Annual Report 2018

European Severe Storms Laboratory

About the Laboratory

The *European Severe Storms Laboratory e.V.* (ESSL) 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. The ESSL office is located at the DLR-Institute for Atmospheric Physics.

In Europe, severe thunderstorms inflict an estimated annual damage of about 5 billion euro and lead to dozens of fatalities. ESSL's mission is to make Europe more resilient to severe weather. It does so 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.

ESSL closely cooperates with its Austrian subsidiary *European Severe Storms Laboratory – Science & Training*, which pursues similar goals and operates the Research and Training Centre, which is the venue of various seminars, workshops and the ESSL Testbed.

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Foreword

Dear Reader,

the European Severe Storms Laboratory can look back to a fruitful year 2018 in which it accomplished many things despite a continuing financial uncertainty that has had important implications for its operation after 2018.

The European Severe Weather Database, a resource that continues to be used in studies across the world generates many requests for data to ESSL. In 2018, 24 individual requests were processed. ESSL would like to engage more with its data users, and therefore organized the first ESWD and EWOB User Forum in March 2018. This workshop delivered feedback on plans to store weather impacts more systematically and to simplify the ESWD web interface. It also helped to define a new standard for crowd-sourced data exchange. All this is detailed in Chapter 1 of this report.

Within scientific projects, ESSL has made important progress in the collaborative project ARCS on changes in convective extremes and their impacts, which it works on jointly with Munich Re. The result that will be finalized in 2019 is a tool based on the typical characteristics of convective storms allowing to investigate the changes in (high-end) impacts as a result of climate change.

Second, ESSL concluded its involvement in the German decadal climate prediction programme MiKlip, to which it has contributed eight years in total, ever since the association employed its first scientific staff. The result is a component to the forecast system that allows predictions of convective storm activity. The STEPCLIM project also enabled ESSL to integrate historical data on severe weather from Russian, Spanish and Italian sources into the ESWD. ESSL's Alois Holzer, Thomas Schreiner and Tomáš Púčik in 2018 reported in a peer-reviewed article on their study of the historic violent tornado in Wiener Neustadt.

Rating tornado and wind damage was a topic that ESSL addressed during a workshop it initiated in August. During this workshop, a first draft of a method to rate such damage consistently across the world, the International Fujita scale, was discussed with participants from Austria, Spain and Germany's national weather services.

All in all, ESSL's scientific work resulted in four (co-)authored scientific publications in 2018, and a further two articles, submitted in 2018, that have since appeared. Furthermore, fourteen conference contributions and invited presentations were given by ESSL staff. ESSL's activity on social media was successfully intensified, as Twitter tweets and Facebook posts continue to attract more followers and readers.

ESSL also continued its trainings, with three courses on-site in Wiener Neustadt, including the Seminar Forecasting Severe Convection II taught by Dr. Paul Markowski and Dr. Tomaš Púčik, and an on-site course at the Cyprus Department of Meteorology.

At the Testbed, ESSL's flagship activity 43 meteorologists from 13 countries participated in the evaluation of a number of forecast-supporting tools provided by the German weather service DWD and EUMETSAT's Nowcasting Satellite Application Facility.

On the administrative side, there is the good news that two new full members, the Institute for Meteorology and Climate Research of the Karlsruhe Institute of Technology, and the U.K. Met Office as well as two supporting members, could be welcomed to ESSL. In the Advisory Council, at the end of 2018, chair Mr. Hans-Joachim Koppert left after serving for two full terms, and was succeeded as Advisory Council member by Mr. Thomas Kratzsch, and by Martin Benko as chair.

Financially, ESSL still remained in a situation with no noteworthy financial reserves, or low positive liquidity. The ending of the STEPCLIM project in December and upcoming end of ARCS in March 2019 generated the prospect of financial difficulties to start in 2019 unless new project income was found. Unfortunately, ESSL was unsuccessful with several submitted project proposals, even though their evaluations were good to excellent, and one project obtained a high enough rating to be eligible for funding in principle.

On the positive side, the ARCS project could be prolonged, and a cooperation with EUMETSAT could be started. Furthermore, the General Assembly decided to raise the membership fees of full institutional members and requested to pay the fees early. The Executive Board is grateful that many of the members did. Nevertheless, it was not sufficient to keep the employment at the same level. Therefore, the Treasurer, Alois M. Holzer decided to take up a full-time position elsewhere. This has led to a difficult situation in 2019 where he fulfils his duties as Treasurer, and more, voluntarily. The Executive Board are seeking to improve this situation by finding additional sources of income. An important component of this remains to expand ESSL's training activities, that continue to attract more participants year after year. Indeed, in 2019 a series of new courses were started and planned on which we will both formally report in the next Annual Report and inform you ahead of time with our newsletters and web site.

It is my pleasure to present you this Annual Report, which constitutes a review of ESSL's achievements in its twelfth business year.

Wessling, 25 September 2019,

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 many studies within and outside of ESSL.

1.1 ESWD Data Users and Partners

Users

ESWD data are used by a wide range of users. These users 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 by an e-mail sent to the address eswd@essl.org. In 2017, ESSL received 21 such requests, and in 2018, this number was 24 (Figure 1-1). Often, the requests come from students who would like to use parts of the database to support their study for a Bachelor or Master degree, or even their doctoral thesis research. ESSL's User Support employee Thomas Schreiner handles such requests. He provides them with data, which can be free of cost if the study is not driven by commercial interest and the student agrees to the User's Agreement. Occasionally, there are also commercial parties, such as developers of risk models, who would like to access the data. They are invited to join the association as a supporting member, or to purchase ESWD data from ESSL.

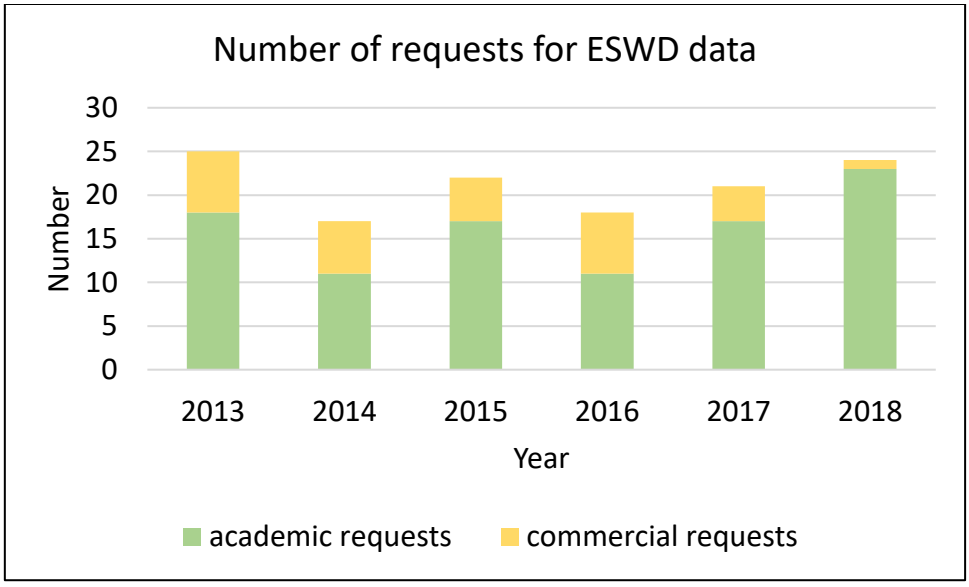

Figure 1-1. Number of requests for ESWD data by non-members.

1.2 Severe Weather in 2018

Event Types

In 2018, the ESWD was expanded with 16428 new severe weather reports (Figure 1-2), which is less than the 22101 reports for the previous year, 2017. This is probably due in part to a reduction of convective episodes in the summer across Europe, that was often dominated by dry, warm air associated with large areas of high pressure. The most frequently reported severe weather were severe wind gusts (7091 reports), followed by heavy rain (3890), large hail (2352), and heavy snowfall and snowstorms (1291).

Table 1-1. Severe Weather Reports collected in the European Severe Weather Database in 2018.

Report Type	**Number of reports**	**%**
Severe wind gusts	7091	43.2
Heavy rain	3890	23.7
Large Hail	2352	14.3
Heavy snowfall/snowstorms	1291	7.9
Damaging lightning strikes	836	5.1
Tornadoes	634	3.9
Avalanches	240	1.5
Lesser whirlwinds	86	0.5
Ice Accumulation	8	0.0
Total	16428	

Table 1-2. Quality control levels of ESWD reports from 2018.

Quality Control level	**Number of reports**	**%**
QC0: as received	0	0.0
QC0+: plausibility checked	2289	13.9
QC1: report confirmed by reliable sources	14011	85.5
QC2: scientific case study	135	0.8

