Sensitivity of HARMONIE to nesting strategy and initial conditions

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Acknowledgements: *Isabel Martinez, Mariano Hortal, Bartolomé Orfila and Maria Díez*

ALADIN/HIRLAM ASM

Norrköping, 5-8 April 2011

Sensitivity of HARMONIE to nesting strategy and initial conditions

OUTLINE

1) Description of the experiments.
2) The period of studying
3) Nesting strategy: Need of an intermediate model to provide boundaries for the 2.5 km model.
4) Sensitivity to the frequency of the boundaries
5) Sensitivity to the initial condition
6) Conclusions

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1) Description of the experiments.

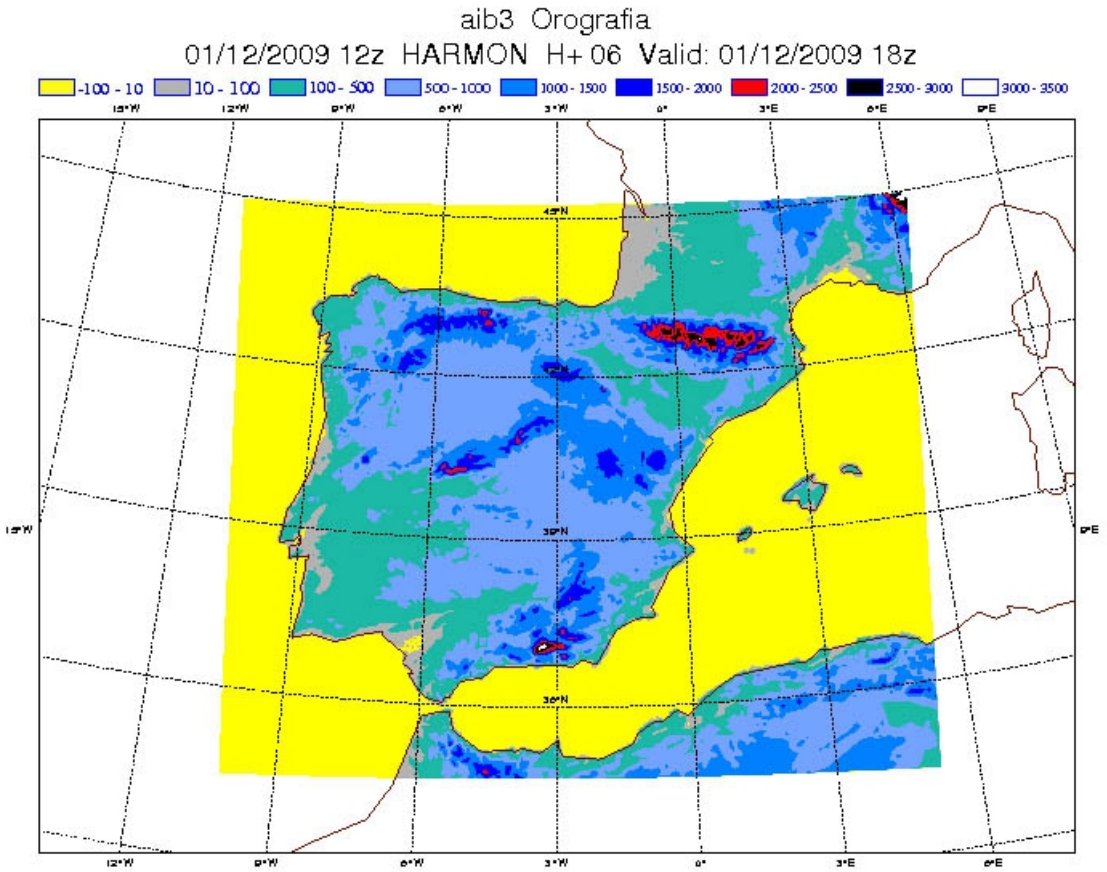
Model version	**HARMONIE 36h1.2**
Resolution	2.5 km, 60 v.l.
Physics:	AROME
Initial state	
Upper levels	None / **3DVar** (6h window) / **Blending**
Surface	CANARI_OI_MAIN
Boundaries:	ECMWF **T1279**
	3 hr frequency (extracted 16/25 km, (046, 048)
	1 hr frequency (expver=048)
	ECMWF T2047 (10 Km, expver=049)
	HIRLAM 8 km (hourly)
	ALADIN 8km (hourly)
Forecast lenght:	H+42 -> 00 y 12 UTC
	H+06 -> 06 y 18 UTC

1) Description of the experiments.

Domain — IBERIA_2.5 (576x480)

Study period — **11-20 dic 2009** Surface assimilation cycle H+6

21-31 dic 2009 Complete cycle H+42



OUTLINE

1) Description of the experiments.
2) **The period of studying**
3) Nesting strategy: Need of an intermediate model to provide boundaries for the 2.5 km model.
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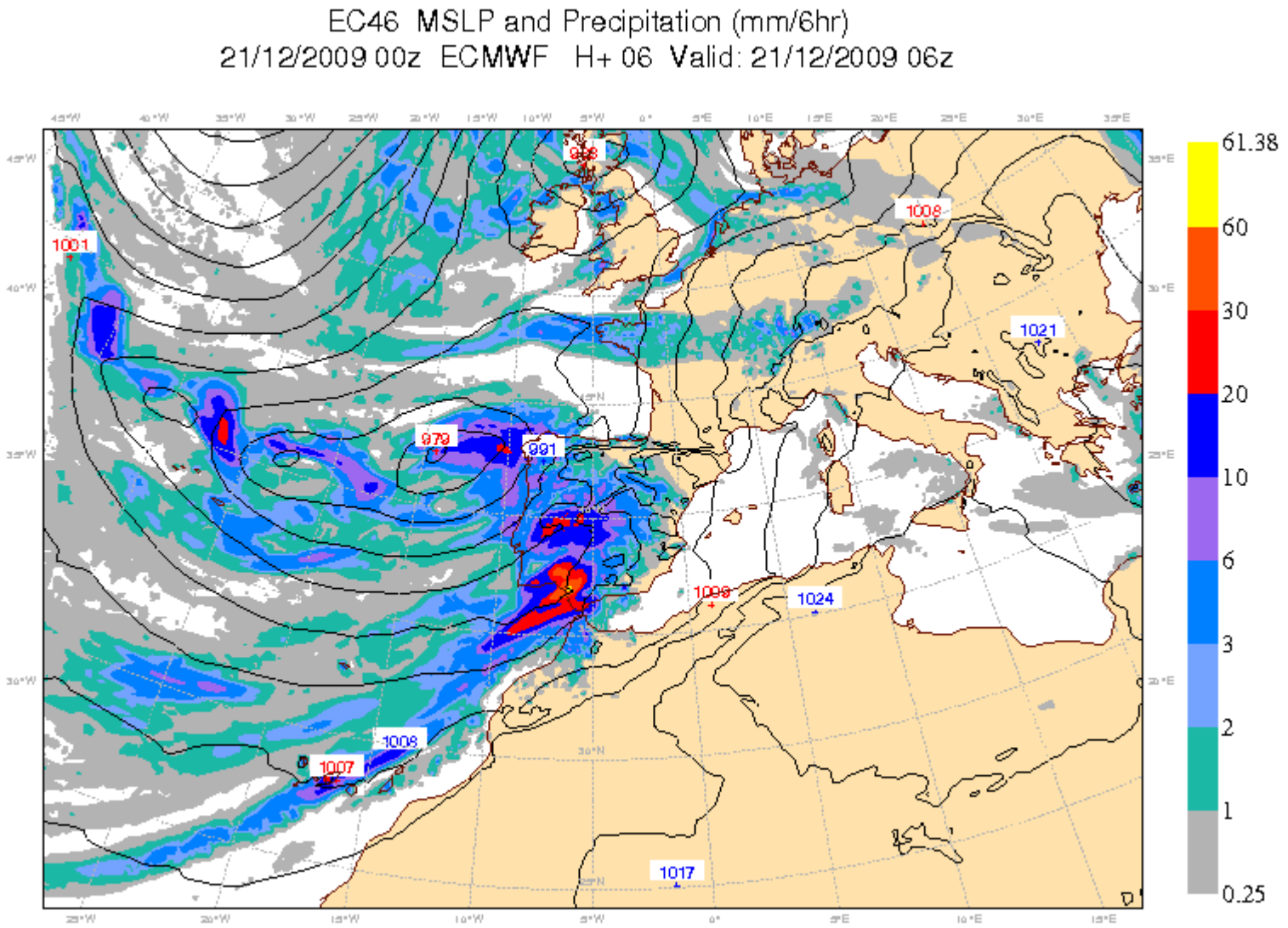
5) Sensitivity to the initial condition
6) Conclusions

2) The period of the study

HARMONIE 2.5 km has been verified over a wet winter period of 11 day: **21-31 dic 2009**



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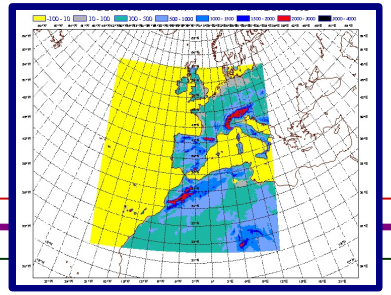
3) Nesting strategy: Need of an intermediate model

IFS ECMWF T1279,

16 km resolution

HIRLAM 8 KM 60 vl

- HIRLAM 7.2.1 **nested in** T1279 (16 km) ECMWF fcs (**3 hr**).
- **3Dvar** (6 h wind) + **Blending** : conv obs + ATOVS
- AEMET_08 (486x500)
- fc up to 48h, hourly



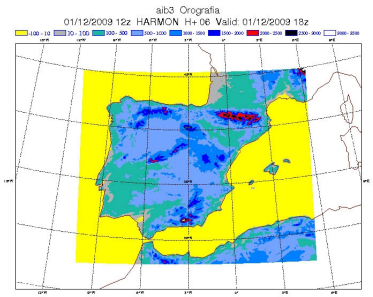
ALADIN 8 KM 60 vl, hydrostatic

- ALADIN 36h1.3 **nested in** T1279 (16 km) ECMWF fc (**3 hr**).
- **3Dvar** (6 h wind): conventional obs
- Scf scheme: old_surface + CANARI
- IBERIA_08 (486x500)
- fc up to 48h, hourly

Three HOST MODELS:

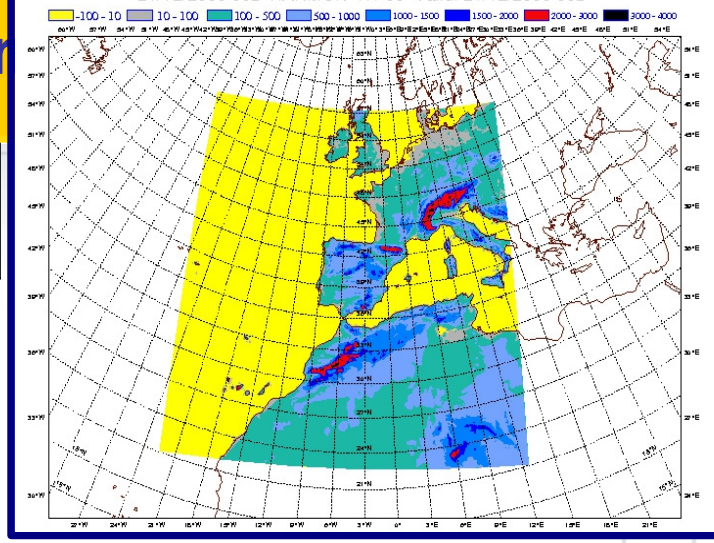
HARMONIE 36h1.2

2.5 km, 60 v.l.



3) Nesting strategy: Need of an interr model

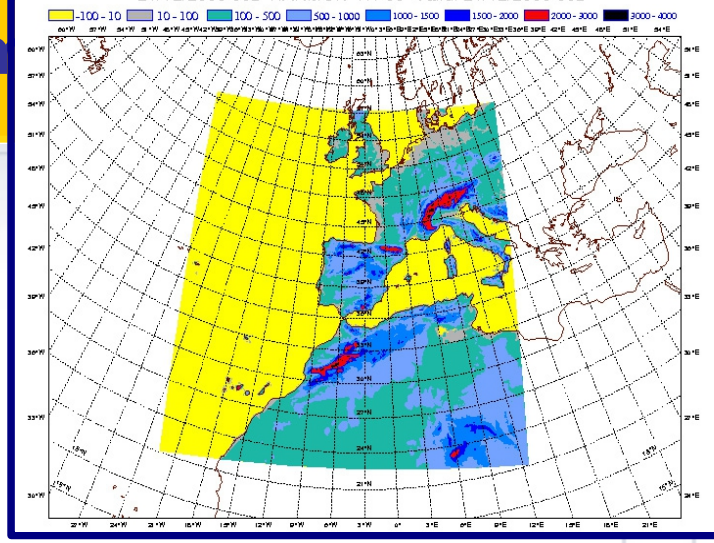
8km exp: HIRLAM HI8



Period	(21-31 /12/2009)
VERSION	7.2.1. (hydrostatic)
Horizontal resol.	8 Km
Vertical res.	60 levels
Domain	AEMET_08 (486x500)
PHYSICS	hirlam, KF
Upper-air scheme	**3DVar** (6hr window) + BLENDING (6hr) conventional obs +ATOVS
IC & Boundaries	**IFS (T1279; 16 Km), 3 hr , fc-6**
Forecast up to:	H+48, hourly.

