A Comparison and Assessment of the USPLN and ENTLN

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Introduction

Previous research has argued that lightning data may assist in nowcasting severe weather hazards. Most investigations that have examined the lightning and severe weather hazard relationship employ the National Lightning Detection Network (NLDN) as their primary lightning data source. However, the installation of two additional remote sensing lightning networks — the United States Precision Lightning Network (USPLN) and the Earth Networks Total Lightning Network (ENTLN) — provide alternative sources of data for climatological and hazard relationship assessments.

Methods

For this investigation, contiguous U.S. cloud-to-ground (CG) stroke lightning climatologies constructed from the USPLN and ENTLN are examined and compared for the entirety of 2011, promoting an independent, systematic assessment of each system's lightning stroke detection and magnitude efficiency. We emphasize distinctive lightning-intensive events as points of comparison.

Equation 1 → $Absolute\ Difference = (ENTLN - USPLN)$

Equation 2 → $Percent\ Difference = \left[\frac{ENTLN - USPLN}{\left(\frac{ENTLN + USPLN}{2}\right)}\right] x\ 100\%$

Contiguous U.S. Analysis

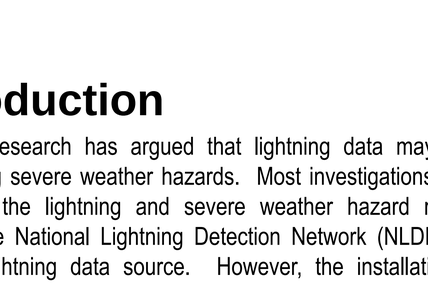

Figure 1. Absolute CG lightning stroke difference (equation 1) USPLN-ENTLN for 2011. Blue indicates greater USPLN CG lightning stroke counts; red indicates greater ENTLN CG lightning stroke counts.

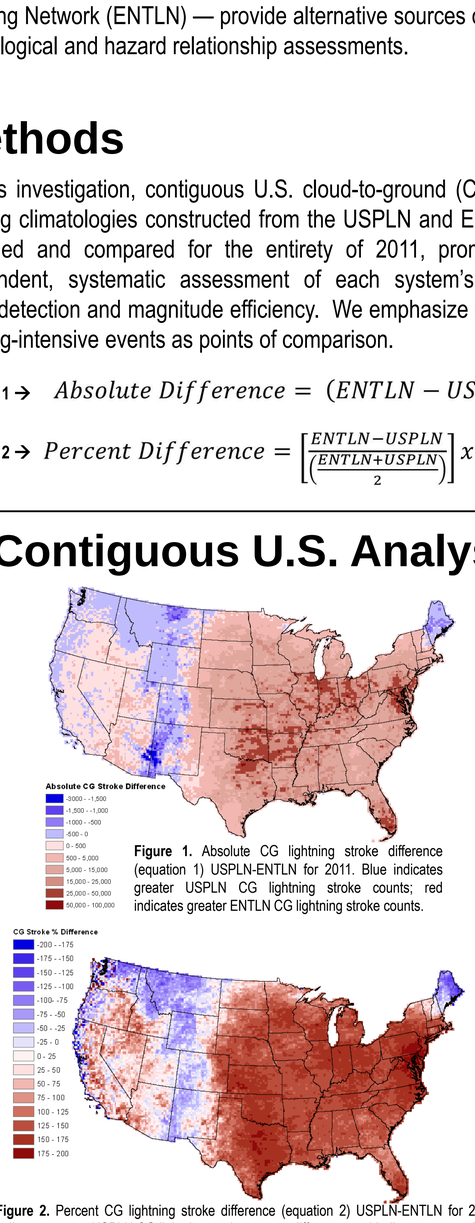

Figure 2. Percent CG lightning stroke difference (equation 2) USPLN-ENTLN for 2011. Blue indicates greater USPLN CG lightning stroke percent difference; red indicates greater ENTLN CG lightning stroke percent difference.

Results

The ENTLN has a greater propensity for the detection of CG lightning strokes in the Eastern and Central U.S., whereas the USPLN has greater tendency for the detection of strokes in the Rocky Mountains, along the West Coast, and in the extreme Northeast. For 2011, the USPLN detected 34,129,097 CG lightning strokes and the ENTLN detected 186,643,998 strokes; that is, the ENTLN detected 152.5 million more strokes than the USPLN resulting in a USPLN-ENTLN percentage difference of 138% for the year.