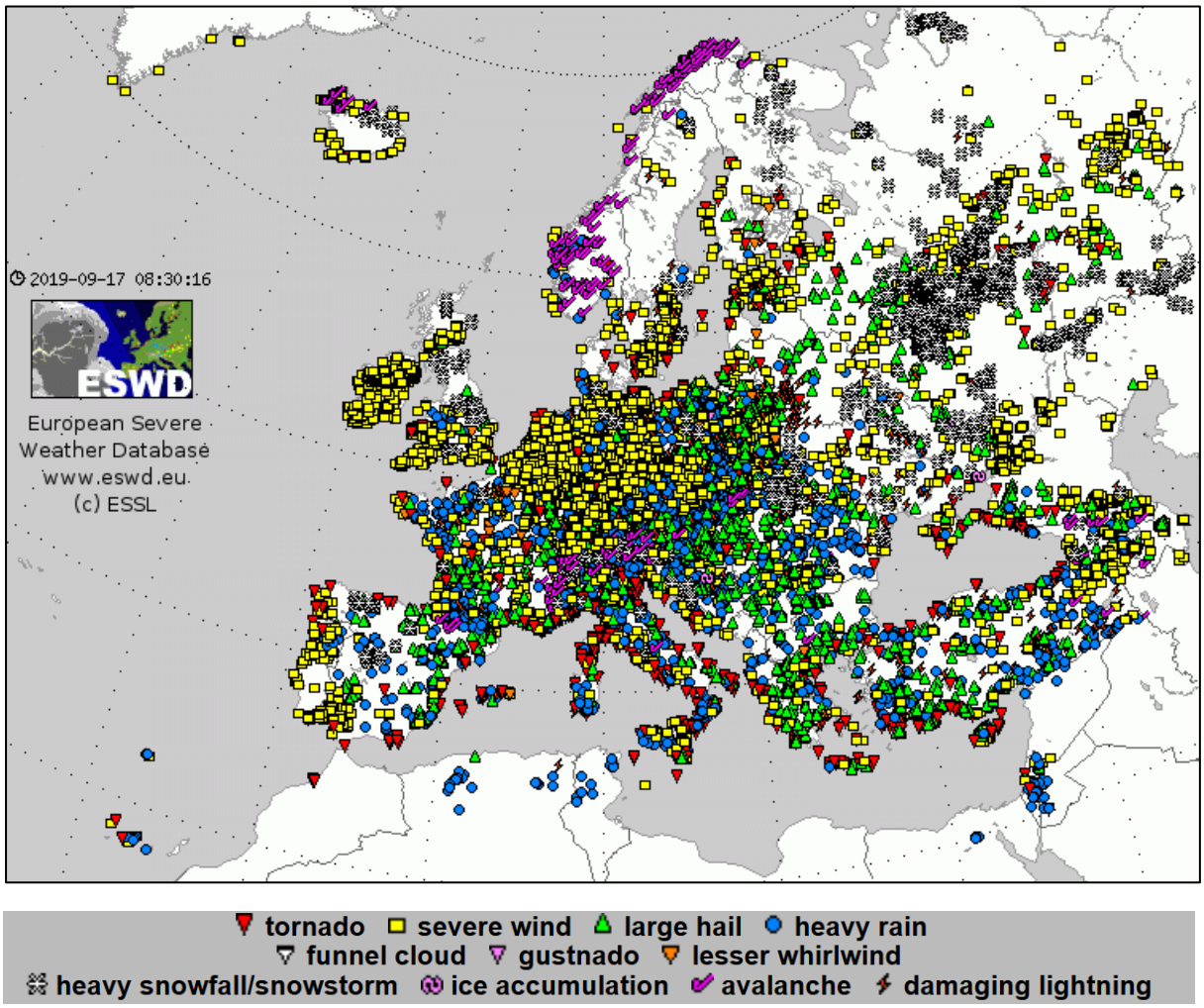

Figure 1-2. The 16431 ESWD reports of events occurring in 2018.

Quality Control

ESWD reports are checked for trustworthiness by a dedicated team at ESSL, and by its ESWD 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 2018 have been upgraded at least to QC0+, QC1 or QC2 (Table 1-2).

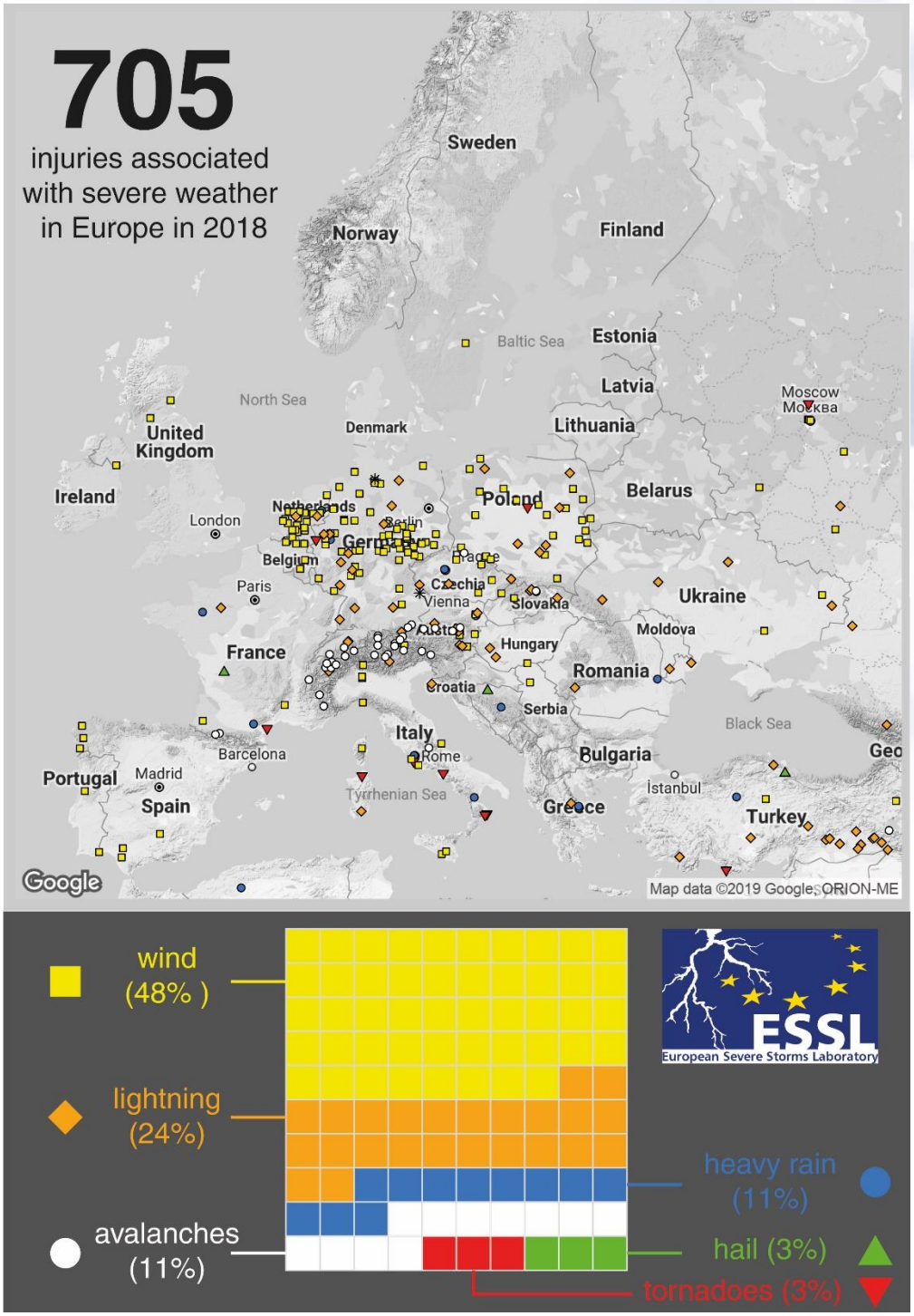

Figure 1-3. The spatial distribution of the ESWD severe weather reports in Europe, associated with injuries in 2018. Below, the percentage of injuries associated with each type of severe weather across the entire ESWD area, i.e. including Mediterranean Africa and Asia, and Central Asia (excluding categories < 1%).

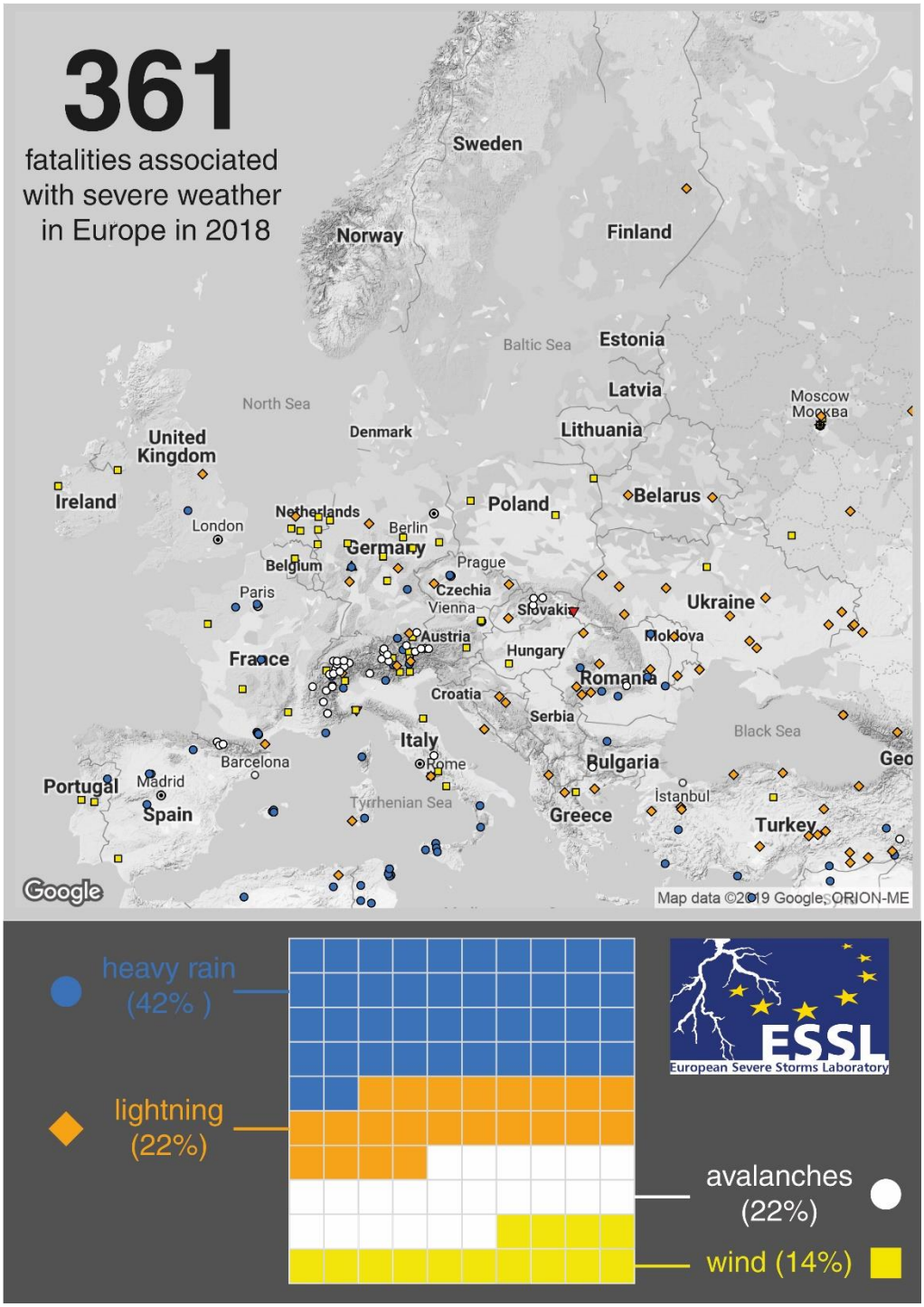

Figure 1-4. The spatial distribution of the ESWD severe weather reports in 2018 associated with fatalities. Below, the percentage of fatalities associated with each type of severe weather across the entire ESWD area, i.e. including Mediterranean Africa and Asia, and Central Asia (excluding categories < 1%).

Fatalities and Injuries

The severe weather reports of 2018 were associated with 705 injuries (Figure 1-3) and 361 fatalities (Figure 1-4). Wind was responsible for almost half of the recorded injuries (48%), but only 14% of all recorded fatalities. Heavy rain and flash floods were responsible for most fatalities (42%) but only 11% of injuries. Lightning caused 24% of injuries and 22% of fatalities. Many fatalities (22%) were also recorded from avalanches.

The single deadliest event was in Jordan in the Middle East (not shown on map), involving 21 fatalities in floods near Wadi Ma'in on 25 October. This was also the day with the highest number of (hydro-)meteorological fatalities. Other days with many fatalities include a hybrid storm event that struck Italy on 19 October with fatal winds, floods and lightning. The top ten of days with most fatalities (Table 1-3) shows that heavy rain and the resulting flash floods, primarily in October and November, were responsible for most fatalities in 2018. In addition, a windstorm in the Benelux and Germany on 18 January, and a series of avalanches after heavy snowfall in March across the Alps are listed.

