The SRNWP-EPS II Programme

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Outline

- The SRNWP-EPS II Project
- Activities of the project:
  - Survey on ensemble systems
  - Application Task:
    - Calibration
    - Products for thunderstorms and fog
  - Research Task:
    - Coordinated experiments
  - Workshops
- Concluding remarks

The SRNWP-EPS II Project

- The enhancement of **cooperation on Limited-area Ensemble Prediction System** was recognized as a high priority goal by EUMETNET members when composing the Forecasting Roadmap
- The development of convection-permitting ensemble prediction capabilities in Europe is crucial for forecasting a range of weather phenomena and in particular to improve severe weather prediction
- The EUMETNET SRNWP-EPS Phase II has a main general aim: to contribute to build very high-resolution ensemble systems in Europe, resolving the convection-permitting scale phenomena

The SRNWP-EPS II Project

- Project duration: from the 1st of July 2015 to the 31st of December 2018
- The activity is organized as two complementary tasks:
  - An **application task**, where new products and methodologies for calibration of LAM ensembles for extremes and for probabilistic prediction of thunderstorms and fog are developed
  - A **research task**, where the sensitivity and complementarity of the models to soil conditions and PBL are studied on the basis of the forecast of selected phenomena (identified in the application task), on different areas with different LAM ensemble systems

The SRNWP-EPS II Project

- The work in the project is **phenomena oriented**
- Recognized that it is impossible to tackle all the topics for cooperation on ensemble in a single project, priority has been given to products for the high impact weather, here thunderstorms and fog
- This has oriented also the research work of the project, focused on understanding complementarity of the different European modeling systems in describing the uncertainties in PBL and soil model formulation

Participating Members

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EUROPEAN METEOROLOGICAL SERVICES NETWORK

arpae
agenzia prevenzione ambiente energia emilia-romagna

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

AEMet
Agencia Estatal de Meteorología

The survey: use of ensembles

Centre	name	ope	civil prot.	energy	aviation	project	various customers	public (web)
AEMET	IFS-ENS GLAMEPS SREPS	X	X	x	x	PreFlexMS	electric power network	
Arpae SIMC	COSMO-LEPS IFS-ENS	X	X	X		X	x	
COMET	COSMO-ME-EPS	X	X					
IMGW	TLE-	X				X COSMO PP		
IPMA	IFS-ENS GLAMEPS	X	X		x			
KNMI	GLAMEPS IFS-ENS	X	X		X			
MCH	IFS-ENS COSMO-LEPS COSMO-E	X	X	X (media n)			hydrological forecast (coupling)	
MeteoFrance	PEARP ECMWF	X	X	X	X		X	
Met.no	IFS-ENS GLAMEPS	X	x	X				
Met Office	MOGREPS-UK MOGREPS-G IFS-ENS	X					Coastal flood Fluvial flood (coupling)	
OMSZ	IFS-ENS ALADIN-EPS	X	X			X PROFORCE		
SHI	IFS-ENS PEPS ALADIN-LAEF NCEP GEFS	X		x			road maintenance, ski resorts	
SHMU	IFS-ENS ALADIN-LAEF lagged ensemble	x	x	x		X POVAPSYS II EFAS		x
SMHI	IFS-ENS GLAMEPS	x	x	x				X
ZAMG	ALADIN-LAEF IFS-ENS	x		x				

The survey: forecasters' feedback

- **Useful features**:
  - forecast in terms of probability (especially useful for severe weather/ extreme events), provides estimation of uncertainty, long range forecast available in ECMWF ENS
- **Drawbacks**:
  - lack of spread, lower spatial resolution, lack of consistency, uncertainty in the interpretation of the probabilities

The survey: calibration

Centre	Status	variable	method	application	focus on extremes
AEMET	plan	t, wind, tp	not decided	no	no
Arpae SIMC	ope	tp	analog	hydrology	no
COMET	devel	tp (both for point and gridded values)	Reliability calibration, quantile-quantile mapping + Bremnes	no	no interest: t, tp, wind
IMGW	plan	t, wind, mslp, tp	Multiple LR, LG for tp	no (road and energy considered)	no interest: t, tp, wind. users: road and energy
KNMI	ope	wind, t, tp	Gaussian, Box-Cox-t	no	no
MCH	ope	tp, t, wind	Quantile mapping (reforecast)	no	yes (same)
MeteoFrance	ope	tp, reflectivity, gusts	Quantile optimization	yes	no
Met.no	plan	tp, t, wind, cloud, lightning	Fit statistical distribution (gamma for tp)	no	no
Met Office	devel	t, tp, wind	EMOS	no	no (interest: tp, wind)
ZAMG	devel	t, tp, wind	LG, BMA, NGA	no	no