3) Nesting strategy: Need of an intern model

8km exp: ALADIN (ib36h13_ec46)

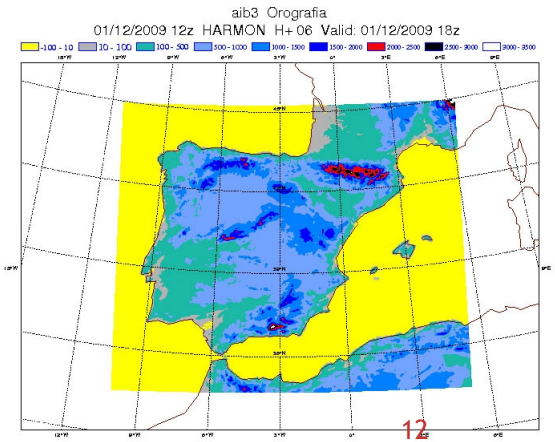


Period	(21-31 /12/2009)
VERSION	36h1.3. (hydrostatic)
Horizontal resol.	8 Km
Vertical res.	60 levels
Domain	IBERIA_8 (384x400)
PHYSICS	aladin; (Old_surface + CANARI)
Upper-air scheme	**3DVar** (6hr window) conventional obs
IC & Boundaries	**IFS (T1279; 16 Km), 3 hr , fc-6, gl_only**
Forecast up to:	H+48, hourly.

3) Nesting strategy: Need of an intermediate model

HARMONIE 2.5 km is nested in IFS ECMWF T1279 (EXP 46) boundaries, or in intermediate 8 km resolution HIRLAM or ALADIN integration.

Experimentos	Versión	Host model
a36h12ec16	36h1.2+Blending	ECMWF 16 km, **3hr, fc-6**
a36h12hi8	36h1.2+Blending	HIRLAM 8 km, **1hr, fc+0**
a36h12al8	36h1.2+Blending	ALADIN 8 km, **1hr, fc+0**



3) Nesting strategy: Need of an intermediate model_

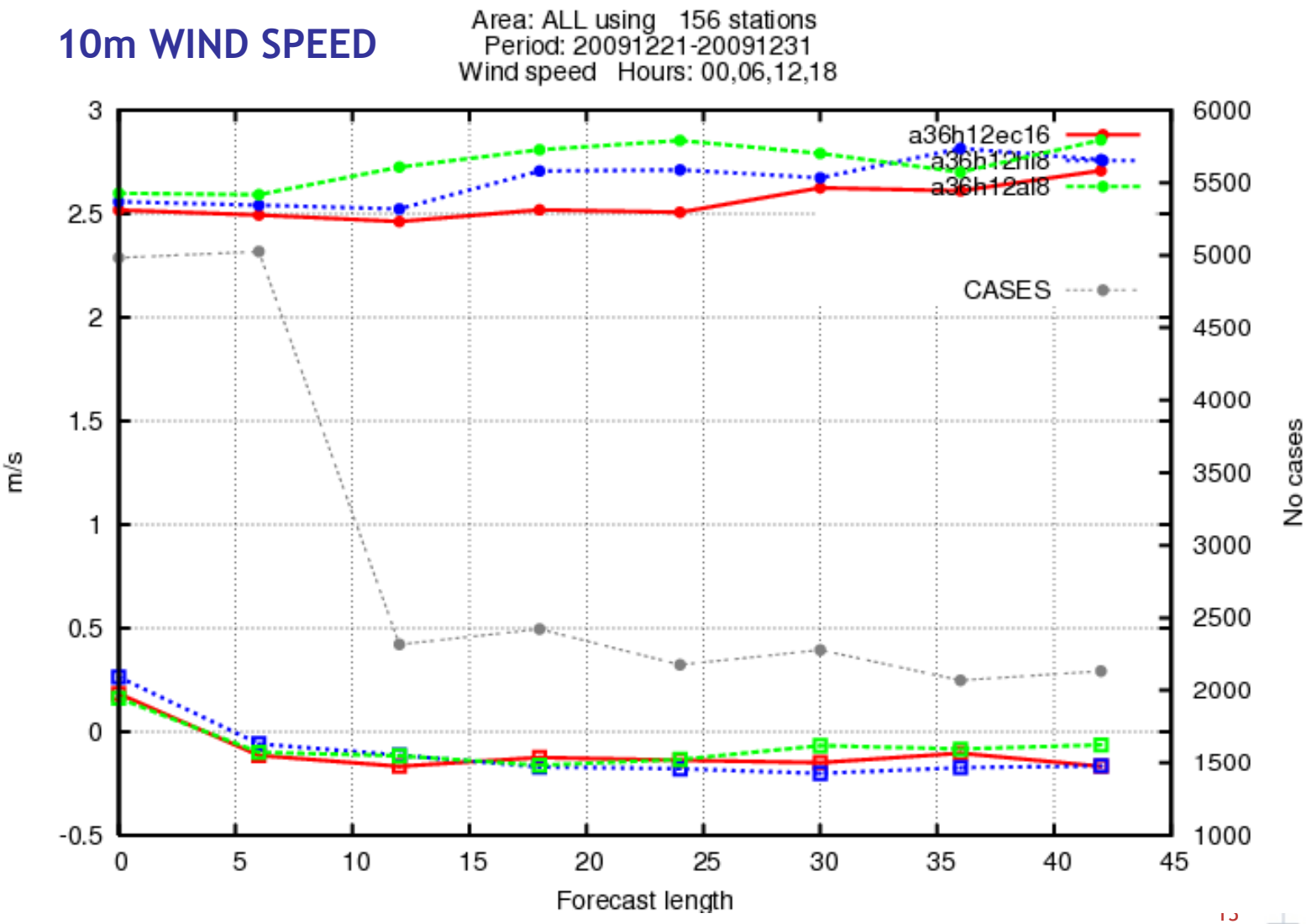
Surface verification for experiments with different host models

RMSE and Bias function of the forecast length for

(a) Sfc pressure,
(b) 10 m wind

- RMSE
- BIAS

EC **HIR8** **ALD8**



3) Nesting strategy: Need of an intermediate model_

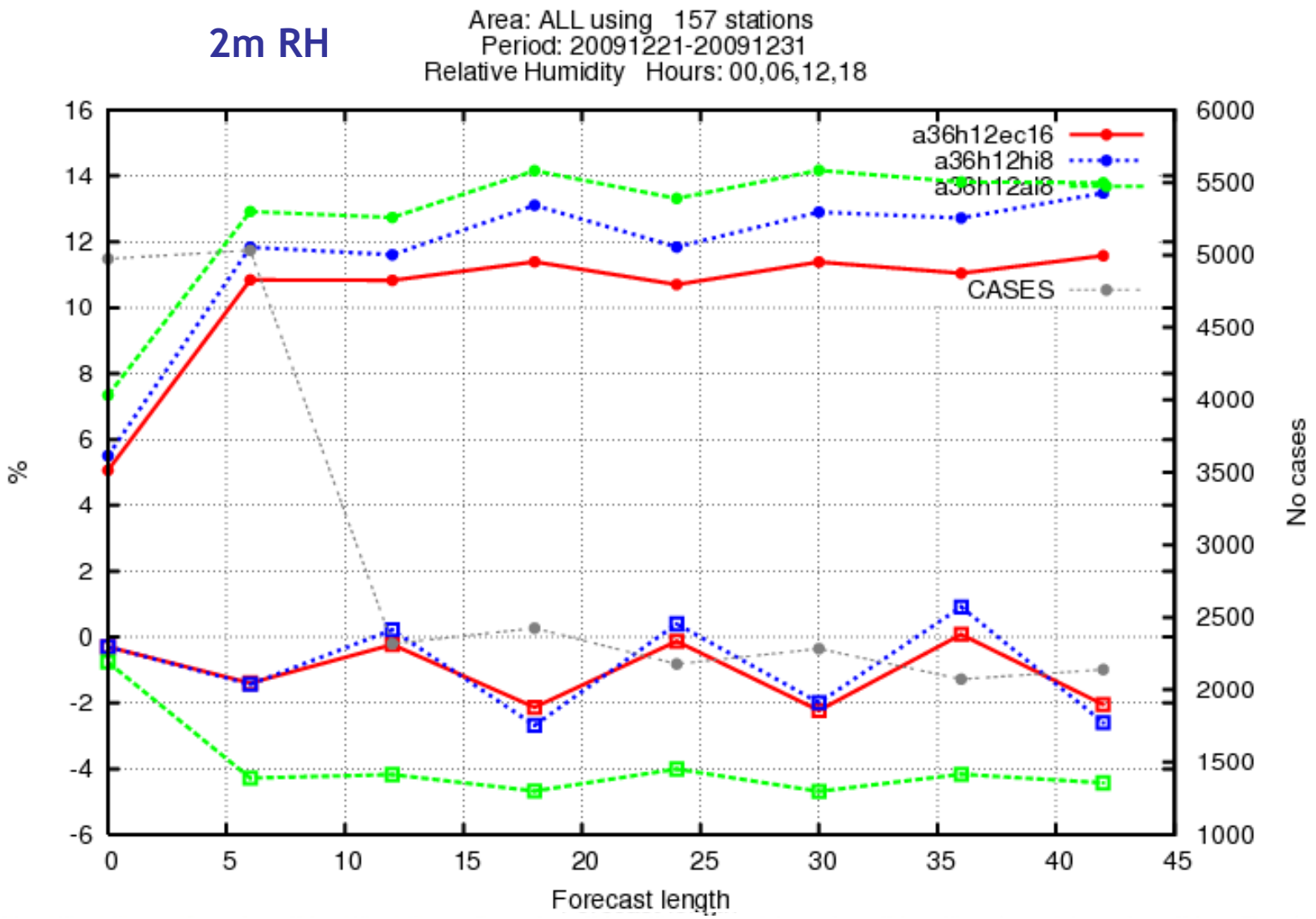
Surface verification for experiments with different host models.

