Annual Report 2020

European Severe Storms Laboratory

About the Laboratory

The *European Severe Storms Laboratory e.V.* (ESSL e.V.) was founded as a private, non-profit research organisation in December 2006. It is a spin-off of German Aerospace Centre DLR in Oberpfaffenhofen, and relies on the expertise of its international team.

In Europe, severe thunderstorms inflict an estimated annual damage of about 5 billion euro and lead to dozens of fatalities. ESSL wants to make Europe more resilient to severe weather by…

- Performing fundamental and applied research on severe convective storms in Europe,
- Operating the European Severe Weather Database, ESWD,
- Organizing the European Conferences on Severe Storms, ECSS.

The *European Severe Storms Laboratory – Science & Training* is a subsidiary located in Wiener Neustadt, Austria, that pursues similar goals. It operates the Research and Training Centre, which is the venue of various courses, workshops and the ESSL Testbed. In addition to the goals above, it…

- Operates the ESSL Testbed, a facility to evaluate new forecast-supporting tools,
- Organizes various courses for various target groups, including weather forecasters, to enhance their understanding of convective storms.

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Foreword

Dear Reader,

In 2020, ESSL, like other organizations, was strongly impacted by the coronavirus pandemic. However, it was able to continue its operations in a good way. Most importantly, all on-site events scheduled to take place at the Research and Training Centre in Wiener Neustadt were changed to online events. This was a pity, since the ESSL team had been looking forward to using the newly rented part of the building adjacent to the existing premises, which include a new, larger, seminar room. That said, the online teaching mode worked well judging from the feedback the team received from participants (see Chapter 4).

The COVID-19 situation also sparked a lot of creativity within the team and several new event concepts were developed and carried out. They included a course specifically focusing on the use of satellite products for monitoring and nowcasting severe convective storms and a series of free webinars called “Refreshers” in which a particular topic related to forecasting convective storms was presented. Additionally, ESSL pioneered the Convective Risk Workshop, where the ESSL core team and external experts presented the newest insights into modelling the occurrence of convective hazards and their impacts.

Compared to training activities, ESSL’s other activities were less impacted by the coronavirus, since ESSL researchers and personnel are not new to working remotely for part of the time. In 2020 in-person meetings were obviously almost not possible at all once the pandemic struck in March.

Regarding research, 2020 was a very promising year, since two large grants were awarded to ESSL, one to ESSL in Germany and one to ESSL – Science & Training in Austria (see Chapter 2). These projects, with the acronyms CHECC and PreCAST, deal with studying changes of severe weather climate extremes and of improving forecasting of severe convection, respectively. For the CHECC project, ESSL is supported by the Institute of Meteorology of the Free University of Berlin that kindly provides an office to new ESSL researcher Francesco Battaglioli. For the project PreCAST, ESSL has teamed up with ZAMG and is supported by ECMWF.

Besides pure research, ESSL also carried out its annual Testbed programme. During four weeks of online sessions, 37 participants contributed to the evaluation of forecast-supporting tools. In 2020, they included nowcasting and warning tools developed by the German weather service DWD, and its new ICON-D2-EPS convection-permitting forecasting system (see Chapter 3).

In the meantime, the ESWD team and the network of volunteers continued to collect real-time severe weather reports. Furthermore, there was a strong focus on integrating historical severe weather events as part of the CHECC project. Overall, this resulted in 25,760 new quality-controlled reports being entered (see Chapter 1).

On the administrative side (Chapter 6), highlights include the starting of Dr Tanja Renko as a deputy Director in ESSL's Executive Board, the joining of one institutional full member, the Institute of Meteorology and Water Management (IMGW-PIB) of Poland, two full personal members, and three institutional supporting members. Financially, the start of two new research projects and the membership fees provided some relief. That said, financial resources were still too limited to allow for adequate payment of, in particular, the financial administration, which therefore was still done partly as voluntary work.

In 2020, it became clear that both EUMETSAT and ECMWF would like to collaborate more closely with ESSL in 2021, which has led to new activities in 2021 that also help to improve ESSL's financial situation. With EUMETSAT, a multi-year framework contract for collaboration on providing support to the Meteosat Third Generation User Preparedness programme has since been concluded, and, for and with ECMWF, several smaller projects are carried out that relate to enhancing ESSL's Weather Displayer and studies on the use of ECMWF products for forecasting severe convection. In ESSL's Newsletters (Chapter 5) the ESSL Executive Board informs its members of those developments, and we will likewise do in next year's Annual Report.

It is my pleasure to present you this Annual Report 2020 that describes ESSL's achievements in its fourteenth full business year.

Wiener Neustadt, 31 August 2021,

Dr Pieter Groenemeijer
ESSL Director
Chair of the Executive Board

1 Severe Weather Data Collection

A key activity of ESSL is the collection of severe weather data in the European Severe Weather Database in cooperation with its partners throughout Europe. The data forms the starting point of research within and outside of ESSL.

1.1 ESWD Data Users and Partners

Users

ESWD data are used by a wide range of users. They include ESSL members who have access to the data as a benefit for members. In addition, ESSL receives a fair number of requests from potential new users, usually initiated by an e-mail sent to the address eswd@essl.org.

With 37 data requests the interest was similar to that of 2019, although a few more commercial requests arrived (Figure 1-1). Most requests however come from students or individual researchers who would like to use parts of the database to support their study. If the study is not driven by commercial interest and the student agrees to the User Agreement, ESSL will deliver the data free of cost. When a commercial party, would like to access the data, they are invited to join the association as a supporting member, or to purchase them from ESSL.

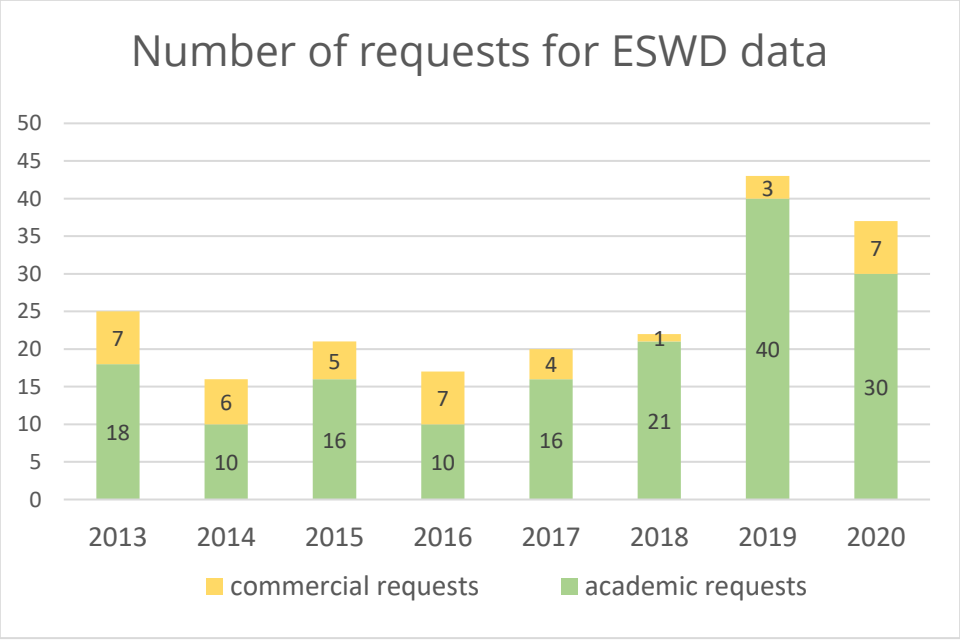


Figure 1-1. Number of requests for ESWD data by non-members.

1.2 Severe Weather in 2020

Event Types

In 2020, the ESWD was expanded with **25 760** new severe weather reports (Figure 1-2), which is more than the 22 216 reports for the previous year, 2019. This is probably due in part to an increase in the number of convective episodes in the spring and summer across Europe.

The most frequently reported severe weather phenomenon were severe wind gusts (14471), followed by heavy rain (3 947), large hail (3 274), and damaging lightning (1 555) (Table 1-1).

Table 1-1. Severe Weather Reports collected in the European Severe Weather Database in 2019.

