# Evaluation of the new AROME-PI model for nowcasting purpose at Météo-France

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# Summary

**Introduction**

- Nowcasting
- AROME-PI configuration

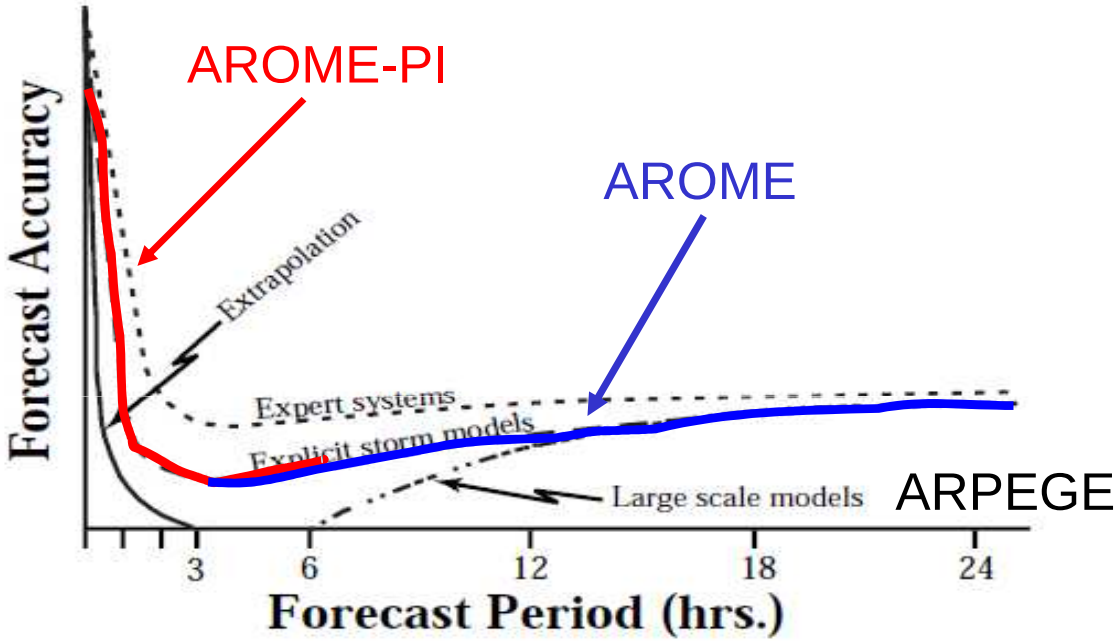
**Verification**

- First verification over November 2014
- Verification process
- Scores computed and parameter verified.

**Conclusion**

# AROME-PI in few words

The purpose with AROME-PI is to enhance the existing nowcasting system SIgnificant weather Object Oriented Nowcasting System (SIGOONS: Brovelli, 2005), by providing a smooth transition between a purely observation-based approach and a model-based approach.




. Qualitative assessment of forecast accuracy as a function of forecast period for convective precipitation on a spatial scale of a few kilometers. Adapted from Browning et al. (1980), Doswell (1986), and Austin et al. (1987).

From Wilson, J. W.,1998

# AROME-PI in few words

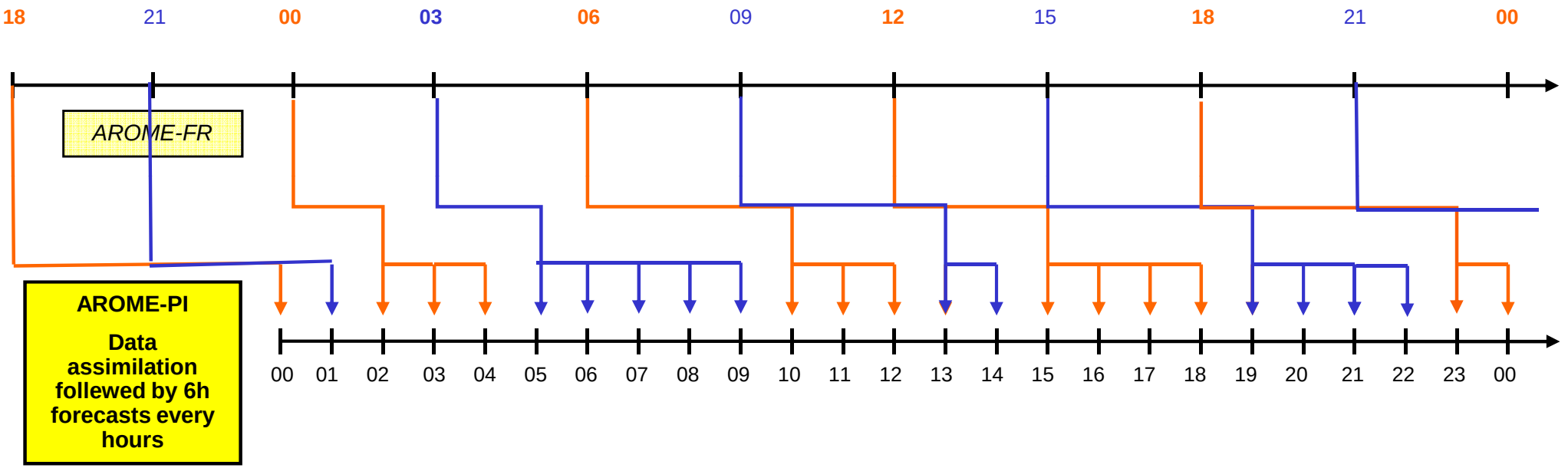
- AROME-PI is the same model as the HR AROME operational model adapted for nowcasting purpose.

- AROME : long cut-off; available 2 or 3 hours after start run; until range 48h; start runs every 3hours.

- Requirements for nowcasting:
  - Very short-range forecast (0 to 6h) every hour
  - Forecast available very early (H+30mn).
  - 3Dvar assimilation with 10 mn cut-off

- Due to very short cut-off,some observations might reach to late our observation database system.
- Most of assimilated data are: Radar data (Doppler winds and reflectivities) and surface data (30% less than longer cut-off)

# Operational AROME-PI : system architecture




AROME guess for hourly assimilation and initialization of surface conditions

AROME and AROME-PI boundary conditions come from ARPEGE

# First AROME-PI verification

- The verification software was developed at Météo-France and checked over November 2014, which corresponds to a period of heavy rain in France:
  - large-scale westerly flows produced stratiform precipitation
  - Mediterranean situations: south warm and wet winds coming from the Mediterranean Sea resulting in important rainfall accumulation over the southeast of France.
    - Major flood events
    - Giving 5 major alerts and 17 warning days

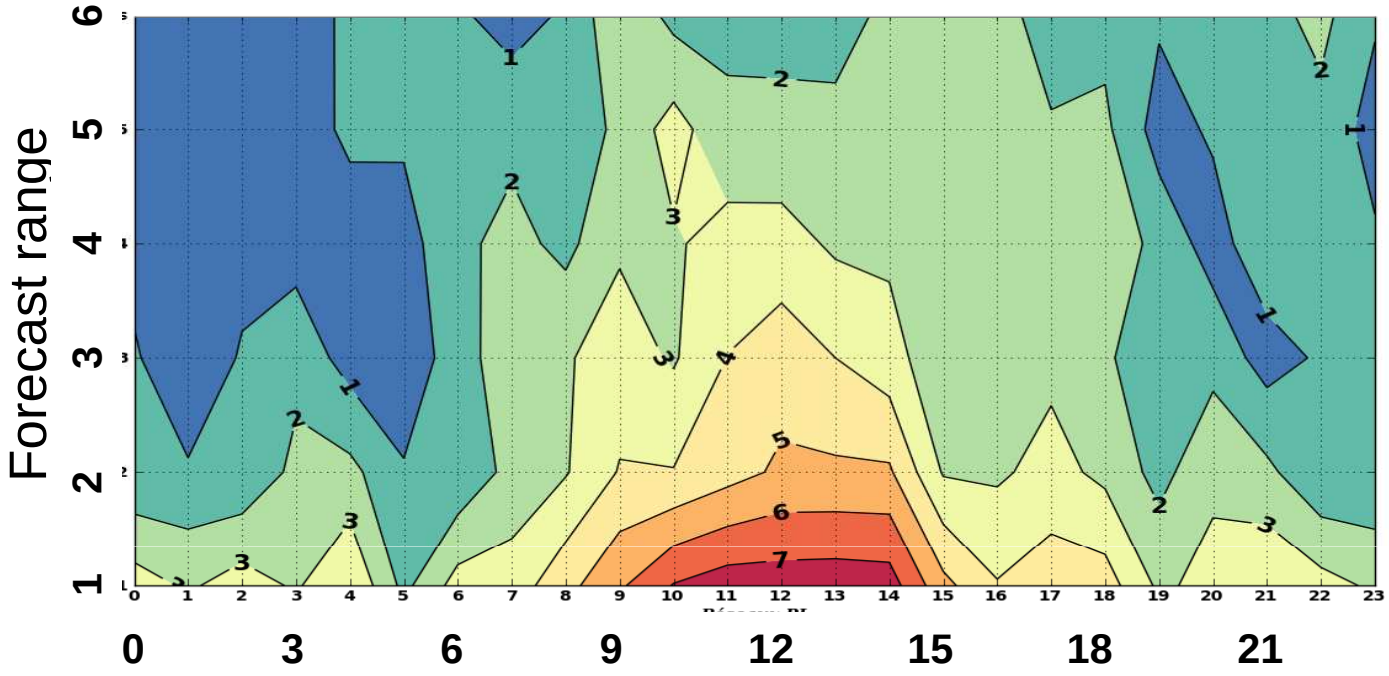
# Scores computed and parameters verified

- **Wind force 10m**:
  - biais (not shown) and **RMSE**
- Wind gusts 10m:
  - contingency table threshold 40km/h
  - Brier Skill Score threshold 40km/h (not shown)
- **1hour accumulated rain**
  - **contingency table** (threshold 0.5 1 2 3 4 **5** 10 mm/h)
  - **Brier Skill Score** (threshold 0.5 1 2 3 4 **5** 10 mm/h)

