EUMETSAT

RÉPUBLIQUE FRANÇAISE
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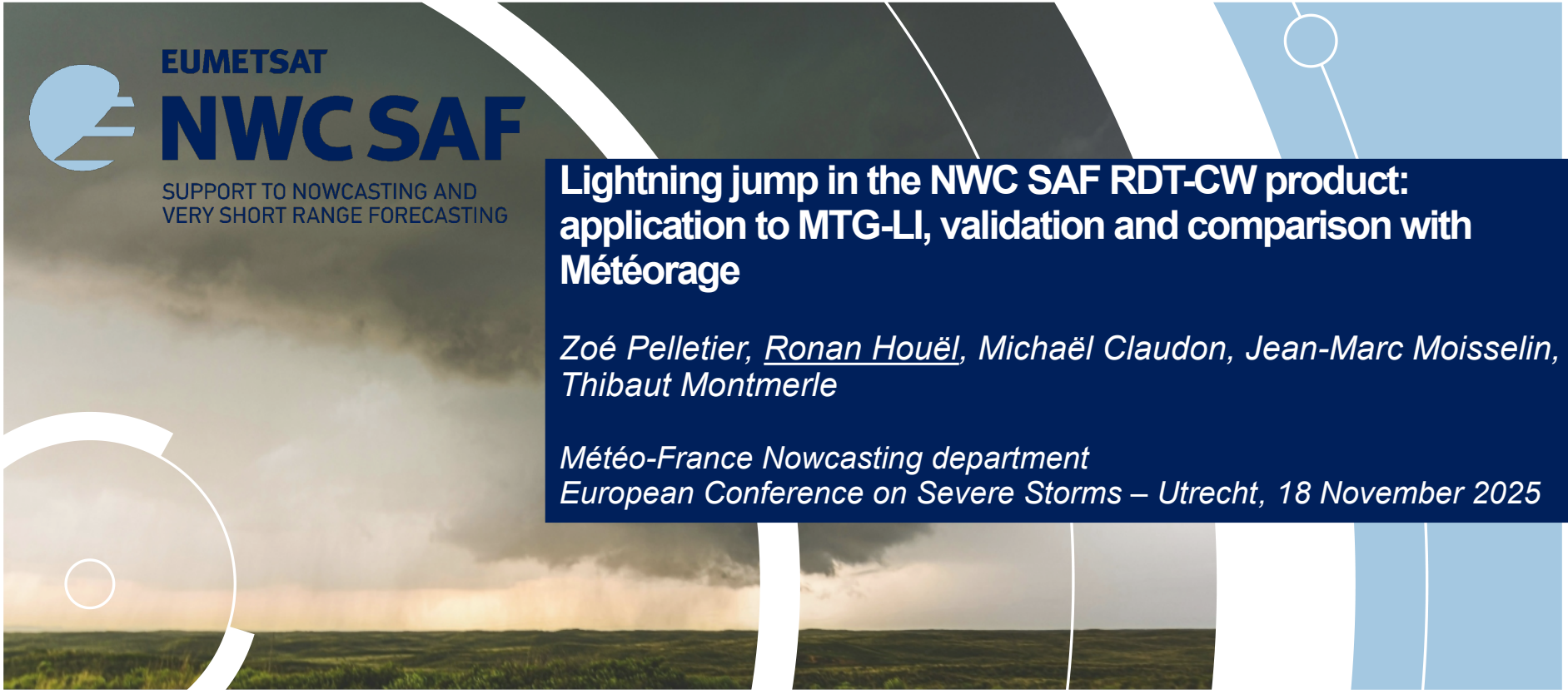
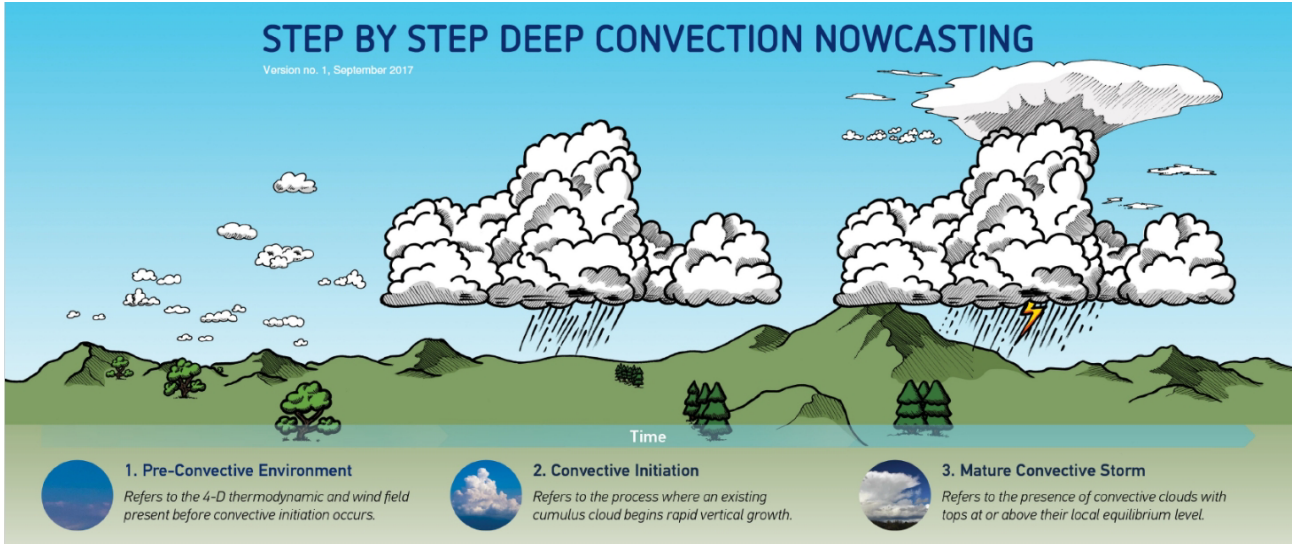


