

EUMETNET SRNWP-EPS project and convection-permitting LAM-EPS database

EMS Annual meeting 2021
27th September – 1st October
BlueJeans Virtual Meeting



Alfons Callado Pallarès,
Francesca Marcucci,
Chiara Marsigli and
Stéphane Vannitsem

Outline

Introduction

- EUMETNET NWP Programme
- SRNWP-EPS main activities

Application Tasks

- Calibration on extremes
- Post-processed Forecasting Tools
- LAM-EPS Extreme Forecast Index (EFI) and SOT

Research activities

- Convection-permitting LAM-EPS database
- Research plan and activities

Introduction

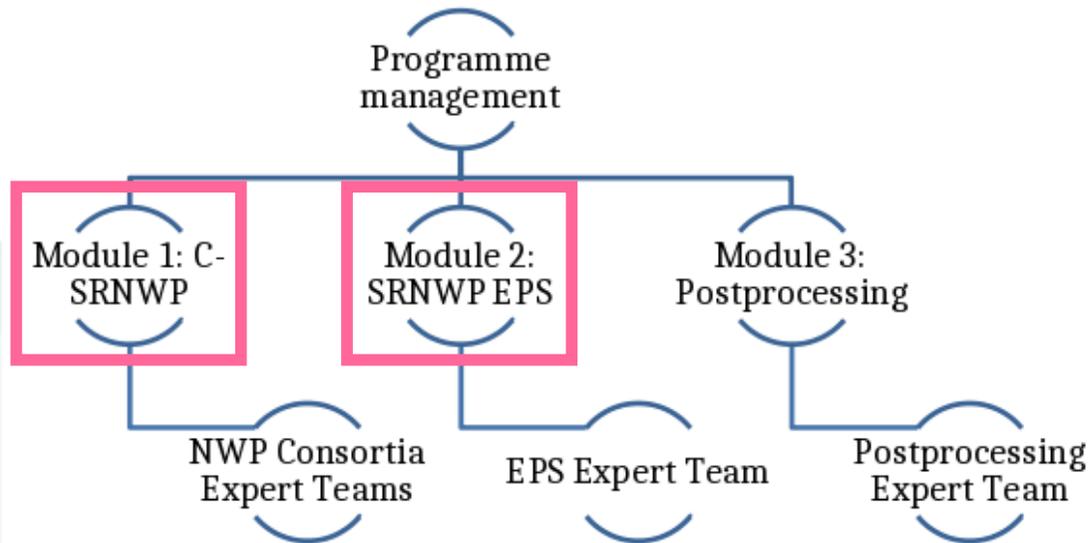


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EUMETNET Forecasting Programme

NWP Cooperation Programme

The **cooperation** on Short Range Numerical Weather Prediction (SRNWP) over Europe is essentially organized **around consortia** (ACCORD [ALADIN/HIRLAM], COSMO, LACE, SEECOP, UKMO) that develop high-resolution prediction models.

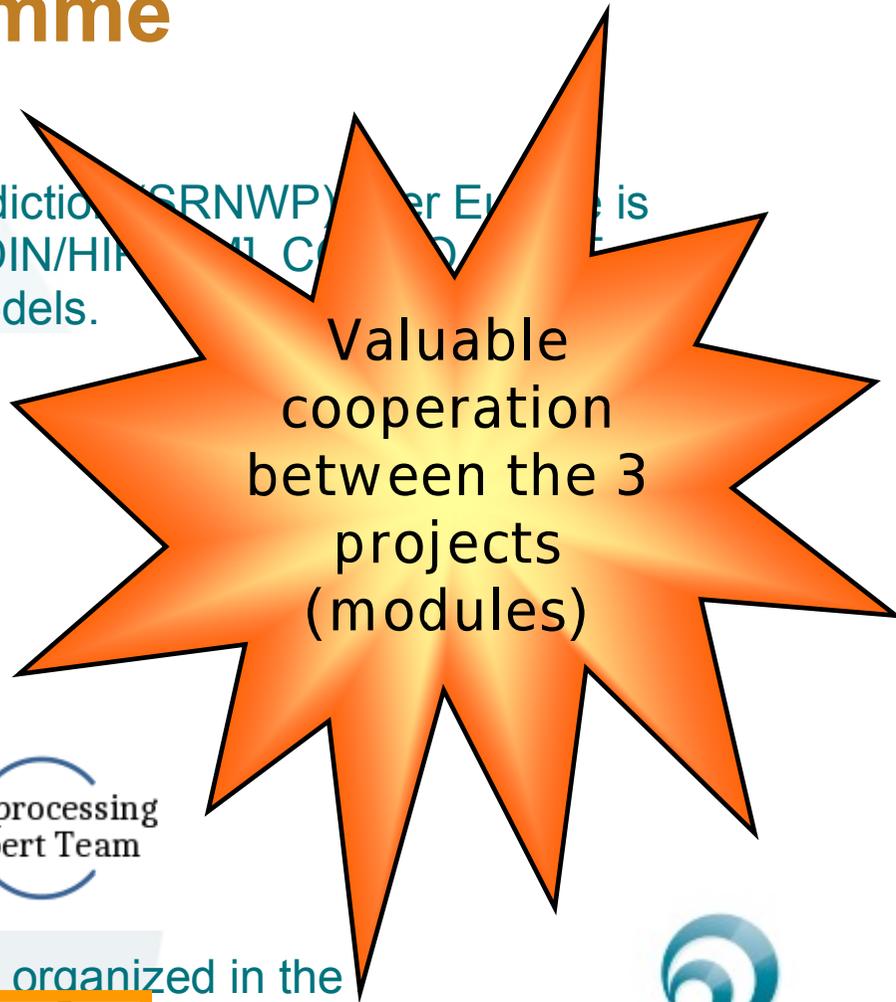
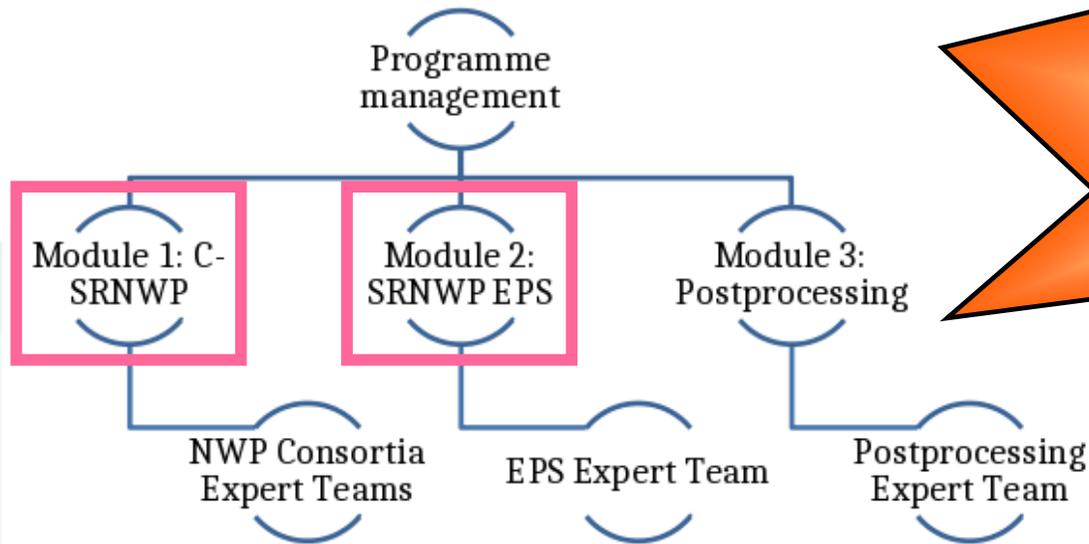


Transversal activities through all the consortia landscape are organized in the context of EUMETNET in order to **share scientific and technical** issues that are common to all consortia, with the ultimate goal of **improving the forecast skill** at these short time scales.

