EVALUATION OF LIGHTNING DATA FROM DIFFERENT DETECTION NETWORKS OVER THE CZECH REPUBLIC

CZECH HYDROMETEOROLOGICAL INSTITUTE

Petr Novák

Contact e-mail: petr.novak@chmi.cz

CZECH HYDROMETEOROLOGICAL INSTITUTE

I. CELDN (Central European Lightning Detection Network operated by Siemens AG)

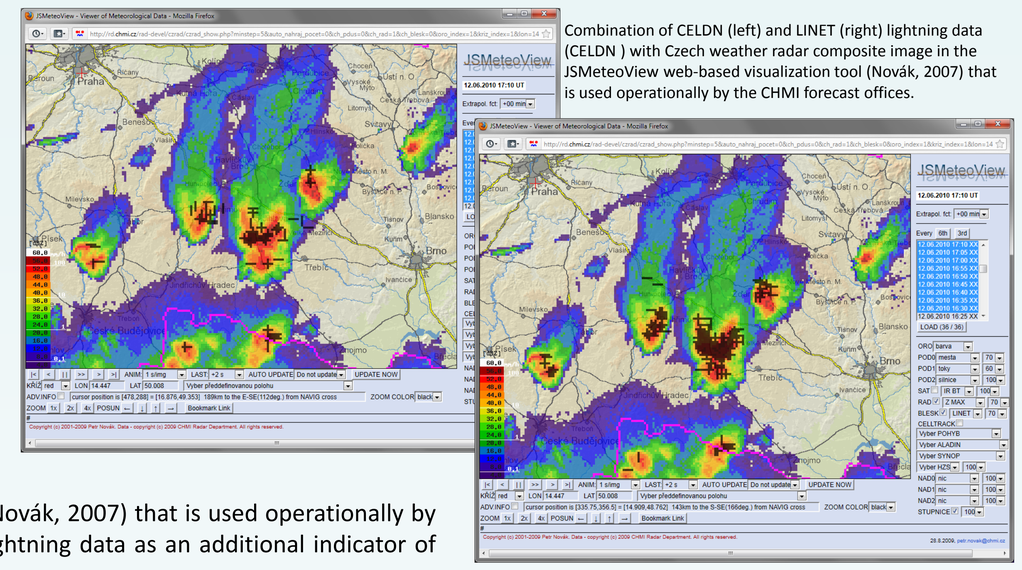
- ✓ Created by combining VAISALA/GAI VLF/LF sensors from German BLIDS network, Austrian ALDIS network and several new sensors installed in Czech Republic, Poland, Slovakia and Hungary.
- ✓ Primarily targeted on detection of cloud-to-ground (CG) lightning but intra-cloud (IC) lightning detection is also available. CELDN sensors are of the same type but several models that differ in detection efficiency mainly for IC lightning. Some of sensors were upgraded during last years.
- ✓ The Czech Hydrometeorological Institute (CHMI) uses CELDN data since May 1999 in free experimental mode and since 2002 fully operationally on commercial basis (Novák and Kyznarová, 2011).

II. LINET (lightning detection network operated by Nowcast GmbH)

- ✓ Homogeneous network of own-developed VLF/LF sensors detecting both CG and IC lightning; variable network density (sensors density over the Czech Republic is less than over Germany)
- ✓ The CHMI have got access to the full LINET data for evaluation period May-September 2010.

III. Utilization of lightning data in the CHMI

- ✓ Mainly used for nowcasting of severe storms as an additional information to the radar measurements but also for making expert opinion of damages caused by convective storms .
- ✓ Combined with other remote sensing data using JSMeteoView web-based visualization tool JSMeteoView (Novák, 2007) that is used operationally by the CHMI forecast offices. Convective cell tracking system CELLTRACK (Kyznarová and Novák, 2009) uses lightning data as an additional indicator of severity of detected cells.



