


A case study on severe hailstorm on 27 July 2019 in the province of Styria, Austria

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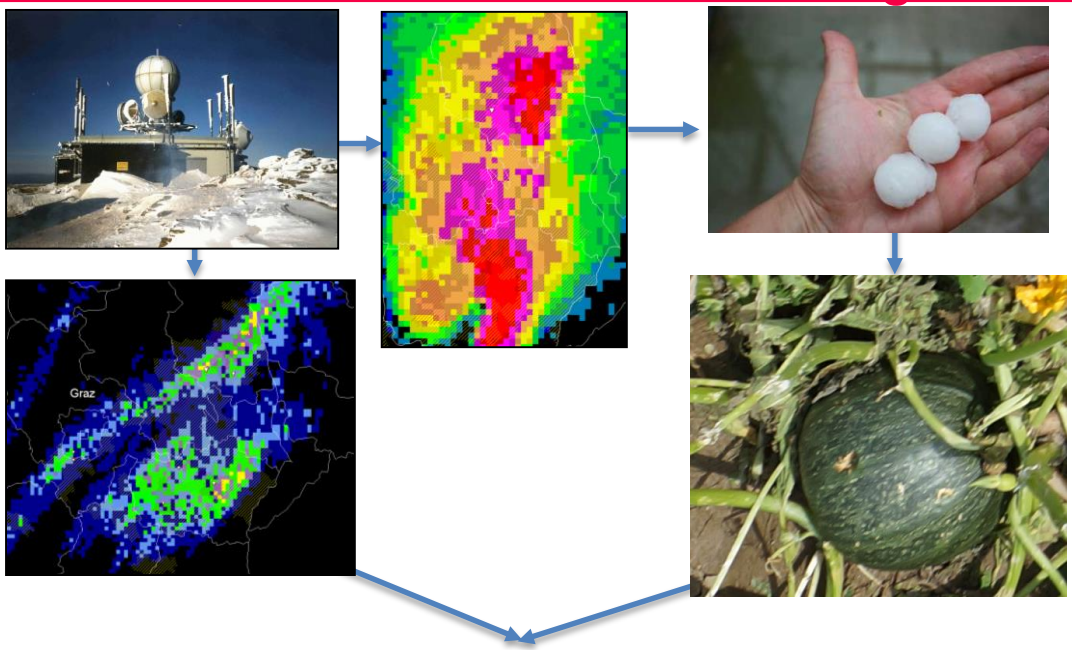
Hailstorm crop damage assessment based on remote sensing technologies



Objectives:

- To develop and evaluate an approach for crop hail damage assessment by integrating remote sensing technologies
- Providing potential intelligent information about crop damage area and severity due to hail storm for crop loss assessment and loss adjustment.
- To deliver near real-time high spatial crop damage information for risk transfer (Insurance claim settlement for loss adjustment) and risk management sector

Radar data source: Austro Control GmbH,

Problem:

- Non-availability of near real-time and high spatial hailstorm crop damage information for insurance and risk management sector (The traditional crop damage assessment approaches are very labour intensive and time-consuming.)

Solution:

- Radar (Spatial resolution: 1km × 1km, Temporal resolution 5 min) and crowdsourcing hail data

Input:

- RADAR based hail detection and crowdsourcing ground truth information are used to asses the hail signature information

Output:

- Evaluate the radar based hailstorm crop damage assessment approaches
- Near real-time over high spatial scale crop damage information for loss assessment

Added value:

- Accuracy in estimation of area and severity of damage information
- Speed up the insurance claim settlement
- High spatial, geo reference tagged, and Intelligent damage information for risk transfer and management

Outline

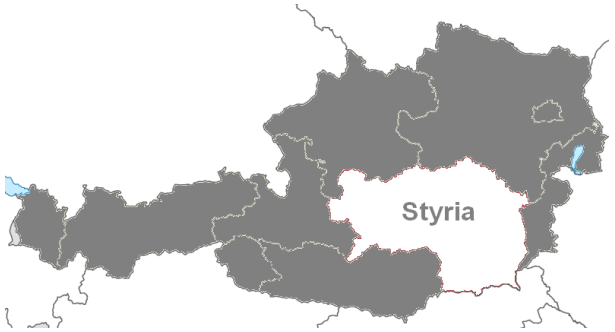
- Introduction
- Data and methodology
  - Radar and ground measurements
  - Radar derived parameters using HAILSYS software
- Results
  - Case studies
- Summary
- Acknowledgements

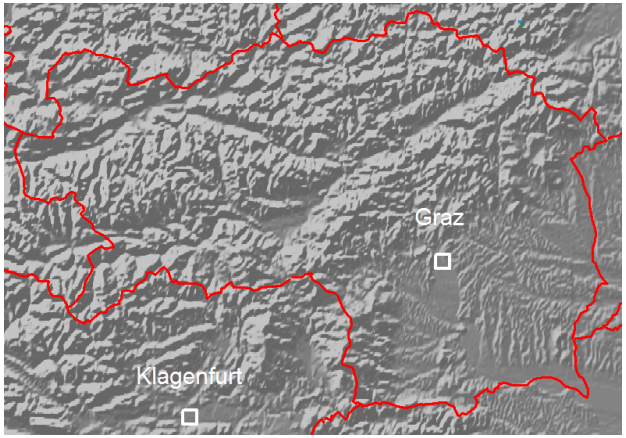
Introduction

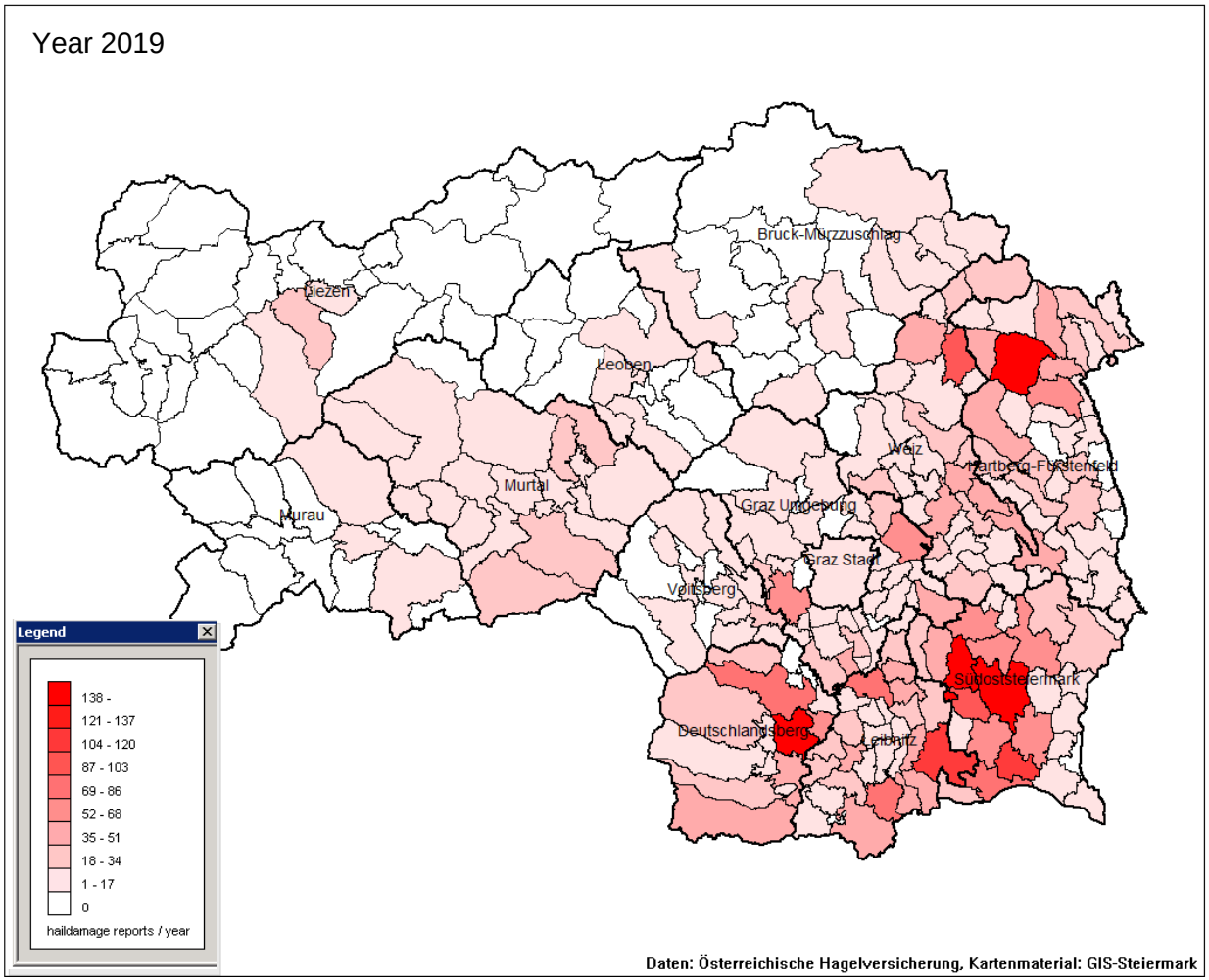
- Hail storm damage is a major concern to the farmers in the province of Styria, Austria. Each year severe hail storms are causing damages to crops, resulting in losses of millions of euros.
- High spatial-temporal resolution data are essential to properly assess crop hail damage information for the insurance sector and also for the better risk assessment
- This study focuses on the combined analysis of hail signature information from radar and ground measurements.

