γ-SREPS

Convection-permitting LAM-EPS at Spanish Met Agency

NCEP seminar

AEMET Predictability Group

Alfons Callado

J.A. García-Moya, *C. Santos*

Pau Escribà, Marc Compte

Overview

- Who are we ? AEMET predictability group
- What have we done and learnt ? SREPS
- What are we currently doing ?
  - AEMET-γ-SREPS
- Why multi-boundary multi-NWP LAM-EPS ?
- WRF-NMM / NMMB in γ-SREPS
- Running γ-SREPS example
- In what are we more worried ?
  - Horizontal and vertical resolution of BCs
- Future development
- My NCEP-NMMB questions

Who are we ?

Spanish Meteorological Agency (AEMET): Predictability group

- Since 2002 an small group of people working on **Limited Area** (LAM) **Ensemble Prediction Systems** (EPS)
- Members of GLAMEPS/HarmonEPS (HIRLAM)

- Current people on the group:
  - **José Antonio García-Moya**: **BCs** and experiments on all aspects of EPS
  - **Pau Escribà**: assimilation: **LETKF**
  - **Alfons Callado**: next operational EPS and model error: **SPPT**
  - **Marc Compte** (scholarship): next EPS
  - **Carlos Santos** (collaboration): verification

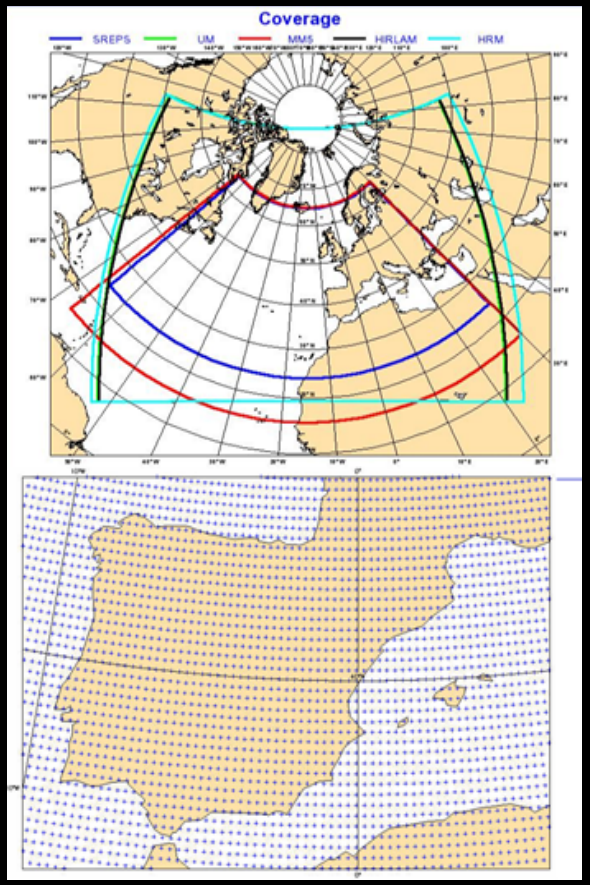
What have we done and learnt ?

AEMET-SREPS

- We run a LAM_EPS called **AEMET-SREPS** since 2006 until 2014
- It was multi-model and multi-boundaries (García-Moya et al., 2011)
- There were 20 members giving a 72 hours forecast two times per day (00 & 12 UTC)
- The horizontal resolution was 0.25 deg (~25 Km horizontal resolution) and it has 40 levels in the vertical

SREPS stands for Short-Range Ensemble Prediction System.

Configuration of AEMET-SREPS



Models / Boundaries	CMC_GEM	DWD_GME	ECMWF_IFS	JMA_GSM	NCEP_GFS
HIRLAM	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop
HRM	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop
LM	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop
UM	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop	HH+024 Graphics Loop

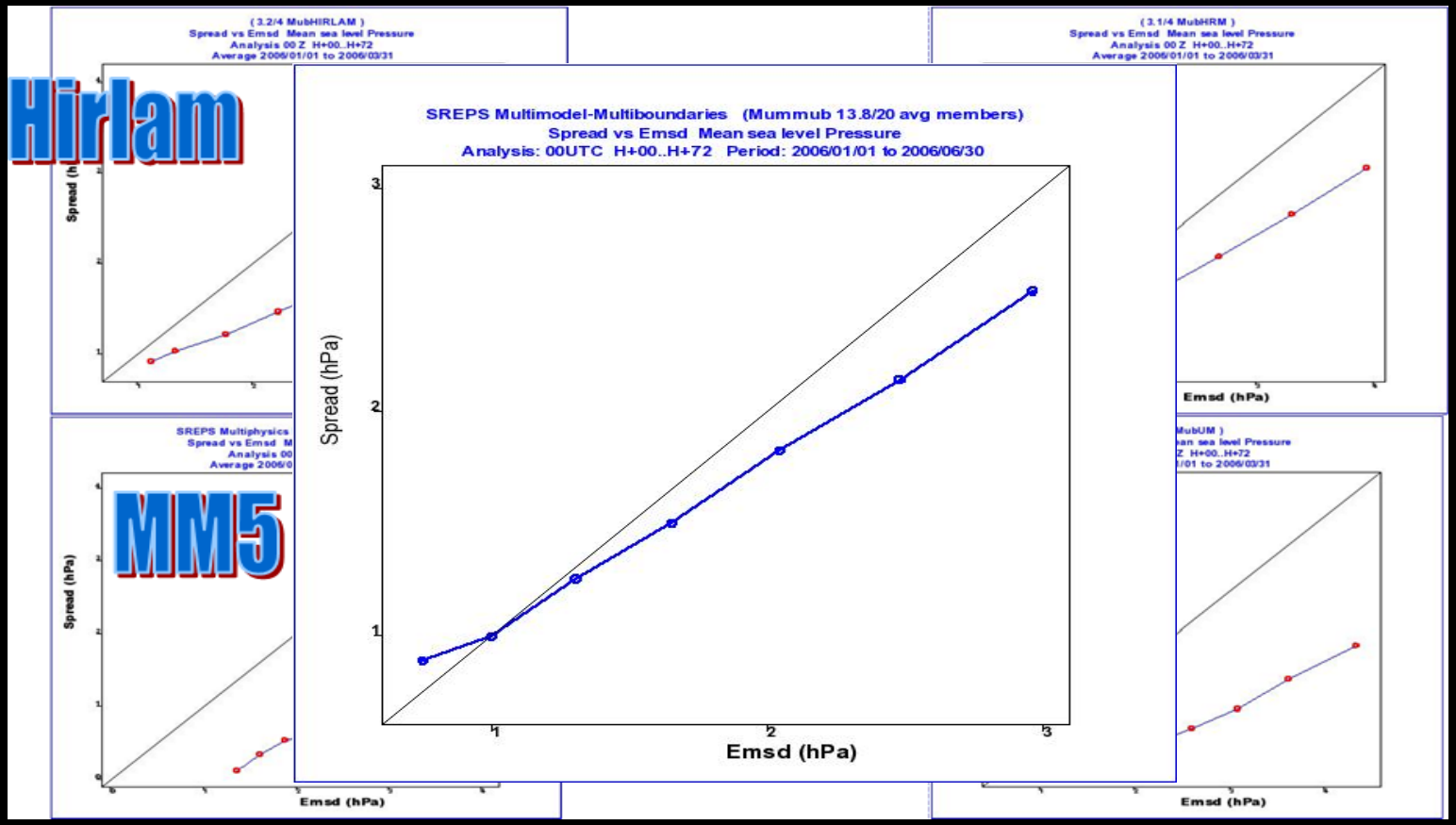
25-members on AEMET-SREPS: at some point we have MM5 NWP model. But we have to drop it due to use a lot of HPC resources.

What we have learned from AEMET-SREPS

- **Multi-model** seems to be the best strategy for sampling model error
- Using **different global models as boundaries** seems to give the best spread in the short range
- The skill of the ensemble saturates around 25 members for non-extreme events but not for extreme events
- **Time-lagged super-ensembles** give additional quality almost for free
- **Resolution matters**

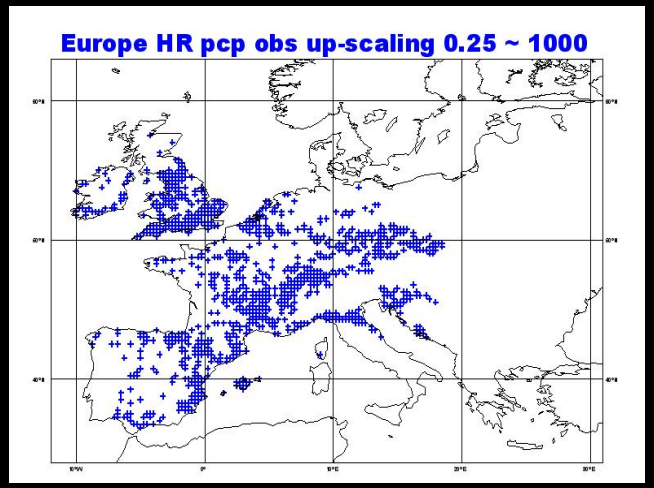
What we have learned from AEMET-SREPS

- **Multi-model** seems to be the best strategy for sampling model error: **Pmsl SPREAD-SKILL relationship**

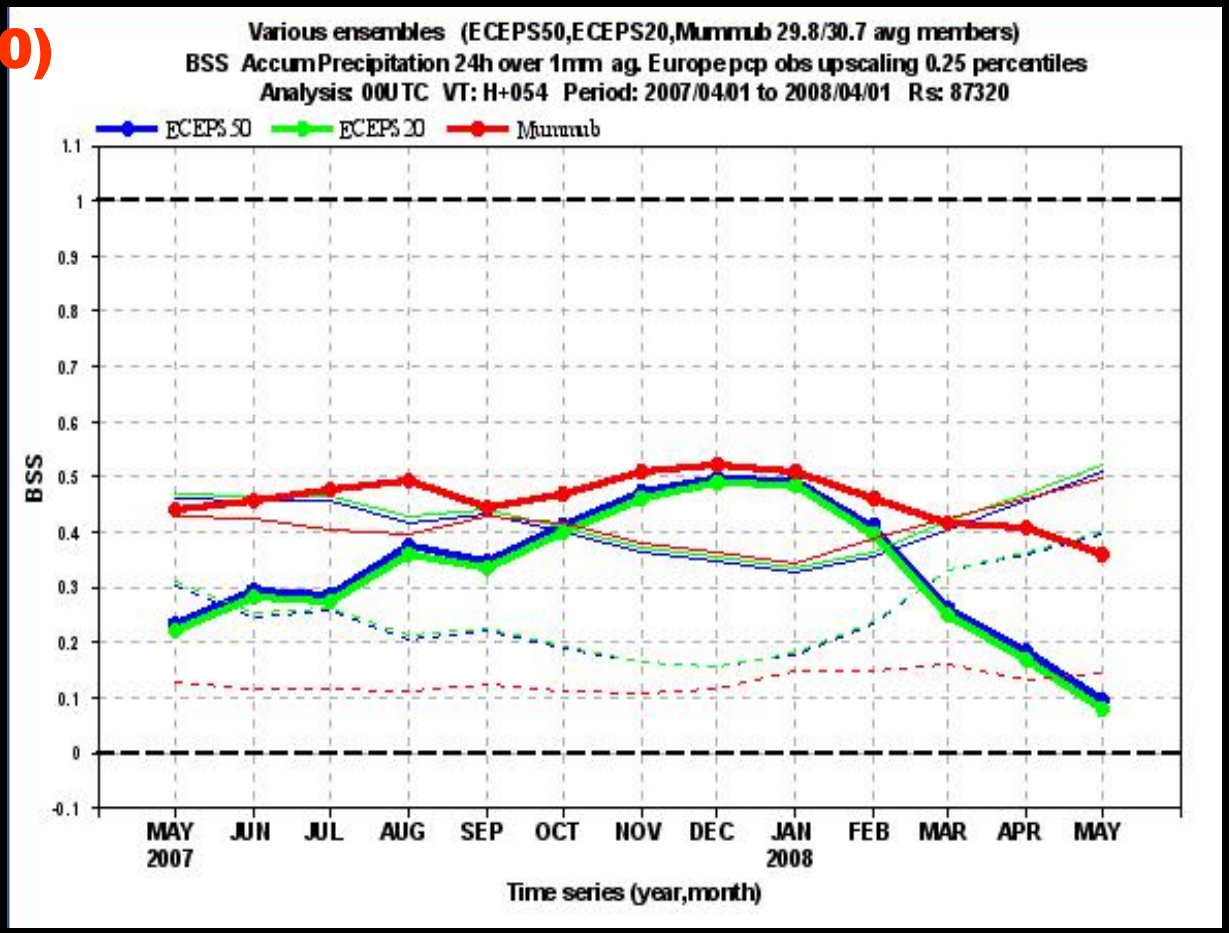


What we have learned from AEMET-SREPS

- **Resolution matters**: AEMET-SREPS better than ECMWF-EPS
- The skill of the ensemble saturates around 25 members for non-extreme events but not for extreme events. Comparison with ECMWF-EPS: **24-Acc Pcp BSS**
  - AEMET-SREPS (20)
  - ECMWF-EPS (21)
  - ECMWF-EPS (51)

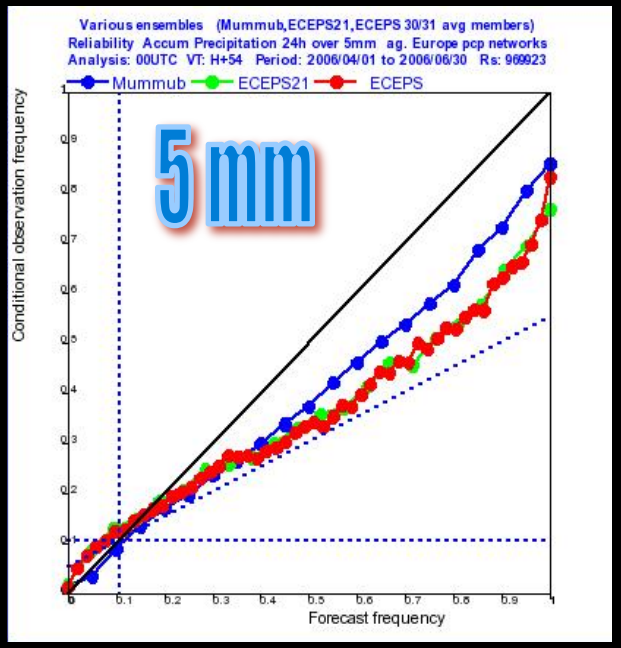


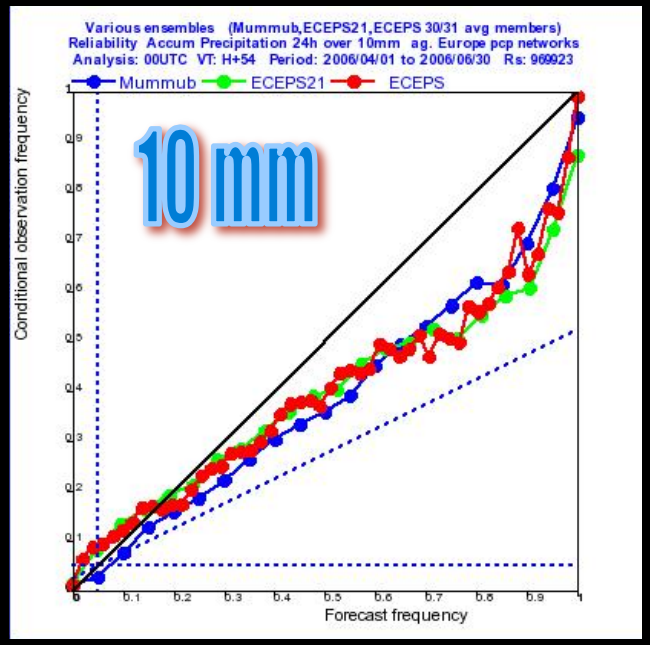
Upscaled observations.

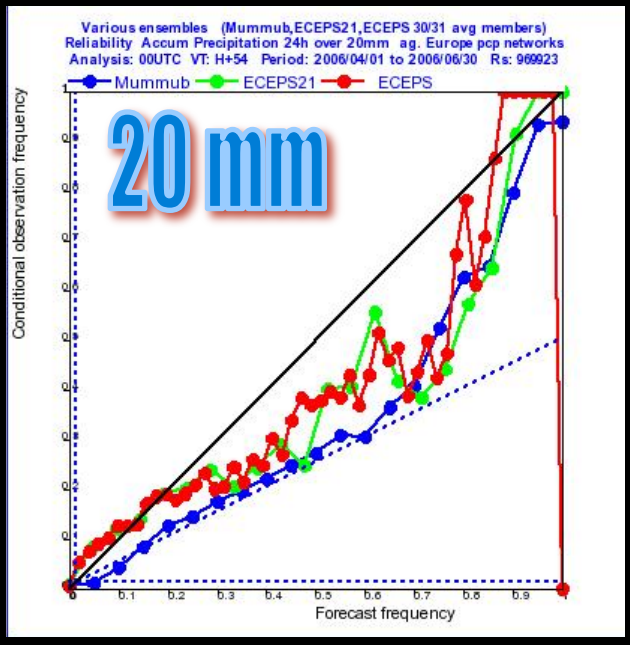


What we have learned from AEMET-SREPS

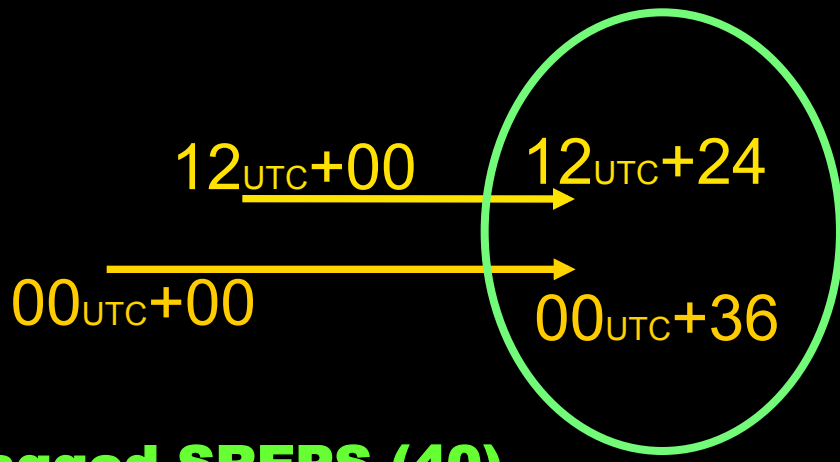
- The skill of the ensemble saturates around 25 members for non-extreme events but not for extreme events. Comparison with ECMWF-EPS: **24-Acc Pcp Reliability**
  - **AEMET-SREPS**
  - **ECMWF-EPS (21)** & **ECMWF-EPS (51)**





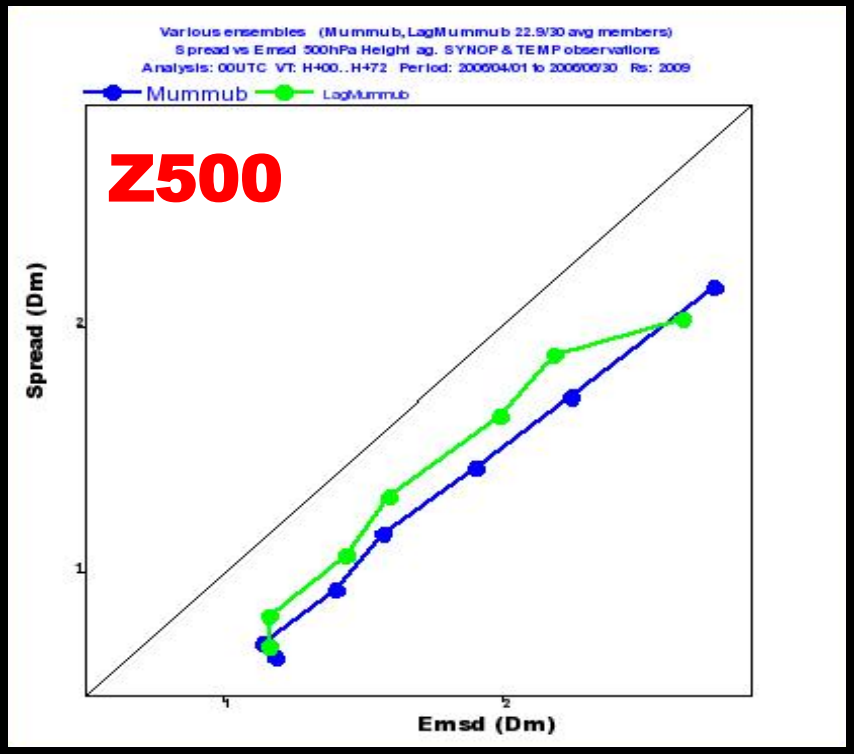


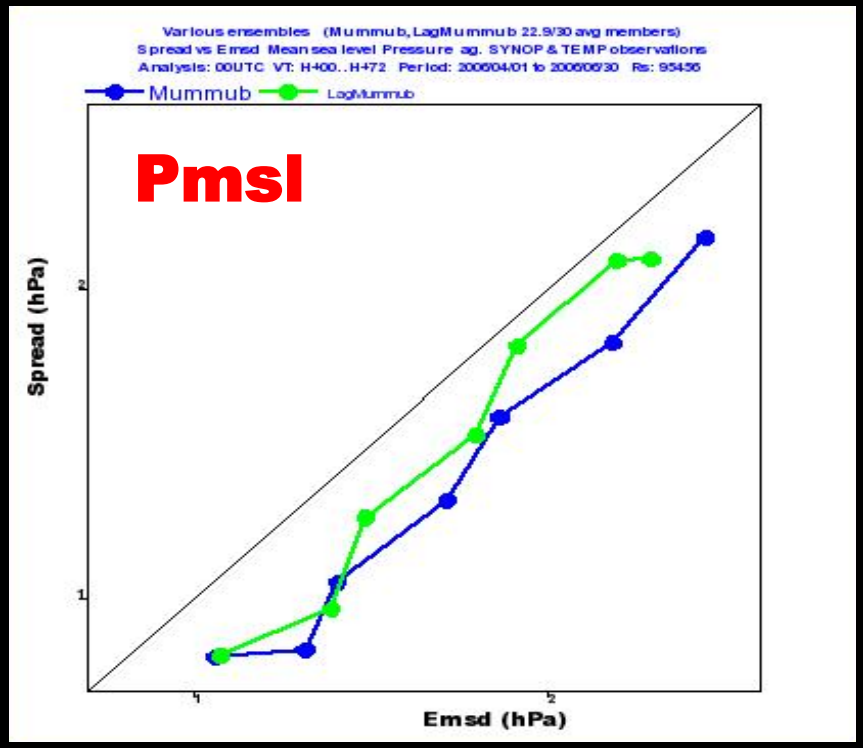
What we have learned from AEMET-SREPS



- **Time-lagged super-EPS** give additional quality almost for free; **SPREAD-SKILL**

Lagged SREPS (40)
Non-Lag. SREPS (20)

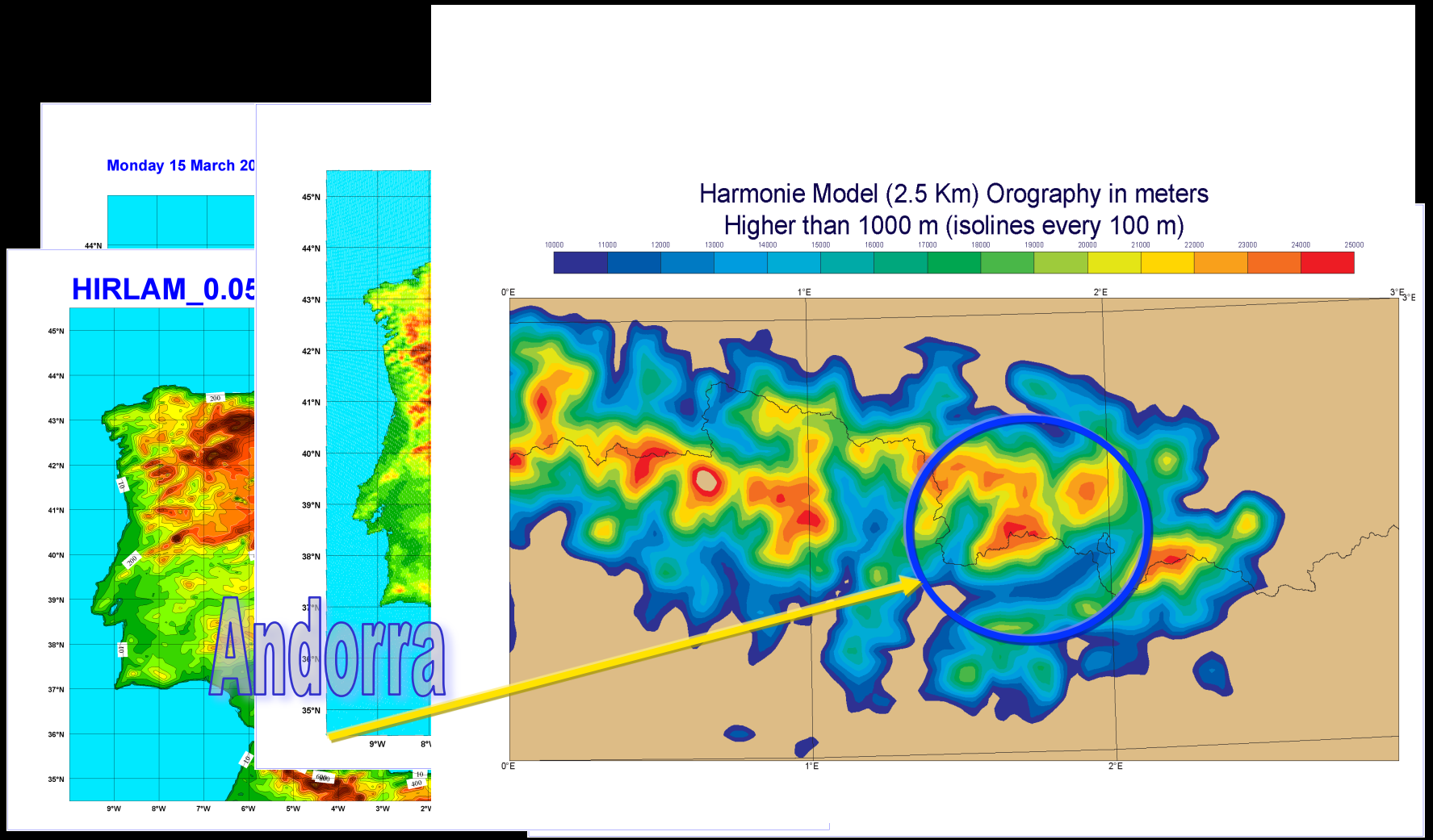




Smooth transition between cycles: appreciated by forecasters ...

