

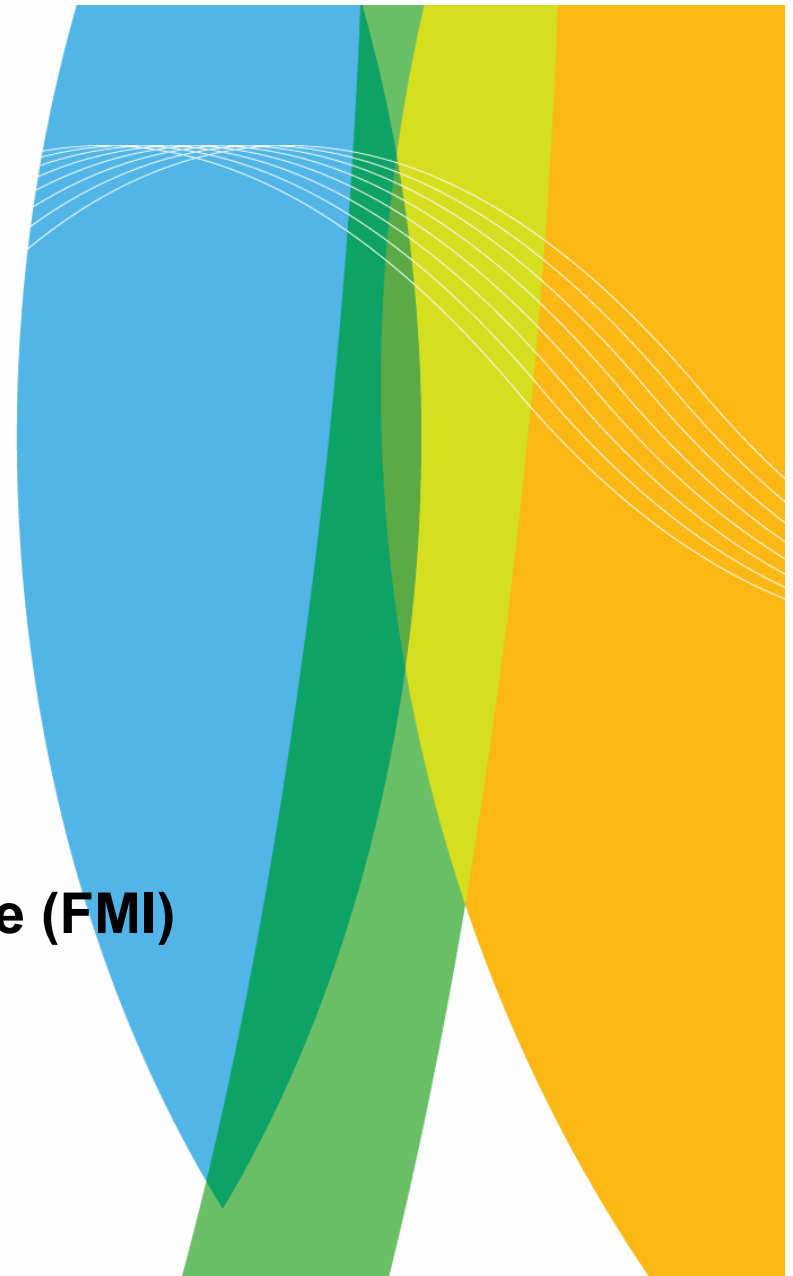


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# Time differences of VHF and LF lightning locations in Finland in 2006

