

## EUROPEAN SEVERE THUNDERSTORM WARNINGS

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### I. INTRODUCTION

No study summarizes the current severe thunderstorm warning and forecast operations in different European National Hydro-Meteorological Services. This study aims to provide that summary, and, in doing so, to suggest ways for countries developing their own warning service to learn from the previous experiences in other countries. These results are also compared to the warning operations in the United States (USA), the longest-lived and most advanced warning operations in the world.

This study is based on a questionnaire sent to several European National Hydro-Meteorological Services (NHMS) in October 2006. The countries surveyed were Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Holland, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Norway, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

### II. SEVERE THUNDERSTORM AND TORNADO WARNINGS IN EUROPE

Severe thunderstorms are considered as convective storms with damaging wind gusts, large hail or a tornado. For the purposes of this paper, severe thunderstorms may or may not be associated with lightning and thunder, although most likely they are. Also, in this paper, we use the general term *warning*, whereas, in the USA, many of the warnings would be termed *outlooks* (about 6–24 hours) or *watches* (about 1–6 hours).

Most European National Hydro-Meteorological Services issue severe thunderstorm warnings for damaging wind gusts or large hail (Fig. 1). Some countries use their general wind warning also for thunderstorms. For example, the general wind gust warning in Sweden and the wind warning for land areas in Finland also includes gusts from thunderstorms. Ireland and United Kingdom issue, however, general thunderstorm warnings.

The severe thunderstorm warning criteria varies considerably between European countries (Table 1). The minimum wind speed criterion for thunderstorm gust warnings may be as low as 15 m/s or as high as 28 m/s. Many countries have several awareness levels for their thunderstorm warnings, depending on their forecasted severity. Severe thunderstorm warnings on large hail, typically 2 cm, are issued only in some countries. A few countries base their severe thunderstorm warnings on the number of cloud-to-ground lightning strikes, the rain amount, or other forecast parameters (e.g., CAPE).

The typical maximum lead time from the time of warning issuance to the first severe weather report varies from 0.5 to 24 hours, indicating that different warning philosophies are used. In countries where the typical lead time is minutes or few hours, detecting severe storms play major role in warning decision making, and the warning process is more akin to the USA severe thunderstorm



FIG. 1: Severe thunderstorm warnings for damaging wind gusts or large hail in Europe. Countries that issue severe thunderstorm warnings are denoted with green circle, the ones that don't with red square.

| Country        | Gust speed (m/s) | Hail size (cm) | Lead time (h) |
|----------------|------------------|----------------|---------------|
| Austria        | 17               | any            | 5             |
| Belgium        | -                | -              | 0–24          |
| Cyprus         | 21               | -              | 6–24          |
| Czech Republic | 22               | 2              | 0.2–24        |
| Denmark        | -                | -              | 3             |
| Estonia        | -                | -              | -             |
| Finland        | 20               | -              | 0–24          |
| Germany        | 28               | 1.5            | 0–2           |
| Greece         | -                | -              | 3–6           |
| Holland        | 28               | -              | 0–12          |
| Hungary        | 25               | 2              | 0.5–2         |
| Iceland        | -                | -              | -             |
| Italy          | 22               | 2              | 0–6           |
| Latvia         | -                | -              | 0–1           |
| Lithuania      | 15               | 2              | 0–3           |
| Luxembourg     | -                | -              | -             |
| Portugal       | 19               | -              | 0–24          |
| Romania        | 15               | 2.5            | 0.5           |
| Slovenia       | 20               | -              | 6–12          |
| Spain          | -                | -              | 1–24          |
| Sweden         | 21               | -              | -             |
| Switzerland    | 21               | 2              | 0.5           |

TABLE 1: Severe thunderstorm warning criteria (minimum wind gust speed (m/s) or hail size (cm)) if specified and typical warning lead time (h).

warnings. Quite a few countries, however, may issue a warning even 24 hours before the event, clearly based on a forecast, and more akin to the USA outlooks. This system is the case in Finland, where a severe thunderstorm warning may be used for anticipated severe weather 24 hours in advance over a large area for a general time frame or for observed severe weather in real time where the risk is more limited spatially and temporally.

