (BRN) shear163-20 °C reflectivity, 95th percentile229Lowest-altitude reflectivity, 95th-percentile gradient163-20 °C reflectivity, 95th percentile229Lowest-altitude reflectivity, 95th-percentile gradient164-20 °C reflectivity, 95th percentile229Lowest-altitude reflectivity, 95th-percentile gradient164-20 °C reflectivity, 95th percentile229Lowest-altitude reflectivity, 95th-percentile gradient164-20 °C reflectivity, 95th percentile221Mid-level azimuthal shear, 5th percentile164-10 °C reflectivity, 50th percentile212Low-level azimuthal shear, 25th percentile068-10 °C reflectivity, 50th percentile21212068-10 °C reflectivity, 50th percentile212212068-10 °C reflectivity, 50th percentile212212068-10 °C refl	-20 °C reflectivity, mean	2.54	-20 °C reflectivity, mean	2.33
-20 °C reflectivity, 50th percentile2.40-20 °C reflectivity, 50th percentile2.11-20 °C reflectivity, 25th percentile2.45Lapse rate from 850-500 mb1.87-20 °C reflectivity, 75th percentile2.40Vertical-totals index1.75-10 °C reflectivity, 75th percentile2.37Speed of motion1.63-20 °C reflectivity, 5th percentile2.34Magnitude of bulk Richardson number (BRN) shear1.40-20 °C reflectivity, 5th percentile2.32Fosberg fire-weather index1.75-20 °C reflectivity, 95th percentile2.32Fosberg fire-weather index1.28VIL, 50th percentile2.29Lowest-altitude reflectivity, 95th-percentile gradient1.04-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 100th-percentile gradient0.920 °C reflectivity, 50th percentile2.18Lowest-altitude reflectivity, standard deviation of gr1.040 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr1.040 °C reflectivity, 50th percentile2.12-20 °C reflectivity, standard deviation of gr1.040 °C reflectivity, 50th percentile2.12-20 °C reflectivity, standard deviation of gr1.040 °C reflectivity, 50th percentile2.12-20 °C reflectivity, standard deviation of gr1.040 °C reflectivity, 50th percentile2.09-20 °C reflectivity, mean gradient0.440 °C reflectivity, 50th percentile2.09-20 °C reflectivity, mean gradient0.440 °C reflectivity, 50th percenti	-10 °C reflectivity, 50th percentile	2.51	-10 °C reflectivity, 50th percentile	2.23
-20 °C reflectivity, 25th percentile2.43Lapse rate from 850-500 mb1.59-20 °C reflectivity, 75th percentile2.43Vertical-totals index1.87-10 °C reflectivity, 75th percentile2.40Magnitude of shear from 0-6 km AGL1.63-20 °C reflectivity, 5th percentile2.34Speed of motion1.5250-dBZ echo top, mean2.32Fosberg fire-weather index1.40VIL, mean2.29Lowest-altitude reflectivity, 95th-percentile gradient1.64-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 10th-percentile gradient1.63-20 °C reflectivity, 95th percentile2.22Supercell composite parameter for left-mover1.40-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 10th-percentile gradient1.16-20 °C reflectivity, 5th percentile2.21Mid-level azimuthal shear, 5th percentile0.920 °C reflectivity, 5th percentile2.15Lowest-altitude reflectivity, mean gradient0.800 °C reflectivity, 5th percentile2.12-20 °C reflectivity, mean gradient0.680 °C reflectivity, 5th percentile2.09-20 °C reflectivity, mean gradient0.440 °C reflectivity, 5th percentile2.07Sine of shear from 0-1 km AGL0.440.442.07Energy-helicity index for left-mover0.20	-20 °C reflectivity, 50th percentile	2.40	-20 °C reflectivity, 50th percentile	2.11
-20 °C reflectivity, 75th percentile2.43Vertical-totals index1.67-10 °C reflectivity, 75th percentile2.37Magnitude of shear from 0.6 km AGL1.63-20 °C reflectivity, 5th percentile2.37Speed of motion1.6350-dBZ echo top, mean2.32Fosberg fire-weather index1.28VIL, mean2.29Lowest-altitude reflectivity, 95th-percentile gradient1.28-20 °C reflectivity, 95th percentile2.23Supercell composite parameter for left-mover1.040 °C reflectivity, 95th percentile2.21Mid-level azimuthal shear, 5th percentile0.920 °C reflectivity, 50th percentile2.15Low-level azimuthal shear, 25th percentile0.800 °C reflectivity, 5th percentile2.12Low-level azimuthal shear, 25th percentile0.680 °C reflectivity, 5th percentile2.12Low-level azimuthal shear, 25th percentile0.680 °C reflectivity, 5th percentile2.12Low-level azimuthal shear, 25th percentile0.680 °C reflectivity, 5th percentile2.09-20 °C reflectivity, mean gradient0.640 °C reflectivity, 5th percentile2.07Sine of shear from 0.1 km AGL0.440 °C reflectivity, 5th percentile2.07Energy-helicity index for left-mover0.44	-20 °C reflectivity, 25th percentile	2.43	Lapse rate from 850-500 mb	1.99
-10 °C reflectivity, 75th percentile2.40Magnitude of shear from 0-6 km AGL1.73-20 °C reflectivity, 5th percentile2.37Speed of motion1.6350-dBZ echo top, mean2.34Magnitude of bulk Richardson number (BRN) shear1.40VIL, mean2.29Fosberg fire-weather index1.40VIL, 50th percentile2.26Lowest-altitude reflectivity, 95th-percentile gradient1.63-20 °C reflectivity, 95th percentile2.23Supercell composite parameter for left-mover1.400 °C reflectivity, mean2.23Comp reflectivity, 100th-percentile gradient1.640 °C reflectivity, 50th percentile2.23Supercell composite parameter for left-mover1.640 °C reflectivity, 50th percentile2.21Comp reflectivity, 100th-percentile gradient0.9250-dBZ echo top, 75th percentile2.15Lowest-altitude reflectivity, standard deviation of gr0.68-10 °C reflectivity, 50th percentile2.12Low-level azimuthal shear, 25th percentile0.68-10 °C reflectivity, 5th percentile2.09-20 °C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.440.502.04Energy-helicity index for left-mover0.32	-20 °C reflectivity, 75th percentile	2.45	Vertical-totals index	1.07
-20°C reflectivity, 5th percentile2.37Speed of motion1.0350-dBZ echo top, mean2.34Magnitude of bulk Richardson number (BRN) shear1.52VIL, mean2.32Fosberg fire-weather index1.40-20°C reflectivity, 95th percentile2.29Lowest-altitude reflectivity, 95th-percentile gradient1.66-20°C reflectivity, 95th percentile2.23Supercell composite parameter for left-mover1.040°C reflectivity, mean2.21Mid-level azimuthal shear, 5th percentile0.9250-dBZ echo top, 75th percentile2.15Lowest-altitude reflectivity, standard deviation of gr0.800°C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, mean gradient0.920°C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr0.680°C reflectivity, 50th percentile2.12-20°C reflectivity, mean gradient0.440°L, 25th percentile2.09-20°C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.07Energy-helicity index for left-mover0.32	-10 °C reflectivity, 75th percentile	2.40	Magnitude of shear from 0-6 km AGL	1.75
50-dBZ echo top, mean2.34Magnitude of bulk Richardson number (BRN) shear1.32VIL, mean2.32Fosberg fire-weather index1.402.20Lowest-altitude reflectivity, 95th-percentile gradient1.28-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 95th-percentile gradient1.64-20 °C reflectivity, 95th percentile2.23Comp reflectivity, 100th-percentile gradient1.040 °C reflectivity, mean2.21Mid-level azimuthal shear, 5th percentile0.9250-dBZ echo top, 75th percentile2.15Lowest-altitude reflectivity, standard deviation of 2.150.800 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, mean gradient0.92-10 °C reflectivity, 50th percentile2.12Lowest-altitude reflectivity, standard deviation of 90.68-10 °C reflectivity, 50th percentile2.12Lowest-altitude reflectivity, mean gradient0.64VIL, 25th percentile2.09-20 °C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.07Energy-helicity index for left-mover0.32	-20 °C reflectivity, 5th percentile	2.37	Speed of motion	1.03
VIL, mean2.32Fosberg fire-weather index1.40VIL, 50th percentile2.29Lowest-altitude reflectivity, 95th-percentile gradient1.28-20 °C reflectivity, 95th percentile2.26Supercell composite parameter for left-mover1.16-20 °C reflectivity, mean2.21Comp reflectivity, 100th-percentile gradient0.9250-dBZ echo top, 75th percentile2.18Lowest-altitude reflectivity, standard deviation of gr40 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of gr4-10 °C reflectivity, 50th percentile2.12Low-level azimuthal shear, 25th percentile0.68-10 °C reflectivity, 5th percentile2.09-20 °C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.04Energy-helicity index for left-mover0.20	50-dBZ echo top, mean	2.34	Magnitude of bulk Richardson number (BRN) shear	1.52
VIL, 50th percentile2.29Lowest-altitude reflectivity, 95th-percentile gradient1.20-20 °C reflectivity, 95th percentile2.26Supercell composite parameter for left-mover1.16-20 °C reflectivity, mean2.21Comp reflectivity, 100th-percentile gradient0.9250-dBZ echo top, 75th percentile2.18Lowest-altitude reflectivity, standard deviation of gradient0.800 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, mean gradient0.80-10 °C reflectivity, 5th percentile2.12-20 °C reflectivity, mean gradient0.68VIL, 25th percentile2.09-20 °C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.04Energy-helicity index for left-mover0.32	VIL, mean	2.32	Fosberg fire-weather index	1.40
-20 °C reflectivity, 95th percentile2.20Supercell composite parameter for left-mover1.100 °C reflectivity, mean2.23Comp reflectivity, 100th-percentile gradient0.9250-dBZ echo top, 75th percentile2.18Lowest-altitude reflectivity, standard deviation of0.800 °C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, mean gradient0.68-10 °C reflectivity, 5th percentile2.12-20 °C reflectivity, mean gradient0.68VIL, 25th percentile2.09-20 °C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.04Energy-helicity index for left-mover0.20	VIL, 50th percentile	2.29	Lowest-altitude reflectivity, 95th-percentile gradient	1.20
0°C reflectivity, mean2.2.3Comp reflectivity, 100th-percentile gradient0.9250-dBZ echo top, 75th percentile2.18Mid-level azimuthal shear, 5th percentile0.920°C reflectivity, 50th percentile2.15Lowest-altitude reflectivity, standard deviation of0.68-10°C reflectivity, 5th percentile2.12Low-level azimuthal shear, 25th percentile0.68VIL, 25th percentile2.09-20°C reflectivity, mean gradient0.44VIL, 75th percentile2.07Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.04Energy-helicity index for left-mover0.20	-20 °C reflectivity, 95th percentile	2.20	Supercell composite parameter for left-mover	1.10
50-dBZ echo top, 75th percentile2.21Mid-level azimuthal shear, 5th percentile0.920 °C reflectivity, 50th percentile2.18Lowest-altitude reflectivity, standard deviation of0.80-10 °C reflectivity, 5th percentile2.15Low-level azimuthal shear, 25th percentile0.80VIL, 25th percentile2.12-20 °C reflectivity, mean gradient0.56VIL, 75th percentile2.09-20 °C reflectivity, mean gradient0.440.322.07Energy-helicity index for left-mover0.32	0 °C reflectivity, mean	2.23	Comp reflectivity, 100th-percentile gradient	1.04
0°C reflectivity, 50th percentile2.16Lowest-altitude reflectivity, standard deviation of Low-level azimuthal shear, 25th percentile0.80-10°C reflectivity, 5th percentile2.15Low-level azimuthal shear, 25th percentile0.68VIL, 25th percentile2.12-20°C reflectivity, mean gradient0.56VIL, 75th percentile2.09Sine of shear from 0-1 km AGL0.3250-dBZ echo top, 50th percentile2.04Energy-helicity index for left-mover0.20	50-dBZ echo top, 75th percentile	2.21	Mid-level azimuthal shear, 5th percentile	0.92
-10 °C reflectivity, 5th percentile VIL, 25th percentile VIL, 75th percentile 50-dBZ echo top, 50th percentile 2.04 2.07 50-dBZ echo top, 50th percentile 2.04 2.07 2.04	0 °C reflectivity, 50th percentile	2.10	Lowest-altitude reflectivity, standard deviation of gr	
VIL, 25th percentile VIL, 75th percentile 50-dBZ echo top, 50th percentile 2.07 2.04 2.07 2.07 2.04 2.09 2.07 2.07 2.04 2.09 2.07 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.09 2.07 2.04 2.07 2.04 2.09 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04 2.07 2.04	-10 °C reflectivity, 5th percentile	2.15	Low-level azimuthal shear, 25th percentile	0.00
VIL, 75th percentile 50-dBZ echo top, 50th percentile 2.09 2.07	VIL, 25th percentile	2.12	-20 °C reflectivity, mean gradient	0.50
50-dBZ echo top, 50th percentile	VIL, 75th percentile	2.09	Sine of shear from 0-1 km AGL	0.44
	50-dBZ echo top, 50th percentile	2.07	Energy-helicity index for left-mover	0.52

