**ABSTRACTS**

**EUMETNET SRNWP- EPS 2019-2023**

**Workshop on "LAM-EPS prediction of high impact weather and extremes"**

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# Abstracts of presentations

## Stochastically Perturbed Parameterizations (SPP) in High Resolution Rapid Refresh Ensemble (HRRRE)

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In most existing regional ensemble systems, model-related uncertainty is addressed by using multiple dynamic cores, multiple physics suites, or a combination thereof. While such multi-model ensembles have demonstrated potential, their maintenance is resource-intensive, especially in operations. More importantly, probabilistic forecasts from multi-models do not have consistent distributions; since each ensemble member can have a different mean error and variance. Post-processing generally assumes independent and identically distributed random variables, a requirement that is not met by multi-model forecasts. An alternative option of creating desirable spread and reliability by perturbing the ensemble simulations stochastically. The stochastic approach results in statistically consistent ensemble distributions. Two widely used stochastic schemes are the Stochastic-Kinetic Energy Backscatter (SKEB) and the Stochastic Perturbations of Physics Tendencies (SPPT). These methods are formulated to represent the effect of unresolved

subgrid-scale variability and are added a posteriori to independently tuned models. Stochastically perturbed parameterizations (SPP) approach targets parameters and variables uncertainty within a physical parameterization schemes.
For the purpose of this study, SPP, which spatially and temporally perturbs parameters in the Mellor-Yamada-Nakanishi-Niino planetary boundary layer (PBL) scheme, the Rapid Update Cycle land surface model, Thompson microphysics and RRTMG radiation scheme was developed within the High Resolution Rapid Refresh convection-allowing ensemble (HRRRE) system. The SPP approach has been mainly used to target the performance of low-level variables (e.g. 2-m temperature and dew point, and 10-m wind and precipitations). The stochastic experiments were compared to the HRRRE without SPP as well as to operational High Resolution Ensemble Forecasting (HREF) system.

## The UK Met Office convective-scale ensemble: overview of the latest developments in ensemble perturbations

**Aurore Porson**[1], Anne McCabe[2], Charmaine Franklin[3], David Walters[2], Ken Mylne[2]

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The UK Met Office has recently upgraded its operational configuration from a 6-hourly ensemble with 12 members to an hourly time-lagged ensemble with 18 members. Whilst this upgrade results in more timely forecasts and increase in ensemble size, the upgrade also results in additional perturbations at the small scales associated with the use of multiple hourly high-resolution analyses. In the first part of this presentation, we provide some examples of objective verification and visualization developments to capture the improvements related to this hourly time-lagged ensemble.
Secondly, an update to the random parameter scheme regarding the use of convective parameterizations is reviewed here through a case study analysis and objective verification.
Finally, a brief overview of the ongoing and planned research projects related to the improvements to ensemble perturbations will also be presented.

## Ensemble forecasting at DWD

**Chiara Marsigli**, Deutscher Wetterdienst, Offenbach am Main (D)

Ensemble forecasting is at the core of the modeling system of the Deutscher Wetterdienst. The convection-permitting COSMO-D2-EPS ensemble is running operationally since 2012 (previously in the COSMO-DE-EPS configuration). The COSMO model is run with 2.2 km horizontzal resolution, with 65 vertical layers, over Germany and its surroundings. The ensemble has 20 members, which receive Boundary Conditons from the coarser resolution ICON-EU-EPS ensemble. Initial Conditions are provided by the first 20 analyses computed by the KENDA Ensmeble Data Assimilation system, based on LETKF. Model perturbations are also applied, by allowing a set of parameters of the physics schemes to be assigned few different values at the start of the ensemble run. These values are kept fixed during the integration (Perturbed Parameters) but are randomly chosen and combined at each forecast start.
The ensmeble runs 8 times per day, with a +27 h forecast range. Several products are generated, parrticularly for the forecast of severe / high impact weather phenomena.
An upscaling of the probabilities for precipitation, Lighting Potential Index and Reflectivity over 10 x 10 grid point boxes is also performed and provided to the forecasters.
The transition to the ICON-D2-EPS ensemble, which is now starting its pre-operational phase, is also addressed in this talk. Particularly, the first results of the impact of the Parameter Perturbation in this ensemble are presented.
Finally, the global ensmeble ICON-EPS and its European refinement ICON-EU-EPS
are shortly described.

