Towards the use of EUMETNET observations in AROME-France

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Outline

- The AROME-France model

- Assimilation of OPERA radar data

- Assimilation of MODE-S/ADS-B aircraft data

- Ongoing and future activities

# AROME-France : main features (CY43T2)

- Spectral non-hydrostatic model

- SI-SL dynamical core

- Explicit deep moist convection
  (single moment cloud scheme)

- Horizontal resolution $\Delta x = 1.3$ km

- Vertical grid : 90 levels (up to 10 hPa)
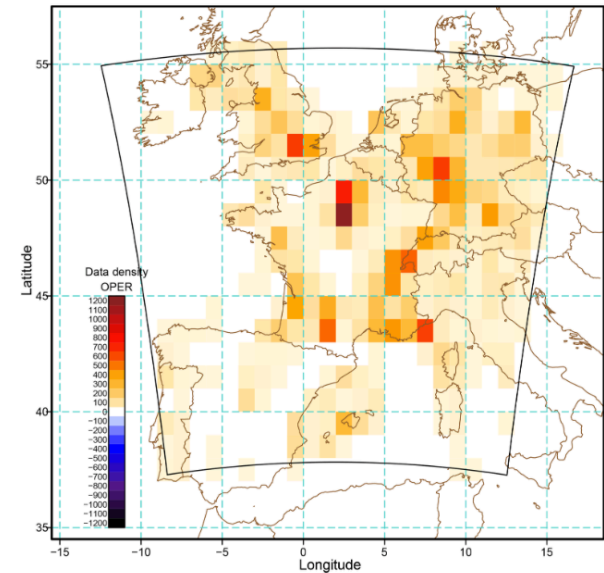
Density of E-AMDAR in May 2017
Doerenbecher & Mahfouf (2019) in ASR

- Incremental 3D-Var system @ 1.3 km
- Rapid Update Cycle : 1 h (since 2015)
- Forecast ranges from 42 to 48 h (00, 03, 06, 12, 18 UTC)
- Cuf-off times between 1 hour and 3 hours

