UEF 2018

ECMWF model outputs: the only limit is your imagination

5–8 June 2018

ECMWF

UEF 2018

ECMWF model outputs: the only limit is your imagination

5–8 June 2018

ECMWF

Contents

Programme

LV = Livestreamed

Tuesday 5 June		
13:15-14:00	***Registration***	**Weather Room**
14:00-14:15	Welcome and housekeeping **LV**	Anna Ghelli (ECMWF)
Session Chair: Anna Ghelli		
14:15-14:45	ECMWF product development **LV**	David Richardson (ECMWF)
14:45-15:15	ECMWF@UEF2018: past, present and future **LV**	Florian Pappenberger (ECMWF)
15:15-15:45	***Coffee break***	**Lobby**
15:45-16:15	Verification news from ECMWF **LV**	Thomas Haiden (ECMWF)
16:15-16:45	On the causes of systematic biases in near-surface weather parameters in the ECMWF forecasting system **LV**	Irina Sandu (ECMWF)
17:00-19:00	***Drinks reception and poster session 1***	

Wednesday 6 June		
Session Chair: Ivan Tsonevsky		
09:30-09:50	Forecasting the 'Beast from the East" and Storm Emma **LV**	Ken Mylne (Met Office)
09:50-10:10	Identification of weather factors affecting the number of refugees and migrants following the central Mediterranean route	Thomas Petroliagkis (Joint Research Center)
10:10-10:30	How well do we use weather forecasts? Current examples of 'impact' forecasting, and ideas for future improvements **LV**	Isla Finney (Lake Street Consulting Ltd)
10:30-11:00	***Coffee break***	**Lobby**
11:00-12:00	Workshop: Simple access to quality weather data via API	Martin Fengler (Meteomatics AG)
12:00-12:20	Using ECMWF data for impact based warnings **LV**	Elín Björk Jónasdóttir (Icelandic Met Office)

12:20-12:40	An ensemble-based storm surge forecasting system for the coast of Norway **LV**	Haldis Berge (Met Norway)
12:40-13:00	ECMWF forecasts for African small-scale farmers **LV**	Fiona van der Burgt (Weather Impact BV)
13:00-14:00	***Lunch break***	
14:00-15:30	**User Voice Corner:** provide your feedback	**Weather Room, Council Chamber, MR1, LCR, Mezzanine**
15:30-16:00	***Coffee break***	**Lobby**
16:00-18:00	***Poster session 2***	
19:00	***Dinner: Côte Brasserie***	

Thursday 7 June		
Session Chair: David Richardson		
09:30-09:50	Imaginative insights or flights of (forecast) fantasy? **LV**	Leonard Smith (LSE CATS)
09:50-10:10	Diagnostics at ECMWF **LV**	Laura Ferranti (ECMWF)
10:10-10:30	Calibration at ECMWF **LV**	Estibaliz Gascon (ECMWF)
10:30-11:00	***Coffee break***	**Lobby**
11:00-11:20	The relative contributions of ECMWF deterministic and ensemble forecasts in an automated consensus forecasting system **LV**	Brett Basarab (Global Weather Corporation)
11:20-11:40	Turbulence resolving weather forecasting: applications and operational aspects **LV**	Remco Verzijlbergh (Whiffle Weather Finecasting Ltd)
11:40-12:00	GLOFAS/EFAS **LV**	Christel Prudhomme (ECMWF)
12:00-12:20	Fire forecast: the skill provided by ECMWF ensemble prediction system **LV**	Francesca Di Giuseppe (ECMWF)
12:20-13:00	**User Voice Corner:** feedback	**Weather Room, Council Chamber, MR1, LCR, Mezzanine**
13:00-14:00	***Lunch break***	
14:00-14:20	Breaking the barriers: eLearning at ECMWF **LV**	Anna Ghelli (ECMWF)

14:20-15:10	Exploring geoscience with AR/VR technologies **LV**	Tim Scheitlin (NCAR)
15:10-15:45	***Coffee break***	**Lobby**
15:45-17:00	**Discover ECMWF:** ecCharts, Data Services, Software, Services	**Weather Room, Lobby**

Friday 8 June		
Session Chair: Estibaliz Gascon		
09:30-09:50	Use of direct radiation forecasts to improve the reliability of solar thermal energy **LV**	Jose L Casado-Rubio (AEMET)
09:50-10:10	Improvement of numerical model forecasts by using Meteodrone measurements in planetary boundary layer **LV**	Martin Fengler (Meteomatics AG)
10:10-10:30	Project Loon and ECMWF **LV**	Rob Carver (Project Loon at X Development)
10:30-11:00	***Coffee break***	**Lobby**
11:00-11:20	The development of new products by forecasters – Example: Probability of Thunder algorithm **LV**	Paavo Korpela (Finnish Meteorological Institute)
11:20-11:40	Visualisation products using COSMO-LEPS: recent upgrades at Arpae-SIMC **LV**	Andrea Montani (Arpae-SIMC)
11:40-12:00	How climate information can be made user relevant and usable: the case of the Sectoral Information System of C3S **LV**	Samuel Almond (ECMWF, Copernicus)
12:00-12:15	Concluding remarks	

Abstracts (in programme order)

ECMWF product development

David Richardson
ECMWF

The presentation will review forecast product development activities at ECMWF over the past year, in response to user requests and feedback. New forecast output fields including lightning activity, vertically integrated water-vapour transport and maximum CAPE will be presented. Enhancements to ecCharts include the addition of extended-range forecasts, with a number of interactive functionalities. Recent work to evaluate the ability to predict severe events in the extended range will be reported. A major new ecCharts feature, the ability to plot vertical profiles of HRES and ENS forecasts, will be introduced. Recent changes to the ECMWF web site will be covered, and the new substantially revised edition of the User Guide to ECMWF Forecast Products will be highlighted.

ECMWF@UEF2018: past, present and future

Florian Pappenberger
ECMWF

ECMWF has made a noticeable step towards fulfilling our Strategy to 2025, with the implementation of Cycle 45r1 in June bringing seamless coupling to a dynamical 3- dimensional ocean and sea-ice model in all ECMWF forecasts. In the past year, coupling processes have progressed in line with the Earth system approach, options for higher resolution ensembles are being investigated, new headline scores are proposed focussing on ensembles and extremes, and Scalability is delivering its share of the efficiency gains required to remain sustainable. Particular highlights include:

1. Very significant progress has been made in the representation of physical processes, leading to a reduction in radiation biases and an improved representation of precipitation near land/water boundaries.
2. Recent changes in the Ensemble of Data Assimilation (EDA), which plays a key role in providing input to 4D-Var, contributed to better scores in Cycle 43r3. Cycle 45r1 is improving analyses notably through a better use of radiosondes, whilst changes addressing the systematic short-wave radiation biases in the storm tracks and over the southern oceans, as well as changes addressing the longstanding precipitation issues along coastlines, improve forecasts.
3. A cost–loss value analysis indicates that the precipitation type (rain and snow) probabilities are useful for decision-making for a broad range of cases.

4. Substantial progress has been made by coupling the complete IFS moist physical parametrizations to the prospective IFS-Finite Volume Model (FVM) dynamical core. The results so far bode well for the future with the new approach giving us enhanced flexibility to be able to take advantage of evolving HPC architectures.
5. New Continuous Data Assimilation is allowing the assimilation of observations up to 30 minutes before cut-off time, as well as the start of the 4D-Var analysis earlier for an identical delivery time. Experimental results for this process to be implemented as part of IFS Cycle 46r1 show consistent improvements, translating into a 2 to 3-hour gain in forecast skill.
6. The new seasonal system, SEAS5, partially supported by Copernicus, was successfully implemented last November, providing significantly improved El Niño forecasts.
7. Diagnostics and developments linked to the Arctic area have been the focus of various activities, in collaboration with Member States in the context of the Year of Polar Prediction.
8. In Copernicus, three chemical modules are now included in CAMS (CB05/BASCOE from KNMI, MOZART from MPI and MOCAGE from Météo-France), ERA-I now figures prominently for the first time on the state of climate presented by WMO at COP23 in Bonn, and the global flood predictions from GloFAS now extend to the seasonal timescales. The highly-anticipated release of the Climate Data Store (CDS) marks the marks the transition of C3S into its operational phase. Other notable Copernicus activities include the release of CAMS reanalysis, GloFAS also becoming fully operational, and the new FIRE project delivering its first forecasts.
9. eLearning modules have been made available, to improve the efficiency of the training provided by the Centre to its Member States.
10. A new user guide to ECMWF forecasts was released on 14 May. This includes improved descriptions of the most popular parameters and will make ECMWF forecasts easier to use. Also on the users' front, a new vision for data services has been developed, based upon the concept of providing Member States and other customers with ECMWF NWP products via an on-site cloud named ecCloud.

Verification news from ECMWF

Thomas Haiden
ECMWF

An update is given on the evolution of HRES and ENS skill as seen in headline and supplementary scores. The increase in skill relative to ERA5 (replacing ERA-Interim as a reference) is shown for various surface parameters. New developments in verification at ECMWF are presented, such as two additional headline scores for 2-m temperature in the medium and extended range, the inclusion of observation error in ensemble verification, and the benefit of high-density observations from ECMWF Member and Cooperating States in precipitation verification.

On the causes of systematic biases in near-surface weather parameters in the ECMWF forecasting system

Irina Sandu
ECMWF

ECMWF has started an internal project entitled 'Understanding uncertainties in surface-atmosphere exchange'. The main objective of this project is to better understand the causes of biases in near-surface weather parameters, such as temperature, humidity and winds, in the Integrated Forecast System in order to come up with suggestions of how they could be reduced. The representation of these parameters is governed by many processes, such as clouds, radiation, turbulent mixing, surface processes or the strength of the land-atmosphere coupling, which makes error attribution difficult. Although the forecasts of weather parameters have improved over the years, along with improvements in large-scale forecast skill, many unanswered questions remain regarding systematic and persistent features of these biases, like for example the underestimation of the diurnal cycle of near-surface temperatures over land. The main findings of this project so far will be summarized in this talk.

Forecasting the 'Beast from the East' and Storm Emma

Ken Mylne , Robert Neal
Met Office

The end of February and first days of March 2018 saw the most severe outbreak of cold winter weather in the UK for several years, as well as over much of western Europe, compounded by Storm Emma which came from the south and generated exceptional blizzards and freezing rain in the south of the country. This series of events presented a major challenge to forecast systems and operational meteorologists alike. The cold outbreak had been well predicted in advance, firstly from long-range predictions of a Sudden Stratospheric Warming increasing the risk of blocking, and then two weeks ahead from the Decider system. Decider clusters ECMWF and other global ensembles according to weather regimes, and identified very high probabilities of cold easterly flows up to two weeks ahead. In fact the real cold air came a few days later than first anticipated but by the end of the week before it was very clear that a major winter outbreak was coming. Forecasting throughout the week exploited a combination of ECMWF and Met Office models, and a few others including NCEP, to provide multi-model ensemble guidance at all time ranges. Key to successful forecasting under such extreme conditions was a strong interaction between Science teams and operational meteorologists to analyse model guidance and provide new diagnostics, resulting in exceptionally good guidance and warnings throughout the week, including an unprecedented simultaneous two Red warnings in different parts of the UK. This talk will focus particularly on the use of ECMWF data in supporting the early forecasting of the event, and the benefits of a multi-model ensemble approach.