• SFS results for buffer distance of 5 km and lead time of [0, 15] minutes.

Top 20 variables from SFS.		
-10 [°] C reflectivity, mean		25
Speed of motion		25
Lapse rate from 0-3 km AGL		24
Vertical-totals index		23
Precipitable water		25
Height of -10 [°] C		22
Fosberg fire-weather index		21
Lapse rate from 700-500 mb		20
Magnitude of mean boundary-layer wind		20
K-index		19
MCS-maintenance probability		18
Sine of shear from 0-3 km AGL		17
CAPE		L /
Significant-severe parameter		16
Low-level azimuthal shear, 100th-percentile gradie	n	15
Sine of bulk Richardson number (BRN) shear		1/
Significant-hail parameter		14
-10 °C reflectivity, 25th percentile		13
Downdraft CAPE		12
Cosine of mean wind from 0-1 km AGL		11

• *J*-measure results for buffer distance of 5 km and lead time of [15, 30] minutes.

	256
-10 °C reflectivity, mean 2.53 -10 °C reflectivity, mean	2.50
-20 °C reflectivity, mean -20 °C reflectivity, mean	2.44
-10 °C reflectivity, 50th percentile	2.55
-20 °C reflectivity, 50th percentile	2.21
-10 °C reflectivity, 25th percentile	2.09
-20 °C reflectivity, 25th percentile	1.90
-20 °C reflectivity, 75th percentile	1.00
-10 °C reflectivity, 75th percentile	1.74
-20 °C reflectivity, 95th percentile	1.05
-20 °C reflectivity, 100th percentile	1.01
50-dBZ echo top, mean 2.20 Fosberg fire-weather index	1.59
VIL, mean Z.20 Maximum lifted index	1.20
VIL, 50th percentile 2.25 Storm-relative helicity for left-mover	1.10
-20 °C reflectivity, 5th percentile	1.04
50-dBZ echo top, 75th percentile	0.95
-10 °C reflectivity, 95th percentile	0.01
VIL, 75th percentile	0.09
0 °C reflectivity, mean 2.09 Energy-helicity index from 0-3 km AGL	0.50
50-dBZ echo top, 50th percentile	0.40
50-dBZ echo top, 95th percentile 2.04 Lowest-altitude reflectivity, mean gradient	0.54

• SFS results for buffer distance of 5 km and lead time of [15, 30] minutes.

Top 20 variables from SFS.		
-10 °C reflectivity, mean		~ -
Speed of motion		25
Vertical-totals index		24
Fosberg fire-weather index		23
Precipitable water		25
MCS-maintenance probability		22
Height of -10 °C		21
Lapse rate from 0-3 km AGL		20
Sine of shear from 0-3 km AGL		20
Significant-severe parameter		19
SWEAT index		18
50-dBZ echo top, 100th-percentile gradient		17
50-dBZ echo top, 100th percentile		1/
Downdraft CAPE		16
VIL, 0th-percentile gradient		15
Sine of bulk Richardson number (BRN) shear		1/
Surface relative humidity		14
Derecho composite parameter		13
Significant-hail parameter		12
Low-level azimuthal shear, 100th-percentile gradien	It	11

• *J*-measure results for buffer distance of 5 km and lead time of [30, 45] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	2 1/	Top 20 J-measures (AFTER controlling for linear correlation).	2 1/
-10 °C reflectivity, mean	2.14	-10 [°] C reflectivity, mean	2.14
-20 °C reflectivity, mean	2.12	-20 [°] C reflectivity, mean	1.05
-10 [°] C reflectivity, 50th percentile	2.09	-10 °C reflectivity, 50th percentile	1.95
-20 [°] C reflectivity, 50th percentile	2.07	-20 °C reflectivity, 50th percentile	1.05
-20 [°] C reflectivity, 75th percentile	2.04	-20 °C reflectivity, 75th percentile	1.75
-10 °C reflectivity, 25th percentile	2.02	-10 °C reflectivity, 25th percentile	1.00
-20 [°] C reflectivity, 25th percentile	2.00	-20 °C reflectivity, 25th percentile	1.30
-10 °C reflectivity, 75th percentile	1.97	Lapse rate from 850-500 mb	1.40
-20 [°] C reflectivity, 95th percentile	1.95	Vertical-totals index	1.37
-20 [°] C reflectivity, 100th percentile	1.95	Magnitude of shear from 0-6 km AGL	1.27
50-dBZ echo top, mean	1.90	Magnitude of shear from 0-8 km AGL	1.17
-20 [°] C reflectivity, 5th percentile	1.00	Fosberg fire-weather index	1.08
VIL, mean	1.05	Comp reflectivity, 95th-percentile gradient	0.98
VIL, 50th percentile	1.05	Supercell composite parameter for left-mover	0.00
-10 [°] C reflectivity, 95th percentile	1.01	Storm-relative helicity for left-mover	0.79
50-dBZ echo top, 75th percentile	1.70	-10 °C reflectivity, mean gradient	0.09
VIL, 75th percentile	1.70	0 [°] C reflectivity, mean gradient	0.59
50-dBZ echo top, 50th percentile	1.73	0 °C reflectivity, 25th-percentile gradient	0.50
0 °C reflectivity, mean	1./1	Comp reflectivity, 100th-percentile gradient	0.40
VIL, 25th percentile	1.09	Sine of shear from 0-1 km AGL	0.30
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• SFS results for buffer distance of 5 km and lead time of [30, 45] minutes.

Top 20 variables from SFS.	
-10 °C reflectivity, mean	25
Vertical-totals index	25
Lapse rate from 0-3 km AGL	24
Fosberg fire-weather index	23
Speed of motion	20
Precipitable water	22
Sine of shear from 0-1 km AGL	21
Downdraft CAPE	20
Magnitude of shear from 0-6 km AGL	10
Sine of bulk Richardson number (BRN) shear	19
Significant-severe parameter	18
Height of -10 °C	17
K-index	17
MCS-maintenance probability	16
SHERB parameter	15
Derecho composite parameter	14
Effective-layer depth	17
Magnitude of mean LCL-EL wind	13
CAPE	12
Boundary-layer depth	11

• J-measure results for buffer distance of 5 km and lead time of [45, 60] minutes.