Observations in AROME
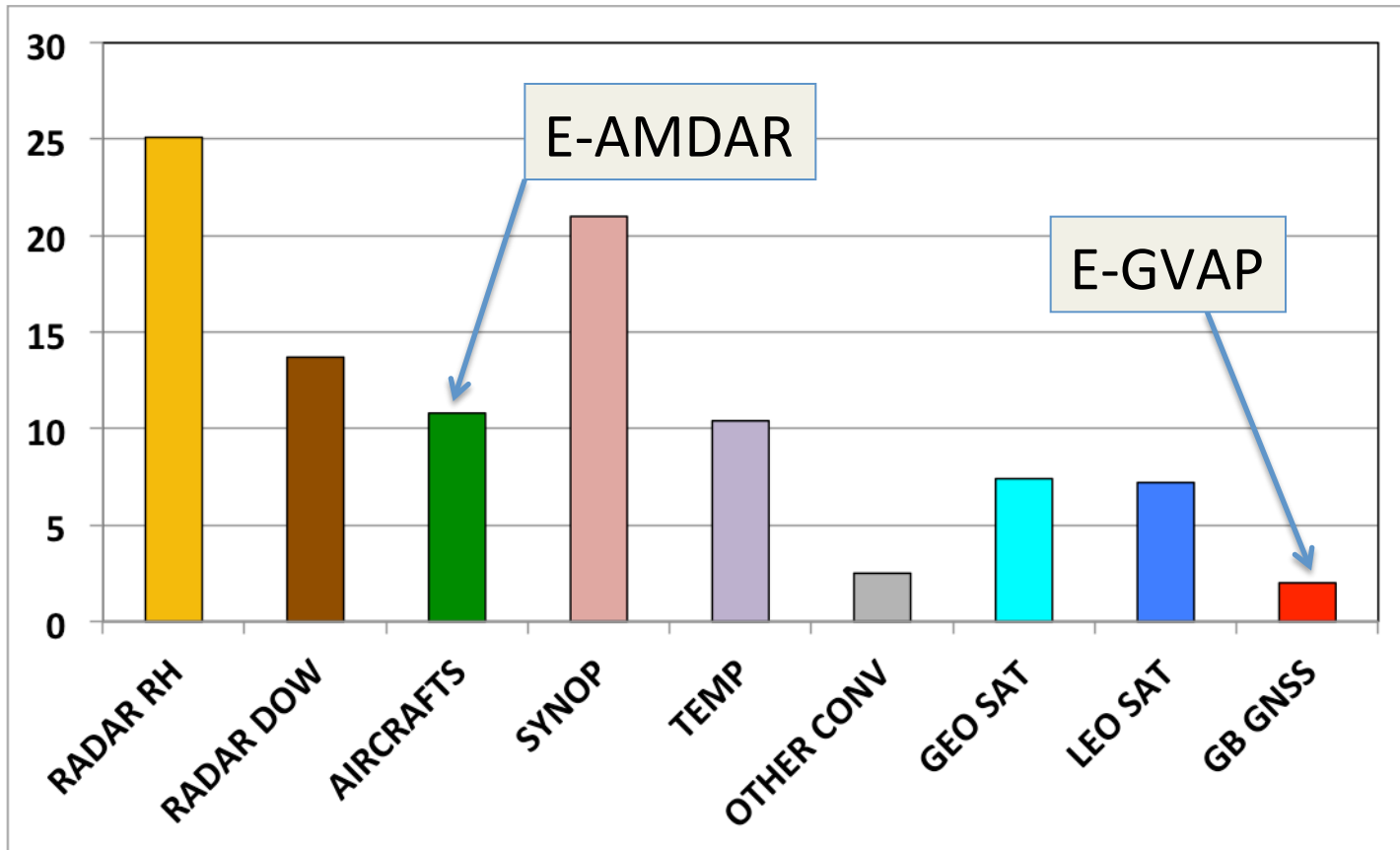
About 900 000 observations assimilated each day
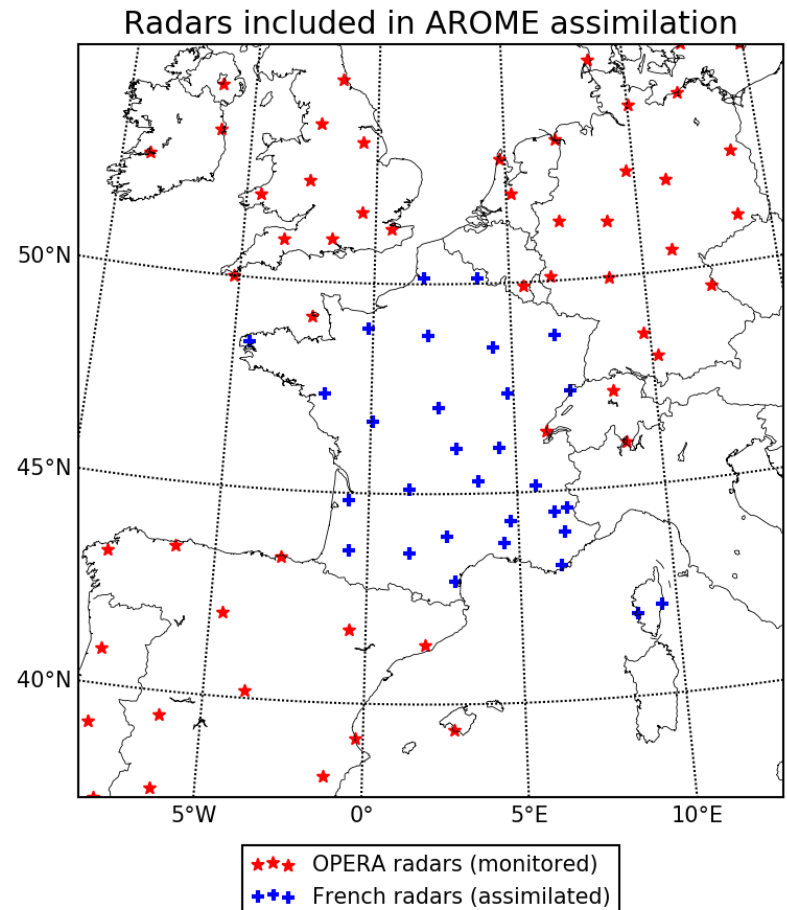
Assimilation of OPERA radar data