Hail Damages in Styria

Orchards in the south-eastern parts of Styria are affected by hail



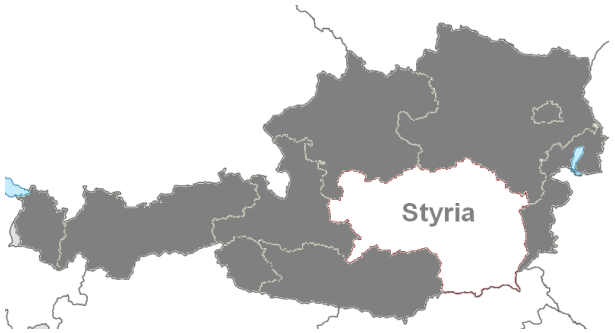


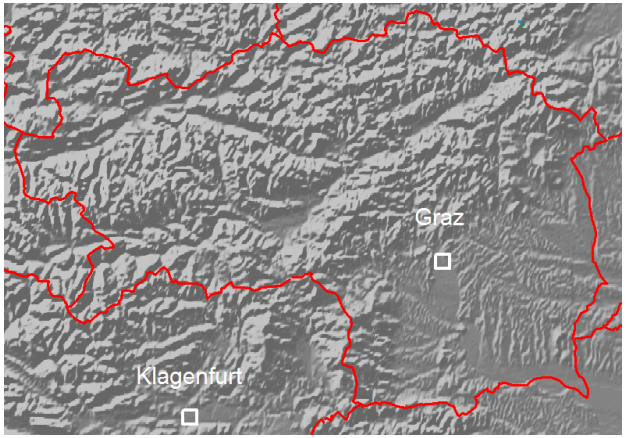


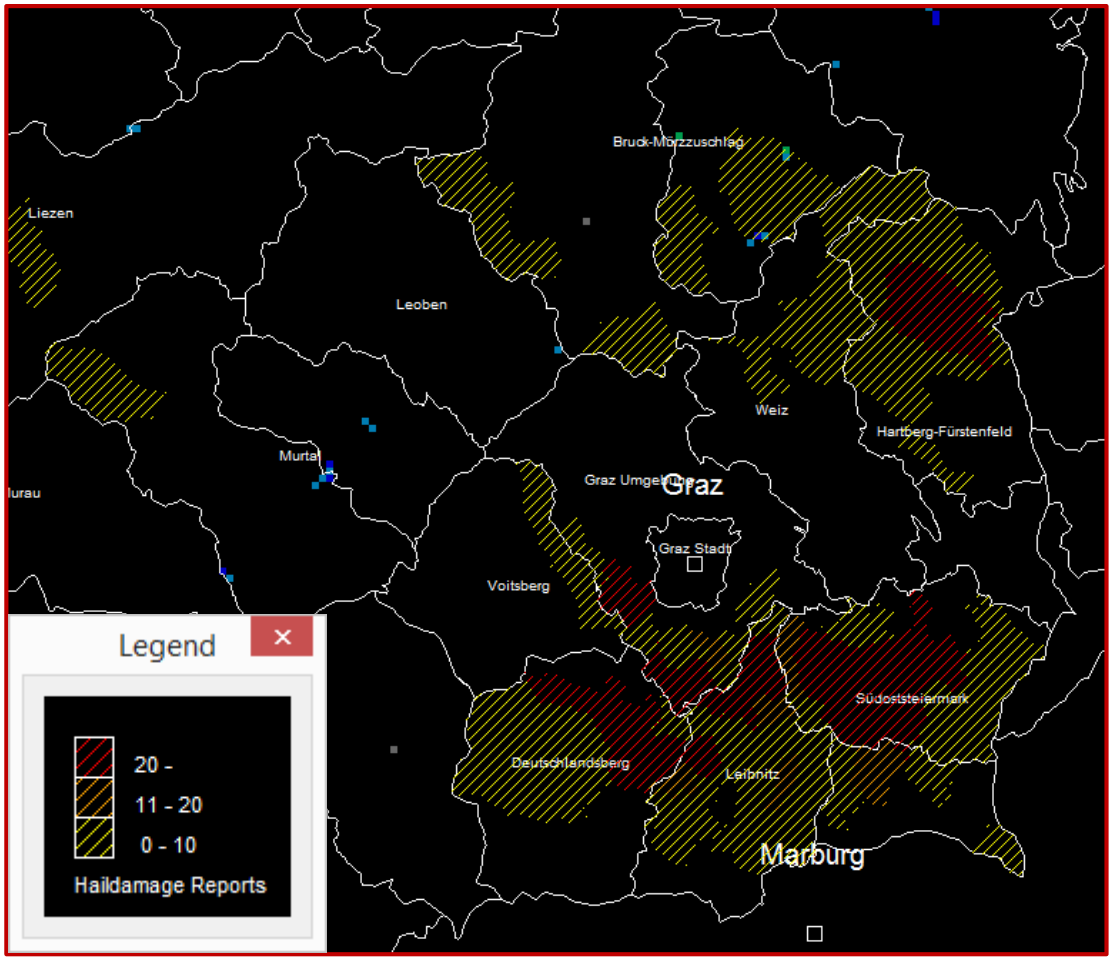
Data source: Crop damage (Austrian hail inusrance)

Hail Damages in Styria

Total 1040 crop damage reports were claimed due to severe hailstorm on 27th July 2019



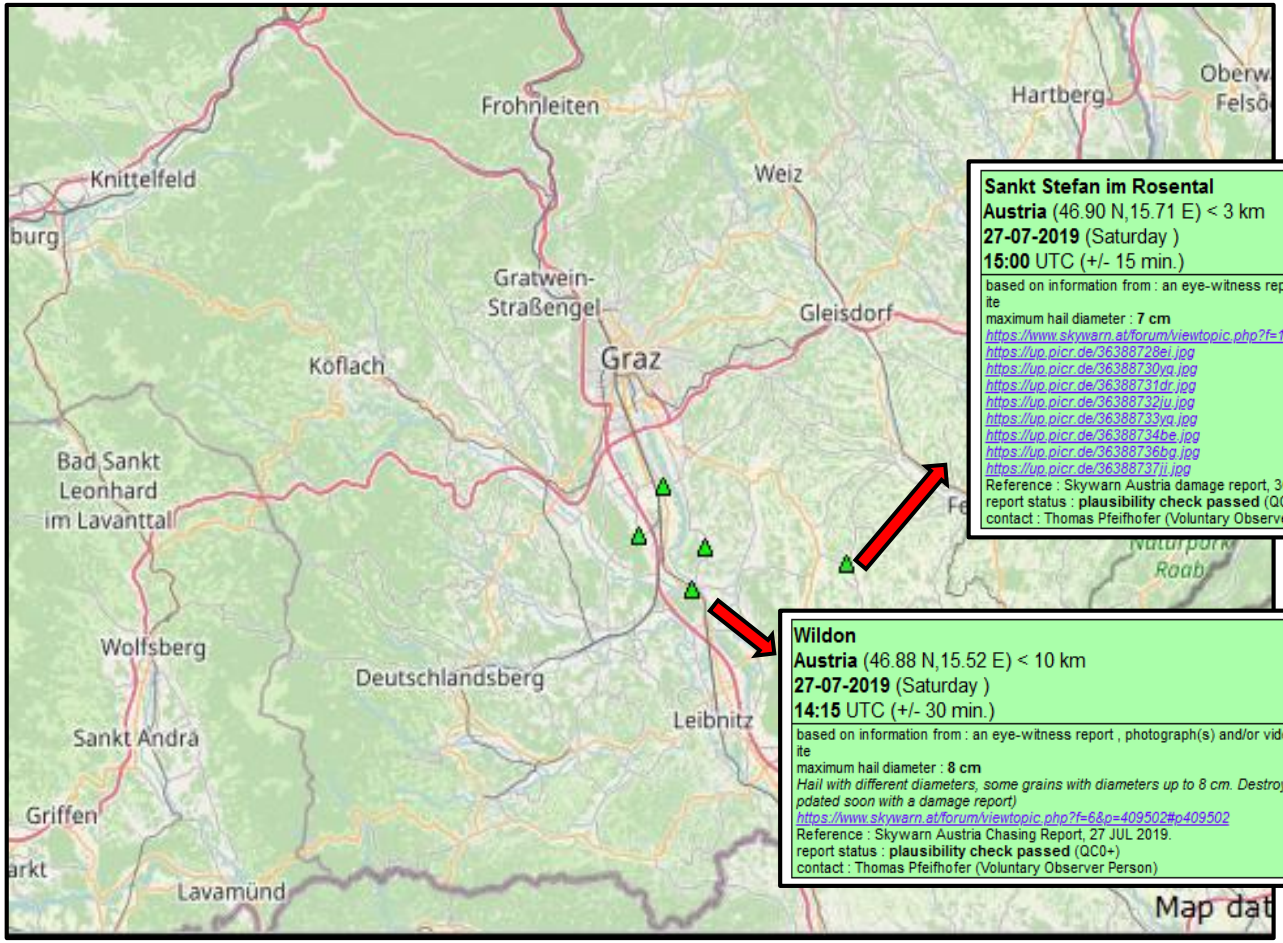




Hail damage reports of each municipality

Data source: Crop damage (Austrian hail inusrance)

Hail data from **ESWD** (European Severe Weather Database)



Sankt Stefan im Rosental
Austria (46.90 N,15.71 E) < 3 km
27-07-2019 (Saturday)
15:00 UTC (+/- 15 min.)

based on information from : an eye-witness report , photograph(s) and/or video footage of the inflicted damage , a report on a website
maximum hail diameter : **7 cm**
https://www.skywarn.at/forum/viewtopic.php?f=152&t=25926
https://up.picr.de/36388728ei.jpg
https://up.picr.de/36388730yq.jpg
https://up.picr.de/36388731dr.jpg
https://up.picr.de/36388732iu.jpg
https://up.picr.de/36388733yq.jpg
https://up.picr.de/36388734be.jpg
https://up.picr.de/36388736bg.jpg
https://up.picr.de/36388737ji.jpg
Reference : Skywarn Austria damage report, 30 JUL 2019
report status : **plausibility check passed** (QC0+)
contact : Thomas Pfeifhofer (Voluntary Observer Person)

Wildon
Austria (46.88 N,15.52 E) < 10 km
27-07-2019 (Saturday)
14:15 UTC (+/- 30 min.)

based on information from : an eye-witness report , photograph(s) and/or video footage of the inflicted damage , a report on a website
maximum hail diameter : **8 cm**
Hail with different diameters, some grains with diameters up to 8 cm. Destroyed agricultures, damaged bricks on roofs. (Will be updated soon with a damage report)
https://www.skywarn.at/forum/viewtopic.php?f=6&p=409502#p409502
Reference : Skywarn Austria Chasing Report, 27 JUL 2019.
report status : **plausibility check passed** (QC0+)
contact : Thomas Pfeifhofer (Voluntary Observer Person)

Source**:** **ESWD** (European Severe Weather Database)

Hail damage ground truth information surrounding of Wildon, Styria, Austria)





Source**: Styrian hail protection cooperative**

Data

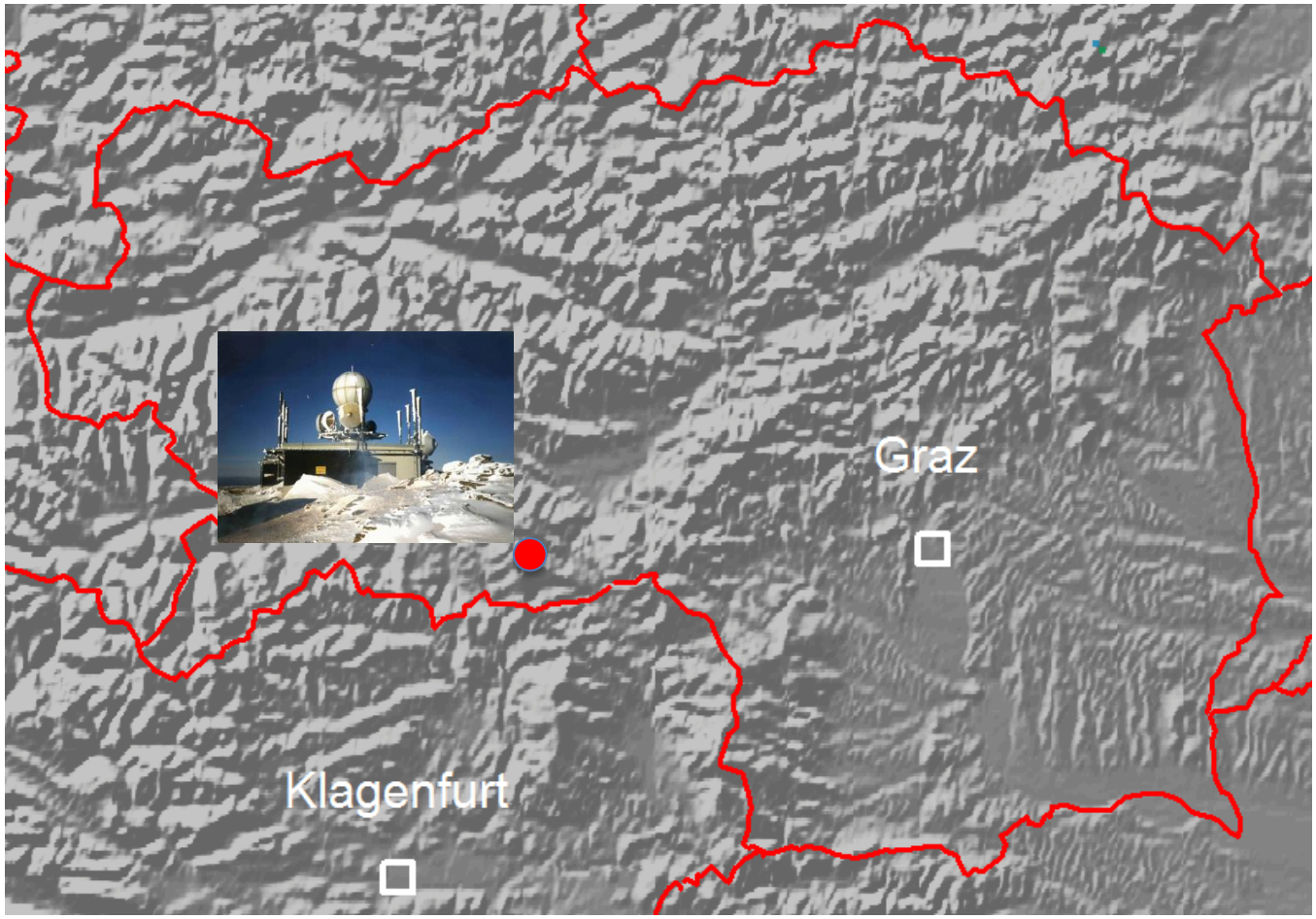
- 3D single polarization C-band weather radar data and radiosonde freezing level data (Radar data: Austro Control GmbH, radiosonde data: ZAMG, Austria)

