WMO Regional Conference of the Regional Association VI on the F
National Meteorological and Hydrological Services: Leadership an
Geneva, Switzerland, 3 November 2022

ESSLs' European Severe Weather Database (ESWD) – its manifold uses as an example of citizen science and NGO participation

Alois M. Holzer
ESSL Director of Operations

IF4 Tornado in Hodonín, Czechia, on 24 June 2021 Photo: Marek Sita

European Severe Weather Database

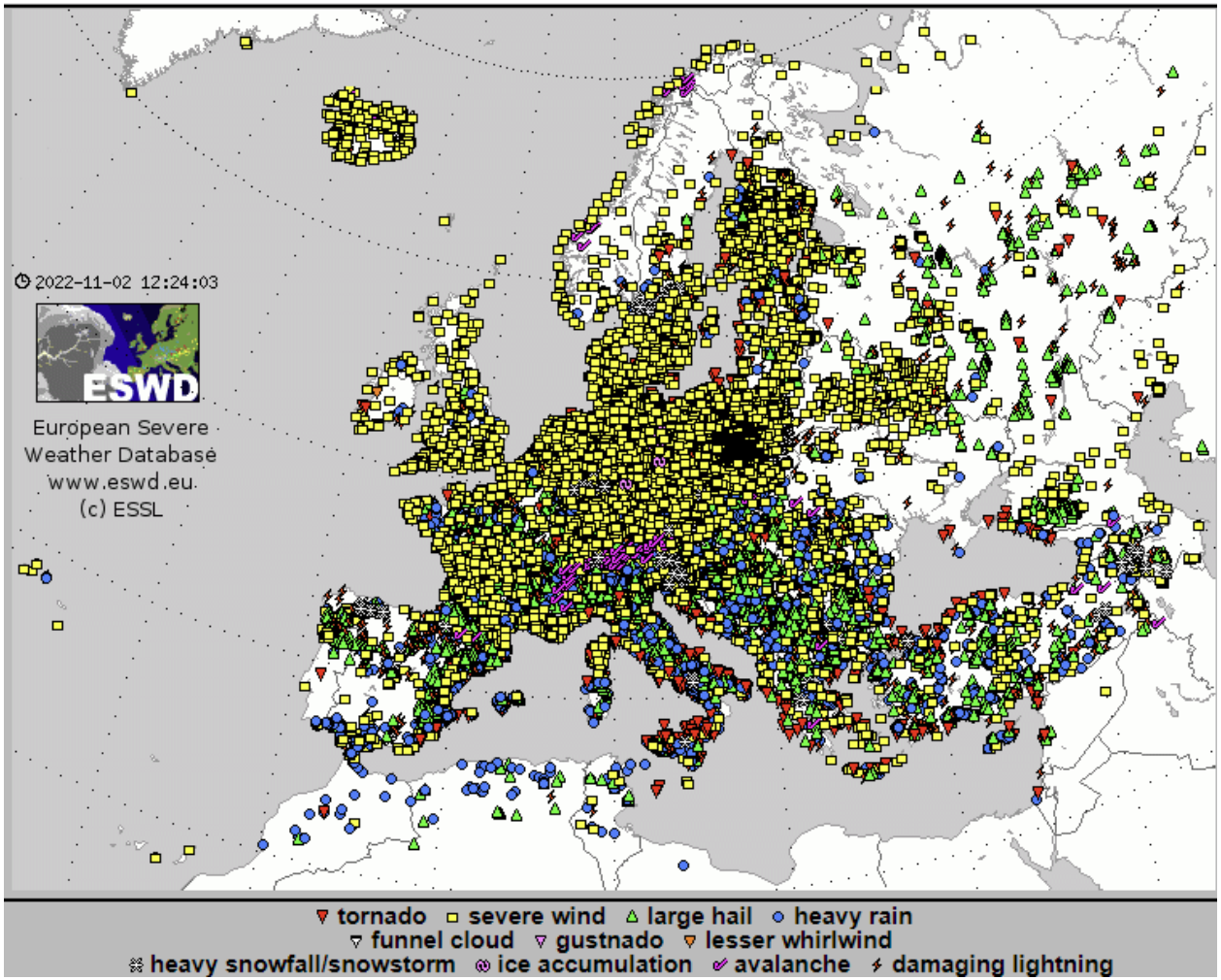
- pan-European database of severe weather reports
- collected and quality-controlled by ESSL and partners
- as of today, contains more than 310,000 severe weather reports
- for event types typically not well-covered by conventional weather or climate station reports

European Severe Weather Database

- Main data sources are trained spotter networks (volunteers) and manually quality-controlled media reports
- **Criterion is severe damage** or severe interruption of daily life (with further definitions)
- Covered event-types:
  - Hail diameter larger 2 cm or hail cover larger 2 cm
  - A severe wind gust measured to have a speed of at least 25 m/s or one doing such damage that a wind speed of 25 m/s or higher is likely to have occurred.
  - Tornadoes
  - Heavy Rain, heavy snowfall and/or snowstorm
  - Ice Accumulations, avalanches
  - Damaging lightning

European Severe Weather Database

- ESWD data for year 2022 to yesterday
- ESWD started in year 2006, but also historical data included



European Severe Weather Database - Users

- In part, ESSL is a service provider to NHMSs and international organizations like EUMETSAT and ECMWF
- The European Severe Weather Database (ESWD) is one of the main reasons to become an ESSL member

Member	Country	Member since
Deutscher Wetterdienst (DWD)	Germany	2007
EUMETSAT	Europe	2008
AustroControl	Austria	2009
Zentralanstalt für Meteorologie und Geodynamik (ZAMG)	Austria	2010
National Meteorological Administration	Romania	2010
Czech HydroMeteorological Institute (CHMI)	Czech Republic	2011
Finnish Meteorological Institute (FMI)	Finland	2011
Institute for Hydrometeorology and Seismology	Montenegro	2012
Slovak HydroMeteorological Institute (SHMÚ)	Slovakia	2013
Meteorological and Hydrological Service (DHMZ)	Croatia	2013
Consorzio LaMMa	Italy	2014
Royal Netherlands Meteorological Institute (KNMI)	Netherlands	2016
European Centre for Medium-Range Weather Forecasts (ECMWF)	International	2016
Croatia Control, Croatian Air Navigation Services	Croatia	2017
Cyprus Department of Meteorology	Cyprus	2017
Republic Hydrometeorological Service of Serbia (RHMSS)	Serbia	2017
Institute of Meteorology and Climate Research (IMK), Karlsruhe Institute of Technology (KIT)	Germany	2018
UK Met Office	United Kingdom	2018
Agenzia Regionale per la Protezzione dell'Ambiente Ligure – ARPAL	Italy	2019
Thüringer Landesamt für Umwelt, Bergbau und Naturschutz	Germany	2019
Instytut Meteorologii Gospodarki Wodnej – Panstwowy Instytut Badawczy	Poland	2020
Department of Economics and Management "Marco Fanno", Università di Padova	Italy	2022
Met Éireann	Ireland	2022

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Department of Economics and Management "Marco Fanno", Università di Padova	Italy	2022
Met Éireann	Ireland	2022

