Present status and preliminary results of the Belgian lightning detection network

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Abstract: At present, two different processors perform calculations in parallel to retrieve the location of lightning discharges. These processors differ from each other in the way to determine in the low-frequency (LF) band of the spectrum the position of the cloud-to-ground (CG) return stroke. Hence, to quantify this difference, data from May-August 2011 are analysed and intercompared with the lightning data of the overlapping long-range network ATDnet of the United Kingdom Met Office (UKMO).

Network setup: The Royal Meteorological Institute of Belgium (RMI) operates a SAFIR network since 1992, consisting out of 5 sensors. In addition, from January 2011, RMI shares data with 3 LS8000 sensors (LF and VHF) belonging to a Vaisala demo-network around Paris. In the near future, RMI will share its data with the four sensors of the KNMI network in the Netherlands.

Data processing: Two different processors are running in parallel to calculate lightning positions; one in operational mode, the other is in test phase.

I. Operational processor (OP): The location of the CG stroke is operated in the VHF band, and uses solely the RMI SAFIR sensors. The sensors have a capacitive electrical antenna which can distinguish between intracloud (IC) and CG signals. Once a LF signal is detected, the CG stroke is assigned a location using the position of a time-correlated VHF signal, based on an interferometric location retrieval method.

II. Test phase processor (TLP): RMI runs a Total Lightning Processor (TLP) of Vaisala, combining VHF interferometry with a LF time-of-arrival (TOA) approach for the localization of CG strokes. The TOA technique uses the relative arrival times of a signal from the sensors to form hyperboloids, from which the intersection is then used as the location of the signal. The effect on the location accuracy using TOA is seen in Fig.1.

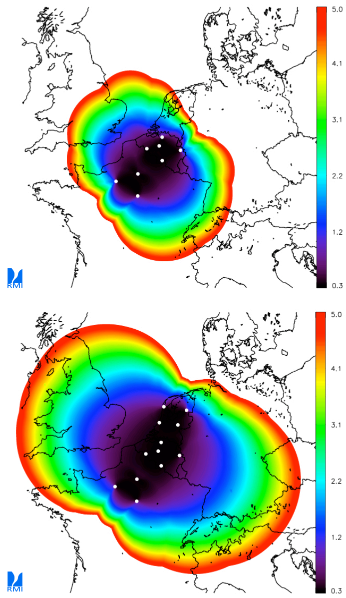

Fig.1: Theoretical location accuracy [km] based on the TOA technique with a sensor timing error of 1.5μs for the RMI + Paris demo network (*top*) and RMI + Paris demo network + KNMI configuration (*bottom*). The white dots represent the sensor positions.

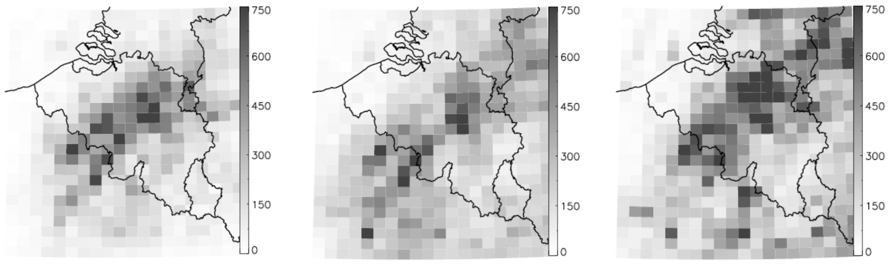

Fig.2: Number of CG flashes per 0.125° (lat) × 0.25° (lon) detected by the OP (*left*), TLP (*middle*) and ATDnet (*right*) during May-August 2011. Note that all values above 750 are given the same value.

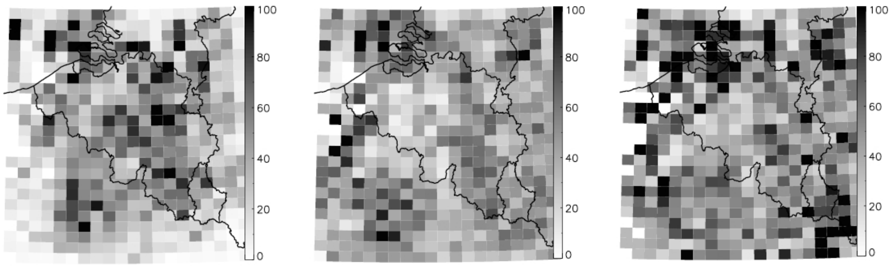

Fig.3: POD [%] per 0.125° (lat) × 0.25° (lon) for TLP out of OP (*left*), OP out of ATDnet (*middle*) and TLP out of ATDnet (*right*) during May-August 2011.

Method & Results: CG flashes are compared over a region with boundaries lat ∈ [49,52] / lon ∈ [2,7]. The probability of detection (POD) concept is used to evaluate the relative performance of two different datasets by calculating the amount of overlapping events registered by one system assuming the other as truth, and vice versa; see Drüe et al. (2007) and Finke (1999). A flash overlaps in two datasets if $\Delta t < 1$s and $\Delta r < 25$km.
The total amount of strokes/flashes and POD values are presented in Table I. Density and POD values are plotted in Fig. 2 and 3, resp.

TABLE I. Intercomparison values

	Strokes	Flashes		
OP	166893	79041		
TLP	177862	106243		
ATDnet	213592	134978		
POD	**Value**	**POD**	**Value**	**Median Deviation**
TLP out of OP	58%	OP out of TLP	43%	8.5km
TLP out of ATDnet	46%	ATDnet out of TLP	59%	5.0km
OP out of ATDnet	40%	ATDnet out of OP	69%	9.5km

Conclusions & Outlook: **[i]** ATDnet outnumbers the amount of CG detections compared to the RMI network. **[ii]** TLP recognizes ~60% of the OP flashes. This rather low POD can be attributed to the difference in amount of sensors used and method to determine the CG locations. Overlappig flashes have a large spatial difference of 8.5km. **[iii]** About 70% (60%) of ATDnet's flashes overlap with the OP (TLP) flashes. However, the spatial difference between TLP and ATDnet is about half the value of OP-ATDnet's deviation. **[vi]** Overall, we find that TLP tends to match slightly better than does OP with ATDnet.

At the end of August 2011, RMI has installed a new LS7000 sensor for LF detections in the middle of the Belgium. Together with the future connection of the KNMI network this is expected to have a significant effect on the total performance of the network; increasing the detection efficiency and location accuracy. This will be monitored closely in the future.

Acknowledgments:
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References:

Drüe, C., et al. 2007: Comparing a SAFIR lightning detection network in northern Germany to the operational BLIDS network. *Journal of Geophysical Research*, Vol. 112, D18114

Finke, C., 1999: Space-time correlations of lightning distributions. *Monthly Weather Review*, 127, 1850-1861