# AROME-PI validation: **10 meters Wind force**

**100(AROME RMSE –AROME-PI RMSE) / AROME RMSE (%)**

About 700 stations from French meteorological network



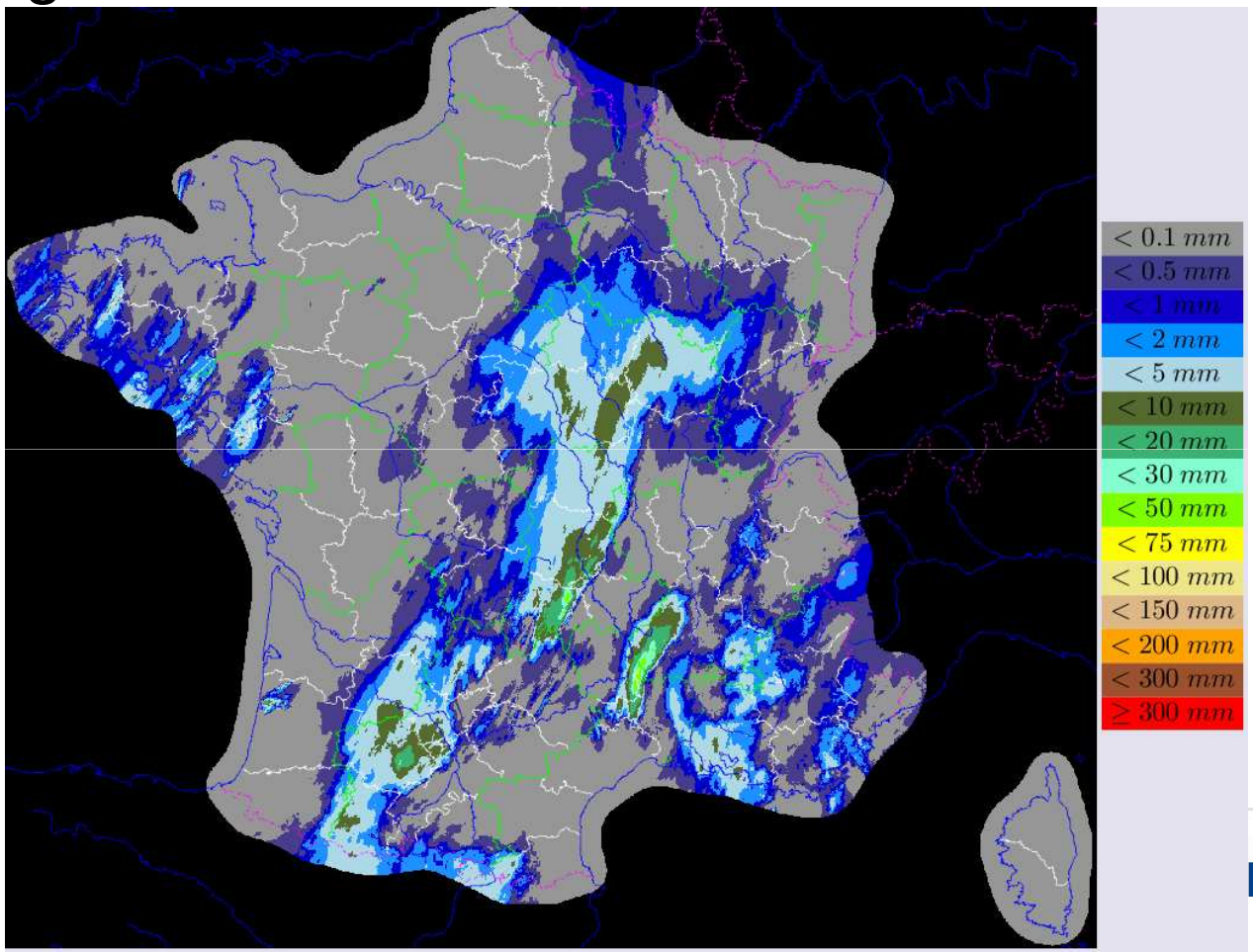

- AROME-PI > AROME Every where
- Stronger improvement during the day between 8am and 4pm when bias are smaller for the two models
- Weak improvement during the night when winds are weak.

# AROME-PI validation: **1h rainfall accumulation**

References used are hourly accumulated rainfall from the ANTILOPE analysis.
They are made from the mixture of data between radar reflectivity and rain gauges.

ANTILOPE analysis

1h accumulated rainfall for the 14/11 at 5pm



# BIAS, POD and FAR threshold 5 mm/1h

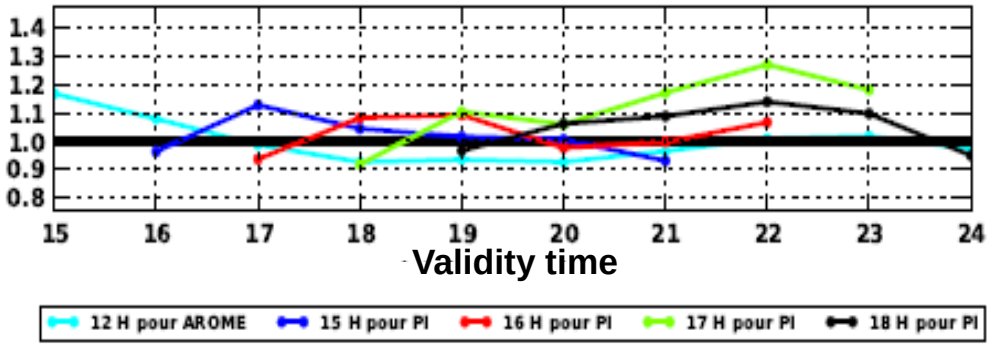
**AROME run 12UTC and AROME-PI runs 15, 16, 17 and 18UTC**

- Compared to AROME
  - Weak overestimation by PI
  - Less false alarms
  - More detections

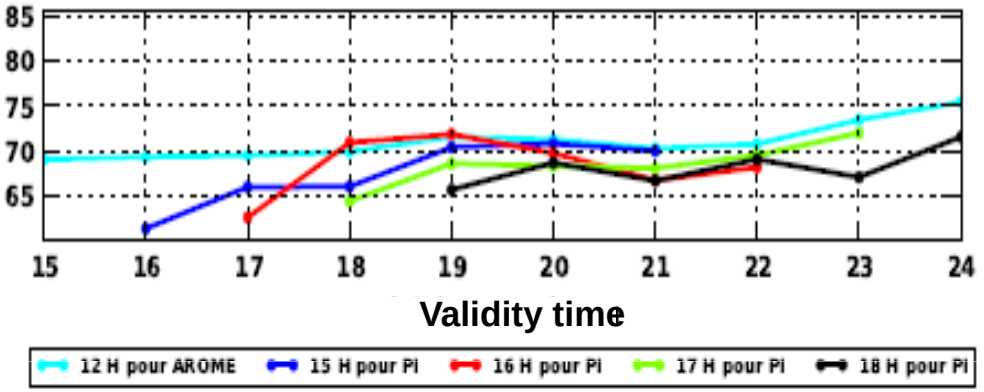
- Improvement lasts more than 1 hour and often extends till 6 hours

- 5mm per hour = Heavy rains :
  - base rate is less than 1% of the sample
  - False alarms stay high