Identification of weather factors affecting the number of refugees and migrants following the central Mediterranean route

Thomas Petroliagkis
Joint Research Center

Every summer since 2014 has seen an increase in the number of refugees and migrants fleeing war, violence, persecution, or poverty to cross the Mediterranean Sea to Italy and Malta following the Central Mediterranean Route (CMR), which re-emerged as the world's deadliest maritime migration route in 2015 and again in 2016 and 2017. The CMR is heavily influenced by a variety of interconnected factors, including immigration policies and border control in North Africa and Europe; shifts in the main countries of origin of refugees and migrants; changing social, political, economic, and environmental conditions in countries of origin, transit, and destination; the adaptability of smuggling networks and the prevailing weather and seasonal patterns. Refugees and migrants are increasingly using the CMR again, which has become the main route after the effectively closing of the Greece's northern borders and the Turkey/Greece route in Kos/Lesvos islands as a result of the EU/Turkey agreements (2016). Based on the results so far, it seems highly probable that a certain number of meteorological parameters and weather factors affect significantly the number of monthly arrivals over CMR areas especially during the later years (2013 to 2017). Above all, a seasonal pattern can be seen in the monthly number of arrivals peaking up during the warm months and decreasing during the cold months of the year. On close investigation, a distinct aspect of this pattern relating to air temperature was identified and documented especially during the later years.

In non-extreme mode, although a coherence (correlation) between the number of refugee arrivals and air temperature (T2M) values does not seem to exist during the first years (until 2013), a significant (positive) correlation was found between the monthly mean of daily mean air temperature and monthly number of arrivals while a similar behaviour exists for the maximum and minimum air temperature. Further, a coherence between the number of refugee arrivals and significant wave height (SWH) values does not seem to exist during the first years (until 2013), whereas a significant (negative) correlation has found between the monthly mean of daily mean significant wave height and the monthly number of arrival for the later years. An almost identical (negative) type and strength of coherence was found to exist between arrivals and maximum wave height (HMAX), wind speed (WS) and wind speed gusts (FG6). For sea surface temperature (SST), results showed that in zero lag mode significant (positive) correlation has found between the monthly mean of daily maximum SST and monthly number of arrival for the later years. Correlations become distinctly higher in one-month lag mode for the later years. In addition, for total (large-scale plus convective) precipitation (PRECI), results revealed that a significant (negative) correlation has found between the monthly mean of daily-accumulated PRECI and monthly number of

arrival for the later years. Same wise, for total snowfall (SNOW), results revealed that a considerable (negative) correlation has found between the monthly mean of daily-accumulated SNOW and monthly number of arrival for the later years.

In extreme mode, not clear results of coherence were found for the extreme forecast indices of wind speed at 10 meters (WSI10), wind speed gusts at 10 meters (FGI10) and air temperature at 2 meters (TI2) although all of them (as non-extreme parameters) were found to produce distinctly high (absolute) values of correlation. On the contrary, considerably high (negative) values of coherence were found for both extreme forecast indices of precipitation (TPI) and snowfall (SFI).

This study has focused mainly over monthly data so far, so, even if results are quite promising and strengthening the possibility of tailored weather (factor) anomalies, the forecast horizon of one month is mostly pointing to planning rather than actually operational activities performed by (Italian) Coastguard and FRONTEX. Based on this, we are already planning to focus and investigate over daily arrivals data referring to CMR or even to the other two routes (Eastern & Western). A potential coherence between daily / sub-weekly / weekly / half monthly / arrivals and prevailing weather conditions could be the basis of designing and producing new tailored operational products with various forecast horizons spanning the short (T+0 to T+48 hours), early medium-range (T+72 to T+120 hours), medium-range (T+144 to T+240 hours), late medium-range (T+264 to T+360 hours) besides the monthly one (T+720 hours). Such products should be prepared (designed) in full collaboration with (Italian) Coastguard and FRONTEX while their validation, verification, calibration and optimisation before final implementation should be the next steps to follow.

How well do we use weather forecasts? Current examples of ‘impact’ forecasting, and ideas for future improvements

Isla Finney
Lake Street Consulting Ltd

Having spoken at previous end user meetings about examples of ‘impact’ forecasting in the energy and agricultural sectors, the aim here is to take one step further. Using some current examples of ‘impact’ forecasts, we examine what causes their limitations. And then suggest how these might be overcome.

Simple access to quality weather data via API

Martin Fengler
Meteomatics AG

The availability of quality weather data has improved dramatically over the past decade. At the same time the number of big data analytics businesses delivering sector-specific solutions and business insights has also grown dramatically. However timely access to quality weather data, as cut outs that are suited to specific business requirements,

delivered in formats that users can simply apply to new and existing in-house systems and models has remained a challenge.

Meteomatics is a commercial weather data provider that is working collaboratively with National Met Services (NMSs), Academia and Scientific communities. We bring together historical, nowcast and forecast weather data from global models such as the ECMWF EC model, satellite operations and station data. By applying in-house modelling and downscaling capabilities, Meteomatics is able to deliver weather data for any lat / long and time series to use in 3rd party models via an industrial scale robust Weather API.

Within this workshop the API is introduced and demonstrated.

Weather API data enable insights that are not only relevant to industry but across all sectors, both public and private. By way of example, leveraging simplified access to these weather data makes it possible to better inform traditional catastrophe modelling and to write business for new perils and territories. Increasingly Insurance Linked Securities managers and reinsurers are looking to weather linked products such as catastrophe bonds as potential new avenues to put capital to work.

In the field of agriculture, weather risk management solutions are already protecting the crops of farmers across Africa from drought and innovative start-ups around the globe are applying weather data to a variety of models to meet precision farming challenges.

Energy companies, both in the traditional and renewable sectors, are extensively using these solutions to forecast demand, power output, inform energy trading, protect themselves against unfavourable seasons and safeguard revenues. Meanwhile, wind farm operators seek protection against low or excessively strong wind to secure cash flow and underpin their financing.

Marine insurers are combining vessel tracks and crew behaviours in differing weather conditions to influence their view of risk, and Lloyd's of London are using historical weather data and ship tracks to identify fraudulent marine claims.

Water utilities are enhancing demand and leakage models, better managing system capacity and ensuring regulatory compliance through weather-enabled automation of alarms, catchment modelling and enhanced workforce management.

So, in summary, simple API access to quality weather is extending the understanding of weather risk for a broad range of sectors. The speed of development of new products and services underpinned by quality weather data, indices, benchmarks and parametric triggers is growing rapidly.

Using ECMWF data for impact based warnings

Elín Björk Jónasdóttir
Icelandic Met. Office

During the winter of 2017-2018 several unusual rain events caused flooding in Iceland. The most severe of the flooding events happened in September and were directly linked to an atmospheric river connected to three major hurricanes in the Atlantic basin. Three consecutive rain events caused catastrophic flooding and land slides, causing damages to roads, farm land and live stock as well as major bridges along the national highway. Several other events occurred during the winter during intense thawing periods causing river flooding, ground flooding and in some cases landslides and avalanches. Most of these events were well forecasted, with fairly accurate severity and forecasted impact. At IMO we have several tools at our disposal but the visualisation of ECMWF data such as SOT and EFI for precipitation as well as ENS and determinist runs for mean sea level pressure, precipitation and temperature were key ingredients in successful forecasts.

An Ensemble-Based Storm Surge Forecasting System for the Coast of Norway

Haldis Berge, Øyvind Sætra, Nils Melsom Kristensen, Anne-Mette Olsen, Merete Hogstvedt Øiestad,
MET Norway

The Norwegian Meteorological Institute (MET Norway) has established a regional ensemble storm surge forecasting system with 51 members, based on forcing from ECMWF ensemble prediction system. The system receives observations from 23 sea-level stations along the Norwegian coast. The observational system is operated by the Norwegian Mapping Authority and 10-minute data are transferred to MET Norway in near real-time. The data are used to correct the forecast for slowly varying errors and trends in the model sea-level. The data are also used for model verifications. The model predictions are the basis for the forecasters on duty to issue warnings when certain threshold sea-levels are expected to be exceeded. For this purpose, three alert levels has been identified for each coastal stations: yellow when forecast exceeds 1-year return value, amber for the 5-year return value and red for exceedanse of 20-year return value. The latter case is defines an extreme-event in which case warning are send to national and regional authorities in addition to responsible rescue and emergency agencies. The extreme-event forecasts are also broadcasted on national radio and television. To simplify this decision processes, a graphical support tool has been developed. This combines both the ensemble and deterministic forecasts together with the appropriate threshold levels and other relevant information for each single station.

The aim of the presentation is to give an overview of the whole production chain from observations and ensemble model forecasts to the final methods for the issuing of sea-

level warnings. In addition some examples of the verification scores for the latest winter season (2017-2018) will be presented.

ECMWF forecasts for African small-scale farmers

Fiona van der Burgt, Saskia van Pelt, Stefan Ligtenberg
Weather Impact BV

In drought-prone Sub-Saharan Africa every rain drop counts; around 96% of agriculture is rain-fed. Weather affects almost every aspect of agricultural business, from determining the time of planting and harvests to efficient planning of irrigation.

Weather Impact provides African farmers with local weather forecasts based on output of the ECMWF ensemble model. From the terabytes of model output data a mobile-text message of maximum 160 characters is formulated. Text messaging allows to send localised forecasts through a technology that is widely available in rural Africa. Based on the forecasts, farmers are supported in determining the best time to plant, optimise the usage of fertiliser or protect their crops if hazardous weather is coming up.

We present several case studies from Ethiopia, Kenya and South-Africa. For Ethiopia we validated the performance of the ECMWF model output in collaboration with the National Meteorological Agency. With this work we aim at supporting African farmers to increase food security and strengthen their resilience to climate change.

Imaginative Insights or Flights of (Forecast) Fantasy?

Leonard Smith [1], Erica Thompson [2], Ed Wheatcroft [1], Hailiang Du [3]
(Durham)
[1] LSE CATS/Pembroke Oxford, [2] LSE, [3] Durham

Embracing the possibility that weather prediction will never provide accountable probabilities frees us to do much more insightful things with the models we have today, things much more relevant and more useful for the consumers of weather information. This discussion will be framed in the context of anticipatory disaster risk reduction and the energy sector; it is trivially generalise to a host of other applications in the insurance sector, agricultural sector, satellite launches and elsewhere.

First we illustrate the value (and need) for easing practitioners' ability to explore bespoke forecast evaluation statistics. The aim here is to make it easier to judge the strengths and weaknesses of a forecast for particular targets at a particular (reference class of) locations; this will significantly aid those tasked with deciding whether today's best available forecast system is adequate for their purpose. It is useful to keep in mind the value of getting even the best available forecast off the table when it does not inform decision of the day. Second, letting go of the drive for "fantastic objects" (for example probability forecasts, useable as such) frees physical scientists to reorient resource allocation toward providing more valuable forecast information.

