Annual Report 2017

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

ESSL has had a very active year in 2017 with highlights such as the 9th European Conference on Severe Storms in Pula, Croatia, that was organized with the Croatian Hydrometeorological Institute DHMZ. 2017 also saw the introduction of a Summer School as a new activity, while ESSL published or submitted a number of 7 important scientific articles in peer-reviewed literature.

Besides all that, data collection into the European Severe Weather Database again accelerated, as no fewer than 22 101 new reports were collected by ESSL and its expanding network of collaborators. Furthermore, almost 100 persons received week-long trainings by ESSL, either at seminars or the ESSL Testbed on site, or at a remote location. Considering that the employments at ESSL only add up to around 4 full-time equivalents, I believe it is fair to say that the enthusiastic ESSL team, including its volunteers, has been exceptionally productive.

Another great development in 2017 was the welcoming of three new full institutional members: Croatia Control - Croatian Air Navigation Services, the Cyprus Department of Meteorology, and the Republic Hydrometeorological Service of Serbia.

Having said that, it is unfortunate that ESSL's future is still endangered by the limited success of its efforts to attract sustained funding. Currently, the membership fees constitute this very important type of income. These fees can, unfortunately, sustain little more than the ESWD quality control work, ESWD user support and some administration. This becomes a problem when there are discontinuities in project work, a situation that is on the horizon for the end of 2018 and early 2019. In the *Financial and Administrative Report* in Section 6, the positive financial result achieved in 2017 is presented and explained, as well as the uncertainties in the near future. The ultimate consequence of a failure to acquire new projects in time would be that all ESSL activities besides the database and the ECSS will have to stop.

Therefore, I would like to call on all ESSL members and partners for support – such as joint project applications - which will be necessary for ESSL to continue its scientific and training work. Even though there are two sides to this report, I proudly present you this Annual Report, which constitutes a review of ESSL's achievements in its eleventh business year.

Wessling, 30 April 2018,

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 is used by various users including the scientific community, as is proven by an ever larger body of scientific work that makes use of the database. As of 2018, the original article that describes the ESWD (Dotzek, 2009) has been cited 151 times. These studies include investigations of the severe weather, climate and risk assessment, as well as forecasting and calibration of new radar and satellite detection techniques. The ESWD is also used for forecast verification at the ESSL Testbed. Here we present an overview of the development of the ESWD in 2017.

Data collection partners

ESSL collects data in collaboration with volunteers throughout Europe. They include nationally-organized associations. These associations, sometimes called Skywarn, have members with a high interest in severe weather and typically organize storm spotter courses. Jointly, we call them Voluntary Observer Networks (VONs). Furthermore, some partners of ESSL are individuals who are not a member of any association, or Voluntary Observer Persons (VOPs). By signing a Partner Agreement, VONs and VOPs agree that they will report any severe weather without delay to the ESWD.

In 2017, 9 new Voluntary Observer Persons joined the ESWD network. In total, the partner network consists of 9 National Weather Services, 11 Voluntary Observer Networks (VON), and 28 individuals (Voluntary Observer Persons; VOP).

1.2 Severe Weather in 2017

Event Types

In 2017, the ESWD was expanded with 22 101 new severe weather reports (Figure 1-1), which is a new record for the number reports added to the database in any single year (Figure 1-2). Up until the year 2017, the ESWD now includes 141 657 severe weather reports. Most new reports collected for 2017 were for severe wind gusts (14650 or 66.3 %), large hail (2597 or 11.5 %) and heavy rainfall (2485 or 11.2%). Table 1–1 lists all reports of 2017.

Table 1–1. Severe Weather Reports collected in the European Severe Weather Database in 2017.

Report Type	Number of reports	%
Dust-, sand or steam devils	79	0.4
Gustnadoes	7	0.0
Large hail	2597	11.8
Heavy rain	2485	11.2
Tornadoes	621	2.8
Severe wind gusts	14650	66.3
Heavy snowfall/snowstorms	924	4.2
Ice accumulation	23	0.1
Avalanches	110	0.5
Damaging lightning strikes	605	2.7
Total	22101	100

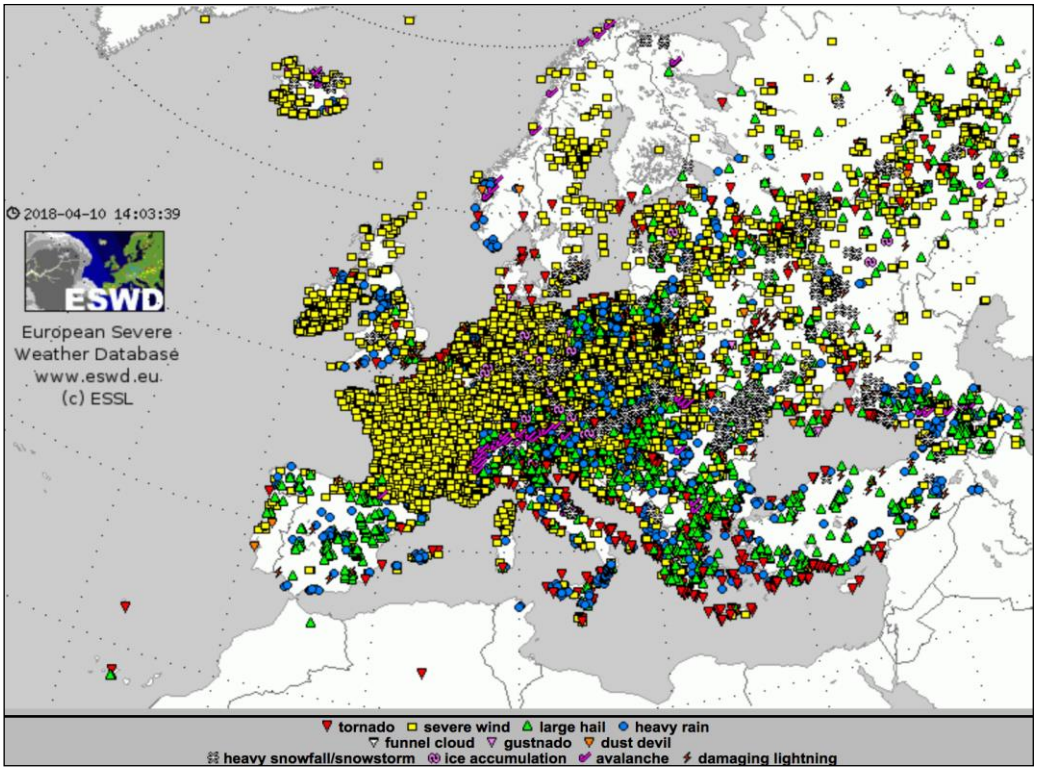

Figure 1-1. All 22 101 ESWD reports of events occurring in 2017.

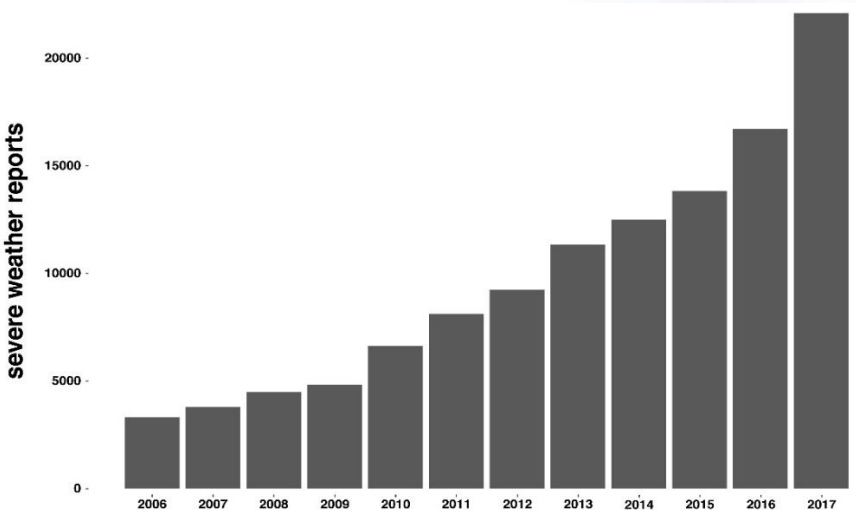

Figure 1-2. The number of severe weather reports included in the ESWD each year since 2006.

Event Distribution

Figure 1.3 shows the distribution of the reports of the most numerous convective event types across Europe. Most severe weather events were reported from central Europe, but a lower coverage was reported in the U.K., Spain, East Europe and North Africa. Indeed, across these areas, improved data collection will need to get priority in the coming years.

A comparison of the number of collected ESWD reports since 2006 (Figure 1-4) shows that the number of collected severe wind reports increases strongly, probably because of the increasing coverage of the ESWD partner network (See Section 1.1). For large hail and heavy rain, a weaker increasing trend can be observed which is strongly modulated by interannual variability. For tornadoes, no overall increase can be seen: It seems likely that the differences in tornado numbers from one year to another are mostly controlled by an actual meteorological signal.

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 2017 have been upgraded at least to QC0+, QC1 or QC2 (Table 1–2).

Table 1–2. Quality control levels of ESWD reports from 2017.