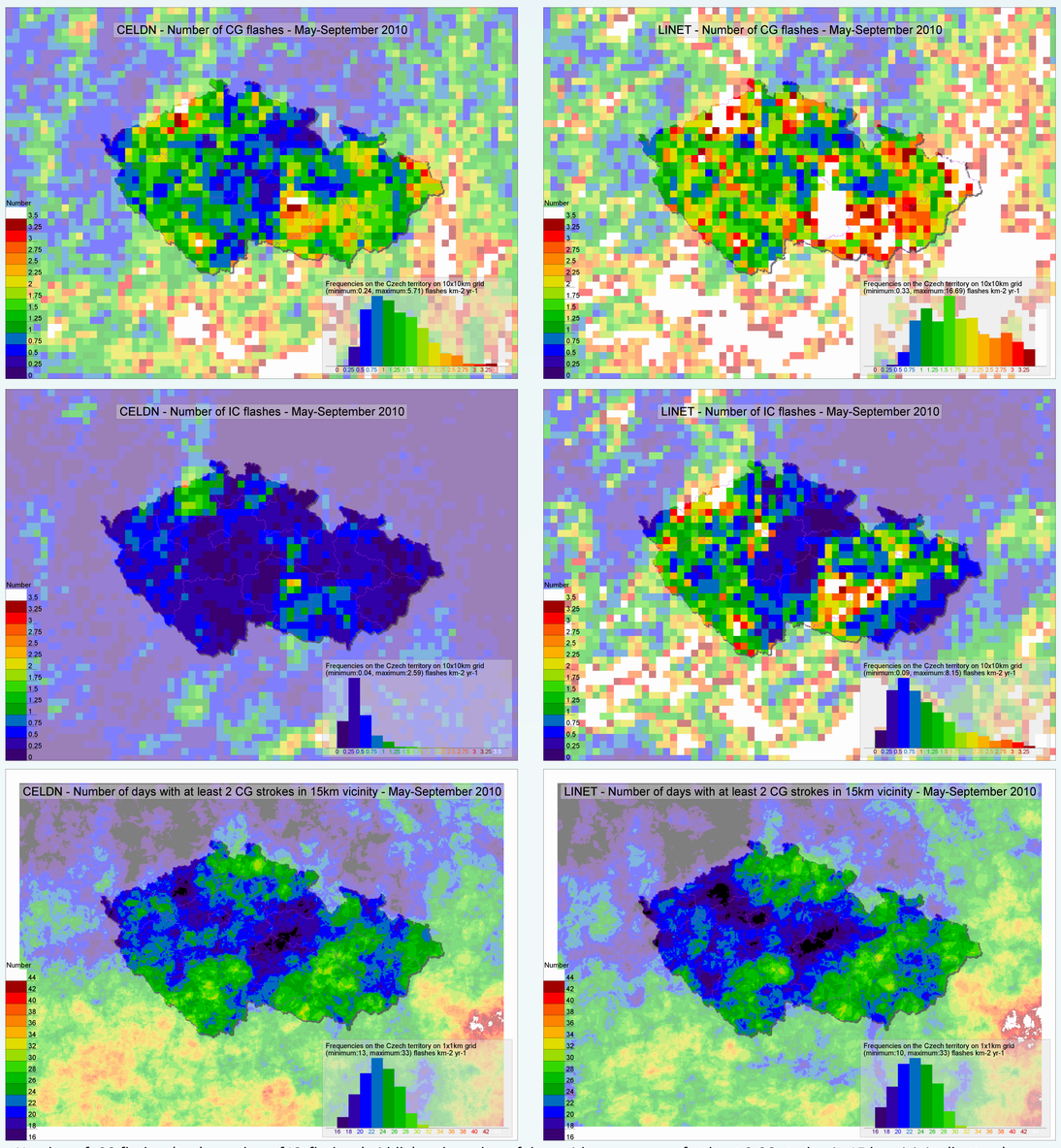
Combination of CELDN (left) and LINET (right) lightning data (CELDN) with Czech weather radar composite image in the JSMeteoView web-based visualization tool (Novák, 2007) that is used operationally by the CHMI forecast offices.