-10 °C reflectivity, mean1.80-10 °C reflectivity, mean1.80-20 °C reflectivity, 50th percentile1.83-20 °C reflectivity, mean1.80-20 °C reflectivity, 50th percentile1.81-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 50th percentile1.79-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 25th percentile1.77-20 °C reflectivity, 25th percentile1.46-20 °C reflectivity, 75th percentile1.77-20 °C reflectivity, 25th percentile1.38-20 °C reflectivity, 75th percentile1.77-20 °C reflectivity, 75th percentile1.38-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.38-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.38-20 °C reflectivity, 75th percentile1.68Magnitude of shear from 0.8 km AGL1.04-20 °C reflectivity, 95th percentile1.63Magnitude of shear from 0.9 km AGL0.96-20 °C reflectivity, 5th percentile1.63Magnitude of mean LCL-EL wind0.88-20 °C reflectivity, 5th percentile1.59Supercell composite parameter for left-mover0.71-20 °C reflectivity, 5th percentile1.54Stom-relative helicity for left-mover0.74-20 °C reflectivity, 5th percentile1.52Cosine of mean wind from 0.8 km AGL0.46-20 °C reflectivity, 5th percentile1.52Cosine of mean wind from 0.8 km AGL0.46-10 °C reflectivity, 100th percentile1.52Cosine of mea	Top 20 J-measures (BEFORE controlling for linear correlation).	188	Top 20 J-measures (AFTER controlling for linear correlation).	1 88
-20 °C reflectivity, mean1.80-20 °C reflectivity, mean1.71-20 °C reflectivity, 50th percentile1.81-20 °C reflectivity, 50th percentile1.63-20 °C reflectivity, 25th percentile1.79-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 25th percentile1.77-20 °C reflectivity, 25th percentile1.38-20 °C reflectivity, 25th percentile1.77-20 °C reflectivity, 25th percentile1.38-20 °C reflectivity, 75th percentile1.75-20 °C reflectivity, 75th percentile1.29-20 °C reflectivity, 75th percentile1.70Lapse rate from 850-500 mb1.21-20 °C reflectivity, 95th percentile1.63Magnitude of shear from 0-8 km AGL1.04-20 °C reflectivity, 95th percentile1.63Magnitude of mean LCL-EL wind0.96-20 °C reflectivity, 5th percentile1.57-20 °C reflectivity, mean1.04-20 °C reflectivity, 5th percentile1.63Magnitude of mean LCL-EL wind0.96-20 °C reflectivity, 5th percentile1.57-20 °C reflectivity, mean0.79-20 °C reflectivity, 5th percentile1.54.500.79-20 °C reflectivity, 5th percentile1.54.500.79-20 °C reflectivity, 5th percentile1.54.500.54-20 °C reflectivity, 100th percentile1.54.500.54-20 °C reflectivity, 5th percentile1.54.500.54-20 °C reflectivity, 5th percentile1.54.500.54-20 °C reflectivity, 5th percentile1.54 <t< td=""><td>-10 °C reflectivity, mean</td><td>1.86</td><td>-10 °C reflectivity, mean</td><td>1.00</td></t<>	-10 °C reflectivity, mean	1.86	-10 °C reflectivity, mean	1.00
-20 °C reflectivity, 50th percentile1.05-20 °C reflectivity, 50th percentile1.71-10 °C reflectivity, 50th percentile1.79-20 °C reflectivity, 25th percentile1.74-20 °C reflectivity, 25th percentile1.74-20 °C reflectivity, 25th percentile1.74-20 °C reflectivity, 25th percentile1.75-20 °C reflectivity, 25th percentile1.76-20 °C reflectivity, 75th percentile1.76-20 °C reflectivity, 75th percentile1.76-20 °C reflectivity, 75th percentile1.76-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 95th percentile1.68-20 °C reflectivity, 95th percentile1.68-20 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-8 km AGL1.04-20 °C reflectivity, 95th percentile1.61-20 °C reflectivity, 50th percentile1.59Supercell composite parameter for left-mover0.71-20 °C reflectivity, 100th percentile1.52-20 °C reflectivity, 100th percentile1.52-20 °C reflectivity, 100th percentile1.54-20 °C reflectivity, 100th percentile1.54-20 °C reflectivity, 100th percentile1.54-20 °C reflectivity, 100th percentile1.54-20 °C r	-20 °C reflectivity, mean	1.00	-20 [°] C reflectivity, mean	1 71
-10 °C reflectivity, 50th percentile1.01-20 °C reflectivity, 25th percentile1.79-20 °C reflectivity, 25th percentile1.77-10 °C reflectivity, 25th percentile1.77-20 °C reflectivity, 25th percentile1.75-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.72-20 °C reflectivity, 75th percentile1.70-20 °C reflectivity, 95th percentile1.68-20 °C reflectivity, 95th percentile1.66-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 95th percentile1.66-20 °C reflectivity, 95th percentile1.61-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 5th percentile1.61-20 °C reflectivity, 5th percentile1.61-20 °C reflectivity, 5th percentile1.61-20 °C reflectivity, 5th percentile1.61-20 °C reflectivity, 5th percentile1.63-20 °C reflectivity, 5th percentile1.61-20 °C reflectivity, 5th percentile1.63-20 °C reflectivity, 5th percentile1.64-20 °C reflectivity, 5th percentile1.64-20 °C reflectivity, 5th percentile1.65-20 °C reflectivity, 5th percentile1.63-20 °C reflectivity, 5th percentile1.64-20 °C reflectivity, 5th percentile1.64-20 °C reflectivity, 5th percentile1.55-20 °C reflectivity, 5th percentil	-20 °C reflectivity, 50th percentile	1.05	-20 °C reflectivity, 50th percentile	1.71
-20 °C reflectivity, 25th percentile1.75-20 °C reflectivity, 25th percentile1.34-10 °C reflectivity, 25th percentile1.75-20 °C reflectivity, 25th percentile1.46-20 °C reflectivity, 75th percentile1.75-20 °C reflectivity, 25th percentile1.29-10 °C reflectivity, 75th percentile1.70Lapse rate from 850-500 mb1.21-20 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-9 km AGL1.04-20 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-9 km AGL0.96-20 °C reflectivity, 5th percentile1.61Fosberg fire-weather index0.96-20 °C reflectivity, 5th percentile1.57Supercell composite parameter for left-mover0.79VIL, 50th percentile1.5450-dBZ echo top, 50th percentile1.5450-dBZ echo top, 75th percentile0.6350-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.38-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.29	-10 °C reflectivity, 50th percentile	1.01	-10 °C reflectivity, 50th percentile	1.05
-10 °C reflectivity, 25th percentile1.77 1.75-10 °C reflectivity, 25th percentile1.38 1.39-20 °C reflectivity, 75th percentile1.77 1.70-20 °C reflectivity, 75th percentile1.38 1.29-10 °C reflectivity, 75th percentile1.70Lapse rate from 850-500 mb1.13-20 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-8 km AGL1.04-10 °C reflectivity, 95th percentile1.66Magnitude of mean LCL-EL wind0.88-20 °C reflectivity, 5th percentile1.61Fosberg fire-weather index0.79VIL, 50th percentile1.57-20 °C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.52Cosine of mean wind from 0-8 km AGL0.6350-dBZ echo top, 75th percentile1.52Cosine of mean wind from 0-8 km AGL0.540.10 °C reflectivity, 100th percentile1.54Storm-relative helicity for left-mover0.540.10 °C reflectivity, 100th percentile1.50Cosine of mean wind from 0-8 km AGL0.460.10 °C reflectivity, 100th percentile1.46Fosberg fire-weather index0.79VIL, 50th percentile1.50Cosine of mean wind from 0-8 km AGL0.630.10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.380.10 °C reflectivity, 100th percentile1.46Feffective-layer depth0.380.10 °C reflectivity, 100th percentile1.46Feffectivity, 50th-percentile gradient0.29	-20 °C reflectivity, 25th percentile	1.79	-20 °C reflectivity, 25th percentile	1.54
-20 °C reflectivity, 75th percentile1.73-20 °C reflectivity, 75th percentile1.29-10 °C reflectivity, 75th percentile1.70Lapse rate from 850-500 mb1.21-20 °C reflectivity, 95th percentile1.68Magnitude of shear from 0-8 km AGL1.04-10 °C reflectivity, 95th percentile1.61Magnitude of mean LCL-EL wind0.9650-dBZ echo top, mean1.61Fosberg fire-weather index0.79VIL, 50th percentile1.57Supercell composite parameter for left-mover0.71VIL, soth percentile1.54Storm-relative helicity for left-mover0.5450-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-20 °C reflectivity, 100th percentile1.54Storm-relative helicity for left-mover0.540.71VIL, both percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.46-20 °C reflectivity, 50th-percentile gradient0.38	-10 °C reflectivity, 25th percentile	1.77	-10 °C reflectivity, 25th percentile	1.40
-10 °C reflectivity, 75th percentile1.72Vertical-totals index1.29-20 °C reflectivity, 95th percentile1.68Lapse rate from 850-500 mb1.21-20 °C reflectivity, 100th percentile1.68Magnitude of shear from 0-8 km AGL1.04-10 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-9 km AGL0.9650-dBZ echo top, mean1.61Fosberg fire-weather index0.88-20 °C reflectivity, 5th percentile1.59Supercell composite parameter for left-mover0.79VIL, 50th percentile1.57-20 °C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.52Storm-relative helicity for left-mover0.5450-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.38-10 °C reflectivity, 100th percentile1.46Fiftertive-laver depth0.38-20 °C reflectivity, 50th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.29	-20 [°] C reflectivity, 75th percentile	1.75	-20 °C reflectivity, 75th percentile	1.30
-20 °C reflectivity, 95th percentile1.70Lapse rate from 850-500 mb1.21-20 °C reflectivity, 100th percentile1.68Magnitude of shear from 0-8 km AGL1.13-10 °C reflectivity, 95th percentile1.66Magnitude of shear from 0-9 km AGL0.9650-dBZ echo top, mean1.61Fosberg fire-weather index0.96-20 °C reflectivity, 5th percentile1.59Supercell composite parameter for left-mover0.79VIL, 50th percentile1.57-20 °C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.52Cosine of mean wind from 0-8 km AGL0.6450-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Fffective-layer depth0.29	-10 °C reflectivity, 75th percentile	1.72	Vertical-totals index	1.29
-20°C reflectivity, 100th percentile1.00Magnitude of shear from 0-8 km AGL1.04-10°C reflectivity, 95th percentile1.66Magnitude of shear from 0-9 km AGL1.0450-dBZ echo top, mean1.61Nagnitude of mean LCL-EL wind0.96-20°C reflectivity, 5th percentile1.59Supercell composite parameter for left-mover0.79VIL, 50th percentile1.57-20°C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.5450-dBZ echo top, 50th percentile0.5450-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10°C reflectivity, 100th percentile1.48-20°C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Feffectivity, 50th-percentile gradient0.29	-20 [°] C reflectivity, 95th percentile	1.70	Lapse rate from 850-500 mb	1.21
-10°C reflectivity, 95th percentile1.00Magnitude of shear from 0-9 km AGL0.9650-dBZ echo top, mean1.61Magnitude of mean LCL-EL wind0.96-20°C reflectivity, 5th percentile1.59Supercell composite parameter for left-mover0.79VIL, 50th percentile1.57-20°C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.52Storm-relative helicity for left-mover0.7150-dBZ echo top, 75th percentile1.50Cosine of mean wind from 0-8 km AGL0.46-10°C reflectivity, 100th percentile1.48-20°C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Ffective-layer depth0.38	-20 °C reflectivity, 100th percentile	1.00	Magnitude of shear from 0-8 km AGL	1.13
50-dBZ echo top, mean1.03Magnitude of mean LCL-EL wind0.90-20 °C reflectivity, 5th percentile1.61Fosberg fire-weather index0.79VIL, 50th percentile1.57Supercell composite parameter for left-mover0.71VIL, mean1.54Storm-relative helicity for left-mover0.6350-dBZ echo top, 50th percentile1.52Cosine of mean wind from 0-8 km AGL0.64-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46-20 °C reflectivity, 50th-percentile gradient0.380.290.290.290.29	-10 °C reflectivity, 95th percentile	1.00	Magnitude of shear from 0-9 km AGL	1.04
-20 °C reflectivity, 5th percentile1.01Fosberg fire-weather index0.00VIL, 50th percentile1.59Supercell composite parameter for left-mover0.71VIL, mean-20 °C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.54Storm-relative helicity for left-mover0.6350-dBZ echo top, 75th percentile1.52Cosine of mean wind from 0-8 km AGL0.46-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Effective-laver depth0.29	50-dBZ echo top, mean	1.05	Magnitude of mean LCL-EL wind	0.90
VIL, 50th percentile1.59Supercell composite parameter for left-mover0.79VIL, mean1.57-20 °C reflectivity, mean gradient0.6350-dBZ echo top, 50th percentile1.52Cosine of mean wind from 0-8 km AGL0.5450-dBZ echo top, 75th percentile1.50Cosine of mean LCL-EL wind0.46-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Effective-laver depth0.29	-20 [°] C reflectivity, 5th percentile	1.01	Fosberg fire-weather index	0.88
VIL, mean1.57-20 °C reflectivity, mean gradient0.7150-dBZ echo top, 50th percentile1.541.540.6350-dBZ echo top, 75th percentile1.52Cosine of mean wind from 0-8 km AGL0.54-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.4650-dBZ echo top, 100th percentile1.46-20 °C reflectivity, 50th-percentile gradient0.38VIL 25th percentile1.46Effective-layer depth0.29	VIL, 50th percentile	1.59	Supercell composite parameter for left-mover	0.79
50-dBZ echo top, 50th percentile1.54Storm-relative helicity for left-mover0.6350-dBZ echo top, 75th percentile1.52Cosine of mean wind from 0-8 km AGL0.54-10 °C reflectivity, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.3850-dBZ echo top, 100th percentile1.46Effective-laver depth0.29	VIL, mean	1.57	-20 °C reflectivity, mean gradient	0.71
50-dBZ echo top, 75th percentile1.52Cosine of mean wind from 0-8 km AGL0.34-10 °C reflectivity, 100th percentile1.50Cosine of mean LCL-EL wind0.4650-dBZ echo top, 100th percentile1.48-20 °C reflectivity, 50th-percentile gradient0.38VIL 25th percentile1.46Effective-layer depth0.29	50-dBZ echo top, 50th percentile	1.54	Storm-relative helicity for left-mover	0.05
-10 °C reflectivity, 100th percentile 50-dBZ echo top, 100th percentile VIL 25th percentile	50-dBZ echo top, 75th percentile	1.52	Cosine of mean wind from 0-8 km AGL	0.54
50-dBZ echo top, 100th percentile 1.40 -20 °C reflectivity, 50th-percentile gradient 0.50 VII. 25th percentile 1.46 Effective-layer depth 0.29	-10 °C reflectivity, 100th percentile	1.30	Cosine of mean LCL-EL wind	0.40
VII. 25th percentile I.40 Effective-layer depth 0.29	50-dBZ echo top, 100th percentile	1.40	-20 °C reflectivity, 50th-percentile gradient	0.30
	VIL, 25th percentile	1.40	Effective-layer depth	0.29

