

WIND POWER FORECASTING IN A FRENCH CONTEXT METEOROLOGICAL FEEDBACK

09. June 2016 – IEA Wind Task 36 Forecasting : Workshop on Experiences and Research Gaps –
Barcelona

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- 2 • FORECASTING WITH APOGEES®
- 3 • METEOROLOGICAL FEEDBACK
- 4 • CONCLUSIONS





1. BACKGROUND INFORMATION

CNR IN EUROPEAN ELECTRICITY MARKETS

COMPAGNIE NATIONALE DU RHÔNE

ASSETS IN FRANCE

France's first only renewable electricity producer



Hydropower plants

3 027 MW



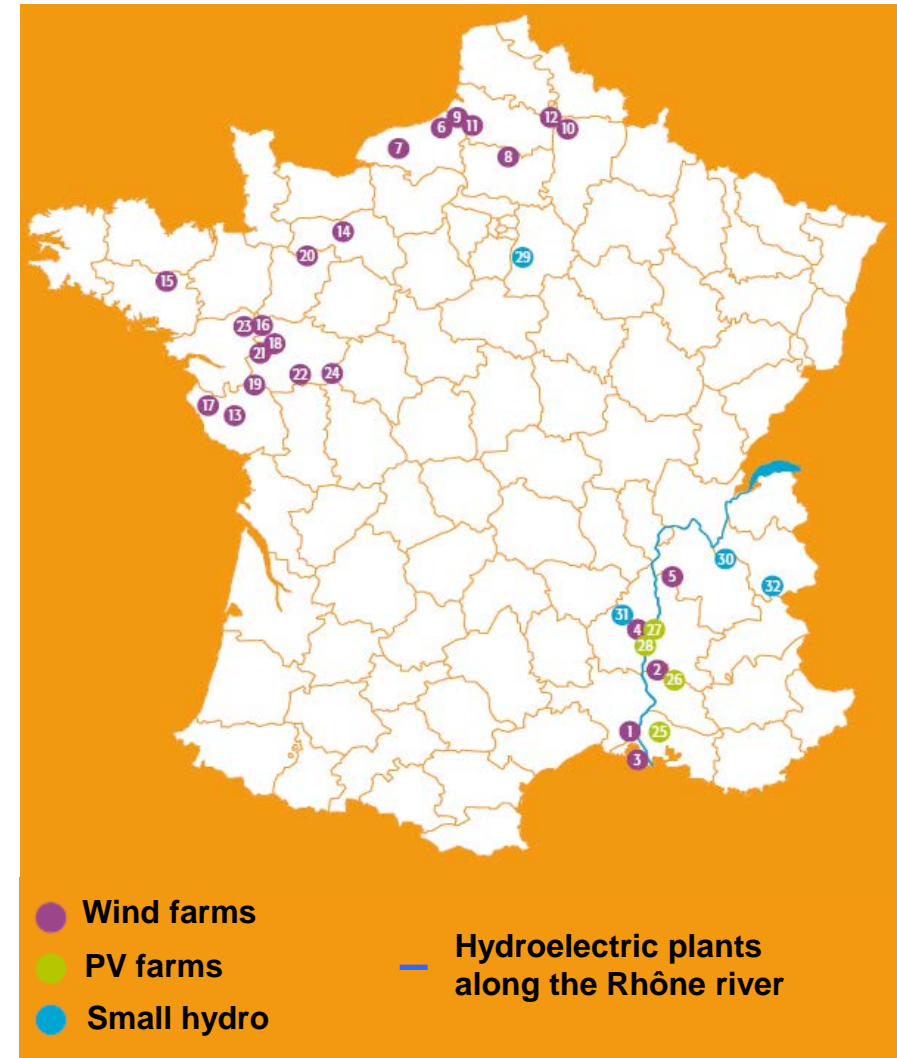
Wind farms

382 MW



PV farms

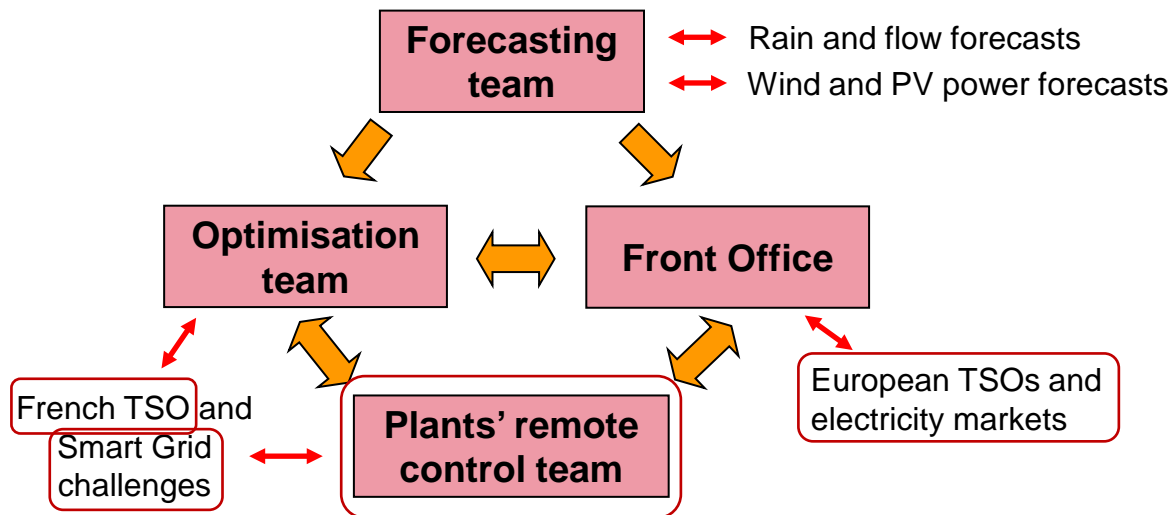
47 MWp



COMPAGNIE NATIONALE DU RHÔNE

METEOROLOGICAL EXPERIENCE

- Operational **hydro-meteorological forecasting system** on the Rhône river basin in relation to the TSO and the market



HYDROMET – SIH®
 PHARE® OPALÉ®
 MAPI® GIC®
 GAIPAR®
 DEMETER® OSCAR®
 INTRANET TELECONTROL®
 OSIRIS® INARI®
 APOGEES®
 ...