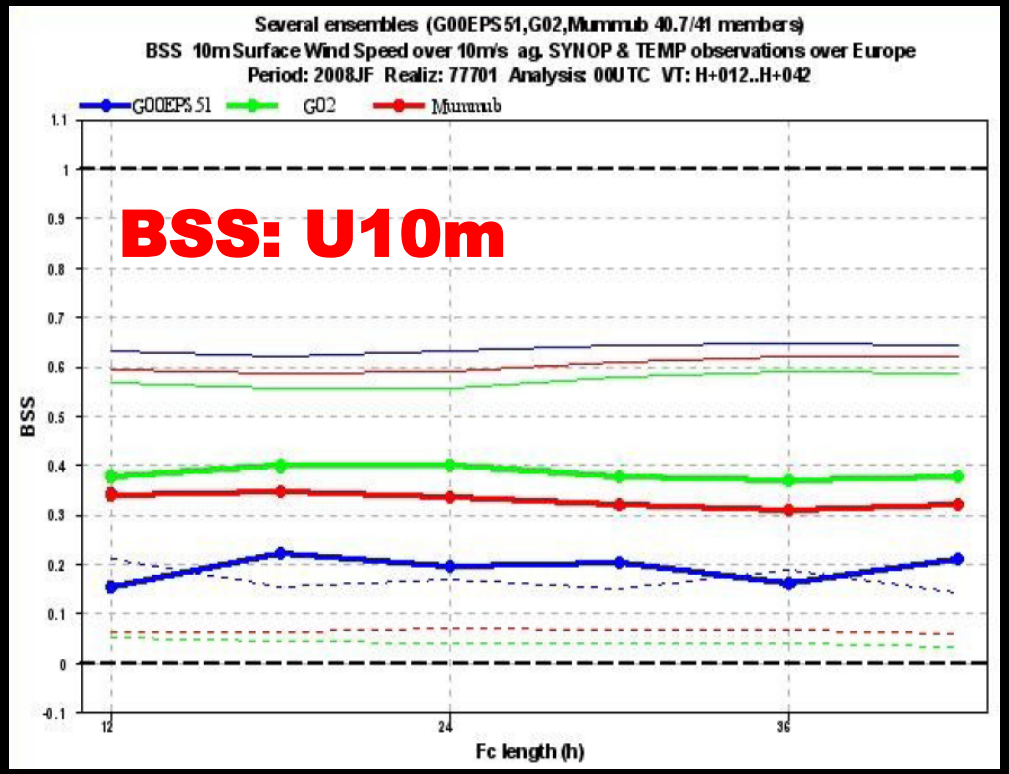
What we have learned from AEMET-SREPS

- **Resolution matters**

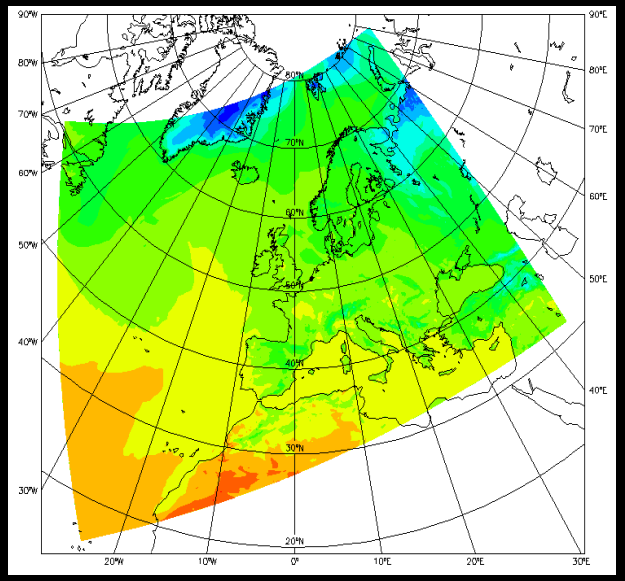


What we have learned from AEMET-SREPS

- **Resolution matters**. Comparison with GLAMEPS: **U10m BSS**
- **GLAMEPS** is a HIRLAM – ALADIN pan-European ensemble. It runs since 2006. It has 54 members and 10 km of horizontal resolution



AEMET-SREPS → 25km
GLAMEPS → 11 km
ECMWF-EPS (51) → 32 km



What have we lost ?

Our SREF ...

Expected to be at 12 km horizontal resolution, but we have not HPC resources

AEMET-SREPS stopped on October of 2014 when Cray X1E finalises its service

IMPORTANT DECISION: forget about 12-8 km and go directly to convection-permitting EPS at 2.5 km

And meanwhile we have GLAMEPS (HIRLAM consortia) at 12 km (now 8 km) for our forecasters

What are we currently doing ?

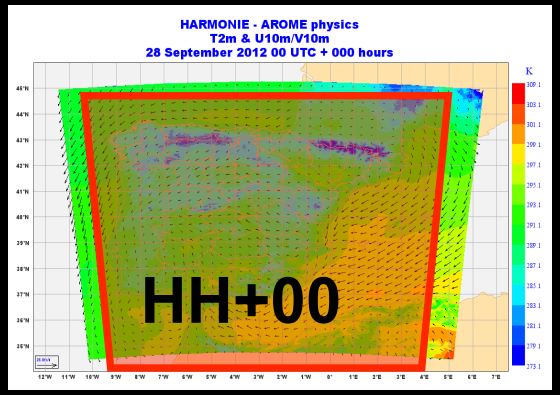
CONVECTION-PERMITTING EPS

Goal: forecast mesoscale high impact events as heavy precipitations estimating their uncertainty and forecast social-economic close to surface variables

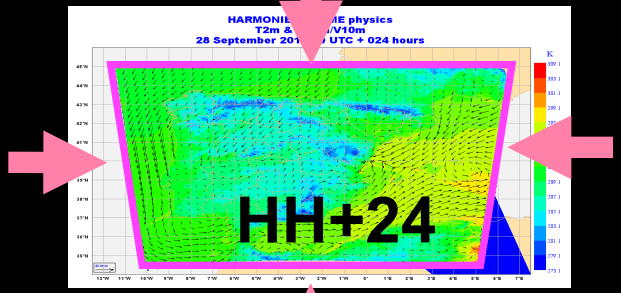
AEMET-γ-SREPS

- **Developing a *convection-permitting* EPS**
  - **3 sources of uncertainties**

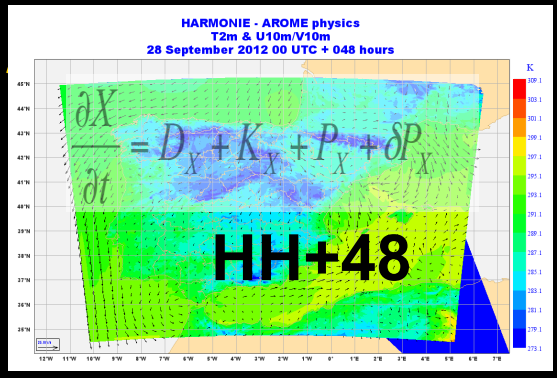
1 INITIAL CONDITIONS

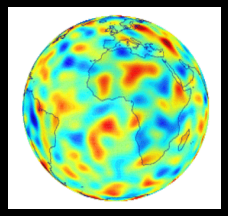


2 BOUNDARY CONDITIONS



3 MODEL *ERROR*





Initial conditions and Multi-BCs

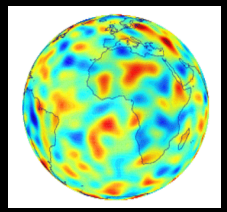
ECMWF – IFS

NCEP – GFS (Americans)

MétéoFrance – ARPÈGE

CMC – GEM (Canadencs)

JMA - JMA (Japonesos)



Multi-model

HARMONIE-AROME

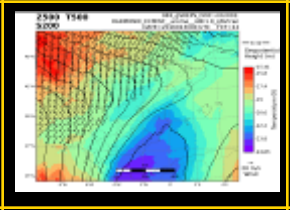
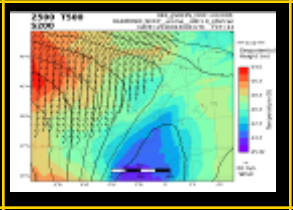
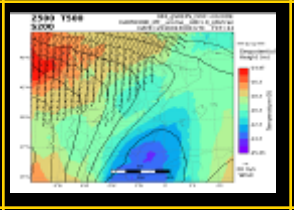
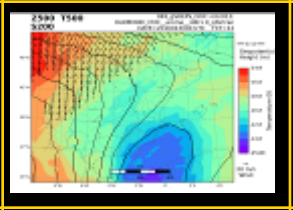
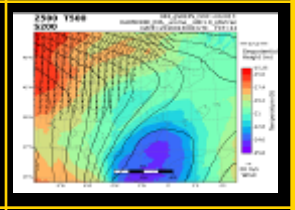
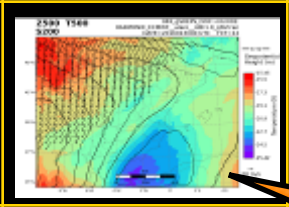
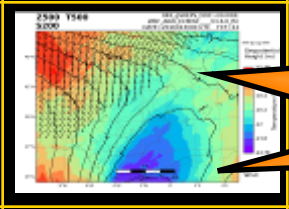
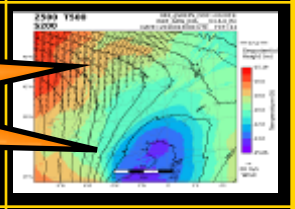
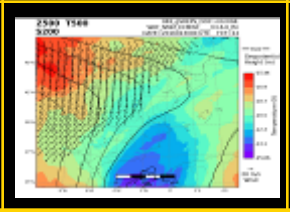
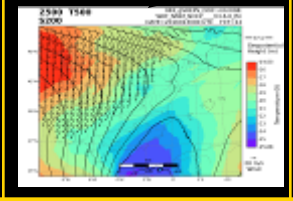
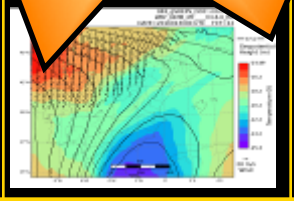
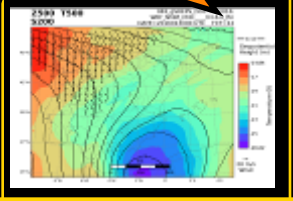
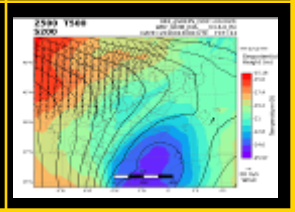
HARMONIE-ALARO

WRF-ARW

WRF-NMM

AEMET-γ-SREPS system

- 20-members ***convection-permitting*** EPS
- **Multi-Boundary-Conditions** from 5 Global NWP models
- **Multi-model** with 4 NWP models

Multi-BCs / Multi-NWP	ECMWF / IFS	NCEP / GFS	MF / ARPÈGE	JMA / GSM	CMC / GEM
HARMONIE-AROME					
HARMONIE-ALARO					
WRF ARW					
WRF NMM					

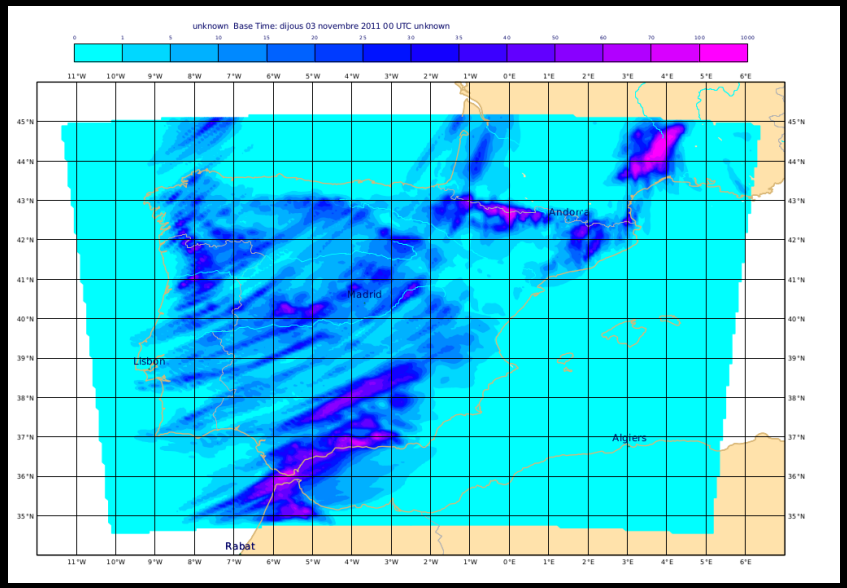
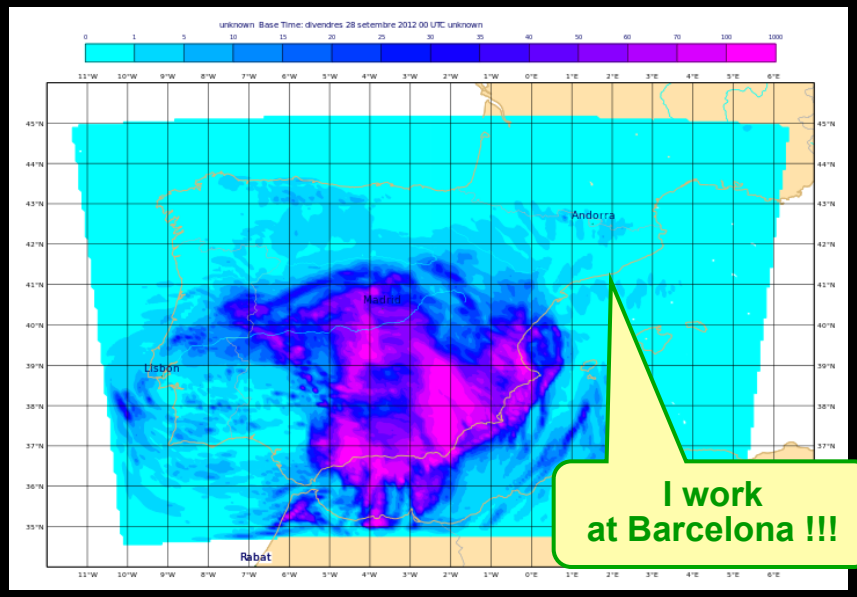
We have to updated WRF-NMM to NMMB !!!

Why a multi-boundaries multi-NWP model LAM-EPS ?

Due to experimental results

Experiments PERIODs & DOMAINs

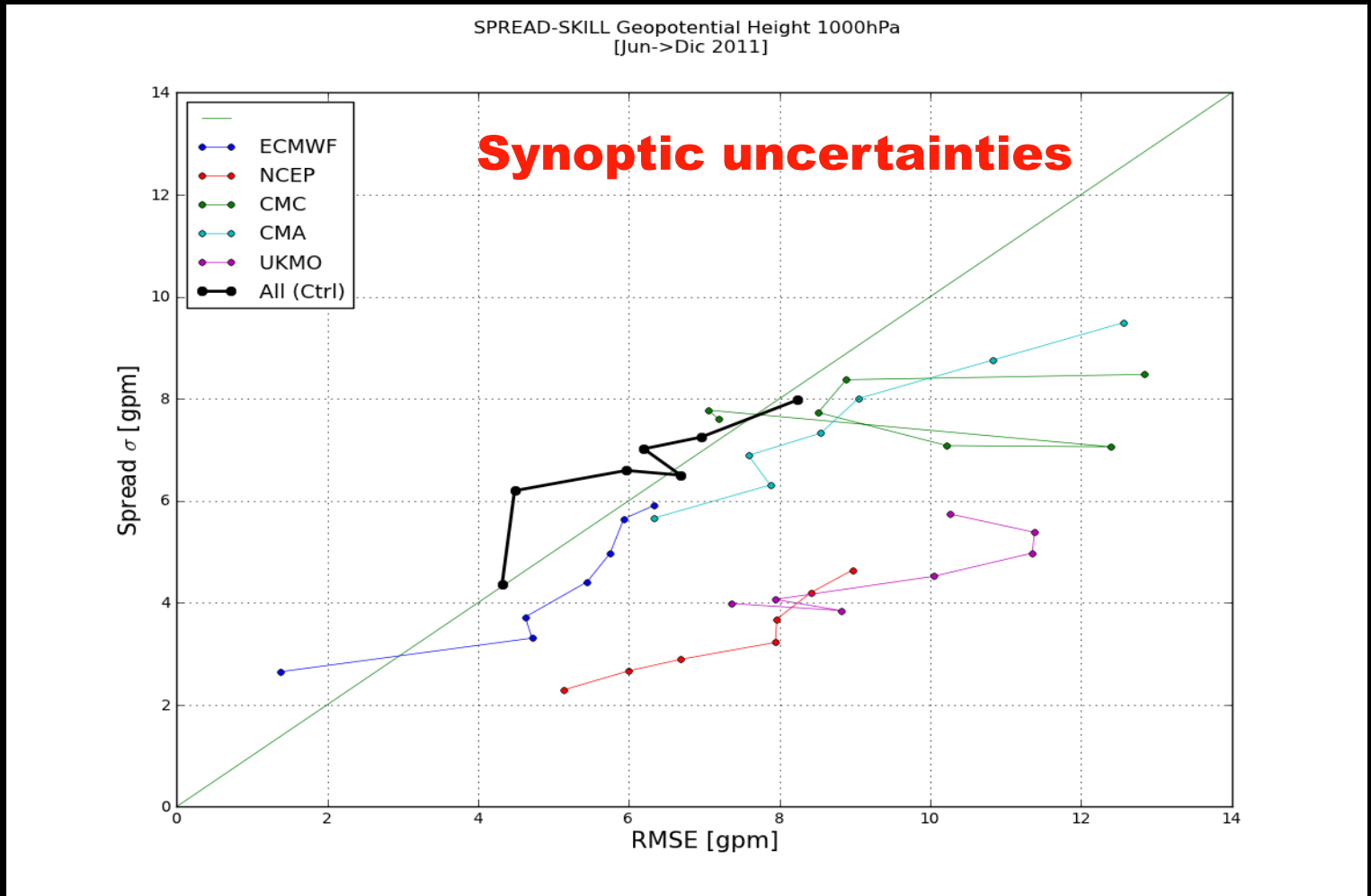
Periods and domains

NoSWEx autumn test period Summer and winter periods	Malaga convective case study (FLASH FLOOD on Malaga)
Several 14-18 days periods Always with convection	2012/09/28 1 day Organized convection synoptic driven
	
575x479 grid-points IBERIA_2.5 domain	Iberian peninsula & W Mediterranean

Why Multi-BCs?

Analysis of boundary conditions from different Global EPS (TIGGE)

Z1000 SPREAD-SKILL at +00, 12, 24, 36, 48, 60 and 72



Comparison of BCs from ECMWF with SLAF methodologhy

ECMWF-EPS-BCs ~30 km

ECMWF-EPS-BCs ~16 km

→ SLAF-ECMWF-DET-BCs

SLAF Scaled Lagged Average Forecast

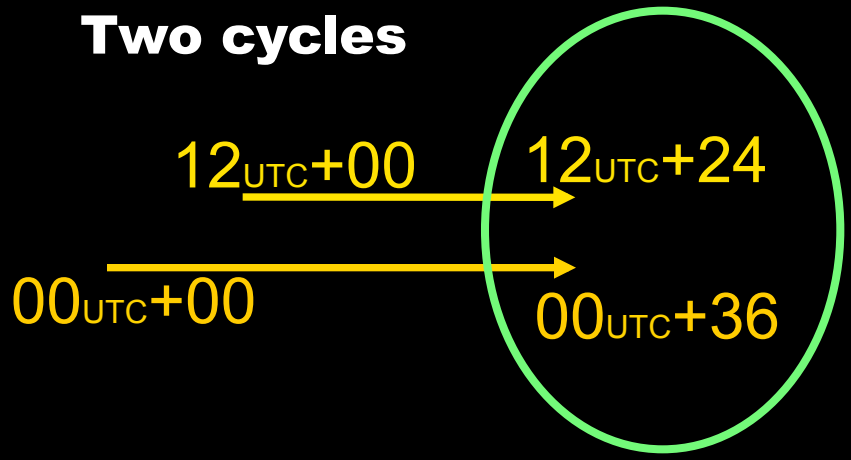
$FCREF \pm \sum K \cdot (FCREF - FCHH)$, $K=cte$

SLAF Scaled Lagged Average Forecast

$FCREF \pm \sum K \cdot (FCREF - FCHH)$, K=cte

Only 1 deterministic Global model

Two cycles



FCREF_12+24

FCHH_00+36

K=0.75

Two new BCs

BC1 = FCREF_12+24 + 0.75 (FCREF_12+24 – FCHH_00+36)

BC2 = FCREF_12+24 - 0.75 (FCREF_12+24 – FCHH_00+36)

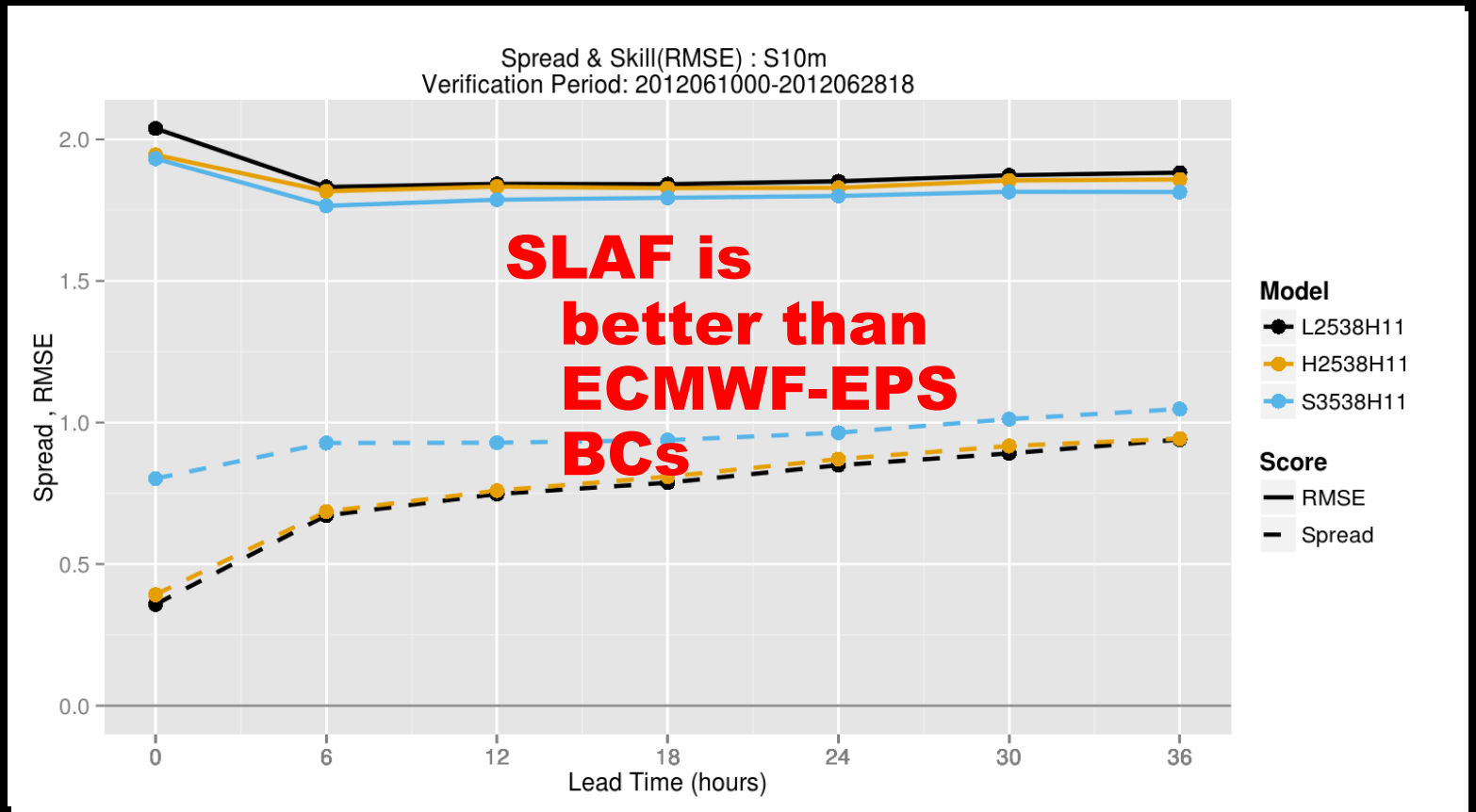
It is suppose that FCREF-FCHH contains the errors and uncertainties between two deterministic Global model cycles ...