• SFS results for buffer distance of 5 km and lead time of [45, 60] minutes.

Top 20 variables from SFS.	
-10 °C reflectivity, mean	~-
MCS-maintenance probability	25
Vertical-totals index	24
Fosberg fire-weather index	22
SHERB parameter	25
Precipitable water	22
Magnitude of shear from 0-6 km AGL	21
50-dBZ echo top, 100th-percentile gradient	20
-20 °C reflectivity, 100th percentile	20
Downdraft CAPE	19
Sine of shear from 0-1 km AGL	18
Lapse rate from 0-3 km AGL	17
Derecho composite parameter	1/
Height of -30 °C	16
Significant-severe parameter	15
Sine of shear from 0-3 km AGL	14
Cosine of shear from 0-6 km AGL	17
-20 °C reflectivity, mean	13
Speed of motion	12
CAPE from 0-3 km AGL	11

• *J*-measure results for buffer distance of 5 km and lead time of [60, 90] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	1 50	<u>Top 20 J-measures (AFTER controlling for linear correlation).</u>		1 5 9
-20 °C reflectivity, mean	1.59	-20 °C reflectivity, mean		1.55
-20 °C reflectivity, 50th percentile	1.56	-20 °C reflectivity, 50th percentile		1.52
-20 °C reflectivity, 25th percentile	1.50	-20 °C reflectivity, 25th percentile		1.40
-10 °C reflectivity, mean	1.54	-10 °C reflectivity, mean		1.50
-20 °C reflectivity, 75th percentile	1.52	-20 °C reflectivity, 75th percentile		1.51
-10 °C reflectivity, 50th percentile	1.51	-10 °C reflectivity, 50th percentile		1.24
-10 °C reflectivity, 25th percentile	1.49	-10 °C reflectivity, 25th percentile		1.1/
-10 °C reflectivity, 75th percentile	1.47	-10 °C reflectivity, 75th percentile		
-20 °C reflectivity, 95th percentile	1.45	Lapse rate from 850-500 mb		1.05
-20 °C reflectivity, 100th percentile	1.44	Vertical-totals index		0.90
50-dBZ echo top, mean	1.42	Magnitude of shear from 0-8 km AGL		0.09
-20 °C reflectivity, 5th percentile	1.40	Magnitude of mean LCL-EL wind		0.02
VIL, mean	1.30	Fosberg fire-weather index		0.75
VIL, 50th percentile	1.50	Maximum lifted index		0.00
50-dBZ echo top, 75th percentile	1.55	Supercell composite parameter for left-mover		0.01
MESH, 75th percentile	1.33	Cosine of mean wind from 0-8 km AGL		0.54
50-dBZ echo top, 50th percentile	1.51	Cosine of mean storm-relative wind from 0-2 km	G	0.47
MESH, mean	1.29	Effective-layer depth		0.40
VIL, 25th percentile	1.20	Comp reflectivity, standard deviation		0.55
VIL, 75th percentile	1.20	Cosine of mean LCL-EL wind		0.20

• SFS results for buffer distance of 5 km and lead time of [60, 90] minutes.

Top 20 variables from SFS.	
MCS-maintenance probability	
Magnitude of shear from 0-6 km AGL	25
Fosberg fire-weather index	24
Lapse rate from 0-3 km AGL	23
Magnitude of shear from 0-1 km AGL	25
-10 °C reflectivity, mean	22
Sine of bulk Richardson number (BRN) shear	21
Height of -30 °C	20
Vertical-totals index	20
SHERB parameter	19
Downdraft CAPE	18
Lapse rate from 3-6 km AGL	17
-20 °C reflectivity, mean	т,
Cosine of bulk Richardson number (BRN) shear	16
CAPE from 0-3 km AGL	15
Magnitude of effective bulk wind difference	1/
Precipitable water	14
K-index	13
VIL, 75th-percentile gradient	12
Sine of motion	11

• *J*-measure results for buffer distance of 10 km and lead time of [0, 15] minutes.