Lightning jump in the NWC SAF RDT-CW product: application to MTG-LI, validation and comparison with Météorage

Zoé Pelletier, Ronan Houël, Michaël Claudon, Jean-Marc Moisselin, Thibaut Montmerle

Météo-France Nowcasting department
European Conference on Severe Storms – Utrecht, 18 November 2025

Introduction



CI product

RDT-CW product

NWC GEO-I v2025

- MTG-I
- MSG 0°, MSG RSS, MSG IODC
- Himawari 8/9
- GOES-R series

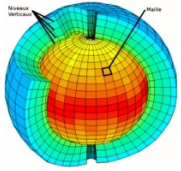
- Météo-France develops **CI (Convection Initiation)** and **RDT-CW (Rapid Developing Thunderstorm - Convection Warning)** products in the framework of the EUMETSAT NWC SAF

Introduction

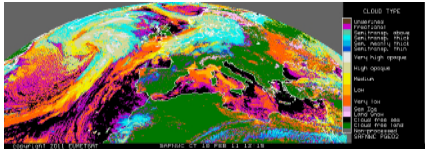
Input

GEO Satellite Data
(multi-channels IR, VIS, WV...)

Numerical Weather Prediction model
(winds, instability indices, tropopause)



Other NWC SAF products
(Cloud Type, Cloud microphysics…)



Lightning data
- **Satellite**: **LI**, GLM
- **Ground network**: **Météorage**, GLD360, WWLLN

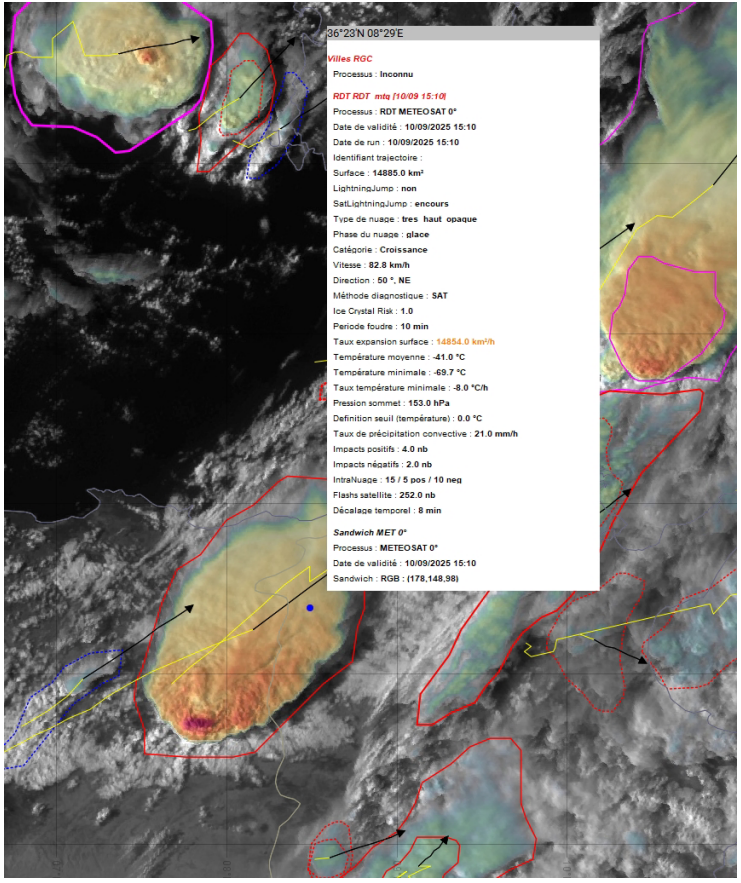
I. **Detection**
IR adaptative threshold
→ Identification of cloud towers

II. **Tracking**
Cell overlap between consecutive images
→ Motion field, trajectory, trends

III. **Discrimination**
Statistical models + lightning data
→ Identification of convective cells

IV. **Nowcast**
Linear advection of the cloud towers up to 1h

Introduction



RDT-MTG + Sandwich image. 20251009 – 1510 UTC over Eastern Algeria

Output

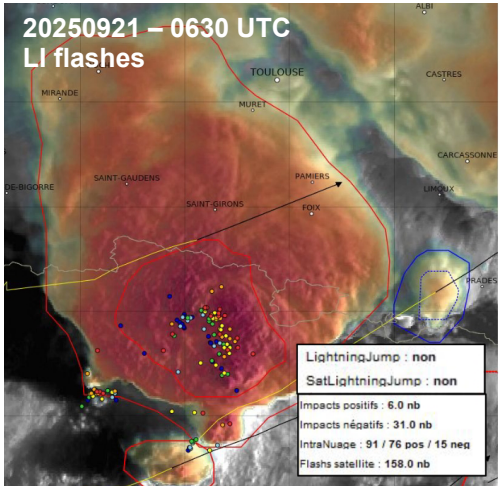
Object-oriented approach (2D outlines + attributes)
Description of **observed** and **forecasted** convective objects**:**