Report Type	Number of reports	%
Severe wind gusts	14 471	56.2
Heavy rain	3 947	15.3
Large Hail	3 274	12.7
Damaging lightning strikes	1 555	6.0
Heavy snowfall/snowstorms	1 403	5.4
Tornadoes	837	3.3
Avalanches	157	0.6
Ice Accumulation	100	0.4
Lesser whirlwinds	16	< 0.1
Total	25 760	

Table 1-2. Quality control levels of ESWD reports from 2019.

Quality Control level	Number of reports	%
QC0: as received	0	0.0
QC0+: plausibility checked	1 759	6.8
QC1: report confirmed by reliable sources	23 998	93.2
QC2: scientific case study	0	0.0

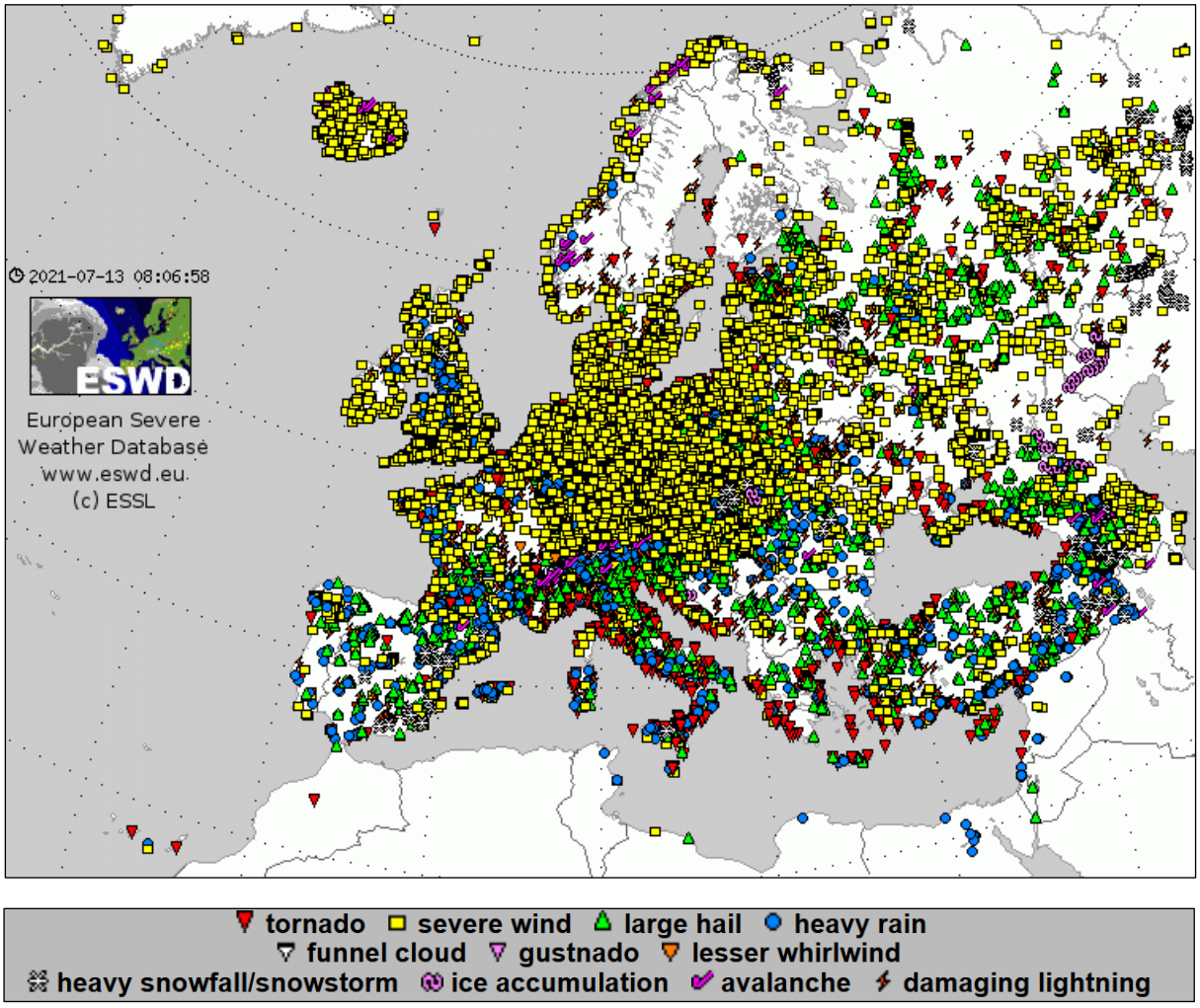


Figure 1-2. The 25 760 ESWD reports of events occurring in 2020.

Quality Control

ESWD reports are checked for trustworthiness by ESSL's ESWD team and its partners. Any report that reaches ESSL from an untrusted source will initially be given the QC0 quality level, indicating that no check has been carried out. After checking, ESSL and its partners can assign any of three QC-levels to a report, based on the level of trustworthiness (plausible = QC0+, or confirmed by a reliable source = QC1) or whether – in rare cases – a full scientific case study has been carried out (QC2). Upgrading from one level to another is possible at any time as more or better information comes in to corroborate the report. All reports from 2020 have been upgraded at least to QC0+ or QC1 (Table 1-2).

ESWD Partners

We like to stress the importance of the work of ESSL's partners in collecting and checking ESWD reports for correctness. Such partners are individuals, associations, and weather services. ESSL's most active partners are listed in Table 1-3.

Mr. Igor Laskowski, who tops the list, is member of Skywarn Poland. He collects both recent and historical severe weather data. The historical reviews from old administrative reports are sometimes done in collaboration with researchers at the University of Silesia. ESSL has specifically thanked and awarded Igor and colleagues them for their extraordinary contributions.

The Association MeteoNetwork/PRETEMP has automated their reported to the ESWD using the ESWD API. Once a severe weather report is collected in Italy that meets the ESSL criteria, it is automatically forwarded to the ESWD. After solving some minor initial glitches, the system works very well.

To show its gratitude, ESSL sends individual volunteers awards, such as ESSL merchandise or small financial award on a yearly basis.

Table 1-3. Most active ESWD partners in 2020

Name	Country	Number of reports
1. Mr Igor Laskowski	Poland	12 408
2. Association MeteoNetwork/PRETEMP	Italy	1 219
3. Mr Nicholas Baluteau	France	811
4. Amateur Meteorological Society	Czechia	442
5. Mr Bas van der Ploeg	Netherlands	310
6. Mr Igor Azhigov	Russia	237
7. Slovak HydroMeteorological Institute	Slovakia	228
8. Mr Markus Weggässer	Germany	193
9. Mr Mario Sekulić	Croatia	177
10.Mr. Kairo Kiitsak	Estonia	162