EUMETNET Forecasting Programme

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NWP Cooperation Programme

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22 of 31 EUMETNET NM(H)Ss participate directly into SRNWP-EPS

- Météo-France joined last year
- Expecting to join DWD in 2021 autumn

Valuable cooperation between the 3 projects (modules)

NWP Consortia Expert Teams

PS Expert Teams

Postprocessing Expert Team

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Management of the SRNWP-EPS project

EUMETNET Phase 2019-2023

The management of the project/module is organised through an agreement (MoU) between partners:



• **AEMET**

→ The Spanish Meteorological Agency
Alfons Callado Pallarès ⇔ **Project Manager**



• **ItAF-REMET**

→ The Italian Air Force Meteorological Service
Francesca Marcucci (COMET)



• **RMI**

→ The Royal Meteorological Institute of Belgium
Stéphane Vannitsem ⇔ **Manager of Postprocessing project**

DWD in-kind collaboration

Chiara Marsigli collaborates with the project, mainly on scientific research and verification

→ **Wednesday 14:00-16:00 Breakout Session on Predictability**

Previous Phase II (2015-2018) ⇔ It was managed by **José A. García-Moya**

[Passed away last 2020 December after been run over by a car when riding a bicycle]



SRNWP-EPS MAIN OBJECTIVES

I) Application oriented objective (R2O) → Partly-funded

- **LAM-EPS calibration** focused on **extremes** (AEMET): T2m, Wind gust 10m, etc.
- Development of **derived/post-processing products** (ItAF-REMET-COMET): wind gusts, icing, severe convection, wind storms and turbulence.
- **EFI** (Extreme Forecast Index) and SOT development for LAM-EPS (2021-2023)

II) Research oriented objective → Workshops and participants in-kind contribution

- Representation of **model uncertainties** relevant for forecasting HIW
- Organise coordinated testing/research on **LAM-EPS perturbations**
- **Annual workshop** at the end of October: last one with **Post-Processing** project
- To **foster research** has been established the:
 - **SRNWP-EPS Convection-permitting LAM-EPS database**

Application Tasks



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Application tasks' status

Calibration on extremes

API → Application
Programming
Interface

EPS_1. Calibration on extremes (AEMET)

- **Maria Cortès Simó** (1st year since June 2020)
- **Post-Processing** collaboration about methodologies (e.g. mbr-by-mbr RMI) and parameters
- 1st STEP: reviewed literature and test the performance of distinct calibrations methods → R2O
- 2nd STEP: develop **1st API-Python** which will be tested with LAM-EPSS into the database for:
 - Daily/12hours **T2m MAX/MIN, 10m wind gust, AccPcp and AccSnow**

EPS_2. Developing post-processing products (ItAF-REMET-COMET)

- **Raffaele Golino** (experience from the previous phase)
- **Forecasting tools** [all in one FORTRAN package software]:
 - Available improved **thunderstorm** (Updraft Helicity, isobaric levels) and **fog/visibility** products
 - Aviation **icing** and **clear-air turbulence** products available to use/test
 - First steps applying **Machine Learning** to forecast/detect **thunderstorms/heavy showers**

Comparison on ensemble post-processing methods using the SNRNWP-EPS database

Daily precipitation

Variables: Daily precipitation, wind gust, maximum and minimum temperature

Observations: ECMWF

Stations: Barcelona, **Biarritz**, Llanes, Madrid, Montpellier, Palma de Mallorca, Puerto de San Isidro, Santiago de Compostela, Toulouse

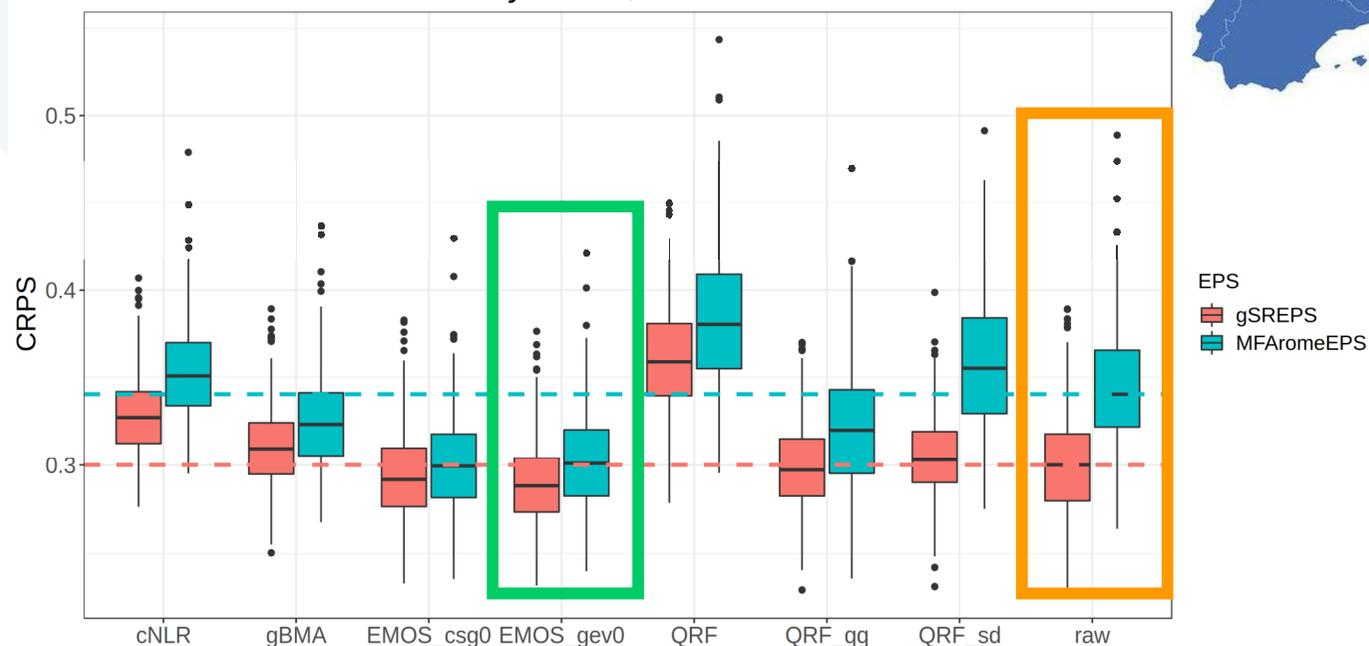
Period: 01/06/2020 – 31/08/2021

- Training period: 01/06/2020 - 28/02/2021
- Test period: 01/03/2021 - 31/08/2021

EPS:

- **gSREPS:** runs 00/12 UTC; 20 distinguishable members
- **MFAromeEPS:** runs 09/21 UTC 16 indistinguishable members

Continuous Rank Probability Score, Biarritz



Methods

cNLR: censored Nonhomogeneous Logistic Regression

gBMA: Bayesian Model Averaging mixture with gamma 0 distribution

EMOS_csg0: censored and shifted gamma EMOS modelling

EMOS_gev0: censored generalized **extreme** value distribution EMOS modelling

QRF: Quantile Regression Forest (ensemble mean)

QRF_qq: Quantile Regression Forest (ensemble mean + 10th and 90th quantile)

QRF_sd: Quantile Regression Forest (ensemble mean + ensemble standard deviation)

raw: raw ensembles

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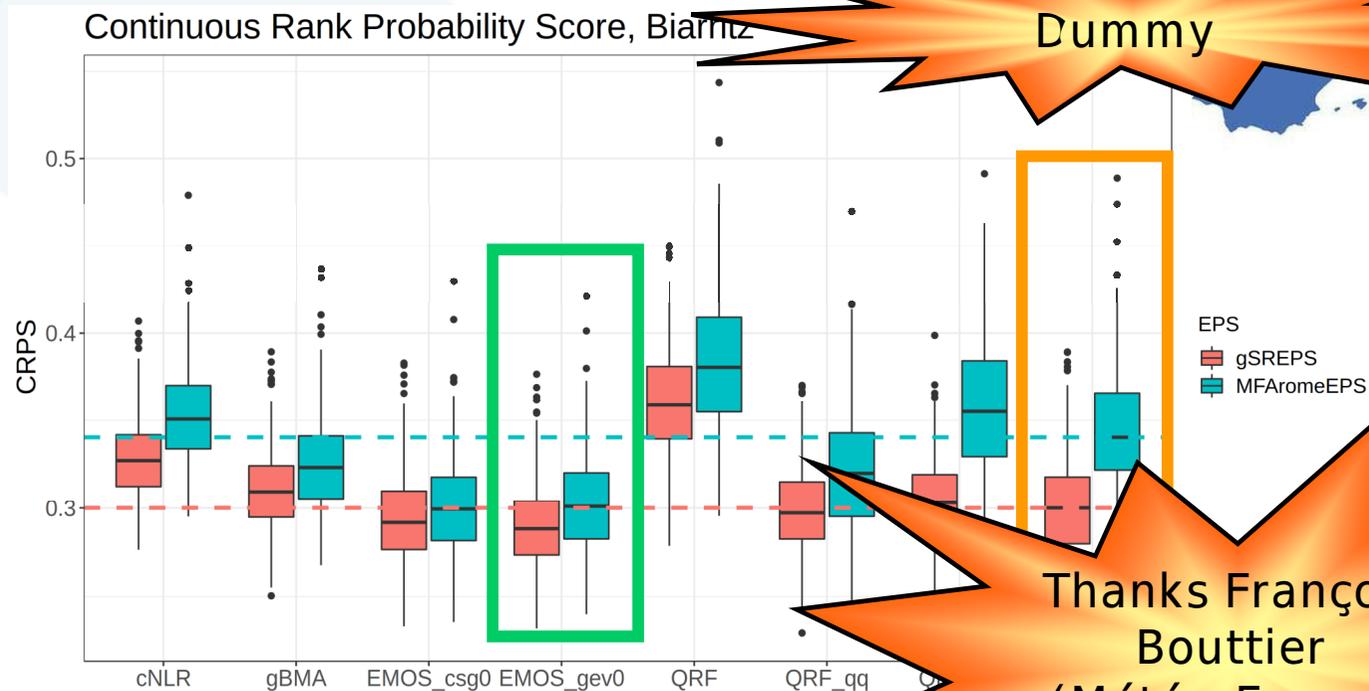
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Application tasks' status