European Severe Storms Laboratory

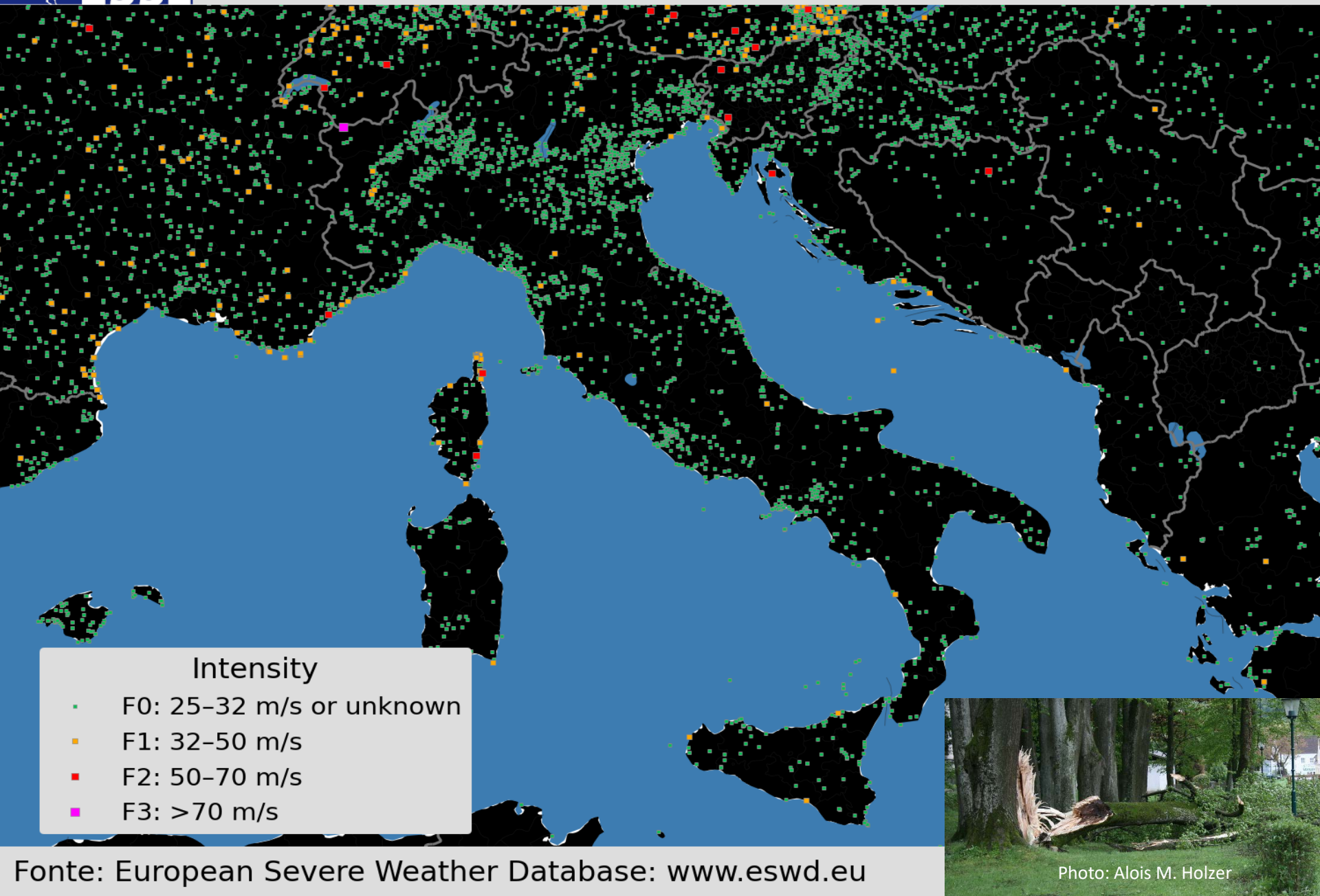
Heavy rain events in Italy 1950–2020

heavy rain event

Fonte: European Severe Weather Database: www.eswd.eu

European Severe Storms Laboratory

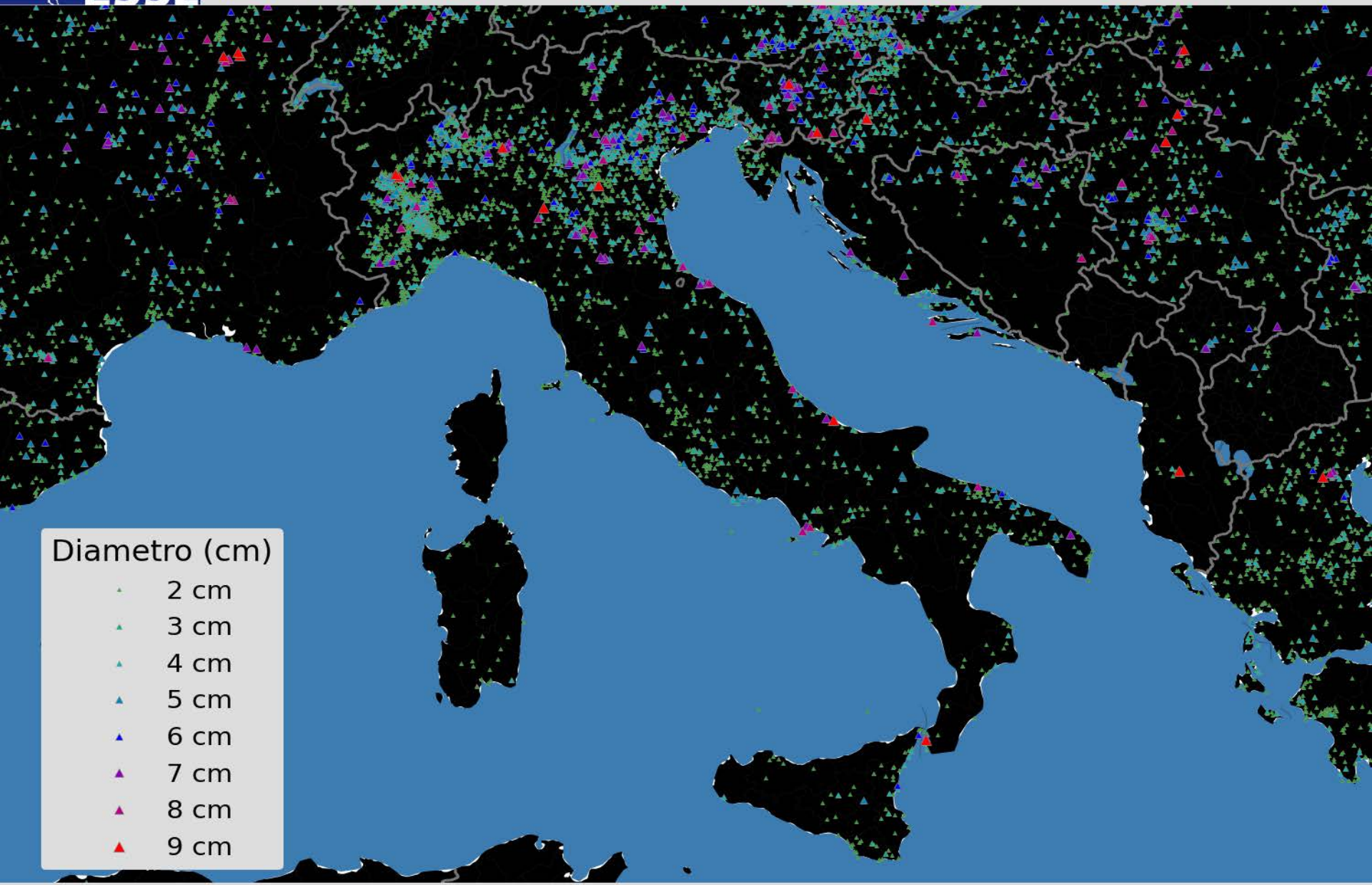
Convective wind gusts in Italia 1950–2020