Quality Control level	Number of reports	Percentage
QC0: as received	0	0.0
QC0+: plausibility checked	1298	5.9
QC1: report confirmed by reliable sources	20465	92.6
QC2: scientific case study	338	1.5

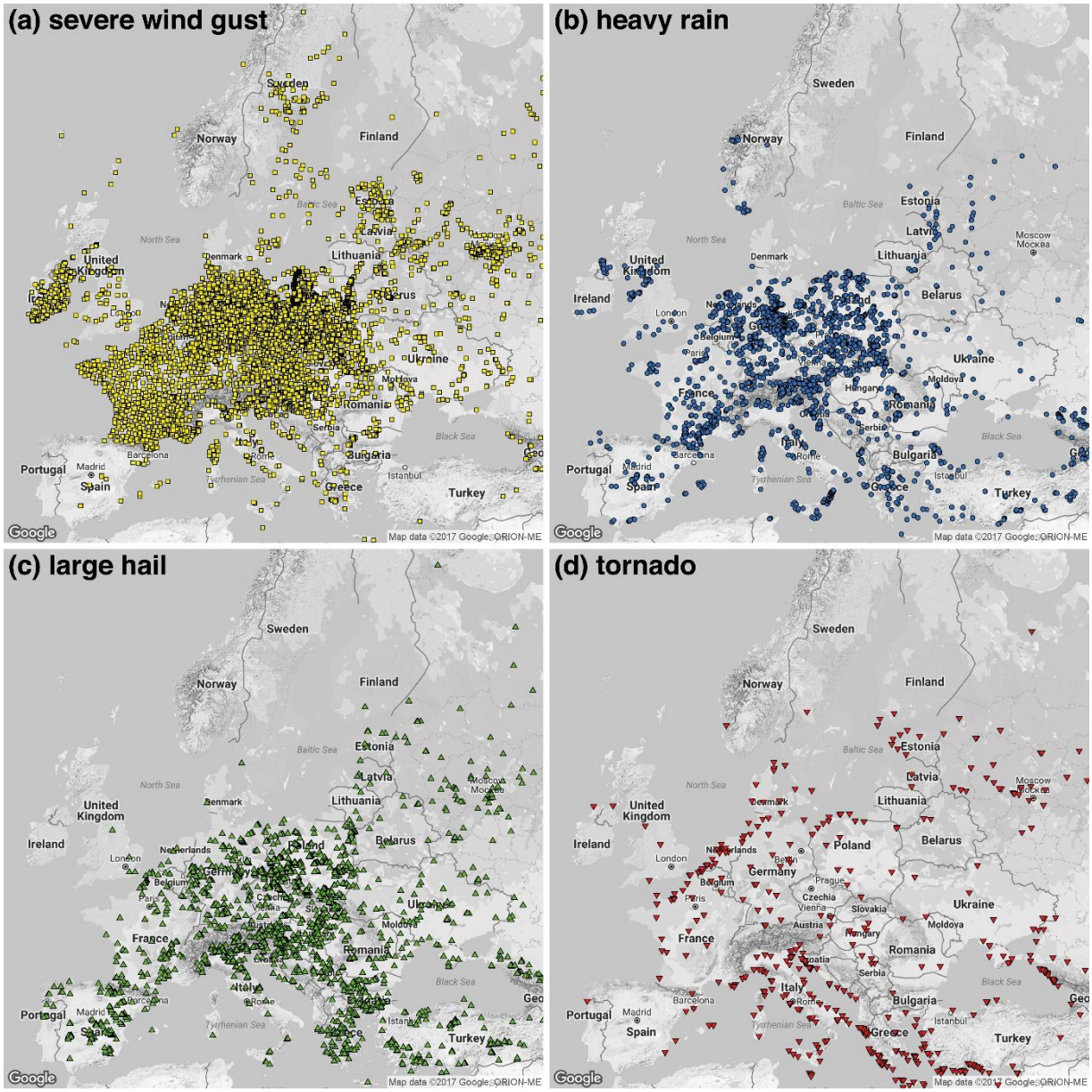

Figure 1-3. Distribution of four convective weather hazards across Europe in 2017.

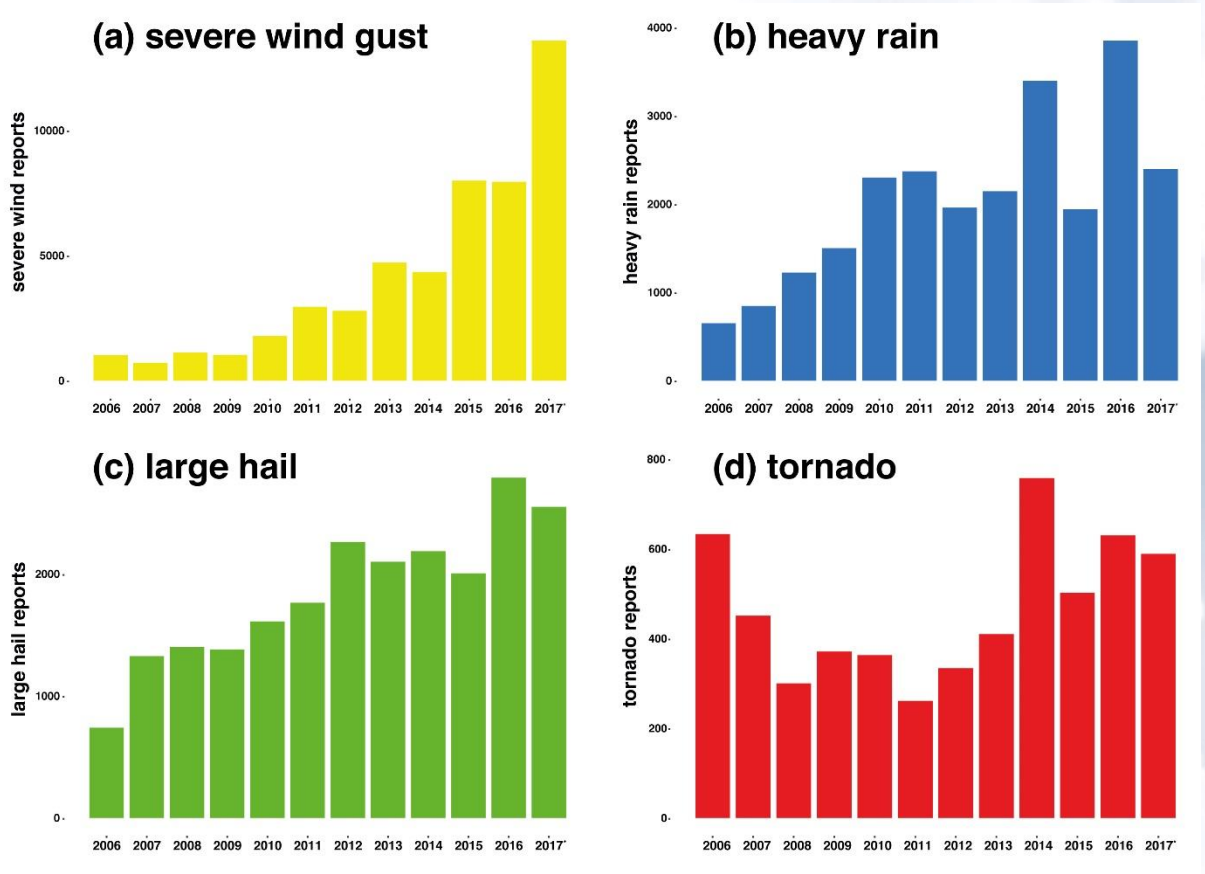

Figure 1-4. Annual number of reports for four convective hazards since 2006.

Fatalities and Injuries

The severe weather reports of 2017 were associated with 927 injuries and 294 fatalities (Figure 1-5 and

Figure 1-6). Severe weather-related fatalities were caused primarily by four event types: avalanches (34%), severe wind gusts (30%), lightning (21%) and heavy rain (14%). The majority of the injuries were caused by non-tornadic severe wind gusts (73%) and a smaller fraction by lightning (8%), tornadoes (6%) and avalanches (5%), heavy rain (3%) and heavy snowfall (3%).

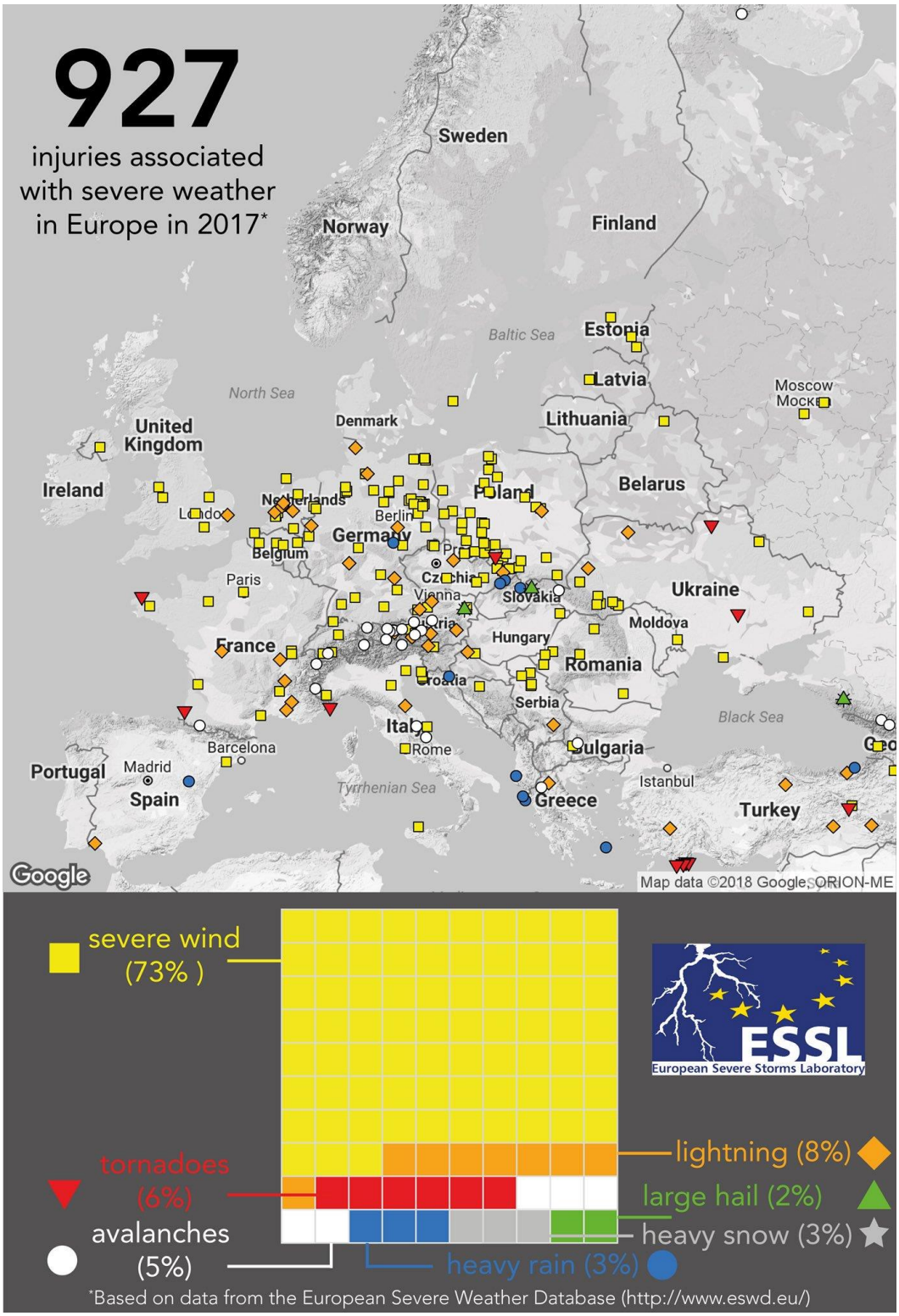

Figure 1-5. The spatial distribution of the ESWD severe weather reports associated with injuries in 2017. Also shown is the percentage of injuries associated with each type of severe weather.