IV. Networks comparison

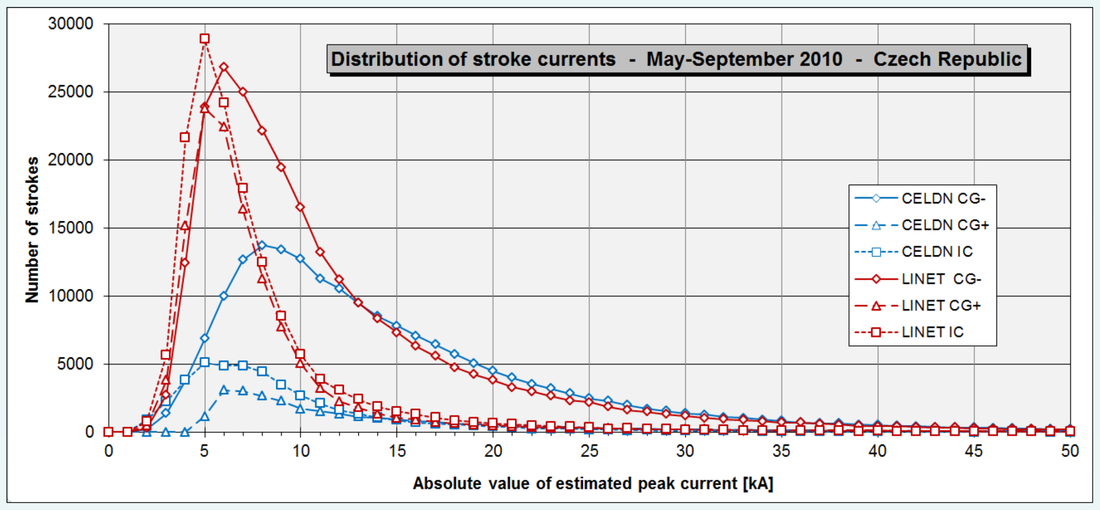
- ✓ LINET data were integrated into JSMeteoView and were operationally available to the CHMI forecasters for the whole evaluation period. Subjective comparisons in real operation were done.
- ✓ After end of evaluation period CELDN and LINET data, more detailed comparison was done.
- ✓ Strokes were grouped into flashes (max. 10km range, max. 1s total duration, max. 500ms between strokes, see also (Novák and Kyznarová, 2011)).
- ✓ Compared also with observations from meteorological station (SYNOP messages)

	Strokes				Flashes			
	CG-	CG+	IC	CG+/(CG+ + CG-)	CG-	CG+	IC	CG+/(CG+ + CG-)
CELDN	186815	34195	45012	0,15	81725	23860	37911	0,23
LINET	246001	137358	148791	0,36	103733	71403	97619	0,41
CELDN/LINET	1,32	4,02	3,31		1,27	2,99	2,57	

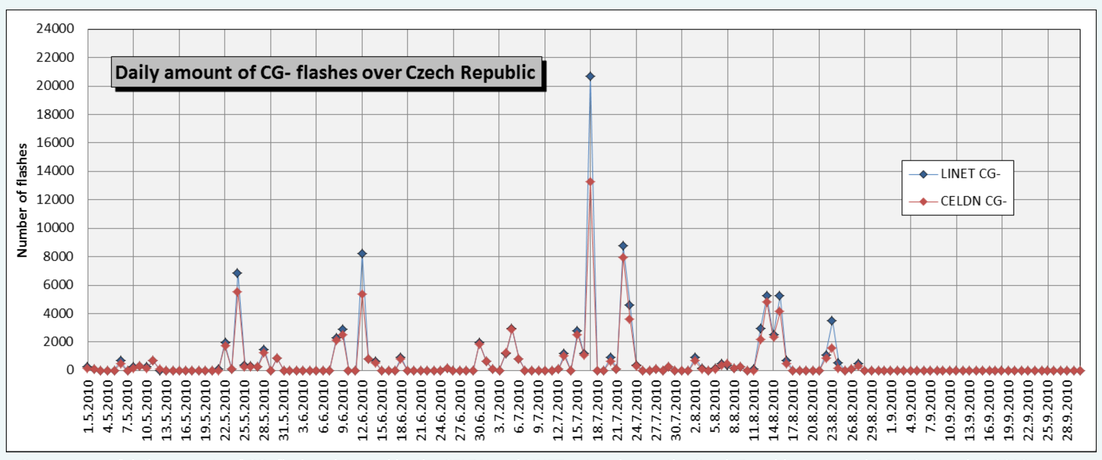
Numbers of individual types of strokes and flashes detected by CELDN and LINET network over the Czech Republic in period May-September 2010



Number of CG flashes (top), number of IC flashes (middle) and number of days with occurrence of at least 2 CG strokes in 15 km vicinity (bottom) detected by the CELDN (left) and the LINET (right) network



Distribution of stroke currents. Strokes detected by CELDN and LINET network over the Czech Republic in period May-September 2010. Distribution bin size is 1 kA. Strokes with a peak current above 50 kA were also recorded, but their frequencies are very low. Strokes with a peak current above 50 kA represent 1,9% respectively 1% of all CELDN respectively LINET strokes. Maximum recorded peak current was 328 kA for CG+ CELDN stroke respectively 329 kA for CG+ LINET stroke.



