The South African Lightning Detection Network

MTG LI Mission Advisory Group Meeting

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2021/03/02

History

- For many years South Africa had no observations of lightning.
- In the 1980's to early 1990' the Council for Scientific and Industrial Research (CSIR) operated a network of lightning flash counters across the country.



 In the 1990's, Eskom, the power utility in South Africa operated LPATS sensors to monitor lightning strikes to their distribution lines.

History

- In 2005, the South African Weather Service started installing a lightning detection network over the country.
- A Network of Vaisala sensors
- Original network consisted of 19 LS7000 sensors
- Fully operational in 2006.



SAWS LIGHTNING DETECTION NETWORK



Upgrades

• The network has undergone regular upgrades throughout the years.

2009/10 upgrade

- Three new LS7001 sensors were added
- One sensor replaced with a LS7001 sensor
- 22 sensors



2011 upgrade

- Four sensors relocated to new sites
- One new LS7001 sensors were added
- One old LS7000 sensor added
- 24 sensors



2021/03/02

Upgrades

- In 2015 one new sensor was added to give a network of 25 sensors.
- We also frequently upgrade the Vaisala processing software.
- <u>Currently in the process of</u> <u>upgrading sensors to LS7002</u>
- Three sensors were upgraded in 2020
- Additional two in 2021
- Procure a further 10 in 2021
- The remaining sensors to follow.
- Currently:
 - 18 LS7000 sensors
 - 4 LS7001 sensors
 - 3 LS7002 sensors





Network

- Sensors operate in the VLF/LF frequency ranges.
- Designed for cloud-to-ground lightning.
- Also detect a percentage of cloud lightning (30-50%).
- Sensors make use of both time-of-arrival and magnetic direction-finding principles.
 - Minimum of two sensors required to locate a lightning discharge (instead of 3).
 - Improved detection of low amplitude pulses in CG
 - Improved detection of cloud pulses
 - Magnetic field measurements improve peak field measurements
 - Improved overall accuracy



Network

- Several sensors participate in the detection of lightning.
- The more sensors participating to produce a lightning solution, the more accurate the solution.





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Network

• Maximum range we produce solutions for:



• Outside network accuracy and efficiency decreases.



Performance

- Validation of the performance of the network is complicated due to the lack of ground-truth observations.
- High-speed camera footage or rocket-triggered lightning needed.
- Modelled projections of Detection Efficiency and Location Accuracy:



Detection Efficiency

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Location Accuracy

Performance

Dynamic projections of Detection Efficiency and Location Accuracy

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	18	19	20	21	22	23	24	25	26	27	1 241 90 44	8 ,76 8416 80 1211	0,53 1907 80 956	0,42 4410 80 670	8,46 522 80 479	8.79 78 90 113	34
	35	36	37	38	3.8 76 < 50	40	41	42	43	0.79 364 80 406	8.78 8800 3626	0.49 27333 90 10026	0.44 38647 80 11185	0.46 17527 90 1246	8.51 3688 90 2852	8.58 669 90 785	51
	52	53	54	1.4 2 90 1	1.9 1178 98 289	57	3.4 288 90 163	9,95 1893 90 1387	8.6 890 90 894	8.5 1542 2865	0,49 16048 90 5886	0,44 27900 90 13443	0,49 29696 90 15186	0,43 38481 90 3893	8.42 9194 90 3617	8.44 1802 98 1970	0.6 9 80 2
	69	70	71	1 5 80 1	8,96 2246 90 255	1.7 390 90 129	9.86 11581 80 2829	1.2 14585 90 4910	0,49 13934 90 5409	0.4 7212 90 5936	0,39 9185 90 8212	0.43 16685 90 16692	0,48 22697 90 14578	0.4 22103 90 14755	8.4 26658 90 4340	0,48 3368 90 3841	0,53 444 90 1195
\langle	86	87	88	1 34 90 1	1 8233 90 952	0.95 4826 80 1711	8.54 9798 80 4758	8.53 25629 90 6505	8.51 32248 90 5746	8.4 10934 90 3861	0.39 10885 90 5458	0.39 16251 90 5677	0.46 16753 90 5327	8.42 15850 90 6586	8.4 12559 90 3595	8.4 1285 90 13630	8.64 1578 98 2783
	$\mathbf{\underline{\vee}}$	^ •+	0.53 61 80 18	8.71 788 99 401	8.67 4986 90 1590	0.52 3370 90 1086	0.44 14570 90 2425	0.46 40143 90 3642	0.47 23925 90 4128	0.39 21819 90 3535	0.39 23610 90 5376	0.38 17655 90 6588	0.37 16462 90 6616	0,39 18629 90 4050	0.37 3410 90 3327	8,44 6096 98 7597	8, 69 295 80 819
	120	1.8 130 < 50 7	0,44 1332 80 440	8.4 4705 80 1568	0.37 2445 90 959	0,32 3599 90 1179	0,36 11583 90 1521	0,34 6656 90 1332	0,38 6981 90 2212	0.37 9992 90 3367	0,36 14765 90 6996	0.30 26244 10116	0,32 13996 90 7283	8.37 13027 90 3096	0,39 14914 90 2175	8.57 6679 729	136
	137	116 294 < 58 15	0,66 1837 90 348	0.34 3566 90 805	0.37 10028 90 1169	0,39 11818 90 1183	0,38 5475 90 2023	0,29 1646 90 1156	0.43 2220 90 1903	0.41 9283 90 3594	0.36 15065 90 6670	0.37 24435 90 10129	9.4 8438 90 5096	0,45 18453 90 3756	8.83 1312 98 2758	152	153
	154	8.9 668 80 17	0.61 3048 90 27	0,48 710 90 107	8,44 2090 98 596	0,51 2994 90 558	0,36 1818 90 482	0,36 1328 90 1337	0.4 6957 90 2896	0.4 13561 90 3344	0,38 18160 90 5504	0,39 17248 90 10400	0.42 15082 90 10520	8,54 6721 98 876	8.88 430 90 21	169	170
	171	0.1 1 90 1	1)3 90 111	0.63 815 80 341	8.57 3389 90 1134	0,56 6098 90 889	0,41 3189 90 1673	0,44 3009 90 1393	0.4 14126 80 1373	8.41 24781 80 4138	0.33 11810 90 7004	0,49 5768 90 7548	8.64 3277 99 098	0,38 10 90 5	185	186	187
	188	189	2.2 36 90 10	0,68 376 90 72	8.6 3504 90 640	8,54 2576 90 1210	0,58 6698 90 2802	8,64 3894 90 1200	0,59 4440 90 266	8,49 3559 90 551	0.47 1276 90 2272	1 559 90 481	200	201	202	203	204
	205	206	1.4 19 80 12	1.1 1455 90 5	0.9 1422 99 3	0,66 550 90 178	0,6 340 80 120	8.71 182 90 21	8.58 116 90 35	0 0 90 3	215	216	217	218	219	220	221



Performance

- Recent performance evaluation was performed using high-speed camera footage of lightning to two towers in Johannesburg.
- Flash Detection Efficiency (128 flashes):
 - Detection Efficiency of downward flashes (101) = 94%
 - Detection Efficiency of upward flashes (27) = 66.7%
 - Overall Flash Detection Efficiency = 88.3%
- Stroke Detection Efficiency (466 strokes from upward and negative flashes):
 - Overall Stroke Detection Efficiency = 72.1%
- Median Location Accuracy (71 events) = 68.5 meters
- Not representative of entire country and all events

Fensham H.G., Shumann C., Hunt H.G.P., Tasman J.D, Nixon K.J., Warner T.A., & Gijben M., 2018: Performance evaluation of the SALDN using high-speed camera footage of ground truth lightning events over Johannesburg, South Africa. Presentation presented at the 34th International Conference on Lightning Protection, 2-7 September 2018, Rzeszow, Poland. 978-1-5386-6635-7/18/\$31.00 ©2018 IEEE



Plans for network

- We recently upgraded the Vaisala TLP processing software.
- New software + upgrade of sensors should improve performance of network.

- We also want to add more sensors in South Africa (especially on the edges) – At least 5 to start, more later.
- Extend network into neighbouring countries.





Data

0.02

- We have a data archive from March 2006 to present available.
- Data for lightning flashes and strokes available.
- Data for real-time and reprocessed flashes/strokes available.







Uses

- Monitoring of thunderstorms
- Nowcasting
- Input to systems
- Research
- Product development
- Product validation
- Climatology
- Lightning verification (e.g. insurance sector)
- Clients (e.g. power utility)
- Etc.
- We will be happy to assist with data comparisons between the Lightning Imager onboard MTG and the SAWS LDN.





Thank you