RMSE and Bias function of the forecast length for

(c) 2m T
(d) 2m RH

- RMSE
- BIAS

EC HIR8 ALD8



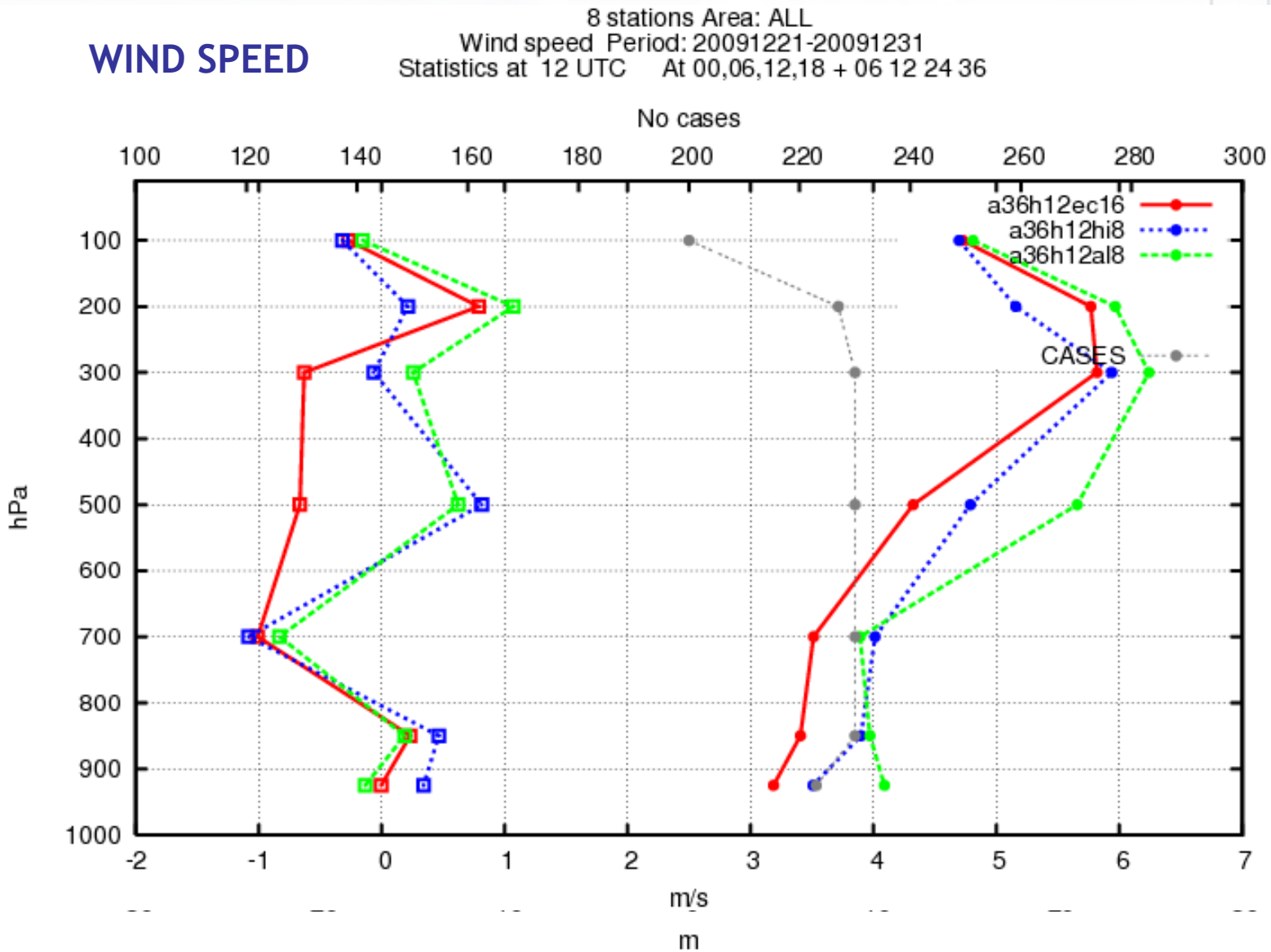
3) Nesting strategy: Need of an intermediate model_

Verification against soundings, RMSE and Bias at 12 UTC of

(a) Height
(b) Wind speed

- RMSE
- BIAS

EC HIR8 ALD8

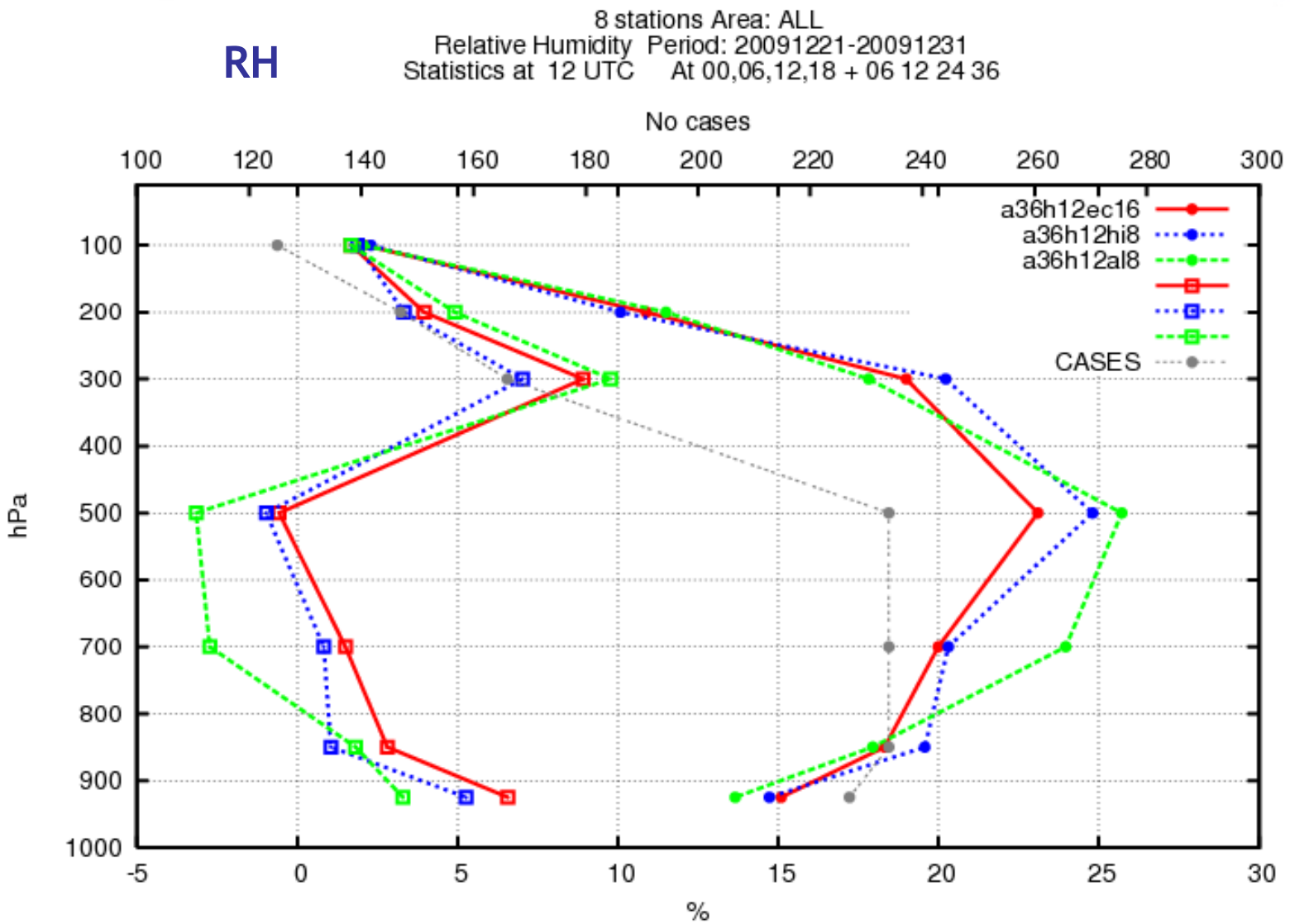


3) Nesting strategy: Need of an intermediate model_

EC HIR8 ALD8

Verification against soundings, RMSE and Bia at 12 UTC of

(a) T
(b) RH



- RMSE
- BIAS

3) Nesting strategy: Need of an intermediate model_

Would an intermediate model introduce any advantage in the forecast?

- **On precipitation verification** there is an improvement when using ECMWF directly as host model, for lower precipitation rates (<15 mm/12h) .

- **For wind speed,** the experiment nested in IFS model shows better skill to predict wind speeds until 8m/s.

✓**It is not observed a clear benefit of using an intermediate limited area model integration to provide boundaries or initial fields for HARMONIE 2.5**

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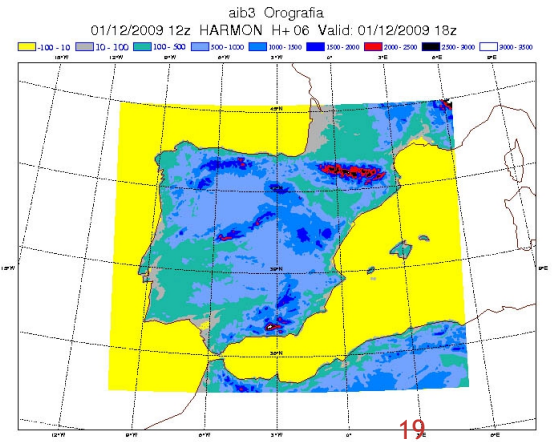
4) Sensitivity to the the frequency of the boundaries

IFS ECMWF T1279, **16 km** resolution

HARMONIE 2.5 km hosted in IFS ECMWF T1279 (EXP 48)

each **3 hr and 1 hr**

Experimentos	Version	Host model
a36h12ecc3	36h1.2+Blending	ECMWF 16 km, 3hr
a36h12ecc1	36h1.2+ Blending	ECMWF 16 km, 1hr



4) Sensitivity to the the frequency of the boundaries

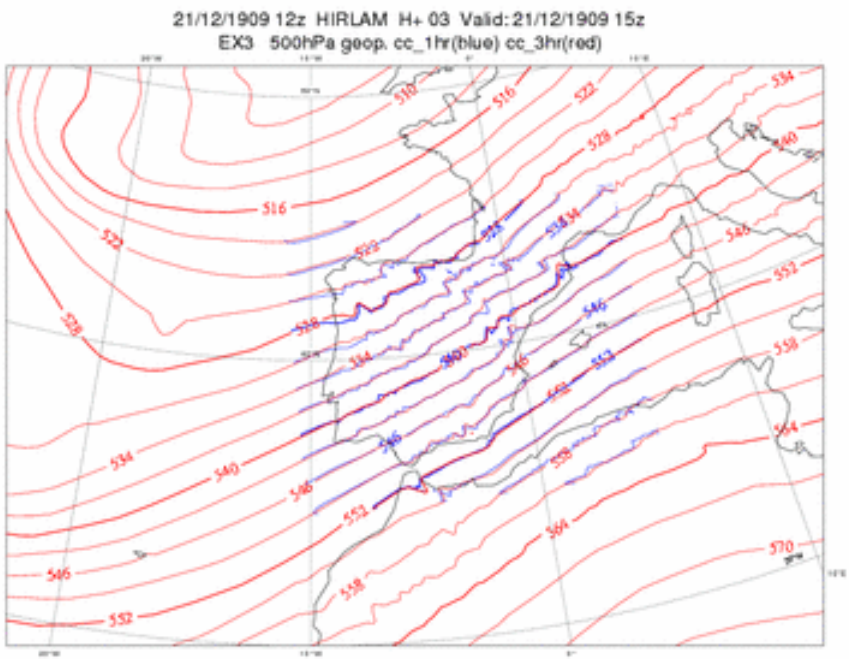
Traslation of boundary patterns to the inner domain

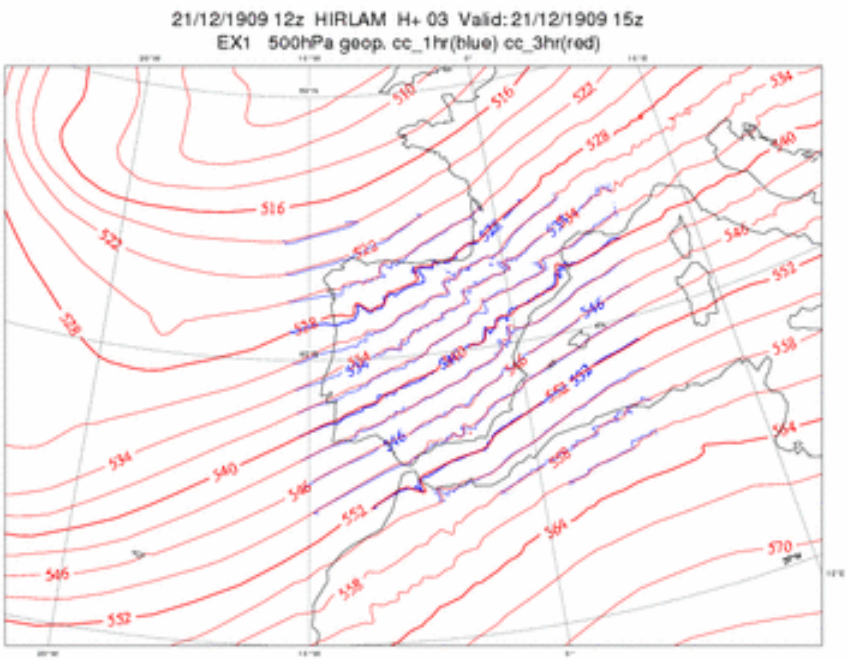
Comparison of HARMONIE 2.5 km with ECMWF boundaries