- Operational **small hydro, wind and solar power production forecasting system** :

- ✓ Maintenance optimisation
- ✓ Energy portfolio management in deregulated markets
- ✓ TSO demands
- ✓ Smart Grid challenges



CNR

Version 3.14.1.30429

APOGEES- ϕ

Application Pour l'Optimisation de la Gestion
de l'Energie Eolienne & Solaire

2. FORECASTING WITH APOGEES ®

CNR KNOW-HOW APPLIED TO WIND AND SOLAR POWER FORECASTING



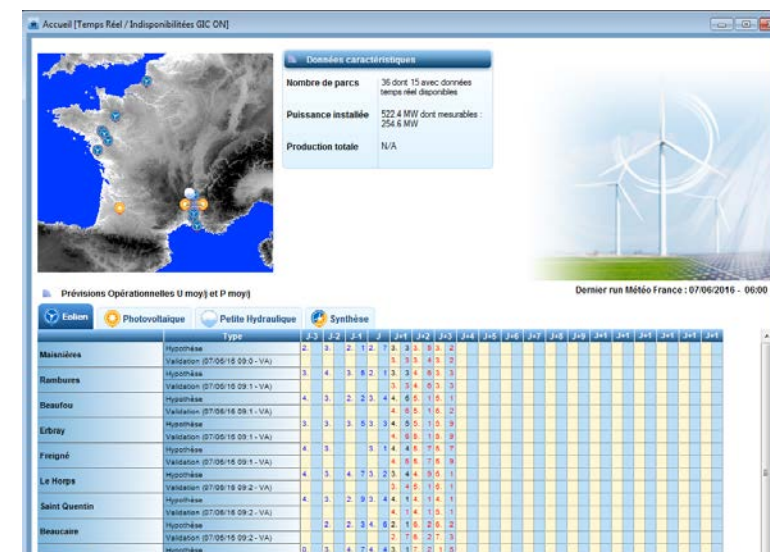
Wind, solar and small hydro power forecasting

- In-house development
- Spatial scale : from unique-park scale to all-CNR-park scale
- Temporal scale :
 - Timestep : hourly, with intra-hour interpolations
 - Horizon : mainly up to +4 days, but up to +15 days for 2 wind parks
- Deterministic forecasts and associated uncertainties
- Room for meteorological expertise



Current operational use

- CNR farms (9 wind, 2 PV and 2 small hydro)
- 2 ENGIE Romania wind farms (48 and 50 MW)
- 2 GP Joule PV farms (40 and 34 MWp)
- Small Hydro from private owners
- Ongoing benchmarks

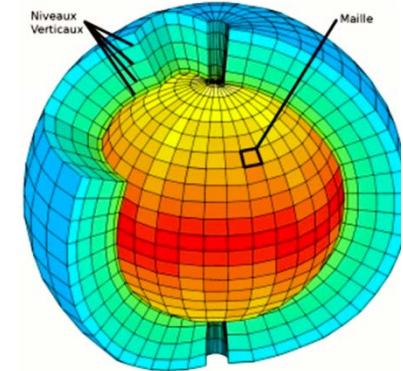


APOGEES®

METHODOLOGY AND RESULTS

Input data

- AROME and ARPEGE (Météo-France), IFS (ECMWF), GFS (NOAA) and COSMO (Météo Suisse) -> multi-model approach
- On-site observed SCADA data
- Farm availability (maintenance operations)



Modelisation

- Stats : data mining (NN) and basic regressions (GLM + non linear regressions), ARIMA for short lead-time
- 2-phases (wind + prod) or 1-phase (prod only) modelisation approaches
- Physical : for PV modeling only
- MOS for uncertainty forecasting

Results Trial for 1 wind farm in Romania (45 MW) during 2 months

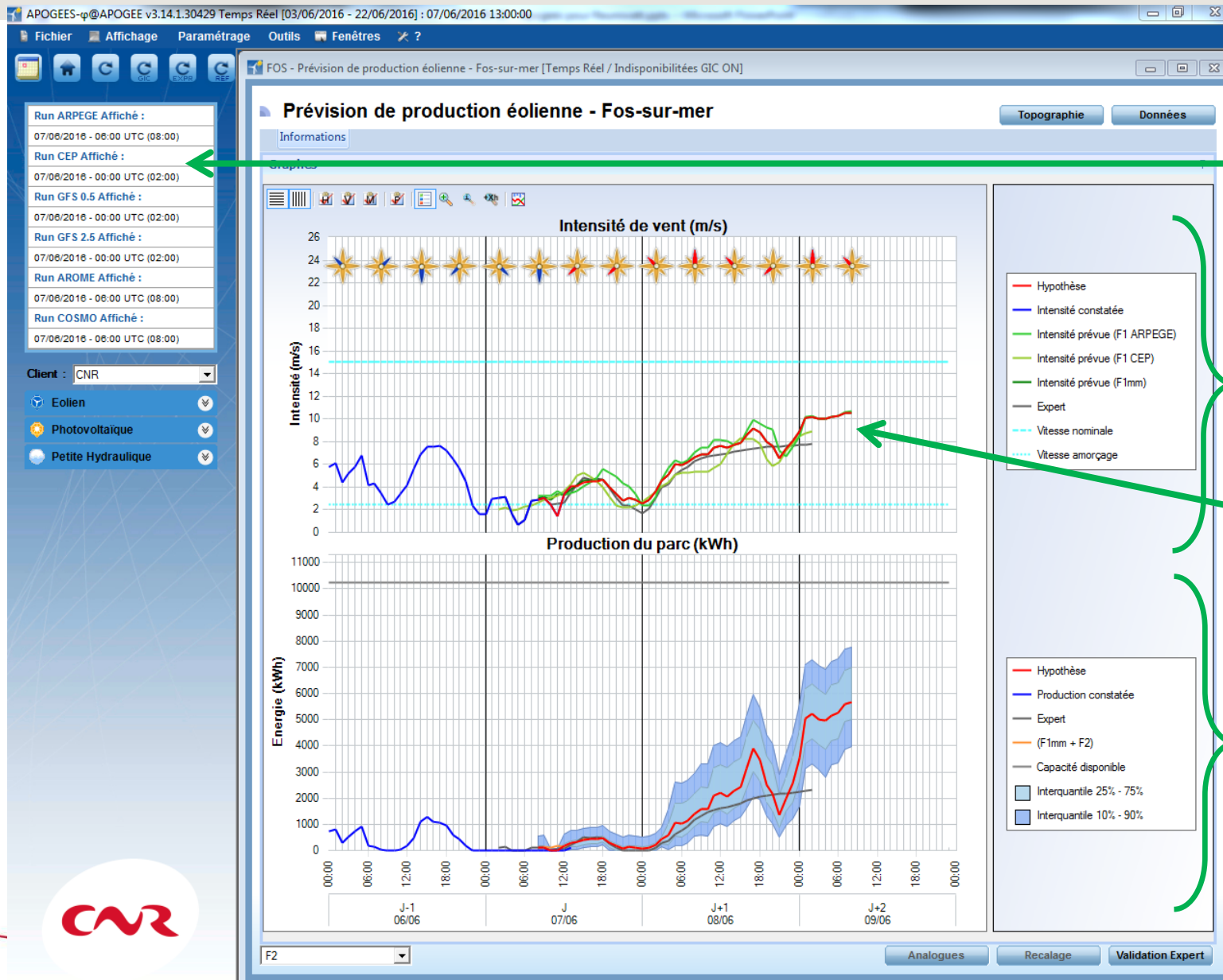
- Forecast Quality (day-ahead, error relative to production) 

Overview Forecast Performance															
PSAE	Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 6	Provider 7	Provider 8	Provider 9	Provider 10	Provider 11	Provider 12	Provider 13	Provider 14	Provider 15
Oct-Nov	37.3%	35.1%	66.8%	43.4%	47.2%	58.6%	47.1%	45.2%	35.1%	52.8%	42.0%	58.3%	52.8%	75.0%	56.0%

- Service quality :

		Provider 1	Provider 2	Provider 3	Provider 4	Provider 5	Provider 6	Provider 7	Provider 8	Provider 9	Provider 10	Provider 11	Provider 12	Provider 13	Provider 14	Provider 15
Q01	Set-up Trial															
Q02	Compliance															
Q03	Timing															
Q04	Reliability	✓12	✓10	✗5	! 7	✗4	! 9	✓12	✓12	✓10	✓10	✓12	! 9	✗5	✗5	✗3