- Hail damage reports at municipality level (Austrian Hail Insurance)

- Hail event data (Hail data source: **ESWD** (European Severe Weather Database) and **HeDi** (Hail event Data interface)

Weather Radar Station in Styria

Weather Radar
Zirbitzkogel
2400m msl.
Operated by Austro Control GmbH

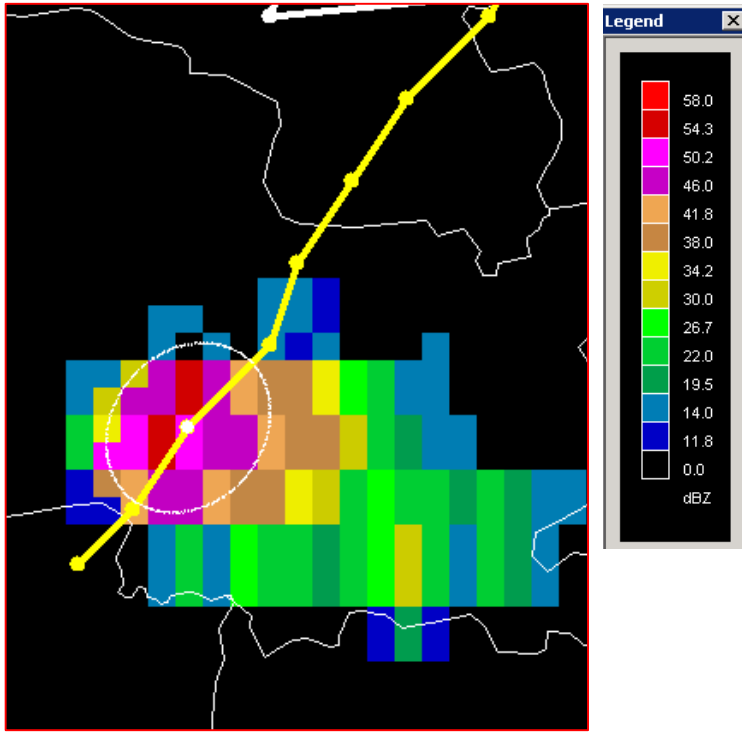


Radar-derived parameters & Cell tracking

A special software HAILSYS developed for radar data analysis. This analysis uses volume-scan single polarisation C-band radar data and storm cell tracking (Dixon and Wiener 1993) to capture thunderstorm life cycle from developing stage to dissipating stage, cell tracking includes all merging or splitting echoes as part of the storm complex behaviour

The following radar-derived parameters extracted for each storm cell

- Duration of the storm cell, total area and volume of the storm cell, the cloud top height,
- Echo Top Height : The highest altitude of the cell (≥ 41.8 dBZ)
- Area 2: Area of the cell with reflectivity thresholds of ≥ 46 dBZ
- Volume2: Volume of the cell with reflectivity thresholds of ≥ 46 dBZ
- Vertical Integrated Liquid (VIL) (kg/m^2): The vertically accumulated rainfall in the cell



Cell detection radar reflectivity >40 dBZ, with area >10 km^2 (white colour ellipse) and cell tracking path (Yellow colour line)

Radar data source: Austro Control GmbH

Methodology: **Radar derived hail kinetic energy (HKE)**

- The comparison between the HKE and radar reflectivity was extensively researched by Waldvogel e al.(1987a;b)

- 3D single polarization C-band weather radar data and radiosonde freezing level data were used to derive hail kinetic energy flux.

- The kinetic energy flux was computed using the Witt et al.1998 and implemented for our conditions. Kinetic energy flux is computed only for positions (columns) in which two conditions are met:

a. Z > 45 dBZ (< 5km) , and

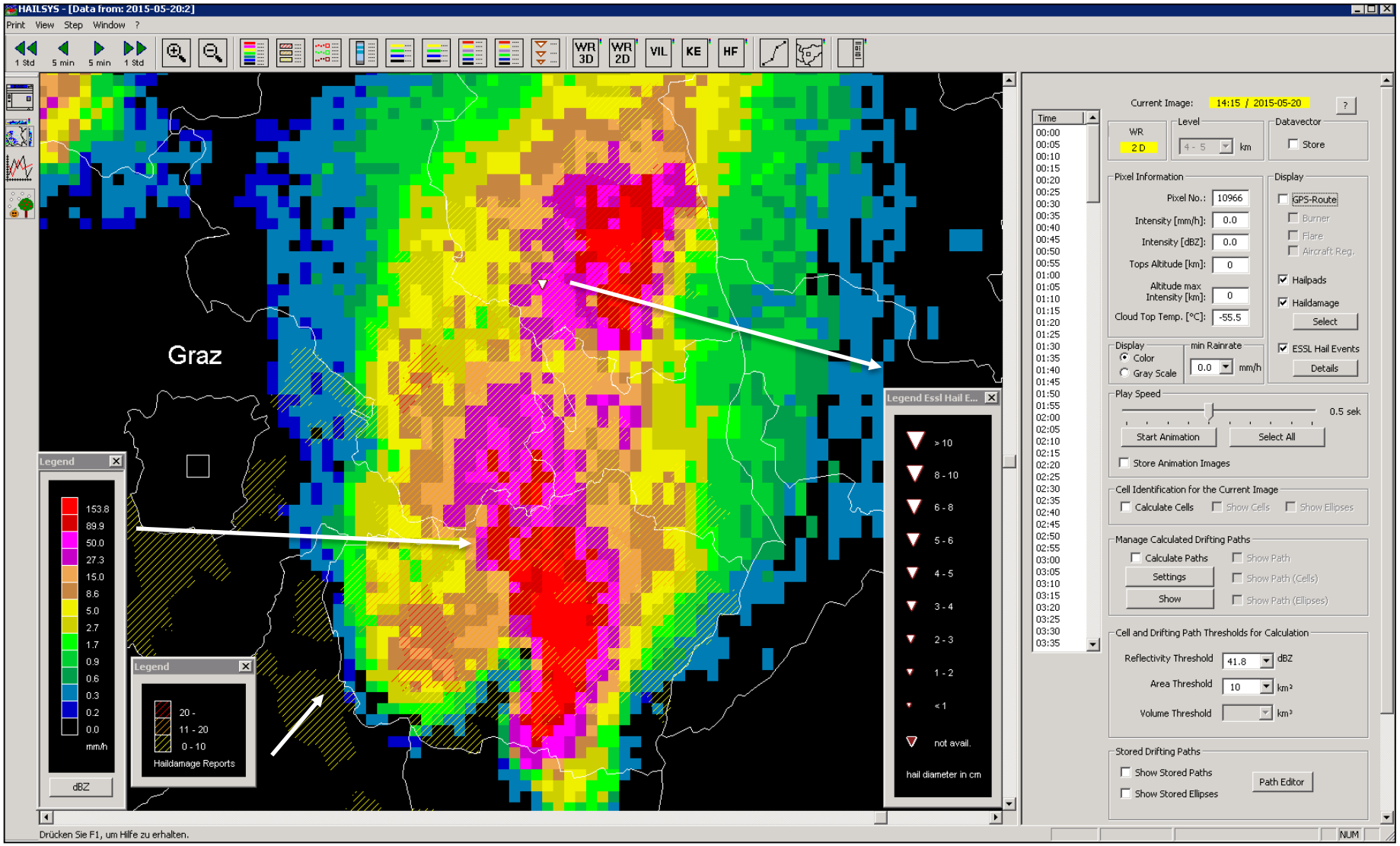
b. Z > 45 dBZ at height > 1.4 km above the freezing (0^o C) level (Waldvogel et al. 1979)

$$\dot{E} = 5 \times 10^{-6} \times 10^{0.084z} W(z) \longrightarrow$$ Witt et al. 1998

Z is in dBZ, E in (**J m^{-2}s^{-1}**), the weighting function W (Z) can be used to define a transition zone between rain and hail reflectivities

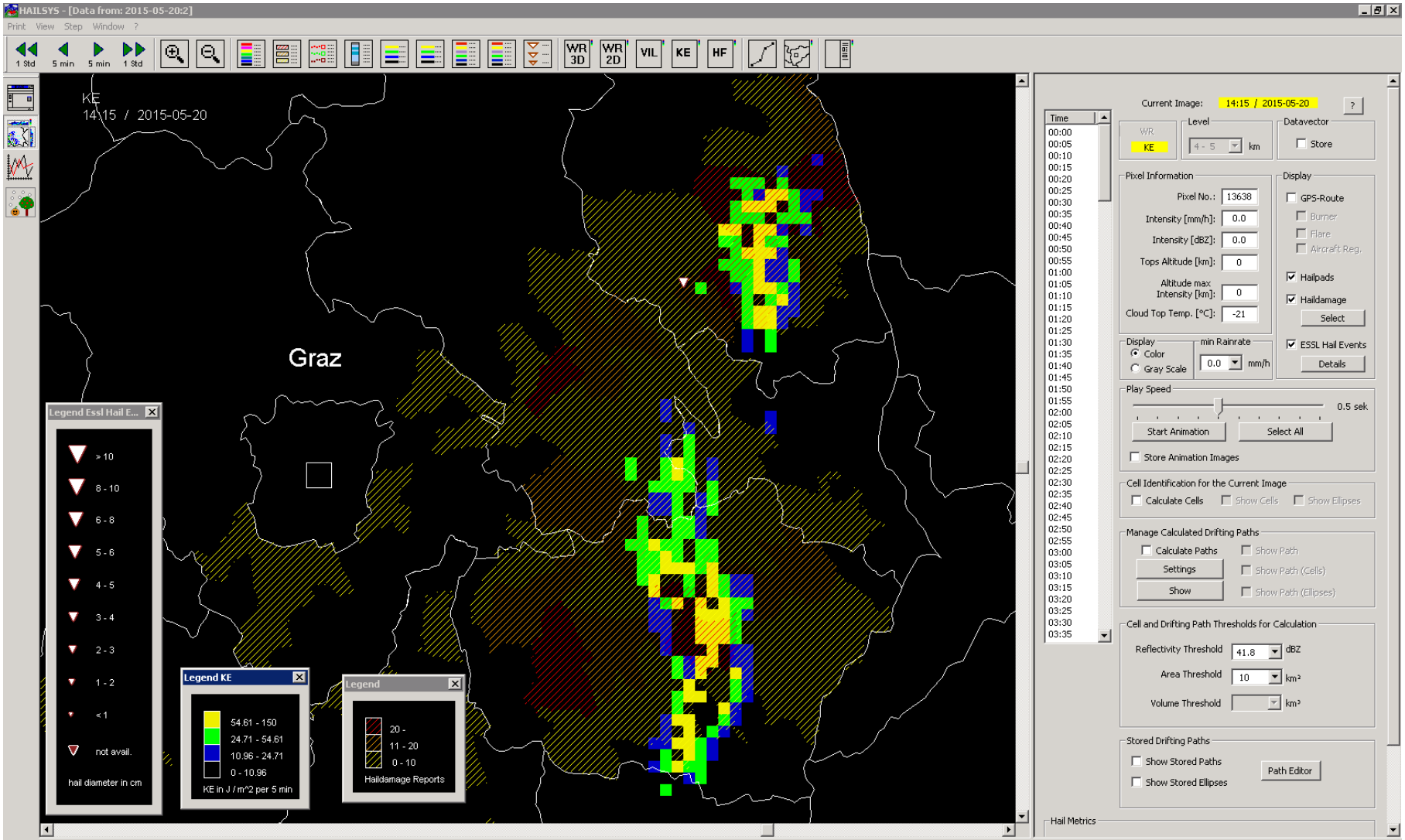
A. Witt, M. D. Eilts, G. J. Stumpf, J. T. Johnson, E. D. Mitchell, and K. W.Thomas, 1998: An enhanced hail detection algorithm for the WSR-88D. *Wea.Forecasting.*, **13**, 286-303.