Boundaries updated **3hr**

Boundaries updated **1hr**

500 hPa geopotential





4) Sensitivity to the the frequency of the boundaries

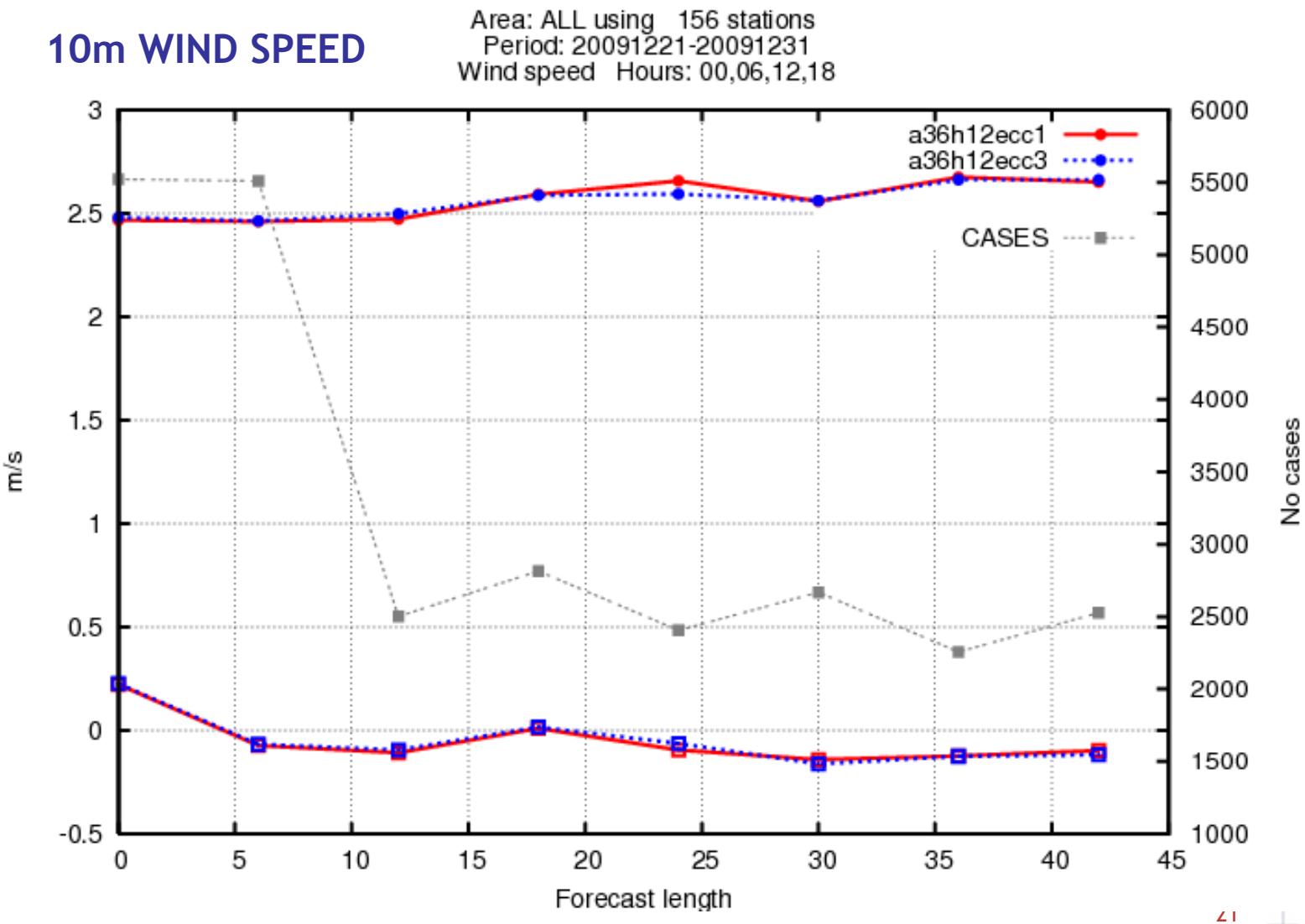
Surface verification for experiments with different freq of bd

RMSE and Bias function of the forecast length for

(a) Sfc pressure,
(b) 10 m wind

- RMSE
- BIAS

1hr **3hr**



4) Sensitivity to the the frequency of the boundaries

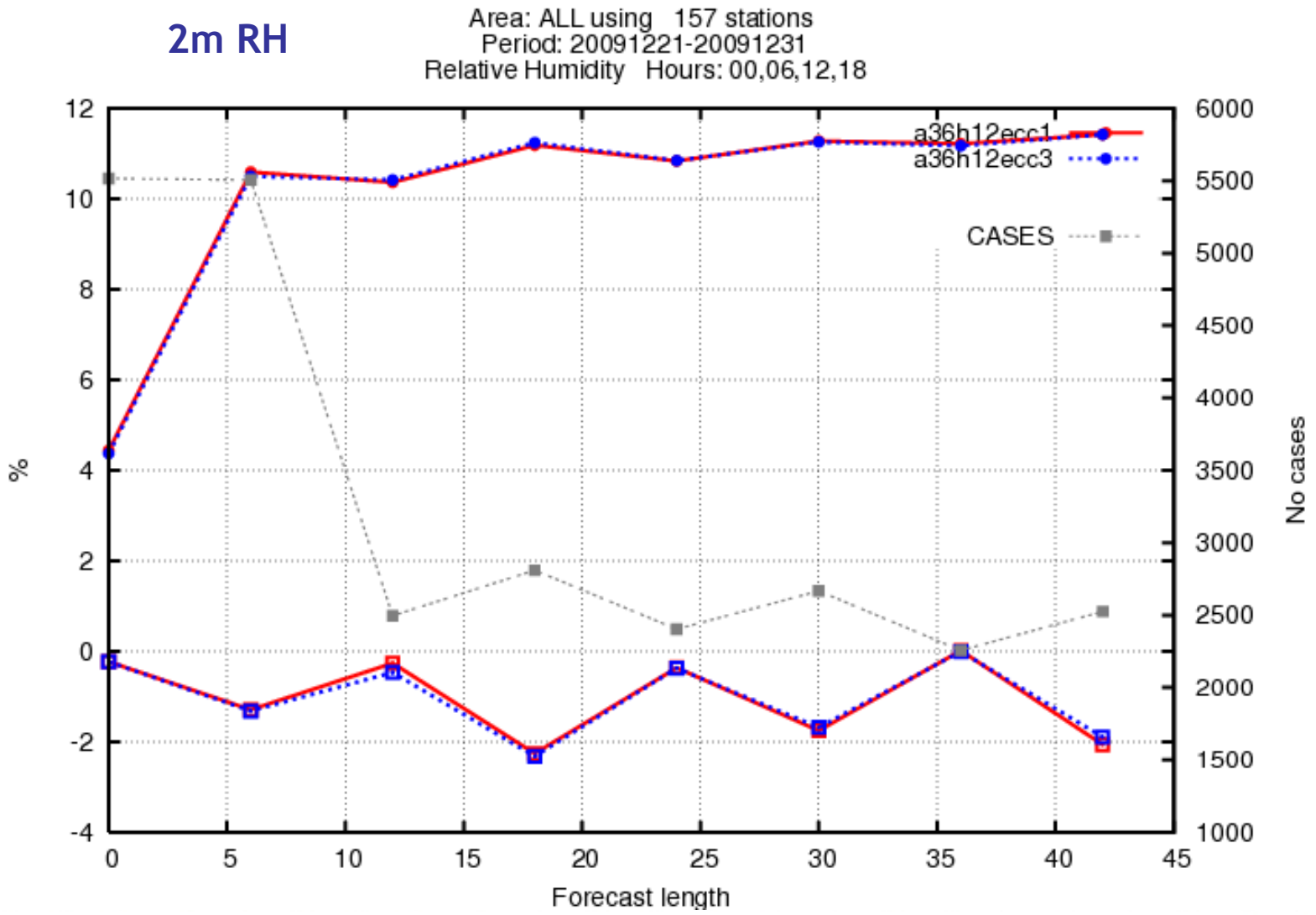
1hr 3hr

Surface verification for experiments with different freq of bd.

RMSE and Bias function of the forecast length for

(c) 2m T
(d) 2m RH

- RMSE
- BIAS



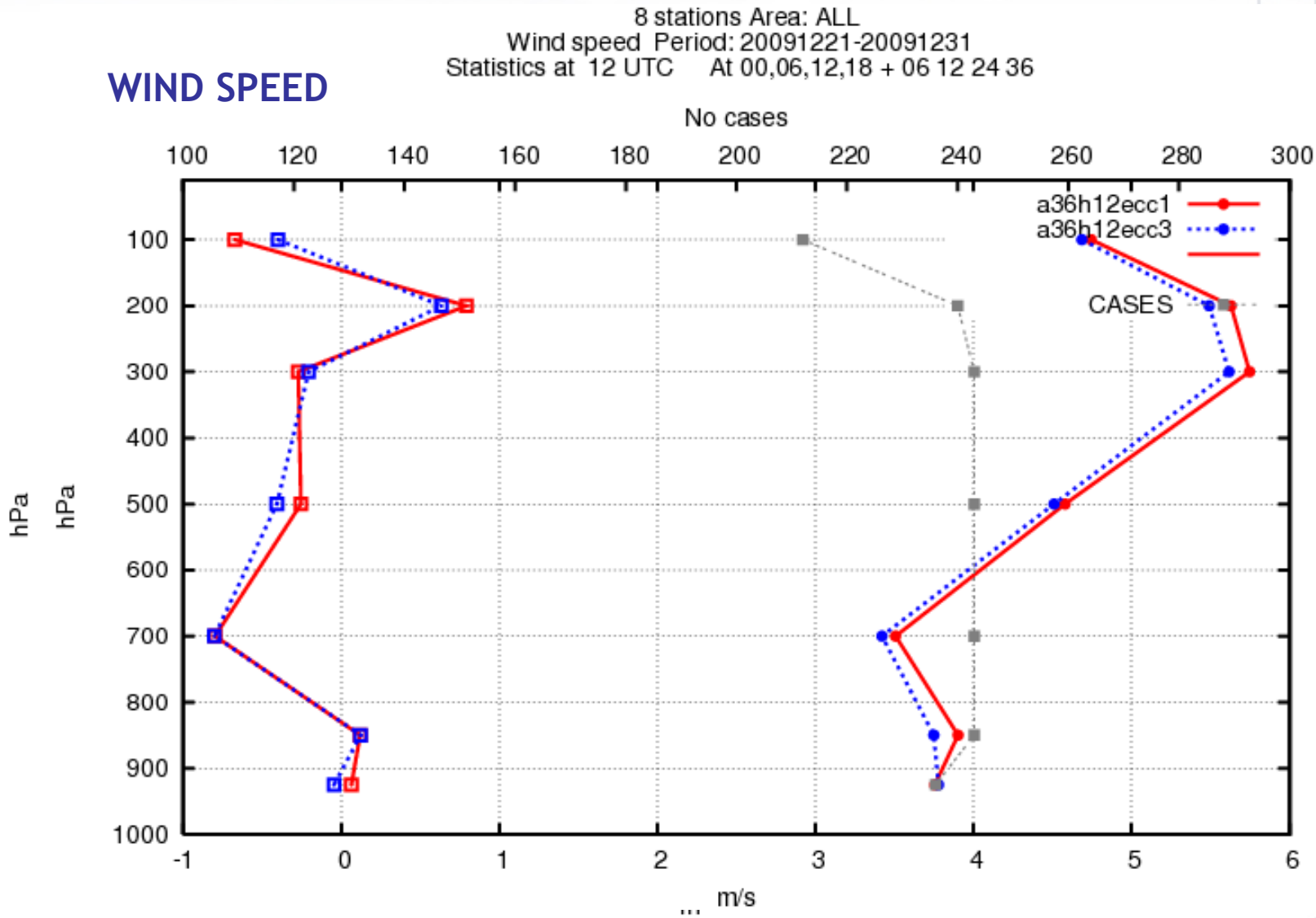
4) Sensitivity to the the frequency of the boundaries

