ANNUAL REPORT 2016

European Severe Storms Laboratory e.V.

Contents

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.

Registration number: VR200584, Amtsgericht München
V.A.T. Number: DE 252519763

Address:
European Severe Storms Laboratory (ESSL)
c/o DLR
Münchener Str. 20, Geb. 126
82234 Weßling, Germany

E-Mail: eb@essl.org

http://www.essl.org
Tel.: +49 151 5903 1839
Fax: +49 8151 9659 999 11

1 Introduction

The ESSL board is happy to present you the Annual Report of the year 2016 in which ESSL celebrated its 10th Anniversary. During a special session in Wiener Neustadt this happy occasion was celebrated in the presence of many ESSL members, Advisory Council members and partners. In the Chapter Outreach, one can find a summary of this event. An article was written for the Bulletin of the American Meteorological Society, which summarizes ESSL's achievements in its first decade.[1]

The scientific work that ESSL carried out in 2016 was primarily within three multi-year externally funded projects. The first of them is ARCS, a new research project that officially started in April. ARCS stands for "Assessment of changes of Risk of Convective Storms in Europe". The project is a cooperation with long-term supporting ESSL member Munich Re, which funds the project together with the German Ministry of Research and Education (BMBF). An early accomplishment within this project is the framework for statistical models (AR-CHaMo) to deduce the probability of severe weather from climate model and reanalysis data. As a spin-off of ARCS, ESSL developed an application for DWD to apply AR-CHaMo to forecast models. Within the project STEPCLIM, ESSL researchers continued their work contributing to a decadal forecast system within the German research framework MiKlip – Phase 2. The AR-CHaMo models to MiKlip's decadal simulations in order develop a decadal prediction system for severe convection.

ESSL was also active in the FP7 RAIN project, coordinating the Work Package on "Hazard Identification". Here, ESSL researchers pioneered the use of an ensemble of regional climate model simulations to predict changes in severe convection frequency until 2100. The analyses revealed that increases in moisture will likely lead to an increase in unstable situations supporting severe convection, especially in Central and South-Central Europe, and particularly if climate change is not effectively mitigated. This trend and those of other hazards were investigated by ESSL and its partners, and were published in an extensive report.[2]

In 2016, the European Severe Weather Database (ESWD) grew by 16 718 reports in 2016, the largest increase in any year. This was not only due to the continuing efforts of the data collection by ESSL, but also by its growing network of volunteers, associations and (hydro-) meteorological services. An interface between the EWOB app and the ESWD was established, so that app reports can be transferred to the ESWD database if they are reports of severe weather.

---

[1] Groenemeijer et al, 2017: Severe Convective Storms in Europe: Ten Years of Research and Education at the European Severe Storms Laboratory, *Bulletin of the American Meteorological Society*, early online release available at: http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-16-0067.1

[2] RAIN report D2.5: Present and future probability of meteorological and hydrological hazards in Europe, downloadable at: https://www.essl.org/cms/research-projects/new-eu-project-rain/

Furthermore, with the help of a large number of volunteers, the EWOB app was enhanced to allow for no fewer than 35 different input languages.

In ESSL's Research and Training Centre in Wiener Neustadt, several activities were organized, including two seminars on forecasting severe convection and the ESSL Testbed. The Testbed has an attendance of 40 external participants, who evaluated a number of new products, including a lightning detection product and a version of the nowcast system NowcastMIX of the German Weather Service, optimized for usage in a mobile app. Moreover, the participants worked with both German and Swiss convection-permitting ensemble simulations. In addition, ESSL hosted an international workshop on tornado damage which was combined with a meeting of the EF-Scale International Working Group. In 2016, ESSL also continued its support of the Convection Working Group, for which it hosts the secretariat.

Financially, 2016 was a slightly better year than the past years as a result of the income of three external projects. In the Administrative and Financial report in Chapter 5, this is described in detail. That being said, the importance of the income from membership fees in addition to project funds can hardly be overstated. They are needed to cover all expenses at ESSL beyond the salaries of project researchers. They are also essential to build financial reserves needed to bridge gaps between project payments. In 2016, ESSL was still not able to accumulate any noteworthy financial reserves, which makes ESSL vulnerable. Although the General Assembly has agreed to raise membership fees, the Board is aware that this will not solve the problem. Instead, acquiring more members and getting involved in projects and task with a longer duration is necessary. This is why I would like to call on all ESSL members to suggest possibilities for collaborative projects in which ESSL can play a role.

In 2016, one individual full member and five institutional supporting members joined. Moreover, we could welcome two institutional full members as new ESSL members, the European Centre for Medium-range Weather Forecasts (ECMWF) and the Netherlands Meteorological Institute (KNMI). We would be happy to welcome other new members, as the interest in ESSL's activities across Europe continues to grow as they become better known.

With that, I conclude and am happy to present you this Annual Report, which constitutes a review of ESSL's achievements in its tenth business year.

Pieter Groenemeijer
ESSL Director, Chair of the Executive Board

Weßling, 4 August 2017

2 Severe Weather Data Collection

An important resource for scientific research into severe storms are “ground-truth” observations of severe storm events. The central theme of many research projects carried out at ESSL and elsewhere is to combine these with other data, such as data from remote sensing systems or numerical models is. Furthermore, they are important for the verification of severe weather forecasts and warnings. Therefore, ever since ESSL was founded, it has put much effort into the collection of such observations in collaboration with networks of voluntary observers throughout Europe. The initiative to collect even more severe weather reports through crowd-sourcing by means of its app — European Weather Observer (EWOB) — continue through 2016.

2.1 The European Severe Weather Database

The operation and extension of the European Severe Weather Database (ESWD) is one of ESSL’s three statutory purposes. The ESWD has already been used in many dozens of peer-reviewed studies. Members of ESSL can obtain access to the ESWD (*see: ESWD Data Policy*).

ESWD data use and user support

The studies for which the ESWD is used 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 various weather services and at the ESSL Testbed.

Development of ESWD data in 2016

In 2016, the ESWD was expanded by 16,718 new severe weather reports (Figure 2.1), which is a **new record** for the number reports added to the database in any single year (Figure 2.2). In total, the ESWD contains 100630 severe weather reports (considering the period 01/01/01–31/12/2016).The majority of reports that were collected in 2016 were for severe wind gusts (7,944 reports; 47.5 %), heavy rain (3,819 reports; 22.8 %), and large hail (2,803 reports; 16.8 %).

ESWD Data Policy

ESSL provides ESWD data free-of-cost to individual academic scholars who carry out small studies, but will request a contribution for data usage within large or (partly) commercially-funded projects. This contribution serves to cover ESSL’s expenses for the collection and quality-control of the data and to finance further database enhancements. The preferred form of contribution is a multi-year supporting membership of ESSL, which includes ESWD access as a benefit.

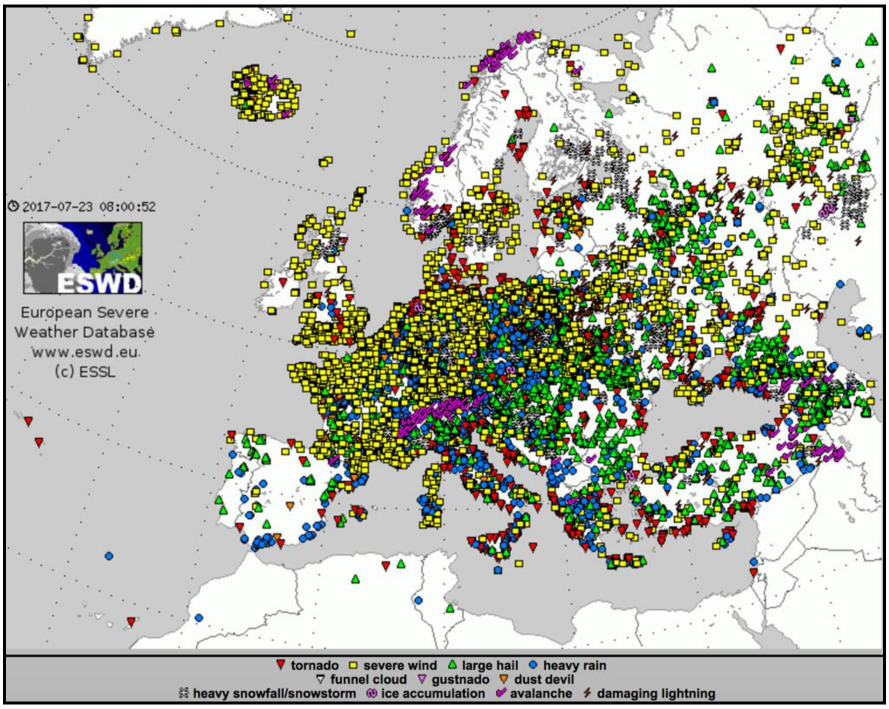


Figure 2.1. All 16718 ESWD reports of events occurring in 2016. Numbers as of 23 July 2017.