Current operational status :

- Assimilation of 30 French radars in terms of Doppler wind velocities & reflectivities (converted in RH profiles through Bayesian inversion)
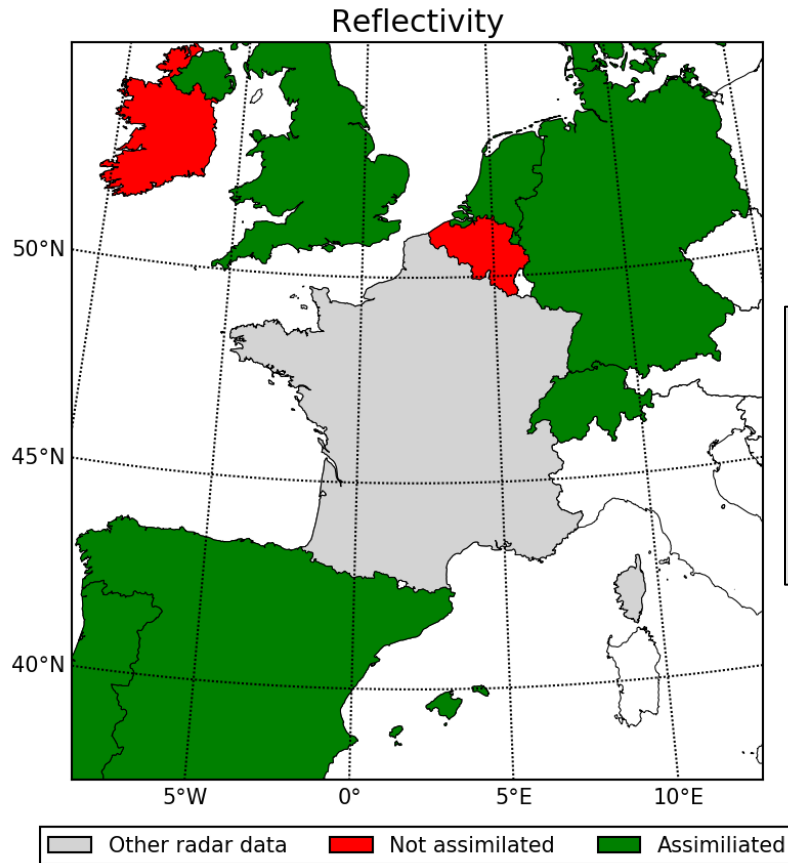
Data provided by MF : BUFR format, cartesian grid, V_{ny}=60 m/s, attenuation (masks and precipitation), echo types

- Monitoring of 62 European radars (since 2 July 2019)

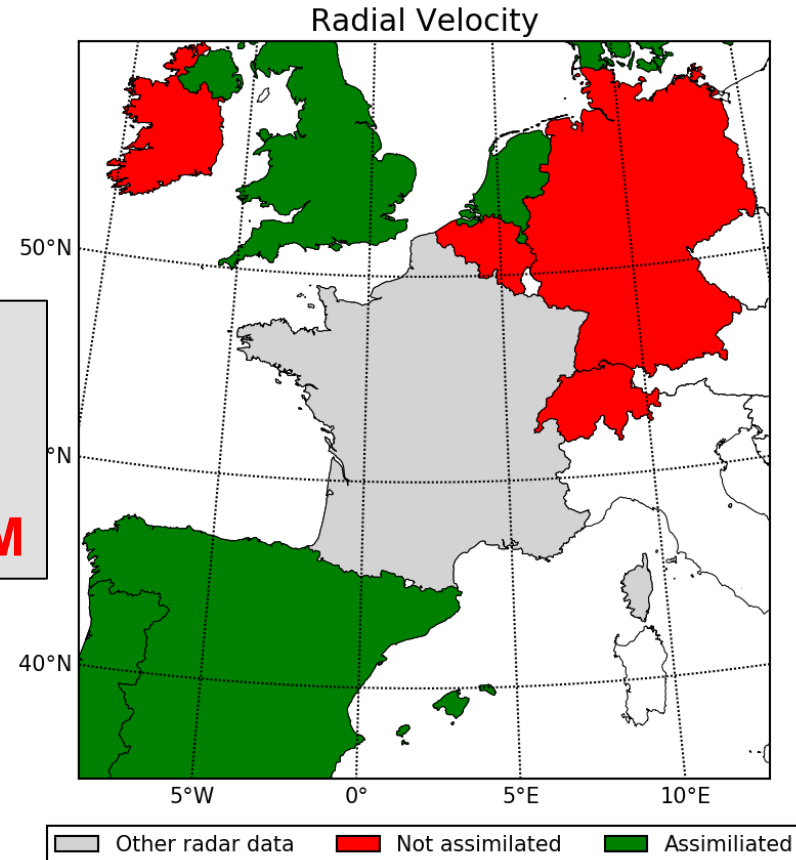*Data provided by MF (similar to OIFS) : ODIM HDF5, polar grid, availability of metadata (different according to country), quality index*