APOGEES® USER INTERFACE



Several NWP
input

Local wind speed

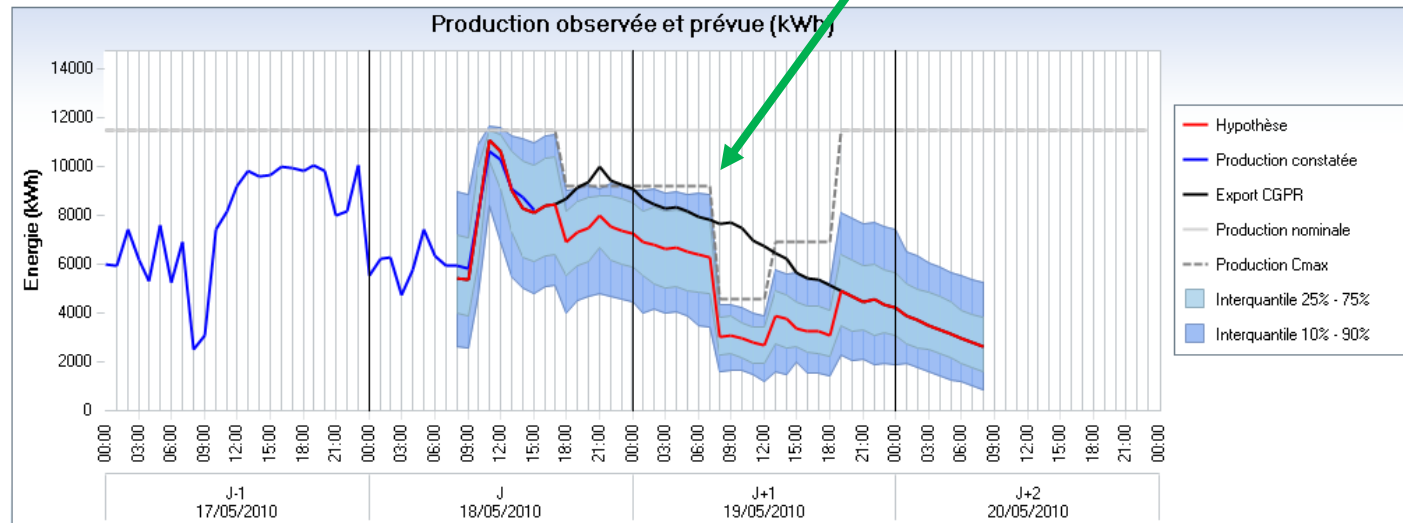
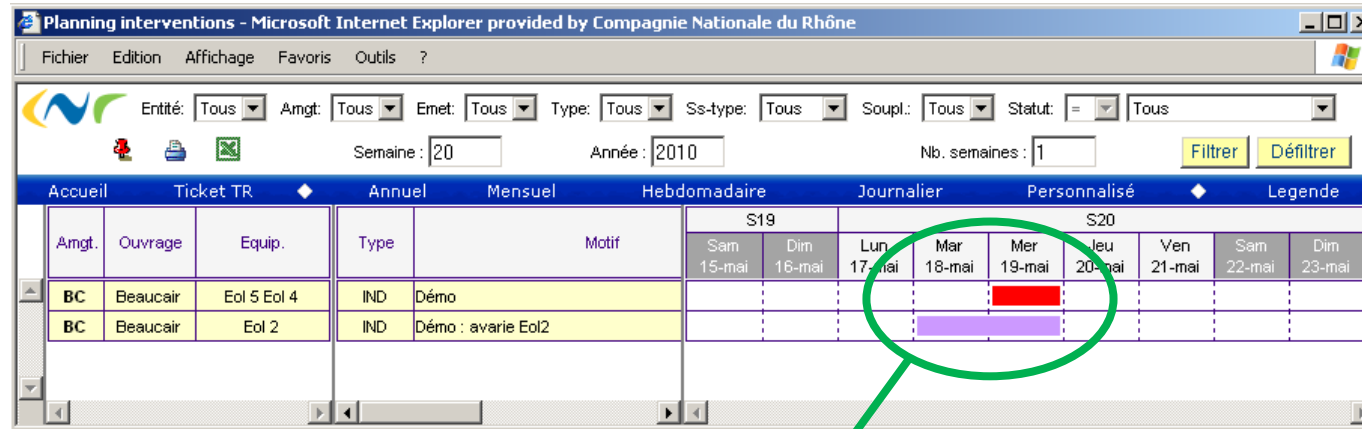
Possible
expertise through
modulation of red
curve



