Comparison of electrostatic, radio and human observation techniques for thunderstorm warning at the WMO field intercomparison site in Vigna di Valle – Italy

Dr. Alec Bennett
Biral

Magg. Stefania Vergari
Technical Centre for Meteorology
Italian Air Force

CIMO TECO-2018

Motivation for the investigation

Thunderstorm observations are not present in AUTO METAR

Thunderstorms are a major source of disruption to aerodrome activities

- Lightning (air/ground crew and passenger exposure, refuelling/arming)
- Severe turbulence and low-level wind shear (take-off and landing)
- Hail and intense rainfall (aircraft damage, poor visibility)

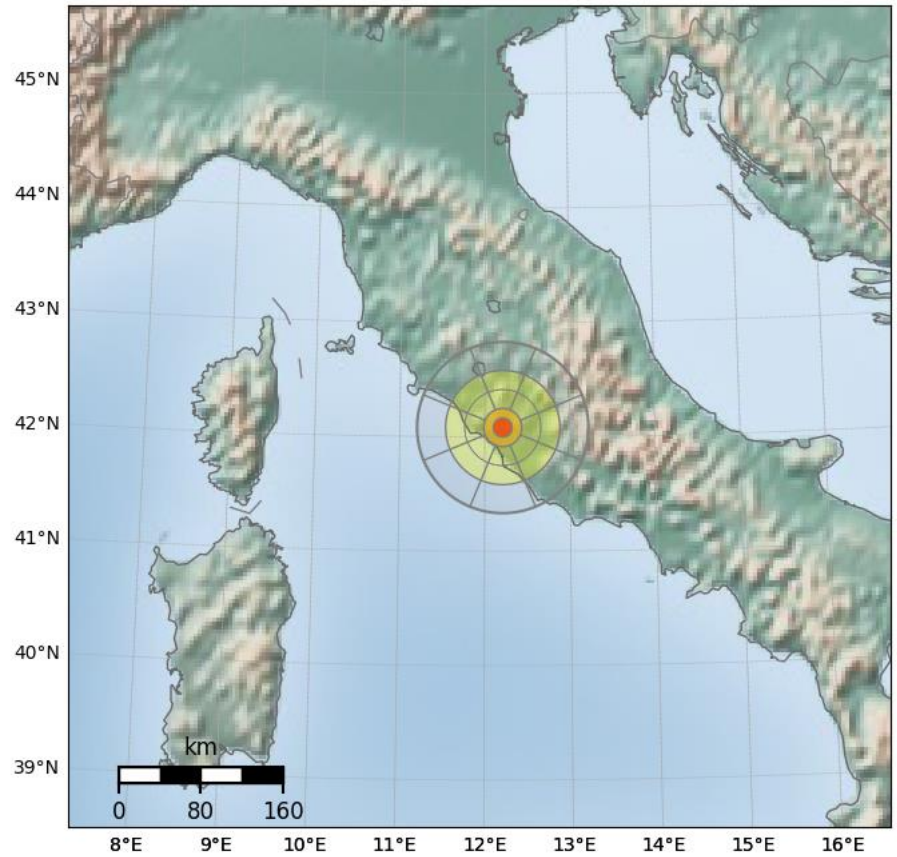
Variety of thunderstorm detection methods available