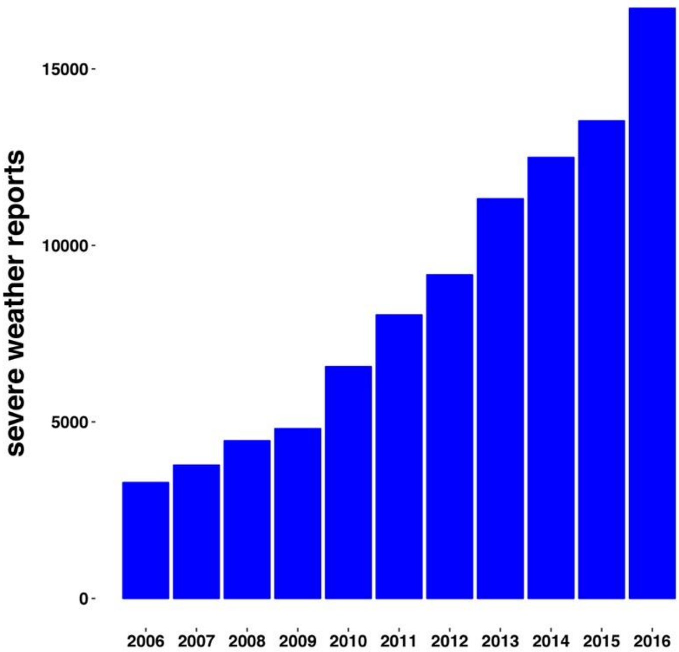


Figure 2.2. The number of severe weather reports included in the ESWD each year since 2006. There is an increase by 23.6% in the number of severe weather reports in 2016 compared with 2015. Also, the number of reports between 2006 and 2016 represent 93.6% all reports in the ESWD (considering the period 01/01/01–31/12/2016).

The absolute numbers and percentage in terms of weather type are listed in Table 2.1. All reports of 2016 have passed the first quality control level QC0+ and 91% are considered “confirmed by reliable sources”, i.e. QC1 or higher and thereby usable for most types of analyses (Tabel 2.2).

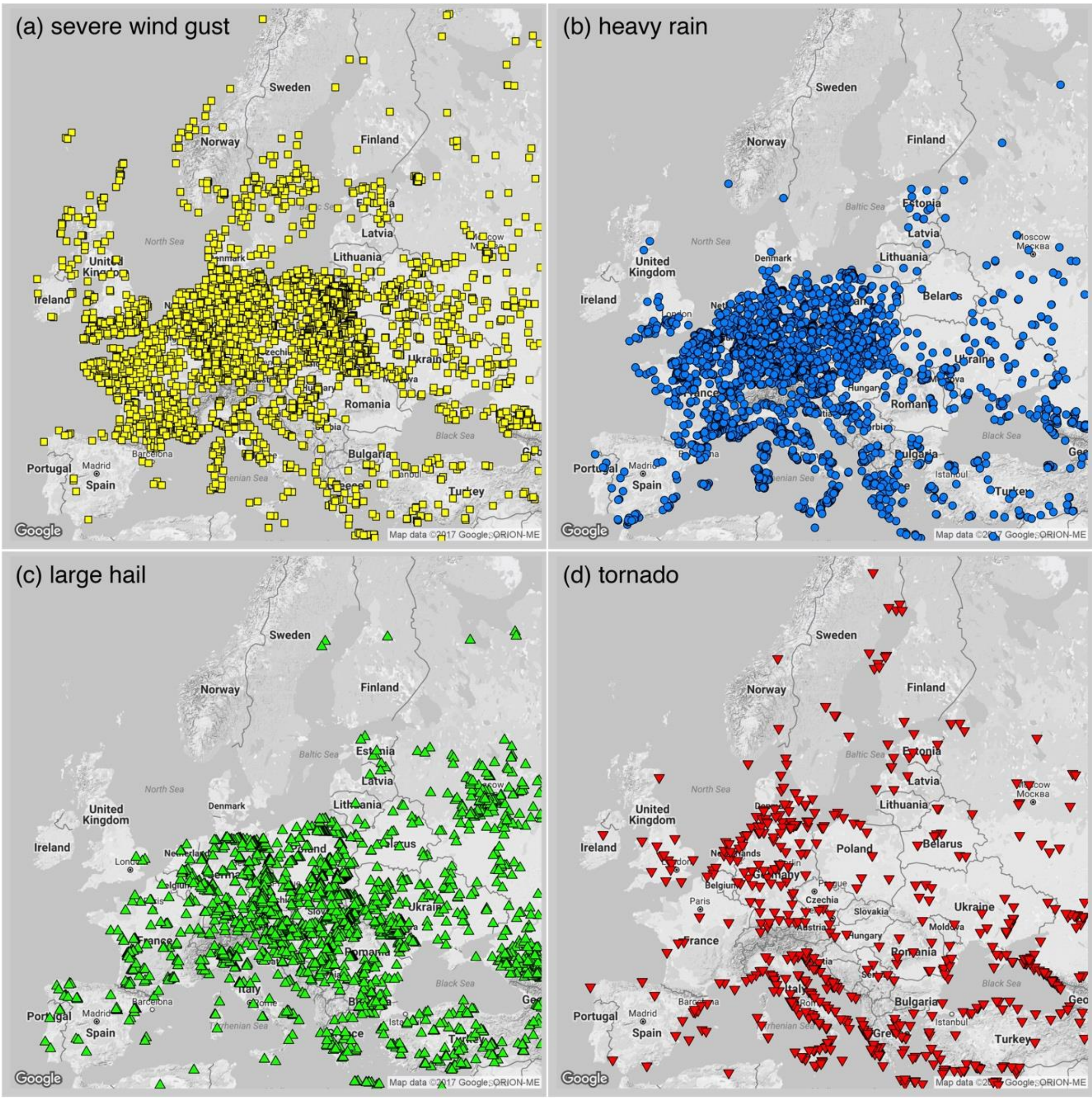


Figure 2.3. The spatial distribution of the ESWD reports for (a) wind gust, (b) heavy rain, (c) large hail, and (d) tornado.

Table 2.1. Number of reports for the year 2016 per severe weather .

Event type	Number of reports	Percentage
severe wind gust	7,944	47.52
heavy rain	3,819	22.84
large hail	2,803	16.77
heavy snowfall	654	3.91
tornado	627	3.75
damaging lightning	611	3.65
avalanche	191	1.14
dust devil	34	0.20
ice accumulation	33	0.20
gustanado	2	0.01

Table 2.2. Number of ESWD reports in 2016 per Quality Control category.

Quality Control level	Number of reports	Percentage
QC0: as received	4	0.02
QC0+: plausibility checked	903	5.40
QC1: report confirmed by reliable sources	15597	93.29
QC2: scientific case study	214	2.28

The majority (80.72%) of the severe weather reports included in ESWD in 2016 were for events that occurred in France (20.30%), Germany (17.85%), Poland (12.20%), Russia (10.98%), Ukraine (4.79%), Italy (3.85%), Austria (3.06%), Iceland (2.90%), Turkey (2.51%), and United Kingdom (2.28%). The remaining 19.28% were reports for severe weather events that occurred in other 42 countries. The spatial distribution in 2016 and the annual number of reports between 2006 and 2016 are shown in Figures 2.3 and 2.4 for severe wind gust, heavy rain, large hail, and tornado reports.

In 2016, severe weather reports in Europe were associated with 685 injuries and 217 fatalities. The majority of the injuries were produce by damaging lightning and severe wind gust events (70% of all injuries, Figure 2.5). Fatalities were mainly produced by heavy rain and avalanches (62% of all fatalities, Figure 2.6).

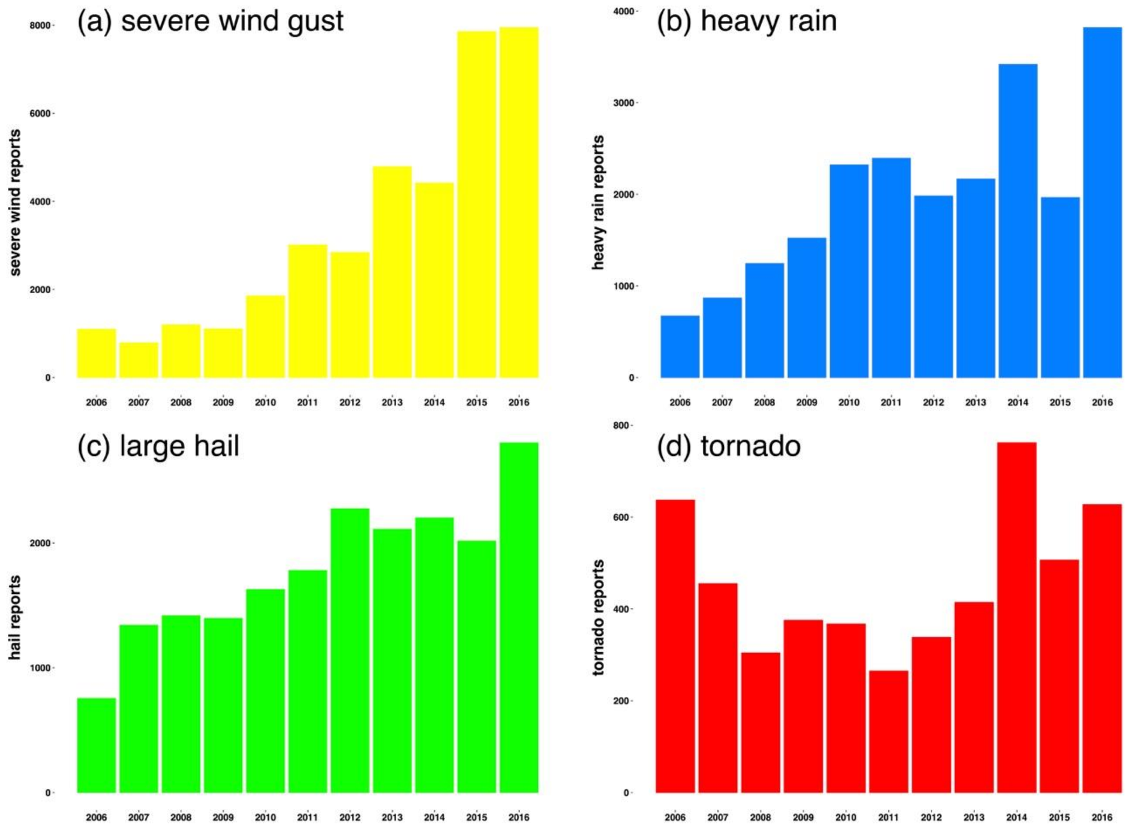


Figure 2.4. The changes between 2006 and 2016 in the annual number of ESWD for (a) wind gust, (b) heavy rain, (c) large hail, and (d) tornado.