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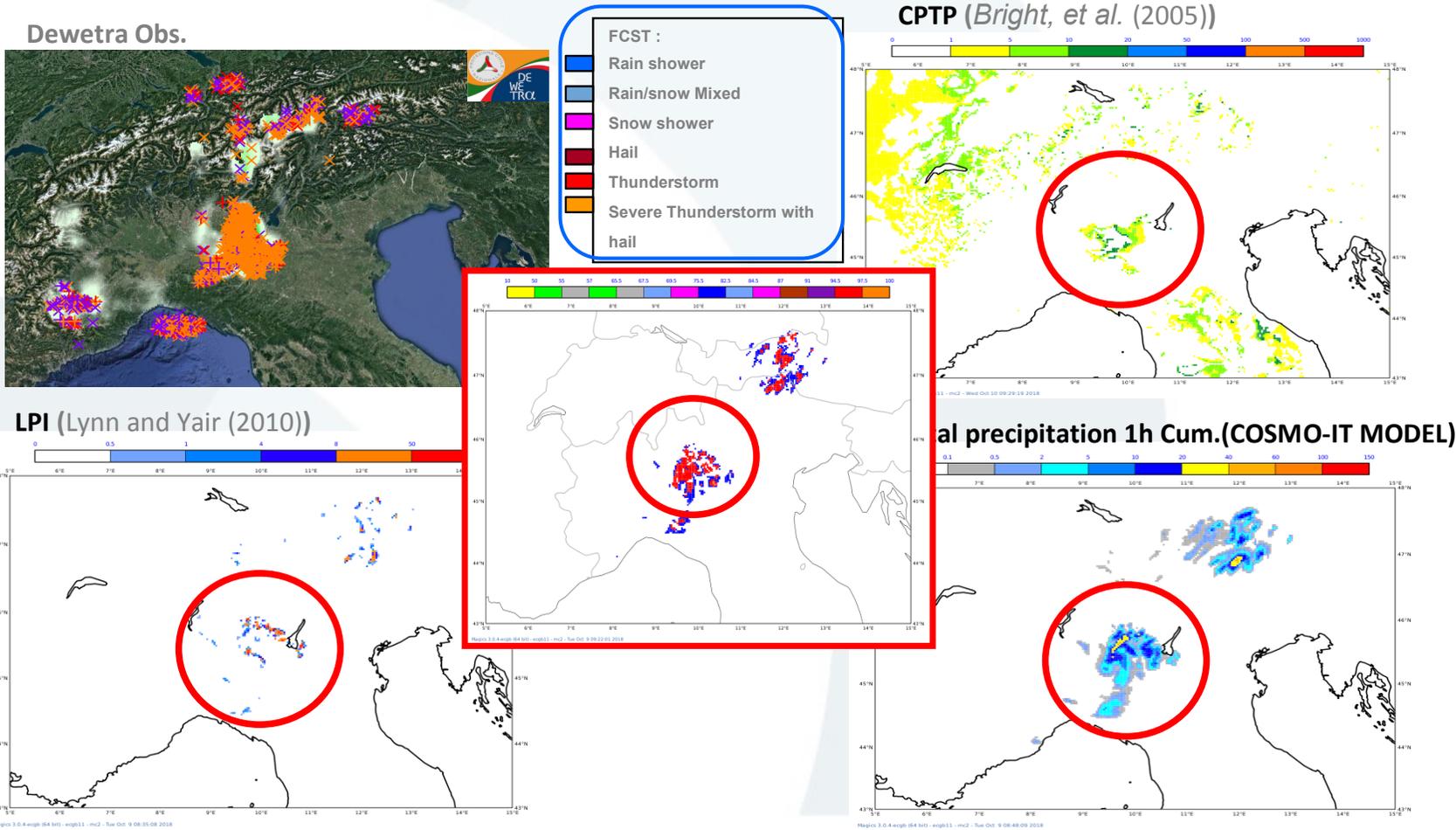
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↔ CONTACT Francesca Marcucci
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THUNDERSTORM forecasting tool (ItAF-REMET, 2015-2018)

Results with regional NWP model outputs: COSMO-IT (2.8 km, Italian domain) 29 Jul 2017, 00UTC, T+21h



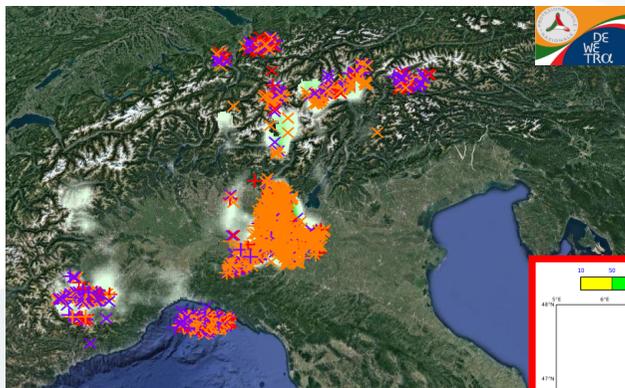
LPI → Lightning Potential Index
 CPTP → Cloud Physics Thunder Parameter

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THUNDERSTORM forecasting tool (ItAF-REMET, 2015-2018)

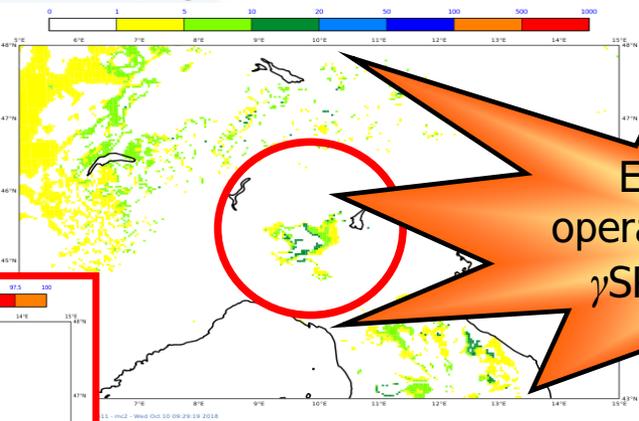
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Dewetra Obs.



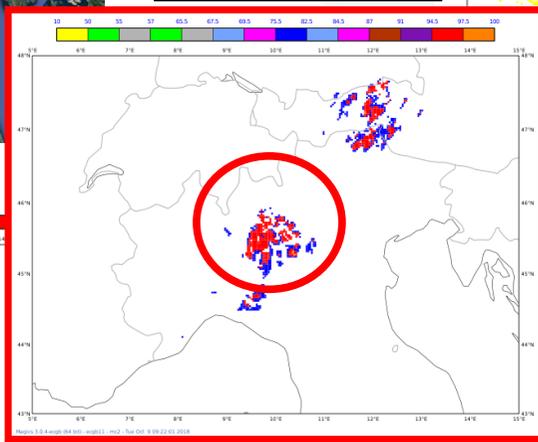
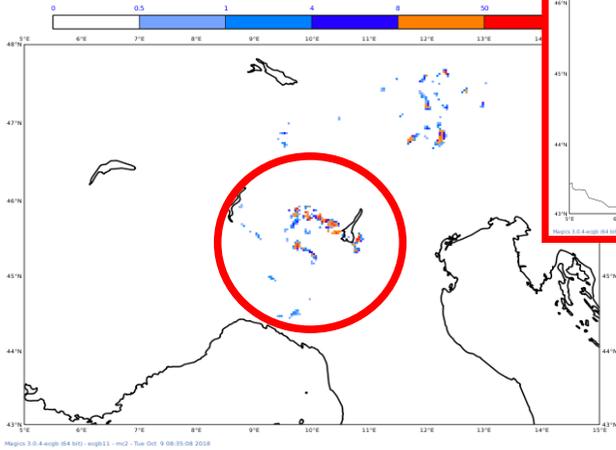
- FCST :
- Rain shower
 - Rain/snow Mixed
 - Snow shower
 - Hail
 - Thunderstorm
 - Severe Thunderstorm with hail

CPTP (Bright, et al. (2005))

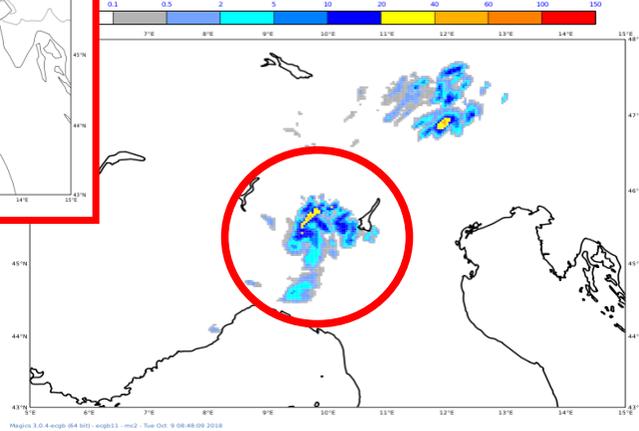


Expecting to use operationally in AEMET-γSREPS aeronautics

LPI (Lynn and Yair (2010))



al precipitation 1h Cum.(COSMO-IT MODEL)