Fonte: European Severe Weather Database: www.eswd.eu

European Severe Storms Laboratory

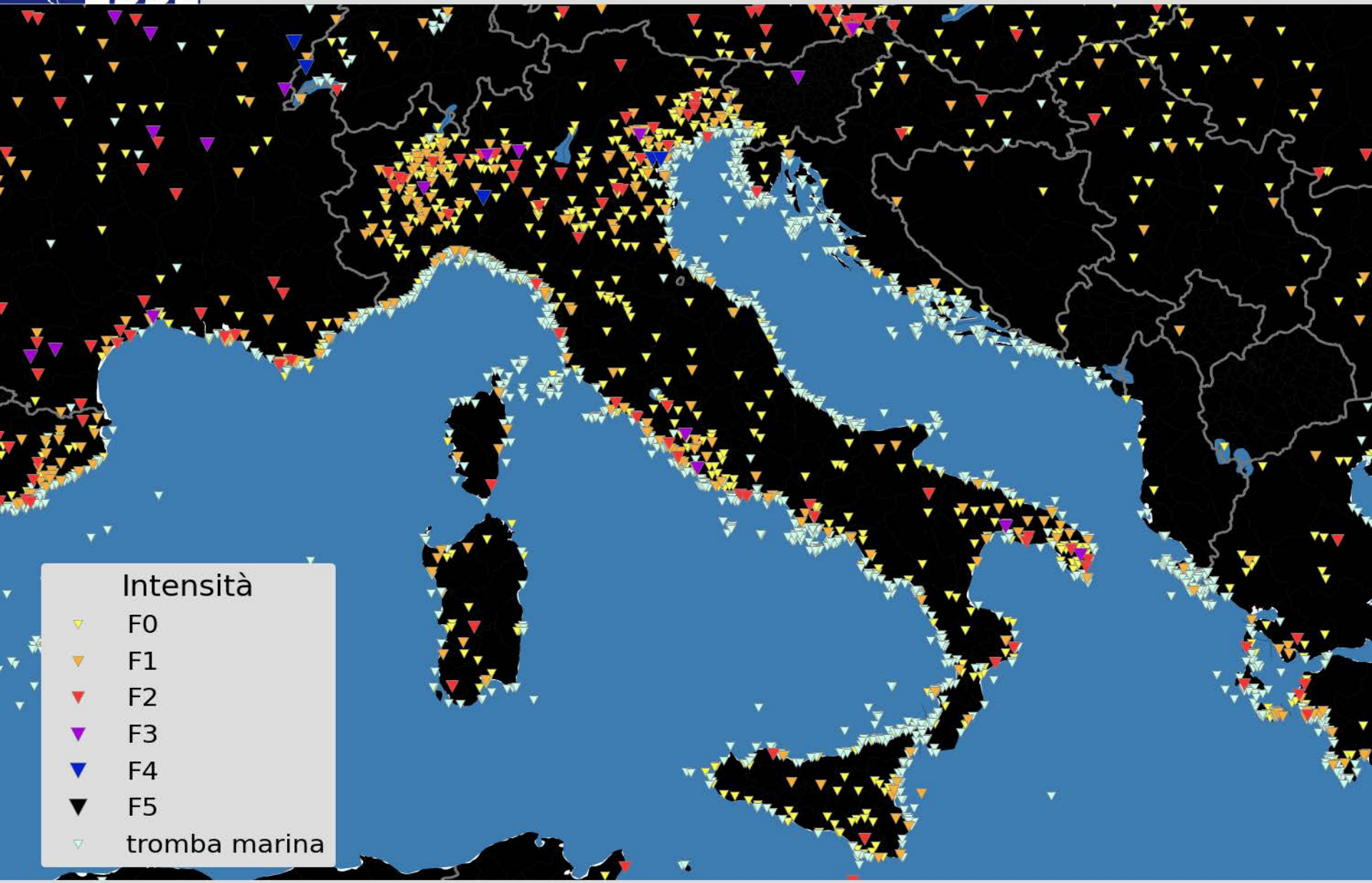
Grandine in Italia 1950–2020



Fonte: European Severe Weather Database: www.eswd.eu

European Severe Storms Laboratory

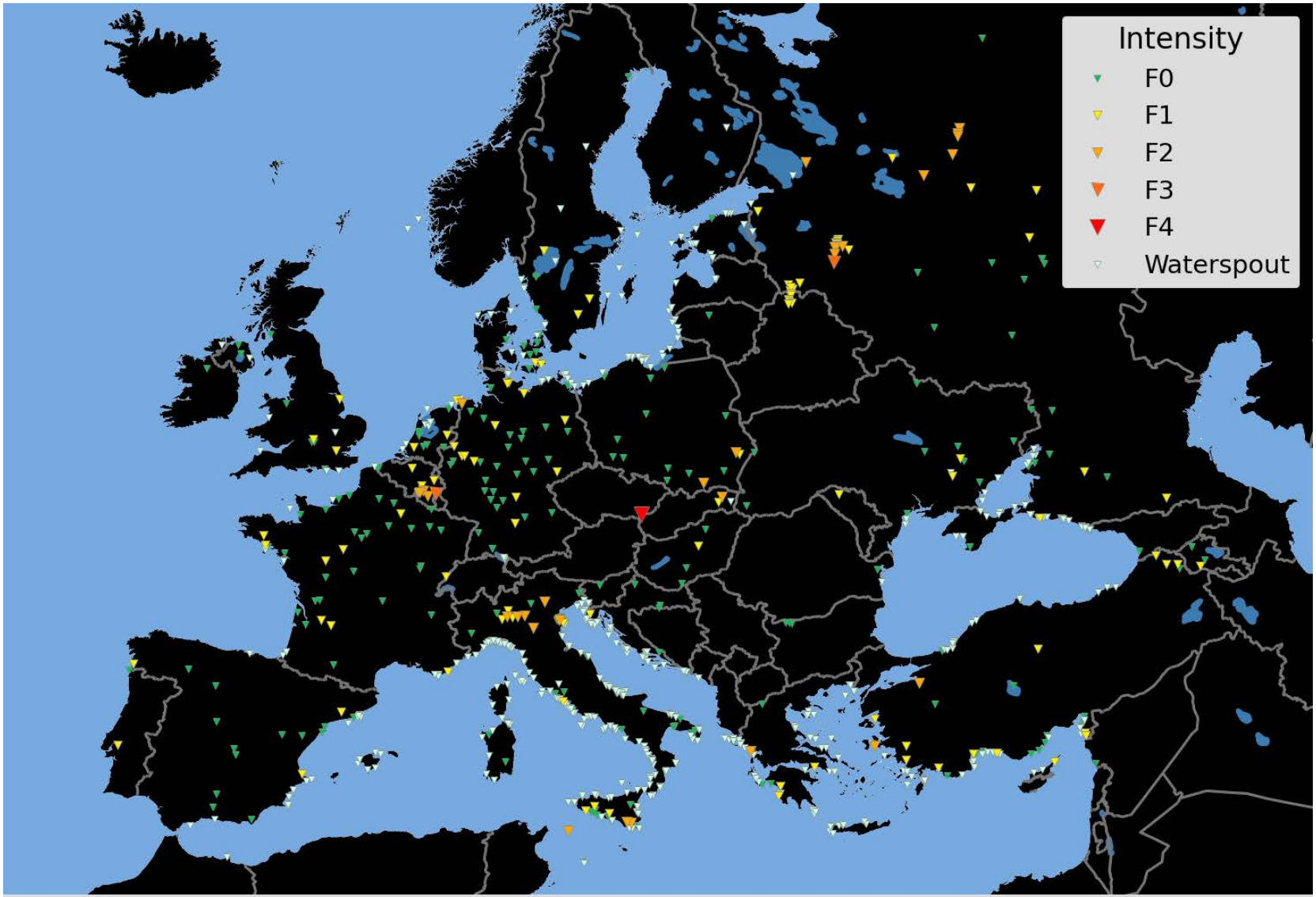
Tornado in Italia 1950–2020



Fonte: European Severe Weather Database: www.eswd.eu

European Severe Storms Laboratory

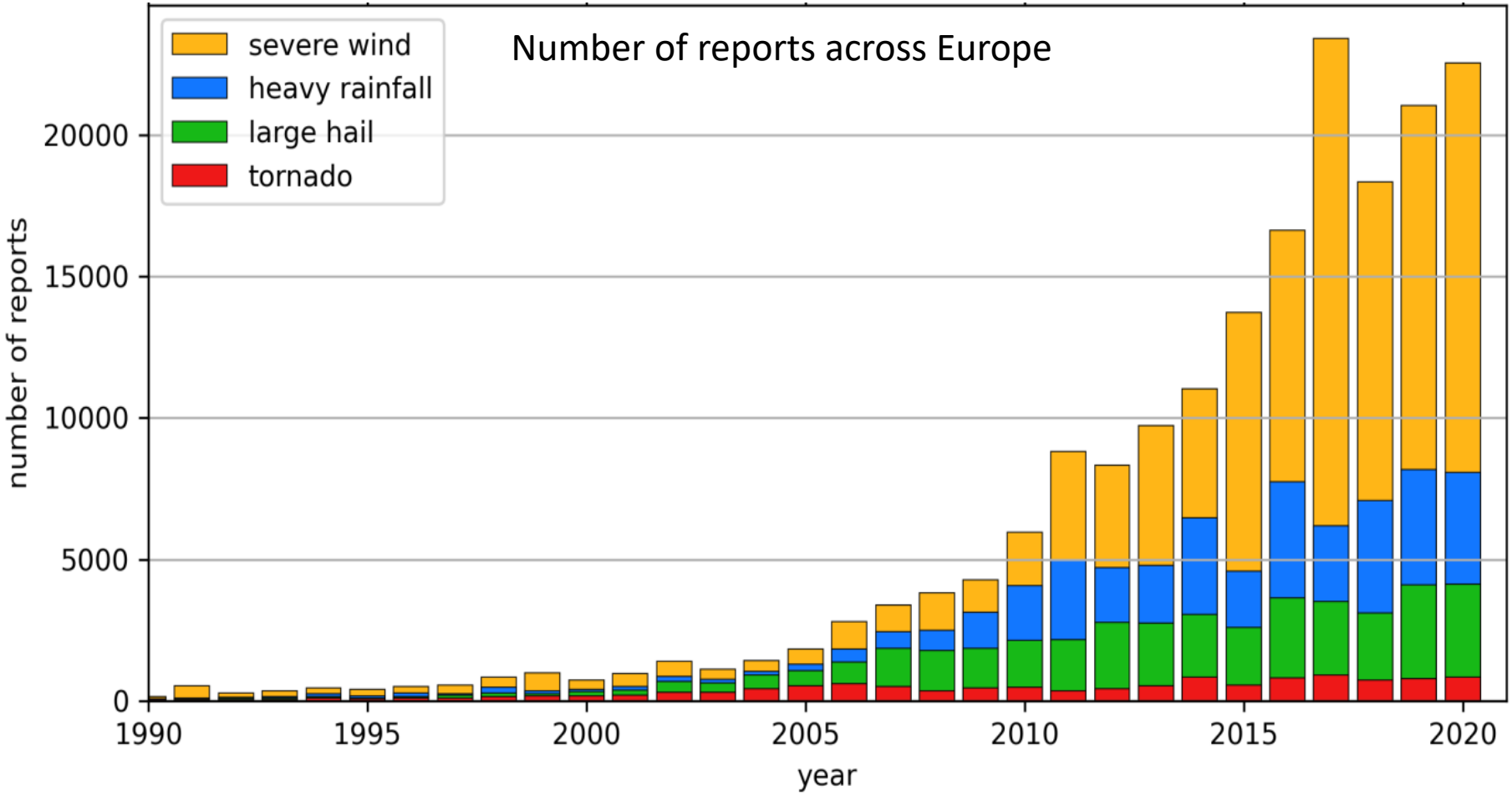
Yearly overviews, example tornadoes 2021



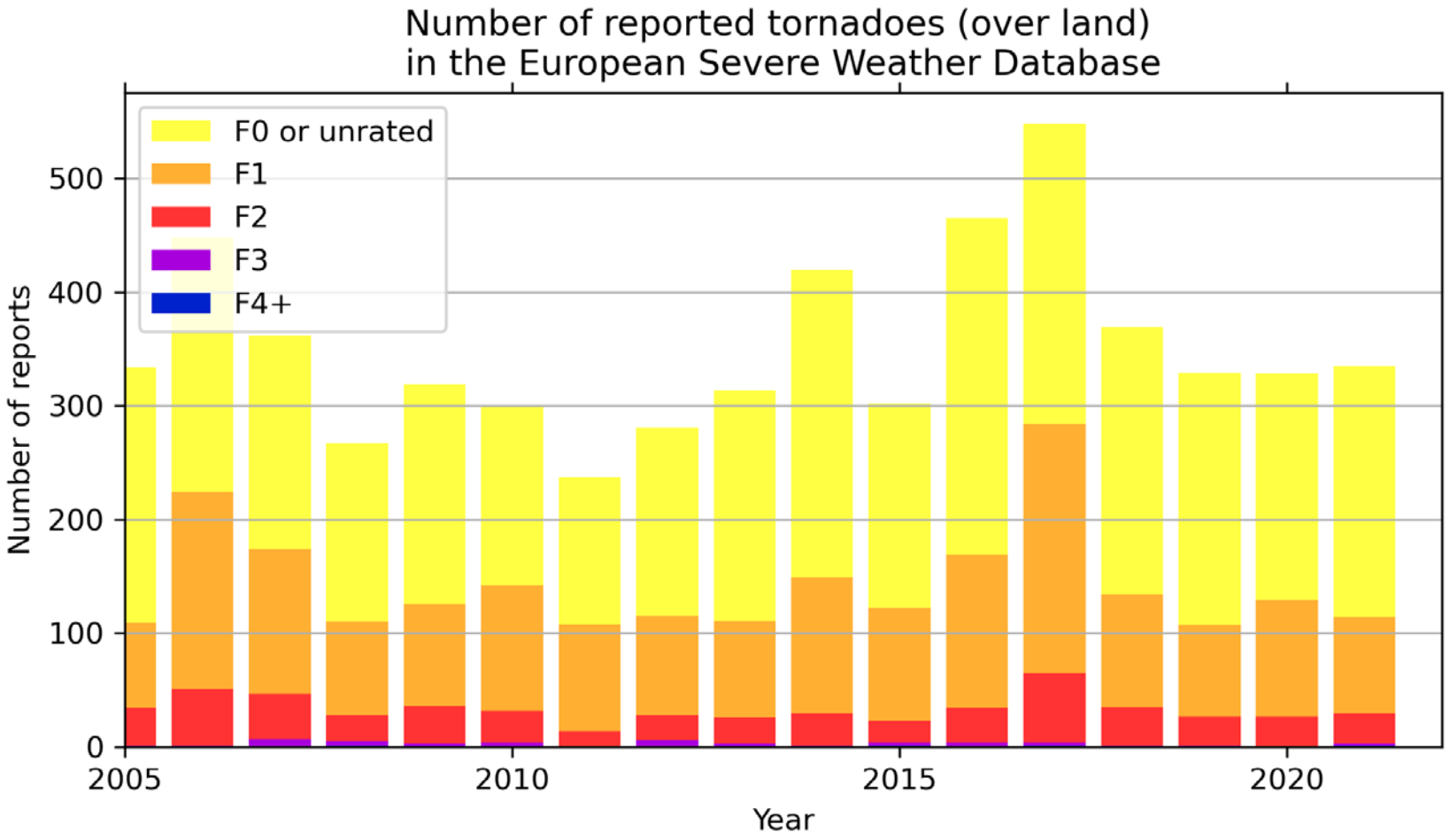
Source: European Severe Weather Database: www.eswd.eu