-10 °C reflectivity, 25th percentile2.38-10 °C reflectivity, 25th percentile2.30-10 °C reflectivity, mean2.36-10 °C reflectivity, mean2.19-20 °C reflectivity, 25th percentile2.33-20 °C reflectivity, mean2.07-20 °C reflectivity, 50th percentile2.30Lapse rate from 850-500 mb1.96-10 °C reflectivity, 50th percentile2.25Vertical-totals index1.74-20 °C reflectivity, 50th percentile2.22Magnitude of effective bulk wind difference1.62-20 °C reflectivity, 50th percentile2.22Lowest-altitude reflectivity, mean gradient1.51-10 °C reflectivity, 5th percentile2.17Supercell composite parameter for left-mover1.40-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.20-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.20-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.20-10 °C reflectivity, 75th percentile2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean storm-relative wind from 0-2 km AG0.73-20 °C reflectivity, 25th percentile1.98Effective-layer depth0.50-20 °C reflectivity, 25th percentile1.99Cosine of mean storm-relative wind from 0-2 km AG0.390 °C reflectivity, 25th percentile1.90Cosine of mean storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.	Top 20 J-measures (BEFORE controlling for linear correlation).	2 / 1	Top 20 J-measures (AFTER controlling for linear correlation).	2 / 1
-10 °C reflectivity, mean2.36-10 °C reflectivity, mean2.19-20 °C reflectivity, Z5th percentile2.33-20 °C reflectivity, mean2.07-20 °C reflectivity, S0th percentile2.302.08Vertical-totals index1.96-20 °C reflectivity, S0th percentile2.28Vertical-totals index1.62-20 °C reflectivity, S0th percentile2.25Magnitude of effective bulk wind difference1.62-20 °C reflectivity, Sth percentile2.20Coreflectivity, mean gradient1.62-20 °C reflectivity, Sth percentile2.21Lowest-altitude reflectivity, mean gradient1.62-20 °C reflectivity, Sth percentile2.17Fosberg fire-weather index1.40-10 °C reflectivity, Sth percentile2.17Supercell composite parameter for left-mover1.29-10 °C reflectivity, Sth percentile2.12Low-level azimuthal shear, 25th percentile1.17-10 °C reflectivity, mean2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.610 °C reflectivity, 25th percentile1.98Cosine of mean wind from 0-2 km AG0.730 °C reflectivity, 50th percentile1.99Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 0th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 0th percent	-10 °C reflectivity, 25th percentile	2.41	-10 °C reflectivity, 25th percentile	2.41
-20 °C reflectivity, mean2.33-20 °C reflectivity, mean2.19-20 °C reflectivity, 25th percentile2.33-20 °C reflectivity, 25th percentile1.96-20 °C reflectivity, 50th percentile2.28Lapse rate from 850-500 mb1.85-20 °C reflectivity, 50th percentile2.25Magnitude of effective bulk wind difference1.62-20 °C reflectivity, 50th percentile2.22Magnitude of effective bulk wind difference1.62-20 °C reflectivity, 75th percentile2.20Lowest-altitude reflectivity, mean gradient1.51-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.29-10 °C reflectivity, 75th percentile2.12Low-level azimuthal shear, 25th percentile1.17-10 °C reflectivity, mean2.09Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.610 °C reflectivity, 50th percentile1.98Effective-layer depth0.610 °C reflectivity, 50th percentile1.99Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.99Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.39	-10 °C reflectivity, mean	2.50	-10 °C reflectivity, mean	2.50
-20 °C reflectivity, 25th percentile2.30-20 °C reflectivity, 25th percentile1.96-20 °C reflectivity, 50th percentile2.30Lapse rate from 850-500 mb1.85-10 °C reflectivity, 50th percentile2.25Vertical-totals index1.74-20 °C reflectivity, 5th percentile2.22Lowest-altitude reflectivity, mean gradient1.62-20 °C reflectivity, 75th percentile2.20Lowest-altitude reflectivity, mean gradient1.51-10 °C reflectivity, 75th percentile2.17Fosberg fire-weather index1.40-10 °C reflectivity, 75th percentile2.12Lowest-altitude reflectivity index for left-mover1.29-10 °C reflectivity, 75th percentile2.12Low-level azimuthal shear, 25th percentile1.17-10 °C reflectivity, 75th percentile2.12Low-level azimuthal shear, 25th percentile1.17-10 °C reflectivity, mean2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.840 °C reflectivity, 95th percentile1.98Cosine of mean wind from 0-3 km AGL0.610 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind0.280 °C reflectivity, 50th percentile1.90Cosine of mean effective bulk wind0.28	-20 [°] C reflectivity, mean	2.30	-20 °C reflectivity, mean	2.19
-20 °C reflectivity, 50th percentile2.30Lapse rate from 850-500 mb1.90-10 °C reflectivity, 50th percentile2.28Vertical-totals index1.74-20 °C reflectivity, 5th percentile2.22Magnitude of effective bulk wind difference1.62-20 °C reflectivity, 75th percentile2.20Lowest-altitude reflectivity, mean gradient1.51-10 °C reflectivity, 5th percentile2.17Supercell composite parameter for left-mover1.40-10 °C reflectivity, 75th percentile2.14Energy-helicity index for left-mover1.2950-dBZ echo top, mean2.12Low-level azimuthal shear, 25th percentile1.17VIL, 50th percentile2.04Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.01Cosine of mean storm-relative wind from 0-3 km AGL0.610 °C reflectivity, 55th percentile1.98Effective-layer depth0.61-20 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.39	-20 °C reflectivity, 25th percentile	2.33	-20 °C reflectivity, 25th percentile	1.06
-10 °C reflectivity, 50th percentile2.25Vertical-totals index1.63-20 °C reflectivity, 5th percentile2.25Magnitude of effective bulk wind difference1.74-20 °C reflectivity, 75th percentile2.22Lowest-altitude reflectivity, mean gradient1.62-10 °C reflectivity, 5th percentile2.17Fosberg fire-weather index1.40-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.2950-dBZ echo top, mean2.12Low-level azimuthal shear, 25th percentile1.17VIL, 50th percentile2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean storm-relative wind from 0-1 km AG0.840 °C reflectivity, 95th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.730 °C reflectivity, 5th percentile1.96Cosine of mean effective-layer depth0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Co	-20 °C reflectivity, 50th percentile	2.30	Lapse rate from 850-500 mb	1.90
-20 °C reflectivity, 5th percentile2.22Magnitude of effective bulk wind difference1.74-20 °C reflectivity, 75th percentile2.20Lowest-altitude reflectivity, mean gradient1.62-10 °C reflectivity, 5th percentile2.17Fosberg fire-weather index1.40-10 °C reflectivity, 75th percentile2.14Supercell composite parameter for left-mover1.2950-dBZ echo top, mean2.12Low-level azimuthal shear, 25th percentile1.06VIL, 50th percentile2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.840 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 0th percentile1.98Effective-layer depth0.390 °C reflectivity, 5th percentile1.93Magnitude of mean effective bulk wind0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 5th percentile1.90Cosine of mean effective-layer storm-relati	-10 °C reflectivity, 50th percentile	2.20	Vertical-totals index	1.05
-20 °C reflectivity, 75th percentile2.22Lowest-altitude reflectivity, mean gradient1.02-10 °C reflectivity, 5th percentile2.20Fosberg fire-weather index1.51-10 °C reflectivity, 75th percentile2.17Supercell composite parameter for left-mover1.40-10 °C reflectivity, 75th percentile2.14Energy-helicity index for left-mover1.4050-dBZ echo top, mean2.12Low-level azimuthal shear, 25th percentile1.17VIL, 50th percentile2.06Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.840 °C reflectivity, 95th percentile1.98Cosine of mean wind from 0-8 km AGL0.610 °C reflectivity, 25th percentile1.96Effective-layer depth0.50-20 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind for 0.2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind for 0.2 km AG0.390 °C reflectivity, 50th percentile1.90 <td< td=""><td>-20 °C reflectivity, 5th percentile</td><td>2.23</td><td>Magnitude of effective bulk wind difference</td><td>1.74</td></td<>	-20 °C reflectivity, 5th percentile	2.23	Magnitude of effective bulk wind difference	1.74
-10 °C reflectivity, 5th percentile2.20Fosberg fire-weather index1.51-10 °C reflectivity, 75th percentile2.17Supercell composite parameter for left-mover1.4050-dBZ echo top, mean2.14Energy-helicity index for left-mover1.29VIL, 50th percentile2.09Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.06Sine of mean wind from 0-3 km AGL0.950 °C reflectivity, mean2.01Cosine of mean wind from 0-3 km AGL0.84-20 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 25th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.500 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective bulk wind0.39	-20 °C reflectivity, 75th percentile	2.22	Lowest-altitude reflectivity, mean gradient	1.02
-10 °C reflectivity, 75th percentile2.17Supercell composite parameter for left-mover1.4050-dBZ echo top, mean2.14Energy-helicity index for left-mover1.29VIL, 50th percentile2.12Low-level azimuthal shear, 25th percentile1.06VIL, mean2.09Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Cosine of mean wind from 0-3 km AGL0.840 °C reflectivity, mean2.01Cosine of mean wind from 0-8 km AGL0.610 °C reflectivity, 25th percentile1.98Effective-layer depth0.610 °C reflectivity, 0th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind0.39	-10 °C reflectivity, 5th percentile	2.20	Fosberg fire-weather index	1.51
50-dBZ echo top, mean2.14Energy-helicity index for left-mover1.29VIL, 50th percentile2.12Low-level azimuthal shear, 25th percentile1.17VIL, 25th percentile2.09Sine of shear from 0-1 km AGL0.950 °C reflectivity, mean2.01Cosine of mean wind from 0-3 km AGL0.84-20 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 0th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind for 0.280.28	-10 °C reflectivity, 75th percentile	2.17	Supercell composite parameter for left-mover	1.40
VIL, 50th percentile2.12Low-level azimuthal shear, 25th percentile1.17VIL, mean2.09Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.04Sine of mean wind from 0-3 km AGL0.950 °C reflectivity, mean2.01Cosine of mean storm-relative wind from 0-1 km AGL0.840 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 25th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective bulk wind0.28	50-dBZ echo top, mean	2.14	Energy-helicity index for left-mover	1.29
VIL, meanZ.09Sine of shear from 0-1 km AGL0.95VIL, 25th percentile2.06Sine of mean wind from 0-3 km AGL0.950 °C reflectivity, mean2.01Cosine of mean storm-relative wind from 0-1 km AG0.73-20 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 25th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.390 °C reflectivity, 0th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective bulk wind0.280 °C reflectivity, 50th percentile1.90Cosine of mean effective bulk wind0.28	VIL, 50th percentile	2.12	Low-level azimuthal shear, 25th percentile	1.17
VIL, 25th percentile2.00Sine of mean wind from 0-3 km AGL0.930 °C reflectivity, mean2.04Cosine of mean storm-relative wind from 0-1 km AG0.84-20 °C reflectivity, 95th percentile1.98Effective-layer depth0.610 °C reflectivity, 25th percentile1.96Cosine of mean storm-relative wind from 0-2 km AG0.610 °C reflectivity, 50th percentile1.93Magnitude of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390 °C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390.2850-dBZ echo top, 50th percentile1.90Cosine of mean effective bulk wind0.21	VIL, mean	2.09	Sine of shear from 0-1 km AGL	1.00
0°C reflectivity, mean2.04Cosine of mean storm-relative wind from 0-1 km AG0.84-20°C reflectivity, 95th percentile1.98Cosine of mean wind from 0-8 km AGL0.730°C reflectivity, 25th percentile1.96Effective-layer depth0.50-20°C reflectivity, 50th percentile1.93Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390°C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind from 0-2 km AG0.390°C reflectivity, 50th percentile1.90Cosine of mean effective-layer storm-relative wind0.2850-dBZ echo top, 50th percentile1.92Cosine of mean effective bulk wind0.21	VIL, 25th percentile	2.00	Sine of mean wind from 0-3 km AGL	0.95
-20 °C reflectivity, 95th percentile 0 °C reflectivity, 25th percentile -20 °C reflectivity, 0th percentile 0 °C reflectivity, 50th percentile 50-dBZ echo top, 50th percentile 0.75 0.61 0.61 0.61 0.50 0.39 0.28 Cosine of mean wind from 0-8 km AGL 0.61 0.50 0.39 0.28 Cosine of mean effective-layer storm-relative wind 0.75 0.61 0.50 0.39 0.28 Cosine of mean effective-layer storm-relative wind	0 °C reflectivity, mean	2.04	Cosine of mean storm-relative wind from 0-1 km AG	0.04
0 °C reflectivity, 25th percentile 1.96 Effective-layer depth 0.50 -20 °C reflectivity, 0th percentile 1.96 Cosine of mean storm-relative wind from 0-2 km AG 0.50 0 °C reflectivity, 50th percentile 1.90 Magnitude of mean effective-layer storm-relative wind 0.28 50-dBZ echo top, 50th percentile 1.90 Cosine of mean effective bulk wind 0.21	-20 °C reflectivity, 95th percentile	2.01	Cosine of mean wind from 0-8 km AGL	0.75
-20 °C reflectivity, 0th percentile 0 °C reflectivity, 50th percentile 50-dBZ echo top, 50th percentile 1.90 0.28 Cosine of mean storm-relative wind from 0-2 km AG 0.39 0.28 Cosine of mean effective-layer storm-relative wind 0.28 0.28	0 °C reflectivity, 25th percentile	1.90	Effective-layer depth	0.01
0 °C reflectivity, 50th percentile 50-dBZ echo top, 50th percentile 0.28 1.90 1.90 1.90 1.90 1.90	-20 °C reflectivity, 0th percentile	1.90	Cosine of mean storm-relative wind from 0-2 km AG	0.50
50-dBZ echo top, 50th percentile	0 °C reflectivity, 50th percentile	1.95	Magnitude of mean effective-layer storm-relative wi	0.59
	50-dBZ echo top, 50th percentile	1.90	Cosine of mean effective bulk wind	0.20

• SFS results for buffer distance of 10 km and lead time of [0, 15] minutes.