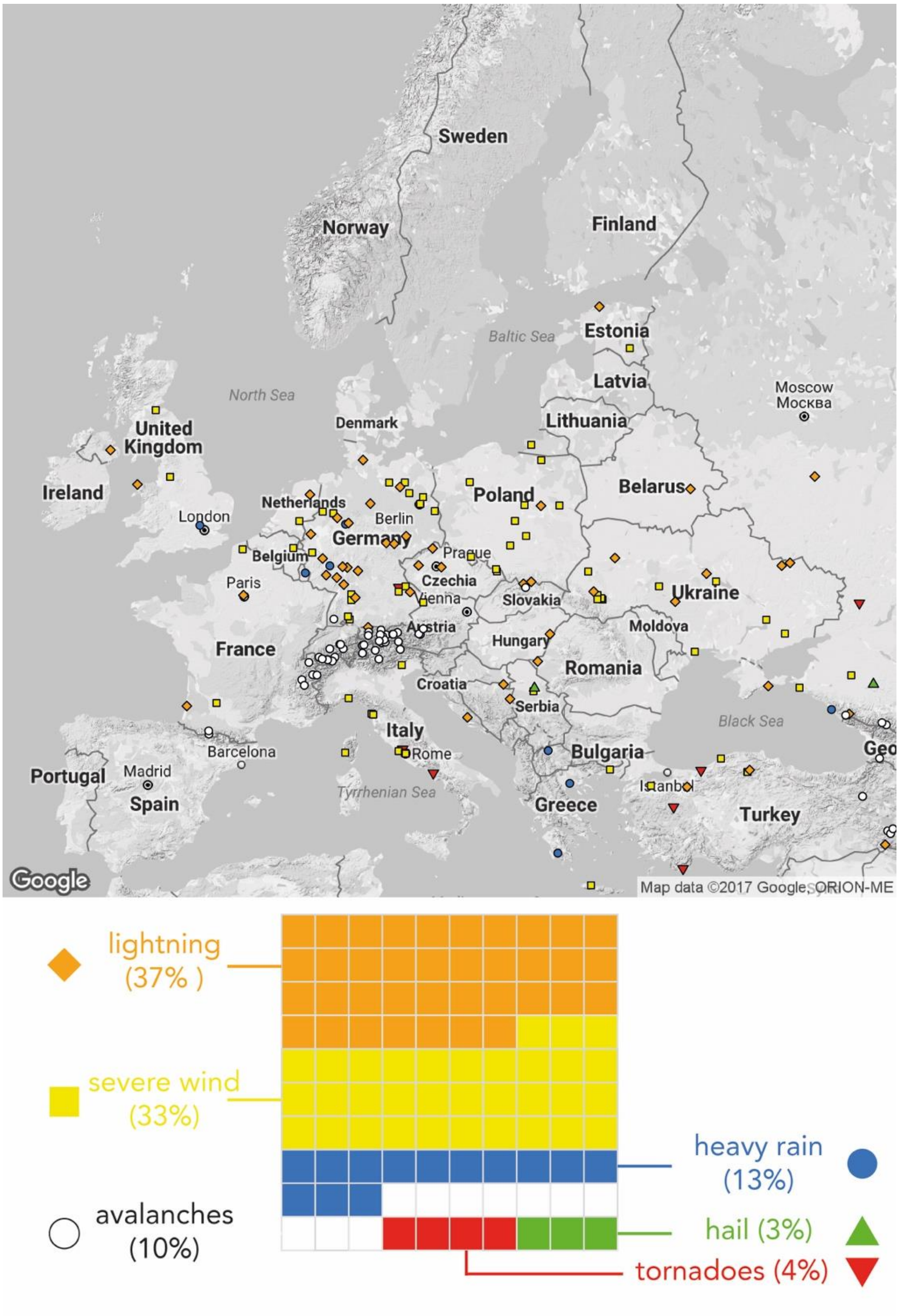


Figure 2.5. The spatial distribution of the ESWD severe weather reports associated with injuries in 2016. Also shown is the percentage form the total number of injuries (685 injuries) associated with different types of severe weather reports.

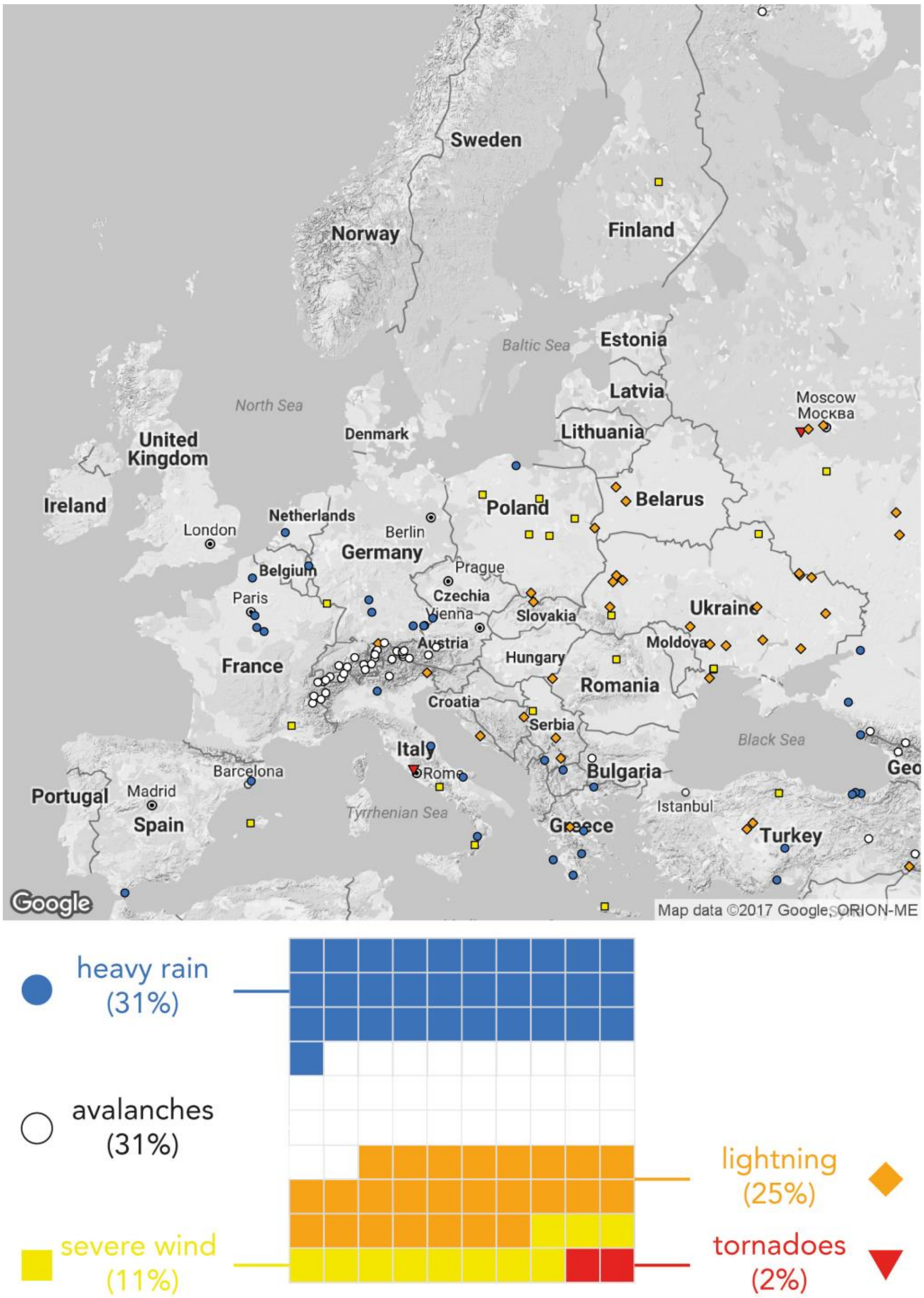


Figure 2.6. The spatial distribution of the ESWD severe weather reports associated with fatalities in 2016. Also shown is the percentage form the total number of fatalities (217 fatalities) associated with different types of severe weather reports.

2.2 ESWD Partner Network

During 2016 ESSL has put much effort in formalizing its cooperations with partners who contribute data to the ESWD. They include weather services that have concluded an Agreement upon becoming full members, but also many 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.

The partner network consist of 8 National Weather Services, 11 Voluntary Observer Networks (VON), and 19 individuals (Voluntary Observer Persons; VOP). In 2016, these four VONs joined:

- Crometeo – motrenje i prognoziranje vremena (Croatia)
- Lovci na oluje Dubrovnik (Storm chasers Dubrovnik) (Croatia)
- ILLAPA Unwetterwarnungen, Wetter- und Klimaforschung (Austria)
- Associazione estremi die Meteo4 (Italy)

In addition, these VOPs joined:

- Mr. Abdullah Kahraman (Azerbaijan, Cyprus, Turkey)
- Mr. Bas van der Ploeg (Belgium, Netherlands)
- Mr. Bogdan Antonescu (United Kingdom incl. Channel Islands, Gibraltar etc.)
- Mr. Marco Cisar (Austria)
- Mr. Mario Marcello Miglietta (Italy)
- Mr. Klodian Zaimi (Albania)
- Mr. Duseigneur François (France, Morocco)

2.3 EWOB - European Weather OBserver app

In 2016 the EWOB app was re-launched with improved GPS positioning stability and some bug-fixes. But the most important novelty was the availability in 35 languages spoken in Europe. We kindly thank all voluntary translators, who invested a lot of time in proper translation and context testing of the app. The full list of all voluntary translators can be found on the ESSL webpage here:

https://www.essl.org/cms/european-severe-weather-database/ewob/ewob-in-your-language/

After completion of this important step, consultations with interested groups started to further integrate EWOB into a regular data stream for weather services and other interested stakeholders. In order to achieve this goal, a standardization of a data format for crowdsourced (severe) weather reports is needed. ESSL tries to offer the EWOB concept to the European meteorological community and cooperates with partners like FMI and ZAMG in order to establish an improved common data standard. For this reason, ESSL participated in a MeteoAlarm meeting and in several smaller working group meetings.