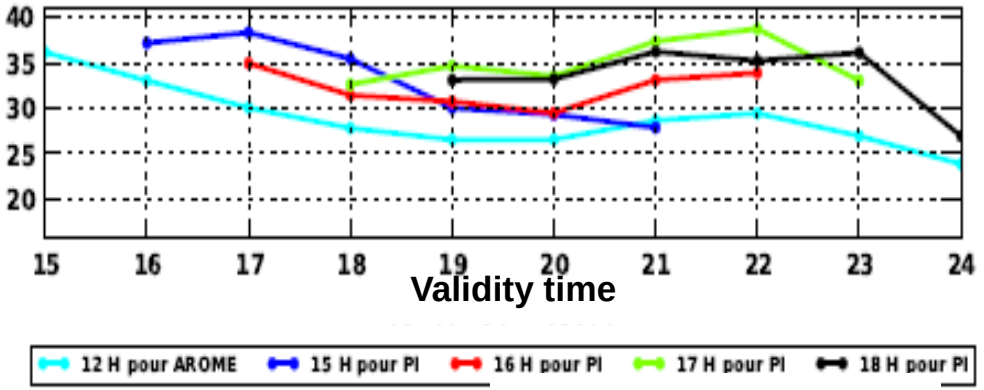
**BIAS**




**FAR**

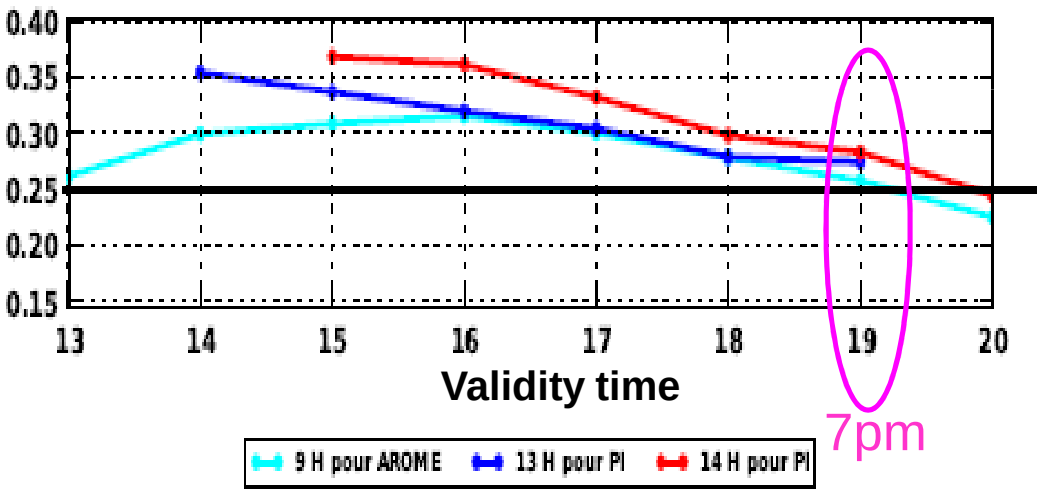



**POD**

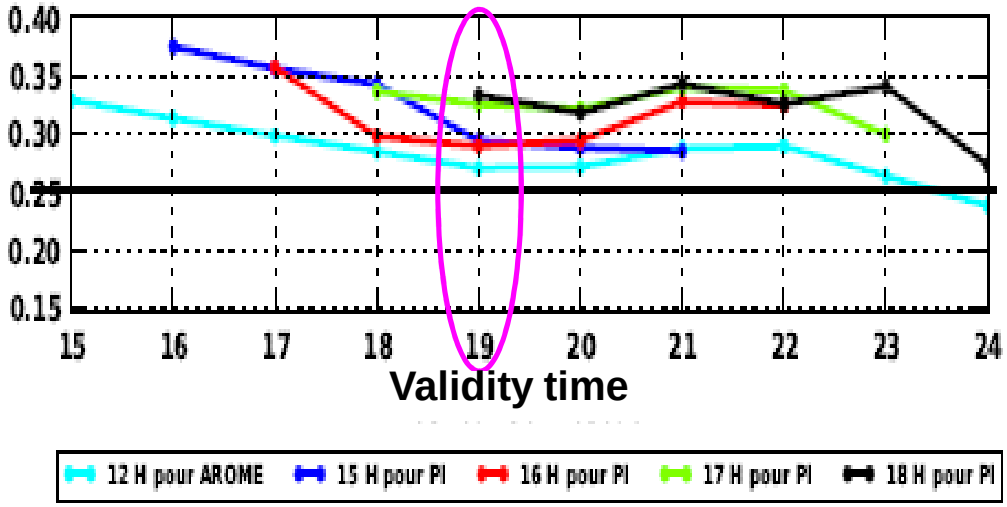


# HSS against chance threshold 5 mm

**AROME start run 9 UTC**




**12 UTC**

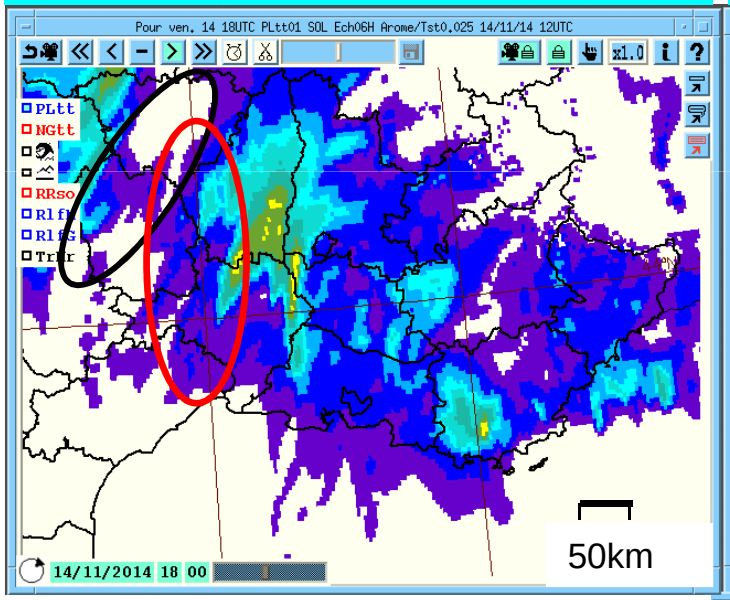



- Using more recent observations allows better skill for AROME-PI over all ranges,

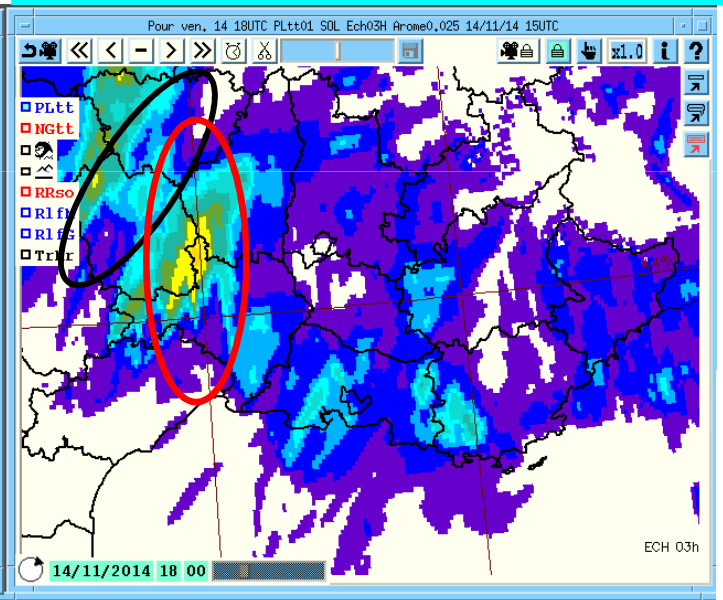
- For a given hour the most recent AROME-PI run scores the previous one especialy when the AROME guess is the most recent.

# Is a spatial tolerence relevent?

**AROME** run **12**UTC Range **5**

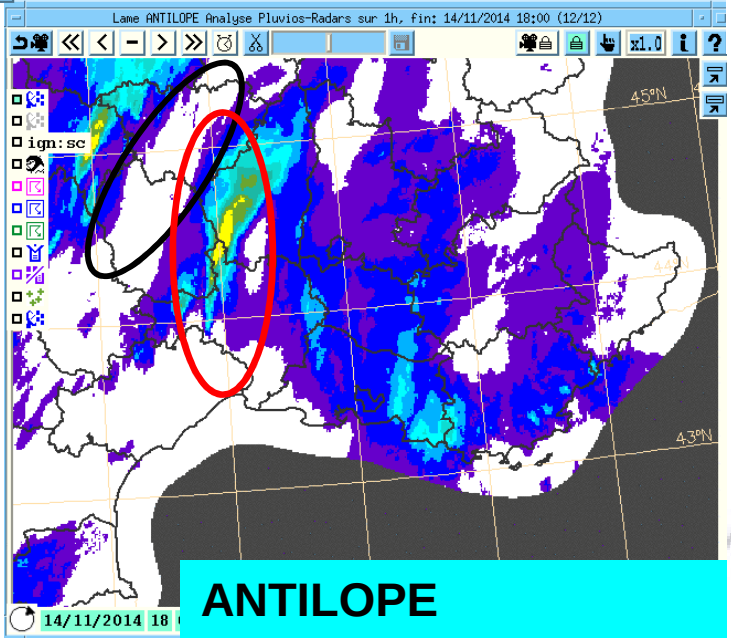



**AROME PI** run **15**UTC Range **3**




**14/11/ 2014**

**6 pm**




**ANTILOPE**

- AROME and AROME-PI forecasts are close each other.
- The maximum of heavy rains is better localised in AROME-PI than in AROME.
- AROME-PI intensifies and extends light rains at the West.

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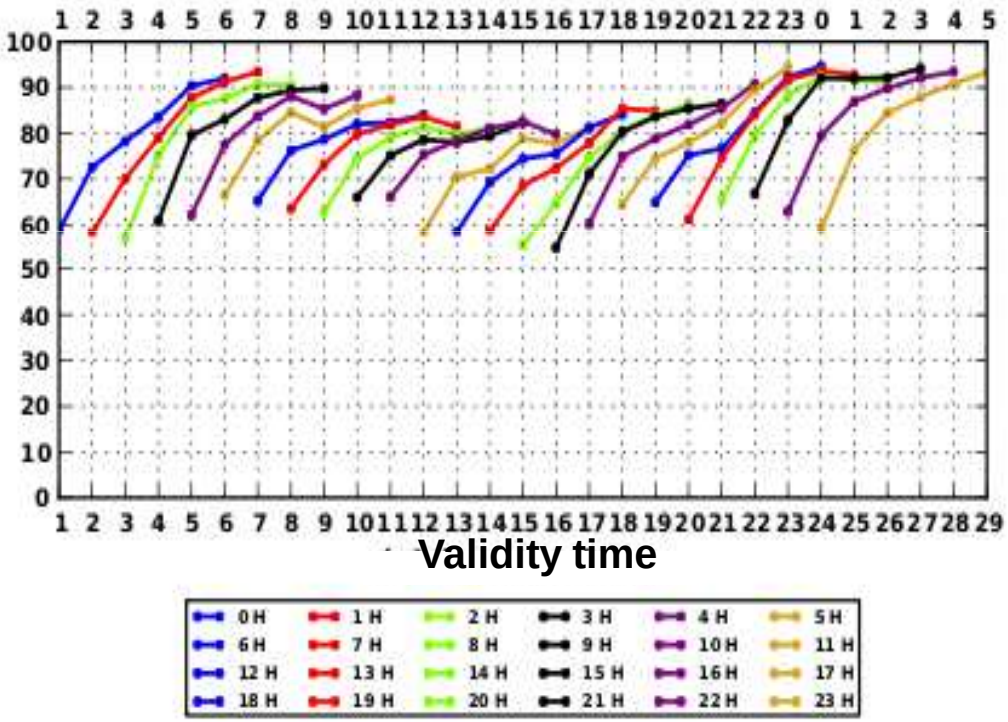
# The Brier score and the BSS

## Brier Skill Score = 1 - $BS_{forecast}$ / $BS_{persistence}$

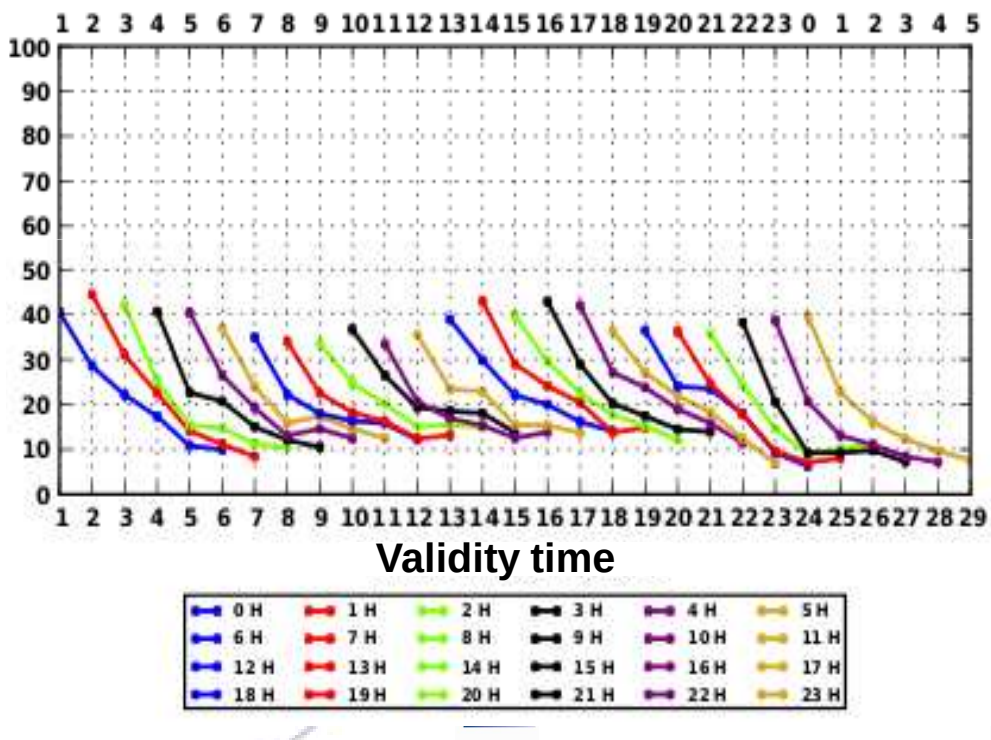
**Persistence :** the ANTILOPE analysis observed 1 hour before the AROME-PI starting hour is taken has the reference forecast for each lead time