Top 20 variables from SFS.		
-10 °C reflectivity, mean		25
Speed of motion		25
Height of -10 °C		24
Lapse rate from 700-500 mb		23
Precipitable water		25
Vertical-totals index		22
K-index		21
Lapse rate from 0-3 km AGL		20
Magnitude of mean boundary-layer wind		20
Fosberg fire-weather index		19
Sine of bulk Richardson number (BRN) shear		18
-10 °C reflectivity, 25th percentile		17
Sine of shear from 0-3 km AGL		1,
-20 °C reflectivity, skewness		16
CAPE		15
Significant-hail parameter		1/
Cosine of mean LCL-EL storm-relative wind		14
Low-level azimuthal shear, 100th-percentile gradie	en	13
Downdraft CAPE		12
Lowest-altitude reflectivity, 95th percentile		11

• J-measure results for buffer distance of 10 km and lead time of [15, 30] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	2 40	Top 20 J-measures (AFTER controlling for linear correlation).	2 40
-10 °C reflectivity, mean	2.40	-10 °C reflectivity, mean	2.40
-20 °C reflectivity, mean	2.57	-20 °C reflectivity, mean	2.23
-10 °C reflectivity, 25th percentile	2.33	-10 °C reflectivity, 25th percentile	2.10
-20 °C reflectivity, 50th percentile	2.52	-20 °C reflectivity, 50th percentile	1.96
-20 °C reflectivity, 25th percentile	2.30	-20 °C reflectivity, 25th percentile	1.90
-10 °C reflectivity, 50th percentile	2.27	-10 °C reflectivity, 50th percentile	1.05
-20 °C reflectivity, 75th percentile	2.25	Lapse rate from 850-500 mb	1.75
-10 °C reflectivity, 75th percentile	2.22	Vertical-totals index	1.04
-20 °C reflectivity, 5th percentile	2.13	Magnitude of shear from 0-6 km AGL	1.55
-20 °C reflectivity, 95th percentile	2.17	Fosberg fire-weather index	1.42
50-dBZ echo top, mean	2.14	Maximum lifted index	1.51
VIL, mean	2.12	Comp reflectivity, standard deviation of gradient	1.20
VIL, 50th percentile	2.09	Comp reflectivity, 95th-percentile gradient	1.09
-20 °C reflectivity, 100th percentile	2.07	Storm-relative helicity for left-mover	0.90
-10 °C reflectivity, 5th percentile	2.04	Lowest-altitude reflectivity, mean gradient	0.87
0 °C reflectivity, mean	2.02	Comp reflectivity, 100th-percentile gradient	0.77
50-dBZ echo top, 75th percentile	1.99	Energy-helicity index for left-mover	0.00
VIL, 25th percentile	1.90	Supercell composite parameter for left-mover	0.55
50-dBZ echo top, 50th percentile	1.94	Mid-level azimuthal shear, 5th percentile	0.44
0 [°] C reflectivity, 50th percentile	1.91	Sine of shear from 0-1 km AGL	

• SFS results for buffer distance of 10 km and lead time of [15, 30] minutes.

Top 20 variables from SFS.		
-10 °C reflectivity, mean		~ -
Precipitable water		25
Speed of motion		24
Fosberg fire-weather index		23
Vertical-totals index		25
K-index		22
Significant-severe parameter		21
Sine of bulk Richardson number (BRN) shear	-	20
Lapse rate from 0-3 km AGL		20
Height of -10 °C		19
Lapse rate from 700-500 mb		18
SWEAT index		17
50-dBZ echo top, 100th percentile		10
Magnitude of mean boundary-layer wind		16
Sine of shear from 0-3 km AGL		15
Significant-hail parameter		14
Magnitude of shear from 0-6 km AGL		10
50-dBZ echo top, 100th-percentile gradient		13
Low-level azimuthal shear, 100th-percentile	gradien	12
CAPE		11

• J-measure results for buffer distance of 10 km and lead time of [30, 45] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	2.05	Top 20 J-measures (AFTER controlling for linear correlation).	2.05
-10 °C reflectivity, mean	2.03	-10 °C reflectivity, mean	1 96
-20 °C reflectivity, mean	2.03	-20 °C reflectivity, mean	1.90
-20 °C reflectivity, 25th percentile	1 00	-20 °C reflectivity, 25th percentile	1 78
-10 °C reflectivity, 25th percentile	1.99	-10 °C reflectivity, 25th percentile	1.70
-20 °C reflectivity, 50th percentile	1.97	-20 °C reflectivity, 50th percentile	1.09
-10 °C reflectivity, 50th percentile	1.94	-10 °C reflectivity, 50th percentile	1.00
-20 °C reflectivity, 75th percentile	1.92	Lapse rate from 850-500 mb	1.52
-10 °C reflectivity, 75th percentile	1.90	Vertical-totals index	1.45
-20 °C reflectivity, 5th percentile	1.86	Magnitude of shear from 0-6 km AGL	1.54
-20 °C reflectivity, 95th percentile	1.83	Fosberg fire-weather index	1.25
50-dBZ echo top, mean	1.05	Maximum lifted index	1.10
-10 °C reflectivity, 5th percentile	1 70	-10 °C reflectivity, 25th-percentile gradient	0.08
VIL, 50th percentile	1 77	Comp reflectivity, standard deviation of gradient	0.90
-20 °C reflectivity, 100th percentile	1.77	Comp reflectivity, 100th-percentile gradient	0.09
VIL, mean	1.75	0 °C reflectivity, mean gradient	0.00
VIL, 25th percentile	1.72	Lowest-altitude reflectivity, mean gradient	0.71
50-dBZ echo top, 75th percentile	1.70	Comp reflectivity, standard deviation	0.02
50-dBZ echo top, 50th percentile	1.00	-10 °C reflectivity, mean gradient	0.55
0 °C reflectivity, mean	1.00	0 °C reflectivity, 25th-percentile gradient	0.44
0 °C reflectivity, 50th percentile	1.61	-20 °C reflectivity, 25th-percentile gradient	0.55

• SFS results for buffer distance of 10 km and lead time of [30, 45] minutes.

Top 20 variables from SFS.	
-10 °C reflectivity, mean	~ -
Fosberg fire-weather index	25
Vertical-totals index	24
50-dBZ echo top, 100th-percentile gradient	23
Sine of bulk Richardson number (BRN) shear	25
MCS-maintenance probability	22
Precipitable water	21
Significant-severe parameter	20
K-index	20
Speed of motion	19
SHERB parameter	18
Downdraft CAPE	17
SWEAT index	1/
Sine of shear from 0-1 km AGL	16
Comp reflectivity, 50th percentile	15
Lapse rate from 0-3 km AGL	14
Mean mixing ratio from 0-100 mb AGL	17
Magnitude of shear from 0-6 km AGL	13
CAPE	12
Mean relative humidity from 0-1 km AGL	11

• J-measure results for buffer distance of 10 km and lead time of [45, 60] minutes.