Comparison of daily amounts of CG- flashes detected by the CELDN and LINET network over the Czech Republic in period May-September 2010

KARLOVY VARY(11414)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	33 - 34	35 - 34	33 - 35
POD	0,71	0,71	0,91
FAR	0,27	0,31	0,03
CSI	0,56	0,53	0,89
Corr. coef.	0,71	0,69	0,94

PARDUBICE(11652)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	30 - 31	38 - 31	30 - 38
POD	0,71	0,77	0,74
FAR	0,27	0,37	0,07
CSI	0,56	0,53	0,70
Corr. coef.	0,72	0,70	0,83

PRAHA-LIBUS(11520)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	34 - 33	31 - 33	34 - 31
POD	0,76	0,76	0,97
FAR	0,26	0,19	0,12
CSI	0,60	0,64	0,86
Corr. coef.	0,74	0,78	0,92

BRNO/TURANY(11723)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	53 - 66	51 - 66	53 - 51
POD	0,65	0,62	0,88
FAR	0,19	0,20	0,15
CSI	0,57	0,54	0,76
Corr. coef.	0,72	0,70	0,86

TEMELIN(11538)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	44 - 36	46 - 36	44 - 46
POD	0,61	0,69	0,87
FAR	0,50	0,46	0,09
CSI	0,38	0,44	0,80
Corr. coef.	0,55	0,61	0,89

OSTRAVA/MOS(11782)	CELDN - SYNOP	LINET - SYNOP	CELDN - LINET
# of detected	40 - 47	48 - 47	40 - 48
POD	0,66	0,70	0,81
FAR	0,23	0,31	0,03
CSI	0,55	0,53	0,80
Corr. coef.	0,71	0,69	0,89

Comparison of detection of at least 2 CG strokes in the 15km vicinity of SYNOP stations with stations observations. Compared are hourly SYNOP reports with corresponding hourly datasets of CELDN and LINET network in period May-September 2010

IV. Preliminary results

- ✓ Both CELDN and LINET lightning data are useful additional remote sensing information for convective storms nowcasting and warning.
- ✓ Subjective comparison by forecasters didn't show any qualitative difference during operational use. The LINET detects more lightning strokes but significant earlier detection or exclusive detection of some weaker storms were not observed. Detection of convective storms is done primarily by weather radars .
- ✓ The LINET is able to detect more strokes/flashes than the CELDN (about 1,3x more of CG- and about 3x more of CG+ and IC) over the Czech Republic territory. The LINET has higher detection efficiency mainly for weak strokes with peak current below 10kA.
- ✓ Amount of CG+ lightning detected by the LINET is suspiciously high (about 40% of all CG lightning). Probable explanation is that the LINET CG/IC discrimination identifies some of the IC lightning as a CG+. It could explain also big difference in CELDN/LINET ratios of CG- and CG+ lightning.
- ✓ Spatial distribution of CG lightning is very similar for both networks. Spatial distribution of IC lightning is much more different, which is obviously caused by the inhomogeneous CELDN network (older sensors without IC detection capability).
- ✓ Comparison of CG detection in the vicinity of SYNOP stations with their observations showed relatively good correlation that is almost same for both network (corresponds also with the high correlation of the CELDN and LINET).

V. References

Kyznarová H., Novák P., 2009: CELLTRACK - Convective cell tracking algorithm and its use for deriving lifecycle characteristics. Atmos. Res., 93, 317-327.

Novák P., 2007: The Czech Hydrometeorological Institute's severe storm nowcasting system. Atmos. Res., 83, 450-457.

Novák P., Kyznarová H., 2011: Climatology of lightning in the Czech Republic. Atmos. Res., 100 , 318-333.

http://www.euclid.org/ – EUCLID and CELDN network , http://www.nowcast.de/ – LINET network

Acknowledgment: This research was carried out under support of the Grant Agency of the Czech Republic, project 205/07/0905 and the Czech Republic Ministry of Education, Youth and Sport, project ME09033