- **Static attributes** (morphology, extreme values, overshooting top)
- **Dynamic attributes** (cloud-top cooling rate,..)
- **Hazard thanks to data fusion** (lightning, cloud top pressure, icing)
- **Synthetic attributes** (**severity**, phase of life)

Context

- The 2-**σ** LJ algorithm is used operationally within the RDT. The product offers two independent LJs coming from satellite and ground lightning detection system

- Over Europe, RDT uses LI and Météorage to compute both **LI-LJ** (SatLightningJump) and **MET-LJ** (LightningJump)



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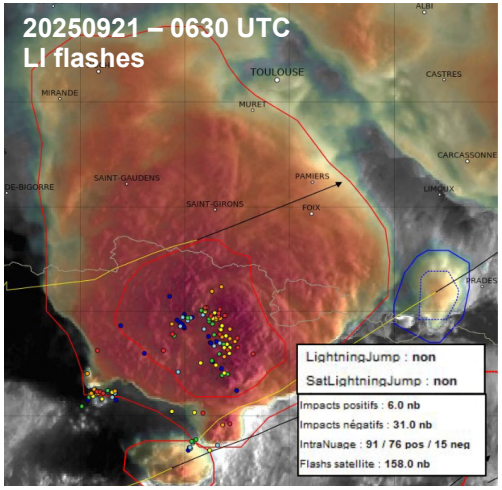
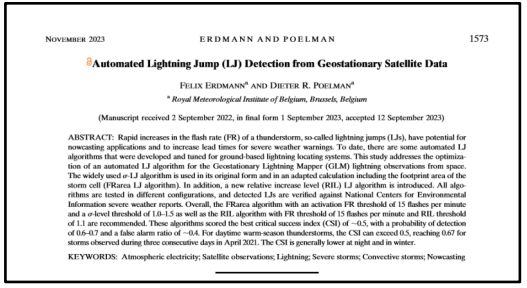


Recent work on automatic LJ detection with GLM (Erdmann and Poelman, 2023)

- Study on 50 000 GOES16-RDT trajectories over the CONUS in 2020/2021 using GLM
- Severe weather reports and 3 different LJ algorithms (2-σ, Frarea, RIL)
- Score computation using severe weather reports for LJ validation

→ **CSI ≈ 0.5 - POD ≈ 0.7 and FAR ≈ 0.4**
→ **Winter/summer as well as day/night variability in scores**



NOVEMBER 2023 ERDMANN AND POELMAN 1573

Automated Lightning Jump (LJ) Detection from Geostationary Satellite Data

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[a] *Royal Meteorological Institute of Belgium, Brussels, Belgium*

(Manuscript received 2 September 2022, in final form 1 September 2023, accepted 12 September 2023)

ABSTRACT: Rapid increases in the flash rate (FR) of a thunderstorm, so-called lightning jumps (LJs), have potential for nowcasting applications and to increase lead times for severe weather warnings. To date, there are some automated LJ algorithms that were developed and tuned for ground-based lightning locating systems. This study addresses the optimization of an automated LJ algorithm for the Geostationary Lightning Mapper (GLM) lightning observations from space. The widely used σ-1 LJ algorithm is used in its original form and in an adapted calculation including the footprint area of the storm cell (FRarea LJ algorithm). In addition, a new relative increase level (RIL) LJ algorithm is introduced. All algorithms are tested in different configurations, and detected LJs are verified against National Centers for Environmental Information severe weather reports. Overall, the FRarea algorithm with an activation FR threshold of 15 flashes per minute and a σ-level threshold of 1.0–1.5 as well as the RIL algorithm with FR threshold of 15 flashes per minute and RIL threshold of 1.1 are recommended. These algorithms scored the best critical success index (CSI) of ~0.5, with a probability of detection of 0.6–0.7 and a false alarm ratio of ~0.4. For daytime warm-season thunderstorms, the CSI can exceed 0.5, reaching 0.67 for storms observed during three consecutive days in April 2021. The CSI is generally lower at night and in winter.

KEYWORDS: Atmospheric electricity; Satellite observations; Lightning; Severe storms; Convective storms; Nowcasting

Purpose of the study: to evaluate the performance of LJs obtained with LI within the RDT product and compare them with Météorage's LJs performance using the approach of Erdmann and Poelman, 2023

Methodology

- RDT-MTG v2025 during spring/summer 2025 – France/Europe domain
- Filters: Domain, land/sea flag, RDT trajectories with lightning