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# Contents

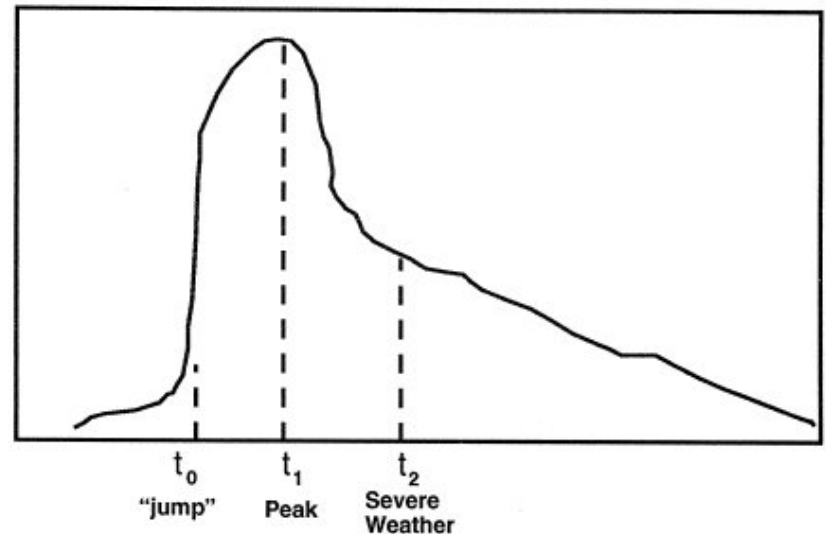
- **Introduction**
- **Data**
- **Results**
- **Examples**
- **Summary and discussion**



# Introduction

- **According to the literature, total lightning is much better indicator of severe weather than CG data alone**
- **Also, the first discharges of the storm are most often intracloud type (lead-time several minutes)**

Image: A schematic history of total lightning flash rates of severe thunderstorms in Florida deduced with the LDAR-system. (Williams et al. 1999).





# Introduction

- **There are several types of LLS's for locating intracloud discharges**
- **The thunderstorms also have different characteristics at different climatological regimes (eg. the cloud flash – ground flash ratio [Mackerras et al. 1998])**
- **Hence, the lead-times obtained from locating intracloud discharges may depend on the type of the LLS and regime**



# Introduction

- **This study has focused on the VHF lead-times measured with a 3-sensor SAFIR interferometer**
- **Average and median lead-times will be shown**
- **Examples of different types of cases will be presented**

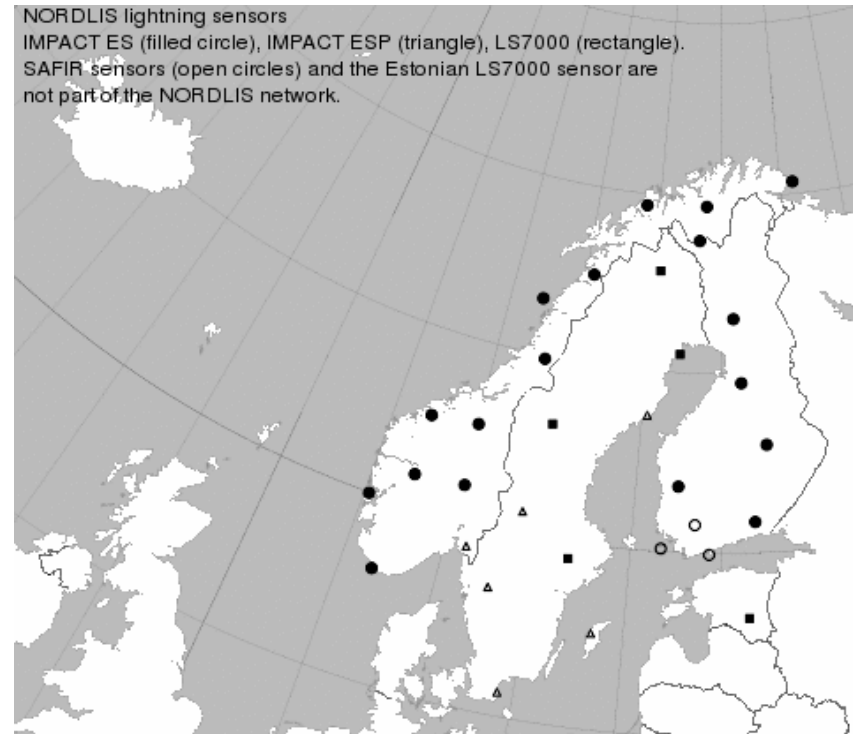


# Data

## •FMI's lightning data based on Vaisala sensors:

- 5 *IMPACT ES* sensors
- 3 *SAFIR* sensors
- cooperation with Norway and Sweden (NORDLIS), and with Estonia*

