2013

ESSL Testbed

1 – 26 July 2013
ESSL Research and Training Centre
Wiener Neustadt, Austria

ESSL Testbed 2013
Operations Plan

Version of 8 July 2013

The ESSL Testbed 2013 is made possible by:

World Meteorological Organization

ZAMG Zentralanstalt für Meteorologie und Geodynamik

EUMETSAT

WIENER NEUSTADT

Deutscher Wetterdienst Wetter und Klima aus einer Hand DWD

eumetcal

EUCLID European Cooperation for Lightning Detection

VAISALA

NIEDERÖSTERREICH HINEIN INS LEBEN. N

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1. Introduction and goals

1.1 Impact of convective storms

In Europe, thunderstorms are increasingly being recognized as an important risk to life and property. According to the Munich Re Group, a yearly total damage of about € 5 billion (Munich Re Group, 2006) is inflicted by thunderstorm-related high-impact weather (hail, flash floods, straight-line winds, tornadoes, and lightning) in Europe, comparable in magnitude to that of windstorms. Additionally, such events cause fatalities and injuries as shown in Table 1. Improved forecasts and warnings for severe thunderstorms will result in large societal benefits.

location	country	date	type of event	killed/injured
Hasselt	Belgium	19 August 2011	downburst	4/140
Sosnovo near St. Petersburg	Russia	29 July 2010	downburst	18/ -
Draguignan, Trans-en-Provence	France	15 June 2010	flash flood	17/ -
near Messina	Italy	1 October 2010	flash flood	17/79
Hautmont	France	3 August 2008	tornado	3/13
Budapest	Hungary	20 August 2006	downburst	1/100

Table 1. Selection of recent thunderstorm-related high-impact weather in Europe (source: European Severe Weather Database, www.eswd.eu)

1.2 ESSL Testbed Approach

The ESSL Testbed will assess and improve forecasting and nowcasting techniques of convective high-impact weather by providing institutional human and technical capacity building, accessible to both developed and developing countries in Europe.

Within the Testbed, occurrences of high-impact weather across Europe will be investigated during a yearly test period of 4 to 5 weeks in spring and/or summer.

The Testbed’s concrete aims are...

1. to assess the ability of new diagnostic products based on satellite measurements, numerical weather prediction, radar and standard weather observations to correctly indentify (upcoming) severe weather events (e.g. via subjective and objective verification procedures).
2. to obtain feedback from forecasters regarding these products, both with respect to their performance and to operational needs and constraints. This feedback helps the product

developers to refine and optimize them, thereby accelerating their successful operational deployment.

3. to familiarize the forecasters of the European National (Hydro-)meteorological Services with the correct use of the new products
4. to enhance the forecasters' overall skills in forecasting of convective high-impact weather, by providing training by internationally known forecasting experts who teach scientifically-motivated forecasting techniques. The training is performed through remote learning in cooperation with EUMETCAL and "hands on" at the ESSL Training Centre.

The overall aim in the Testbed is to ***stimulate interaction between and among developers and forecasters*** which benefits the forecasting and warning process at European National Meteorological Services. The participants therefore include the persons from the following groups:

- weather forecasters from forecasting agencies worldwide and especially from Europe's National (Hydro-)Meteorological Institutes
- researchers/developers from these agencies and from international organizations such as EUMETSAT
- renowned experts on forecasting techniques

The Testbed is loosely modelled after its US counterpart, the Hazardous Weather Testbed Spring Experiment, an annual programme in which several branches of the National Oceanographic and Atmospheric Administration (NOAA) cooperate, including the Storm Prediction Center (SPC) and the National Severe Storms Laboratory (NSSL).

1.3 Facilities

Fig 1. The ESSL Training Centre in Wiener Neustadt, Austria

The ESSL Testbed is located in the ESSL Training Center in Wiener Neustadt, a historical imperial city 45 km south of Vienna and 60 km southeast of the Vienna International Airport. The main train station of Wiener Neustadt with frequent trains to Vienna and other Central European Destinations is only 300 m away, thus within walking distance.

The Testbed facilities are housed on the first floor of an Art Deco Style house (Fig. 1) near the town center of Wiener Neustadt. The Testbed and briefing rooms are situated on 150 m², which also include the secretariat and break rooms.

2. Operations

2.1 Overview

The operations include the following three fundamental components:

1. **forecasting**
2. **verification**
3. **evaluation**

Within the forecasting activities, participants operationally use the experimental forecast products to generate a forecast. After the period for which the forecast was valid has passed, they are verified against observations. Finally, the use of the experimental forecast products is evaluated. Below, these activities are described in more detail.

In addition, there are

- expert lectures (**lecture of the day**)

Within a daily online session, remote participants will receive a briefing of the forecasting, verification and evaluation efforts and are asked to provide feedback and questions. Subsequently, the “lecture of the day” will be transmitted online.

The daily Testbed programme is shown in the Tables 2 and 3, below.

Programme Monday

On-site registration: 08:00 – 08:45 h local time.

Time (local, UTC)		Activity	Description
08:45	0645	Welcome presentation	Presentation of organizational and local matters. Round of introductions.
09:00	0700	Introduction to the ESSL Testbed	Presentation of the concept of the ESSL Testbed and of the available tools.
Part of programme with remote participation			
11:15	0915	Daily briefing	Online weather briefing, discussion of current weather situation and forecasts and subjective evaluation with remote participants - done on the first day by the ESSL Testbed staff.
followed by		Lecture of the day	30 minute expert lecture on forecasting techniques, given by developers of forecast tools or forecasting experts.
~ 12:30		Lunch break	
14:00	1200	Forecast operations	The participants will be split into two groups, each dealing with a particular forecast period. Green Room: Day 1 forecast and Nowcasting Experimental probabilistic convective forecast for the present day. Map Room: Day 2 – 5 forecast Experimental probabilistic convective forecast for day 2, and for day 3 - 5.
17:30	1530	End	End of forecast operations.
18:00			Social programme: Guided City Tour

Table 2. The Testbed's Monday programme

Daily Programme Tuesday – Friday

Time (local, UTC)		Activity	Description
08:45	0645	Verification	Subjective verification of yesterday‘s experimental convective forecasts compared to ESWD severe weather reports, satellite and radar data.
09:15	0715	Forecast operations	The participants will be split into two groups, each dealing with a particular forecast period. Green Room: Day 1 forecast Experimental probabilistic convective forecast for the present day. Map Room: Day 2 forecast Experimental probabilistic convective forecast for day 2.
Part of programme with remote participation			
11:15	0915	Daily briefing	Online weather briefing, discussion of current weather situation and forecasts and subjective evaluation with remote participants: summarizing new insights, preliminary findings, and topic areas needing further examination.
followed by		Lecture of the day	30 minute expert lecture on forecasting techniques, given by developers of forecast tools or forecasting experts.
~ 12:30		Lunch break	
14:00	1200	Forecast tool performance evaluation	Participants jointly discuss forecast tool performance, answer questions
14:30	1230	Forecast operations	Green Room: Nowcasting Short-range forecast and issuance of experimental watches for 2 hours at 15:00, 16:00 and 17:00 local time. Map Room: Day 3 - 5 forecast Experimental probabilistic convective forecast for day 3 - 5. After the finished day 3 - 5 forecast the team can also switch to nowcast-mode. If the weather situation is unusually calm, the programme for both teams will be altered: Studies of past severe weather situations, or severe weather forecasting training by an expert.
1730	1530	end	End of forecast operations. Weather permitting, activities may be continued.

Table 3. The Testbed’s daily programme

2.2 Experimental convective forecasts

On a daily basis, participants will prepare experimental forecasts for severe weather. These forecasts differ in time range, validity time period, domain, and quantities to be forecast. They range from Nowcasts, that have validity time of two hours starting at the moment the forecasts issuance, to Day 5 forecasts, that deal with the weather occurring four days ahead. The forecasts will be issued using a program to draw lines are drawn to designate areas in which a particular probability of severe weather or lightning is expected. In addition, a short(!) text to explain the forecast rationale is to be given.

Table 3 lists the types of forecasts that are to be issued

Type	**Deadlines (UTC)**	**Validity (UTC)**	**Forecast type** The percentages refer to the probability of one or more events within 40 km of a point	**Domain**
Nowcast	1300 (1500 CEST) 1400 (1600 CEST) 1500 (1700 CEST)	1300 – 1500 1400 – 1600 1500 – 1700	warning with indication of expected severe weather type	selected sub-domain
Day 1	0855 (1055 CEST)	0900 – 0600 (next day)	thunder 15 % thunder 50 % level 1 (> 5% severe) level 2 (> 15% severe) level 3 (> 15 % extreme)	selected sub-domain
Day 2	0800 (1000 CEST)	0600 (next day) – 0600 (day + 2)	thunder 15 % thunder 50 % level 1 (> 5% severe) level 2 (> 15% severe) level 3 (> 15 % extreme)	selected sub-domain
Day 3	0855 (1055 CEST), on Mondays: 1300 (1500 CEST)	0600 (day + 2) – 0600 (day + 3)	any severe weather	Europe
Day 4		0600 (day + 3) – 0600 (day + 4)	any severe weather	Europe
Day 5		0600 (day + 4) – 0600 (day + 5)	any severe weather	Europe

Table 4. Forecasts at the testbed.