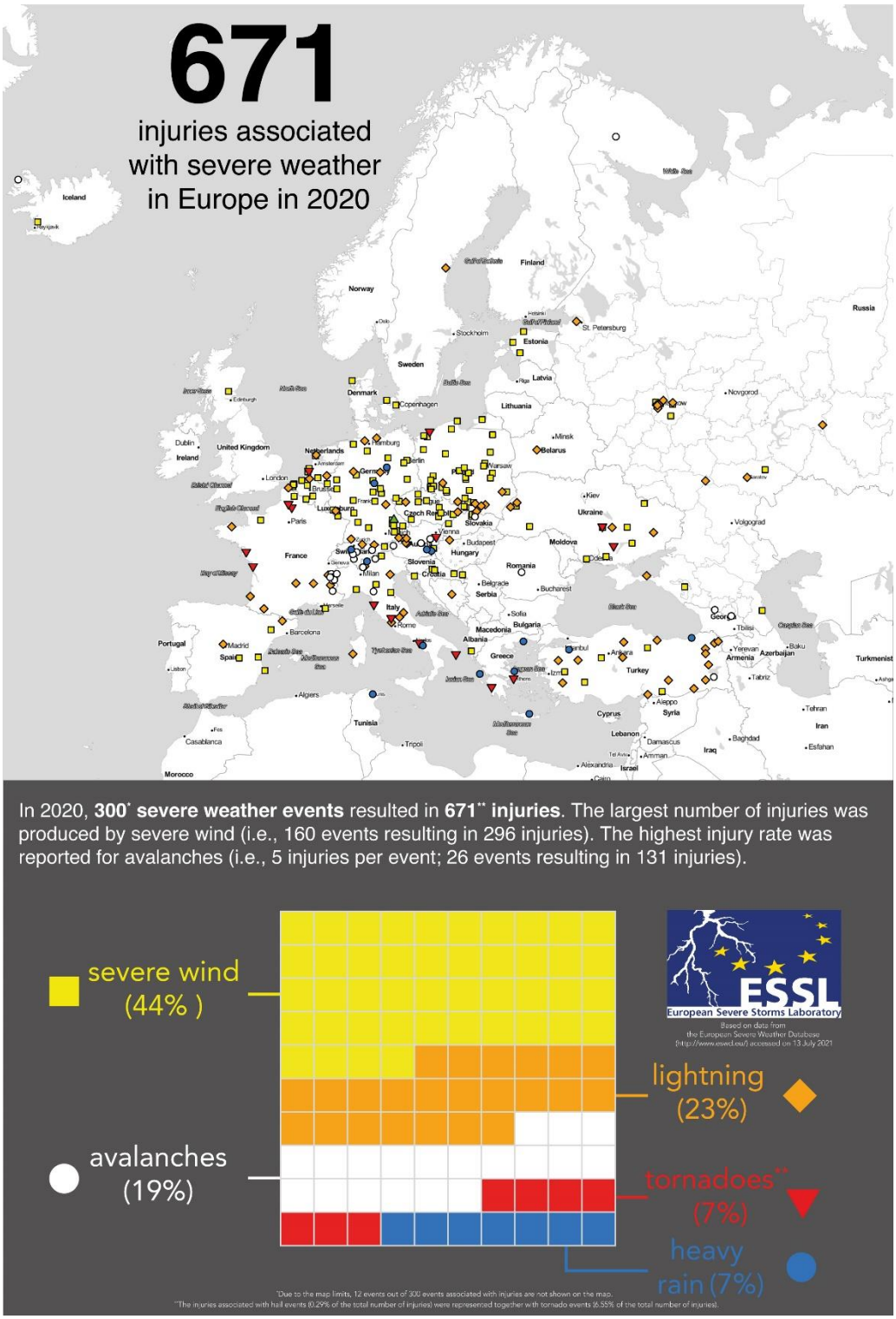


Figure 1-3. The spatial distribution of the ESWD severe weather reports in Europe, associated with injuries in 2020. Below, the percentage of injuries associated with each type of severe weather across the entire ESWD area, i.e., including Mediterranean Africa and Asia, and Central Asia (excluding categories < 1%).

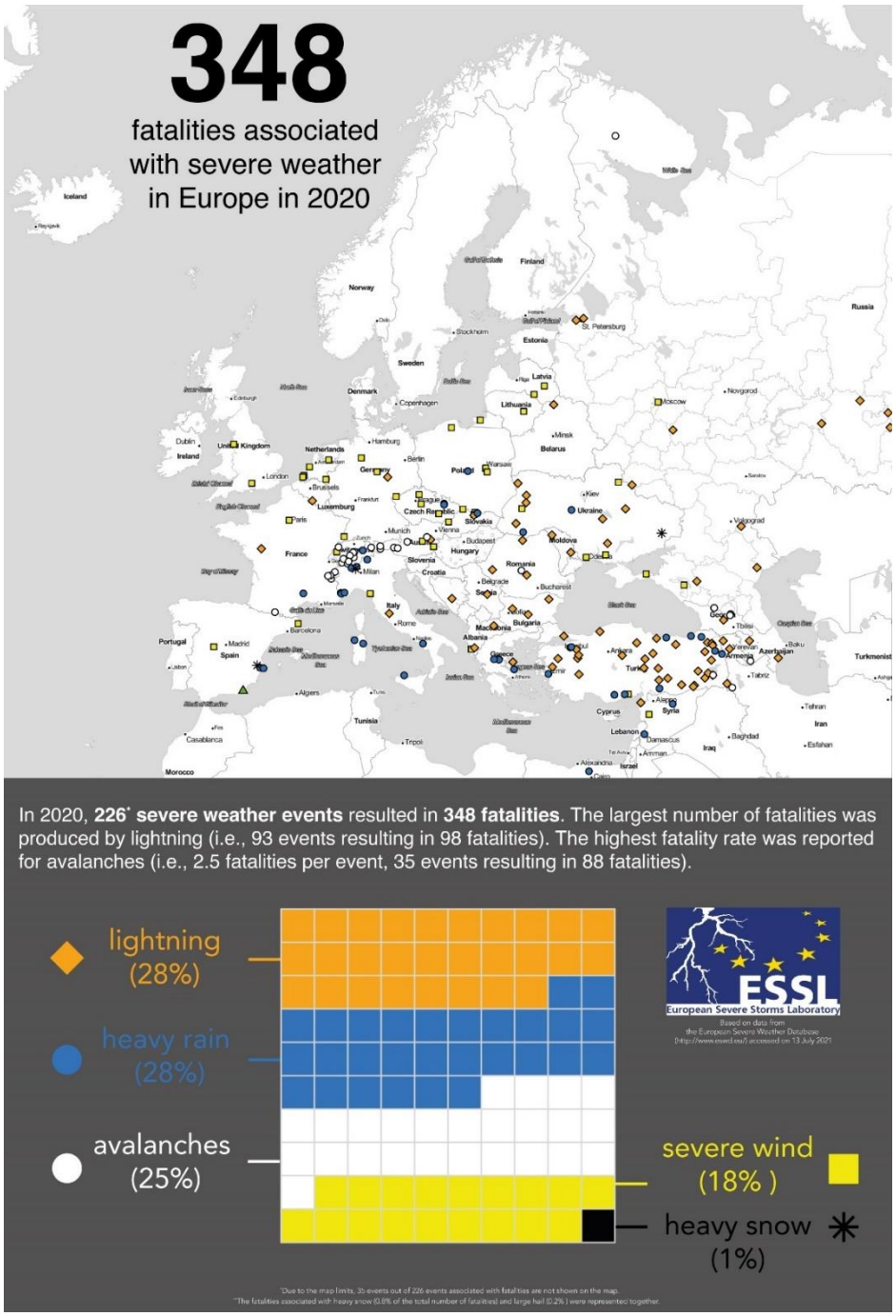


Figure 1-4. The spatial distribution of the ESWD severe weather reports in 2020 associated with fatalities. Below, the percentage of fatalities associated with each type of severe weather across the entire ESWD area, i.e., including Mediterranean Africa and Asia, and Central Asia (excluding categories < 1%).

Fatalities and Injuries

The severe weather reports of 2020 were associated with 671 injuries (Figure 1-3) and 348 fatalities (Figure 1-4). Wind was responsible for 44% of the recorded injuries, and 18% of all recorded fatalities. Heavy rain and flash floods were responsible for 28% of the fatalities, but only 7% of injuries. Lightning caused 23% of injuries and 218% of fatalities. Many fatalities (25%) were also recorded from avalanches.

The single deadliest event involved 23 fatalities in floods at Tulun (Irkutsk, Russia) on 27 June. This was also the day with the highest number of (hydro-)meteorological fatalities. Other events with many fatalities include a heavy rain event that struck Morocco on 8 September resulting in 17 fatalities. The top ten of days with most fatalities (

Table 1-4) shows that heavy rain and the resulting flash floods, primarily in June–September, were responsible for most fatalities in 2019. In addition, a windstorm in Greece on 10 July, and a series of avalanches in January in Germany and Austria and in May in Russia are listed.

	Event type(s)	Date	Country	Fatalities
1	Avalanches Wind	5 February	Turkey Czech Republic Slovakia	38
2	Heavy rain	12 March	Egypt	29

	Wind		Poland Russian Federation Lithuania Latvia	
3	Heavy rain Lightning	12 August	Switzerland Italy Russian Federation France	8
4	Heavy rain	22 August	Turkey	8
5	Heavy rain	27 March	Syria	7
6	Avalanches	4 February	Turkey Greece	6
7	Wind Avalanches	10 February	Poland Czech Republic Switzerland Georgia	6
8	Heavy Rain	21 June	Turkey	6
9	Lightning Heavy rain	9 August	Russian Federation Greece	6
10	Heavy Rain	12 July	Turkey	5

Table 1-4. The ten days with most fatalities in 2020 recorded in the ESWD.

2 Research

ESSL started two long-term research projects in 2020. The project CHECC deals with the changing risk of convective hazards as a result of climate change. The project PreCAST focuses on improving severe weather forecasts.