Radars included in AROME assimilation

★★★ OPERA radars (monitored)
+++ French radars (assimilated)

Assimilation of OPERA radar data

Reflectivity

Radial Velocity

Data Usage
ASSIM
NO ASSIM

Legend: Other radar data | Not assimilated | Assimiliated

Reflectivities not used when clear air echoes cannot be distinguished from « no rain » (e.g. TH not provided)
Doppler winds not used when Nyquist velocity is too low or not provided

Assimilation of OPERA radar data

Monitoring of background and analysis departures (of assimilated obs) for **RH retrievals** *and* **DOW**

- Better fit of analyses and subsequent backgrounds of RH retrievals against all radars

- Better fit of DOW background against all radars
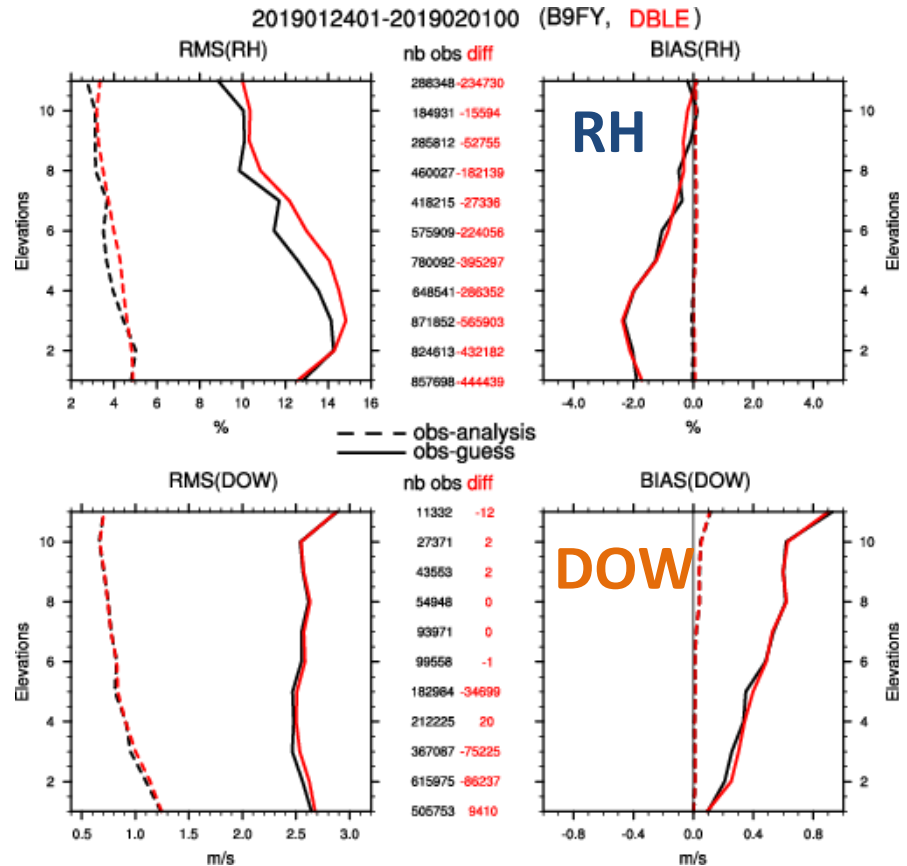
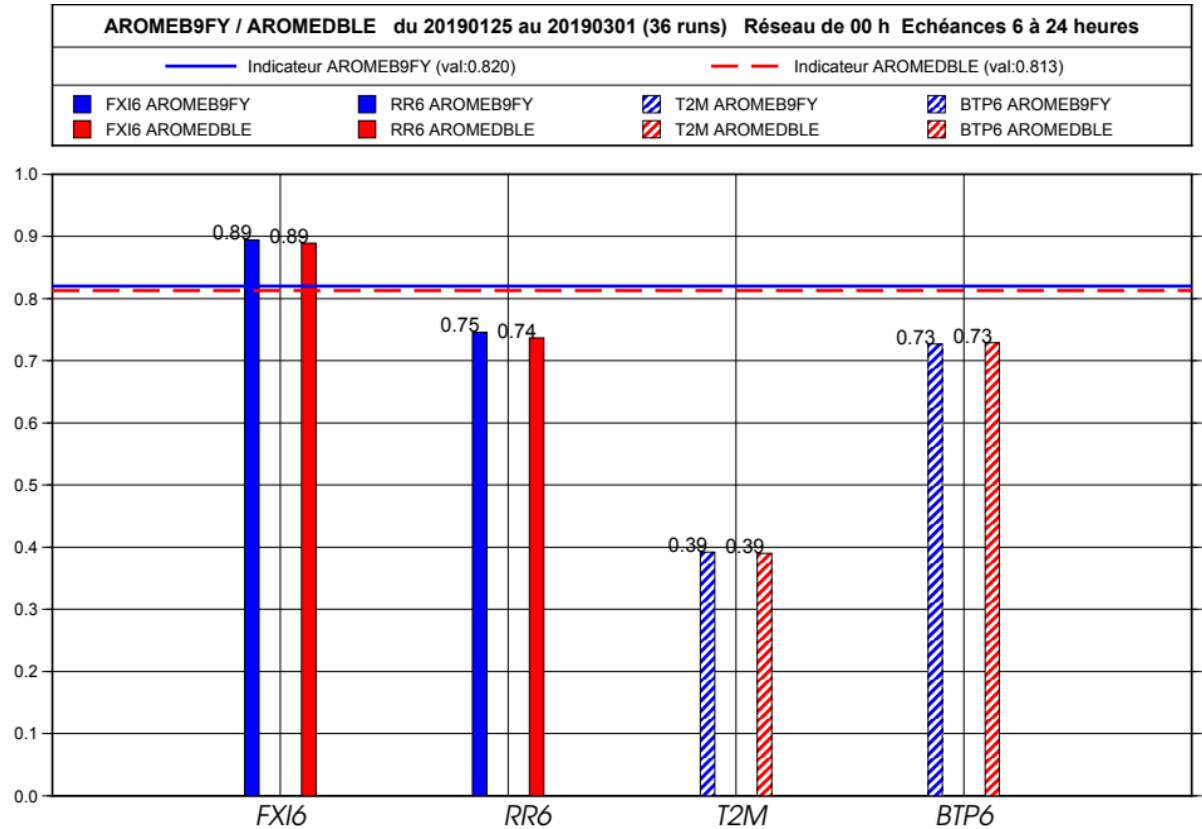Nb RH OPERA = Nb RH France

Nb DOW OPERA = 0.1 * Nb DOW France

Without OPERA radars
With OPERA radars

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Assimilation of OPERA radar data

Score indicateur = mean on thresholds and neighbourhoods of Brier Skill Scores against persistence

- Wind gust in 6 h (40, 60, 80 km/h) between 6 and 24 h forecast ranges – *FXI6*
- 6-h rainfall (0.5, 2 and 5 mm) – *RR6*
- *T2M* and SEVIRI Tbs (*BTP6*) also calculated