-20 °C reflectivity, mean1.77-20 °C reflectivity, mean1.77-10 °C reflectivity, mean1.75-10 °C reflectivity, 25th percentile1.73-20 °C reflectivity, 25th percentile1.73-20 °C reflectivity, 25th percentile1.73-20 °C reflectivity, 25th percentile1.71-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 50th percentile1.69-10 °C reflectivity, 50th percentile1.65-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.63-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 95th percentile1.64-20 °C reflectivity, 95th percentile1.64-20 °C reflectivity, 100th percentile1.59-20 °C reflectivity, 100th percentile1.56VIL, 50th percentile1.54-10 °C reflectivity, 25th percentile1.52-10 °C reflectivity, 25th percentile1.50-10 °C reflectivity, 25th percentile1.50-10 °C reflectivity, 5th percentile1.52Supercell composite parameter for left-mover0.71VIL, 25th percentile1.46-10 °C reflectivity, mean gradient0.48-50-dBZ ech	Top 20 J-measures (BEFORE controlling for linear correlation).	1 78	Top 20 J-measures (AFTER controlling for linear correlation).	1 78
-10 °C reflectivity, mean1.75-10 °C reflectivity, mean1.63-10 °C reflectivity, 25th percentile1.73-10 °C reflectivity, 25th percentile1.63-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 25th percentile1.48-20 °C reflectivity, 50th percentile1.69-20 °C reflectivity, 50th percentile1.40-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 50th percentile1.32-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.32-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.27-20 °C reflectivity, 5th percentile1.65-10 °C reflectivity, 75th percentile1.27-20 °C reflectivity, 5th percentile1.63Vertical-totals index1.09-20 °C reflectivity, 95th percentile1.58Magnitude of shear from 0-8 km AGL0.87-20 °C reflectivity, 100th percentile1.56Fosberg fire-weather index0.79-20 °C reflectivity, 5th percentile1.54Maximun lifted index0.71-10 °C reflectivity, 5th percentile1.48-10 °C reflectivity, mean gradient0.64-10 °C reflectivity, 5th percentile1.48-10 °C reflectivity, mean gradient0.44-20 °C reflectivity, 5th percentile1.44-20 °C reflectivity, mean gradient0.48-20 °C reflectivity, 95th percentile1.44-20 °C reflectivity, 95th-percentile gradient0.64-20 °C reflectivity, 95th percentile1.44-20 °C reflectivity, 95th-percentile gr	-20 °C reflectivity, mean	1 77	-20 °C reflectivity, mean	1.70
-10 °C reflectivity, 25th percentile1.73-10 °C reflectivity, 25th percentile1.05-20 °C reflectivity, 25th percentile1.71-20 °C reflectivity, 25th percentile1.48-20 °C reflectivity, 50th percentile1.69-20 °C reflectivity, 50th percentile1.40-10 °C reflectivity, 75th percentile1.67-20 °C reflectivity, 50th percentile1.32-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.32-20 °C reflectivity, 75th percentile1.63-20 °C reflectivity, 75th percentile1.25-10 °C reflectivity, 75th percentile1.63-20 °C reflectivity, 75th percentile1.25-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 75th percentile1.25-20 °C reflectivity, 95th percentile1.63-20 °C reflectivity, 75th percentile1.02-20 °C reflectivity, 95th percentile1.61Vertical-totals index1.02-20 °C reflectivity, 100th percentile1.58Magnitude of bulk Richardson number (BRN) shear0.94-20 °C reflectivity, 100th percentile1.54Magnitude of shear from 0-8 km AGL0.87-20 °C reflectivity, 5th percentile1.54Fosberg fire-weather index0.79VIL, 50th percentile1.52Supercell composite parameter for left-mover0.71VIL, 25th percentile1.48-10 °C reflectivity, mean gradient0.4850-dBZ echo top, 50th percentile1.44-20 °C reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradie	-10 °C reflectivity, mean	1.75	-10 °C reflectivity, mean	1.71
-20 °C reflectivity, 25th percentile1.71-20 °C reflectivity, 50th percentile1.71-20 °C reflectivity, 50th percentile1.69-10 °C reflectivity, 50th percentile1.67-20 °C reflectivity, 75th percentile1.67-20 °C reflectivity, 75th percentile1.65-10 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.63-20 °C reflectivity, 75th percentile1.61-20 °C reflectivity, 95th percentile1.61-20 °C reflectivity, 95th percentile1.59-20 °C reflectivity, 95th percentile1.58-20 °C reflectivity, 100th percentile1.56-20 °C reflectivity, 50th percentile1.58-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 50th percentile1.52-20 °C reflectivity, 50th percentile1.52-20 °C reflectivity, 50th percentile1.54-20 °C reflectivity, 50th percentile1.52-20 °C reflectivity, 50th percentile1.50-10 °C reflectivity, 25th percentile1.50-10 °C reflectivity, 25th percentile1.48-10 °C reflectivity, mean gradient0.64-20 °C reflectivity, mean gradient0.48-20 °C reflectivity, mean1.48-20 °C reflectivity, mean gradient0.44-20 °C reflectivity, mean gradient </td <td>-10 °C reflectivity, 25th percentile</td> <td>1.75</td> <td>-10 °C reflectivity, 25th percentile</td> <td>1.05</td>	-10 °C reflectivity, 25th percentile	1.75	-10 °C reflectivity, 25th percentile	1.05
-20 °C reflectivity, 50th percentile1.71-10 °C reflectivity, 50th percentile1.69-20 °C reflectivity, 50th percentile1.67-20 °C reflectivity, 75th percentile1.67-20 °C reflectivity, 75th percentile1.65-10 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.65-20 °C reflectivity, 75th percentile1.61-20 °C reflectivity, 95th percentile1.61-20 °C reflectivity, 95th percentile1.61-20 °C reflectivity, 95th percentile1.5950-dBZ echo top, mean1.58-20 °C reflectivity, 5th percentile1.54VIL, 50th percentile1.54VIL, 50th percentile1.50-10 °C reflectivity, 5th percentile1.54VIL, 25th percentile1.50Supercell composite parameter for left-mover0.64VIL, 25th percentile1.46-10 °C reflectivity, mean gradient0.5650-dBZ echo top, 50th percentile1.48-10 °C reflectivity, sth percentile1.48-10 °C reflectivity, 5th percentile1.44-20 °C reflectivity, mean gradient0.56-20 °C reflectivity, mean gradient0.56-20 °C reflectivity, mean gradient0.48-20 °C reflectivity, mean gradient0.41 <td>-20 [°]C reflectivity, 25th percentile</td> <td>1.75</td> <td>-20 °C reflectivity, 25th percentile</td> <td>1.55</td>	-20 [°] C reflectivity, 25th percentile	1.75	-20 °C reflectivity, 25th percentile	1.55
-10 °C reflectivity, 50th percentile1.691.69-20 °C reflectivity, 75th percentile1.65-10 °C reflectivity, 50th percentile1.32-20 °C reflectivity, 75th percentile1.65-10 °C reflectivity, 75th percentile1.25-20 °C reflectivity, 5th percentile1.61Vertical-totals index1.09-20 °C reflectivity, 95th percentile1.59Lapse rate from 850-500 mb1.02-20 °C reflectivity, 100th percentile1.58Magnitude of shear from 0-8 km AGL0.87-20 °C reflectivity, 5th percentile1.56Fosberg fire-weather index0.79-10 °C reflectivity, 5th percentile1.52Supercell composite parameter for left-mover0.64-10 °C reflectivity, 25th percentile1.48-10 °C reflectivity, mean gradient0.56-0.4BZ echo top, 50th percentile1.46Lowest-altitude reflectivity, mean gradient0.44-0 °C reflectivity, mean1.44-20 °C reflectivity, mean gradient0.48-10 °C reflectivity, mean1.44-20 °C reflectivity, mean gradient0.43	-20 [°] C reflectivity, 50th percentile	1.71	-20 °C reflectivity, 50th percentile	1.40
-20 °C reflectivity, 75th percentile107-20 °C reflectivity, 75th percentile165-10 °C reflectivity, 75th percentile163-20 °C reflectivity, 75th percentile163-20 °C reflectivity, 95th percentile161-20 °C reflectivity, 95th percentile159-20 °C reflectivity, 100th percentile158-20 °C reflectivity, 5th percentile156-20 °C reflectivity, 100th percentile156-20 °C reflectivity, 100th percentile156-20 °C reflectivity, 5th percentile156-20 °C reflectivity, 5th percentile156-20 °C reflectivity, 5th percentile157-20 °C reflectivity, 5th percentile158Magnitude of shear from 08 km AGL087-10 °C reflectivity, 5th percentile152-10 °C reflectivity, 5th percentile152Maximum lifted index071VIL, 25th percentile148-10 °C reflectivity, 25th-percentile gradient0.5650-dBZ echo top, 50th percentile146Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean142-20 °C reflectivity, mean gradient0410 °C reflectivity, mean1420 °C reflectivity, mean gradient0410 °C reflectivity, mean1420 °C reflectivity, mean gradient0430 °C reflectivity, mean1420 °C reflectivity, standard deviation033MESH, 75th percentile1420 °C reflectivity, standa	-10 [°] C reflectivity, 50th percentile	1.09	-10 °C reflectivity, 50th percentile	1.40
-10 °C reflectivity, 75th percentile1.63-10 °C reflectivity, 75th percentile1.12 J-20 °C reflectivity, 5th percentile1.63Vertical-totals index1.17-20 °C reflectivity, 95th percentile1.61Lapse rate from 850-500 mb1.0950-dBZ echo top, mean1.59Magnitude of bulk Richardson number (BRN) shear0.94-20 °C reflectivity, 100th percentile1.56Fosberg fire-weather index0.94-10 °C reflectivity, 5th percentile1.54Magnitude of shear from 0-8 km AGL0.87VIL, 50th percentile1.52Supercell composite parameter for left-mover0.71VIL, mean1.50-10 °C reflectivity, 25th-percentile gradient0.6450-dBZ echo top, 50th percentile1.48-10 °C reflectivity, mean gradient0.64VIL, 25th percentile1.46-10 °C reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.410 °C reflectivity, mean1.42Comp reflectivity, mean gradient0.410 °C reflectivity, mean1.42Comp reflectivity, standard deviation0.33	-20 [°] C reflectivity, 75th percentile	1.07	-20 °C reflectivity, 75th percentile	1.52
-20 °C reflectivity, 5th percentile1.03Vertical-totals index1.17-20 °C reflectivity, 95th percentile1.61Lapse rate from 850-500 mb1.0250-dBZ echo top, mean1.59Magnitude of bulk Richardson number (BRN) shear0.94-20 °C reflectivity, 100th percentile1.56Fosberg fire-weather index0.94-10 °C reflectivity, 5th percentile1.52Maximum lifted index0.79-10 °C reflectivity, 5th percentile1.50Supercell composite parameter for left-mover0.71VIL, 25th percentile1.48-10 °C reflectivity, mean gradient0.6450-dBZ echo top, 75th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.44Comp reflectivity, mean gradient0.410 °C reflectivity, mean1.42Comp reflectivity, standard deviation0.33	-10 [°] C reflectivity, 75th percentile	1.05	-10 °C reflectivity, 75th percentile	1.25
-20 °C reflectivity, 95th percentile1.01Lapse rate from 850-500 mb1.0250-dBZ echo top, mean1.59Magnitude of bulk Richardson number (BRN) shear0.94-20 °C reflectivity, 100th percentile1.56Fosberg fire-weather index0.94-10 °C reflectivity, 5th percentile1.54Maximum lifted index0.79-10 °C reflectivity, 5th percentile1.50Supercell composite parameter for left-mover0.64VIL, 25th percentile1.48-10 °C reflectivity, mean gradient0.5650-dBZ echo top, 50th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.44-20 °C reflectivity, mean gradient0.410 °C reflectivity, mean1.42Comp reflectivity, standard deviation0.33	-20 [°] C reflectivity, 5th percentile	1.05	Vertical-totals index	1.17
50-dBZ echo top, mean159Magnitude of bulk Richardson number (BRN) shear0.94-20 °C reflectivity, 100th percentile1.56Magnitude of shear from 0-8 km AGL0.94VIL, 50th percentile1.56Fosberg fire-weather index0.79-10 °C reflectivity, 5th percentile1.52Maximum lifted index0.71VIL, 25th percentile1.50Supercell composite parameter for left-mover0.64VIL, 25th percentile1.48-10 °C reflectivity, mean gradient0.5650-dBZ echo top, 75th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.410 °C reflectivity, mean1.42-20 °C reflectivity, standard deviation0.33	-20 [°] C reflectivity, 95th percentile	1.01	Lapse rate from 850-500 mb	1.09
-20 °C reflectivity, 100th percentile1.56Magnitude of shear from 0-8 km AGL0.94VIL, 50th percentile1.56Fosberg fire-weather index0.79-10 °C reflectivity, 5th percentile1.52Maximum lifted index0.71VIL, 25th percentile1.50Supercell composite parameter for left-mover0.64VIL, 25th percentile1.48-10 °C reflectivity, mean gradient0.5650-dBZ echo top, 50th percentile1.46Lowest-altitude reflectivity, mean gradient0.410 °C reflectivity, mean1.42Comp reflectivity, standard deviation0.33	50-dBZ echo top, mean	1.59	Magnitude of bulk Richardson number (BRN) shear	1.02
VIL, 50th percentile1.50Fosberg fire-weather index0.67-10 °C reflectivity, 5th percentile1.54Maximum lifted index0.79VIL, mean1.52Supercell composite parameter for left-mover0.64VIL, 25th percentile1.48-10 °C reflectivity, 25th-percentile gradient0.5650-dBZ echo top, 50th percentile1.46Lowest-altitude reflectivity, mean gradient0.410 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.33MESH, 75th percentile1.40Comp reflectivity, standard deviation0.33	-20 [°] C reflectivity, 100th percentile	1.50	Magnitude of shear from 0-8 km AGL	0.94
-10 °C reflectivity, 5th percentile VIL, mean VIL, 25th percentile 50-dBZ echo top, 75th percentile 0.71 0.64 1.48 1.48 1.46 1.46 1.46 1.44 0 °C reflectivity, mean gradient 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.71 0.64 0.48 0.71 0.64 0.48 0.71 0.64 0.48 0.41 0.41 0.33 MESH, 75th percentile	VIL, 50th percentile	1.50	Fosberg fire-weather index	0.07
VIL, mean1.52Supercell composite parameter for left-mover0.64VIL, 25th percentile1.48-10 °C reflectivity, 25th-percentile gradient0.5650-dBZ echo top, 50th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.33MESH, 75th percentile1.40Comp reflectivity, standard deviation0.33	-10 [°] C reflectivity, 5th percentile	1.54	Maximum lifted index	0.79
VIL, 25th percentile1.30-10 °C reflectivity, 25th-percentile gradient0.0450-dBZ echo top, 50th percentile1.48-10 °C reflectivity, mean gradient0.5650-dBZ echo top, 75th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.33MESH, 75th percentile1.42Comp reflectivity, standard deviation0.33	VIL, mean	1.52	Supercell composite parameter for left-mover	0.71
50-dBZ echo top, 50th percentile1.46-10 °C reflectivity, mean gradient0.3050-dBZ echo top, 75th percentile1.46Lowest-altitude reflectivity, mean gradient0.480 °C reflectivity, mean1.42-20 °C reflectivity, mean gradient0.33MESH, 75th percentile1.40Comp reflectivity, standard deviation0.33	VIL, 25th percentile	1.30	-10 °C reflectivity, 25th-percentile gradient	0.04
50-dBZ echo top, 75th percentile 1.40 Lowest-altitude reflectivity, mean gradient 0.40 0 °C reflectivity, mean 1.44 -20 °C reflectivity, mean gradient 0.41 MESH, 75th percentile 1.42 Comp reflectivity, standard deviation 0.33	50-dBZ echo top, 50th percentile	1.40	-10 °C reflectivity, mean gradient	0.50
0 °C reflectivity, mean MESH, 75th percentile 1.42 -20 °C reflectivity, mean gradient 0.33 Comp reflectivity, standard deviation 0.33	50-dBZ echo top, 75th percentile	1.40	Lowest-altitude reflectivity, mean gradient	0.40
MESH, 75th percentile 1.42 Comp reflectivity, standard deviation 0.55	0 °C reflectivity, mean	1.44	-20 °C reflectivity, mean gradient	0.41
	MESH, 75th percentile	1.42	Comp reflectivity, standard deviation	0.55

• SFS results for buffer distance of 10 km and lead time of [45, 60] minutes.