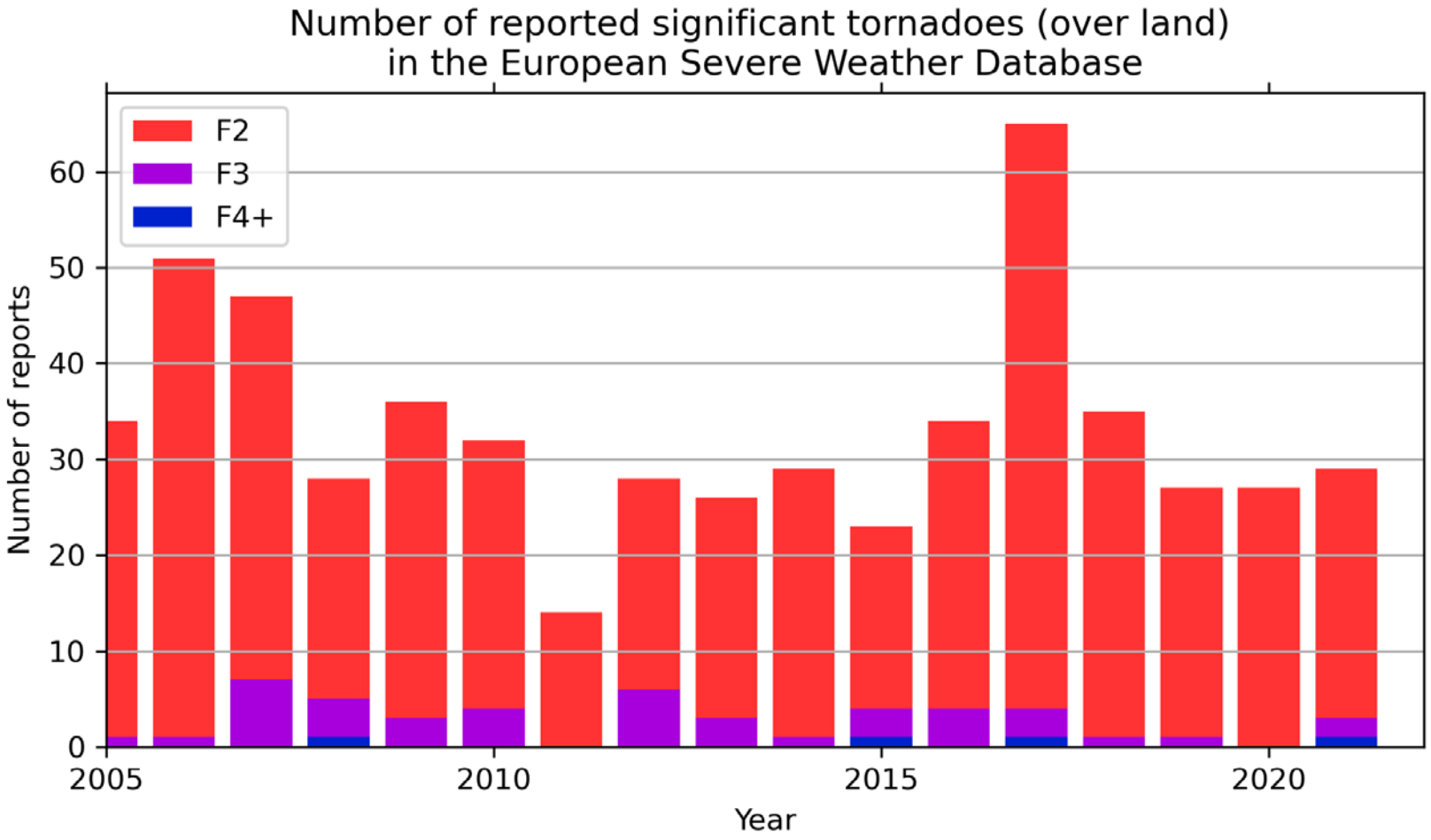
European Severe Storms Laboratory

ESWD based severe weather climatology



European Severe Storms Laboratory

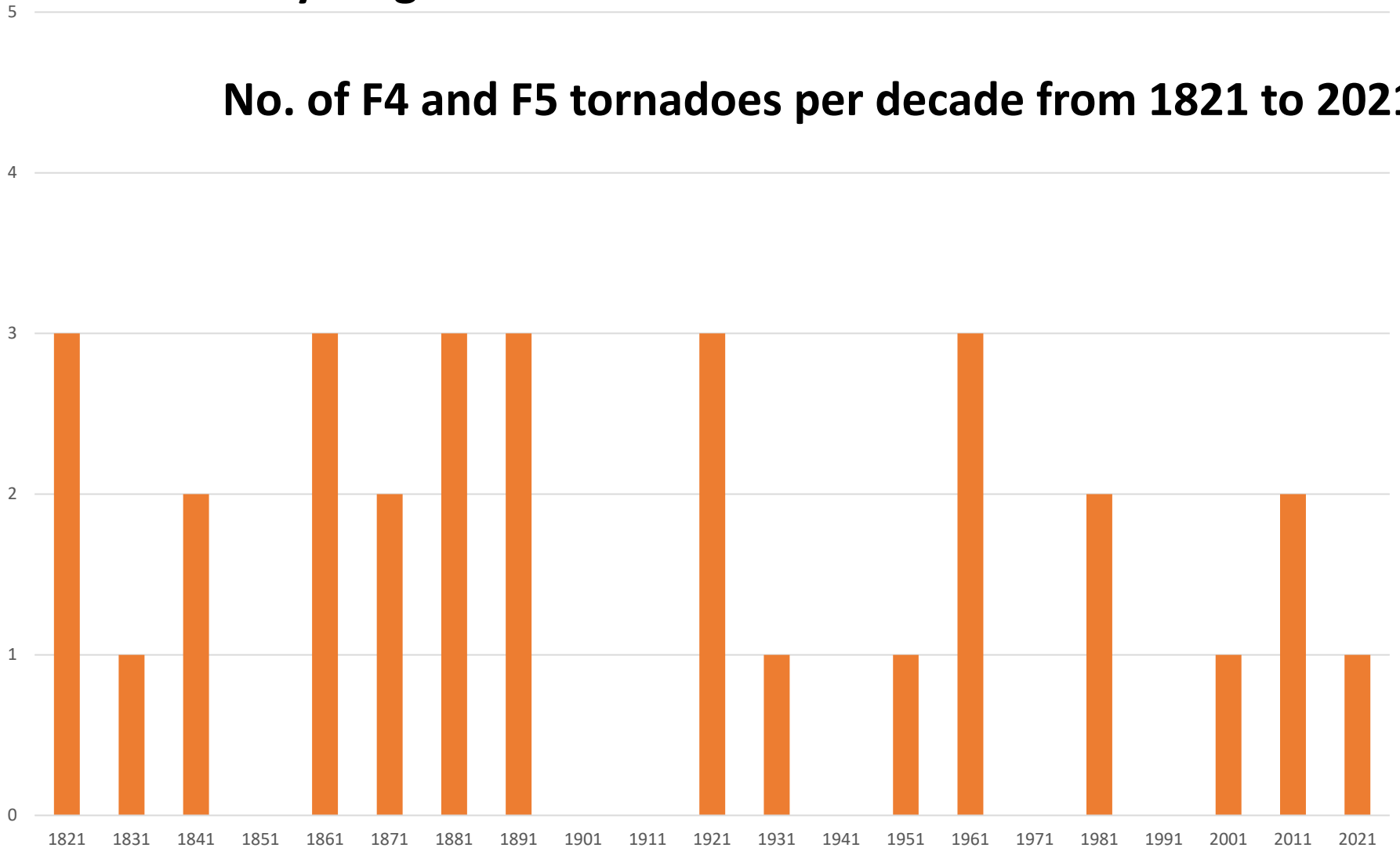



Number of reported significant tornadoes (over land)
in the European Severe Weather Database
F2
F3
F4+
Number of reports
0
10
20
30
40
50
60
2005
2010
2015
2020
Year

European Severe Storms Laboratory

Very long term trends for the most extreme events:

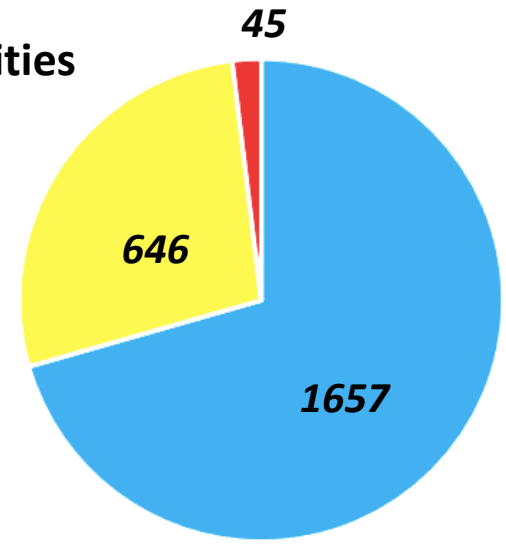
No. of F4 and F5 tornadoes per decade from 1821 to 2021



European Severe Storms Laboratory

The European Severe Weather Database (ESWD)
Societal impacts 2008-2021

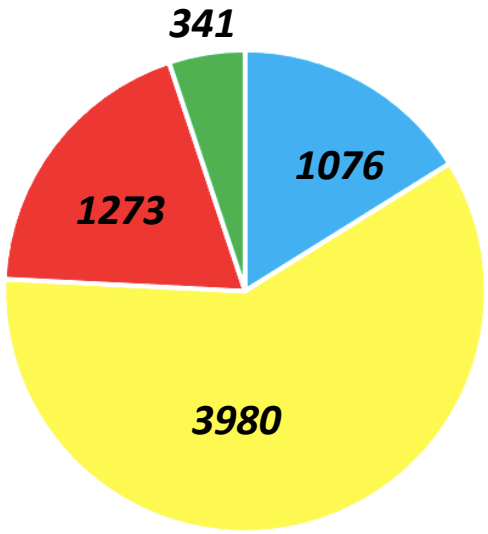
Fatalities



***Most fatalities**: Flooding*

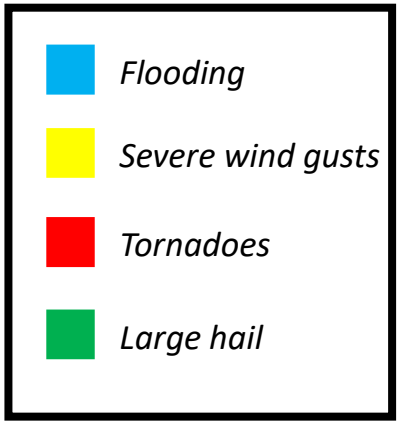
118 per year on average

Injuries



***Most injuries**: Severe wind gusts*

284 per year on average



European Severe Storms Laboratory

Database structure ideal for impact studies and warning verification

severe wind

What was the highest *measured* wind speed? ____ m/s

Please indicate if there are doubts about the nature of the event.