2.1 Convective Hazard Evolution under Climate Change (CHECC)

Grant:	€ 339 987
Funded by:	German Federal Ministry of Education and Research (BMBF)
Period:	1 March 2020 – 28 February 2023
Carried out by:	European Severe Storms Laboratory e.V. (ESSL), Weßling
Supported by:	Institute of Meteorology, FU-Berlin; NSSL; Univ. of Poznań
ESSL employees:	Francesco Battaglioli, Thilo Kühne, Pieter Groenemeijer

In March 2020, ESSL has started to work on a new 3-year research project CHECC, funded by the German Ministry of Research and Education and part of the national ClimXtreme research network, focused on the analysis of extreme climatological events. Within this project, ESSL will improve statistical dynamical models to detect extreme convective events from reanalysis and climate model data, and develop new methods based on convection-permitting model simulations.

The key aim of CHECC is to statistically model the occurrence of convective hazards in order to find out how the frequency and intensity of (the most) extreme convective events and their interannual variability have changed in recent decades, and whether robust trends of event frequency or their variability to be expected in the future. Furthermore, the ESWD is enhanced to investigate the robustness of the projections to the choice of the used data sets, their resolution and geographical region.

Later in the project, the question will be addressed to what extent past, and projected future changes are attributable to changes in tropospheric flow patterns and how information on convective hazard occurrence can be derived from convection-permitting resolution climate projections.

The project is carried out by Thilo Kühne, who contributes with targeted ESWD data collection from old resources, by Francesco Battaglioli, who is a PhD student, and an additional employee to join ESSL in 2021, while Pieter Groenemeijer supervises the work.

Francesco Battaglioli's office is located at the Institute of Meteorology of the Free University of Berlin which has kindly offered to host him while working on his Ph.D. supervised by professors Dr Henning Rust and Dr Uwe Ulbrich.

A collaboration has started as well with Dr Mateusz Taszarek (National Severe Storms Laboratory, USA; and University of Poznań, Poland), who support the study by providing convective parameters calculated from reanalysis data.

2.2 Prediction of Convective hazards Across Spatio-Temporal Scales

Grant:	ESSL: € 293 010, total: € 483 280
Funded by:	FWF Der Wissenschaftsfonds (Austria)
Period:	1 September 2020 – 31 August 2024
Carried out by:	European Severe Storms Laboratory – Science and Training, Wiener Neustadt, and Zentralanstalt für Meteorologie und Geodynamik (ZAMG)
Supported by:	European Centre for Medium-Range Weather Forecasts (ECMWF)
ESSL employees:	Tomáš Púčik, Pieter Groenemeijer

After receiving a positive response from the Austrian Science Fund FWF, the 4-year project PreCAST, started in September. PreCAST is a collaborative project with ZAMG, lead by ESSL and supported by ECMWF.

In this project, lead by ESSL's Tomáš Púčik, the limitations of the predictive skill of NWP-based forecasts of convective hazards, such as large hail and severe wind, on timescales from hours to 10 days in advance. To do this, a probabilistic forecast system that blends short-range (1 - 72 hour) and medium-range (72 - 240 hour) forecasts, each using different approach.

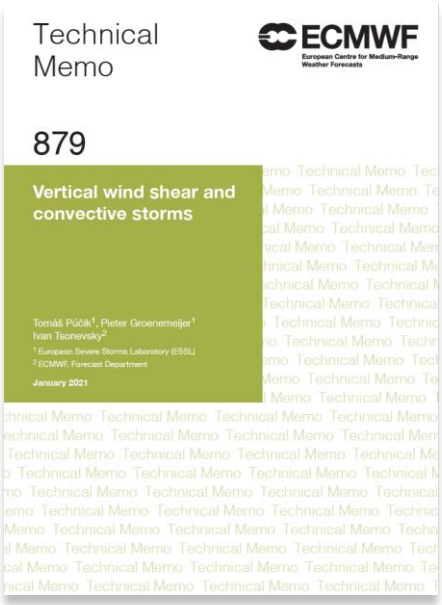
For the medium range, the AR-CHaMo logistic modelling framework is used which was previously developed by ESSL and MunichRe, while for the short range, a convection-permitting ensemble with stochastic microphysics will be developed. In the project, ESSL collaborates with ECMWF to leverage its Ensemble Prediction System to do this

The ZAMG contribution focuses on the short forecast range for which they will leverage and enhance its convection-permitting ensemble forecast system C-LAEF by introducing stochastic physics.

In 2020, ESSL accomplished first technical steps, such as modifying the AR-CHaMo software to be applied to the ERA-5 reanalysis, and explored finding optimal predictors for hail and heavy rainfall forecasting

2.3 Study on wind shear-related forecast parameters

Funded by:	European Centre for Medium-Range Weather Forecasts (ECMWF)
Period:	2020
Carried out by:	ESSL Science & Training, Wiener Neustadt
ESSL employees:	Tomáš Púčik, Pieter Groenemeijer



In addition to the above two projects, a smaller study was carried out by with Dr Ivan Tsonevsky of ECMWF, i.e., a literature review of the effects of vertical wind shear on convective storms and severe weather. The result of the review is an ECMWF technical memorandum, summarizing the state-of-the-art on this topic.

Púčik, T, Groenemeijer, P, Tsonevsky, I.: ECMWF Technical Memorandum 879: Vertical wind shear and convective storms. http://dx.doi.org/10.21957/z0b3t5mrv

3 ESSL Testbed 2020

The Testbed is ESSL's annually returning event that serves two aims: the evaluation of tools supporting the forecast or warning process and providing training in severe convection forecasting to its participants.

The ESSL Testbed 2020 took place during the weeks of 15 – 19 June, 22 – 26 June, 6 – 10 July and 13 – 17 July 2020. Due to the COVID-19 situation, the program was carried out online, instead of the regular on-site setting at the ESSL Research and Training Centre in Wiener Neustadt. The BlueJeans teleconferencing system was used to communicate with the participants. Break-out sessions were used when participants worked in small groups. While many of the participants missed the personal interaction, some commented that being able to handle the interface themselves at their own computers – instead of one computer per several participants in the on-site setting – allowed them to evaluate the products more efficiently.

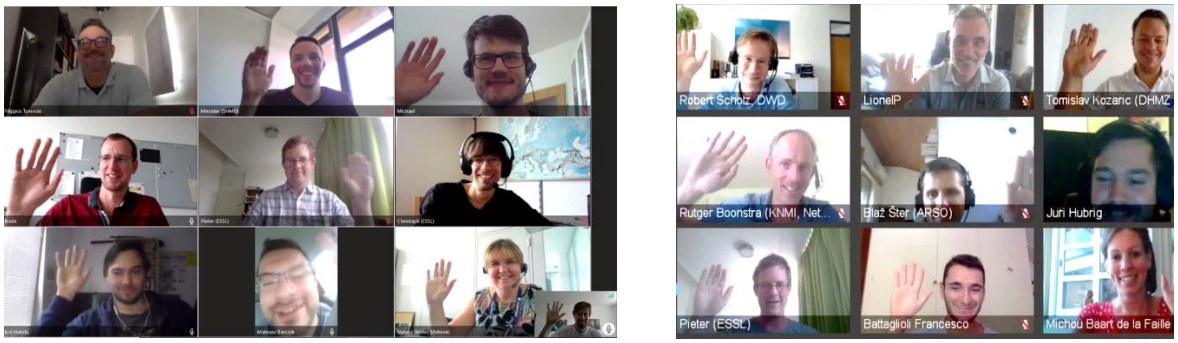


Figure 3-1. Some of the participants of the ESSL Testbed 2020

During the four weeks, 37 participants took part in the Testbed in addition to 6 ESSL staff members. The participants came from 15 different countries: Austria, Germany, the Netherlands, Slovakia, Croatia, Portugal, Switzerland, Poland, Czechia, Cyprus, Lithuania, Latvia, Finland, Slovenia, and Spain. In the first and last weeks, respectively, there was a strong focus on training besides product evaluation. In contrast, product evaluation was the main activity during the second and third Testbed weeks labels as "Expert weeks" in which participants were involved who already had prior Testbed experience.

As in previous years, the participants used experimental forecast-supporting tools while making experimental forecasts and nowcasts, most of them to be issued in real-time to emulate an operational forecasting environment.