## Toward continuous ensemble generation in MetCoOp

**Ulf Andrae**, SMHI, Sweden

Inger-Lise Frogner, Ole Vignes, Andrew Singleton (MetNo, Norway)

MetCoOp, the operational NWP cooperation between Finland, Norway and Sweden, have been running a 10 member ensemble since late 2017. The current ensemble is based on initial and boundary perturbations constructed from IFS HRES data using the SLAF technique. In addition a surface perturbation scheme acts on surface state variables as well as surface properties. The ensemble provides a good additional value to IFSENS but suffers from a large overestimation of initial precipitation, a member dependent bias for e.g. T2M and an upper limit in number of members due to the SLAF methodology used. To meet theses problems and to better utilized an

increased HPC capacity a continuous ensemble generation scheme is being introduced. The scheme involves initial perturbations using EDA and usage of IFSENS boundaries directly in addition to the existing surface perturbations. The scheme allows us to increase the number of member by a factor of three. Different aspects of the new system will be presented.

## Developing SPP in HarmonEPS

**Inger-Lise Frogner**, MetNo, Norway
Ulf Andrae (SMHI), Pirkka Ollinaho (FMI)

SPP (Stochastically Perturbed Parameterizations scheme) is a scheme where perturbations of uncertain parameters evolve in time and space. SPP samples a log-normal distribution for most parameters with independent distributions for each parameter and variable, making sure the perturbations are uncorrelated. SPP has an advantage over SPPT in that it represents the errors close to their source, it respects local budgets of moisture, momentum and energy and can also represent uncertainty beyond a simple amplitude error. The idea originates from ECMWF and is now introduced into HarmonEPS. So far SPP is introduced for 14 parameters in micro-physics and cloud related processes, radiation and turbulence. Results from SPP in HarmonEPS will be presented, and challenges highlighted. A comparison with SPPT will also be shown.

## Prediction and verification of high impact rainfall from DMI's COMEPS system

**Henrik Feddersen**, DMI, Denmark

At DMI we have run our continuous mesoscale ensemble prediction system (COMEPS) operatiaonally for more than two years. The present version is based on HarmonEPS-40h1.1, but differs from the default mainly by assimilation of new observations every hour and by continuously running new members, presently 1 control + 3 perturbed members every hour. The perturbed members are every hour collected from the latest six hours to form a time-lagged ensemble with 18 perturbed members and 1 "deterministic" run. One of the most important applications of COMEPS is prediction of high impact rainfall. To that end we produce probability maps that show probabilities of exceeding a given threshold somewhere in the neighbourhood of a grid point. Recently, we have used new maps of quantitative precipitation estimates, based on a combination of rain gauge observations and radar reflectivities, to verify the probability forecasts in order to use the verification results to provide guidance to the forecasters regarding the use of the probability maps in relation to the issuing of warnings.

## EPS-Case study of serious HIW event in Poland, August 11th, 2017. Increasing resolution approach – from 7 km to 0.7km

**Andzej Mazur**, Institute of Meteorology and Water Management – National Research Institute, (Poland)

On August 11th, 2017, a serious high impact weather (HIW) event took place in northwestern Poland. It resulted in two deaths, many people were injured, the final outcomes will be presented afterward on the basis of the prosecutor's investigation. The case was examined in both deterministic and EPS approaches, with a resolution increasing from 7 to 0.7 km. Various convective indicators were analyzed to assess the nature of the event. The key question that arose was, "Was there a basis to issue a top-level warning, given the forecasts?" In summary, the most probable cause of this event was a supercell moving north in less than three hours. However, the maximum forecasted wind was not strong enough to justify issue a warning at the highest level.