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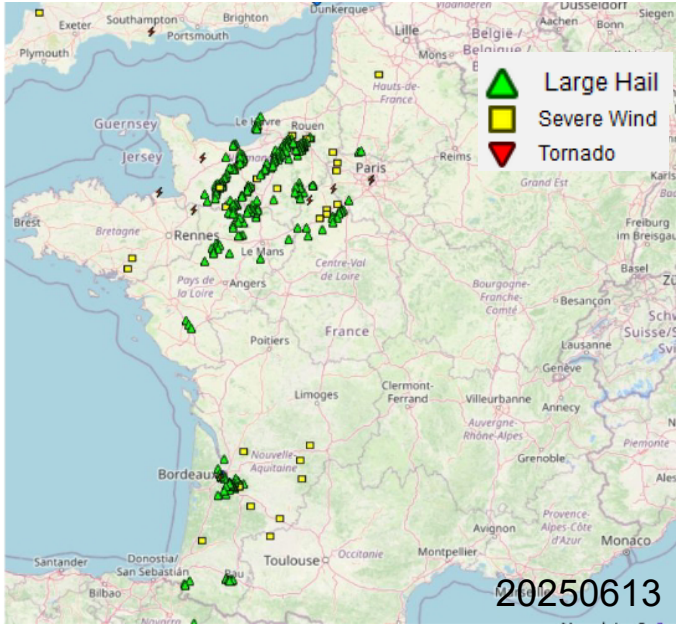
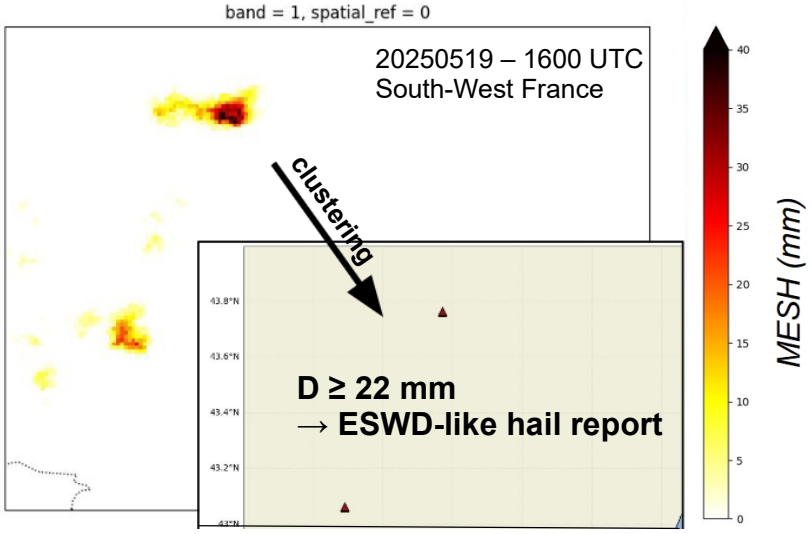
- Severe weather reports

ESWD
(European Severe Weather Database)



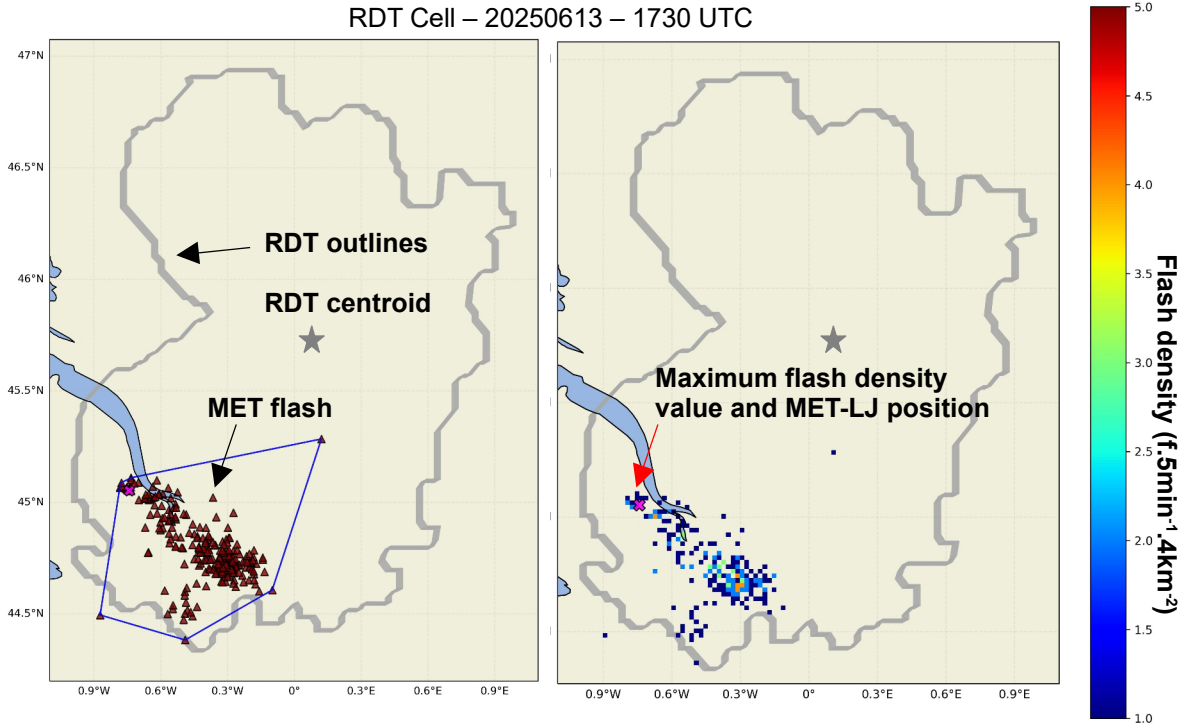
MESH (only over France domain, every 5 min)
(Maximum Estimated Size of Hail, Witt et al., 1998)



→ **Filtering** + **clustering** of reports
→ <u>One enhanced database</u> of ESWD+MESH reports for LJ validation

Methodology

- RDT-MTG v2025 during spring/summer 2025 – France/Europe domain
- Filters: Domain, land/sea flag, RDT trajectories with lightning
- Severe weather reports
- **2-σ** LJ computation + merging of temporally close LJs
- LJ position