Wind farm
production

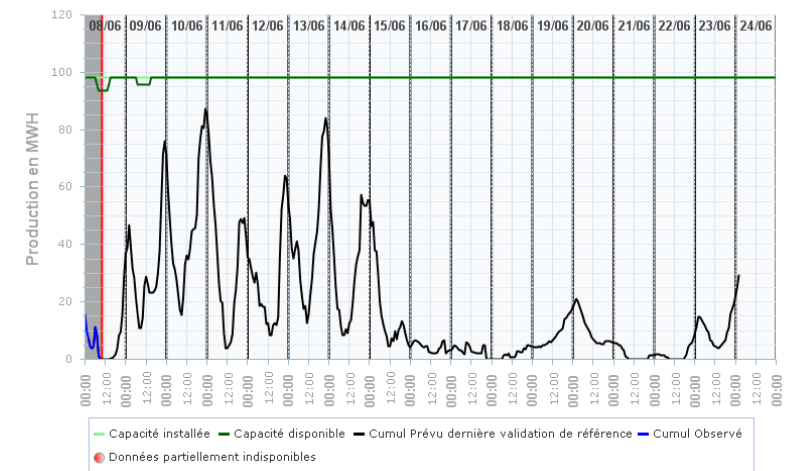
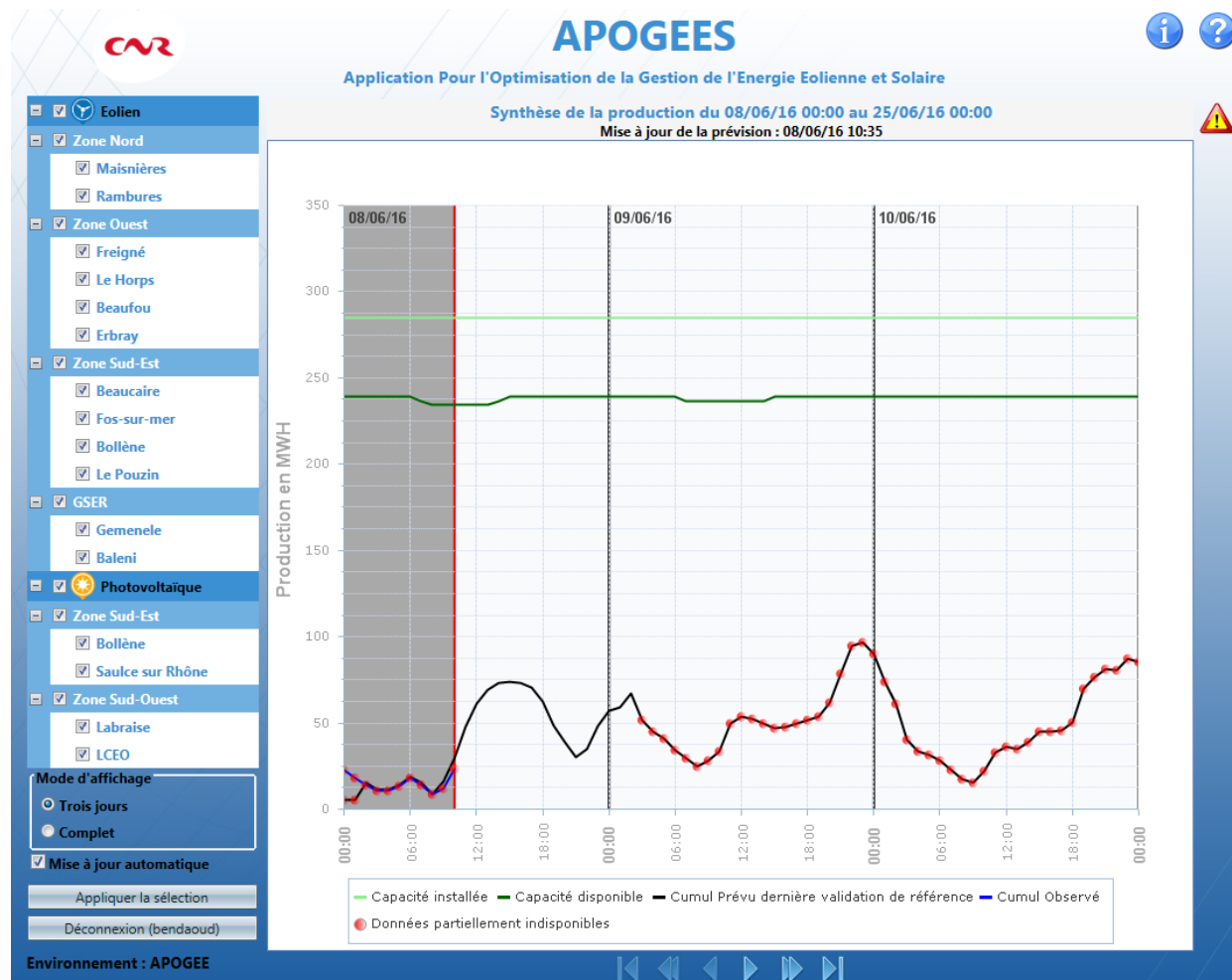
APOGEES® USER INTERFACE

Availabilities data (maintenance operations) as input



APOGEES® WEB-INTERFACE

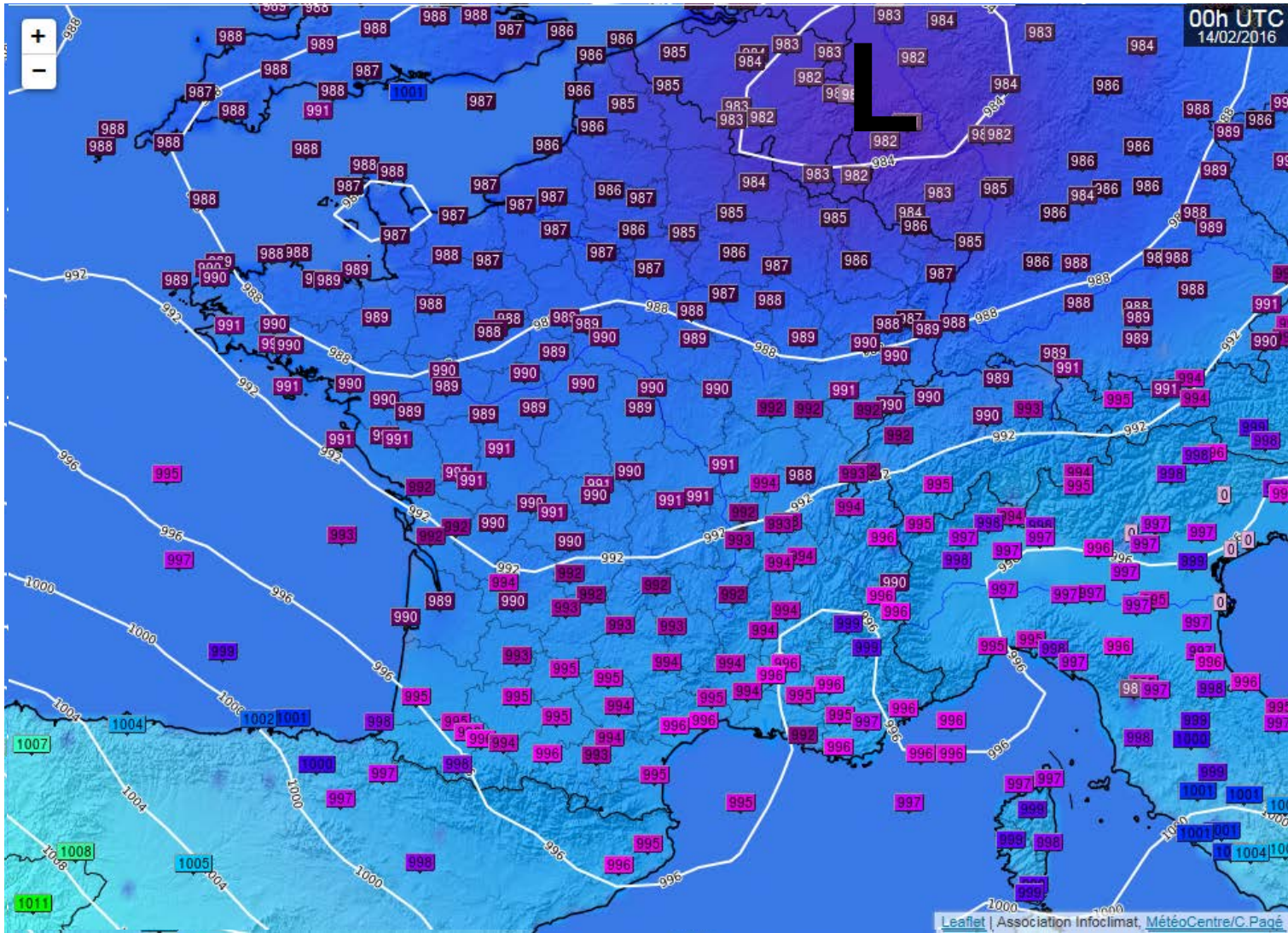
Online web-interface displaying production forecasts (secured connexion)