The forecasts are issued at fixed times and deal with a particular forecast domain. In the case of the Day 3, Day 4, and Day 5 forecasts, the domain is Europe in its entirity, whereas the Nowcasts and Day1 and Day 2 forecasts are issued for a sub-domain that is decided based on the pre-conceived likelihood of severe weather occurring within that sub-domain. The subdomains can be seen in Figure 2. An example of a forecast is given in Fig. 3.

Many of the predictands of the various forecasts relate to the probabilities of severe weather and extreme weather, which for the ESSL Testbed are defined as in Table 4.

Severe weather	**Extremely severe weather**
• hail 2.0 cm or larger in diameter • wind gusts 25 m/s or higher • any tornado • rainfall causing significant damage	• hail with 5.0 cm diameter or larger • wind gusts 32 m/s or higher • tornado F2 or higher
The quantities to be forecast in the Day 1-5 forecasts are the probabilities that lightning / severe / extreme weather occurs within a radius of 40 km of any given point.	

Table 5. ESSL Testbed criteria for severe weather.

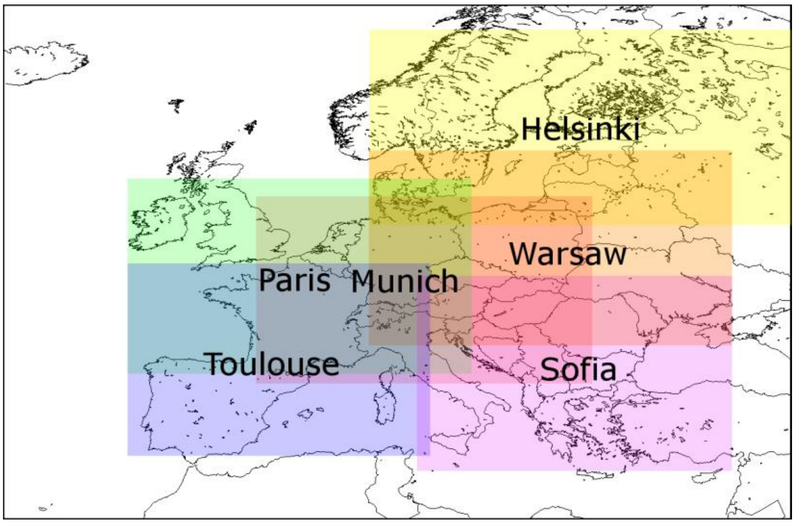
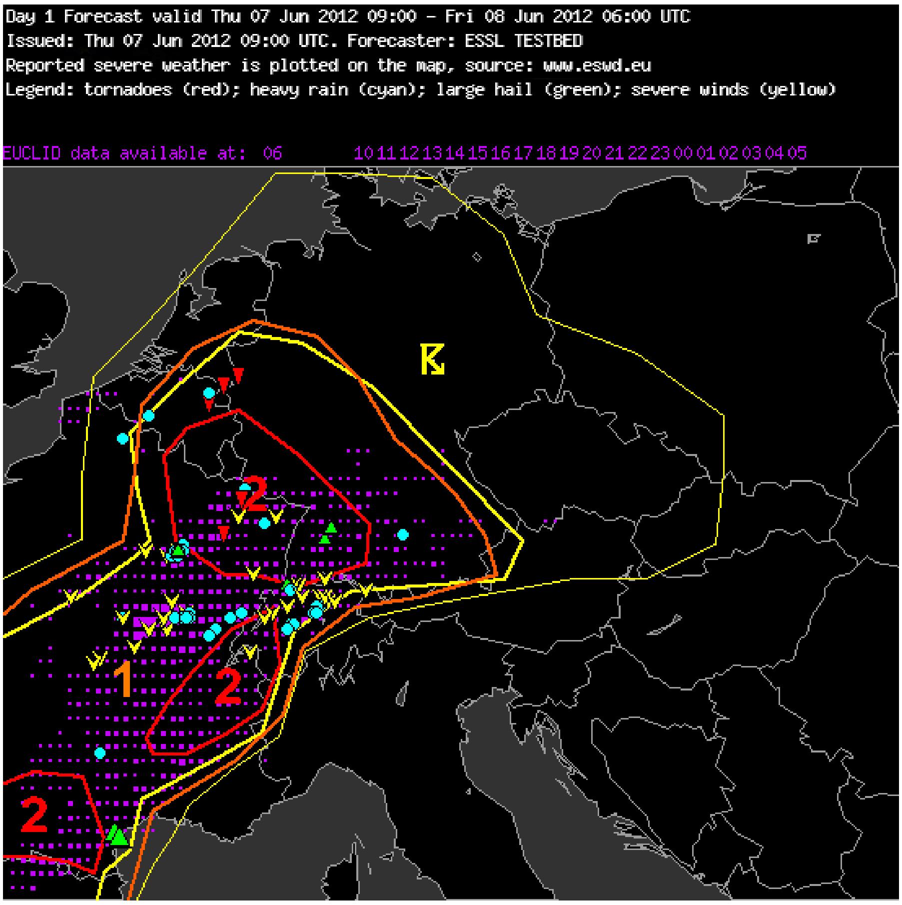


Fig. 2. The full ESSL Testbed domain and the six subdomains for which forecasts are to be made.



a.

b.

Fig. 3: Day 1 forecast map for the domain Munich showing the areas drawn to depict low (15 – 50 %) thunderstorm probability (inside the thin yellow contour) and high (> 50%) thunderstorm probability (inside the thick yellow line), as well as a level 1 and 2 of severe weather threat (see Text and Tables 1 and 2 for definitions). The map also shows the data to verify the forecast, i.e. the observed severe weather reports from the European Severe Weather Database: heavy rain (blue circles), tornadoes (red triangles), yellow V's (severe wind > 25 m/s), and large (>= 2 cm) hail (green triangles), as well as lightning detected by the EUCLID network (purple).

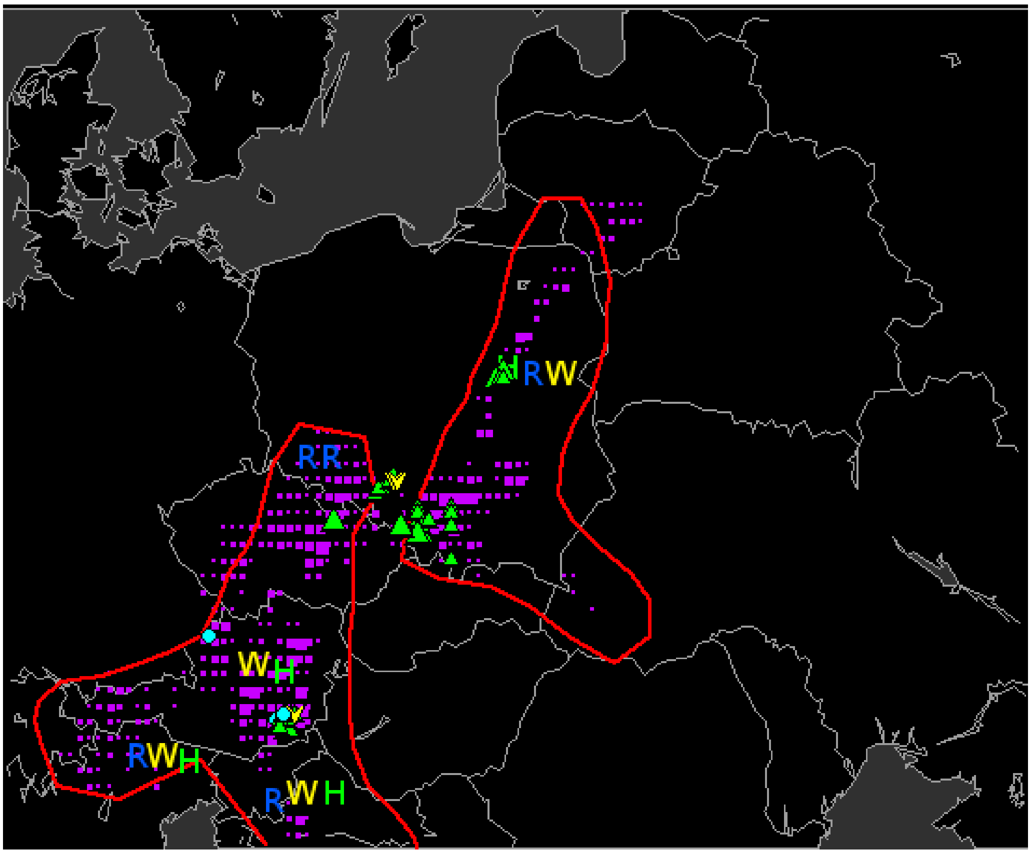


Fig. 4: Nowcast map with verification data. The map shows areas outlined by red contours within which thunderstorms are expected within the next two-hours period. The characters W, H, and R indicate that a threat of wind, hail or rain is expected, respectively. The symbols, as in Fig. 3.a., denote the occurrence of such phenomena according to reports entered into the ESWD.