	Event type(s)	**Date**	**Country**	**Region / Location**	**Fatalities**
1	Heavy rain	25 October	Jordan	Wadi Ma'in	21
2	Wind (11), Heavy rain (2), Lightning (2)	19 October	Italy	several locations	15
3	Heavy rain	15 October	France	Languedoc	13
4	Heavy rain	9 October	Spain	Balearic Islands, Majorca	12
5	Heavy rain	3 November	Italy	Sicily	12
6	Heavy rain	9 November	Jordan	Ma'an, Amman, Madaba	12
7	Wind (several reports)	18 January	Netherlands, Belgium and Germany	several locations	10
8	Heavy rain	20 August	Italy	San Lorenzo Bellizzi	10
9	Heavy rain	26 April	Israel	Nahal Tzafit	10
10	Avalanche	22 March	France, Italy, Austria	Alps	5

Table 1-3. Ten days with most fatalities in 2018 in the ESWD.

1.3 ESWD and EWOB User Forum

On 13 and 14 March 2018, the first ESWD an EWOB User Forum was organized at the ESSL Centre Wiener Neustadt. The aims of this event were to receive feedback from users of ESWD data and to collect and discuss new proposals for ESWD and EWOB features. ESSL welcomed participants from KNMI, ZAMG, and both FMI and AccuWeather attended online.

New ESWD version 4.4

Pieter Groenemeijer (ESSL) suggests several changes to the ESWD web interface to make it more user-friendly. Furthermore, he introduces a way to record impacts of severe weather events more systematically in the database. In the ESWD version 4.4, which has been released in December 2018, the most common impacts of all severe weather events are coded. They can be selected by a user by clicking checkboxes next to a description of the impact. It remains possible, however, to describe the impacts more precisely in a text field.

After this introduction, ESSL Quality Control manager Thilo Kühne has manually reviewed a large part of hail reports contained in the ESWD to enable a systematic review of impacts, as part of a study to be published in 2019.

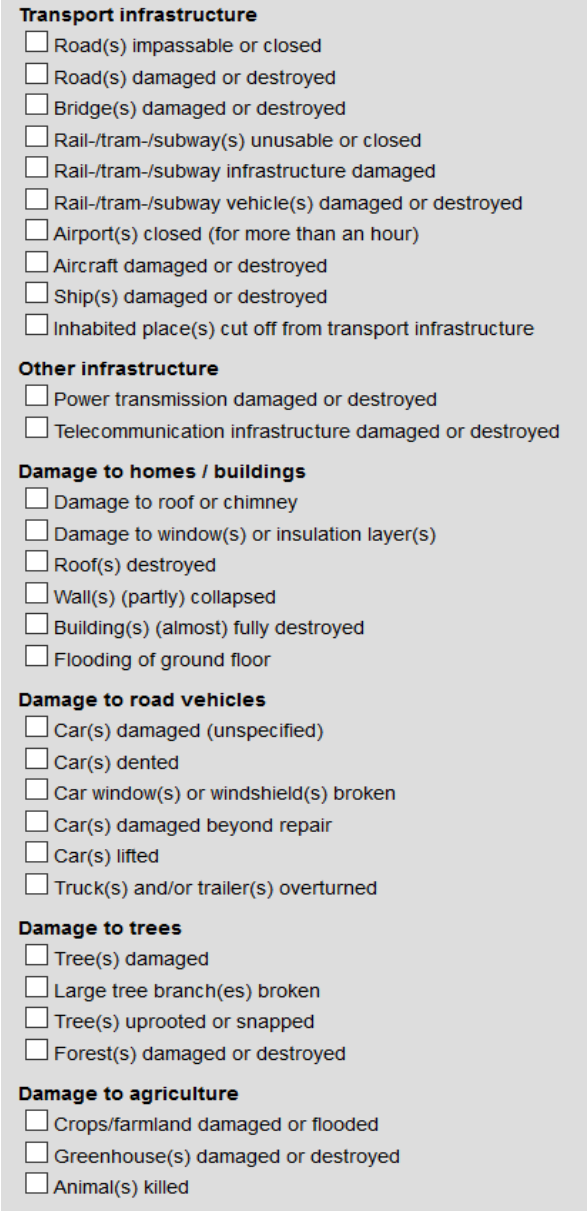

Figure 1-5. Possible impacts that can be selected in the ESWD interface for event type TORNADO.

EWOB Standard

On the second day of the User Forum, an improved standard for the European Weather OBserver App (EWOB) was discussed and decided. This standard has since been distributed to all weather service members of ESSL, whom ESSL would like to cooperate with in exchanging weather and weather impact reports internationally.

Instead of only collecting data through ESSL's own EWOB app, the focus will be on this exchange of data that partners of the (to be formed) EWOB consortium collect through their own channels, as illustrated in Figure 1-6. Those can include apps that the weather services have developed in-house to disseminate their forecasts and warnings, but also sources such a spotter networks or emergency services.

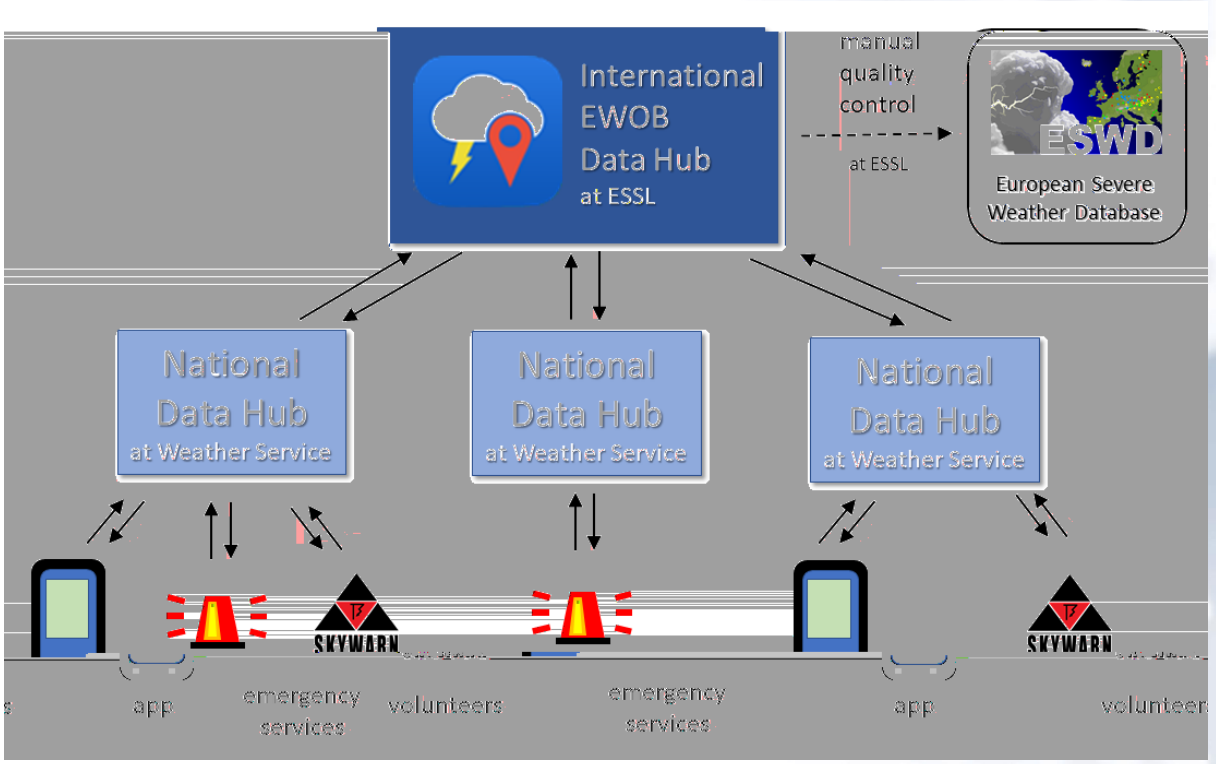

Figure 1-6. Scheme showing the exchange of EWOB reports between original sources, National Data Hubs and the European Hub.

After the User Forum, ESSL has continued to work on an EWOB Standard document, that lists all the technical specifications of EWOB. In addition, a draft document outlining the specifics of the collaboration has been developed in coordination with ESSL's weather service members and with important input from ZAMG.

1.4 Tornado and wind damage assessment workshop

In August, ESSL organized the third edition of this workshop with participation from AEMet, ZAMG, DWD and the University of Genova. Each of the participants from weather services gave an introduction about their respective practices in rating tornadoes.

One of the aims of the workshop was to review existing methods of rating tornado damage, and, building on progress at the previous workshops, develop a method that meets certain fundamental requirements that it must have. First, it should be broadly applicable, covering a wide range of observed wind effects and all possible wind speeds. Second, it should be accurate, or as accurate as possible given the available data. Last, it should be consistent in the sense that it can be applied consistently over time and across many regions, preferably globally. The applicability for some existing scales like the EF-scale, and its Japanese or Canadian counterparts is limited those specific countries. Instead, a new method, called the International Fujita scale or IF-scale, was initiated that by design can consistently be applied across the world.

Making a walking tour though the city of Wiener Neustadt and rating photographed damage from a violent tornado helped greatly in the discussions of the new rating system.

Figure 1-7. Using archived damage photos, participants of the tornado and wind damage workshop tried to get an image of the extent of the historical tornado of 10 July 1916 in Wiener Neustadt.

Ultimately, it was decided that the method, introduced by the EF-scale to define objects (Damage Indicators / DI) that can be damaged to several Degrees of Damages was retained. However, wind speed estimates resulting from the occurrence of each DI/DoD combination would be expressed on the original Fujita scale, however allowing for the suffixes "-" and "+" to denote speeds 1/3 of a step higher of lower than the centre of the scale. Damages can be defined for several objects, with buildings and trees being the most complex ones. For buildings, six building sturdiness classes have been defined, and damage to the anchoring, the roof and the building body are distinguished. For trees, failure in the anchoring (uprooting) and failure to the tree structure itself are distinguished. The full IF-scale document can be found online:

https://www.essl.org/cms/international-fujita-scale/

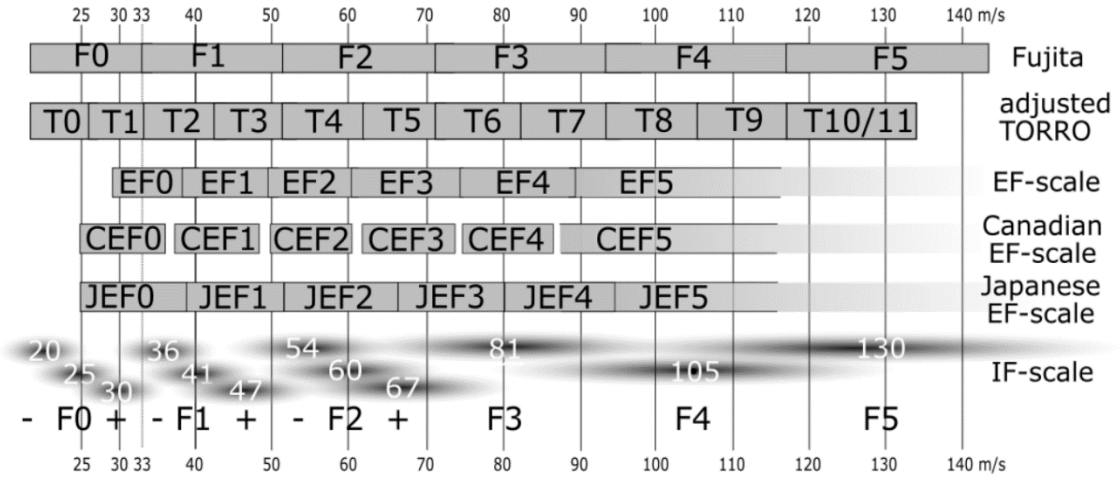

Figure 1-8. Wind speed scales for rating tornado and wind damage.