Boundary conditions

T2m and S10m SPREAD-SKILL

ECMWF-EPS-BCs ~30km ~16km

SLAF-ECMWF-DET-BCs ~16km



Comparison of 3 methodologies to deal with BCs synoptic uncertainties

Multi-BCs

SLAF-ECMWF-BCs

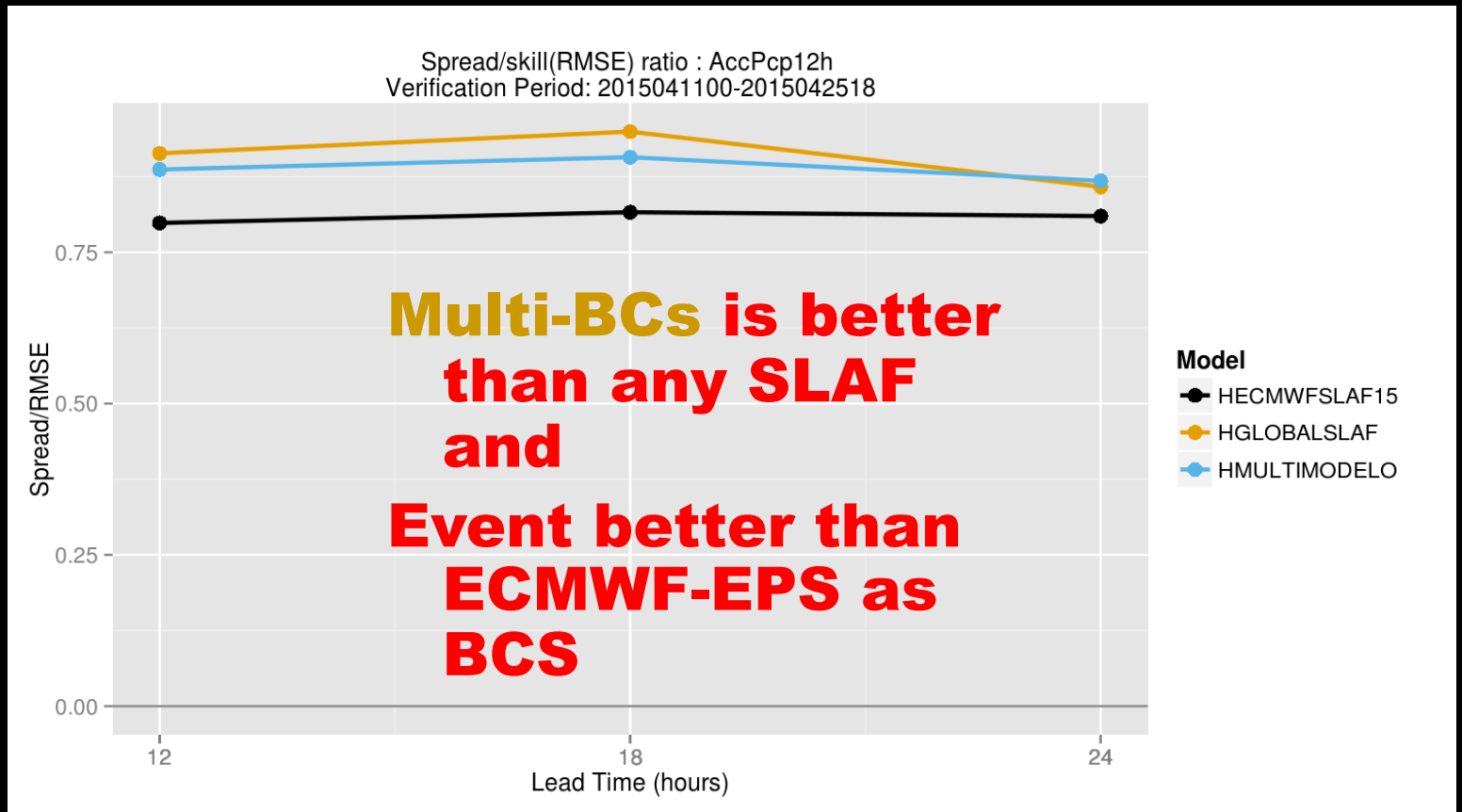
SLAF-Multi-BCs

22 members

Boundary conditions

Pmsl, T2m, S10m & AccPcp 12h SPREAD-SKILL ratio

Multi-BCs **SLAF-ECMWF-BCs** **SLAF-Multi-BCs**



Multi-model

Objective Verification

Comparison between Three-Multi-model and its 3 NWP model components

22 members

ECMWF BCs

Surface parameters PROB

MULNWP3 = HRM-AROME + WRF-ARW + WRF-NMM

RMSE & SPREAD time evolution of Pmsl, T2m, RH2m and S10m

- **Pmsl**

  NWP3 ≈ HRM

- **T2m**

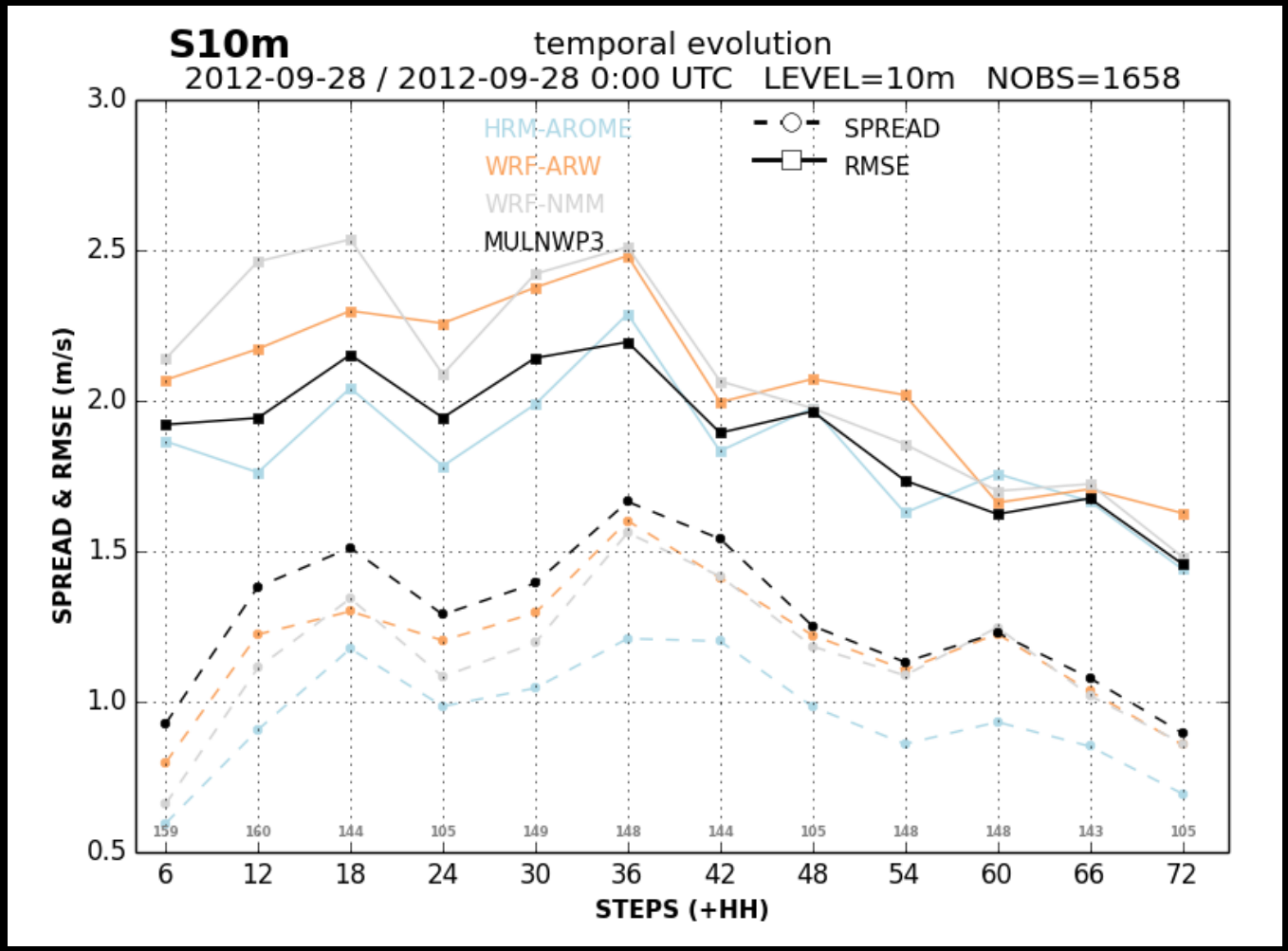
  NWP3 > HAN

- **RH2m**

  NWP3 > HAN

- **S10m**

  NWP3 > HAN



Precipitation 12H AccPcp PROB

37h11

MULNWP3 = HRM-AROME + WRF-ARW + WRF-NMM

Time evolution RMSE and SPREAD

30H Rank Histogram

- **RMSE (H<48H)**

  NWP3 ≈ HRM

  NWP3 > AN

- **SPREAD (H<48H)**

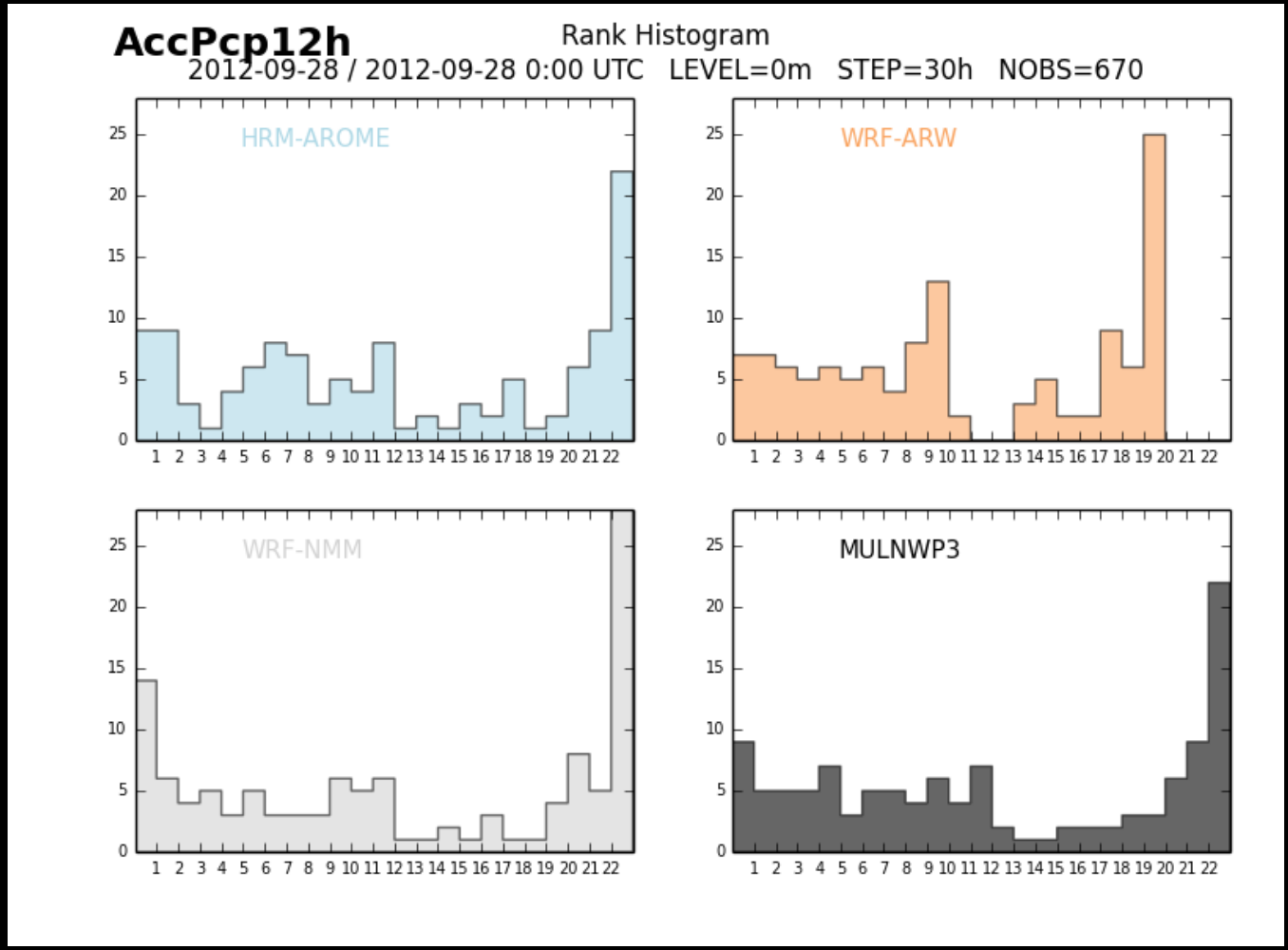
  NWP3 ≈ HRM

  NWP3 > AN

- **Talagrand**

  NWP3 ≈ HRM

  NWP3 > AN



Vertical profiles PROB

37h11

MULNWP3 = HRM-AROME + WRF-ARW + WRF-NMM

24H Geopotential, Temperature and Specific Humidity

- **Geopotential**

  NWP3 <≈ NMM

  NWP3 > HA

- **Temperature**

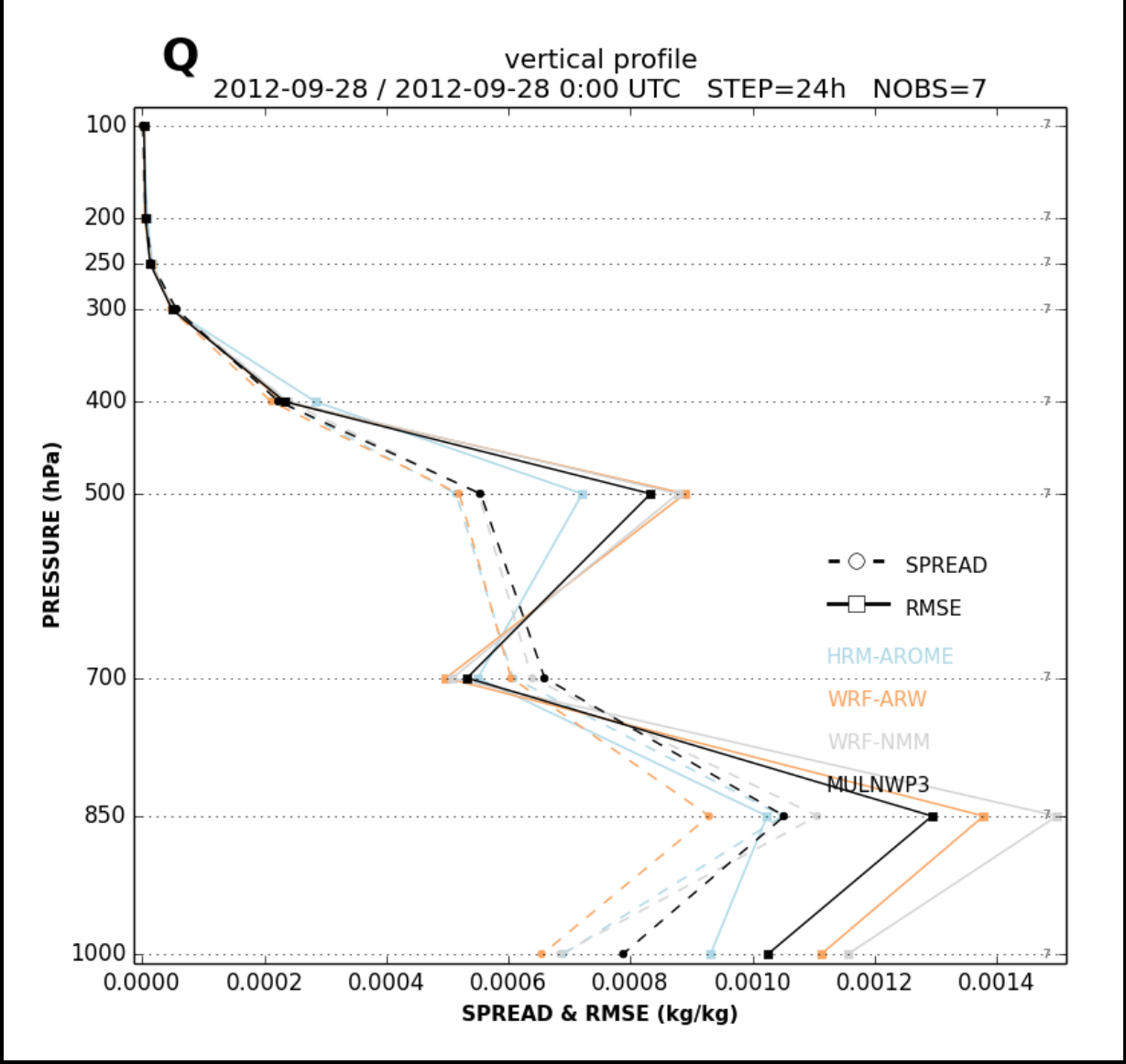
  NWP3 ≈ HRM

  NWP3 > AN

- **Specific Humidity**

  NWP3 <≈ HRM

  NWP3 > AN



Comparison of 3 methodologies to take into account model error

Multi-model

Multi-physics

SPPT

22 members

ECMWF BCs

NOTE: multi-model only with 2 NWP models in order to be more comparable with multi-physics with 2 different sets of parameterisations