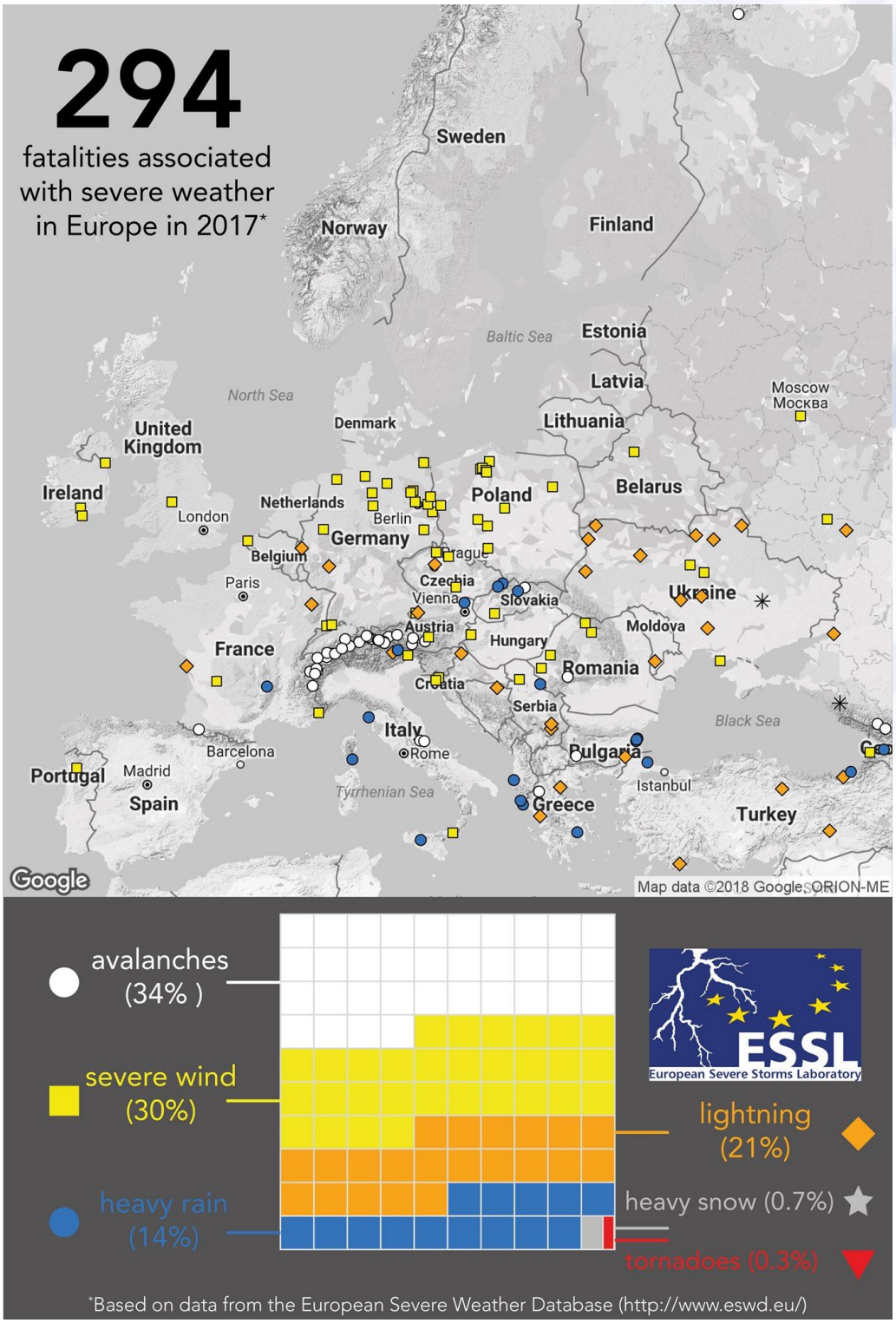

Figure 1-6. The spatial distribution of the ESWD severe weather reports in 2017 associated with fatalities. Also shown is the of fatalities associated with each type of severe weather.

1.3 Developments of the EWOB App

The European Weather OBserver app (EWOB) was running operationally during 2017. Usage levels showed large fluctuations (see Fig. 1-7). Peaks were found for periods of severe weather and also after news releases about the app. The first experiences with the app were presented in a poster at the ECSS in Pula.

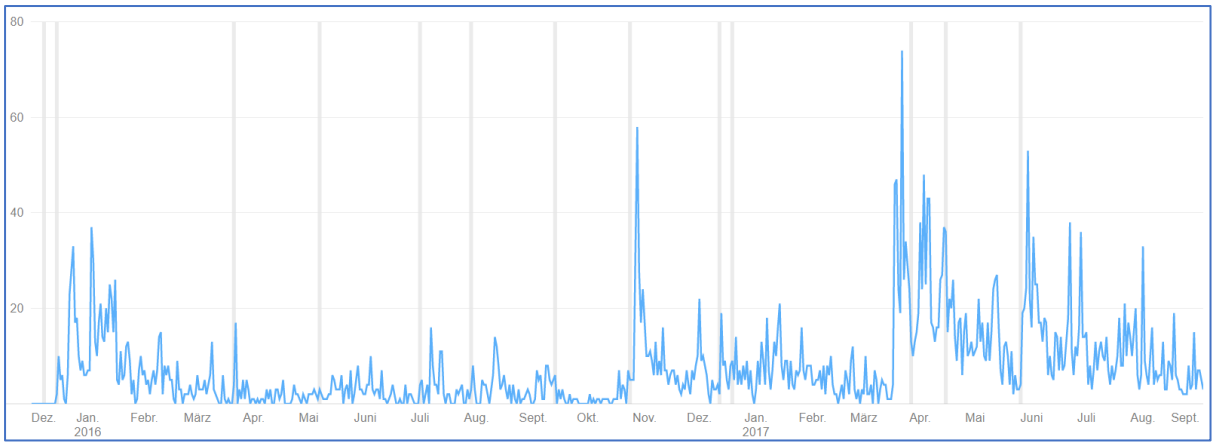

Fig. 1-7: Number of sessions per day (app in use for at least 2 seconds) for the period December 2016 to September 2017. For iOS only, no data for Android.

In 2017, a process started to establish the EWOB data format as a standard for the exchange of crowd-sourced weather and impact reports in Europe (via Application Program Interfaces; APIs), independent from the type of source (smartphone app or other). There are a number of interested partners involved in this initiative, foremost ZAMG, represented by Thomas Krennert and Rainer Kaltenberger. The idea was discussed at several international workshops and meetings, and as a first outcome a list of common reporting options was drafted, which includes substantially more parameters as the current EWOB app. This work will be continued in 2018.

In order to formalize the relationship between ESSL and its future EWOB partners (mainly the national weather services as national data hubs) an agreement will be negotiated in 2018 that shall guarantee a sustainable data flow, also taking into account the latest requirements of personal data policies within the EU.

The EWOB app can be found in Google Play (Android): https://goo.gl/QAI7JN., and in Apple's AppStore (iOS): https://goo.gl/otwnYj.

2 Research

ESSL's research activities in 2017 have concentrated mostly on the two projects ARCS and STEPCLIM. In addition, the European Commission-funded RAIN project came to an end in May.

2.1 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

Together with Munich Re, ESSL is working to analyse the risk posed by convective storms in Europe in the project ARCS. As part of the project, statistical models have been developed, that can be used to extract the probability of severe weather from climate model data. These models have been coined "AR-CHaMo" or "Additive Regression - Convective Hazard Models".

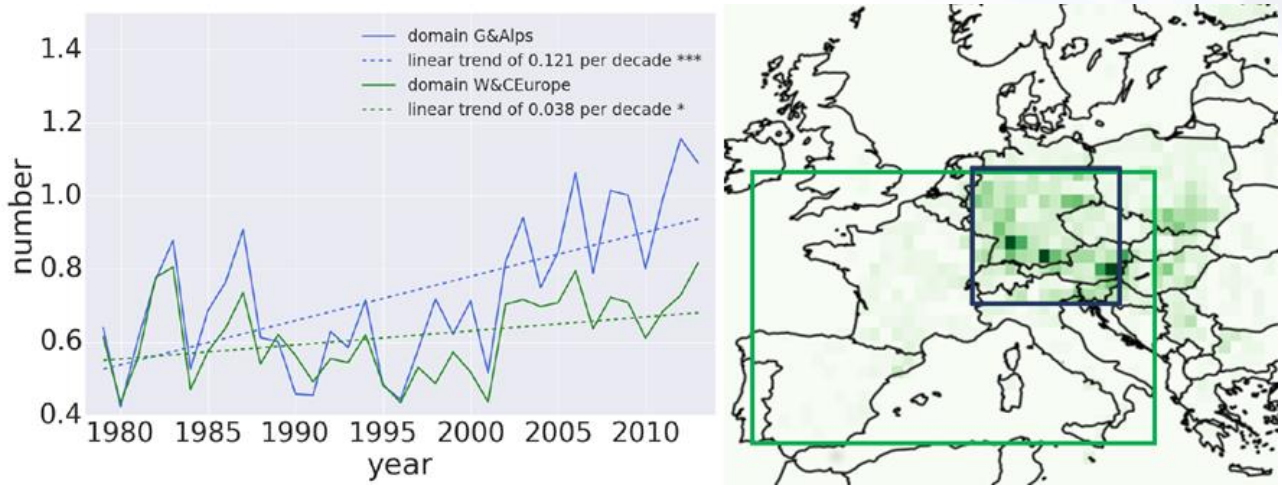

Figure 2-1. Number of expected large hail (> 2 cm) events within 70 km distance of a point, and linear trends, averaged over Germany and the Alps (G&Alps; blue) and West&Central Europe (W&Ceurope; green).