- [ ] It is possible that this was a tornado

IMPACTS

More Details

How many persons were injured? ____

How many persons were killed? ____

Which impacts occurred?

Transport infrastructure

- [ ] Road(s) impassable or closed
- [ ] Bridge(s) damaged or destroyed
- [ ] Rail-/tram-/subway(s) unusable or closed
- [ ] Rail-/tram-/subway infrastructure damaged
- [ ] Rail-/tram-/subway vehicle(s) damaged or destroyed
- [ ] Airport(s) closed (for more than an hour)
- [ ] Aircraft damaged or destroyed
- [ ] Ship(s) damaged or destroyed
- [ ] Inhabited place(s) cut off from transport infrastructure

Other infrastructure

- [ ] Power transmission damaged or destroyed
- [ ] Telecommunication infrastructure damaged or destroyed

Damage to homes / buildings

- [ ] Damage to roof or chimney
- [ ] Roof(s) destroyed
- [ ] Damage to window(s) or insulation layer(s)
- [ ] Wall(s) (partly) collapsed
- [ ] Building(s) (almost) fully destroyed

Damage to road vehicles

- [ ] Car(s) damaged (unspecified)
- [ ] Car(s) dented
- [ ] Car window(s) or windshield(s) broken
- [ ] Car(s) damaged beyond repair
- [ ] Truck(s) and/or trailer(s) overturned

Damage to trees

- [ ] Large tree branch(es) broken
- [ ] Tree(s) uprooted or snapped
- [ ] Forest(s) damaged or destroyed

Damage to agriculture

- [ ] Crops/farmland damaged
- [ ] Greenhouse(s) damaged or destroyed
- [ ] Animal(s) killed

Event consequences

- [ ] Fire as a consequence of the event
- [ ] Evacuation order by authorities

DESCRIPTION

European Severe Storms Laboratory

Database structure ideal for impact studies and warning verification

IMPACTS

More Details

How many persons were injured?

How many persons were killed?

Which impacts occurred?

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Database structure ideal for impact studies and warning verification

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Damage to homes / buildings

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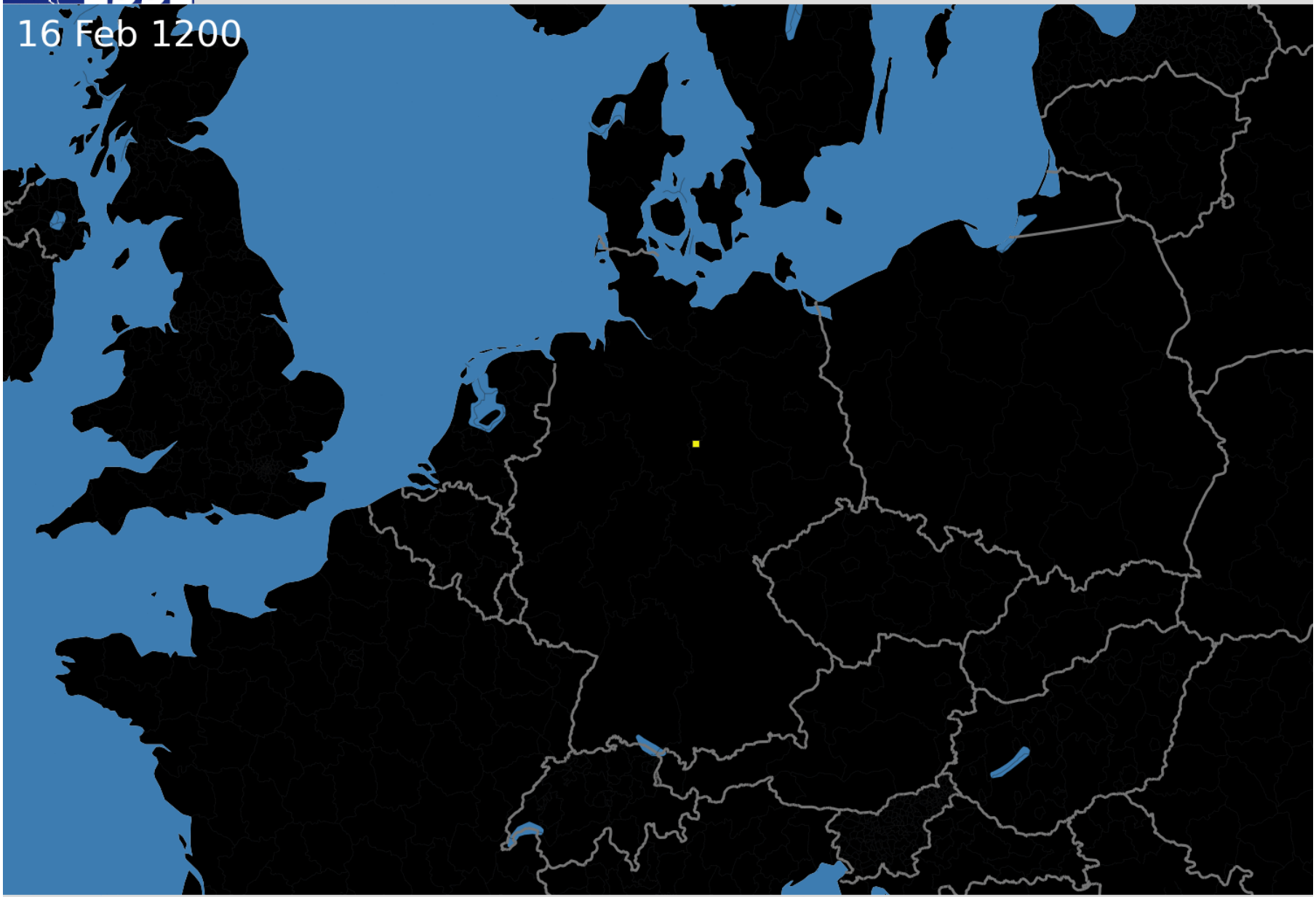
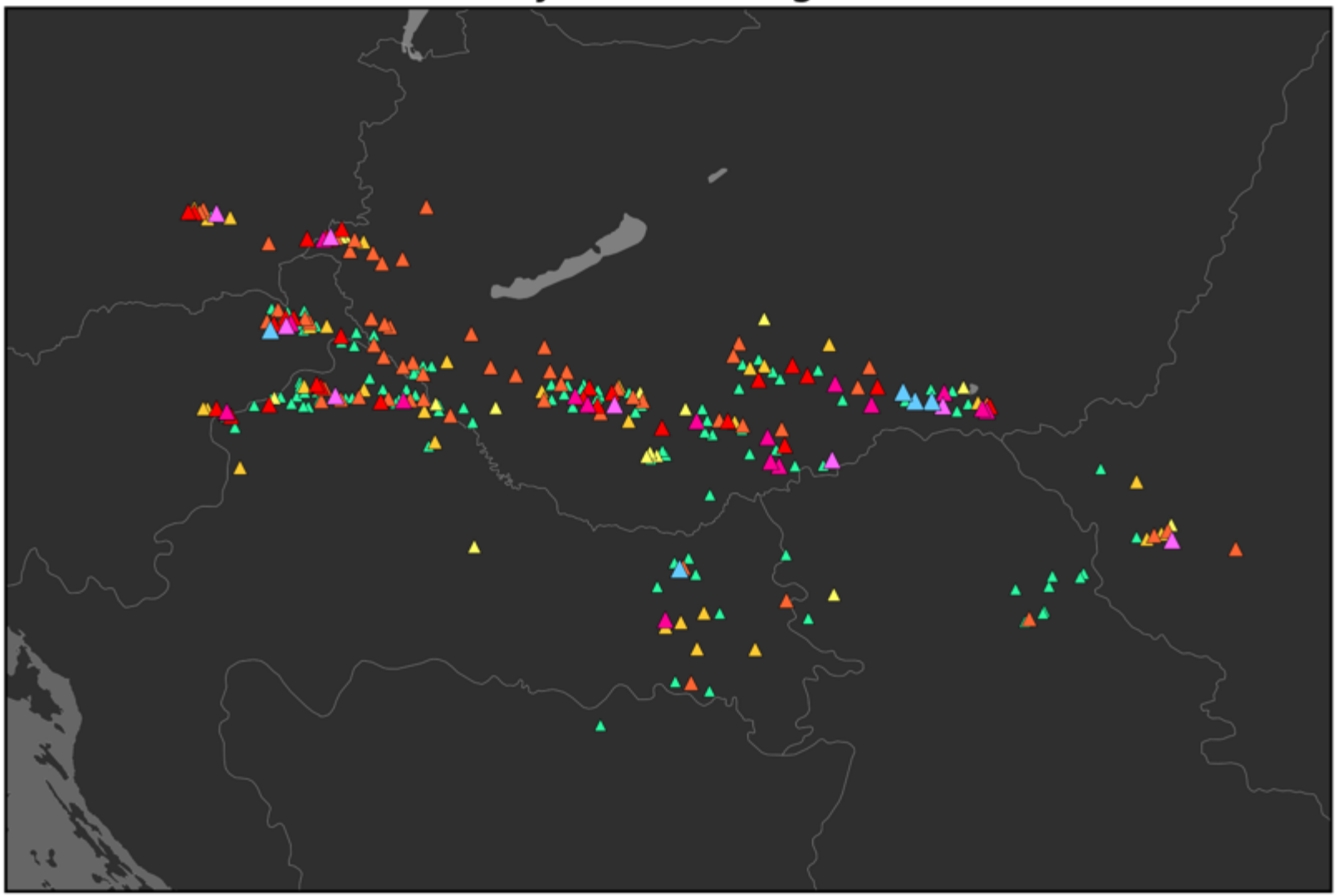
European Severe Storms Laboratory