Examples from the Just Enough Decisive Information (JEDI) framework, including the use of sculpted ensembles, illustrate why this approach is attractive to the consumers of forecasts and conceivable given the resources of an evolving Global Weather Enterprise (GWE). Accepting that the probabilities issued will never reflect the true probability of future conditions can significantly increase the value of our forecasts and the speed with which our understanding of the Earth System increases. While physical scientists may imagine things beyond the limits of mathematical possibility, we will soon see more forecast products for the heavens and the earth than are dreamt of in our philosophy.

Diagnostics at ECMWF

Laura Ferranti
ECMWF

We look at the potential of early warning for severe cold conditions using data from ECMWF extended range forecasts and from the Subseasonal to Seasonal (S2S) Prediction research project archive. We explore the use of a 2-dimensional phase space based on the leading Empirical Orthogonal Functions (EOFs) of mid-tropospheric flow computed over the Euro-Atlantic region, to study the time evolution of flow patterns associated with high-impact temperature anomalies. We find that the phase space is an effective tool for monitoring predictions of regime transitions at medium and extended ranges. We show that a number of S2S systems have some skill in the prediction of cold spells over Europe, even beyond the medium range. In particular the ECMWF model represents well the observed preferential transition paths. We reveal that the MJO impact on the predictive skill of large-scale flow over Europe is asymmetric. We discuss the predictability of the recent cold spell occurred at the end of February 2018.

Calibration at ECMWF

Estibaliz Gascon
ECMWF

Uncertainties exist in numerical weather prediction (NWP) ensemble precipitation forecasts due to combination of the imperfect knowledge of the initial atmospheric conditions, the chaotic nature of the atmosphere and because of the incorrect representation of physical processes by NWP models. As ensemble precipitation forecasts from a global forecast model are sometimes under-spread and not always valid at small scales, numerous post-processing techniques have been developed to statistically correct for biases in NWP output. These techniques usually compare a set of past model forecasts with observations in order to identify systematic relationships that can be used to correct the operational forecast. Additionally, computer resource availability is the main cause of the current limitation imposed on the horizontal resolution of ensemble systems, so another option to improve the forecast can be to

increase the number of ensemble members at the expense of reducing their spatial resolution.

As part of ECMWF's contribution to the EU H2020 IMPREX (Improving PRedictions and management of hydrological Extremes) project, several experiments investigating the performance of non-calibrated and calibrated daily precipitation using two different ensemble forecast resolutions have been undertaken. Firstly, a quantile mapping procedure was applied to calibrate both ensemble systems, using 20 years of reforecasts and EFAS (European Flood Awareness System) 5 km gridded precipitation analysis for Europe; supplemental locations were chosen based on the similarity of precipitation climatology and terrain to increase the sample size. Five different ensemble combinations combining subsets of the 50-member operational ECMWF configuration (18 km grid) and an experimental 200-member low-resolution configuration (28 km grid) were tested. Each combination would have similar computational cost to the current operational ensemble.

The verification of the five ensemble combinations (calibrated and raw) was undertaken with daily EFAS precipitation across Europe for June, July and August in 2016 at 1, 3, 5, 7 and 10 days lead time. The CRPS, ROC, reliability, Brier Score, Quantile Score and Relative economic value were evaluated for different 24-hour precipitation thresholds. The verification shows that the most skilful combination is 40 ensemble members from the operational configuration and 40 from the low-resolution configuration. These results suggest that that this set-up combines the advantage of the high resolution forecast system with an improved the representation of the forecast distribution, especially useful for longer lead times. Finally, for all the lead times and combinations, the calibrated forecast increases not only the reliability but also the resolution of the raw forecast.

The Relative Contributions of ECMWF Deterministic and Ensemble Forecasts in an Automated Consensus Forecasting System

Brett Basarab, William Myers, William Gail
Global Weather Corporation

Global Weather Corporation (GWC) post-processes model output from various national and international weather services to generate a consensus forecast that routinely outperforms the competition. GWC employs a forecast technology known as DICast (Dynamic, Integrated foreCast System) initially developed at the National Center for Atmospheric Research (NCAR) and since adapted and improved at GWC. DICast improves upon component model skill by generating a weighted, bias-corrected consensus forecast that is updated daily to align with recent model performance. In this study, we examine the relative performance of the ECMWF HRES deterministic forecast and ECMWF ensemble mean in several GWC forecast products, including 2m temperature and dewpoint, 10m windspeed, and 80-100m turbine hub-height

windspeed (for wind power forecasting applications). The HRES and ensemble mean perform well in GWC's system, determined by the large weighting that both receive across lead times. The ensemble mean is especially valuable at longer lead times when it diverges significantly from the deterministic forecast solution. We hypothesize that the mean, by implicitly taking the consensus of all the ensemble members, is an effective way to add skill to our forecasts. In light of these results, we are encouraged to continue to incorporate ensemble forecasts for applications to both our deterministic and future probabilistic forecast products.

Turbulence resolving weather forecasting : applications and operational aspects

Remco Verzijlbergh, Pim Van Dorp, Harmen Jonker
Whiffle Weather Finecasting Ltd.

Despite advances in computing power, currently operational NWP models are still far away from directly resolving small-scale phenomena like turbulence and small boundary layer clouds. Whiffle Ltd. is a spin-off from Delft University of Technology that is running, to our best knowledge, the first operational large-eddy simulation (LES) based NWP model in the world. One of the main motivations of using LES in the context of operational weather forecasting is that it overcomes some of the difficulties in the parameterization of turbulence and boundary layer clouds.

In addition to an improved representation of the parameterized atmospheric processes named above, a high resolution LES model also has the benefit of capturing phenomena on scales that are important in many economic sectors. For wind energy applications, dispersion of pollutants or small inland water wind forecasts, to name a few application areas, a resolution below 100m brings potential benefits because it allows for directly resolving wind turbines, buildings or (high) vegetation. Facilitated by the emergence of high-resolution datasets of e.g. land-cover, land-use and elevation, new applications of local weather forecasting are arising.

Whiffle has been running its atmospheric LES model coupled to the ECMWF deterministic high resolution forecasts as well as the recently released ERA5 reanalysis. In this talk we discuss a number of practical applications and operational aspects of LES based weather forecasting.

GLOFAS/EFAS

Christel Prudhomme
ECMWF

The European Flood Awareness System (EFAS) and the Global Flood Awareness System (GloFAS) are part of the Early Warning Services of the Copernicus Emergency Management Service, funded by the European commission. They provide operationally trans-boundary probabilistic flood forecasts for up to 30 days ahead, and overviews of

upcoming wet and dry conditions up to 4 months in advance. In Europe, the service is accessible to national authorities, whilst outside Europe, GloFAS forecasts are freely available to all users. This presentation will give an overview of the two services and their products, and examples of possible applications.

Fire forecast: the skill provided by ECMWF ensemble prediction system

Francescca Di Giuseppe
ECMWF

In the framework of the Copernicus program the European Centre for Medium-range Weather Forecast (ECMWF) on behalf of the Join Research Centre (JRC) is calculating daily fire forecast indices using its medium range ensemble prediction system. ECMWF is also developing open-license software for the manipulation and verification of these data which are made publicly available to guarantee the consistent and reproducible work flow across all users and to aid the use of the products and boost confidence on its quality.

The simultaneous availability of fire danger open-data software tools, poses an unprecedented opportunity to create or advance existing national fire management programs for both European and Worldwide stakeholders. Using one year of operational service in 2017 in this talk we assess the capability of the system globally and analyze in some details three major events that took place in 2017 in Chile, Portugal and California. We also present some suggestions on how products could be tailored to provide information in a probabilistic fashion.

A hands-on session will take place during the course to showcase how to handle ECMWF fire data.

Breaking the barriers: eLearning at ECMWF

Anna Ghelli
ECMWF

ECMWF training courses have changed over the years in response to the needs of its Member and Co-operating States. Practical activities, real-world case studies and webinars on demand are some of the features that have been introduced along side the traditional courses.

Collaborations with the wider training community have inspired the latest development at ECMWF, that is the production a set of eLearning modules. The self-contained modules, which can be used as stand-alones or as part of blended courses (eLearning combined with face to face), follow a learner-centred approach to allow for different knowledge levels and learning styles. The modules are created using an instructional design methodology as set out by Mayes & de Freitas (2004), which assumes that

information is processed through two channels (auditory and visual) of limited capacity. In order to minimise overload, the learner filters, selects, organises and integrates the information presented in the resources. These assumptions and learning principles will guide the creation of our eLearning modules

Exploring Geoscience with AR/VR Technologies

Tim Scheitlin, Nihanth Cherukuru, Matthew Rehme
NCAR

This contribution is invited (by Dr. Anna Ghelli). This would be an overview presentation regarding efforts at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, USA, to develop augmented and virtual reality tools for exploring geoscience datasets. Specifically, the talk would focus on two mobile applications, Meteo AR and Meteo VR, that were developed to help make weather, climate, and space science more accessible and engaging to the general public. The talk would be followed by a hands on demonstration where the audience could download the apps and try them on their own mobile devices. Note - the demo would require that the venue have wifi access for the participants.

Examples of the applications can be found here: *http://bit.ly/NcarMeteoApp*

Use of direct radiation forecasts to improve the reliability of solar thermal energy

Jose L. Casado-Rubio, M. A. Revuelta, Cristina Robles, Isabel Martínez-Marco
AEMET

Concentrated Solar Power (CSP) is one of the two main techniques employed to harness the energy from the Sun. It has the distinctive advantage of being able to store energy, using it subsequently when needed (for example, at night). PreFlexMS project (www.preflexms.eu) aims to extend the flexibility of CSP to daytime, storing energy when it is sunny and dispatching it when it is cloudy. Forecasts from two meteorological models, the global IFS and the local area model Arome-Harmonie, have been used as inputs to help the CSP plant to decide the optimal schedule to follow.

Both models have been verified against observations from AEMET Radiation Network to estimate their reliability, within the framework of PreFlexMS project. In this talk results will be shown (see attached figures) for the period studied, from March 2015 to February 2018.

Another related project, done jointly with Red Electrica, the Spanish Transmission System Operator (TSO) will be also explained in this presentation. A combination of ECMWF radiation forecasts and Copernicus Atmosphere Monitoring Service (CAMS) aerosol forecasts has been used to improve solar power predictions for days with high aerosol content. Although aerosols don't affect scores significantly when averaged for

a long period, it will be shown their huge impact in some events, and how our method can reduce the forecasting error.

Improvement of numerical model forecasts by using Meteodrone measurements in planetary boundary layer

Dr. Martin J. Fengler
Meteomatics AG

During the past 2 years Meteomatics drove Meteodrones operationally to collect measure data in the planetary boundary layer up to 1.500 meter height on special places in Switzerland. These data were processed in their own high-resolution numerical model SWISS1k and lead to significantly better predictions compared to the model without drone data - especially in terms of economic-critical events such as thunderstorms, snow and fog situations.

Using this additional data from the lower 1 to 2 km of the planetary boundary layer, it is demonstrably possible to predict more accurately strength and location of meteorological events. The benefit of the forecasts can be seen for the next 24 hours and often up to day ahead. This measurement data also offers a decisive advantage for the calculation of fog and cloud base. And by the way, inversion layers can be identified accurately for measure regions.