25/01/2019 – 01/03/2019 (36 days)

AROMEB9FY / AROMEDBLE du 20190125 au 20190301 (36 runs) Réseau de 00 h Echéances 6 à 24 heures

Indicateur AROMEB9FY (val:0.820)   Indicateur AROMEDBLE (val:0.813)

FXI6 AROMEB9FY   RR6 AROMEB9FY   T2M AROMEB9FY   BTP6 AROMEB9FY
FXI6 AROMEDBLE   RR6 AROMEDBLE   T2M AROMEDBLE   BTP6 AROMEDBLE

Météo–France Dprévi/COMPAS
Actualisé le 17/07/2019

Without OPERA
With OPERA

On the use of MODE-S/ADS-B data

Since 2017, Météo-France has :

- Installed a set of 7 ADS-B antennas over France to receive signals from commercial aircrafts

- Started collaborations with the French Civil Aviation to set-up an operational link to transfer MODE-S EHS reports in our database from a set of 12 radars (planned by the end of 2020)
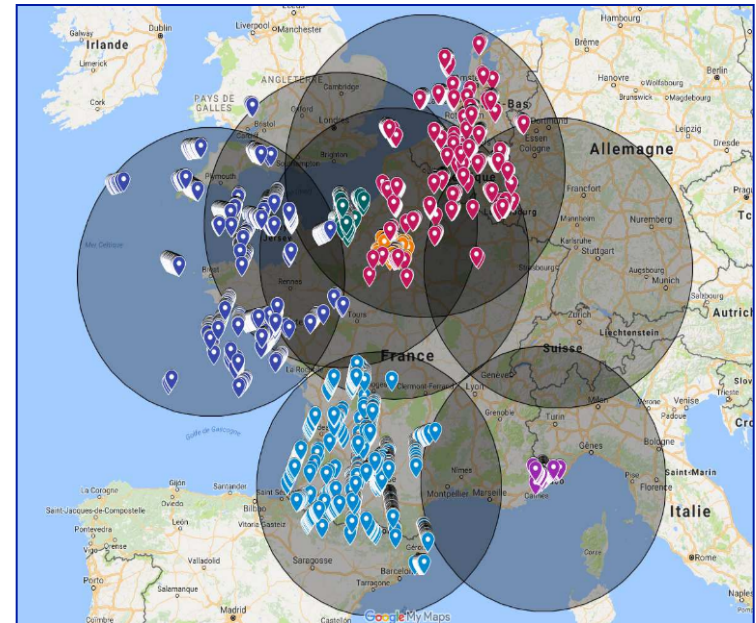
Feasibility studies have started to monitor and assimilate derived winds from ADS-B signals in AROME-France :
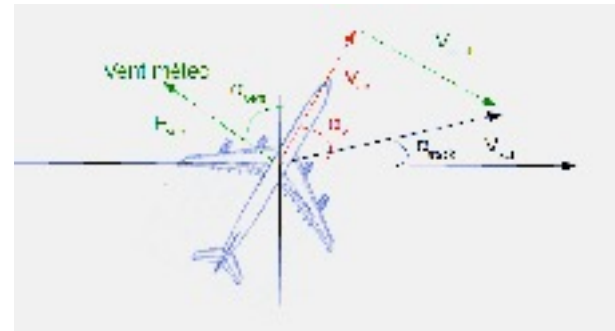
Main differences with AMDAR data :
- They are biased (heading) => need for a bias correction
- They are more numerous => redundancy checks, specific thinnings