Severe weather on 16 & 17 February 2022



Source: European Severe Weather Database: www.eswd.eu 28 February 2022

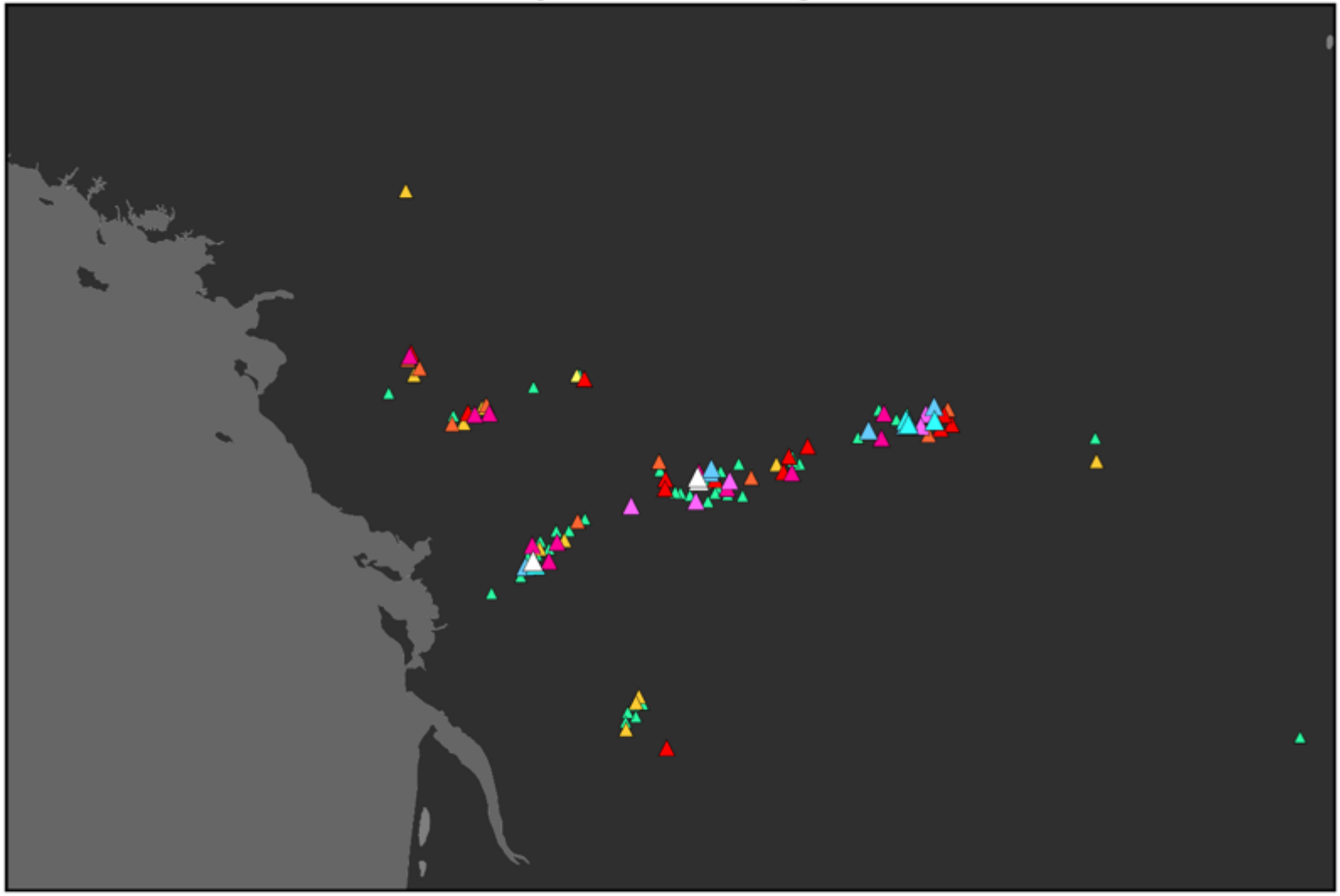
25 May 2022 / Large Hail



Total: 286 Reports / Size rating ratio: 94.8%

Size	unk	2 cm	3 cm	4 cm	5 cm	6 cm	7 cm	8 cm	9 cm	≥10 cm
Reports	15	46	58	85	41	25	10	5	-	-

22 May 2022 / Large Hail



Total: 142 Reports / Size rating ratio: 98.6%

Size	unk	2 cm	3 cm	4 cm	5 cm	6 cm	7 cm	8 cm	9 cm	≥10 cm
Reports	2	29	25	24	19	15	11	10	6	3

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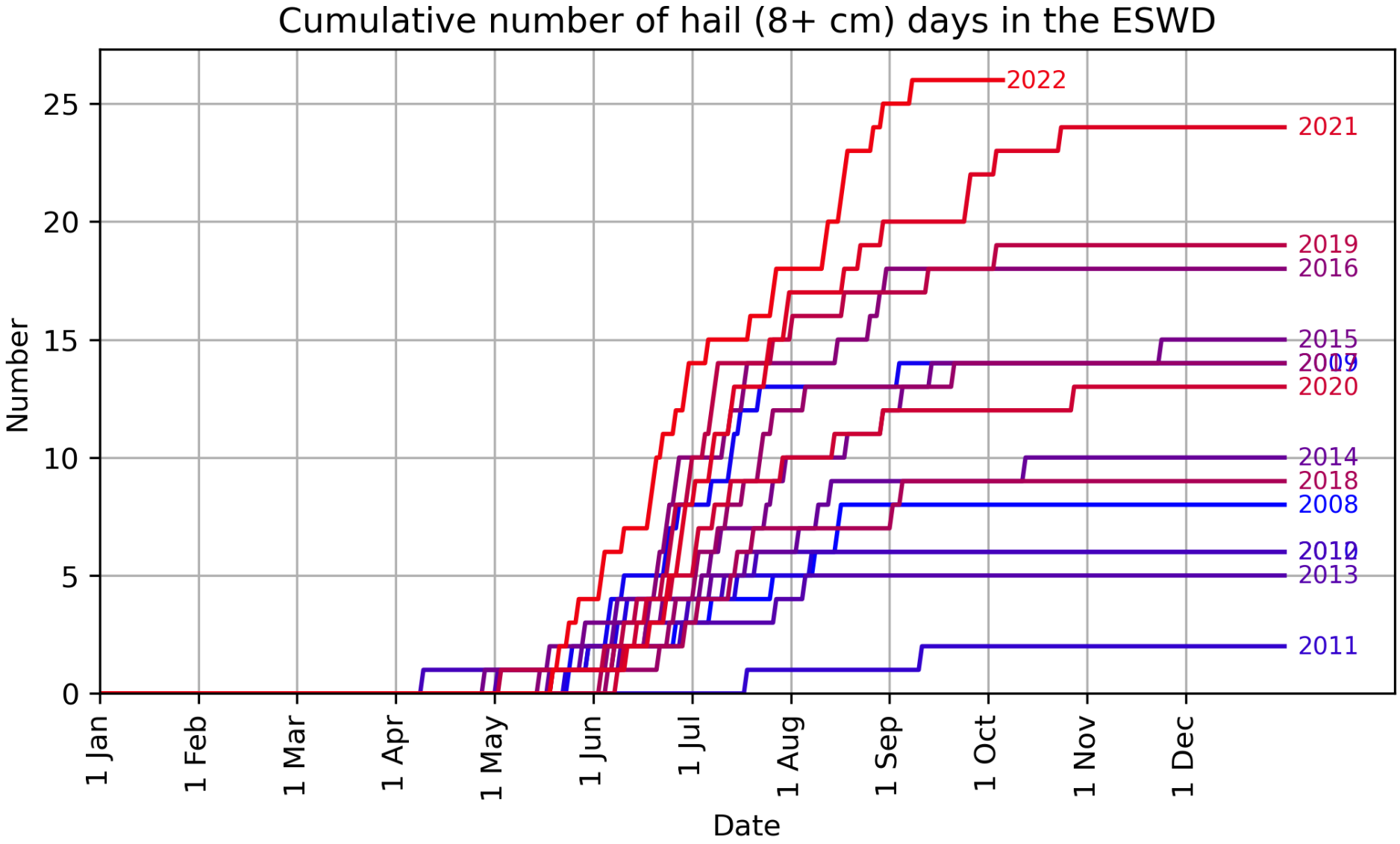
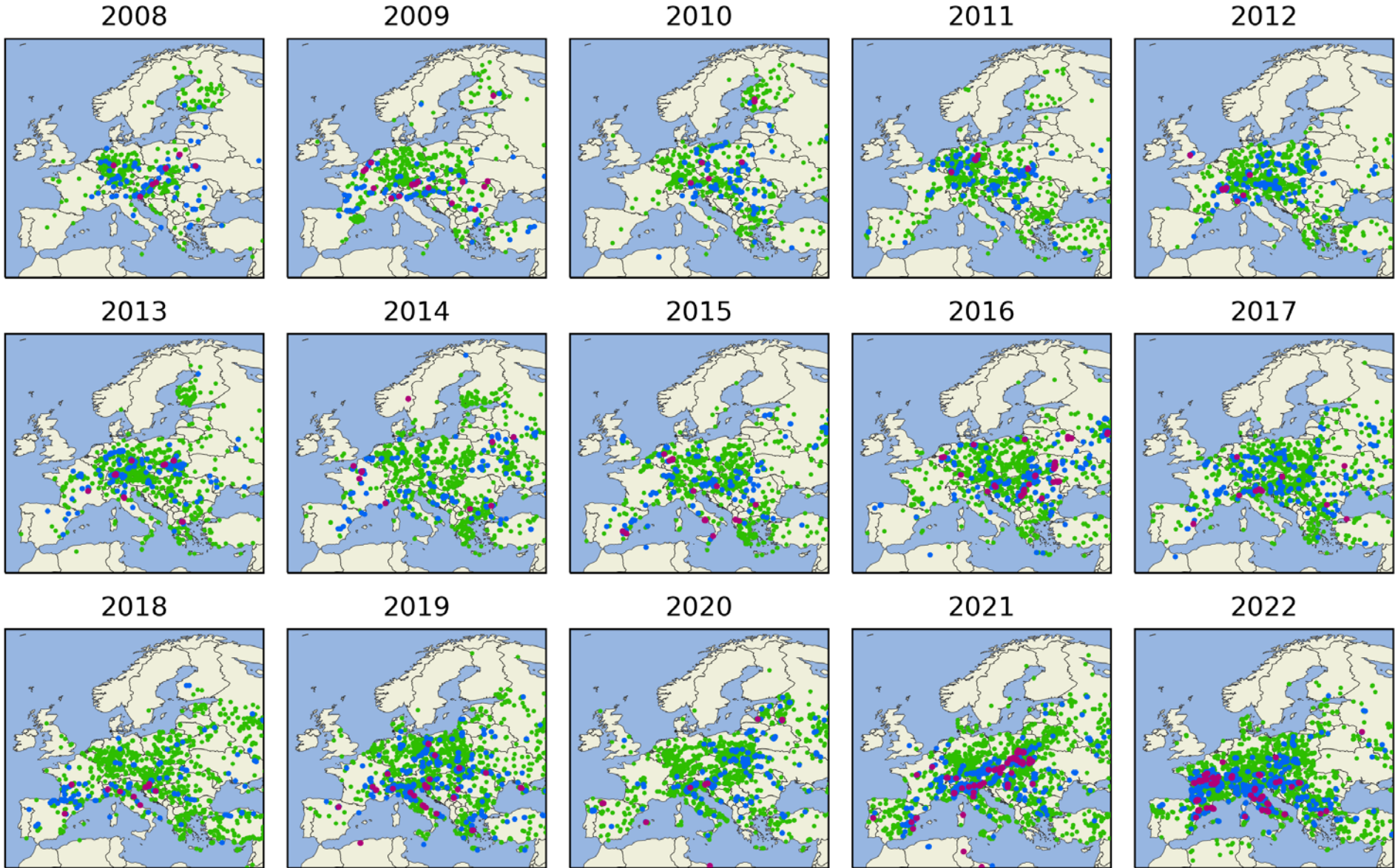