- LJ located at the point with the maximum flash density value
- Flash density calculated every minute based on the last 5 min of flash activity
- 1 potential LJ position for each 10-min RDT-MTG cell taking the highest flash density during the 10 min period

→ LJ position for **LI** and **MET** independently

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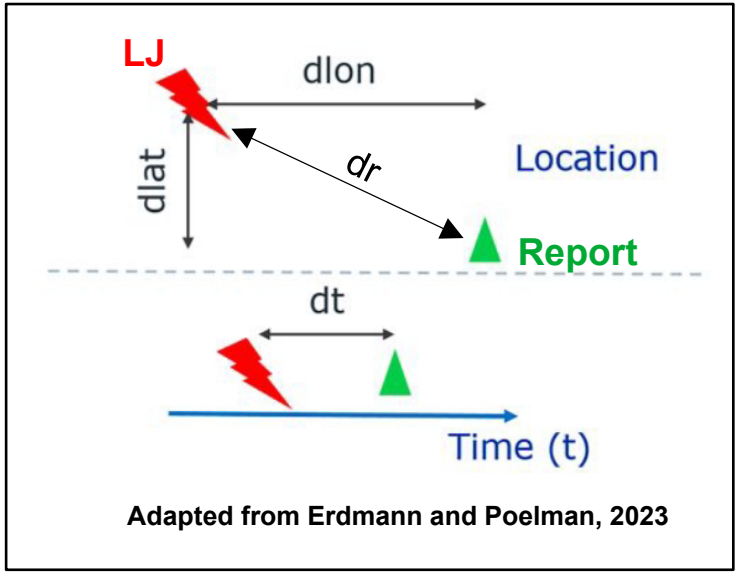
- **2-σ** LJ computation + merging of temporally close LJs
- LJ position
- Matching LJs with reports



Adapted from Erdmann and Poelman, 2023

- LJ and report within 100 km of each other
- LJ occuring 90 minutes before or 20 minutes after a report
- **No parallax** correction for LI and RDT data

LJ-report matching condition :

$$WED = \frac{(90-dt)}{(90min_{LJbefore}+20min_{LJafter})} + \frac{dr}{100km} < 1$$

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- Score computation

- Hit : Report event with at least one coincident LJ

- Miss : Report event with no LJ match

- False alarm : LJ that could not be matched with a report event

→ **Computation of POD, FAR, CSI**

Case Study - 20250613

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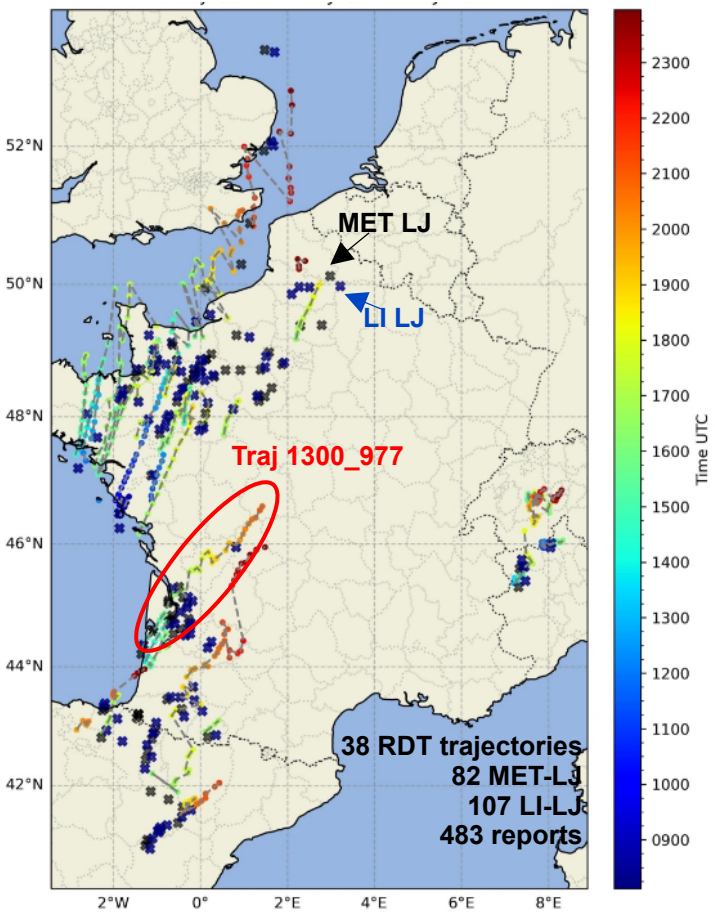
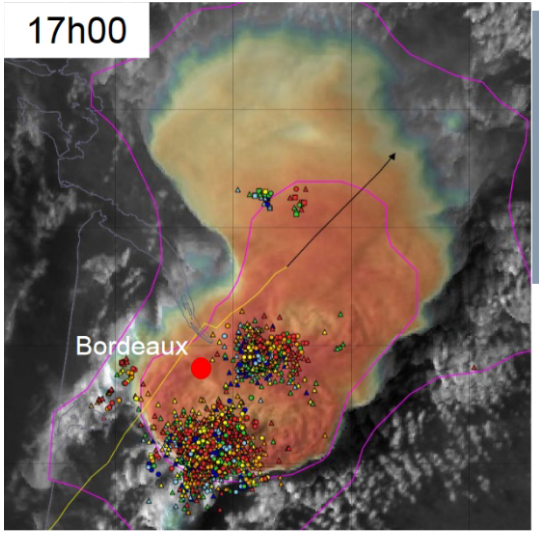
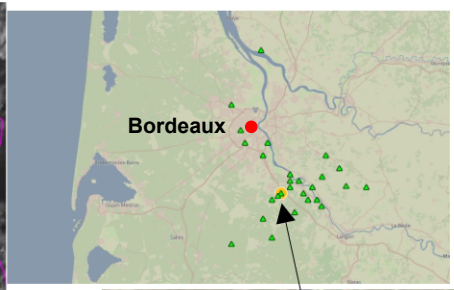
nwc-saf.eumetsat.int