As part of ARCS and of her PhD research, Anja Rädler, the main developer of AR-ChaMo, published a study in which she considered the temporal changes in hazard probability during the last decades (Rädler et al, 2018). She found that the model, when applied to the ERA-Interim reanalysis, predicts a significant increase in large hail events across Central Europe, that quite abruptly started in 2002 or 2003 (Figure 2-1). Further analysis showed that this can be attributed primailty to an increase in instability, as the 5% most unstable situations, suddenly became significantly more unstable: This is shown by a decrease in Lifted Index (Figure 2-2). These findings suggest that changes in losses due

to hail, which have increased during this period may in part be caused by changes in large hail occurrence, rather than exclusively by an increase of vulnerable objects in the storms' paths.

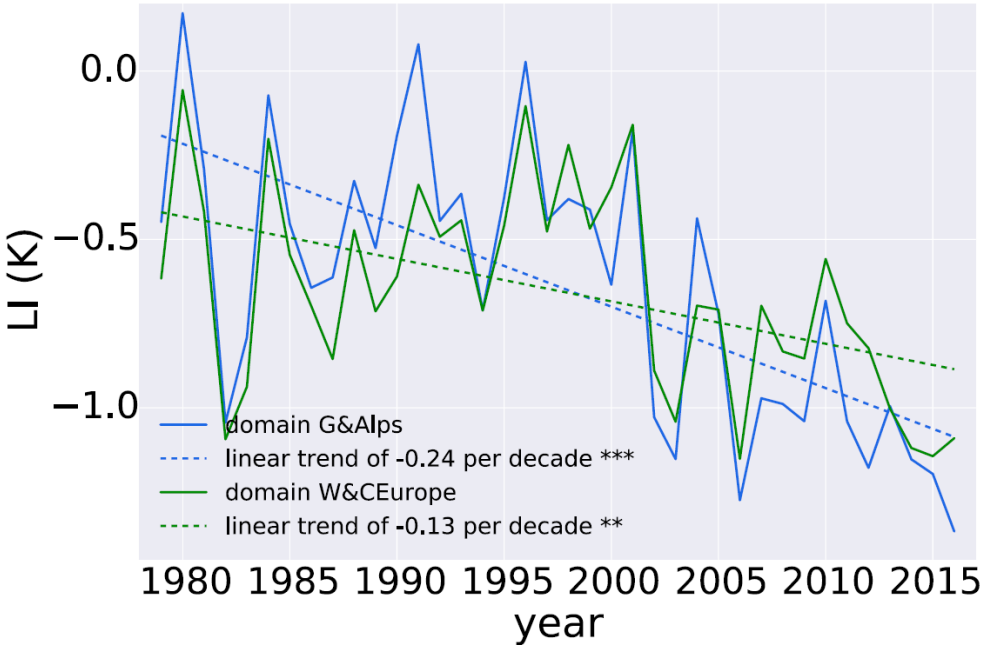

Figure 2-2. Value of the 5th percentile of the distribution of Lifted Index in a given year, averaged over Germany and the Alps (G&Alps; blue) and West&Central Europe (W&Ceurope; green).

In addition to the work on modelling severe weather occurrence, ARCS also deals with modelling the risk of severe weather. To that aim, Chris Castellano has joined the team. He is concerned with finding out how a probability of hail actually translates to individual hailstorms and the losses that they may cause on a much smaller scale. Mr. Castellano's work started on studying the statistical properties of individual observed hailstorms (Figure 2-3).

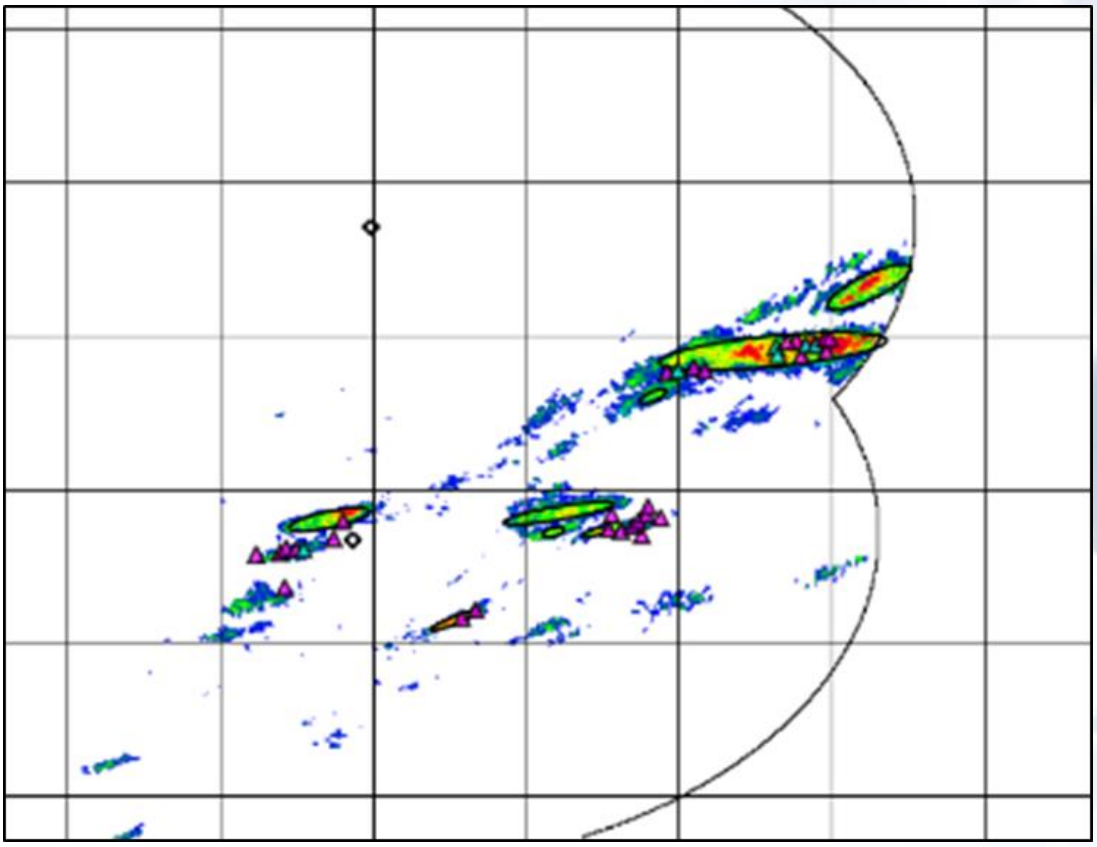

Figure 2-3. Detected hailstorm tracks (black) by a new algorithm that uses the VII product of the German Weather Service on 1 August 2017. Magenta and cyan triangles are ESWD reports with diameters of 2 and 5 cm, respectively.

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

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

The STEPCLIM project is ESSL's project within the German research framework MiKlip that deals with decadal prediction. The role of ESSL within MiKlip is to allow the modelling system that is developed by project partners at other institutions, such as the Max-Planck-Institute for Meteorologie in Hamburg, to be used for decadal prediction of severe convective events. In order to do this, ESSL applies the statistical framework AR-CHaMo to the ensemble predictions of the MiKlip system.

At the same time, ESSL optimizes AR-CHaMo by making sure ever more data is used to calibrate it. To do so, database quality manager Thilo Kühne has been working on adding many more events into the European Severe Weather Database, such as a Russian archive on natural disasters, and a Spanish tornado data set. Additionally, tornado reports from Italy were systematically collected and added to the ESWD (Figure 2-4).

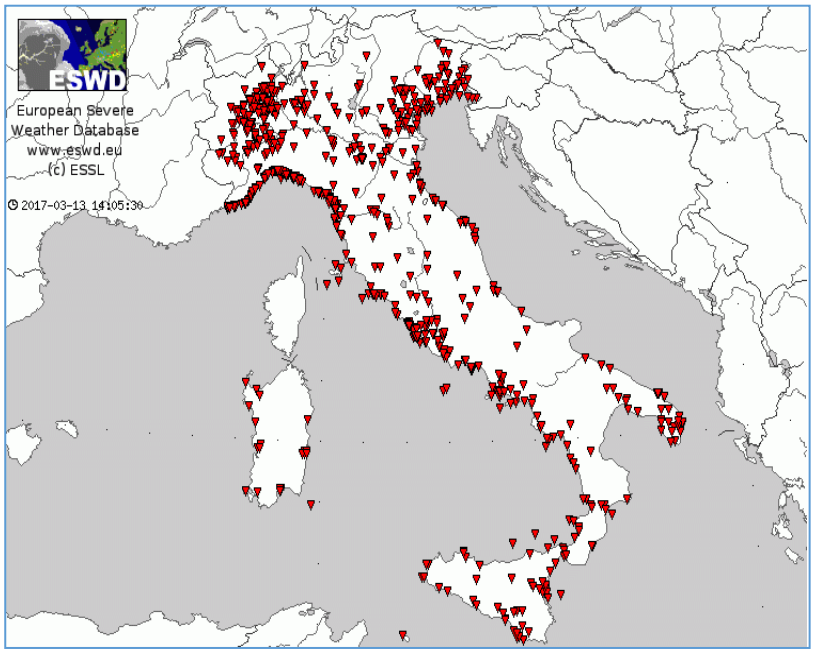

Figure 2-4. The 266 new tornado reports that have been entered into the ESWD as part of the STEPCLIM project.

ESSL researcher Chris Castellano has been working on the actual decadal predictions and evaluated the forecast skill of the MiKlip prediction system, a version called *baseline 1*. Various performance metrics were calculated (Figure 2-5) and show that a strong positive anomaly correlation exists across northern Europe (Center), where the system has important predictive skill. However, a strong conditional bias still needs to be corrected for, so that the Mean Square Skill score reflect this.