MODE-S/ADS-B bias correction scheme

$$V = V_{ground} - V_{air}$$

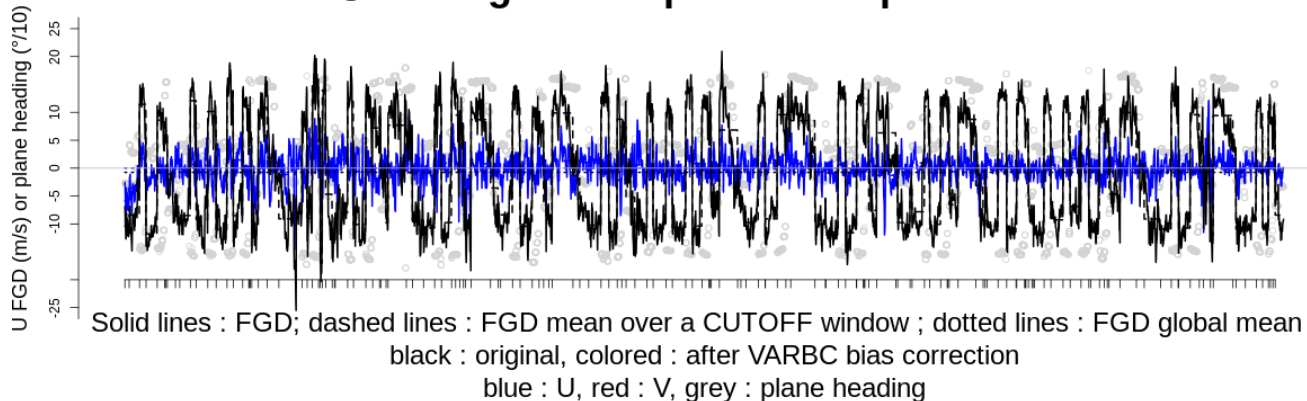$$u = u_g - V_a \sin(D_a)$$
$$v = v_g - V_a \cos(D_a)$$

$$\delta u = -V_a \cos(D_a)\, \delta D_a - \sin(D_a)\delta V_a$$
$$\delta v = V_a \sin(D_a)\, \delta D_a - \cos(D_a)\delta V_a$$

Development of a VarBC scheme with 2 predictors for :
- Heading bias correction
- Airspeed bias correction

## U   first guess departure for plane : 501D7D

Raw
Bias corrected

Solid lines : FGD; dashed lines : FGD mean over a CUTOFF window ; dotted lines : FGD global mean
black : original, colored : after VARBC bias correction
blue : U, red : V, grey : plane heading

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Monitoring statistics

Mean (O-B)	RMS (O-B)	Number	Origin
0.18	**4.54**	5 300 000	MODE-S (ADS/B) raw
0.17	**2.68**	5 300 000	MODE-S (ADS/B) bias corrected
0.04	**2.39**	2 200 000	MODE-S (EHS) MUAC
-0.05	**2.40**	400 000	AMDAR

Zonal wind component background departures (05/04/2018 -> 24/04/2018)