Nowcasts

During the afternoon session, starting at 14:45 local time, one or both of the Testbed teams will work on issuing severe weather warnings for smaller areas within the domain of the day. These are supposed to be warnings for severe weather issued two hours ahead of time.

Climatology

In case almost no convection is expected across the entire domain, the time slots for forecasting the current weather are used for studying historical cases, or for forecaster training sessions.

Fig 4. shows the coverage of high-impact weather during the Testbed period in previous years. The average number of monthly reports is approximately 1000. Considering that the domain covers the entire European continent (except for Islands and the extreme eastern parts), the weather is usually interesting enough somewhere over Europe.

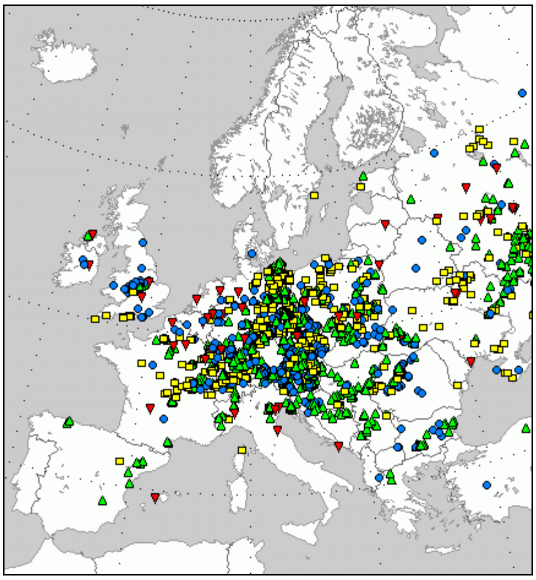


Fig. 5. Severe weather coverage during the Testbed period in 2012; yellow rectangles: severe wind gusts, red triangles: tornadoes, blue circles: flash floods, green triangles: large hail (source: ESWD, www.eswd.eu).

2.3 Forecast verification

During the *verification* slots, the forecasts will be verified subjectively against observed high-impact weather as collected in the European Severe Weather Database (ESSL) and against lightning data. Areas outside of the lightning detection network will be validated using satellite imagery as a proxy for the occurrence of convection. The outcome of the verification procedure is to establish the magnitude of the discrepancies between forecast and observations and to identify possible causes. Such causes may be poor guidance by particular data, poor interpretation of the available data or other reasons.

2.4 Evaluation and reporting

In the evaluation sessions, the value of the individual products to the forecast will be assessed. These assessments result from discussions within the group of participants. At 14:15, a plenary discussion will be held. In addition, sub-groups of participants may be asked to report on the performance of a particular forecast-supporting product. There are three ways in which the feedback is collected:

1. Questionnaires

Questionnaires have been developed for each forecast-supporting product, in collaboration with the responsible researcher/developer. The answers given to these questions will be filled in during the evaluation session, at least once per group per week, but, if needed, more frequently. The collected answers will be sent to the researcher/developer after the conclusion of the Testbed.

2. Testbed Blog

The Testbed blog is a web site (**www.essl.org/testbed/blog**) on which several texts with illustrations on the work at the Testbed will be posted on a daily basis, both by Testbed staff and participants. The posts discuss the forecasting, the products and their performance, as well as general impressions.

3. Direct communication with the developer

Most researchers/developers will be present at the Testbed at a given time. This gives the opportunity to directly interact, discuss and collect feedback on the forecast-supporting products.

2.5 Expert Lectures

Lectures are presentations 30 minutes in length, that will be disseminated online with support from EUMETCAL following the *Daily Briefing*, starting approximately at 0945 UTC (1145 local time). The lecturers include experts on forecasting, modelling, remote-sensing or other relevant topics. These will include scientists from European weather services and overseas, and from international organizations like

EUMETSAT and ECMWF as well as forecasters with a great expertise in the forecasting of convective high-impact weather. A list of speakers is available in Appendix 2.

2.6 Participation schedule

Testbed Groups

Participants to the Testbed, forecasters and scientists/developers, will be assigned to each of five groups. These groups will have sizes of approximately 10-12 persons, not including Testbed staff.

On-site and remote participation

It is recommended that participants first participate one week remotely, followed by a week on site at the ESSL Training Centre in Wiener Neustadt. All participants will however be able to take part in all online sessions. The online participation involves connecting to the Testbed through Saba Meeting teleconferencing system (provided by EUMETCAL) as well as participating in the Daily Briefing, and attending the *Lecture of the day.* These activities take place from 0915 UTC to approximately 1045 UTC, and will effectively cost a remote participant about two hours a day. Participants of the first Testbed week will not have the possibility of prior remote participation, but are welcome to attend remotely later.

2.7 Standard tools at the Testbed

Testbed Data Interface

Data of all experimental products as well as conventional meteorological data are displayed through the Testbed Data Interface, which is a collection of intranet pages, that are accessed through a web browser. These pages include the *Model Comparison* page that displays output from several NWP models simultaneously and the *Nowcast Display* page that allows the user to overlay several layers of satellite, radar, and observational data. For the 2013 Testbed the data will be made available to remote participants, through the internet. The web page to access is www.essl.org/testbed/data. Participants will receive a valid username and password to gain access also from their home institution for the duration fo the Testbed.

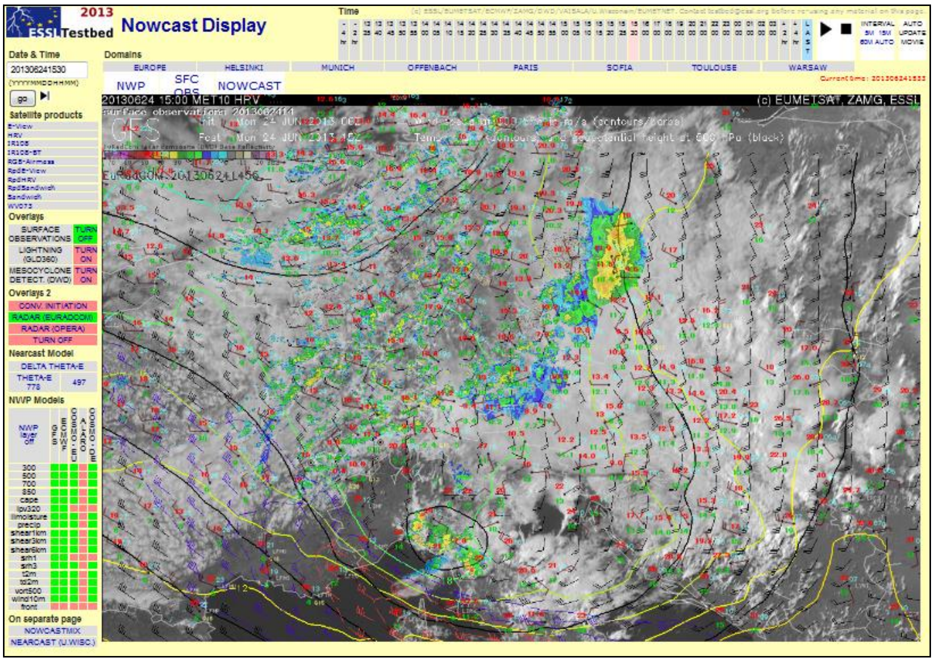


Fig. 6. Nowcast Display

Testbed Participant Page

On a dedicated web page, background information on the experimental products and techniques, beyond the information contained in this Operations Plan is gathered. The web page to access is www.essl.org/testbed/info.

Workstations and printing

ESSL's Research and Training Centre is equipped with 5 workstations that the participants will use to access the Testbed Data Interface. One of the pages of the Testbed Data Interface provides maps of surface observations, that can be printed in A3 format and analysed using provided colour pencils.

Available Standard Meteorological Data

In addition to the experimental products described in the following sections, the following "standard" meteorological is available through the Testbed Data Interface:

NWP

- ECWMF IFS data is provided by ZAMG, and additionally available through the website of ECMWF.
- COSMO-EU (source: DWD)
- COSMO-DE (source: DWD)
- COSMO-DE-EPS (source: DWD; is part of the testing programme)
- ALARO5 (source: ZAMG)
- GFS (source: NCEP)

Satellite

From Meteosat 9 (available every 15 minutes):

- E-View, High Resolution Visible, IR-10.8, IR-10.8 (color enhanced), Airmass-RGB, WV-7.3

From Meteosat 8 RapidScan service (available every 5 minutes):

- E-View, High Resolution Visible, IR-10.8, IR-10.8 (color enhanced)

From these products, two “Sandwich Products” (see section 3.11) are computed by ESSL, both from Meteosat 9 and from MeteoSat8 RapidScan data.