Threshold 5mm/h

**False Alarm Ratio**

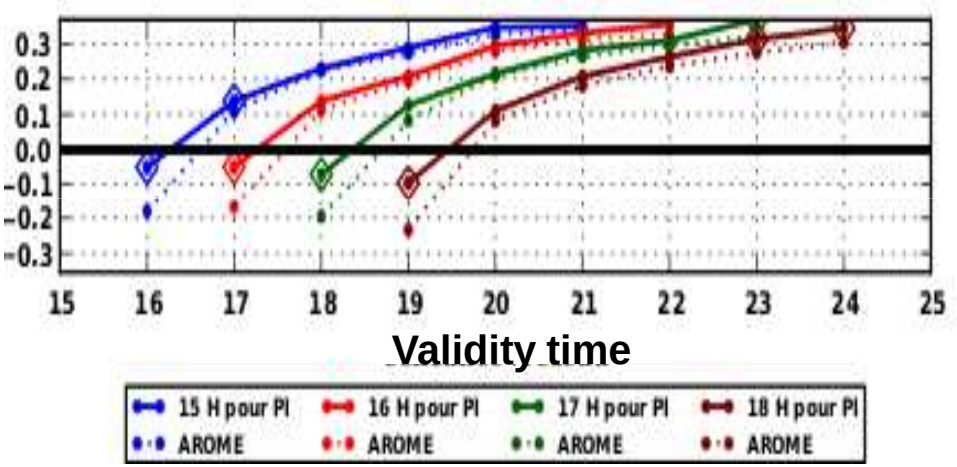


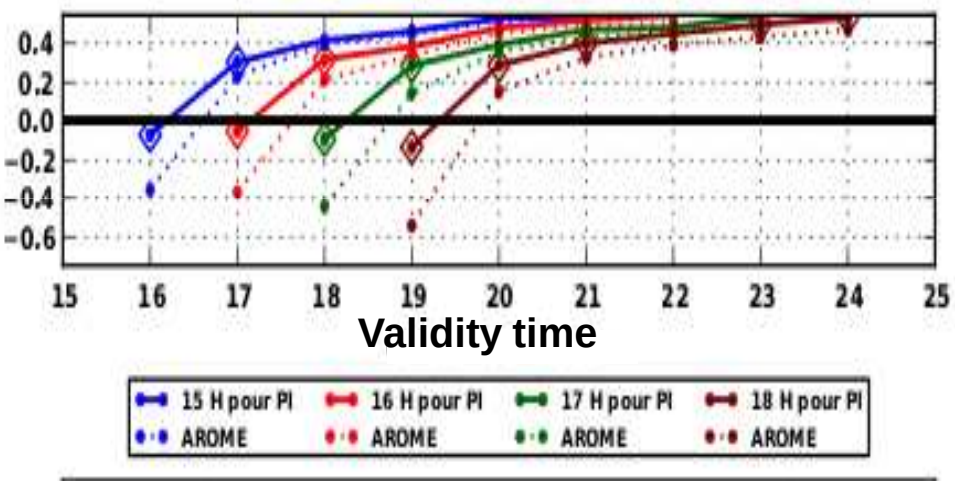

**Probability Of Detection**



# The BSS against persistence: **0.5mm/h**

**BSS for AROME run 12UTC and AROME-PI runs 15, 16, 17 and 18UTC**

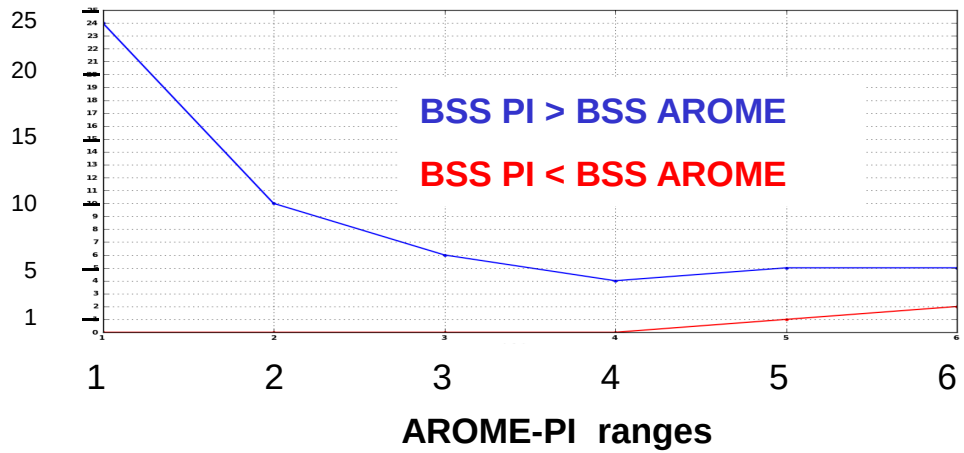


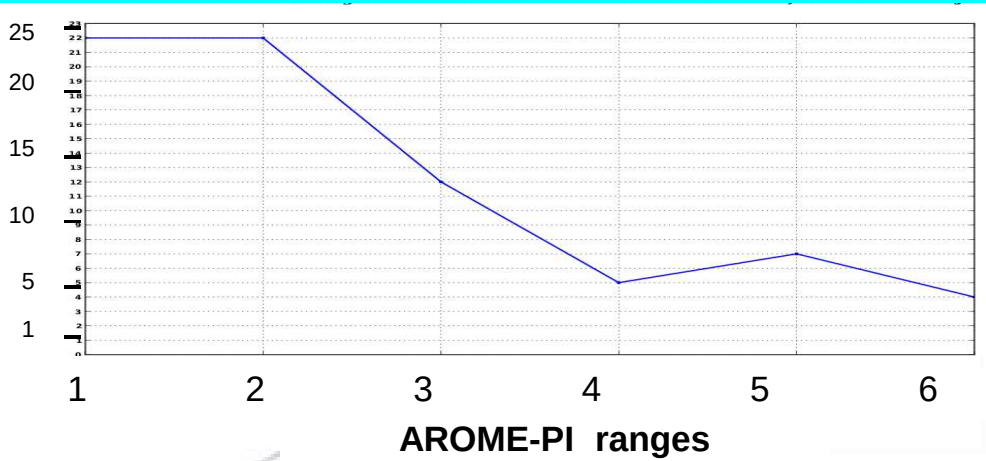




Neighborhood **1.3km**

Neighborhood **20km**

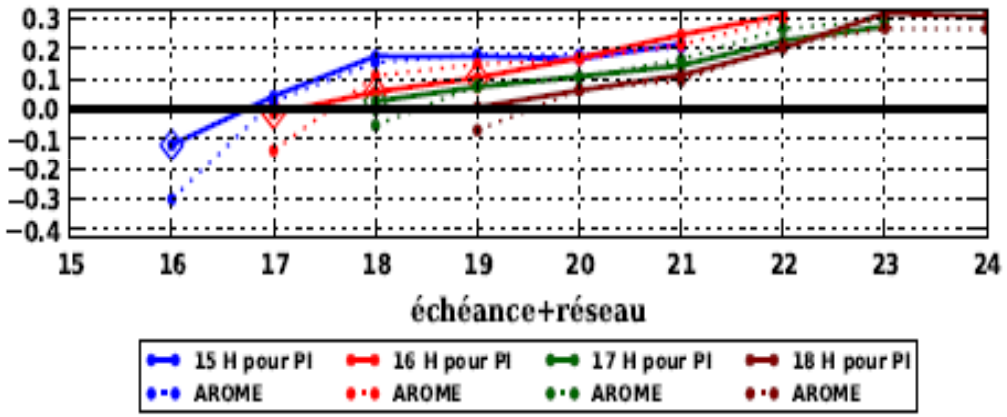
**Number of times where the difference between PI BSS and AROME BSS is significant**