This year, a number of nowcast products from DWD were evaluated which are part of DWD's SINFONY project, which stands for Seamless INtegrated FOrecastiNg sYstem, and aims to integrate numerical weather prediction and nowcasting developments. The products at the Testbed 2020 included STEPS-DWD, an algorithm for the automated

Nowcasting of precipitation based on radar composites from which an ensemble of equally likely short-term evaluations of the precipitation is generated.

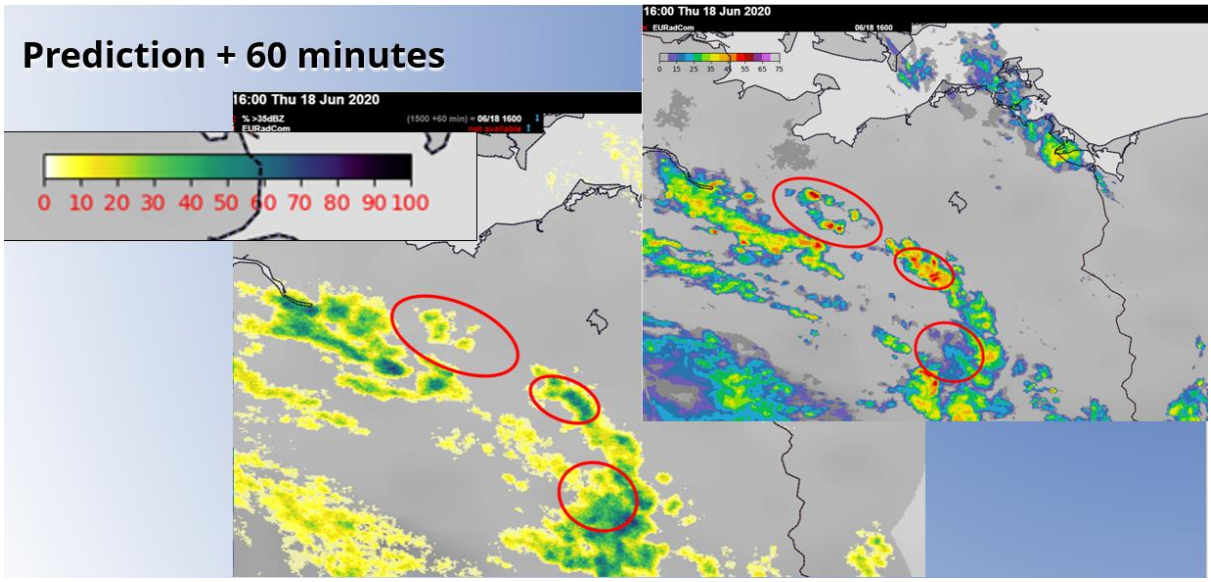


Figure 3-2. STEPS-DWD 60-minute prediction of probability of > 35 dBZ reflectivity (left), compared to observations (right). Areas of interest are indicated with a red ellipse.

Another SINFONY product was KONRAD3D, a developmental cell-detection, tacking and nowcasting system, based on three-dimensional radar data. Additionally, DWD's ICON-D2-EPS modelling system was part of the Testbed programme, where its ability to predict convective storm evolution was studied. Besides these products, the Testbed participants also worked on an evaluation of two products primarily geared to aviation users called NowcastSAT and NowcastELEC, which are designed to detect and predict the evaluation of storms across portions of the world without radar coverage.

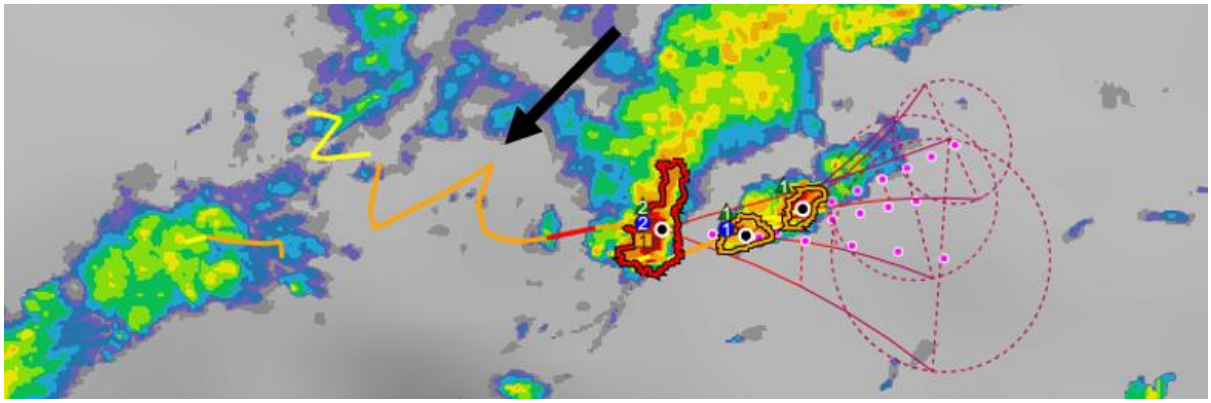


Figure 3-3. Visualization of KONRAD-3D at the ESSL Testbed, showing detected cell outlines with their color-coded intensity, and "ice-cream cones" representing their motion in the next 60 hours. An arrow points at the (rather erratic) past track of the cell.

4 Training activities

In 2020, ESSL the coronavirus pandemic greatly influenced the organization of ESSL's events. However, a large number of events were still successfully carried out through teleconferencing. A number of new event formats were developed.

2020 was a difficult year for the organization of courses at ESSL. The first course that was affected was the "Dynamics and forecasting of severe convection" between 9 and 13 March. As the COVID-19 began spreading across Europe and the U.S., ESSL was forced to move the seminar to the online form.

Professor Dr Jeff Trapp, based in Illinois, helped us greatly by committing to the planned schedule despite the time zone difference and by getting up extremely early to deliver the morning lectures to European participants. The aviation seminars planned for the spring were postponed to the autumn in the hope that the situation would then allow for an on-site presence. On-demand courses for the Civil Protection of the Marche Region (Italy) and the Weather Service of Catalonia (Spain) were postponed to 2021 and an on-demand course for the Meteorological Service of Cyprus was postponed until early December.

Despite all the complications, ESSL managed to organize 7 events lasting 3 to 5 days, and 3 shorter seminars lasting one day each. All of these were held online through videoconferencing. The events included two editions of the "Forecasting Severe Convection" course, two editions of the "Aviation Forecasting of Severe Convection" course and one edition of "Dynamics and Prediction of Severe Convection".

Figure 4-1. Group photo from one of the courses for aviation meteorologists.

Dr Christoph Gatzen joined Dr. Tomáš Púčik in teaching these courses. Our premises in Wiener Neustadt remained empty; there was neither a dinner nor a guided tour of Wiener Neustadt. The group photo on Friday was replaced by a print screen of participants waving in front of their cameras. Although the participants and the ESSL team missed the personal contact, the feedback we received shows that we were able to maintain the high-quality level of these events.

Besides the courses, ESSL also offered three events according to new formats each. The first addition was a series of 1-day "Refreshers" organized on 27 May, and on 3 and 10 June. The refreshers covered these three topics: forecasting convective initiation, forecasting convective type, and forecasting individual convective hazards. The refreshers were free of charge and attracted a lot of attention. The number of registrations exceeded the maximum number technically possible at the time of 100 participants.

Another addition to ESSL's portfolio was a 4-day course on "Optimal use of satellite data in forecasting severe convection", co-organized with EUMETSAT trainers Nataša Strelec-Mahović and Ivan Smiljanić between 16 and 19 November. The course combined lectures on the convective storm forecasting/nowcasting issues and how these can be tackled by effective use of satellite data. For instance, we discussed how satellite data can help us in nowcasting convective initiation or what are the limitations of using storm-top characteristics for nowcasting individual types of severe weather hazards.

Group photo from the "Optimal use of satellite data in forecasting severe convection".

The third addition was a 3-day "Convective Risk Workshop" that took place in the following week, organized between 24 and 26 November. While most ESSL events are aimed especially at the forecast community, the risk workshop was aimed at the risk modelers from the (re-)insurance and research communities. Besides the ESSL team, a number of experts, such as Dr. John Allen, Dr Jürgen Grieser, and Dr Mateusz Taszarek presented their insights into modelling the convective risk across Europe and globally, while also pointing out the limitations of the current tools we have at our disposal.