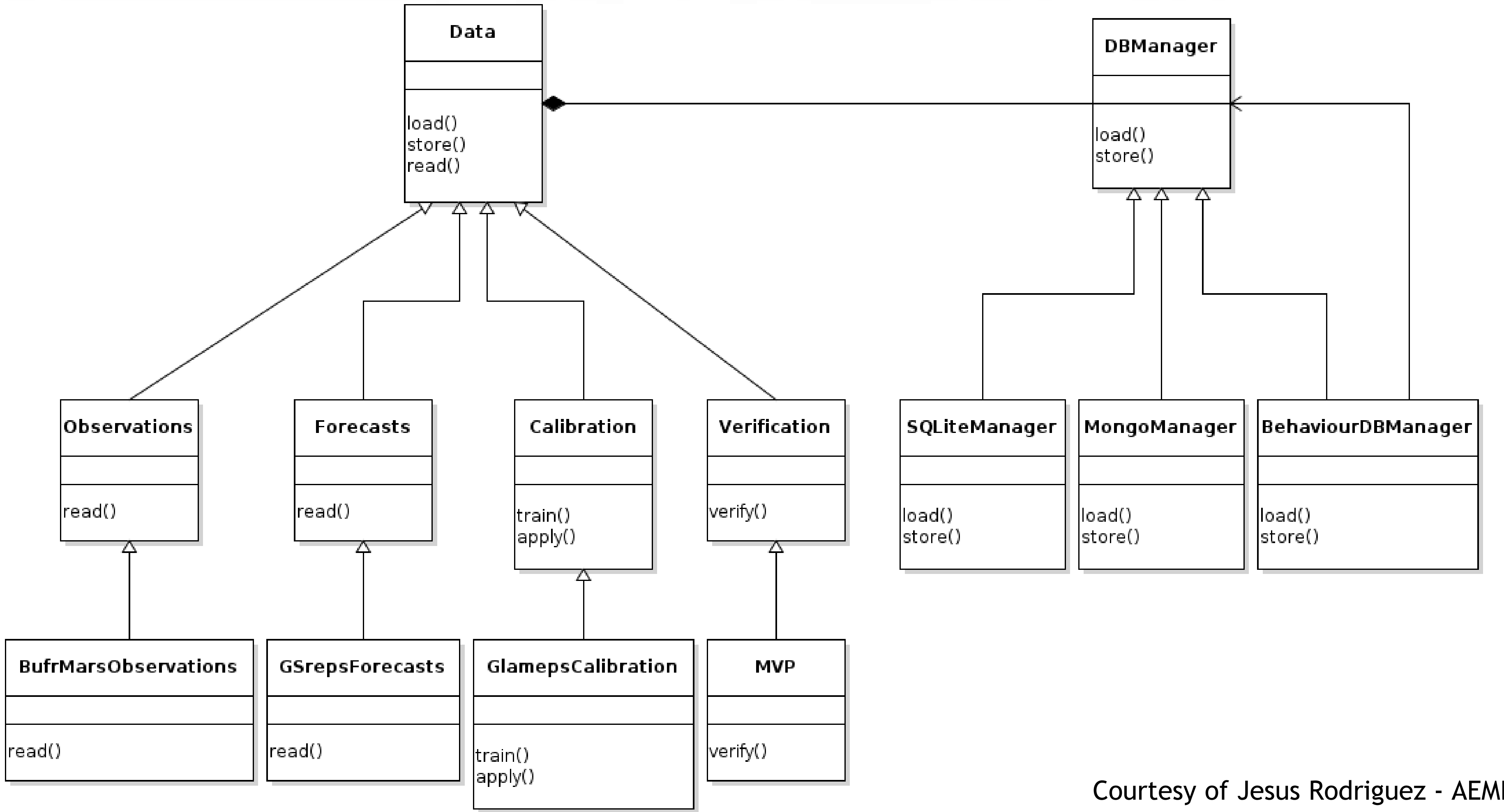
Application task

- Define and develop new products and methodologies for computation/elaboration:
  - calibration of ensemble outputs, mainly for extremes (wind, precipitation, temperature, …) -> **AEMET**
  - products for probabilistic prediction of thunderstorms and fog (focus on selected phenomena) -> **COMET**

SRNWP-EPSII Calibration Features

- Tool to calibrate the ensemble variables t2m and s10m
- Easy adding new vars
- High modularity
- Easy fitting to your needs
- Reusing your own databases
- Motivation for team working
- Faster developing of the full system
- Each specialist can work in
- Reduce costs O(N5) to O(N)