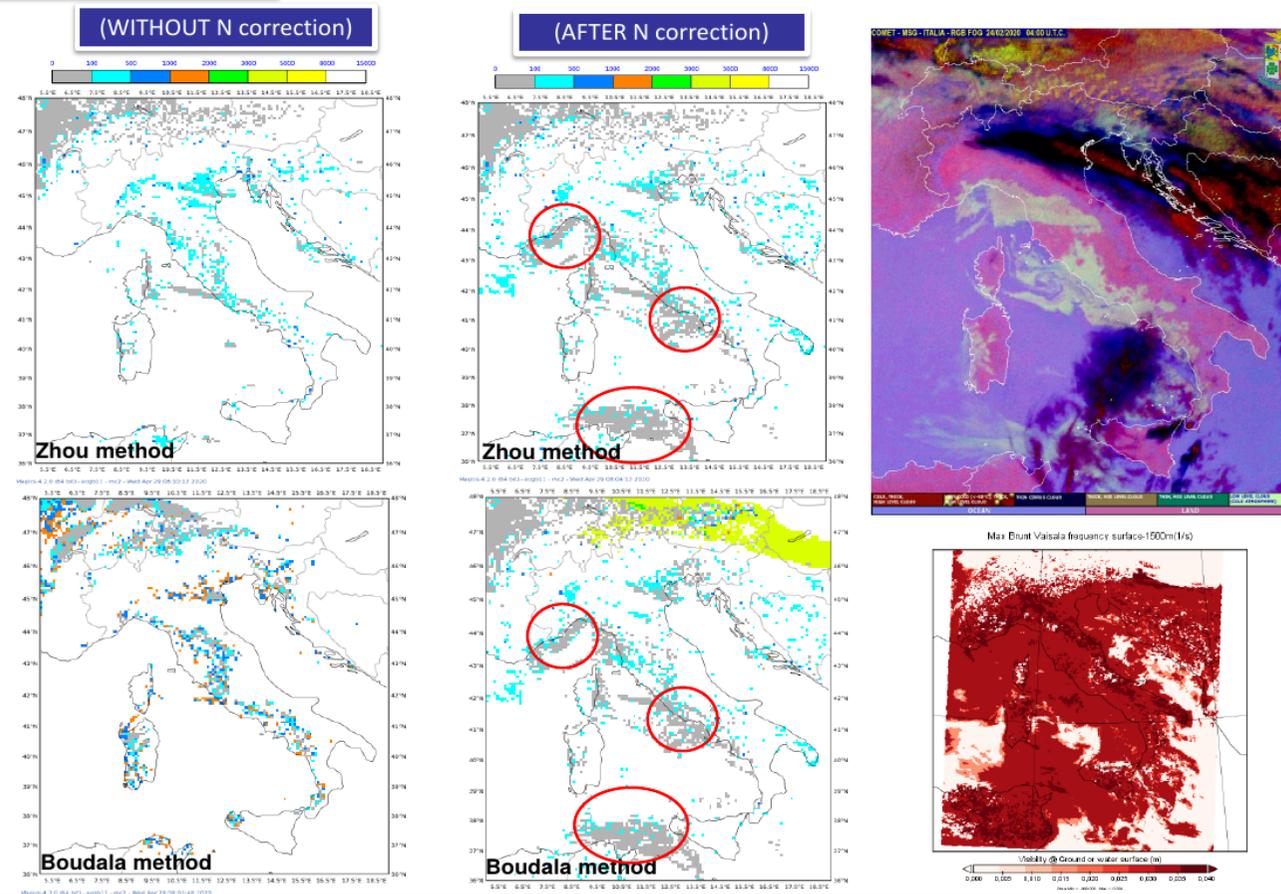
LPI → Lightning Potential Index
 CPTP → Cloud Physics Thunder Parameter



SRNWP-EPS Forecasting Tools (ItAF-REMET-COMET)

Francesca Marcucci and Raffaele Golino (contracted)

FOG CASE TEST 24/02/2020



Forecasting tools

- Fog
- Thunderstorms
- Aviation
 - Icing
 - CAT

SRNWP-EPS Forecasting Tools (ItAF-REMET-COMET)

Francesca Marcucci and Raffaele Golino (contracted)

➤ Thunderstorm forecasting tool – QUICK RECAP

• Compute

Weather phenomenon «Thunderstorm» grib files codified as follow:

Code Figure	
80	Rain shower(s), slight
81	Rain shower(s), moderate or heavy
82	Rain shower(s), violent
83	Shower(s) of rain and snow mixed, slight
84	Shower(s) of rain and snow mixed, moderate or heavy
85	Snow shower(s), slight
86	Snow shower(s), moderate or heavy
87	Shower(s) of snow pellets or small hail, with or without rain or rain and snow mixed
88	
89	Shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder
90	
91	Slight rain at time of observation
92	Moderate or heavy rain at time of observation
93	Slight snow, or rain and snow mixed or hail at time of observation
94	Moderate or heavy snow, or rain and snow mixed or hail at time of observation
95	Thunderstorm, slight or moderate, without hail
96	Thunderstorm, slight or moderate, with hail
97	Thunderstorm, heavy, without hail but with rain and/or snow at time of observation
98	Thunderstorm combined with duststorm or sandstorm at time of observation
99	Thunderstorm, heavy, with hail at time of observation

Mandatory fields

➤ Upper-level fields

- Vertical level heights/pressure
- Temperature : $T(z)$
- Humidity : $Q(z)$ or $RH(z)$
- Wind speeds : $U(z), V(z), W(z)$
- specific content: $qc, qi, (qr, qs, qg)$

➤ Surface fields :

- Surface height : H_{surf}
- 2 m Temperature : T_{2m}
- 10 m wind speeds : U_{10m}, V_{10m}
- Total precipitation (snow/rain)

Forecasting tools

- Fog
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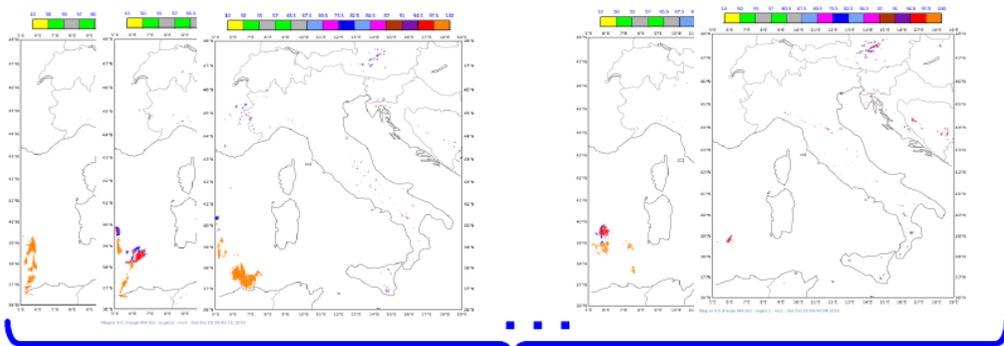


SRNWP-EPS Forecasting Tools (ItAF-REMET-COMET)

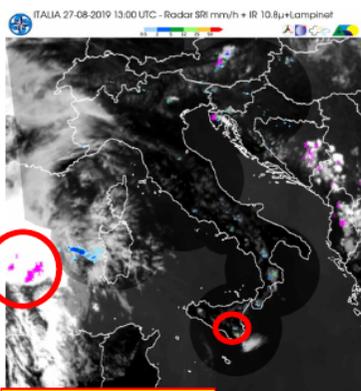
Francesca Marcucci and Raffaele Golino (contracted)

Results with regional NWP model outputs: COSMO-IT EPS (2.2 km, Italian domain)

TEST CASE: 27 Aug 2019, 00UTC, T+13h

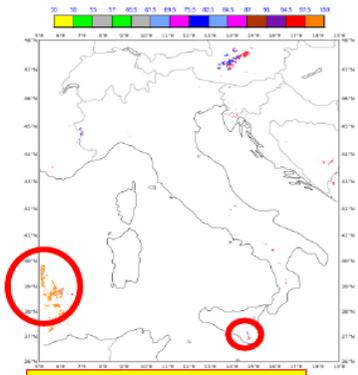


IF EPS Mode is activated, for each Member the tool is able to calculate "TS" phenomenon and return the "most probable" phenomenon

