Global Lightning Research and status of WWLLN

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Global Lightning Research and status of WWLLN

1. Network status/Combination of new data set with Earth Networks
   200 to 300 % increases over WWLLN-only
2. Research
   Lightning Assimilation into forecast models
   NOx from lightning using OMI and WWLLN
   Volcanic lightning studies (Calbuci and Kelud)
   Lightning Whistlers in Magnetosphere (NASA Van Allen Probes)
   Lightning Whistler propagation Study using C/NOFS – multiple whistler dispersions
   Global climatology
   Lightning Clusters as proxy for thunderstorms

For the record;
WWLLN has 76 active stations (over 100 Host scientists)
WWLLN located in 2015: 170 x 10^6 strokes (1.4 billion from 2005 through 2015)
Projected for next year WWLLN+EN(vlf): 350 x 10^6 strokes
101 peer reviewed papers (see http://wwlln.net/publications)
No government or private grants (operations paid by data sales)
WWLLN and Earth Networks stations
One Day, showing percent INCREASE with EN and WWLLN

2016–09–21, WWLLN+EN vs WWLLN relative DE, mean = 295.5%.
Some Recent Research Results

Lightning Assimilation into forecast models (Published 2016)

NOx from lightning using OMI and WWLLN (2016)

Volcanic Lightning at Calbuck, Chile (2016)


Lightning Whistler propagation Study using C/NOFS – multiple whistler dispersions (2016)
New technique for lightning assimilation into forecast model using WWLLN Lightning to nudge water vapor towards saturation

Estimating NOx from lightning for world

[Graph: Scatterplot and linear regression of daily values of total MMoles LNOx summed over grid cells with flashes versus Kflashes in the 3 h prior to OMI overpass for JJA 2008 with CRF > 90% and flash threshold of 3000 flashes.]

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Figure 10. Scatterplot and linear regression of daily values of total MMoles LNOx summed over grid cells with flashes versus Kflashes in the 3 h prior to OMI overpass for JJA 2008 with CRF > 90% and flash threshold of 3000 flashes.

Volcanic lightning and plume behavior reveal evolving hazards during the April 2015 eruption of Calbuco Volcano, Chile

Formation of hazardous pyroclastic density currents signaled by a sharp increase in proximal lightning and slower upwind plume expansion. WWLLN detects strokes.

MAGNETOSPHERIC Lightning Whistlers

NASA Van Allen Probe Wave Data

17 July 2013 L=3

Spectrogram

De-chirped Spectrogram

Waveform (used above)

De-chirped Waveform

WWLLN located Strokes

New whistler propagation code can find multiple DIFFERENT dispersions, automatically

1.4 million whistlers processed using C/NOFS wave data

Different dispersions for different whistlers during the same 12 s record

i.e. Whistlers took DIFFERENT paths to satellite

Newly Updated WWLLN Global Climatology

Based on 1.1 Billion Strokes  Densities at 0.25, 0.5 and 1.0 degree pixels, relative detection efficiency corrected
Mean Annual, and mean monthly (Jan – Dec) and diurnal variability available
A Word about relative detection efficiency:

It is based on Far Field VLF radiated Energy/stroke which is directly related to peak current

NOTE: within 1 hour the global energy distribution is stable in our data.

Relative detection efficiency is calculated GLOBALLY every hour

Strokes
(6.5 times increase)
(mostly from adding new stations)

Clusters
(2.3 times increase from 2005 and just)

10 Years
WWLLN DATA
Three months comparison of vorticity and lightning (by Wallace and Mitchell (UW))

500-700mb $\zeta \left(10^{-4} \text{s}^{-1}, \text{RAP}\right)$

# lightning strikes in 256 km$^2$ (1-2 | 3-20 | $\geq$21, WWLLN)
WWLLN cluster evolution statistics

• Calculate every 10 minutes:
  • Number of strokes
  • Mean stroke energy
  • Convex hull and area

• Define cluster scale time
  0 = time of first lightning in cluster
  1 = time of last lightning
Results consistent for:

- Warm vs. cold season
- Short (<30 min), medium (2-6h), and long-lived (>12h) clusters
- Small and large clusters
- Other land regions
ENTLN cluster evolution statistics

• Assign ENTLN flashes to WWLLN clusters
  • Look for flashes within 0.15° and ±15 minutes
• Calculate every 10 minutes:
  • Number of total, CG, and IC flashes
  • Mean flash energy
  • Polarity
Thank you

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