2 Research

ESSL's research activities in 2018 have concentrated mostly on the project STEPCLIM on decadal prediction, which ended in December, and the ongoing project ARCS on the changing risk of convective storms due to climatic change.

2.1 Severe Thunderstorm Evaluation and Predictability in Climate Models (STEPCLIM)

Funded by: German Ministry of Education and Research (BMBF)
Amount: EUR 271 000 (Phase II)
Duration: January 2016 – December 2018 (3 years)

Within the project STEPCLIM, ESSL contributed a plug-in to the decadal prediction system developed within the German research programme MiKlip. This plug-in enables a user to post-process the decadal ensemble runs of the system to obtain forecasts of severe thunderstorm activity, in particular of lightning, hail, tornadoes and convective wind gusts, Such a prediction is illustrated in Figure 2-1.

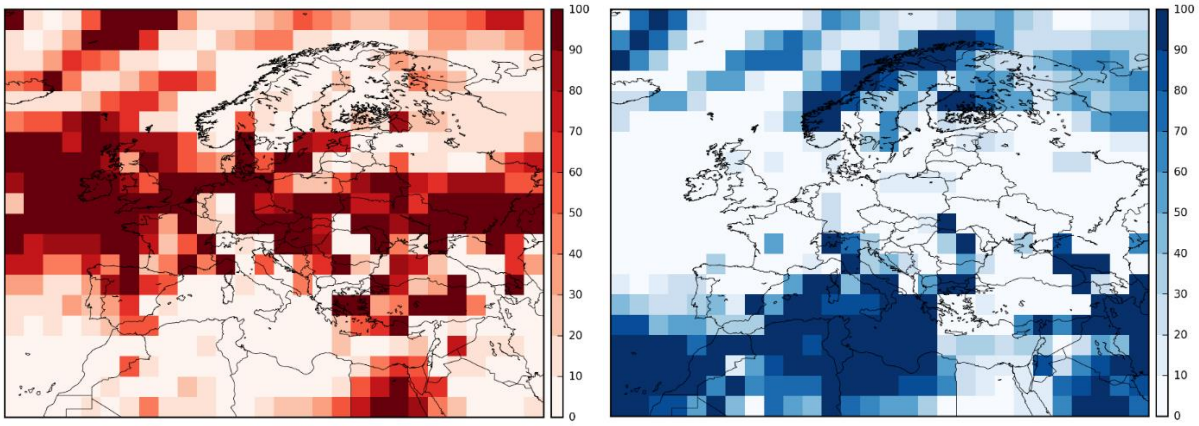

Figure 2-1. Probability of a higher (left) or lower (right) than average lightning activity, predicted by the STEPCLIM plugin to the baseline-1 MiKlip system runs, for the time period 2015–2018 (based on an initialization in 2013).

Besides developing the plug-in, ESSL researcher Chris Castellano, who worked on STEPCLIM during the second half of the project period, also performed an evaluation of the forecast skill of the prediction system, and using several ways to recalibrate the system for known biases (Figure 2-2).

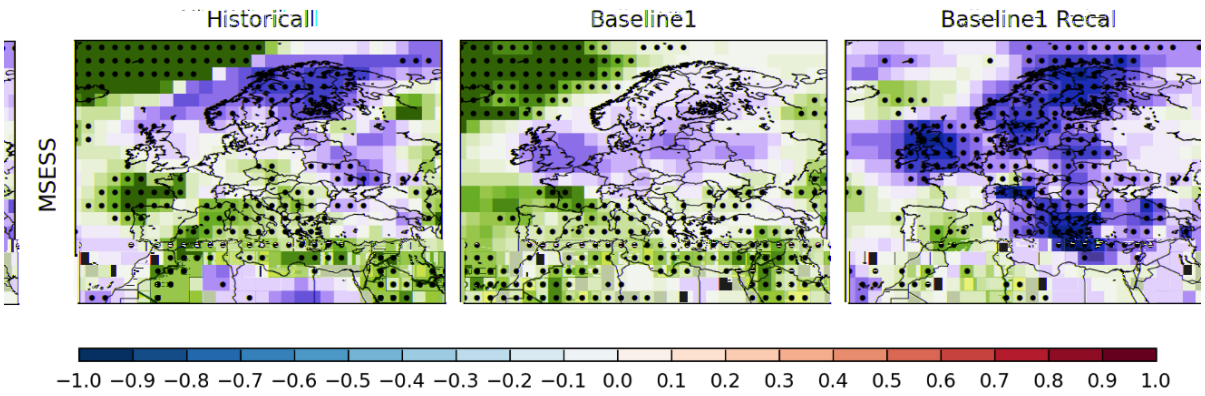

Figure 2-2. Forecast skill for annual lightning activity according to the MiKlip system as measured by the Mean Squared Error Skill Score, with the ERA-Interim reanalysis as reference for forecast years 2—5 and the period 1983-2012. Left shows the skill of uninitialized forecast, the centre of the initialized forecasts, and the right for recalibrated initialized forecasts using a method developed at the Free University of Berlin (Pasternack et al., 2018).

The statistical post-processing at the base of the severe weather predictions, was carried out using in improved version of the AR-CHaMo models, developed by Anja Rädler in the project ARCS (Rädler et al, 2018). These models use physical quantities representing the ingredients for (severe) convective storms directly derived from the climate model or reanalysis data, such as instability, moisture and vertical wind shear.

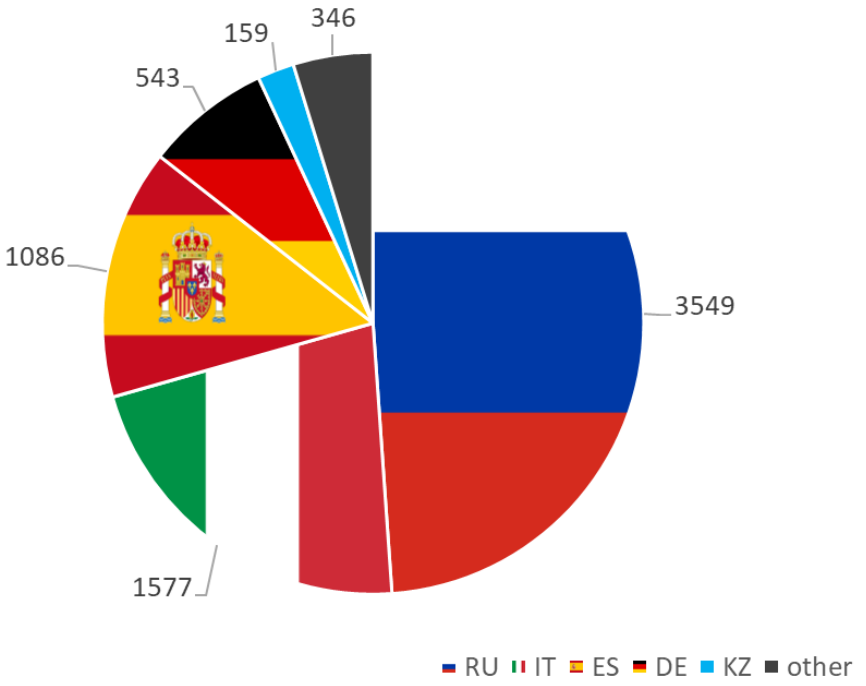

Figure 2-3. Distribution across countries of the 7260 newly entered ESWD reports within STEPCLIM.

In order to train these models, observational data of severe weather occurrence is necessary. In order to improve the availability of such data, Thilo Kühne has manually collected 7260 additional severe weather reports during the project and submitted them to ESSL's European Severe Weather Database from various countries in which archived reports were available, but not yet included in the database. For instance, an Italian newspaper archive, a Russian database of disasters, and a catalogue of tornado events in Spain were processed (Gaya, 2015).

References

Pasternack, Alexander, Jonas Bhend, Mark A. Liniger, Henning W. Rust, Wolfgang A. Müller, and Uwe Ulbrich, 2018: Parametric decadal climate forecast recalibration (DeFoReSt 1.0), Geosci. Model Dev., 11, 351–368. doi: 10.5194/gmd-11-351-2018

Gayá, M., 2015: Els Fiblons a Espanya: Climatologia i catàleg de tornadoes i trombes, Universitat de les Iles Balears.

Anja Rädler, Pieter Groenemeijer, Eberhard Faust and Robert Sausen, 2018: Detecting severe weather trends using an Additive Regressive Convective Hazard Model (AR-CHaMo), Journal of Applied Meteorology and Climatology, 57, 569–587. doi: 10.1175/JAMC-D-17-0132.1

2.2 Analysis of Risk of Convective Storms (ARCS)

Funded by: Munich Re and
German Ministry of Education and Research (BMBF)
Grant: EUR 323 000 (BMBF contribution)
Period: 1 April 2016 – 31 March 2019

ESSL continued its work on the ARCS project in 2018. Jointly with project partner Munich RE the project aims to map the risk of severe thunderstorms in the recent past, present and future. ESSL researcher Chris Castellano since joining the ARCS team has developed a hail swath detection algorithm to identify past hail tracks (2015-2018) in order to derive their statistical properties. An example of the updated algorithm that uses the Vertically Integrated Ice kindly provided by the German Weather Service is shown in Figure 2-4.

The ARCS work continued with combining the derived hail swath statistical properties such as length, aspect ratio, maximum hail size and orientation, with the Additive Regression – Convective Hazard Models (AR-CHaMo). Using the statistical properties, realizations of hail swaths are generated by drawing randomly from the distributions of hail swath properties. By doing this a very large number of times, an *event set* is created that translates predicted grid-scale probabilities to many realizations of those probabilities in hail swaths. The number of generated hail swaths for ERA-Interim is shown in Figure 2-5.