First assimilation results (1 month)
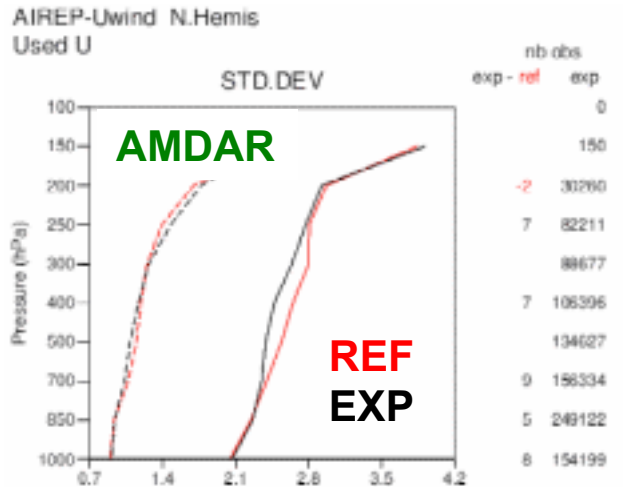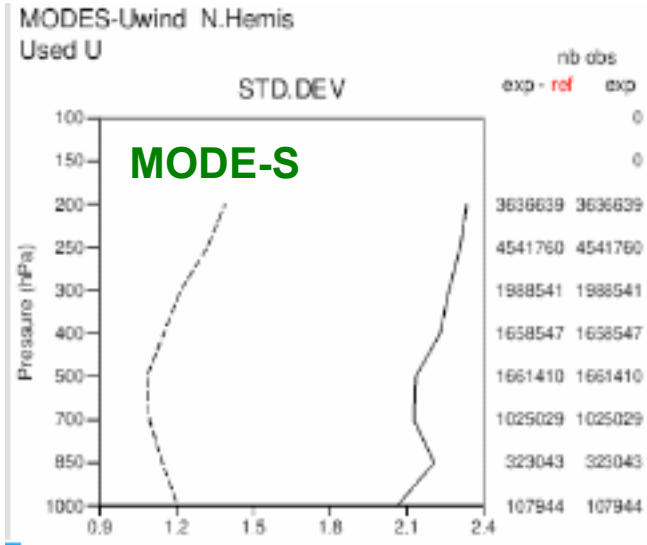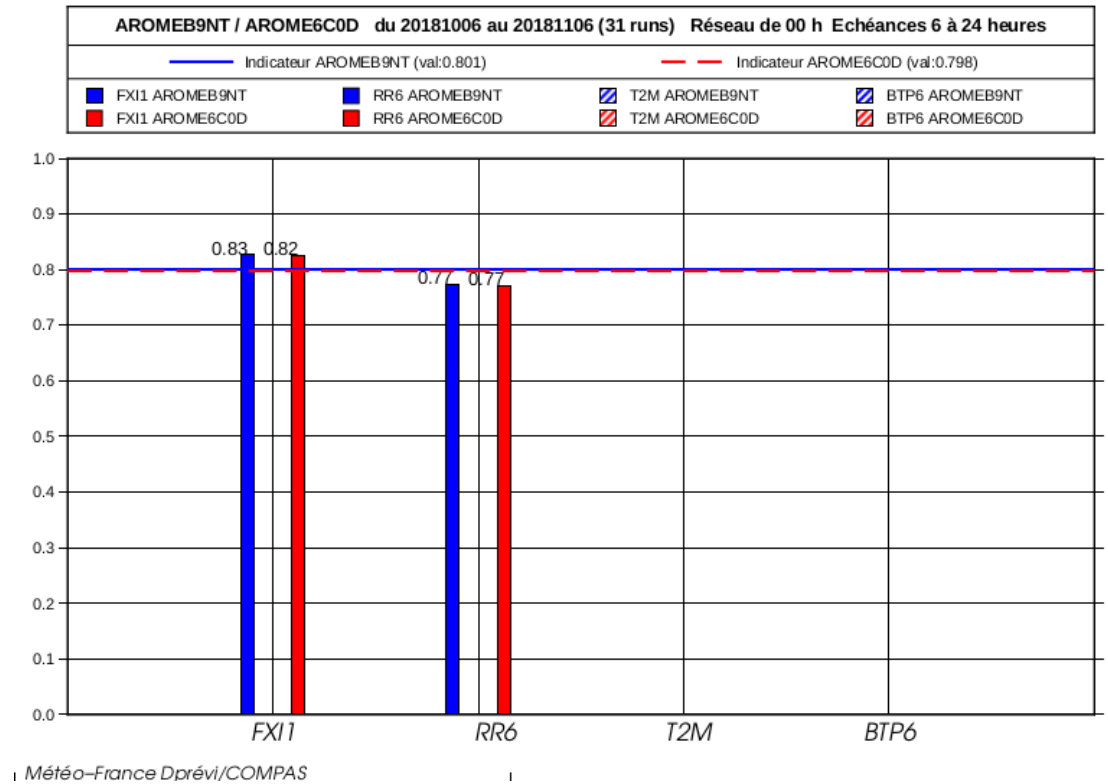
Ongoing and future activities

- After important technical and scientific developments @ MF, the assimilation of OPERA radar data in AROME-France will become operational in November 2019

- Current usage of OPERA data remains sub-optimal => what can we expect from OPERA 5 ? Importance of continuity

- Assimilation results of MODE-S (ADS/B) in AROME-France are encouraging: robust bias correction (VarBC), neutral results in terms of forecasts scores with AMDAR-like set-up (thinning @ 25 km – observation errors)

- Future activities : improved thinning methodology – use of MODE-S/EHS from French ATC SSR radars

- Interest in sharing MODE-S with other countries : EUMETNET E-ABO programme

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Thank you for your attention !