Verification against soundings, RMSE and Bia at 12 UTC of

(a) Height
(b) Wind speed

1hr **3hr**

WIND SPEED



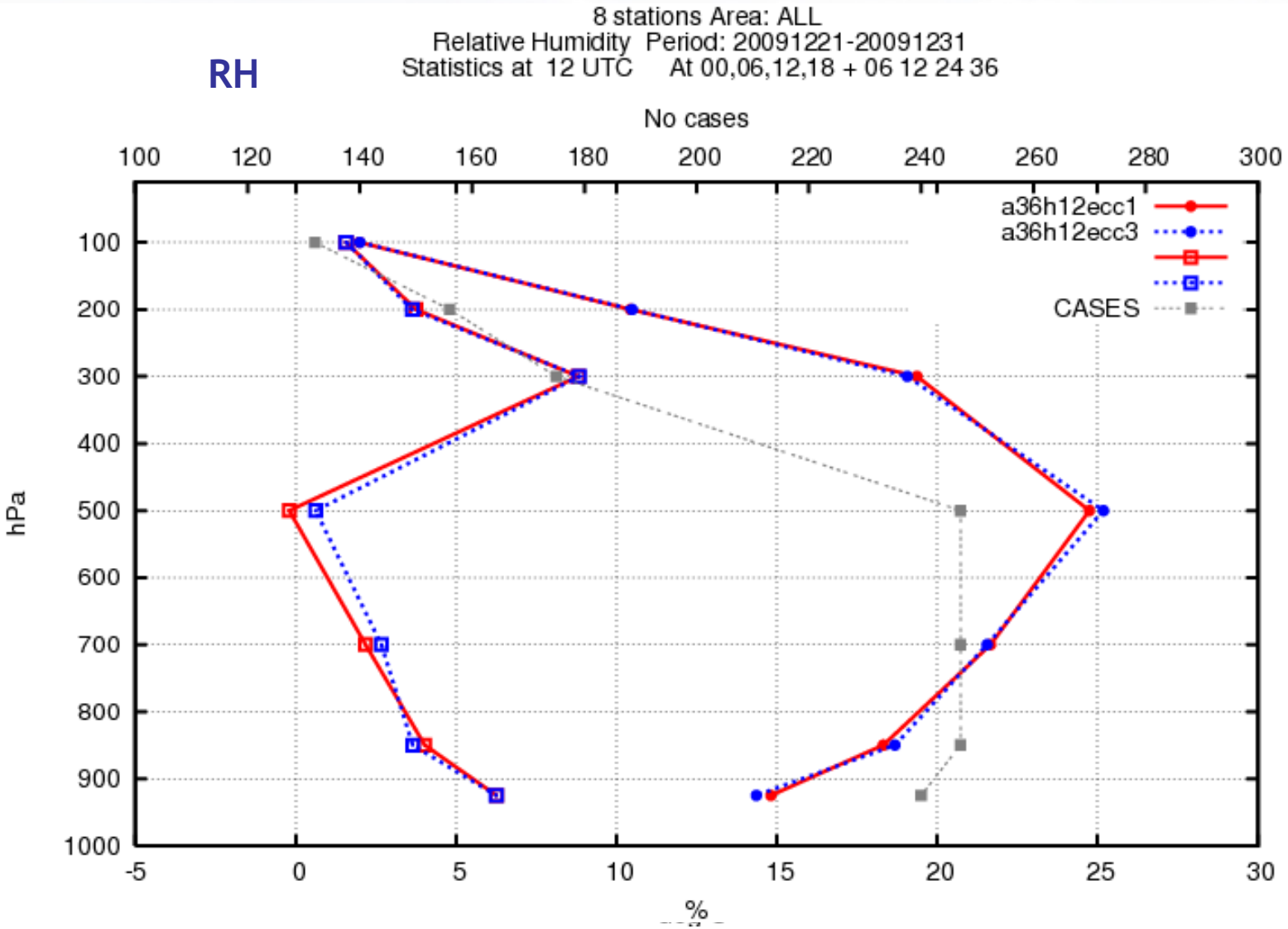
- RMSE
- BIAS

4) Sensitivity to the the frequency of the boundaries

1hr 3hr

Verification against soundings, RMSE and Bias at 12 UTC of

(a) T
(b) RH



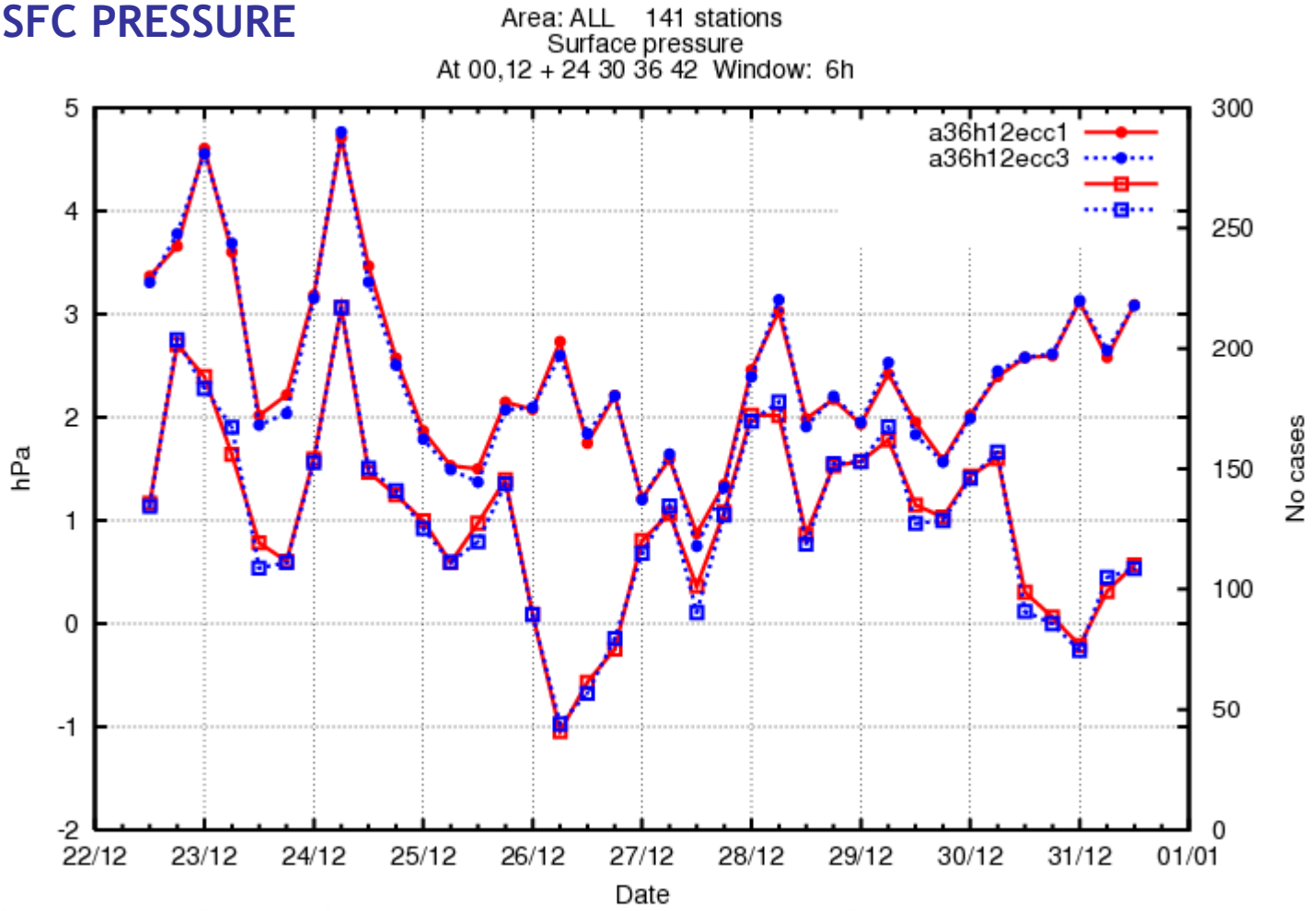
- RMSE
- BIAS

4) Sensitivity to the the frequency of the boundaries

DAY evolution on sfc presure: *different frequency of boundaries: 1h (red), 3h (green).*

1hr **3hr**

SFC PRESSURE

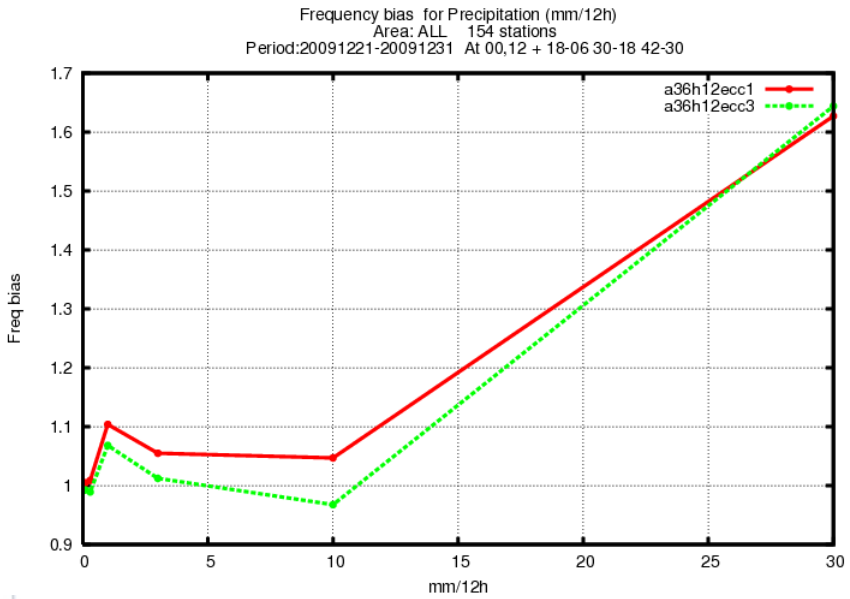


4) Sensitivity to the the frequency of the boundaries

PRECIPITATION 1hr 3hr

Frequency Bias *precipitation and wind speed, different frequency of boundaries:*

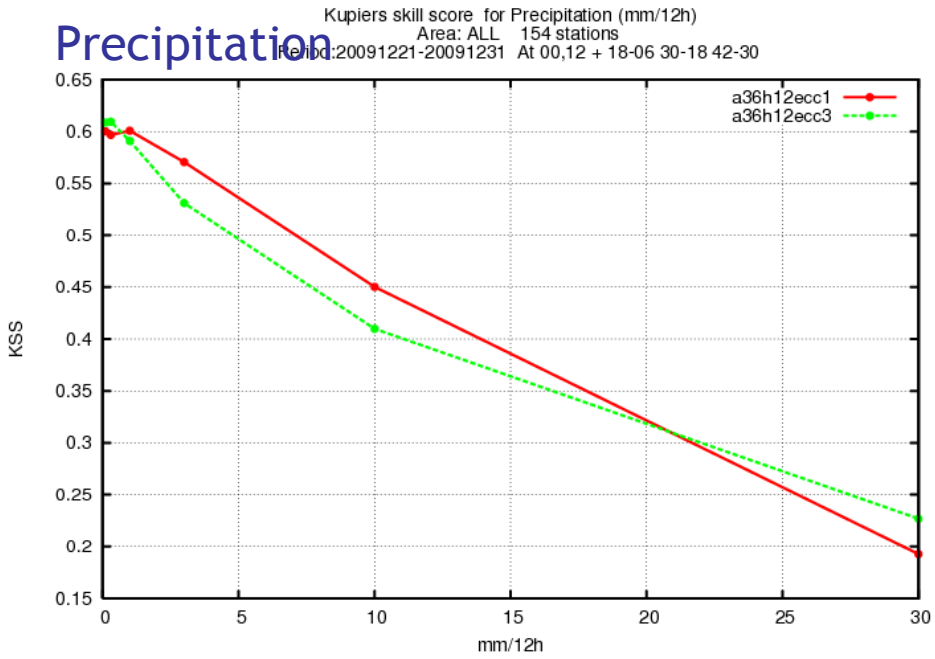
1hr (red), 3hr (green).



Kuiper Skill Score *precipitation and wind speed, different frequency of boundaries:*

1hr (red), 3hr (green).

Precipitation



4) Sensitivity to the the frequency of the boundaries

Would the frequency of boundaries affect the model skill?

- The benefit of using more frequent boundaries in the area is not clear for this period studied over the IBERIA_2.5 domain.

- Day a day some differences are observed between the two configurations.

- 1hr freq seems to have higher impact for upper-air than for surface.

- Precipitation seems to be the only variable that benefit from using more frequent boundaries.