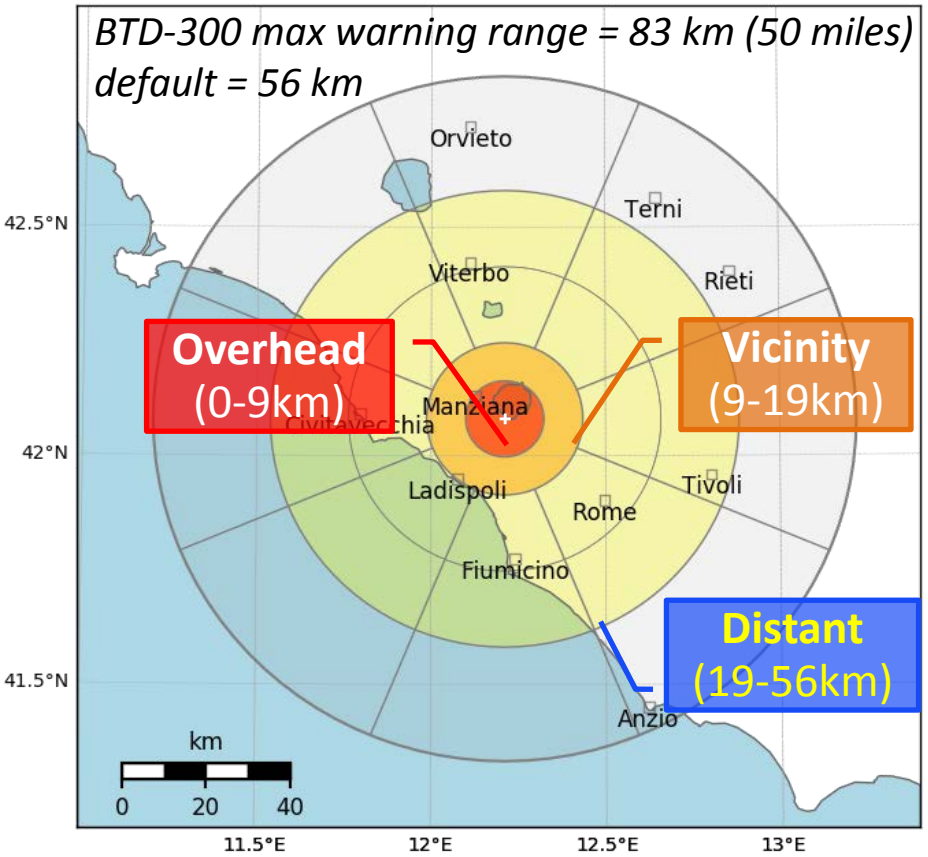
- Human observer
- Radio-detection
- Electrostatic
- Space-based (already for US and China, shortly for Europe)

Direct comparison between techniques not previously reported

WMO Field Intercomparison Site

Technical Centre for Meteorology, Italian Air Force
Vigna di Valle, Italy





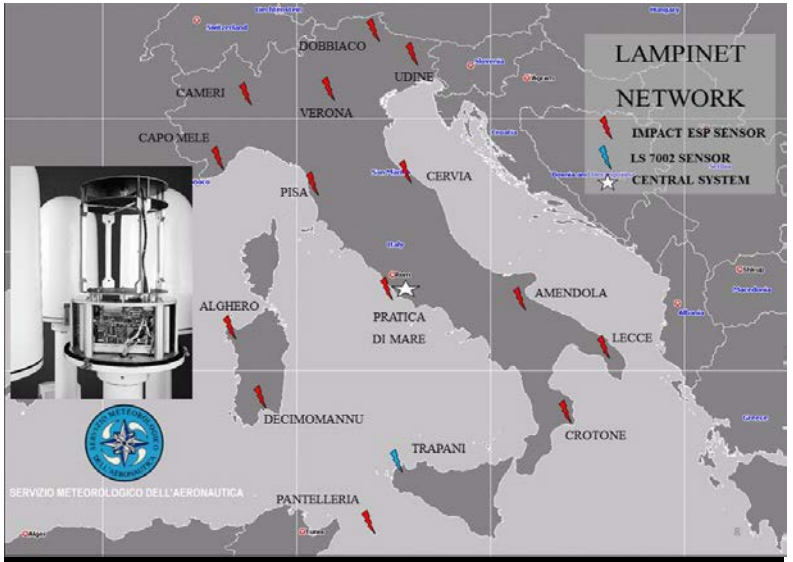
Different thunderstorm detection methods

Human observers
(Vigna di Valle Met Station)

Electrostatic
(BTD-300)

Total lightning
(CG+IC)

Radio network
(Lampinet)



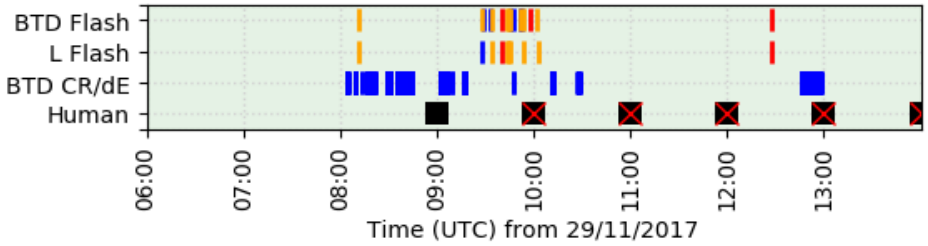
Total lightning (CG+IC)