The innovation of Meteodrones is groundbreaking. Meteomatics uses a completely new approach and self-developed UAVs (Unmanned Aerial Systems). A Team of young scientists work on perfecting the Meteodrones under special weather conditions like storm and icing conditions. Last year the American Weather Service NOAA has checked the quality of measure data during two project periods.

Using Meteodrones to collect more important data to improve forecast models will be one of the most innovation for next generation of weather forecasts.

Project Loon and ECMWF

Rob Carver, Sameera Ponda
Project Loon at X Development

Project Loon involves operating a network of stratospheric balloons to provide internet to remote areas. Accurate stratospheric wind forecasts from ECMWF are vital for this project. In this talk, we will discuss how Project Loon acquires and processes ECMWF forecasts, and how these forecasts are blended with balloon observations to create the best possible estimate of stratospheric winds for planning. We will also discuss how we use ECMWF reanalyses for planning and interpolations errors we encountered using Climate Data Operators with the ERA5 dataset.

The development of new products by forecasters – Example: Probability of Thunder algorithm

Paavo Korpela
Finnish Meteorological Institute

Often very good ideas grow up from the basic everyday work. While forecasters continuously face varying weather situations and utilize numerous different forecasting tools, sometimes arises need for a certain derived forecasting parameter that doesn't exist. FMI's meteorological workstation (SmartMet) includes programmability that enables forecasters to build up scripts and visualize them on-the-go. Scripts can utilize several data sources including NWP models, radar, conventional surface observations, and also location data regarding weather-related emergency calls, lightning detections and citizen observations. This capability motivates and inspires forecasters to visualize, test and develop new algorithms that help weather monitoring, forecasting and decision-making process. Well-designed algorithms can be implemented into the automatic FMI post-processing routines and even into customer products. One of the recent post-processed algorithms is probability of thunder (POT), which is now demonstrated as an example of using ECMWF model data.

The goal was to create a simple but physically well-reasoned thunderstorm forecasting tool that indicates also probability. The best way to approach the likelihood of thunder is to assess the availability of three necessary ingredients; moisture, instability and lift. This approach is used also in the POT algorithm. Conceptual-wise both instability and moisture are represented by most unstable CAPE integrated between temperatures -10....-40C. This parameter is associated with the electrification of convective clouds. Lift, and especially the sufficiency of it, is difficult to determine from the ECMWF model output. However, model precipitation is a result of activation of convective parametrization schemes, which is a sign of sufficient lifting. Hence, the lifting term was considered to be well enough represented simply by model precipitation. POT algorithm is based on these two parameters, in which probabilistic characteristics are generated with approximated thresholds and dependency functions. Also ensemble forecasts have been tested showing promising results.

Visualisation products using COSMO-LEPS: recent upgrades at Arpae-SIMC

Andrea Montani, Chiara Marsigli, Tiziana Paccagnella
Arpae-SIMC

COSMO-LEPS is the limited-area ensemble prediction system of the COSMO consortium, running on an operational basis since 2002.

The system, implemented and maintained by Arpae-SIMC, runs at ECMWF as a member-state time-critical application and provides operational ensemble forecasts

at 7 km of horizontal resolution over Central and Southern Europe in the short and medium range (up to day 5).

In this contribution, we will show the most recent developments of the system in terms of product generation to assist the activity of Civil Protection Agencies for the generation of alerts. Particular attention will be paid to the visual representation of probabilistic products for wind, precipitation and fog forecasting.

The planned upgrades, including a multi-physics approach for the representation of moist convection and an increase in horizontal resolution to 5 km, will be also presented and their benefits on the probabilistic prediction of surface fields will be quantified over a 2-month verification period as well as for individual case studies.

Finally, the blending of COSMO-LEPS products with those of the recently-developed convection-permitting ensemble system COSMO-I2-EPS will be discussed.

How climate information can be made user relevant and usable: the case of the Sectoral Information System of C3S

Samuel Almond, Carlo Buontempo
ECMWF, Copernicus Climate Change Service

The European Commission has entrusted ECMWF with the implementation of the Copernicus Climate Change Service (C3S). C3S vision is to provide open access, authoritative, quality-assured climate information to support adaptation and mitigation policies and the development of downstream services in response to a changing climate. At the heart of the C3S infrastructure is the Climate Data Store (CDS), which provides access to an array of climate information; providing access to climate reanalysis, observations, seasonal predictions and climate projections through a unified web-interface. The CDS will also provide a comprehensive set of tools (the CDS toolbox) which enables users to develop customised applications and explore C3S data.

The C3S will also provide a working example of how the data and the tools available through the Climate Data Store (CDS) can be used in specific user relevant contexts. The Sectoral Information System (SIS) component of the C3S engages with a diverse set of users to scope out and to develop user driven, sector specific applications.

Poster abstracts (in alphabetical order)

Assessment of selected global models in short range forecasting over West Africa: Case study of Senegal

Sadibou Ba, Papa Ngor Ndiaye, Endalkachew Bekele
ANACIM

Over the past decade, flooding has been increasingly frequent in the Sahel, especially during the rainy seasons of 2005, 2008, 2009, 2010. More recently during the summer season of 2012, devastating flood events have been recorded in Senegal, causing widespread severe damages including the loss of life and property, and the displacement of several people. It became increasingly apparent that the frequency of extreme events is associated with global warming. Severe floods in West Africa are associated mainly with meso-scale thunderstorms and squall lines. Forecasting such severe weather to reduce the risk of hazards is one of the challenges faced by many National Meteorological and Hydrological Services (NMHSs). However, recent progress in numerical weather prediction, the acquisition of new equipments and collaboration with the international community through capacity building and training led to improvement of the quality of the forecasts and to development of early warning systems. This presentation contains inter-comparison studies using selected Global models (ECWMF, GFS, UKMET) and attempts to evaluate the strengths and weaknesses of each model with respect to three rainfall events. Thus, the results of this preliminary work indicate the importance of the use of ensemble forecast system in West Africa. We will focus also the role of the ensemble forecast for the success of the SWFDP-West Africa (Severe Weather Forecasting Demonstration Project).

The different application of the ECMWF Short-Term Forecast model in the management of renewable energies

Lucia Benito Capa, Begoña Luaces Daza
Iberdrola Renovables

The social conscience and the irrefutable fact of the negative effect that has the use of non-renewable energies in climate change make renewable energies the present and the future.

Iberdrola, committed to the protocols to reduce greenhouse gas emissions, focus its day a day on the management of wind, solar and hydraulic energy, in short, renewable energy.

For efficient energy management, Iberdrola bases a large part of its R + D + i on quality weather forecast based largely on the ECMWF short-term forecast models.

A quality weather forecast is essential for:

• Good planning of the maintenance of the different facilities

• A secure interaction in the energy market

• A reliable diagnosis of possible incidents

To facilitate these tasks, Iberdrola presents the available information in a graphic way, making it possible to streamline the work

The forecast value of global flood forecasts in Uganda

Leonore Boelee[1], Hannah Cloke, Paul Samuels, Darren Lumbroso

[1] HR Wallingford & Open University, [2] Reading University

There is an increasing interest in mitigating the effects of fluvial flooding using global forecasts for disaster risk management in developing countries with low data availability. In order for the forecasts to have impact and value they need to be skilful enough for mitigating action to be successfully triggered. However, the application of global forecast products to mitigate the effects severe weather remains limited. To increase the impact of forecasts products in mitigating severe weather in these data scares regions a greater understanding of the influence of model skill and uncertainty on the forecast value is required. Coughlan de Perez et al (2015) have developed a method to link together forecast and appropriate humanitarian action in data scares regions using a pilot project which focusses on two locations in North Eastern Uganda (Magoro and Ngariam), working with the Uganda Red Cross Society using forecast from the Global Flood Awareness System (GloFAS). However, there is a lack of understanding of how uncertainties impact the forecast value for a wider range of flood events, locations, catchments sizes and forecast lead times for detailed area and application, like the Uganda forecasts. Forecast uncertainty is expected to increase with increasing lead time and decreasing catchments size. Therefore, forecast uncertainty and skill will be variable for different lead times and locations within the Ugandan case study region and also wider across the globe. The understanding of these uncertainties can contribute to being able to find the optimal balance where increasing forecast uncertainties have not decreased the forecast value. This poster aims to answer the question: 'How do the model skill and uncertainty affect the forecast value in North Easter Uganda?'.

Efforts for Mitigation Weather Hazard Impacts in Portugal

Sandra Correia, Nuno Moreira
IPMA

Nowadays, there is an increasing need to raise population awareness to weather warnings and therefore to weather impacts. For a particular national meteorological service, this is best achieved through cooperation with regional, national and international institutions.

At the Portuguese Meteorological Institute, information interchange is performed with Civil Protection – ANPC (extreme weather events on land and ocean), Navy (issues on warnings in ocean and coastal areas), National Health Institute – DGS (heat and cold waves) and the National Forest Institute – ICNF (during forest fire critical seasons).

Information is currently disseminated on the IPMA website, radio, social networks and television and can be used to address impacts, such as forest fires, dry seasons, basin management due to flooding, and coastal zones hazards.

There are also requests on information by private companies due to extreme weather events, namely those affecting energy and telecommunications networks.

At IPMA, derived products from ECMWF fields are being produced, such as lightning probability, total accumulated precipitation in basins, soil water content, standardized precipitation index, and other that will be presented.

Some impact statistics will be shown regarding, reports that have been requested to IPMA after storms have affected mainland Portugal, essentially due to impacts of wind, precipitation and lightning, but occasionally other phenomena have been included in the request, such as forest fires and freezing rain.

Portugal is also participating in the WGCEF (Working Group on the Cooperation between European Forecasters of EUMETNET) task team on storm naming in Europe since late 2017.

IPMA has recently finished a 2 year participation in ARISTOTLE – All Risk Integrated System TOwards Trans-boundary hoListic Early-warning project, that provided multi-hazard expert information to support the Emergency Response Coordination Centre (ERCC) of the European Commission.

Portugal cooperates with the Tsunami Early Warning Service Providers in the NEAM regions, which will issue alert messages in case of a tsunami on or nearby Portuguese shores. This new service will considerably increase Europe's capacity to issue tsunami alerts to its citizens, and is in operation since late 2017.

Direct Model Outputs Versus Statistically Postprocessed Outputs to Forecast Low Visibility

Sebastian J. Dietz, Philipp Kneringer, Georg J. Mayr, Achim Zeileis
University of Innsbruck

Low visibility conditions at airports require special procedures that reduce the operational flight capacity. The capacity reductions are defined with the low-visibility procedure (lvp) states which are determined by combinations of visibility and ceiling thresholds. This study compares the performance of direct model output, statistically postprocessed model output, and statistically processed observations for lvp state forecasts at Vienna Airport with lead times from 1 hour up to 15 days.

The models used for statistical processing are boosting trees, which work quiet well for forecasts of the lvp state. For lead times shorter than 6 hours forecasts from statistically processed observations provide highest benefit. With longer lead times models based on NWP output perform better. Therefore postprocessed HRES information has higher benefit for lead times up to 1 day and afterwards models with ENS output perform more accurate. Direct output of the ENS, however, has only a small difference to the performance of the statistical models for lead times between 2 and 5 days. The difference in forecast performance between the best models and climatology vanishes after a lead time of approximately 8 days. NWP outputs contributing most to the skill of the statistical models are dew point depression, boundary layer height, evaporation, and sensible heat flux.