Surface parameters PROB

37h11

MULNWP2 → HM-AROME + WRF-MM

MULPHY → HM-AROME + HM-ALARO

BOX-SPPT → HARMONIE-AROME + SPPT

RMSE & SPREAD time evolution of Pmsl, T2m, RH2m and S10m

- **Pmsl**

SPPT > NWP >≈ PHY

- **T2m**

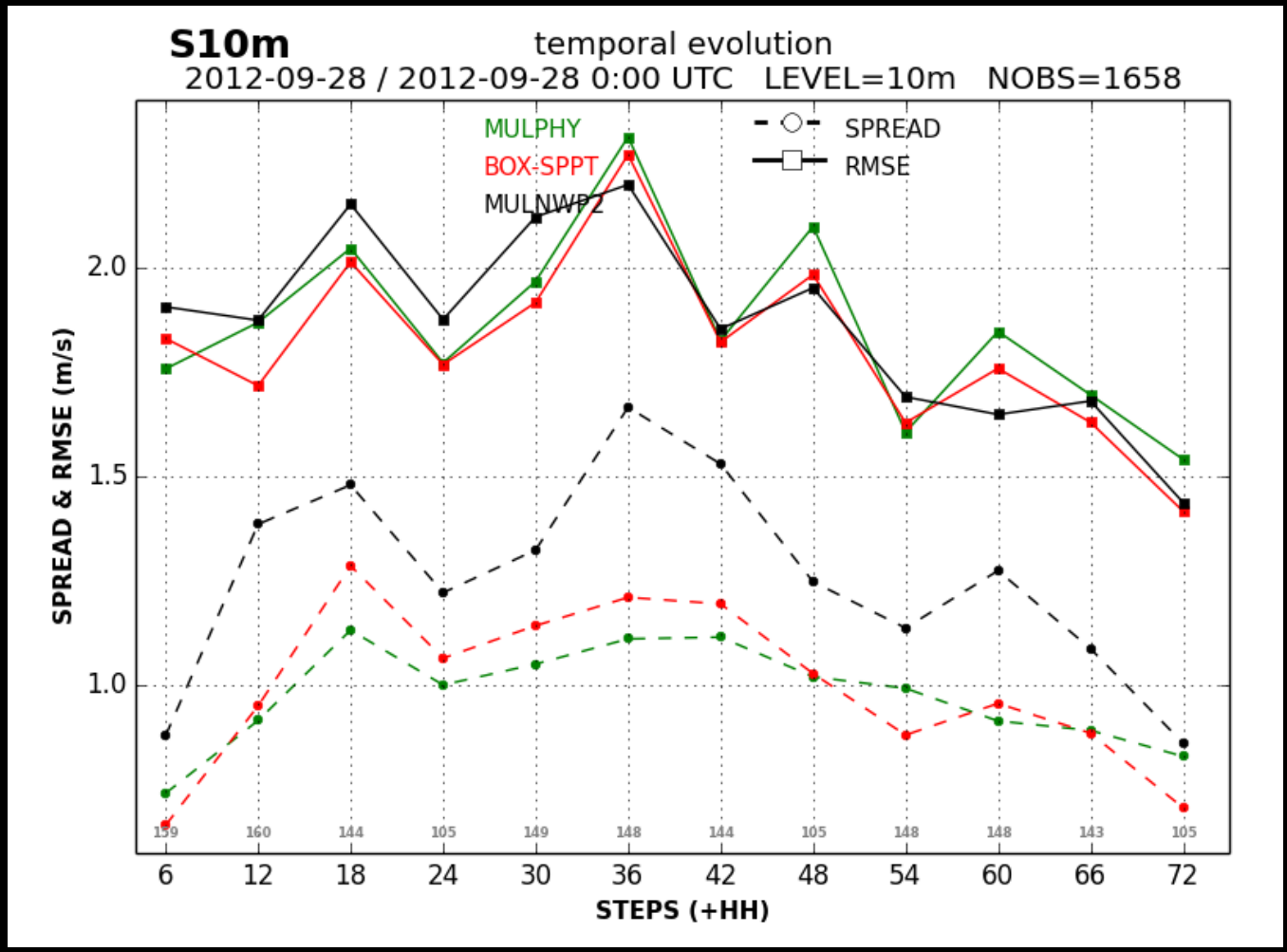
NWP > SPPT ≈ PHY

- **RH2m**

NWP >≈ SPPT > PHY

- **S10m**

NWP > SPPT > PHY



Precipitation 12H AccPcp PROB

37h11

MULNWP2 (AROME+NMM) / MULPHY / BOX-SPPT

Time evolution RMSE and SPREAD

30H Rank Histogram

- **RMSE (H<48H)**

PHY ≈ NWP >> SPPT

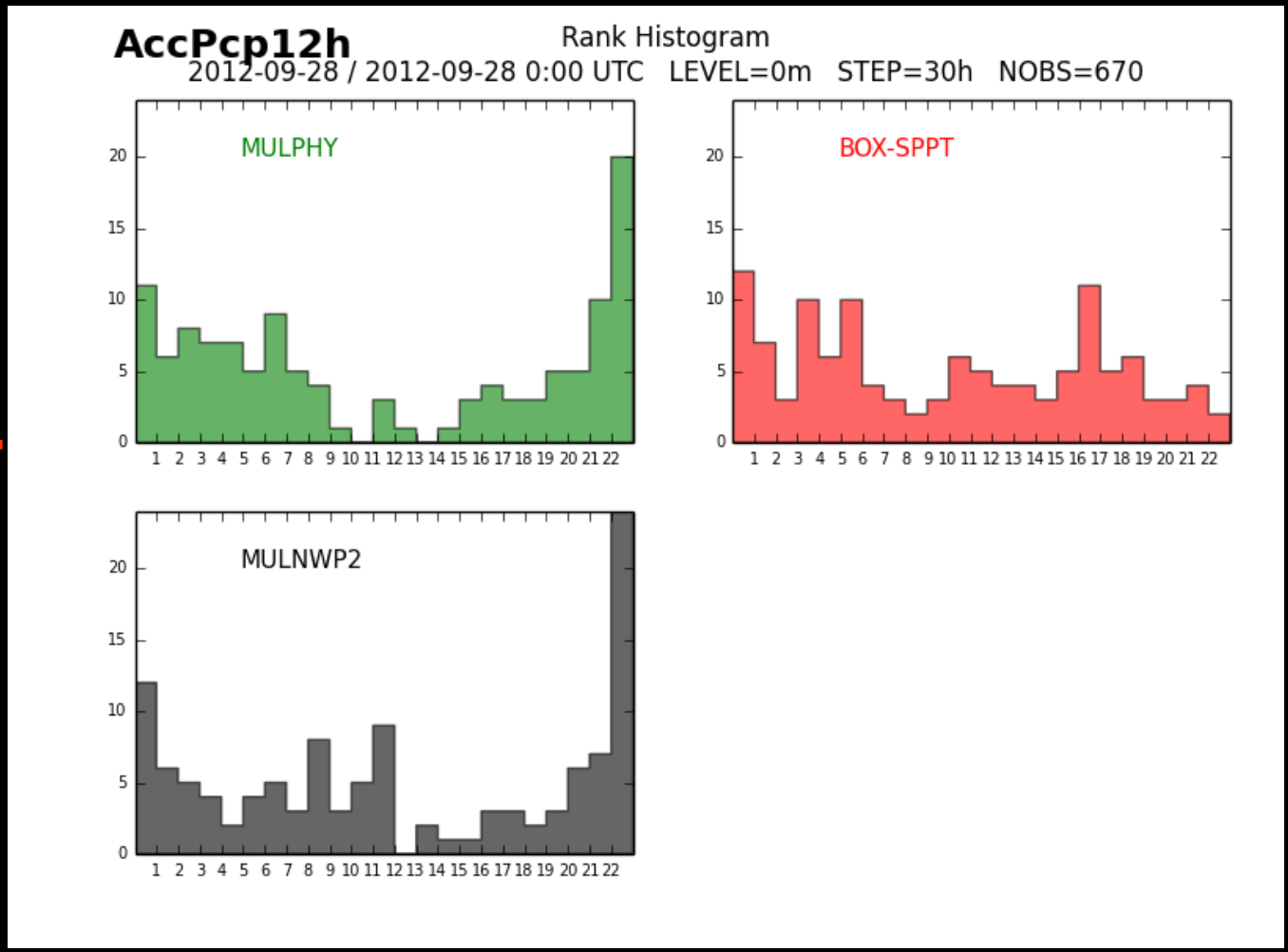
- **SPREAD (H<48H)**

PHY >≈ NWP >>SPPT

- **Talagrand**

SPPT > PHY >≈ NWP

SPPT: problem perturbing water species not solved !!!



Vertical profiles PROB

37h11

MULNWP2 (AROME+NMM) / MULPHY / BOX-SPPT

24H Geopotential, Temperature and Specific Humidity

- **Geopotential**

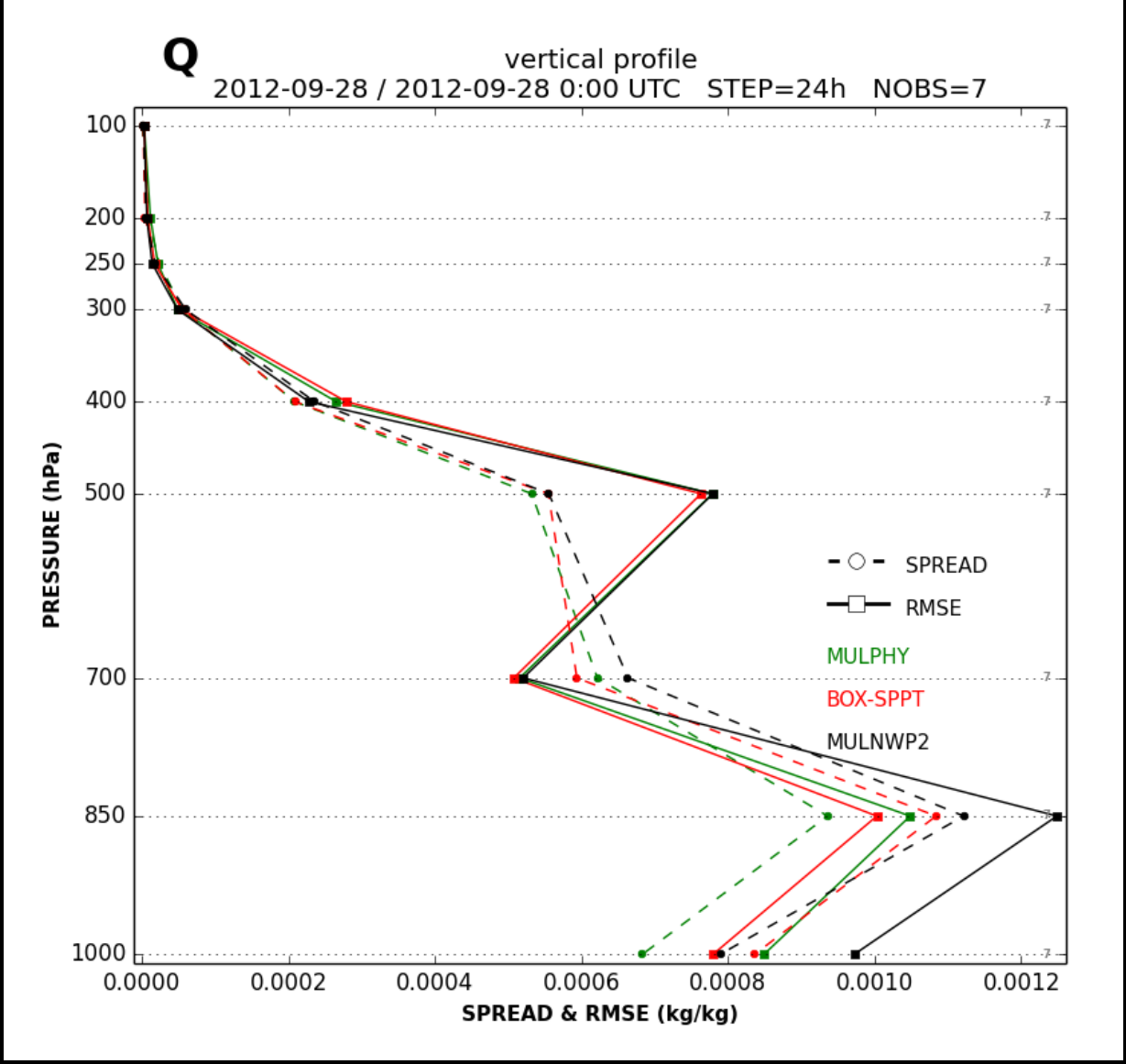
  NWP > PHY > SPPT

- **Temperature**

  NWP > SPPT > PHY

- **Specific Humidity**

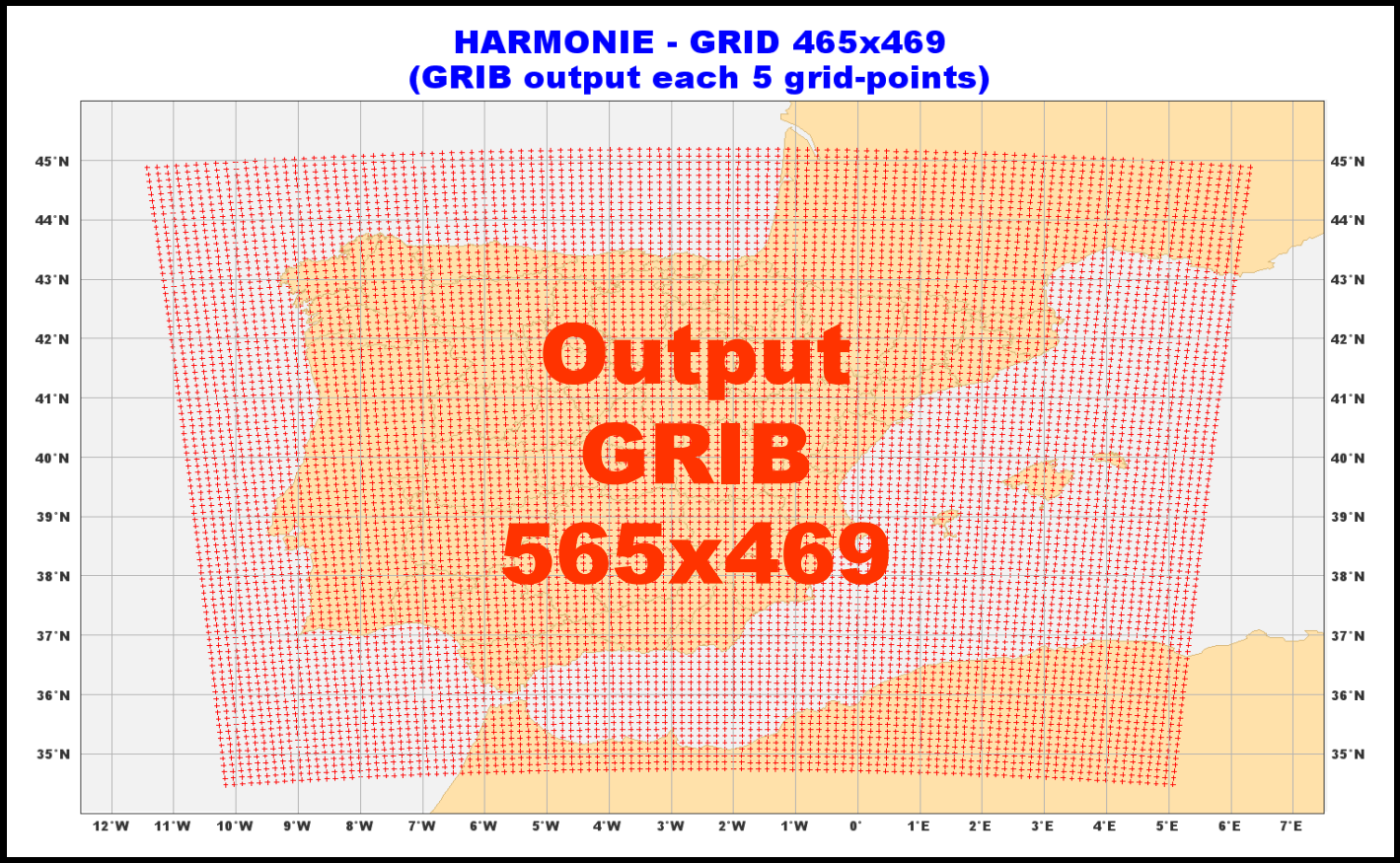
  PHY > SPPT > NWP



WRF-NMM / NMMB

in γ-SREPS

Horizontal grid in GRIB files



- Intended to run NWP with the same / very similar internal GRID
- Exactly the same GRIB output in GRIB
- WRF-NMM: UPP convert from 'rotated_ll' on GRID E to 'lambert'

HARMONIE
lambert
'NLON' => '576',
'NLAT' => '480',
'EZONE' => '11'
'GSIZE' => '2500.',

WRF-ARW
map_proj = 'lambert',
e_we = 566,
e_sn = 470,
dx = 2500,
dy = 2500,

WRF-NMM
map_proj = 'rotated_ll',
e_we = 395,
e_sn = 652,
dx = 0.016049,
dy = 0.015802,

Lambert Conformal Conic Projection Issue

Vertical levels differences between HARMONIE 65 and auto-WRF-NMM 72

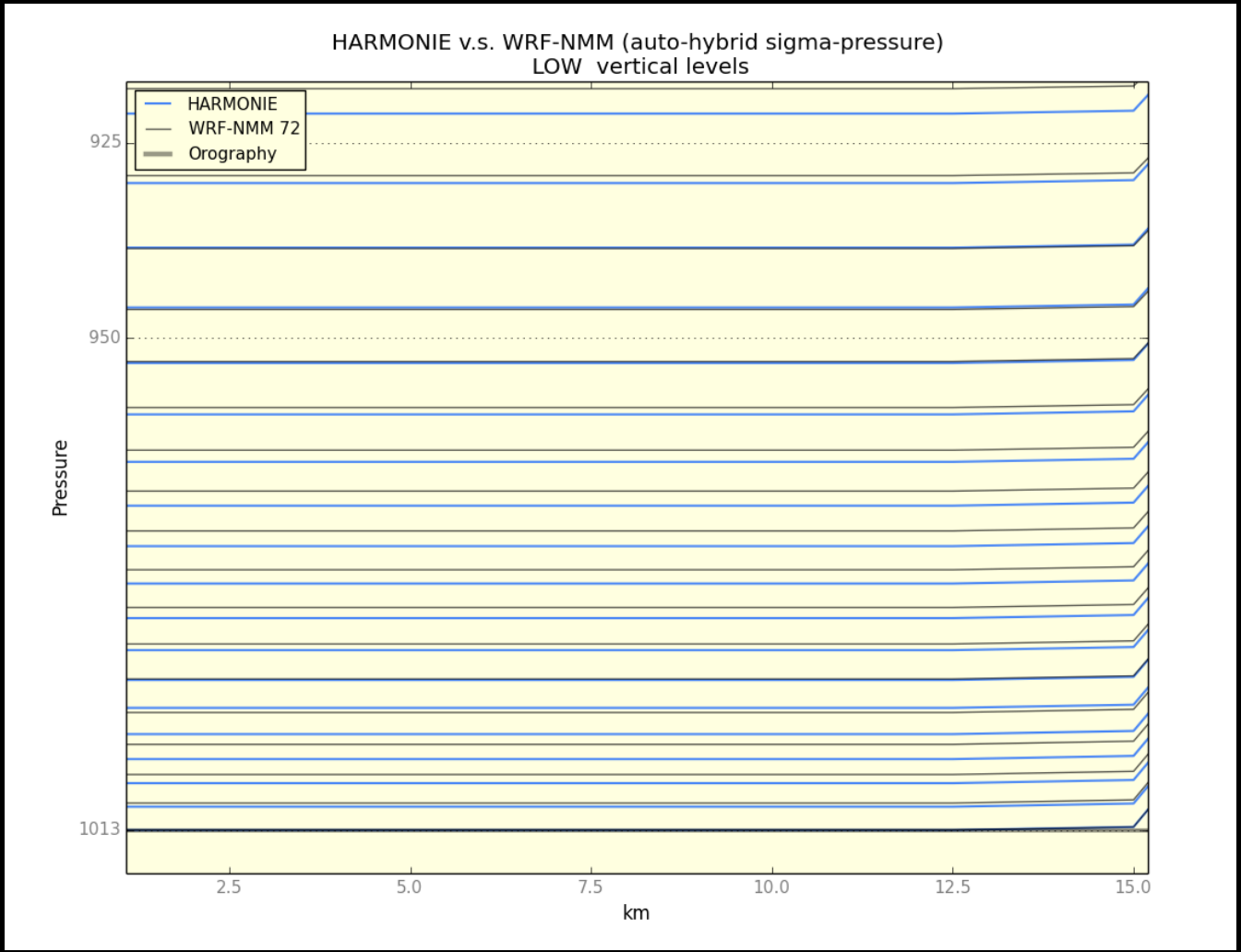
- **72 auto-generated Vert.Lev.:**
  - **Low & mid-lev.:**

    NMM ≈ HM
  - **High-levels:**

    Different because

    40 hPa top

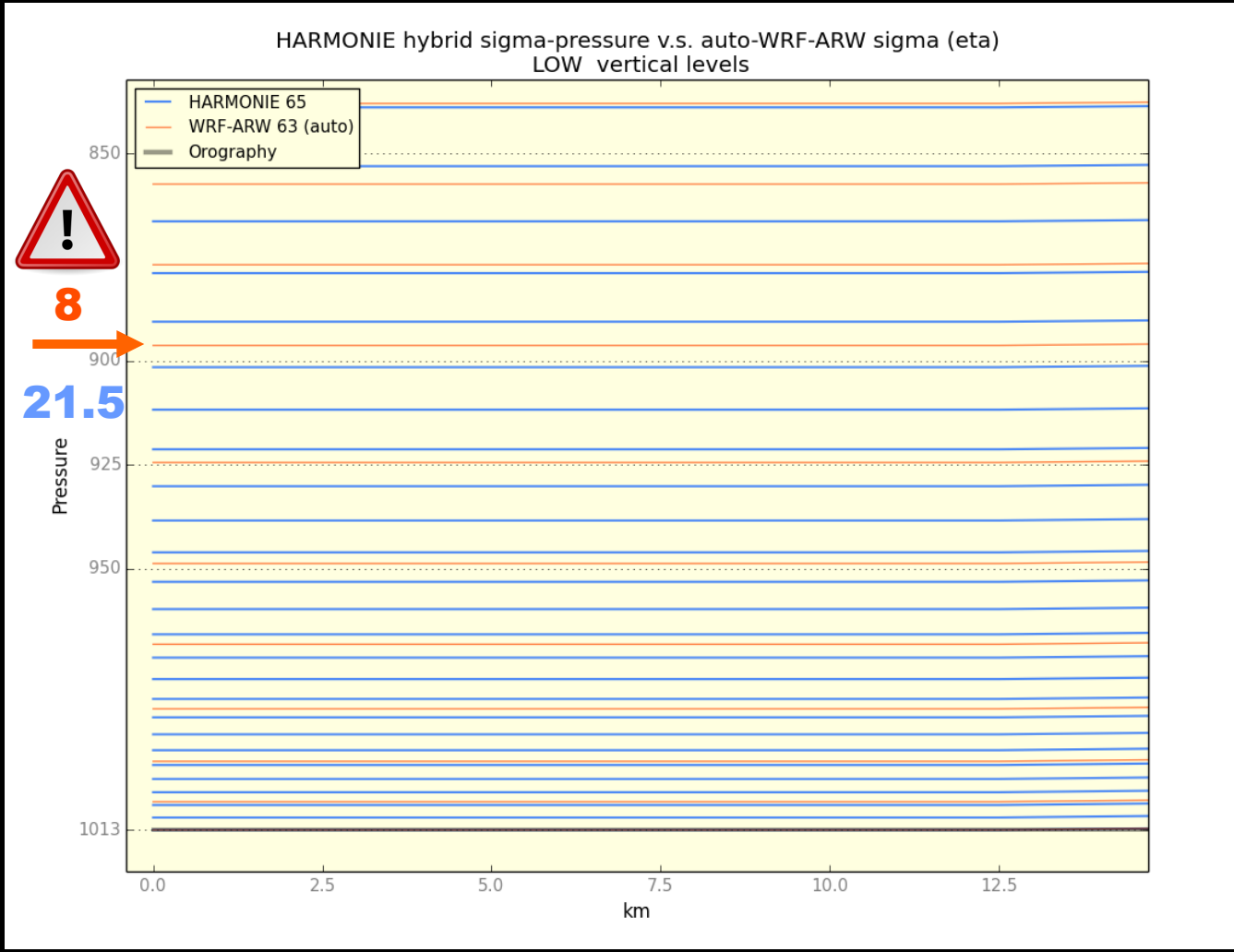
    [Choose to be second-to-last HARMONIE full level]



Both HM and NMM have hybrid levels, but they are defined in a different way: sigma–pressure levels' transition is less smoothly on NMM.

Vertical levels differences between HARMONIE and auto-WRF-ARW 65

- **65 vlev auto-generation:**
  - **Low levels:**
    ARW << HM
    [As NWP at 30 km]
  - **Mid-levels:**
    ARW ≈< HM
  - **High-levels:**
    ARW >> HM

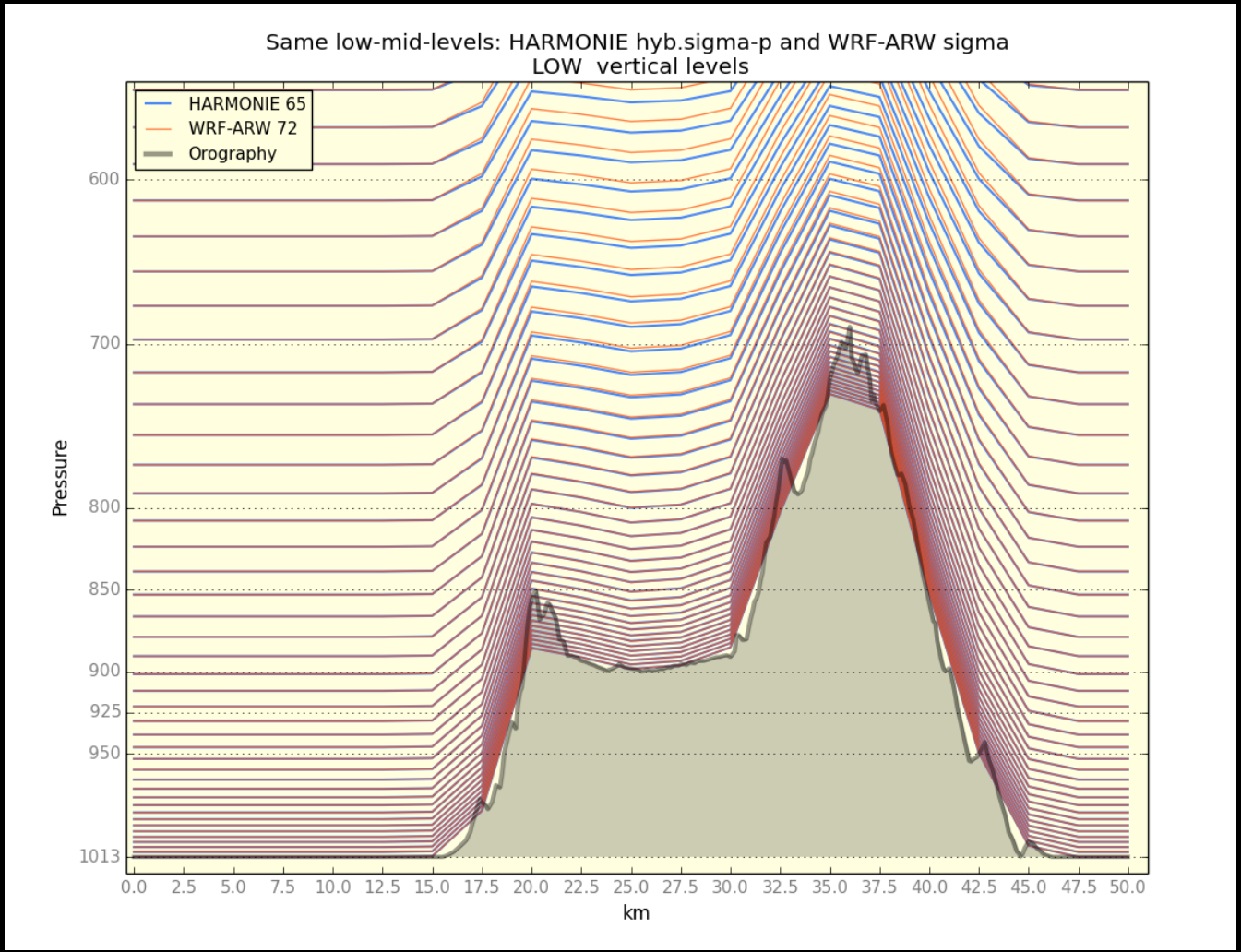


WRF-ARW/sigma levels need lots of them close to the top because of computational stability and performance

Warning: compute_eta.f90 **sets always the same first** 8 fixed low levels **in the PBL**

Vertical levels differences between HARMONIE 65 and defined-WRF-ARW 72

- **72 defined-WRF:**
  43 [~500hPa] lower levels close to HARMONIE;
  above 500 hPa computed by compute_eta.f90:
  - **Low levels:**
    WRF == HM
  - **Mid-levels:**
    WRF ≈ HM
  - **High-levels:**
    WRF >> HM



~72 WRF-ARW sigma levels are necessary to simulate the atmosphere closely to HARMINIE 65 hybrid levels

Summary of models in γ-SREPS:
3 NWP MODELS

NWP models' settings		
HARMONIE	**WRF-ARW**	**WRF-NMM**
AROME physics 65 Hybrid sigma-pressure vertical levels 60 s time step	ARW dynamical core ~~66~~ 72 sigma (ETA) hydrostatic-pressure levels up to 40 hPa [where it is 64 HARMONIE vertical level] 12 s time step	NMM dynamical core ~~66~~ 72 Hybrid sigma-pressure (eta1,eta2) up to 40 hPa 5 s time step
Lambert Conformal Conic projection: lon -2.5º / lat 40.0º center 565 * 469 grid-points		Rotated lon-lat E-grid: lon -2.5º / lat 40.0º center 395(x2) * 652 grid-points
8 LBC relaxation points around grid area		

It has been intended to integrate both NWP models with the closer possible settings in order to be the comparison the more fairly possible.