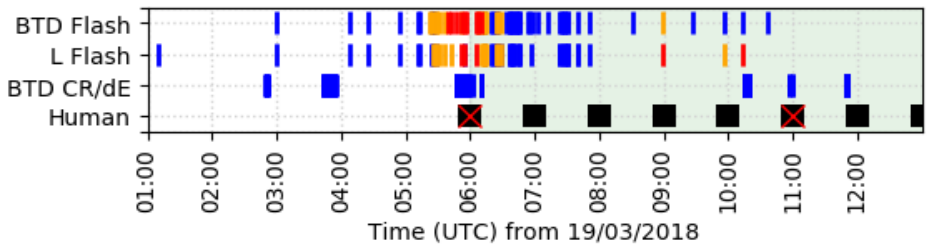
Comparing all three techniques – 6 case studies

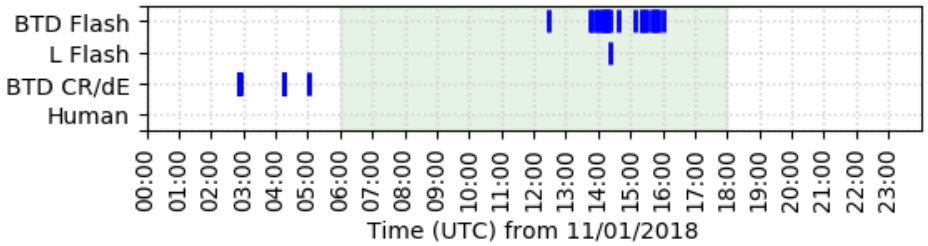
- DISTANT LIGHTNING
- VICINITY LIGHTNING
- OVERHEAD LIGHTNING
- OBSERVED TOWERING CUMULUS
- OBSERVED CUMULONIMBUS
- OBSERVED THUNDERSTORM