Assessment of statistical post-processing of monthly forecast

Nicole Girardot, Alice Lemant, Arnaud Mounier, David Pelot
Météo-France

A set of 2 years of statistical post-processing of 2m-temperature monthly forecasts over France has been studied. This set correspond to current version of monthly forecast up to 46 days. The goal is to explore the ability of this system to forecast temperature anomalies. With basic scores (detection rate, false alarms), different aspects are tested : impact of space or time averaging, impact of using quantiles rather than ensemble mean, significance of large forecast anomalies. The results show some systematic defaults of the forecasts but also what are the best capacities of the system. This study gives also the opportunity to list occasional bad medium-range forecasts.

Forecast Error Analysis of a Persistent Heavy Rainfall Event

Yue Guan
CMA

Errors occur for persistent heavy rainfall over Yangtze river in China from 22 to 27 June 2017 by ECMWF ensemble model. By using conventional data, ECMWF ensemble model and NCEP ensemble forecast data, forecasts of cumulative rainfall and cause of the forecast error is analyzed. The results reveal that (1) The location of the rain belt by NCEP ensemble model forecast is closer to the observed rain belt than ECMWF. However, after 25 June EC model adjust the location of precipitation southward, thus closer to the observed precipitation. (2) Compare wind at 850hPa with NCEP model, the wind shear resulting in heavy rainfall from ECMWF model is obviously located more north than the observed wind and NCEP forecast. (3) The north edge of the Western Subtropical High from EC's ensemble mean at 500hPa is also predicted more north than NCEP, but the error is slighter compared with low level wind. Thus, the forecaster at 8:00 BT 22 JUNE could take advantage of the middle-level and high-level circulation to adjust the location of precipitation.

Applying new 3-D jet core visualisation techniques to the study of extreme cyclones

Tim Hewson[1], Michael Kern[2], Marc Rautenhaus[2]
[1] ECMWF, [2] TUM

Wide-ranging scientific advances are making real-time use of 3D visualisation in meteorology increasingly attractive. Improved computer technology, mainly derived from the gaming industry, and encapsulated in modern-day graphics cards, now allows for transparency, fly through, re-orientation and animation of complex 3D model atmosphere scenes in real time. Meanwhile one can adapt relatively recent mathematical techniques to represent the salient atmospheric features (e.g. cyclones, jet cores, trough lines, fronts) as points, strings or surfaces in 3D space. These algorithms compress large volumes of synoptically relevant gridded data into a very compact yet meaningful form, and likewise dramatically reduce obscuration of other aspects of interest. Together these advances can allow researchers (and indeed forecasters) to quickly establish a clear 3D picture of the key features of the model atmosphere, and their evolution in time. For some aspects one can even visualise the 4D behaviour of multiple ensemble members. ECMWF is beginning to integrate these approaches into its investigations of forecast performance.

This poster illustrates how the above developments are brought together in the open-source, interactive 3D meteorological visualisation tool "Met.3D" (http://met3d.readthedocs.org), showing in particular how a new algorithm for identifying jet cores in 3D as "strings" performs in this environment. The jet core algorithm extends and

adapts 2D jet core mathematics to 3D. It derives from a momentum-based definition of a jet core line; the algorithm is described.

A case of an extreme extra-tropical cyclones (Xavier, 5 October 2017) is used to illustrate applications, and the benefits of 3D versus 2D visualisation. This shows in a clearer way than hitherto the dynamical links between extreme cyclogenesis events and "vertically stacked" jet cores. The plots can also provide helpful pointers to the mechanisms of downward momentum transfer in sting jet regions. There is also an illustration of how jet stream core 'bundles' can be derived from the 51-member ECMWF ensemble and portrayed in a meaningful way.

Performance of forecast deep convection objects as inferred from ECMWF simulated infrared radiances

K. K. Hon, Wai Kin Wong
Hong Kong Observatory

Deep convection, with its associated hazards of lightning, convective turbulence and possibly hail, is one of the aviation-impact weather phenomena for which SIGMET warnings are issued operationally. Due to a lack of radar observations over vast ocean areas, a commonly-accepted means of identifying regions of significant convection on a regional/global scale would be through combination of sensitive frequency channels of infrared sounders on board geostationary satellites.

This study verifies the forecast deep convection "objects" as inferred from IR1 and IR3 channels of the ECMWF-IFS simulated radiance output against corresponding observations from the Advanced Himawari Imager (AHI) of the Himawari-8 satellite over the East Asia and western North Pacific regions.

Hydrometeorological drivers of 2017 Flood in Bangladesh and associated forecasting skill

Sazzad Hossain, Elisabeth Stephens, Hannah Cloke
University of Reading

Flood is the most common natural disaster in Bangladesh which occurs almost every year and causes huge economic losses. There are several reasons that cause flood-geographical location, topography, monsoon climate etc. Transboundary flow is the major source of flood water. The characteristics of monsoon river flood of 2017 is a representative severe flood in terms of duration and magnitude. Several parts of the country experienced flooding for different duration. The Brahmaputra river basin (northwest region) experienced flood in two times- July and August and the Meghna basin (northeast region) experienced flash flood in early April in 2017. Several rivers of the country exceeded their previous historical flood level.

The study identified several meteorological and hydrological characteristics which were responsible for severity of flood. The excess rainfall in pre-monsoon (April-May) provided additional soil moisture, monsoon onset at the beginning of June and two extreme rainfall events northwest region of Bangladesh as well as adjacent catchments to the international border are some major meteorological drivers. The unusual flood water rise was recorded in the rivers of Brahmaputra basin and rivers were reached to their danger level within short period of time. The abnormal rise of water in the Brahmaputra is a new dimension of flood in Bangladesh. Bangladesh has adopted both structural and nonstructural measures for flood management. Flood forecasting is considered as a major non-structural flood management approach. Flood Forecasting and Warning Centre (FFWC) in Bangladesh is responsible for flood warning services, and it provides 3 to 5 days deterministic forecast. Extended range forecast provided by GLOFAS is also available for the major river basins in Bangladesh and FFWC took the advantage of this forecast in flood warning dissemination. Forecast skill has been assessed by mean absolute error (MAE) and coefficient. The present research findings show that extended range forecast provided by GLOFAS was very consistent. Deterministic forecast shows very good correlation with the observed data. However, performance of the deterministic forecast depends on the correct boundary estimation of the model. The objectives of the present study are to investigate different hydrometeorological drivers which causes flood, and its forecasting skill.

Visualizing ECMWF data for forecasters at IMO

Elín Björk Jónasdóttir
Icelandic Meteorological Office

At the Icelandic Met Office, the ECMWF model is one of two main models used for forecasting, and the main model for long range forecasts. To help forecasters scan different types of data in a short amount of time we have created composites of data, for several different types of forecasts. This data also serves as a backup to the main visualising system. In addition to visualising the deterministic maps we also use ensamble data for high impact forecasting, and as such the EFI And SOT maps for precipitation have proven to be extremely useful for flood forecasting.

Ensemble subsetting for dynamical downscaling of global seasonal climate predictions: Evaluation for selected semi-arid regions

Patrick Laux
Karlsruhe Institute of Technology (KIT) Institute of Meteorology and Climate Research

Until 2025 approximately 1.8 billion people are expected to suffer from absolute water scarcity. It is known that an improved water management, with certainly the highest potential in semi-arid regions, can help to mitigate water scarcity. Seasonal

climate forecasts may provide crucial information for water management, but globally available products suffer from a too coarse resolution to support decision making on local scales. Since initial condition are not perfectly known, perturbed simulations are conducted to derive uncertainties, resulting in forecasts consisting of relatively large ensembles. Dynamical downscaling provides a suitable approach to bridge the scale gap from global to local, and is preferential over statistical approaches if subsequent impact models are being applied. The reason is that dynamical downscaling is providing physically consistent hydrometeorological input variables. On the other hand, it requires large computational resources, which may permit the evaluation of the full downscaled forecast ensemble.

Embedded in the Seasonal Water Resources Management (SaWaM) project, this study evaluates whether or not single members from the seasonal ensemble forecast can be omitted. Based on the assumption, that a poor performance in the global forecasts leads to a poor performance in the downscaled forecasts, an ensemble subsetting approach is applied and evaluated for semi-arid regions in Brazil, Iran, and West Africa. For this reason, the hindcasts of ECMWF system 4 and 5 data and the interpolated precipitation observation products GPCC and CRU are used and analyzed for the wet season of period 2001 to 2010. The procedure and results of the subsetting approach will be presented and discussed in the context of decision support in water management.

Use of ECMWF IFS forecast for the provision of flight specific turbulence forecast

Jeffrey Chi Wai Lee, Yiu Fai Lee, Mang Hin Kok, Yan Chun Chan, Boon Leung Choy, Ping Wah Li, Wai Kin Wong
Hong Kong Observatory

High impact weather including turbulence, significant convection and high altitude Ice Crystal (HAIC) may bring hazards to aircraft operations in en-route phase as ascend and descending phases. Under the modernization of the International Civil Aviation Organization (ICAO) global aviation navigation plan (GANP), airlines and air traffic management requires more flight specific information in preparing better flight plans, tactical/pre-tactical flight operations as well as better air space, airport flight management. This paper presents the trial use of ECMWF IFS data to provide flight specific forecast turbulence products based on the flight route specified in the flight plans of the commercial flights. The performance of the forecast product is verified against the in-situ measurement recorded by the quick access recorder (QAR) on board the commercial aircraft. More than 170 selected flight datasets are used in the study for tuning the forecast product as well as for the verification. The calibrated turbulence indices might contribute to the development of next generation of the global turbulence guidance product. The methodology and preliminary results will be presented in the paper.

Evaluating the Forecast Accuracy of Regional Numerical Models on Severe Weather in South China

Jingfu Lin, Qingfeng Zeng, Yang Tang, Lei Xu
Shenzhen Bixuange Technology CO, Ltd

As the 13th typhoon to hit China in August 2017, Hato has made landfall in southern China's Guangdong province, and caused significant damage along its path. To evaluate the forecast performance and provide more precise and localized weather forecast in future, we conduct experiments in the TRAMS (Tropical Region Atmospheric Model System for South China Sea), and make a comparison on the present numerical precipitation models including GRAPES, ECMWF and T639. The comparison results indicate that the EC's initial fields have a significate influence on typhoon track forecast. In addition, it is necessary to utilize data assimilation to refine the typhoon model, and further improve weather forecast accuracy in the south China.

Ensemble-based predictability and diagnostics of tropical cyclone outflow and structure change during the 2017 Atlantic hurricane season

Sharanya Majumdar
University of Miami

A focus of the United States Office of Naval Research (ONR) Tropical Cyclone Intensity (TCI) initiative is to better understand the role of outflow in tropical cyclone (TC) structure and intensity change. An objective of this study is to use ECMWF ensemble data to diagnose the establishment of outflow channels for 2017 Hurricanes Harvey, Irma, Jose and Maria, via interactions with the large-scale environment. The influence of these interactions on TC structure change will be quantified, together with their predictability. Conclusions from an earlier study on Hurricane Joaquin (2015) suggested that the predictability of the TC motion and intensification was largely dependent on the initial vortex structure, and that the interaction with an upstream trough was responsible for enhancing outflow in the north-western quadrant and intensifying the hurricane. It remains to be determined whether the outflow plays an active (causal) role in TC intensification, and whether the conclusions can be generalized. The 2017 hurricanes offer an opportunity to explore these questions in more breadth and depth.