Figure 2.3. EWOB "screenshots" of 4 January 2017 with reports of different fresh snow depths.

Regarding the amount of incoming data, it was seen that there is a high dependency on the type of weather pattern over Europe (the more active, the more reports). The promotion in other weather platforms and groups of enthusiasts is also important and resulted in impressive bursts of reports several times in 2016. As of August 2017, the app was installed on 3161 iOS and approxmimately 5000 Android devices. Until 31 December 2016, 12089 weather reports were made with EWOB. We kindly invite all readers to install, use and further promote EWOB within their communities.

Future plans, besides the standardization process, are a modest enlargement of the reporting options, better photo quality and an integration of other data layers. Of interest could be official warnings, for example.

Figure 2.4. EWOB advertisement.

3 Severe Weather Research

3.1 The RAIN project: Extreme weather impact on critical infrastructure

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

Since May 2014, the ESSL is engaged in the FP7 EU-project RAIN. In 2016, ESSL researchers Tomáš Púčik and Pieter Groenemeijer coordinated the project's Work Package on **Hazard Identification.** Together with the project partners Technical University Delft, the Freie Universität Berlin and the Finnish Meteorological Institute probabilities of occurrence of extreme weather hazards were calculared.

These probabilities and their projected changes during the 21st century are an input to subsequent risk analyses which assist the identification of optimal adaptation measures. The spatial distributions of the probabilities in the present climate were mapped and projections of changes according to the RCP 4.5 and RCP 8.5 climate scenarios were developed. The analyses were primarily based on datasets of observations, atmospheric reanalyses and regional climate models, although several other datasets were used for analyses of floods. The Modelled climate model data covered the European domain in the World Climate Research Program Coordinated Regional Downscaling Experiment (EURO-CORDEX). Information to infer hazard probability of occurrence was extracted from those datasets in several novel ways, for example by using Bayesian networks to infer the flood hazard risk.

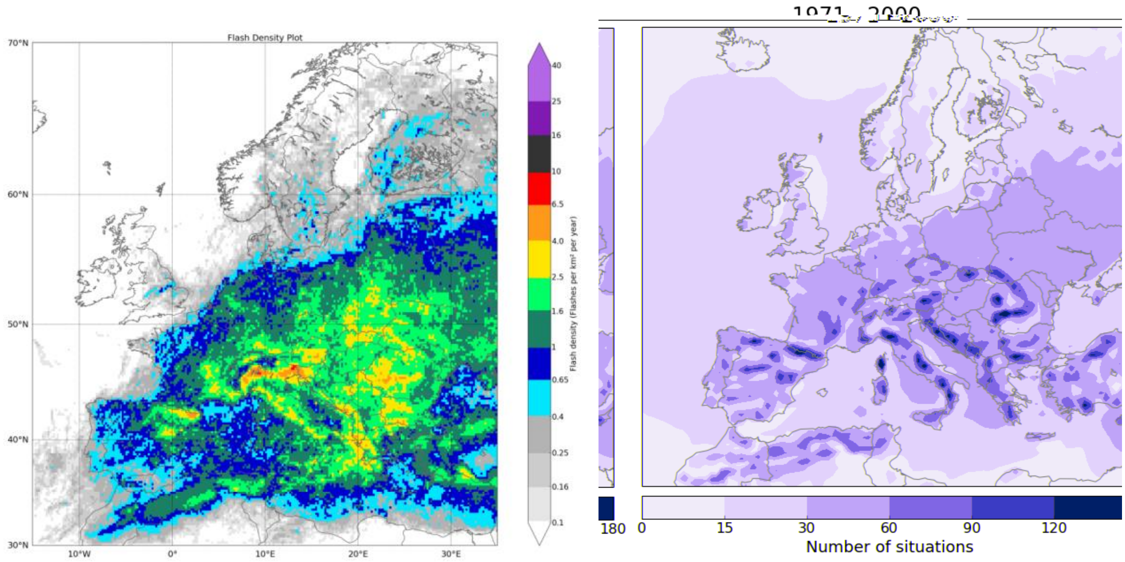


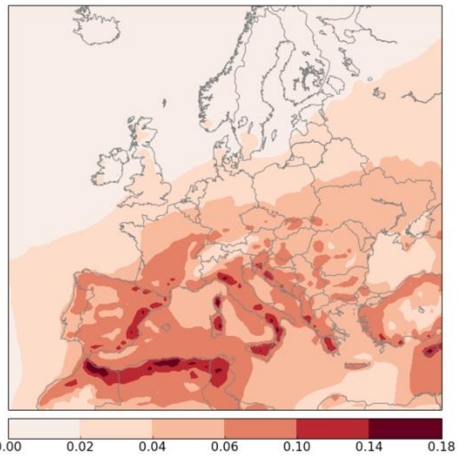
Fig. 3.1. Left: Lightning density as detected by the Met. Office Arrival Time Difference system between 2006 and 2012. From: Anderson and Klugmann, 2014. Right: Modelled annual number of 6-hourly situations conducive to thunderstorm formation based on a 14-member ensemble of historical EuroCordex runs.

Convective windstorms

Annual probability of severe convective wind gust over 32 m/s

Reference Period

1971-2000:



Predicted Changes

2021 - 2050 **2071 – 2100**

RCP 4.5:

RCP 8.5:

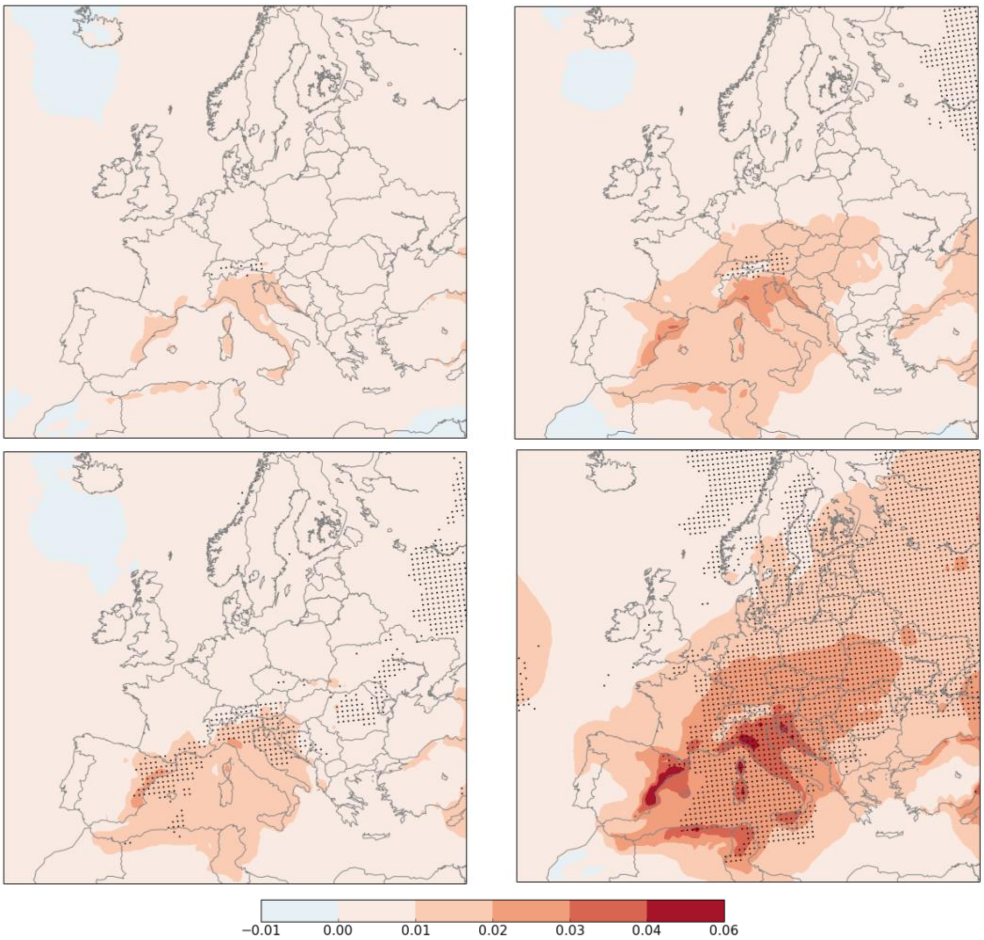


Fig. 3.2. Annual probability of convective winds of 25 m/s in the "historical period" of 1971-2000 (top), and in two climate change scenarios rcp 4.5 (middle) and rcp 8.5 (bottom) by the middle (left) and end (right) of the 21st century.

Besides establishing the present spatial distribution of probability, projections for the 21st century indicate that a number of changes are to be expected across Europe. For instance, ESSL has found that lightning will become more common, in particular across northern and central Europe. The simple model that was used, was able to represent actual lightning occurrence quite well (Fig. 3.1), which lends credibility to the extrapolation into the future.