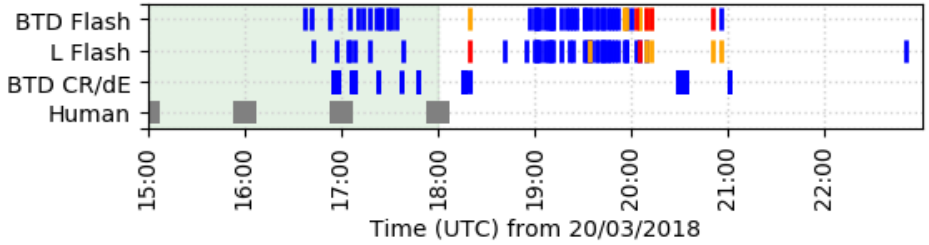
Green = Human observation available

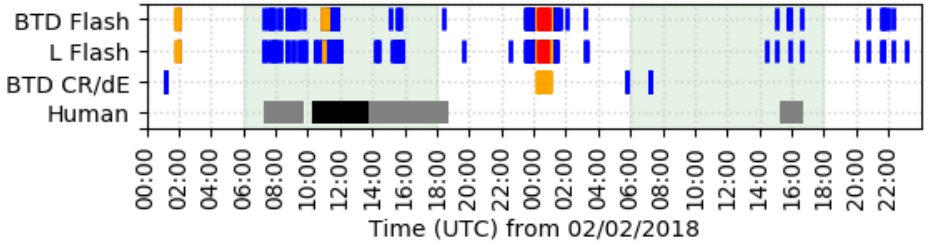
Nov 2017 – Apr 2018
6 case study days

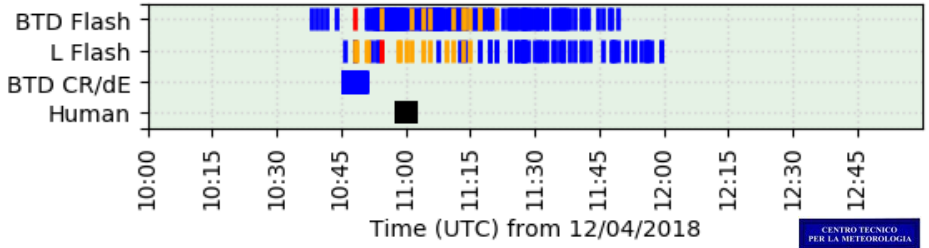






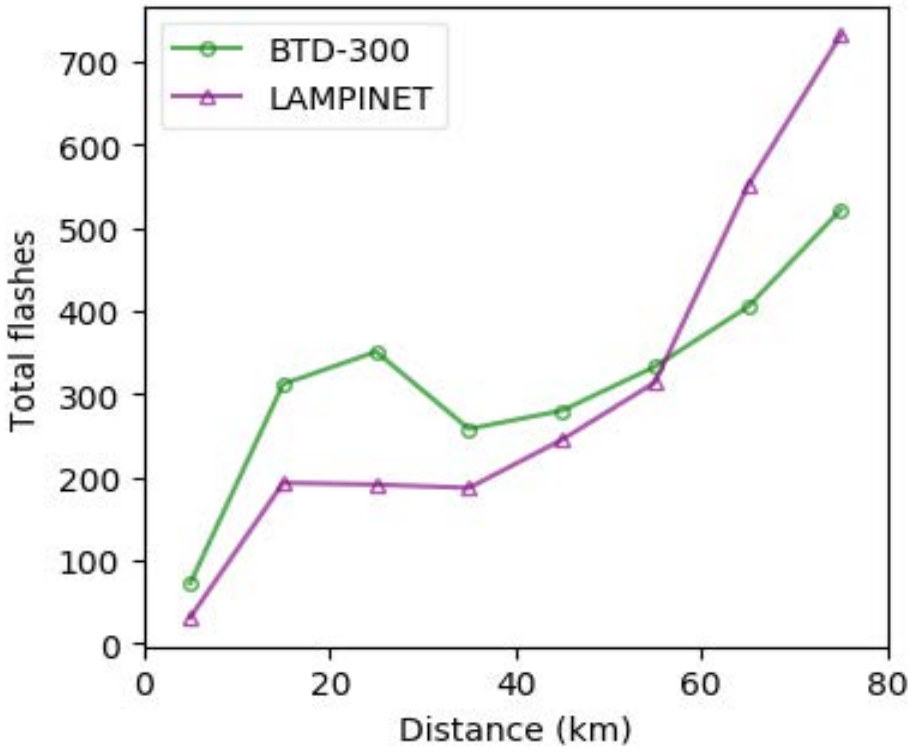


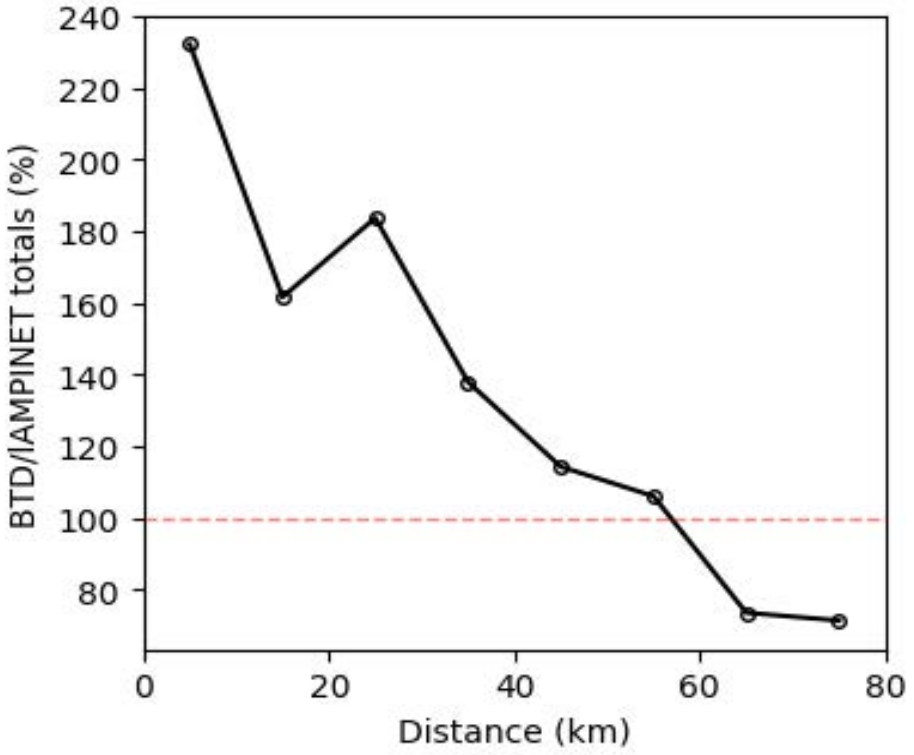




BTD-300 vs Lampinet (Detection Efficiency)