3. METEOROLOGICAL FEEDBACK CASE STUDY AND OPERATION/MAINTENANCE SUPPORT

CASE STUDY : 13/02/2016



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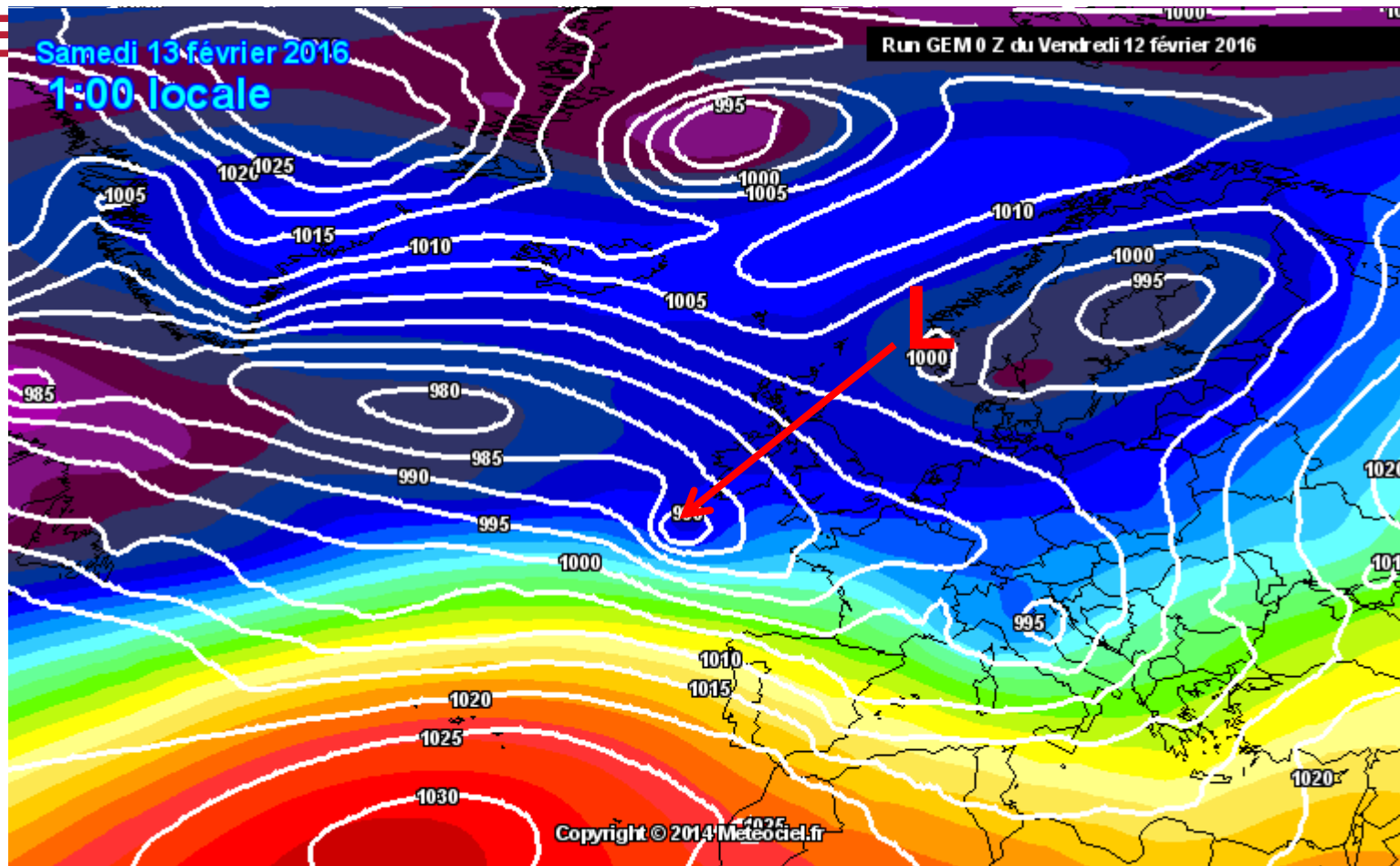
CASE STUDY : 13/02/2016

- Production forecasts for day ahead market : made the 12/02/2016 before 12:00 CET
- Wind & temperature forecasts based on NWP's running at 00:00 UTC
- Expert charts (maps) from different NWP's available over France :
 - GFS (& WRF-NMM)
 - AROME (Météo-France)
 - ARPEGE (Météo-France)
 - ECMWF – archive available online only with a granularity of 24h
 - UKMO (UK Met Office) – archive available online only from +72h lead-time with a granularity of 24h
 - GEM (Canadian Meteorology Centre)
 - ensemble NWP's from ECMWF and NOAA institutes – unavailable archive

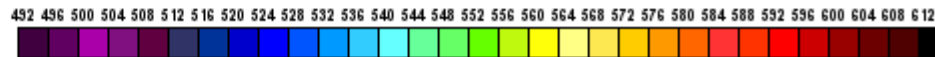
CASE STUDY : 13/02/2016

Lead-time : 13/02/2016 at 00:00 UTC (+24h)

GES
ARPEGE
ECMWF
GEM



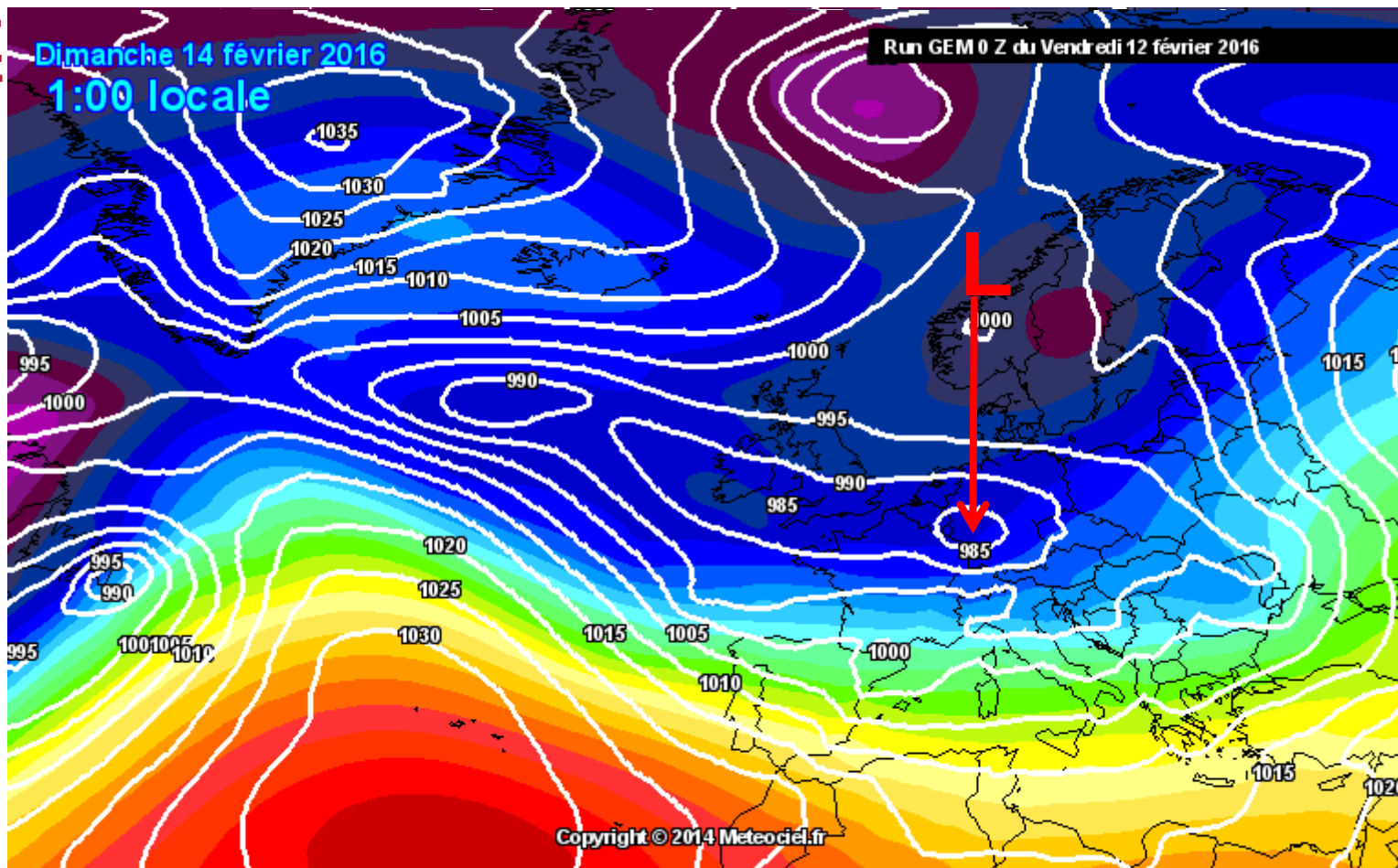
Géop. Z500 & pression au sol
(+ 24 h)