In addition, it was found that conditions supportive of severe thunderstorms with large hail, tornadoes and severe wind gusts become more likely as well, especially in south-central Europe. This change can primarily attributed to increased low-level humidity and the resulting higher convective available potential energy (CAPE).

RAIN project partners analysed several non-convective hazards. For instance, FU-Berlin has found that the windstorm hazard may become more relevant across continental Europe, while a slight decrease is expected across the Mediterranean region and the North Atlantic Ocean. Extreme precipitation, of both short (3 hour) and medium (24 hours) time ranges are forecast to increase across most of Europe. The increase will be most pronounced in North-Western Europe, especially over Scandinavia and across the British Isles. The numbers of sub-daily, high-intensity events are predicted to increase at a higher rate than the number of long-duration events characterised by high accumulated rain amounts.

In part resulting from the increased frequency of heavy rainfall, TU-Delft found that river floods will become more likely over large areas, especially the case of central Europe and the UK, unless mitigation efforts are taken. Throughout Europe, the regions at risk from 10-year, 30-year and 100-year return period floods will expand greatly. Germany, Hungary, Poland and France are expected to have the largest absolute increases in flood-prone areas. On the other hand, northern Europe will encounter a decrease in flood-prone areas.

The Finnish Meteorological Institute discovered that longer dry spells will likely cause conditions supportive of forest fires and wildfires to become much more frequent across Europe, in particular in the south and especially in the RCP 8.5 scenario. Heavy snowfall, blizzards and snow load should become less likely across much of Europe, with the exception of central and northern Fennoscandinavia and northern Russia, where increases are predicted for heavy snowfall and snow load. The occurrence of freezing rain is expected to undergo a northward shift, with slight decrease in probability in central Europe but intensification in Fennoscandinavia and Northern Russia.

The results of the RAIN Work Package 2 were published in three reports. For these reports (see also the list of publications) and more background information on the RAIN project, please visit: http://www.rain-project.eu

3.2 Analysis of Risk of Convective Storms

Funded by: Munich Re and German Ministry of Education and Research (BMBF)
Grant: BMBF: EUR 323 000 (BMBF contribution)
Personnel: 1 Researcher at ESSL, 1 Researcher at Munich Re
Period: 1 April 2016 – 30 March 2019

Together with Munich Re, ESSL is working to analyse the risk posed by convective storms in Europe in the project ARCS. Funding by the German government for the ESSL part of the project was secured in April 2016.

Within ARCS, Anja Rädler, who is pursuing her PhD degree at the Ludwig-Maximilians-University in Munich, has developed a statistical modelling framework for predicting the probability of occurrence of convective hazards such as large hail, tornades and severe wind gusts. We call them AR-CHaMo (Additive Regression - Convective Hazard Models). An example of two simple models for the probability of lightning and of large hail (conditional on the occurrence of lightning) are shown in Fig 3.3. They were developed with data from ESSL's European Severe Weather Database, EUCLID lightning detection data, and ECMWF's ERA-Interim reanalysis. When these models are applied to the ERA-Interim reanalysis, maps can be created that show the spatial distribution of the hazard probability (Fig. 3.4.).

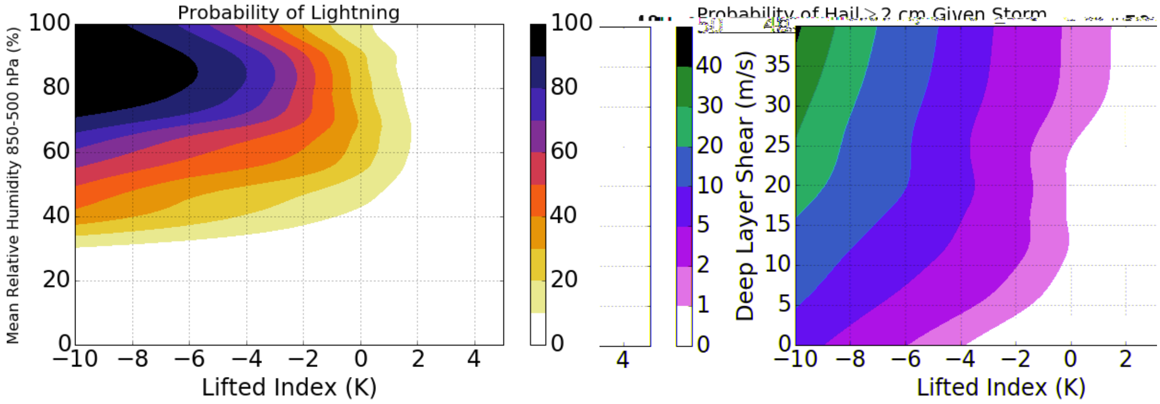


Fig. 3.3. Model for the probability of lightning as a function of Lifted Index and Mean Relative Humidity between the 850 and 500 hPa pressure levels.

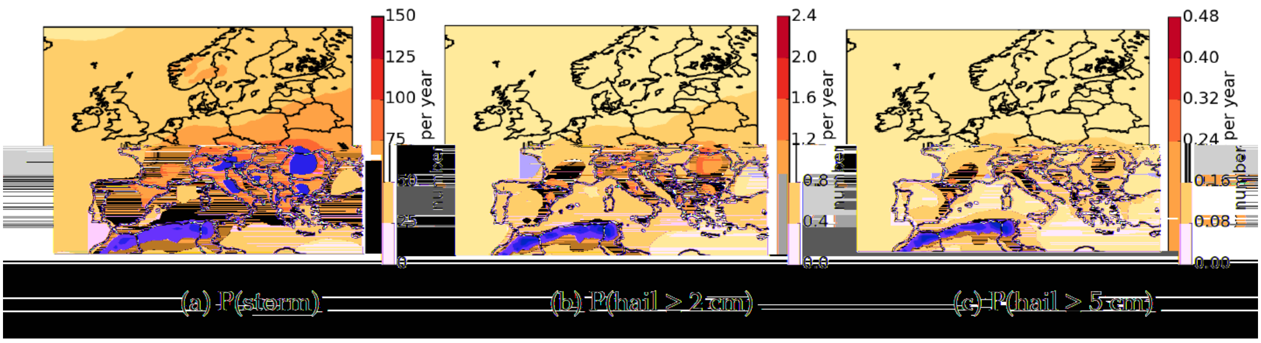


Fig. 3.4. Expected number of annual six-hourly periods of lightning (a), hail ≥ 2 cm (b), hail ≥ 5 cm (c), according to selected AR-CHaMo statistical models, when applied to the ERA-Interim reanalysis (1979-2013).

Researcher Tomáš Púčik has, in the mean time, studied the future changes of atmospheric conditions favourable for severe storms, such as high instability (CAPE) and strong wind-shear, according to EuroCordex models. Fig. 3.5 shows the present frequency that particular combinations of Lifted Index (a measure of instability, where values < 0 indicate unstable conditions) and deep-layer wind shear (DLS) occur with dashed lines. The colors indicate the changes expected by the end of the century (2071-2100) in the aggressive rcp8.5 climate scenario. Across Central Europe, unstable situations, bot with weak and strong DLS will become more frequent. This means that convective storms occurring by the end of the century in this scenario have the potential to become stronger and more likely to produce severe weather.

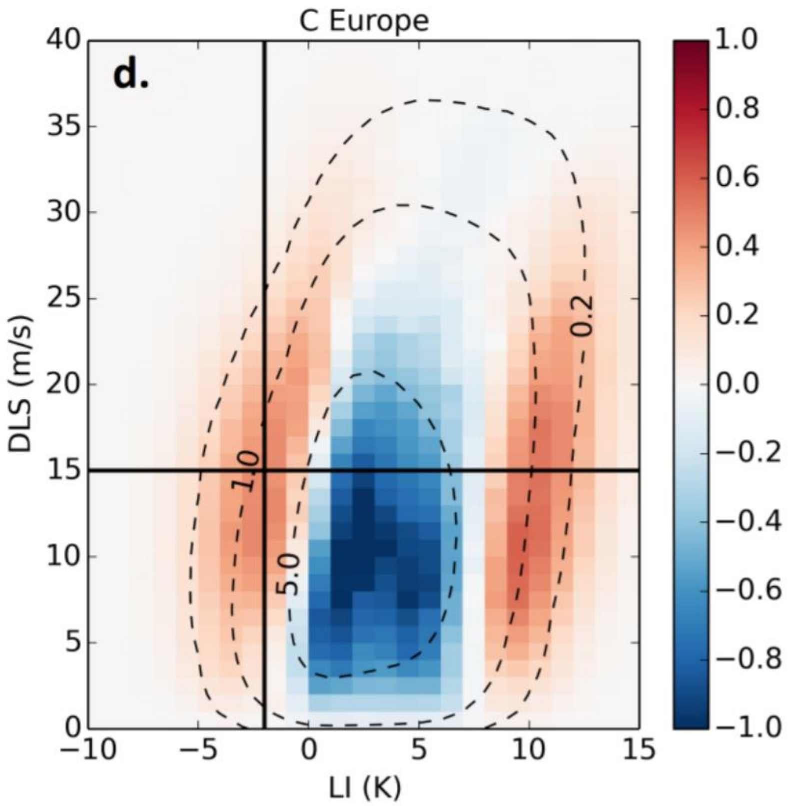


Fig. 3.5. 2-D histogram showing the 14-member EURO-CORDEX ensemble mean annual numbers of 6-hourly periods with a given combination of Lifted Index and 0-6 km bulk wind shear (DLS) (dashed lines). Changes in the 8.5 rcp scenario in the period 2071-2100 compared to the historical period (1971-2000) across Central Europe are shaded (red = increase). The red colors to the left of the black line at LI = -2 indicate that environmental conditions with LI < -2 will become more frequent. From Púčik et al. (2017).