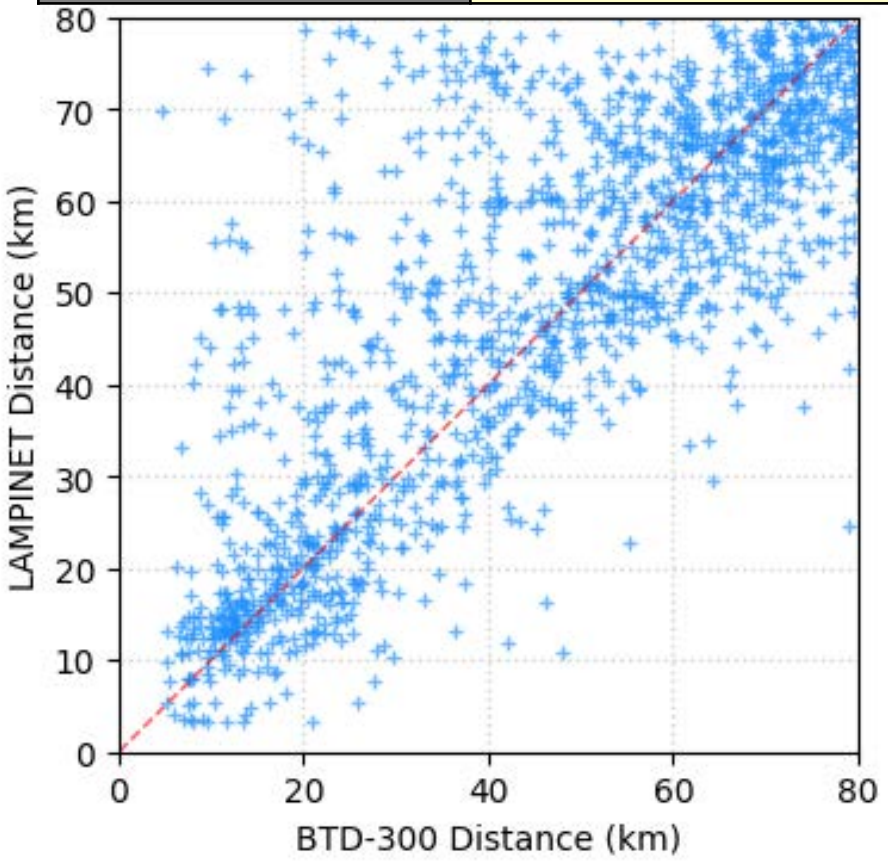
- BTD-300, single site sensor, detected more overhead or vicinity flashes (<19 km)
- Lampinet network, 15 sensors over Italy optimized for discharge intensity >= 50 kA, detected more flashes >60 km from the site