## The use of HARP system for ensemble calibration and verification at FMI

**Juha Kilpinen** and Kaisa Ylinen, Finnish Meteorological Institute (FMI)

Finnish Meteorological Institute has been participated to HIRLAN-C work in EPS calibration and verification developments in recent years. So far, we have used and tested the HARP system in ensemble verification and calibration in two projects I-REACT/H2020 and VaGe/Academy of Finland. In these projects we concentrated on 2m temperature, 10m wind speed and 100m wind speed calibrations. Some tests were also made with precipitation calibration. The results were encouraging giving increased skill on average for all tested variables with ECMWF ENS data. However, there is still work with the local skill of calibrated forecasts.

The promising results in projects encouraged us to use HARP system also in operation work at FMI. Currently we are working to calibrate ECMWF ENS T2m for the FMI operative editing area. This area covers the Northern Europe. In earlier projects we also made calibrations to whole Western Europe. The calibrated data will then be in the core of FMI weather service production system.

## Multiensemble probabilistic thunderstorm forecasting

**Francois Bouttier**, Hugo Marchal and Axelle Fleury, Meteo-France, CNRM

User-oriented point forecasts of thunderstorm risk can be efficiently generated using a combination of heterogeneous NWP systems: IFS, Arpege, Arome and their ensembles. For thunderstorm occurrence probability, we present objective verifications that show the value of blending multiple systems for minimizing non-detections and false alarms. The corresponding post-processing algorithm involves several tunable parameters related to spatial tolerance, kernel dressing, event threshold, ensemble weightning and calibration. Fortunately, their tuning can be automated using a very simple machine learning algorithm.
The approach can be adapted to violent thunderstorm forecasts (although their verification is much more difficult) and to precipitation forecasts for hydrological applications (where the time consistency of forecast scenarios is a specific constraint).

## Lightning forecasting with HARMONIE graupel fields

**José Antonio Sosa**, AEMET, Spain

Graupel-ice mechanism is one of the responsable mechanisms in atmospheric electrification.
Various forecast fiels generated by HARMONIE-AROME model are related with graupel.
A model that correlates HARMONIE graupel fields and lightning observations by AEMET's lightning detection network has been developed.
A time lagged ensemble is used as a rough estimation of probability of lightnings.

## Some remarks regarding the calibration of the temperature for the gSREPS

**David Quintero**, AEMET, Spain

We show some studies performed when calibrating the 2 meters temperature for the Spanish gSREPS ensemble. The rank histogram for the H+12 leadtime has been plotted for some locations in Spain that represent different climatic and orographic conditions. We have been doing member by member calibration and we show there is a tendency to limit the spread, as the theoretical approach suggests. We also present the rank histograms without any calibration, showing what it seems a tendency towards a cold bias in the ensemble.

## Making use of ensemble forecasts for seamless prediction – IMPROVER at the Met Office and a few other things

**Nigel Roberts**, MetOffice, UK

This talk describes how we are developing the IMPROVER post processing system at the Met Office and the rationale behind this approach. The aim is to blend deterministic and ensemble forecasts probabilistically using a variety of models to provide seamless probabilistic forecasts. The outputs can be divided into those focussed on ordinary weather for automated products (for example Apps and Web pages), and those that give indicators of severe weather to be used by operational meteorologists for aiding decision-making in the creation of warnings.
Examples will be shown of the sorts of outputs being developed as well as some of the outputs already produced in our existing gridded post processing system along with a discussion of challenges we need to overcome when using a probabilistic framework and blending between different models.

## Detection of Severe Weather Events in AROME-EPS using EFI and SOT

**Laure Raynaud**, Meteo-France, CNRM

Extreme Forecast Index (EFI) and Shift Of Tails (SOT) are commonly used to detect potential high-impact weather events at the global scale. In this talk, the feasibility and the relevance of EFI and SOT computations with the convection-permitting Arome-France ensemble prediction system (EPS) will be discussed. We will first address the problem of computing a reliable model climate from a small and heterogeneous operational archive. Subjective and objective evaluations of Arome-EPS EFI for different surface variables will be then presented, as well as suggestions to integrate these indices in the production of early warnings.