Figure 4-2. Advertisement for the Convective Storm Risk Workshop 2020

5 Publications and Communications

ESSL produced many scientific and other results in 2020, which lead to a high number of presentations and publications. Below, a list of all publications is given, with the names of ESSL-affiliated authors underlined.

5.1 Peer-reviewed scientific publications

1. Bogdan Antonescu, Tomáš Púčik, and David M. Schultz, 2020: **Hindcasting the First Tornado Forecast in Europe: 25 June 1967**. *Weather and Forecasting*, **35**, 417–436. https://doi.org/10.1175/WAF-D-19-0173.1

2. Alexander Chernokulsky, Michael Kurgansky, Igor Mokhov, Andrei Shikhov, Igor Azhigov, Evgeniya Selezneva, Denis Zakharchenko, Bogdan Antonescu, and Thilo Kühne, 2020: **Tornadoes in Northern Eurasia: From the Middle Age to the Information Era**. *Monthly Weather Review*, **148**, 3081–3110. https://doi.org/10.1175/MWR-D-19-0251.1

3. Taszarek, M., J. T. Allen, P. Groenemeijer, R. Edwards, H. E. Brooks, V. Chmielewski, and S. Enno, 2020: **Severe convective storms across Europe and the United States. Part 1: Climatology of lightning, large hail, severe wind, and tornadoes.** *Journal of Climate,* 10239–10261. https://doi.org/10.1175/JCLI-D-20-0345.1

4. Taszarek, M., J. T. Allen, T. Púčik, K. A. Hoogewind, and H. E. Brooks, 2020: **Severe convective storms across Europe and the United States. Part 2: ERA5 environments associated with lightning, large hail, severe wind, and tornadoes.** *Journal of Climate*, 10263–10286. https://doi.org/10.1175/JCLI-D-20-0346.1

5. Brázdil, Rudolf, Kateřina Chromá, Tomáš Púčik, Zbyněk Černoch, Petr Dobrovolný, Lukáš Dolák, Oldřich Kotyza, Ladislava Řezníčková and Mateusz Taszarek, 2020: **The Climatology of Significant Tornadoes in the Czech Republic.** *Atmosphere*, **11**, 689. https://doi.org/10.3390/atmos11070689

6. Šinger, M. and T. Púčik, 2020: **A challenging tornado forecast in Slovakia**. *Atmosphere*, **11**, 821. https://doi.org/10.3390/atmos11080821

5.2 Scientific and Invited Presentations

Oral presentations

- Pieter Groenemeijer, Anja Rädler, Chris Castellano, Tomáš Púčik, Eberhard Faust: Modelling risk hailstorm risk using a generated event set based on AR-CHaMo, **Munich Re-internal webinar on the joint ESSL-Munich Re project ARCS**, 9 September 2020.
- Pieter Groenemeijer: Nimmt die Gefahr von Tornados in Europa zu? **10. Extremwetterkongress**, Hamburg, 23 – 25 September 2020.
- Pieter Groenemeijer and Chiara Marsigli: **ICON-D2-EPS in the European Severe Storms Laboratory (ESSL) Testbed 2020**, EWGLAM Meeting, 1 October 2020.
- Pieter Groenemeijer and Zhongjian Liang: **Barcelona Hackathon**, 16–18 October 2020.
- Pieter Groenemeijer: **Konvektive Unwetterhäufigkeit im Klimawandel**, Fortbildung Wetterredaktion ORF, 5 November 2020.
- Thilo Kühne: **Severe Weather Data Collection in the ESWD**, ESSL Convection Risk Workshop, 24 – 26 November 2020.
- Tanja Renko: **Risk mitigation: Severe weather warnings**, ESSL Convection Risk Workshop, 24 – 26 November 2020.
- Gabriel Strommer: **Zusammenhänge zwischen Starkregen und Hochwasser**, Trusted Spotter Network Workshop on 7 November 2020.
- Thomas Schreiner: **Die wissenschaftliche Verwendung von Wetter- und Impact-Meldungen via ESWD**, Trusted Spotter Network Workshop on 7 November 2020.
- Bogdan Antonescu: **Tornadoes in Europe: What is the worst that could happen?** ESSL Convection Risk Workshop, 24 – 26 November 2020.
- Bogdan Antonescu: **Climatology of observed severe convective storms and their impacts**, ESSL Convection Risk Workshop, 24 – 26 November 2020.
- Bogdan Antonescu, Pieter Groenemeijer, Thilo Kühne, David M. Schultz, Tomáš Púčik, Alois M. Holzer: **Tornadoes in Europe: What we have learned so far,** 54th Congress of the Canadian Meteorological and Oceanographical Society, 25 May–15 June, Ottawa, Canada.

Poster presentation

- Francesco Battaglioli: Convective Hazard Evolution Under Climate Change, *ClimXtreme General Kick-off Meeting,* 11 -- 12 November 2020 (online).

5.3 Reports

- Púčik, T, Groenemeijer, P, Tsonevsky, I.: **ECMWF Technical Memorandum 879: Vertical wind shear and convective storms**. http://dx.doi.org/10.21957/z0b3t5mrv
- Tomáš Púčik and Pieter Groenemeijer: **Report on the evaluation of DWD Forecast and Warning products at the ESSL Testbed 2020**, ESSL Report 2020/01.
- Pieter Groenemeijer: **Report on the evaluation of ICON-D2(-EPS) products at the ESSL Testbed 2020,** ESSL Report 2020/02.

5.4 Notable press communications and outreach activities

- Nature Talks (blog, naturetalks.ro), 9 October, on climate change and severe weather
- Antena3 (TV station) on 30 May and 12 June, interviews about recent severe weather events in Romania.
- Realitatea TV (TV station), on 25 and 30 May, interview about tornadoes and severe storms in Romania.
- TVR2 (TV station), 29 January and 16 June, interview about the ESWD reports for 2019 and severe storms.
- Radio România Cultural (Radio Station) on 15 January, interview about the Australian fires and the severe weather events of 2019.
- Interviews with the TV station Digi24 on 2 January, 24 May, 13 June, 16 June, 23 June, 25 June, 5 July, 8 July, 3 September, 19 September, and 26 October on topics related to severe storms, tornadoes, heat waves and flash floods.

ESSL's Dr Bogdan Antonescu on Romanian television.

5.5 Social Media

ESSL is active on Facebook and on its Twitter account @essl_ecss. Through this account, ESSL posts and shares news regarding ESSL's research, Testbed, training and ECSS activities. As of writing, the number of Twitter account followers has increased in the last year to 1845 followers (479 more followers compared with 2019). 42 times ESSL tweeted a message, that had typically a few thousand impressions and were retweeted 430 times. ESSL's Facebook account was used to post 23 messages during 2020. The ESSL's posts reached an audience of approximately 174,000 people in 2020. ESSL plans to continue its social media presence during 2021.

6 Financial and Administrative Report

6.1 Employment and Payroll Accounting

In 2020, the European Severe Storms Laboratory e.V. directly employed one full time employee (a researcher for the project ClimXtreme), one part-time employee (ESWD quality control manager), and one so-called "Mini-Jobber" (for database programming), a form of minor employment according to German law. The joint Secretariat of ESSL e.V. and the European Severe Storms Laboratory – Science and Training was hosted by the latter and employed three persons (the Director full-time, the Assistant to the Board part-time, and two employees for ESWD user support and ESWD quality control via mini-jobs). Other tasks were taken over by voluntary workers (i.e., without payment): most importantly, the tasks of the three Deputy Directors and the Treasurer.

As in previous years, an external payroll accountant (Andreas Schnaubelt in Schongau, Bavaria) was mandated during 2020 to take care of paperwork and bureaucratic handling of taxes and social insurances, which would otherwise have exceeded ESSL's internal administrative capacity.

6.2 Auditing of the Annual Accounts

In accordance with the Articles of Association, ESSL's finances for 2020 were audited by the ESSL Advisory Council, based on the report on the annual accounts prepared by ESSL's tax advisor, Mr. Andreas Schnaubelt, Loewenstrasse 5, 86956 Schongau, Germany. This report states:

"Record of Income and Expenses

During our work no indications occurred which would give raise for objections against the correctness of the record.

Financial Statements

During our work no indications occurred which would give raise for objections against the correctness of the financial statements."