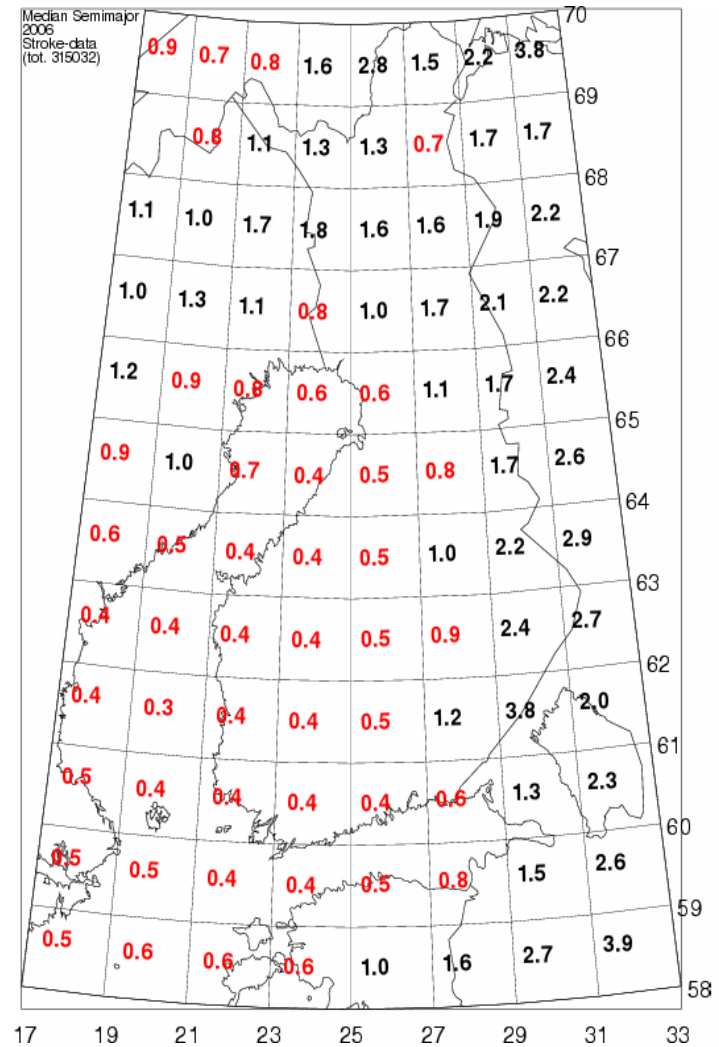
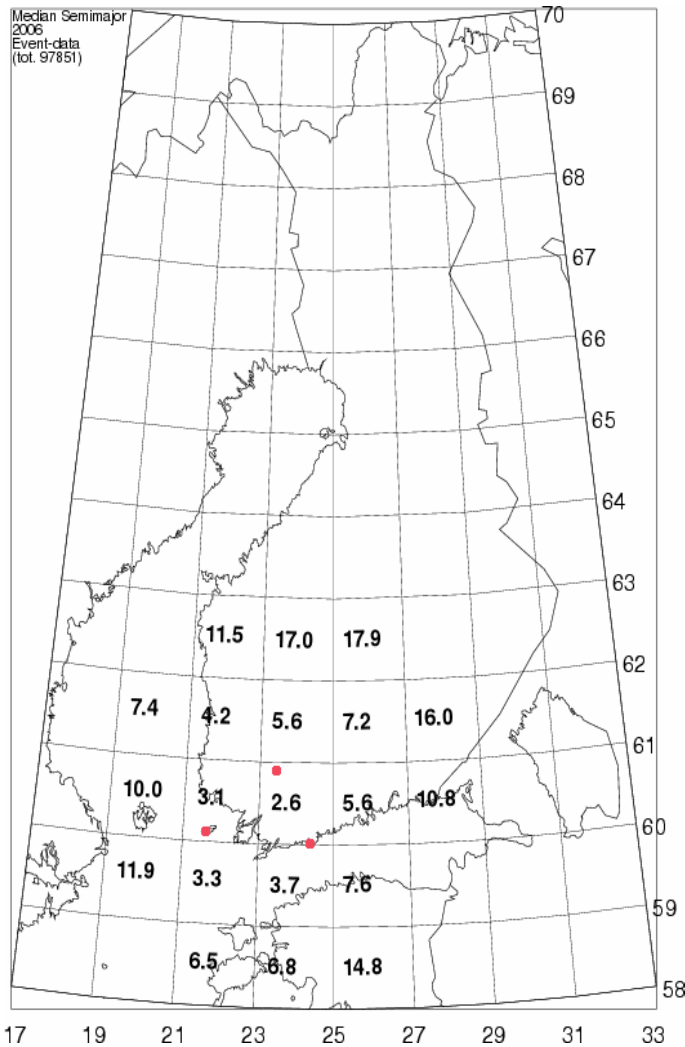
## •The same central processor for **IMPACT** and **SAFIR (CP8000)**