Evaluation of IFS and AROME day-ahead and very short term GHI, DNI and DIF forecasting skill

Marie Cassas, Raphaël Legrand, Ludovic Bouilloud, Sophie Martinoni Lapierre
Météo-France

In the current context of energy transition, the amount of power produced by photovoltaic farms is rapidly increasing and raises the question of the integration in the grid. The electricity production and consumption need to be fairly equal at any time. However, unlike other energy sources, PV production depends substantially on meteorological conditions (irradiance and temperature) which means that PV farms generate only intermittent energy. To reconcile these two constraints it is becoming essential to precisely forecast the PV power production in order to anticipate its variations and better monitor the grid.

The energy division at Météo-France is developing, in connection with the French National Meteorological Research Center (CNRM), a PV power production forecast product that uses mainly numerical weather prediction model outputs. For this purpose it is a major stake to evaluate the errors in the models and especially in the solar irradiance forecasts.

The quality of the day ahead and very short term (<6h range) global, direct and diffuse irradiances from IFS and AROME (the high-resolution model from Météo-France) have been evaluated. Scores have been computed over France using two years of data from Météo-France's ground stations network. Discrimination of cloudy and clear sky simulation is applied. The clear sky situations have been filtered to quantify the impact of the errors of the cloud forecasts on irradiance forecasts and to study the behaviour of the radiation scheme without interactions with clouds.

This study shows for instance the large influence of cloud positioning errors on the quality of the irradiance forecasts and a bias in the distribution between the direct and diffuse components in clear sky conditions (underestimation of the direct component).

Application of ECMWF products in winter weather situations at OMSZ

Andras Mesterhazy
OMSZ

To forecast weather situations in winter - especially concerning the precipitation type around 0°C - is one of the most difficult tasks in meteorology. This is the case in the Carpathian Basin, and in Hungary as well. There is a very big difference in the expected weather character and impact depending on snow, sleet or rain. In the Hungarian Meteorological Service (OMSZ), a number of products based mainly on the ECMWF model have been developed and introduced to operational work in the recent years, hence these weather situations can be better identified by public and our customers as well. These new developments will primarily help to predict the precipitation type, and to specify the areas affected by snowdrift with higher precision.

How the uncertainty of a forecast or warning could be communicated

Thomas Schumann
Deutscher Wetterdienst

Uncertainty of warnings and forecasts and how to communicate that.

Early heat warnings for European workers

Christoph Spirig, Pascal Notti, Ana Casanueva, Jan Rajczak, Alessandro Messeri, Marco Morabito, Sven Kotlarski, Mark Liniger
MeteoSwiss, Analysis and Forecasting

The European HEAT-SHIELD project aims at increasing the thermal resilience of European workers in the context of global warming. As part of technical solutions to counter the heat-induced risk to workers' health and productivity we aim at providing robust meteorological heat predictions on different temporal scales and tailor the forecasts to specific needs of key European industries. We here present a prototype system of a European early-warning system for heat stress episodes several weeks ahead based on the IFS extended range forecasts of ECMWF. The wet bulb globe temperature (WBGT) is applied as primary heat stress indicator. Ensemble forecasts of WBGT are used to derive daily probabilities of WBGT exceeding certain thresholds. The choice of appropriate thresholds allow to produce tailored heat risk predictions for different working sectors in consideration of different work intensities. Based on forecasts of the past 20 years, we analyze the performance of the predictions against an extensive European-wide observation data set. The results demonstrate that appropriate post-processing of forecast model output is essential for achieving

skillful heat event predictions beyond 10 days lead time. Best forecast performance is found around the Baltic Sea and in Eastern Europe where skill (referenced against climatological forecasts) extends to lead times of about 20 days.

Impact of ECMWF products in Energy forecasting

Andrei Steau
NEAS Energy

Compared forecast between HRES and global model Maps indicating the real production and the impact of the maps need to know and need to do.

ECMWF products at MET Norway

Vibeke Thyness
Norwegian Meteorological Institute

The poster gives a brief overview of the main uses of ECMWF products at MET Norway.

AutoAutomatic gale warning proposals for Swiss lakes and airports

Sarah Schöpfer, Lysiane Mayoraz, Roland Egger, Christophe Voisard
Federal Office of Meteorology and Climatology MeteoSwiss

The Swiss national meteorological service has the duty to issue warnings for wind gusts exceeding 25 knots 30 minutes to 3 hours before such event occurs at regional airports and relevant lakes. In order to support the forecasters duty an automatic system combining model output and continuous measurements of atmospheric data has been set up. The system is composed of a set of algorithms developed with passed data, combined with logistic regression. Overall the algorithms obtain significantly higher hit rate than model output or forecaster. However the large proportion of false alarms remains an unsolved issue. In daily operations the automatic system issues proposals which the forecaster on duty can accept or reject. This procedure combines the high hit rate of the algorithms with the expertise of the forecaster. This strategy helps improve the warning system.

Use of ECMWF Model Data in support of Seamless Forecast of High Impact Weather at the Hong Kong Observatory

Wai Kin Wong
Hong Kong Observatory

The Hong Kong Observatory (HKO) makes use of ECMWF model data to support its weather forecasting and warning service. With advances in data assimilation, model dynamics, physical processes and ensemble forecasting, the ECMWF deterministic model and ensemble prediction system (EPS) demonstrate increasing level of skills in short-range to medium-range forecasts of high impact weather such as that of tropical cyclone (TC). This presentation will outline the applications of ECMWF data, post-processing techniques of deterministic and EPS products, and verification of TC track and intensity forecasts.

In recent years, new forecast products such as the Extreme Forecast Index (EFI) and the Shift-of-Tail (SoT) are found to provide useful reference about the chance of extreme cold and hot days, or extreme rain episodes. In supporting forecast assessment of significant convective weather, post-processing techniques are developed for EPS data to generate thunderstorm potential (PoTS) and convective diagnostics using ingredient-based approach, which enable forecasters to better assess the possible scenarios and chance of severe convection.

Recently, HKO has launched a new experimental extended outlook to provide probabilistic forecasts of the daily minimum and maximum temperatures out to the next 14 days and the TC track probability for the next 9 days, paving way for the development of probabilistic and high-impact weather services in the forthcoming years.

New research development on ECMWF model products will also be discussed. For instance, the use of clustering technique to select EPS members with better similarity to the actual rainfall is found to give a more skillful quantitative precipitation forecast in short-range and possibly useful for blending with radar or satellite nowcast products. Application of new verification methodology to understand model forecast performance of TC wind structure will be illustrated as well.

ECMWF IFS Bias Analysis on Vortex Shear Line Rainstorm in Southern China in 2016-2017

Jun Xu, Kan Dai, Yun Chen
National Meteorological Center of China

Vortex shear line rainstorm in southern china, as the most important precipitation system in CMA forecast operation, often leads to thousands of sufferers and huge economic loss. Since ECMWF IFS resolution was updated to 9km in 2016, bias

statistics revealed that most forecast rain bands above 50mm per day laid north to the observation by tens of kilometers even in 36h forecast time, which troubled forecaster. Analysis was conducted on aspects of mesoscale convective system initiation, maintenance and propagation. Results showed that temperature and moisture deficiency in low level troposphere gave rise to the low level CAPE deficiency. Hence either stronger wind convergence or longer way of lifting was needed to trigger convection. Then precipitation initiation location was behind the observation and started later. Low level CAPE deficiency could also make mesoscale convective precipitation in the warm sector ahead of the front missed. This problem often occurred in southwest part of China in the outset of rainstorms, which could be seemed as the source of the bias. Convection was weaker in the model on account of CAPE deficiency and convection parameterization that could not remove excessive CAPE and moisture. Then excessive grid-scale precipitation leading to mesoscale cyclogenesis and stronger vortex formed. In forecast, mesoscale convective system structure was not clear on account of weak cold pool and downdraft, which also made the precipitation system move slowly. Finally, forecast rain bands fell behind. In conclusion, convection strength and location estimation is important in operation meanwhile simulated infrared radiation product is efficient. More ECMWF products showing convections such as simulated radar echo are necessary.

Speakers' biographies (in alphabetical order)

SAMUEL ALMOND • ECMWF/Copernicus

Samuel is working at ECMWF, the entrusted entity implementing the Copernicus Climate Change Service (C3S) on behalf of the EC. In the role of 'Sectoral Information System Officer' he manages a diverse set of contracts which aim to showcase how the C3S's Climate Data Store (CDS) and associated infrastructure can be be used to deliver user-driven climate information for specific sectors.

.

BRETT BASARAB • Global Weather Corporation

Brett studied physics at Middlebury College in Vermont before earning his Master's degree in atmospheric science from Colorado State University in Fort Collins, CO. For his Master's work, Brett focused on improved methods to predict lightning frequency in thunderstorms. He then moved on to his current role as a meteorologist at Global Weather Corporation in Boulder, CO. Brett's passions and interests in the field include mesoscale meteorology, numerical weather prediction, and NWP model blending and post-processing. Outside of meteorology, he is an avid piano player and enjoys hiking, skiing, and exploring the mountains of Colorado.

HALDIS BERGE • Met Norway

Haldis has a Master degree in Meteorology from the University in Oslo. She works as a forecaster in Bergen, Norway, at the Norwegian Meteorological Institute. She does general and marine forecasting. She has been a forecaster in Bergen since autumn 2010.

ROB CARVER • Project Loon at X Development

Rob Carver is a meteorologist for Project Loon. For Project Loon, Rob keeps track of the latest meteorology research and is the meteorology expert for the project. Prior to joining Project Loon, Rob worked with the Google team responsible for weather-related searches. Rob's first professional job was R&D scientist at Weather Underground, where he became an expert in explaining meteorology to programmers. Rob has a PhD from Penn State, a MS from University of Oklahoma, and a bachelor's degree from New Mexico Tech.

JOSE-LUIS CASADO • AEMET

Jose-Luis Casado, MSc in Physics, joined the Spanish Meteorological Service (AEMET) in 2005. He had been employed previously as an IT consultant for the private sector for five years. In AEMET he worked first as an operational forecaster in the Canary Islands. He took a temporary leave of absence between 2009 and 2011 to accept a position as a Graduate Trainee in the Operations Department at ECMWF. After returning to Spain he joined the NWP Applications Group in AEMET as a researcher. He is currently working in projects which aim to give better wind and solar radiation forecasts to the renewable energy industry.

FRANCESCCA DI GIUSEPPE • ECMWF

Francesca leads the development of the Fire Forecasting system at ECMWF. The system provides operational predictions to the European Forest Fire Information System (EFFIS) under the umbrella of the European Copernicus Emergency Management Services. EFFIS is also being expanded into the Global Wildfire Information System to create an integrated system that provides access to all fire related available information on a global scale. Since joining ECMWF in 2011, Francesca has worked extensively on seasonal and sub-seasonal forecasting for sectoral application related to drought, fire and health, with a focus over Europe and Africa.