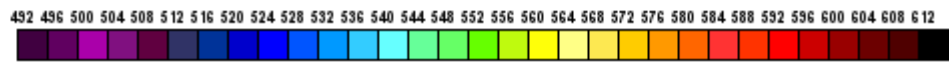
CASE STUDY : 13/02/2016

Lead-time : 14/02/2016 at 00:00 UTC (+48h)

GFS
ARPEGE
ECMWF
GEM



Géop. Z500 & pression au sol
(+ 48 h)



CASE STUDY : 13/02/2016

- At +24h : NWP's very close with small pattern differences
- At +48h : NWP's not in agreement - ARPEGE as an outlier, other models suggesting a similar tracking of the low pressure system

Expertise → given that for CNR wind farms, only ARPEGE/AROME/ECMWF are used for DAM forecasts, a more important weight is applied to the **ECMWF** forecast, especially in northern France

CASE STUDY : 13/02/2016

Multi-model approach in APOGEES :

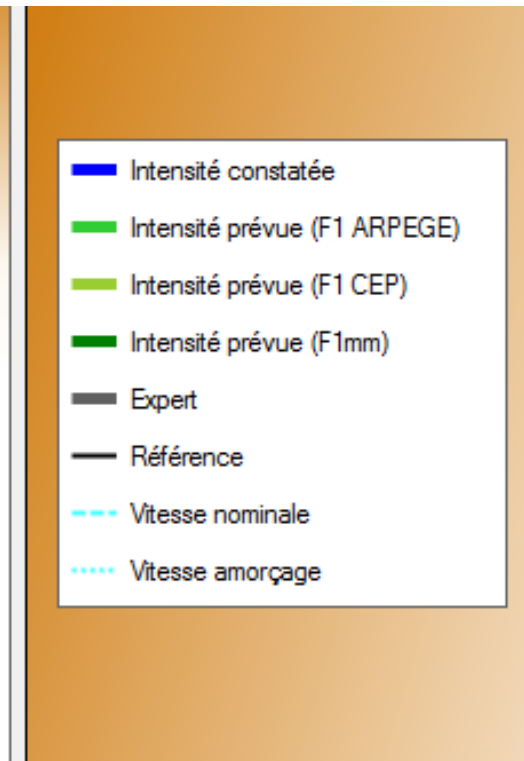
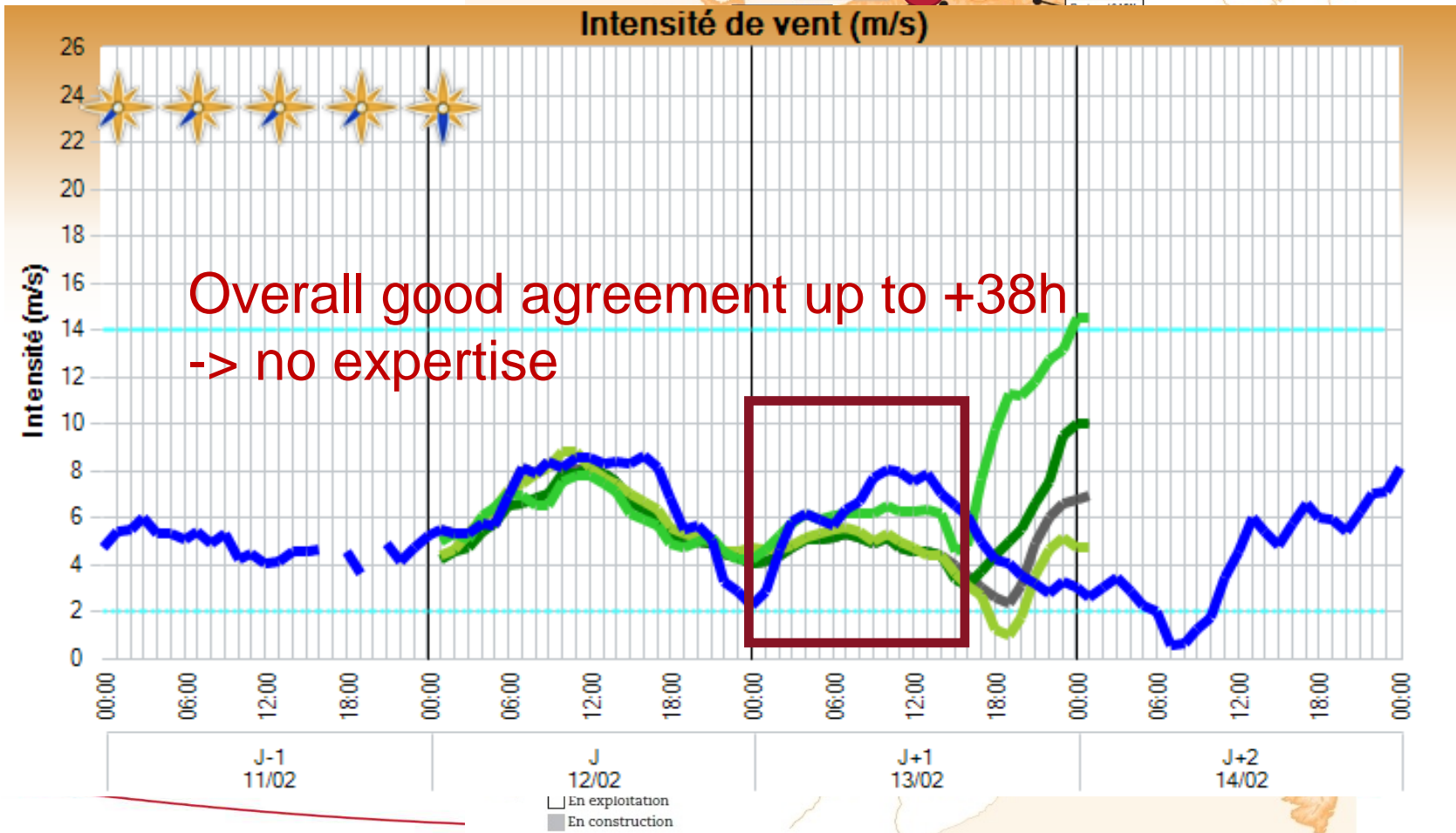
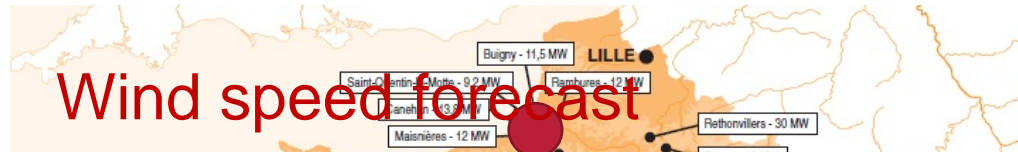
- 'F1 ARPEGE' : statistical adaptation from ARPEGE model
- 'F1 CEP' : statistical adaptation from ECMWF model
- 'F1mm' : statistical adaptation from a combination of both models, the best algorithm in average

