Sensitivity of HARMONIE to nesting strategy and initial conditions

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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
Sensitivity of HARMONIE to nesting strategy and initial conditions

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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 length:
- 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
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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

**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:

**IFS ECMWF T1279, 16 km resolution**

**HARMONIE 36h1.2** 2.5 km, 60 v.l.
3) Nesting strategy: Need of an intermediate model

8km exp: HIRLAM

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 intermediate 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.

ASM, 5-8 april 2011
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.

<table>
<thead>
<tr>
<th>Experimentos</th>
<th>Versión</th>
<th>Host model</th>
</tr>
</thead>
<tbody>
<tr>
<td>a36h12ec16</td>
<td>36h1.2+Blending</td>
<td>ECMWF 16 km, 3hr, fc-6</td>
</tr>
<tr>
<td>a36h12hi8</td>
<td>36h1.2+Blending</td>
<td>HIRLAM 8 km, 1hr, fc+0</td>
</tr>
<tr>
<td>a36h12al8</td>
<td>36h1.2+Blending</td>
<td>ALADIN 8 km, 1hr, fc+0</td>
</tr>
</tbody>
</table>
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
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
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

WIND SPEED

8 stations Area: ALL
Wind speed Period: 20091221-20091231
Statistics at 12 UTC At 00,06,12,18 + 06 12 24 36

ASM, 5-8 april 2011
3) Nesting strategy: Need of an intermediate model

**Verification against soundings, RMSE and Bias at 12 UTC of**

(a) $T$
(b) $RH$

- RMSE
- BIAS

8 stations Area: ALL
Relative Humidity Period: 20091221-20091231
Statistics at 12 UTC At 00, 06, 12, 18 + 06 12 24 36

No cases

- hPa
- %

ASM, 5-8 April 2011
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
Sensitivity of HARMONIE to nesting strategy and initial conditions

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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

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<td>a36h12ecc3</td>
<td>36h1.2+Blending</td>
<td>ECMWF 16 km, <strong>3hr</strong></td>
</tr>
<tr>
<td>a36h12ecc1</td>
<td>36h1.2+ Blending</td>
<td>ECMWF 16 km, <strong>1hr</strong></td>
</tr>
</tbody>
</table>

ASM, 5-8 april 2011
4) Sensitivity to the frequency of the boundaries

Translation of boundary patterns to the inner domain

Comparison of HARMONIE 2.5 km with ECMWF boundaries

Boundaries updated 3hr 500 hPa geopotential

Boundaries updated 1hr
4) Sensitivity to 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) 10m wind

- RMSE
- BIAS
4) Sensitivity to the frequency of the boundaries

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 frequency of the boundaries

Verification against soundings, RMSE and Bia at 12 UTC of

(a) Height
(b) Wind speed

- RMSE
- BIAS
4) Sensitivity to the frequency of the boundaries

Verification against soundings, RMSE and Bias at 12 UTC of

(a) T
(b) RH

- RMSE
- BIAS
4) Sensitivity to the frequency of the boundaries

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

![SFC PRESSURE Graph](image-url)

- Area: ALL 141 stations
- Surface pressure
- At 00,12 + 24 30 36 42
- Window: 6h

**Graph Details:**
- Scale: hPa and No cases
- Dates: 22/12 to 01/01

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ASM, 5-8 April 2011

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4) Sensitivity to the frequency of the boundaries

**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).
4) Sensitivity to 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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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)

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<tr>
<td>a36h123blend</td>
<td>36h1.2+</td>
<td>Blending ECMWF 16 km, cc3hr</td>
</tr>
<tr>
<td>a36h123Dvar</td>
<td>36h1.2+</td>
<td>3DVar ECMWF 16 km, cc3hr</td>
</tr>
</tbody>
</table>
5) Sensitivity to the initial condition

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

Area: ALL using 156 stations
Period: 20091221-20091231
Wind speed Hours: 00,06,12,18

3DVar
Blending
5) Sensitivity to the initial condition

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

2m RH

Area: ALL using 157 stations
Period: 20091221-20091231
Relative Humidity Hours: 00,06,12,18
5) Sensitivity to the initial condition

Verification against soundings, RMSE and Bias at 12 UTC of

(a) Height
(b) Wind speed

- RMSE
- BIAS
5) Sensitivity to the initial condition

Verification against soundings, RMSE and BIAS at 12 UTC

(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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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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Jana Sánchez, Javier Calvo and Ana Morata

Thank you!
3) Nesting strategy: Need of an intermediate model

**Kuiper Skill Score** for precipitation and wind speed, different host models:
- ECMWF 16 km (red), HIRLAM 8 km (green), ALADIN 8km (blue).

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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 frequency of the boundaries

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

![Graph showing Kupiers skill score for wind speed (m/s)]
4) Sensitivity to the frequency of the boundaries

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

**WIND SPEED**

Frequency bias for Wind speed (m/s)
Area: ALL 156 stations
Period: 20091221-20091231 At 00,06,12,18 + 06 18 30 42

![Graph showing frequency bias for wind speed with two curves representing 1hr and 3hr intervals.](image-url)
5) Sensitivity to the initial condition

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

- **3DVar** (red)
- **Blending** (green)

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**Kupiers skill score for Wind speed (m/s)**
- **Area:** ALL 156 stations
- **Period:** 20091221-20091231 At 00,06,12,18 + 06 18 30 42

![Graph showing Kuiper Skill Score for Wind speed](image)

**Conventional observations:**
- SYNOP
- AIREP
- TEMP

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**3DVar**  **Blending**