# Median location accuracy for VHF (left) and LF (right) in 2006



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# Data

- **Dataset consists of a total of 35 cases**
- **Case = a situation with thunderstorm development starting at the good detection area of the SAFIR network**
- **The time difference of the first VHF and LF event is calculated (= lead-time)**
- **The further lifecycle of the storm is not investigated, only the first detected signals**



# Results

- **Out of 35 cases**

- *28 contained both VHF and LF*
- *5 contained only VHF*
- *2 contained only LF*

- **Mean lead-time in the 28 cases with both VHF and LF events is 6.9 minutes**

- **The median lead-time is 0 minutes**

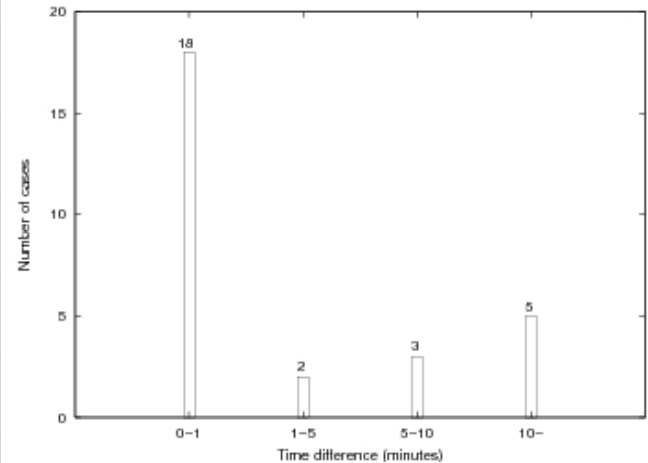
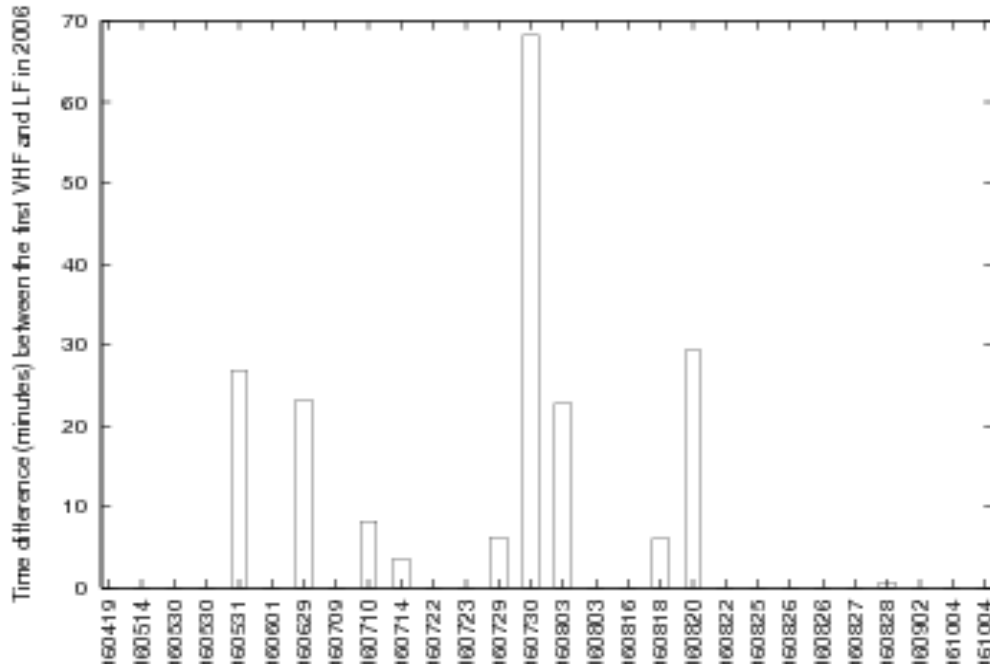
- > in the majority of the cases the VHF and LF are detected almost simultaneously (time diff. ~few ms)**

- > in these cases the VHF radiation is apparently emitted from the incloud processes of the ground flash**



# Results

• In the images the lead-times of the 28 cases with both VHF and LF events





## Results

- **In the table the properties of the 5 VHF-only cases**
- **These cases contain only a few SAFIR points and only ~one or two cloud flashes (in parenthesis)**
- **Almost all occurred at the sea (weak convection)**
- **“Duration” indicates the time between the first and the last VHF event**

Case	VHF points	Duration (sec)
060530	22 (1)	0.0595
060714	4 (1)	0.0004
060804	12 (1)	0.0021
061006	8 (3)	260.8260
061008	3 (1)	0.0003