Calibration components



Courtesy of Jesus Rodriguez - AEMET

SRNWP-EPSII Calibration Framework status

	Implemented	Tested in AEMET	Setup on ECMWF	Tested on ECMWF
Bufr reader	✓	✓	✓	✓
Grib reader	✓	✓	✓	✓
Observation classes	✓	✓	✓	✓
Forecast classes	✓	✓	✓	✓
Calibration classes	✓	✓	✓	✓
Verification classes	✓	✓	✓	✓
Database Subsystem	✓	✓	✓	✓

Courtesy of Jesus Rodriguez - AEMET

Products

FOG:

- Create a tool that combines selected methods in order to maximize the benefits of each one, reducing false alarm.

THUNDERSTORM:

- Similarly to the approach of fog forecasting, create a tool which combines different stability indices, helicity and lightning indices.

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Fog forecasting tool *(fortran code)*

- **Input**:

  standard GRIB1/GRIB2 fcst from different models (defined by configuration namelist)

- **Output**:

  horizontal visibility [m] at surface computed with different algorithms

  + precipitation reduction (optional)

- **Methods**

  - Boudala et al., 2012 (minimum set of input parameters ... only surface fields T,Td,Ps,UV)
  - LWC (surface fields + T,Q,P,UV fields at lowest model level + qi,qc,qr,qs,qg)
  - Zhou, 2011 (surface fields + T,Q,P,UV vertical information at least in the first 500 m)
  - UPS approach (surface fields + T,Q,P,UV vertical information at least in the first 1200 m + 0-24 hours fcst of TD2m and T2m)
  - combined methods + correction for visibility reduction by precipitation

input parameters

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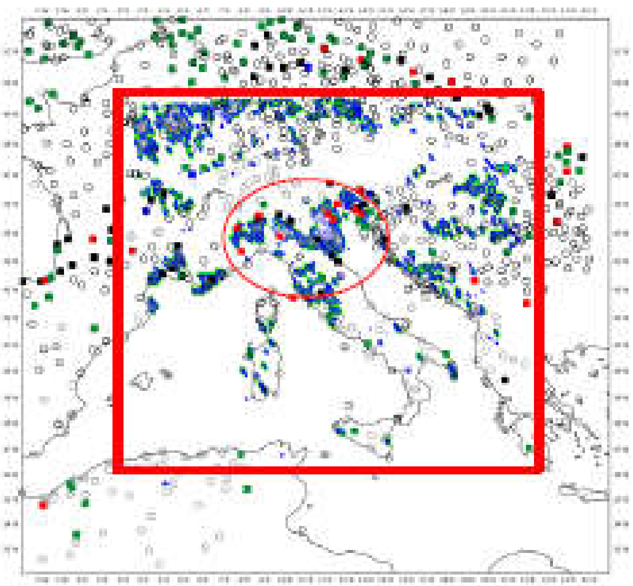
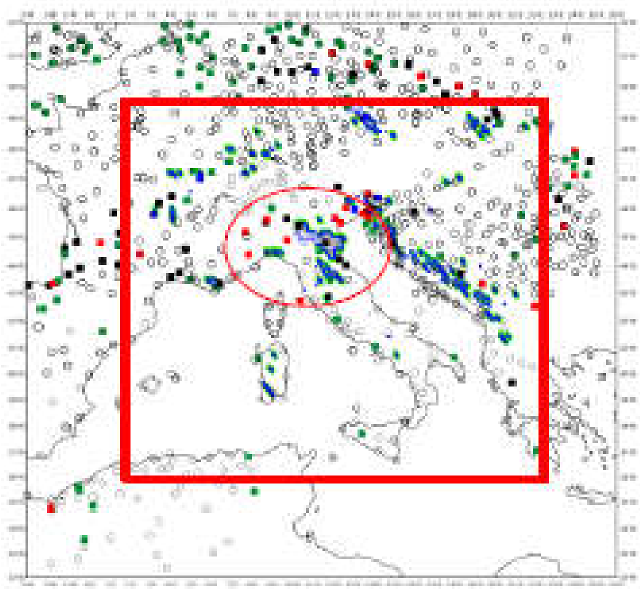
Results with regional NWP model outputs:
COSMO-IT (2.8 km, Italian domain)