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5) Sensitivity to the initial condition

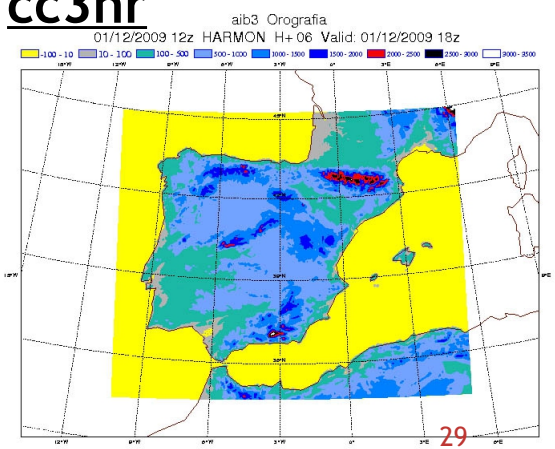
IFS ECMWF T1279, 16 km resolution

HARMONIE 2.5 km hosted in IFS ECMWF T1279 (EXP 48) each 3 hr:

Dynamical adaptation (Blending) vs **3DVar**

(Both with surface assimilation)

Experimentos	Version	Host model
a36h123blend	36h1.2+ **Blending**	ECMWF 16 km, **cc3hr**
a36h123Dvar	36h1.2+ **3DVar**	ECMWF 16 km, **cc3hr**



5) Sensitivity to the initial condition

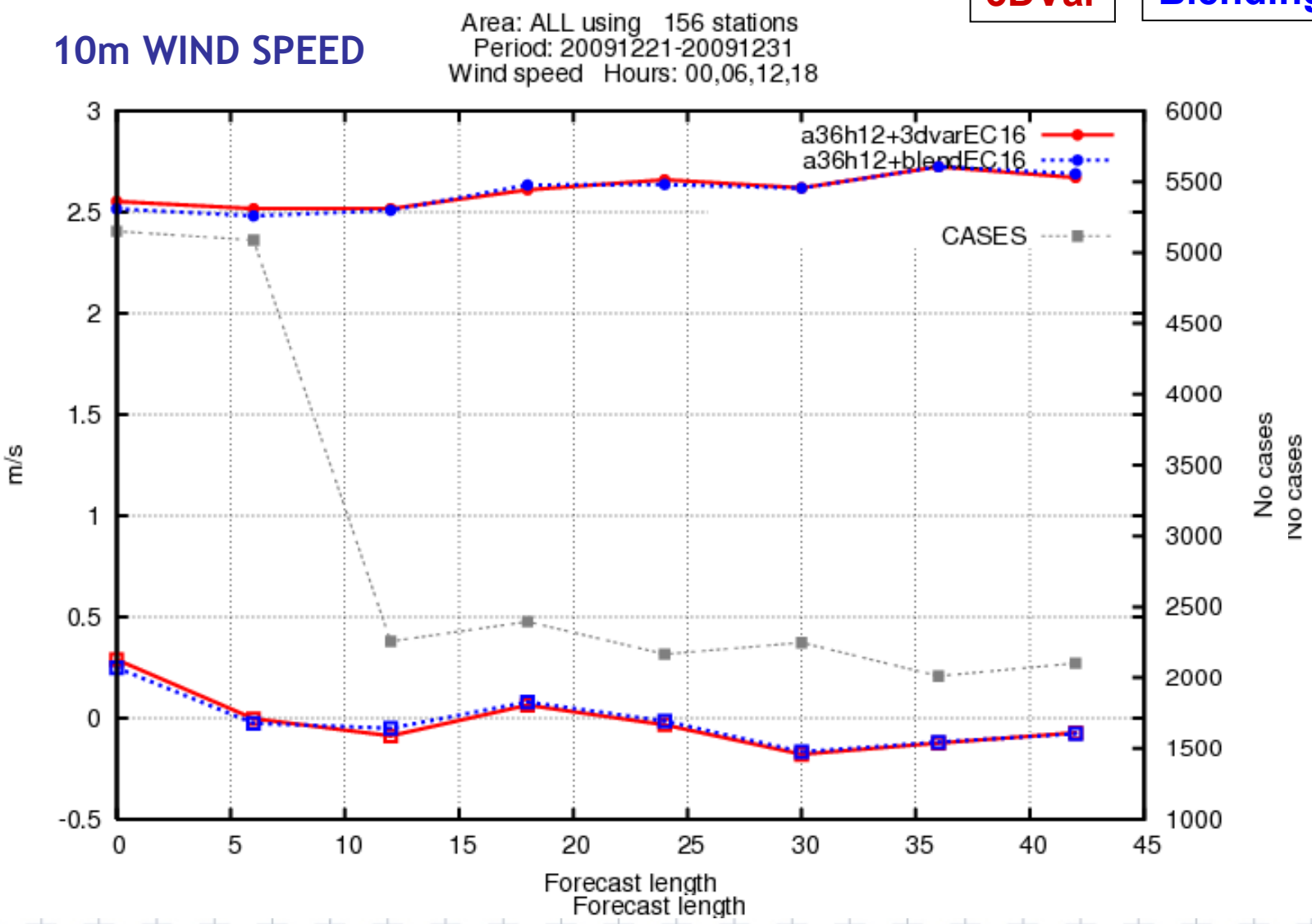
Surface verification for experiments with different hos models

RMSE and Bias function of the forecast length for

(a) Sfc pressure,
(b) 10 m wind

- RMSE
- BIAS

3DVar **Blending**



5) Sensitivity to the initial condition

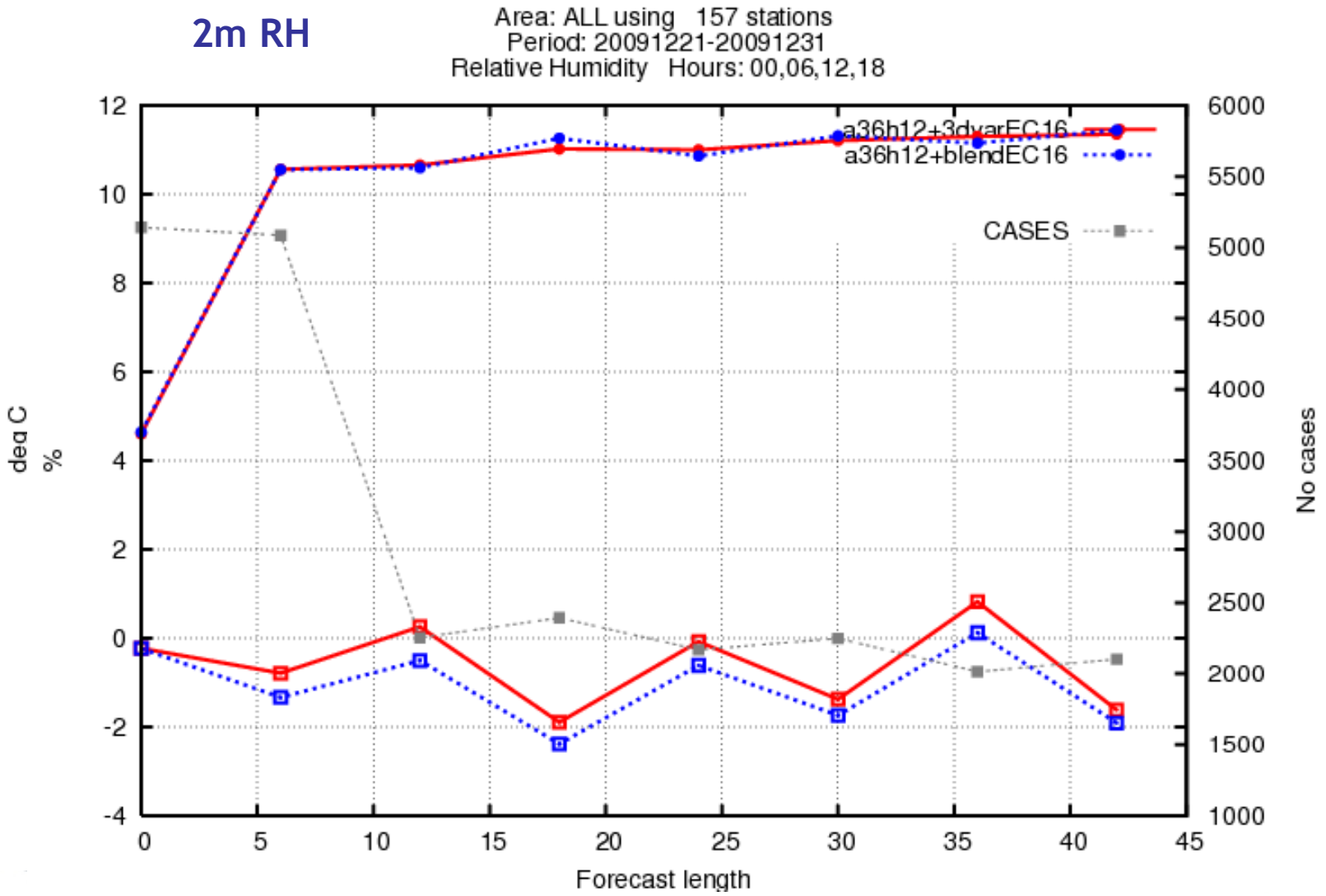
3DVar | Blending

Surface verification for experiments with different host models.