European Severe Storms Laboratory

ESWD reports of hail ≥ 2, 5, and 8 cm diameter



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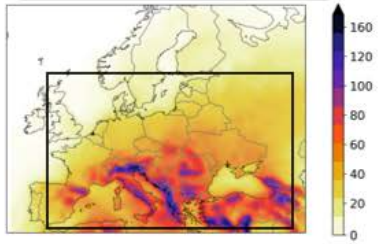
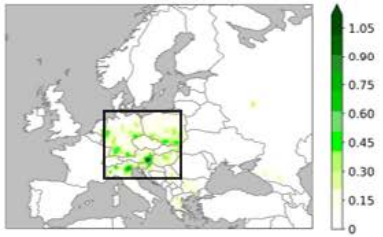
Logistic modeling of proxies for large hail based on ESWD data for past and future climates

Training data:
2008-2020 – e.g. Europe

Lightning



Hail ≥ 2cm

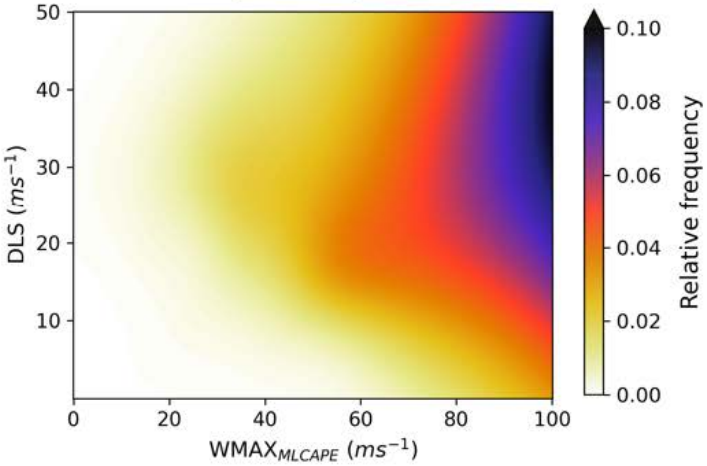


ERA5 reanalysis

AR-CHaMo

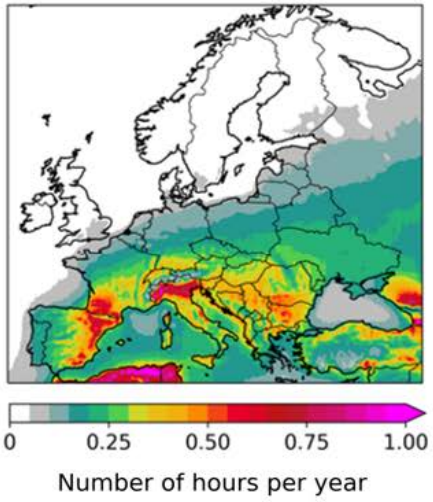
$$P_{hail} = P_{storm} \times P_{hail|storm}$$

Fraction of environments with hail ≥ 2cm ***(modelled)***



Application
1950-2021 – All Europe

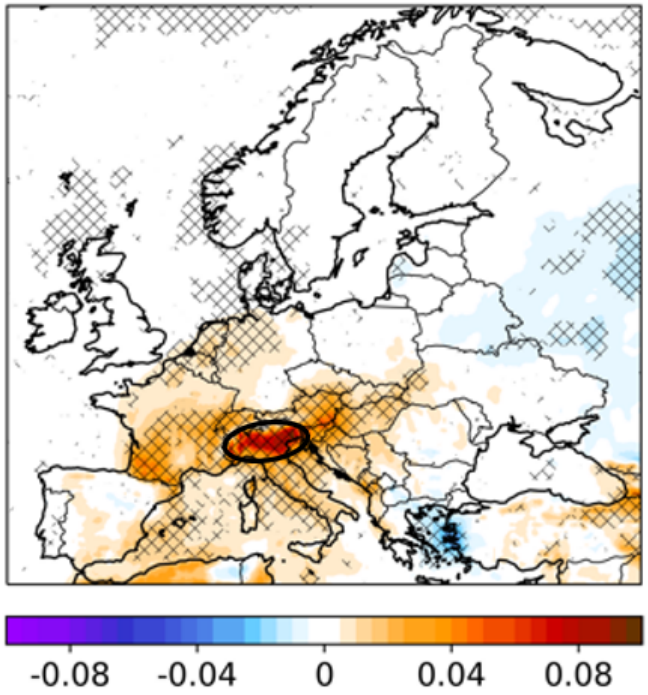
Modelled *spatial distribution of hail ≥ 2cm (1950-2021)*



European Severe Storms Laboratory

Past trends in hail ≥ 2 cm (1950-2021)

Number of hours per decade

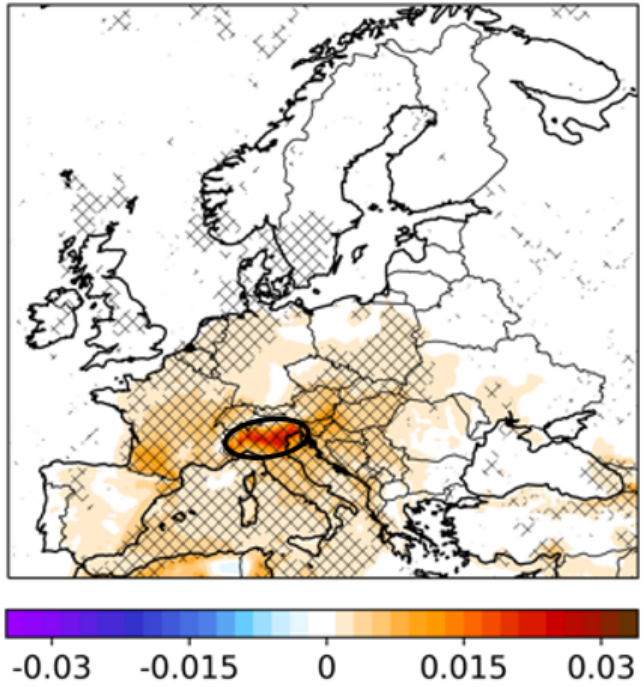


Widespread ***increases across most of Europe***

Highest *overall increase across* ***Northern Italy***

Past trends in hail ≥ 5 cm (1950-2021)