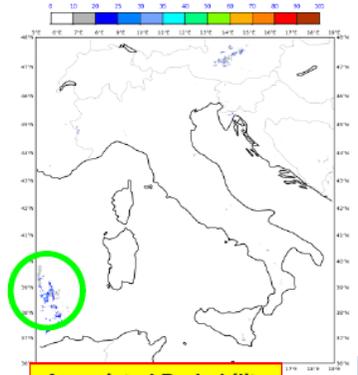


Observations

N= 20 members



«most probable» phenomenon



Associated Probability

Forecasting tools

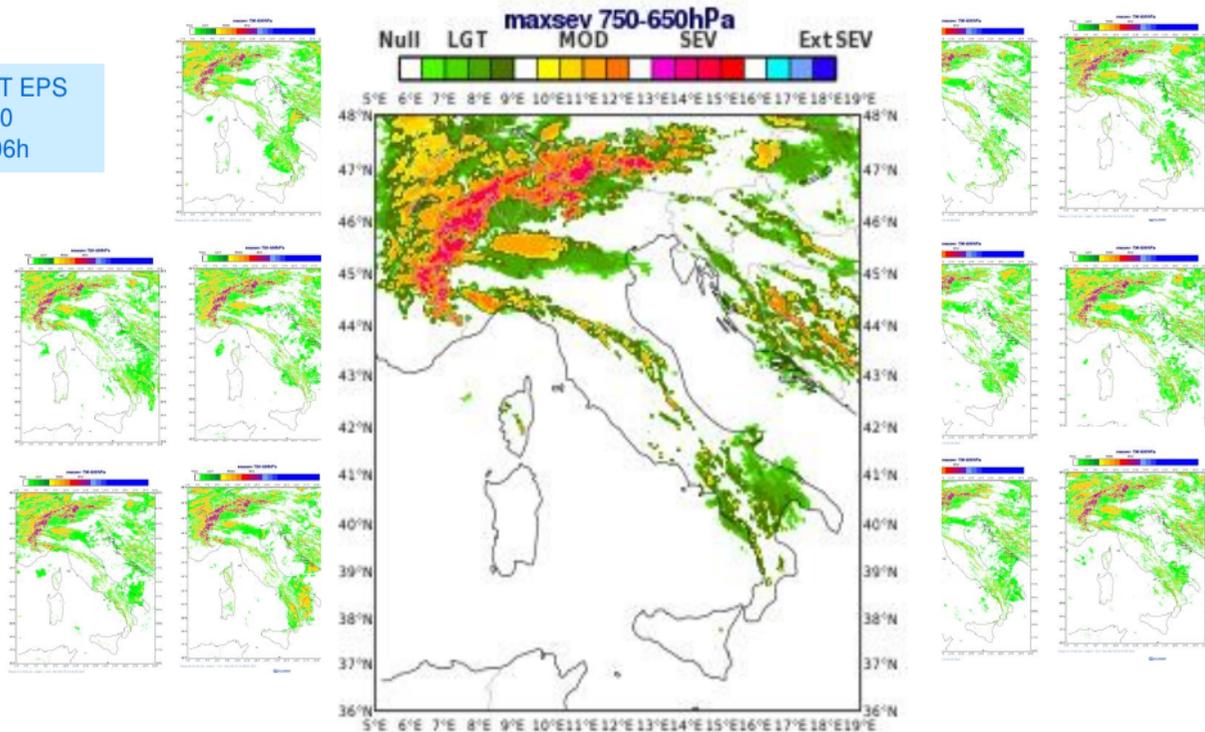
- Fog
- Thunderstorms
- Aviation
 - Icing
 - CAT

SRNWP-EPS Forecasting Tools (ItAF-REMET-COMET)

Francesca Marcucci and Raffaele Golino (contracted)

Ensemble outputs and «most probable» turbulence intensity

COSMO-IT EPS
10/02/2020
00UTC +06h



Forecasting tools

- **Fog**
- **Thunderstorms**
- **Aviation**
 - **Icing**
 - **CAT**



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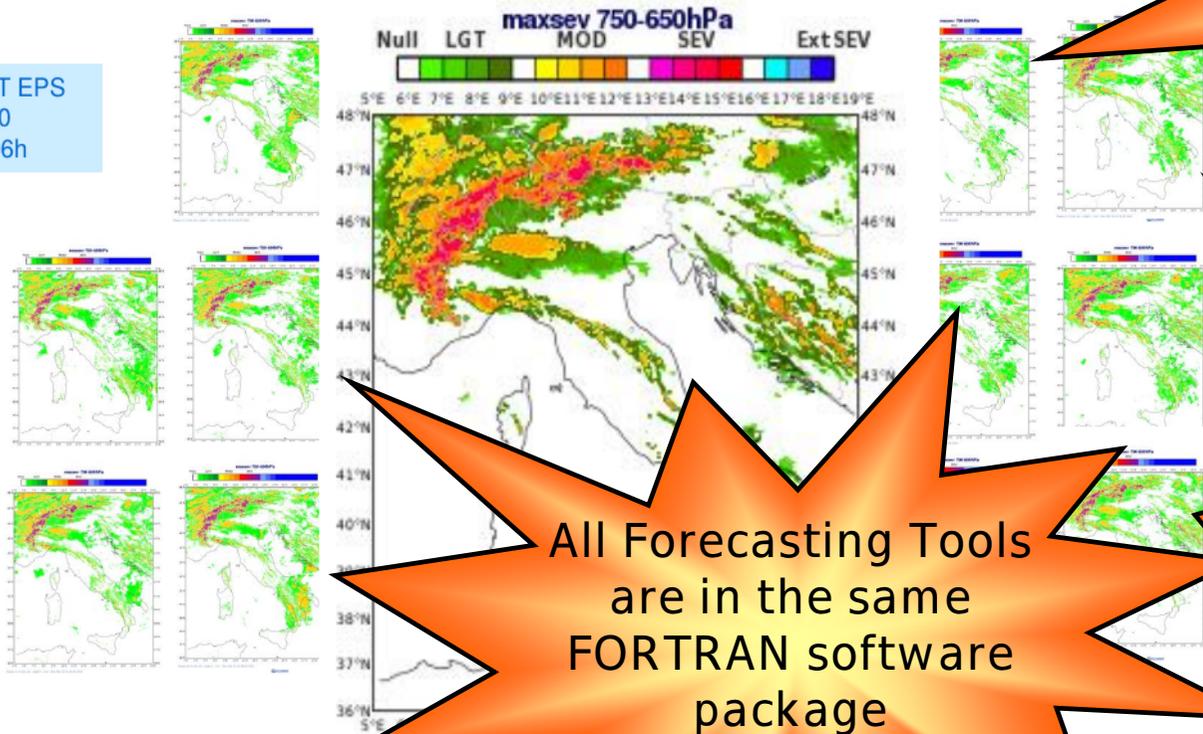


SRNWP-EPS Forecasting Tools (ItAF-REMET-COMET)

Francesca Marcucci and Raffaele Golino (co-lead)

Ensemble outputs and «most probable» turbulence in

COSMO-IT EPS
10/02/2020
00UTC +06h



ALL
Forecasting Tools
are available

- Thunderstorms
- Aviation

All Forecasting Tools
are in the same
FORTRAN software
package

For details
→ SRNWP-EPS
Workshops
presentation on
EUMETNET portal
→ Next SRNWP-
EPS Workshop

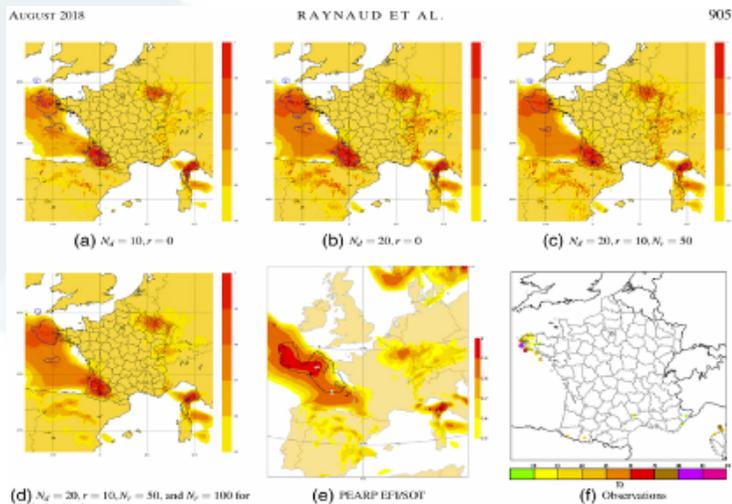


Application tasks' status

Extreme Forecast Index

EPS_8. Develop EFI and SOT for LAM-EPS (AEMET)

- Selected extra-application task with 2021-2023 extra-funding
- **Joan Montolio Llenas** (since 6th April 2021, 2 years and 9 months contract)
 - Reviewed ECMWF EFI/SOT documentation and AROME-EPS Météo-France EFI/SOT paper [Laure Raynaud]
 - Expecting to follow *and maybe improve* Météo-France EFI/SOT application on LAM-EPS



MétéoFrance EFI and SOT from AROME-EPS

R2O: climate model is the key issue → they show it could be done *without EPS re-forecast* but from LAM-EPS archiving data but with a spatial/temporal *relaxation*

Raynaud, L., B. Touzé, and P. Arbogast, 2018: *Detection of Severe Weather Events in a High-Resolution Ensemble Prediction System Using the Extreme Forecast Index (EFI) and Shift of Tails (SOT)*. *Wea. Forecasting*, **33**, 901–908, <https://doi.org/10.1175/WAF-D-17-0183.1>

EFI → Extreme Forecast Index
SOT → Shift Of Tails

SRNWP-EPS convection-permitting LAM-EPS database



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EUMETNET SRNWP-EPS Convection-permitting LAM-EPS database