Regional Analysis

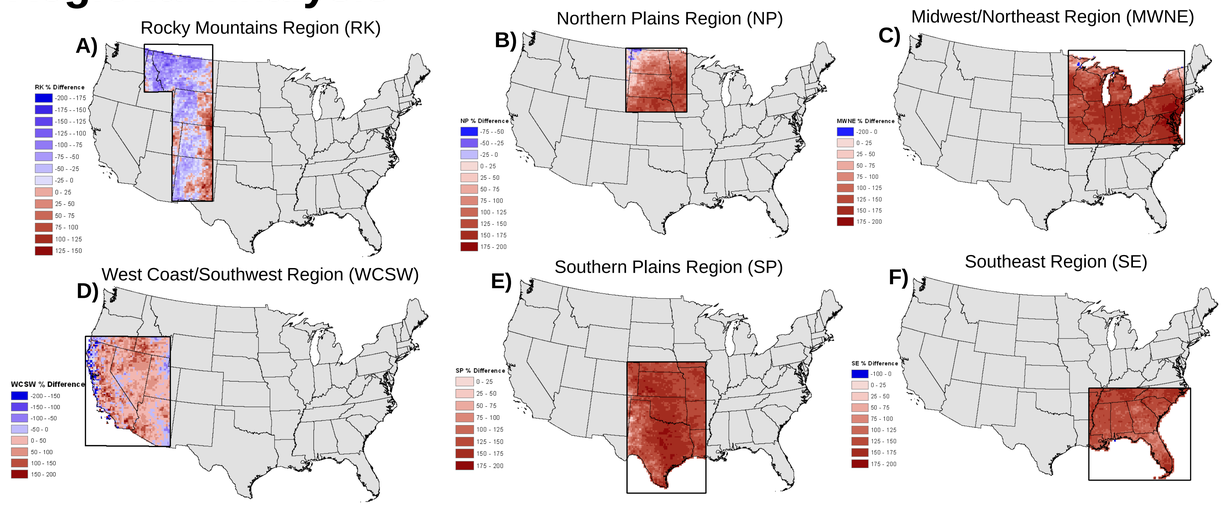

Figure 3. A) RK regional USPLN-ENTLN percent difference; B) NP regional USPLN-ENTLN percent difference; C) MWNE regional USPLN-ENTLN percent difference; D) WCSW regional USPLN-ENTLN percent difference; E) SP regional USPLN-ENTLN percent difference; F) SE regional USPLN-ENTLN percent difference Blue cells indicate greater USPLN CG lightning percent differences; Red cells indicate greater ENTLN CG lightning percent differences.

Table 1. USPLN and ENTLN regional lightning stroke count, total USPLN-ENTLN regional absolute CG lightning stroke difference, and percent difference. Cells shaded in red indicate greater ENTLN CG lightning stroke count metrics; cells shaded in blue indicate greater USPLN CG lightning stroke count metrics.

	USPLN CG Lightning Stroke Count	ENTLN CG Lightning Stroke Count	Total Absolute CG Stroke Difference (count)	Total CG Stroke Percent Difference
RK	3,105,103	2,796,225	308,878	10%
NP	3,218,050	13,049,706	9,831,656	121%
MWNE	9,151,610	67,844,977	58,693,367	152%
WCSW	1,497,414	2,190,961	693,547	38%
SP	8,736,957	61,232,736	52,495,779	150%
SE	7,932,165	41,373,155	33,440,990	136%

Results

There is great regional-dependent spatial disparity between the ENTLN and USPLN CG lightning stroke detection efficiencies. The MWNE, SE, SP, NP, and WCSW regions have greater ENTLN CG lightning stroke detection efficiencies. The only region that has a larger USPLN CG lightning stroke detection efficiency is the Rocky Mountains region where the USPLN detected 308,878 more CG lightning strokes than the ENTLN with a percent difference of 10% (Table 1). The greatest difference between USPLN and ENTLN detection efficiencies is found in the MW region where 58.7 million more ENTLN CG lightning strokes were detected with a USPLN-ENTLN percent difference of 152%.