Number of hours per decade



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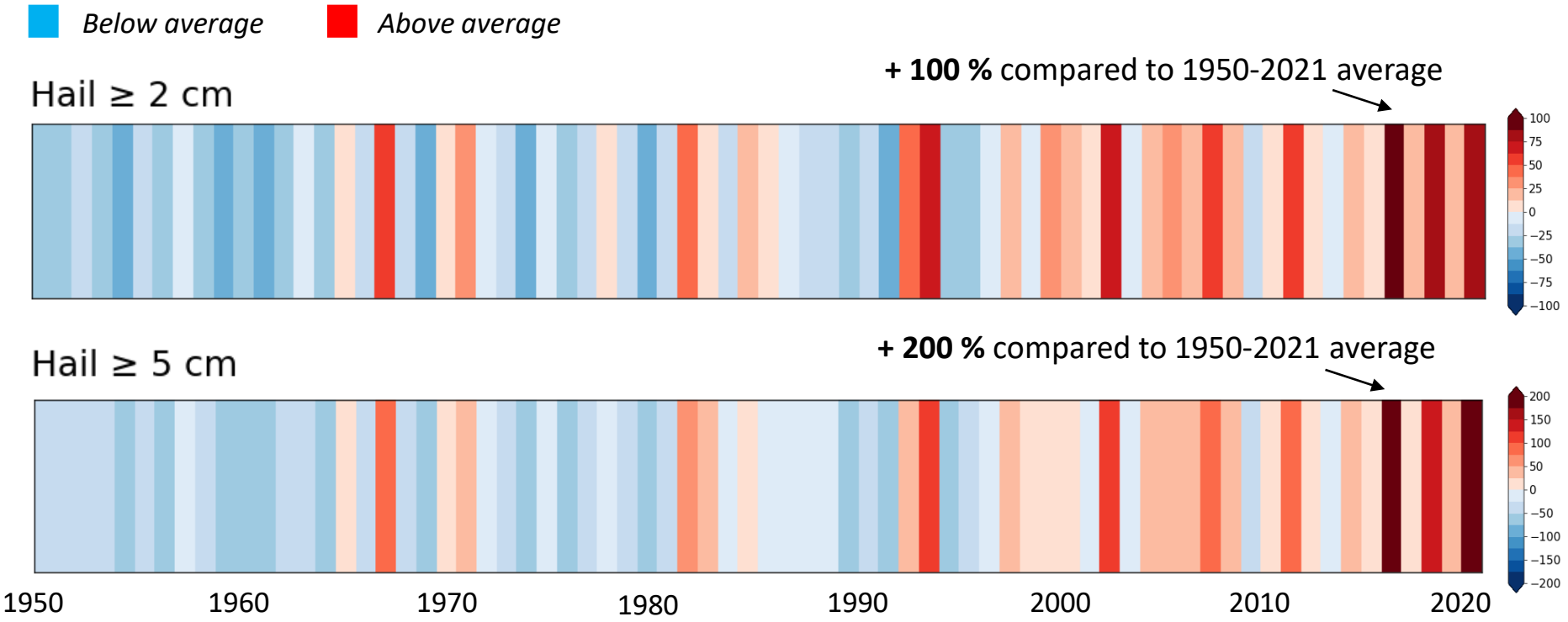
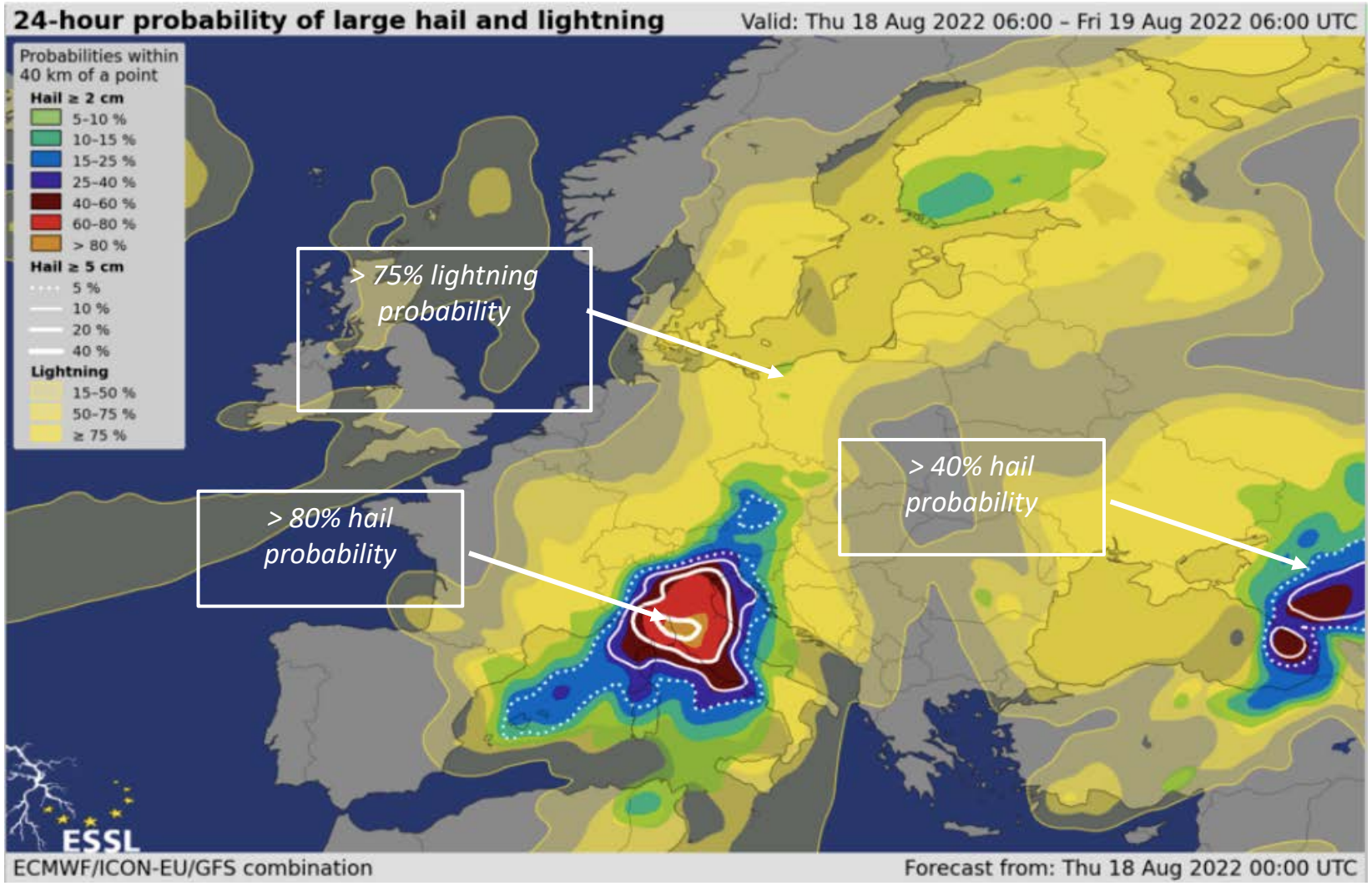
How rapid is the increase? - Northern Italy



Very large *hail is now (2012-2021)* ***3 times*** *more likely than it was in the 1950s*

Application to medium-range forecasting



Work within PreCAST, an FWF project in cooperation with ZAMG and ECMWF.

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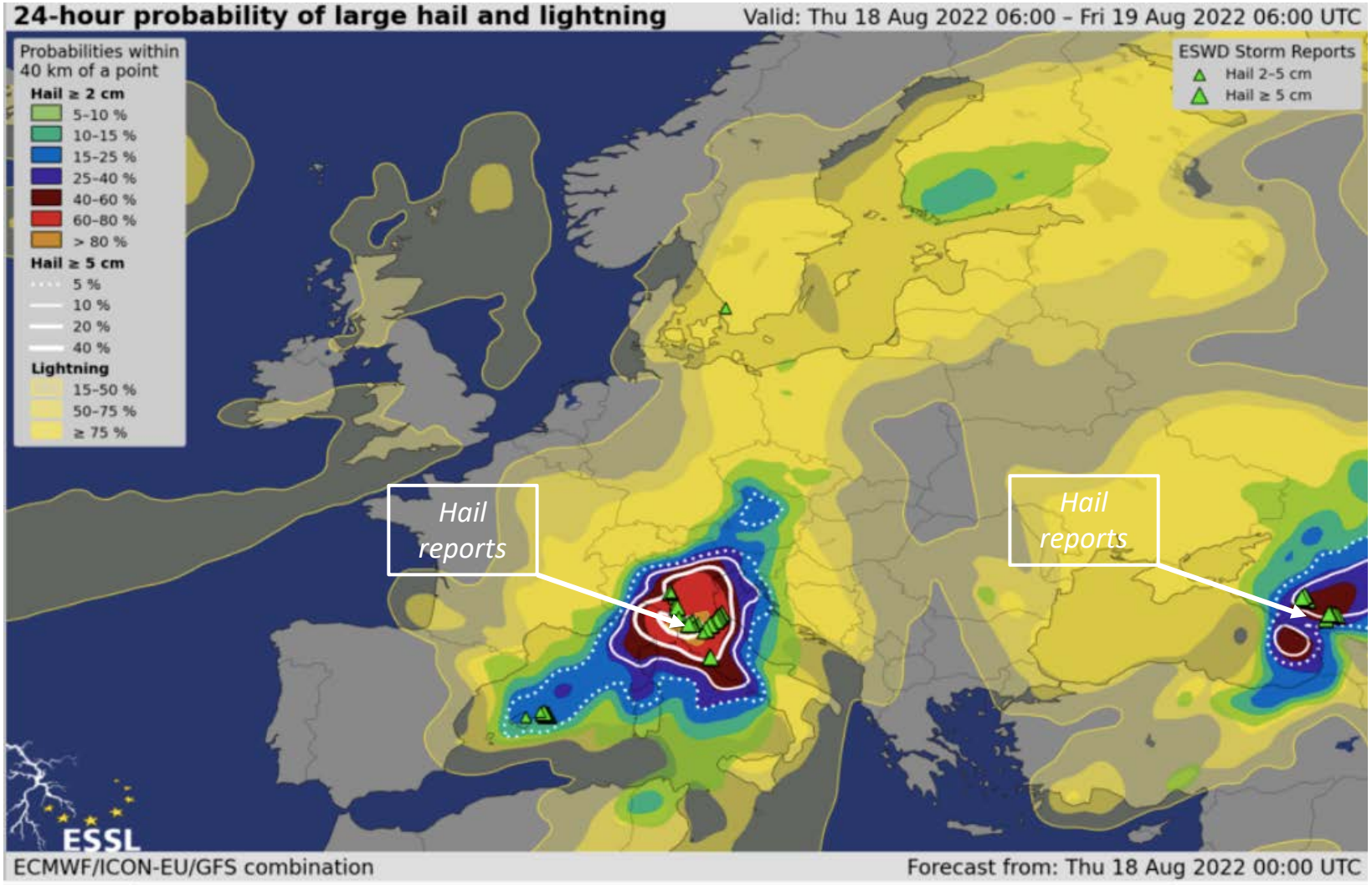
Application to medium-range forecasting



Work within PreCAST, an FWF project in cooperation with ZAMG and ECMWF.

Many scientific papers based on ESWD data

- The ESWD has already been cited 320 times in peer-reviewed scientific literature from around the world: satellite, radar and model studies as well as classic climatology and societal impacts.

- In addition, international institutions (like EUMETSAT and ECMWF) use ESWD data for verification purposes, so do a number of NHMSs (like DWD).

European Severe Storms Laboratory

Access to the ESWD

We are happy to also serve your NHMS.

Most straightforward option get permission to use the data:

- Institutional ESSL membership of NHMS, research institute or public authority
- Includes continuous access to the ESWD (all of Europe), which is continuously updated

Contact: alois.holzer@essl.org

www.eswd.eu

Only in 2021 there were **24330 reports**:

- **5375** Large Hail (15 per day)
- **5795** Heavy Rain (16 per day)
- **12256** Severe wind (34 per day)