Quick summary

- **Off-line flexible** database
- Archiving relevant **surface parameters** in GRIB format (editions 1 and 2)
- Main goal: to foster research and collaboration in order to improve European LAM-EPS
- Focussing on **high-impact weather (HIW) and convection**
- Hosted at **ECMWF ECFS** (located at [ec:/srnwpeps](https://ecmwf.ecfs.eu))
- Currently:
 - First *testbed* 3-month **period from 1st June to 31st August 2020** (9 LAMEPS)
 - Decided to try to **archive continuously** until the end of 2023
 - **10 LAM-EPS** participants: **mogreps-uk** (MetOffice), **MEPS** (MetCoOp), **gSREPS** (AEMET), **IT-EPS** (ItAF-REMET), **IREPS** (Met Eireann), **COMEPS** (DMI), **MF-AromeEps** (MétéoFrance), **RMI-EPS** (RMI)[not archiving] and **ICON-D2-EPS** (DWD) and **C-LAEF** (LACE)
- Open to EUMETNET groups: e.g. ET from C-SRNWP as Verification and Physics, Postprocessing, etc.
 - And external users for research/education without non-commercial use

EUMETNET SRNWP-EPS Convection-permitting LAM-EPS database

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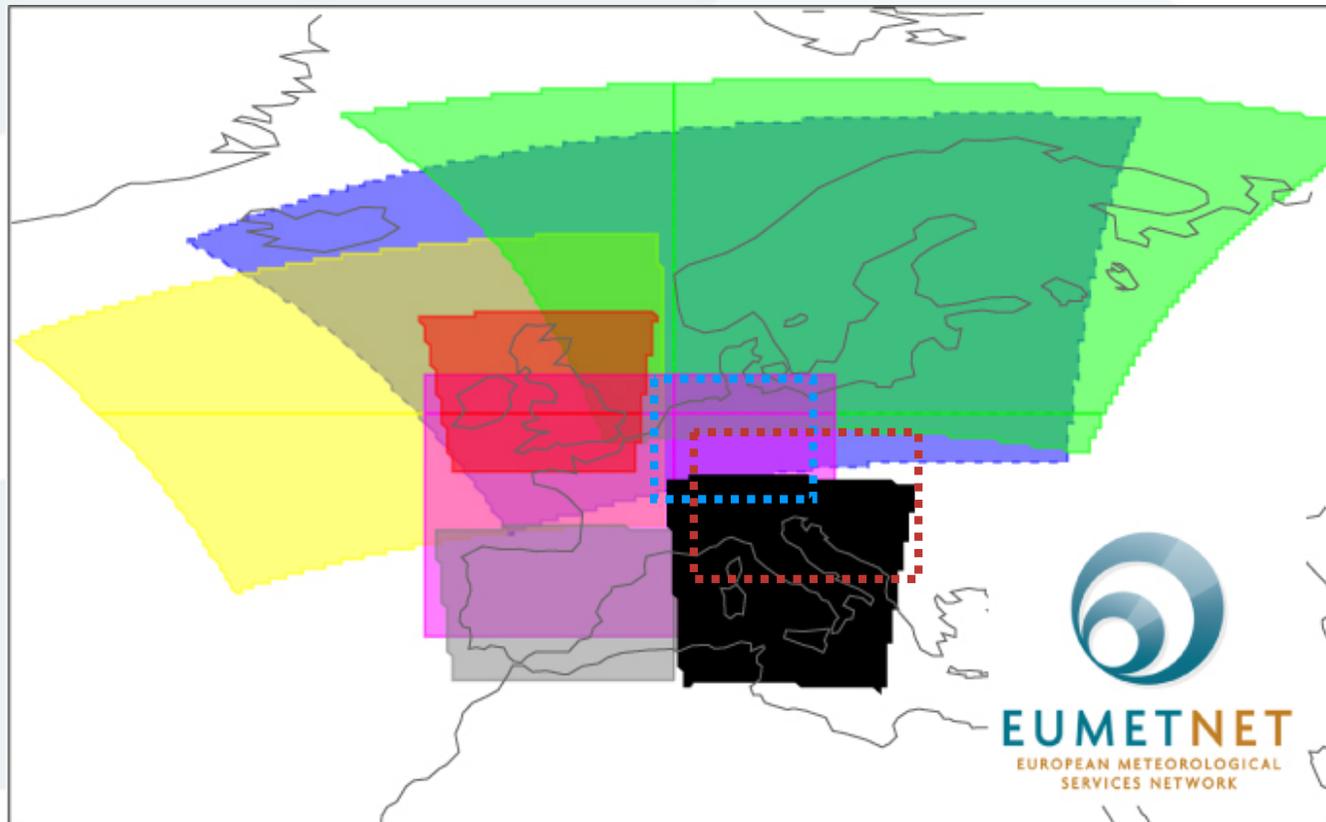
Thanks to ECMWF to collaborate holding and supporting the database

EUMETNET SRNWP-EPS Convection-permitting LAM-EPS database

Surface parameters from documentation

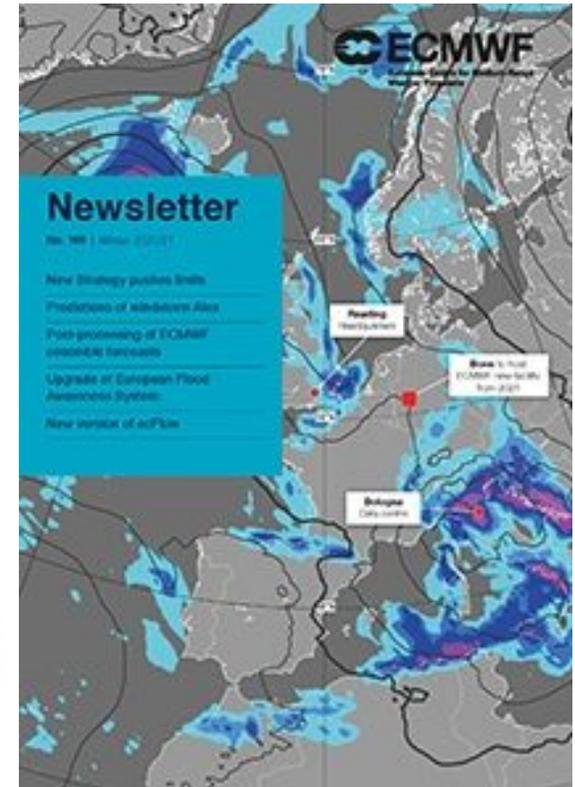
LIST OF SURFACE PARAMETERS	<p>Pmsl: mean sea level pressure</p> <p>Psurf: surface pressure</p> <p>T2m: screen level temperature</p> <p>T2mMAX and T2mMIN: daily maximum and minimum T2m</p> <p>U10m and V10m: the two components of 10 metres wind</p> <p>G10m: wind gust speed at 10m</p> <p>RH2m and/or Q2m: relative and/or specific humidity at 2m</p> <p>AccPcp: total accumulated precipitation from leadtime 0</p> <p>TCC: total cloud cover</p> <p>VIS: visibility</p> <p>LTG: lightning</p>
CONSTANT PARAMETERS	<p>ORO: orography</p> <p>LSM: Land-Sea mask</p>
FORMAT	GRIB on editions 1 and 2 (see GRIB Table)
ARCHIVING TIME DELAY	Expected from one day to one month later <i>But better archiving later than one month than never</i>

LAM-EPS domains and overlappings



- | | | | |
|---|--|--|--|
|  COMEPS |  IREPS |  MEPS |  MF-AROME-EPS |
|  MOGREPS |  γ SREPS |  IT-EPS |  ICON-D2-EPS |
| | | |  C-LAEF |