RMSE and Bias function of the forecast length for

(c) 2m T
(d) 2m RH

- RMSE
- BIAS



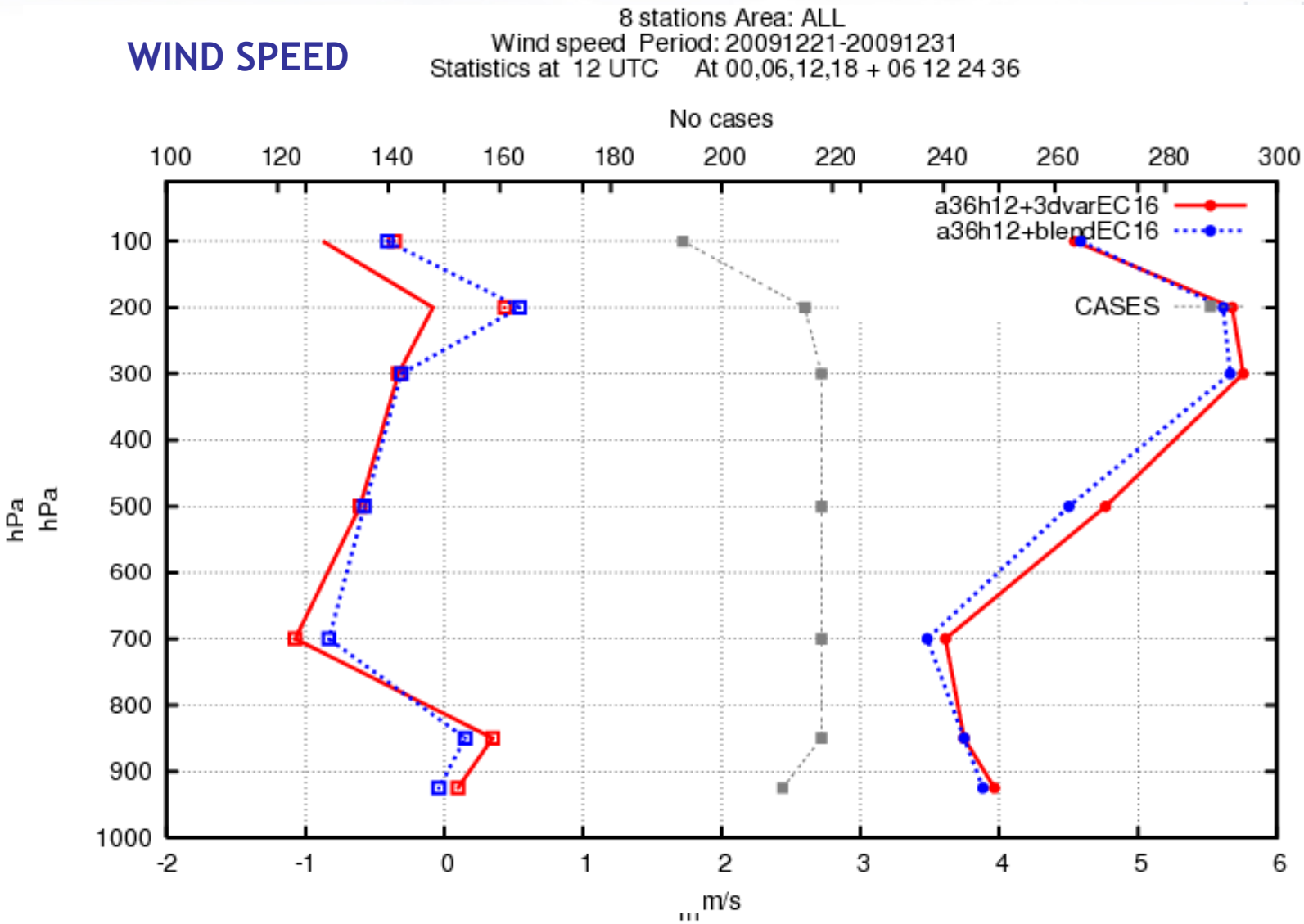
5) Sensitivity to the initial condition

Verification against soundings, RMSE and Bias at 12 UTC of

(a) Height
(b) Wind speed

- RMSE
- BIAS

3DVar **Blending**

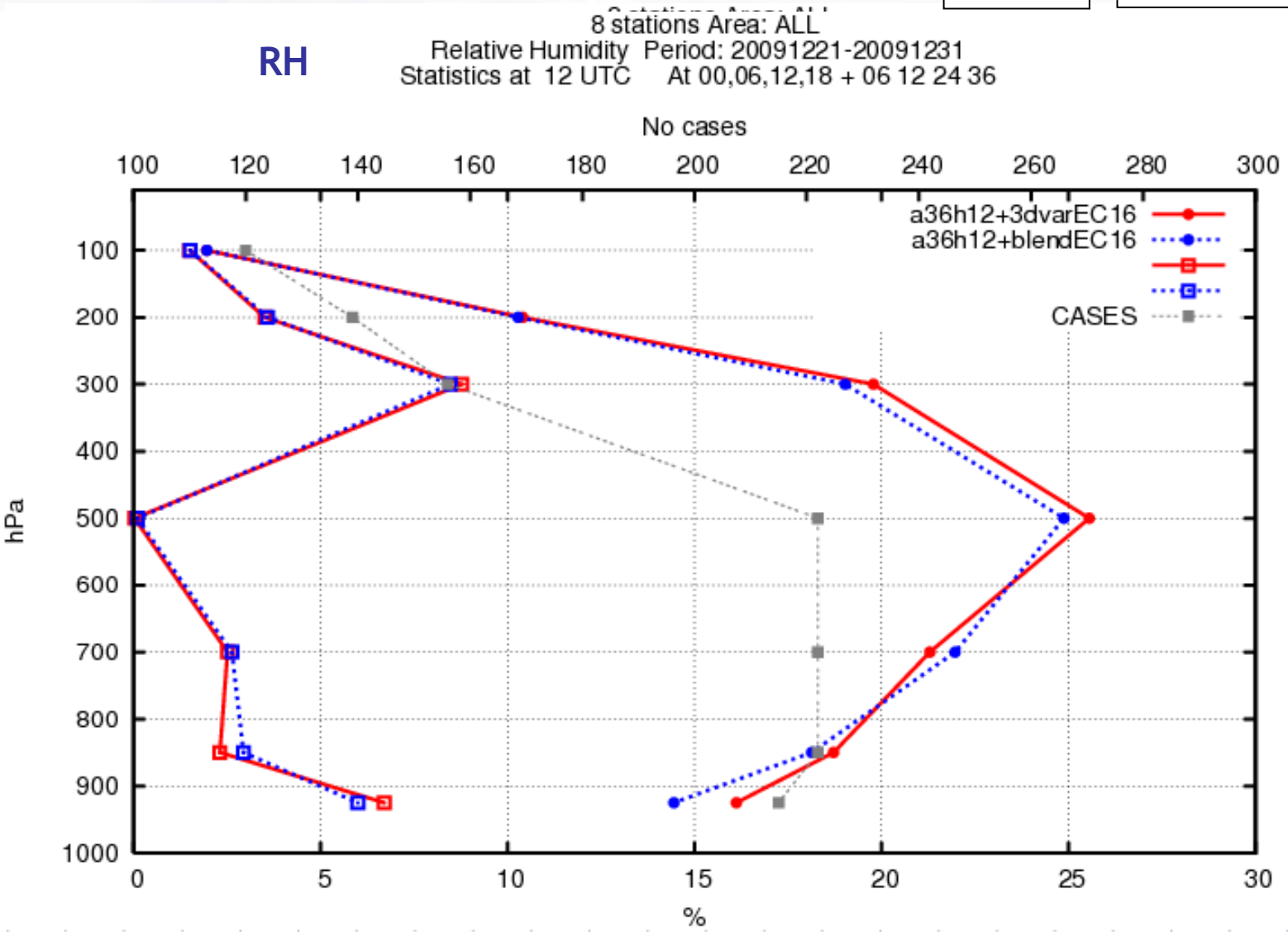


5) Sensitivity to the initial condition

3DVar | Blending

Verification against soundings, RMSE and Bi at 12 UTC of

(a) T
(b) RH



- RMSE
- BIAS

5) Sensitivity to the initial condition

Is currently Blending a better option than 3DVar in Harmonie 36h1.2 for this period?

- Results are very similar for the two configurations, so no conclusions can be extracted about what strategy for the initial conditions is better.
- Anyway, 3DVar is a little bit better for surface and Blending for upper-air.

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6) **Conclusions**

6) Conclusions

HARMONIE 2.5 km has been run over a wet winter period of 11 days so not large enough to draw firm conclusions

1. Sensitivity to the host model:

- ✓ No clear benefit of using an intermediate limited area model integration to provide boundaries or initial fields for HARMONIE 2.5.
- ✓ Direct coupling to ECMWF seems to work well.

2. Sensitivity to the boundary frequency:

- ✓ We have compared 3-hr vs 1-hr boundaries. There are differences but these have little impact on the scores even in a daily basis.
- ✓ Apparently BC every 1-hr would benefit upper air scores but would deteriorate near surface scores. More noise? Need further research.

3. Impact of 3DVar compared with dynamical adaptation (blending)

- ✓ Overall Blending gives slightly better results although 3DVar has positive impact at lower levels. These would have two consequences:
  - ✓ **So far dynamical adaptation for the upper-air fields seems to be a good option**
  - ✓ **Taking into account that we have only use convectional obs over a relatively small domain, 3DVar has promising perspectives**

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AEMet Agencia Estatal de Meteorología

Sensitivity of HARMONIE to nesting strategy and initial conditions

Jana Sánchez, Javier Calvo and Ana Morata

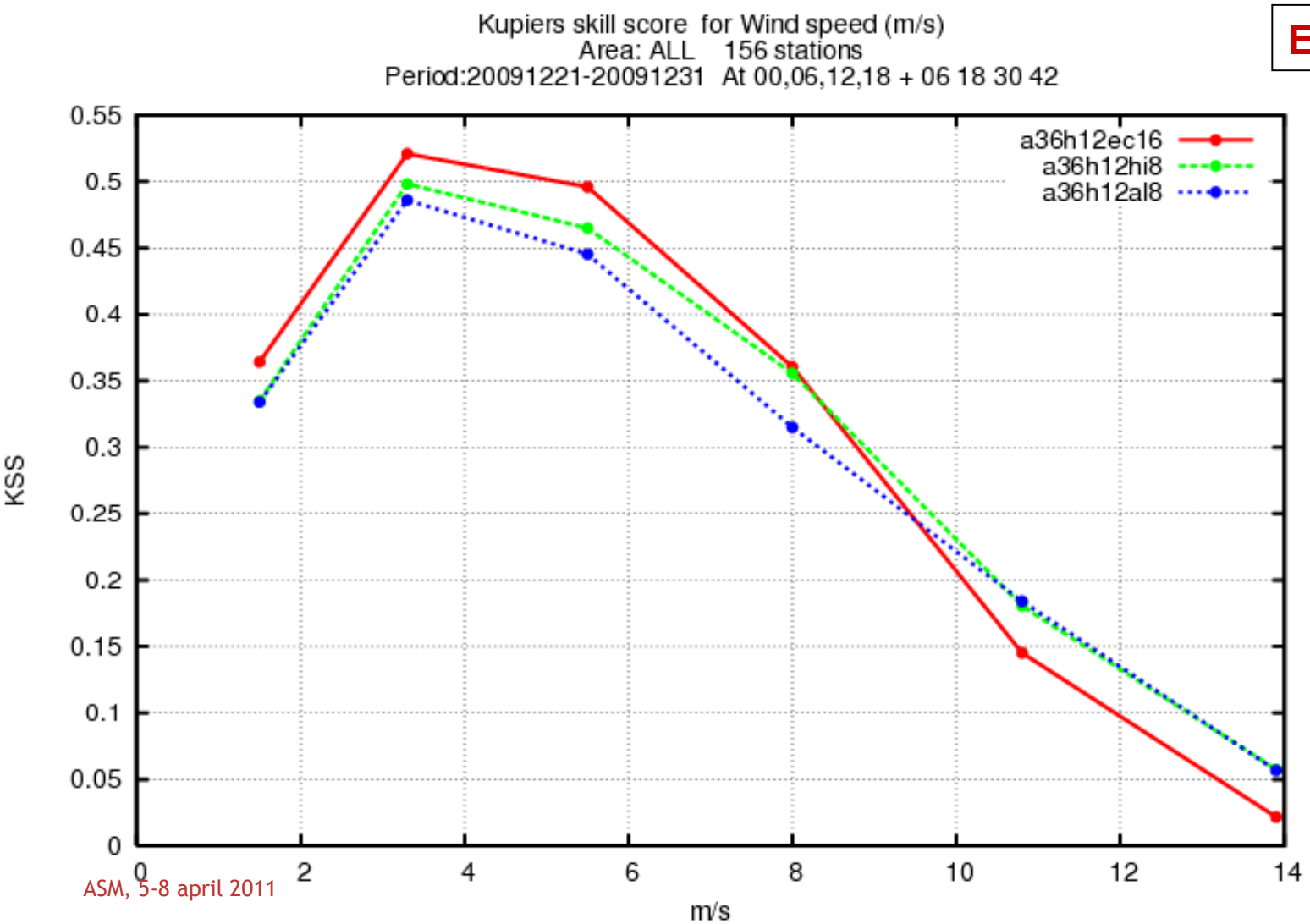
Thank you !

3) Nesting strategy: Need of an intermediate model_

Kuiper Skill Score *prec and wind speed, different host models:*

ECMWF 16 km (red), HIRLAM 8 km (green), ALADIN 8km (blue).

EC HIR8 ALD8



Sensitivity of HARMONIE to nesting strategy and initial conditions

HARMONIE 2,5 Km resolution nested in ECMWF 16 Km model…
some questions:

1) Do we need an **intermediate model** to provide boundaries?

2) What if we increase the resolution of the host model?

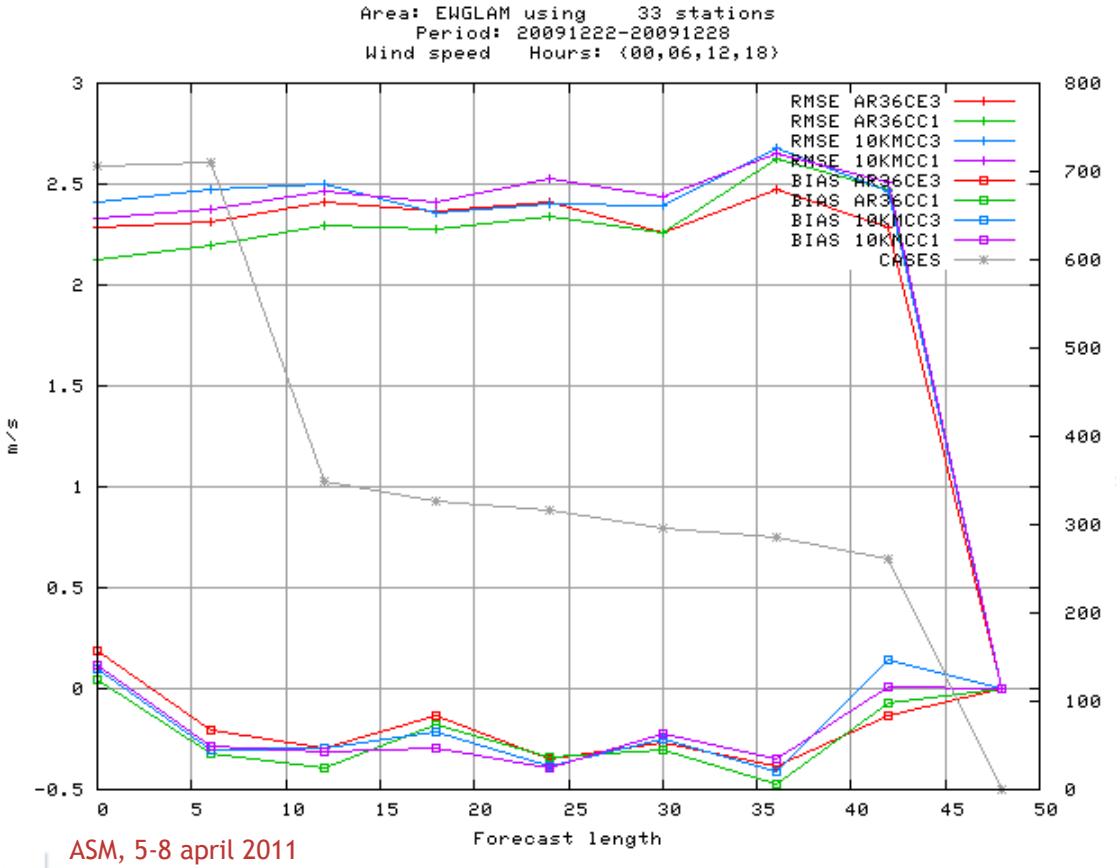
3) Would the **frequency** of boundaries affect the model skill?