Radar imagery

- The European radar composite OPERA is made available by ZAMG through an agreement with EUMETNET
- The West-European radar composite EuRadCom is provided by DWD

Observations

- Severe weather observations are available from the European Severe Weather Database.
- SYNOP and METAR surface observations of Europe
- Radiosonde data are available on the internet through the University of Wyoming and the University of Oklahoma

Lightning data

- The GLD360 product by Vaisala which is part of the testing programme (Section 3.7), and, secondly, data from the ground-based EUCLID network which can be accessed through a web interface.

3. Forecast-supporting products

A wide range of tools that support the forecaster in early operational or pre-operational stage (Forecast-Supporting Products) are evaluated at the ESSL Testbed. For example, new versions or configurations of numerical weather prediction models, new techniques to extract information from satellite, radar and other remote sensing data. This includes new visualizations and ways to combine different types of meteorological data relevant to the prediction of high-impact weather. The products up for evaluation in 2013 are listed in Table 2, and described in the sections that follow.

forecast-supporting product	developer	Description
Mesocyclone Detection Algorithm	DWD	Radar-based algorithm to detect and assign severity levels to mesocyclones, based on Doppler velocity data from radars in the German national radar network
Convective Initiation Product (SATCAST)	DWD /Univ. Alabama at Huntsville / EUMETSAT	0-1 hour forecasts (i.e. "nowcasts") of new storms, based on satellite data
NearCAST	Univ. Wisconsin	CIMSS Convective Development Nearcasting Model
GLD360	VAISALA	Global lightning detection network
COSMO-DE-EPS visualizations	DWD / ESSL	Visualizations of high-resolution convection-permitting ensemble NWP model
NowCastMIX	DWD	Grid-based system combining nowcast data from multiple sources using fuzzy logic

Table 6. Forecast-supporting products.

3.1 Mesocyclone Detection Algorithm

Thomas Hengstebeck (DWD)

Data basis

The basic data of the volume scan are provided as input for the MDA [1]. In the 5 min scan strategy 10 sweeps corresponding to 10 elevations ranging from 0.5° to 25° build up a 3D-volume. The MDA uses the radial wind (Doppler wind) information of such a volume as detection basis. The further classification of a detected mesocyclone, i.e. the severity estimation, is based on both radial wind and reflectivity information. A detected mesocyclone cell is assigned a time stamp corresponding to the time of the rotation signature (feature, see below) closest to ground. Due to the 5 min scan strategy the time stamp lies within an interval of 4 min after the time of the scan begin, the so-called reference time, which is 0, 5, 10, 15, etc min after the full hour.

Description of Algorithm

General remarks

A mesocyclone (often found in connection with the updraft in supercells) is an atmospheric vortex field, that can be described by a so-called “Rankine Combined Vortex"-model (Zrnic et al, 1985). Here, one distinguishes between an outer and inner region of rotation. In the outer region, the rotation smoothly merges into the overall wind field. However, the inner region is characterized by rigid rotation and shows constant and high values of azimuthal shear. This region of high azimuthal shear – in the Doppler wind data visible as central part of the typical rotation dipole - is the signature that is searched for by the automatic mesocyclone detection algorithm. The algorithm follows the approach described in (Zrnic et al, 1985).

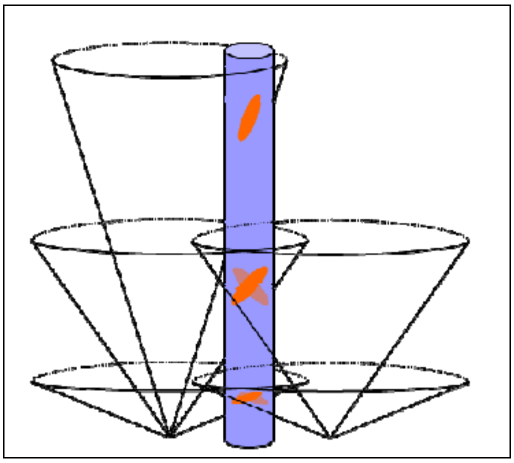
Pattern Vectors and Features

A so-called "pattern vector"-method is used for identifying regions of high azimuthal shear, i.e. in each radial wind sweep one tries to find contiguous azimuthal sequences of pixels with high azimuthal shear. The found pattern vectors are filtered with respect to the values of azimuthal shear and specific angular momentum and are grouped to so-called features (spatially correlated pattern vectors). The features are filtered according to symmetry criteria: Since a feature ideally resembles a complete rotation signature, it should have roughly equal extensions in range and azimuth directions. The "pattern vector-feature"-search is performed for each sweep of each volume (all radar stations) yielding a list of geo-referenced features (i.e. features with latitude / longitude coordinate pairs).

Meso-Objects

Within the above described list vertically aligned features, i.e. features with similar latitude / longitude coordinates, are searched for. A group of such features resembles a so-called mesocyclone-object (see

Figure), which is classified as mesocyclone-cell with related severity level after validation. (In NinJo an upside down triangle symbol with color coding of severity index is visualized).



A vertically aligned group of geo-referenced features (orange patches) forms a mesocyclone object (depicted as blue cylinder).

The validation is done with the help of the reflectivity data. Properties of the region of the detected mesocyclonic rotation like mean / max. reflectivity, cell-based VIL (vertically integrated liquid water), VIL density , height of lowermost detected rotation signature over ground, total height of rotational column and echo top height are calculated.

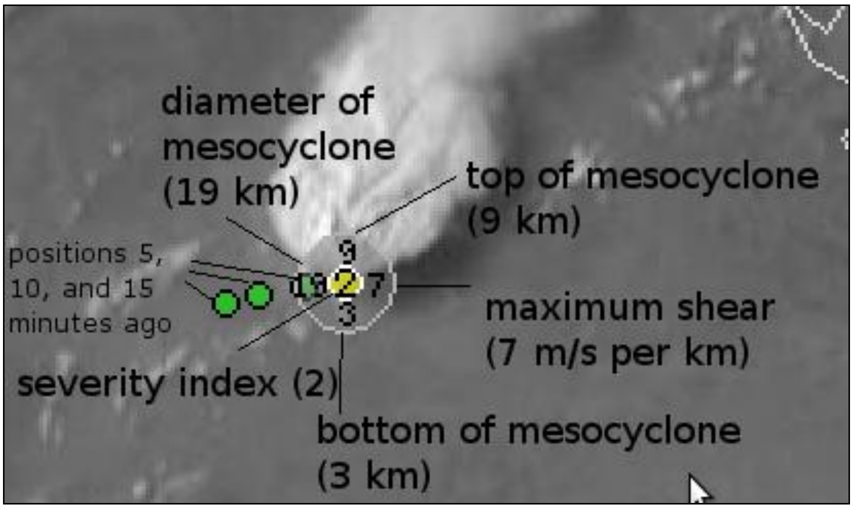
The severity level is determined by applying thresholds to these cell-characteristics. The severity levels 2-5 imply mesocyclonic rotation with increasing strength and clearness. Severity-level 1 rather serves for test / tuning purposes, but may also give hints to early stages of rotation. The latitude / longitude-coordinate-pair of the mesocyclone-cell is determined as shear weighted mean of the lowest 3 km of the mesocyclone object. Table A1 shows the basic thresholds.

Meso cell attributes		**Severity-Level**				
		1	**2**	**3**	**4**	**5**
Max. dBZ	≥	10	30	40	50	55
Avg. dBZ	≥	10	20	25	35	40
Height agl [km]	≤	5	3	2.5	2	1.5
Meso Height [km]	>	0	0	2	4	6
VIL [kg m^{-2}]	>	2	5	10	20	30
Echo top height [km]	>	1	3	4	5	7
VIL dens. [g cm^{-3}]	>	0	1	1.5	2	2.5
Max. shear [m/s/km]	>	0	0	0	15	20
Max. mom. [m/s·km]	>	0	0	0	150	200

Table A1: Basic thresholds for severity estimation.

Some of the mesocyclone attributes, in particular VIL, are affected by the geometrical resolution, which naturally changes with the distance from the radar. Therefore a fuzzy logic scheme is used, which allows a slight violation of the thresholds. This means that e.g. VIL my drop by as much as 4.5% below the threshold of the current severity class without a change of the severity (adjustable value).

For the ESSL Testbed, the algorithm has been integrated into the Nowcast Display. The figure explains which parameters are shown.



Visualisation of a mesocyclone detection in the Testbed Nowcast Display.

3.2 Convective Initiation (CI)

Pierre Fritzsche (DWD)

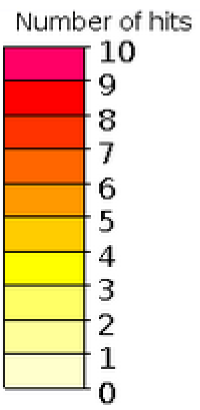
Data basis

Data base for the every 15 min updated product is the European Geostationary Satellite METEOSAT in its current evolution. The algorithm also used additional data. The Cloud Mask, Cloud Type and Atmospheric Motion Vectors are obtained from the NWC SAF packet. A pixel-wise detected CI event will be marked in the corresponding image, which is stamped with the corresponding EOS (End of Scan) time and highlighted with an color-code, marking the number of hit interested fields.