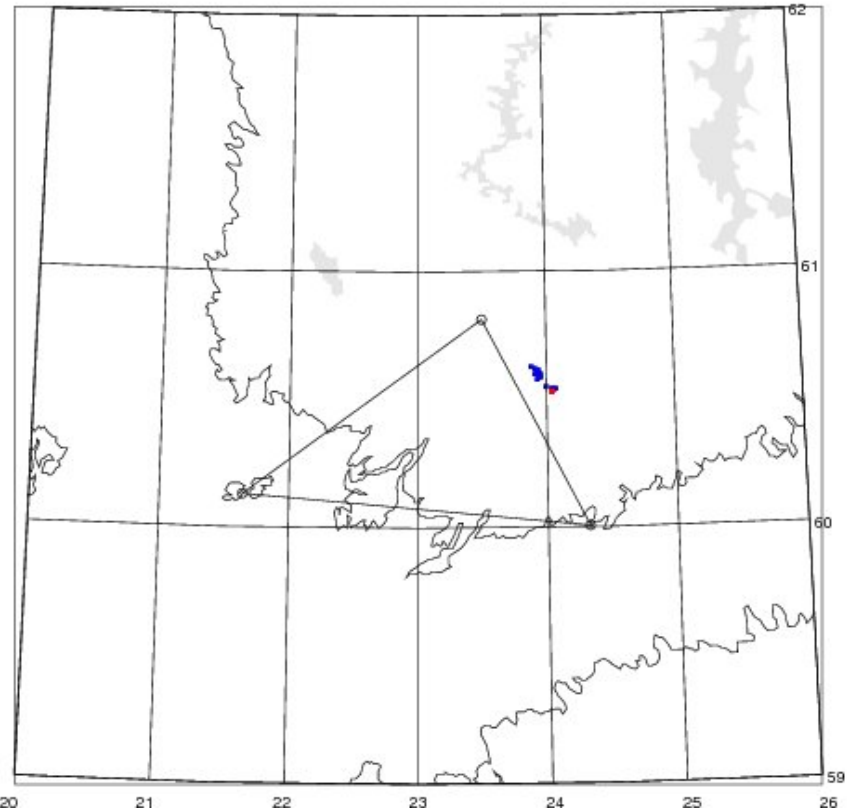


## Examples – VHF and LF with small time diff.

LIGHTNING LOCATION SYSTEM OF THE FINNISH METEOROLOGICAL INSTITUTE  
060722 08:02 - 08:02 UTC  
ON THE MAP 1 CG FLASH (RED [.] OR [+]), 20 VHF POINTS (BLUE) AND 0 LF CLOUD FLASHES (RED X).

**July 22<sup>nd</sup>**

- **First VHF event at 08:02 UTC (11:02 local time)**