HAILSYS software



Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance, Hail data : **ESWD** (European Severe Weather Database)

HAILSYS software

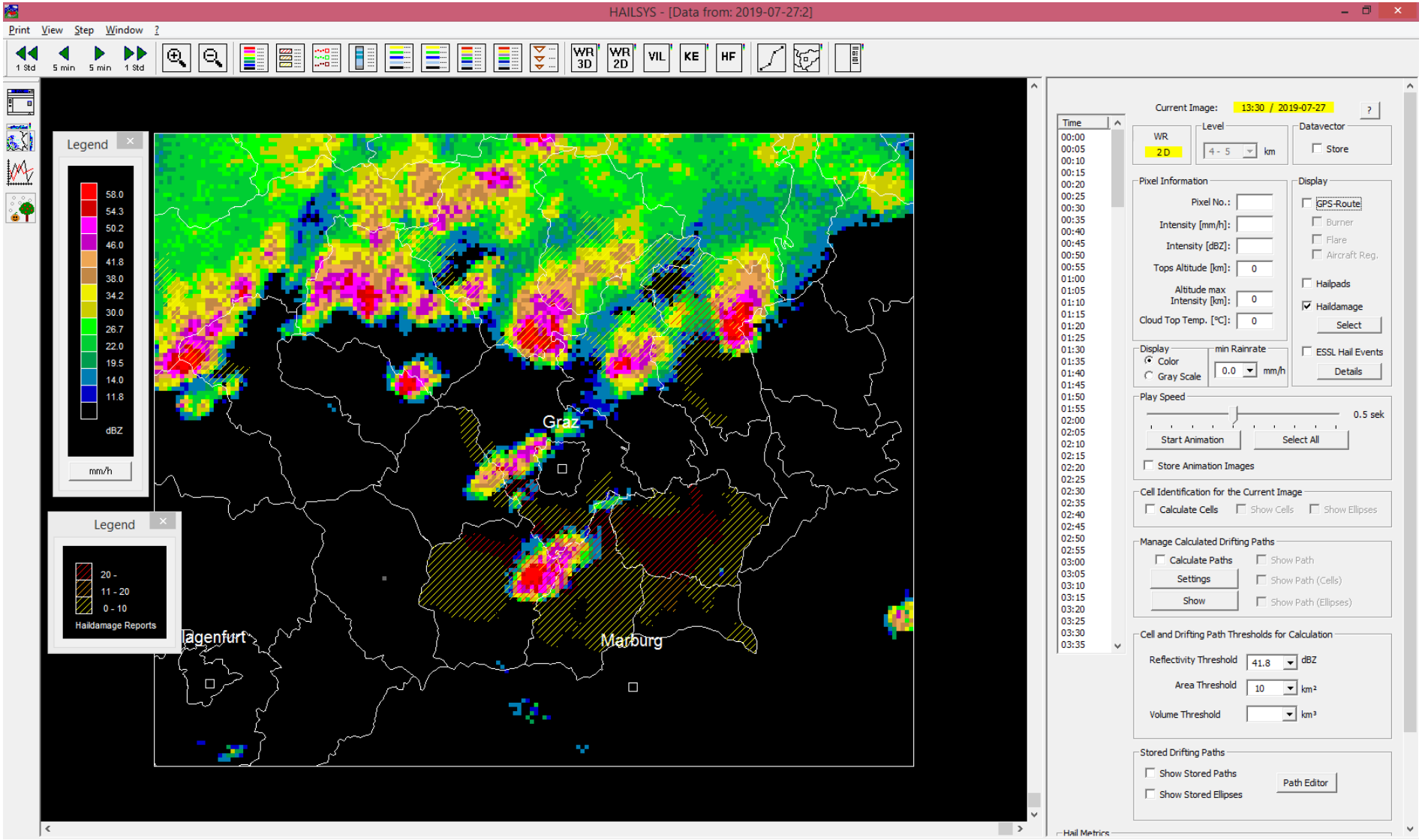


Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance, Hail data : **ESWD** (European Severe Weather Database)

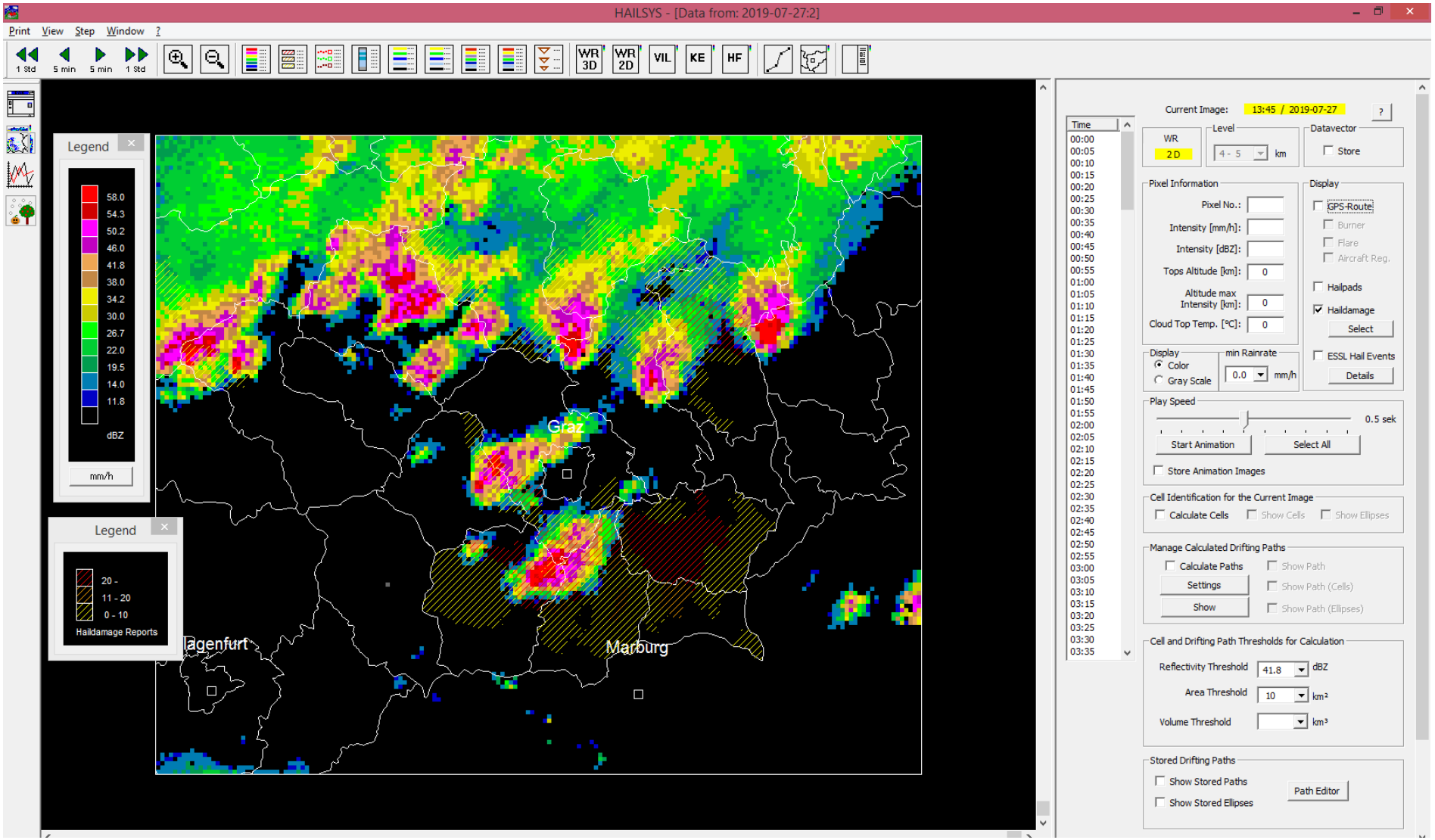
Results

Case study on 27th July 2019

Visual documentation of damage reports, hail events and analysis of radar hail signature information



Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance,



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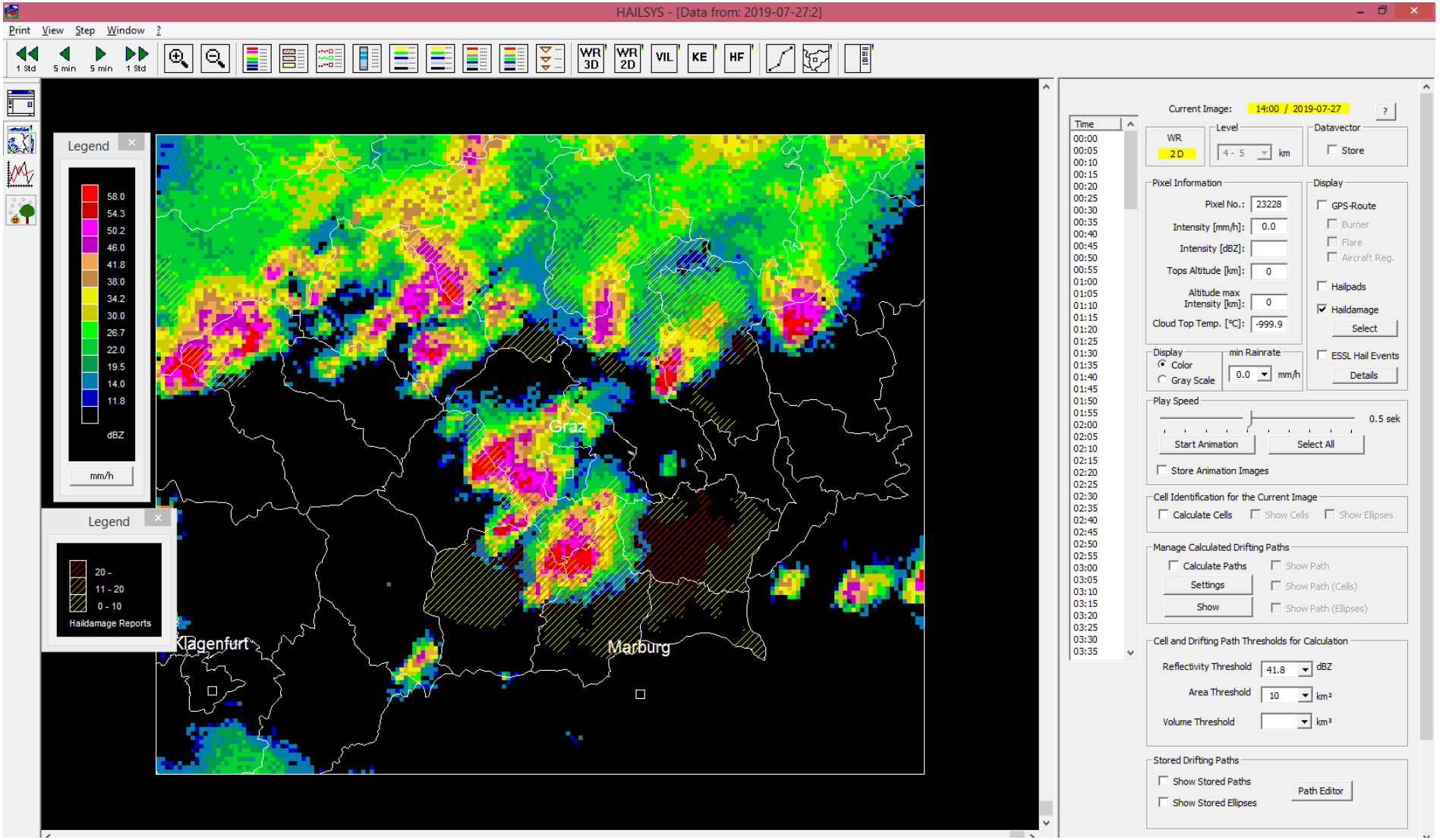