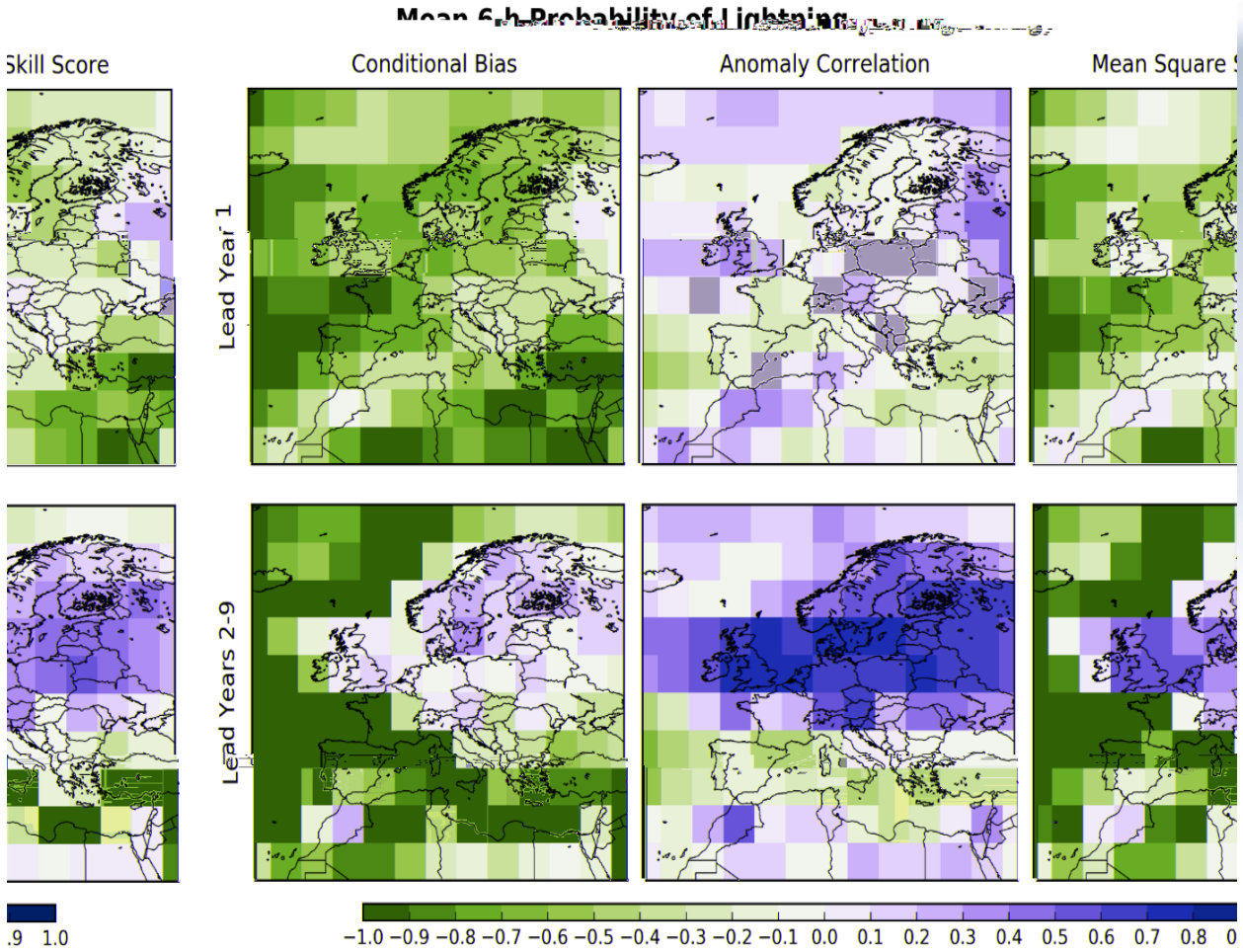

Figure 2-5. Conditional Bias, Anomaly Correction, and Mean Square Skill Score (MSSS) of MiKlip baseline-1 forecasts of lightning using AR-CHaMo for lead year 1 and averaged over lead years 2 through 9.

Making appropriate bias corrections and delivering a software *plug-in* to the MiKlip system will be the work to be carried out in the upcoming last year of the project, 2018.

2.3 Risk Analysis of Critical Infrastructure Networks in Response to Extreme Weather

Funded by: European Commission (FP7)
Grant: 327 720 euro
Personnel: 0.5 Researcher, 0.5 Researcher
Period: 1 May 2014 – 30 April 2017

In spring 2017, the RAIN project formally concluded with a Final Seminar in Dublin and a final meeting at the European Commission in Brussels. In the RAIN project, ESSL researchers Pieter Groenemeijer and Tomáš Púčik coordinated the project's Work Package on *Hazard Identification***.** Most of that work, which included the modelling of probabilities of occurrence of extreme weather hazards, had already been concluded in 2016.

The results of the RAIN Work Package 2 were published in three reports. In addition, ESSL (co-) authored several peer-reviewed publications, such as the article "Future Changes in European Severe Convection Environments in a Regional Climate Model Ensemble" that was published in the *Journal of Climate* and "Assessment of the impacts of extreme weather events upon the pan-European infrastructure to the optimal mitigation of the consequences" in *Transportation Research Procedia (see Publications in Chapter 3 for references).*

For these reports (see also the list of publications) and more background information on the RAIN project, please visit: http://www.rain-project.eu.

3 European Conference on Severe Storms – ECSS 2017

In September 2017, ESSL and the Croatian HydroMeteorological Institute DHMZ jointly organized the 9th edition of the ECSS conference in Pula, Croatia. With 198 participants and high quality scientific presentations, it was a great success.

3.1 ECSS 2017 review

186 presenters from 29 European and non-European countries showed their research at the conference during twelve sessions (Figure 3-1, Figure 3-2). In addition to the presentations, the ESSL General Assembly and a EUMETSAT Convection Working Group (CWG) meeting took place during the ECSS.

About 40 % (75 persons) of the conference participants filled out a feedback form at the end of the ECSS. They graded the conference with a mean 8.7 points out of 10 possible points. The lowest grade was 6 and some tried to grade higher than 10. According to the feedback forms 27 persons (most votes) liked most the interesting and wide ranged presentations and programme.

Some negative feedback was received about technical issues, including the quality of the projector and several participants complained about timing issues leading to delays in the programme and suggested more rigorous time keeping of presentations and breaks.

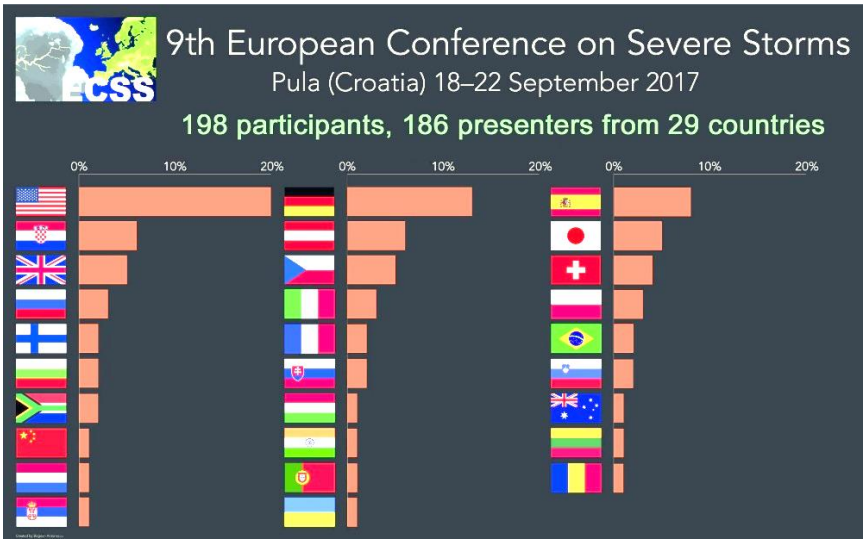

Figure 3-1. Countries of origin of ECSS2017 participants.

Figure 3-2. Photo of the Conference participants. Photo: Thomas Schreiner.

3.2 Awards during the ECSS 2017

The European Severe Storms Laboratory presents two awards to outstanding scientists: the Nikolai Dotzek Award for an outstanding contribution to the science of severe storms and the Heino Tooming Award for pan-European collaboration in the severe storms research community.

Dr. Joshua Wurman is the 2017 Nikolai Dotzek awardee. He has been given the award for his work on radar techniques, his groundbreaking work in developing the Doppler-on-Wheels radars that were first operated in the large field program VORTEX in the mid 1990's, and for the outstanding research he has done with the Doppler-on-Wheels and the work which he supervised.

This research has revealed the structure of flow in tornadoes in extreme detail; it has also contributed to important new insight into the immediate environment of tornadoes, and into other weather phenomena that the Doppler-on-Wheels have scanned around the world.

Figure 3-3. Dr. Wurman receives the Nikolai Dotzek Award including the trophy representing a giant hailstone.

Figure 3-4. ESSL (deputy) directors and awardees of the Heino Tooming Award 2017.

In addition to the **Nikolai Dotzek Award**, the **Heino Tooming Award 2017,** that is given for outstanding international collaboration, has been given to Christoph Gatzen, Michaël Kreitz, Sébastien Leprince, Lisa Schielicke, Maja Rabrenović, and Sven-Eric Enno for their joint work on "Combined analysis of severe convective wind gusts in European data sets" (Figure 3-4).

In addition, a number of outstanding posters, oral presentations and student contributions were awarded at the ECSS (Table 3–1).

Table 3–1. Conference Awards.

Award	Awardees	Presentation title
Best Presentation Jury Award	Alexander Chernokulsky, Michael Kurgansky, Igor Mokhov, Evgeniya Selezneva, Andrey Shikhov, Igor Azhigov, Denis Zakharchenko, Bogdan Antonescu, and Thilo Kühne	The modern climatology of Northern Eurasia tornadoes and waterspouts
Best Poster Jury Award	Shiho Onomura, Kenichi Kusunoki, Hanako Inoue, Naoki Ishitsu, Ken-ichiro Arai and Chusei Fujiwara	Statistical features of near-ground tornadic vortices in comparison with radar-observed vortices aloft
Best Oral Presentation Audience Award	Matthew D. Parker Brown	What have we learned about high-shear low-CAPE severe weather? A review
Best Poster Audience Award	Anja Rädler, Tomas Pucik, Pieter Groenemeijer and Lars Tijssen	Comparison between European and US severe convective weather environments

The ECSS 2017 was sponsored by Munich RE and organized in collaboration with DHMZ.