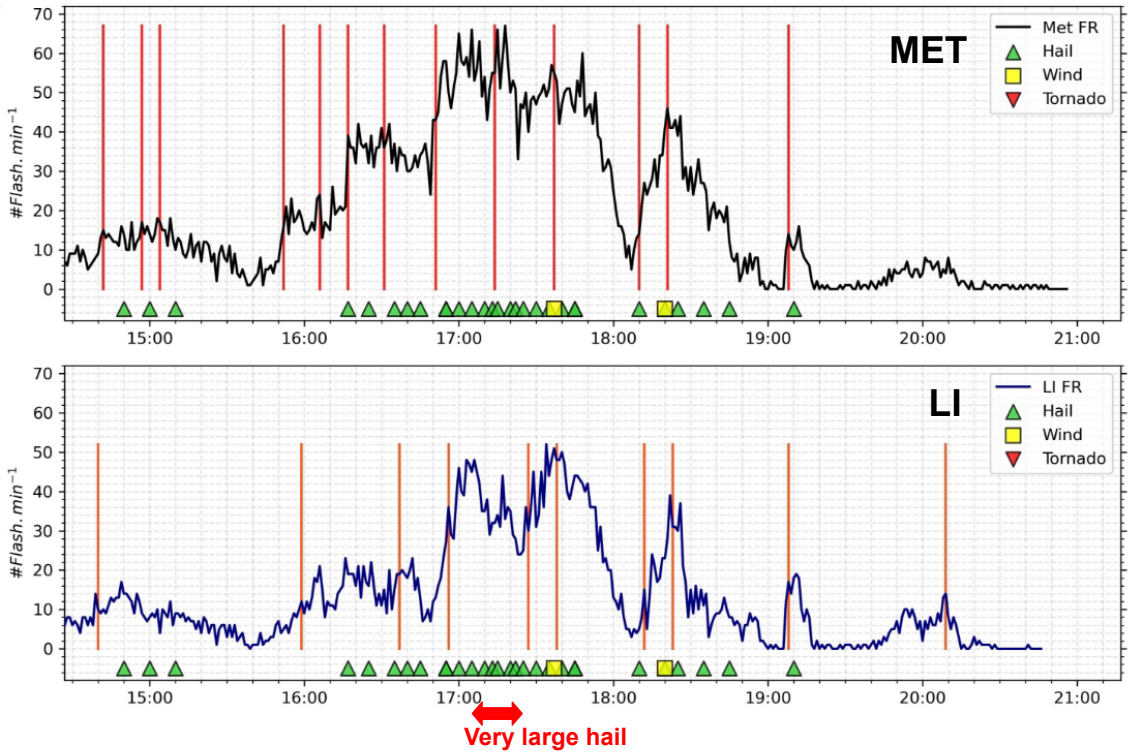






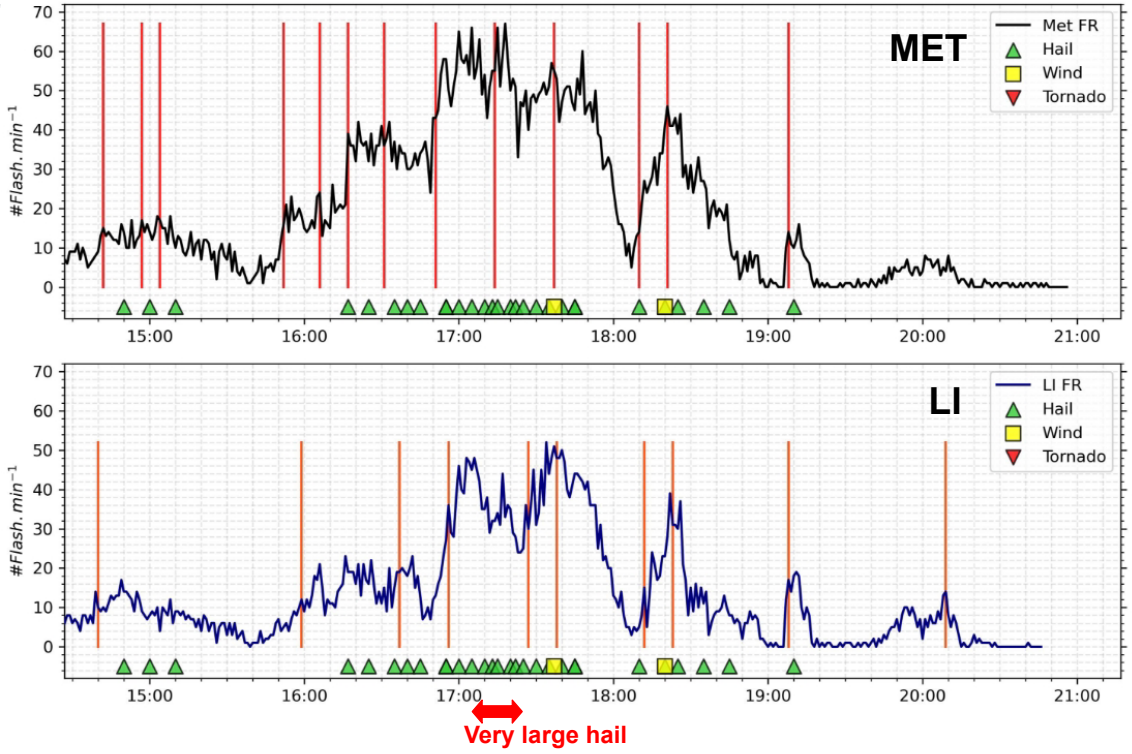
Traj 1300_977
1410 UTC → 2110 UTC – 41 RDT cells
31 reports associated to this trajectory (29 hail)
8 cm hail at 1712 UTC, south-east of Bordeaux