6.3 Financial Status 2020

European Severe Storms Laboratory e.V.

The accounting year was dominated by income from a project funded by the German ministry of Education and Research, i.e., the project ClimXtreme. Furthermore, income from membership fees was important and necessary to cover overhead costs not covered by the project as well as costs for general ESSL activities not attributable to single projects. The detailed Annual Accounts were presented to the ESSL Advisory Council and

can be inspected in the original format and in person by each member at our secretariat. Digital copies of the full document can by members alternatively be requested from the ESSL Treasurer. Attachment A1 provides a condensed version of these Annual Accounts.

As required by the German tax authorities, in the detailed accounting 'cost centres' distinguish between the ideational branch of ESSL (*Idealistic Purpose*, i.e., management of the association and its core activities) and its branches directly serving the statutory purposes of the ESSL (dedicated activities). No activities were booked under the commercial type of branch (minor activities of this kind would have been permissible), thus easily fulfilling the requirements of the tax authorities.

The following key figures from the Annual Accounts characterize the business conditions in 2020:

ESSL obtained EUR 176,526 (2019: 162,000) in membership fees and EUR 50,000 (2019: 167,594) from scientific projects. ECSS income amounted to EUR 0 (2019: 89,306), because there was no conference in 2020.

Total income amounts to **EUR 228,028** (2019: 421,840).

Total expenses amount to **EUR 211,511** (2019: 419,502).

The dominant cost factors were direct personnel costs with EUR 73,259 (2019: 241,534), including taxes and social security, third party services by ESSL Science and Training (subsidiary in Wiener Neustadt, Austria) with EUR 101,523 (2019: 80,393) and, due to the pandemic, low travel expenses with EUR 3,960 (2019: 14,230). Costs for the tax advisor and external bookkeeping add up to EUR 6,450 (2019: 6,320).

The tight cooperation with the Austria-based association "European Severe Storms Laboratory – Science and Training" reduces costs for administrative work substantially since common services and their associated costs are shared between the two associations. Personnel lumpsum costs for the Director and the Assistant to the Board were paid through this ESSL subsidiary at first hand (EUR 60,000). The final phase of the new seminar interior and reconstruction costs added up to EUR 21,534, office rental costs to EUR 9,194 and other costs (electricity, internet, IT services, insurance) to EUR 10,795.

At the end of the business year, liquid assets at ESSL's bank accounts amounted to EUR 42,333 (2019: 61,108). At the end of the year 2020, accounts receivables amounted to EUR 0 (2019: 21,687), deferred expenses (payments made for future accounting periods) to EUR 1,500 (2019: 1,500), deferred income (payments received for future accounting periods) to EUR 9,900 (2019: 19,895). Comparing liquid assets with mean monthly expenses it can be seen that ESSL was running with a small reserve for about 2 months only.

The **annual result is a positive EUR 16,517** (compare: positive 2,338 in 2019, negative 14,899 in 2018, positive 21,621 in 2017, positive 4,169 in 2016, positive EUR 3,552 in 2015,

negative EUR 3,957 in 2014, positive EUR 2,625 in 2013, negative 34,365 in 2012, positive EUR 7,093 in 2011, negative EUR 46,859 in 2010, positive EUR 60,599 in 2009).

The financial planning for 2021 foresees enough liquidity until the end of the year, as massive cost cuts were introduced starting January 2019 that will continue into 2021 (e.g., discontinuation of the working contract with the Treasurer, now working on a voluntary basis only). At the end of 2021 there will again be little reserves.

Subsidiary European Severe Storms Laboratory - Science and Training

The financial result of the subsidiary association "European Severe Storms Laboratory – Science and Training" (ESSL-ST) can be summarized as follows:

At the end of the business year 2020, the liquid assets at its bank account amounted to EUR 88,638 (2019: 23,019). Of this amount, EUR 80,000 are a current reserve for the ESSL Testbed 2021. The current reserve of EUR 20,000 for 2020 was dissolved. The remaining annual result for the subsidiary association in 2020 was a positive 6,696 EUR (2019: positive EUR 3,019, 2018: negative EUR 1,687).

The main income source were the ESSL Testbed and related activities, and a basic funding from the provincial state of Lower Austria. The main cost factors were investments in new seminar infrastructure, office rental, IT infrastructure and running costs, invited lecturers and speakers, and personnel and travel costs. For the second time, finances of ESSL-ST were audited by an external auditor (Scheicher und Partner Wirtschaftsprüfungs GmbH Wiener Neustadt), as this was an obligation for receiving funding from the Government of Lower Austria. The external auditor states (own translation from the German original) in formal wording:

"In the performance of our duties as auditors, we have not identified any facts that may jeopardize the existence of the audited association or significantly impair its development, or that indicate serious violations of the law or the association's statutes by the management body or employees. No material weaknesses in the internal control of the accounting process have come to our attention."

The financial planning for 2021 again foresees a near neutral annual result.

6.4 ESSL Members

Members are at the core of ESSL and provide essential support to ESSL activities. Membership fees form an important source of income for ESSL. However, ESSL members are also important in catalysing the pursuit of the Association's goals. This type of support is sometimes provided in-kind and sometimes by financial support. In 2020, ESSL was happy to welcome one institutional full member, the Institute for Meteorology and Water Management (IMGW-PIB) of Poland.

In addition, three Institutional Supporting Members have joined ESSL: GreenTriangle AG, Genillard & Co GmbH, and Banca d'Italia. The full member list as of 31 December 2020 can be found in Attachment A2.

6.5 Executive Board and Advisory Council

The Executive Board, the Advisory Council, and the General Assembly, which consists of all full members, constitute the three bodies forming the ESSL. Figure 6-1 outlines some of their responsibilities.

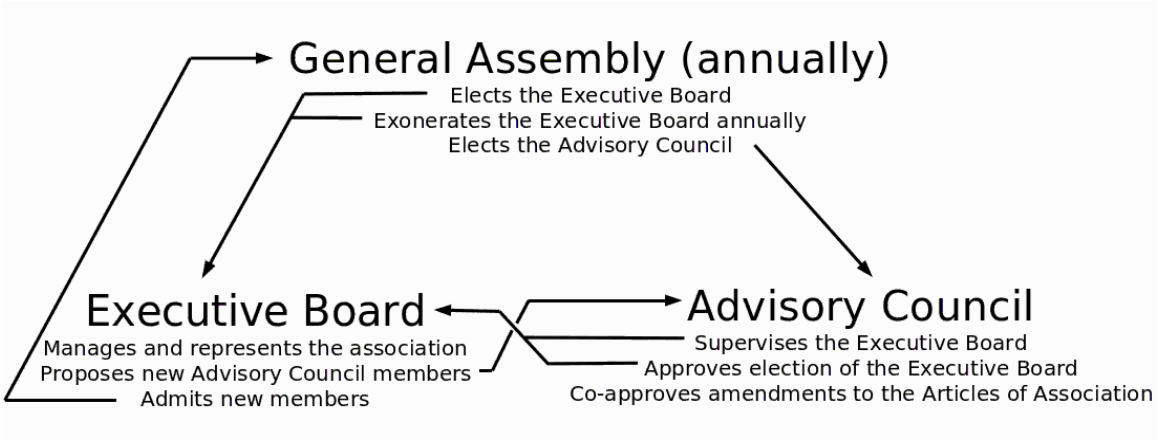


Fig. 6-1: Bodies of the ESSL. The Advisory Council consists of six members from two groups - three members each: (1) Science, (2) NMHS / EUMETNET.

Executive Board

In 2020, the Executive Board consisted of:

Dr Pieter Groenemeijer, Director

Dr Bogdan Antonescu, Deputy Director

Ms Michou Baart de la Faille, Deputy Director

Dr Tanja Renko, Deputy Director

Mr Alois M. Holzer, Treasurer

These Executive Board members are elected for a term until 31 December 2021, with the exception of Dr. Tanja Renko, who succeeded Dr Kathrin Riemann-Campe from 1 January 2021 onward as Deputy Director. She was elected for a full three year term at the General Assembly of 2020 until 31 December 2023.