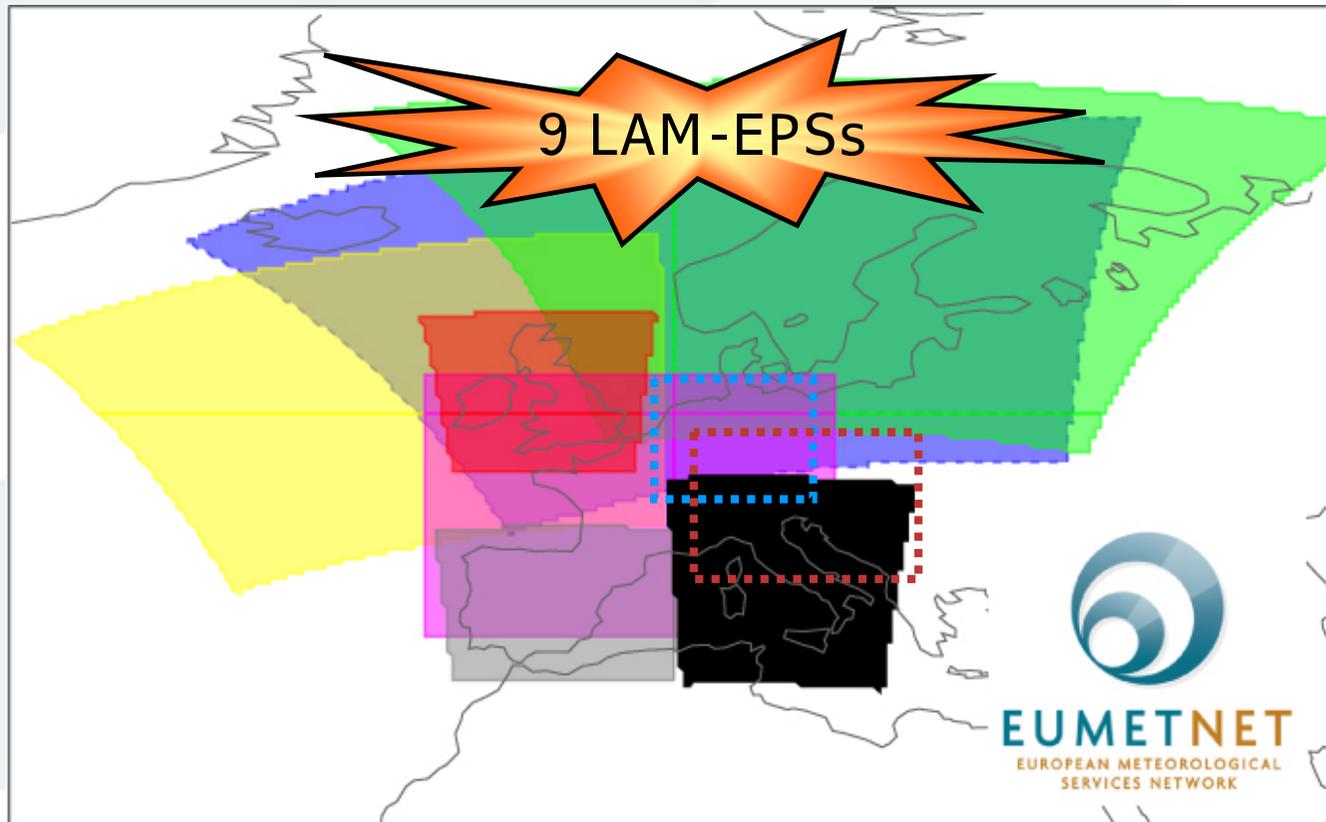
Domains



Newsletter No. 166 - Winter 2020/21

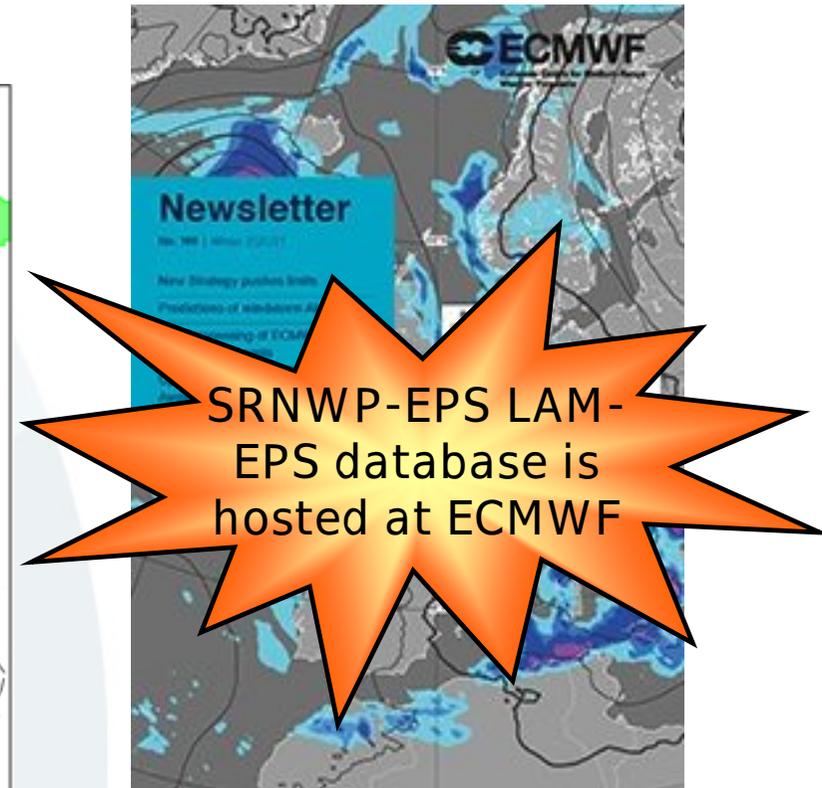
EUMETNET convection-permitting ensemble database hosted at ECMWF

LAM-EPS domains and overlappings



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| | | |  C-LAEF |

Domains



Newsletter No. 166 - Winter 2020/21

EUMETNET convection-permitting ensemble database hosted at ECMWF

srnwpepsDB STATUS

June 2021 → 9 LAM-EPS

2020 Joint EPS-PP workshop
 → **AGREE TO** archive continuously
 (at least until 31st December 2023)

LAM-EPS	Jun 2020	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2021	Feb	Mar	Apr	May	Jun	Jul	Aug
gSREPS AEMET sp0w															
IT-EPS ItAF-REMET cm1				+6											
mogreps-uk frar Met Office															
IREPS Met Eireann duah															
MEPS MetCoOp snh															
MF-AromeEps rmb MétéoFrance															
COMEPS DMI nhf															
ICON-D2-EPS gd0 DWD															
C-LAEF zat RC LACE															

LAM-EPSs database
 is open to everybody for:
 - Research
 - *Non-commercial use*

The... Chiara Marsigli
 and... Wastl for
 incorporate **ICON-D2-EPS**
 and **C-LAEF** respectively

Research Activities

In-kind



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Research activities

Quick summary

- Based on *SRNWP-EPS convection-permitting database*
 - Specific research archive*
- Focus on **HIW** and **convection**
- Coordinated **Research Plan** which is discussed in Annual Workshops

Research Task of the SRNWP-EPS Project

Coordinated research activity aimed at ensemble development

Focus on high-impact weather and convection.

Purpose: to improve our knowledge about the role of the different perturbations, by trying to answer some scientific questions. The final aim is to improve our ensembles.

All the ensembles are collected in a unique repository (LAM-EPS archive).

The scientific questions have been identified as follows:

1. What is the role of the different perturbations we apply to our ensembles? How do they influence the spread/skill relation, separately or when combined?
2. At what spatial scale are the ensemble members different?
3. What spatial scale is influenced by the different perturbations? *Comment AP: Are you there suggesting we try to constrain the ensembles for certain types of perturbations and share these new model runs? It could be a nice project indeed. CM: I am not sure to understand what you mean here ... this part is for me the most unclear. Also during the Stochastic Workshop, there was a lot of debate and uncertainty about how to discriminate the effect of the different perturbations (e.g. PP and SPPT) with depending on both the scale to which they are applied and the scale on which they show and effect. I think this could be a good point for discussion.*
4. At what spatial scale are the ensembles able to predict the considered phenomena? How does this vary with the geographical area? How does this vary with the type of event?
5. To what extent are these findings dependent on the method used to define the sensitivity to spatial scale (problem of the metric)?
6. What is the impact of combining the different ensembles, where possible?

In order to be able to answer these questions, analysis, comparisons, combination and verification will be performed, thanks to the data collected in the shared archive.

Research activities

Quick summary

- Coordinated **Research Plan** which is discussed in Annual Workshops
 - **Scientific questions**
 - Role perturbations
 - Significant *spatial scales* for members, perturbations, phenomena and so on.
 - Multi-ensemble
 - Looking answers through verification, analysis and diagnostic methods (common / **better metrics**):
 - Probability maps and time series
 - Reliable scale: FSS / dFSS-eFSS
 - Frequency HIW
 - Two variables spread correlation (I.Jankov)

Research Task of the SRNWP-EPS Project

Coordinated research activity aimed at ensemble development

Focus on high-impact weather and convection.

Purpose: to improve our knowledge about the role of the different perturbations, by trying to answer some scientific questions. The final aim is to improve our ensembles.

All the ensembles are collected in a unique repository (LAM-EPS archive).

The scientific questions have been identified as follows:

1. What is the role of the different perturbations we apply to our ensembles? How do they influence the spread/skill relation, separately or when combined?
2. At what spatial scale are the ensemble members different?
3. What spatial scale is influenced by the different perturbations? *Comment AP: Are you there suggesting we try to constrain the ensembles for certain types of perturbations and share these new model runs? It could be a nice project indeed. CM: I am not sure to understand what you mean here ... this part is for me the most unclear. Also during the Stochastic Workshop, there was a lot of debate and uncertainty about how to discriminate the effect of the different perturbations (e.g. PP and SPPT) with depending on both the scale to which they are applied and the scale on which they show and effect. I think this could be a good point for discussion.*
4. At what spatial scale are the ensembles able to predict the considered phenomena? How does this vary with the geographical area? How does this vary with the type of event?
5. To what extent are these findings dependent on the method used to define the sensitivity to spatial scale (problem of the metric)?
6. What is the impact of combining the different ensembles, where possible?

In order to be able to answer these questions, analysis, comparisons, combination and verification will be performed, thanks to the data collected in the shared archive.