DHMZ

Munich RE

4 Testbed and Trainings

ESSL organized various Training Events in 2017, including two seminars on-site in Wiener Neustadt, one seminar in Italy and started a new activity: the ESSL Summer School. In addition, the ESSL Testbed was organized which featured the evaluation of products of the Nowcasting-SAF.

4.1 ESSL Testbed 2017

The Testbed is ESSL's annually returning project 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 2017 edition of the ESSL Testbed took place during the weeks of 5 – 9 June, 19 – 23 June, 26 – 30 June, and 3 – 7 July 2017 at the Research and Training Centre in Wiener Neustadt, Austria. ESSL was happy to welcome 43 participants from 15 countries in total.

Figure 4-1. Participants of the ESSL testbed 2017 and some of the ESSL staff.

A number of products provided by the German Weather Service were evaluated at the Testbed. They included the COSMO ensemble modelling system with KENDA data assimilation and the new ICON-EU ensemble over Europe, several COSMO model-based storm (rotation) track products, lightning detection and radar-based products to detect rotating and other severe storms.

NWC-SAF products

In addition to the DWD products, the 2017 ESSL Testbed cooperated with the Nowcasting Satellite Application Facility (NWC-SAF), a consortium of National Meteorological Services: AEMet, MeteoFrance, SHMI and ZAMG. They have developed a number of satellite-based products that were evaluated at the ESSL Testbed. One of the products was satellite-based estimate of the convective rain rate (Figure 4-2).

In order to enable the local NWC-SAF image production, additional hardware was installed at the ESSL Research and Training Centre in Wiener Neustadt in the first months of 2017, including a new satellite dish as well as adequate reception and production computers. The ESSL team was kindly supported by Zsofia Kocsis from the Hungarian Met-Service OMSZ and Jan Kaňak from SHMÚ.

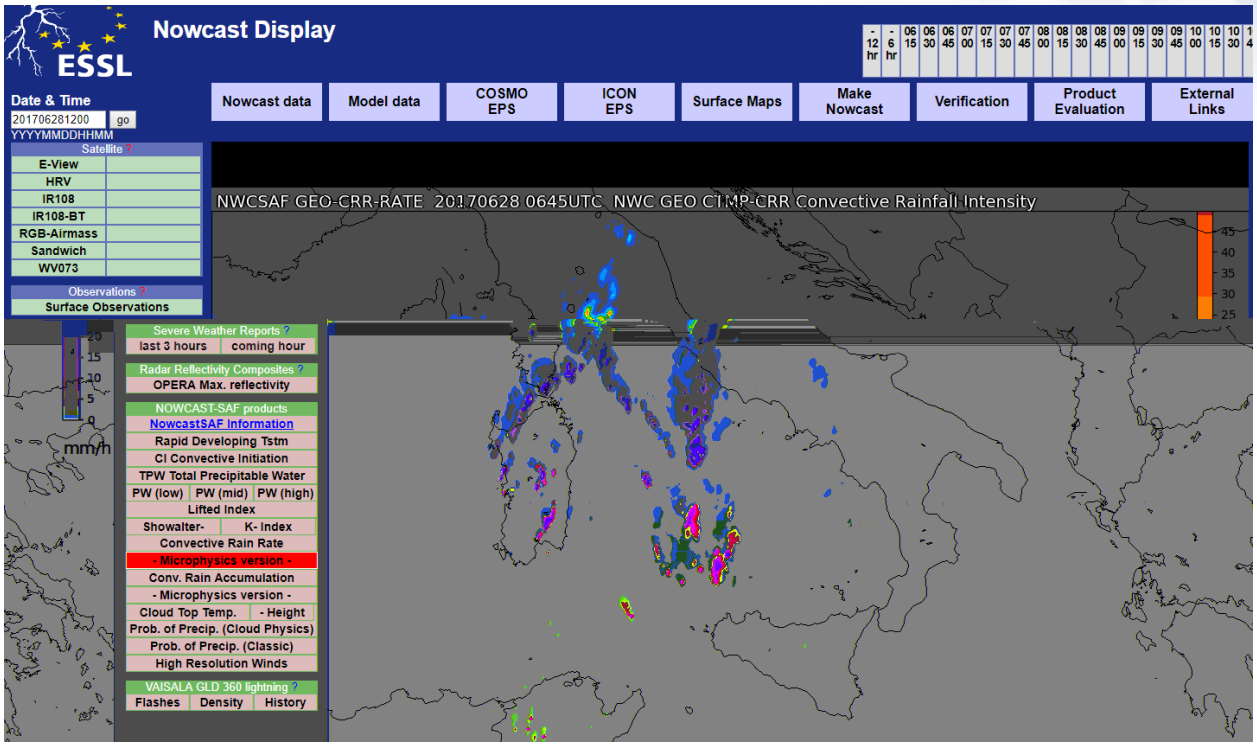

Figure 4-2. NWC-SAF Convective Rain Rate (microphysics) product, displayed at the ESSL Testbed.

4.2 Seminars

Seminar "Forecasting Severe Convection II" by Prof. Matthew Parker (19 - 23 June 2017)

Every year another international top expert is invited by ESSL to lecture our advanced seminar week "Forecasting Severe Convection II". Participants typically take part in our advanced course after having successfully taken part in the seminar "Forecasting Severe Convection I". In 2017, Prof. Matthew Parker from the North Carolina State University gave the seminar. Based on his own research he focused on low-CAPE situations, that are not only a topic in the Southeast of the USA, but also prevalent in parts of Europe. Such situations pose a challenge in forecasting severe convective weather. The seminar was a success, and feedback from the participants was very good. After the seminar, testimonials could be taken, and the outcome proved the successful teaching and high level of expertise of the participants. This is very encouraging not only for ESSL but also for all institutions responsible for optimal severe weather warnings. In 2018, we will continue this top-level seminar series with Prof. Paul Markowski from the Pennsylvania State University.

Seminar "Forecasting Severe Convection I" (2 - 6 October 2017)

ESSL organized a 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 particular convective phenomena.

Figure 4-3. Participants to the Seminar "Forecasting Severe Convection I".

Training Course in Genoa (20 November – 1 December 2017)

ESSL conducted its first training course outside the premises in Wiener Neustadt. The course was held in ARPA-Liguria (Regional Environmental Protection Agency) in Genoa, Italy, by tutor Dr. Tomáš Púčik. Altogether, 20 forecasters from ARPA-Liguria participated, but also several people from other regional ARPA offices.

Figure 4-4. Participants of the Training Course at ARPA-L in Genoa.

In order to ensure that the normal forecasting shifts were filled, the forecasters were divided in two groups, each group spending a half week at the course. The first week was heavy on theory as forecasters had to go through the basics of convective storms and their dynamics, as well as the advanced topics of convective modes and the recognition of individual convective hazard risks.

All forecasters were very active and had many questions, which made the theory lectures both interactive and more interesting. The second week was full of practice as many past events of severe convective storms across Liguria and Europe were reviewed. Special attention was given to stationary convective systems that often form over the region causing very heavy convective rainfall with a long duration. To make the forecasting sessions more interesting, each forecast was verified and the best forecaster awarded the honorary title of "forecaster of the day" (see photo).

4.3 ESSL Summer School (28 August – 1 September)

For the first time, ESSL organized a Summer School on Severe Convection. The ESSL Summer School focused on the formation, climatology, and forecasting of flash-floods, convective windstorms, hail, lightning, and tornadoes, and also on subtropical and tropical cyclones in the Mediterranean Sea and on climate change and severe storms. The target audience of the ESSL Summer School are students, early career researchers, weather forecasters, emergency and risk managers, and risk modellers from insurance and re-insurance sector.

During the ESSL Summer School, lectures were delivered by Prof. Marco Borga (University of Padova, Italy) on the climatology and impact of flash-flood in Europe; Prof. Michael Kunz and Dr. Heinz Jürgen Punge (Karlsruhe Institute of Technology, Germany) on hail in Europe; Dr. Christoph Gatzen (ESTOFEX) on windstorms; and Prof. Robert Jeffrey Trapp (University of Illinois at Urbana-Champaign, USA) on tornado dynamics. The ESSL team lectured on severe convective storms and climate change (Dr. Pieter Groenemeijer), on tropical cyclones in the Mediterranean Sea (Alois M. Holzer), and

lightning and tornadoes in Europe (Dr. Bogdan Antonescu). Dr. Tomáš Púčik (ESSL) delivered lectures on atmospheric convection, provided daily weather briefings, and conducted the afternoon practicals. This first edition of the ESSL Summer School gathered 15 participants from Europe and Australia.

Figure 4-5. ESSL Summer school lecturers and participants.

4.4 Convection Working Group Secretariat

In 2017 ESSL continued to provide secretarial support to the EUMETSAT CWG. A splinter meeting was held at the ECSS in Pula. In addition to the regular updates of the CWG website, mailing list and the support to the CWG Co-Chairs, we also set up a new web portal- satellite guidance for forecasting severe convection: https://www.essl.org/cwg-satellite-guidance/

This portal is designed to explain the usage of different satellite based products. The forecaster community repeatedly asked for such a support, and by initiative and request of Mateja Iršič Žibert from ARSO in Ljubljana, Slovenia, who is one of the Co-Chairs of the CWG, this new satellite guidance portal was set up by ESSL within a very short time in November and December 2017. A large number of contributors to this portal, all active in the CWG, enabled us to make this vision become reality. There also was a strong support from the other two Co-Chairs on behalf of EUMETSAT for this CWG initiative: Vesa Nietosvaara and Jochen Grandell. ESSL will continue its support to the CWG in 2018.