Top 20 variables from SFS.		
MCS-maintenance probability		
Fosberg fire-weather index		25
-10 °C reflectivity, mean		24
Vertical-totals index		23
50-dBZ echo top, 100th-percentile gradient		20
Downdraft CAPE		22
Magnitude of shear from 0-6 km AGL		21
Height of -30 °C		20
Sine of bulk Richardson number (BRN) shear		10
Significant-severe parameter		19
Lapse rate from 0-3 km AGL		18
Surface relative humidity		17
Cosine of mean storm-relative wind from 0-1 km A	GL	1/
-20 °C reflectivity, mean		16
Sine of shear from 0-3 km AGL		15
SHERB parameter		14
Precipitable water		T.4
Derecho composite parameter		13
Cosine of shear from 0-1 km AGL		12
Lapse rate from 3-6 km AGL		11

• J-measure results for buffer distance of 10 km and lead time of [60, 90] minutes.

Top 20 J-measures (BEFORE controlling for linear correlation).	1.63	Top 20 J-measures (AFTER controlling for linear correlation).	1.63
-20 °C reflectivity, mean	1.61	-20 °C reflectivity, mean	1.05
-20 °C reflectivity, 50th percentile	1.01	-20 °C reflectivity, 50th percentile	1.33
-20 °C reflectivity, 25th percentile	1.59	-20 °C reflectivity, 25th percentile	1.40
-10 °C reflectivity, mean	1.57	-10 [°] C reflectivity, mean	1.41
-10 °C reflectivity, 25th percentile	1.50	-10 °C reflectivity, 25th percentile	1.34
-20 °C reflectivity, 75th percentile	1.54	-20 °C reflectivity, 75th percentile	1.27
-10 °C reflectivity, 50th percentile	1.52	-10 °C reflectivity, 50th percentile	1.20
-20 °C reflectivity, 5th percentile	1.30	Vertical-totals index	1.15
-10 °C reflectivity, 75th percentile	1.49	Lapse rate from 850-500 mb	1.00
-20 °C reflectivity, 95th percentile	1.47	Magnitude of shear from 0-8 km AGL	0.99
50-dBZ echo top, mean	1.45	Magnitude of shear from 0-3 km AGL	0.92
-20 °C reflectivity, 100th percentile	1.45	Fosberg fire-weather index	0.65
VIL, 50th percentile	1.42	Maximum lifted index	0.78
VIL, mean	1.40	Comp reflectivity, standard deviation	0.70
VIL, 25th percentile	1.30	Supercell composite parameter for left-mover	0.05
50-dBZ echo top, 75th percentile	1.50	-10 °C reflectivity, 25th-percentile gradient	0.50
-10 °C reflectivity, 5th percentile	1.55	-10 °C reflectivity, mean gradient	0.49
50-dBZ echo top, 50th percentile	1.55	Cosine of mean storm-relative wind from 0-2 km AC	0.42
MESH, 75th percentile	1.51	Effective-layer depth	0.55
MESH, mean	1.29	Sine of shear from 0-1 km AGL	0.20

• SFS results for buffer distance of 10 km and lead time of [60, 90] minutes.

Results forthcoming... sorry!
Variable	Description	Units	Vector?
brn	Bulk Richardson number	None	
brnDenom	BRN denominator	$m^2 s^{-2}$	
brnShear	BRN shear term	m s⁻¹	Yes
capStrength	Cap strength	К	
cape	Convective available potential energy	J kg ⁻¹	
cape3km	CAPE from 0-3 km above ground level (AGL)	J kg ⁻¹	
cape6km	CAPE from 0-6 km AGL	J kg ⁻¹	
capeFreezing	CAPE from surface – freezing level	J kg ⁻¹	
cin	Convective inhibition	J kg ⁻¹	
convectiveTemp	Convective temperature	К	
critAngle	Critical angle	0	
crossTotals	Cross-totals index	К	
dcape	Downdraft CAPE	J kg ⁻¹	
dcp	Derecho composite parameter	None	
effBwd	Effective bulk wind difference	m s⁻¹	Yes
effLayerBottom	Effective-layer bottom	m	

Variable	Description	Units	Vector?
effLayerDepth	Effective-layer depth	m	
effLayerTop	Effective-layer top	m	
effShear	Effective-layer shear	m s⁻¹	Yes
ehi1km	Energy helicity index from 0-1 km AGL	J kg ⁻¹	
ehi3km	EHI from 0-3 km AGL	J kg ⁻¹	
ehiLeft	EHI for left-mover	J kg ⁻¹	
ehiRight	EHI for right-mover	J kg ⁻¹	
elHeight	Height AGL of equilibrium level (EL)	m	
esp	Enhanced stretching potential	None	
fosberg	Fosberg fire-weather index	None	
height0C	Height of 0 °C level	m	
height-10C	Height of -10 °C level	m	
height-20C	Height of -20 °C level	m	
height-30C	Height of -30 °C level	m	
kIndex	K-index	К	
lapseRate3km	Lapse rate from 0-3 km AGL	K km ⁻¹	

Variable	Description	Units	Vector?
lapseRate3-6km	Lapse rate from 3-6 km AGL	K km ⁻¹	
lapseRate700-500mb	Lapse rate from 700-500 mb	K km ⁻¹	
lapseRate850-500mb	Lapse rate from 850-500 mb	K km ⁻¹	
lclHeight	Height AGL of lifting condensation level (LCL)	m	
lfcHeight	Height AGL of level of free convection	m	
lhp	Large-hail parameter	None	
li300mb	Lifted index from surface – 300 mb	К	
li500mb	Lifted index from surface – 500 mb	К	
liMax	Maximum lifted index (surface – any level)	К	
maxWindPbl	Maximum boundary-layer wind	m s⁻¹	Yes
mburst	Microburst index	None	
meanEffBulkWind	Mean effective bulk wind	m s⁻¹	Yes
meanEffWind	Mean effective-layer wind	m s⁻¹	Yes
meanMixr100mb	Mean mixing ratio from 0-100 mb AGL	g kg ⁻¹	
meanRh1km	Mean relative humidity (RH) from 0-1 km AGL	%	
meanRh150mb	Mean RH from 0-150 mb AGL	%	

Variable	Description	Units	Vector?
meanRh150-350mb	Mean RH from 150-350 mb AGL	%	
meanRhPbl	Mean boundary-layer RH	%	
meanWind1km	Mean wind from 0-1 km AGL	m s⁻¹	Yes
meanWind3km	Mean wind from 0-3 km AGL	m s⁻¹	Yes
meanWind6km	Mean wind from 0-6 km AGL	m s⁻¹	Yes
meanWind8km	Mean wind from 0-7 km AGL	m s⁻¹	Yes
meanWindLclEl	Mean wind from LCL-EL	m s⁻¹	Yes
meanWindPbl	Mean boundary-layer wind	m s⁻¹	Yes
minBuoyancy	Minimum buoyancy in column	К	
mmp	Mesoscale convective system (MCS)-maintenance probability	%	
mplHeight	Maximum parcel height	m	
pblDepth	Boundary-layer depth	m	
рพ	Precipitable water	mm	
rhSurface	Surface RH	%	
scpLeft	Supercell composite parameter (SCP) for left-mover	None	
scpRight	SCP for right-mover	None	

Variable	Description	Units	Vector?
shear1km	Wind shear from 0-1 km AGL	m s⁻¹	Yes
shear3km	Wind shear from 0-3 km AGL	m s⁻¹	Yes
shear6km	Wind shear from 0-6 km AGL	m s⁻¹	Yes
shear8km	Wind shear from 0-8 km AGL	m s⁻¹	Yes
shear9km	Wind shear from 0-9 km AGL	m s⁻¹	Yes
shearLclEl	Wind shear from LCL-EL	m s⁻¹	Yes
sherb	Severe hazards in environments with reduced buoyancy (SHERB) parameter	None	
ship	Significant-hail parameter	None	
sigSevere	Significant-severe parameter	None	
srh1km	Storm-relative helicity (SRH) from 0-1 km AGL	J kg ⁻¹	
srh3km	SRH from 0-3 km AGL	J kg ⁻¹	
srhLeft	SRH for left-mover	J kg ⁻¹	
srhRight	SRH for right-mover	J kg ⁻¹	
srw1km	Mean storm-relative wind (SRW) from 0-1 km AGL	m s⁻¹	Yes
srw2km	Mean SRW from 0-2 km AGL	m s⁻¹	Yes
srw3km	Mean SRW from 0-3 km AGL	m s⁻¹	Yes

Variable	Description	Units	Vector?
srw4-5km	Mean SRW from 4-5 km AGL	m s ⁻¹	Yes
srw4-6km	Mean SRW from 4-6 km AGL	m s⁻¹	Yes
srw6km	Mean SRW from 0-6 km AGL	m s⁻¹	Yes
srw8km	Mean SRW from 0-8 km AGL	m s⁻¹	Yes
srw9-11km	Mean SRW from 9-11 km AGL	m s⁻¹	Yes
srwBulk	Mean bulk SRW	m s⁻¹	Yes
srwEff	Mean effective-layer SRW	m s⁻¹	Yes
srwLclEl	Mean SRW from LCL-EL	m s⁻¹	Yes
stpEff	Significant-tornado parameter (STP) for effective layer	None	
stpFixed	STP for fixed layer	None	
sweat	SWEAT index	None	
thetaeDiff	Difference between min and max equiv potential temperature (θ_e) from 0-3 km AGL	К	
thetaeIndex	θ_e -index	К	
totalTotals	Total-totals index	К	
updraftTilt	Updraft tilt	0	

Variable	Description	Units	Vector?
verticalTotals	Vertical-totals index	К	
wdi	Wind-damage index	None	