Description

Using METEOSAT's Spinning Enhanced Visible and Infrared Imager (SEVIRI) the algorithm identifies growing Cu clouds in a sequence of image data. In a 3 x 3 pixel window (called boxes) certain channel temperatures, channel differences and time trends are computed (Kocsis & König, 2012). The algorithm is designed to monitor the development of early signs of convection on the base of updraught strength, cooling rate (e.g. freezing) and other criteria. In total there are 17 criteria, taking physical properties and temporal progression in account:

- 15-minute cooling rate (time 3 - time 2) in temp(10.8)
- 30-minute cooling rate (time 3 - time 1) in temp(10.8) less than the 15-minute cooling rate!
- 10.8 cloud temperature (irtemp), at time 3
- 6.2 - 7.3 difference (temp) at time 3
- 6.2 - 10.8 difference (temp) at time 3
- 8.7 - 10.8 difference (temp) at time 3
- 30-min trend of 8.7 - 10.8 difference (temp) (time 3 - time 1)
- 15-min trend of this tri-channel difference (time 3 - time 2)
- 15-min trend of 6.2 - 7.3 difference (temp) (time 2 - time 1)
- 30-min trend of 6.2 - 7.3 difference (temp) (time 3 - time 1)



Severity level by number of hits

By detecting convection on the earliest possible point, the increased lead time can be used to determine the situation and warn the public on possible severe weather events even more minutes ahead. In cooperation with operational forecasters a first version of a severity scale was developed. The severity level is defined by a contingency table:

The number of hits represents the number of interested fields which are true for every pixel. In order to reduce over information, a balance between too much information (displaying every hit) and nearly no visible information (displaying only 7 or more hits) was found in displaying 6 hits or more.

One major problem are cloudless areas, where only very spacious wind vectors are derived. The scientific code, provided from EUMETSAT, was analysed and improved by code optimization. The main focus was on improving the code as time-critical application. By introduce parallel processing and an improved data handling the run-time stability and data IO was significantly improved, leading to an increased performance by around 30%. The optimized method was implemented into the operational DWD environment, continuously evolved by focusing on operational use.

First experiences suggest that sometimes convection was detected, where only little energy and potential is available. In general, the CI should be investigated with all professional care. It inherits a certain false alarm rate (see (Mecikalski, Minnis, & Palikonda, 2013; Mecikalski, Watts, & Koenig, 2011), which causes alarm but does not implicate a certain or imminent danger.

3.3 Vaisala GLD360

Hannamari Jaakkola, Jing Lin (VAISALA)

In 2009, Vaisala launched the Global Lightning Dataset GLD360. GLD360 data is produced by a Vaisala owned and operated lightning detection network that provides uniform, high quality lightning information across the globe. Data delivered includes CG stroke and cloud lightning information – and it can be delivered to the customer in real time.

Patented sensor algorithms and extreme sensitivity give GLD360 sensors the ability to detect lightning at distances up to 9,000 km. Each GLD360 sensor provides both direction and time-of-arrival information. Scientific studies have shown that lightning networks using a combination of direction and time-of-arrival sensor information provide significant detection efficiency and redundancy improvements over lightning networks using time-of-arrival sensor information alone. Through its GLD360 offering Vaisala provides the highest quality global lightning data in the market:

- Location Accuracy (LA): The median cloud-to-ground lightning stroke location accuracy 2-5 km
- Detection Efficiency (DE): 70% for cloud-to-ground flashes and >5% for cloud flashes with near uniform coverage around the globe (ref. the DE map in the Figure 1 below).
- Polarity & Peak Amplitude (kA): Unique to the GLD360 is the ability to provide polarity & peak amplitude (kA), which is typically the reserve of precision networks. The GLD360 polarity classification is greater than 90% and peak current estimates are accurate to within 25 % of the peak current value.

To ensure GLD360 provides the high level of network performance described above, validation studies have been performed in North America, Europe, and are now ongoing in South America. The results of these studies show that GLD360 has a CG flash detection efficiency of 70% or greater and a median CG stroke location accuracy of 2-5 km in all three regions.

Long-range severe weather detection has traditionally been limited by data gaps, leading to situations where people have late or no warnings. GLD360 is the only severe weather data set that has no data gaps and provides a nearly uniform, global coverage. GLD360 routinely detects over 1.5 million lightning events across the world each day.

As your global window, the GLD360 provides immediate access to a world-wide lightning dataset, anywhere around the globe. Vaisala thus has a unique offering that supports:

- Ability to detect and characterize lightning in areas of the world where meteorological observations may be partially lacking or absent.
- Lightning as a radar proxy or radar complement where weather radar information is limited or nonexistent.

- The ability to extend the range of lightning being assimilated into weather models and enhance the foresight of advancing weather systems.
- Quality lightning warnings on a truly global scale.

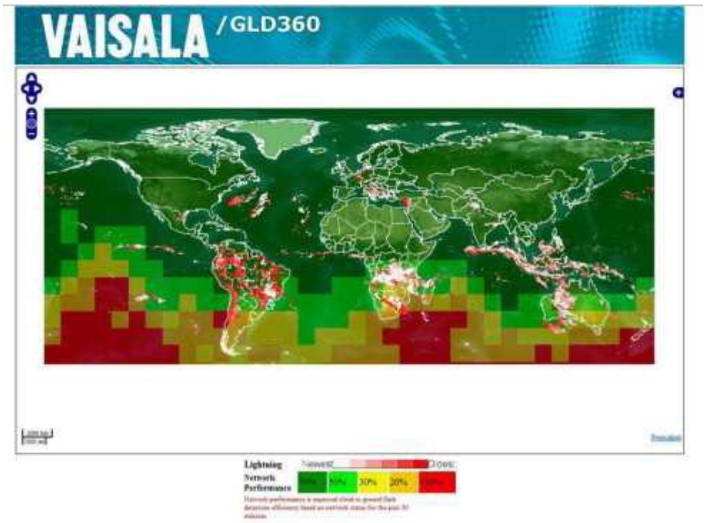


Figure: The global detection efficiency map for GLD360.

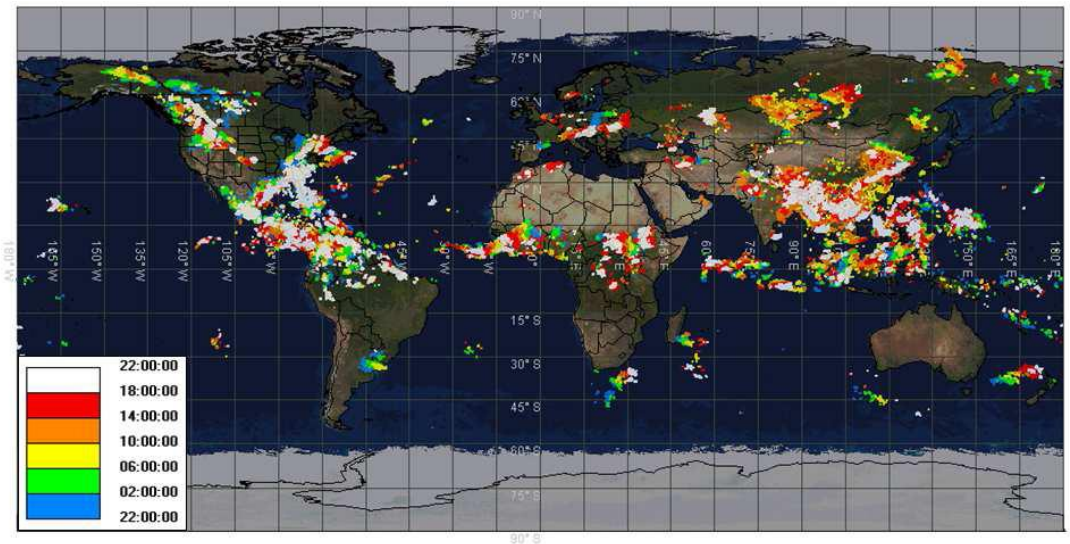
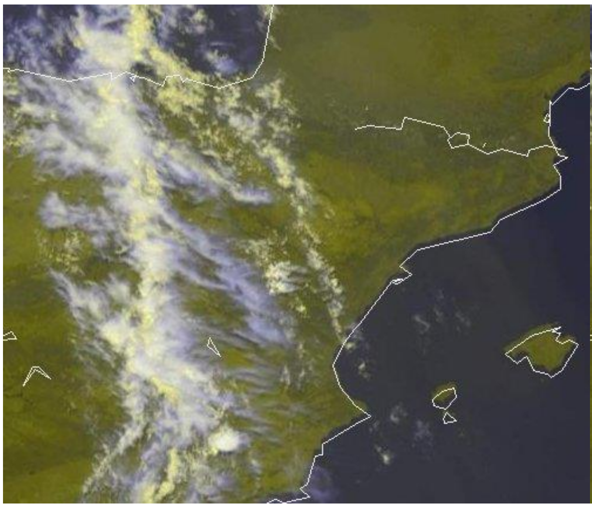
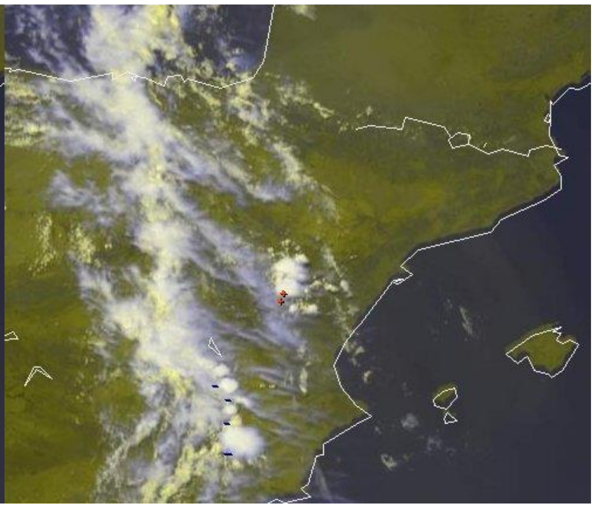