In the second half of the ARCS project, the focus of the research will shift towards mapping the risk of the convective hazards, i.e. modelling the impact of the convective hazards, as well as to using higher-resolution data.

3.3 STEPCLIM: Decadal Forecasting - Severe Thunderstorm evaluation and Predictability in CLImate Models – 2nd Phase

Funded by: German Ministry of Education and Research (BMBF)
Amount: EUR 271 000
Duration: January 2016 – December 2018 (3 years)
Project Website: http://www.fona-miklip.de/en/350.php

In 2016, ESSL started to work for the second phase of the project STEPCLIM. STEPCLIM is funded by the German Ministry of Education and Research as part of MiKlip, a research programme on decadal climate prediction, i.e. forecasts for 1 to 10 years in advance.

Within STEPCLIM, decadal forecasts produced by the MiKlip consortium were evaluated with respect to severe thunderstorms. ESSL researcher Lars Tijssen applied statistical models for lightning and severe weather occurrence, that were developed within the ARCS project, to the MiKlip simulations.

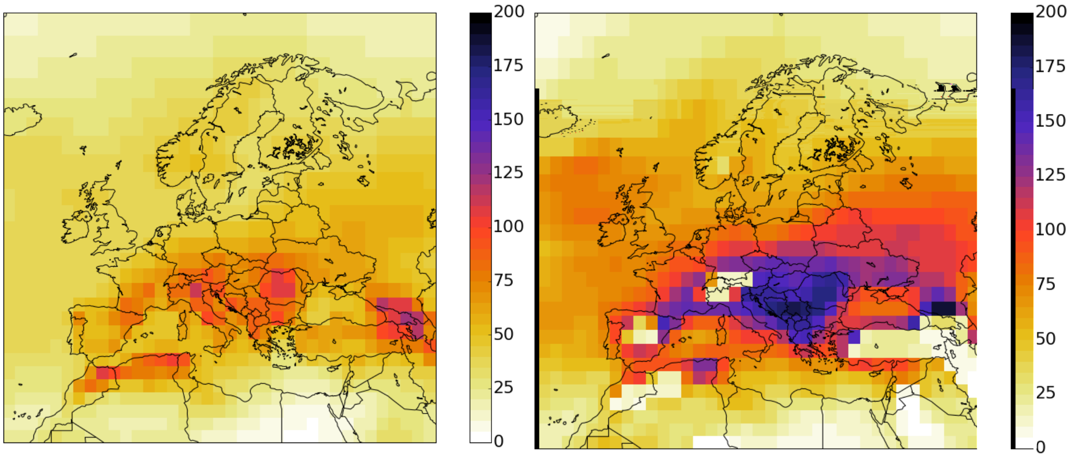


Fig. 3.6. Simulated number of 6-hourly periods with lightning, according to the ERA-Interim reanalysis data set (left) and the MIKLIP (MPI-ESM global baseline 1) climate model (right).

The result shows that MIKLIP (right) overestimates the number of lightning events compared to the ERA-interim reanalysis (left), which can be attributed to an overestimate of instability in the MIKLIP models. Regardless of these biases, one can evaluate the predictive skill of anomalies in lightning activity. First evaluations have been carried out of the predictability of the global MiKlip system and of the regional reanalyses that are part of the system. These analyses show that some skill is probably likely present, but that further development of post-processing tools is necessary to ascertain this.

Within STEPCLIM a collection of historical severe weather events is carried out. In 2016, Thilo Kühne completed the collection of severe weather reports from an online Italian newspaper archive. In total, 411 Italian tornado events were entered. Furthermore, approximately 2000 historical severe weather reports from a Russian environmental database were added. Finally, STEPCLIM also partially supported the collection of near-real-time reports in 2016.

3.4 Estimation of convective hazards in NWP models

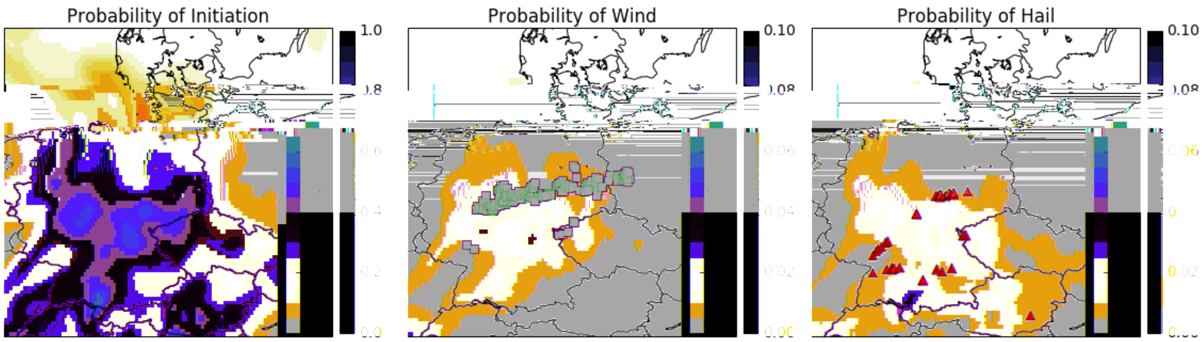


Fig. 3.7. Probability of hail on 7 July 2015 at 18 UTC (colours) and hail reports (green triangles), wind reports (yellow) from the ESWD (+30 h ECMWF forecast).

In spring 2016, the German Weather Service (DWD) expressed interest in a tool to predict severe weather events such as lightning, hail, severe winds and tornadoes using NWP data 12 to 36 hours ahead. ESSL was offer to develop such a tool based on the AR-CHaMo framework developed in the project ARCS. These statistical models give the probability of lightning, hail, severe wind and tornadoes using reanalysis data and observations.

The probabilities are calculated using a set of severe weather predictors from NWP or climate models. ESSL researcher Lars Tijssen developed a program that uses ECMWF and ICON forecast data to yield probabilities of various severe weather events over Germany. An example is shown in the figure above.

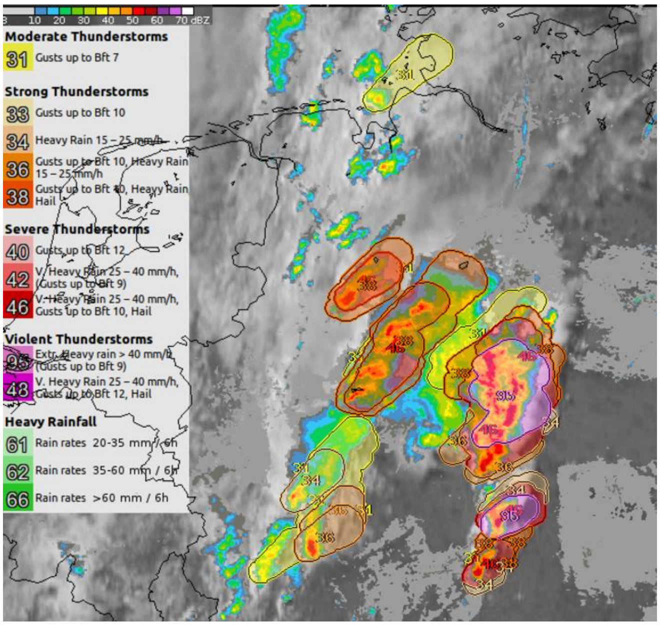
4 Conferences, workshops and outreach

4.1 The ESSL Testbed 2016

The ESSL Testbed 2016 has taken place during the weeks of 6 – 10 Jun, 13 – 17 Jun, 27 Jun – 1 Jul and 4 – 8 Jul 2016 at the ESSL Research and Training Centre in Wiener Neustadt. During these four weeks, 38 external participants took part in the Testbed in addition to 5 ESSL staff.

Participants to the Testbed in 2016 included delegates of AustroControl (Austria), CHMI (Czechia), DWD (Germany), EHMI (Estonia), FMI (Finland), KNMI (Netherlands), ZAMG (Austria), IPMA (Portugal), SHMU (Slovakia), NOAA (USA), VAISALA (Finland/USA), DHMZ (Croatia), SRF (Switzerland), LHMS (Lithuania), MeteoSwiss (Switzerland) and MeteoCat (Catalonia/Spain).

The programme included evaluations of convection permitting COSMO ensembles of DWD and MeteoSwiss, as well as DWD's ICON-EU model. Additionally, a number of improved products to support Nowcasting were evaluated, for instance a modified version of DWD's NowcastMIX system optimized for use in a mobile weather app.



Top: Fig. 4.1. Participants to the Testbed Edition of 2016

Left: Fig. 4.2 Screenshot of DWD's WarnApp NowcastMIX on 24 June 2016 at 1400, incidating the various warning levels.

4.2 Awards for ESSL researchers

ESSL researchers Tomas Pucik and Anja Rädler have both received an award at the American Meteorological Society's Severe Local Storms Conference. Pucik presented his work on future changes in severe thunderstorm environments across Europe and won the second prize for student presentation. Rädler presented a poster on Additive Logistic Regression Models for Convective Hazards and their Application to Reanalyses and Climate Scenarios. She won the third prize for best student poster. Tomas Pucik's presentation can be listened to here:

https://ams.confex.com/ams/28SLS/webprogram/Paper300871.html

Anja Rädlers conference abstract can be found here:

https://ams.confex.com/ams/28SLS/webprogram/Paper301712.html

4.3 Convection Working Group

In 2016, ESSL continued its support to the EUMETSAT Convection Working Group (CWG) by hosting the CWG Secretariat. The tasks of the secretariat include updating and hosting its web site, taking minutes of CWG meetings and workshops and several smaller tasks. The CWG convened for a Workshop in Florence from 4 to 8 April 2016, where ESSL's Alois M. Holzer took the meeting minutes. The CWG is chaired by Mateja Irsic-Zibert (Slovenian Environment Agency), Vesa Nietosvaara (EUMETSAT) and Jochen Grandell (EUMETSAT). A splinter Meeting took place on 27 September 2016 at the EUMETSAT Conference in Darmstadt, Germany. The CWG website https://www.essl.org/cwg/ now also hosts an updated section "New relevant papers" with links to their full texts under the header "Documentation".