DR. MARTIN J. FENGLER • Meteomatics AG

Martin studied at TU Kaiserslautern (Germany) where he received his PhD in applied mathematics. After his studies he developed several numerical weather prediction codes for Meteomedia AG (now MeteoGroup Switzerland) where he became responsible for the technology & innovation department. In spring 2012 he decided to found Meteomatics in St. Gallen. Meteomatics focuses on weather solutions for industry. One of its USPs is the Meteodrone technology to enhance weather forecasts for fog, low stratus & storms.

LAURA FERRANTI • ECMWF

Laura Ferranti is a principal scientist in the ECMWF Forecast Department. She studied physics in Bologna and holds a PhD in meteorology from the University of Reading. For over a decade Laura worked in research on predictability of seasonal variations. Later she moved to work on the operational aspects of the ensemble forecasts, applying her expertise on predictability to introduce new products and diagnostic tools to the ensemble forecasting system. She has many years of experience working on diagnostic studies looking at the medium to seasonal forecast ranges. Laura is currently a member of the Working Group on Subseasonal to Interdecadal Prediction (WGSIP) and member of the joint CBS/CCl Expert Team on Operational Predictions from Sub-seasonal to Longer-time Scales (ET-OPSLS).

DR ISLA FINNEY • Lake Street Consulting Ltd

Dr Isla Finney is an operational weather forecaster and the founder of Lake Street Consulting Ltd, which aims to help more organisations use weather data to improve their business. A brief stint as an academic, looking into the sources of error in numerical weather forecasts which limit their accuracy, gave her a strong knowledge base with which to transition to the commercial sector in 2001. Her past employers vary from a consultancy company, an investment bank and a hedge fund.

ESTIBALIZ GASCON • ECMWF

Estibaliz Gascon has been working as a Scientist in the "Forecast Performance and Products" section at ECMWF since 2016. She is involved in two European H2020 projects: ANYWHERE and IMPREX. As such her primary role is creating new products for high-impact weather, related to heavy precipitation, precipitation type, convection or droughts. She is also an analyst as part of the "Forecast Daily Report" group, whose main task is to summarise the important aspects of the real-time analyses and forecasts of ECMWF's operational models.

Previously Estibaliz was a Scientist at the University of Leon (Spain), where she carried out various researches and experimental campaigns in the framework of projects related to convective precipitation in winter and summer periods with tasks that cover both roles, researcher and forecaster. Collaborations in other research institutes such as the Cyprus Meteorological Service, Research Center of Environmental Changes (Taiwan) and Institute of the National Research Council of Italy (CNR) were developed during her PhD and Post-doc in Spain.

ANNA GHELLI • ECMWF

Anna Ghelli works at ECMWF as international Liaison officer. Her background is in meteorology: she obtained a PhD from the Eidgenössische Technische Hochschule (ETH), Zuerich (CH) in Data Assimilation. She manages training activities for ECMWF and for the Copernicus Climate Change Service (C3S), as well as relations with ECMWF Member and Co-operating States. She is the contact point for the ECMWF training activities in support of the World Meteorological Organisation projects aimed at capacity building in developing countries to strengthen the skills of the National Meteorological and Hydrological Services.

THOMAS HAIDEN • ECMWF

Thomas joined ECMWF in 2010. He is leading the Team on Verification and Observation Monitoring in ECMWF's Evaluation Section. During previous affiliations with Austrian (ZAMG) and US (NOAA) forecasting centres he specialised in boundary-layer meteorology, mountain meteorology, and nowcasting. His current work at ECMWF focuses on forecast verification with emphasis on clouds, precipitation, and the atmospheric boundary-layer. He is a member of the WMO WWRP Joint Working Group on Forecast Verification Research.

ELÍN BJÖRK JÓNASDÓTTIR • Icelandic Meteorological Office

Elín Björk Jónasdóttir is the Group leader for weather services at Icelandic Meteorological Office.

She has considerable forecasting experience in land, aviation and marine forecasting. She has worked several severe weather events in Iceland for the past 8 years, both as a weather forecaster and as a warning coordinator. These events range from bombing lows to volcanic eruptions and the forecasting of volcanic ash- and gas distribution.

Her main projects involve case studies, analyses and further development of new tools for forecasting purposes, training of new personnel as well as communication of weather related hazards to Civil Protection Authorities and the public.

Elín earned a B.Sc. in Meteorology from the University of Oklahoma, and a M.Sc. from the University of Oslo. She has worked in different departments at IMO since her student days and as a full-time forecaster since May 2010.

PAAVO KORPELA • Finnish Meteorological Institute

Paavo Korpela is a forecaster at FMI's weather and warning center with almost 15 years of experience in operational weather forecasting from the warning perspective. Currently working half time in operational and half time developmental duties. In the latter the focus is to support operational meteorology by advancing post-processing and nowcasting.

ANDREA MONTANI • Arpae-SIMC

Andrea Montani works at the Meteorological Service of the Emilia-Romagna Region, Arpae-SIMC (Bologna, Italy), in the Numerical Modelling area.

His main duties include the following:
– to manage and develop COSMO, the numerical weather prediction model, used to provide operational weather forecasts by Arpae-SIMC;
– to maintain and develop the limited-area ensemble prediction system COSMO-LEPS and related procedures, on behalf of the full

COSMO consortium, so as to generate probabilistic forecast products in meteorological operational rooms;
– to develop new forecast products for medium-range weather predictions.

Andrea joined Arpae-SIMC in 2001, after completing an MSc and a PhD at the Department of Meteorology at the University of Reading.

KEN MYLNE • Met Office

Ken Mylne is Head of Verification, Impacts and Post-Processing at the Met Office and is currently leading a major project to replace existing post-processing systems with a new unified, probabilistic system blending output from different NWP models and ensembles, including ranging from ECMWF global systems to Met Office convective-scale model and ensemble. Before this Ken has been an operational forecaster and then led the development of ensemble forecasting at the Met Office for 15 years.

FLORIAN PAPPENBERGER • ECMWF

Florian Pappenberger is Director of Forecasts at the European Centre For Medium-Range Weather Forecasts. The Forecast Department at ECMWF has a strong user focus and undertakes production of forecasts, forecast evaluation and diagnostics, development of forecast products and applications, software development, catalogue and data services and outreach and training. Florian has a scientific background in the forecasting of weather driven natural hazards including floods, droughts, windstorms, forest fires and impacts on human health. He has over 10 years of expertise in operational probabilistic forecasting, extreme value statistics and numerical model system development at ECMWF. He was responsible for the development and implementation of the operational centre of the Copernicus Emergency Service - Early Warning Systems (floods). Florian is the author of over 150 publications, has won several scientific awards and is visiting Professor at the University of Bristol. He is an elected fellow of the Royal Geographical Society and the Royal Meteorological Society and a member of several other professional bodies including HEPEX, British Hydrological Society, EGU, AGU, EMS, AMS. He is on the editorial board of several international scientific journal and regularly advises on international committees including WMO

THOMAS I. PETROLIAGKIS • Joint Research Center

Thomas I. Petroliagkis is a senior weather forecaster having worked several years on the development and operational implementation of various NWP systems and mesoscale modelling platforms for supporting both wind and solar energy applications.

In the past, he also participated in the core development group of the ECMWF EPS (Ensemble Prediction System) focusing on extreme weather events.

As Chief Technical Advisor he completed successfully all the phases of installation and operational implementation of the UAE / AFWM (United Arab Emirates / Air Force Weather Model). He has also worked for a couple of years as a consultant in solar energy and wind power operational forecasting applications.

Before joining the European Crisis Management Laboratory at the Disaster Risk Management Unit of the Space Security & Migration (SSM) Directorate, he had worked on the validation of both deterministic and probabilistic fire weather products for the EFFIS (European Forest Fire Information System) of the IES / JRC (Institute of Environment & Sustainability / Joint Research Center) of the European Commission.

CHRISTEL PRUDHOMME • ECMWF

Christel Prudhomme is a hydrologist with over 20 years' experience working on hydrological extremes and a visiting Professor (Loughborough University) specialised in Hydro-climatology. She joined ECMWF in April 2017, where she leads the Environment Forecasts team, responsible for the development and operational maintenance and running of the Computation centre of the Copernicus Emergency System - Early Warning System on floods. Prior to that, she was principal scientists at the Centre for Ecology and Hydrology, a public research institute in the UK, leading a small team dedicated to study, understand and model the development in time and space of water deficits across spatial scales (from local to global), to assess their associated uncertainty and to quantifying the impact of climate variability and change on the hydrological processes and how in turn this impacts on the environment.

DAVID RICHARDSON • ECMWF

David Richardson is Head of Evaluation ECMWF. The Evaluation Section is responsible for assessing the performance of the ECMWF forecasting system and providing feedback to users and model developers. It also manages the meteorological and hydrological content of forecast products and applications, developing these to meet user needs.

David has over 25 years' experience in weather forecasting research and operations. He has worked on all aspects of ensemble prediction methods for weather forecasts for weeks to seasons ahead. This includes the configuration of ensembles to represent the uncertainties in the initial conditions and modelling systems, development of products and tools for forecast users, and evaluation of forecast performance. He has published numerous scientific papers as well as book chapters on these topics.

David is chair of the World Meteorological Organisation (WMO) Expert Team on Operational Weather Forecasting Process and Support.

IRINA SANDU • ECMWF

Irina Sandu is the Team Leader of Physical Processes Team in the Research Department of ECMWF. Before joining ECMWF in 2010, Irina got a Phd from Universite Paul Sabatier, Toulouse (2007), and spent a couple of years as an Alexander von Humbolt post doctoral fellow at the Max Planck Institute for Meteorology in Hamburg. At the time, the bulk of her research revolved around boundary layer clouds, their interaction with aerosols and the large scale conditions controlling their evolution. At ECMWF, Irina's work aims at improving the representation of both stable and cloudy boundary layers and understanding the impact of surface drag on the large scale circulation.

TIM SCHEITLIN • NCAR

Tim Scheitlin has worked as a software engineer with the National Center for Atmospheric Research (NCAR) for over 25 years, with a focus on scientific visualization and creating animations of high resolution, multi-dimensional, geoscience data. He manages the Visualization Lab (VisLab) program, which develops and disseminates innovative visualizations of NCAR science, maintains a venue for outreach and education to diverse audiences, and explores multiple technologies for distributed collaborative science. Working closely with NCAR scientists, he creates striking computer visualizations of severe weather, climate change, wildfires, ocean temperatures, and other geoscience phenomena. Visitors to the VisLab can view scientifically precise, aesthetically engaging animations, displayed in high-definition, often in 3-D, created by Tim and his colleagues.

Before joining the European Crisis Management Laboratory at the Disaster Risk Management Unit of the Space Security & Migration (SSM) Directorate, he had worked on the validation of both deterministic and probabilistic fire weather products for the EFFIS (European Forest Fire Information System) of the IES / JRC (Institute of Environment & Sustainability / Joint Research Center) of the European Commission.