WRF-NMM in γ-SREPS

Subjective VERIFICATION

Low levels Pmsl & T850 WRF-NMM

- **Consistent results, BUT perhaps:**
  - **Pmsl in the LOW center:**

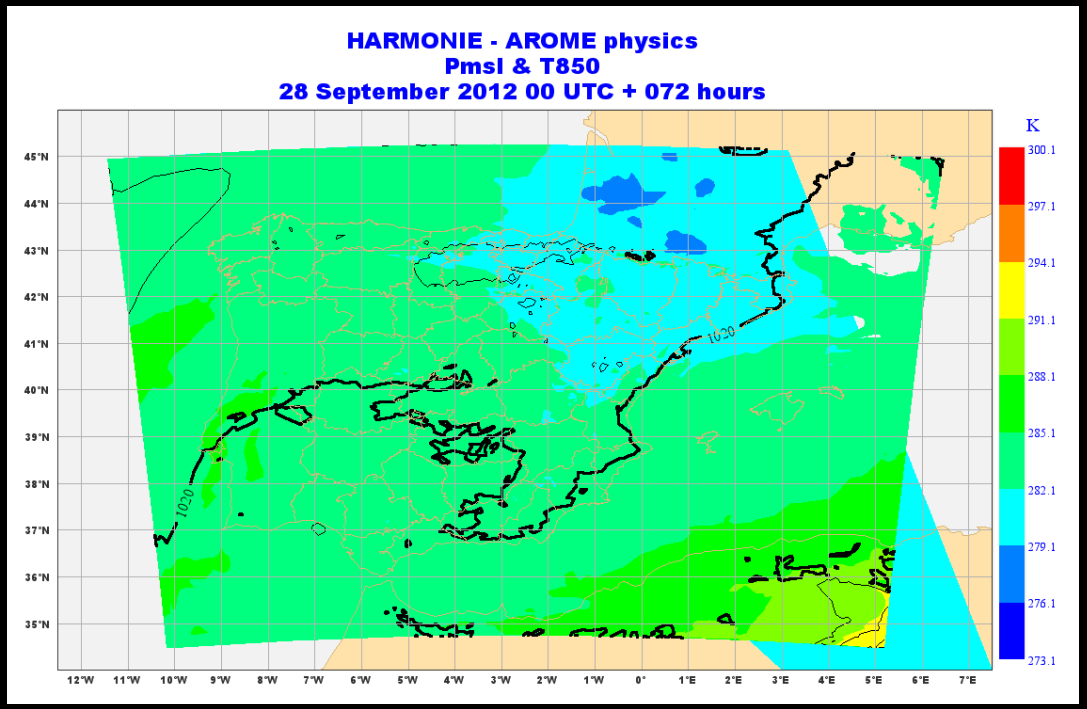
    WRF-NMM > HARMONIE

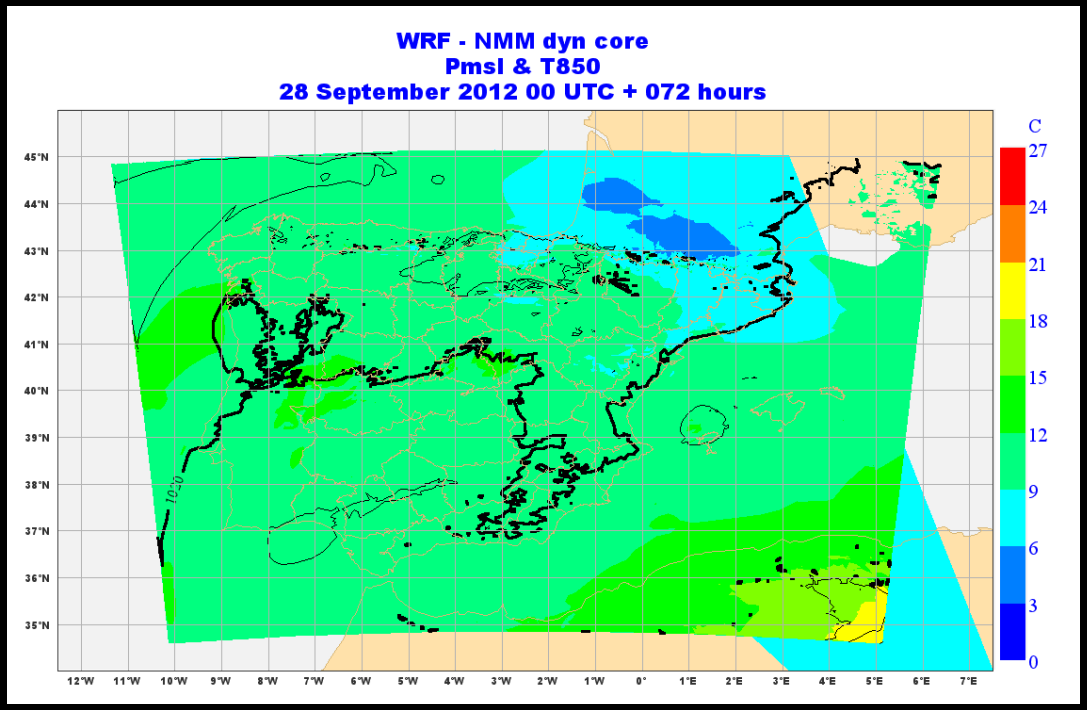
    [WRF-UPP-Pmsl method used: Shuell. Two another methods available: MAPS and Mesinger]

  - **T850:**

    WRF-NMM >= HARMONIE
    [cold air]

    WRF-NMM ≈ HARMONIE
    [warm air]





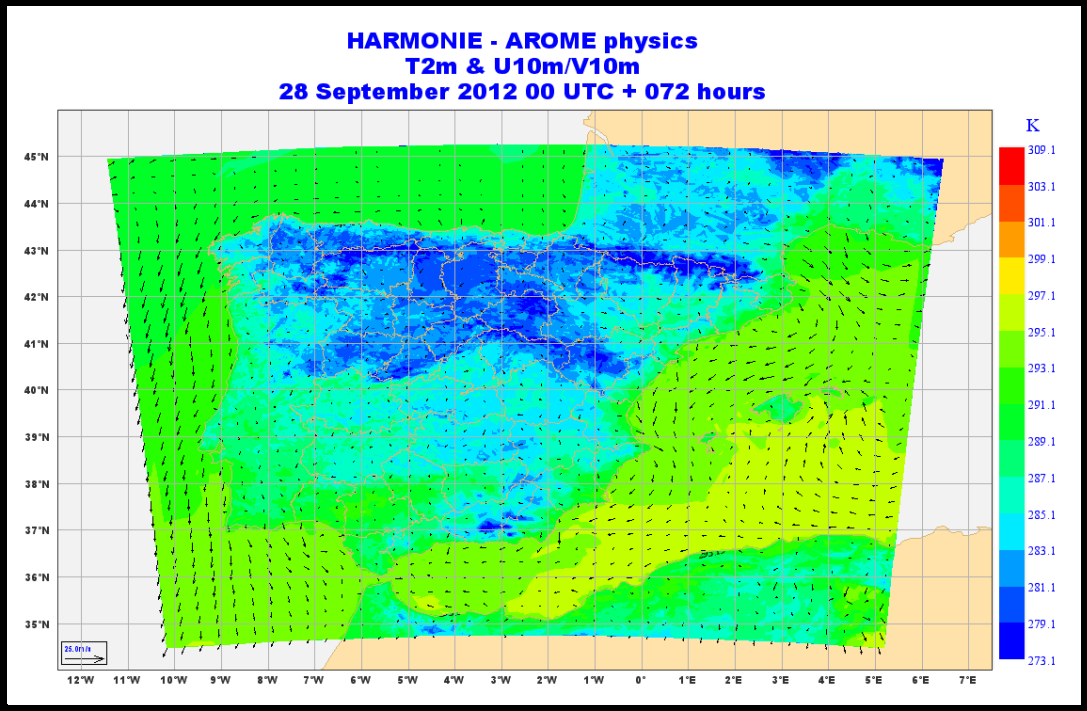
SURFACE
T2m & S10m
WRF-NMM

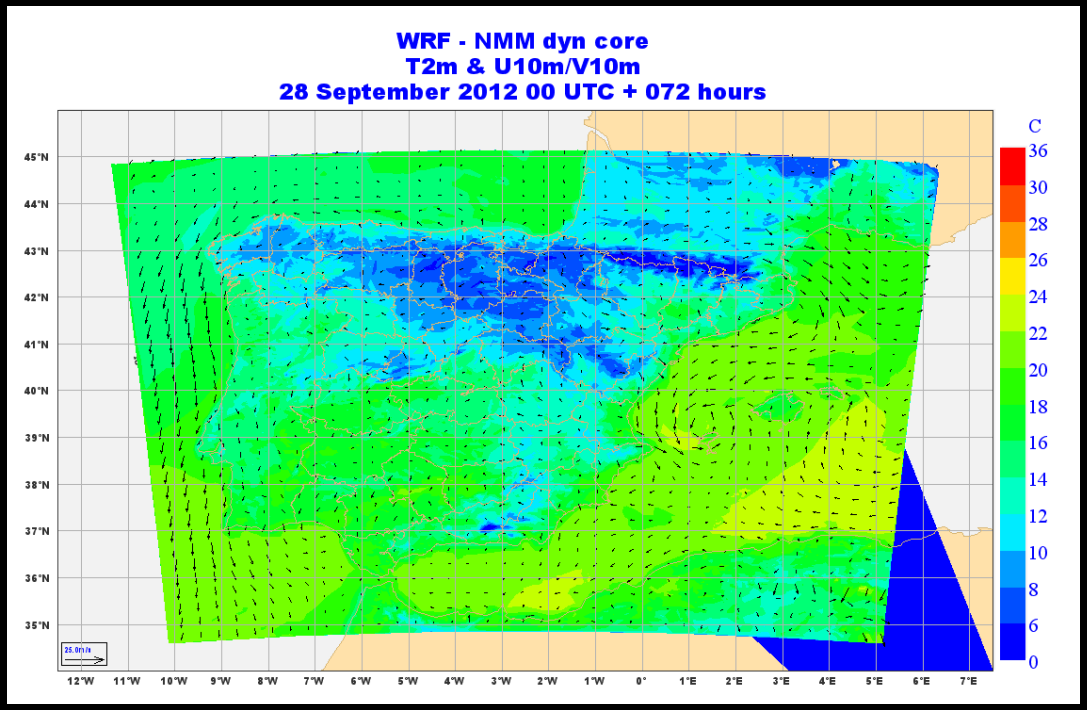
- **Similar results, BUT:**
  - **Strong winds:**

    WRF-NMM <= HARMONIE

  - **Land/sea temperature contrast:**

    WRF-NMM ≈ HARMONIE





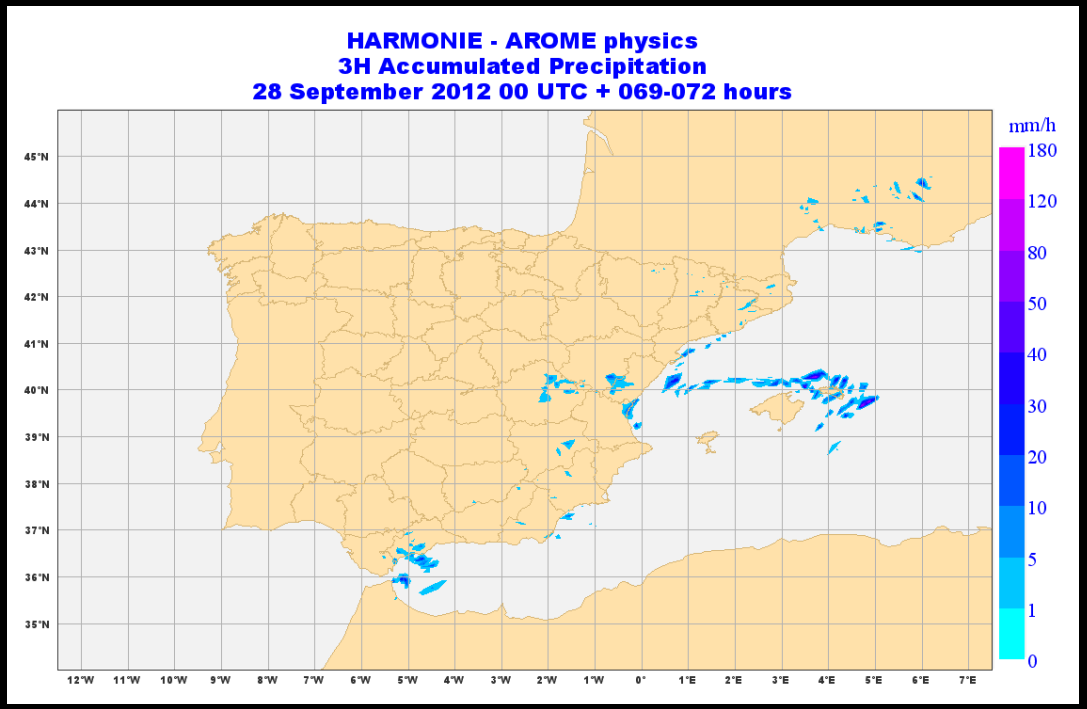
Precipitation 3H AccPcp WRF-NMM

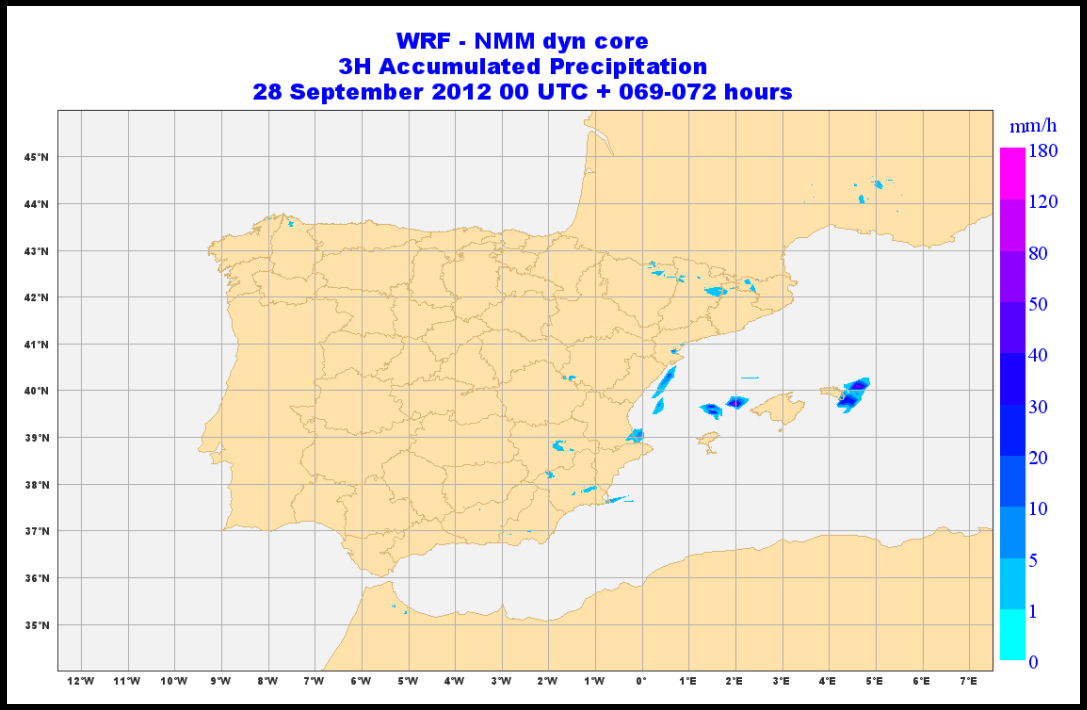
- Comparable and consistent precipitation structures, BUT:
  - Maximum Pcp in 3H:

    WRF-NMM ≈ HARMONIE

    [Even more than 120 mm/3h]
  - "Fine" structures:

    WRF-NMM ≈ HARMONIE



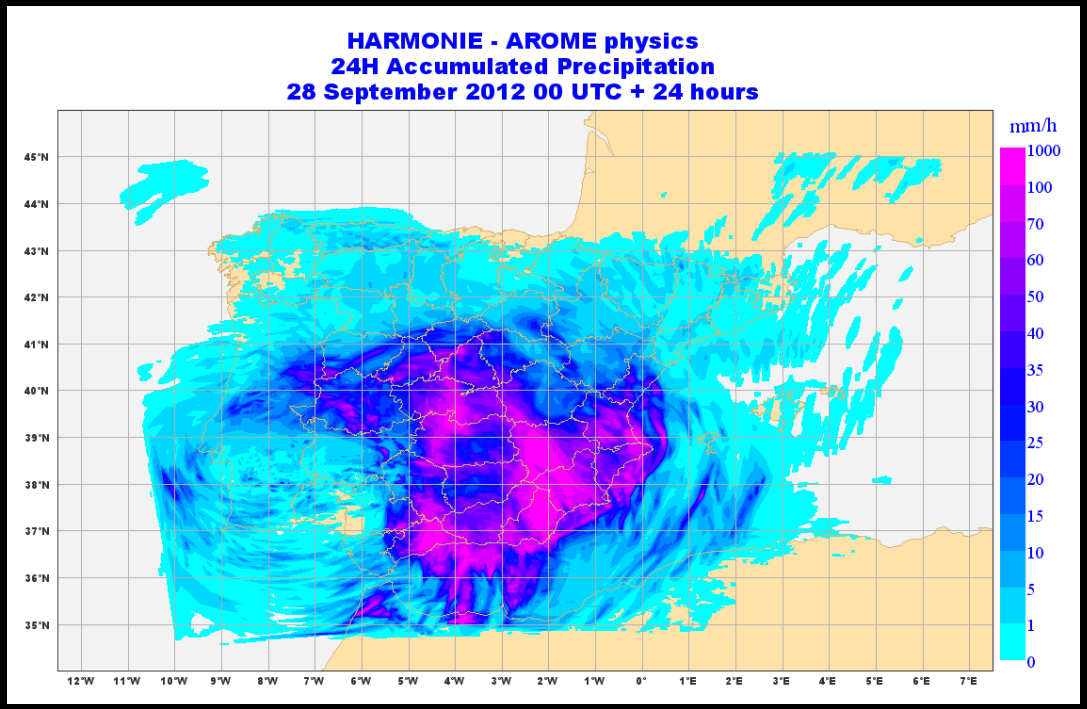


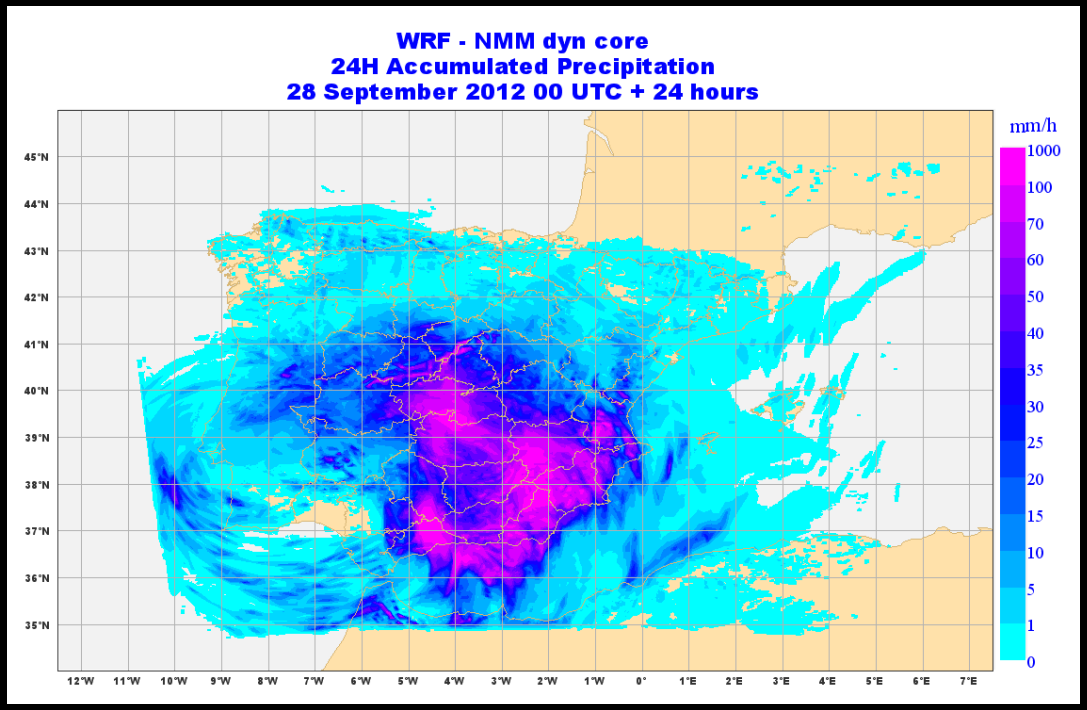
Precipitation 24H AccPcp WRF-NMM

- Quite similar precipitation distribution, BUT:
  - Pcp “linear traces”:

    WRF-NMM ≈ HARMONIE
  - Pcp over the sea:

    WRF-NMM < HARMONIE





WRF-NMM in γ-SREPS

Objective VERIFICATION

WRF-NMM performs as HARMONIE-AROME

Surface parameters
HM-ARW-NMM
RMSE & BIAS time evolution of
Pmsl, T2m, RH2m, S10m, and Cloud cover