- **Single-stroke CG 2.8 ms later (-35.5 kA, 0.3 km, 14 sensors, PTZ = 56 us)**
- **A total of 20 VHF events in the flash, 14 preceding the CG**



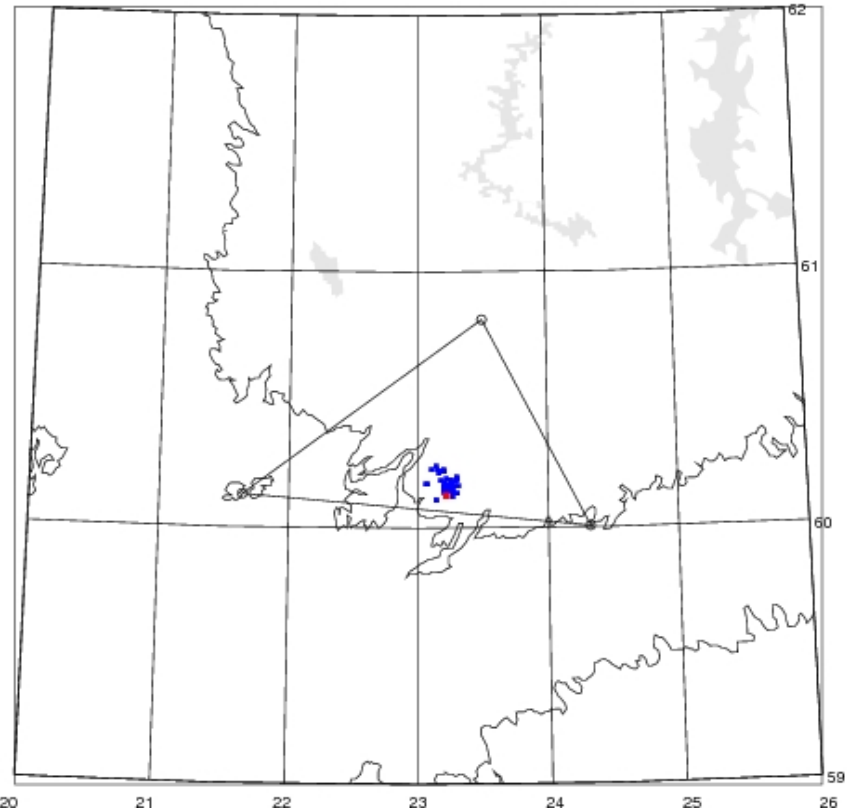


# Examples – VHF and LF with large lead-time

LIGHTNING LOCATION SYSTEM OF THE FINNISH METEOROLOGICAL INSTITUTE  
060629 14:43 - 15:06 UTC  
ON THE MAP 1 CG FLASH (RED [.] OR [+]), 43 VHF POINTS (BLUE) AND 0 LF CLOUD FLASHES (RED X).