Seasonal Analysis

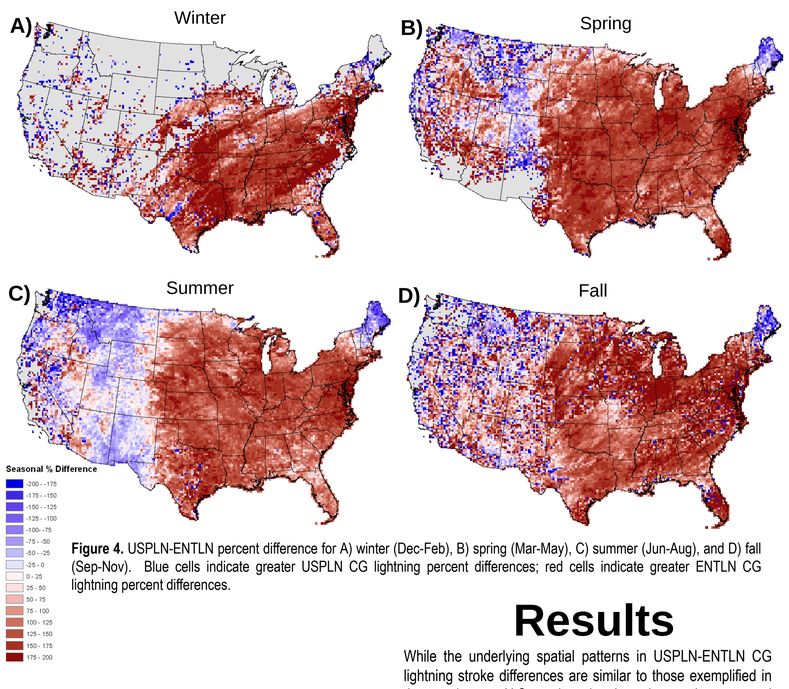

Figure 4. USPLN-ENTLN percent difference for A) winter (Dec-Feb), B) spring (Mar-May), C) summer (Jun-Aug), and D) fall (Sep-Nov). Blue cells indicate greater USPLN CG lightning percent differences; red cells indicate greater ENTLN CG lightning percent differences.

Table 2. USPLN and ENTLN seasonal lightning stroke count, total USPLN-ENTLN seasonal absolute CG lightning stroke difference and percent difference. Cells shaded in red indicate greater ENTLN CG lightning stroke count metrics; cells shaded in blue indicate greater USPLN CG lightning stroke count metrics.

	USPLN CG Lightning Stroke Count	ENTLN CG Lightning Stroke Count	Total Absolute CG Stroke Difference (count)	Total CG Stroke Percent Difference
Winter	582,565	3,102,589	2,520,024	137%
Spring	7,725,871	59,181,021	51,455,150	154%
Summer	21,615,607	97,547,515	75,931,908	127%
Fall	4,205,054	26,812,879	229,607,819	146%

Results

While the underlying spatial patterns in USPLN-ENTLN CG lightning stroke differences are similar to those exemplified in the contiguous U.S. and regional analyses, the seasonal USPLN and ENTLN CG lightning stroke detection efficiency results suggest that there is also great seasonal variation between the USPLN and ENTLN CG stroke detection efficiency. The ENTLN has a greater propensity for CG lightning stroke detection in the Central and Eastern U.S., with the exception of the far Northeastern U.S., for all seasons. The USPLN has greater CG lightning stroke detection in the Rocky Mountains during the spring and summer months. During the fall, the USPLN and ENTLN CG lightning stroke detection efficiency spatial pattern is variable and inconsistent in the western half of the U.S. (i.e., west of the Rocky Mountains). Overall, the greatest difference between USPLN and ENTLN CG lightning stroke detection efficiency was during the spring months where the ENTLN detected 51.5 million more CG lightning strokes than the USPLN, with a percent difference of 154% (Table 2).