- HM > NMM

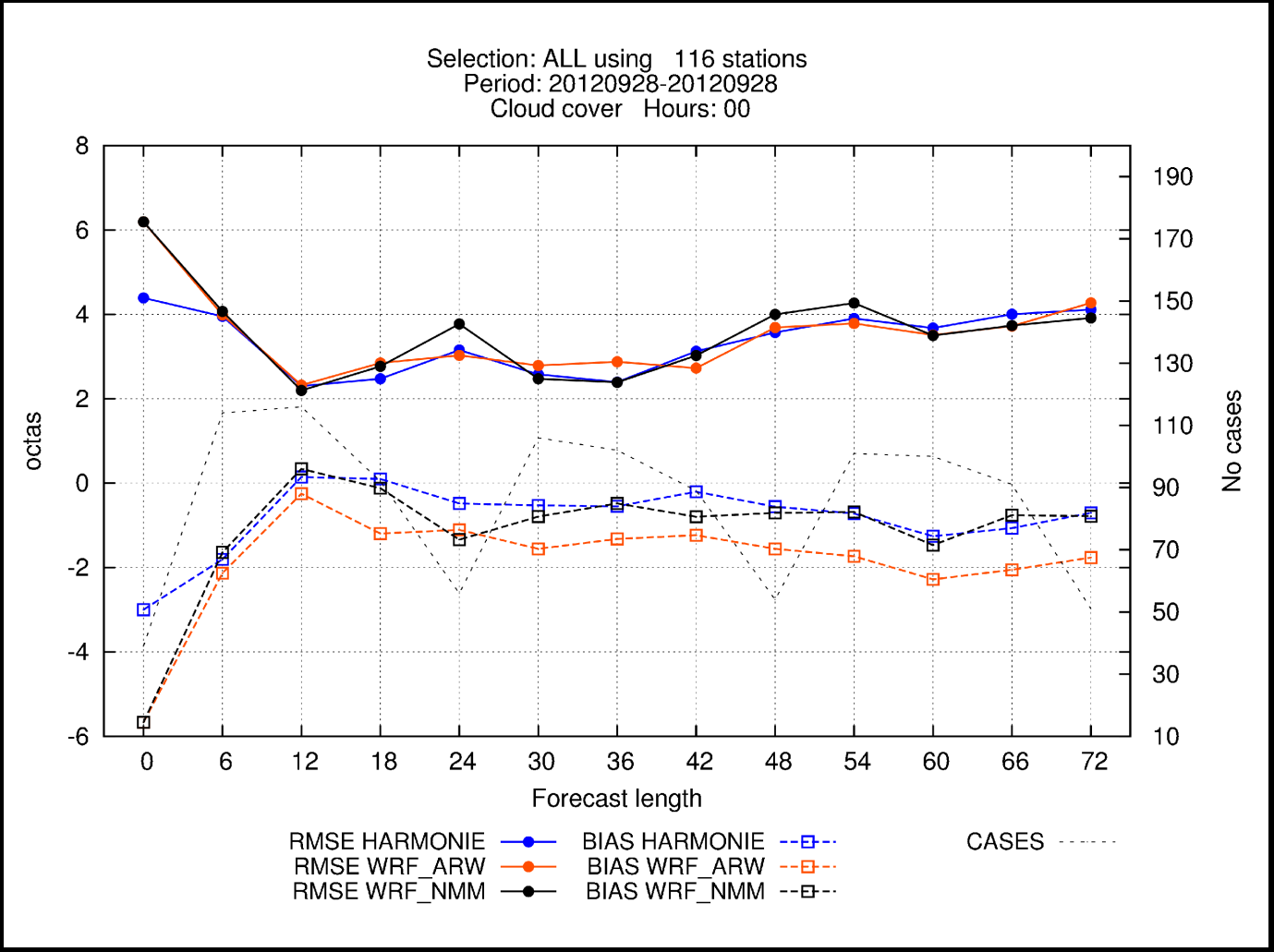
  T2m

- NMM > HM

  RH2m

- NMM ≈ HM

  Pmsl, S10m, Cloud Cover



Precipitation 12H AccPcp
HM-ARW-NMM
Time evolution RMSE, BIAS, FREQ and ETS

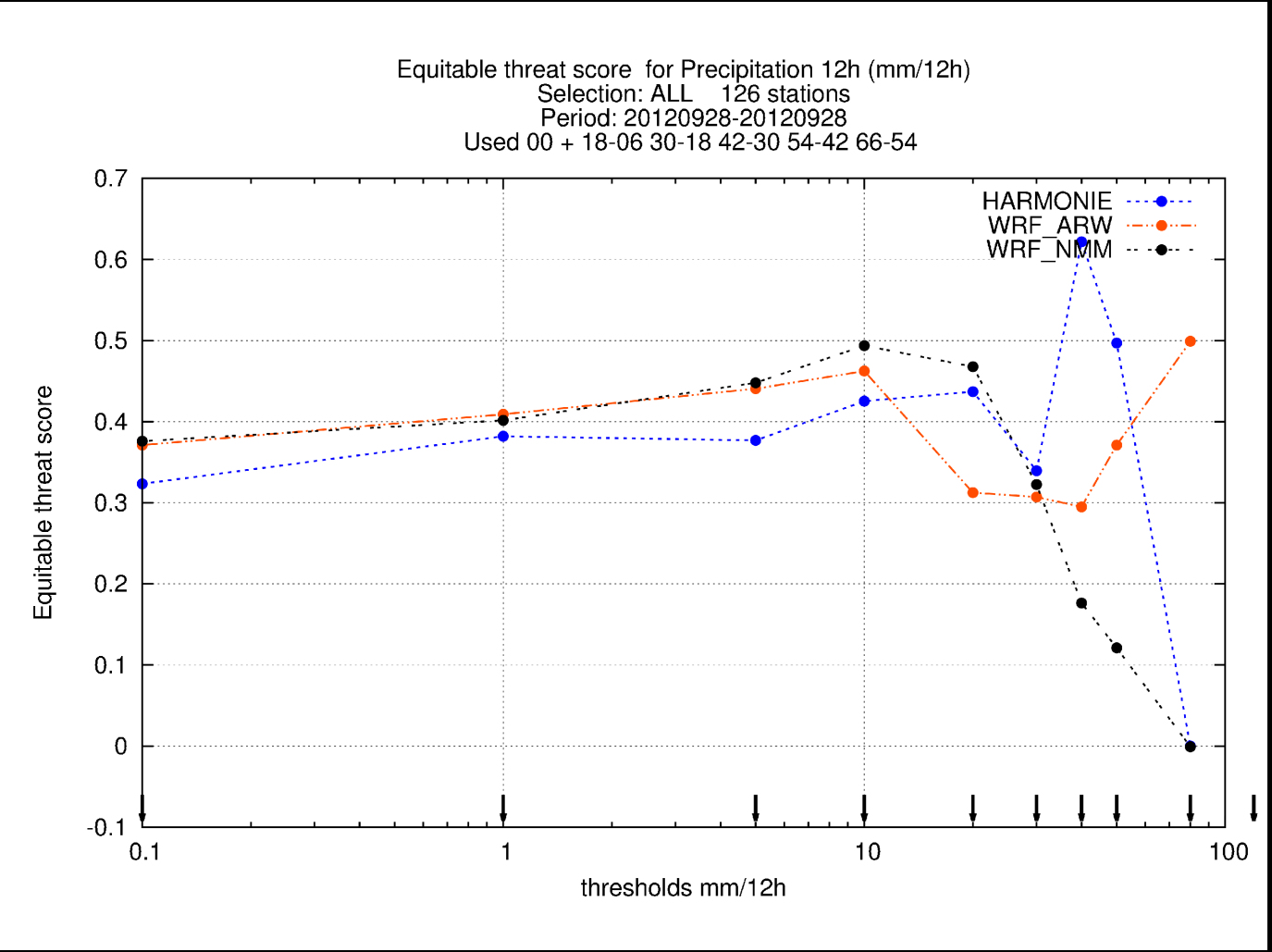
- **Very similar performance**
- **RMSE:**

  NMM ≈< HM
- **BIAS:**

  NMM ≈ HM
- **FREQ:**

  NMM < HM
  (low thresholds)
- **ETS:**

  NMM ≈ HM

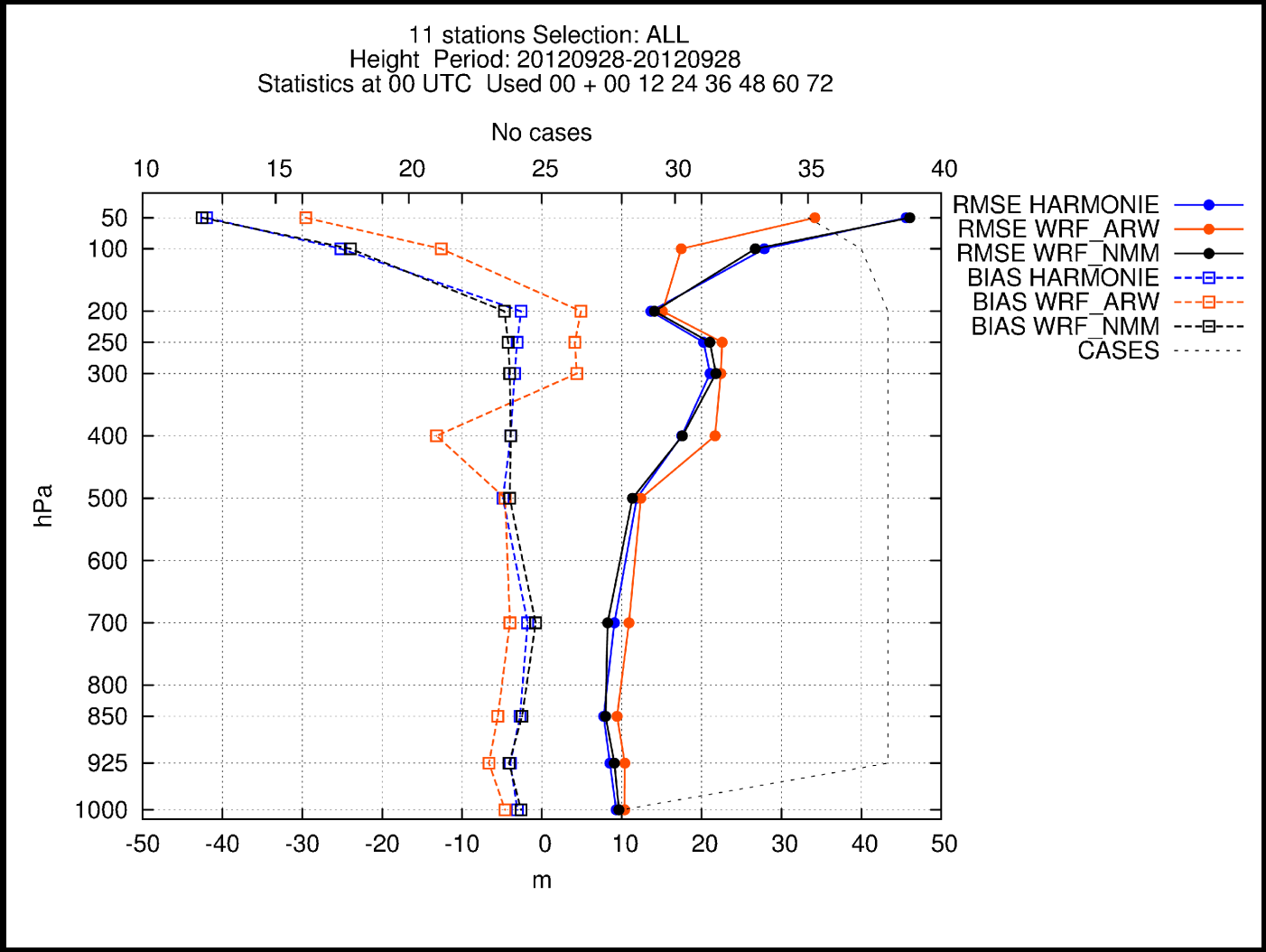


Geopotential height
HM-ARW-NMM
vertical profile

- **Similar performance**
- **In general:**

  NMM ≈ HM

  ARW < HM

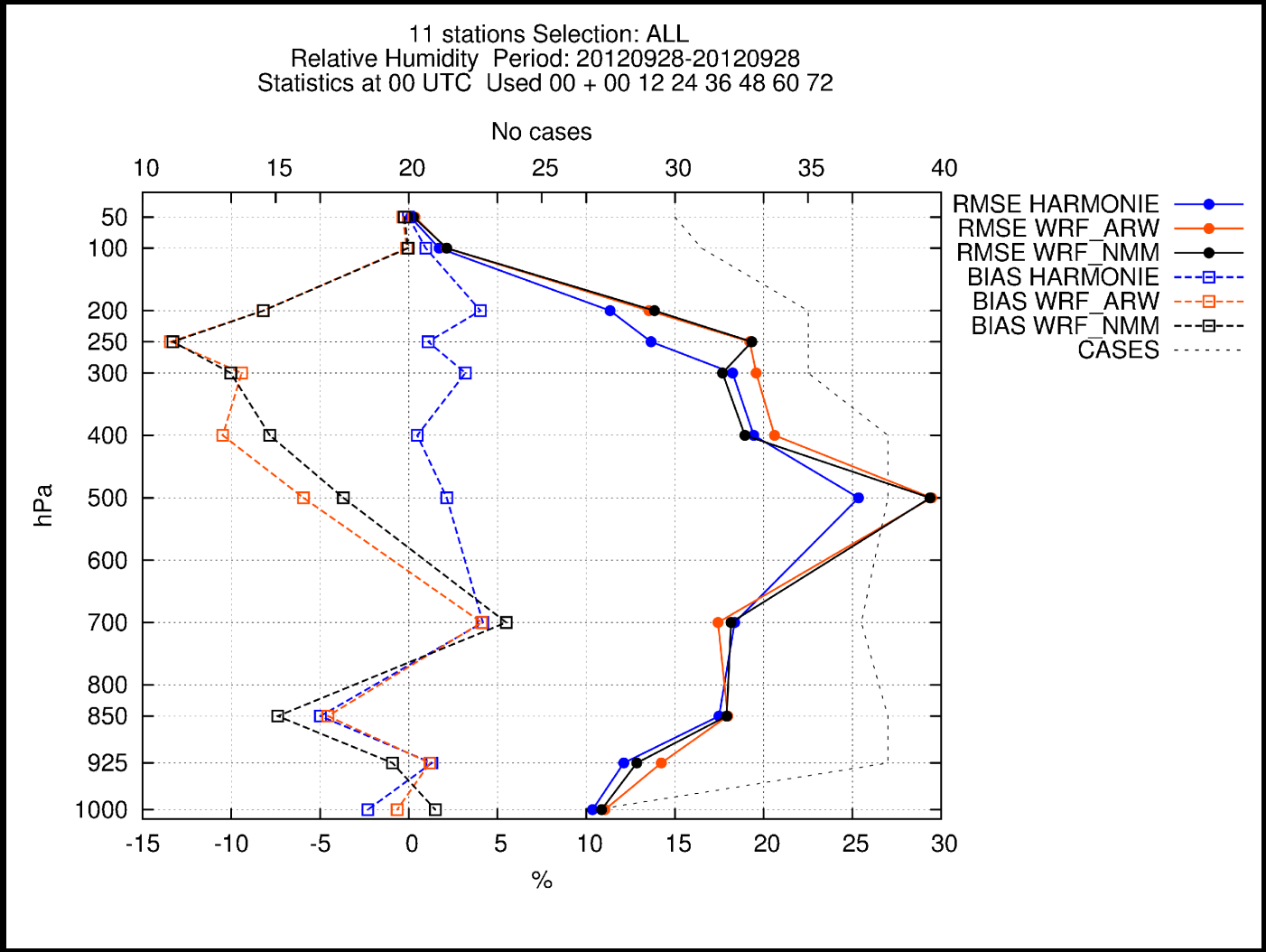


Relative Humidity
HM-ARW-NMM
vertical profile

- **No similar performance**
- **At mid-levels:**

  ARW << HM

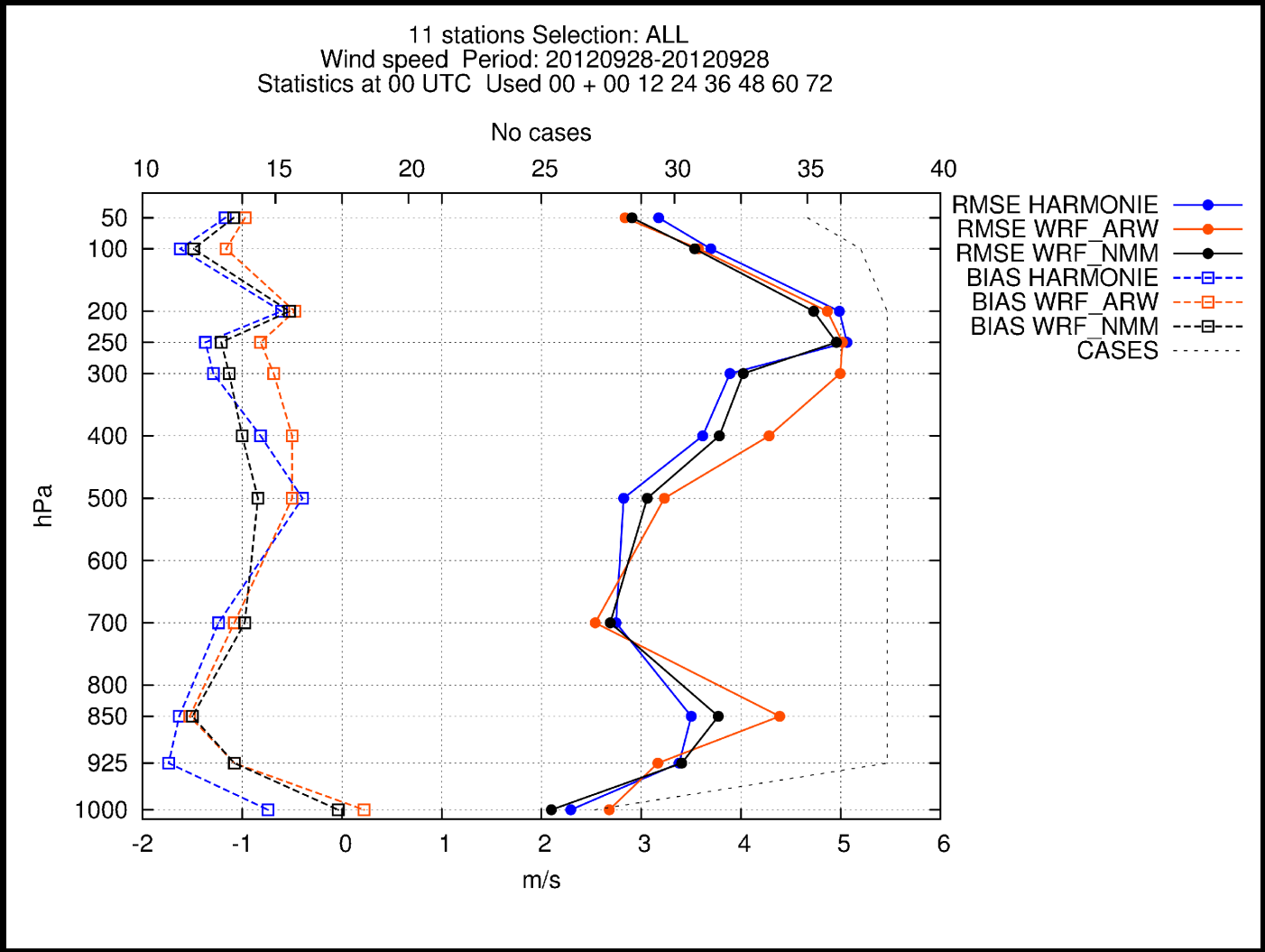
- **WRF dries excessively the mid and high levels**
- **But without an increase on AccPcp**



Wind Speed
HM-ARW-NMM
vertical profile

- **Slightly differences on performance**
- **Through all levels:**

ARW <≈ HM



Running γ-SREPS example

γ-SREPS at ECMWF Cray XC30

- **EcFlow: tasks management**

ecFlowview (4.0.9)

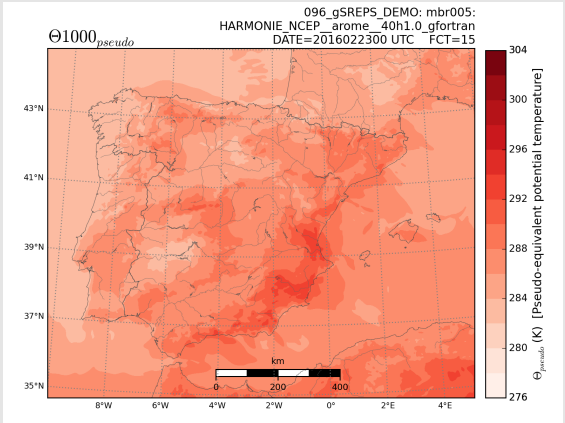
File Edit Show Servers Windows Help

2016-02-23 14:20:14

gSREPS
- 094_gSREPS
- 095_gSREPS
- 096_gSREPS_DEMO
  - 00
    - YMD: 20160223
    - 1_bcs
    - 2_eps
    - 3_grb
    - 4_vrf
      - ./2_eps/EPS_control:members_finished gt 0
      - VRF_control
      - GEO
        - mbr001
        - mbr002
        - mbr003
        - mbr004
        - mbr005
          - HARMONIE: NCEP__arome__40h1.0_gfortran
          - GEO_plot_MBR ../../../3_grb/download/mbr005/get_MBR eq complete
        - mbr006
        - mbr007
        - mbr008
        - mbr009
        - mbr010
        - mbr011
        - mbr012
        - mbr013
        - mbr014
        - mbr015
        - mbr016
        - mbr017
        - mbr018
        - mbr019
        - mbr020
        - GEO_tar_plot_MBR

VeRiFication

SUBJECTIVE Member plots



In what we are more worried ?