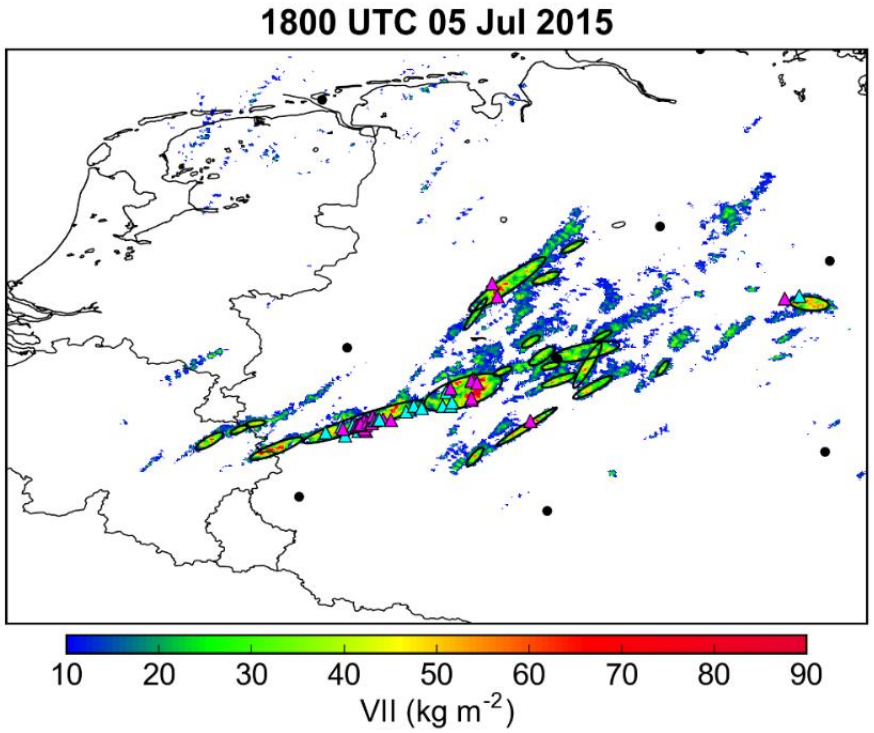

Figure 2-4. Radar-based detection of hail swaths for the time period 1200-1800 UTC, 5 July 2015. The shaded colours show accumulated values of Vertically Integrated Liquid, black ellipses the identified hail swaths, and black dots the locations of DWD radars. ESWD reports of hail are shown in magenta (cyan) for hail ≥ 2 cm (5 cm).

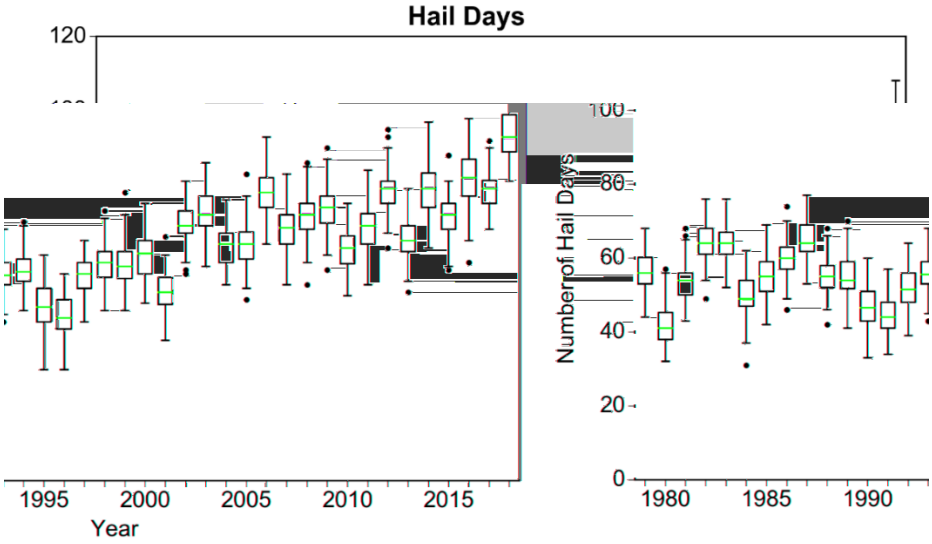

Figure 2-5. Number of generated hail days across Central Europe, obtained by applying the event set generator 100 times to AR-CHaMo probabilities and ERA-Interim from 1979 to 2018.

ESSL researcher Tomáš Púčik continued his study of past losses. He compared loss data provided by Munich Re's NatCatSERVICE to the probabilities predicted by AR-CHaMo and found that those probabilities correlated poorly with the recorded financial losses but rather well with the frequency of large hail events (Figure 2-6). Both AR-CHaMo and the recorded

number of hail events exhibit an increase since 1990, which suggests that large hail may indeed have happened more frequently and may be partly responsible for the increase in the recorded losses.

A final report on the achievements of the ARCS project will be available in 2019.

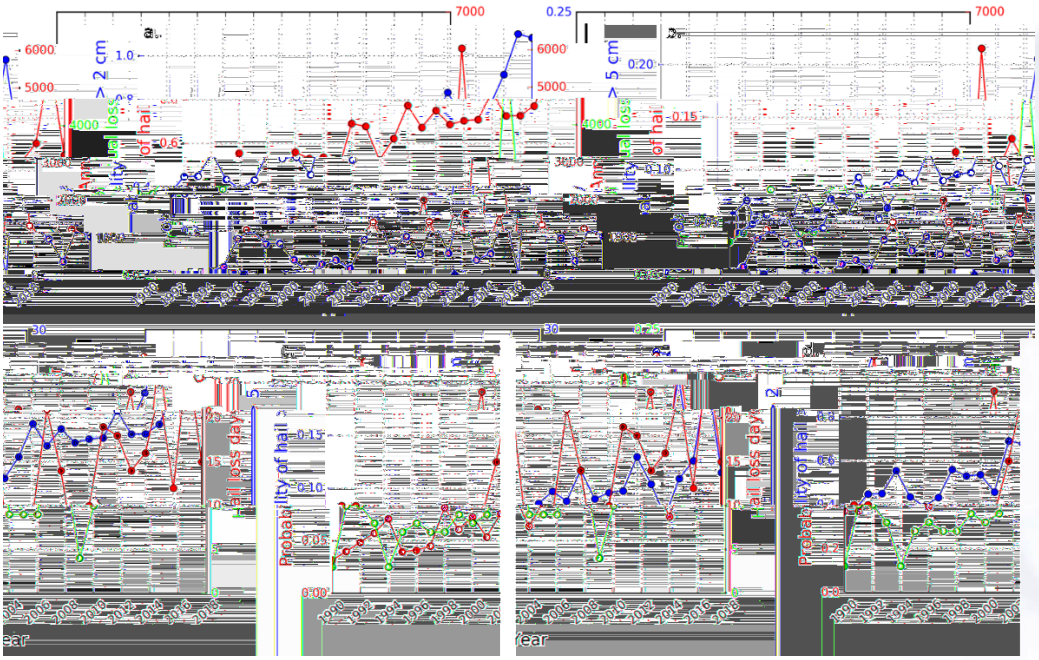

Figure 2-6. Ratio of average annual hail probability according to the statistical models AR-CHaMo, compared to the amount of hail-related losses (in million USD) for a) large (≥ 2 cm) and b) very large (≥ 5 cm) hail, and the relation of modelled hail to the number of days with c) large and d) very large hail, across Germany between 1990 and 2018.

A very happy occasion took place in July, when collaborator in the ARCS project, Anja Rädler, successfully defended her Ph.D. thesis at the Ludwig-Maximilians-University of Munich. Her thesis "Modelling of convective storm hazard occurrence, taking convective initiation explicitly into account" describes the development and application of the statistical method, named AR-CHaMo, to infer severe convective occurrence from climate models and reanalyses. Her promotors are Prof. Dr. Robert Sausen (DLR) and Prof. Dr. Peter Höppe (Ludwig-Maximilians-University Munich). Her direct supervisor at ESSL was ESSL Director Dr. Pieter Groenemeijer.

Figure 2-7. Dr. Anja Rädler with extravagant Doctor's hat and her supervisor, Pieter Groenemeijer.

3 ESSL Testbed 2018

The Testbed is ESSL's annually returning programme 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 2018 edition of the ESSL Testbed took place during the weeks of 11 – 15 and 26 – 30 June, and 2 – 6 and 9 – 13 July 2018 at the Research and Training Centre in Wiener Neustadt, Austria. ESSL was happy to welcome 42 participants from 14 countries in total. To support Testbed operations every week, a trained assistant is invited to support the ESSL staff in helping the participants with their tasks.

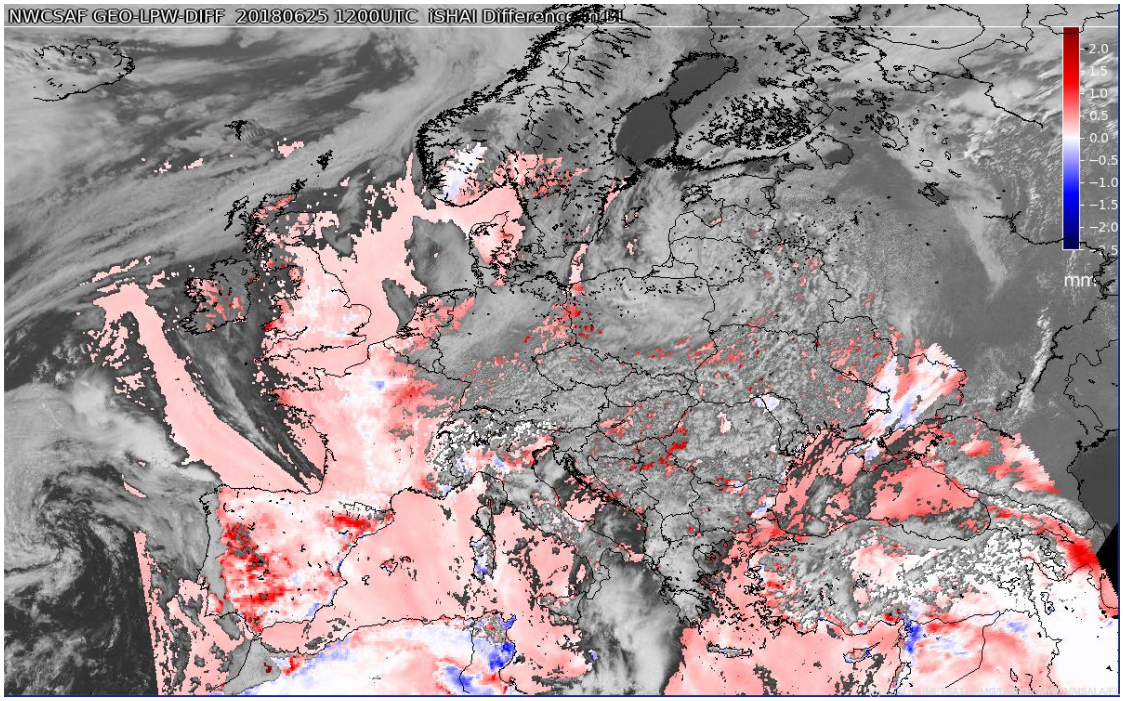

Figure 3-1. Example of 25 June 2018 12 UTC for the time-wise frequent and space-wise predominant positive signal of the low-level precipitable water difference product.