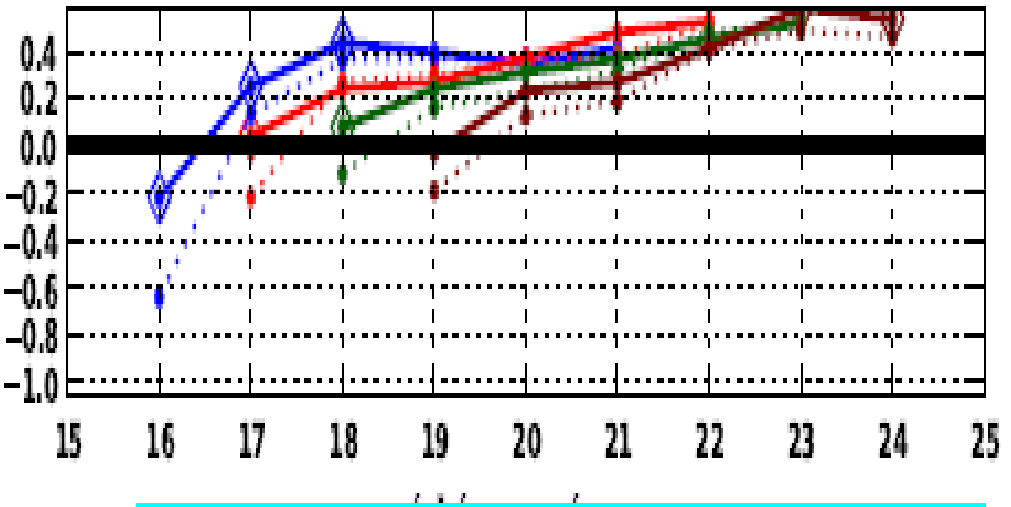


# The BSS against persistence: **5mm/h**

**BSS for AROME run 12UTC and AROME-PI runs 15, 16, 17 and 18UTC**

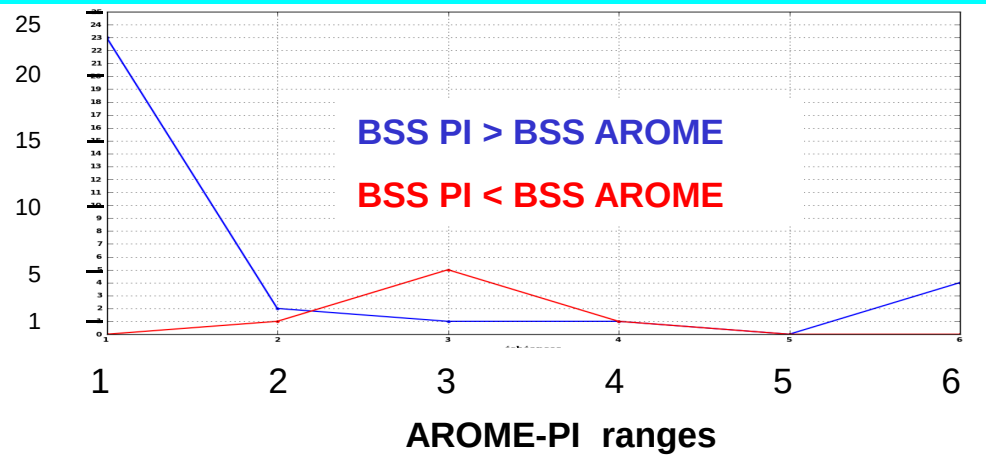


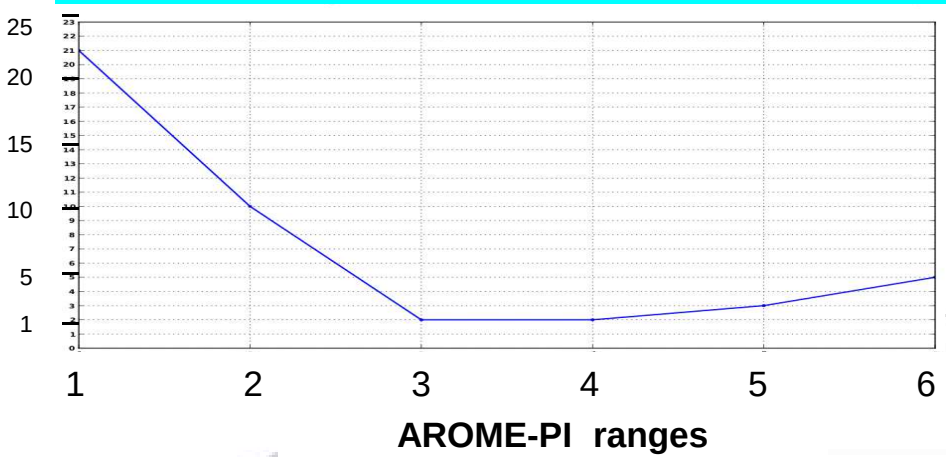




Neighborhood **1.3km**

Neighborhood **20km**

**count of times where the difference between PI BSS and AROME BSS is significant**



# Conclusion

- AROME-PI is the nowcasting system at Meteo-France and has been developed in order to cover the nowcasting 0-6h range. It will be operational at the end of 2015.
- The verification software checked over November 2014 brings interesting informations on the quality of AROME-PI. The systematic study of the 24 AROME-PI runs shows that running this HR model every hour, taking into account the most recent observations has a positive impact for all parameters. On average, the last AROME-PI run presents a gain compared to previous ones.
- During november 2014, the performance of the operational model AROME was quite good and AROME-PI provided usefull informations during the first 2 hours of forecast ; both models were equivalents for the most distant ranges.
- When we introduce a spatial tolerance the benefit lasts longer for lighter rains and increases for heavy rains.

Thanks for your attention

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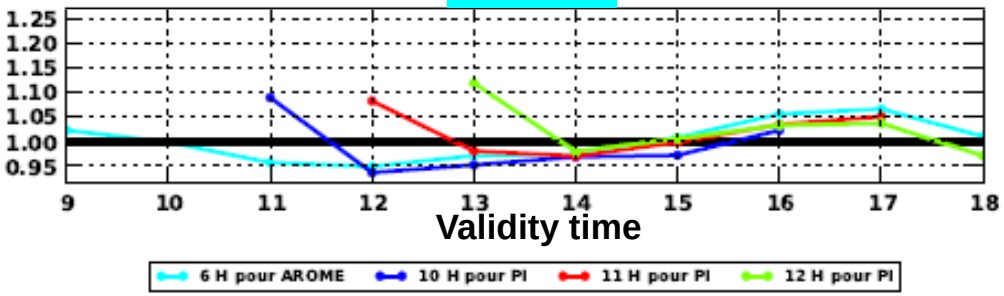
# AROME-PI validation: **10 meter wind gust 40Km/h**

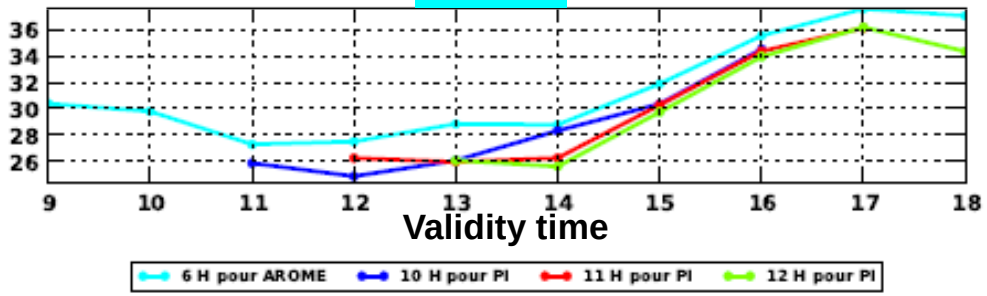
About 700 stations from French meteorological network

**AROME run 06UTC and AROME-PI runs 10, 11 and 12UTC**

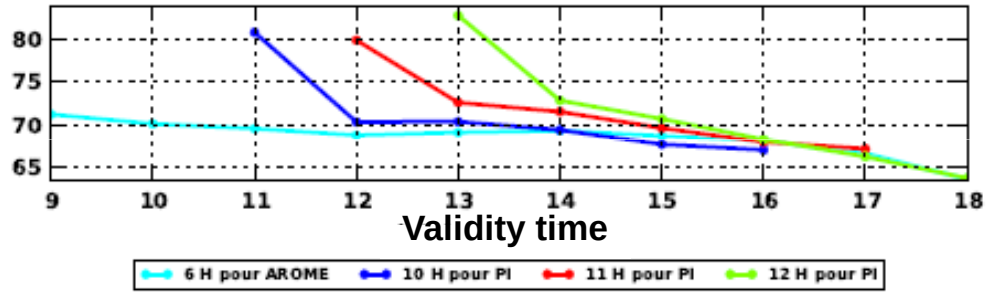
## BIAS



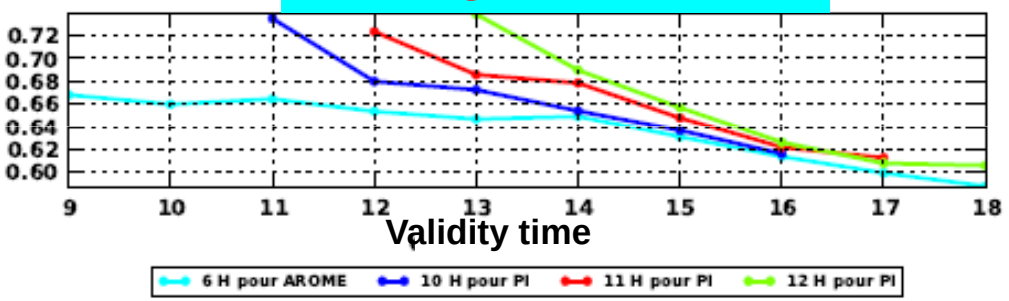

## FAR




## POD




## HSS against chance




- Stronger improvement the during the two first hours.
- Data assimilation add information at the right place