Convection Working Group at its Workshop in Florence, 4 – 8 April 2016

4.4 Publications, courses and seminars

A wide range of outreach and PR activities took place in 2016. ESSL was well represented with scientific contribution. At various other occasions, ESSL employees and members engaged in interaction with particular interest groups and the general public.

The ESSL Research and Training Centre in Wiener Neustadt was used to host several events with a focus on training, namely a seminar on Forecasting Severe Convection, a Workshop on Tornado and Windstorm Damage Assessment including a meeting of the International Tornado Working Group and, of course, the ESSL Testbed. Again, an interactive blog was maintained during the Testbed (www.essl.org/testbed/blog).

ESSL also helped with the creation of an exhibition in the Municipal Museum (Stadtmuseum) of Wiener Neustadt to commemorate the violent tornado that struck the city in 1916.

4.5 Seminar on Forecasting Severe Convection

In the week starting 20 June, a week-long course entitled **Forecasting Severe Convection I** was organized with lecturer Dr. Charles A. Doswell III. At the beginning of each course, a pre-test is done with the participants in order to assess the level or pre-knowledge in the field of interest, which is of help for the lecturer to fine-tune the content and speed of the course. It also allows one to learn what the typical level of knowledge of severe convection is among forecasters. The results will be presented by Dr. Doswell in a talk on “Pre-Testing Trainees in Forecaster Training Workshops” at the ECSS Conference in Pula in September 2017.

4.6 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 4 September 2017, the Twitter account has 410 and the Facebook account 2590 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.

4.7 List of publications

These publications by ESSL (co-)authors have appeared in 2016:

Peer-reviewed journal articles published in 2016

- Wapler, Kathrin, Thomas Hengstebeck and Pieter Groenemeijer, 2016: Mesocyclones in Central Europe as seen by radar. *Atmospheric Research*, **168**, 112–120, doi: 10.1016/j.atmosres.2015.08.023.

- Antonescu, Bogdan, David M. Schultz, Fiona Lomas and Thilo Kühne, 2016: Tornadoes in Europe: Synthesis of Observational Datasets. *Monthly Weather Review*, **144**, 2445–2480, doi: 10.1175/MWR-D-15-0298.1.

- Pistotnik, Georg, Pieter Groenemeijer and Robert Sausen, 2016: Validation of Convective Parameters in MPI-ESM Decadal Hindcasts (1971–2012) against ERA-Interim Reanalyses, *Meteorologische Zeitschrift*, **25**, 753–766, doi: 10.1127/metz/2016/0649.

- Westermayer, Anja, Pieter Groenemeijer, Georg Pistotnik, Robert Sausen and Eberhard Faust, 2016: Identification of thunderstorms in reanalysis data, *Meteorologische Zeitschrift*, **26**, 59–70, doi: 10.1127/metz/2016/0754.

Peer-reviewed journal articles submitted in 2016

- Púčik, Tomáš, 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,* doi: 10.1175/JCLI-D-16-0777.1

- Groenemeijer, Pieter, 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,* doi: 10.1175/BAMS-D-16-0067.1

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

ESSL Reports

- Pieter Groenemeijer, Andrea Vajda, Ilari Lehtonen, Matti Kämäräinen, Ari Venäläinen, Hilppa Gregow, Nico Becker, Katrin Nissen, Uwe Ulbrich, Oswaldo Morales Nápoles, Dominik Paprotny, Tomáš Púčik, 2016: RAIN report D2.5: **Present and future probability of meteorological and hydrological hazards in Europe**, available at: https://www.essl.org/cms/wp-content/uploads/RAIND25.pdf

In response to a request by the German Weather Service, we have published a number of reports concerning the evaluation of DWD products at previous editions of the ESSL Testbed. These can be found on the ESSL website (www.essl.org) in the *Publications* section.

For 2016, this includes the following report:

- Report 2016-01: Summary of the evaluation of COSMO models at the ESSL Testbed 2016, available at: https://www.essl.org/media/publications/essl-report-2016-01.pdf

- Report 2016-02: Summary of the evaluation of DWD Nowcast and Warning tools at the ESSL Testbed 2016, available at: https://www.essl.org/media/publications/essl-report-2016-02.pdf

4.8 List of presentations and conference contributions

Oral presentations

- Anja Westermayer, Pieter Groenemeijer, Tomas Pucik, Robert Sausen, and Eberhard Faust, Statistical modelling of thunderstorms in the present and future climate, 2016 Severe Convection and Climate Workshop, March 9-10 2016, Columbia University, New York.

- Alois M. Holzer, Pieter Groenemeijer, Aktuelle Praxis von Tornado- und Downburst-Bewertungen im ESSL, General Assembly, Skywarn Austria, 23 April 2016, Mariazell.

- Alois M. Holzer, Eye witness reports from the Wiener Neustadt 1916 tornado, Exhibition Opening Stadtmuseum Wiener Neustadt, 29 June 2016.

- Tomas Pucik, Pieter Groenemeijer, Lars Tijssen and Anja Rädler, Future changes of severe thunderstorms frequency over Europe, 16th EMS Annual Meeting & 11th European Conference on Applied Climatology (ECAC), 12 – 16 September 2016, Trieste, Italy.

- Tomas Pucik, Pieter Groenemeijer, Lars Tijssen and Anja Rädler, Future changes in severe thunderstorm environments over Europe, 28th Conference on Severe Local Storms, 7 – 11 November 2016, Portland, Oregon, USA.

- Antonescu, B., D. M. Schultz, A. Holzer, and P. Groenemeijer, 2016: Tornadoes in Europe: An Underestimated Threat. 28th Conference on Severe Local Storms, 7–11 November, Portland, OR, USA.

- Antonescu, B., D. M. Schultz, F. Lomas, and T. Kühne, 2016: What do we know about tornadoes in Europe? Severe Convection and Climate Workshop, 9–10 March, Columbia University, New York, USA.

- Pieter Groenemeijer, Lars Tijssen, Thilo Kühne, Robert Sausen, Severe Thunderstorm Evaluation and Predictability in CLImate Models STEPCLIM (Phase 2), MiKlip II kick-off, 17-19 February 2016, Hamburg, Germany.

Poster presentations

- Anja Rädler, Pieter Groenemeijer, Tomas Pucik, Robert Sausen and Eberhard Faust, Additive logistic regression models for convective hazards and their application to reanalyses and climate scenarios, 28th Conference on Severe Local Storms, 7 – 11 November 2016 Portland, OR

- Antonescu, B., H. Ricketts, and D. M. Schultz, 2016: A History of Tornadoes in Europe from Aristotle to Alfred Wegener. 28th Conference on Severe Local Storms, 7–11 November, Portland, OR, USA.

- Antonescu, B., Jonathan G. Fairman Jr., and D. M. Schultz, 2016: A Preliminary Climatology of Sounding-Derived Parameters for Deep, Moist Convection in Europe. 28th Conference on Severe Local Storms, 7–11 November, Portland, OR, USA.

- Lars Tijssen, Anja Rädler, Pieter Groenemeijer, Robert Sausen, Application of Additive Logistic Regression Models for Convective Hazards to NWP. 28th Conference on Severe Local Storms, 7–11 November, Portland, OR, USA.

- Lars Tijssen, Pieter Groenemeijer, Robert Sausen, Comparison of Convective Parameters in MPI-ESM Regional and Global Decadal Hindcasts to ERA-Interim Reanalysis. 28th Conference on Severe Local Storms, 7–11 November, Portland, OR, USA.

5 Financial and administrative report

5.1 ESSL General Assembly 2016 and celebration of the 10 year existence of ESSL

The ESSL General Assembly (GA) has taken place on 1 July 2016 in Wiener Neustadt, Austria. At this occasion, three new members of the Advisory Council were elected, namely Prof. Dr. Yvette Richardson (Penn State University, USA), Prof. Dr. Sorin Cheval (University of Bucharest, Romania), and Dr. Marina Baldi (CNR, Italy), whose terms will start on 1 Jan. 2017.

In addition, the GA positively decided on a proposal to increase membership fees for institutional members by a moderate amount. Other topics of discussion included the next ECSS and the status of the ESWD and the new EWOB app. More details regarding the General Assembly can be found in the respective meeting minutes.

After the GA jubilee scientists Harold Brooks, Charles Doswell III addressed the audience highlighting some of the biggest achievements of ESSL, the European Severe Weather Database and the ESSL Testbed. Subsequently, Prof. Robert Sausen, who has chaired the Advisory Council for six years, then gave his view of the early development of ESSL. Hans-Joachim Koppert, the present chair of the Advisory Council and Director of Forecasting at the German Weather Service congratulated ESSL on its tenth birthday and showed a video made by Testbed participants from the German Weather Service.

Chair of the Advisory Council Hans-Joachim Koppert congratulating ESSL on its 10th birthday at the celebration on 1 July 2016 in Wiener Neustadt.

5.2 Employment and Payroll accounting

An external payroll accountant (Andreas Schnaubelt in Schongau, Bavaria) was mandated during 2016 to take care of paperwork and bureaucratic handling of taxes and social insurances, which would otherwise have exceeded ESSL's internal administrative capacity.