A range of forecast-supporting tools was evaluated at the Testbed, including a new version of the NowcastMIX system of the German Weather Service DWD with explicit tracking, and a new product for aviation, NowcastSAT-Aviation. In addition, several products from the Nowcasting SAF of EUMETSAT were evaluated, as well as the renewed COSMO-D2 ensemble NWP system that runs 20 members on a grid with 2.2 km horizontal spacing. All these products were implemented into the Testbed data display.

Figure 3-1 shows a selected Nowcasting SAF product, that shows the corrections satellite retrievals of low-level humidity – an essential ingredient for convective storms – made to a first guess provided by a numerical weather prediction model. The widespread pink areas show

that the satellite measurements tend to show higher humidity than the model predictions. In another product that shows cloud top height, it was found that the colour scale could be adjusted to make tall storm clouds stand out more, aiding nowcasting of convection.

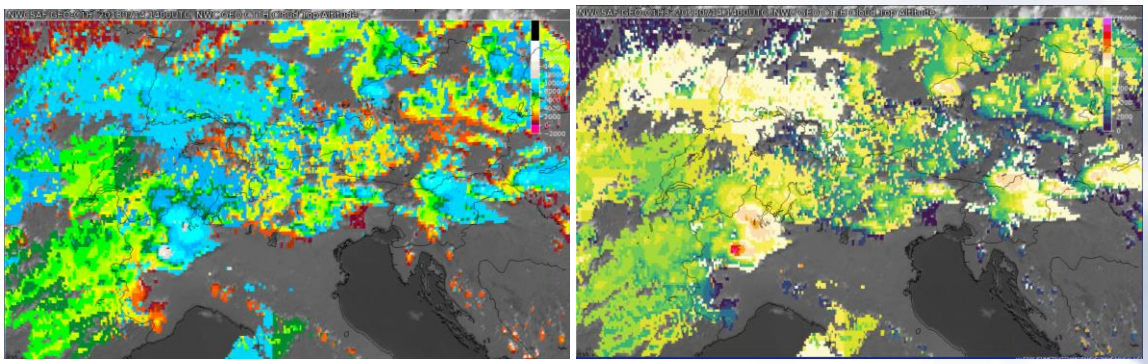

Figure 3-2 Original (left image) and alternative colour scale (right image) for a case on 14 July 2018 at 14 UTC. The tall, severe storm over NW Italy produced extremely large hail with a diameter of up to 10 cm in the town of Chivasso.

The "Tracks" version of DWD's NowcastMIX allowed to visualize past tracks of storms along with their intensity and analysed propagation vectors. This helpful product was used in the Testbed's nowcasting exercises and feedback was collected afterwards.

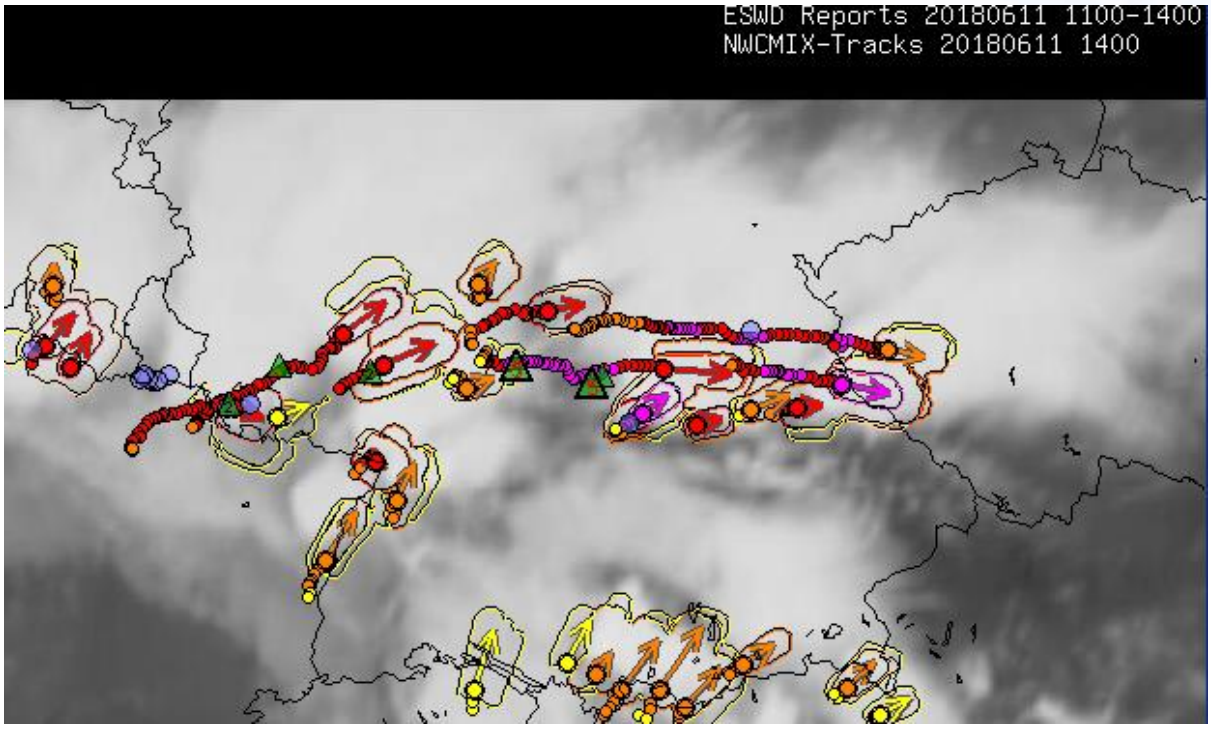

Figure 3-3. NowcastMIX tracks (the 'snakes' of coloured circles), their propagation in the next hours (arrows), and ESWD severe weather reports between 1100 and 1400 UTC on 11 June 2018. ESWD reports are blue circles (flooding), green triangles (hail with max diameter in cm where available).

4 Training activities

ESSL organized various Training Events in 2018, including two seminars on-site in Wiener Neustadt, one seminar in. In addition, the ESSL Testbed was organized which featured the evaluation of products of the Nowcasting-SAF.

4.1 Courses and Seminars

Seminar "Forecasting Severe Convection II" by Prof. Dr. Paul Markowski (4 – 8 June 2018)

Every year, an international expert is invited by ESSL to teach the advanced seminar "Forecasting Severe Convection II". Participants take part in this advanced course after having successfully taken part in the seminar "Forecasting Severe Convection I". Earlier teachers have been Dr. Johannes Dahl and Dr. Matthew Parker.

From 4 to 8 June 2018, Dr. Paul Markowski of The Pennsylvania State University - a renowned researcher of severe storms and tornadoes, taught the FSC-II seminar. The topics on mesoscale meteorology covered by him included one of his research interests, the interaction between mountains and convective storms.

Figure 4-1. Dr. Markowski explaining the effects of orography on convective storms, during the course "Forecasting Severe Convection II".

After the seminar, participants could choose whether to take an examination. Upon passing the exam, a European testimonial on the successful completion of the course would be handed out to the successful candidate.

In 2019 and 2020, the course "Dynamics and Prediction of Severe Convection " will be taught by Prof. Dr. Yvette Richardson (Pennsylvania State University) and Prof. Dr. Robert (Jeff) Trapp (University of Illinois).

Seminar "Forecasting Convective Precipitation and Flash Floods" (10 - 14 September 2018)

A new course, offered by ESSL in 2018 focused on flash floods, which are after all the most fatal convective storm risk in Europe. ESSL is thankful that Dr. Russ Schumacher of the University of Colorado was willing to teach this course, with support of ESSL's tutor Dr. Tomáš Púčik.

The topics covered included the basic ingredients for flash floods, the role of convective organization on the flash flood risk, mesoscale convective systems, and novel machine learning techniques to improve flash flood forecasting.

At the end of the course, an exam could be taken voluntarily. Three participants who decided to take the exam and passed it were handed a European Testimonial to certify this accomplishment.

Figure 4-2. Group photo of the Forecasting Convective Precipitation and Flash Floods seminar.

Seminar "Forecasting Severe Convection I" (1 - 5 October 2018)

In October 2018, ESSL organized an edition of the seminar "Forecasting Severe Convection I" by tutor Dr. Tomáš Púčik. From Monday to Friday, participants dealt with the basics of the ingredient-based approach to storm forecasting as well as more complicated material, for example, how to identify environments conducive to different convective modes or how to tell the difference between environments favouring convective phenomena. Afternoon sessions with actual forecasting exercises complemented the theoretical sessions in the mornings.

Figure 4-3. Participants and tutor of the Seminar "Forecasting Severe Convection I".

In 2019, ESSL will continue offering this seminar as one of ESSL's courses, and additionally, offer a course adapted to forecasting for aviation.

Training Course at the Cyprus Department of Meteorology (4 December – 7 December 2018)

Dr. Tomáš Púčik travelled to Nicosia, Cyprus to give a course on the forecasting of severe convection. This course was organised by Department of Meteorology and took place at the Athalassa radiosonde station.

Cyprus frequently experiences thunder- storms during the winter months and that December week was no exception: A severe thunderstorm produced wind gusts and large hail over Cyprus on the first day of the course. This provided opportunity to apply the newly acquired knowledge on a very recent convective forecasting problem! The course was concluded on Friday by launching a 12 UTC radiosonde together by all course participants, a worthy ending for a thunderstorm-related course.

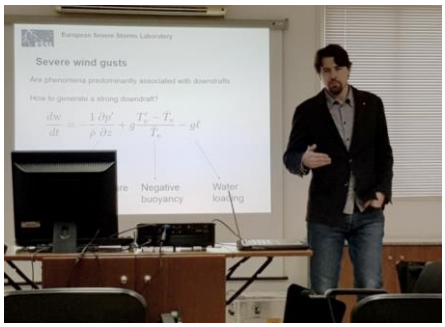

Figure 4-4. ESSL tutor Dr. Tomáš Púčik teaching on the concept of buoyancy at the Cyprus Department of Meteorology. Photo: Filippos Tymvios.

4.2 Convection Working Group (CWG) Secretariat

In 2018 ESSL continued its support to the CWG, by providing secretarial services. The CWG met in Ljubljana on 17-19 April and was attended by Alois Holzer for ESSL. Although ESSL remains very supportive of the Convection Group, the ESSL Executive Board decided to not prolong its secretarial support contract with EUMETSAT beyond 2018. This decision was made in order to concentrate more on offering services to the satellite community that ESSL has a unique position to deliver, for example the ESSL Testbed. In contrast, minute taking, and web site hosting are not ESSL's core business: such secretarial duties can be taken over more easily by other parties. ESSL will remain an active contributor to the Convection Working Group as participant, and by hosting CWG splinter meetings at the venues of its conferences and workshops.