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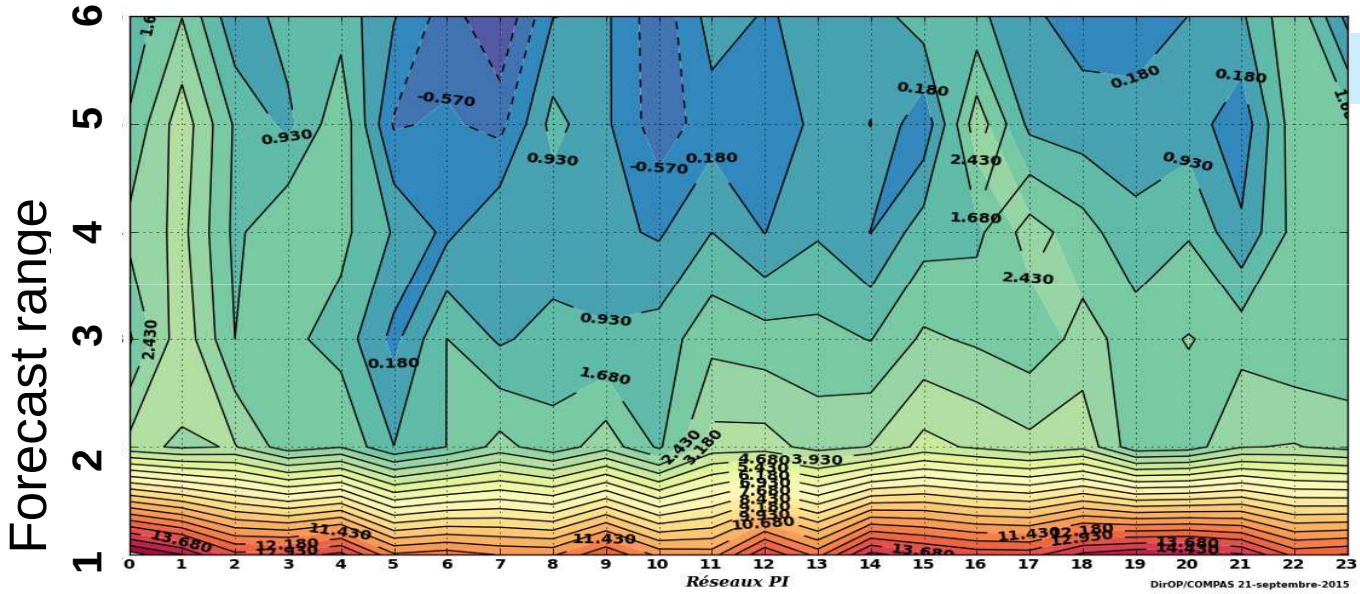
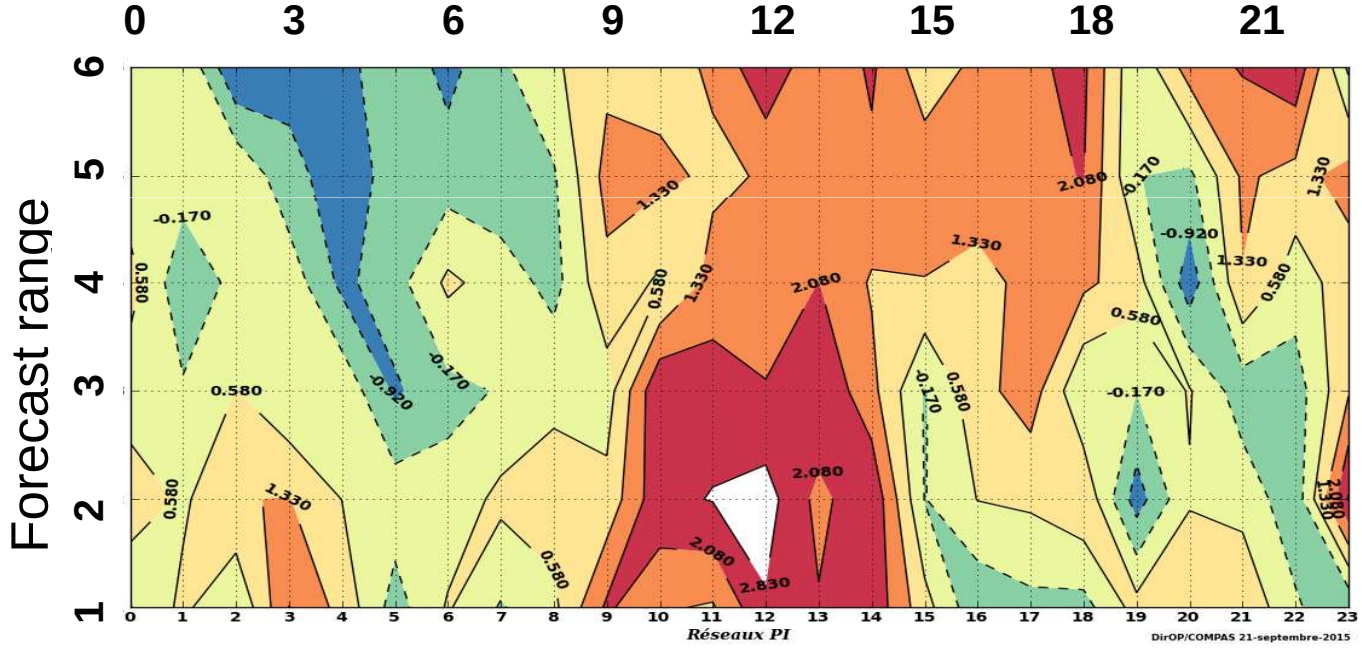
# AROME-PI validation: **10 meter wind gust 40km/h**




0 3 6 9 12 15 18 21

**AROME-PI starting hour**

## AROME-PI POD – AROME POD

- AROME-PI > AROME most of the time
- Maximum improvement of 10 to 13% bonus detection during the first hours of AROME-PI forecast
- Small differencies after 3hour of forecast all day long

## AROME FAR – AROME-PI FAR

- False alarm are reduced during the day between 9am and 3pm when number of observed wind gust is maximum.

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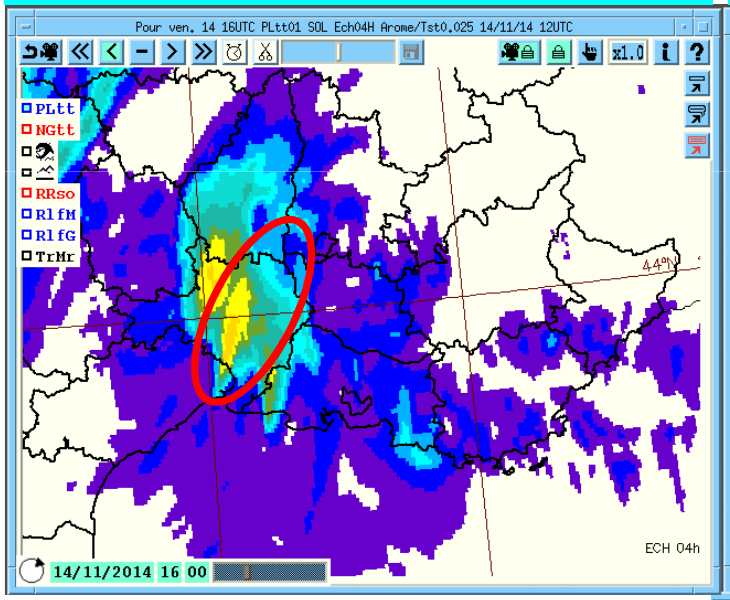
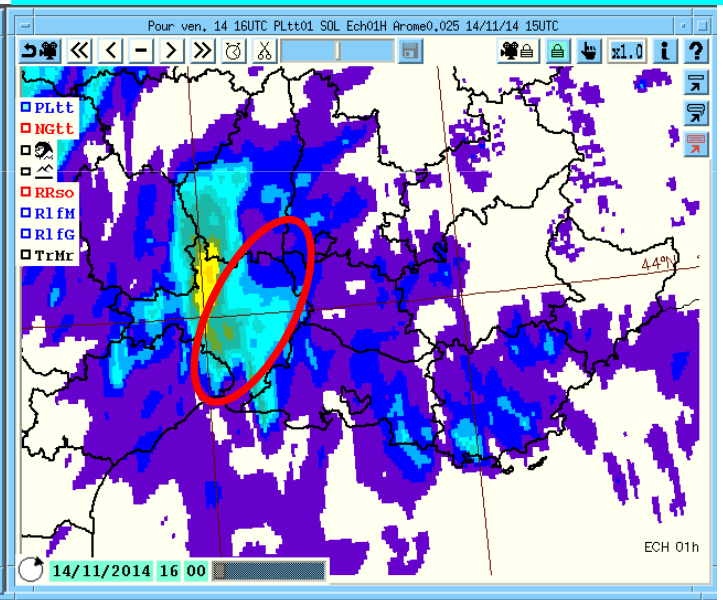
# Case Study: **14 of November 2014**

**AROME** run **12**UTC Range **4**

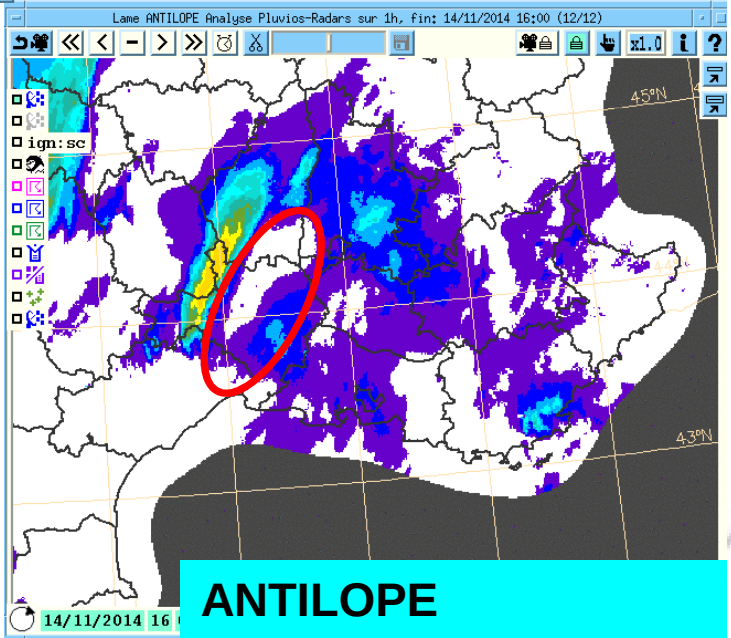



**AROME PI** run **15**UTC Range **1**




**4 pm**

A double hight rains maximum is supressed in AROME-PI forecast after the assimilation of new data.