Horizontal and vertical resolution of BCs

BCs' horizontal & vertical resolution

- **Constraint: we have not enough human and computing resources to run an intermediate EPS between Global NWP models (15-30km) and convection-permitting EPS (2.5km)**
  - **Like your convection-permitting EPS into SREF**
- **The leap of horizontal resolution between BCs and convection-permitting EPS seems not to be critical (at least for synoptic / meso-α scales), BUT it seems to be VERTICAL RESOLUTION**

SO

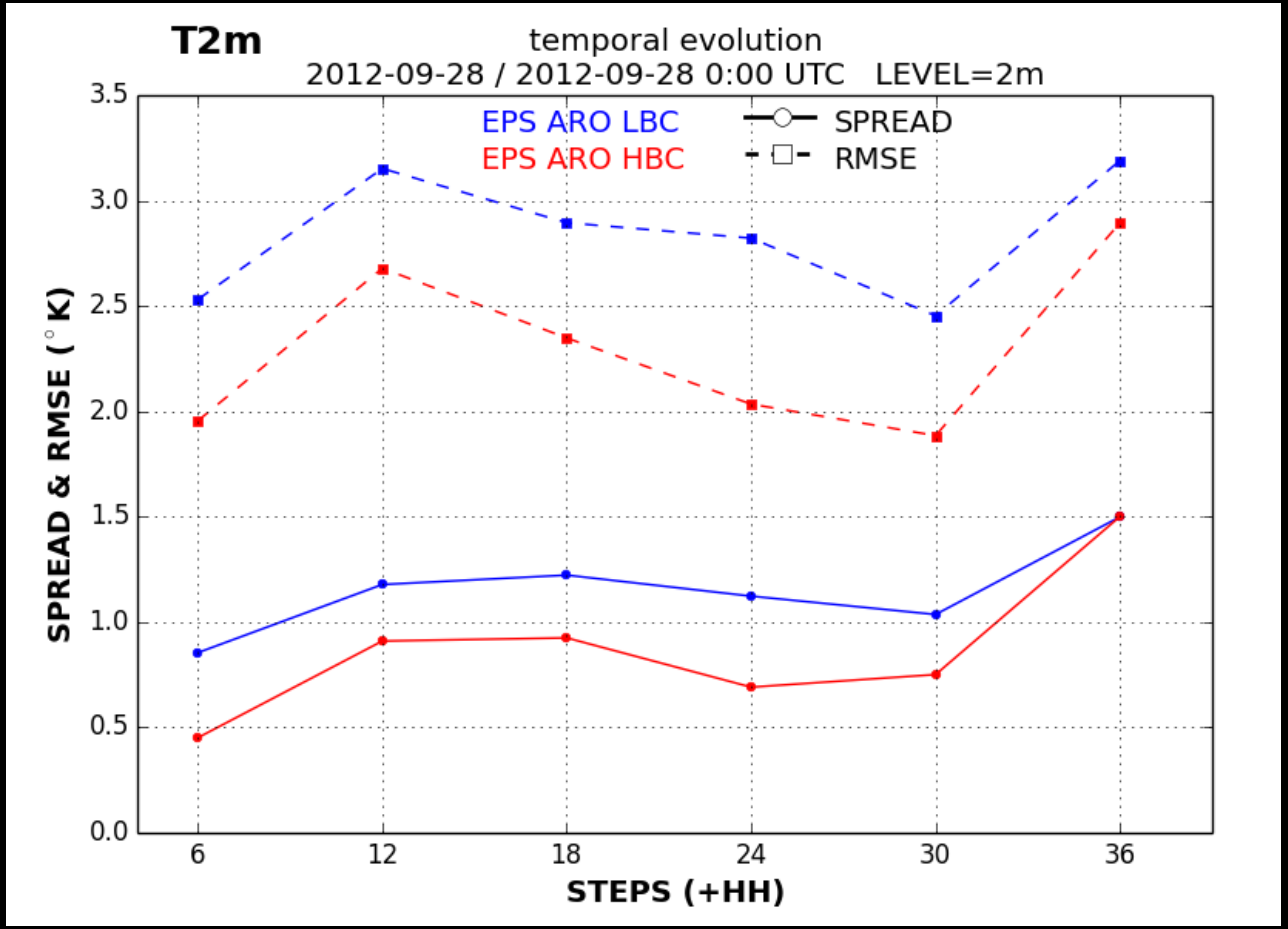
- **We would like to have the FULL VERTICAL and HORIZONTAL resolution from Global NWP models**

Resolution leap between BCs and 2.5km EPS

ECMWF BCs **~16 km** **~30 km**

T2m

- **SPREAD:**
  - **HR < LR**
- **SKILL:**
  - **HR >> LR**



Resolution leap between BCs and 2.5km EPS

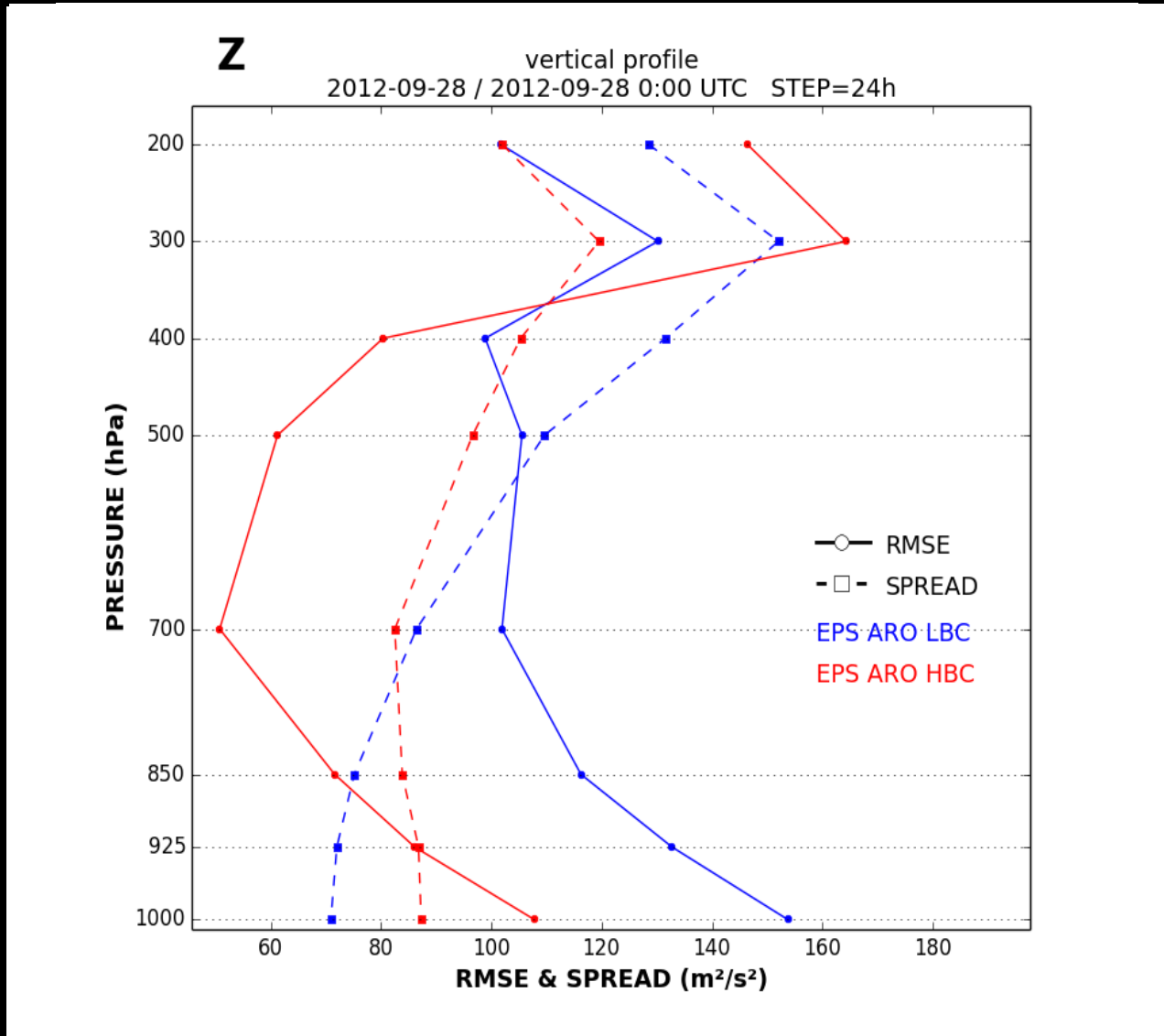
ECMWF BCs

~16 km

~30 km

Z Geopotential

- **SPREAD:**
  - **HR ≈ LR**
- **SKILL:**
  - **HR >> LR**



Testing vertical resolution from MétéoFrance

José Antonio García-Moya

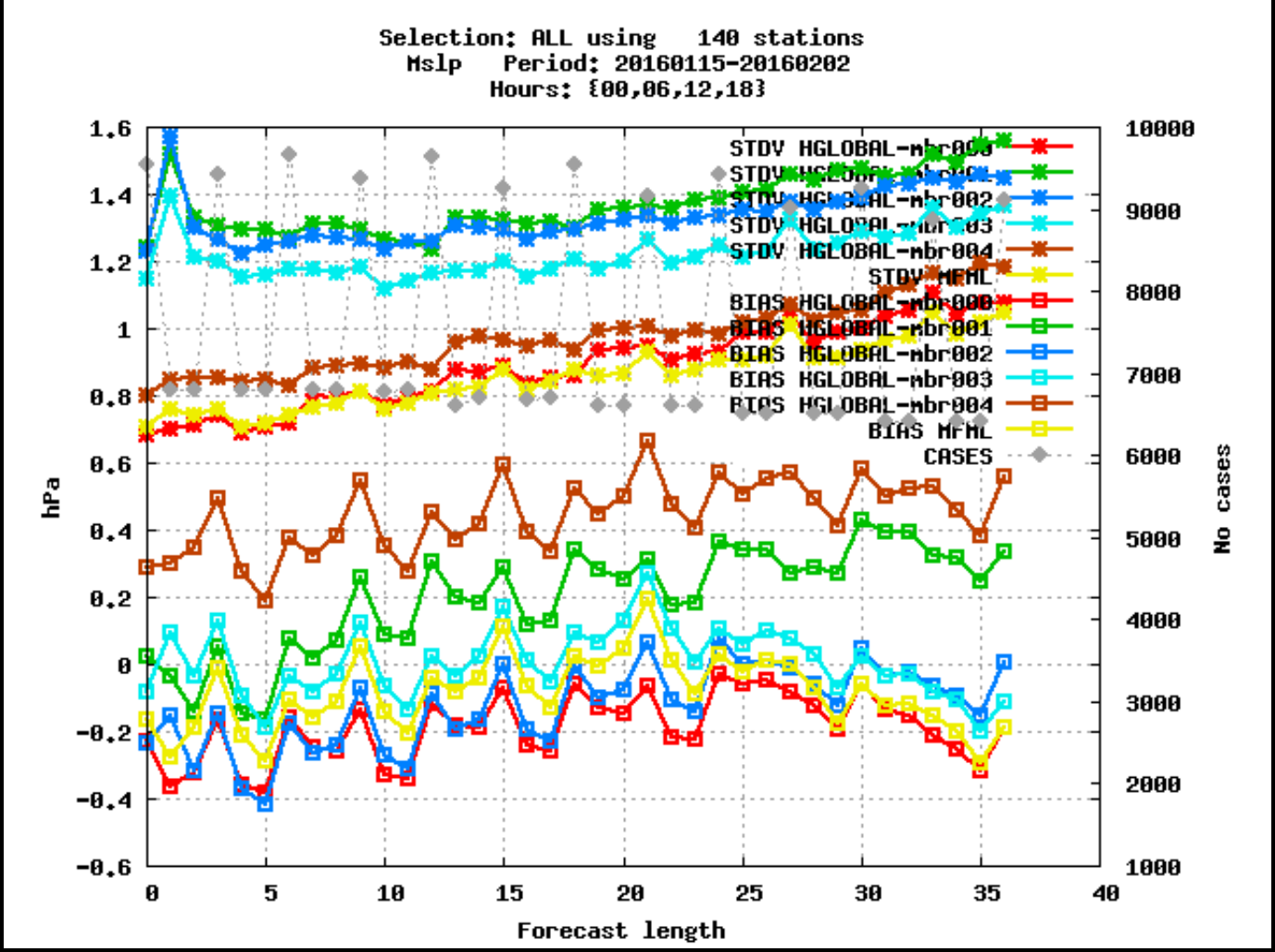
Model	How they are			What we get (Every 3 hours – 00 and 12 UTC)		
	Hor Res (km)	Vert Levels #	Type of levels	Hor Res (Km)	Vert Levels	Type of levels
ECMWF	16	137	Hybrid	16 (0.16 deg)	137	Hybrid
Arpege MF_PL	7	105	Hybrid	11 (0.10 deg)	**28**	Pressure
Arpege MF_ML	7	105	Hybrid	10	**60**	Hybrid

Model: HARMONIE-AROME, Period: 2016011512 - 2016020300

Surface parameters
ECMWF-MF_PL-MF_ML

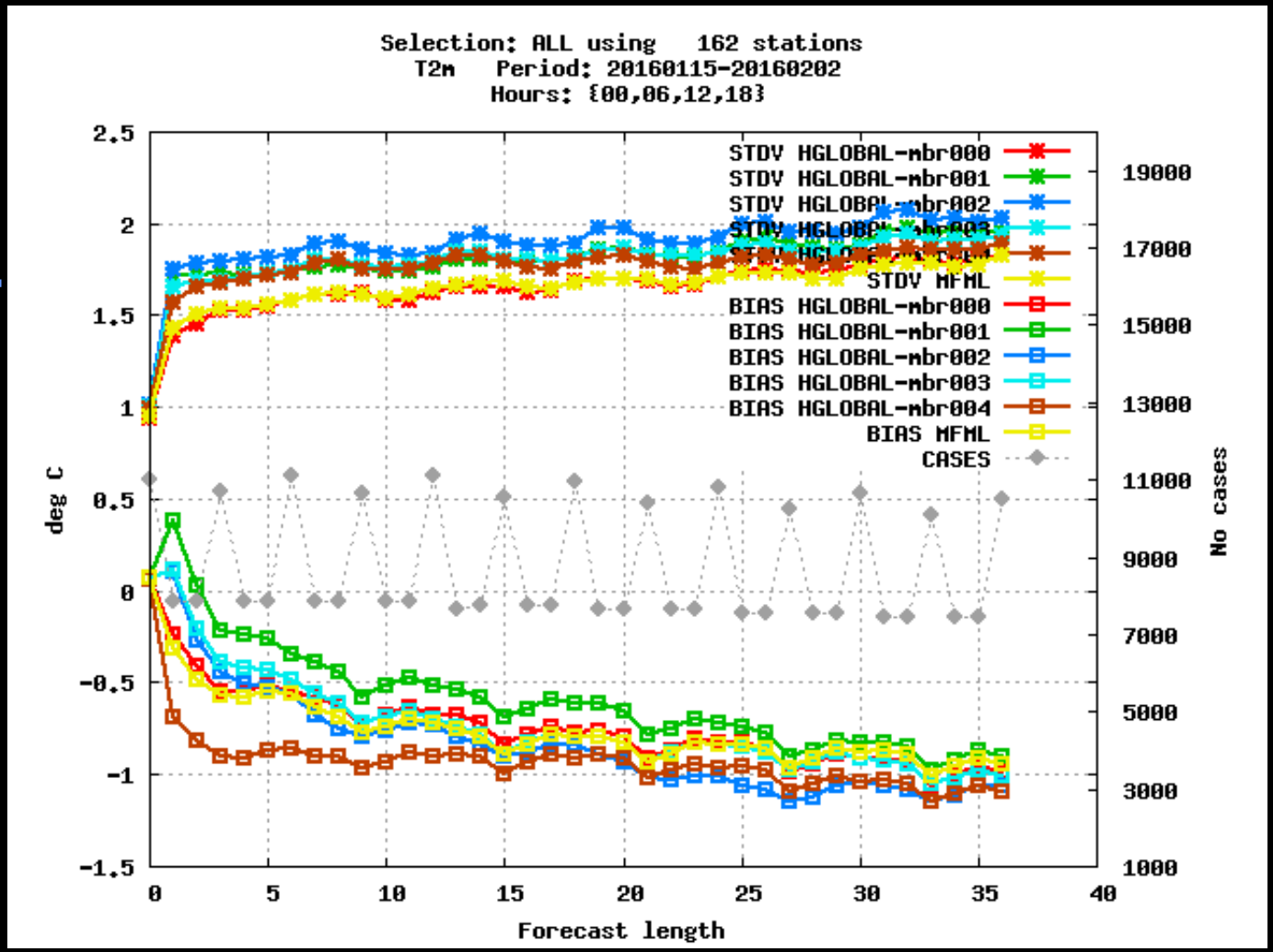
*RMSE & □BIAS time evolution of Pmsl

- MF_ML > MF_PL
- MF_ML ≈ ECMWF
- ECMWF > GFS
- GFS ≈ MF_PL



Surface parameters
ECMWF-MF_PL-MF_ML
*RMSE & □BIAS time evolution of T2m

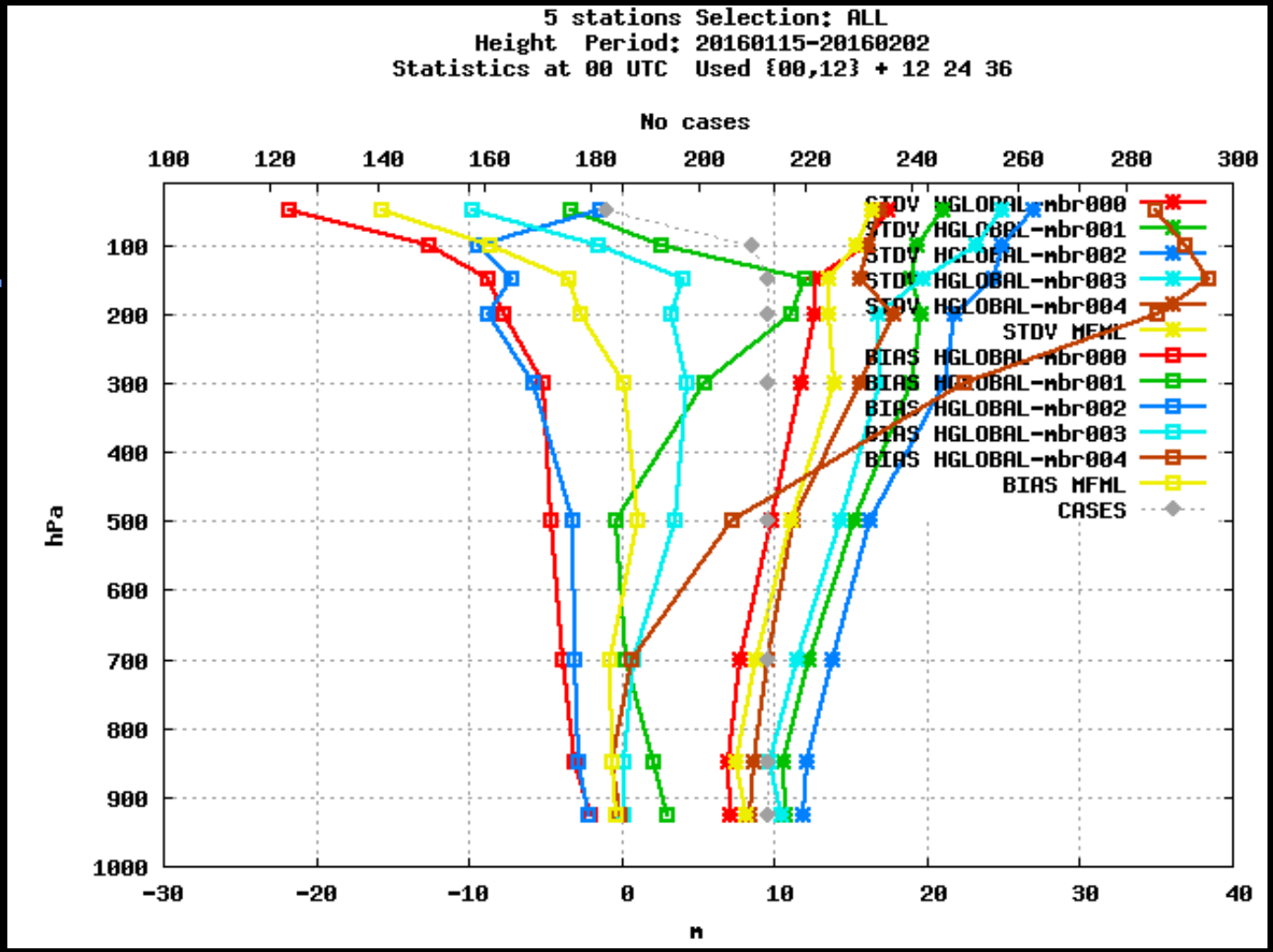
- MF_ML > MF_PL
- MF_ML ≈ ECMWF
- ECMWF > GFS
- GFS ≈ MF_PL



Surface parameters
ECMWF-MF_PL-MF_ML

*RMSE & □BIAS vertical profile of Z Geopotential

- MF_ML > MF_PL
- MF_ML ≈ ECMWF
- ECMWF > GFS
- GFS ≈ MF_PL



NCEP/GFS BCs

- **It could be possible to have available NCEP/GFS to FULL VERTICAL and HORIZONTAL resolution for γ-SREPS ???**
  - **AREA: LON (-30.00, 20.00) LAT (20.00, 55.00)**

BCs	How they are			What we get (Every 3 hours – 00 and 12 UTC)		
	Hor Res (km)	Vert Levels #	Type of levels	Hor Res (Km)	Vert Levels	Type of levels
ECMWF	16	137	Hybrid	16 (0.16 deg)	137	Hybrid
GFS	13	64	Sigma	26 (0.25 deg)	26	Pressure
CMC	25	80	Hybrid	25 (0.24 deg)	28	Pressure
Arpege	7	105	Hybrid	11 (0.10 deg)	15	Pressure
JMA	20	100	Hybrid	55 (0.5 deg)	86	Hybrid

Future γ–SREPS development

2016 Work plan

- **March: 00 and 12 UTC cold γ-SREPS daily runs until 36 (¿72 hours?)**
  - **Pre-operational system debugging**
  - **Products development:**
    - **General: AEMET forecaster probabilistic products**
    - **Specific: Airports EPSgrams, solar power, wind power, local city forecasts, etc.**
- **Summer-autumn: test and run γ-SREPS on assimilation cycles 1-2 hours**
  - **LETKF**
  - **3DVAR (¿4DVAR?)**

¿RADAR assimilation?

Pau Escribà Ayerbe

- **Autumn: model errors and uncertainties**
  - **Multi-model: +NWP model: ¿GEM-LAM? 25 memb.**
  - **Multi-model complement: Stochastic parameterisation: SPPT [WRF: JUDITH BERNER]**

2017- Work plan

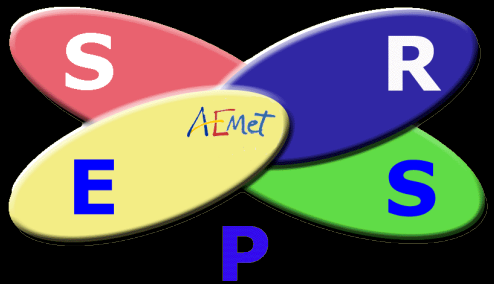
- **Expecting full γ-SREPS development:**
  - **8 cycle per day: 00, 03, 06, … , 18, 21**
  - **Intermediate cycles: NOWCASTING**
    - **HH+12 (RADAR assimilation crucial)**
  - **00 and 12 UTC cycles: SHORT RANGE**
    - **HH+72**

BUT NOTHING IS YET DECIDED

Thank you
for your attention !!!

jgarciamoyaz@aemet.es acalladop@aemet.es
pescribaa@aemet.es mcompter@aemet.es

Any question will be wellcome



NCEP seminar
AEMET Predictability Group
Alfons Callado
J.A. García-Moya, *C. Santos*
Pau Escribà, Marc Compte

My WRF-NMM / NMMB questions

WRF-NMM / NMMB questions

- NMMB
  - Difference between WRF-NMM and NMMB ? What's going on ? Are we have to use NMMB instead of WRF-NMM ?
    - GRID E → GRID B

WRF-NMM / NMMB questions

- **Assimilation: 3DVAR**
  - **What are your using? 3DVAR or 4DVAR ??**
    - **OBS format**
    - **HARMONIE → BUFR (ECMWF)**
    - **XML ???**

[Pau Escribà]

WRF-NMM questions

- T2m: lost at last step “real” ??? It is essential to have ???
- Skin Temperature: it seems to be mandatory. It is abolutely necessary ???
  - Not avalaible on CMC/GEM

WRF-NMM questions

- q/RH: Why so many conversions ???
  - “ungrib”: q → RH
  - “real”: RH → q [back again]

  [it looks inconsistent]

WRF-NMM questions

- Soil parameters: it seems it could work just with only one level, but:
  - It has to include all NOAH levels
  - Difference between LEVELS and LAYERS:
    - LAYERS seems to be able to interpolate from 3m depth climatological fields of temperature and humidity

[We are trying to run all BCs independently between them]

WRF-NMM questions

- How are stochastic parameterisations: SPPT and SKEB??? Are you using them ??? [Judith Berner]
  - Both [V3.6] have exactly the same result … one of them it does not work and the other is selected

WRF-NMM questions

- What are our currently convection-allowing systems: deterministic foerecast and EPS ???

WRF-NMM questions

- Something important I have not asked and we have to know ???