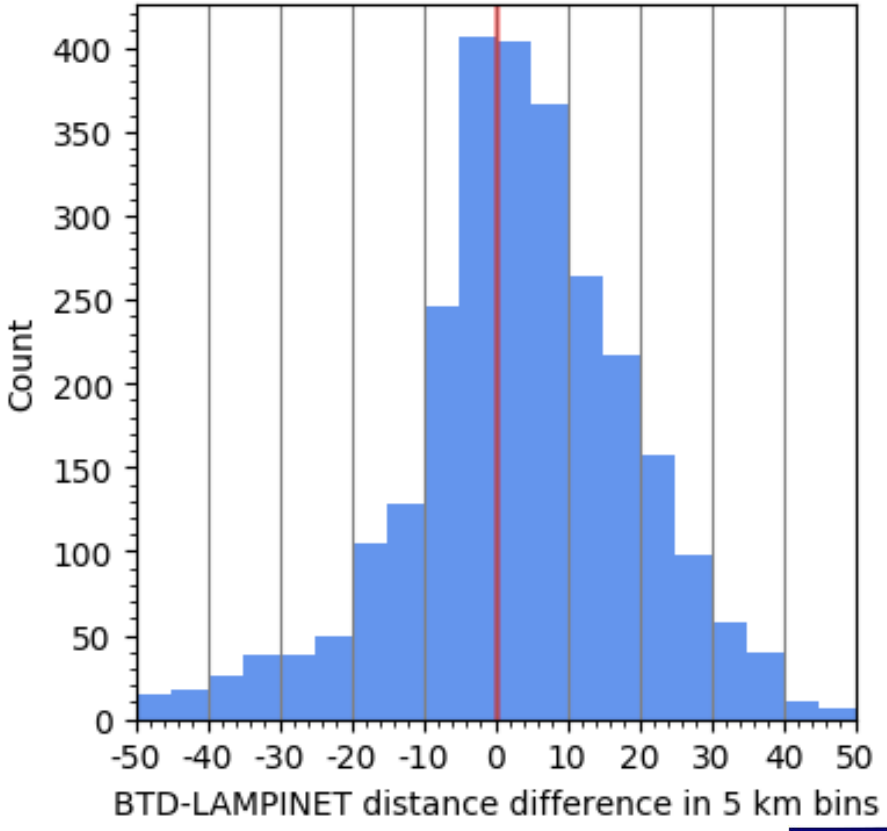




BTD-300 vs Lampinet (Distance)

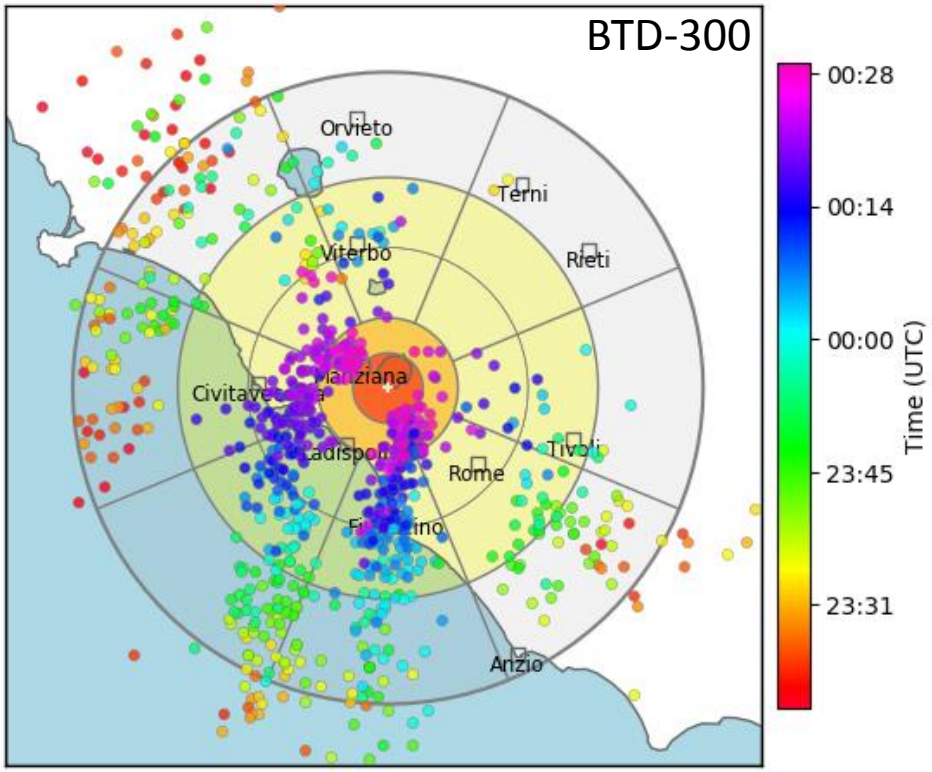
	Median (km)	25th percentile (km)	75th percentile (km)
Overhead/Vicinity	**0.6**	**-2.1**	**6.4**
Distant (19-56 km)	**0.6**	**-7.0**	**8.0**