Only six out of the surveyed European National Hydro-Meteorological Services issue tornado warnings (Fig. 2). In Spain, a tornado warning is included in a severe thunderstorm warning if needed. In Holland, the warning is on waterspouts only, not for tornadoes over land. In Germany, Holland, and Cyprus, the warning is issued on basis of observations of tornadoes already on the ground, whereas, tornado warnings are issued based on the forecast in Estonia, and on the basis of radar data and algorithms in Romania. Cyprus issued their first tornado warning in 1977, Estonia in 2002, and Germany and Romania in 2005.

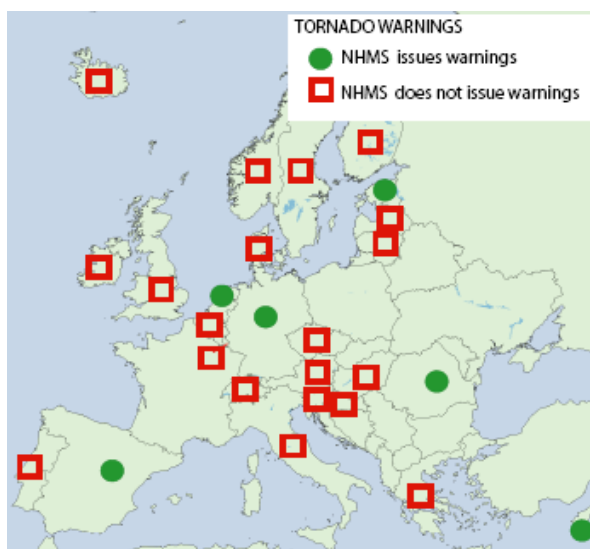


FIG. 2: Tornado warnings by European National Hydro-Meteorological Services (green circles). The countries that don't issue tornado warnings are denoted by red square.

### III. WARNING PROCESS

Almost all (90% of surveyed) European NHMS cooperate with media in major severe thunderstorm events. Typical means of co-operation are by distributing warnings and giving media interviews during or after the event. Half of those surveyed have co-operation with neighbouring countries in severe storm events, typically done by exchanging information between two countries, by METEORISK (an international alpinewide project to coordinate severe weather forecasts), by Meteoalarm, or by the European Severe Weather Database (ESWD). Co-operation with civil protection agencies occurs by all surveyed countries.

### IV. EUROPEAN CHALLENGES

Severe weather does not follow country borders. Typically a severe weather event affects several European countries simultaneously or over several days, making the exchange of information between countries the major challenge in Europe. Since every country is responsible for

warnings in their area and has different warning criteria, countries do not necessarily have to agree when issuing warnings. For a good warning decision, one would, however, very often need to know the severe weather reports and information on warnings on the other side of country borders. The challenge is in exchanging both warning information and severe weather observation reports. The exchange of warning information in Europe has become easier since Meteoalarm became operational in March 2007. On the Meteoalarm webpage, the European weather warnings from EUMETNET countries are displayed in one figure. The European Severe Weather Database is a web-based interface where the public and NHMSs can submit and retrieve severe weather reports. If fully operational in real time, it has potential to become a major tool for severe thunderstorm nowcasting and warning operations when severe weather advances over Europe. Even still, not all European NHMSs participate in Meteoalarm or ESWD.

Many European NHMSs are actively developing their severe thunderstorm forecast process and warning services. Major challenges that remain include: obtaining observations of severe weather for real-time forecasting (e.g., radar data) and post-event verification (e.g., storm reports), educating forecasters in the latest forecasting techniques, and having access to state-of-the-art forecaster workstations.

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