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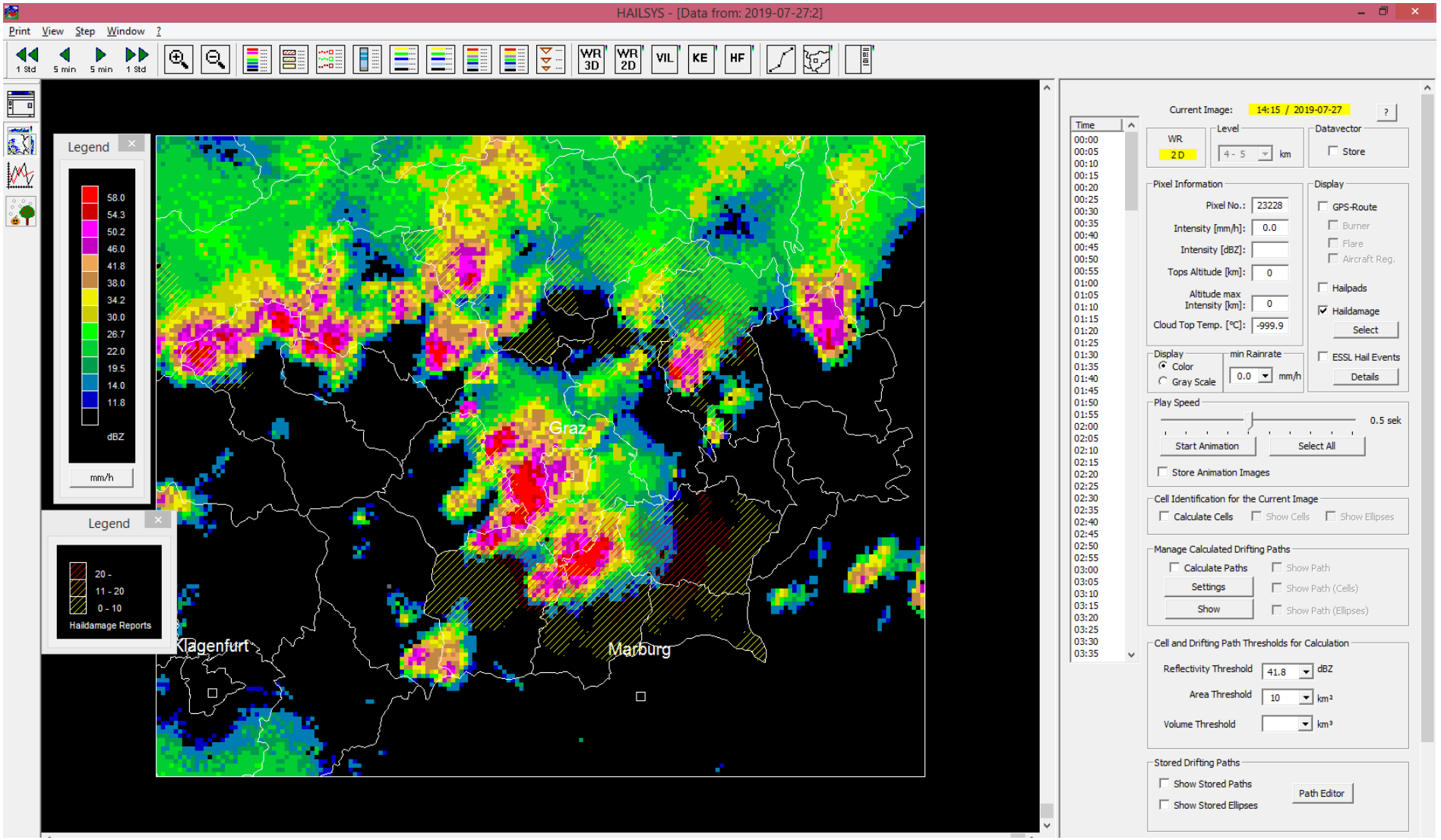

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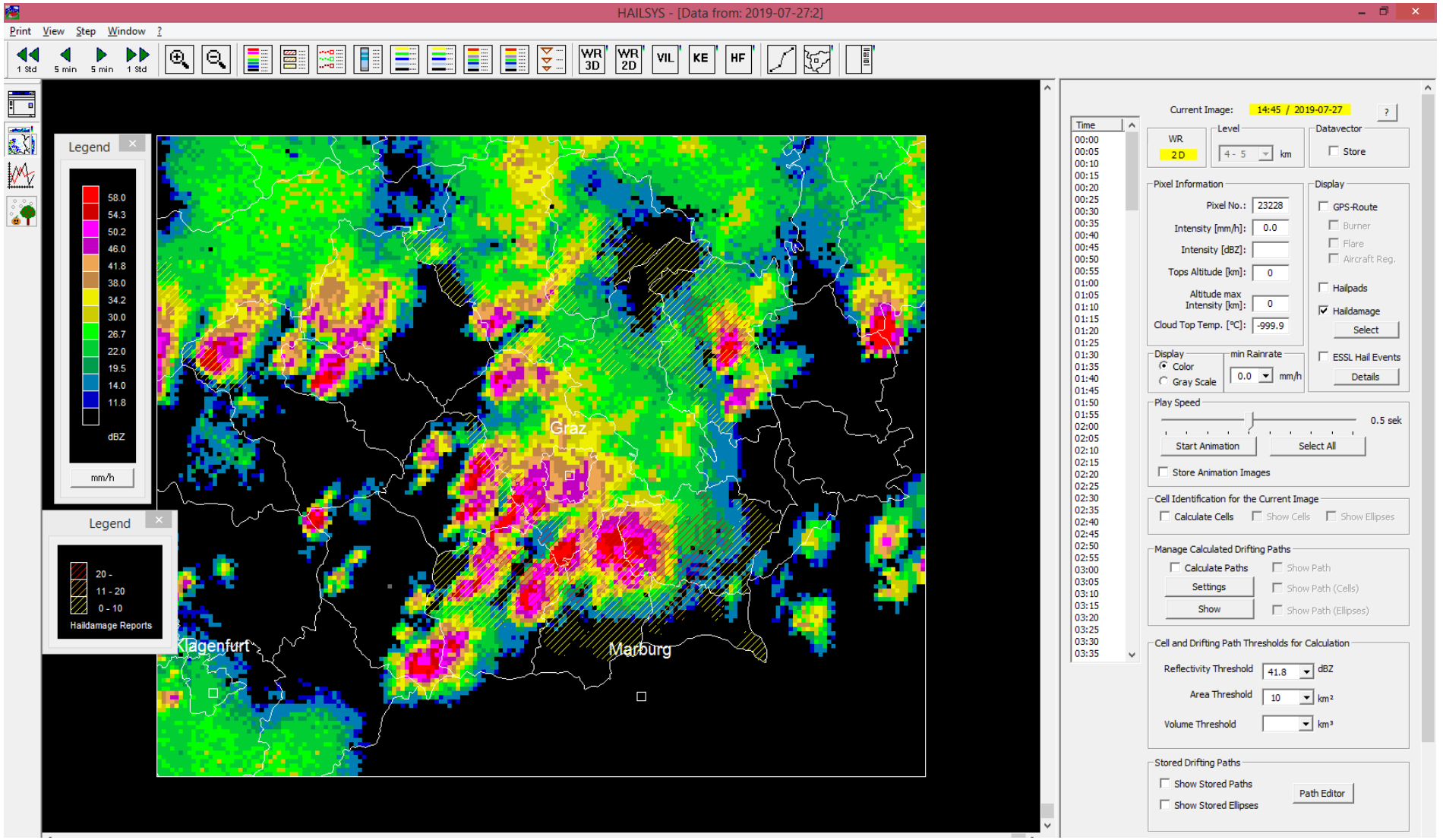

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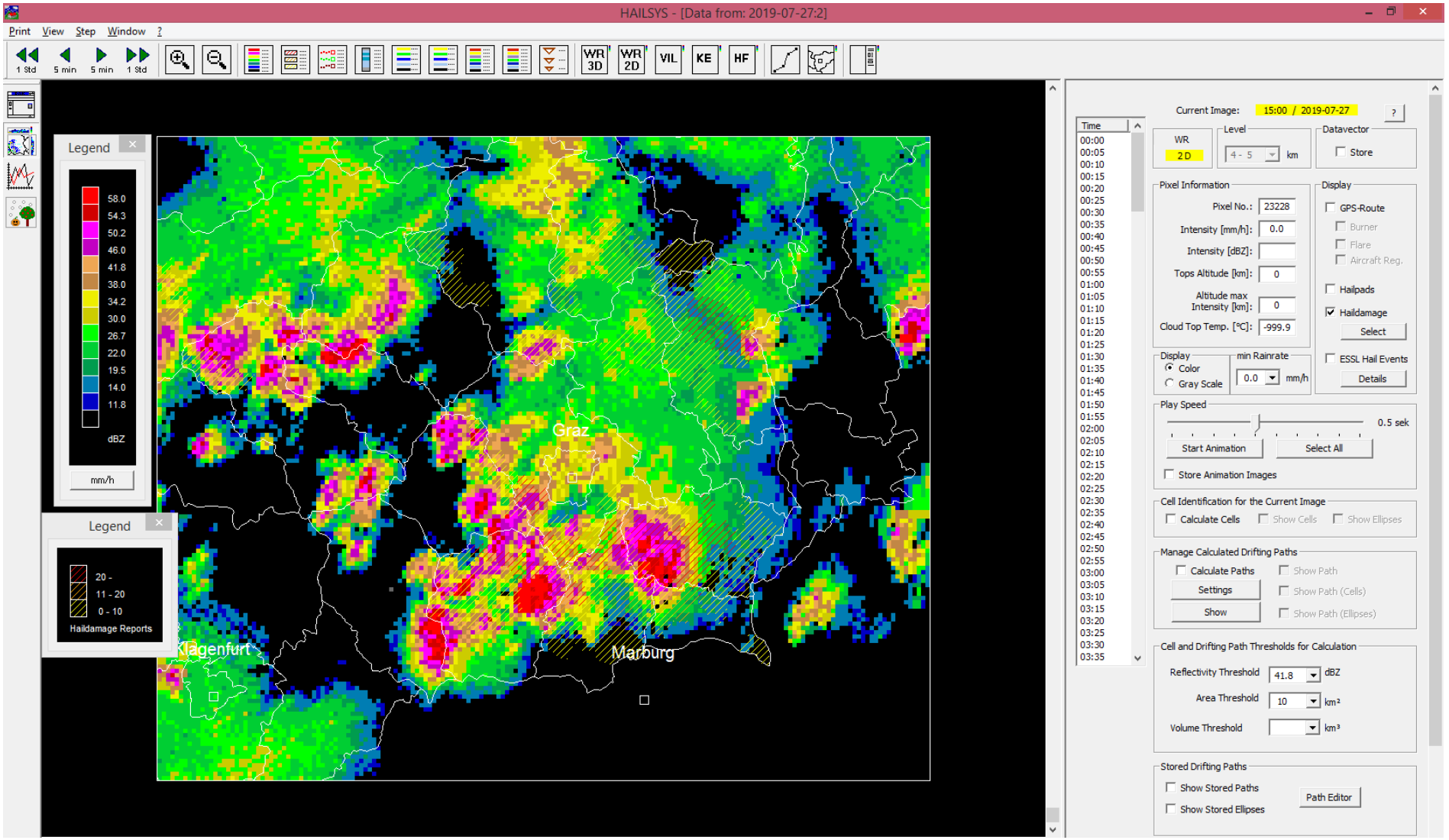