LEONARD SMITH • LSE CATS

Leonard Smith is Director of the Centre for the Analysis of Time Series and Professor of Statistics at the London School of Economics. He is a Senior Research Fellow at Pembroke College Oxford and a Senior Research Fellow at the Energy Policy Institute at the University of Chicago. His research focuses on making, evaluating and actually using forecast systems; his current focus is on weather forecasting for anticipation in Disaster Risk Reduction, and the use of probability in the insurance sector. In the long run, he hopes to figure out a viable framework for interpreting probabilistic forecasts given a set of imperfect forecast systems. His book Chaos: A Very Short Introduction is an Amazon #1 Best Seller, now available in eight languages. He has received the Royal Meteorological Society's Fitzroy Prize and an Australian Academy of Sciences Selby Fellowship.

FIONA VAN DER BURGT • Weather Impact BV

Fiona van der Burgt works as a consultant Extreme Weather and Climate Change at Weather Impact BV. She has a background in physics, climate change and meteorology and graduated as climate physicist at the Utrecht University in 2014. At Weather Impact her research work focusses on forecasting the impacts of climate change on agriculture and making risk analysis of extreme weather. Her work field is mainly in developing countries, where she develops operational weather services for the agricultural sector.

REMCO VERZIJLBERGH • Whiffle Weather Finecasting

Remco Verzijlbergh is co-founder and director of operations of Whiffle Weather Finecasting, a company that specializes in high-resolution weather forecasting and simulation. He has an MSc in applied physics and a PhD in renewable energy economics. He also works as an assistant professor at the faculty of Technology, Policy and Management of Delft University of Technology, on issues related to the integration of renewable energy sources into the power system.

UEF2018 Participants

Samuel Almond ..... ECMWF / Copernicus
samuel.almond@ecmwf.int

Eyal Amitai..... Israel Meteorological Service
amitaie@ims.gov.il

Brett Basarab ..... Global Weather Corporation
bbasarab@globalweathercorp.com

Lucia Benito Capa..... iberdrola Renovables
lbca@iberdrola.es

Hannah Bennett ..... Speedwell Weather
hannah.bennett@speedwellweather.com

Haldis Berge..... MET Norway
haldisb@met.no

Helene Blanchonnet..... ECMWF
helene.blanchonnet@ecmwf.int

Leonore Boelee ..... HR Wallingford & Open University
l.boelee@hrwallingford.com

Luke Boxall..... MetSet
lboxall@met-set.com

Carlo Buontempo..... ECMWF
carlo.buontempo@ecmwf.int

Rob Carver ..... Project Loon at X Development
carver@google.com

Jose L. Casado-Rubio..... AEMET
jcasador@aemet.es

Sandra Correia ..... IPMA - Instituto Portugues do Mar e da Atmosfera
sandra.correia@ipma.pt

Conor Daly..... Met Eireann
conor.daly@met.ie

Francesca Di Giuseppe..... ECMWF
francesca.digiuseppe@ecmwf.int

Sebastian Dietz ..... University of Innsbruck
sebastian.dietz@uibk.ac.at

Mike Doll..... AccuWeather
michael.doll@accuweather.com

Nils Dorband..... Citadel
nils.dorband@citadel.com

Michael Dukes ..... MetDesk
michael@metdesk.com

James Farley Nicholls ..... Citadel
james.farleynicholls@citadel.com

Martin Fengler ..... Meteomatics AG
mfengler@meteomatics.com

Laura Ferranti ..... ECMWF
laura.ferranti@ecmwf.int

Klara Finkele ..... Met Eireann
klarafinkele@ymail.com

Isla Finney ..... Lake Street Consulting Ltd
isla@lakestreetconsulting.co.uk

Biserka Frankovic ..... Crocontrol Ltd.
biserka.frankovic@crocontrol.hr

Estibaliz Gascon ..... ECMWF
estibaliz.gascon@ecmwf.int

Anna Ghelli ..... ECMWF
anna.ghelli@ecmwf.int

Nicole Girardot ..... Météo-France
nicole.girardot@meteo.fr

Henning Gisselø ..... Danish Meteorological Institute
hg@dmi.dk

Diego Gozalo ..... Meteologica
diego.gozalo@meteologica.com

Yue Guan ..... CMA
guany@cma.gov.cn

Lara Gunn ..... MetDesk
lara@metdesk.com

Marta Gutierrez ..... ECMWF
marta.gutierrez@ecmwf.int

Imanol Gutiérrez ..... METEOLOGICA
imanol.gutierrez@meteologica.com

Thomas Haiden ..... ECMWF
thomas.haiden@ecmwf.int

Tim Hewson ..... ECMWF
tim.hewson@ecmwf.int

Alfred Hofstadler ..... ECMWF
a.hofstadler@ecmwf.int

Sazzad Hossain ..... University of Reading, UK
mdsazzad.hossain@pgr.reading.ac.uk

Jaakko Hyvätti ..... Foreca Ltd
jaakko.hyvatti@foreca.com

Liping Jiang ..... Zhongshan Meteorological Service
1330274690@qq.com

Elín Björk Jónasdóttir ..... Icelandic Met. Office
elin@vedur.is

Lovro Kalin ..... Meteorological and Hydrological Service (DHMZ)
kalin@cirus.dhz.hr

Paavo Korpela ..... Finnish Meteorological Institute
paavo.korpela@fmi.fi

Jasnica Krulc ..... Crocontrol
jasnica.krulc@crocontrol.hr

Jonatan Kvernby ..... Swedish Meteorological and Hydrological Institute
jonatan.kvernby@smhi.se

Sylvie Lamy-Thepaut ..... ECMWF
sylvie.lamy-thepaut@ecmwf.int

Frank Lantsheer ..... KNMI
frank.lantsheer@knmi.nl

Patrick Laux ..... Karlsruhe Institute of Technology (KIT) Institute of Meteorology and Climate Research
patrick.laux@kit.edu

David Lavers ..... ECMWF
david.lavers@ecmwf.int

Jingfu Lin ..... Shenzhen Bixuange Technology CO
linjingfu@bixuange.com

Alex Longden ..... Met Office
alex.longden@metoffice.gov.uk

Begoña Luaces Daza ..... Iberdrola
blda@iberdrola.es

Vicky Lucas ..... Institute for Environmental Analytics
v.lucas@the-iea.org

Linus Magnusson ..... ECMWF
linus.m.magnusson@gmail.com

Shanti Majithia ..... RMS
shanti.majithia@hotmail.com

Sharanya Majumdar ..... University of Miami
smajumdar@rsmas.miami.edu

Sophie Martinoni-Lapierre .... Météo-France
sophie.martinoni@meteo.fr

Andras Mesterhazy ..... Hungarian Meteorological Service (OMSZ)
mesterhazy.a@met.hu

Gian Paolo Minardi ..... ARPA Lombardia
g.minardi@arpalombardia.it

Arnaud Monges ..... PredictWind
arnaudmonges@predictwind.com

Andrea Montani ..... Arpae Servizio IdroMeteoClima
amontani@arpae.it

Thomas Mould ..... MetraWeather UK
thomas.mould@metraweather.com

Evelyn Müller ..... MeteoGroup
evelyn.mueller@meteogroup.com

William Myers ..... Global Weather Corporation
bmyers@globalweathercorp.com

Ken Mylne ..... Met Office
ken.mylne@metoffice.gov.uk

Ling Ou Yang ..... Oyoung Consulting
ling.ouyang@oyoung.eu

Bob Owens ..... Independent
bob47iow@gmail.com

Florian Pappenberger ..... ECMWF
florian.pappenberger@ecmwf.int

Rosen Penchev ..... BULATSA
rosen.penchev@bulatsa.com

Thomas Petroliagkis ..... Joint Research Center
thomas.petroliagkis@ec.europa.eu

Emma Pidduck ..... ECMWF
emma.pidduck@ecmwf.int

David Plavcan ..... UBIMET
dplavcan@ubimet.com

Meghan Plumridge ..... ECMWF Analyst
meghan.plumridge@ecmwf.int

Katy Pol ..... EDF R&D
pol.katy@neuf.fr

Fernando Prates ..... ECMWF
fernando.prates@ecmwf.int

Christel Prudhomme ..... ECMWF
christel.prudhomme@ecmwf.int

Raed Rafid..... Jordan Meteorological Department
raedrafid@yahoo.com

Jan Rajczak ..... MeteoSwiss
jan.rajczak@googlemail.com

David Richardson ..... ECMWF
david.richardson@ecmwf.int

Javier Rodríguez Marcos..... AEMET
frodriguezm@aemet.es

Iryna Rozum ..... ECMWF
iryna.rozum@ecmwf.int

Cihan Sahin ..... ECMWF
c.sahin@ecmwf.int

Aurela Sakaj..... University of Cologne
asakaj1@uni-koeln.de

James Salter..... Met Office
james.salter@metoffice.gov.uk

Irina Sandu ..... ECMWF
irina.sandu@ecmwf.int

Tim Scheitlin..... National Center for Atmospheric Research
scheitln@ucar.edu

Thomas Schumann ..... Deutscher Wetterdienst
thomas.schumann@dwd.de

Johannes Schweiger..... UBIMET
jschweiger@ubimet.com

Leonard Smith..... London School of Economics/Pembroke College Oxford
lenny@maths.ox.ac.uk

Andrei Steau..... NEAS ENERGY
ats@neasenergy.com

Martin Steinheimer ..... Austro Control
martin.steinheimer@austrocontrol.at

Dan Suri..... Met Office
dan.suri@metoffice.gov.uk

Pei Tang..... Zhongshan meteorological Service
tangpeid@gmail.com

Yang Tang..... Shenzhen Bixuange Technology CO
tangyang@bixuange.com

Vibeke Thyness ..... Norwegian Meteorological Institute
vibekewt@met.no

Alexandre Trajan ..... Météo-France
alexandre.trajan@meteo.fr

Antonio Troisi ..... Italian Air Force
antonio.troisi@aeronautica.difesa.it

Ivan Tsonevsky ..... ECMWF
ivan.tsonevsky@ecmwf.int

Thomas Turecek ..... Austrian Meteorological Service ZAMG
thomas.turecek@zamg.ac.at

Fiona van der Burgt ..... Weather Impact BV
fiona.vanderburgt@weatherimpact.com

Thomas Vanhamel ..... RMI Belgium
vanhamel@meteo.be

Fabio Venuti ..... ECMWF
fabio.venuti@ecmwf.int

Remco Verzijlbergh ..... Whiffle Weather Finecasting, Delft University of Technology
r.a.verzijlbergh@tudelft.nl

Claudia Vitolo ..... ECMWF
claudia.vitolo@ecmwf.int

Evgeni Vladimirov ..... BULATSA
evvladimirov@gmail.com

Christophe Voisard ..... MeteoSwiss
christophe.voisard@meteoswiss.ch

Edward Wheatcroft ..... London School of Economics and Political Science
e.d.wheatcroft@lse.ac.uk

Dale Wiles ..... Met Office
dale.wiles@metoffice.gov.uk

Wai Kin Wong ..... Hong Kong Observatory
wkwong@hko.gov.hk

Jun Xu ..... National Meteorological Center of China
xuj@cma.gov.cn

Lei Xu ..... Shenzhen Bixuange Technology CO., Ltd,
xulei@bixuange.com