23 March 2017, 06UTC, T+30h

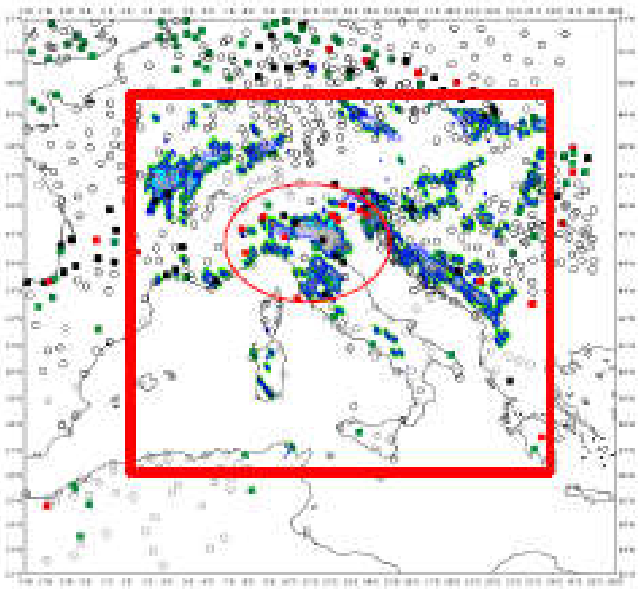
Zhou



LWC



Boudala



OBS	■	1-500	■	500-1000	■	1000-2000	■	2000-5000	O	> 5000
FCST	▭	1-500	▭	500-1000	▭	1000-2000	▭	2000-5000	▭	> 5000

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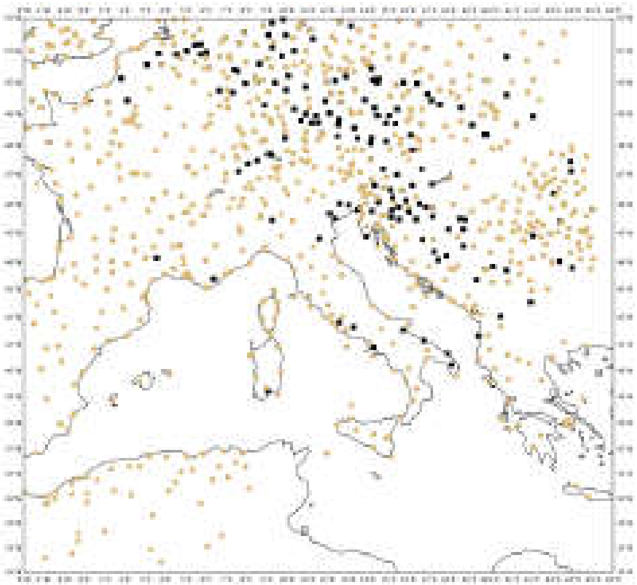
Results with regional NWP model outputs:

COSMO-ME EPS (7 km, Euromediterranean domain)