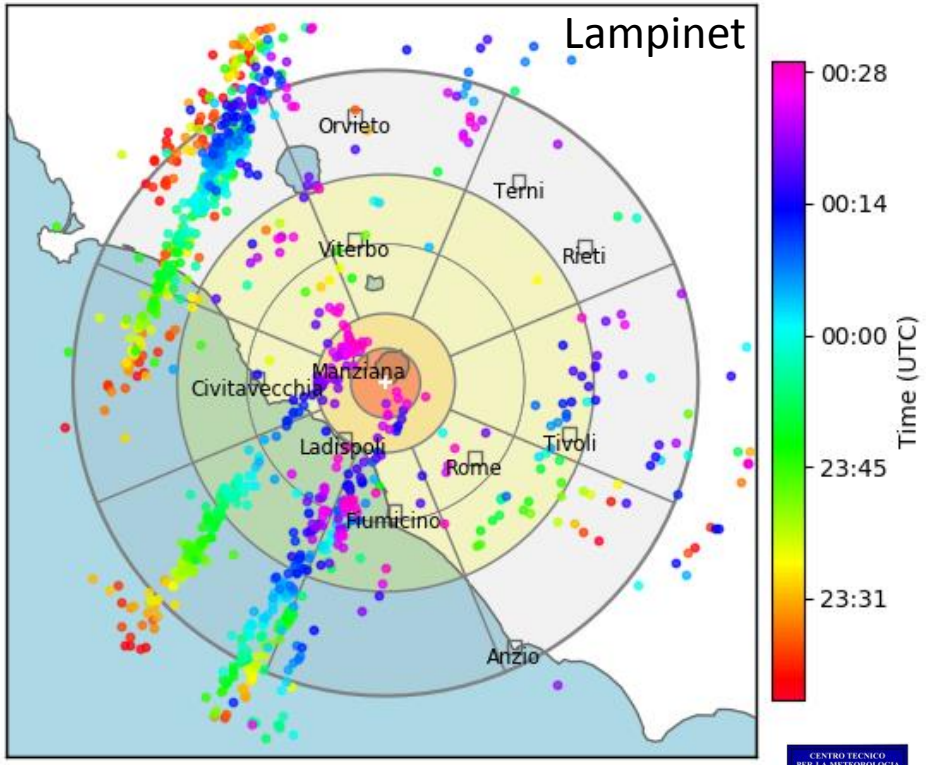




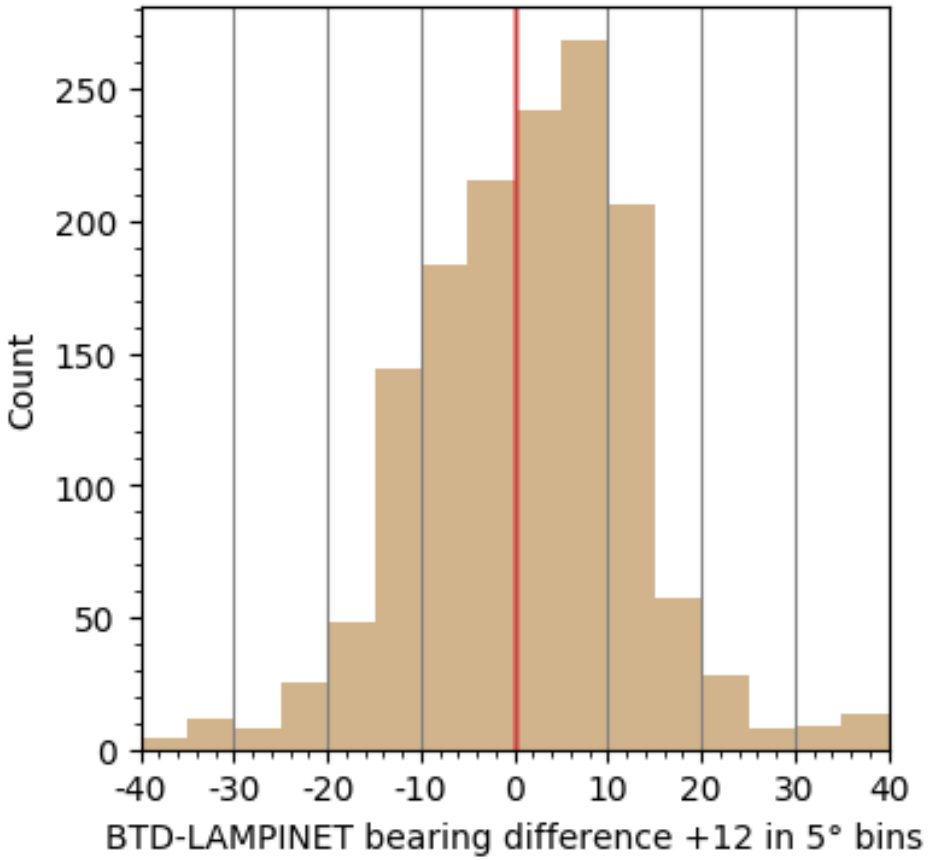
BTD-300 vs Lampinet (Direction)