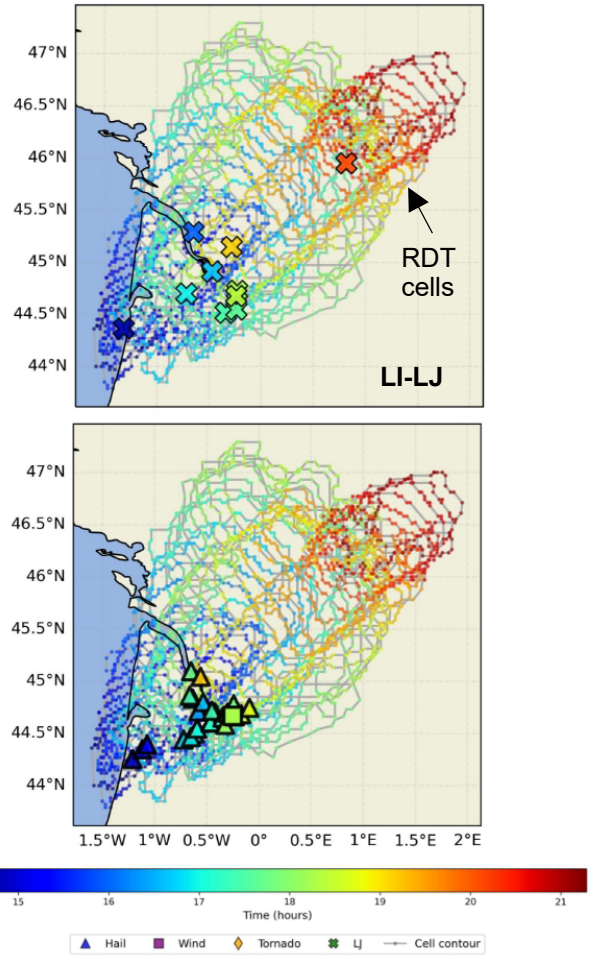
Case Study - 20250613 – Traj 1300_977



- 10 **LI-LJ** - 13 **MET-LJ**
- Max LI FR ≈ 50 f.min^{-1} ; max MET FR ≈ 65 f.min^{-1}
- 100% of reports are preceded by an LJ, one FA for LI-LJ

Case Study - 20250613 – Traj 1300_977



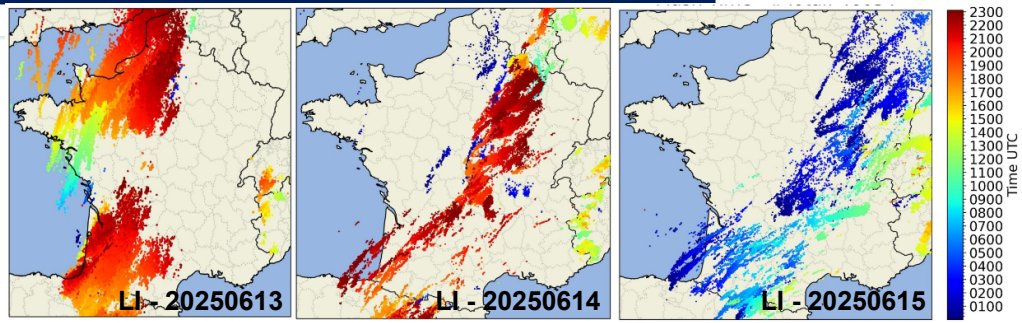


- 10 **LI-LJ** - 13 **MET-LJ**
- Max LI FR ≈ 50 f.min^{-1} ; max MET FR ≈ 65 f.min^{-1}
- 100% of reports are preceded by an LJ, one FA for LI-LJ
- The reports and LJs are fairly well co-located

3-day results

Scores for three successive days

- Algo : 2-sigma ; Threshold : 10 f.min^{-1}
- ESWD + MESH as reports, France domain
- Max density LJ position



- 765 reports
  (71% MESH hail; 21% ESWD hail ; 8 % ESWD wind)
- 96 trajectories – 1844 cells – 2 hours 20 min median cell duration
- 279 882 LI flashes - 318 700 MET flashes (**+14%**)