**June 29<sup>th</sup>**

- **First VHF event at 14:43 UTC**
- **Single-stroke CG 23 minutes later (-7.8 kA, 0.4 km, 6 sensors, PTZ = 28 us)**
- **A total of 43 VHF events (two set of bursts), 41 preceding the CG**



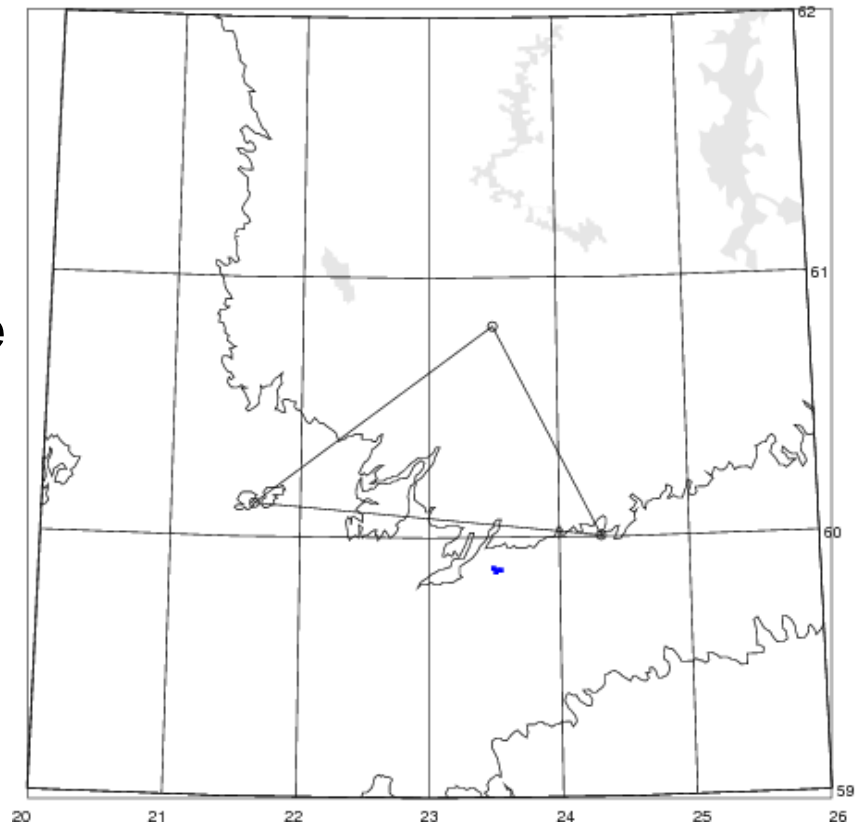


# Examples – VHF only

LIGHTNING LOCATION SYSTEM OF THE FINNISH METEOROLOGICAL INSTITUTE  
060714 09:31 - 09:31 UTC  
ON THE MAP ○ CG FLASHES (RED [.] AND [+]), ◻ VHF POINTS (BLUE) AND ◊ LF CLOUD FLASHES (RED X).