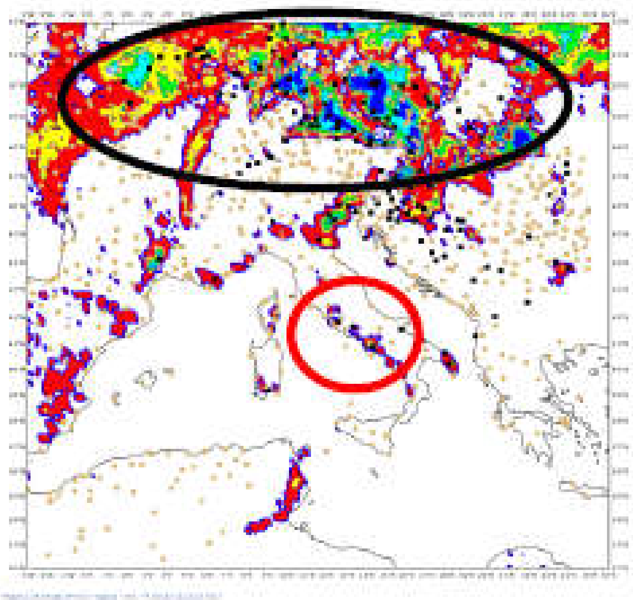
Probabilities of visibility < 1000 m

18 October 2017, 06UTC

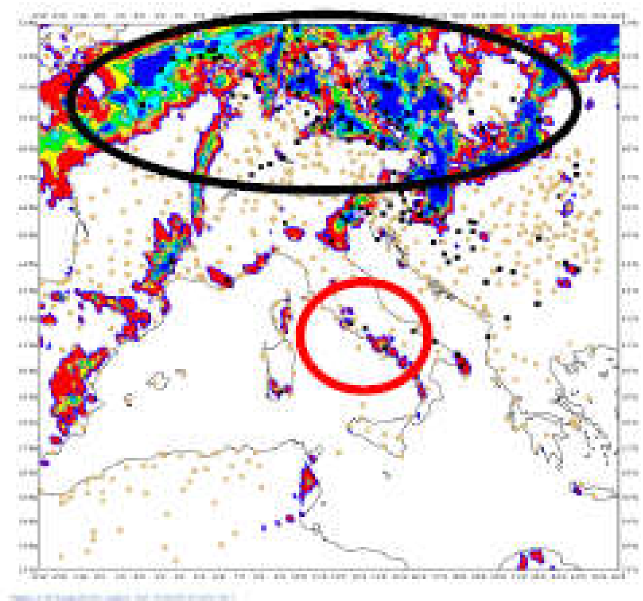
OBS



Zhou



Boudala



OBS ● > 1000 m ■ < 1000 m

PROBABILITY 1-20% 20 - 40% 40 - 60% 60 - 80% 80-100%

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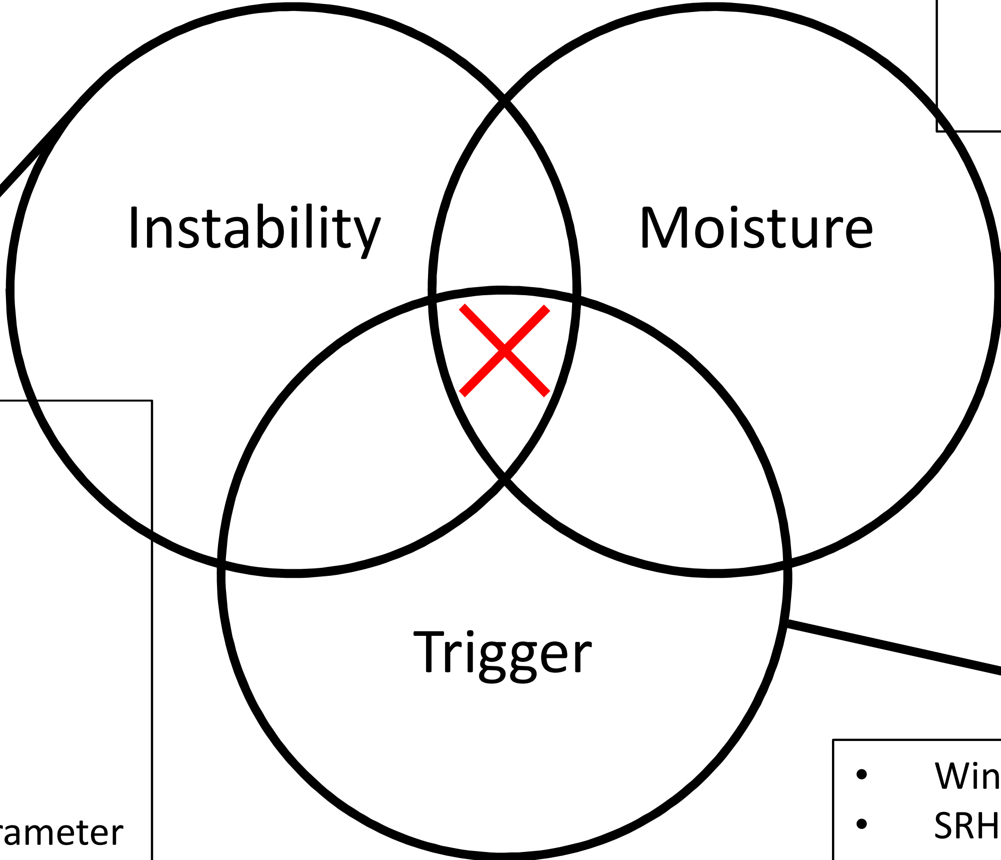
Introduction: Thunderstorm ingredients

Post processing of standard model output through combination of different ingredients

- RH vertical integral (0-3 km)
- Wet bulb temperature@850 hPa

(Total Totals index, K index)



- Total Totals Index
- CIN
- CAPE
- K Index
- Jefferson Index
- Showalter Index
- KO Index
- Dynamical tropopause
- Cloud Physics Thunder Parameter (CPTP)