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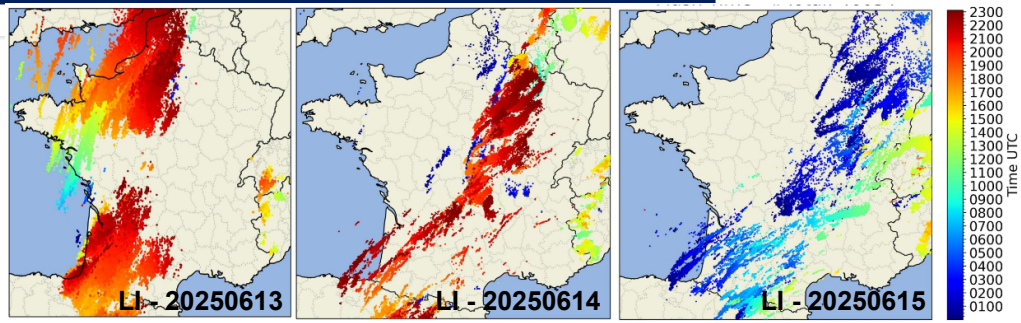

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	MET 245 LJs	LI 275 LJs
POD	0.71	0.78
FAR	0.16	0.16
CSI	0.62	0.68

- More LJs with LI despite fewer flashes observed
- LI slightly better than MET
- The difference comes mainly from the POD, with a higher number of LJ detected with LI
- Adding MESH data as reports increases CSI by 46% (29%) for LI (MET) (versus only ESWD)

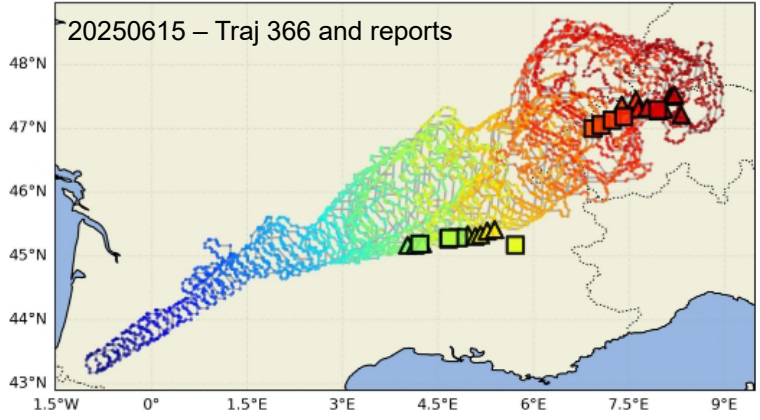
Conclusions and perspectives

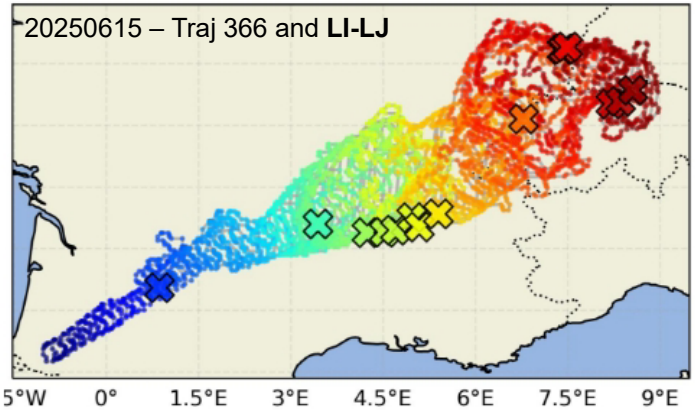
- **First evaluation of LJ within RDT cells with LI – Preliminary results on few cases**

- Good results: POD ~ 0.7 and FAR ~ 0.16 for both LI and MET
  → Very promising for the operational use of LI-LJ

- LI and Météorage are quite close, but LI gives better results (fewer flashes but more LJ detected)

- Using the **maximum lightning density** as the **location of the LJs** helps to better pinpoint the most dangerous area of the RDT cells



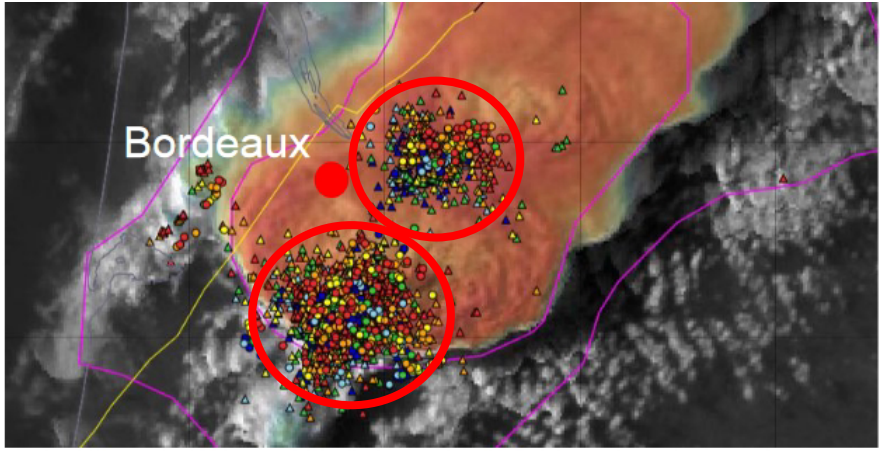


Conclusions and perspectives

- Extended validation time (90 minutes) probably non physical

- Enhanced reports database with MESH reports but also known for many false alarms
  - A stricter MESH diameter could be a way to mitigate

- Significant uncertainty regarding the position and the LJ detection in large RDT cells with multiple convective cores of electrical activity
  - Identification and tracking of convective cores within RDT cells. LJ computation for each core



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→ Scores across Europe with **more cases**

→ Investigate how to use size/footprint of LI flashes as an indicator of small flashes increase in LJ algorithm

Thank you!

Questions are welcome.