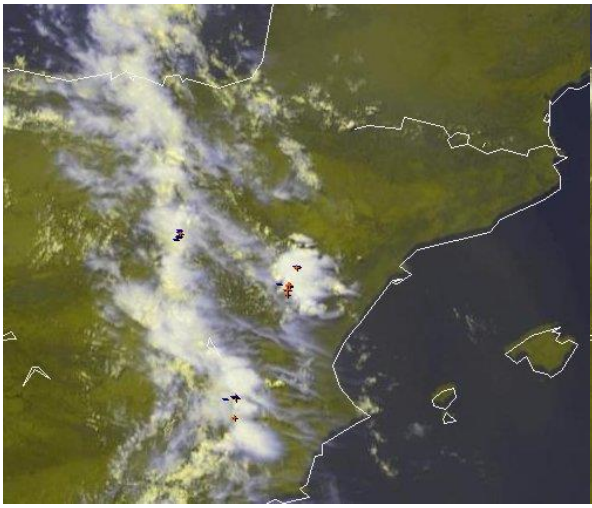
Figure: Global image showing more than two million lightning events reported by GLD360 on 22-23 June 2011. Colors show age of lightning events in 4-hour intervals starting on 22 June at 22:00 and ending on 23 June at 22:00.



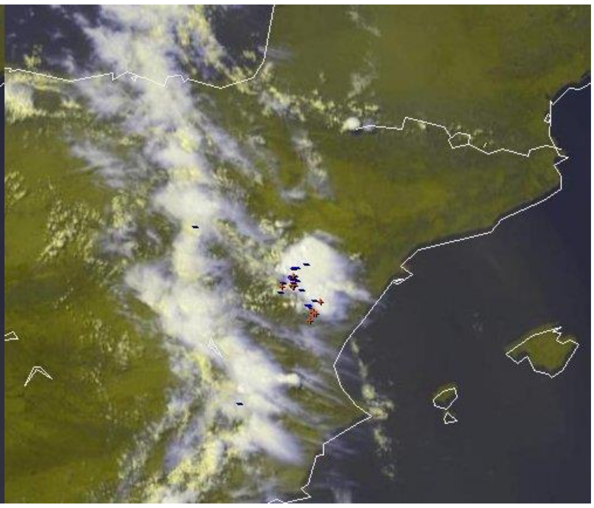
1230 UTC



1300 UTC



1330 UTC



1400 UTC

E-View satellite imagery (source: EUMETSAT/ZAMG/ESSL) with GLD360 overlay on 27 June 2012.

3.4 COSMO-DE (-EPS) visualizations

Dirk Heizenreder (DWD), Marcus Paulat (DWD), Pieter Groenemeijer (ESSL)

COSMO-DE-EPS is an ensemble of the German Weather Service's high-resolution, convection permitting model COSMO-DE (COnsortium for Small-scale MOdelling - DEutschland). Different initial and boundary conditions of the ensemble members are obtained from four different COSMO runs at 7 km which are in turn driven by different global NWP models (ECMWF IFS, DWD GME, NCEP GFS and UKMO UM) and varying parameters during the assimilation phase. Additionally, the ensemble members use varying model physics parameters.

Visualization of large volumes of ensemble data is a challenge. For example, in plotting the average and standard deviation of forecast quantities much information is lost. For a field like radar reflectivity such a display would not make much sense. At the Testbed, the following visualizations of the following fields will be evaluated:

Value of the Most Extreme Member, Threshold Contours of Exceeding Members, Number of Members Exceeding Threshold

Field	**Visualizations**
Reflectivity	1. Value of the Most Extreme Member 2. Threshold (40dBZ) Contours of Exceeding Members 3. Fraction of Members Exceeding Threshold (40dBZ)
10 m wind gust	1. Value of the Most Extreme Member 2. Threshold Contours of Exceeding Members (25 m/s, 32 m/s) 3. Fraction of Members Exceeding Threshold (25 m/s, 32 m/s)
Supercell Detection Index (Wicker et al., 2005)	1. Value of the Most Extreme Member 2. Threshold (0.001) Contours of Exceeding Members 3. Fraction of Members Exceeding Threshold (0.001)
3 hourly accumulated precipitation	1. Value of the Most Extreme Member 2. Threshold Contours of Exceeding Members (20mm, 40mm) 3. Fraction of Members Exceeding Threshold (20mm, 40mm)

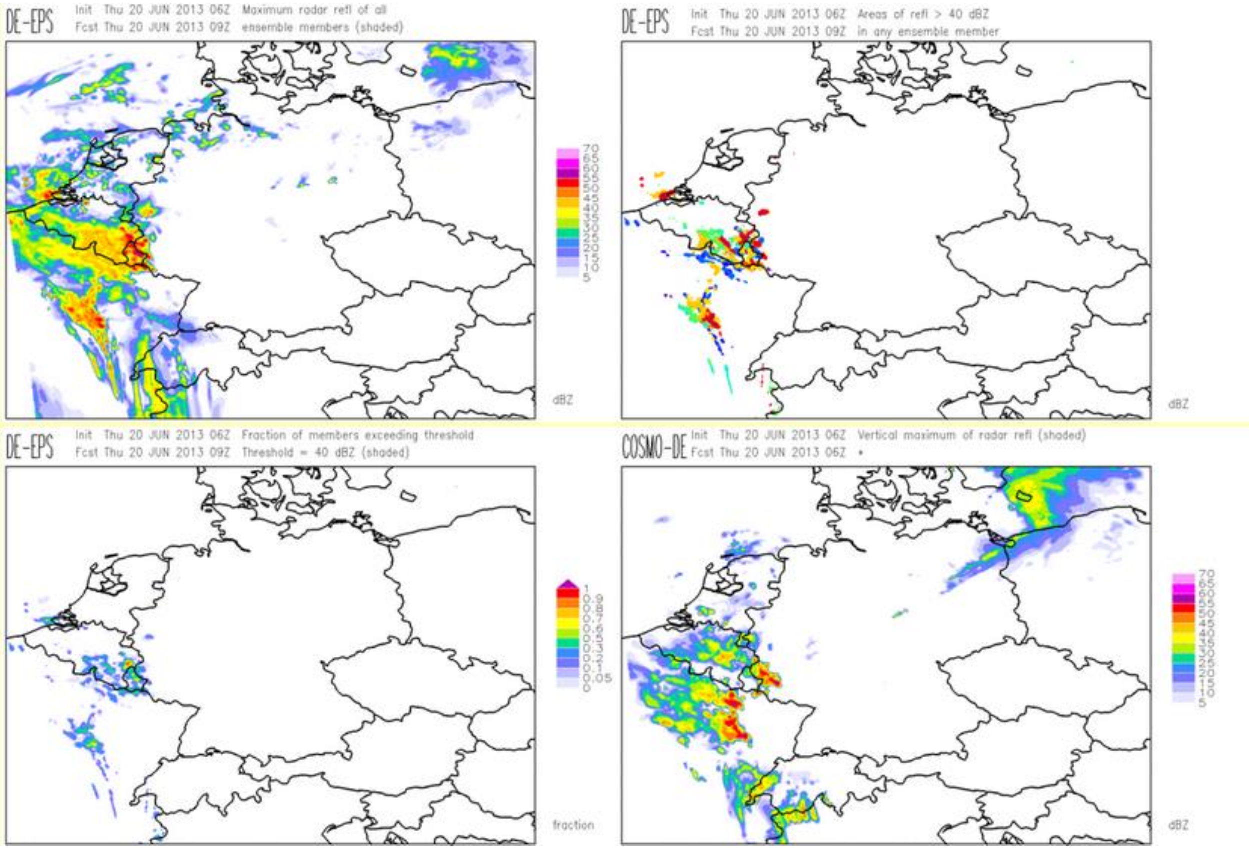
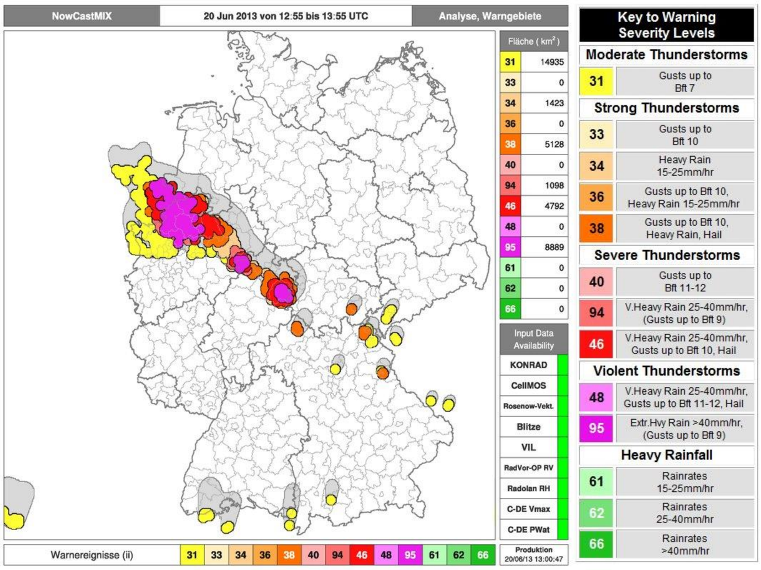