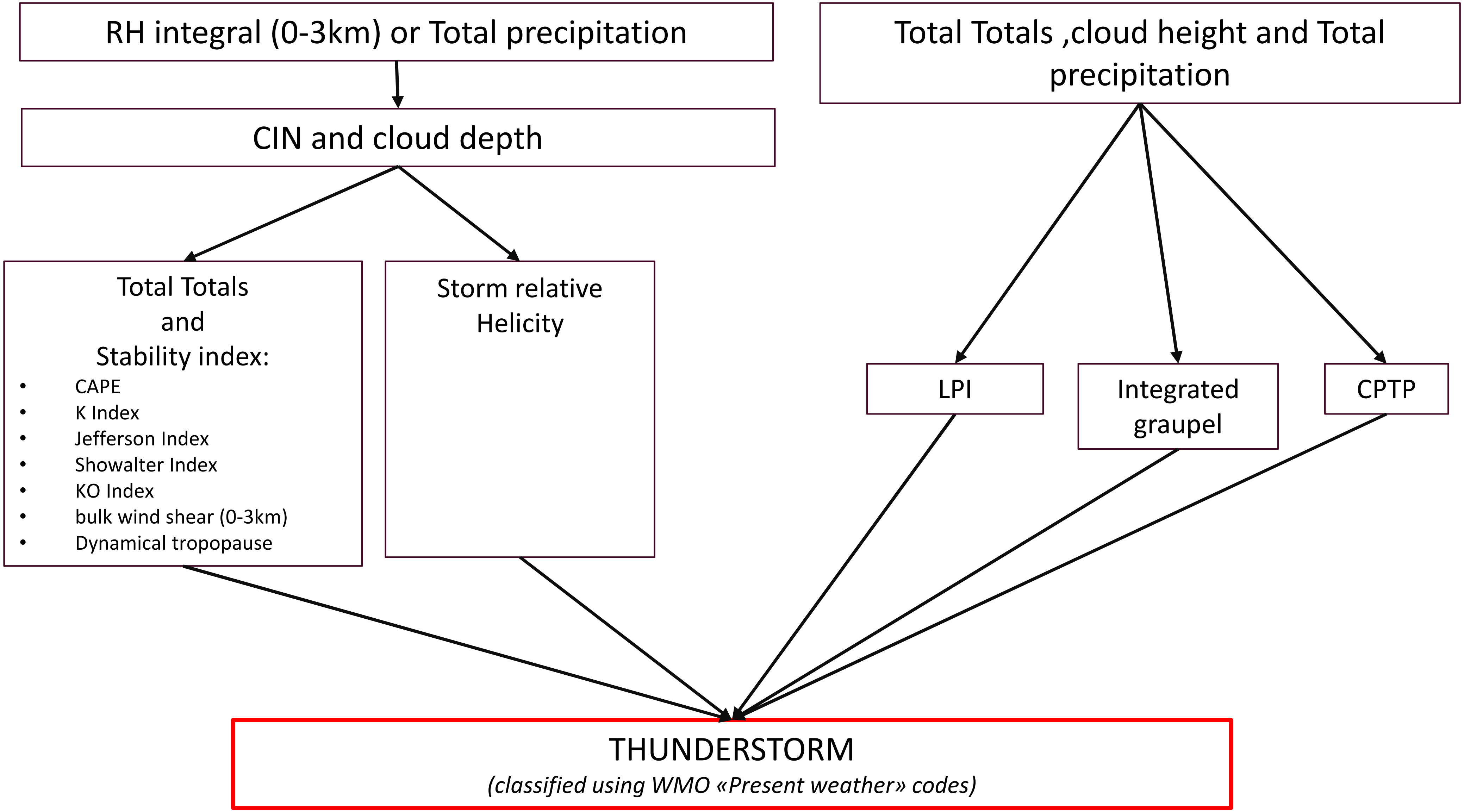
- Wind shear (0-6 km)
- SRH
- Orography

Is also used:

•Integrated graupel

•Lightning potential index (LPI)