5 Publications and Communications

ESSL has produced many scientific and other results in 2018, which lead to a high number of presentations and publications. Below, a list of all publications is given.

5.1 Peer-reviewed scientific publications

Appeared in 2018:

- Bogdan Antonescu, and F. Cărbunaru, 2018:
  Lightning-Related Fatalities in Romania from 1999 to 2015.
  Weather, Climate, and Society, **10**, 241–252.
  https://doi.org/10.1175/WCAS-D-17-0091.1

- Bogdan Antonescu, Jonathan G. Fairman Jr., and David M. Schultz, 2018:
  What's the Worst That Could Happen? Re-examining the 24–25 June 1967 Tornado Outbreak Over Western Europe
  Weather, Climate, and Society, **10,** 323–340.
  http://dx.doi.org/10.1175/WCAS-D-17-0076.1

- Anja Rädler, Pieter Groenemeijer, Eberhard Faust and Robert Sausen, 2018:
  Detecting severe weather trends using an Additive Regressive Convective Hazard Model (AR-CHaMo)
  Journal of Applied Meteorology and Climatology, **57,** 569–587.
  http://dx.doi.org/10.1175/JAMC-D-17-0132.1

- Alois M. Holzer, Thomas M. E. Schreiner, and Tomáš Púčik, 2018:
  A forensic re-analysis of one of the deadliest European tornadoes
  Nat. Hazards Earth Syst. Sci., **18**, 1555-1565.
  https://doi.org/10.5194/nhess-18-1555-2018

Submitted in 2018, appeared in 2019:

- Mateusz Taszarek, John T. Allen, Tomáš Púčik, Pieter Groenemeijer, Bartosz Czernecki, Leszek Kolendowicz, Kostas Lagouvardos, Vasiliki Kotroni and Wolfgang Schulz, 2019:
  A climatology of thunderstorms across Europe from a synthesis of multiple data sources.
  Journal of Climate, **32**, 1813–1837.
  https://doi.org/ 10.1175/JCLI-D-18-0372.1

- Brooks, H.E., A. Chernokulsky, E. Tochimoto, B. Hanstrum, E. de Lima Nascimento, D.M. Sills, B. Antonescu, and B. Barrett, 2019:
  A century of progress in severe convective storm research and forecasting. *AMS Meteorological Monographs*.
  https://doi.org/10.1175/AMSMONOGRAPHS-D-18-0026.1

5.2 Reports

In 2018, ESSL published the following reports:

1. Report 2018-01**: Summary of the evaluation of COSMO-D2 at the ESSL Testbed 2018**
   https://www.essl.org/media/publications/essl-report-2018-01.pdf

2. Report 2018-02**: Summary of the evaluation of DWD Nowcast and warning products at the ESSL Testbed 2018**
   https://www.essl.org/media/publications/essl-report-2018-02.pdf

These reports can also be found online on the ESSL web site (www.essl.org) under "Publications".

5.3 Scientific and Invited Presentations

1. Chris Castellano, and Pieter Groenemeijer**: STEPCLIM: Severe thunderstorm evaluation and predictability in climate models**, MiKlip Module-E Meeting, 22–23 February 2018, Offenbach, Germany.

2. Pieter Groenemeijer: **Konvektive Unwetter in Europa: Vorhersage und Klimawandel**, Meteorologisches Kollquium, Meteorologisches Institut, Ludwig-Maximilians Universität, München, 17 April 2018.

3. Alois M Holzer and Pieter Groenemeijer: **NWC-SAF products at the ESSL Testbed, what users like most**, Convection Working Group Workshop 2018, Ljubljana, 18 April 2018.

4. Chris Castellano, and Pieter Groenemeijer: **STEPCLIM: Severe thunderstorm evaluation and predictability in climate models**, MiKlip Status Seminar 2018, 28–30 May 2018, Berlin, Germany.

5. Antonescu, B., D. M. Schultz, J. G. Fairman Jr., F. Carbunaru, S. Andrei, and F. Toanca , 2018: **What we know and don't know about the societal and economic impact of severe weather events in Europe**. European Conference for Applied Meteorology and Climatology, 3–7 September, Budapest, Hungary.

6. Chris Castellano, and Pieter Groenemeijer: **STEPCLIM: Severe thunderstorm evaluation and predictability in climate models**, EMS Annual Meeting 2018, 3–7 September 2018, Budapest, Hungary.

7. Tomáš Púčik, Bogdan Antonescu and Pieter Groenemeijer: **Long-lived convective windstorms of 2017 and their impacts across Europe**, EMS Annual Meeting 2018, 3–7 September 2018, Budapest, Hungary.

8. Anja Rädler, Tomáš Púčik, P. Groenemeijer, C.M. Castellano, R. Sausen, and E. Faust, **Modeling the Implications of Climate Change on Lightning, Hail and Wind in Europe**, 29th Conference on Severe Local Storms, 22.-26. October 2018, Stowe, VT, USA

9. Rädler, A.T., **Modeling of convective storm hazard occurrence, taking convective initiation explicitly into account**, Seminar at Institut für Physik der Atmosphäre, Erdsystem-Modellierung, 9. May 2018, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen-Wessling

10. Alois M. Holzer: **Extreme Stürme in NÖ – gestern, heute und morgen**, Niederösterreichische Landesfeuerwehrschulung für Führungkräfte, 9 November 2018, Tulln, Austria.

Poster presentations

1. Rädler, A.T., T. Pucik, P. Groenemeijer, and C.M. Castellano, and Eberhard Faust: **Comparison between European and U.S. Severe Convective Weather Environments in Multiple Reanalyses**, 29th Conference on Severe Local Storms, 22.-26. October 2018, Stowe, VT, USA

2. Castellano, C. M., P. Groenemeijer, T. Púčik, A. T. Rädler, and E. Faust, **Simulation of a hail event set for Central Europe**, 29th Conference on Severe Local Storms, 22–26 October 2018, Stowe, Vermont, USA.

3. Pieter Groenemeijer and Alois M. Holzer**: The International Fujita Scale: A Globally Applicable Scale for Tornado and Wind Damage Classification**, 29th Conference on Severe Local Storms, 22–26 October 2018, Stowe, Vermont, USA.

4. Pieter Groenemeijer: **The European Severe Storms Laboratory**, ANYWHERE workshop, 13-14 November 2018.

5.4 Press and other Communications

Weatherwatch: Europe has a history of fatal tornadoes, The Guardian, 13 April 2018. https://www.theguardian.com/news/2018/apr/13/weatherwatch-europe-has-a-history-of-fatal-tornadoes

Entretien – Dr. Pieter Groenemeijer, Directeur de l'European Severe Storms Laboratory (ESSL), Jean-Pierre Chalon, in: Météo et Climat Info, nº68, Septembre 2018.

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 doubled in the last year to 1152 followers. 58 times ESSL tweeted a message, that had typically a few thousand impressions. ESSL's Facebook account was used to post 41 messages during 2018, reaching typically between 1 000 and 16 000 people. ESSL plans to continue its social media presence during 2019.

6 Financial and Administrative Report

6.1 Employment and Payroll Accounting

In 2018, the European Severe Storms Laboratory e.V. employed two full time employees (ESSL Director and STEPCLIM/ARCS-Researcher), three part-time employees (ESWD quality control manager, ESSL Treasurer and one Researcher/Senior Trainer), and two so-called "Mini-Jobbers" (programming and secretarial support), 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 (Assistant to the Board, ESWD user support and ESWD quality control). Other tasks were taken over by voluntary workers (i.e. without payment), most importantly, the tasks of the two Deputy Directors.

As in previous years, an external payroll accountant (Andreas Schnaubelt in Schongau, Bavaria) was mandated during 2018 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

According to the Articles of Association, ESSL's finances for 2018 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. The 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 2018

European Severe Storms Laboratory e.V.

The accounting year was dominated by income from two projects funded by the German ministry of Education and Research - STEPCLIM and ARCS. Furthermore, income from membership fees was important and necessary to cover overhead costs not covered by the German projects as well as costs for general ESSL activities not attributable to single projects. The detailed annual accounts for 2018 were presented to the ESSL Advisory Council and can be inspected in the original format and in person by each member at the General Assembly. Digital copies of the full document can alternatively be requested from the ESSL Treasurer. Attachment A1 provides a condensed version of these Annual Accounts.

While in 2017 the financial situation was significantly better than in the previous years, based on the reliable income from 3 different scientific projects, in 2018 only two projects were left, and at the end of the year the STEPCLIM project ended. Therefore, at the end of 2018 only one project was left (ARCS). This led to a situation where liquidity reserves were consumed up, resulting in a very negative outlook for the beginning of 2019.

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 had to be booked under the commercial type 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 2018:

ESSL obtained EUR 140,048 (2017: 125,589) in membership fees and EUR 270,910 (2017: 271,636) from scientific projects.

Total income amounts to **EUR 416,999** (2017: 399,967).

Total expenses amount to **EUR 431,898** (2017: 378,345).

The major cost factors were personnel costs with EUR 358,942 (2017: 305,577), including taxes and social security, shared IT infrastructure and shared administration (with ESSL Science and Training) with EUR 27,584 (2017: 32,139) and travel expenses with EUR 11,408 (2017: 8,678). Tax advisor and external bookkeeping costs add up to EUR 6,117 (2017: 8,451).

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 costs for the Assistant to the Board were paid through this ESSL subsidiary at first hand.

At the end of the business year, liquid assets at our bank accounts amounted to EUR 97,159 (2017: 41,452). Reason for the relatively high liquidity was the request of the board to pay

membership fees early in order to avoid a critical liquidity situation at the beginning of 2019. This request was fulfilled by a substantial number of members. At the end of the year 2018, accounts receivables amounted to EUR 0 (2017: 6,130), deferred expenses (payments made for future accounting periods) to EUR 1,500 (2017: 8,031), deferred income (payments received for future accounting periods) to EUR 62,241 (2017: 24,998) – again an effect of the early membership fee payments. Comparing liquid assets with deferred income, it can be stated that ESSL was running without noteworthy reserves.

The **annual result is a negative EUR 14,899** (compare: 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 2019 foresees enough liquidity until the end of the year, as massive cost cuts were introduced starting January 2019 (e.g. discontinuation of the working contract with the Treasurer, now working on a voluntary basis only). Still, at the end of 2019 there will be no noteworthy reserves left.

Subsidiary European Severe Storms Laboratory - Science and Training

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

At the end of the business year, liquid assets at its bank accounts amounted to EUR 31,727 (2017: 33,414). Of this amount, EUR 30,000 are a current reserve for the ESSL Testbed 2019. The current reserve of EUR 30,000 for 2018 was dissolved. The remaining annual result for the subsidiary association in 2018 is a negative EUR 1,687 (2017: positive 3,136; 2016: positive 3,156; 2015: positive 121).