Figure. Top left: Value of the Most Extreme Member, top right: Threshold (40dBZ) Contours of Exceeding Members bottom-left: Fraction of members exceeding threshold, bottom-right: deterministic COSMO-DE run for comparison.

3.5 NowcastMix

Paul James (DWD)

The GermanWeather Service's AutoWARN system integrates various meteorological data and products in a warning decision support process, generating real-time warning proposals for assessment and possible modification by the duty forecasters. These warnings finally issued by the forecaster are then exported to a system generating textual and graphical warning products for dissemination to customers. On very short, nowcasting timescales, several systems are continuously monitored. These include the radar-based storm-cell identification and tracking methods, KONRAD and CellMOS; 3D radar volume scans yielding vertically integrated liquid water (VIL) composites; precise lightning strike locations; the precipitation prediction system, RadVOR-OP as well as synoptic reports and the latest high resolution numerical analysis and forecast data. These systems provide a huge body of valuable data on rapidly developing mesoscale weather events. However, without some form of pre-processing, the forecasters could become overwhelmed with information, especially during major, widespread summer convective outbreaks. NowCastMIX thus processes all available nowcast data together in an integrated grid-based analysis, providing a generic, optimal warning solution with a 5-minute update cycle, combining inputs using a fuzzy logic approach.



The method includes optimized estimates for the storm cell motion vectors by combining raw cell tracking inputs from the KONRAD and CellMOS systems with vector fields derived from comparing consecutive radar images. Finally, the resulting gridded warning fields are spatially filtered to provide regionally-optimized warning levels for differing thunderstorm severities which can be managed adequately by the duty forecasters. NowCastMIX thus delivers an ongoing real-time synthesis of the various nowcasting and forecast model system inputs to provide consolidated sets of most-probable short-term forecasts. More information is given in James et al. (2011).

3.6 NearCast Model using SEVIRI Data

Ralph Petersen

The following section lists the objectives of the testing of the NearCast Model at the ESSL Testbed:

- Obtain and demonstrate an understanding of the NearCast analysis and short-range forecast processes and the temperature and moisture data derived Geostationary Satellite Moisture and Temperature Retrievals from SEVIRI

- Understand how NearCast Analyses enhance the areal coverage of conventional SEVIRI stability products

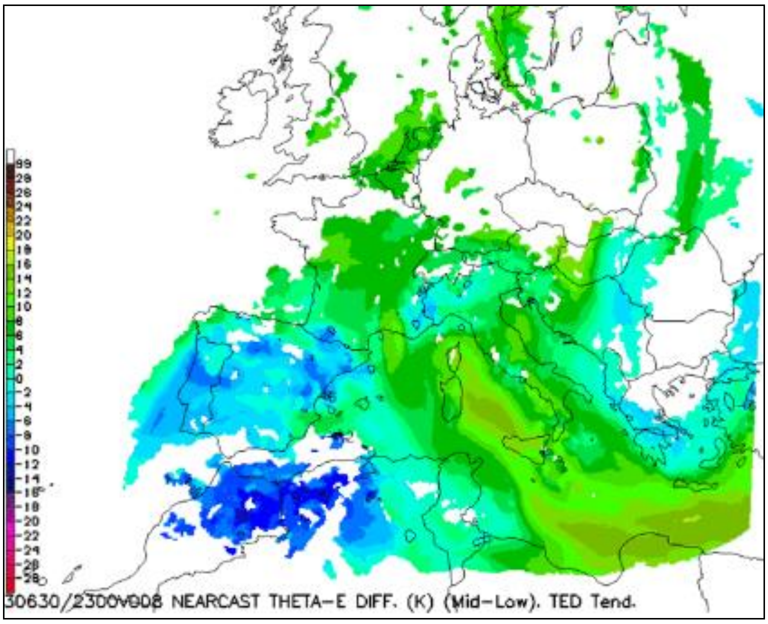
- Understand how lower-level NearCasts of SEVIRI observations can be used to anticipate the evolution of the pre-convective environment 1-9 hours into the future.

- Understand how mid-level NearCasts of SEVIRI observations can be used to help isolate areas conducive for deep-layer convective destabilization 1-9 hours into the future.

- Understand how lower- and mid-level NearCasts of SEVIRI temperature and moisture observations can be used jointly (in the form of Equivalent Potential Temperature) to help identify areas conducive for development of deep-layer convective destabilization 1-9 hours into the future. This will be accomplished by mimicking what has been observed in satellite Water Vapor imagery for decades – that convection tends to develop along the edges of upper-level dry bands where they overtake regions of enhanced lower-level moisture and heat.

Product Overview:

NearCasts are Near-term forecasts which are intended to help fill the information gap between 0-1 hour long Nowcasts and longer-range NWP, covering the period 1-9 hours into the future. The overall goal of NearCasts is to provide forecasters with new, data-driven tools to help identify areas of enhanced moisture transport and convective destabilization using products from current and future Geostationary Satellites. The NearCasting system uses a trajectory-based approach that preserves large gradients and maxima and minima observed in the SEVIRI data, as well as using successive temporal data insertions to revalidate/revise previous projections every hour.



NearCast example, showing potential instability as predicted by the model 8 hours after initialization time at 15 UTC.

NearCasts were developed as a means of allowing forecasters to extend the utility of the SEVIRI sounder observations by increasing situational awareness and increasing thunderstorm prediction skill both by 1) filling gaps in the SEVIRI infrared data sets in areas where clouds have already formed and 2) adding a forecast component to the detailed SEVIRI moisture observations. The primary source of data for the NearCasting system is Moisture and Temperature observations made hourly at ~10km resolution by the SEVIRI sounder. Although the SEVIRI moisture observations are only available for 3 layers of the troposphere (nominally from the surface to 900 mb, from 900-700 mb, and from 700-300 mb), the data provide greater detail (both horizontally and in time) than any other operational NWS data system. These moisture products are probably the variables that the GOES sounder observes best. The Total Precipitable Water (TPW) measurements from these GOES data exceed the accuracy of NWP model forecasts providing the “first guess fields” used in generating the satellite retrievals and add important small-scale details in many situations, especially during the warm season. These moisture observations can then be combined with temperature data to produce graphical depictions of the analyses and 1-9 forecasts of total thermal energy (Equivalent Potential Temperature (θe) which, at lower-levels, are useful as indicators of source regions and local ‘hot spots’ for development of subsequent convection. By super-positioning of dry intrusions found in the upper-level θe imagery over the lower-level θe fields, products are created to mimic the decades-old observation from Water Vapor Imagery that convection tends to form on the leading (and trailing) edges of deep bands of upper-level dry air as they overtake areas of substantial low-level moisture.

The NearCast predictions are made using dynamical trajectory techniques that are significantly different than traditional NWP. This process is done for every GOES observation and at every observing time as follows:

1. Wind data from short-range NWP forecasts are interpolated to the location and layer of each 10 km spaced SEVIRI observation. Observed SEVIRI data types used in the NearCasts include temperature, mixing ratio and calculated equivalent potential temperature.

2. The observed data are then projected forward to future locations using dynamically changing winds. At the end of each time step, the velocity of each parcel is changed using accelerations calculated from the Coriolis force of the parcels and pressure gradient fields (also obtained from the GFS) that have been interpolated to each of the parcel locations. The locations and values of each of the parcels are saved at 30 minutes intervals out to 9 hours in the future.

Note: The parcel-following Lagrangian trajectory method retains all maxima and minima in the observed data sets throughout the full integration period. It also allows the model to use 10-15 minutes time steps, which is much more efficiently than the 20-30 seconds time steps that would be required at this resolution in conventional Eulerian grid-point models.