**July 14<sup>th</sup>**

- **Small convective cell in the sea**
- **4 located VHF points**
- **No CG's**





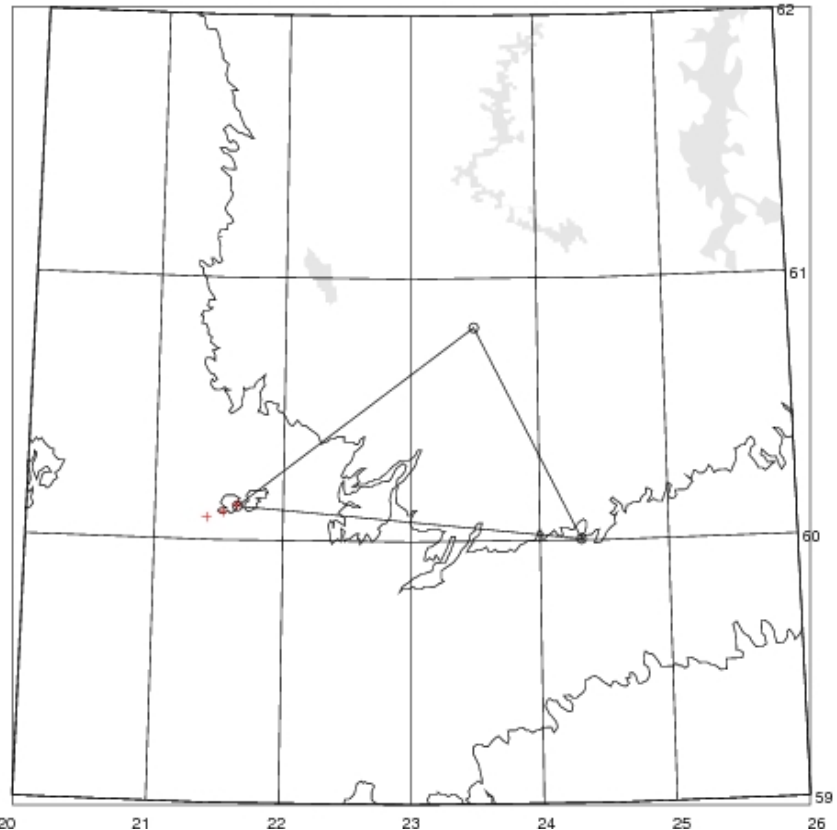
# Examples – LF only

## October 27<sup>th</sup>

### • 3 CG flashes:

- *one bipolar*
- *two single-stroke positive (high peak current)*
- *close to one SAFIR sensor*

LIGHTNING LOCATION SYSTEM OF THE FINNISH METEOROLOGICAL INSTITUTE  
061027 09:51 - 09:53 UTC  
ON THE MAP 3 CG FLASHES (RED [,] AND [+]), 0 VHF POINTS (BLUE) AND 0 LF CLOUD FLASHES (RED X).



UTC-time	Str	Err	NSR	PTZ
061027				
09:51:59.3316	+48.2	7.5	2	25.0
09:51:59.3317	-41.1	0.5	3	98.0
09:51:59.3575	+102.6	0.3	12	102.0
09:53:51.0132	+44.0	0.3	10	19.0



# Summary and discussion

- **According to the dataset**

- *VHF lead-time in 30% of the cases*
- *VHF and LF simultaneously in 50%*
- *only VHF in 15%*
- *only LF in 5%*

- **Mean lead-time ~7 minutes, median 0 minutes (large variation among the cases)**



## Summary and discussion

- **In Finland, a 3-sensor SAFIR system provides significant lead-time only in the minority of the cases**
- **This might be due to the possible unsensitiveness of SAFIR, or to climatological effects (eg. lower cloud base and top than in the lower latitudes)**
- **However, in some cases the only information is provided with SAFIR (these cases might be of interest eg. to aviation)**
- **Quite small dataset (the SAFIR area is small and the thunderstorm season 2006 in Finland was rather poor)**



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# Thank You!

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# References

D. Mackerras, M. Darveniza, R. E. Orville, E. R. Williams and S. J. Goodman, 1998: Global lightning: total, cloud and ground flash estimates. *J. Geophys. Res.*, vol 103(D16), pp. 19791-19810.

Williams, E. R., Boldi, B., Matlin, A., Weber, M., Hodanish, S., Sharp, D., Goodman, S., Raghavan, R. and Buechler D, 1999: The behavior of total lightning activity in severe Florida thunderstorms. *Atmos. Res.*, 51, 245-265.