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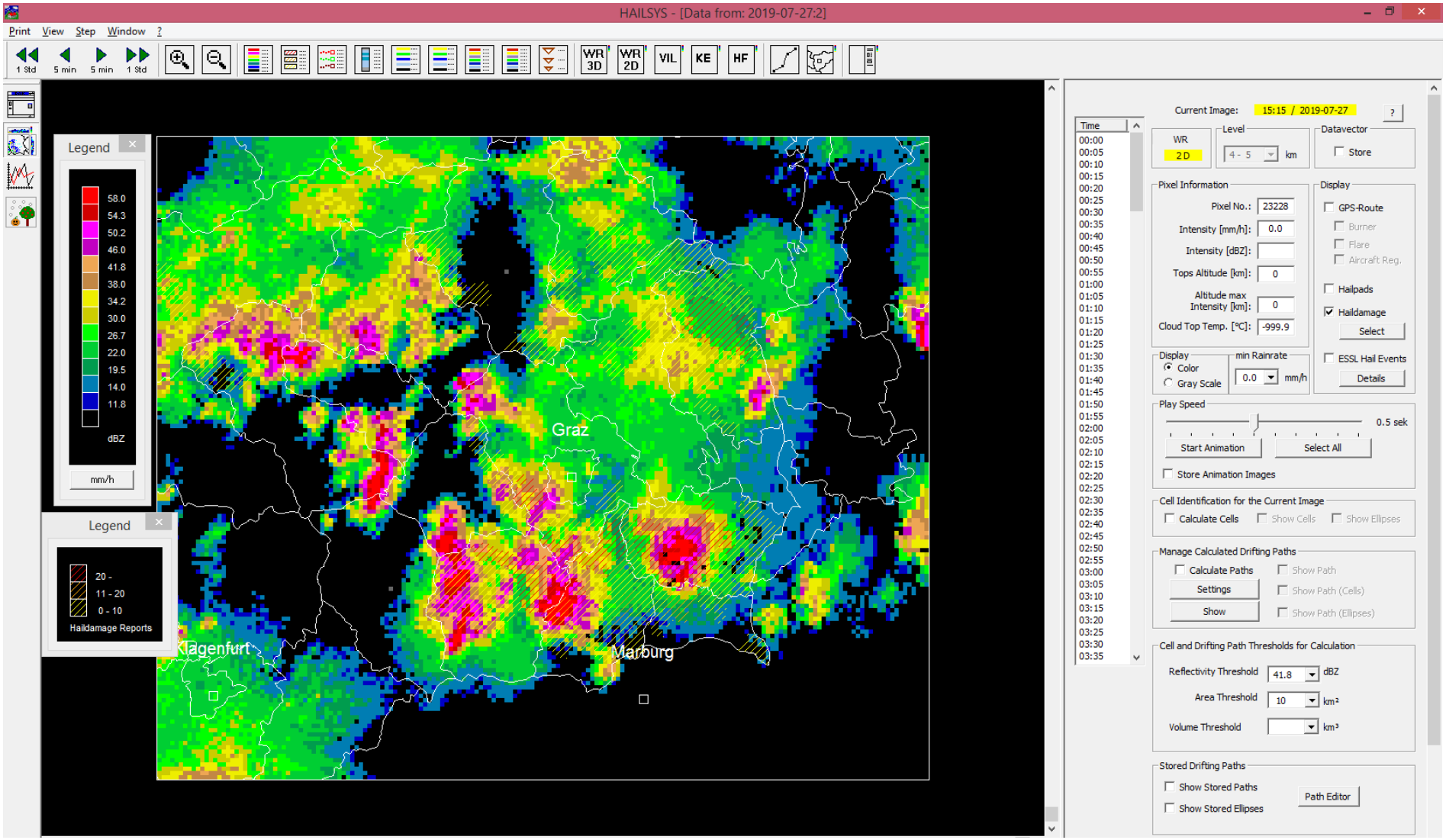

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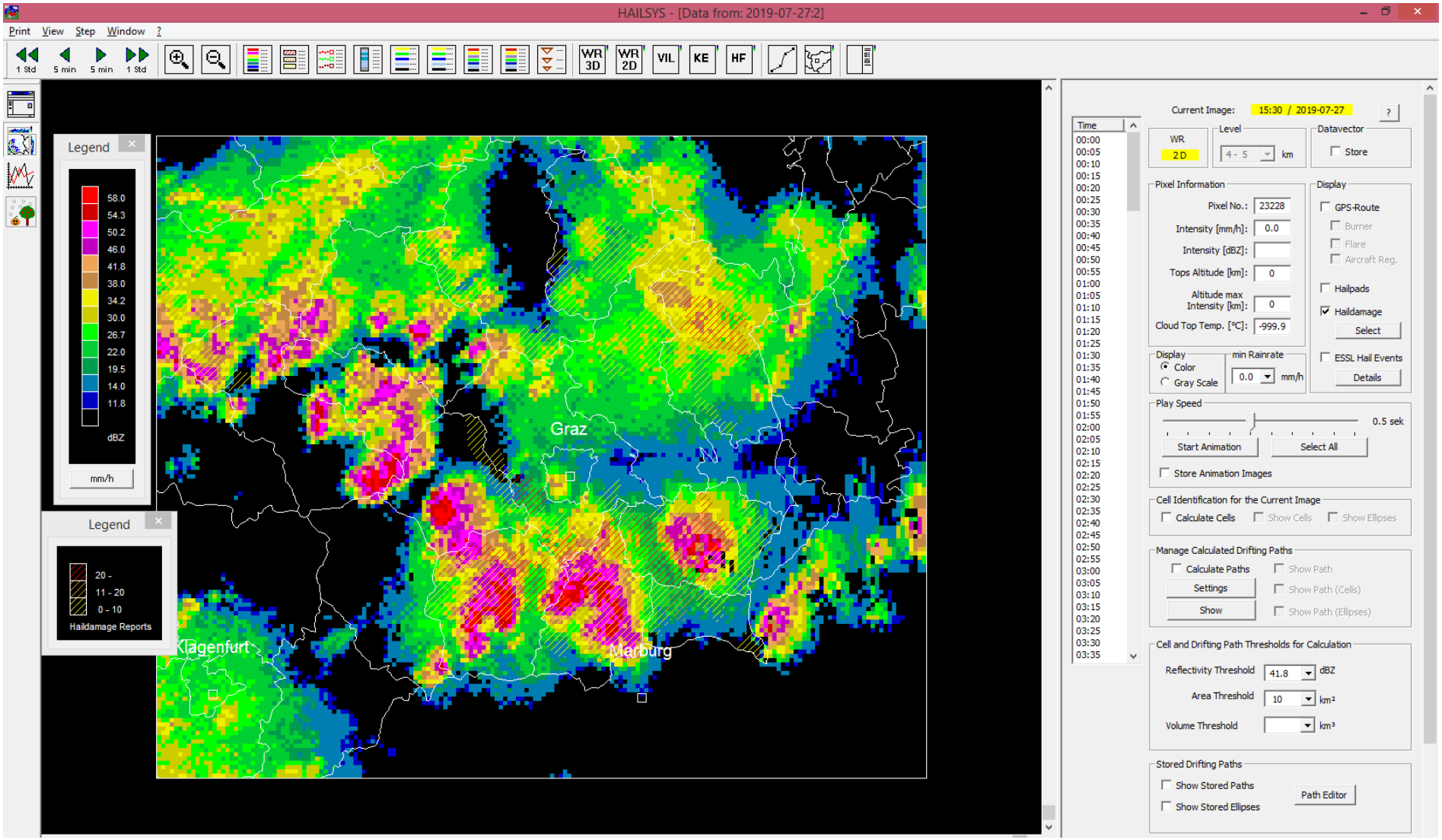

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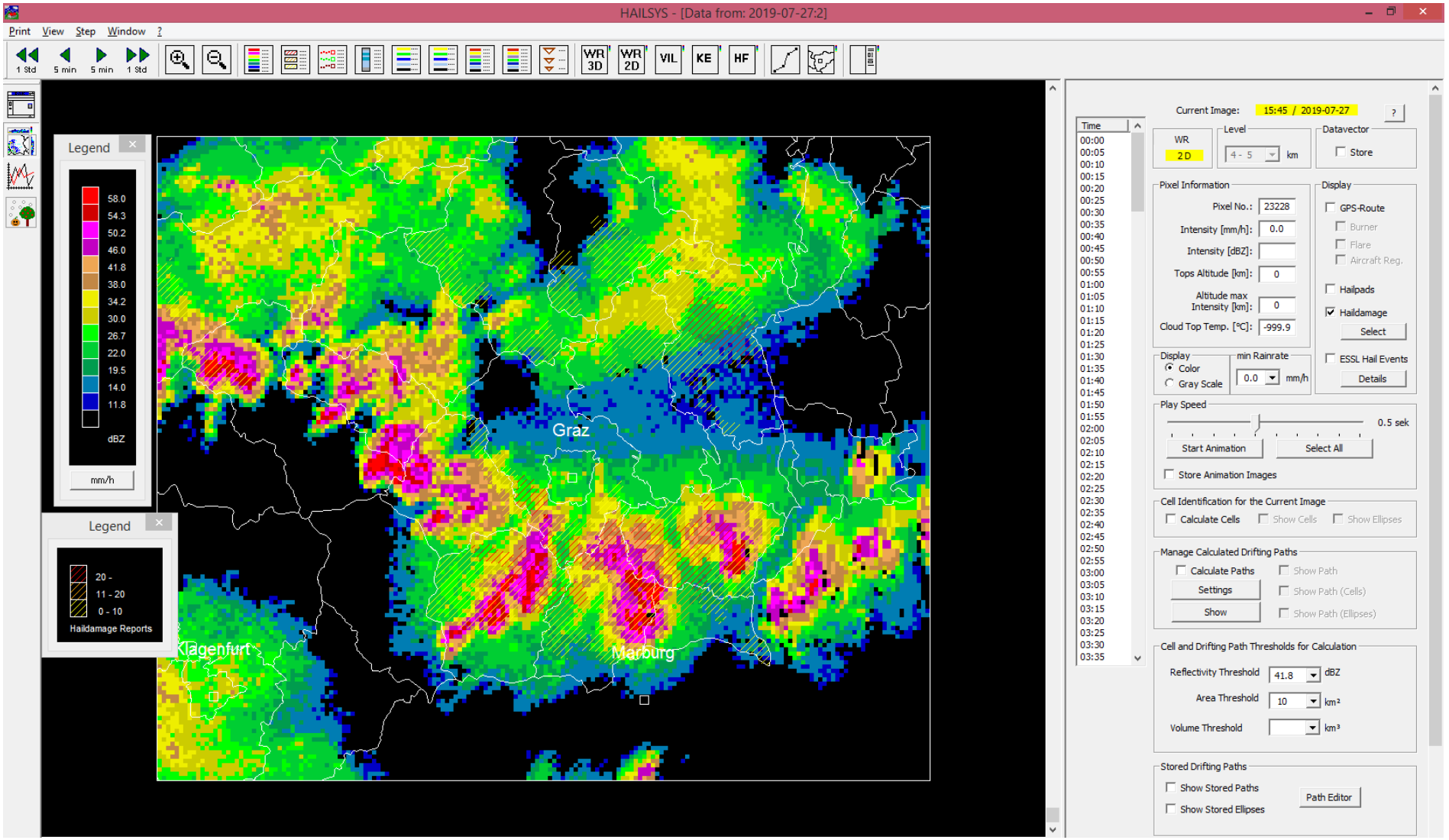