**ANTILOPE**

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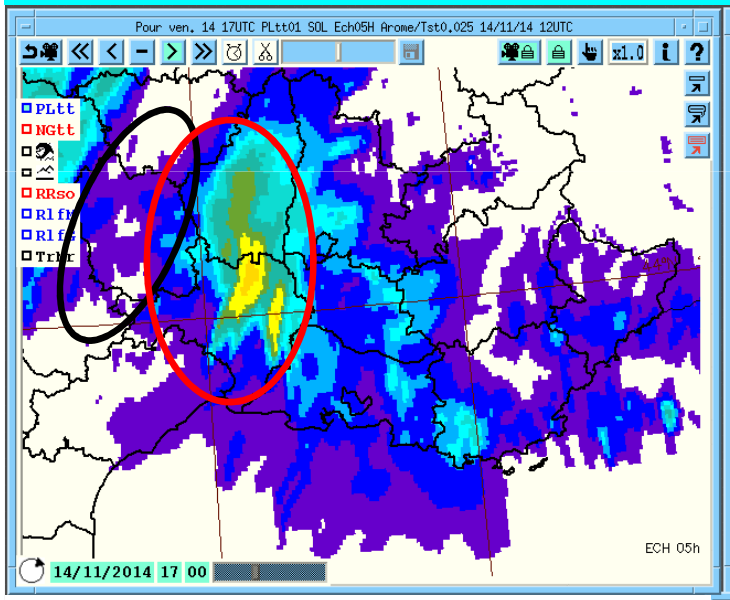
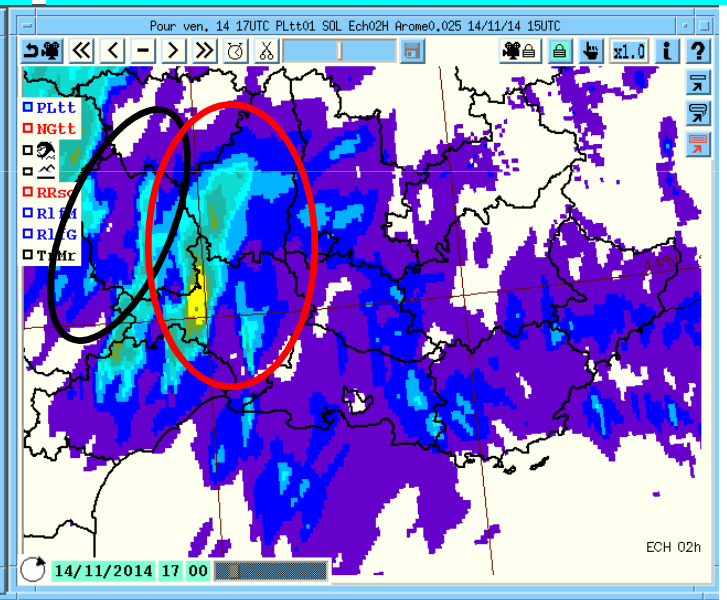
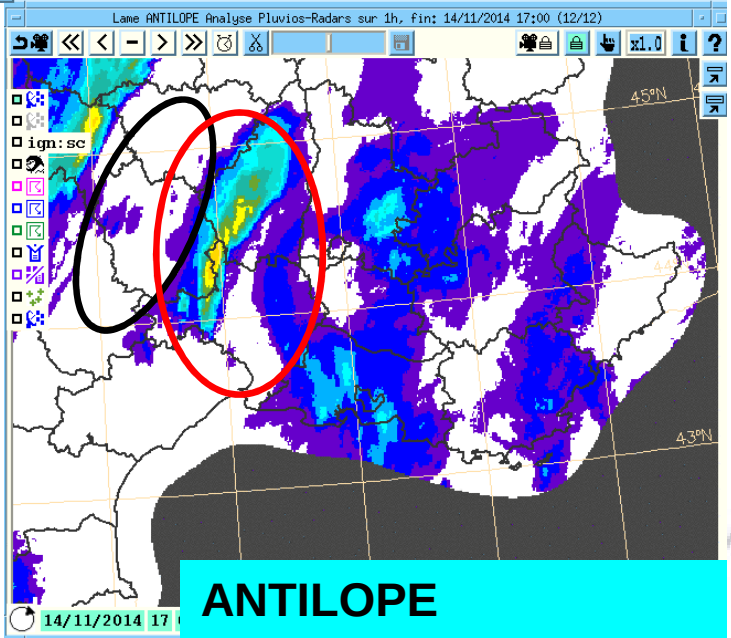
# Case Study: **14 of November 2014**

**AROME** range **12**UTC Range **5**




**AROME PI** run **15**UTC Range **2**




**ANTILOPE**

**5 pm**

- AROME forecast shows always a double maximum on the contrary of AROME-PI.
- But AROME-PI simulates wrong light rains further West

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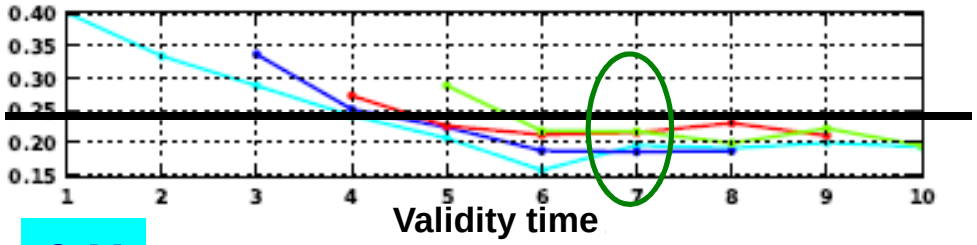
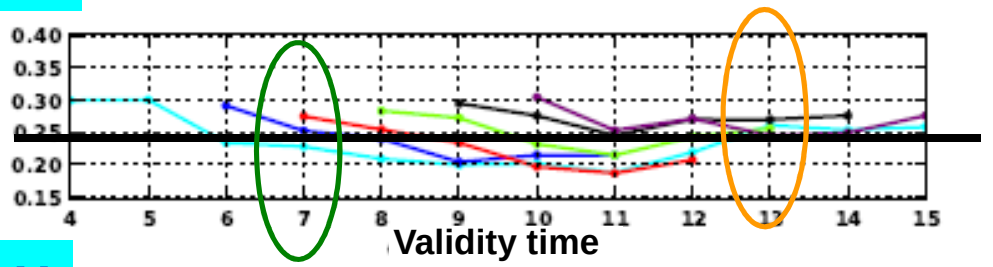
# HSS against chance threshold 5 mm