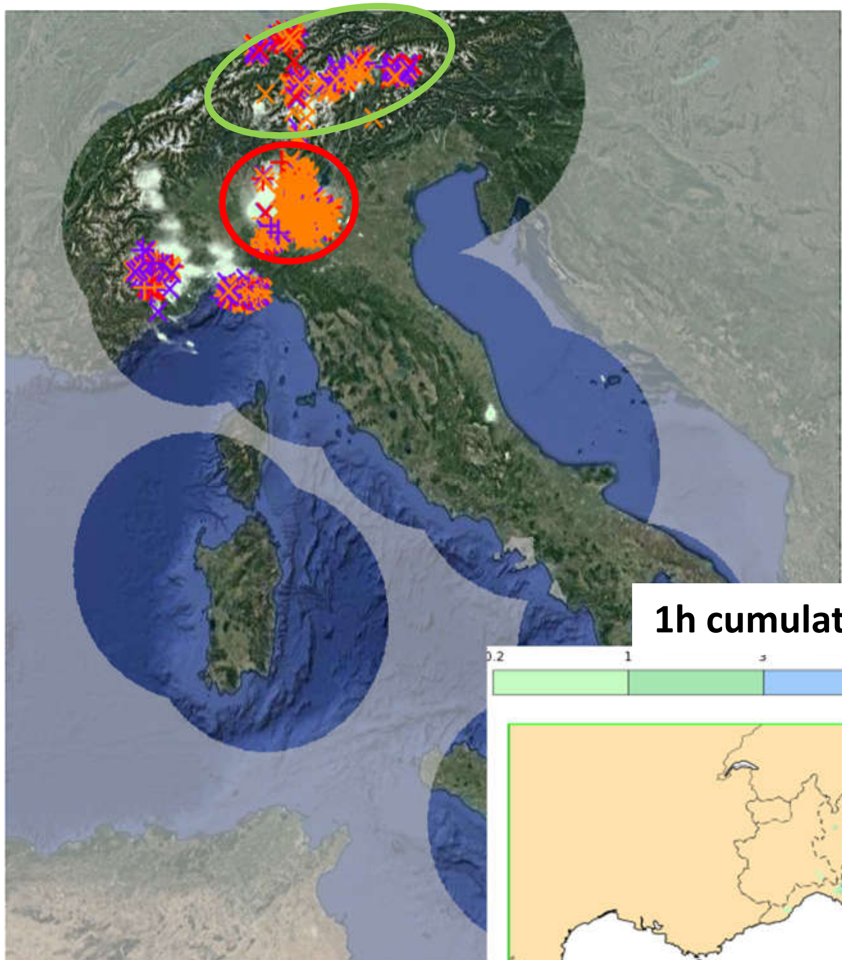
«TH-code» Forecast tree (current implementation … to be refined)



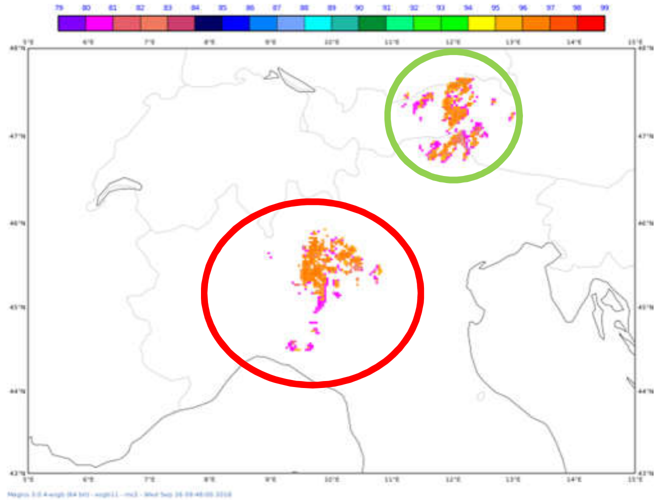
Test case

COSMO-IT (2.8 km), 29july2017 run 00UTC

2017/07/29 21:00 UTC



TH-code output

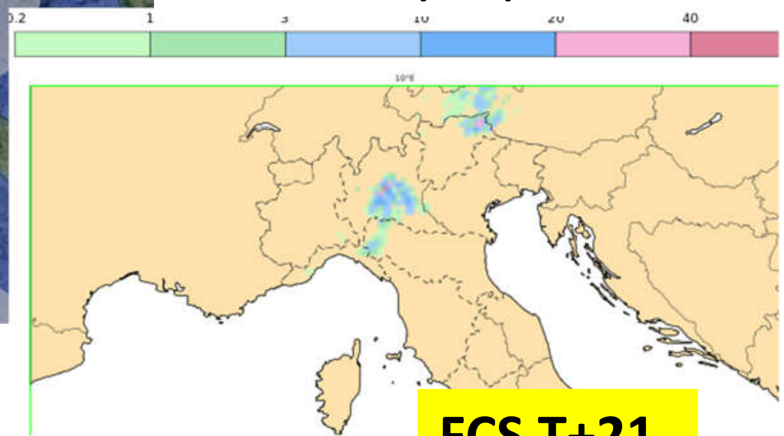


FCS T+21

95 TH

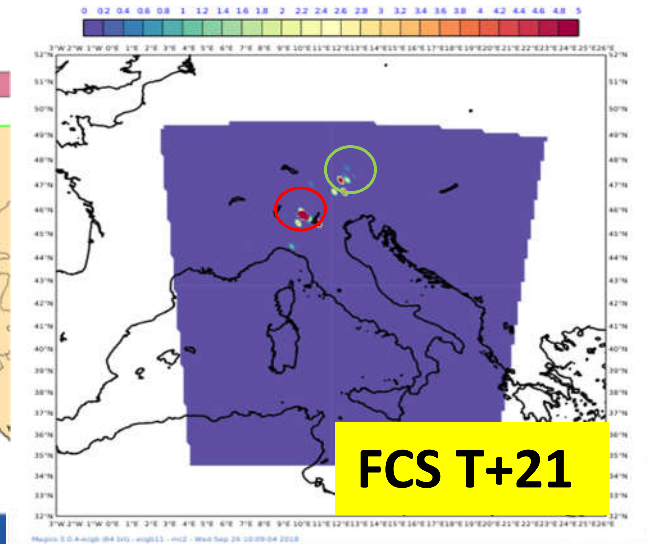
80 SH

1h cumulated precipitation



FCS T+21

LPI (Lynn and Yair (2010))