4) Is there any improvement using **3DVar** for upper levels compared with a simple dynamical adaptation from the boundary (**Blending** option)?

2) Experiment COMPARISON: Different resolution on the host model

IFS ECMWF T1279, **16 km** resolución (cada 3 horas Y cada hora)
IFS ECMWF T2047, **10 km** resolución (cada 3 horas y cada hora)

Harmonie 36h1.1, 2,5 km , no DA.



What if we increase the resolution of the host model?

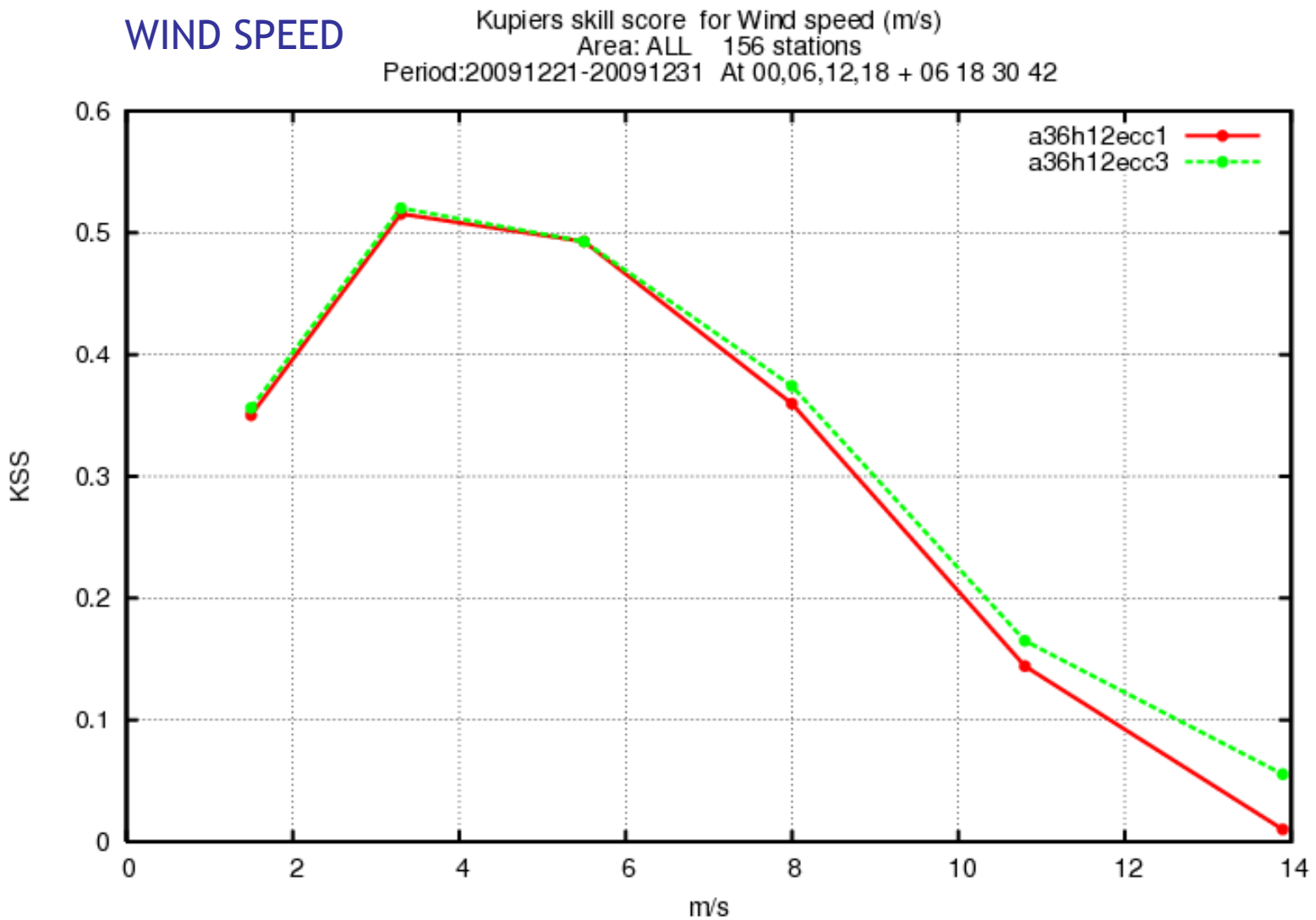
NEUTRAL IMPACT (T2m y RH2m) for this study period.

4) Sensitivity to the the frequency of the boundaries

Kuiper Skill Score *precipitation and wind speed, different frequency of boundaries:*
1hr (red), 3hr (green).

1hr **3hr**

WIND SPEED

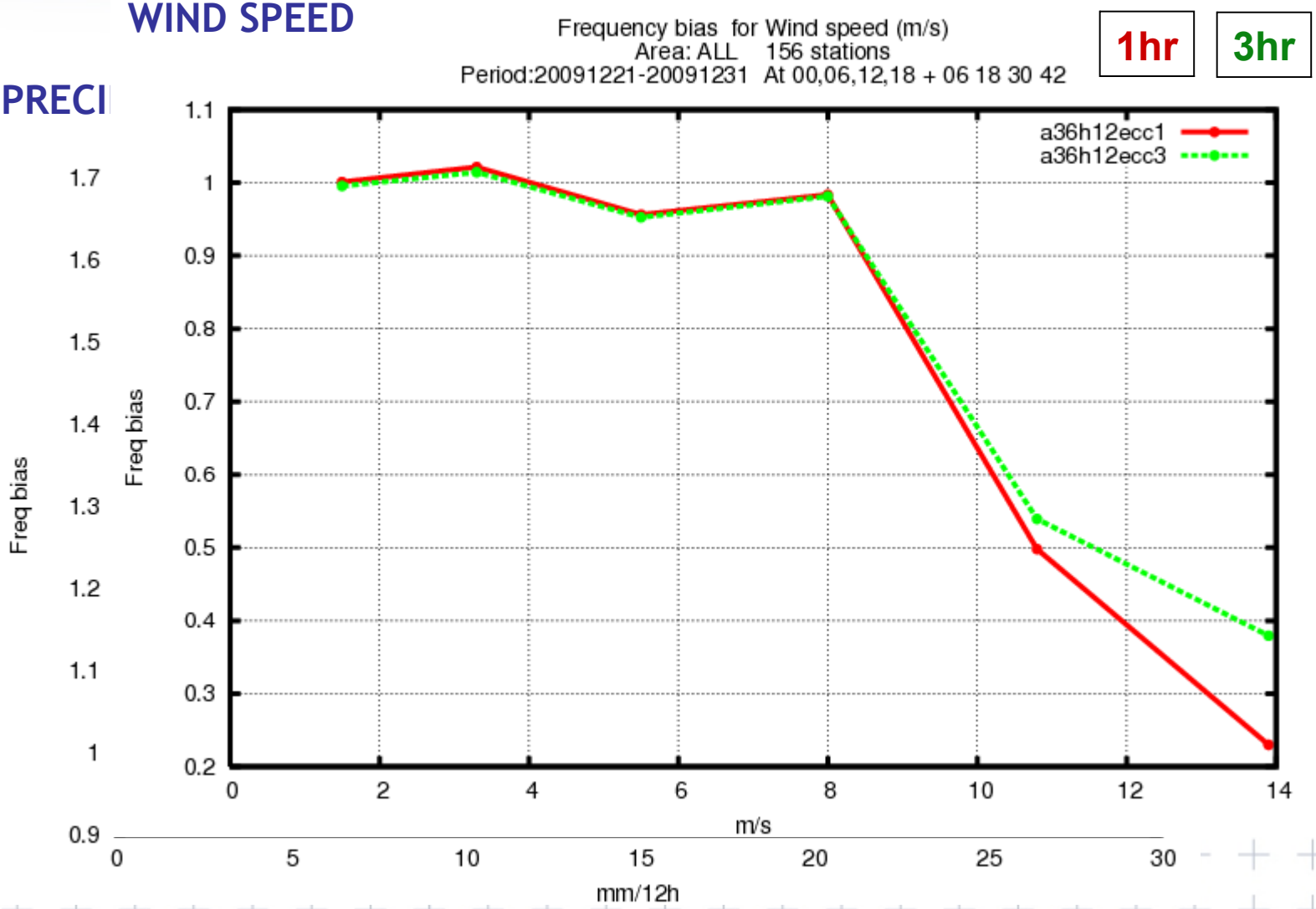


4) Sensitivity to the the frequency of the boundaries

Frequency Bias *precipitation and wind speed, different frequency of boundaries:*

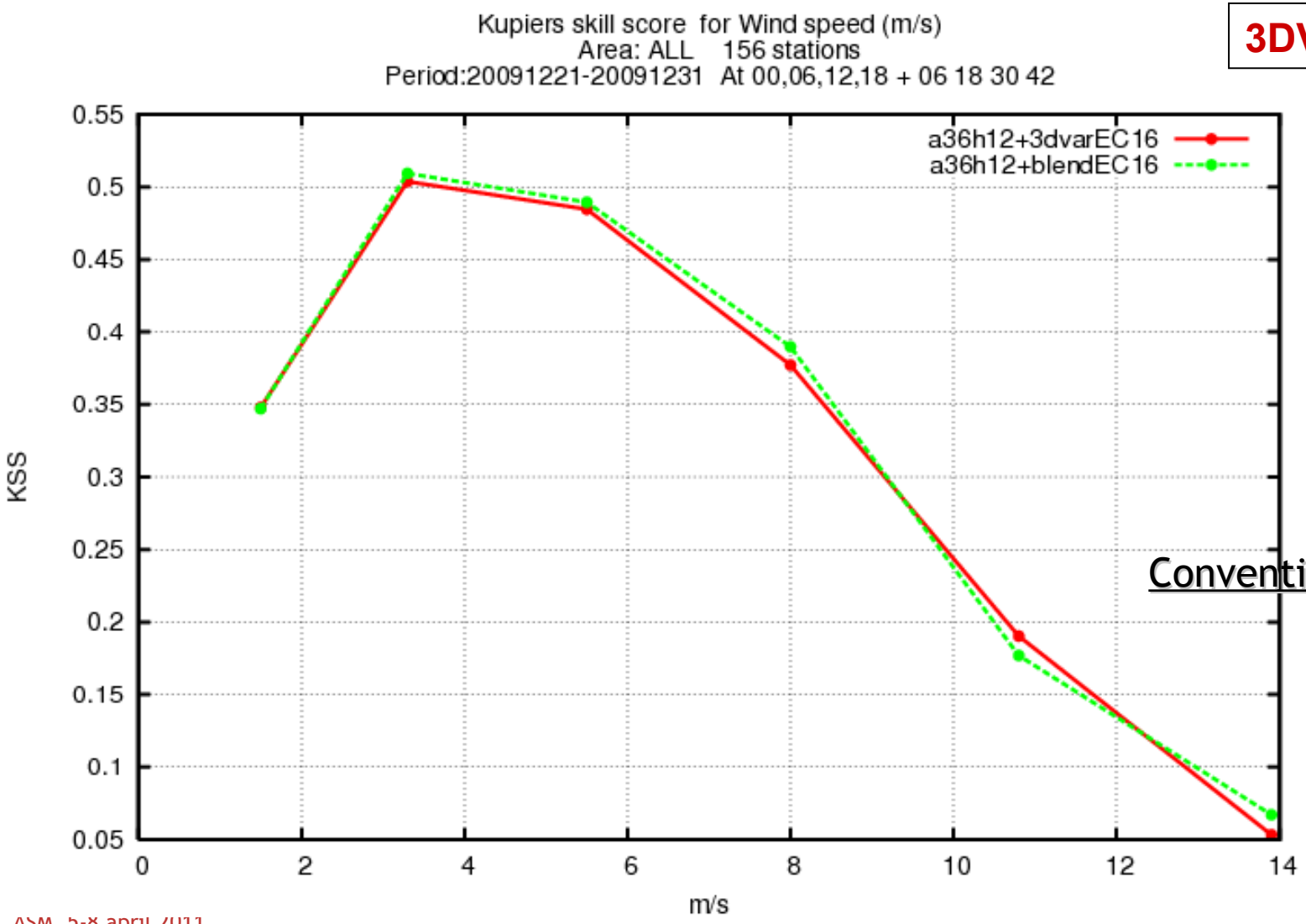
WIND SPEED

PRECI



5) Sensitivity to the initial condition

Kuiper Skill Score *precipitation and wind speed, different frequency of boundaries:*
3DVar (red), Blending (green).



3DVar **Blending**

Conventional observations:

SYNOP

AIREP

TEMP