5 Publications and Communications

ESSL has produced many scientific and other results in 2017, 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 2017

- Tomáš Púčik, Pieter Groenemeijer, Anja T. Rädler, Lars Tijssen, Grigory Nikulin, Andreas F. Prein, Erik van Meijgaard, Rowan Fealy, Daniela Jacob, and Claas Teichmann, 2017:
  Future Changes in European Severe Convection Environments in a Regional Climate Model Ensemble, *Journal of Climate*, **30**, 6771–6794. http://dx.doi.org/10.1175/JCLI-D-16-0777.1**.**

- Pieter Groenemeijer, Tomáš Púčik, Alois M. Holzer, Bogdan Antonescu, Kathrin Riemann-Campe, David M. Schultz, Thilo Kühne, Bernold Feuerstein, Harold E. Brooks, Charles A. Doswell III, Hans-Joachim Koppert, and Robert Sausen, 2017:
  Severe Convective Storms in Europe: 10 Years of Research at the European Severe Storms Laboratory, *Bulletin of the American Meteorological Society*, **98**, 2641–2651. http://dx.doi.org/10.1175/BAMS-D-16-0067.1**.**

- Bogdan Antonescu, David M. Schultz, Alois M. Holzer, Pieter Groenemeijer, 2017:
  Tornadoes in Europe: An underestimated threat. *Bulletin of the American Meteorological Society*, **98**, 713–728. http://dx.doi.org/10.1175/BAMS-D-16-0171.1.

Submitted in 2017

- 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*, in print. 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*, in print. http://dx.doi.org/10.1175/JAMC-D-17-0132.1.

- Holzer, A. M., Schreiner, T. M. E., and Púčik, T., 2017**: Re-Analysis of one of the deadliest Tornadoes in European History and its implications**, *Nat. Hazards Earth Syst. Sci. Discuss.*, https://doi.org/10.5194/nhess-2017-314.

- Maria Nogal, Alan O'Connor, Pieter Groenemeijer, Peter Prak, Maria Luskova, Milenko Halat, Pieter van Gelder and Kenneth Gavin, 2018: **Assessment of the impacts of extreme weather events upon the pan-European infrastructure to the optimal mitigation of the consequences**, *Transportation Research Procedia*, 15, in print.

5.2 Reports

In 2017, ESSL published the following reports:

1. Report 2017-01**: Summary of the evaluation of COSMO and ICON models at the ESSL Testbed 2017**: https://www.essl.org/media/publications/essl-report-2017-01.pdf
2. Report 2017-02**: Testing of NWC-SAF products at the ESSL Testbed 2017**: https://www.essl.org/media/Testbed2017/20170929ESSLTestbedReportforNWCSAFfinal.pdf
3.

5.3 Scientific and Invited Presentations

1. Alois M. Holzer: **Stürme über Europa Neueste Erkenntnisse der Unwetterforschung**, Niederösterreichische Katastrophenschutzfachtagung, 28 November 2017, Tulln, Austria.
2. Pieter Groenemeijer: **The European Severe Weather Database, International workshop on cataloguing and managing information on extreme weather water and climate events**, 20-22 November 2017, WMO, Geneva, Switzerland.
3. Pieter Groenemeijer: **Educational Activities and Severe Weather Data collection at the European Severe Storms Laboratory**, 16th Session of the Informal Conference of South-East European NHMS Directors, ICSEED-16, Belgrade, 23-24 Oct 2017.
4. Pieter Groenemeijer, Tomáš Púčik, Andrea Vajda, Ilari Lehtonen, Matti Kämäräinen, Nico Becker, Katrin Nissen, and Uwe Ulbrich: **Trends of rain, wind-, snow- and thunderstorm events during the 21st Century according to regional climate model**s, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
5. Anja T. Rädler, Pieter Groenemeijer, Tomáš Púčik, Robert Sausen, and Eberhard Faust: **An additive regression convective hazard model (ARCHaMo) for detecting past and future trends in severe weather events**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
6. Tomas Pucik, Pieter Groenemeijer, Anja Rädler, and Lars Tijssen: **Future of severe thunderstorm environments in Europe: simulated changes and uncertainties**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
7. Alexander Chernokulsky, Michael Kurgansky, Igor Mokhov, Evgeniya Selezneva, Andrey Shikhov, Igor Azhigov, Denis Zakharchenko, Bogdan Antonescu, and Thilo Kühne: **The modern climatology of**

Northern Eurasia tornadoes and waterspouts, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.

8. Pieter Groenemeijer, Tomáš Púčik, Anja T. Rädler: **Severe Convective Storms in a Changing Climate**, ESSL Summer School, 1 September 2017, Wiener Neustadt, Austria.
9. Anja T. Rädler**, Modeling Severe Weather Occurrence Using Additive Regressive Convective Hazard Models (AR-CHaMo)**, *Institutional Seminar*, Institute of Atmospheric Physics, 31 July 2017, DLR Oberpfaffenhofen.
10. Bogdan Antonescu: **The European Severe Weather Database**, Aon Benfield Impact Forecasting meeting, 21 June 2017, London, United Kingdom.
11. Pieter Groenemeijer: **The ESSL Testbed Data Interface**, ECMWF User Forum, 14 June 2017, Reading, United Kingdom.
12. Bogdan Antonescu: **The European Severe Weather Database**, Aon Benfield Impact Forecasting meeting, 12 June 2017, Zürich, Switzerland.
13. Alois M. Holzer: **Human capacity building to support a stable "DNA" for SEE-MHEWS-A**, Final Conference of the 1st Phase of South-East European Multi-Hazard Early Warning Advisory System (SEE-MHEWS-A), Ljubljana, 15 June 2017.
14. Pieter Groenemeijer, Alois M. Holzer, Tomáš Púčik: **Evaluation of Nowcast Systems at the ESSL Testbed since 2012**, 2nd European Nowcasting Conference, 4 May 2017, Offenbach, Germany.
15. Tomáš Púčik, **The end of stormchasing in the Czech Republic (?), or how climate models simulate the presence and future of severe convective storms in Europe (in Czech)**, *CHMI/AMS Seminar on Thunderstorms*, 27 May 2017, Drhleny, Czechia.
16. Pieter Groenemeijer: **Modelling the large hail hazard in the past, present, near and far future**, *2nd European Hail Workshop*, 19 April 2017, University of Bern, Bern, Switzerland.
17. Pieter Groenemeijer and Alois M. Holzer, Tomáš Púčik, Lars Tijssen and 18 co-authors, **Establishing and Modelling the Exceedance of Severe Weather Thresholds Today and Considering Climate Change**, *RAIN Final Event*, 24 March 2017, Trinity College, Dublin, Ireland.
18. Anja T. Rädler, **Trends of severe convection in Europe detected by AR-CHaMo - additive regression convective hazard models**, *Geoscientific Seminar*, Geo Risks Research, 22 March 2017, Munich Re.
19. Thomas M. E. Schreiner: **Eigene Unwettermeldungen in Social Media weitererzählen, Session "To Hell with Facts - we need stories",** *3rd Austrian Citizen Science Conference*, 2-3 March 2017, Vienna, Austria.
20. Pieter Groenemeijer: **Needs in forecaster training and collaboration: Suggestions based on ESSL's experience**, *Regional Conference on South-East Europe Multi-Hazard Early Warning Systems*, 7 Feb 2017, Skopje, Macedonia.
21. Alois M. Holzer, Thomas M.E. Schreiner, and co-authors: **EWOB als Teil eines perfekten Beobachtungssystems (in German)**, *ZAMG-TSN Workshop, 28 January 2017, Vienna, Austria.*

Poster presentations

1. Alois M. Holzer, Pieter Groenemeijer, Kathrin Riemann-Campe, and Bogdan Antonescu: **Experience after 1 year of EWOB**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
2. Anja T. Rädler, Tomas Pucik, Pieter Groenemeijer, and Lars Tijssen: **Comparison between European and US severe convective weather environments**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
3. Tomáš Púčik, Petr Zacharov, and Pieter Groenemeijer: **Local enhancement of latent instability and vertical wind shear in the Alpine foreland during the 1984 Munich hailstorm case**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.

4. Lars Tijssen, Pieter Groenemeijer, and Anja Rädler: **Medium-range forecasting of convective hazards using ESSL's Additive Regression Convective Hazard Model (ARCHaMo)** , *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
5. Bogdan Antonescu, Hugo Ricketts, and David M. Schultz: **100 Years after Alfred Wegener's Opus on Tornadoes in Europe**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
6. Katrin Pfeifer, Alois M. Holzer, and Thilo Kühne: **Historic severe weather events in Europe (414 BC - 1590)**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
7. Thilo Kühne, Andreas Kollmohr, Martin Hubrig, Thomas Sävert, Oliver Schlenczek, Werner Simon, and Heiko Wichmann: **Statistical analysis of the spatial and temporal distribution of tornadoes in Germany**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
8. Gabriel Strommer: **Analysis of run-off rates and tracks of the resulting flash floods during a heavy rain event in Vienna (Austria) on 24 May 2014**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
9. Katrin Pfeifer and Alois M. Holzer, **Historic severe weather events in Austria (1815-1830): Impacts on society and magnitude assessments,** *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia.
10. Thomas Krennert, Rainer Kaltenberger, Georg Pistotnik, Alois M. Holzer, Franz Zeiler, and Mathias Stampfl, **Trusted Spotter Network Austria - Towards a New Standard in the Field of Crowd-Sourced Weather- and Impact-Observations**, *9th European Conference on Severe Storms – ECSS 2017*, 8-14 September 2017, Pula, Croatia..
11. Lars Tijssen, Pieter Groenemeijer, Thilo Kühne, and Robert Sausen: **STEPCLIM (WP E-7) Severe Thunderstorm Evaluation and Predictability in CLImate Models**, MiKlip Status Seminar 2017, 1-3 March 2017, Harnack Haus, Berlin, Germany.

5.4 Press Communications

28 September 2017: Article for The Conversation: **European tornadoes are real and their threat is underestimated**. The article also appeared in RealClearScience, Business Insider UK, and Yahoo! News.