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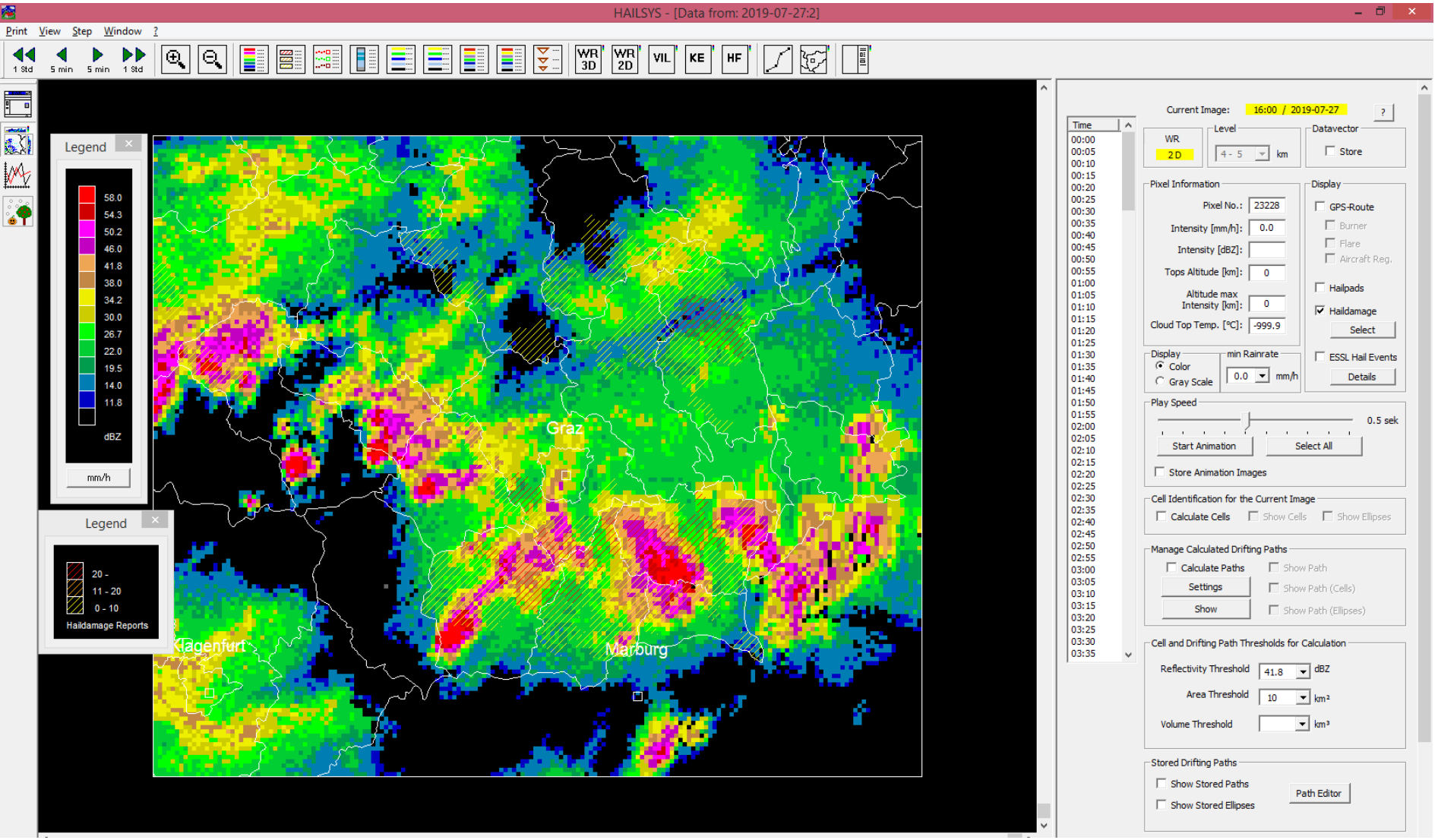

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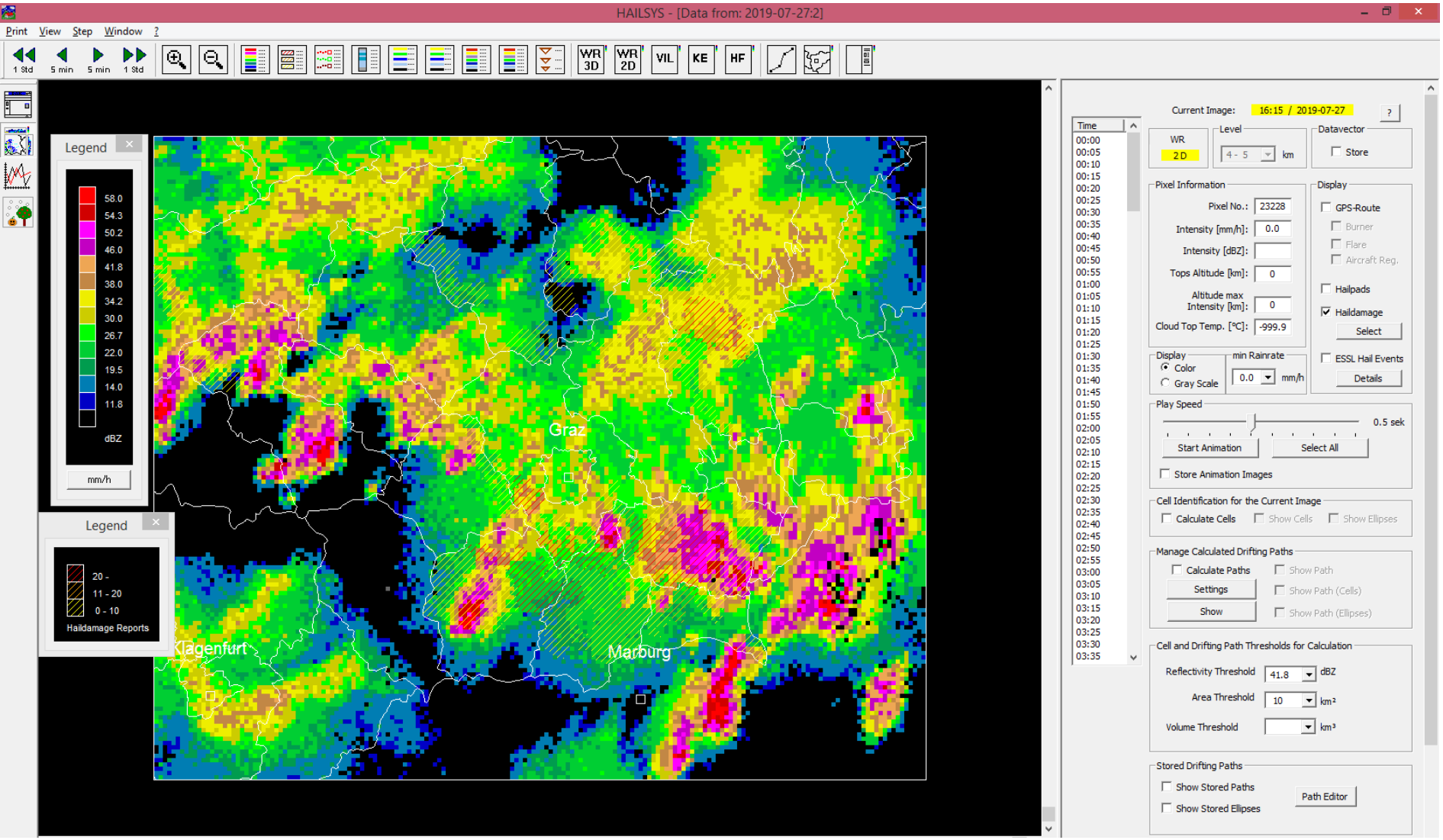
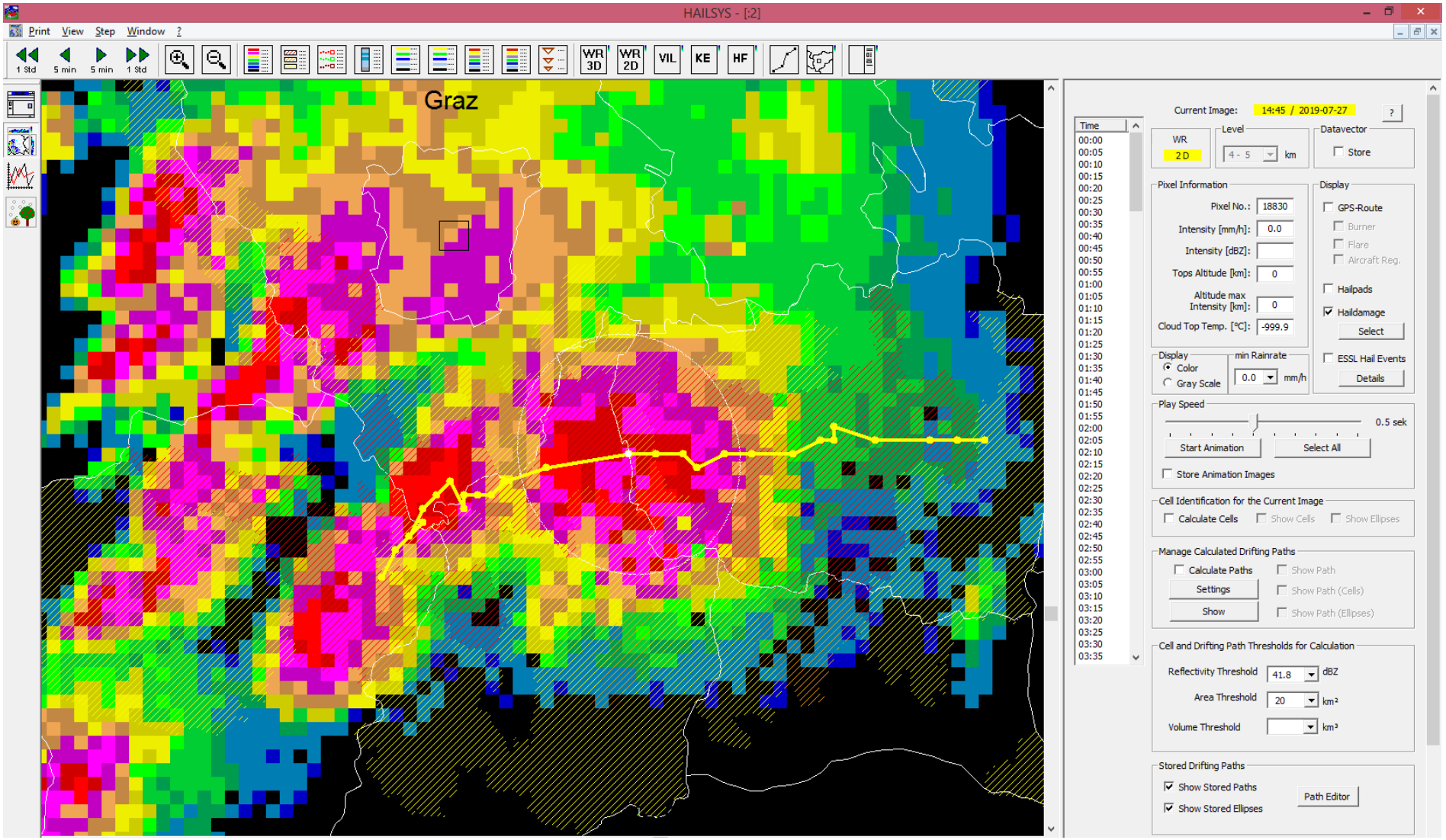