- Good general agreement between BTD-300 and Lampinet on storm location
- Systematic and direction-dependent differences identified





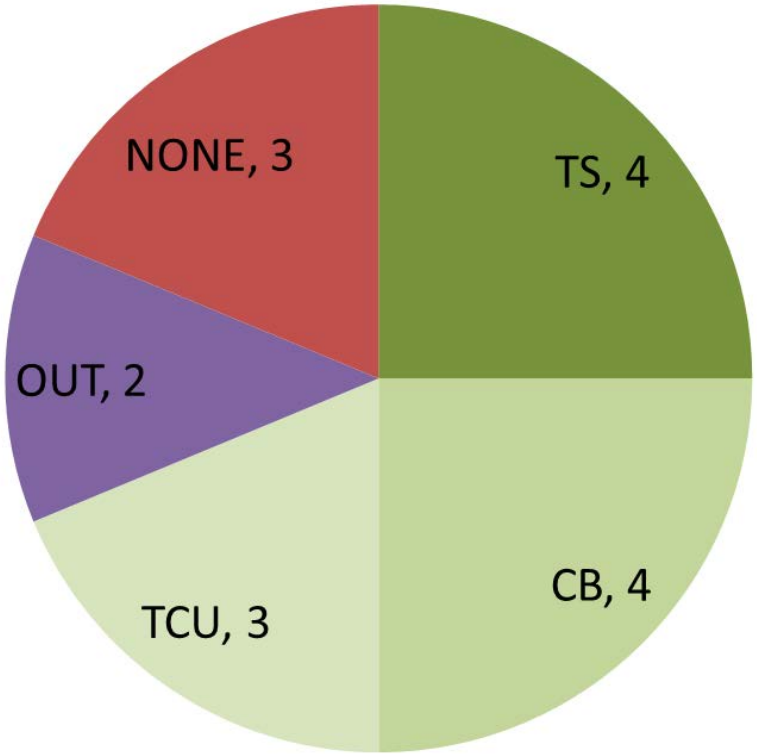
BTD-300 vs Lampinet (Direction)



- 12° systematic (orientation) offset identified, which can be corrected for by BTD-300 software
- Direction-dependent offset also identified, thought to be related to site characteristics
- 73% within an octant (±22.5°)
- 46% within 5° if site-dependent factors were corrected for in post-processing

Automatic vs Human Observer

Human observer report type for the 16 days when at least one vicinity flash was detected by the BTD-300



- BTD-300 detected vicinity lightning on 16 days
- Two of these events occurred outside of reporting hours
- Thunderstorm (TS) reported by human observer on 4 of these days
- Human observer reported deep convection on 11 of the 14 observation days (79%)

OUT = Outside obs hours
NONE = Observers did not report anything significant

BTD-300 warning triggers

Performance of different BTD-300 warning triggers for lightning within 30 minutes and 19 km (vicinity/overhead)

	Charged Rain	Strong E-field	Distant Lightning
Probability of Detection (POD)	**0.64**	**0.66**	**0.94**
False Alarm Ratio (FAR)	**0.19**	**0.01**	**0.26**

- Distant lightning gives the highest probability of detection, at 94%
- Approximately 65% of nearby lightning was preceded by CR or E-field
- CR and E-field had a lower false alarm ratio than distant lightning

Summary

- All thunderstorms reported by the human observers were detected by the BTD-300 and Lampinet (during the case study days)
- Human observers reported TCu, Cb or TS on 11 out of 14 days where overhead or vicinity lightning occurred during observer hours
- Whilst deep convective cloud can be readily identified within the vicinity of a site during daylight, lightning is more challenging to observe reliably without appropriate instrumentation
- Further investigation is needed before the use of instrumental thunderstorm detection in AUTO metar (definition of correct range and thresholds)
- BTD-300 detected more flashes than Lampinet on short range, although Lampinet detected more than the BTD-300 beyond 60 km
- BTD-300 and Lampinet have different operating methods so further investigation is needed for a conclusive assessment

Acknowledgements

- **Antonio Spalletta** from S3Consulting for his assistance in arranging the trial
- **Marco Taliani** from gm-servizi for installing the BTD-300
- **The meteorological observation team at Vigna di Valle** for their observation records with particular reference to thunderstorm activity.
- The Lampinet data were supplied by the **Italian Air Force**

Biral

CENTRO TECNICO
PER LA METEOROLOGIA

Thank you