ADDITIONAL ISSUES / SLIDES

Subjective VERIFICATION

Low levels Pmsl & T850 WRF-ARW

- **Consistent results, BUT perhaps:**
  - **Pmsl in the LOW center:**

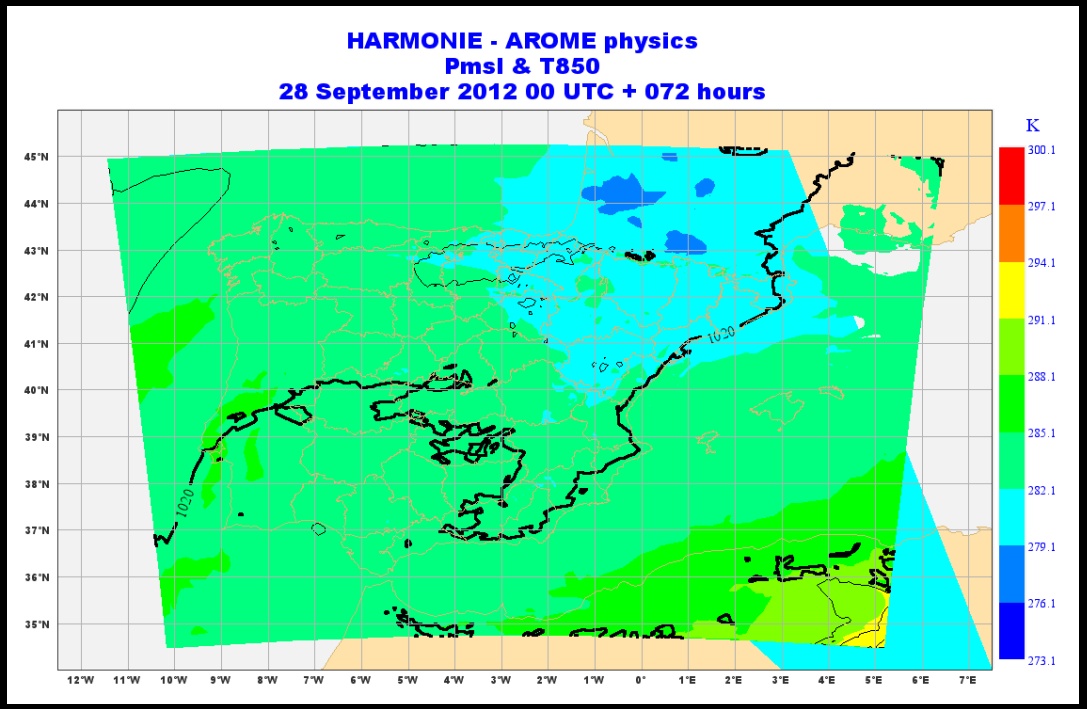
    WRF-ARW < HARMONIE

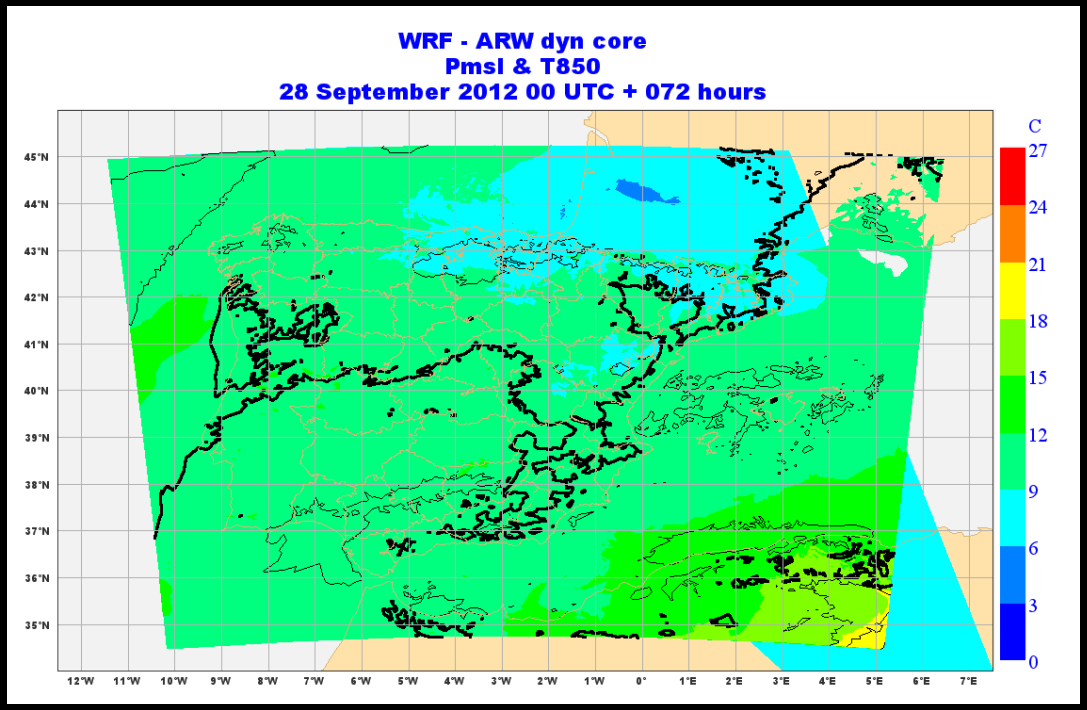
    [WRF-UPP-Pmsl method used: Shuell. Two another methods available: MAPS and Mesinger]

  - **T850:**

    WRF-ARW >= HARMONIE
    [cold air]

    WRF-ARW <= HARMONIE
    [warm air]





Low levels Pmsl & T850 WRF-NMM

- **Consistent results, BUT perhaps:**
  - **Pmsl in the LOW center:**

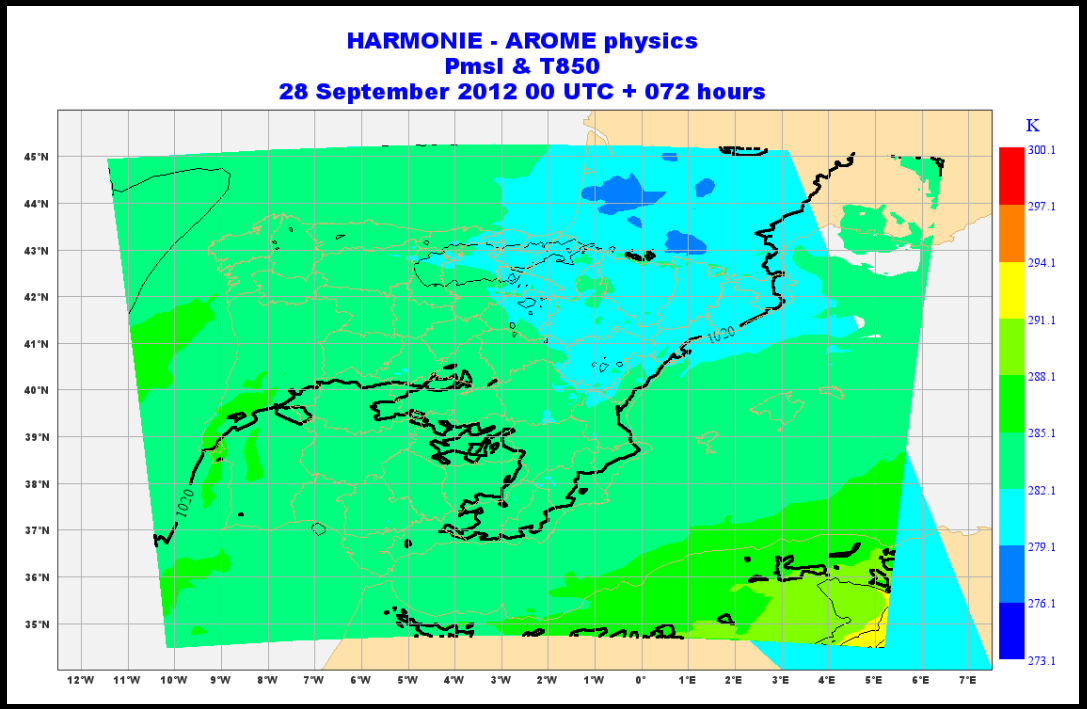
    WRF-NMM > HARMONIE

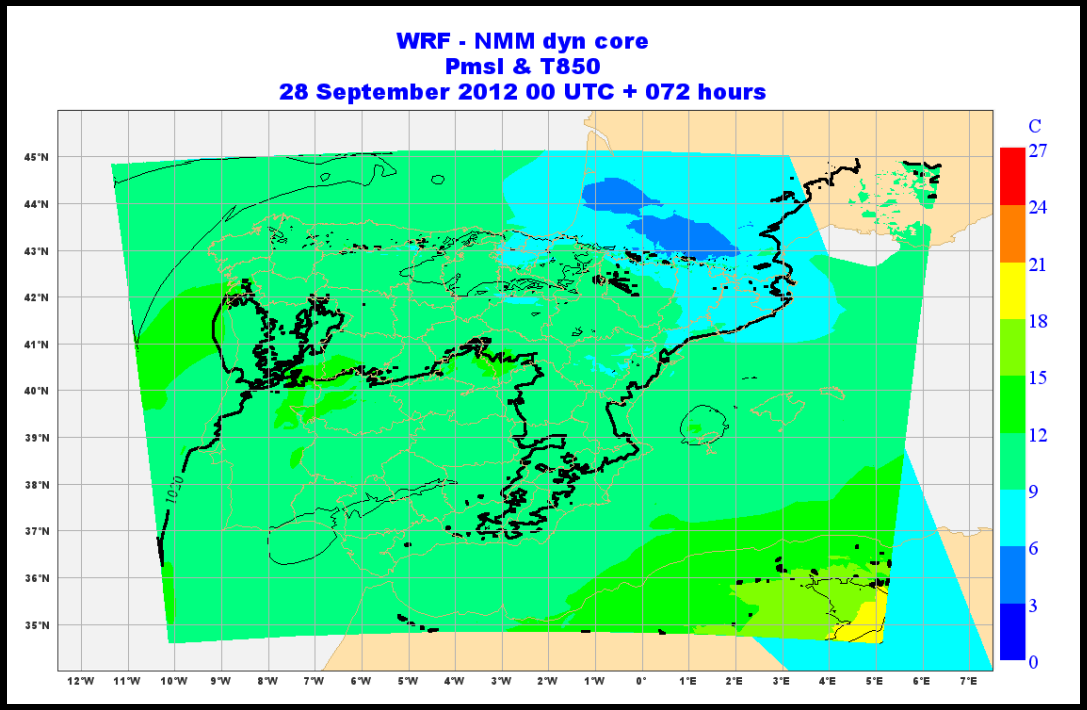
    [WRF-UPP-Pmsl method used: Shuell. Two another methods available: MAPS and Mesinger]

  - **T850:**

    WRF-NMM >= HARMONIE
    [cold air]

    WRF-NMM ≈ HARMONIE
    [warm air]



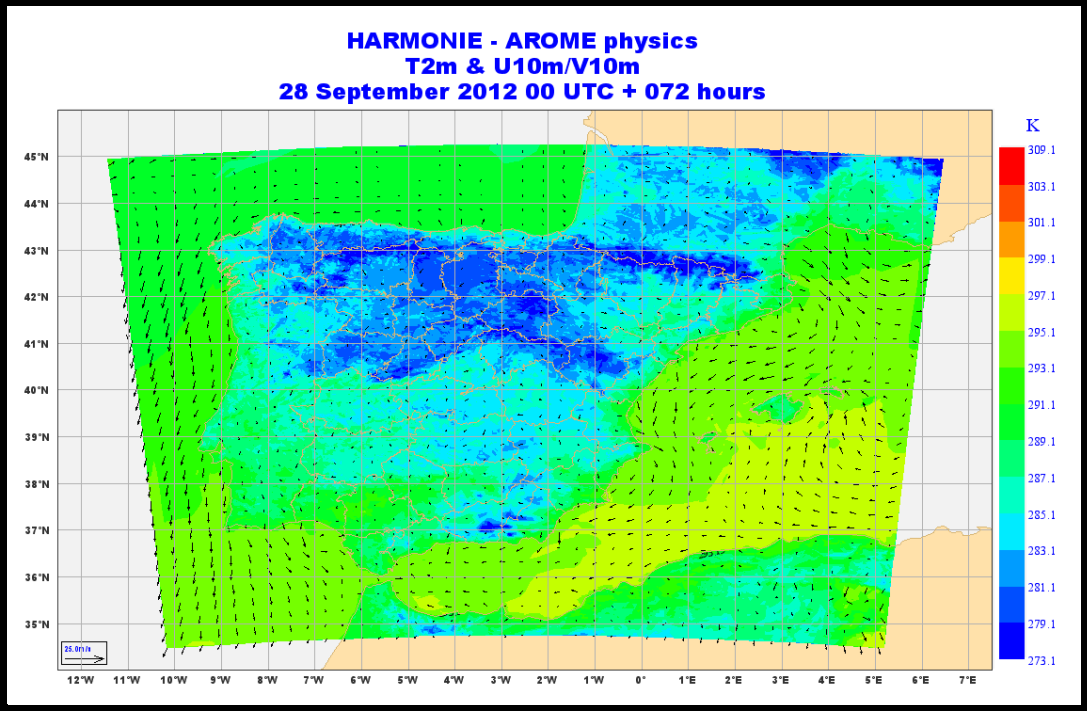


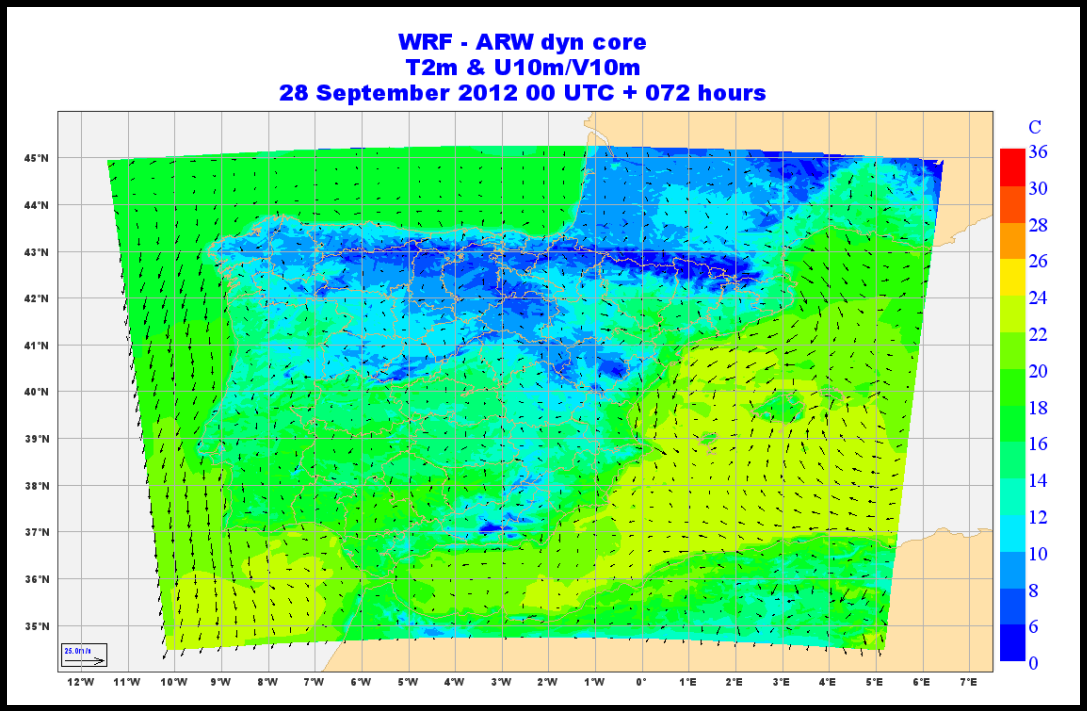
SURFACE T2m & S10m WRF-ARW

- Similar results, BUT:
  - Strong winds:

    WRF-ARW < HARMONIE
  - Land/sea temperature contrast:

    WRF-ARW > HARMONIE





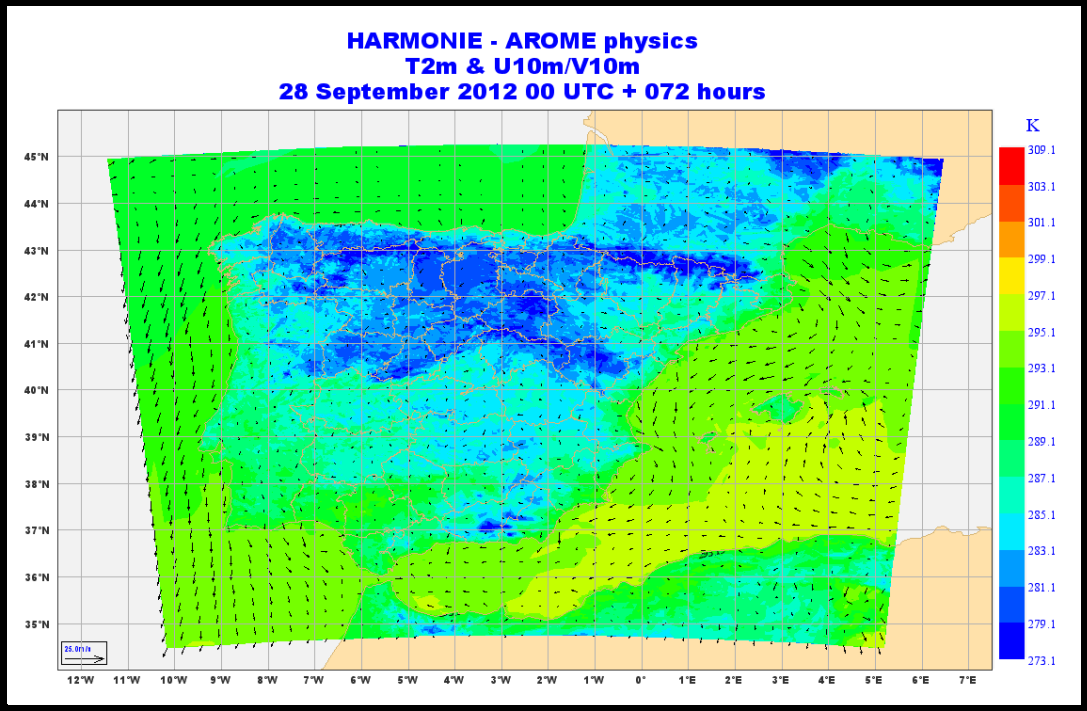
SURFACE
T2m & S10m
WRF-NMM

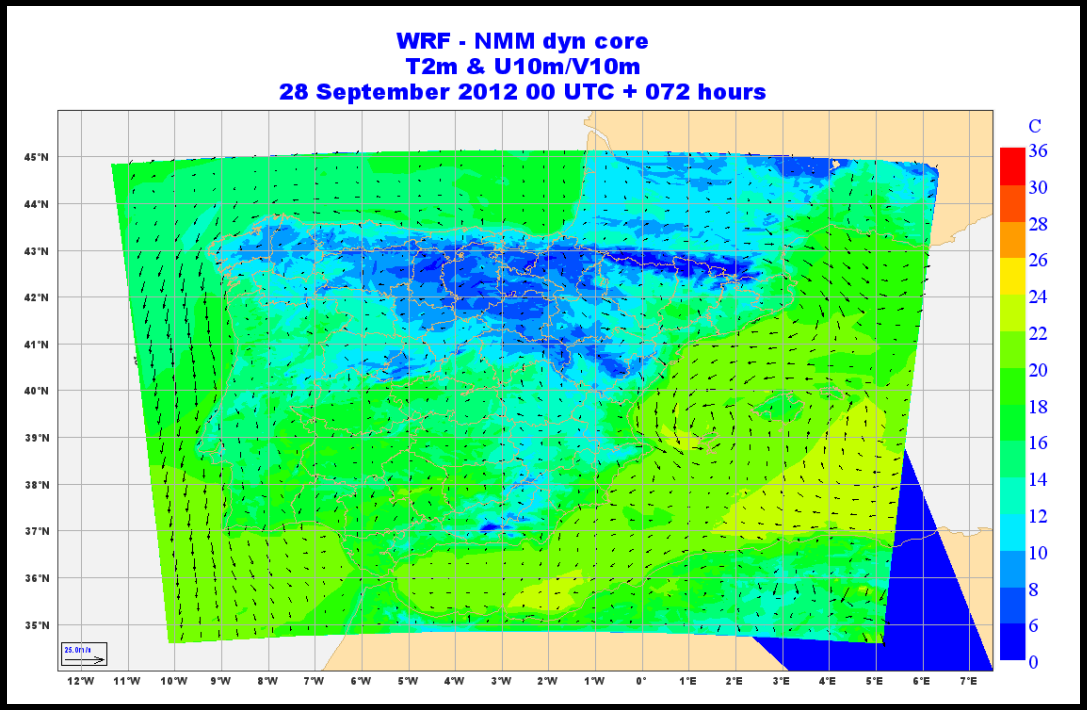
- **Similar results, BUT:**
  - **Strong winds:**

    WRF-NMM <= HARMONIE

  - **Land/sea temperature contrast:**

    WRF-NMM ≈ HARMONIE



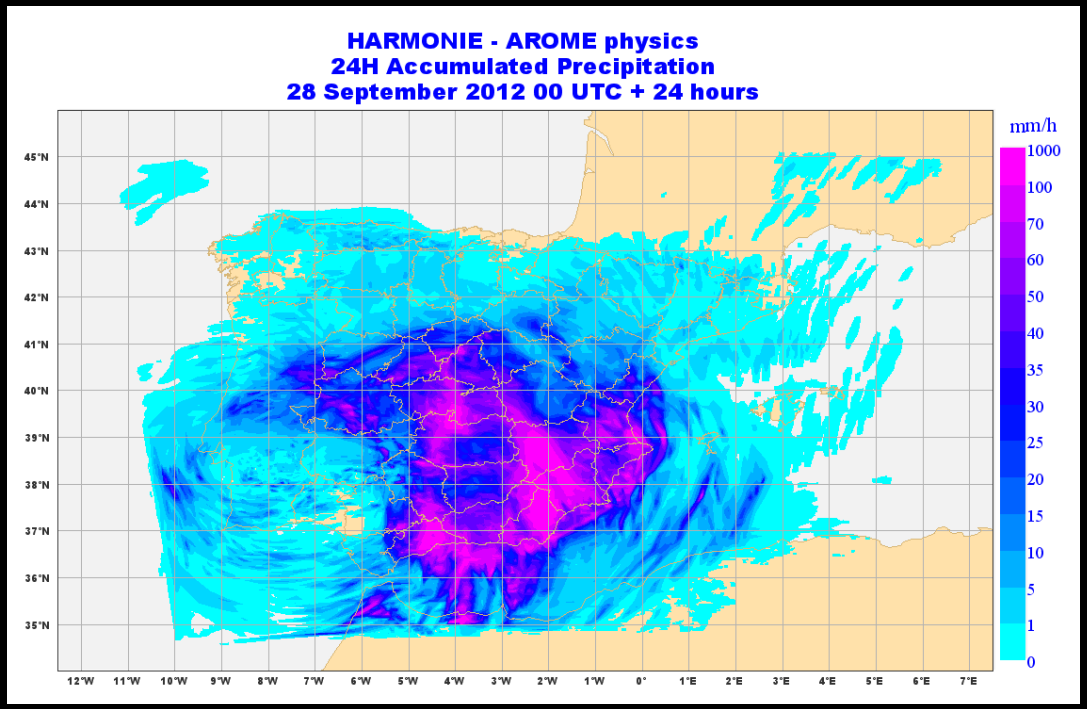


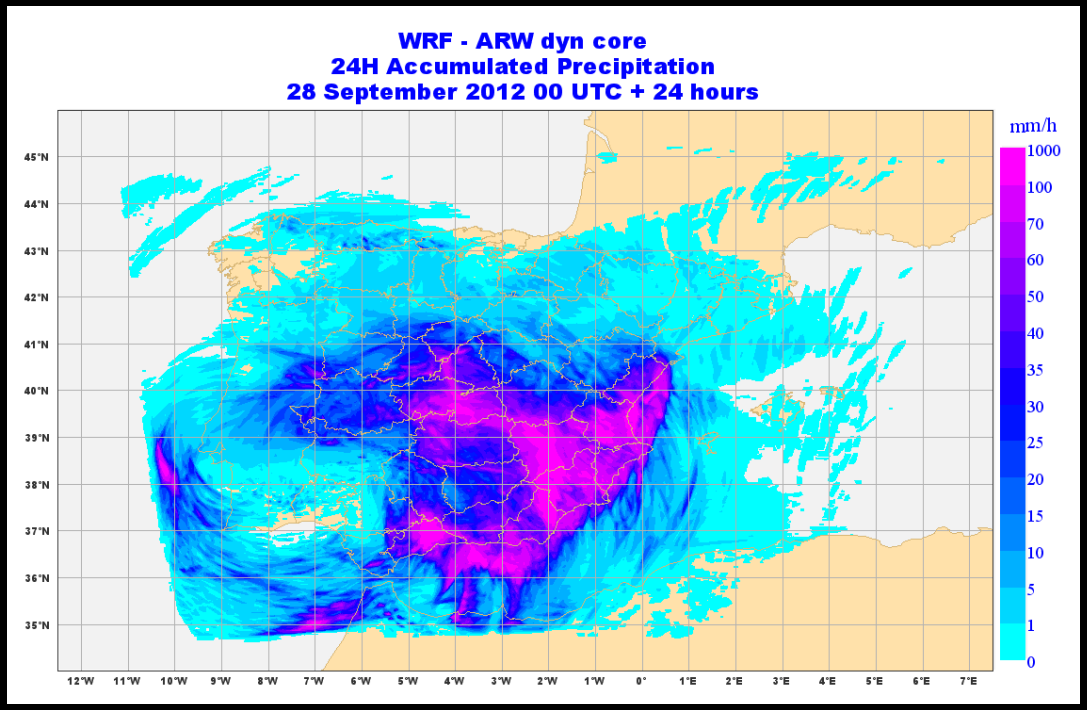
Precipitation 24H AccPcp WRF-ARW

- Quite similar precipitation distribution, BUT:
  - Pcp “linear traces”:

    WRF-ARW > HARMONIE
  - Pcp over the sea:

    WRF-ARW < HARMONIE





Precipitation 3H AccPcp WRF-ARW

- Comparable and consistent precipitation structures, BUT:
  - Maximum Pcp in 3H:

WRF-ARW > HARMONIE

[Even more than 120 mm/3h]

  - "Fine" structures:

WRF-ARW > HARMONIE