In 2016, the European Severe Storms Laboratory e.V. employed one full time employee (ESSL Director) and five part-time employees, including two so-called "Mini-Jobbers", a form of minor employment according to the German law (scientific staff, ESWD quality control manager, IT – software engineer). The joint Secretariat of ESSL e.V. and the European Severe Storms Laboratory – Science and Training was hosted by the latter entity and employed two persons. Other tasks were taken over by voluntary workers (i.e. without payment) at least for periods, in particular the positions of the Deputy Directors and the Treasurer.

5.3 Auditing of the Annual Accounts

ESSL's finances for 2016 were audited by the independent and sworn certified financial auditor Andreas Schnaubelt, Loewenstrasse 5, 86956 Schongau, Germany. Summarizing our certified financial auditor 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."

The original was duly forwarded to the Advisory Council.

5.4 Financial status 2016

European Severe Storms Laboratory e.V.

The accounting year was dominated by income from two projects funded by the German ministry of research - STEPCLIM and ARCS, and the ongoing EU-FP7 project RAIN. Also 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 2016 were presented to the ESSL Advisory Council and can be inspected in the original 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 A2 provides a condensed version of the annual accounts.

Based on the reliable income from 3 different scientific projects the financial situation in 2016 was overall slightly better than in the previous years. Still ESSL was running on very low reserves. As a result a multi-month delay in the midterm payment of the RAIN project caused again a critical situation in early summer.

As required by the 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 fulfilling the requirements of the tax authorities.

The following figures from the annual accounts evidence the business conditions:

ESSL obtained EUR 126,539.50 in membership fees, EUR 3,821.19 from ESWD data sales, EUR 215,782.99 from scientific projects, and EUR 300.00 from donations.

Total income amounts to **EUR 352,365.55** (2015: EUR 297,129.49).

Total expenses amount to **EUR 348,196.09** (2015: EUR 293,577.19).

The major cost factors were personnel costs with EUR 277,417.90 (2015: 235,520.06) including taxes and social security, and travel expenses with EUR 20,312.42 (2015: 17,928.91). Tax advisor and external bookkeeping costs sum up to EUR 7,130.00 (2015: 7,300.00) and shared administration (with ESSL Science and Training) to EUR 20,592.70 (2015: 12,490.59).

The overhead costs of third-party funded projects still pose a challenge to ESSL, since overhead costs are almost not covered in projects funded by the German ministry of research. 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 81,175.52 (2015: liability -18,046.98). At the end of the year 2016 accounts receivables amounted to EUR 0.00 (2015: 501.26), deferred expenses (payments made for future accounting periods) to EUR 18,532.00 (2015: 22,178.00), deferred income (payments received for future accounting periods) to EUR 90,767.78 (2015: 0.00). Comparing liquid assets with deferred income it can be stated that ESSL was still running without noteworthy reserves.

The **annual result is a positive EUR 4,169.46** (compare: 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 2017 foresees a slightly better liquidity development, mainly because of three projects will run in parallel at least during the first third of the year: RAIN, STEPCLIM and ARCS. Savings can only be built up slowly as there are no sources of income available that generate a substantial surplus. Most income is tightly connected with (strictly defined) personnel expenses. Projects from the German ministry of research even require ESSL to bear part of the project costs, i.e. cause a structural deficit, if not covered by other sources of income.

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 23,277.13 (2015: 10,121.36), out of this EUR 20,000.00 are a current reserve for the ESSL Testbed 2017. The current reserve of EUR 10,000.00 for 2016 was dissolved. The remaining annual result for the subsidiary association in 2016 is a positive 3,155.77 (2015: 121.36).

The main income source was the ESSL Testbed with EUR 50,238.08. The main cost factors were office rental with EUR 16,176.34, IT Infrastructure and IT running costs with EUR 14,901.92, invited lecturers and speakers with EUR 11,221.64, and personnel and travel costs with EUR 16,296.22.

The financial planning for 2017 again foresees a near neutral annual result.

5.5 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 2016, ESSL was happy to welcome five new Institutional Supporting Members, and two new Institutional Full Members, the Netherlands Meteorological Institute and the European Centre for Medium-range Weather Forecasts.

5.6 Executive Board and Advisory Council

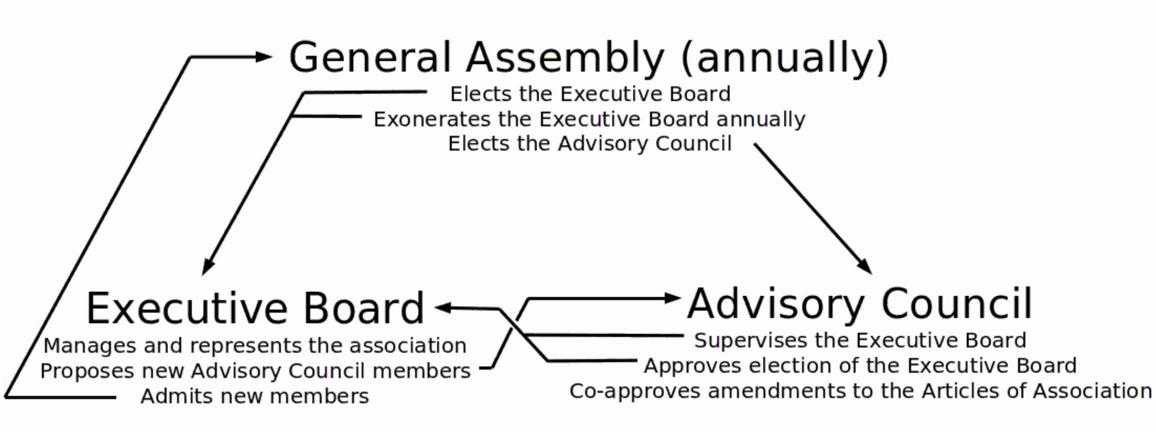


Fig. 5.1. Bodies of the ESSL. The Advisory Council consists of six members from two groups - three members each: (1) Science, (2) NMHS / EUMETNET.

The Executive Board, the Advisory Council and the General Assembly, which consists of all full members, constitute the three bodies forming the ESSL. Figure 5.1. outlines some of their responsibilities.

Executive Board

In 2016, 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 2016, 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

Vincenzo Levizzani (CNR, National Research Council, Italy)
1 Jan. 2013 - 31 Dec. 2016 (second term)

Pertti Nurmi (FMI, Finnish Meteorological Institute, Finland)
1 Jan. 2013 - 31 Dec. 2016 (first term)

David M. Schultz (University of Manchester, United Kingdom)
1 Jan. 2013 - 31 Dec. 2016 (second term)

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

Appendix A1: Member list 2016

The following table shows all ESSL members as of 31 December 2016, 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 2016 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	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	Oliver Schlenczek	GERMANY
INDF	Dr. Victor Homar Santaner	SPAIN
INDF	Dr. Sanjay Sharma	INDIA
INDF	Dr. Aurora Bell	ROMANIA
INDF	Sorin Burcea	ROMANIA

INDF	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	Tomáš Pučik	CZECH REPUBLIC
INDF	Patrick Marsh	USA
INDF	Marcus Beyer	GERMANY
INDF	Lisa Schielicke	GERMANY
INDF	Dr. Charles A. Doswell III	USA
INDF	Abdullah Kahraman	TURKEY
INDF	Dr. John Allen *	USA
INDS	Casper ter Kuile	NETHERLANDS
INDS	Stefan Meulemans	SWITZERLAND
INDS	Francesco Meneguzzo	ITALY
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
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 IncGuy Carpenter Limited	JAPAN
INSS	Air Worldwide	USA
INSS	RMS - Risk Management Solutions *	UNITED KINGDOM
INSS	Research Center for Environmental Changes	TAIWAN
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	UBYRISK Consultants *	FRANCE
INSS	AON Central and Eastern Europe a.s. trading as AON Benfield *	CZECH REPUBLIC
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.

Appendix A2: Annual Accounts 2016

The following presents in extract a copy of the "Report on the Preparation of the Financial Statements for 2016", as prepared by the financial auditor. Figures of the previous year (*italic*) were added for comparison.

	2015	2016
INCOME		
Membership fees personal members	*3,514.48*	4,377.51
Membership fees institutional members and ESWD data fees	*69,775.00*	122,161.99
ESWD data sales	*0.00*	3,821.19
Public project funding Federal Republic of Germany	*102,820.01*	92,238.99
Public project funding European Union	*120,920.00*	65,544.00
Applied research	*0.00*	58,000.00
Donations	*100.00*	300.00
German VAT on sales and refunds	*0.00*	5,921.87
Total income	***297,129.49***	**352,365.55**
EXPENSES		
Personnel	*231,640.06*	277,417.90
Depreciations	*825.00*	1,137.00
Travel costs	*17,928.91*	20,312.42
Office costs and insurance	*1,882.51*	1,910.65
Phone and data (internet) services	*6,173.63*	5,425.41
Tax advisor including software	*7,300.00*	7,130.00
Shared administration	*12,490.59*	20,592.70
Value added tax	*4,856.49*	1,804.21
Lump sums for small support jobs	*3,880.00*	6,860.00
Third party services (DLR for project STEPCLIM) and other	*6,600.00*	5,605.80
Total expenses	***293,577.19***	**348,196.09**
Result	***3,552.30***	**4,169.46**

	2015	2016
Fixed Assets (office equipment)	*1,595.00*	1,457.00
Current Assets		
Receivables	*501.26*	0.00
Bank balances	*0.00*	81,175.52
Deferred Expenses	*22,178.00*	18,532.00
Assets total	***24,274.26***	**101,164.52**
Equity (own capital)		
Retained earnings brought forward	*2,674.98*	6,227.28
Remaining result of the year	*3,552.30*	4,169.46
Deferred Income	*0.00*	90,767.78
Liabilities to the bank	*18,046.98*	0.00
Equity and Liabilities total	***24,274.26***	**101,164.52**