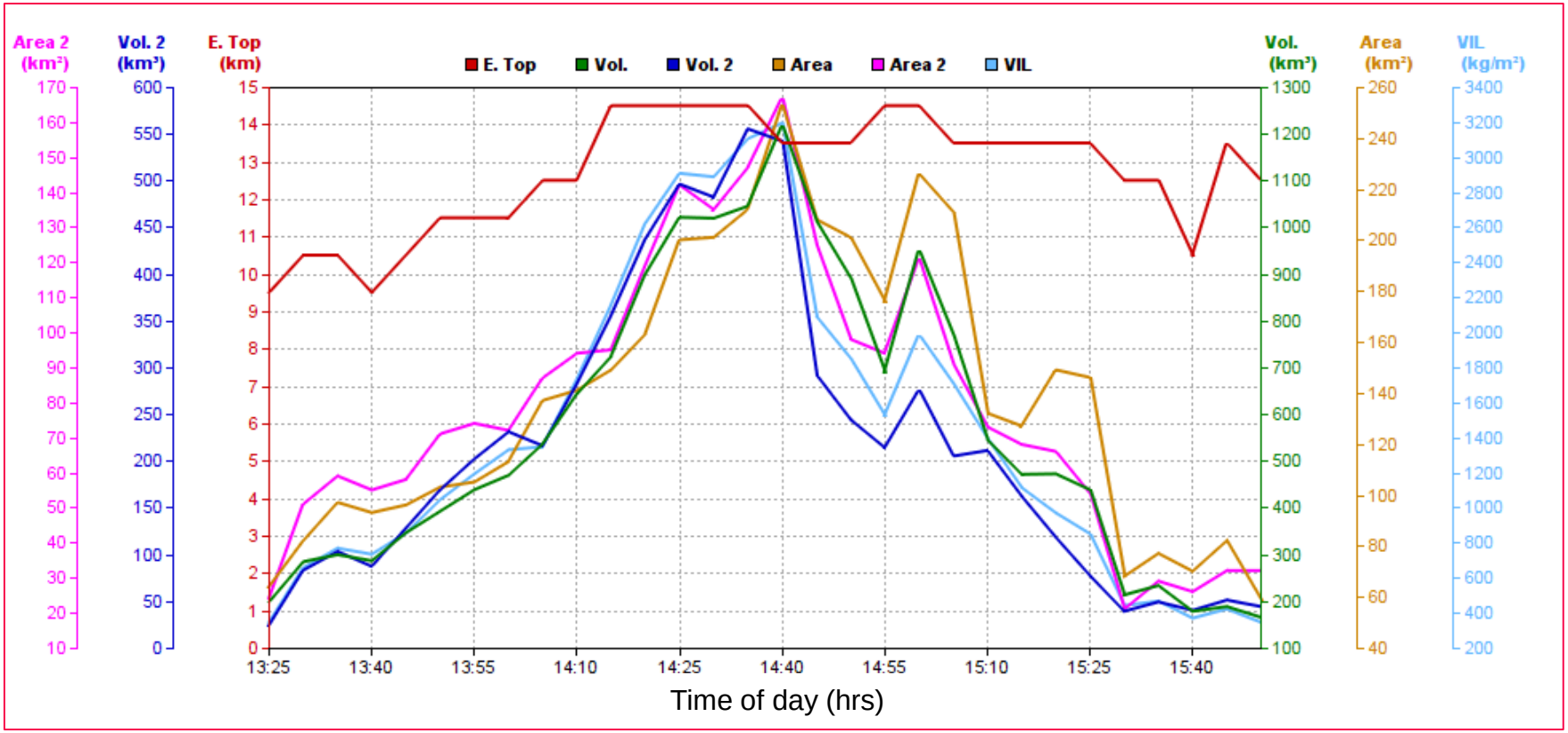
Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance,

Thunderstorm cell tracking



Cell detection radar reflectivity >40 dBZ, with area >20 km^2 (white colour ellipse) and cell tracking path (Yellow colour line)

Radar-derived parameters

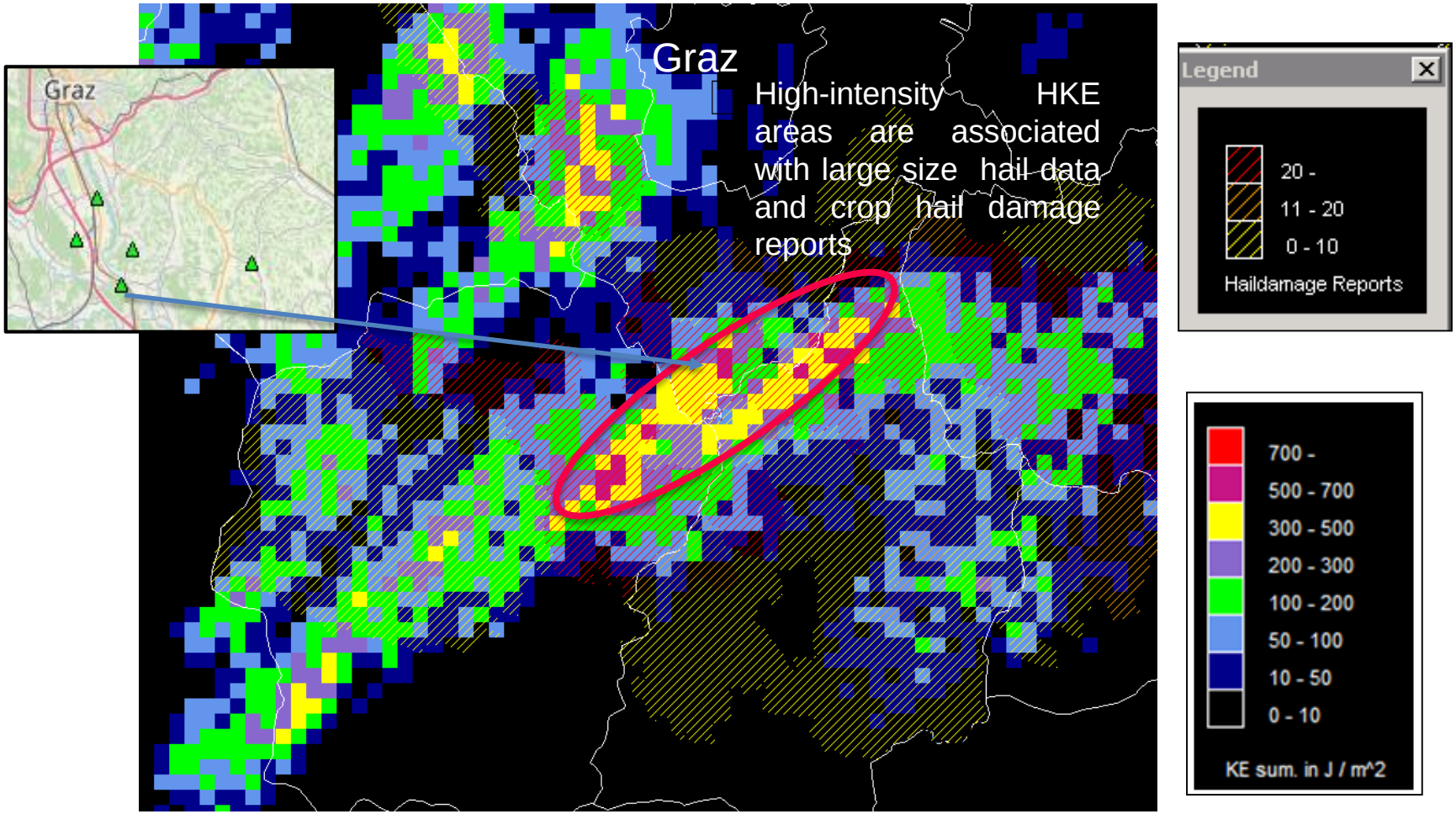


The behaviour of radar-derived cell parameters over the entire life cycle of a thunderstorm

Radar data source: Austro Control GmbH

Case study 1: Radar derived hail kinetic energy (HKE) event wise

Radar based hail signature information and Crop damaged areas

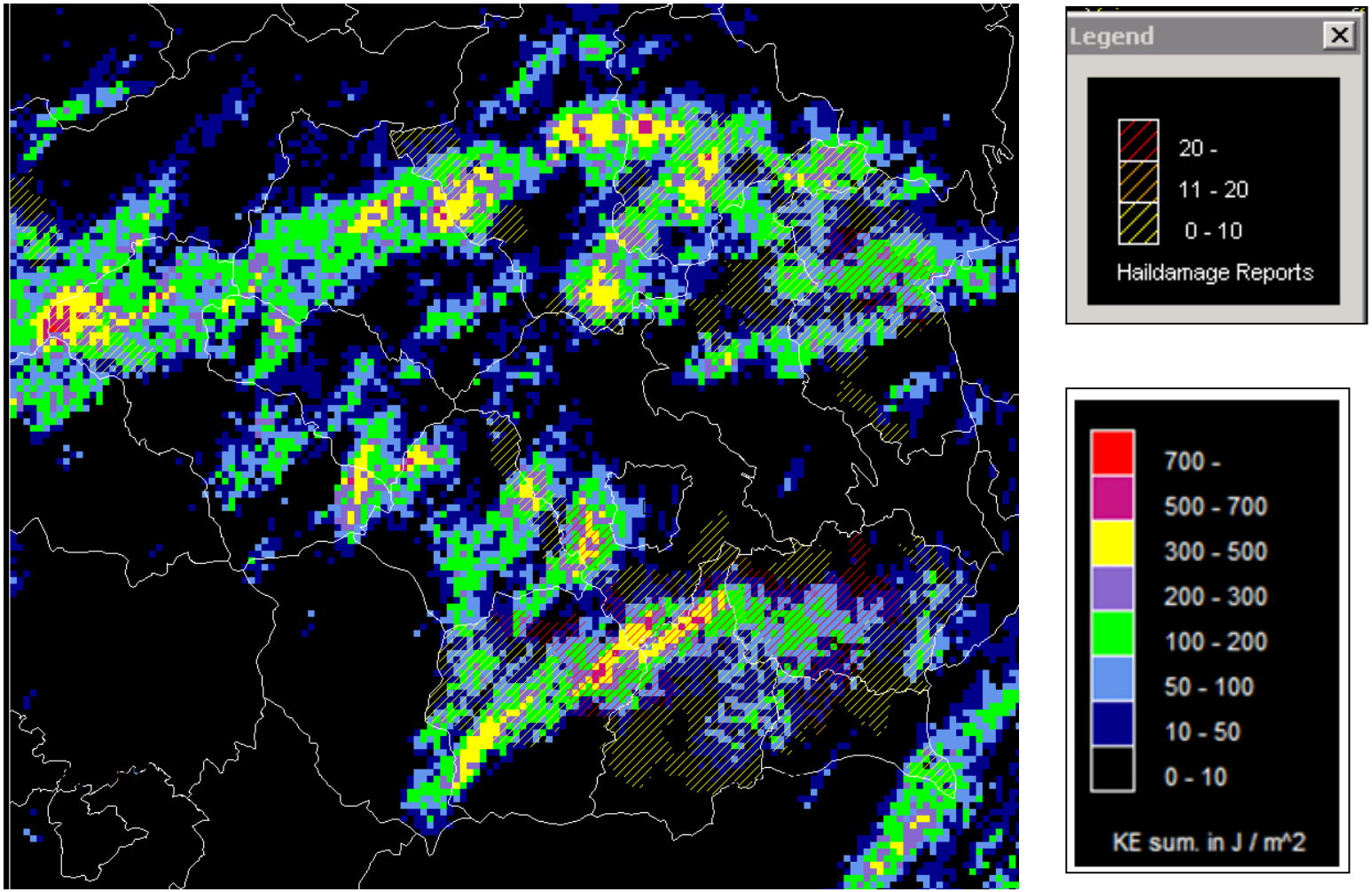


Total kinetic energy per pixel is integrated over the period 13:00 to 16:00 hrs (27 July 2019)

Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance, Hail data : **ESWD** (European Severe Weather Database)

Case study 1: Radar derived hail kinetic energy (HKE) event wise

Radar based hail signature information and Crop damaged areas



Total kinetic energy per pixel is integrated over the period 10:00 to 18:00 hrs (27 July 2019)

Radar data source: Austro Control GmbH, Crop damage: Austrian hail inusrance, Hail data : **ESWD** (European Severe Weather Database)

Summary

- The results show that in most cases radar-based hail signature information well capture the swath areas and also corresponds to the areas where hail events and damage footprints were reported

- The radar-based hail signature information is a useful detection option for the assessment of crop damage and hail risk.

Thank you!

Acknowledgments