Value-added forecasts :

- 'Expert' : forecast based on expertise when needed

CASE STUDY : 13/02/2016

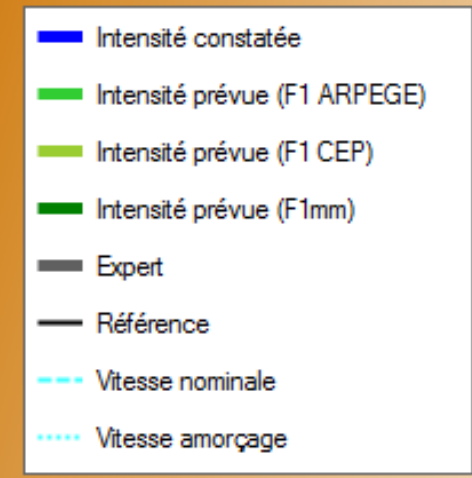
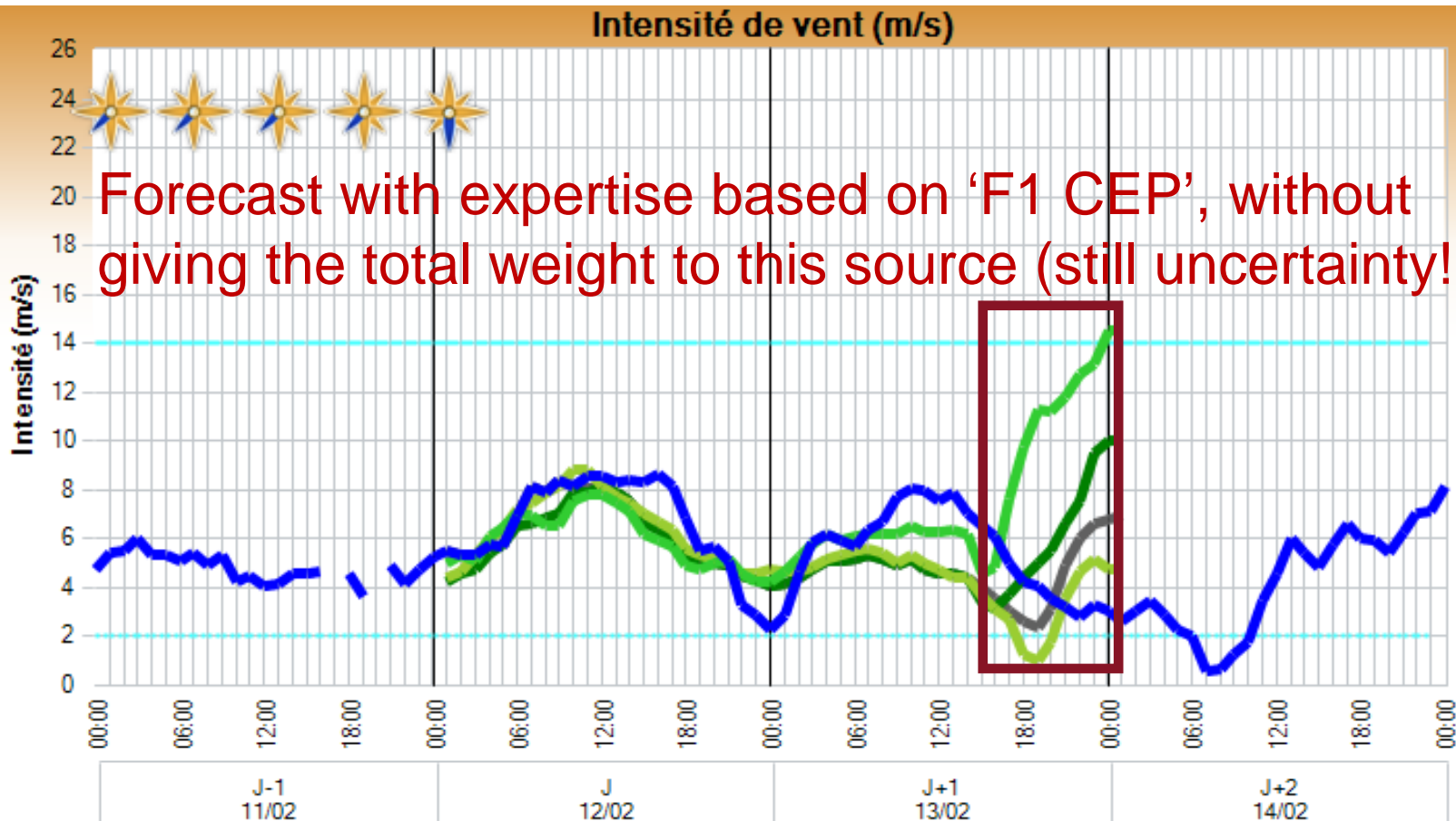
Example of Maisnières wind farm in northern France