Event Analysis

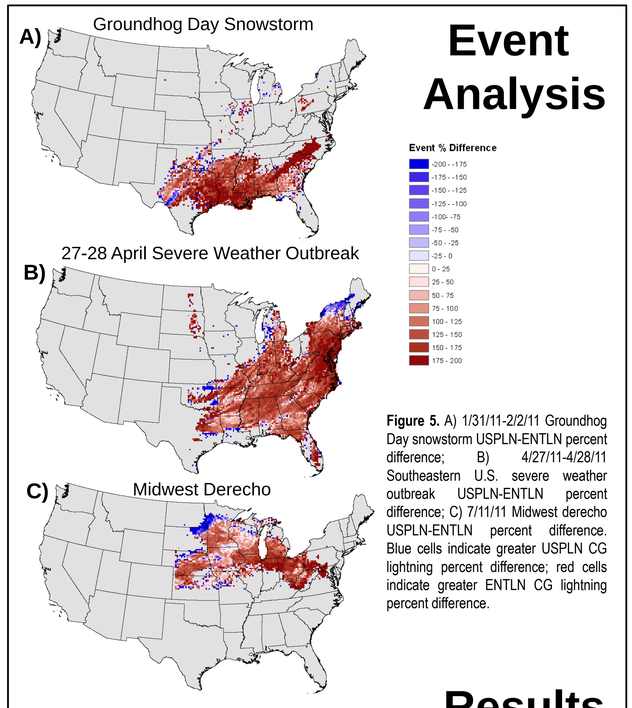

Figure 5. A) 1/31/11-2/2/11 Groundhog Day snowstorm USPLN-ENTLN percent difference; B) 4/27/11-4/28/11 Southeastern U.S. severe weather outbreak USPLN-ENTLN percent difference; C) 7/11/11 Midwest derecho USPLN-ENTLN percent difference. Blue cells indicate greater USPLN CG lightning percent difference; red cells indicate greater ENTLN CG lightning percent difference.

Table 3. USPLN and ENTLN event lightning stroke count, total USPLN-ENTLN event absolute CG stroke difference and percent difference. Cells shaded in red indicate greater ENTLN lightning stroke count metrics; cells shaded in blue indicate greater USPLN lightning stroke count metrics.

	USPLN CG Lightning Stroke Count	ENTLN CG Lightning Stroke Count	Total Absolute CG Lightning Stroke Difference (count)	Total CG Lightning Stroke Percent Difference
Groundhog Day Snowstorm	48,011	404,667	356,656	156%
April Severe Weather Outbreak	571,549	3,544,232	2,972,683	144%
Midwest Derecho	261,604	1,328,704	1,067,100	134%

Results

The individual event analysis results are similar to those found in the contiguous U.S., regional, and seasonal analyses where ENTLN CG lightning stroke detection efficiencies were greater in the Eastern U.S. with the exception of the extreme Northeastern U.S. where the USPLN CG lightning stroke detection efficiency was greater.

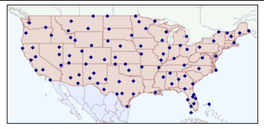

Figure 6. USPLN sensor location for the contiguous U.S. (from WSI (2012)).

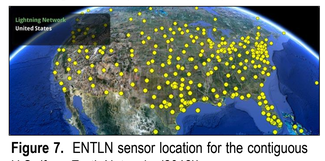

Figure 7. ENTLN sensor location for the contiguous U.S. (from Earth Networks (2012)).

Table 4. USPLN, and ENTLN network efficiency and accuracy standards (from WSI (2011) and Earth Networks (2012)).

Remote sensing network accuracy and efficiency metrics	USPLN	ENTLN
Number of sensors	100	450-500
CG stroke detection efficiency	95% or greater	95% or greater
Median location accuracy	250m or greater	less than 500m

Conclusion

- Overall, the ENTLN comprises greater CG lightning stroke count metrics than the USPLN for the Central/Eastern U.S. with the exception of the extreme Northeast U.S.
- The USPLN signifies greater CG lightning stroke counts in comparison to the ENTLN in the Rocky Mountain region for the contiguous U.S., regional, and seasonal analyses.
- Seasonal CG lightning stroke analyses indicate similar spatial patterns to those of the contiguous U.S. and regional analyses.
- While overall patterns in the event analysis of USPLN-ENTLN CG lightning stroke detection efficiency are similar to the contiguous U.S., regional, and seasonal analyses, subtle differences in CG lightning stroke detection are apparent in the 7/11/11 Midwest derecho event (i.e. greater USPLN CG lightning stroke detection counts in the Northern/Central Plains)
- We hypothesize that the reason for the difference in USPLN-ENTLN CG lightning stroke count metrics is primarily due to sensor coverage, the amount of sensors, and the spatial distribution of the USPLN and ENTLN sensors across the contiguous U.S. (Figures 6 and 7; Table 4).