The main income source was the ESSL Testbed. The main cost factors were office rental, IT infrastructure, IT running costs, invited lecturers and speakers, and personnel and travel costs. The financial planning for 2019 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 2018, ESSL was happy to welcome two new Institutional Full Members: *Institute for Meteorology and Climate Research*, and the *Met Office*. Two new Institutional Supporting Members could be welcomed as well: *Spekter GmbH*, and *Swiss Re Management Ltd*. The full member list as of 31 December 2018 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.

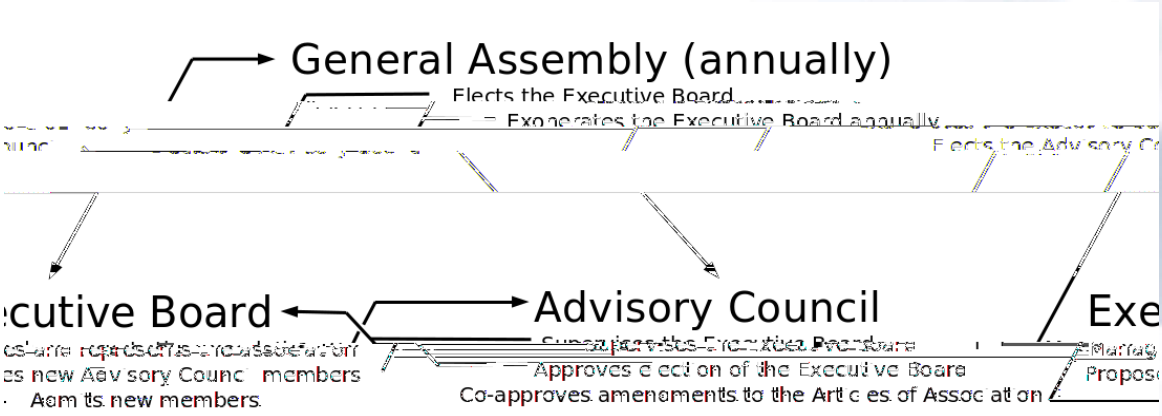

Fig. 6-1: Bodies of the ESSL. The Advisory Council consists of six members from two groups - three members each: (1) Science, (2) NMHS / EUMETNET.

Executive Board

In 2018, the Executive Board consisted of:

Dr. Pieter Groenemeijer, Director
Dr. Kathrin Riemann-Campe, Deputy Director
Dr. Bogdan Antonescu, Deputy Director
Mr. Alois M. Holzer, Treasurer

They had been elected for a term until 31 Dec. 2018. At the General Assembly in Wessling, they were re-elected until 31 December 2021. A third Deputy Director was also elected to join the Executive Board: **Ms. Michou Baart de la Faille**.

Advisory Council

In 2018, the Advisory Council consisted of:

Hans-Joachim Koppert, chair (DWD, Deutscher Wetterdienst, Germany)
1 Jan. 2015 - 31 Dec. 2018 (second term), chair since 1 Jan. 2016

Dr. Martin Benko, vice-chair (SHMÚ, Slovak Hydrometeorological Institute)
1 Jan. 2016 - 31 Dec. 2019 (first term), vice-chair since 1 Jan. 2016

Dr. Uwe Ulbrich (Freie Universität Berlin, Germany)
1 Jan. 2016 – 31 Dec. 2019 (first term)

Dr. Marina Baldi (National Research Council, Italy)
1 Jan. 2017 – 31 Dec. 2020 (first term)

Dr. Yvette Richardson (Penn State University, USA)
1 Jan. 2017 – 31 Dec. 2020 (first term)

Dr. Sorin Cheval (University of Bucharest, Romania)
1 Jan. 2017 – 31 Dec. 2020 (first term)

The General Assembly elected Mr. Thomas Kratzsch as a new Advisory Council member, to take office 1 January 2019. Dr. Martin Benko was elected by the Advisory Council to become its new chair.

Appendix A1: Annual Accounts

The following presents in extract a copy of the "*Report on the Preparation of the Financial Statements for 2018*", as prepared by the financial auditor. Figures of the previous year (*italic*) were added for comparison.

	2018	2017
INCOME		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Applied research	[illegible]	[illegible]
Donations	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Total income	[illegible]	[illegible]
EXPENSES		
Personnel	358.941,59	305.576,59
Depreciations	981,21	990,00
Travel costs	11.408,02	8.677,73
Office costs and insurance	1.231,16	1.077,40
Phone and data (internet) services	5.510,97	5.232,31
Tax advisor including software	6.116,52	8.450,94
IT infrastructure and shared administration	27.583,82	32.138,70
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Total expenses	[illegible]	[illegible]
Result	**-14.898,81**	**21.621,43**

Assets and Liabilities

	2018	2017
Fixed Assets (office equipment)	1.366,00	1.403,00
Current Assets		
Receivables	[illegible]	[illegible]
Bank balances	[illegible]	[illegible]
Deferred Expenses	[illegible]	[illegible]
Assets total	100.024,64	57.016,29
Equity (own capital)		
Retained earnings brought forward	32.018,17	10.396,74
Remaining result of the year	-14.898,81	21.621,43
Deferred Income	62.240,53	24.998,12
Liabilities	20.664,75	0,00
Equity and Liabilities total	**100.024,64**	**57.016,29**

Appendix A2: Member list 2018

The following table shows all ESSL members as of 31 December 2018, sorted according to their ESSL-ID (which corresponds in ascending order to the beginning date of the ESSL membership). The new members who have joined ESSL in 2018 have an * next to their names. The 8 founding members who are still members are printed in italics. The given country corresponds to the main residence or statutory seat, not necessarily their nationality.

ESSL has these five types of members:

INDF: Individual Full Member
INDS: Individual Supporting Member
INSF: Institutional Full Member
INSS: Institutional Supporting Member
HMEM: Honorary Members

INDF	*Dr. Bernold Feuerstein*	*GERMANY*
INDF	*Dr. Pieter Groenemeijer*	*GERMANY*
INDF	*Alois M. Holzer*	*AUSTRIA*
INDF	*Dr. Maria-Carmen Llasat-Botija*	*SPAIN*
INDF	*Dr. Romualdo Romero*	*SPAIN*
INDF	*Dr. Martin Setvák*	*CZECH REPUBLIC*
INDF	*Dr. Fulvio Stel*	*ITALY*
INDF	*Jenni Rauhala*	*FINLAND*
INDF	Thilo Kühne	GERMANY
INDF	Helge Tuschy	GERMANY
INDF	Zhongjian Liang	GERMANY
INDF	Lionel Peyraud	SWITZERLAND
INDF	Thomas Krennert	AUSTRIA
INDF	Dr. Johannes Dahl	USA
INDF	Martin Hubrig	GERMANY
INDF	Dr. Oliver Schlenczek	GERMANY
INDF	Dr. Victor Homar Santaner	SPAIN
INDF	Dr. Sanjay Sharma	INDIA
INDF	Dr. Aurora Bell	AUSTRALIA
INDF	Dr. Bogdan Antonescu	ROMANIA

INDF	Dr. Michael Kunz	GERMANY
INDF	Erik Dirksen	GERMANY
INDF	Dr. Christoph Gatzen	GERMANY
INDF	Dr. Alexander Keul	AUSTRIA
INDF	Dr. Kathrin Riemann-Campe	GERMANY
INDF	Dr. Koji Sassa	JAPAN
INDF	Dr. Tomáš Pučik	CZECH REPUBLIC
INDF	Dr. Patrick Marsh	USA
INDF	Marcus Beyer	GERMANY
INDF	Dr. Lisa Schielicke	GERMANY
INDF	Dr. Charles A. Doswell III	USA
INDF	Dr. Abdullah Kahraman	TURKEY
INDF	Dr. John Allen	USA
INDF	Dr. Anja T. Rädler	GERMANY
INDF	Dr. Darrel Kingfield	USA
INDF	Stavros Dafis *	FRANCE
INDF	Michou Baart de la Faille *	NETHERLANDS

INDS	Casper ter Kuile	NETHERLANDS
INDS	Stefan Meulemans	BELGIUM
INDS	Jan Jacob Groenemeijer	NETHERLANDS

INSF	DWD, Deutscher Wetterdienst	GERMANY
INSF	EUMETSAT	GERMANY
INSF	AUSTRO CONTROL	AUSTRIA
INSF	ZAMG, Zentralanstalt für Meteorologie und Geodynamik	AUSTRIA
INSF	NMA, National Meteorological Administration of Romania	ROMANIA
INSF	FMI, Finnish Meteorological Institute	FINLAND
INSF	CHMI, Czech Hydrometeorological Institute	CZECH REPUBLIC
INSF	Institute for Hydrometeorology and Seismology of Montenegro	MONTENEGRO

INSF	DHMZ, Meteorological and Hydrological Service of Croatia	CROATIA
	SHMU, Slovak Hydrometeorological Institute	
INSF	Consorzio LaMMA	SLOVAKIA
INSF	KNMI	ITALY
INSF	ECMWF - European Centre for Medium-Range Weather	NETHERLANDS
INSF	Forecasts	UNITED KINGDOM
	Croatia Control, Croatian Air navigation Services, Ltd	
INSF	Cyprus Department of Meteorology	CROATIA
INSF	RHMSS – Republic Hydrometeorological Service of Serbia	CYPRUS
INSF	Institute for Meteorology and Climate Research*	SERBIA
	Met Office *	
INSF		GERMANY
INSF		UNITED KINGDOM
INSS	Münchener Rückversicherungs-Gesellschaft AG	GERMANY
INSS	Tokio Marine Technologies LLC	USA
INSS	Willis Ltd	UNITED KINGDOM
INSS	Deutsche Rückversicherung	GERMANY
INSS	DLR - Deutsches Zentrum für Luft- und Raumfahrt	GERMANY
INSS	Guy Carpenter Limited	UNITED KINGDOM
INSS	Air Worldwide	USA
INSS	RMS - Risk Management Solutions	UNITED KINGDOM
INSS	AccuWeather Enterprise Solutions, Inc.	USA
INSS	Renaissance RE Services Ltd	BERMUDA
INSS	CORELOGIC SARL	FRANCE
INSS	FM Global	USA
INSS	Nowcast GmbH	GERMANY
INSS	Impact Forecasting LLC - AON Central and Eastern Europe	CZECH REPUBLIC
	a.s.	
INSS	Spekter GmbH*	GERMANY
INSS	Swiss Re Management Ltd. *	SWITZERLAND

HMEM	Birgit Büsing	GERMANY
HMEM	Gregor Dotzek	GERMANY
HMEM	Armin Dotzek	GERMANY

In addition, ESSL has a partnership with the European Meteorological Society (EMS) through a Memorandum of Understanding.