3. The observed values and locations of each data projection are then merged with information about the trajectories generated from the previous 9 NearCast runs to create rectangular grids. These grids are then used to generate output graphics and/or for diagnostic calculations. In this process, the most recent trajectories receive the highest weighting. In areas where clouds may have developed and prevented the retrieval of IR-based soundings, data from previous model runs can fill many of the gaps left in the most recent data sets, especially after convection develops near the area of interest. This same procedure if followed by all forecasts and analyses.

Specific Field Test Objectives:

Objective #1: Obtain and demonstrate an understanding of the NearCast analysis and short-range forecast processes and the SEVIRI moisture and temperature and data that drive the system.

Objective #2: Understand how lower-level NearCast analyses and forecasts of SEVIRI moisture (and temperature) observations can be used together in the form of Equivalent Potential Temperature (θe) to understand and anticipate the evolution of the pre-convective environment 1-9 hours into the future.

Objective #3: Understand how mid-level NearCasts of SEVIRI observations can be used to help isolate areas conducive for deep-layer convective destabilization 1-9 hours into the future.

Objective #4: Understand how the combination of lower- and mid-level NearCasts of SEVIRI moisture and temperature observations can be used to help identify mesoscale areas conducive (and not conducive) for development convection and heavy precipitation

3.7 European Severe Weather Database, ESWD

Pieter Groenemeijer, Thilo Kühne, Alois Holzer (ESSL)

The ESWD (Groenemeijer et al, 2004, 2009; Dotzek et al, 2009) is a dataset of severe weather reports managed by ESSL. The dataset is fed by observations from cooperating National (Hydro-)Meteorological Services, networks of voluntary observers, the general public and by ESSL itself. The following categories of severe weather are included in the ESWD at this time:

- straight-line wind gusts (v > 25 m s-1)
- tornadoes
- large hail (diameter > 2 cm; or layer > 2 cm)
- heavy precipitation
- damaging lightning strikes
- and several others

The ESWD database can be run in a *Nowcast mode* that features a map showing the reports in real-time as they are reported by its various sources. At the Testbed, the ESWD's usefulness for both nowcasting and forecast verification purposes will be evaluated.

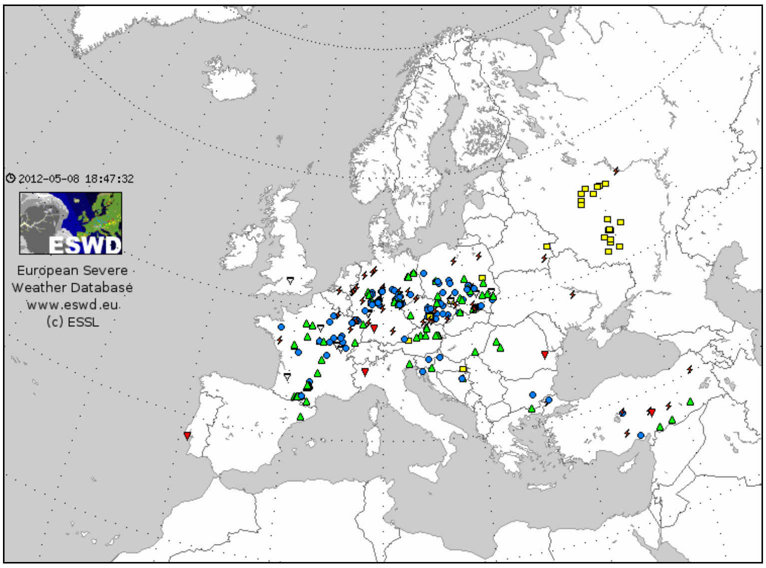


Figure: Example ESWD database display with several rain (blue), hail (green), tornado (red) and severe wind reports (yellow) plotted.

Appendix 1: List of on-site participants

Week 1: 1 – 5 July

Daniel Fuchs – AustroControl, Austria
Marek Kurowski – IMGW, Poland
Barbara Wrzesinska – IMGW, Poland
Kristina Petraityte – EUMETSAT, Germany
Andrej Velkavrh – ARSO, Slovenia
Taimi Paljak – EHMI, Estonia
Paulina Valova – SHMI, Slovakia
Gayretli Salman – TSMS, Turkey
Harald Seidl – ZAMG, Austria
Damir Santic – FIHBH, Bosnia and H.
Tomas Pucik – CHMI, Czechia
Georg Pistotnik – ESSL
Alois Holzer – ESSL
Pieter Groenemeijer – ESSL

Week 2: 8 – 12 July

Jennifer Doerkopf – DWD, Germany
Grzegorz Pietrucha – IMGW, Poland
Rafal Szewczyk – IMGW, Poland
Janis Veveris – LEGMC, Latvia
Vangjel Mustaqi – IGEWE, Albania
Eugenija Kuliesaite – LHMS, Lithuania
Pierre Fritzsche – DWD, Germany
Milica Djordjevic – RHMZRS, Rep. Srpska, Bosnia-H.
Helge Tuschy – DWD, Germany
Luis Bañon Peregrin – AEMET, Spain
Chuck Doswell – U.S.A.
Georg Pistotnik – ESSL
Alois Holzer – ESSL
Pieter Groenemeijer – ESSL

Week 3: 15 - 19 July

Christian Herold – DWD, Germany
Tomas Siemieniuk – IMGW, Poland
Marco Manitta – DWD, Germany
Piotr Manczak – IMGW, Polan
José-Antonio García-Moya – AEMET, Spain
Zsofia Kocsis – OMSZ, Hungary
Liliane Hofer – ZAMG, Austria
Martin Suklitsch – ZAMG, Austria
Ralph Petersen – U. Wisc, U.S.A.
Greg Stumpf – NOAA, U.S.A.
Oscar van der Velde – UPC, Spai
Georg Pistotnik – ESSL
Alois Holzer – ESSL
Pieter Groenemeijer – ESSL

Week 4: 22 - 26 July

Simon Trippler – DWD, Germany
Ewa Lapinska – IMGW, Poland
Szymon Ogórek – IMGW, Poland
Pavel Borovicka – CHMI, Czechia
Margarida Belo-Pereira – IPMA, Portugal
Kathrin Götzfried – ZAMG, Austria
Thomas Hengstebeck – DWD, Germany
Yiu Fai Lee - Hong Kong Observatory, Hong Kong, China
Vera Meyer – ZAMG, Austria
Christoph Gatzen – MeteoGroup, Germany
Greg Stumpf (Mon-Tue) – NOAA, U.S.A.
John Mecikalsk (Mon-Wed) – U. Alabama, U.S.A.
Jing Lin – VAISALA, Finland
Georg Pistotnik - ESSL
Alois Holzer - ESSL
Pieter Groenemeijer - ESSL
Thilo Kühne - ESSL
Kathrin Riemann-Campe - ESSL

Appendix 2: Expert Lectures

Expert lectures are daily returning lectures (30 minutes) on a specific topic, starting after the Daily Briefing at 11:15 l.t. /0915 UTC has ended, i.e. between 11:45 and 12:00 l.t. (0945-1000 UTC). They are intended both for the audience on site and for remote participants that can follow the presentation through the Saba Meeting teleconferencing software.

Day		**Speaker**	**Topic**
Monday	1 July	David Schultz (remote)	Scientific Forecasting
Tuesday	2 July	Thomas Hengstebeck (remote)	The Mesocyclone detection algorithm of DWD
Wednesday	3 July	Tomas Pucik	Severe weather predictors
Thursday	4 July	Paul James (remote)	NowcastMIX
Friday	5 July	Hannamari Jaakkola (remote)	Lightning detection and GLD360
Monday	8 July	Marcus Paulat (remote)	COSMO-DE-EPS
Tuesday	9 July	Chuck Doswell	Ingredients-based forecasting for severe conv.
Wednesday	10 July	Pierre Fritzsche	Convective initiation detection
Thursday	11 July	Helge Tuschy	Hodographs and flash flood forecasting
Friday	12 July	Chuck Doswell	A Forecaster’s “Defining Moment”
Monday	15 July	Greg Stumpf	Storm types and warning philosophies
Tuesday	16 July	Ralph Petersen	NearCast
Wednesday	17 July	Oscar van der Velde	Ingredients-based forecasting
Thursday	18 July	José-Antonio García-Moya	Probabilistic Forecasting
Friday	19 July	t.b.d.	t.b.d.
Monday	22 July	Greg Stumpf	NSSL's and NWS's future warning capabilities
Tuesday	23 July	t.b.d.	t.b.d.
Wednesday	24 July	Thomas Hengstebeck	The Mesocyclone detection algorithm of DWD
Thursday	25 July	Christoph Gatzen	Forecasting Convective Windstorms
Friday	26 July	t.b.d.	t.b.d.

Appendix 3: References

Hengstebeck, T., D. Heizenreder, P. Joe, P. Lang, (2011): The Mesocyclone Detection Algorithm of DWD, 6th European Conference on Severe Storms, 3-7 October 2011, Palma de Mallorca, Spain.

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