Advisory Council

In 2020, the Advisory Council consisted of:

Dr. Martin Benko, chair (SHMÚ, Slovak Hydrometeorological Institute)
1 Jan. 2020 - 31 Dec. 2023 (second term), vice-chair since 1 Jan. 2016

Dr. Marina Baldi (National Research Council, Italy)
1 Jan. 2021 – 31 Dec. 2024 (second term)

Dr. Yvette Richardson (Penn State University, USA)
1 Jan. 2021 – 31 Dec. 2024 (second term)

Dr. Sorin Cheval (University of Bucharest, Romania)
1 Jan. 2021 – 31 Dec. 2024 (second term)

Dr. Uwe Ulbrich (Freie Universität Berlin, Germany)
1 Jan. 2020 – 31 Dec. 2023 (second term)

Mr. Thomas Kratzsch, (DWD, Deutscher Wetterdienst, Germany)
1 Jan. 2019 - 31 Dec. 2022 (first term)

Appendix A1: Annual Accounts

The following presents in extract a copy of the "*Report on the Preparation of the Financial Statements for 2020*", as prepared by the financial auditor in Germany. Figures of the previous 2 years were added for comparison.

	2020	2019	2018
INCOME			
Membership fees institutional members and ESWD data fees	173.103,50	158.039,43	136.620,74
Membership fees personal members	3.422,72	3.961,06	3.427,62
Income from scientific meetings (ECSS)	0,00	89.306,36	0,00
Public project funding Federal Republic of Germany	50.000,00	167.594,46	188.052,36
Public project funding European Union	0,00	0,00	49.158,00
Applied research	0,00	0,00	33.700,00
Donations	1.502,18	190,00	1.100,00
German VAT on sales and refunds	0,00	2.748,97	4.940,06
Total income	**228.028,40**	**421.840,28**	**416.998,78**
EXPENSES			
Personnel	73.258,73	241.534,68	358.941,59
Depreciations	1.260,98	1.013,94	981,21
Costs related to scientific meetings (ECSS)	0,00	51.345,47	0,00
Travel costs	3.959,62	14.229,95	11.408,02
Office costs and insurance	2.242,53	615,72	1.231,16
Phone and data (internet) services	3.877,55	5.982,25	1.214,99
Tax advisor including software	6.450,23	6.320,02	6.116,52
Third party services by ESSL Science and Training, Austria	101.523,21	80.393,08	27.583,82
Value added tax	8.508,33	4.593,35	6.712,55
Third party services and other	10.429,90	13.473,63	17.707,73
Total expenses	**211.511,08**	**419.502,09**	**431.897,59**
Result	**16.517,32**	**2.338,19**	**-14.898,81**

Assets and Liabilities

	2020	2019	2018
Fixed Assets (office equipment)	2.942,00	1.097,00	1.097,00
Current Assets			
Receivables	0,00	21.687,36	20.432,36
Bank balances	42.333,48	61.108,56	61.108,56
Deferred Expenses	1.500,00	1.500,00	1.500,00
Assets total	**46.775,48**	**85.392,92**	**84.137,92**
Equity (own capital)			
Retained earnings brought forward	19.457,55	19.457,55	17.119,36
Remaining result of the year	16.517,32	2.338,19	2.338,19
Deferred Income	9.900,00	19.895,00	19.895,00
Liabilities	900,61	46.040,37	1.538,42
Equity and Liabilities total	**46.775,48**	**87.731,11**	**40.890,97**

Appendix A2: Member list 2020

The following table shows all ESSL members as of 31 December 2020, sorted according to their ESSL-ID (which corresponds in ascending order to the beginning date of the ESSL membership). Members joining ESSL in 2020 have an * next to their names. The 8 founding members who are still members are *printed in italic font*. The given country corresponds to the main residence or statutory seat, not necessarily their nationality.

Individual Full members

Dr. Bernold Feuerstein	*GERMANY*	Dr. Michael Kunz	GERMANY
Dr. Pieter Groenemeijer	*NETHERLANDS*	Erik Dirksen	GERMANY
Alois M. Holzer	*AUSTRIA*	Dr. Christoph Gatzen	GERMANY
Dr. Maria-Carmen Llasat-Botija	*SPAIN*	Dr. Kathrin Riemann-Campe	GERMANY
Dr. Romualdo Romero	*SPAIN*	Dr. Koji Sassa	JAPAN
Dr. Martin Setvák	*CZECH REPUBLIC*	Dr. Tomáš Pučik	CZECH REPUBLIC
Dr. Fulvio Stel	*ITALY*	Dr. Patrick Marsh	USA
Jenni Rauhala	*FINLAND*	Marcus Beyer	GERMANY
Thilo Kühne	GERMANY	Dr. Lisa Schielicke	GERMANY
Helge Tuschy	GERMANY	Dr. Abdullah Kahraman	TURKEY
Zhongjian Liang	GERMANY	Dr. John Allen	USA
Lionel Peyraud	SWITZERLAND	Dr. Anja T. Rädler	GERMANY
Thomas Krennert	AUSTRIA	Dr. Darrel Kingfield	USA
Dr. Johannes Dahl	USA	Stavros -Dafis	FRANCE
Martin Hubrig	GERMANY	Michou Baart de la Faille	NETHERLANDS
Dr. Oliver Schlenczek	GERMANY	Jannick Fischer	GERMANY
Dr. Victor Homar Santaner	SPAIN	Dr. Tanja Renko*	CROATIA
Dr. Sanjay Sharma	INDIA	Dr. Mateusz Taszarek *	POLAND
Dr. Bogdan Antonescu	ROMANIA		

Individual Supporting Members

Casper ter Kuile	NETHERLANDS
Jan Jacob Groenemeijer	NETHERLANDS

Institutional Full Members

DWD, Deutscher Wetterdienst	GERMANY
EUMETSAT	GERMANY
AUSTRO CONTROL	AUSTRIA
ZAMG, Zentralanstalt für Meteorologie und Geodynamik	AUSTRIA
NMA, National Meteorological Administration of Romania	ROMANIA
FMI, Finnish Meteorological Institute	FINLAND
CHMI, Czech Hydrometeorological Institute	CZECHIA
Institute for Hydrometeorology and Seismology of Montenegro	MONTENEGRO
DHMZ, Meteorological and Hydrological Service of Croatia	CROATIA
SHMU, Slovak Hydrometeorological Institute	SLOVAKIA
Consorzio LaMMA	ITALY
KNMI, Royal Netherlands Meteorological Institute	NETHERLANDS
ECMWF, European Centre for Medium-Range Weather Forecasts	INTERNATIONAL
Croatia Control, Croatian Air navigation Services, Ltd	CROATIA
Cyprus Department of Meteorology	CYPRUS
RHMSS – Republic Hydrometeorological Service of Serbia	SERBIA
Institute for Meteorology and Climate Research	GERMANY
Met Office	UNITED KINGDOM
ARPAL – Argenzia Regionale Prodezione Ambiente Ligure	ITALY
TLUBN - Thüringer Landesamt für Umwelt, Bergbau und Naturschutz	GERMANY
IMGW–PIB, Institute for Meteorology and Water Management*	POLAND

Institutional Supporting Members

Münchener Rückversicherungs-Gesellschaft AG	GERMANY
Willis Ltd	UNITED KINGDOM
Deutsche Rückversicherung	GERMANY
DLR - Deutsches Zentrum für Luft- und Raumfahrt	GERMANY
Guy Carpenter Limited	UNITED KINGDOM
RMS - Risk Management Solutions	UNITED KINGDOM

Renaissance RE Services Ltd	BERMUDA
CORELOGIC SARL	FRANCE
FM Global	USA
Nowcast GmbH	GERMANY
Impact Forecasting LLC - AON Central and Eastern Europe a.s.	CZECH REPUBLIC
Spekter GmbH	GERMANY
Berkshire Hathaway Specialty Insurance Company	USA
Arcturus B.V.	NETHERLANDS
Descartes Underwriting	FRANCE
riskine GmbH	AUSTRIA
FCM - Fermat Capital Management, LLC	USA
GIE AXA	FRANCE
GreenTriangle AG*	SWITZERLAND
Genillard & Co GmbH*	GERMANY
Banca d'Italia*	ITALY

Honorary Members

Birgit Büsing	GERMANY
Gregor Dotzek	GERMANY
Armin Dotzek	GERMANY
Dr. Charles A. Doswell III	USA

ESSL has a partnership with the European Meteorological Society (EMS) through a Memorandum of Understanding, is member of the Climate Change Center Austria, and a participating organization in the GEO Group on Earth Observations.