CASE STUDY : 13/02/2016

Example of Maisnières wind farm in northern France

Wind speed forecast

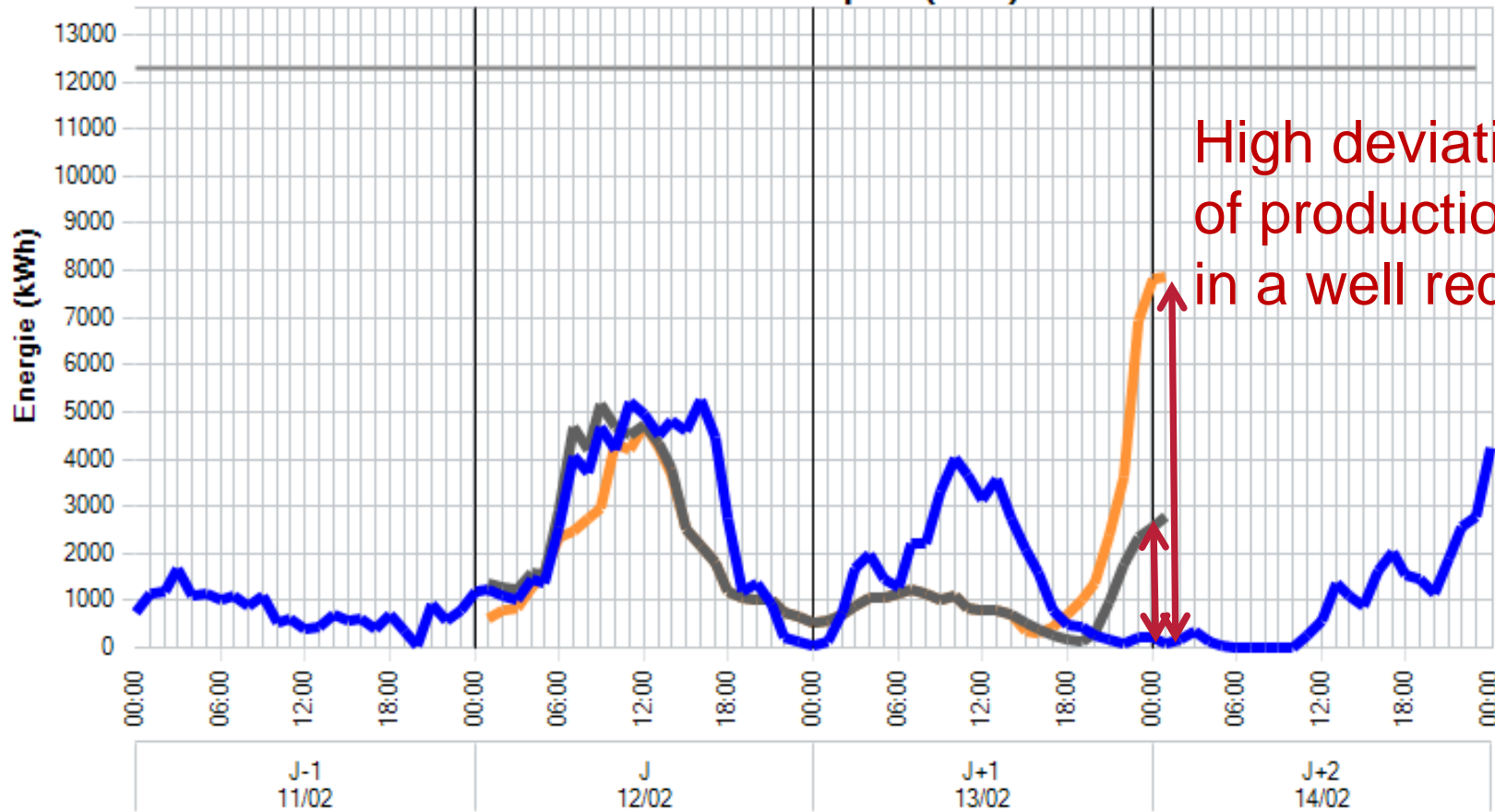


CASE STUDY : 13/02/2016

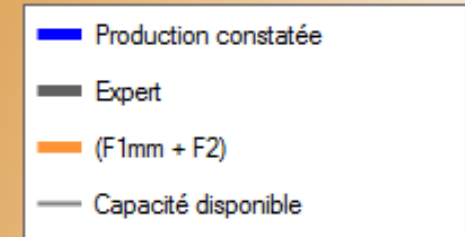
Example of Maisnières wind farm in northern France

Production forecast

Production du parc (kWh)



High deviation in terms of production, resulting in a well reduced error



CASE STUDY : 13/02/2016

Example of Maisnières wind farm in northern France

Cumulated production over 24 hours the 13/02/2016 : **39 MWh**

➔ Error level : sum of the hourly absolute errors the day ahead

⇒ Expert : **30.9 MWh**

⇒ Forecast based on 'F1mm' : **45.4 MWh**

CASE STUDY : 13/02/2016

Conclusion :

- Meteorological expertise **is applied** :
 - ✓ **when uncertainties are high** (spatially : e.g. different low pressure systems trajectories and/or temporally : e.g. ramps or temporary peaks)
 - ✓ over **one single** wind farm or over **several wind farms** located in one region under the **same meteorological influence**.
 - ✓ by **'weighting'** different NWP, allowing an expertise at a **larger scale**
- At CNR, wind and solar energy forecasting is built on the meteorological experience acquired with its historical « hydro » activities

COMMUNICATION TO WIND FARM EXPLOITATION TEAM

CNR FORECASTING REPORT

Bulletin météo pour l'exploitation éolienne					Mise à jour du : vendredi 29 avril 2016
Zone NORD					
Echéance	Production/Vent	Risque Foudre	Risque Vent fort	Fiabilité	Commentaire
vendredi 29 avril 2016	+ ↘ -	Fort		Bonne	Faible risque orageux vendredi et samedi avec le passage d'une perturbation renforçant temporairement les vents.
samedi 30 avril 2016	- ↗ +	Fort		Bonne	
dimanche 1 mai 2016	-/+			Bonne	
lundi 2 mai 2016	-/+			Moyenne	
mardi 3 mai 2016	-			Moyenne	
mercredi 4 mai 2016	-/+			Faible	
jeudi 5 mai 2016	-/+			Faible	
Zone OUEST					
Echéance	Production/Vent	Risque Foudre	Risque Vent fort	Fiabilité	Commentaire
vendredi 29 avril 2016	-/+	Fort		Bonne	Vents globalement faible sur la période, avec de très faibles risques orageux isolés.
samedi 30 avril 2016	+	Fort		Bonne	
dimanche 1 mai 2016	-			Bonne	
lundi 2 mai 2016	-/+			Moyenne	
mardi 3 mai 2016	-			Moyenne	
mercredi 4 mai 2016	-/+			Faible	
jeudi 5 mai 2016	-/+			Faible	
Zone SUD					
Echéance	Production/Vent	Risque Foudre	Risque Vent fort	Fiabilité	Commentaire
vendredi 29 avril 2016	-/+			Bonne	Vent globalement faible aujourd'hui, en hausse à partir de samedi pour devenir fort dimanche avant de baisser très lentement en début de semaine prochaine.
samedi 30 avril 2016	+ ↗ ++			Bonne	
dimanche 1 mai 2016	++/+++		Fort	Bonne	
lundi 2 mai 2016	+++ ↘ ++		Fort	Moyenne	
mardi 3 mai 2016	++ ↘ +			Moyenne	
mercredi 4 mai 2016	+ / ++			Faible	
jeudi 5 mai 2016	+ / ++			Faible	
LEGENDE					
-	Puissance Conditions calmes [P(%)<5 ; V(m/s)<4]	Risque de foudre			
+	Conditions normales [5<P(%)<50 ; 4<V(m/s)<9]	Fort			
++	Conditions agitées [50<P(%)<90 ; 9<V(m/s)<12]	Faible			
+++	Conditions extrêmes [P(%)>90 ; V(m/s)>12]	Fort			
		Risque vent fort			
		Rafales > 100 km/h			
		Faible			
		Fort			

Qualitative wind speed forecast

Meteorological analysis (synopsis)
Qualitative lightning risk forecast

Qualitative high wind speed forecast



4. CONCLUSIONS

WHAT'S NEXT ?

CONCLUSIONS

Performance from our end-user point of view

- NWP's have improved...
- ...but more than further improvement, it could be worth working on very practical issues :
 - Providing hourly forecasts
 - Shortening supplying period after each run
 - Providing re-forecasts when updated
- No need for more than 3 good NWP sources
- Human expertise bring improvement in average, but has to be facilitated

Ongoing development / current interest

- Improvement of short-term wind power forecasting (doppler radar ? spatial nowcasting based on SCADA ?)
- Monitoring and assessment of human expertise
- Wind and solar ensemble forecasting
- Combined hydro, PV and wind energy production management studies

L'énergie au cœur des territoires

cnr.tm.fr