FCS T+21

INPUT (grib 1 and/or grib 2):

Fields on vertical model levels:

- ✓CAPE and CIN (computed if not present)
- ✓heights/pressure
- ✓Temperature
- ✓Relativity Humidity
- ✓Wind speeds
- ✓Convective cloud base/top(computed if not present)
- ✓specific content: q, q_c,q_r,q_s,q_i(the code checks the presence of q_g)
- ✓Cloud Cover

Surface fields:

- ✓Total precipitation
- ✓orography
- ✓2 m Temperature
- ✓2m Relative humidity (or T_d2m or q_2m)
- ✓10 m wind speeds
- ✓Surface pressure or meansea level pressure)

Research task: main research lines in the NMSs

- Addressing (or improving) the representation of the initial condition uncertainty (ensemble data assimilation methods)
- Improving the representation of the model error (stochastic perturbation of tendencies or perturbation of physical processes)
- Including perturbation of land surface (initial conditions, parameters, SPPT)
- Multi-physics and random parameters
- Work on lagged-based approach and post-processing

Common testing

- common testing of ensembles run on different regions -> **focus on "similar" events**
- the common focus on the selected weather phenomena (mainly thunderstorms and fog) provides the common basis of this work, allowing a meaningful exchange of the results
- periods and cases can be different for the different NMSs but they should include "similar" phenomena
- each project participant has identified test periods including cases of significant thunderstorms and fog
- each NMS tests the impact of their own perturbation method(s) on their own ensemble and on their own domain

Participation

Denmark:

Harmonie-DKA domain, horizontal resolution 2.5 km; 65 vertical levels.

Hungary:

AROME-EPS, horizontal resolution 2.5 km; 60 vertical levels.

Italy:

COSMO-IT-EPS, horizontal resolution 2.2 km; 65 vertical levels.

Netherland:

Harmon-EPS

Norway and Sweden:

Sweden and Norway have a shared convection permitting ensemble system.

MEPS is based on Harmonie, horizontal resolution 2.5 km; 65 vertical levels.

Poland:

TLE-MVE ensemble (COSMO), horizontal resolution 2.8 km; 50 vertical levels.

Spain:

gSREPS, based on a multi-model, horizontal resolution 2.5 km.

The Workshops

- WS1:
  - Workshop on “Probabilistic prediction of severe weather phenomena”, 17-19 May 2016, Bologna (I)
  - talks and reports available at: http://www.arpae.it/dettaglio_notizia.asp?idLivello=32&id=7654
- WS2:
  - Workshop on “Probabilistic prediction of severe weather phenomena”, 24-26 October 2017, Madrid (E)
- WS3 (joint with ASIST Project):
  - Workshop on “Connecting Nowcasting and mesoscale EPS”, 16-18 May 2018, Bologna (I)
  - talks and reports available at: https://www.arpae.it/dettaglio_evento.asp?id=2701&idlivello=1530
- WS4:
  - Workshop on “Probabilistic prediction of severe weather phenomena: ”, 23-25 October 2017, Barcelona (E)

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Some achievements from the Workshops

- Invite experts, contributing with talks and taking active part to the discussion
- Monitor the status of the application task
- Share and discuss the results of the experiments coordinated by the reserach task:
  - Understanding the different model perturbation methods
  - Identify common problems
  - Highlight open issues in the working groups and exchange experiences, also w.r.t. users
- Exchange results and open issues with experts from other fields (Nowcasting, physics)

Concluding remarks

- The development of convection-permitting ensemble predictions in Europe is crucial to improve severe weather prediction
- New SW package for calibration of ensemble output
- New SW for product generation (thunderstorms and fog)
- The project has guaranteed a dedicated exchange in the ensmeble European community, beside the C-SRNWP coordination,
- Workshops, focussed on relevant topics, have been judged as very useful
- There is a general shared understanding about model perturbations
- Interest in high impact weather and user oriented products

SRNWP-EPS Phase II

Thank you for your attention!