26 April 2017: Press release by the University of Manchester: **European tornadoes are unrecognised threat say University experts**. The press release was timed with the publication of "Tornadoes in Europe: An underestimated threat" in the Bulletin of the American Meteorological Society. The press release was used by many international media and formed the source for these articles:

Tornado, anche l'Europa è a rischio in palermomania.it, ***Meteo: i tornado in Europa*** in Focus, ***UWAGA! Zagrożenie tornadem w UK jest całkiem REALNE!*** in Express Polish, ***Anche l'Europa a rischio tornado*** in Ansa.it, ***Tornado, anche in Europa ci sono aree fortemente a rischio*** in 105.net, ***Tornadoes threat to Britain, Germany and Italy: weather expert*** in XinhuaNet, ***UK tornado alert: Scientists issue warning of Britain's hidden danger - 'DO NOT IGNORE'"*** in Sunday Express, ***Tornado in Europa, una minaccia sottovalutata*** in meteo.it, ***Els tornados a Europa, una amenaça poc coneguda*** in ara.cat, ***Tornades : Leur menace este sours-estimee en Europe*** in Science et Vie, ***Tornadoes threat to Britain, Germany, and Italy*** in Post Online Media, ***Tornadoes threat to Britain, Germany and Italy: weather experts*** in Asia Pacific Daily, ***Tornadoes threat to Britain, Germany and Italy: weather experts*** in China.org.cn, ***European tornadoes are an unrecognised threat, say U.K. meteorologists*** in Phys.org

Interviews were given for: Jurnalul National, PressOne, and Antena 1 [in Romanian].

14 February 2017: News item: ***Twist and shout: European tornadoes*** in Geographical Magazine about the upcoming paper on the threat of tornadoes to Europe.

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 now, the Twitter account has 575 followers and the Facebook account 3,191 followers. We invite the reader to follow us. Also, news posts on the ESSL website provide updates on recent activities. During ESSL Testbed participant phases, a daily testbed blog is maintained. The Twitter account was used extensively during the ECSS conference in September 2017.

Figure 5-1. The Twitter account @essl_ecss is also used to retweet humorous posts with a high interest to its followers, such as this tweet by Director of Operations Alois M. Holzer, featuring a picture of deputy Director Bogdan Antonescu (left) and Director Pieter Groenemeijer in the process of preparing an award at the ECSS conference :-)

6 Financial and Administrative Report

6.1 Employment and Payroll Accounting

In 2017, the European Severe Storms Laboratory e.V. employed one full time employee (ESSL Director), three part-time employees (ESWD quality control manager, ESSL Treasurer and one Researcher), 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 2017 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 2017 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 2017

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, and the final phase of the EU-FP7 project RAIN. 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 2017 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.

Based on the reliable income from 3 different scientific projects and from membership fees, the financial situation in 2017 was significantly better than in the previous years. As a result, the liquidity situation was uncritical during the whole year, a novelty compared to previous years. Nevertheless, ESSL could only build up a tiny reserve for costs expected at the beginning of 2018.

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 2017:

ESSL obtained EUR 125,589 (2016: 126,539) in membership fees and EUR 271,636 (2016: 215,782) from scientific projects.

Total income amounts to **EUR 399,967** (2016: EUR 352,365).

Total expenses amount to **EUR 378,345** (2016: EUR 348,196).

The major cost factors were personnel costs with EUR 305,576 (2016: 277,418), including taxes and social security, and travel expenses with EUR 8,678 (2016: 20,312). Tax advisor and external bookkeeping costs add up to EUR 8,451 (2016: 7,130) and the shared IT infrastructure and shared administration (with ESSL Science and Training) to EUR 32,139 (2016: 20,592).

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 41,452 (2016: 81,176). At the end of the year 2017, accounts receivables amounted to EUR 6,130 (2016: 0), deferred expenses (payments made for future accounting periods) to EUR 8,031 (2016: 18,532), deferred income (payments received for future accounting periods) to EUR 24,998 (2016: 90,768). Comparing liquid assets with deferred income, it can be stated that ESSL was still running without noteworthy reserves (covering less than the mean monthly costs).

The **annual result is a positive EUR 21,621.43** (compare: positive 4,169.46 in 2016, positive EUR 3,552.30 in 2015, negative EUR 3,957.15 in 2014, positive EUR 2,625.89 in 2013, negative 34,365.67 in 2012, positive EUR 7,093.32 in 2011, negative EUR 46,859.77 in 2010, positive EUR 60,599.84 in 2009).

The financial planning for 2018 foresees sufficient liquidity until autumn. Towards the end of the year the situation deteriorates, mainly because of a missing follow-up project for RAIN. The two projects STEPCLIM and ARCS will end in late 2018 and early 2019 respectively, posing a big challenge for the funding of ESSL for 2019.

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 33,413 (2016: 23,277). Of this amount, EUR 30,000 are a current reserve for the ESSL Testbed 2018. The current reserve of EUR 20,000 for 2017 was dissolved. The remaining annual result for the subsidiary association in 2017 is a positive EUR 3,136 (2016: 3,156; 2015: 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 ECSS conference ended with a slightly positive result. The financial planning for 2018 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 catalyzing the pursuit of the Association's goals. This type of support is sometimes provided in-kind and sometimes by financial support.

In 2017, ESSL was happy to welcome three new Institutional Full Members: *Croatia Control (the Croatian Air Navigation Services)*, the *Cyprus Department of Meteorology*, and

the *Republic Hydrometeorological Service of Serbia (RHMSS)*. The full member list as of 31 December 2017 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.

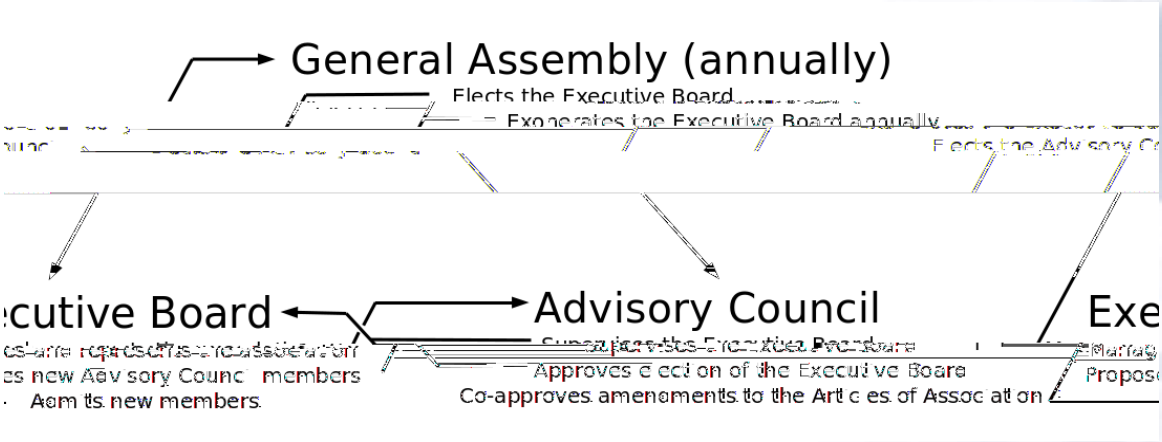

Fig. 6-1: Bodies of the ESSL. The Advisory Council consists of six members from two groups - three members each: (1) Science, (2) NMHS / EUMETNET.

Executive Board

In 2017, 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 have been elected for a term until 31 Dec. 2018.

Advisory Council

In 2017, 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

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

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

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

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

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

Appendix A1: Annual Accounts

The following presents in extract a copy of the "*Report on the Preparation of the Financial Statements for 2017*", as prepared by the financial auditor. Figures of the previous year (*italic*) were added for comparison.

	2017	***2016***
INCOME		
Membership fees institutional members and ESWD data fees	122,939.57	*122,161.99*
Membership fees personal members	2,650.00	*4,377.51*
ESWD data sales	0.00	*3,821.19*
Public project funding Federal Republic of Germany	238,864.73	*92,238.99*
Public project funding European Union	32,772.00	*65,544.00*
Applied research	0.00	*58,000.00*
Donations	500.00	*300.00*
German VAT on sales and refunds	2,240.43	*5,921.87*
Total income	**399,966.73**	***352,365.55***
EXPENSES		
Personnel	305,576.59	*277,417.90*
Depreciations	990.00	*1,137.00*
Travel costs	8,677.73	*20,312.42*
Office costs and insurance	1,077.40	*1,910.65*
Phone and data (internet) services	5,232.31	*5,425.41*
Tax advisor including software	8,450.94	*7,130.00*
IT infrastructure and shared administration	32,138.70	*20,592.70*
Value added tax	6,092.12	*1,804.21*
Third party services and other	10,109.51	*12,465.80*
Total expenses	**378,345.30**	***348,196.09***
Result	**21,621.43**	***4,169.46***

Assets and Liabilities 2017

	2017	***2016***
Fixed Assets (office equipment)	1,403.00	*1,457.00*
Current Assets		
Receivables	6,130.00	*0.00*
Bank balances	41,452.29	*81,175.52*
Deferred Expenses	8,031.00	*18,532.00*
Assets total	**57,016.29**	***101,164.52***
Equity (own capital)		
Retained earnings brought forward	10,396.74	*6,227.28*
Remaining result of the year	21,621.43	*4,169.46*
Deferred Income	24,998.12	*90,767.78*
Liabilities to the bank	0.00	*0.00*
Equity and Liabilities total	**57,016.29**	***101,164.52***

Appendix A2: Member List 2017

The following table shows all ESSL members as of 31 December 2017. New members who have joined ESSL in 2017 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.

ESSL has these five types of members:

INDF - Individual Full Member
INSF - Institutional Full Member
HMEM - Honorary Member
INDS - Individual Supporting Member
INSS - Institutional Supporting Member

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	Georg Pistotnik	AUSTRIA
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	Emmanuel Wesolek	FRANCE
INDF	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	Anja T. Rädler *	GERMANY
INDF	Dr. Darrel Kingfield *	USA
INDS	Casper ter Kuile	NETHERLANDS
INDS	Stefan Meulemans	BELGIUM
INDS	Jan Jacob Groenemeijer	NETHERLANDS
INDS	Christopher Claude Valois Barthe	FRANCE
INDS	Mathias Stampfl	AUSTRIA
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
INSF	SHMU, Slovak Hydrometeorological Institute	SLOVAKIA
INSF	Consorzio LaMMA	ITALY
INSF	KNMI	NETHERLANDS
INSF	ECMWF - European Centre for Medium-Range Weather Forecasts	UNITED KINGDOM
INSF	Croatia Control, Croatian Air navigation Services, Ltd *	CROATIA
INSF	Cyprus Department of Meteorology *	CYPRUS
INSF	RHMSS – Republic Hydrometeorological Service of Serbia *	SERBIA
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	Sompo Risk Management & Health Care Inc	JAPAN
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 a.s.	CZECH REPUBLIC

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