Research activities

Quick summary

- **Specific** researches are organised in **groups** (not all participants):

e.g. **multi-ensemble**

(see next two slides examples)

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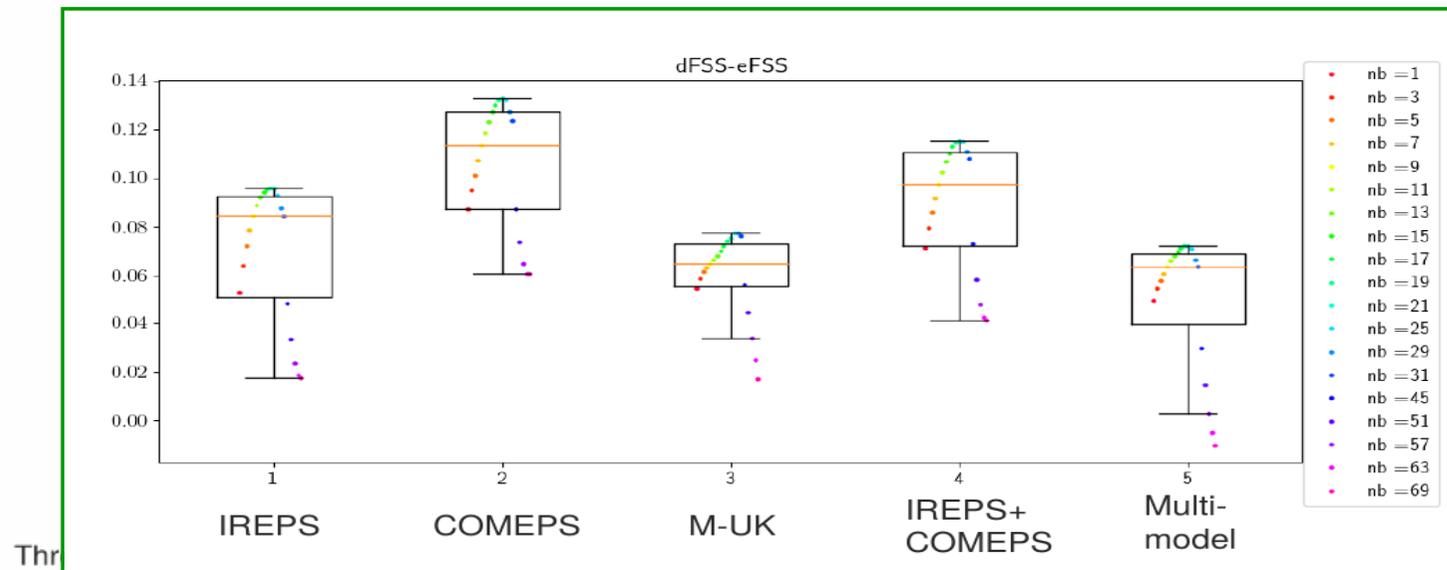
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EUMETNET SRNWP-EPS Convection-permitting LAM-EPS database

Research group on multi-Ensemble



Evaluate ensemble subjectively



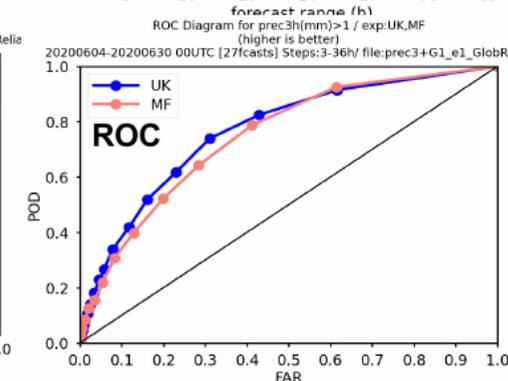
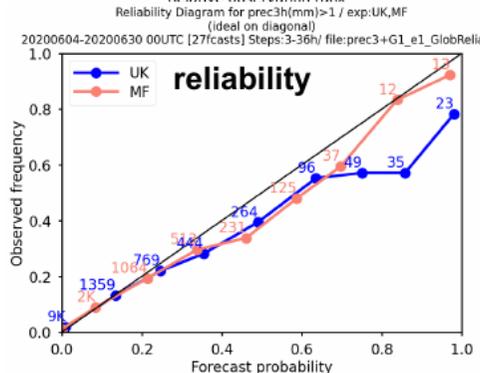
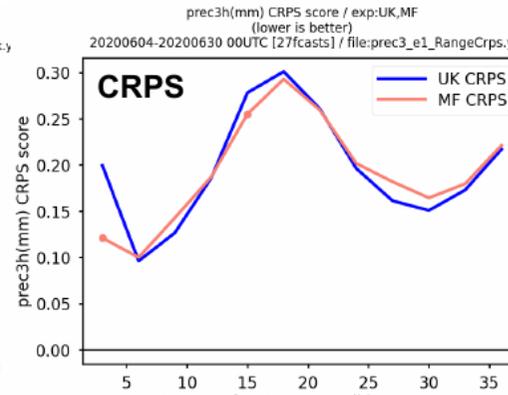
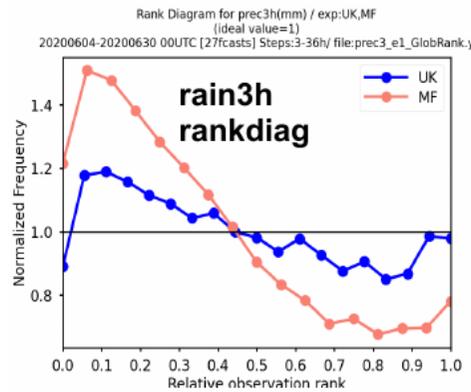
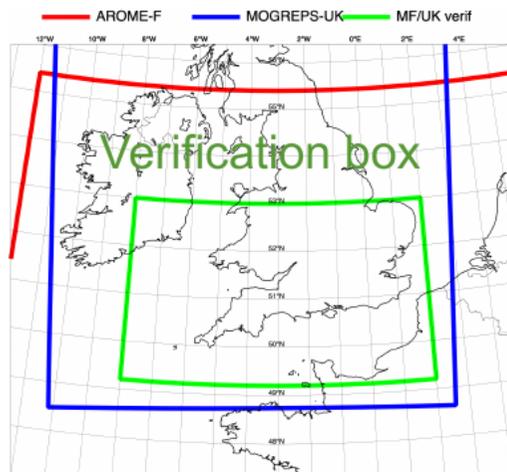
Managed by
Aurore Porson
(MetOffice)

- Development of subjective and objective metrics suitable for ensemble comparison and assessments, as viewed from the operational meteorology
- Fractions Skill Score analysis
- Comparison of rainfall structure, rainfall intensity and development of convection metrics

EUMETNET SRNWP-EPS Convection-permitting LAM-EPS database

Another research: LAM-EPS comparison on overlapping zones

- Arome-France-EPS and MOGREPS-UK are compared over June 2020 using same observations, over geographical overlap zone : (T2m, HU2m, ff10m, rain)
- ranges (T=00utc to T+36h), Nmembers (16 vs 18), analysis times (21utc vs 19-00utc).



Research done by
François Bouttier
(Météo-France)

SRNWP-EPS Annual Workshop



EUMETNET
EUROPEAN METEOROLOGICAL
SERVICES NETWORK

SRNWP-EPS annual meeting



EUMETNET 2019-2023

SRNWP-EPS workshop 2021

Workshop on "LAM-EPS verification on extremes and forecasting value chain for High Impact Weather"

26-28 October 2021, BlueJeans video-conference meeting

First Announcement

In the framework of the **SRNWP-EPS** module of the NWP Cooperation Programme (NWP-C) of EUMETNET, the Workshop entitled "LAM-EPS verification on extremes and forecasting **value chain** for High Impact Weather" will be organized in 2021 by videoconference due to pandemic situation.

The Workshop will take place during the last week of **October** 2021 tentatively from the **26th** to **28th** starting at **07:30 UTC** (09:30 CEST) and finishing at **10:30 UTC** (12:30 CEST) with two afternoon sessions devoted to non-European invited speakers or extra-discussions. It will be hold through **BlueJeans** video conferencing meetings.

The general aim of the Workshop is to bring together EPS scientists/developers and some forecast's users to discuss and about the quality and the usefulness of the LAM-EPS systems in forecasting high-impact weather, with the purpose to find out the strong and weak points and how it could be improved. In particular, it is expected to realise together a **practise/exercise on a value chain** approach, focusing on convective high impact weather and extremes.

Interested to assist e-mail to:

Alfons Callado (AEMET)

acalladop@aemet.es

Francesca Marcucci (ItAF-REMETS)

francesca.marcucci@aeronautica.difesa.it

Chiara Marsigli (DWD)

Chiara.Marsigli@dwd.de

Workshop 2021:

- **Value Chain**

Joint workshop 2022 with E-NWC (Franziska Schmid)

→ **Session into ENC2022**

European Nowcasting Conference

(~March, April)

- **EPS**
- **Nowcasting (E-NWC)**
- **Post-processing**



SRNWP-EPS annual meeting

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Confirmed speakers !!!
(Expecting two more)

- Dr. **Beth Ebert** (WMO-HIWeather) ⇔ *Value Chain*
- Dr. **Sebastian Lerch** (KIT) ⇔ *IA, ML, Extremes*
- Dr. **Maxime Taillardat** (Météo-France) ⇔ *Calibration on extremes*

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Value Chain will be introduced by Chiara Marsigli in the **Wednesday 14:00-16:00 Breakout Session on Predictability**

→ Dr. Ma

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Thank you for your attention

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Chiara.Marsigli@dwd.de Chiara Marsigli (DWD)

svn@meteo.be Stéphane Vannitsem (RMI)

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