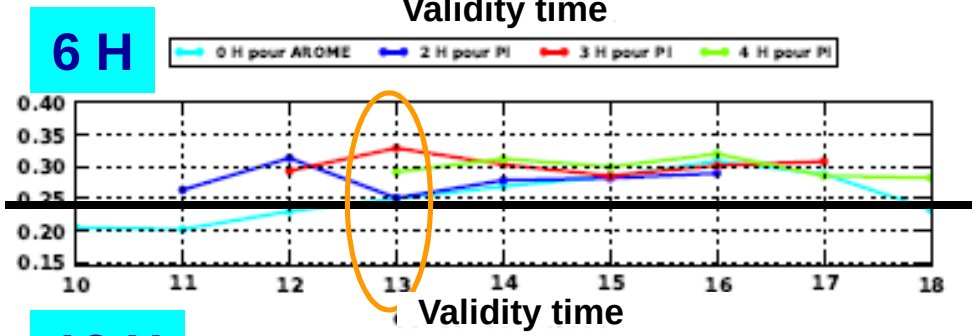
## AROME issue 0H



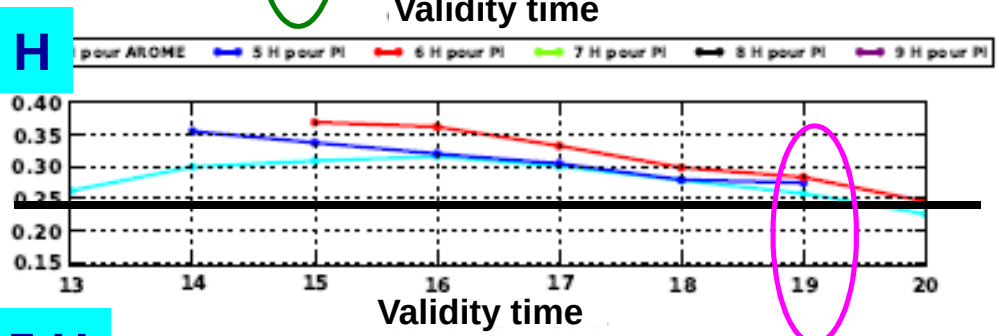

## 3 H



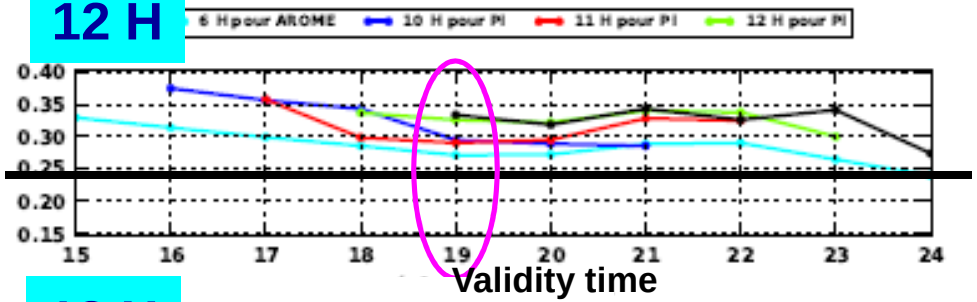

## 6 H



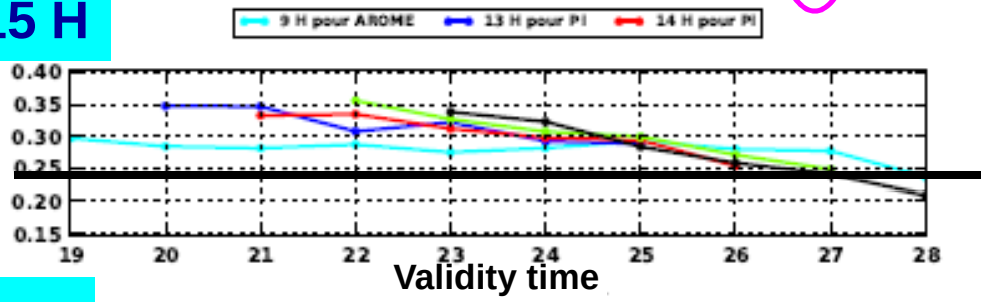

## 9 H



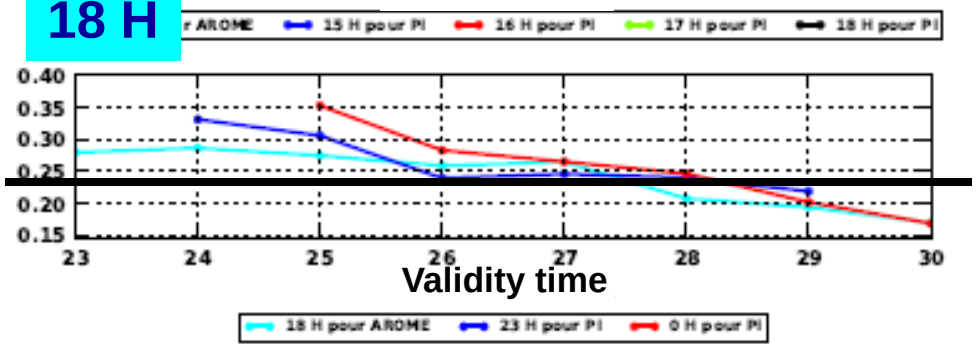

## 12 H



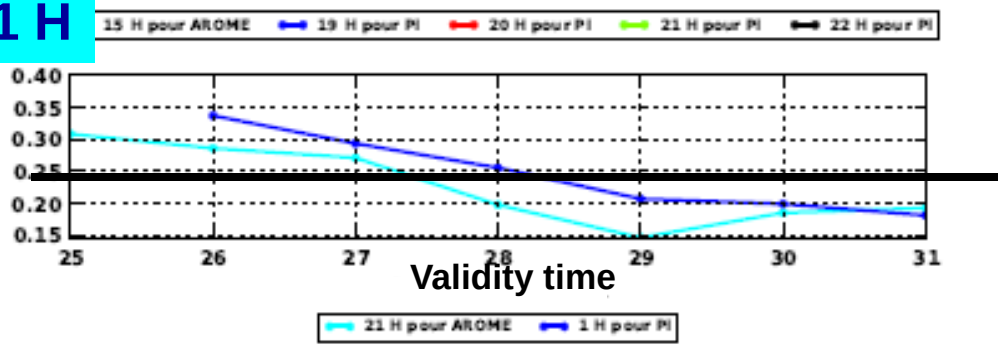

## 15 H




## 18 H




## 21 H



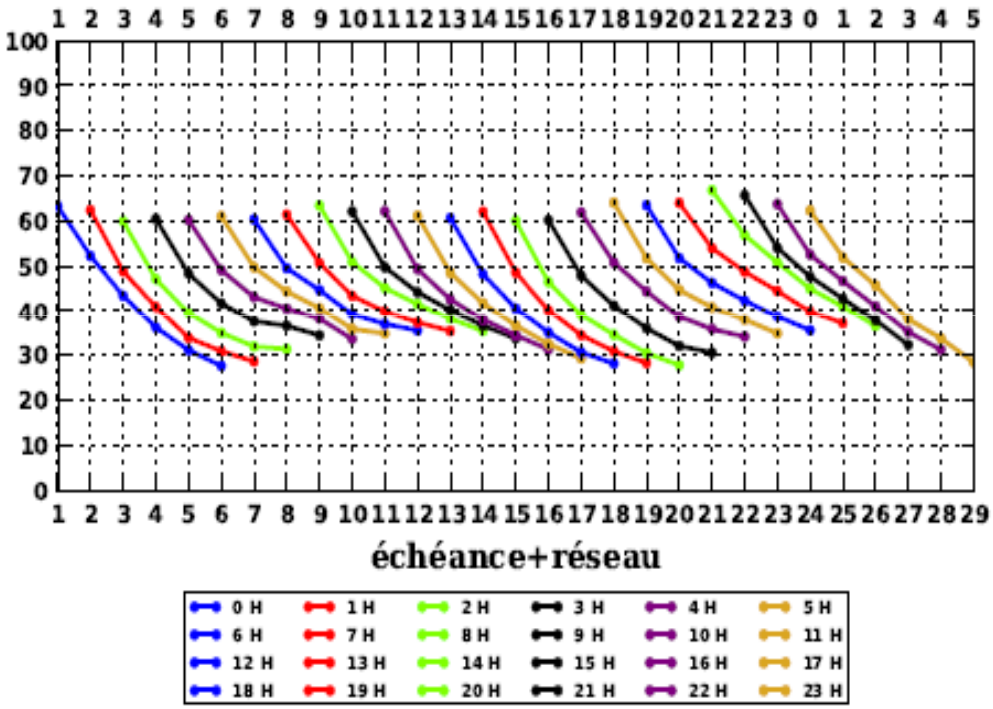
# The Brier score and the BSS

## BSS = 1 - BS$_{forecast}$ / BS$_{persistence}$

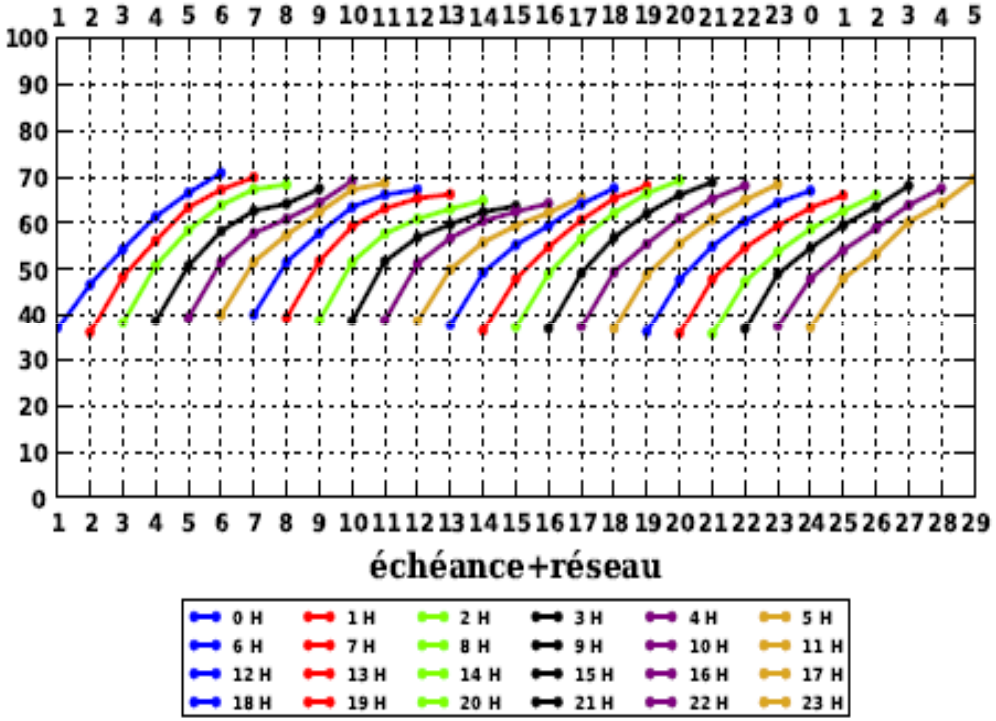
**Persistence :** Observations of the hour before the verified AROME-PI starting hour.
The persistence is the same for all the terms of a same starting hour.

Threshold 0.5mm/h

**Probability Of Detection**




**False Alarm Ratio**

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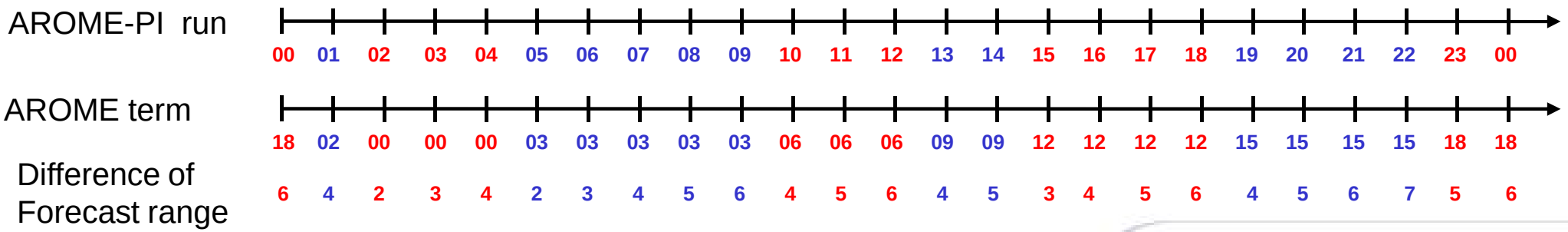
# Verification process

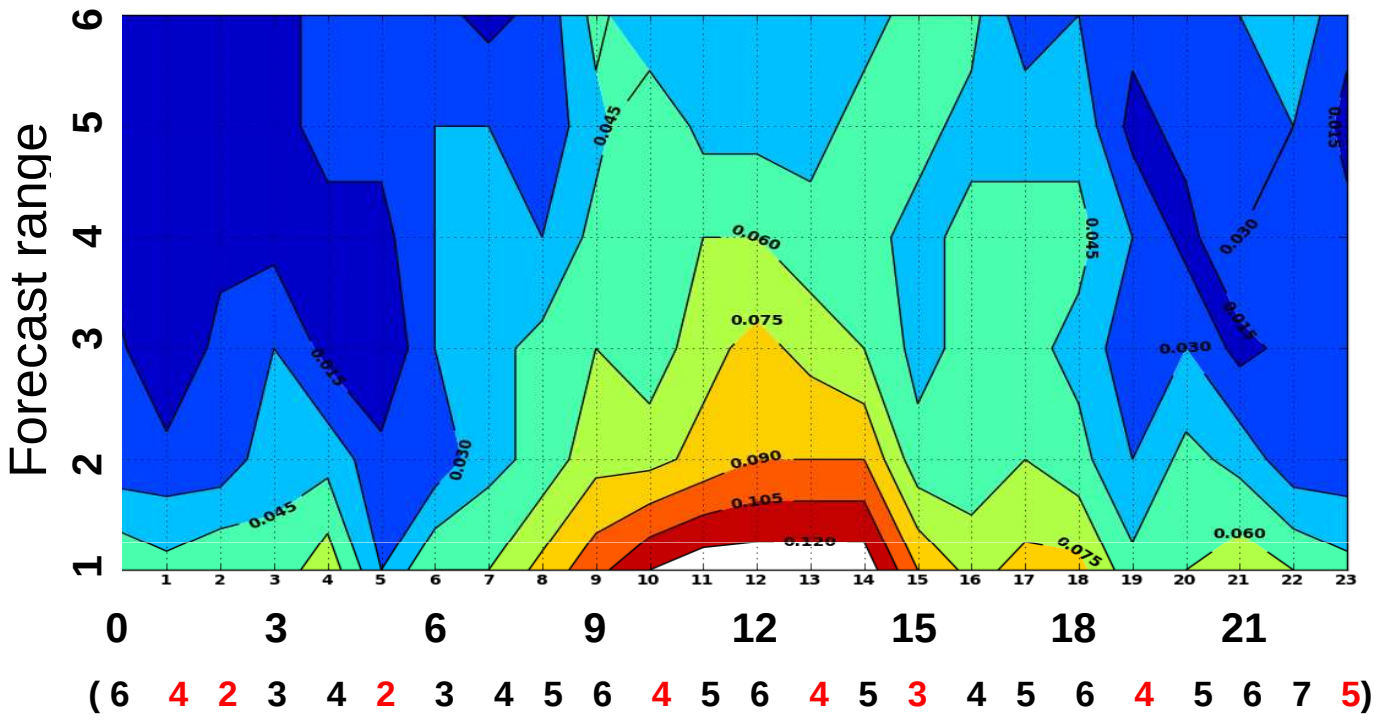
- The methodology used to assess the AROME-PI performance consist in measuring the distance between the forecast and the verifying observations for both the AROME-PI experiment and the AROME operational model.

- Comparison is made between AROME-PI forecast and the latest AROME forecast available at the same time in an operational context.



# AROME-PI validation: **Wind force**

**AROME RMSE –AROME-PI RMSE**
**10 meters wind force**
About 700 stations from French meteorological network




AROME-PI starting hour

**(Difference of forecast range)**

- AROME-PI > AROME Every where
- Stronger improvement during the day between 8am and 4pm
- Weak improvement during the night when winds are weak.
- Dicrease of RMSE difference when a more recent AROME is available and then difference between forecast ranges is smaller

METEO FRANCE